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LOOK BEFORE THE LNG LEAP:

Why Policymakers and the Public Need Fair Disclosure Before Exports of Fracked Gas Start

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Why Policymakers and the Public Need Fair Disclosure Before Exports of Fracked Gas Start

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EXECUTIVE SUMMARY

Exporting American natural gas to the world market would spur unconventional natural gas production across the country, increasing pollution and disrupting landscapes and communities. Deciding whether to move forward is among the most pressing environmental and energy policy decisions facing the nation. Yet, as the Department of Energy (DOE) considers whether to greenlight gas exports of as much as 45% of current U.S. gas production—more gas than the entire domestic power industry burns in a year—it has refused to disclose, or even acknowledge, the environmental consequences of its decisions. In fact, DOE has not even acknowledged that its own National Energy Modeling System can be used to help develop much of this information, instead preferring to turn a blind eye to the problem. DOE needs to change course. Even much smaller volumes of export have substantial environmental implications and exporting a large percentage of the total volume proposed would greatly affect the communities and ecosystems across America. The public and policymakers deserve, and are legally entitled to, a full accounting of these impacts.

Gas exports are only possible because of the unconventional natural gas boom which hydraulic fracturing ("fracking") has unlocked. DOE's own advisory board has warned of the boom's serious environmental impacts. DOE is charged with determining whether such exports are in the public interest despite the damage that would result. To do that, it needs a full accounting of the environmental impacts of increasing gas production significantly to support exports.

These environmental considerations include significant threats to air and water quality from the industry's wastes, and the industrialization of entire landscapes. Gas production is associated with significant volumes of highly-contaminated wastewater and the risk of groundwater contamination; it has also brought persistent smog problems to entire regions, along with notable increases in toxic and carcinogenic air pollutants. Regulatory measures to address these impacts have been inadequate, meaning that increased production very likely means increased environmental harm. Natural gas exports also have important climate policy implications on several fronts: Even if exported gas substitutes for coal abroad (which it may or may not do), it will not produce emissions reductions sufficient to stabilize the climate, and gas exports will increase our investment in fossil fuels. Moreover, the gas export process is particularly carbon-intensive, and gas exports will likely raise gas prices domestically, increasing the market share of dirty coal power, meaning that perceived climate benefits may be quite limited if they exist at all. The upshot is that increasing gas production comes with significant domestic costs.

The National Environmental Policy Act (NEPA) process is designed to generate just such an analysis. NEPA analyses, properly done, provide full, fair, descriptions of a project's environmental implications, remaining uncertainties, and alternatives that could avoid environmental damage. A full NEPA environmental impact statement looking programmatically at export would help DOE and the public fairly weigh these proposals' costs and benefits, and to work with policymakers at the federal, state, and local levels to address any problems. In fact, the U.S. Environmental Protection Agency has repeatedly called for just such an analysis.Without one, America risks committing itself to a permanent role as a gas supplier to the world without determining whether it can do so safely while protecting important domestic interests.

Equally troublingly, even as DOE has thus far failed to fulfill its obligation to protect the public interest

by weighing environmental impacts, it risks losing its authority altogether. A drafting quirk in the export licensing statute intended to speed gas imports from Canada means that DOE must grant licenses for gas exports to nations with which the United States has signed a free trade agreement which includes national treatment of natural gas. This rubber-stamp applies even if the proposed exports would not otherwise be in the public interest. As the U.S. negotiates a massive trade agreement which may include nations hungry for U.S. exports, the Trans-Pacific Partnership, this mandatory rubber-stamp risks undercutting DOE's ability to protect the public.

The bottom line is that before committing to massive gas exports, federal decisionmakers need to ensure that they, and the public, have the environmental information they need to make a fair decision, and the authority to do so. That means ensuring that a full environmental impact statement discloses exports' impacts and develops alternatives to reduce them. It also means defending DOE's prerogatives against the unintended effects of trade pacts. Congress and the U.S. trade negotiators must ensure that agreements like the Trans-Pacific Partnership are designed to maintain DOE's vital public interest inquiry.

Gas exports would transform the energy landscape and communities across the country. We owe ourselves an open national conversation to test whether they are in the public interest. We need to look before we leap.

I. Introduction

For the first time ever, the United States has the ability to become a major natural gas exporter, but that possibility comes with substantial economic and environmental risks. The huge volumes of natural gas proposed for export as liquefied natural gas (LNG) would raise domestic energy prices and require a significant expansion of unconventional gas production using hydraulic fracturing ("fracking").

This shift in the energy landscape raises serious questions: What will export-induced production mean for people living in the gas fields? What will it mean for utilities weighing coal and gas prices as they chart the future of their generation fleets? What it will mean for environmental regulators seeking to manage risk? What will it mean for our air and water quality? What will it mean for climate policy if we increase the extraction and use of this fossil fuel? In the end, are exports worth higher prices and more pollution from fracked gas?

The policy debate continues, but without crucial information: Incredibly, neither the Department of Energy ("DOE")'s Office of Fossil Energy nor the Federal Energy Regulatory Commission ("FERC"), which share responsibility over LNG export proposals under the Natural Gas Act, have completed a full assessment of the environmental risks associated with export and the expanded gas production needed to support it. The agencies could do so using publicly available information and modeling systems, but have so far refused, implausibly insisting that it is impossible to predict *any* upstream impacts from expanded LNG exports.

For more than forty years, Congress has directed federal agencies to use the National Environmental Policy Act (NEPA)'s environmental impact statement process to address environmental decisions like this one. The NEPA process allows agencies to generate comprehensive data, weigh alternatives, and expose assumptions to public scrutiny, so they can base decisions on a fully developed analysis of the impacts of a proposed activity. Amidst the ongoing raucous public debate on export, the information NEPA can provide is not just legally required, but sorely needed.

DOE and FERC have failed to provide this critical analysis. Only one LNG export proposal, for a terminal at Sabine Pass on the Louisiana-Texas border, has moved most of the way through the federal licensing process. FERC, which focuses largely on terminal siting, refused to consider any of the upstream consequences of Sabine Pass's plan to export 2.2 billion cubic feet of gas every day.[2] It did so even though Sabine Pass's export application trumpets that the project intends to "play an influential role in contributing to the growth of natural gas production in the U.S." and relies substantially on this point to argue that the project is in the public interest.[3] DOE followed suit, adopting FERC's analysis to support its own public interest determination, while maintaining that the induced gas production necessary to support export is not

[2] FERC, *Order Granting Section 3 Authorization [to Sabine Pass]*, 139 FERC ¶ 61,039 (Apr. 16, 2012).
[3] Sabine Pass Export Application at 56, DOE/FE Docket 10-111-LNG (Sept. 7, 2010).

"reasonably foreseeable," and so warrants no consideration.[4] DOE recently announced that it would take time to consider whether to stand by this decision, but it has not yet reversed course.[5]

Thus, even while authorizing a proposal which, on its own, would increase U.S. gas exports by more than 50% annually,[6] and which explicitly relies on increased natural gas production to support itself, the federal decisionmakers charged with protecting the public interest were asleep at the switch. Even though export proponents themselves advertise that their projects will drive unconventional natural gas production, DOE and FERC are willfully blind to this major impact. This position is particularly untenable because the National Energy Modeling System (NEMS) which the Energy Information Administration ("EIA") within DOE administers, is designed to project changes in gas production caused by new demand, and could therefore predict precisely the production-level impacts which DOE and FERC insist cannot be foreseen at all.[7]

Instead, applications to export more than ten times the gas which was authorized in the Sabine Pass matter are moving forward in a piecemeal terminal-by-terminal licensing process which has not provided any meaningful analysis of the national and regional environmental challenges linked to export. This ongoing legal and policy failure warrants immediate correction.

Not only have DOE and FERC failed to provide a proper accounting, they may lose even their authority to do so if a controversial trade agreement now under negotiation is finalized. That deal, the Trans-Pacific Partnership ("TPP"), could further liberalize trade with much of the Pacific Rim, including major natural gas importers like Japan. Thanks to a little-known provision of the Natural Gas Act, it could also remove federal oversight of LNG exports. Twenty years ago, in an effort to speed Canadian gas *imports*, Congress provided that LNG shipments between countries with which the U.S. has a free trade agreement were to be automatically granted. Although Congress never anticipated massive LNG exports, that same provision could nonetheless remove DOE and FERC's discretion to weigh whether huge volumes of export are in the public interest, or to meaningfully regulate the process. Yet neither agency has insisted that TPP negotiators protect this critical federal authority.

For communities across the country, therefore, the future is in real question. If LNG export goes forward, they will experience a surge of unconventional new gas production, along with all

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[4] DOE, *Final Opinion and Order Granting Long-Term Authorization to Export Liquefied Natural Gas from Sabine Pass LNG Terminal to Non-Free Trade Agreement Nations*, FE Docket No. 10-111-LNG (Aug. 7, 2012).

[5] *See* DOE, *Order Granting Rehearing for Further Consideration*, FE Docket No. 10-111-LNG (Oct. 5, 2012).

[6] *See* EIA, *U.S. Natural Gas Imports & Exports 2011* (July 18, 2012). The U.S. now exports about 1,500 billion cubic feet "bcf" of natural gas annually, with the vast majority travelling by pipeline to Mexico and Canada. Sabine Pass would export 2.2 bcf/day, or 803 bcf annually.

[7] *See, e.g.*, EIA, *The National Energy Modeling System: An Overview* (2009) at 54-55 (explaining that NEMS contains "play-level" production models for each unconventional natural gas play and projects production based on demand); 59-62 (transmission and distribution module of NEMS allocates demand based through modeling the transmission network and can account for imports and exports).

the environmental burdens of the boom that are outlined below. If DOE and FERC do not analyze and disclose these impacts, neither they or state and local governments can weigh whether they are in the public interest, or take action to lessen them. And if the TPP and pacts like it are signed without due reflection and before a full NEPA environmental impact statement is available, the U.S. will be locked into a future of gas export without ever having considered the cost.

It is not yet too late to change course. DOE has committed not to release any more export licenses until an economic study has been finalized, which will not occur until this winter. Negotiations for the TPP have not concluded. FERC has not sited any more new terminals. So, although the United States has begun to edge into exports, that future has not yet been chosen. Cooler heads can still prevail, and decisionmakers can develop the information we and they so clearly need.

II. The Magnitude of the Export Boom

Even if only some of the 19 export projects now before DOE are approved, they would, once operational, transform the domestic energy market and greatly increase unconventional natural gas production. There is no domestic precedent for changes of the magnitude which DOE is now considering.

Before the shale gas boom began, the U.S. exported almost no gas beyond Canada and Mexico, and even those North American exports were not very large. In 2006, for instance, the U.S. exported a total of 723.9 bcf per year of natural gas, with 663 of that by pipeline.[8] Only the remaining approximately 60 bcf per year are exported as LNG, essentially all of it going to Japan from a single Alaskan terminal, with a few bcf to Mexico by truck.[9] Policymakers largely assumed that this pattern would continue, urging that the U.S. develop gas *import* capacity to accommodate growing domestic demand.[10]

The situation now is very different. Projections of abundant domestic natural gas from unconventional, largely shale, plays has dropped domestic gas prices to record lows while prices abroad remain high. As a result, U.S. pipeline exports have risen, pushing total exports over 1,500 bcf per year (or about 4 bcf per day), and investors have flooded DOE with an ever-growing number of export proposals. As of late October 2012, the 19 different export projects before DOE proposed to export as much as 28.39 bcf *per day* of LNG.[11] Of this, 23.71 bcf per day was proposed for export to countries with which the U.S. has not signed a free trade

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[8] EIA, U.S. Natural Gas Exports by Country, *available at*: http://www.eia.gov/dnav/ng/ng_move_expc_s1_a.htm.
[9] *See id.*
[10] *See, e.g.*, National Petroleum Council, *Balancing Natural Gas Policy: Fueling the Demands of a Growing Economy* at 36-40 (2003)
[11] Department of Energy Office of Fossil Energy, *Applications Received by DOE/FE to Export Domestically Produced LNG from the Lower-48 States (as of October 26, 2012)*, available at http://www.fossil.energy.gov/programs/gasregulation/reports/Long_Term_LNG_Export_10-26-12.pdf. Other proposals to export at least 2.5 bcf/d of LNG have also been reported, but have not yet been filed with DOE.

agreement providing for national treatment of natural gas; DOE has clear authority to disapprove such proposals if they are not in the public interest.

How much gas is 28.39 bcf per day? It is equivalent to 10,362 bcf per year. By comparison, the entire country produced just 23,000 bcf in 2011, meaning that exports equivalent to about 45% of domestic production are now before DOE.[13] Exporting this much gas would be bound to strongly affect domestic gas production and consumption patterns. For example, the country consumed 24,316 bcf of gas last year – slightly more than it produced, with imports making up much of the difference.[14] Dedicating forty percent of U.S. gas production to export would, therefore, cause big shifts in the domestic market. The amount of gas slated for export is considerably more than the 7,602 bcf that the entire electric power sector used last year, and nearly twice as much gas as was used for electricity by every home in the country.[15] If this amount of gas is exported, the United States must produce more gas, use less, or do both.

The Energy Information Administration ("EIA") has come to just that conclusion in a DOE-commissioned January 2012 report, which estimated that about two-thirds (63%) of export demand will be met by increased production, rather than by decreases in gas consumption elsewhere in the economy.[16] That new production, in turn, will come almost entirely (93%) from unconventional gas plays, and so will be produced by fracking.[17]

Thus, if the DOE authorizes all of the 10,362 bcf of exports now before it, about 63% of that exported gas, or 6,5282 bcf, would likely be from new production, and 6,397 bcf of that new production would be fracked gas. Total domestic gas production would increase by 27%.

To be sure, there are legitimate questions as to the real scope of the export boom. The global LNG market may be hungry for U.S. gas, but limits on near-term demand and regasification capacity may mean that not every export terminal will be built, or operate at capacity. On the other hand, the scramble for export licenses shows no signs of diminishing. In fact, the pace and intensity of this export boom seems to have caught decisionmakers by surprise. In January 2012, DOE and the EIA assumed that exports of 12 bcf/d were at the high end of possible export futures.[18] Export applications for more than double that volume have now been lodged with DOE. The "high end" scenario now looks decidedly mid-range compared to pending applications.[19]

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[13] EIA, Natural Gas Monthly November 2012, Table 1 (volume reported is dry gas).
[14] *Id.*, Table 2.
[15] *Id.* (electric power sector gas use in 2011 was 7,602 bcf; residential use was 4,730 bcf).
[16] EIA, *Effects of Increased Natural Gas Exports on Domestic Energy Markets* (Jan. 2012) at 6, 10-11.
[17] *Id.* at 11.
[18] EIA, *Effects of Increased Natural Gas Exports on Domestic Energy Markets* at 1.
[19] In its Annual Energy Outlook for 2012, EIA very conservatively projects that only 2.2 bcf/d of LNG will be exported by 2035, noting that this projection is subject to considerable regulatory uncertainty. *See* EIA, *Annual Energy Outlook* (2012) at 94. This amount would correspond to about a 470 bcf annual increase in unconventional natural gas production – about a 2% national increase. Notably, the 2.2 bcf of annual LNG export EIA conservatively projects are equivalent to the export proposed by the Sabine Pass facility which DOE has already all

Moreover, even a much smaller gas export increase would still mean major changes in the U.S. gas market. If only one-quarter of the proposed projects move forward, about 6 bcf/d of gas would still be exported – the equivalent of 2,190 bcf annually. That demand would, in turn, be accompanied by about 1,172 bcf of new unconventional gas production if the EIA is correct, increasing U.S. gas production overall by 5%.

Proposed export terminal sites are on all three U.S. sea coasts. Most applications are focused on the Gulf Coast, but applicants have also filed to export from Atlantic coastal sites in Maryland and Georgia and from Pacific coastal sites in Oregon. Between the terminals themselves, the pipelines required to feed them with gas, the barge traffic they will engender and, of course, the fracking boom they will support and extend, few regions of the United States will be untouched by LNG export.

III. Environmental Implications of Export

Producing and exporting large volumes of natural gas will have significant environmental implications that are best evaluated in the NEPA process with an Environmental Impact Statement. The urgency of a comprehensive look is clear from an examination of a subset of those effects: impacts associated directly with increasing gas production, impacts from changes in the gas market associated with export, and impacts associated with export itself, particularly its implications for climate change.

A. The Environmental Impacts of Increased Unconventional Gas Production

While the DOE's Office of Fossil Energy continues to consider pending export applications, the Secretary of Energy Advisory Board has been sounding the alarm about the fracking process on which export depends. Its Shale Gas Production Subcommittee issued a detailed set of recommendations in late 2011, emphasizing that a substantially enhanced regulatory and research effort is needed to ensure that unconventional natural gas production can move forward safely.

The Subcommittee, composed of nationally-regarded independent experts, wrote that it "believes that if action is not taken to reduce the environmental impact accompanying the very considerable expansion of shale gas production expected across the country – perhaps as many as 100,000 wells over the next several decades – there is a real risk of serious environmental consequences causing a loss of public confidence that could delay or stop this activity."[20] As of late 2011, the Subcommittee warned that "progress to date is less than the Subcommittee

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but approved. The EIA projection thus functionally assumes that *none* of the other projects now before DOE are built. While that might occur, it is obviously prudent to consider the impacts of other projects.

[20] Secretary of Energy Advisory Board Shale Gas Production Subcommittee ("SEAB"), *Second-Ninety Day Report* (Nov. 18, 2011) at 10.

hoped."[21] It cautioned that "some concerted and sustained action is needed to avoid excessive environmental impacts of shale gas production and the consequent risk of public opposition to its continuation and expansion."[22]

As the Subcommittee recognized, the impacts of unconventional gas production stretch across multiple mediums and contexts. Its recommendations identify areas for improvement in managing air pollution, water pollution, subsurface contamination, land use, and community impacts.[23] The Subcommittee also issued an urgent call for improved transparency and disclosure throughout the process, and for greatly enhanced research and development to better understand and improve production processes.[24]

Significant environmental impacts associated with unconventional natural gas production, and hence with export, include the following:

Air Pollution

Natural gas production has significant air quality impacts. As the DOE's Shale Gas Subcommittee summarized the matter last August:

> Shale gas production, including exploration, drilling, venting/flaring, equipment operation, gathering, accompanying vehicular traffic, results in the emission of ozone precursors (volatile organic compounds (VOCs), and nitrogen oxides), particulates from diesel exhaust, toxic air pollutants and greenhouse gases (GHG), such as methane.
>
> As shale gas operations expand across the nation these air emissions have become an increasing matter of concern at the local, regional and national level. Significant air quality impacts from oil and gas operations in Wyoming, Colorado, Utah and Texas are well documented, and air quality issues are of increasing concern in the Marcellus region (in parts of Ohio, Pennsylvania, West Virginia and New York).[25]

The tight link between gas production and ground-level ozone, or smog, is a particularly pressing problem. The gas industry is a major source of two major ozone precursors: VOCs and NO_x.[26] Smog harms the respiratory system and has been linked to premature death, heart

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[21] *Id.*
[22] *Id.*
[23] *Id.* at Annex C.
[24] *Id.*
[25] SEAB, *First Ninety Day Report* (August 18, 2011) at 15.
[26] *See, e.g.,* Al Armendariz, *Emissions from Natural Gas Production in the Barnett Shale Area and Opportunities for Cost-Effective Improvements* (Jan. 26, 2009), *available at* http://www.edf.org/documents/9235_Barnett_Shale_Report.pdf (hereinafter "Barnett Shale Report").

failure, chronic respiratory damage, and premature aging of the lungs.[27] Smog may also exacerbate existing respiratory illnesses, such as asthma and emphysema, or cause chest pain, coughing, throat irritation and congestion. Children, the elderly, and people with existing respiratory conditions are the most at risk from ozone pollution.[28]

As a result of significant VOC and NO_x emissions associated with oil and gas development, numerous areas of the country with heavy concentrations of drilling are now suffering from serious ozone problems. For example, the Dallas Fort Worth area in Texas is home to substantial oil and gas development. Within the Barnett shale region, as of July 2012, there were 16,213 gas wells and another 2,764 wells permitted.[29] Of the nine counties surrounding the Dallas Fort Worth area that EPA has designated as in "nonattainment" with national air quality standards for ozone, five contain significant oil and gas development.[30] A 2009 study found that summertime emissions of smog-forming pollutants from gas production in these counties were roughly comparable to emissions from all the cars in those same areas.[31] These nonattainment designations are particularly striking because the current ozone standard is set below the level EPA's own scientific advisors recommend as adequate to protect public health.[32] That gas production emissions can cause violations even of this relatively *lax* standard underlines their severity.

Oil and gas development has also brought serious ozone pollution problems to rural areas, such as western Wyoming.[33] On March 12, 2009, the governor of Wyoming recommended that EPA designate Wyoming's Upper Green River Basin as an ozone nonattainment area under EPA's current ozone.[34] The Wyoming Department of Environmental Quality conducted an extended assessment of the ozone pollution problem and found that it was "primarily due to local emissions from oil and gas . . . development activities: drilling, production, storage, transport, and treating."[35] In the winter of 2010-2011, the residents of Sublette County suffered thirteen

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[27] *See, e.g.*, Jerrett *et al.*, *Long-Term Ozone Exposure and Mortality*, New England Journal of Medicine (Mar. 12, 2009), *available at* http://www.nejm.org/doi/full/10.1056/NEJMoa0803894#t=articleTop.

[28] *See* EPA, *Ground-Level Ozone, Health Effects*, *available at* http://www.epa.gov/glo/health.html; EPA, Nitrogen Dioxide, Health, available at http://www.epa.gov/air/nitrogenoxides/health.html.

[29] Texas Railroad Commission, http://www.rrc.state.tx.us/data/fielddata/barnettshale.pdf (Accessed Sept. 25, 2012).

[30] Barnett Shale Report at 1, 3.

[31] *Id.* at 1, 25-26.

[32] *See,e.g.*, Elizabeth Shogren, NPR, *EPA Seeks to Tighten Ozone Standards* (July 24, 2011) (when EPA set the current standards it "ignored the advice of its own panel of outside scientific advisers"). EPA has since opted not to immediately update the out-dated standards, but revisions may be forthcoming next year.

[33] Schnell, R.C, et al. (2009), "Rapid photochemical production of ozone at high concentrations in a rural site during winter," *Nature Geosci.* 2 (120 – 122). DOI: 10.1038/NGEO415.

[34] *See* Letter from Wyoming Governor Dave Freudenthal to Carol Rushin, Acting Regional Administrator, USEPA Region 8, (Mar. 12, 2009) ("Wyoming 8-Hour Ozone Designation Recommendations"), *available at* http://deq.state.wy.us/out/downloads/Rushin%20Ozone.pdf; Wyoming Department of Environmental Quality, Technical Support Document I for Recommended 8-hour Ozone Designation of the Upper Green River Basin (March 26, 2009) ("Wyoming Nonattainment Analysis"), at vi-viii, 23-26, 94-05, *available at* http://deq.state.wy.us/out/downloads/Ozone%20TSD_final_rev%203-30-09_jl.pdf.

[35] Wyoming Nonattainment Analysis at viii.

days with ozone concentrations considered "unhealthy" under EPA's current air-quality index, including days when the ozone levels exceeded the worst days of smog pollution in Los Angeles.[36]

As oil and gas production moves into new areas ozone problems are likely to follow. For example, regional air quality models predict that gas development in the Haynesville shale will increase ozone pollution in northeast Texas and northwest Louisiana and may lead to violations of ozone air quality standards.[37] Experts also anticipate air quality problems associated with development of the Marcellus shale in the Mid-Atlantic region.[38]

Ozone pollution is not the only danger associated with natural gas production, however. Toxic air emissions are also a significant concern. Emissions from gas fields contain carcinogenic compounds, including benzene, which are associated with significant increases in cancer risk. In fact, Colorado researchers sampling the air near a field there recently determined that residents living within half a mile of from wells were at increased risk of cancer, compared to those living further away, due to long-term exposure to toxic leaks.[39] As the industry expands, this toxic problem will come with it.

In addition to these serious problems, the industry poses a significant threat to the global climate. The natural gas industry is also among the very largest sources of methane pollution in the country. Methane is a potent greenhouse gas, and these emissions rank the industry as the second largest industrial greenhouse gas source, second only to power production.[40] Because fracking operations tend to produce substantially more methane, and are also supporting new well development across the country, unconventional natural gas production is increasing these emissions. EPA has recently estimated annual industry methane emissions as the equivalent of 328 million metric tons of CO_2.[41]

This pollution will remain a serious danger even though EPA has recently finalized its first attempt at comprehensive air pollution controls for the industry.[42] While these standards will

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[36] EPA, *Daily Ozone AQI Levels in 2011 for Sublette County, Wyoming*, *available at* http://www.epa.gov/cgi-bin/broker?msaorcountyName=countycode&msaorcountyValue=56035&poll=44201&county=56035&msa=-1&sy=2011&flag=Y&_debug=2&_service=data&_program=dataprog.trend_tile_dm.sas.; *see also* Wendy Koch, *Wyoming's Smog Exceeds Los Angeles' Due to Gas Drilling*, USA Today, *available at* http://content.usatoday.com/communities/greenhouse/post/2011/03/wyomings-smog-exceeds-los-angeles-due-to-gas-drilling/1.

[37] *See* Kemball-Cook et al., *Ozone Impacts of Natural Gas development in the Haynesville Shale* 44 Environ. Sci. Technol. 9357, 9362 (Nov. 18, 2010).

[38] Elizabeth Shogren, *Air Quality Concerns Threaten Natural Gas's Image*, National Public Radio (June 21, 2011), *available at* http://www.npr.org/2011/06/21/137197991/air-quality-concerns-threaten-natural-gas-image.

[39] *See generally* Lisa McKenzie *et al.*, *Human health risk assessment of air emissions from development of unconventional natural gas resources*, Sci. Total Environment (May 2012), *abstract available at*: http://www.ncbi.nlm.nih.gov/pubmed/22444058.

[40] *See* EPA, Inventory of US Greenhouse Gas Emissions and Sinks 1990-2010 (2012).

[41] *See* 74 Fed. Reg. 52,738, 52,756 (Aug. 23, 2011).

[42] *See* 77 Fed. Reg. 49,490 (Aug. 16, 2012).

play a significant role in reducing air pollution from new infrastructure, many new sources and existing infrastructure escape regulation. Moreover, the standards do not regulate methane directly. As a result, air pollution from production will continue to be a serious problem, despite this important first regulatory effort.

Water Pollution

Much public concern over expanded fracking operations has focused on water pollution, and with good reason. Significant water resource impacts can occur throughout the production process.

Fracking requires large volumes of water per well. While operators have sought to reduce their water demands in some areas, numerous sources indicate that fracturing a single well requires at least 1 to 5 million gallons of water.[43] Water withdrawals can harm aquatic ecosystems and human communities by reducing instream flows—especially in small headwaters streams -- and by harming aquatic organisms at water intake structures.[44] Where water is withdrawn from aquifers rather than surface sources, withdrawal risks permanent depletion.[45] Withdrawals for fracking pose a greater risk than other withdrawals, because fracking is a consumptive use. Fluid injected during the fracking process is ideally deposited below freshwater aquifers and into sealed formations, so much of it never returns to the surface.

The well-site management of fracking fluid and wastes, including flowback water, poses water quality risks throughout the process. Spills at the surface, leaks through well casings, and contaminant migration from the fracking site itself can all contaminate ground and surface water.

Fracturing fluid itself contains many chemicals that present health risks. Diesel fuel and similar compounds pose particularly pressing risks. The DOE Subcommittee singled out diesel for its harmful effects and recommended that it be banned from use as a fracturing fluid additive.[46] The minority staff of the House Committee on Energy and Commerce determined that despite diesel's risks, between 2005 and 2009, "oil and gas service companies injected 32.2 million gallons of diesel fuel or hydraulic fracturing fluids containing diesel fuel in wells in 19 states."[47]

Fracking fluids are not the only source of potential contamination.[48] Fluid naturally occurring in the target formation "may include brine, gases (e.g. methane, ethane), trace metals, naturally occurring radioactive elements (e.g. radium, uranium) and organic compounds." [49] Inadequate

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[43] *See, e.g.*, SEAB, *First Ninety-Day Report* at 19; NY RDSGEIS 6-10.
[44] NY RDSGEIS at 6-3, 6-4.
[45] *Id.* 6-5; SEAB, *First Ninety Day report* at 19 ("[I]n some regions and localities there are significant concerns about consumptive water use for shale gas development.").
[46] *Id.* at 25.
[47] Letter from Reps. Waxman, Markey, and DeGette to EPA Administrator Lisa Jackson (Jan. 31, 2011) at 1.
[48] NY RDSGEIS at 5-75 to 5-78
[49] SEAB *First Ninety-Day Report* at 21.

well cementing, among other faults, can allow these substances to contaminate groundwater resources.[50] Storage, transport, and treatment of produced water on the surface create risks of spills and inadequate disposal, providing another vector for contamination of surface and groundwater resources.[51]

Properly treating these waste products, and other production waste, is essential to protecting water quality. Limited treatment capacity and the challenges of safely using underground injection as an alternative disposal method for large volumes of waste are pressing problems. Treating and discharging extremely salty, highly-contaminated wastewater is energy-intensive and technically difficult, and can put surface streams at risk. Meanwhile, injection also faces challenges, as not all regions have substantial injection capacity and injection wells themselves have been associated with earthquakes of up to 4.0 on the Richter scale.[52]

Finally, sediment contamination associated with the significant land disturbance and construction activities needed to construct and manage a well field is a persistent challenge. Run-off from production sites can readily contaminate streams without careful management.

Incidents of water contamination from various phases of the production process have been widely reported. Although EPA, other federal agencies and some states have begun to move forward with regulatory responses, many of these challenges remain unresolved. Thus, increased gas production for export will be accompanied by increasing risks of water pollution.

Land and Community Impacts

Intense gas production can transform entire regions. The gas boom means hundreds of thousands of new wells, along with the vast infrastructure of roads, pipelines, and support facilities they require. This landscape-level industrialization can transform formerly rural areas into vast construction sites, with thousands of trucks moving down an expanding webwork of gravel roads. This landscape change, too, is a significant environmental impact of increasing gas production.

The scope of potential change is great. Each well pad alone occupies roughly 3 acres, and associated infrastructure (roads, water impoundments, and pipelines) more than doubles this figure.[53] Many of these acres remain disturbed through the life of the well, estimated to be 20 to 40 years.[54] This directly disturbed land is generally no longer suitable as wildlife habitat. *Id.* at 6-68. In addition to this direct disturbance, indirect habitat loss occurs as areas around the directly disturbed land lose essential habitat characteristics. As New York regulators, for

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[50] *Id.* at 20.
[51] *See* NY RDSGEIS at 1-12 (describing risks of fluid containment at the well pad).
[52] *See, e.g.*, Columbia University, Lamont-Doherty Earth Observatory, *Ohio Quakes Probably Triggered by Waste Disposal Well, Say Seismologists* (Jan. 6, 2012); Alexis Flynn, *Study Ties Fracking to Quakes in England*, Wall Street Journal (Nov. 3, 2011).
[53] NY RDSGEIS at 5-5.
[54] *Id.* at 6-13.

instance, report, "[r]esearch has shown measureable impacts often extend at least 330 feet (100 meters) into forest adjacent to an edge."[55]

These effects will harm rural economies and decrease property values, as major gas infrastructure transforms and distorts the existing landscape. United States Geological Survey researchers, reviewing recent patterns of unconventional gas extraction, combined with coalbed methane projects, report that these activities create "potentially serious patterns of disturbance on the landscape."[56]

Pennsylvania presents a particularly striking example of the many ways in which gas production can transform a landscape. A recent state study of drilling in Pennsylvania's hitherto relatively undisturbed forest lands found that the forests have been so thoroughly fragmented and disrupted by the influx of gas activity that "zero" remaining acres of the state forests are suitable for further leasing with surface disturbing activities.[57]

Increased gas production for export can be expected to intensify and extend these impacts to new regions as drilling continues to meet increased demand.

Summary

The environmental impacts of increasing gas production of course extend well beyond those captured by this short summary. There are real environmental risks inherent in every phase of gas's life-cycle, from site preparation to drilling to waste disposal. Greatly increasing gas demand will increase the scope and intensity of these risks. The DOE's Shale Gas Subcommittee has already found that our regulatory infrastructure is not adequate to manage these risks at their current level of intensity. The United States is even less prepared for a greater and more rapid expansion of natural gas extraction.

B. Environmental Impacts Due to Fuel Market Shifts

Increasing demand for gas will necessarily raise gas and energy prices. These price effects have important environmental impacts as well because changing gas prices and availability affects the domestic fuel market. If natural gas is relatively more expensive, utilities, in particular, may be more likely to use competing fuels and generation technologies, each of which has its own environmental implications.

The prospect that LNG exports could incentivize domestic coal-fired generation is particularly important to understand. Coal-fired generation is a major source of many air pollutants,

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[55] *Id.* at 6-75.
[56] E.T. Slonecker *et al.*, USGS, *Landscape Consequences of Natural Gas Extraction in Bradford and Washington Counties, Pennsylvania, 2004–2010* (2012) at 1.
[57] PA DCNR, *Impacts of Leasing Additional State Forest for Natural Gas Development* (2011).

including asthma-inducing SO_2, and among the very largest sources of combustion-related CO_2. Thus, LNG-induced market changes could have important implications for domestic air quality.

The EIA has modeled this fuel-shifting effect for gas exports of up to 12 bcf/d.[58] It reports that as exports rise, domestic gas consumption falls. Utilities largely switch to coal, while also making up a bit of the displaced gas generation with energy efficiency and renewable energy.[59] On balance, this shift results in increased emissions because the bulk of the new energy (72% of the total) comes from coal generation.[60]

More coal generation means greater carbon dioxide emissions from combustion, which are more than sufficient to balance out any emissions savings from greater use of efficiency and renewable energy in most of the scenarios that the EIA considered.[61] In fact, even in the few scenarios where the EIA predicted a larger market share for low carbon sources, LNG exports still resulted in a net increase in CO_2 emissions nationally, once emissions from the liquefaction process itself were accounted for.[62] The size of this increase depends upon the volume and size of exports, and the baseline price of gas and coal under various scenarios, so the EIA analysis estimates it within a broad range of 187 to 1,587 million metric tons of CO_2 over the next twenty years. These are large amounts. Even at the low end, 187 million metric tons is equivalent to the CO_2 emitted in a year by roughly 44 coal-fired power plants.[63] These emissions have the potential to increase as more LNG is exported with commensurate impacts on the market. They would be accompanied by corresponding increases in other coal-generation-related air pollutants, like SO_2.

This market-linked pollution effect could work to disrupt important policy work at the national and local level. Many utilities, public service commissions, and environmental regulators increasingly assume that coal generation's market share will steadily fall, in favor of gas, renewable energy, and energy efficiency. These entities are planning accordingly. Indeed, the EPA's recent proposed carbon pollution standards for fossil-fired generation are premised on EPA's understanding that "in light of a number of economic factors, including the increased availability and significantly lower price of natural gas … few, if any, new coal-fired power plants will be built in the foreseeable future."[64] As policymakers adapt to a world of more readily-available natural gas, export's tendency to make gas *less* available and more expensive will have important environmental implications throughout the country.

C. Impacts from Export Itself: Focus on Climate

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[58] EIA, *Effects of Increased Natural Gas Exports on Domestic Energy Markets* at 17-19.
[59] *Id.*
[60] *Id.* at 18.
[61] *See id.* at 18-19.
[62] *Id.*
[63] Calculated with EPA's *Greenhouse Gas Equivalencies Calculator*, available at http://www.epa.gov/cleanenergy/energy-resources/calculator.html#results.
[64] *See* 77 Fed. Reg. 22,392, 22,399 (Apr. 13, 2012).

Finally, exports themselves have substantial environmental impacts.

Export terminals are large industrial sites. The liquefaction facilities needed to chill natural gas until it condenses into a liquid well below zero are energy-intensive and can produce substantial amounts of air and water pollution. Likewise, the pipeline and compressor networks needed to transport gas to the terminal, and the international shipping system needed to carry it onward all have significant impacts on the environments they traverse. The highly explosive nature of LNG means that carefully mapping out the potential for serious accidents around terminals and ships is an ongoing and important exercise in worst-case scenario analysis.

Looking more broadly, the use of LNG itself has environmental impacts, both positive and negative. Examining the climate implications of LNG is particularly important because LNG proponents have touted the fuel for its supposed potential to substantially reduce greenhouse gas pollution by displacing coal.

This claim is not well-supported. Because of the energy used to liquefy, transport, and re-gasify LNG, its life-cycle climate footprint is greater than that of most gas sources. Indeed, at least one peer-reviewed study has found LNG's life-cycle greenhouse gas emissions approach the low-end of coal life-cycle emissions.[65] Notably, that study was based on emissions from conventionally-produced natural gas, which are considerably lower than those from unconventional gas. Other studies, though concluding that LNG emissions are still lower than those of coal, have likewise documented that LNG life-cycle emissions are on the order of 30% greater than those of ordinary gas.[66] Whichever figures ultimately turn out to be correct, it is clear that LNG is among the most carbon-intensive forms of natural gas.

Further, whether or not LNG produces as much greenhouse gas pollution as coal, increased use of *any* fossil fuel is not consistent with preventing dangerous climate change. Recent climate studies show that increased natural gas use (from whatever source), without aggressive additional carbon control efforts, will not prevent dangerous increases in global temperature. The International Energy Agency, for instance, recently considered a future in which global gas use (including LNG use) sharply increases because of the unconventional gas boom.[67] In this scenario, despite gas's presumed life-cycle emissions advantage over coal, atmospheric CO_2 concentrations nonetheless rise on a trajectory towards 650 ppm, up from near 400 ppm today, pushing towards a 3.5°C temperature increase.[68] As a result, even if LNG emits less greenhouse gas pollution than coal, and even if it displaces some amount of coal power (which may or may not occur), it will not put on a path towards safe climate.

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[65] Jaramillo et al., *Comparative Life-Cycle Air Emissions of Coal, Domestic Natural Gas, LNG, and SNG for Electricity Generation*, 41 Environ. Sci. Technol. 6,290, 6,295 (2007).
[66] *See* European Commission Joint Research Centre, *Liquefied Natural Gas for Europe – Some Important Issues for Consideration* (2009) at 16-17; European Commission Joint Research Centre, *Climate impact of potential shale gas production in the European Union* (2012).
[67] International Energy Agency, *Golden Rules for a Golden Age of Gas* (2012).
[68] *Id.* at 91.

We can only avoid the worst impacts of climate change if emissions fall sharply. As IEA explains, "reaching the international goal of limiting the long-term increase in global mean temperature to 2°C above pre-industrial levels cannot be accomplished through greater reliance on natural gas alone."[69] Thus, expanded natural gas exports may, at best, very slightly slow the pace of warming. In the worst case, they will maintain the status quo, while deepening a national and global investment in climate-disrupting fossil fuels and delaying the transition to renewable energy sources.

D. Conclusions on Environmental Impacts

In sum, the environmental impact of LNG export is large, and stretches from local effects near individual gas wells to significant cumulative impacts on the country as gas production increases and gas prices rise to significant shifts in the international energy market. Some of these impacts are better understood than others, but all are worthy of careful analysis.

That analysis has not been forthcoming. DOE and FERC have prepared no environmental reports studying the impacts of export and, worse, have so far declined to do so, as is explained below. Export proponents, who generally trumpet production increases as a central benefit of their projects, are silent on the environmental costs of these production shifts.

The policy community has not yet seriously engaged these questions either. Two much-discussed recent LNG export papers, which generally favor exports, devote almost no attention to the environmental impacts of exports and the increased gas production that would accompany them. A report from the Brookings Institution, titled *Liquid Markets*, cites the DOE's Shale Gas Subcommittee's serious concerns and reviews ongoing regulatory initiatives, but makes no effort to quantify the likely environmental impacts of increased production.[70] Instead, it settles for predicting only that the "current regulatory environment" – the one which DOE has judged to be inadequate – should not put any insuperable hurdles in the way of new drilling.[71]

A second report, from Michael Levi of the Council on Foreign Relations and the Hamilton Project, also lacks a detailed treatment of these issues.[72] The environmental portion of that analysis also largely considers whether public backlash over environmental damage will be sufficient to derail exports, warning that the EIA projects "that a large part of increased production spurred by export demand would be in the Northeast, where opposition to shale gas development has been strongest."[73] Levi views this possibility as an argument for improved regulation, such as the DOE has called for. He implies, however, that because LNG exports will

[69] *Id.* at 100.
[70] Brookings Energy Security Initiative, *Liquid Markets: Assessing the Case for U.S. exports of Liquefied Natural Gas* (May 2012) at 6-12.
[71] *Id.* at 11.
[72] Michael Levi, The Hamilton Project, *A Strategy for U.S. Natural Gas Exports* (June 2012).
[73] *Id.* at 20-21.

not commence "for several years," there will be time to put the necessary rules in place before hand.[74] Suffice to say that this is back-to-front thinking: There is no guarantee that rules will be in place to manage a wave of increased fracking. On the contrary, with billions of dollars sunk into export terminals, one might expect export proponents to oppose new regulation.

These two recent reports are representative: There has been a great deal of discussion of the economic potential of LNG exports, but the environmental discussion has lagged dangerously behind. Mere assertions that environmental impacts will not be sufficiently disturbing as to cause a massive public backlash, or that regulations will doubtless be in place by the time exports occur, are not enough to support careful consideration of these transformative changes. The decision to allow substantial LNG exports requires a thorough accounting of the likely impacts and how they can best be managed.

To be sure, a great deal of useful information is being developed on the environmental impacts of unconventional gas production generally, as state and federal regulators grapple with the implications of the boom. That information, however, has not been integrated into an analysis of the impacts of LNG exports or used to inform export decisions. If DOE or FERC began that study, they would find a rich and developing literature to draw upon and synthesize. The export licensing system, supported by the NEPA process, should produce just an analysis. That information is long overdue.

IV. The Regulatory Infrastructure

The Natural Gas Act and NEPA provide a framework under which DOE and FERC must weigh the environmental impacts of export, and then ensure that exports, if any, are regulated to protect the public interest. Thus far, this fundamental oversight machinery has not been fully used.

Natural gas imports and exports have been regulated under the Natural Gas Act since the late 1930s. Until very recently, however, large-scale exports of LNG were not in the picture. The two core regulatory bodies, DOE's Office of Fossil Energy, and FERC, dealt largely with pipeline shipments to Canada and Mexico and with LNG import terminals. Although they occasionally handled periodic permit renewals for a sole, small, LNG export terminal in Alaska that has served the Asian market off and on since the 1960s, this minor project does not remotely compare to the enormous export proposals now before them. This striking shift underlines the importance of proceeding carefully now.

A. The Public Interest Determination and Siting Process

The Natural Gas Act provides that "no person" may export or import natural gas without a license.[75] Such a license will be granted unless the proposal "will not be consistent with the

[74] *See id.* at 21.
[75] 15 U.S.C. § 717b(a).

public interest."[76] This public interest standard is broad and invites careful analysis. Among other points, it includes "the authority to consider conservation, environmental, and antitrust questions."[77] The Supreme Court has made clear that environmental considerations, in particular, are due close attention in this analysis.[78] DOE has recently affirmed that it is required to examine a "wide range of criteria" to best understand the public interest, "including… U.S. energy security… [i]mpact on the U.S. economy… [e]nvironmental considerations… [and] [o]ther issues raised by commenters and/or interveners deemed relevant to the proceeding."[79]

DOE and FERC share responsibility for Natural Gas Act determinations, with DOE taking, in many ways, the more fundamental role. Under their current division of authority, FERC is charged with location-specific concerns: Its primary responsibility is to investigate how to safely site and operate export and import terminals themselves.[80] DOE, by contrast, is charged with more broadly considering whether the project should move forward at all: It must make the public interest determination, and so must survey the information before it in order to discern how a given export or import proposal will affect the many considerations relevant to the public interest.[81] Although DOE reads its governing statute to afford export applicants a rebuttable presumption that their project is in the public interest, this presumption is not dispositive and a detailed public interest analysis is required in each case.[82]

NEPA analysis supports this public interest determination by providing the environmental information which DOE must weigh under the Natural Gas Act. The NEPA process, described in detail below, is the joint responsibility of DOE and FERC, and must be completed before either one issues a final order. Since 2005, FERC has been charged by statute as the "lead" agency for NEPA compliance, meaning that it coordinates the environmental assessment process.[83] DOE, however, must contribute to and review the documents which FERC prepares, and must independently determine whether they are sufficient to support its public interest determination, or whether more analysis is needed.[84] Only once DOE determines that it has NEPA documents which fully analyze the environmental impacts of the decision before it does it weigh those impacts and make its final public interest decision.

This process applies to all the export applications now before FERC and DOE with one important exception, which is discussed in more detail in the final section of this paper. In the 1992

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[76] *Id.*
[77] *Nat'l Ass'n for the Advancement of Colored People v. Federal Power Commission*, 425 U.S. 662, 670 n.4 & n.6 (1976).
[78] *See Udall v. Federal Power Comm'n*, 387 U.S. 428, 450 (1967).
[79] Testimony of Christopher Smith, Deputy Assistant Secretary of Oil and Gas Before the Senate Committee on Energy and Natural Resources (Nov. 8, 2011).
[80] Department of Energy Delegation Order No. 00-004.00A § 1.21 (May 16, 2006).
[81] *See* Department of Energy Redelegation Order No. 00-002.04E § 1.3 (Apr. 29, 2011).
[82] *See Panhandle Producers and Royalty Owners Ass'n v. Economic Regulatory Administration*, 822 F.2d 1105, 1110-1111 (D.C. Cir. 1987).
[83] *See* 15 U.S.C. § 717n.
[84] *See* 40 C.F.R. § 1501.6.

Energy Policy Act, Congress amended DOE's Natural Gas Act authority to provide that DOE *must* grant applications for export to (or import from) nations with which the United States has signed a free trade agreement providing for national treatment in natural gas.[85] In those cases, FERC still oversees terminal siting, but DOE loses its broad oversight role as to whether export is wise in the first place. This loophole was created to support natural gas imports from Canada – rather than massive LNG *exports* from the U.S. – but it has been relatively unimportant until recently. Significant export projects generally must go through the usual public interest process because the United States does not have free trade agreements with most major LNG importers. The 2010 free trade agreement with South Korea, a large LNG importer, changed this picture somewhat, but the South Korean market is still relatively limited and the free-trade "loophole" has not short-circuited DOE's usual process in most cases. That situation highlights, however, the importance of maintaining the public interest determination process as trade negotiations continue with other importers.

Accordingly, though most exporters do secure the "free" license to export to free-trade-agreement nations, the license to export to non-free-trade-act nations remains more valuable, and is often essential to doing business. Of the 19 projects now before DOE, only 4 rely exclusively on a free-trade-agreement license.[86] The remaining proposals are proceeding through the full public interest determination process.

B. The NEPA Process

The NEPA phase of this process must provide DOE and the public with a full and fair understanding of the environmental implications of export.

NEPA is our bedrock environmental statute.[87] It is rooted in democratic decisionmaking informed by excellent information. NEPA directs federal agencies to look before they leap: by requiring the preparation of environmental impact statements (EISs) for major federal actions, it helps ensure sound decisions before bulldozers roll. Policymakers have a pressing need for the information the NEPA process can provide as they consider whether and how to permit LNG export. NEPA analysis, accordingly, is not just a legal mandate but a prudent measure.

NEPA requires all federal agencies to "utilize a systematic, interdisciplinary approach" to make decisions, ensuring that their decisions are fully informed before they act with a goal of maintaining "the environment for succeeding generations."[88] The core of this obligation is the EIS, which must be prepared for every major Federal action which could significantly affect "the quality of the human environment."[89]

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[85] *See* 15 U.S.C. 717b(c).
[86] Those four are the SB Power Solutions, Golden Pass Productions, Main Pass Energy Hub, and Waller LNG Services proposals.
[87] It is codified at 42 U.S.C. §§ 4321 *et seq.*
[88] 42 U.S.C. §§ 4332(A) & 4331(b)(1).
[89] 42 U.S.C. § 4332(C).

An EIS is designed to develop information describing the environmental impact of a proposed action, alternatives to the proposal, and the relationship between the short-term proposal and "the maintenance and enhancement of long-term [environmental] productivity."[90] NEPA, in other words, helps prompt agencies to look more broadly than the immediate matter at hand, to understand how their actions fit within a larger environmental context. As the first court to review the statute explained, "NEPA, first of all, makes environmental protection a part of the mandate of every federal agency and department."[91]

This is not a paper exercise. The Council on Environmental Quality, the high-level body which administers NEPA across the government, explains in its regulations that "[u]ltimately, of course, it is not better documents but better decisions that count. NEPA's purpose is not to generate paperwork--even excellent paperwork--but to foster excellent action."[92] This means that "[t]he NEPA process is intended to help public officials make decisions that are based on an understanding of environmental consequences, and take actions that protect, restore, and enhance the environment."[93]

This process proceeds in several steps, designed to build a strong platform for the final decision. It is to begin as early as possible in order to ensure that the EIS can "serve practically as an important contribution to the decisionmaking process and will not be used to rationalize or justify decisions already made."[94] After an initial "scoping" phase during which the agency gathers comments from stakeholders to identify key issues,[95] the agency prepares a draft and then a final EIS.

The "heart of the environmental impact statement" is a careful discussion of the proposal and all relevant alternatives, "sharply defining the issues and providing a clear basis for choice among options by the decisionmaker and the public."[96] With regard to each option, the agency must develop a careful description of its environmental consequences.[97]

These consequences are generally divided between direct, indirect, and cumulative impacts.[98] Direct impacts are simply those immediately caused by the action at issue; indirect impacts are those which may occur a bit further afield, but which are still causally linked to the federal action.[99] The agency must cast a wide net, analyzing all "reasonabl[y] foreseeable" impacts, including those "induced" by its action – think, for instance, of the "growth inducing" impacts of building a highway, or, for that matter, an export terminal inducing drilling with its attendant

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[90] *Id.*
[91] *Calvert Cliffs' Coordinating Committee, Inc. v. U.S. Atomic Energy Comm'n*, 449 F.2d 1109, 1112 (D.C. Cir. 1971).
[92] 40 C.F.R. § 1500.1(c).
[93] *Id.*
[94] 40 C.F.R. § 1502.5.
[95] 40 C.F.R. § 1501.7.
[96] 40 C.F.R. § 1502.14.
[97] 40 C.F.R. § 1502.16.
[98] 40 C.F.R. §§ 1508.7 & 1508.8.
[99] 40 C.F.R. § 1508.8.

effects on "air and water and other natural systems."[100] The analysis must also include the "cumulative" impacts of federal action – the "incremental impact of the action when added to other past, present, and reasonably foreseeable future actions."[101] For instance, in the LNG context, the cumulative production inducing effects of all relevant LNG terminals should be considered together. It would also make sense to consider the cumulative impact of new production from export along with the impact of existing gas production.

The EIS, in short, ultimately presents a full accounting of all the reasonably foreseeable impacts of the agency's proposed course of action, along with alternatives to that course of action. It is designed to bring information to light and to generate syntheses of formerly scattered information.

Congress recognized, in this regard, that some uncertainty will always be present in any prediction of environmental impacts. Such uncertainty does not excuse agencies from complying with NEPA – if it did, NEPA analyses would never succeed in developing the new research agencies need to inform their decisions. Rather, the NEPA process is designed to limit uncertainty, while carefully characterizing remaining questions. Where information is incomplete, the agency must gather it (expending reasonable funds to do so) to fill in key aspects of the picture.[102] If costs are truly exorbitant, or it is very difficult to generate a particular piece of information, an agency must still do its best, providing a careful description of what it believes to be missing from its evaluation, a "summary of existing credible scientific evidence" relevant to its problem, and the agency's best "evaluation" of the impacts before it based upon what it knows.[103] In all cases, the goal is to develop the best-informed analysis possible, advancing the public's understanding, even of uncertainties, before the final decision is made.

Uncertainties can also be managed by beginning at a higher level of generality with a special form of EIS known as a "programmatic" environmental impact statement, and then filling in more specific information down the road as individual projects are considered. As the name suggests, programmatic EISs are intended to provide a broad overview of entire programs, or classes of activity.[104] Such documents are particularly useful as road maps. They provide an overview of how a class of decisions – such as granting many different export applications – will affect the environment. As the D.C. Circuit Court of Appeals has explained, this process has "a number of advantages" which recommend it here:[105] A programmatic EIS, the court explained, "provides an occasion for a more exhaustive consideration of effects and alternatives than would be practicable in a statement on an individual action. It ensures consideration of

[100] *See id.*
[101] 40 C.F.R. § 1508.7.
[102] 40 C.F.R. § 1502.22(a).
[103] 40 C.F.R. § 1502.22(b)(1).
[104] *See* 40 C.F.R. § 1502.14(b)-(c).
[105] *Scientists' Institute for Public Information, Inc. v. Atomic Energy Comm'n*, 481 F.2d 1079, 1087 (D.C. Cir. 1973).

cumulative impacts that might be slighted in a case-by-case analysis. And it avoids duplicative reconsideration of basic policy questions."[106]

To facilitate this broad overview, the NEPA regulations in turn explain that agencies can structure programmatic EISs by looking, for instance, geographically at "actions occurring in the same general location"; generically, by looking at actions with, for instance, "common timing, impacts, alternatives, methods of implementation, media, or subject matter"; or even by "stage of technical development" as processes and technologies mature.[107] Once such an overview is in hand, an agency is free to rely upon it to guide more specific analyses of particular projects, thereby saving work and time down the road.[108]

Whether an EIS is programmatic or project-specific, as the Supreme Court has explained, by ensuring that agencies take a "hard look" at the environmental consequences of their decisions, NEPA is "almost certain to affect the agency's substantive decision."[109] In this sense, NEPA reflects a fundamentally democratic approach to decisionmaking, a faith that putting the best information forward transparently will help policymakers and the public navigate uncertainty and make difficult choices. The Supreme Court identifies these two purposes this way:

> First, [NEPA] ensures that the agency, in reaching its decision, will have available, and will carefully consider, detailed information concerning significant environmental impacts. Second, it guarantees that the relevant information will be made available to the larger audience that may also play a role in both the decisionmaking process and the implementation of that decision.[110]

With this process in place, the goal is that "the most intelligent, optimally beneficial decision will ultimately be made."[111]

There is a pressing need for such careful, deliberate, decisionmaking in the LNG export context.

V. Applying NEPA to LNG Exports

DOE affirms in its governing regulations that it will "follow the letter and spirit of NEPA" and will "apply the NEPA review process early in the planning stages" of its projects.[112] These rules are clear that DOE must base its final decisions on matters with significant environmental impacts on a carefully developed environmental impact statement.[113] But DOE has refused to prepare

[106] *Id.* (internal quotations and citation omitted).
[107] 40 C.F.R. § 1502.14(c)(1)-(3).
[108] *See*, *e.g.*, 40 C.F.R. § 1502.20
[109] *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 350 (1989).
[110] *Dep't of Transp. v. Public Citizen*, 541 U.S. 752, 767 (2004) (internal quotations omitted).
[111] *Calvert Cliffs*, 449 F.2d at 1114.
[112] 10 C.F.R. § 1021.102.
[113] *See, e.g.*, 10 C.F.R. §§ 1021.210 (affirming that DOE will complete NEPA review "before making a decision"); 1021.214 (affirming that this standard applies for adjudicatory proceedings, such as licensing processes).

an environmental impact statement to help it wrestle with the weighty export decisions now before it. Worse, it has refused even to acknowledge that it has the tools to do so, even though its own modeling system could go far to help answer the vital questions now before it.

DOE *should* have approached NEPA compliance in a far more considered way. It should have begun by preparing a national programmatic environmental impact statement – either on its own or as a partner with FERC, the usual NEPA lead agency -- that would have considered the cumulative effect of the export proposals before it and ways to mitigate those effects. Such an analysis would be a natural counterpart to a national economic study it is now preparing. In fact, the U.S. Environmental Protection Agency (EPA) has now twice filed formal comments making clear that just such an analysis is necessary.[114] With both such studies in hand, DOE and FERC could then have developed shorter, subsidiary studies for each proposal before it, considering their particular circumstances in the context of its comprehensive public disclosures.

The unwise course the agencies have thus far taken in the environmental arena contrasts sharply with DOE's far wiser commitment to consider national economic impacts before moving forward on any further export applications. These two approaches are irreconcilable. DOE must undertake a full EIS for LNG export, including the effects of increased gas production, if it is to make prudent decisions and satisfy its legal mandates.

A. DOE's Failure to Properly Apply NEPA Thus Far

DOE has assured Congress that it recognizes that the cumulative impact of "future LNG export authorizations could affect the public interest."[115] Unfortunately, though DOE is attempting to better understand some of the economic implications of LNG export, it has thus far actively refused to consider the environmental implications.

The only nearly-complete example of DOE's deliberative process thus far is its handling of the Sabine Pass LNG export project proposed for southern Louisiana. Sabine Pass was the first LNG export application filed in the current wave of proposals, and proposed to export 803 bcf of gas annually. This volume of export, alone, would increase *total* U.S. gas exports by more than 50%.[116] One might have expected DOE to analyze this historic application in detail, but it did not.

Instead, applying the rebuttable presumption-based approach to export, DOE did not develop significant independent analyses when considering the application. It relied almost entirely on Sabine Pass's own assertions. In spring 2011, it "conditionally" approved the Sabine Pass's request to export up to 2.2 bcf/d of natural gas, largely on the ground that no opposing party

[114] Letter from Christine B, Reichgott, EPA Region 10 to FERC (Oct. 29, 2012) at 12-13; Letter from Jeffrey D. Lapp, EP Region 3 to FERC (Nov. 15, 2012) at 2.
[115] Letter from Christopher Smith, Deputy Assistant Secretary of Oil and Gas to Representative Edward Markey (Feb. 24, 2012) at 3.
[116] *See* n. 3, *supra*.

had shown that the project was *not* in the public interest.[117] DOE thus approved the beginning of the export boom largely on the export proponents' say-so, without preparing its own analysis.

The "conditional" part of the approval referred in large part to DOE's decision to defer its consideration of environmental matters pending FERC's work on NEPA documents for Sabine Pass as the lead agency for NEPA compliance. Because FERC had not yet prepared an environmental analysis or environmental impact statement, DOE opted not to weigh any environmental factors in its public interest analysis. Instead, it stated that FERC, with DOE's cooperation, would undertake the environmental study for both agencies as part of FERC's facility siting process.[118] DOE stated that it would review FERC's final product before finally signing off on Sabine Pass.

But FERC did not prepare an EIS for Sabine Pass and did not consider the national implications of the application, including its implications for production. FERC recognized that Sabine Pass itself identified the purpose and need of the facility as to "provide a market solution to allow the further development of unconventional (particularly shale gas-bearing formation) sources in the United States."[119] Nonetheless, it instead prepared only a more limited document called an environmental assessment (an "EA"), which focused only on the environmental impacts of the facility siting decision before it.[120]

FERC justified this decision on the grounds that the impacts from increased gas development were not "reasonably foreseeable" because "no specific shale-gas play is identified."[121] It did so even though Sabine Pass itself affirmed that the "most likely" sources of supply for its project were "the historically prolific Gulf Coast Texas and Louisiana onshore gas fields, the gas fields in the Permian, Anadarko, and Hugoton basins, and the emerging unconventional gas fields in the Barnett, Fayetteville, Woodford, and Bossier basins."[122] FERC apparently felt that the applicant's own assurances that export would spur production, and would likely do so in specific places, provided no ground for analysis. Because FERC believed that it could not identify precisely where Sabine Pass would catalyze gas production, it refused to consider these impacts at all.[123]

But NEPA analyses are not dependent on this sort of location-specific analysis. Instead, a programmatic EIS, for instance, could readily have presented the environmental choices before DOE on a national level, with particular attention to potential production patterns in prolific shale plays. Even a project-specific EIS could have addressed pressing environmental issues directly. FERC could have evaluated the sorts of pollution risks and ecosystem threats

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[117] DOE, Order 2961 (May 20, 2011) at 42.
[118] *Id.* at 40-41.
[119] *Id.* at 1-10.
[120] *See* FERC, *Environmental Assessment for the Sabine Pass Liquefaction Project* (December 2011).
[121] FERC, Order Granting Section 3 Authorization, 139 FERC ¶ 61,039 at ¶¶ 96-97 (Apr. 16, 2012).
[122] Sabine Pass Export Application (Sept. 7, 2010) at 16.
[123] *Id.* at ¶¶ 98-100.

associated with increased fracking. It could have described the likely cumulative impacts of the many proposed LNG projects, including those at Sabine Pass, and could have estimated the scale of environmental disruption that they may cause. Instead, FERC provided none of this information. Perversely, because it concluded that Sabine Pass might promote gas production "in any of the numerous shale plays that exist in most of the eastern United States," and hence could have nationwide impacts, FERC decided that these impacts swept too broadly to be analyzed.[124]

DOE did not have to accept this blinkered view, but it nonetheless did so, declaring, on its review of FERC's EA, that FERC had "examined all reasonably foreseeable impacts" of the project.[125] DOE therefore accepted FERC's EA as a "complete picture for purposes of meeting DOE's NEPA responsibilities and fulfilling its duty to examine environmental factors as a public interest consideration under the [Natural Gas Act]."[126] In doing so, DOE also accepted FERC's reasoning that because it was "impossible" to know precisely how much new production Sabine Pass would cause, or exactly where this production would occur, there was no way to discuss these impacts at all.[127]

Thus, though DOE affirmed that it was "fully aware of concerns of the environmental effects of shale gas production," it insisted that it could not provide a "meaningful analysis" of Sabine Pass – or of the cumulative impacts of LNG export as a whole.[128] Sierra Club petitioned for rehearing of this decision, and DOE has announced that it continues to consider whether its decision was correct.[129]

DOE has not moved forward on any other LNG export applications (with the exception of licenses for export to countries with which the U.S. has a free trade agreement, discussed below), so the Sabine Pass order stands as its current word on the subject. If DOE does not change course, huge volumes of natural gas will be produced and exported without any consideration of how this massive production increase will affect communities across the country. Far from working to protect the public interest, DOE will not acknowledge, much less address, the challenge before it.

B. How NEPA Should Be Applied to LNG Exports

The Sabine Pass decisions made a bad beginning, but they need not determine the rest of the story. DOE may yet reconsider its Sabine Pass order. Moreover, many other LNG export applications have been filed with DOE and, as it considers them, it may still treat this environmental challenge with the seriousness it deserves. Before granting any further licenses,

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124 FERC, Order Denying Rehearing and Stay, 140 FERC ¶ 61,076 at ¶ 12 (July 26, 2012).
125 DOE, Order 2961-A (Aug. 7, 2012) at 27.
126 *Id.*
127 *Id.* at 28.
128 *Id.*
129 DOE, *Order Granting Rehearing for Further Consideration*, FE Docket No. 10-111-LNG (Oct. 5, 2012).

DOE should ensure that the NEPA process develops the information it needs to make a sound public interest determination.

For purposes of this discussion, DOE or FERC could undertake the tasks described below. FERC would be the most likely coordinator, given its lead agency role under the Natural Gas Act, but it is ultimately DOE's responsibility to ensure that the final NEPA analysis is sufficient to support a careful public interest determination, whether it is prepared entirely by FERC or later supplemented by DOE. For ease of reference, this section therefore refers to "DOE" as conducting the analysis, though FERC would play an important coordinating role.

In this context, a programmatic EIS makes a great deal of sense. By looking first at the common questions inherent in export, DOE could help develop a fundamental shared understanding of their impacts before turning to the particular impacts of specific proposals.

i. Determining Foreseeable Production Associated with Export

The most important first question for DOE is to determine a "reasonably foreseeable" range of natural gas which may be exported and the corresponding range of reasonably foreseeable increases in production. So far, DOE and FERC have insisted that *no* production impacts are reasonably foreseeable, as the Sabine Pass decisions state. This conclusion is simply wrong. The DOE's own NEMS program can forecast these production impacts. DOE's failure to develop such projections is unjustifiable.

NEMS is a very well-established modeling system designed to model the economy's energy use through a series of interlocking "modules" that represent different energy sectors on regional and national levels.[130] Relevant here, NEMS has an "Oil and Gas Supply Module"[131] and a "Natural Gas Transmission and Distribute Module."[132] Rhese modules jointly represent the entire domestic natural gas sector, and describe how production responds to demand across the country. They can be used, therefore, to model the effects of increased export demand on gas production. In fact, they *have* been used for this purpose by DOE already: The January 2012 EIA special report on LNG, which included production forecasts, relies on NEMS, as does the summer 2012 Annual Energy Outlook, which contains LNG projections.[133]

EIA's formal documentation for NEMS is available online, and thoroughly describes the system. That documentation demonstrates that DOE/FE is in error when it states that the implications of LNG export demand for the production and supply of domestic gas are not foreseeable. In fact, NEMS's natural gas sub-models are explicitly designed to project how supply will respond to demand on a national and a regional basis; indeed, they *must* do so for the model to

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[130] *See* EIA, *The National Energy Modeling System: An Overview* (2009) at 1-2 ("NEMS Overview").
[131] *See* EIA, *Documentation of the Oil and Gas Supply Module* (2012 ("OGSM Documentation").
[132] *See* EIA, *Model Documentation: Natural Gas Transmission and Distribution Module of the National Energy Modeling System* (2012) (TDM Documentation).
[133] *See, e.g.*, EIA, *Effects of Increased Natural Gas Exports on Domestic Energy Markets* at 3 (EIA used NEMS for this forecast); EIA, . *See* EIA, *Annual Energy Outlook* (2012) at App. E (describing NEMS).

generate predictions. As such, NEMS could (and in fact has) be used to project likely production increases in response to increased demand caused by LNG exports. NEMS therefore provides the analysis of "when, where, and how shale-gas development will be affected" that the DOE has so far stated it would be impossible to produce.

To begin with, the Supply Module is built on detailed state-by-state reports of gas production across the country.[134] These reports allow the EIA to develop regionally differentiated models of the costs of production in each gas field, and how readily production can be increased in those fields. As the EIA explains, "production type curves have been used to estimate the technical production from known fields" as the basis for a sophisticated "play-level model that projects the crude oil and natural gas supply from the lower 48."[135] The module reports its results for regions throughout the United States, including the Northeast, the Gulf Coast, and areas in Texas and Arkansas with large gas plays.[136] It also distinguishes coalbed methane, shale gas, and tight gas from other resources, allowing for specific predictions distinguishing unconventional gas production from conventional natural gas production.[137] The module further projects the number of wells drilled each year, and their likely production; these are important figures for estimating environmental impacts.[138]

In short, this module "includes a comprehensive assessment method for determining the relative economics of various prospects based on future financial considerations, the nature of the undiscovered and discovered resources, prevailing risk factors, and the available technologies. The model evaluates the economics of future exploration and development from the perspective of an operator making an investment decision."[139] Thus, for each play in the lower 48 states, the EIA is able to predict future production based on existing data. Importantly, the EIA makes clear that "the model design provides the flexibility to evaluate … environmental, or other policy changes in a consistent and comprehensive manner."[140] Those policy changes include permitting LNG export.

LNG export creates new demand and transmission needs. The next NEMS module, the Transmission and Distribution Module, can address these impacts. It integrates supply projections with regional and national demand to help determine how gas will flow to areas experiencing increased demand. As EIA explains, the module "represents the transmission, distribution, and pricing of natural gas" using a national module of the transmission system, which, in turn, is divided by region.[141] The module "links natural gas suppliers (including importers) and consumers in the lower 48 States and across the Mexican and Canadian borders via a natural gas transmission and distribution network, while determining the flow of natural

[134] *See* OGSM Documentation at 2-2.
[135] *Id.* at 2-3.
[136] *Id.* at 2-4.
[137] *Id.* at 2-7.
[138] *See id.* at 2-25 -2-26
[139] *Id.*
[140] *Id.*
[141] TDM Documentation at 2.

gas and the regional market clearing prices between suppliers and end-users."[142] Because the Transmission Module represents demand regionally, it can distinguish, for instance, between LNG export demand on the Gulf Coast and demand in the Northeast.[143] For each region, the module then links supply and demand annually, taking transmission costs into account, in order to project how demand will be met by the transmission system.[144] Thus, it interacts with the Supply Module to develop projections for how supply in each production region will evolve in response to demand.[145]

Importantly, the Transmission Module already is designed to model LNG imports and exports, and contains an extensive modeling apparatus to do so.[146] The Module includes import/export pipelines and the sole existing LNG export terminal in Alaska.[147] There is, thus, no technical barrier to modeling increased export demand going forward.[148] One source of demand is much like any other, so additional export terminals can simply be modeled as additional demand centers in the regions in which terminals are proposed. The Module could, for instance, readily model additional demand along the Gulf Coast or other coasts, and translate that demand back to the Supply Module. Again, this process is essentially what the EIA already did in the context of its January 2012 LNG export study, which relied on NEMS to forecast the production and price impacts of export.

In short, NEMS is already set up to do the sort of work which DOE needs to do here.[149] In response to a given demand in a particular region, it projects transmission system flows and

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[142] *Id.*
[143] *See id.* at 12-14.
[144] *See id.* at 15-16.
[145] *See id.* at 16-20.
[146] *See id.* at 22-32.
[147] *Id.* at 3.
[148] *See id.* at 30-31.
[149] As are several models used by private consultants. For instance, the Deloitte consultancy regularly makes such predictions. *See, e.g.*, Deloitte, *Made in America: The Economic Impact of LNG Exports from the United States* (2011) at 6 (explaining that if LNG is "exported from one particular geographic point, the entire eastern part of the United States reorients production and flows and basis differentials change substantially"); *see also id.* at 6 (explaining that the reference case for the model predicts increased production in the Marcellus and Haynesville shales) & 8 (explaining that Deloitte considers how producers will "develop more reserves in anticipation of demand growth, such as LNG exports" and forecasting different prices depending on where exports occur).

According to Deloitte, its "World Gas Model" and its component "North American Gas Model" are designed precisely to provide this sort of finer-grained analysis. Deloitte explains that "[t]he North American Gas Model is designed to simulate how regional interactions of supply, transportation, and demand determine market clearing prices, flowing volumes, storage, reserve additions, and new pipelines throughout the North American natural gas market." *See* Deloitte, *Natural Gas Models.* The model "contains field size and depth distributions for every play, with a finding and development cost model included. This database connects these gas plays with other energy products such as coal, power, and emissions." *Id.* According to Deloitte, its modeling thus allow it to predict how gas production, infrastructure construction, and storage will respond to changing demand conditions, including those resulting from LNG export: "The end result is that valuing storage investments, identifying maximally effectual storage field operation, positioning, optimizing cycle times, demand following modeling, pipeline sizing and location, and analyzing the impacts of LNG has become easier and generally more accurate." *Id.* The point here is that linking exports to production is plainly possible.

production responses at the level of individual plays across the country. Thus, DOE is fully capable of analyzing the production impacts of particular levels of LNG export. Its failure to do so – and its insistence that such projections are somehow impossible to make – is inexplicable.

Given this capability, DOE should look at a range of possible export volumes and timing, just as the EIA did in the economic study that DOE commissioned. It should then consider the amount of natural gas (either produced or diverted from other uses) necessary to meet this demand, and can, using the same analysis EIA applied, predict how much of this gas is likely to come from new production.

Because NEPA is rooted in the alternatives analysis, DOE should also develop alternative approaches to the range of possible exports. It might, for instance, look at the impacts of allowing the maximum and minimum volumes of exports it thinks are plausible, along with its projection of the most likely scenario. It also makes sense to look at variations in export timing and volume driven by public interest concerns. For instance, DOE could consider permitting exports only after the environmental safeguards the Shale Gas Subcommittee identified are in place, or only permitting exports at a volume that would not cause serious price disruptions or economic harm domestically. And, of course, DOE must consider a "no action" alternative baseline, in which exports do not move forward at all. The point of the analysis, as always, is to ensure that the agency thoroughly explores the possible solution space, rather than simply pursuing its preconceived plans.

DOE, in short, has many options before it open for analysis. The only option which it simply may not pursue, however, is the one that it has picked: It cannot and must not refuse to use its *own models* to help inform the public as to the vital choices ahead.

ii. Estimating the Impacts of Production

With this array of options in mind, the next task for DOE is to identify the environmental impacts associated with each of the reasonable alternatives it has developed. EPA has twice instructed FERC (in its role as the lead agency) that just such an analysis is necessary.

EPA's formal comments put the matter well. As EPA explained in comments on a proposal to export LNG from Oregon:

> The 2012 report from the Energy Information Administration states that[] "natural gas markets in the United States balance in response to increased natural gas exports largely through increased production." That report goes on to say that about three-quarters of that increase[d] production would be from shale resources. We believe it is appropriate to consider available information about the extent to which drilling activity might be stimulated

> by the construction of an LNG export facility on the west coast, and any potential environmental effects associated with that drilling expansion.[150]

EPA made a similar point in comments on another, Maryland-based, export facility. It wrote:

> We also recommend expanding the scope of analysis to include indirect effects related to gas drilling and combustion. … Th[e EIA] report also indicated that about three-quarters of that increase[d] production would be from shale gas resources and that domestic natural gas prices could rise by more than 50% if permitted to be exported. We believe it is appropriate to consider the extent to which implementation of the proposed project, combined with implementation of other similar facilities nationally, could increase the demand for domestic natural gas extraction and increase domestic nautral gas prices.[151]

EPA, in short, recognizes that the important national debate needs to be informed by careful environmental analysis. Because this analysis may best be done at the programmatic level, DOE should look at the impacts of export-linked production across the country, before applying this programmatic analysis to informed consideration of particular project proposals. The NEMS system and similar models will help DOE to project national impacts and to regionalize them. As it considers these options, it will need to answer several key questions. These include, but are certainly not limited to, the following:

> *What is the magnitude and timing of the increased natural gas production associated with a range of export scenarios?*
>
> This is the most fundamental question that the NEPA process should answer. The EIA has already developed models linking export to increased production. A NEPA analysis could use this starting point to investigate the magnitude of production needed to support a range of export volumes. This inquiry, on its own, would meaningfully assist decisionmakers. If they know, for instance, that permitting 1 bcf/d of export means that some dozens, hundreds, or thousands, of additional wells will need to be drilled, that consideration should be balanced transparently in the public interest analysis. Again, NEMS should be able to supply this analysis and, indeed, to do so on play-by-play and regional levels, as well as nationally.
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> *What incremental air pollution risk is associated with increased natural gas production generally, and with increased unconventional gas production in particular?*
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> The air pollution impacts of both conventional and unconventional gas production are serious and need to be better understood – especially if exports significantly increase production, as they are likely to do. The DOE can use the NEPA process to better describe these impacts. For instance, the Environmental Protection Agency has developed

[150] Letter from Christine B, Reichgott, EPA Region 10 to FERC (Oct. 29, 2012) at 12.
[151] Letter from Jeffrey D. Lapp, EP Region 3 to FERC (Nov. 15, 2012) at 2.

increasingly accurate emissions figures corresponding to processes through the natural gas production system, from well drilling to gas transport.[152] By estimating the amount production is likely to increase, DOE can evaluate the approximate range of new air pollution likely to be associated with increased production. Likewise, it can assess the likely emissions associated with any upgrades to pipeline transmission networks required to get natural gas to export terminals. DOE can, in other words, forecast whether a given export scenario is likely to be associated with many thousands of tons of additional air pollution, or a more limited amount.

Going further, DOE can predict where this pollution is most likely to occur. Although exported gas can be produced in many places, some natural gas basins are declining or stable, while others – such as those near the Texas Gulf coast and the Marcellus shale of the east coast -- are rapidly growing and are near proposed export terminal sites, reducing transportation costs. DOE can and should forecast the most likely targets for additional development in response to increasing gas demand; these locations are, in turn, the most likely to suffer from increased air pollution and to have to invest in appropriate control efforts. NEMS will it allow it do so.

In short, DOE can map out the air pollution control challenge ahead under various export scenarios. It can also forecast which regions are most likely to have to manage this increased pollution, and some of its likely public health and environmental impacts.

What incremental water pollution risk is associated with increased natural gas production generally, and with increased unconventional gas production in particular?

As with air pollution, water pollution risk increases with increased gas production. Here, too, an overview of pollution risk and response needs with substantially higher production will assist policymakers and the public. Although many other questions should be answered here, two areas of investigation within this general field jump out for investigation at the programmatic level.

First, increased gas production will generate a predictable amount of waste for treatment. Looking at the national scale, a proper EIS would consider the adequacy of treatment available for this increase in wastewater and other substances. Does existing treatment plant capacity correspond to the likely increased volume and can those plants properly treat all pollutants from the industry? Do injection wells appear ready to take up the slack? If not, where is waste likely to go? Before licensing exports, it makes sense to make sure that the nation is ready to handle the waste they leave behind.

Second, water *quantity* issues also deserve a close look. A substantial increase in fracking means a substantial increase in water use. Even though water use varies among gas

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[152] *See generally*, EPA, *Regulatory Impact Analysis: Final New Source Performance Standards and Amendments to the National Emissions Standards for Hazardous Air Pollutants for the Oil and Natural Gas Industry* (Apr. 2012).

fields, DOE can calculate a range of water demand likely to be associated with increased gas production. That range will help to determine whether gas export will add substantially to water stress in the nation's gas fields.

DOE's task here, as in the air pollution analysis, will thus generally be to forecast the likely scope of increased threats to water quantity and quality. Because both waste and water can be transported significant distances, this analysis does not depend on knowing precisely which fields will increase their production, but such forecasts will be helpful in assessing the most likely impacts. That said, where DOE can localize these impacts, as NEMS allows, it will be able to provide extremely important information to policymakers working to protect particular watersheds and aquifers.

What degree of land and community disturbance will be associated with increased gas production for export?

A given volume of export will be associated with an approximate number of new wells, well pads, roads, and associated infrastructure. In some gas fields, this infrastructure is already causing serious conflicts and challenges for communities and for wildlife. For instance, DOE might answer questions like these: What acreage of new disturbance is necessary to meet the increased demand for gas? How many new truck trips and how many new miles of pipeline are likely to be necessary? How many people are living in areas likely to see increased production? And how able are the already disrupted communities and ecosystems in the most likely areas for new production to absorb these impacts without excessive damage? This area of inquiry should prompt DOE to think seriously about the degree of landscape transformation that export will drive.

What are the domestic energy and environmental policy implications of export?

As we have discussed above, gas exports will likely raise gas and energy prices. These market shifts have the potential to change the electrical generation mix and also have implications for domestic industry. DOE is already analyzing these economic questions and is beginning to chart their implications. EIA's initial look at shifts in CO_2 emissions from the utility sector is a good example of this analysis. DOE should extend it to consider, at a range of export volumes and timings, what changes in emissions from other sources are likely. If price increases from export, for instance, prompt increased use of highly polluting coal plants, DOE should carefully address the impacts resulting from that shift.

What are the international energy and environmental policy implications of export?

The atmosphere does not respect national boundaries. Accordingly, if LNG exports lead to changes in climate-disrupting pollution – by replacing either cleaner or dirtier energy sources or simply by increasing the load of carbon in the atmosphere – the United States will feel the effects. The country will also experience changes in transboundary transport of other chemicals and pollutants. To the extent possible, DOE can help forecast these impacts by considering which energy sources LNG is most likely to replace, and the extent of any such replacement.

What alternatives are available to reduce these impacts?

The alternatives analysis is the heart of the EIS. Developing a range of export policies – from permitting all exports, to only a subset of exports; from giving the green light now to waiting until protective regulations are in place – will allow DOE to test these alternatives against their impacts. The EIS should produce a map of possible trade-offs, showing how export decisions affect the environment and which export plans will best protect communities and ecosystems.

With answers to these and other questions in hand, DOE will be far better placed to understand the trade-offs inherent in LNG export and to decide whether export are in the public interest (and, if so, the proper volumes and timing which can best protect the public). This information is, in fact, necessary to properly conclude that process. Moreover, if the NEPA process reveals pressing risks from LNG export, DOE will be able to address them in advance or help other federal or state agencies do so. It will also have contributed to a crucial public conversation on a matter of vital national importance. When and if DOE does license exports, in this future, it will do so with its eyes wide open and will able to develop appropriate mitigation strategies.

Not all of the questions above are easy to answer. Many of them are difficult to address with complete precision, though DOE modeling and publicly available data will provide useful projections and estimates. But residual uncertainty is not a reason to shirk the task. The alternative, after all, is not safe inaction: It is blindly permitting a major change in the nation's energy system, committing to billions of dollars in LNG export infrastructure, and licensing a major increase in fracking activity across the country without any proper analysis. That course should not be undertaken casually. The nation will discover the answers to these questions with or without NEPA compliance, but without NEPA, the answers will come directly from suffering communities and ecosystems. NEPA ensures that decision-makers instead discover them in advance, "at a stage where real environmental protection may come about [rather] than at a stage where corrective action may be so costly as to be impossible."[153]

Forecasts of this sort are thus extraordinarily helpful, even if they are not entirely precise. As the D.C. Circuit Court of Appeals explained in a seminal NEPA case, the statute is designed to help outline crucial questions and answers early on, in order to guide continued decisionmaking and inquiry:

> The agency need not foresee the unforeseeable, but by the same token neither can it avoid drafting an impact statement simply because describing the environmental effects of and alternatives to particular agency action involves some degree of forecasting. And

[153] *Calvert Cliffs*, 449 F.2d at 1129.

> one of the functions of a NEPA statement is to indicate the extent to which environmental effects are essentially unknown. *It must be remembered that the basic thrust of an agency's responsibility under NEPA is to predict the environmental effects of proposed action before the action is taken and those effects are known.*[154]

The point is not that NEPA analysis at this phase will answer every question about export definitively and completely. Instead, "[r]easonable forecasting and speculation is… implicit in NEPA."[155] What DOE can, at a minimum, do now is to map out the fundamental environmental implications of LNG export. It can identify the scope and magnitude of likely impacts, and it can point to key unknowns that warrant more research. It can underline key concerns (such as the availability of treatment capacity to manage the waste associated with increased production for export) and offer alternatives that could address them. It can consider which regions are most likely to bear the costs of export, and where the benefits are most likely to fall. It can offer the sort of well-balanced, comprehensive, projections for which NEPA is designed.

Such an analysis, at an appropriate level of generality, is plainly required. There is absolutely no serious question that increased unconventional gas production is a "reasonably foreseeable" consequence of licensing LNG exports. Export proponents themselves predict such production increases; indeed, they premise their arguments that their projects are in the public interest in large part on the economic growth which they contend will follow from increased gas production.

For instance, Sabine Pass's promoters promised that their project would "play an influential role in contributing to the growth of natural gas production in the U.S."[156] The proponents of the Freeport project, likewise affirmed their project was "positioned to provide the Gulf Coast region and the United States with significant economic benefits by increasing domestic gas production."[157] Likewise, the Lake Charles project's backers maintained that their export would "spur[] the development of new natural gas resources that might not otherwise make their way to market."[158] The Gulf Coast LNG project's supporters asserted that their project will "allow the U.S. to benefit now from the natural gas resources that may not otherwise be produced for many decades, if ever."[159]

The litany goes on: In Oregon, the investors behind the Jordan Cove project assured DOE that it would be "instrumental in providing the increased demand to spur exploration and development of gas shale assets in North America."[160] And in Maryland, the Dominion Cove Point's project's supporters proclaimed that "[t]he most basic benefit of the proposed LNG exports will be to encourage and support increased domestic production of natural gas…. The

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154 *Scientists' Institute*, 481 F.2d at 1092 (emphasis added).
155 *Id.*
156 Sabine Pass Application at 56 (Sept. 7, 2010).
157 Freeport LNG Application at 14-15 (Dec. 19, 2011).
158 Lake Charles Application at 20 (May 6, 2011).
159 Gulf Coast Application at 11 (Jan. 10, 2012).
160 Jordan Cove Application at 19 (Mar. 23, 2012).

steady new demand associated with LNG exports can spur the development of new natural gas resources that might not otherwise be developed."[161]

The bottom line is that increased domestic gas production is a necessary consequence of export. It is not just foreseeable: It is a principal *justification* for gas export projects. As such, its environmental impacts must be disclosed under NEPA and weighed in the Natural Gas Act public interest determination.[162]

Programmatic analyses of this sort are not unfamiliar to DOE. DOE, in fact, recognizes the importance of the NEPA process as a support for its decisionmaking, and has deep experience with programmatic EISs. Secretary Chu has written that he "cannot overemphasize the importance" of building NEPA compliance into DOE project management.[163] DOE has regularly done so. Over the years, the department has prepared draft and final programmatic EISs and environmental assessments for a nationwide effort to promote energy efficiency,[164] a solar energy promotion program in six western states,[165] energy "corridors" in 11 different states,[166] a global program supporting nuclear power,[167] and a national coal power research and development initiative.[168] Plainly, DOE has had no difficulty developing national-level environmental surveys of large-scale energy decisions, even when the precise location and nature of all site-specific impacts were not yet known. Instead, such broad overviews informed policy. An EIS for LNG export would fit well into this tradition and is certainly entirely possible using DOE's own modeling capacity, as is discussed above.

The courts have made clear, as well, that NEPA requires agencies to take a hard look at the upstream consequences of their decisions. In one recent decision, the Ninth Circuit Court of Appeals rejected the Surface Transportation Board's assertion that, when permitting a new train line serving a coal-producing area, it did not need to consider the coal production the line would doubtless make possible.[169] The agency insisted that such development was not "reasonably foreseeable," even though it relied on the coal production to determine that the train line would be financially viable.[170] The court rightly held that the agency could not permit an infrastructure project justified in large part on increasing fossil fuel production without considering those impacts in a NEPA analysis. The same analysis applies here. LNG export

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[161] Dominion Cove Point Application at 35 (Oct. 3, 2011).

[162] *See also Center for Biological Diversity v. National Highway Traffic and Safety Administration*, 538 F.3d 1172, 1200 (9th Cir. 2008) (where the impact of an agency action is uncertain, agency may not simply given that impact zero weight and fail to address it).

[163] DOE Memorandum, "Improved Decisionmaking Through the Integration of Program and Project Management with [NEPA] Compliance" (June 12, 2012).

[164] *See* DOE, Programmatic Environmental Assessment for the State Energy Conservation Program (1996).

[165] *See* 77 Fed. Reg. 44,267 (July 27, 2012).

[166] *See* 73 Fed. Reg. 72,477 (Nov. 28, 2008).

[167] *See* 73 Fed. Reg. 61,845 (Oct. 17, 2008).

[168] *See* DOE, Final Programmatic Environmental Impact Statement Clean Coal Technology Demonstration Program (1996).

[169] *Northern Plains Resource Council v. Surface Transportation Board*¸668 F.3d 1067, 1081-82 (9th Cir. 2011).

[170] *Id.*

terminals will drive new gas production and, in fact, depend upon that new production to justify their existence.

In the end, it should come as no surprise that DOE's own NEPA regulations provide that large LNG export projects will "normally require EISs."[171] When a project involves either "major operational changes (such as a major increase in the quantity of liquefied natural gas imported or exported)" or the "construction of major new facilities or the significant modification of existing facilities," an EIS is appropriate.[172] These rules, which have been in place since DOE first issued its NEPA regulations,[173] set a clear course for the agency. The applications before it now uniformly involve major increases in the quantity of LNG set for export – by many times over – and also require multi-billion dollar construction projects to create new facilities to support these facilities. An EIS, in these circumstances, is plainly mandated by DOE's own regulations.

C. DOE's National Economic Analyses Demonstrate That It Can Approach Environmental Impacts On A National Level

DOE's abdication of its environmental responsibilities is illegal and unwise. It is unjustifiable based on DOE's own modeling capabilities. It is also strikingly inconsistent with DOE's own approach to the national *economic* implications of LNG export. There, DOE has invested considerable effort in developing a comprehensive general understanding of the economic implications of LNG export, including the impacts of new production. That it can generate such an analysis at a national scale demonstrates that it can pursue the same course for environmental considerations. It should do so to ensure that policymakers and the public have a balanced view of *both* the economic and environmental impacts of exports.

The national economic analysis began, as DOE has explained to Congress, with DOE's realization, after the Sabine Pass conditional approval had issued and more LNG export applications were flooding in, that LNG exports could have real effects on the public interest.[174] DOE did not attempt to avoid grappling with these impacts just because it did not know with complete certainty exactly where production would occur. But, unlike in the environmental context, DOE correctly recognized that such uncertainties were not fatal to a proper national overview.

Instead, DOE immediately and responsibly embarked on two national studies, which were intended to help bring the national economic impacts of export into sharper focus. The first of these was the EIA report discussed above. At DOE's behest, EIA modeled a range of possible export and production scenarios, exploring combinations of different exports rate and timing

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[171] 10 C.F.R. Pt. 1021 App. D to Subpart D, § D8 & D9.
[172] *Id.*
[173] *See* 45 Fed. Reg. 20,694, 20,700 (Mar. 28, 1980).
[174] Letter from Christopher Smith, Deputy Assistant Secretary of Oil and Gas to Representative Edward Markey (Feb. 24, 2012) at 3.

and possible variations in gas supply and economic demand.[175] As a result, EIA was able to generate a range of well-supported impact predictions for these varying scenarios. This analysis uncovered important effects for DOE's consideration, including the prospect of sharp domestic gas and electricity price increases with some export scenarios. Rather than allowing uncertainty to defeat the analysis, EIA considered a range of reasonable outcomes to help better inform policy – just as NEPA requires in the environmental context.

The second study will build further on these results. According to DOE, it will look at sixteen different hypothetical export scenarios to investigate:

> (1) [t]he potential impacts of additional natural gas exports on domestic energy, consumption, production, and prices; (2) the cumulative impact on the U.S. economy, including the effect on gross domestic product, job creation balance of trade; and (3) the impact on the U.S. manufacturing sector (especially energy intensive manufacturing industries).[176]

Rather than dismissing this analysis as "impossible" because it involves some degree of uncertainty, DOE sensibly embraced the task of investigating likely national impacts under varying production scenarios. Although there is, of course, some uncertainty as to the precise effects a particular proposal will have on the economy, the major wave of export proposals will have a predictable effect which can be investigated despite uncertainty as to particular production patterns. Indeed, as noted above, export proponents rely upon induced gas production to help justify their projects.

It is thus not at all surprising that DOE felt it to be both possible and necessary to analyze the economic ramifications of these changes. Of course, such an analysis is appropriate. The surprising point, instead, is that DOE nonetheless has blinded itself to the environmental impacts of the very same production increases it is analyzing.

D. DOE Must Look at Environmental Impacts With the Same Rigor With Which It Examines Economic Impacts

This double-vision – with economics in sharp focus and environmental impacts blurred to invisibility – impermissibly skews the choice before DOE. Both economic impacts and environmental costs weigh in the public interest determination. If DOE is only willing to look at one side of the ledger, it cannot properly fulfill its obligations because it cannot understand the all the aspects of the public's interest which are implicated by export. Without a full NEPA analysis, it cannot make a sound final decision.

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[175] *See* EIA, *Effects of Increased Natural Gas Exports on Domestic Energy Markets* at 1-2.

[176] Letter from Christopher Smith, Deputy Assistant Secretary of Oil and Gas to Representative Edward Markey at 4.

The courts have made this point clear. Very early in NEPA's history, the Atomic Energy Commission insisted that it could not forecast the environmental impacts of a power plant research program for which it had already developed an economic analysis.[177] The D.C. Circuit Court of Appeals held this position had a "hollow ring" given that the Commission was happy to use its economic analyses in "convincing Congress" to support its plans.[178] As the court held, if economic analyses can be prepared, then "in turn … parallel environmental forecasts would be accurate for use in planning how to cope with and minimize the detrimental effects attendant upon" the course the agency wishes to pursue, "and in evaluating the program's overall desirability."[179] Agencies cannot skew their analyses, or mask the costs of their actions, by examining only one side of a problem while refusing to consider the other.

The Ninth Circuit Court of Appeals corrected the same error in its coal train line case, discussed above. There, too, while insisting that coal mines triggered by a new train line were too speculative to analyze under NEPA, the agency nonetheless "relied on the coal mine development … to justify the financial soundness of the proposal" which it approved.[180] Once again, the court held that an agency may not rely on economic predictions while simultaneously refusing to acknowledge the environmental impacts of the economic activity it is permitting.

The same analysis applies, with great force, to DOE's situation here. The agency has proven willing and able to analyze the economic impacts of LNG export and is in the process of expending considerable funds to improve its forecasting. Further, in individual licensing proceedings, it is clearly open to relying on predictions of increased economic activity from gas production to justify the licensing export. The very same drilling and production forecasts it is now working up in that context could, and should, inform an analysis of the environmental impacts of those decisions. There is nothing inherently harder in saying that ten thousand new wells will produce *x* dollars in tax revenue or *y* tons of pollution than in predicting they will produce *z* new jobs. DOE cannot conduct one analysis while neglecting the other.

DOE cannot embrace sunny economic predictions while ignoring real environmental costs. Such a course is not only contrary to NEPA, but will render the public interest determination process fundamentally unreliable. DOE must tally up the benefits of export, but it must also count the costs.

E. The Need for NEPA

DOE has thus far refused to give any weight to the landscape-level changes large-scale LNG export would produce. This error is serious. Uncorrected, it will distort policy by masking the domestic consequences of export.

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[177] *See Scientists' Institute*, 481 F.2d at 1096-97.
[178] *Id.* at 1097.
[179] *Id.*
[180] *Northern Plains*, 668 F.3d at 1082.

Export proponents would, of course, prefer that these consequences go unremarked. Even as they tout the large increases in fracking that their projects will support, they insist that DOE must not and cannot even begin to account for the environmental consequences of their projects. But even if DOE ignores these impacts, American communities will feel the impacts of this production as exports ramp up. Rather than proceeding blindly while locking in these future harms, NEPA charges DOE with accounting for those impacts now, and the Natural Gas Act makes clear that it must take these harms into account as it considers the public interest.

DOE has the time it needs to do the right thing. It has already committed to Congress not to issue any further export licenses for export to non-free-trade-agreement nations until its second economic study is complete.[181] (Its decision to nonetheless finalize the in-process Sabine Pass license is a disturbing anomaly). DOE has recently announced that this economic study, originally slated for release in spring 2012, will not be released until this coming winter. It is taking the time it needs to gather meaningful economic information. It can and should do the same for environmental information.

There is no statutory deadline to issue licenses, and every reason to ensure that DOE's final decisions are as well-reasoned as possible. LNG export terminals represent billions of dollars in investment capital, and export licenses often last for decades. Before committing to this near-irrevocable investment, DOE owes it to itself and the public to take the time it needs to develop as full and careful analysis as possible.

VI. Preserving DOE's Authority to Protect the Public Interest

DOE must use its authority to prepare a proper EIS for LNG export. But, thanks to ongoing trade negotiations, this is not the only challenge DOE faces in order to protect the public interest. It must also act quickly, in coordination with Congress and the Executive, to ensure that its regulatory ability to protect the public is not inadvertently destroyed.

The problem confronting DOE is an unintended consequence of Congress's 1992 decision to speed LNG imports from Canada. To protect those imports, Congress directed that DOE *must* license LNG imports *and exports* from nations with which the U.S. has signed a free trade agreement providing for national treatment of natural gas.[182] Up to this point, this rubber stamp process has not been at issue, but that may be about to change.

The proposed Trans-Pacific Partnership (TPP) is a massive trade agreement currently under negotiation between the United States and ten other Pacific Rim nations.[183] Its influence could be even broader, however. The TPP is intended to be a "docking station" for new signatories,

[181] Letter from Christopher Smith, Deputy Assistant Secretary of Oil and Gas to Representative Edward Markey at 4.
[182] *See*15 U.S.C. § 717b(c).
[183] *See* http://www.ustr.gov/tpp.

permanently open for expansion, so it could establish an ever-expanding web of countries to which LNG *must* be exported if the market can sustain the demand.

Already, several potential signatories, including Chile and Singapore, are LNG importers and so would be able to take imports from the United States without any public interest oversight. And, critically, there is a very real possibility that Japan may join the talks and the final agreement.[184] Japan is the largest LNG importer in the world.[185]

If Japan is included in the TPP, with national treatment of natural gas, DOE will lose its discretion to condition any exports to Japan on the public interest. Such exports would be automatically licensed. Because Japan has the potential to absorb large amounts of U.S. gas, the loss of DOE's ability to carefully examine the consequences of those exports before licensing them is a serious concern. Regardless of the results of the NEPA analysis we recommend here, or of the economic studies DOE is conducting, exports would be legally mandated.

This result is not what Congress intended when it inserted the free-trade-agreement exception language in 1992. At that time, LNG export from the United States was neither possible nor contemplated. Instead, Congress was focused on removing barriers to natural gas imports from Canada.

The 1992 amendments, in fact, did not even reference export when proposed. Congressman Phil Sharp (D-IN), Chairman of the House Subcommittee on Energy and Power (and H.R. 776's original sponsor) stated that the amendments' purpose was only "deregulating Canadian natural gas imports."[186] Likewise Congressman Norman Lent (R-NY), Ranking Member of the House Committee on Energy and Commerce, explained that the amendments were "vital to assuring that U.S. regulators do not interfere with the importation of natural gas to customers in the United States."[187]Congressman Edward Markey (D-OR), who is a current skeptical voice on export, strongly supported the provisions, describing them as "important new statutory assurances that U.S. regulators will not discriminate against *imported* natural gas."[188]

Language providing for automatic approval of export applications as well as import applications in the free trade context was added in the final conference on the bill, with no recorded debate. The conference report does not justify this discussion, noting only that the final bill "includes an

[184] *See, e.g.*, Paul McBeth, National Business Review, "Pressure on Japan as Canada joins TPP talks" (June 20, 2012); ICIS Heren, "Japan Warms to U.S. Liquefaction Prospects" (Mar. 12, 2012).
[185] *See* EIA Country Statistics for Japan, http://www.eia.gov/countries/country-data.cfm?fips=JA#ng.
[186] 138 Cong. Rec. 32,075 (Oct. 5, 1992).
[187] 138 Cong. Rec. 32,083 (Oct. 5, 1992)
[188] Extension of Remarks, Cong. Rec. (Oct. 9, 1992), "Concerning Gas Import Provisions in H.R. 776, The Energy Policy Act of 1992) (emphasis added).

amended section… regarding fewer restrictions on certain natural gas imports and exports."[189] Whatever the justification for this expansion, it seems very clear that large-scale LNG exports were not on Congress's mind. The debate to this point had focused on Canadian imports, and, large-scale LNG exports were, in any event, not possible at the time. Indeed, Chairman Sharp described the final amended language as concerning "exports of natural gas *to Canada* from the United States" and affirmed (despite the seemingly open-ended final language) that "as drafted, the new fast task track process would not be available for LNG exports to, for example, Pacific rim nations other than Canada."[190]

At bottom, as DOE explained in a recent letter to Congress, "Congress's attention [in 1992] was focused on North American trade, not on the potential impact of the amendment on United States trade with other countries overseas."[191] Yet, the TPP, and the prospect of other such agreements, threatens to expand this exemption into a wholesale roll-back of DOE's regulatory discretion to protect the public interest. Should this occur, both the careful NEPA process and the public interest determination themselves would be suddenly and inappropriately truncated. In essence, the U.S. would see as much fracking activity as is necessary to support exports for the Asian market, with no direct domestic oversight of these exports.

This serious unintended consequence argues for swift remedial action. Several courses could be available. It may, first, be possible for the U.S. Trade Representative to draft the TPP to include exceptions for national treatment in natural gas, which could preserve DOE's authority. Second, Congress could certainly modify the provision to remove fast track authority for exports. Third, at a minimum, agreements that would remove DOE's discretion to regulate exports certainly should not be concluded until a full environmental impact statement for export has been completed. That report will help policymakers determine how exports should be managed – critically important information for U.S. trade negotiators before they finalize any deal that would commit the nation to exports without any further oversight.

So far, however, DOE has not taken any of these steps, and neither has the U.S. Trade Representative. In meetings and phone conversations with the Sierra Club, the Trade Representative has insisted that DOE, not the Representative, must address the issue. DOE, in turn, has placed responsibility for protecting the public interest review process back on the Trade Representative. The result is that both agencies are pointing fingers at each other, and neither is taking responsibility for addressing this serious matter. Unless they change course,or Congress or the Executive act to insist that they do so, the result may be that the U.S. gives up its ability to manage LNG exports without even thinking about it.

VII. Conclusion: A Full EIS is Needed to Inform Policymakers and the Public

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[189] H.R. Conf. Rep. 102-1018, 1992 USCCAN 2472, 2477 (Oct. 5, 1992); *see also* 138 Cong. Rec. 34,043 (Oct.8. 1992) (statement of conferees, explaining only that the final bill "has been expanded to include fewer restrictions on exports of natural gas to countries with which the United States has a Free Trade Agreement.").

[190] 38 Cong. Rec. 32,076 (Oct. 5, 1992) (emphasis added).

[191] Letter from Christopher Smith, Deputy Assistant Secretary of Oil and Gas to Representative Edward Markey (Feb. 24, 2012) at 1.

The United States is sleepwalking through one of the biggest energy policy decisions of our time. Even as billions of dollars in investment capital are marshaled to support an ever-growing wave of export proposals, the federal agencies in charge of protecting the public interest have failed even to consider the environmental implications of exporting a large amount of the domestic gas supply – including the intensified fracking needed to support exports. Meanwhile, trade negotiators risk stripping away DOE's discretion ever to properly manage these problems, even if it does finally analyze and disclose them.

No matter where one stands on the ultimate wisdom of LNG exports, it is clear that this sort of blind, piecemeal, decisionmaking is what NEPA was designed to prevent. For more than 40 years, NEPA has reflected a national commitment to transparent, democratic, and careful decisionmaking to protect communities and our environment. That commitment applies with great force to DOE's decisionmaking now, and the agency should honor it. The possible conversion of the United States into one of the world's largest LNG exporters is a matter of national importance and a key shift in environmental and economic policy. If a full NEPA analysis of all the consequences, upstream and downstream, of an agency's decisions were ever appropriate for any agency action, then an EIS is surely appropriate now, when the nation's energy future is profoundly implicated by DOE's decisions. It is time for a full programmatic environmental impact statement for LNG export.

DOE has the time and the duty to do the right thing and begin the open, public, environmental impact statement process it should have initiated at the outset. It must retreat from its dereliction of duty in the Sabine Pass environmental process, and instead extend its national review process from the economic studies it has already begun to the environmental studies it also plainly needs. Before issuing another license on a piecemeal basis, it should change course, acknowledge its responsibilities, and begin the national conversation we urgently need to have.

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Table 1. Summary of natural gas supply and disposition in the United States, 2007-2012
(billion cubic feet)

Year and Month	Gross Withdrawals	Marketed Production	Extraction Loss[a]	Dry Gas Production[b]	Supplemental Gaseous Fuels[c]	Net Imports	Net Storage Withdrawals[d]	Balancing Item[e]	Consumption[f]
2007 Total	**24,664**	**20,196**	**930**	**19,266**	**63**	**3,785**	**192**	**-203**	**23,104**
2008 Total	**25,636**	**21,112**	**953**	**20,159**	**61**	**3,021**	**34**	**2**	**23,277**
2009 Total	**26,057**	**21,648**	**1,024**	**20,624**	**65**	**2,679**	**-355**	**-103**	**22,910**
2010									
January	R2,210	R1,824	R87	R1,737	5	291	822	R-46	R2,810
February	R2,048	R1,683	R80	R1,603	5	236	628	R9	R2,481
March	R2,277	R1,865	R89	R1,776	5	219	34	R109	R2,143
April	R2,190	R1,813	86	R1,727	5	223	-364	R102	R1,692
May	R2,237	R1,886	90	R1,797	5	212	-416	R19	R1,617
June	R2,139	R1,802	86	R1,717	5	192	-326	R61	R1,650
July	R2,209	R1,896	R90	R1,806	R5	243	-231	R2	R1,826
August	R2,235	R1,918	R91	R1,827	6	221	-190	R16	R1,879
September	R2,238	R1,861	89	R1,772	5	202	-363	R21	R1,637
October	R2,357	R1,956	93	R1,863	6	199	-360	R-42	R1,665
November	R2,277	R1,893	90	R1,802	5	150	77	R-61	R1,973
December	R2,400	R1,984	R95	R1,890	6	217	675	R-73	R2,714
Total	**R26,816**	**R22,382**	**R1,066**	**R21,316**	**65**	**2,604**	**-13**	**R115**	**R24,087**
2011									
January	R2,299	R1,953	92	R1,861	R5	R236	R811	R-31	R2,882
February	R2,104	R1,729	R82	R1,647	R4	R186	R594	R16	R2,448
March	R2,411	R2,002	R95	R1,908	R5	R171	R151	R-3	R2,232
April	R2,350	R1,961	R93	R1,868	5	R151	R-216	R20	R1,828
May	R2,411	R2,031	R96	R1,935	R5	139	R-405	R-10	R1,663
June	R2,313	R1,954	R92	R1,862	5	R147	R-346	R-15	R1,653
July	R2,340	R2,033	R96	R1,937	5	R180	R-248	R3	R1,877
August	R2,370	R2,057	R97	R1,960	5	R169	R-249	R-7	R1,878
September	R2,358	R1,987	R94	R1,893	5	R125	R-404	R27	R1,646
October	R2,502	R2,119	R100	R2,019	5	R173	R-391	R-65	R1,741
November	R2,476	R2,076	R98	R1,978	5	R121	R-41	R-50	R2,014
December	R2,544	R2,135	R101	R2,034	R5	R163	R390	R-69	R2,524
Total	**R28,479**	**R24,036**	**R1,134**	**R22,902**	**R60**	**R1,962**	**R-354**	**R-185**	**R24,385**
2012									
January	R2,573	RE2,149	109	RE2,041	6	R151	545	R8	R2,750
February	R2,378	RE1,989	102	RE1,887	5	R140	459	R10	R2,501
March	R2,537	RE2,123	109	RE2,014	6	124	-39	R19	R2,124
April	R2,445	RE2,065	105	RE1,960	R4	120	-137	R8	R1,956
May	R2,530	RE2,139	108	RE2,031	4	R126	-283	R-8	R1,871
June	R2,420	RE2,061	103	RE1,958	5	134	-230	R0	R1,868
July	R2,456	RE2,137	106	RE2,031	5	162	-134	R7	R2,071
August	R2,372	RE2,128	107	RE2,021	5	R142	-168	R1	R2,001
September	R2,428	RE2,086	109	RE1,978	5	R121	R-291	R-14	R1,798
October	2,571	E2,172	114	E2,058	5	113	-241	-46	1,888
2012 10-Month YTD	**24,710**	**E21,051**	**1,073**	**E19,978**	**51**	**1,332**	**-520**	**-14**	**20,827**
2011 10-Month YTD	**23,459**	**19,825**	**936**	**18,890**	**50**	**1,677**	**-704**	**-65**	**19,847**
2010 10-Month YTD	**22,139**	**18,505**	**882**	**17,623**	**53**	**2,238**	**-765**	**250**	**19,399**

[a] Monthly extraction loss is derived from sample data reported by gas processing plants on Form EIA-816, "*Monthly Natural Gas Liquids Report*," and Form EIA-64A, "*Annual Report of the Origin of Natural Gas Liquids Production*."

[b] Equal to marketed production minus extraction loss.

[c] Supplemental gaseous fuels data are collected only on an annual basis except for the Dakota Gasification Co. coal gasification facility which provides data each month. The ratio of annual supplemental fuels (excluding Dakota Gasification Co.) to the sum of dry gas production, net imports, and net withdrawals from storage is calculated. This ratio is applied to the monthly sum of these three elements. The Dakota Gasification Co. monthly value is added to the result to produce the monthly supplemental fuels estimate.

[d] Monthly and annual data for 2007 through 2010 include underground storage and liquefied natural gas storage. Data for January 2011 forward include underground storage only. See Appendix A, Explanatory Note 5, for discussion of computation procedures.

[e] Represents quantities lost and imbalances in data due to differences among data sources. Net imports and balancing item for 2007-2009 excludes net intransit deliveries. These net intransit deliveries were (in billion cubic feet): 44 for 2011; -9 for 2010; -14 for 2009; -31 for 2008; and -6 for 2007. See Appendix A, Explanatory Note 7, for full discussion.

[f] Consists of pipeline fuel use, lease and plant fuel use, vehicle fuel, and deliveries to consuming sectors as shown in Table 2.

[R] Revised data.

[E] Estimated data.

[RE] Revised estimated data.

Notes: Data for 2007 through 2010 are final. All other data are preliminary unless otherwise indicated. Geographic coverage is the 50 States and the District of Columbia. Totals may not equal sum of components because of independent rounding.

Sources: 2007-2010: Energy Information Administration (EIA), *Natural Gas Annual 2011*. January 2011 through current month: Form EIA-914, "*Monthly Natural Gas Production Report*"; Form EIA-857, "*Monthly Report of Natural Gas Purchases and Deliveries to Consumers*"; Form EIA-191M, "*Monthly Underground Gas Storage Report*"; EIA computations and estimates; and Office of Fossil Energy, "*Natural Gas Imports and Exports*." See Table 7 for detailed source notes for Marketed Production. See Appendix A, Notes 3 and 4, for discussion of computation and estimation procedures and revision policies.

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U.S. Energy Information Administration

Effect of Increased Natural Gas Exports on Domestic Energy Markets

as requested by the Office of Fossil Energy

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Preface

The U.S. Energy Information Administration (EIA) is the statistical and analytical agency within the U.S. Department of Energy. EIA collects, analyzes, and disseminates independent and impartial energy information to promote sound policymaking, efficient markets, and public understanding of energy and its interaction with the economy and the environment. By law, EIA's data, analyses, and forecasts are independent of approval by any other officer or employee of the U.S. Government. The views in this report, therefore, should not be construed as representing those of the Department of Energy or other Federal agencies.

The projections in this report are not statements of what *will* happen but of what *might* happen, given the assumptions and methodologies used. The Reference case in this report is a business-as-usual trend estimate, reflecting known technology and technological and demographic trends, and current laws and regulations. Thus, it provides a policy-neutral starting point that can be used to analyze policy initiatives. EIA does not propose, advocate, or speculate on future legislative and regulatory changes.

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Introduction

This report responds to an August 2011 request from the Department of Energy's Office of Fossil Energy (DOE/FE) for an analysis of "the impact of increased domestic natural gas demand, as exports." Appendix A provides a copy of the DOE/FE request letter. Specifically, DOE/FE asked the U.S. Energy Information Administration (EIA) to assess how specified scenarios of increased natural gas exports could affect domestic energy markets, focusing on consumption, production, and prices.

DOE/FE provided four scenarios of export-related increases in natural gas demand (Figure 1) to be considered:

- 6 billion cubic feet per day (Bcf/d), phased in at a rate of 1 Bcf/d per year (low/slow scenario),
- 6 Bcf/d phased in at a rate of 3 Bcf/d per year (low/rapid scenario),
- 12 Bcf/d phased in at a rate of 1 Bcf/d per year (high/slow scenario), and
- 12 Bcf/d phased in at a rate of 3 Bcf/d per year (high/rapid scenario).

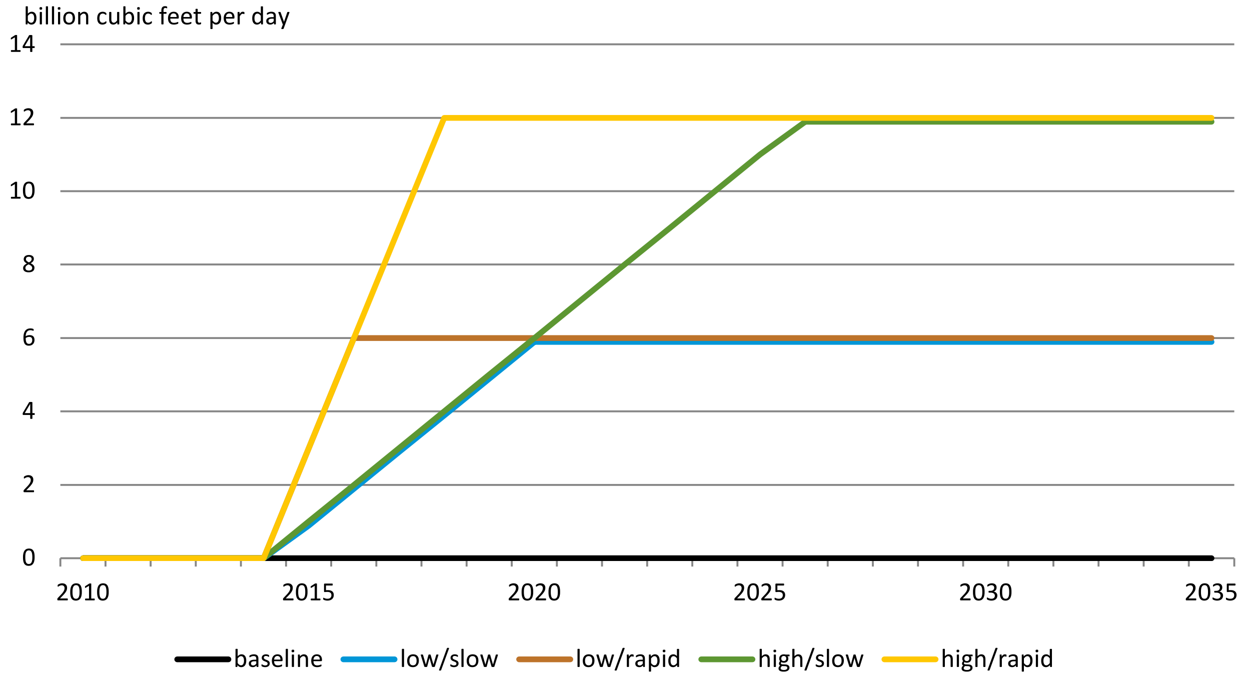
Total marketed natural gas production in 2011 was about 66 Bcf/d. The two ultimate levels of increased natural gas demand due to additional exports in the DOE/FE scenarios represent roughly 9 percent or 18 percent of current production.

DOE/FE requested that EIA consider the four scenarios of increased natural gas exports in the context of four cases from the EIA's *2011 Annual Energy Outlook* (*AEO2011*) that reflect varying perspectives on the domestic natural gas supply situation and the growth rate of the U.S. economy. These are:

- the *AEO2011* Reference case,
- the High Shale Estimated Ultimate Recovery (EUR) case (reflecting more optimistic assumptions about domestic natural gas supply prospects, with the EUR per shale gas well for new, undrilled wells assumed to be 50 percent higher than in the Reference case),
- the Low Shale EUR case (reflecting less optimistic assumptions about domestic natural gas supply prospects, with the EUR per shale gas well for new, undrilled wells assumed to be 50 percent lower than in the Reference case), and
- the High Economic Growth case (assuming the U.S. gross domestic product will grow at an average annual rate of 3.2 percent from 2009 to 2035, compared to 2.7 percent in the Reference case, which increases domestic energy demand).

DOE/FE requested this study as one input to their assessment of the potential impact of current and possible future applications to export domestically produced natural gas. Under Section 3 of the Natural Gas Act (NGA) (15 U.S.C. § 717b), DOE must evaluate applications to import and export natural gas and liquefied natural gas (LNG) to or from the United States. The NGA requires DOE to grant a permit unless it finds that such action is not consistent with the public interest. As a practical matter, the need for DOE to make a public interest judgment applies only to trade involving countries that have not entered into a free trade agreement (FTA) with the United States requiring the national treatment for trade in natural gas and LNG. The NGA provides that applications involving imports from or exports to an FTA country are deemed to be in the public interest and shall be granted without modification or delay. Key countries with FTAs include Canada and Mexico, which engage in significant natural gas trade with the United States via pipeline. A FTA with South Korea, currently the world's second largest importer of LNG, which does not currently receive domestically produced natural gas from the United States, has been ratified by both the U.S. and South Korean legislatures, but had not yet entered into force as of the writing of this report.

Figure 1. Four scenarios of increased natural gas exports specified in the analysis request



Source: U.S. Energy Information Administration based on DOE Office of Fossil Energy request letter

Analysis approach

EIA used the *AEO2011* Reference case issued in April 2011 as the starting point for its analysis and made several changes to the model to accommodate increased exports. EIA exogenously specified additional natural gas exports from the United States in the National Energy Modeling System (NEMS), as the current version of NEMS does not generate an endogenous projection of LNG exports. EIA assigned these additional exports to the West South Central Census Division.[1] Any additional natural gas consumed during the liquefaction process is counted within the total additional export volumes specified in the DOE/FE scenarios. Therefore the net volumes of LNG produced for export are roughly 10 percent below the gross volumes considered in each export scenario.

Other changes in modeled flows of gas into and out of the lower-48 United States were necessary to analyze the increased export scenarios. U.S. natural gas exports to Canada and U.S. natural gas imports from Mexico are exogenously specified in all of the *AEO2011* cases. U.S. imports of natural gas from

[1] This effectively assumes that incremental LNG exports would be shipped out of the Gulf Coast States of Texas or Louisiana.

Canada are endogenously set in the model and continue to be so for this study. However, U.S. natural gas exports to Mexico and U.S. LNG imports that are normally determined endogenously within the model were set to the levels projected in the associated *AEO2011* cases for this study. Additionally, EIA assumed that an Alaska pipeline, which would transport Alaskan produced natural gas into the lower-48 United States, would not be built during the forecast period in any of the cases in order to isolate the lower-48 United States supply response. Due to this restriction, both the *AEO2011* High Economic Growth and Low Shale EUR cases were rerun, as those cases had the Alaska pipeline entering service during the projection period in the published *AEO2011*.

Caveats regarding interpretation of the analysis results

EIA recognizes that projections of energy markets over a 25-year period are highly uncertain and subject to many events that cannot be foreseen, such as supply disruptions, policy changes, and technological breakthroughs. This is particularly true in projecting the effects of exporting significant natural gas volumes from the United States due to the following factors:

- NEMS is not a world energy model and does not address the interaction between the potential for additional U.S. natural gas exports and developments in world natural gas markets.
- Global natural gas markets are not integrated and their nature could change substantially in response to significant changes in natural gas trading patterns. Future opportunities to profitably export natural gas from the United States depend on the future of global natural gas markets, the inclusion of relevant terms in specific contracts to export natural gas, as well as on the assumptions in the various cases analyzed.
- Macroeconomic results have not been included in the analysis because the links between the energy and macroeconomic modules in NEMS do not include energy exports.
- NEMS domestic focus makes it unable to account for all interactions between energy prices and supply/demand in energy-intensive industries that are globally competitive. Most of the domestic industrial activity impacts in NEMS are due to changes in the composition of final demands rather than changes in energy prices. Given its domestic focus, NEMS does not account for the impact of energy price changes on the global utilization pattern for existing capacity or the siting of new capacity inside or outside of the United States in energy-intensive industries.

Representation of natural gas markets

Unlike the oil market, current natural gas markets are not integrated globally. In today's markets, natural gas prices span a range from $0.75 per million British thermal units (MMBtu) in Saudi Arabia to $4 per MMBtu in the United States and $16 per MMBtu in Asian markets that rely on LNG imports. Prices in European markets, which reflect a mix of spot prices and contract prices with some indexation to oil, fall between U.S and Asian prices. Spot market prices at the U.K. National Balancing Point averaged $9.21 per MMBtu during November 2011.

Liquefaction projects typically take four or more years to permit and build and are planned to run for at least 20 years. As a result, expectations of future competitive conditions over the lifetime of a project play a critical role in investment decisions. The current large disparity in natural gas prices across major world regions, a major driver of U.S. producers' interest in possible liquefaction projects to increase natural gas exports, is likely to narrow as natural gas markets become more globally integrated. Key questions remain regarding how quickly convergence might occur and to what extent it will involve all or only some global regions. In particular, it is unclear how far converged prices may reflect purely "gas on gas" competition, a continuing relationship between natural gas and oil prices as in Asia (and to a lesser extent in Europe), or some intermediate outcome. As an example of the dynamic quality of global gas markets, recent regulatory changes combined with abundant supplies and muted demands appear to have put pressure on Europe's oil-linked contract gas prices.

U.S. market conditions are also quite variable, as monthly average Henry Hub spot prices have ranged from over $12 to under $3 per MMBtu over the past five years. Furthermore, while projected Henry Hub prices in the *AEO2011* Reference case reach $7.07 per MMBtu in 2035, in the High and Low Shale EUR cases prices in 2035 range from $5.35 per MMBtu to $9.26 per MMBtu.[2] For purposes of this study, the scenarios of additional exports posited by DOE/FE in their request do not vary across the different baseline cases that are considered. In reality, given available prices in export markets, lower or higher U.S. natural gas prices would tend to make any given volume of additional exports more or less likely.

The prospects for U.S. LNG exports depend greatly on the cost-competitiveness of liquefaction projects in the United States relative to those at other locations. The investment to add liquefaction capacity to an existing regasification terminal in the United States is significant, typically several times the original cost of a regasification-only terminal. However, the ability to make use of existing infrastructure, including natural gas processing plants, pipelines, and storage and loading facilities means that U.S. regasification terminals can reduce costs relative to those that would be incurred by a "greenfield" LNG facility. Many of the currently proposed LNG supply projects elsewhere in the world are integrated standalone projects that would produce, liquefy, and export stranded natural gas. These projects would require much more new infrastructure, entailing not only the construction of the liquefaction plant from the ground up, but also storage, loading, and production facilities, as well pipelines and natural gas processing facilities.

While the additional infrastructure for integrated standalone projects adds considerably to their cost, such projects can be sited at locations where they can make use of inexpensive or stranded natural gas resources that would have minimal value independent of the project. Also, while these projects may require processing facilities to remove impurities and liquids from the gas, the value of the separated liquids can improve the overall project economics. On the other hand, liquefaction projects proposed for the lower-48 United States plan to use pipeline gas drawn from the largest and most liquid natural gas market in the world. Natural gas in the U.S. pipeline system has a much greater inherent value than stranded natural gas, and most of the valuable natural gas liquids have already been removed.

Future exports of U.S. LNG depend on other factors as well. Potential buyers may place additional value on the greater diversity of supply that North American liquefaction projects provide. Also, the degree of regulatory and other risks are much lower for projects proposed in countries like the United States,

[2] All prices in this report are in 2009 dollars unless otherwise noted. For the Low Shale EUR case used in this study the Henry Hub price in 2035 is $9.75 per MMBtu, slightly higher than in the AEO2011 case with the Alaska pipeline projected to be built towards the end of the projection period.

Canada, and Australia than for those proposed in countries like Iran, Venezuela, and Nigeria. However, due to relatively high shipping costs, LNG from the United States may have an added cost disadvantage in competing against countries closer to key markets, such as in Asia. Finally, LNG projects in the United States would frequently compete not just against other LNG projects, but against other natural gas supply projects aimed at similar markets, such as pipeline projects from traditional natural gas sources or projects to develop shale gas in Asia or Europe.

Macroeconomic considerations related to energy exports and global competition in energy-intensive industries

Macroeconomic results have not been included in the analysis because energy exports are not explicitly represented in the NEMS macroeconomic module. [3] The macroeconomic module takes energy prices, energy production, and energy consumption as inputs (or assumptions) from NEMS energy modules. The macroeconomic module then calculates economic drivers that are passed back as inputs to the NEMS energy modules. Each energy module in NEMS uses different economic inputs; however these economic concepts are encompassed by U.S. gross domestic product (GDP), a summary measure describing the value of goods and services produced in the economy.[4]

The net exports component of GDP in the macroeconomic module, however, does not specifically account for energy exports. As a result, increases in energy exports generated in the NEMS energy modules are not reflected as increases in net exports of goods and services in the macroeconomic module. This results in an underestimation of GDP, all else equal. The components of GDP are calculated based on this underestimated amount as well, and do not reflect the increases in energy exports. This is particularly important in the industrial sector, where the value of its output will not reflect the increased energy exports either.

The value of output in the domestic industrial sector in NEMS depends in general on both domestic and global demand for its products, and on the price of inputs. Differences in these factors between countries will also influence where available production capacity is utilized and where new production capacity is built in globally competitive industries. For energy-intensive industries, the price of energy is particularly important to utilization decisions for existing plants and siting decisions for new ones. Given its domestic focus, however, NEMS does not account for the impact of energy price changes on global utilization pattern of existing capacity or the siting of new capacity inside or outside of the United States in energy-intensive industries. Capturing these linkages requires an international model of the particular industry in question, paired with a global macroeconomic model.

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[3] In the macroeconomic model, energy exports are used in two places: estimating exports of industrial supplies and materials and estimating energy's impact on the overall production of the economy. To assess their impact on overall production, energy exports are included in the residual between energy supply (domestic production plus imports) and energy demand. This residual also includes changes in inventory.

[4] GDP is defined as the sum of consumption, investment, government expenditure and net exports (equal to exports minus imports).

Summary of Results

Increased natural gas exports lead to higher domestic natural gas prices, increased domestic natural gas production, reduced domestic natural gas consumption, and increased natural gas imports from Canada via pipeline.

Impacts overview

- **Increased natural gas exports lead to increased natural gas prices.** Larger export levels lead to larger domestic price increases, while rapid increases in export levels lead to large initial price increases that moderate somewhat in a few years. Slower increases in export levels lead to more gradual price increases but eventually produce higher average prices during the decade between 2025 and 2035.

- **Natural gas markets in the United States balance in response to increased natural gas exports largely through increased natural gas production.** Increased natural gas production satisfies about 60 to 70 percent of the increase in natural gas exports, with a minor additional contribution from increased imports from Canada. Across most cases, about three-quarters of this increased production is from shale sources.

- **The remaining portion is supplied by natural gas that would have been consumed domestically if not for the higher prices.** The electric power sector accounts for the majority of the decrease in delivered natural gas. Due to higher prices, the electric power sector primarily shifts to coal-fired generation, and secondarily to renewable sources, though there is some decrease in total generation due to the higher price of natural gas. There is also a small reduction in natural gas use in all sectors from efficiency improvements and conservation.

- **Even while consuming less, on average, consumers will see an increase in their natural gas and electricity expenditures.** On average, from 2015 to 2035, natural gas bills paid by end-use consumers in the residential, commercial, and industrial sectors combined increase 3 to 9 percent over a comparable baseline case with no exports, depending on the export scenario and case, while increases in electricity bills paid by end-use customers range from 1 to 3 percent. In the rapid growth cases, the increase is notably greater in the early years relative to the later years. The slower export growth cases tend to show natural gas bills increasing more towards the end of the projection period.

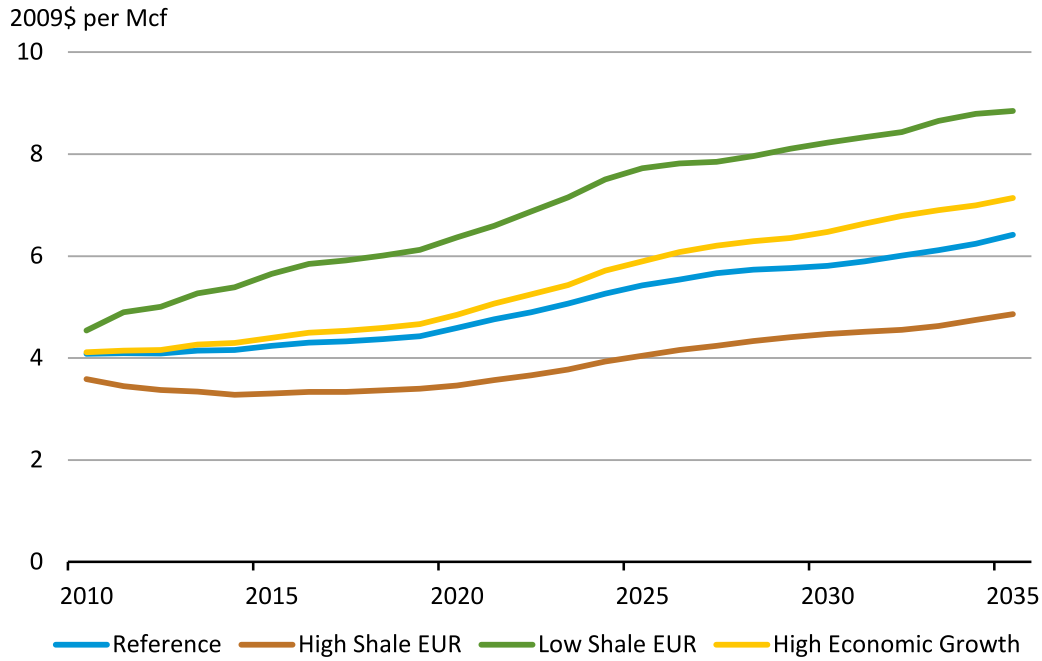
Natural gas prices

Wellhead natural gas prices in the baseline cases (no additional exports)

EIA projects that U.S. natural gas prices are projected to rise over the long run, even before considering the possibility of additional exports (Figure 2). The projected price increase varies considerably, depending on the assumptions one makes about future gas supplies and economic growth. Under the Reference case, domestic wellhead prices rise by about 57 percent between 2010 and 2035. But different assumptions produce different results. Under the more optimistic resource assumptions of the High Shale EUR case, prices actually fall at first and rise by only 36 percent by 2035. In contrast, under the more pessimistic resource assumptions of the Low Shale EUR case, prices nearly double by 2035.

While natural gas prices rise across all four baseline cases (no additional exports) considered in this report, it should be noted that natural gas prices in all of the cases are far lower than the price of crude oil when considered on an energy-equivalent basis. Projected natural gas prices in 2020 range from $3.46 to $6.37 per thousand cubic feet (Mcf) across the four baseline cases, which roughly corresponds to an oil price range of $20 to $36 per barrel in energy-equivalent terms. In 2030, projected baseline natural gas prices range from $4.47 to $8.23 per Mcf in the four baseline cases, which roughly corresponds to an oil price range of $25 to $47 per barrel in energy-equivalent terms.

Figure 2. Natural gas wellhead prices in the baseline cases (no additional exports)



Source: U.S. Energy Information Administration, National Energy Modeling System

Export scenarios—relationship between wellhead and delivered natural gas prices

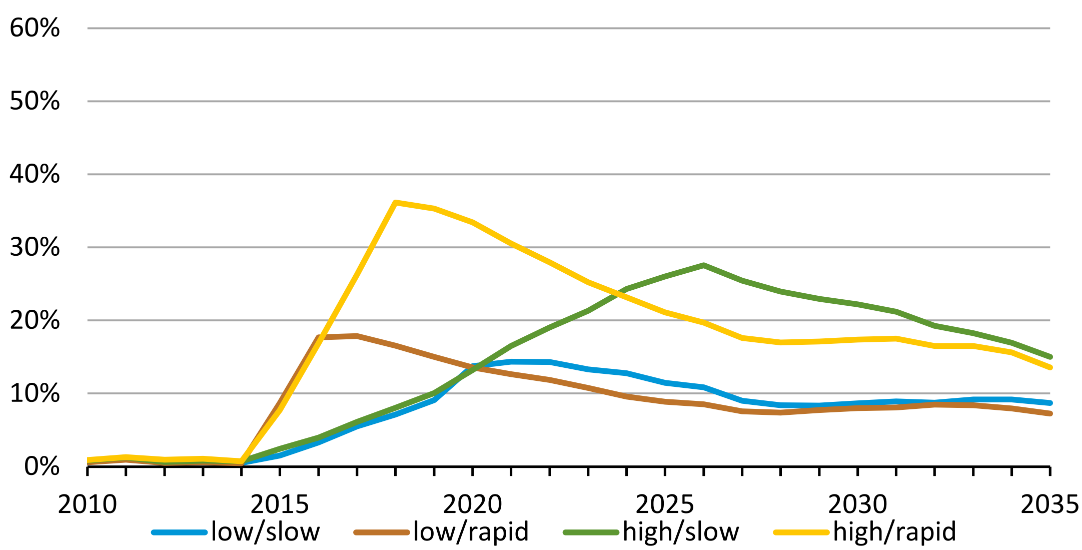
Increases in natural gas prices at the wellhead translate to similar absolute increases in delivered prices to customers under all export scenarios and baseline cases. However, delivered prices include transportation charges (for most customers) and distribution charges (especially for residential and commercial customers). These charges change to much less of a degree than the wellhead price does under different export scenarios. As a result, the percentage change in prices that industrial and electric customers pay tends to be somewhat lower than the change in the wellhead price. The percentage change in prices that residential and commercial customers pay is significantly lower. Summary statistics on delivered prices are provided in Appendix B. More detailed results on delivered prices and other report results can be found in the standard NEMS output tables that are posted online.

Export scenarios – wellhead price changes under the Reference case.

Increased exports of natural gas lead to increased wellhead prices in all cases and scenarios. The basic pattern is evident in considering how prices would change under the Reference case (Figure 3):

- The pattern of price increases reflects both the ultimate level of exports and the rate at which increased exports are phased in. In the low/slow scenario (which phases in 6 Bcf/d of exports over six years), wellhead price impacts peak at about 14% ($0.70/Mcf) in 2022. However, the wellhead price differential falls below 10 percent by about 2026.
- In contrast, rapid increases in export levels lead to large initial price increases that would moderate somewhat in a few years. In the high/rapid scenario (which phases in 12 Bcf/d of exports over four years), wellhead prices are about 36 percent higher ($1.58/Mcf) in 2018 than in the no-additional-exports scenario. But the differential falls below 20 percent by about 2026. The sharp projected price increases during the phase-in period reflect what would be needed to balance the market through changes in production, consumption, and import levels in a compressed timeframe.
- Slower increases in export levels lead to more gradual price increases but eventually produce higher average prices, especially during the decade between 2025 and 2035. The differential between wellhead prices in the high/slow scenario and the no-additional-exports scenario peaks in 2026 at about 28 percent ($1.53/Mcf), and prices remain higher than in the high/rapid scenario. The lower prices in the early years of the scenarios with slow export growth leads to more domestic investment in additional natural gas burning equipment, which increases demand somewhat in later years, relative to rapid export growth scenarios.

Figure 3. Natural gas wellhead price difference from *AEO2011* Reference case with different additional export levels imposed

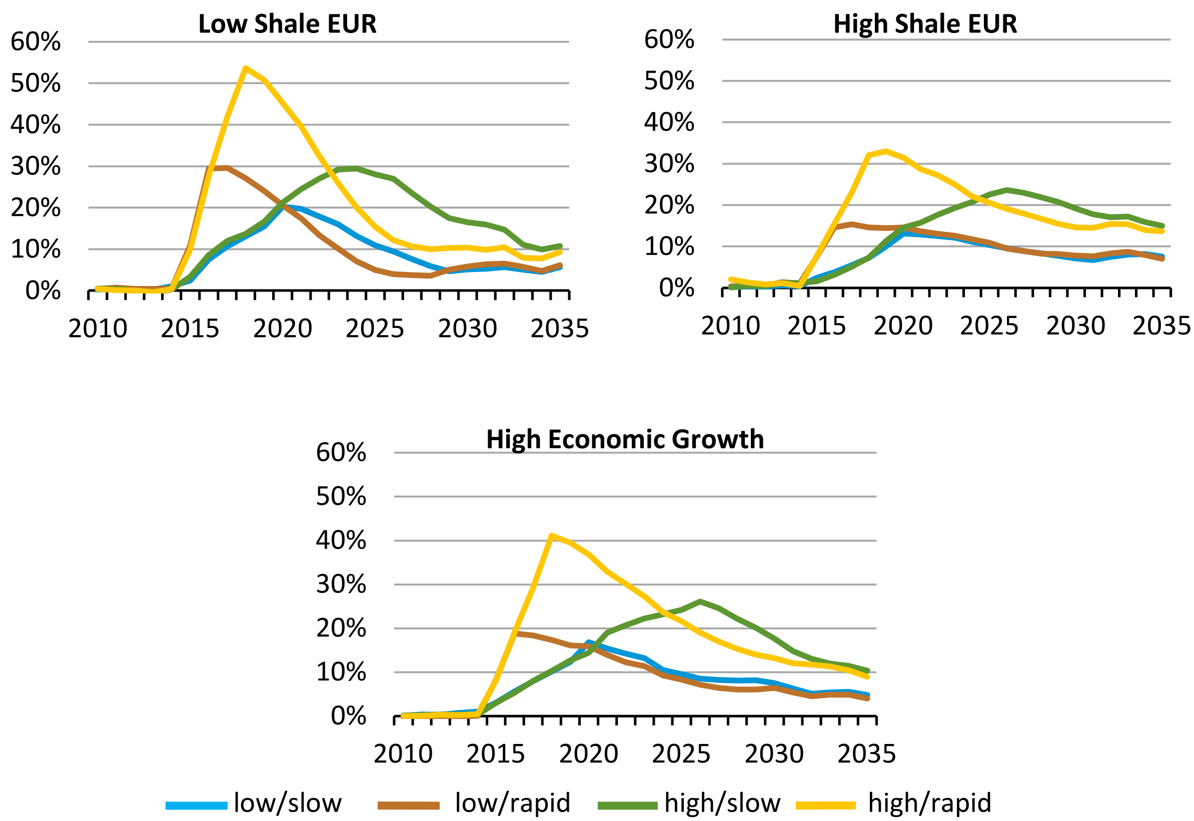


Source: U.S. Energy Information Administration, National Energy Modeling System

Export scenarios—wellhead price changes under alternative baseline cases

The effect of increasing exports on natural gas prices varies somewhat under alternative baseline case assumptions about resource availability and economic growth. However, the basic patterns remain the same: higher export levels would lead to higher prices, rapid increases in exports would lead to sharp price increases, and slower export increases would lead to slower but more lasting price increases. But the relative size of the price increases changes with changing assumptions (Figure 4).

Figure 4. Natural gas wellhead price difference from indicated baseline case (no additional exports) with different additional export levels imposed



Source: U.S. Energy Information Administration, National Energy Modeling System

In particular, with more pessimistic assumptions about the Nation's natural gas resource base (the Low Shale EUR case), wellhead prices in all export scenarios initially increase more in percentage terms over the baseline case (no additional exports) than occurs under Reference case conditions. For example, in the Low Shale EUR case the rapid introduction of 12 Bcf/d of exports results in a 54 percent ($3.23/Mcf) increase in the wellhead price in 2018; whereas under Reference case conditions with the same export scenario the price increases in 2018 by only 36 percent ($1.58/Mcf).[5] But the percentage price increase falls in later years under the Low Shale EUR case, even below the price response under Reference case conditions. Under Low Shale EUR conditions, the addition of exports ultimately results in wellhead prices exceeding the $9 per Mcf threshold, with this occurring as early as 2018 in the high/rapid scenario.

[5] The percentage rise in prices for the low EUR case also represents a larger absolute price increase because it is calculated on the higher baseline price under the same pessimistic resource assumptions.

More robust economic growth shows a similar pattern – higher initial percentage price increases and lower percentage increases in later years. On the other hand, with more optimistic resource assumptions (the High Shale EUR case), the percentage price rise would be slightly smaller than under Reference case conditions, and result in wellhead prices never exceeding the $6 per Mcf threshold.

Natural gas supply and consumption

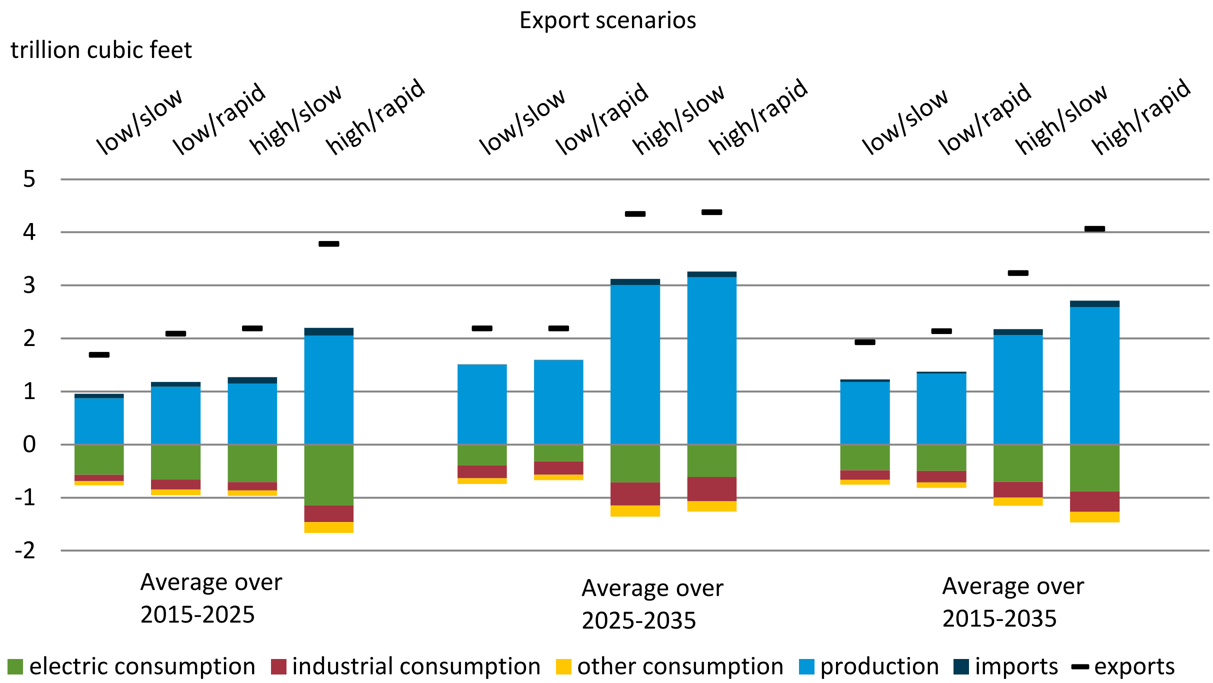
In the AEO2011 Reference case, total domestic natural gas production grows from 22.4 trillion cubic feet (Tcf) in 2015 to 26.3 Tcf in 2035, averaging 24.2 Tcf for the 2015-2035 period. U.S. net imports of natural gas decline from 11 percent of total supply in 2015 to 1 percent in 2035, with lower net imports from Canada and higher net exports to Mexico. The industrial sector consumes an average of 8.1 Tcf of natural gas (34.2% of delivered volumes) between 2015 and 2035, with 7.1 Tcf, 4.8 Tcf, and 3.6 Tcf consumed in the electric power, residential, and commercial sectors respectively.

Under the scenarios specified for this analysis, increased natural gas exports lead to higher domestic natural gas prices, which lead to reduced domestic consumption, and increased domestic production and pipeline imports from Canada (Figure 5). Lower domestic consumption dampens the degree to which supplies must increase to satisfy the additional natural gas exports. Accordingly, in order to accommodate the increased exports in each of the four export scenarios, the mix of production, consumption, and imports changes relative to the associated baseline case. In all of the export scenarios across all four baseline cases, a majority of the additional natural gas needed for export is provided by increased domestic production, with a minor contribution from increased pipeline imports from Canada. The remaining portion of the increased export volumes is offset by decreases in consumption resulting from the higher prices associated with the increased exports.

The absolute value of the sum of changes in consumption (delivered volumes), production, and imports (represented by the total bar in Figure 5) approximately[6] equals the average change in exports. Under Reference case conditions, about 63 percent, on average, of the increase in exports in each of the four scenarios is accounted for by increased production, with most of the remainder from decreased consumption from 2015 to 2035. The percentage of exports accounted for by increased production is slightly lower in the earlier years and slightly higher in the later years. While this same basic relationship between added exports and increased production is similar under the other cases, the percentage of added exports accounted for by increased production is somewhat less under a Low Shale EUR environment and more under a High Economic Growth environment.

[6] The figure displays the changes in delivered volumes of natural gas to residential, commercial, industrial, vehicle transportation, and electric generation customers. There are also some minor differences in natural gas used for lease, plant, and pipeline fuel use which are not included.

Figure 5. Average change in annual natural gas delivered, produced, and imported from *AEO2011* Reference case with different additional export levels imposed



Source: U.S. Energy Information Administration, National Energy Modeling System

One seeming anomaly that can be seen in Figure 5 is in the 2025 to 2035 timeframe: the decrease in consumption is somewhat lower in the rapid export penetration relative to the slow export penetration scenarios. This is largely attributed to slightly lower prices in the later years of the rapid export penetration scenarios relative to the slow penetration scenarios.

Supply

Increases in natural gas production that contribute to additional natural gas exports from the relative baseline scenario come predominately from shale sources. On average, across all cases and export scenarios, the shares of the increase in total domestic production coming from shale gas, tight gas, coalbed, and other sources are 72 percent, 13 percent, 8 percent, and 7 percent, respectively. Most of the export scenarios are also accompanied by a slight increase in pipeline imports from Canada. Under the Low Shale EUR case (which just applies to domestic shale), imports from Canada contribute to a greater degree than in other cases.

Consumption by sector

In general, greater export levels lead to higher domestic prices and larger decreases in consumption, although the price and consumption differences across the scenarios narrow in the later part of the projection period.

Electric power generation

In the AEO2011 Reference case, electric power generation averages 4,692 billion kilowatthours (bkWh) over the 2015-2035 period. Natural gas generation averages 23 percent of total power generation, increasing from 1,000 bkWh in 2015 to 1,288 bkWh in 2035. Coal, nuclear, and renewables provide an average of 43 percent, 19 percent, and 14 percent of generation, respectively, with a minimal contribution from liquids.

In scenarios with increased natural gas exports, most of the decrease in natural gas consumption occurs in the electric power sector (Figure 5). Most of the tradeoff in electric generators' natural gas use is between natural gas and coal, especially in the early years (Figure 6), when there is excess coal-fired capacity to allow for additional generation. Over the projection period, excess coal capacity progressively declines, along with the degree by which coal-fired generation can be increased in response to higher natural gas prices.[7] Increased coal-fired generation accounts for about 65 percent of the decrease in natural gas-fired generation under Reference case conditions.

The increased use of coal for power generation results in an average increase in coal production from 2015 to 2035 over Reference case levels of between 2 and 4 percent across export scenarios. Accordingly, coal prices also increase slightly which, along with higher gas prices, drive up electricity prices. The resulting increase in electricity prices reduces total electricity demand, also offsetting some of the drop in natural gas-fired generation. The decline in total electricity demand tends to be less in the earlier years.

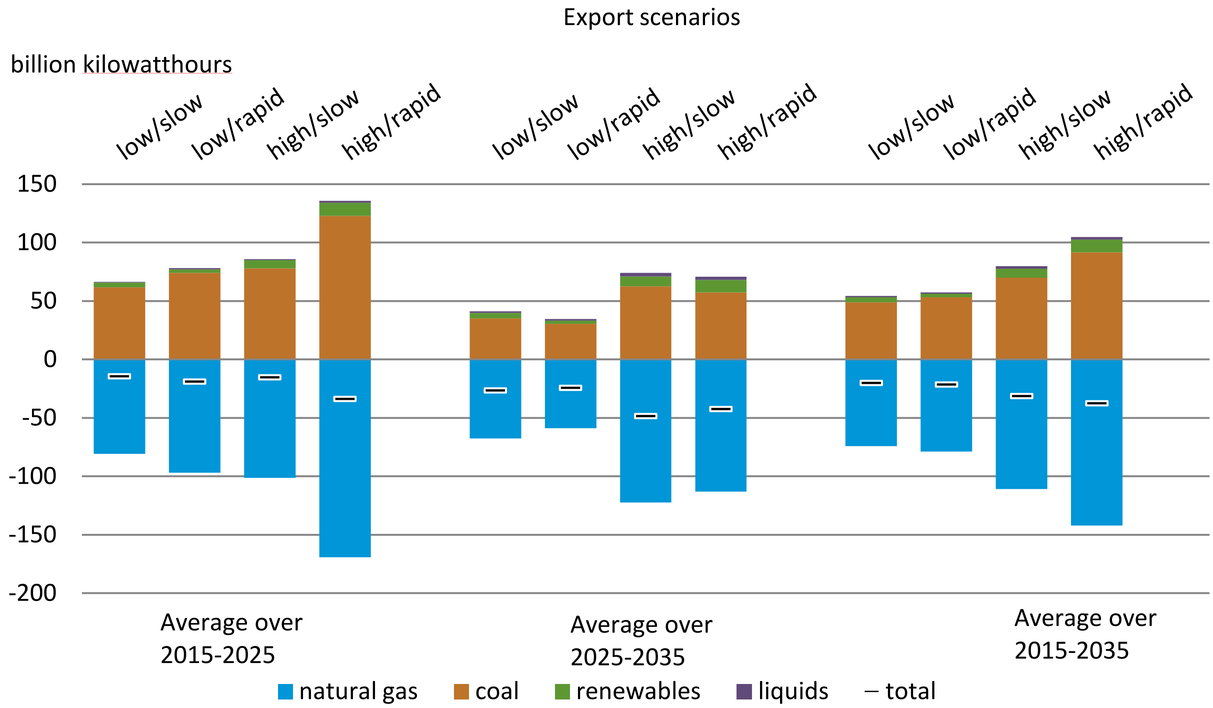
In addition, small increases in renewable generation contribute to reduced natural gas-fired generation. Relatively speaking, the role of renewables is greater in a higher-gas-price environment (i.e., the Low Shale EUR case), when they can more successfully compete with coal, and in a higher-generation environment (i.e., the High Economic Growth case), particularly in the later years.

Industrial sector

Reductions in industrial natural gas consumption in scenarios with increased natural gas exports tend to grow over time. In general, higher gas prices earlier in the projection period in these scenarios provide some disincentive for natural gas-fired equipment purchases (such as natural gas-fired combined heat and power (CHP) capacity) by industrial consumers, which has a lasting impact on their projected use of natural gas.

[7] The degree to which coal might be used in lieu of natural gas depends on what regulations are in-place that might restrict coal use. These scenarios reflect current laws and regulations in place at the time the *AEO2011* was produced.

Figure 6. Average change in annual electric generation from *AEO2011* Reference case with different additional export levels imposed



Source: U.S. Energy Information Administration, National Energy Modeling System

Note: Nucleargeneration levels do not change in the Reference case scenarios.

As noted in the discussion of caveats in the first section of this report, the NEMS model does not explicitly address the linkage between energy prices and the supply/demand of industrial commodities in global industries. To the extent that the location of production is very sensitive to changes in natural gas prices, industrial natural gas demand would be more responsive than shown in this analysis.

Other sectors

Natural gas consumption in the other sectors (residential, commercial, and compressed natural gas vehicles) also decreases in response to the higher gas prices associated with increased exports, although less significantly than in the electric and industrial sectors. Even so, under Reference case conditions residential and commercial consumption decreases from 1 to 2 percent and from 2 to 3 percent, respectively, across the export scenarios, on average from 2015 to 2035. Their use of electricity also declines marginally in response to higher electricity prices. In response to higher natural gas and electricity prices, residential and commercial customers directly cut back their energy usage and/or purchase more efficient equipment.

Exports to Canada and Mexico

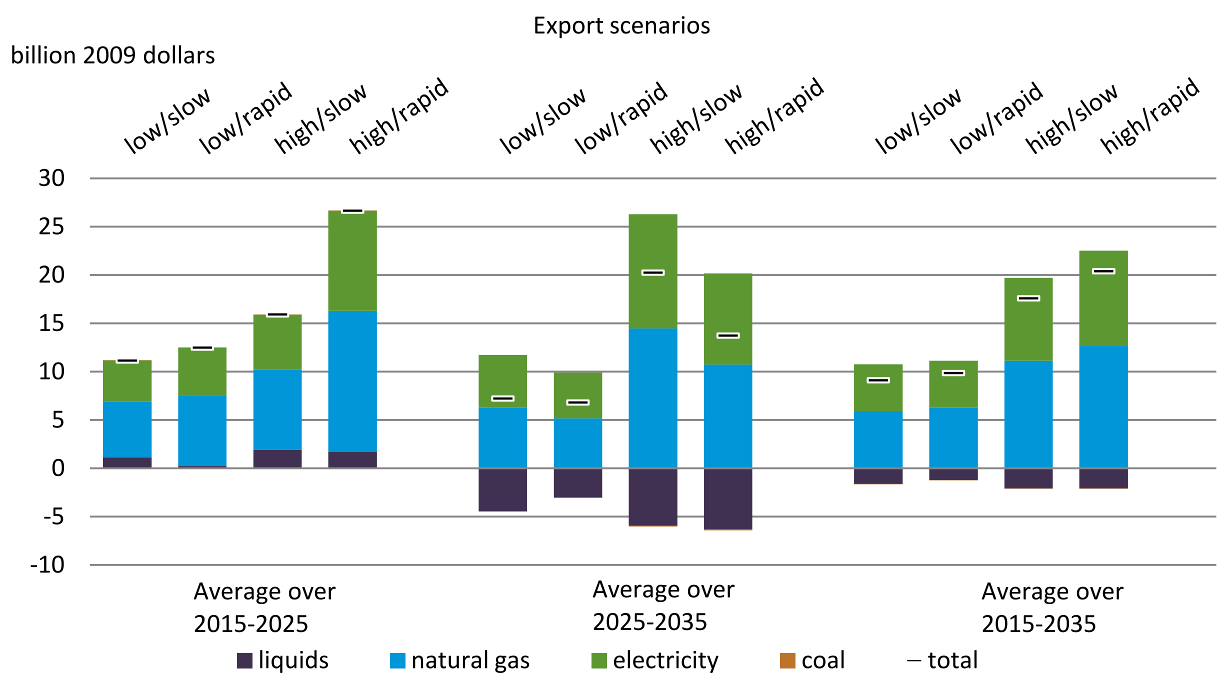
If exports to Canada and Mexico were allowed to vary under these additional export scenarios, they would likely respond similarly to domestic consumption and decrease in response to higher natural gas prices.

End-use energy expenditures

The AEO2011 Reference case projects annual average end-use energy expenditures of $1,490 billion over the 2015-2035 period. Of that, $975 billion per year is spent on liquids, $368 billion on electricity bills, $140 billion on natural gas bills, and $7 billion on coal expenditures.

From an end-user perspective in the scenarios with additional gas exports, consumers will consume less and pay more on both their natural gas and electricity bill, and generally a little less for liquid fuels (Figure 7). Under Reference case conditions, increased end-use expenditures on natural gas as a result of additional exports average about 56 percent of the total additional expenditures for natural gas and electricity combined. For example, under Reference case conditions in the low/slow scenario, end-use consumers together are expected to increase their total energy expenditures by $9 billion per year, or 0.6 percent on average from 2015 to 2035. Under the high/rapid scenarios, consumed total energy expenditures increase by $20 billion per year, or 1.4 percent on average, between 2015 and 2035.

Figure 7. Average change in annual end-use energy expenditures from *AEO2011* Reference case as a result of additional natural gas exports



Source: U.S. Energy Information Administration, National Energy Modeling System

Natural gas expenditures

As discussed earlier, given the lower consumption levels in response to the higher prices from increased exports, the percentage change in the dollars expended by customers for natural gas is less than the percentage change in the delivered prices. In general, the relative pattern of total end-use expenditures across time, export scenarios, and cases, is similar to the relative pattern shown in the wellhead prices in Figures 3 and 4. The higher export volume scenarios result in greater increases in expenditures, while those with rapid export penetration show increases peaking earlier and at higher levels than their slow export penetration counterpart, which show bills increasing more towards the end of the projection period. Under Reference case conditions, the greatest single year increase in total end-use consumer bills is 16 percent, while the lowest single year increase is less than 1 percent. In all but three export scenarios and cases, the higher average increase over the comparable baseline scenario in natural gas bills paid by end-use consumers occurred during the early years. The greatest percentage increase in end-use expenditures over the comparable baseline level in a single year (26 percent) occurs in the high/rapid scenario under the Low Shale EUR case.

On average between 2015 and 2035, total U.S. end-use natural gas expenditures as a result of added exports, under Reference case conditions, increase between $6 billion to $13 billion (between 3 to 9 percent), depending on the export scenario. The Low Shale EUR case shows the greatest average annual increase in end-use natural gas expenditures over the same time period, with increases over the baseline (no additional exports) scenario ranging from $7 billion to $15 billion.

At the sector level, since the natural gas commodity charge represents significantly different portions of each natural gas consuming sector's bill, the degree to which each sector is projected to see their total bill change with added exports varies significantly (Table 1). Natural gas expenditures increase at the highest percentages in the industrial sector, where low transmission and distribution charges constitute a relatively small part of the delivered natural gas price.

Table 1. Change in natural gas expenditures by end use consumers from AEO2011 Reference case with different additional export levels imposed

Sector	Scenario	Average 2015-2025	Average 2025-2035	Average 2015-2035	Maximum Annual Change	Minimum Annual Change
Residential	low/slow	3.2%	3.3%	3.2%	4.7%	0.5%
Residential	low/rapid	4.2%	2.9%	3.6%	5.4%	2.2%
Residential	high/slow	4.4%	7.1%	5.6%	8.9%	0.9%
Residential	high/rapid	8.3%	5.7%	7.0%	10.9%	2.5%
Commercial	low/slow	3.2%	3.2%	3.2%	4.8%	0.6%
Commercial	low/rapid	4.3%	2.7%	3.5%	5.8%	2.0%
Commercial	high/slow	4.6%	6.9%	5.6%	8.9%	0.9%
Commercial	high/rapid	8.3%	5.4%	6.9%	11.4%	2.7%
Industrial	low/slow	7.2%	5.8%	6.4%	11.1%	1.2%
Industrial	low/rapid	9.4%	4.6%	7.1%	14.0%	3.5%
Industrial	high/slow	10.2%	14.7%	12.2%	19.3%	2.0%
Industrial	high/rapid	18.7%	10.4%	14.6%	26.9%	5.2%

Source: U.S. Energy Information Administration, National Energy Modeling System

The results in Table 1 do not reflect changes in natural gas expenditures in the electric power sector. The projected overall decrease in natural gas use by generators is significant enough to result in a decrease in natural gas expenditures for that sector, largely during 2015-2025. However, electric generators will see an increase in their overall costs of power generation that will be reflected in higher electricity bills for consumers.

Electricity expenditures

On average across the projection period, electricity prices under Reference case conditions increase by between 0.14 and 0.29 cents per kilowatthour (kWh) (between 2 and 3 percent) when gas exports are added. The greatest increase in the electricity price occurs in 2019 under the Low Shale EUR case for the high export/rapid growth export scenario, with an increase of 0.85 cents per kWh (9 percent).

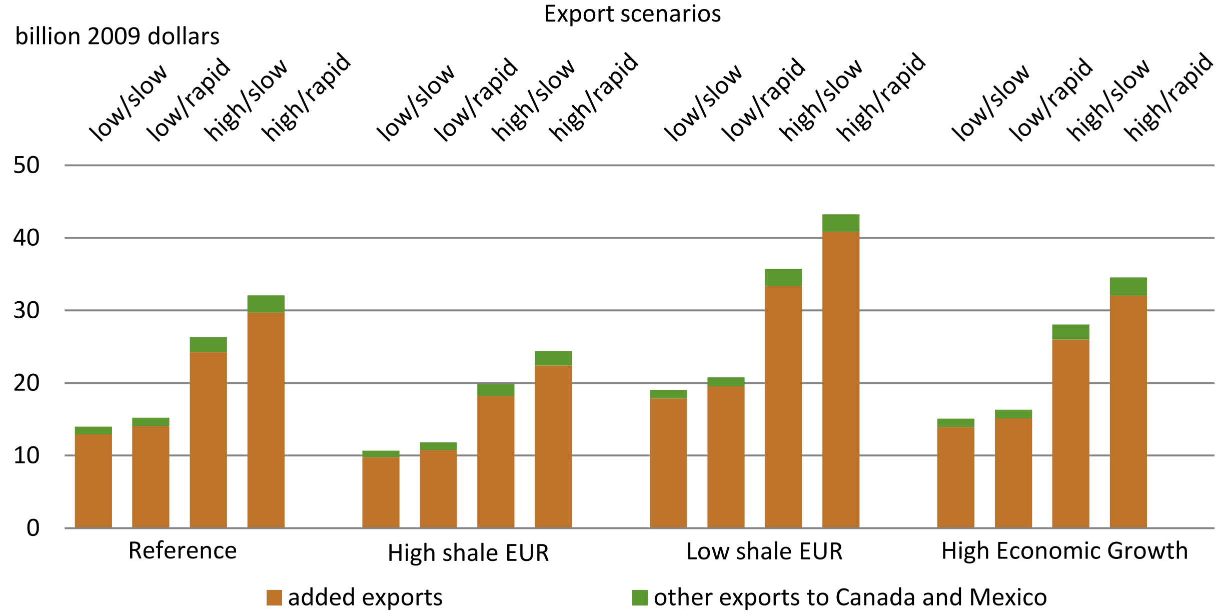
Similar to natural gas, higher electricity prices due to the increased exports reduce end-use consumption making the percentage change in end-use electricity expenditures less than the percentage change in delivered electricity prices; additionally, the percentage increase in end-use electricity expenditures will be lower for the residential and commercial sectors and higher for the industrial sector. Under Reference case conditions, the greatest single year increase in total end-use consumer electricity bills is 4 percent, while the lowest single year increase is negligible. The greatest percentage increase in end-use electricity expenditures over the comparable baseline level in a single year (7 percent) occurs in the high/rapid scenario under the Low Shale EUR case.

On average between 2015 and 2035, total U.S. end-use electricity expenditures as a result of added exports, under Reference case conditions, increase between $5 billion to $10 billion (between 1 to 3 percent), depending on the export scenario. The High Macroeconomic Growth case shows the greatest average annual increase in natural gas expenditures over the same time period, with increases over the baseline (no additional exports) scenario ranging from $6 billion to $12 billion.

Natural gas producer revenues

Total additional natural gas revenues to producers from exports increase on an average annual basis from 2015 to 2035 between $14 billion and $32 billion over the *AEO2011* Reference case, depending on the export scenario (Figure 8). These revenues largely come from the added exports defining the scenarios, as well as other exports to Canada and Mexico in the model that see higher prices under the additional export scenarios, even though the volumes are assumed not to vary. Revenues associated with the added exports reflect dollars spent to purchase and move the natural gas to the export facility, but do not include any revenues associated with the liquefaction and shipping process. The Low Shale EUR case shows the greatest average annual increase in revenues over the 2015 to 2035 time period, with revenues ranging from over $19 billion to $43 billion, due to the relatively high natural gas wellhead prices in that case. These figures represent increased revenues, not profits. A large portion of the additional export revenues will cover the increased costs associated with supplying the increased level of production required when natural gas exports are increased, such as for equipment (e.g., drilling rigs) and labor. In contrast, the additional revenues resulting from the higher price of natural gas that would have been produced and sold to largely domestic customers even in the absence of the additional exports posited in the analysis scenarios would preponderantly reflect increased profits for producers and resource owners.

Figure 8. Average annual increase in domestic natural gas export revenues from indicated baseline case (no additional exports) with different additional export levels imposed, 2015-2035



Source: U.S. Energy Information Administration, National Energy Modeling System

Impacts beyond the natural gas industry

While the natural gas industry would be directly impacted by increased exports, there are indirect impacts on other energy sectors. The electric generation industry shows the largest impact, followed by the coal industry.

As discussed earlier, higher natural gas prices lead electric generators to burn more coal and less natural gas. Coal producers benefit from the increased coal demand. On average, from 2015 to 2035, coal minemouth prices, production, and revenues increase by at most 1.1, 5.5, and 6.2 percent, respectively, across the increased export scenarios applied to all cases.

Domestic petroleum production in the form of lease condensate and natural gas plant liquids also rises due to increased natural gas drilling. For example, under Reference case conditions, in the scenario with the greatest overall response (high/rapid exports), total domestic energy production is 4.13 quadrillion British thermal units (Btu) per year (4.7 percent), which is greater on average from 2015 to 2035 than in the baseline scenario, while total domestic energy consumption is only 0.12 quadrillion Btu (0.1 percent) lower.

Effects on non-energy sectors, other than impacts on their energy expenditures, are generally beyond the scope of this report for reasons described previously.

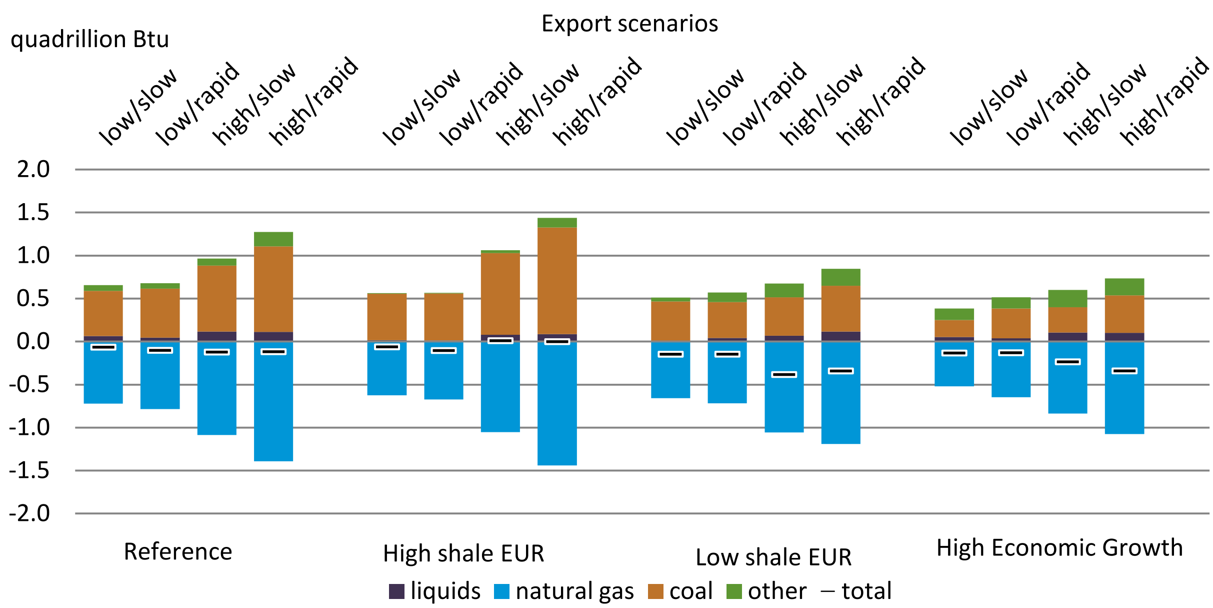
Total energy use and energy-related carbon dioxide emissions

Annual primary energy consumption in the AEO2011 Reference case, measured in Btu, averages 108 quadrillion Btu between 2015 and 2035, with a growth rate of 0.6 percent. Cumulative carbon dioxide (CO_2) emissions total 125,000 million metric tons for that twenty-year period.

The changes in overall energy consumption across scenarios and cases are largely reflective of what occurs in the electric power sector. While additional exports result in decreased natural gas consumption, changes in overall energy consumption are relatively minor as much of the decrease in natural gas consumption is replaced with increased coal consumption (Figure 9). In fact, in some of the earlier years total energy consumption increases with added exports since directly replacing natural gas with coal in electricity generation requires more Btu, as the heat rates (Btu per kWh) for coal generators exceed those for natural gas generators.

On average from 2015 to 2035 under Reference case conditions, decreased natural gas consumption as a result of added exports are countered proportionately by increased coal consumption (72 percent), increased liquid fuel consumption (8 percent), other increased consumption, such as from renewable generation sources (9 percent), and decreases in total consumption (11 percent). In the earlier years, the amount of natural gas to coal switching is greater, and coal plays a more dominant role in replacing the decreased levels of natural gas consumption, which also tend to be greater in the earlier years. Switching from natural gas to coal is less significant in later years, partially as a result of a greater proportion of switching into renewable generation. As a result decreased natural gas consumption from added exports more directly results in decreased total energy consumption via the end-use consumer cutting back energy use in response to higher prices. This basic pattern similarly occurs under the Low Shale EUR and High Economic Growth cases – less switching from natural gas into coal and more into renewable than under Reference case conditions, as well as greater decreases in total energy consumption as a result of added exports.

Figure 9. Average annual change from indicated baseline case (no additional exports) in total primary energy consumed with different additional export levels imposed, 2015-2035



Source: U.S. Energy Information Administration, National Energy Modeling System
Note: Other includes renewable and nuclear generation.

While lower domestic natural gas deliveries resulting from added exports reduce natural gas related CO_2 emissions, the increased use of coal in the electric sector generally results in a net increase in overall

CO_2 emissions. The exceptions occur in environments when renewables are better able to compete against natural gas and coal. However, when also accounting for emissions related to natural gas used in the liquefaction process, additional exports increase CO_2 levels under all cases and export scenarios, particularly in the earlier years of the projection period. Table 2 displays the cumulative CO_2 emissions levels from 2015 to 2035 in all cases and scenarios, with the change relative to the associated baseline case.

Table 2. Cumulative CO_2 emissions from 2015 to 2035 associated with additional natural gas export levels imposed (million metric tons CO_2 and percentage)

Case	no added exports	low/slow	low/rapid	high/slow	high/rapid
Reference					
Cumulative carbon dioxide emissions	125,056	125,699	125,707	126,038	126,283
Change from baseline		643	651	982	1,227
Percentage change from baseline		0.5%	0.5%	0.8%	1.0%
High Shale EUR					
Cumulative carbon dioxide emissions	124,230	124,888	124,883	125,531	125,817
Change from baseline		658	653	1,301	1,587
Percentage change from baseline		0.5%	0.5%	1.0%	1.3%
Low Shale EUR					
Cumulative carbon dioxide emissions	125,162	125,606	125,556	125,497	125,670
Change from baseline		444	394	335	508
Percentage change from baseline		0.4%	0.3%	0.3%	0.4%
High Economic Growth					
Cumulative carbon dioxide emissions	131,675	131,862	132,016	131,957	132,095
Change from baseline		187	341	282	420
Percentage change from baseline		0.1%	0.3%	0.2%	0.3%

Source: U.S. Energy Information Administration, National Energy Modeling System, with emissions related to natural gas assumed to be consumed in the liquefaction process included.

Appendix A. Request Letter

Department of Energy
Washington, DC 20585
August 15, 2011

MEMORANDUM

TO: HOWARD K. GRUENSPECHT
ACTING ADMINISTRATOR
ENERGY INFORMATION ADMINISTRATION

FROM: CHARLES D. MCCONNELL
CHIEF OPERATING OFFICER
OFFICE OF FOSSIL ENERGY

SUBJECT: **ACTION:** Request for EIA to Perform a Domestic Natural Gas Export Case Study

ISSUE: The Department of Energy's (DOE) Office of Fossil Energy (FE) must determine whether exports of liquefied natural gas (LNG) to non-free trade agreement countries are not inconsistent with the public interest. An independent case study analysis of the impact of increased domestic natural gas demand, as exports, under different incremental demand scenarios, performed by the Energy Information Administration (EIA) will be useful to assist DOE/FE in making future public interest determinations.

BACKGROUND: DOE/FE has been delegated the statutory responsibility under section 3 of the Natural Gas Act (NGA) (15 U.S.C. § 717b) to evaluate and approve or deny applications to import and export natural gas and liquefied natural gas to or from the United States. Applications to DOE/FE to export natural gas and LNG to non-free trade agreement countries are reviewed under section 3(a) of the NGA, under which FE must determine if the proposed export arrangements meet the public interest requirements of section 3 of the NGA.

To-date, DOE/FE has received applications for authority to export domestically produced LNG by vessel from three proposed liquefaction facilities, one application to export LNG by ISO containers on cargo carriers, and additional applications could be submitted by others in the future. Applications submitted to DOE/FE total 5.6 billion cubic feet per day (Bcf/day) of natural gas to be exported from the United States, equal to over 8 percent of U.S. natural gas consumption in 2015 compared to the EIA reference case projection of 68.8 Bcf/day in 2015.[1]

Studies and analyses submitted with, and in support of, LNG export applications to DOE/FE evaluated the impact LNG exports could have on domestic natural gas supply.

[1] *EIA Annual Energy Outlook 2011 (AEO2011)*

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demand and market prices. It would be helpful in DOE/FE reviews of these applications, and other potential applications, to understand the implications of additional natural gas demand (as exports) on domestic energy consumption, production, and prices under different scenarios.

Understanding that the domestic natural gas market is sensitive to a number of factors, including those highlighted on page 37 of the *AEO2011*, we request that EIA include sensitivity cases to explore some of these uncertainties, using the modeling analysis presented in the *AEO2011* as a starting point. The results of this study will be beneficial to DOE/FE by providing an independent assessment of how increased natural gas exports could affect domestic markets, and could be used in making future public interest determinations. The specific request of the study is provided in the attachment. We would like to receive the study, along with an analysis and commentary of the results by October 2011, and recognize that the study may be made available on EIA's website.

We are available to further discuss the study with your staff as they begin the study to clarify any issues associated with this request as needed.

RECOMMENDATION: That you approve this request.

APPROVE:_____________ DISAPPROVE: _______________ DATE: _______

ATTACHMENTS:
Impact of Higher Demand for U.S. Natural Gas on Domestic Energy Markets
Background: (15 U.S.C. § 717b)

Impact of Higher Demand for U.S. Natural Gas on Domestic Energy Markets

The Office of Fossil Energy (FE) requests the Energy Information Administration (EIA) to evaluate the impact of increased natural gas demand, reflecting possible exports of U.S. natural gas, on domestic energy markets using the modeling analysis presented in the *Annual Energy Outlook 2011 (AEO2011)* as a starting point. In discussions with EIA we learned that EIA's National Energy Modeling System is not designed to capture the impact of increased export-driven demand for natural gas on economy-wide economic indicators such as gross domestic product and employment, and that it does not include a representation of global natural gas markets. Therefore, EIA should focus its analysis on the implications of additional natural gas demand on domestic energy consumption, production, and prices.

The study should address scenarios reflecting export-related increases in natural gas demand of between 6 billion cubic feet per day (Bcf/d) and 12 Bcf/d that are phased in at rates of between 1 Bcf/d per year and 3 Bcf/d per year starting in 2015. Understanding that the domestic natural gas market is sensitive to a number of factors, including those highlighted on page 37 of the *AEO2011*, we request that EIA include sensitivity cases to explore some of these uncertainties. We are particularly interested in sensitivity cases relating to alternative recovery economics for shale gas resources, as in the *AEO2011 Low and High Shale EUR* cases, and a sensitivity case with increased baseline natural gas demand as in the *AEO2011 High Economic Growth* case.

The study report should review and synthesize the results obtained in the modeling work and include, as needed, discussions of context, caveats, issues and limitations that are relevant to the study. Please include tables or figures that summarize impacts on annual domestic natural gas prices, domestic natural gas production and consumption levels, domestic expenditures for natural gas and other relevant fuels, and revenues associated with the incremental export demand for natural gas. The standard *AEO 2011* reporting tables should also be provided, with the exception of tables reporting information that EIA considers to be spurious or misleading given the limitations of its modeling tools in addressing the study questions.

We would like to receive the completed analysis by October 2011 and recognize that EIA may post the study on its website after providing it to us.

Thank you for your attention to this request. Please do not hesitate to contact me (Charles D. McConnell) or John Anderson at 6-0521, if you have any questions.

Source: http://uscode.house.gov/download/pls/15C15B.txt

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-CITE-
    15 USC Sec. 717b                                          01/07/2011

-EXPCITE-
    TITLE 15 - COMMERCE AND TRADE
    CHAPTER 15B - NATURAL GAS

-HEAD-
    Sec. 717b. Exportation or importation of natural gas; LNG terminals

-STATUTE-
    (a) Mandatory authorization order
      After six months from June 21, 1938, no person shall export any
    natural gas from the United States to a foreign country or import
    any natural gas from a foreign country without first having secured
    an order of the Commission authorizing it to do so. The Commission
    shall issue such order upon application, unless, after opportunity
    for hearing, it finds that the proposed exportation or importation
    will not be consistent with the public interest. The Commission may
    by its order grant such application, in whole or in part, with such
    modification and upon such terms and conditions as the Commission
    may find necessary or appropriate, and may from time to time, after
    opportunity for hearing, and for good cause shown, make such
    supplemental order in the premises as it may find necessary or
    appropriate.
    (b) Free trade agreements
      With respect to natural gas which is imported into the United
    States from a nation with which there is in effect a free trade
    agreement requiring national treatment for trade in natural gas,
    and with respect to liquefied natural gas -
        (1) the importation of such natural gas shall be treated as a
      "first sale" within the meaning of section 3301(21) of this
      title; and
        (2) the Commission shall not, on the basis of national origin,
      treat any such imported natural gas on an unjust, unreasonable,
      unduly discriminatory, or preferential basis.
    (c) Expedited application and approval process
      For purposes of subsection (a) of this section, the importation
    of the natural gas referred to in subsection (b) of this section,
    or the exportation of natural gas to a nation with which there is
    in effect a free trade agreement requiring national treatment for
    trade in natural gas, shall be deemed to be consistent with the
    public interest, and applications for such importation or
    exportation shall be granted without modification or delay.
    (d) Construction with other laws
      Except as specifically provided in this chapter, nothing in this
    chapter affects the rights of States under -
        (1) the Coastal Zone Management Act of 1972 (16 U.S.C. 1451 et
      seq.);
        (2) the Clean Air Act (42 U.S.C. 7401 et seq.); or
        (3) the Federal Water Pollution Control Act (33 U.S.C. 1251 et
      seq.).
    (e) LNG terminals
      (1) The Commission shall have the exclusive authority to approve
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or deny an application for the siting, construction, expansion, or operation of an LNG terminal. Except as specifically provided in this chapter, nothing in this chapter is intended to affect otherwise applicable law related to any Federal agency's authorities or responsibilities related to LNG terminals.

(2) Upon the filing of any application to site, construct, expand, or operate an LNG terminal, the Commission shall -

(A) set the matter for hearing;

(B) give reasonable notice of the hearing to all interested persons, including the State commission of the State in which the LNG terminal is located and, if not the same, the Governor-appointed State agency described in section 717b-1 of this title;

(C) decide the matter in accordance with this subsection; and

(D) issue or deny the appropriate order accordingly.

(3)(A) Except as provided in subparagraph (B), the Commission may approve an application described in paragraph (2), in whole or part, with such modifications and upon such terms and conditions as the Commission find (!1) necessary or appropriate.

(B) Before January 1, 2015, the Commission shall not -

(i) deny an application solely on the basis that the applicant proposes to use the LNG terminal exclusively or partially for gas that the applicant or an affiliate of the applicant will supply to the facility; or

(ii) condition an order on -

(I) a requirement that the LNG terminal offer service to customers other than the applicant, or any affiliate of the applicant, securing the order;

(II) any regulation of the rates, charges, terms, or conditions of service of the LNG terminal; or

(III) a requirement to file with the Commission schedules or contracts related to the rates, charges, terms, or conditions of service of the LNG terminal.

(C) Subparagraph (B) shall cease to have effect on January 1, 2030.

(4) An order issued for an LNG terminal that also offers service to customers on an open access basis shall not result in subsidization of expansion capacity by existing customers, degradation of service to existing customers, or undue discrimination against existing customers as to their terms or conditions of service at the facility, as all of those terms are defined by the Commission.

(f) Military installations

(1) In this subsection, the term "military installation" -

(A) means a base, camp, post, range, station, yard, center, or homeport facility for any ship or other activity under the jurisdiction of the Department of Defense, including any leased facility, that is located within a State, the District of Columbia, or any territory of the United States; and

(B) does not include any facility used primarily for civil works, rivers and harbors projects, or flood control projects, as determined by the Secretary of Defense.

(2) The Commission shall enter into a memorandum of understanding

with the Secretary of Defense for the purpose of ensuring that the Commission coordinate and consult (!2) with the Secretary of Defense on the siting, construction, expansion, or operation of liquefied natural gas facilities that may affect an active military installation.

(3) The Commission shall obtain the concurrence of the Secretary of Defense before authorizing the siting, construction, expansion, or operation of liquefied natural gas facilities affecting the training or activities of an active military installation.

-SOURCE-

(June 21, 1938, ch. 556, Sec. 3, 52 Stat. 822; Pub. L. 102-486, title II, Sec. 201, Oct. 24, 1992, 106 Stat. 2866; Pub. L. 109-58, title III, Sec. 311(c), Aug. 8, 2005, 119 Stat. 685.)

-REFTEXT-

REFERENCES IN TEXT

The Coastal Zone Management Act of 1972, referred to in subsec. (d)(1), is title III of Pub. L. 89-454 as added by Pub. L. 92-583, Oct. 27, 1972, 86 Stat. 1280, as amended, which is classified generally to chapter 33 (Sec. 1451 et seq.) of Title 16, Conservation. For complete classification of this Act to the Code, see Short Title note set out under section 1451 of Title 16 and Tables.

The Clean Air Act, referred to in subsec. (d)(2), is act July 14, 1955, ch. 360, 69 Stat. 322, as amended, which is classified generally to chapter 85 (Sec. 7401 et seq.) of Title 42, The Public Health and Welfare. For complete classification of this Act to the Code, see Short Title note set out under section 7401 of Title 42 and Tables.

The Federal Water Pollution Control Act, referred to in subsec. (d)(3), is act June 30, 1948, ch. 758, as amended generally by Pub. L. 92-500, Sec. 2, Oct. 18, 1972, 86 Stat. 816, which is classified generally to chapter 26 (Sec. 1251 et seq.) of Title 33, Navigation and Navigable Waters. For complete classification of this Act to the Code, see Short Title note set out under section 1251 of Title 33 and Tables.

-MISC1-

AMENDMENTS

2005 - Pub. L. 109-58, Sec. 311(c)(1), inserted "; LNG terminals" after "natural gas" in section catchline.

Subsecs. (d) to (f). Pub. L. 109-58, Sec. 311(c)(2), added subsecs. (d) to (f).

1992 - Pub. L. 102-486 designated existing provisions as subsec. (a) and added subsecs. (b) and (c).

-TRANS-

TRANSFER OF FUNCTIONS

Enforcement functions of Secretary or other official in Department of Energy and Commission, Commissioners, or other official in Federal Energy Regulatory Commission related to compliance with authorizations for importation of natural gas from Alberta as pre-deliveries of Alaskan gas issued under this section with respect to pre-construction, construction, and initial operation of transportation system for Canadian and Alaskan natural gas transferred to the Federal Inspector, Office of Federal Inspector for Alaska Natural Gas Transportation System, until first anniversary of date of initial operation of Alaska Natural Gas Transportation System, see Reorg. Plan No. 1 of 1979, Secs. 102(d), 203(a), 44 F.R. 33663, 33666, 93 Stat. 1373, 1376, effective July 1, 1979, set out under section 719e of this title. Office of Federal Inspector for the Alaska Natural Gas Transportation System abolished and functions and authority vested in Inspector transferred to Secretary of Energy by section 3012(b) of Pub. L. 102-486, set out as an Abolition of Office of Federal Inspector note under section 719e of this title. Functions and authority vested in Secretary of Energy subsequently transferred to Federal Coordinator for Alaska Natural Gas Transportation Projects by section 720d(f) of this title.

DELEGATION OF FUNCTIONS

Functions of President respecting certain facilities constructed and maintained on United States borders delegated to Secretary of State, see Ex. Ord. No. 11423, Aug. 16, 1968, 33 F.R. 11741, set out as a note under section 301 of Title 3, The President.

-EXEC-

EX. ORD. NO. 10485. PERFORMANCE OF FUNCTIONS RESPECTING ELECTRIC POWER AND NATURAL GAS FACILITIES LOCATED ON UNITED STATES BORDERS

Ex. Ord. No. 10485, Sept. 3, 1953, 18 F.R. 5397, as amended by Ex. Ord. No. 12038, Feb. 3, 1978, 43 F.R. 4957, provided:

Section 1. (a) The Secretary of Energy is hereby designated and empowered to perform the following-described functions:

(1) To receive all applications for permits for the construction, operation, maintenance, or connection, at the borders of the United States, of facilities for the transmission of electric energy between the United States and a foreign country.

(2) To receive all applications for permits for the construction, operation, maintenance, or connection, at the borders of the United States, of facilities for the exportation or importation of natural gas to or from a foreign country.

(3) Upon finding the issuance of the permit to be consistent with the public interest, and, after obtaining the favorable recommendations of the Secretary of State and the Secretary of Defense thereon, to issue to the applicant, as appropriate, a permit for such construction, operation, maintenance, or connection. The Secretary of Energy shall have the power to attach to the issuance of the permit and to the exercise of the rights granted thereunder such conditions as the public interest may in its judgment require.

(b) In any case wherein the Secretary of Energy, the Secretary of State, and the Secretary of Defense cannot agree as to whether or not a permit should be issued, the Secretary of Energy shall submit to the President for approval or disapproval the application for a permit with the respective views of the Secretary of Energy, the Secretary of State and the Secretary of Defense.

Sec. 2. [Deleted.]

Sec. 3. The Secretary of Energy is authorized to issue such rules and regulations, and to prescribe such procedures, as it may from time to time deem necessary or desirable for the exercise of the authority delegated to it by this order.

Sec. 4. All Presidential Permits heretofore issued pursuant to Executive Order No. 8202 of July 13, 1939, and in force at the time of the issuance of this order, and all permits issued hereunder, shall remain in full force and effect until modified or revoked by the President or by the Secretary of Energy.

Sec. 5. Executive Order No. 8202 of July 13, 1939, is hereby revoked.

-FOOTNOTE-

(!1) So in original. Probably should be "finds".

(!2) So in original. Probably should be "coordinates and consults".

-End-

Appendix B. Summary Tables

Table B1. U.S. Annual Average Values from 2015 to 2025

	Reference					High Shale EUR					Low Shale EUR					High Macroeconomic Growth				
	baseline	low/ slow	low/ rapid	high/ slow	high/ rapid	baseline	low/ slow	low/ rapid	high/ slow	high/ rapid	baseline	low/ slow	low/ rapid	high/ slow	high/ rapid	baseline	low/ slow	low/ rapid	high/ slow	high/ rapid
NATURAL GAS VOLUMES (Tcf)																				
Net Exports	(1.90)	(0.29)	0.11	0.17	1.74	(1.32)	0.32	0.70	0.79	2.35	(2.72)	(1.17)	(0.88)	(0.73)	0.66	(2.00)	(0.38)	0.01	0.07	1.64
gross imports	3.62	3.70	3.70	3.74	3.76	3.19	3.25	3.26	3.27	3.31	4.27	4.42	4.53	4.48	4.68	3.70	3.78	3.79	3.82	3.85
gross exports	1.72	3.41	3.81	3.91	5.50	1.87	3.56	3.96	4.06	5.65	1.56	3.25	3.65	3.75	5.34	1.70	3.39	3.79	3.89	5.49
Dry Production	23.27	24.15	24.37	24.42	25.33	26.24	27.28	27.51	27.57	28.41	19.80	20.72	20.78	20.99	21.83	23.85	24.90	25.10	25.22	26.20
shale gas	8.34	8.96	9.17	9.13	9.90	11.90	12.66	12.87	12.89	13.64	3.88	4.42	4.63	4.53	5.22	8.73	9.49	9.70	9.69	10.51
other	14.93	15.18	15.20	15.29	15.43	14.34	14.61	14.65	14.68	14.77	15.91	16.30	16.15	16.45	16.62	15.12	15.41	15.39	15.53	15.70
Delivered Volumes (1)	23.34	22.57	22.38	22.37	21.68	25.58	24.94	24.79	24.75	24.00	20.82	20.13	19.90	19.94	19.35	23.99	23.37	23.17	23.22	22.60
electric generators	6.81	6.25	6.16	6.11	5.67	8.35	7.94	7.88	7.80	7.30	5.07	4.66	4.55	4.54	4.23	6.99	6.63	6.53	6.54	6.21
industrial	8.14	8.01	7.95	7.98	7.83	8.55	8.40	8.34	8.37	8.19	7.74	7.58	7.51	7.56	7.38	8.50	8.34	8.27	8.30	8.12
residential	4.83	4.80	4.79	4.79	4.75	4.94	4.92	4.90	4.91	4.87	4.68	4.63	4.61	4.62	4.57	4.90	4.86	4.85	4.85	4.81
commercial	3.48	3.44	3.42	3.42	3.37	3.65	3.61	3.59	3.60	3.55	3.27	3.20	3.17	3.18	3.11	3.52	3.46	3.45	3.45	3.39
NATURAL GAS END-USE PRICES (2009$/Mcf)																				
residential	11.19	11.63	11.77	11.81	12.33	9.92	10.24	10.37	10.36	10.72	13.23	14.05	14.27	14.42	15.10	11.56	12.09	12.21	12.29	12.87
commercial	9.23	9.66	9.79	9.83	10.34	7.97	8.28	8.40	8.39	8.74	11.27	12.09	12.31	12.46	13.16	9.60	10.12	10.24	10.31	10.88
industrial	5.59	6.10	6.25	6.32	6.91	4.41	4.80	4.95	4.94	5.41	7.50	8.40	8.62	8.83	9.59	5.89	6.49	6.63	6.73	7.41
OTHER PRICES																				
Natural Gas Wellhead Price (2009$/Mcf)	4.70	5.17	5.30	5.37	5.91	3.56	3.90	4.02	4.03	4.42	6.52	7.41	7.63	7.84	8.64	4.99	5.54	5.66	5.77	6.39
Henry Hub Price (2009$/MMBtu)	5.17	5.69	5.83	5.91	6.51	3.92	4.29	4.43	4.43	4.87	7.18	8.16	8.41	8.64	9.51	5.49	6.10	6.23	6.35	7.04
Coal Minemouth Price (2009$/short-ton)	32.67	32.76	32.89	32.89	32.89	32.33	32.69	32.52	32.59	32.77	32.91	33.15	33.10	32.97	33.04	33.23	33.18	33.06	33.33	33.28
End-Use Electricity Price (2009 cents/KWh)	8.85	8.98	9.00	9.02	9.17	8.56	8.62	8.67	8.64	8.70	9.44	9.64	9.71	9.78	9.97	9.08	9.26	9.27	9.32	9.46
NATURAL GAS REVENUES (B 2009$)																				
Export Revenues (2)	9.47	20.64	23.25	25.10	37.74	7.51	16.01	18.17	19.27	28.89	12.83	29.03	32.72	36.09	53.91	10.04	22.11	24.82	26.97	40.81
Domestic Supply Revenues (3)	160.19	175.25	179.33	181.70	199.21	147.33	159.55	163.65	164.23	177.50	177.88	201.92	206.65	213.21	236.34	171.34	190.13	193.88	197.79	218.78
production revenues (4)	109.53	125.29	129.41	132.23	150.47	93.68	106.70	111.00	111.90	126.30	129.24	154.00	158.75	165.84	189.27	119.39	138.71	142.53	146.83	168.64
delivery revenues (5)	50.65	49.97	49.92	49.46	48.74	53.65	52.85	52.65	52.33	51.20	48.64	47.92	47.91	47.37	47.07	51.94	51.41	51.36	50.96	50.14
Import Revenues (6)	17.44	19.22	19.72	19.92	21.97	12.09	13.35	13.86	13.83	15.35	28.00	31.62	33.03	33.32	36.58	18.96	21.07	21.66	21.94	24.19
END-USE ENERGY EXPENDITURES (B 2009$)	1,398.11	1,409.25	1,410.59	1,414.03	1,424.75	1,368.25	1,375.50	1,377.65	1,379.69	1,386.87	1,448.36	1,465.24	1,469.02	1,473.83	1,482.50	1,485.34	1,498.28	1,499.67	1,504.03	1,514.65
liquids	913.43	914.55	913.66	915.34	915.15	908.98	909.65	908.67	911.23	911.57	920.92	921.56	921.21	920.98	916.83	971.80	971.63	971.22	972.09	970.98
natural gas	128.00	133.77	135.27	136.30	142.58	113.26	117.51	119.11	119.24	123.94	151.16	161.03	163.24	165.90	173.42	136.49	143.47	144.71	146.37	153.61
electricity	349.77	354.03	354.76	355.46	360.10	339.21	341.51	343.06	342.39	344.53	369.28	375.68	377.60	379.98	385.31	369.58	375.70	376.28	378.08	382.59
coal	6.90	6.91	6.91	6.93	6.92	6.80	6.82	6.81	6.83	6.83	6.99	6.98	6.97	6.97	6.94	7.47	7.49	7.46	7.49	7.46
END-USE ENERGY CONSUMPTION (quadrillion Btu)	67.88	67.68	67.59	67.67	67.37	68.58	68.40	68.28	68.37	68.11	66.93	66.63	66.49	66.54	66.20	70.23	70.02	69.89	69.98	69.64
liquids	36.71	36.74	36.74	36.78	36.78	36.67	36.71	36.71	36.74	36.75	36.71	36.72	36.71	36.74	36.73	38.13	38.18	38.16	38.20	38.20
natural gas	16.04	15.85	15.76	15.81	15.55	16.76	16.55	16.45	16.49	16.23	15.22	14.97	14.86	14.91	14.65	16.49	16.26	16.16	16.21	15.92
electricity	13.44	13.41	13.41	13.41	13.37	13.48	13.47	13.46	13.48	13.47	13.32	13.26	13.24	13.22	13.16	13.84	13.81	13.80	13.79	13.75
coal	1.68	1.68	1.68	1.68	1.67	1.67	1.67	1.67	1.67	1.67	1.68	1.68	1.68	1.68	1.67	1.77	1.77	1.77	1.77	1.76
ELECTRIC GENERATION (billion kWh)	4,456.38	4,441.98	4,437.47	4,441.10	4,422.62	4,492.78	4,484.65	4,477.63	4,483.35	4,471.75	4,391.20	4,369.32	4,360.19	4,356.29	4,329.07	4,594.62	4,577.41	4,572.19	4,572.39	4,552.42
coal	1,921.25	1,982.85	1,995.33	1,999.09	2,044.09	1,756.51	1,808.90	1,813.78	1,828.74	1,885.58	2,093.76	2,132.35	2,134.49	2,123.82	2,139.82	2,004.09	2,036.83	2,052.54	2,043.09	2,073.78
gas	999.19	918.42	902.15	898.01	829.83	1,232.25	1,170.15	1,158.31	1,147.99	1,070.38	733.83	671.33	653.23	655.42	608.52	1,036.47	978.19	959.84	964.71	909.63
nuclear	866.34	866.34	866.34	866.34	866.34	850.50	850.50	850.50	851.17	855.05	866.34	866.34	866.34	866.34	866.34	866.34	866.34	866.34	866.34	866.34
renewables	610.16	614.27	613.17	617.16	621.29	593.01	594.47	595.24	594.57	599.35	636.27	638.25	645.09	648.70	651.89	626.90	634.74	632.26	636.59	641.06
other	59.43	60.11	60.48	60.50	61.08	60.51	60.63	59.80	60.87	61.39	61.00	61.04	61.03	62.00	62.50	60.83	61.30	61.21	61.65	61.61
PRIMARY ENERGY (quadrillion Btu)																				
Consumption	104.89	104.90	104.87	104.98	104.91	105.24	105.25	105.14	105.32	105.27	104.34	104.16	104.07	104.06	103.75	108.35	108.31	108.25	108.36	108.12
Imports	28.62	28.75	28.72	28.78	28.90	27.69	27.73	27.77	27.87	27.94	29.78	29.83	29.92	29.98	30.08	30.06	30.22	30.21	30.24	30.28
Exports	7.06	8.76	9.15	9.26	10.86	7.20	8.92	9.32	9.43	11.03	6.85	8.54	8.93	9.01	10.60	7.10	8.80	9.20	9.30	10.90
Production	83.14	84.73	85.12	85.28	86.71	84.63	86.34	86.60	86.79	88.26	81.15	82.63	82.84	82.86	84.05	85.16	86.66	87.01	87.18	88.52
ENERGY RELATED CO_2 EMISSIONS (including liquefaction)(million metric tons)	5,793.73	5,832.23	5,837.67	5,846.39	5,869.62	5,754.36	5,787.50	5,787.31	5,804.76	5,833.35	5,832.09	5,853.23	5,846.94	5,841.58	5,843.35	6,017.09	6,037.23	6,043.12	6,043.12	6,055.08

Table B2. Differential from Base in U.S. Average Annual Values from 2015 to 2025 when Exports are Added

	Reference				High Shale EUR				Low Shale EUR				High Macroeconomic Growth			
	low/ slow	low/ rapid	high/ slow	high/ rapid	low/ slow	low/ rapid	high/ slow	high/ rapid	low/ slow	low/ rapid	high/ slow	high/ rapid	low/ slow	low/ rapid	high/ slow	high/ rapid
NATURAL GAS VOLUMES (Tcf)																
Net Exports	1.61	2.00	2.07	3.64	1.64	2.02	2.11	3.67	1.55	1.84	1.99	3.38	1.62	2.01	2.07	3.64
gross imports	0.08	0.09	0.12	0.15	0.05	0.07	0.08	0.12	0.14	0.25	0.20	0.41	0.07	0.08	0.12	0.14
gross exports	1.69	2.09	2.19	3.78	1.69	2.09	2.19	3.78	1.69	2.09	2.19	3.78	1.69	2.09	2.19	3.78
Dry Production	0.87	1.09	1.15	2.05	1.04	1.28	1.33	2.17	0.92	0.98	1.19	2.04	1.05	1.24	1.37	2.35
shale gas	0.62	0.82	0.79	1.55	0.77	0.97	0.99	1.74	0.53	0.75	0.65	1.33	0.76	0.97	0.96	1.78
other	0.25	0.27	0.36	0.50	0.27	0.31	0.34	0.43	0.39	0.24	0.54	0.71	0.29	0.27	0.41	0.57
Delivered Volumes (1)	(0.77)	(0.95)	(0.97)	(1.66)	(0.64)	(0.80)	(0.84)	(1.59)	(0.69)	(0.91)	(0.88)	(1.46)	(0.62)	(0.82)	(0.77)	(1.39)
electric generators	(0.57)	(0.66)	(0.71)	(1.15)	(0.42)	(0.47)	(0.55)	(1.05)	(0.41)	(0.52)	(0.53)	(0.84)	(0.36)	(0.46)	(0.45)	(0.78)
industrial	(0.13)	(0.19)	(0.16)	(0.32)	(0.15)	(0.22)	(0.19)	(0.36)	(0.15)	(0.23)	(0.18)	(0.35)	(0.16)	(0.23)	(0.20)	(0.38)
residential	(0.03)	(0.04)	(0.04)	(0.08)	(0.03)	(0.04)	(0.04)	(0.07)	(0.05)	(0.07)	(0.07)	(0.11)	(0.04)	(0.05)	(0.05)	(0.09)
commercial	(0.05)	(0.06)	(0.06)	(0.11)	(0.04)	(0.06)	(0.05)	(0.10)	(0.07)	(0.09)	(0.09)	(0.15)	(0.05)	(0.07)	(0.07)	(0.13)
NATURAL GAS END-USE PRICES (2009$/Mcf)																
residential	0.44	0.58	0.62	1.14	0.32	0.45	0.44	0.80	0.81	1.03	1.18	1.87	0.53	0.65	0.72	1.31
commercial	0.43	0.57	0.61	1.12	0.31	0.43	0.42	0.76	0.82	1.04	1.19	1.89	0.52	0.64	0.71	1.28
industrial	0.51	0.66	0.73	1.32	0.39	0.54	0.54	1.00	0.90	1.13	1.33	2.09	0.61	0.74	0.85	1.52
OTHER PRICES																
Natural Gas Wellhead Price (2009$/Mcf)	0.47	0.60	0.68	1.21	0.33	0.46	0.47	0.86	0.88	1.11	1.32	2.11	0.55	0.67	0.77	1.40
Henry Hub Price (2009$/MMBtu)	0.52	0.66	0.74	1.34	0.37	0.51	0.51	0.95	0.97	1.22	1.46	2.33	0.60	0.74	0.85	1.54
Coal Minemouth Price (2009$/short-ton)	0.09	0.21	0.22	0.22	0.36	0.19	0.26	0.44	0.24	0.19	0.06	0.13	(0.05)	(0.17)	0.11	0.06
End-Use Electricity Price (2009 cents/KWh)	0.13	0.15	0.17	0.31	0.06	0.11	0.08	0.14	0.20	0.27	0.34	0.53	0.17	0.19	0.24	0.38
NATURAL GAS REVENUES (B 2009$)																
Export Revenues (2)	11.17	13.77	15.63	28.26	8.50	10.65	11.75	21.38	16.20	19.89	23.25	41.08	12.07	14.79	16.93	30.78
Domestic Supply Revenues (3)	15.07	19.14	21.51	39.02	12.22	16.32	16.91	30.17	24.04	28.77	35.33	58.46	18.79	22.55	26.46	47.44
production revenues (4)	15.75	19.88	22.70	40.93	13.02	17.31	18.22	32.62	24.76	29.51	36.60	60.03	19.32	23.13	27.44	49.24
delivery revenues (5)	(0.68)	(0.74)	(1.19)	(1.91)	(0.80)	(0.99)	(1.32)	(2.45)	(0.72)	(0.74)	(1.28)	(1.58)	(0.53)	(0.59)	(0.98)	(1.80)
Import Revenues (6)	1.78	2.28	2.48	4.53	1.26	1.77	1.74	3.26	3.62	5.03	5.32	8.58	2.12	2.70	2.99	5.24
END-USE ENERGY EXPENDITURES (B 2009$)	11.15	12.49	15.92	26.65	7.26	9.40	11.44	18.63	16.89	20.67	25.47	34.14	12.94	14.33	18.69	29.31
liquids	1.12	0.22	1.91	1.72	0.68	(0.30)	2.26	2.60	0.64	0.29	0.05	(4.09)	(0.18)	(0.59)	0.29	(0.82)
natural gas	5.76	7.26	8.30	14.58	4.26	5.85	5.98	10.68	9.86	12.07	14.73	22.25	6.98	8.22	9.88	17.12
electricity	4.26	4.99	5.69	10.32	2.31	3.85	3.18	5.32	6.39	8.31	10.70	16.02	6.12	6.70	8.50	13.01
coal	0.01	0.01	0.03	0.02	0.02	0.00	0.03	0.03	(0.00)	(0.01)	(0.01)	(0.04)	0.02	(0.01)	0.02	(0.00)
END-USE ENERGY CONSUMPTION (quadrillion Btu)	(0.20)	(0.29)	(0.21)	(0.50)	(0.18)	(0.30)	(0.21)	(0.47)	(0.30)	(0.44)	(0.38)	(0.73)	(0.22)	(0.34)	(0.26)	(0.60)
liquids	0.03	0.03	0.06	0.06	0.04	0.04	0.07	0.08	0.01	(0.00)	0.03	0.02	0.05	0.03	0.07	0.07
natural gas	(0.19)	(0.28)	(0.23)	(0.49)	(0.22)	(0.32)	(0.27)	(0.53)	(0.25)	(0.36)	(0.31)	(0.57)	(0.24)	(0.34)	(0.28)	(0.57)
electricity	(0.03)	(0.04)	(0.04)	(0.08)	(0.00)	(0.02)	(0.00)	(0.01)	(0.06)	(0.08)	(0.09)	(0.16)	(0.03)	(0.04)	(0.05)	(0.09)
coal	(0.00)	(0.00)	0.00	(0.00)	(0.00)	(0.00)	0.00	(0.00)	(0.00)	(0.01)	(0.00)	(0.01)	(0.00)	(0.00)	0.00	(0.01)
ELECTRIC GENERATION (billion kWh)	(14.39)	(18.91)	(15.27)	(33.75)	(8.13)	(15.15)	(9.43)	(21.02)	(21.89)	(31.02)	(34.92)	(62.13)	(17.21)	(22.43)	(22.23)	(42.20)
coal	61.59	74.07	77.84	122.84	52.39	57.26	72.23	129.07	38.59	40.73	30.06	46.06	32.74	48.46	39.01	69.70
gas	(80.76)	(97.03)	(101.17)	(169.36)	(62.10)	(73.94)	(84.25)	(161.86)	(62.50)	(80.59)	(78.41)	(125.31)	(58.28)	(76.63)	(71.76)	(126.84)
nuclear	-	-	-	-	0.00	0.00	0.67	4.55	(0.00)	-	-	(0.00)	-	-	-	-
renewables	4.10	3.00	7.00	11.12	1.46	2.24	1.57	6.35	1.98	8.82	12.43	15.61	7.85	5.36	9.70	14.17
other	0.67	1.04	1.07	1.64	0.11	(0.71)	0.36	0.88	0.04	0.03	1.00	1.50	0.47	0.38	0.82	0.78
PRIMARY ENERGY (quadrillion Btu)																
Consumption	0.02	(0.02)	0.09	0.02	0.01	(0.09)	0.08	0.03	(0.18)	(0.27)	(0.28)	(0.59)	(0.03)	(0.10)	0.01	(0.23)
Imports	0.13	0.10	0.16	0.28	0.04	0.08	0.18	0.26	0.05	0.14	0.20	0.30	0.16	0.15	0.18	0.22
Exports	1.70	2.09	2.20	3.79	1.72	2.12	2.23	3.83	1.69	2.08	2.16	3.75	1.70	2.10	2.20	3.80
Production	1.59	1.98	2.14	3.58	1.71	1.96	2.16	3.63	1.47	1.69	1.71	2.90	1.50	1.85	2.02	3.36
ENERGY RELATED CO_2 EMISSIONS (including liquefaction)(million metric tons)	38.50	43.94	52.67	75.90	33.14	32.94	50.39	78.99	21.14	14.85	9.48	11.26	20.14	26.03	26.03	37.99

Table B3. U.S. Annual Average Values from 2025 to 2035

	Reference					High Shale EUR					Low Shale EUR					High Macroeconomic Growth				
	baseline	low/ slow	low/ rapid	high/ slow	high/ rapid	baseline	low/ slow	low/ rapid	high/ slow	high/ rapid	baseline	low/ slow	low/ rapid	high/ slow	high/ rapid	baseline	low/ slow	low/ rapid	high/ slow	high/ rapid
NATURAL GAS VOLUMES (Tcf)																				
Net Exports	(0.71)	1.48	1.48	3.52	3.57	0.10	2.16	2.15	4.19	4.20	(2.09)	(0.21)	(0.33)	1.83	1.76	(0.88)	1.29	1.29	3.21	3.38
gross imports	2.98	2.99	2.98	3.10	3.09	2.47	2.60	2.61	2.73	2.75	3.99	4.30	4.42	4.41	4.52	3.09	3.11	3.11	3.35	3.21
gross exports	2.28	4.47	4.47	6.62	6.66	2.57	4.76	4.76	6.91	6.95	1.90	4.09	4.09	6.25	6.28	2.21	4.40	4.40	6.56	6.59
Dry Production	25.07	26.58	26.66	28.08	28.23	28.73	30.16	30.21	31.50	31.51	20.98	22.22	22.24	23.61	23.89	26.84	28.59	28.55	29.99	30.31
shale gas	10.96	12.08	12.10	13.10	13.27	15.51	16.70	16.75	17.75	17.74	5.22	6.06	6.13	6.78	6.97	12.19	13.49	13.47	14.49	14.75
other	14.12	14.49	14.56	14.98	14.96	13.21	13.46	13.47	13.75	13.77	15.76	16.16	16.11	16.83	16.91	14.65	15.10	15.08	15.50	15.56
Delivered Volumes (1)	23.96	23.22	23.29	22.60	22.70	26.63	25.94	26.00	25.19	25.19	21.41	20.69	20.82	19.97	20.27	25.80	25.29	25.26	24.72	24.85
electric generators	7.27	6.87	6.95	6.56	6.66	8.89	8.55	8.65	8.11	8.20	5.78	5.28	5.41	4.82	5.08	8.21	8.04	8.03	7.77	7.93
industrial	8.06	7.82	7.81	7.62	7.60	8.68	8.45	8.42	8.25	8.16	7.47	7.34	7.32	7.20	7.19	8.68	8.43	8.40	8.22	8.18
residential	4.82	4.78	4.78	4.73	4.74	4.95	4.91	4.91	4.88	4.88	4.64	4.61	4.61	4.56	4.58	5.01	4.97	4.97	4.93	4.94
commercial	3.68	3.62	3.62	3.56	3.57	3.91	3.85	3.85	3.80	3.80	3.40	3.36	3.37	3.29	3.32	3.75	3.70	3.71	3.66	3.66
NATURAL GAS END-USE PRICES (2009$/Mcf)																				
residential	12.90	13.45	13.39	14.05	13.85	11.31	11.66	11.68	12.10	11.98	15.49	15.96	15.83	16.76	16.27	13.70	14.13	14.06	14.67	14.51
commercial	10.61	11.15	11.09	11.73	11.54	9.01	9.34	9.36	9.75	9.63	13.24	13.71	13.58	14.53	14.02	11.39	11.80	11.73	12.32	12.15
industrial	6.82	7.43	7.36	8.26	7.98	5.39	5.86	5.88	6.46	6.32	9.30	9.79	9.66	10.69	10.09	7.50	8.05	7.96	8.82	8.59
OTHER PRICES																				
Natural Gas Wellhead Price (2009$/Mcf)	5.88	6.42	6.35	7.14	6.88	4.45	4.82	4.83	5.31	5.17	8.25	8.77	8.68	9.69	9.10	6.52	6.98	6.90	7.67	7.43
Henry Hub Price (2009$/MMBtu)	6.47	7.06	6.99	7.86	7.58	4.90	5.30	5.31	5.85	5.69	9.08	9.66	9.56	10.67	10.02	7.18	7.68	7.60	8.45	8.18
Coal Minemouth Price (2009$/short-ton)	33.46	33.51	33.43	33.68	33.43	33.20	33.45	33.21	33.42	33.25	33.77	34.11	33.89	33.76	33.85	34.30	34.01	33.95	33.99	34.16
End-Use Electricity Price (2009 cents/KWh)	9.02	9.17	9.15	9.36	9.28	8.57	8.65	8.67	8.75	8.69	9.86	9.98	9.94	10.25	10.06	9.50	9.67	9.63	9.90	9.78
NATURAL GAS REVENUES (B 2009$)																				
Export Revenues (2)	12.81	29.82	29.50	50.58	48.98	10.46	23.42	23.49	38.88	38.06	17.38	39.57	38.98	66.69	62.90	14.21	32.48	32.11	54.16	52.87
Domestic Supply Revenues (3)	199.45	221.98	220.95	249.66	244.39	184.30	200.41	201.19	220.08	216.08	222.71	243.85	242.19	276.77	266.61	230.96	254.64	252.33	282.66	278.95
production revenues (4)	147.54	170.77	169.47	200.63	194.52	128.09	145.41	146.06	167.45	162.93	173.25	194.92	193.13	228.66	217.47	175.63	199.91	197.44	230.19	225.48
delivery revenues (5)	51.91	51.21	51.48	49.03	49.87	56.21	55.00	55.13	52.63	53.14	49.47	48.94	49.06	48.11	49.13	55.33	54.74	54.89	52.47	53.47
Import Revenues (6)	18.06	19.89	19.65	22.97	22.09	11.69	13.64	13.75	16.04	15.80	33.87	37.50	37.30	41.19	39.73	20.96	22.75	22.52	26.35	24.99
END-USE ENERGY EXPENDITURES (B 2009$)	1,582.70	1,589.93	1,589.52	1,602.94	1,596.44	1,543.37	1,552.01	1,553.43	1,559.62	1,552.40	1,648.34	1,658.55	1,651.04	1,673.64	1,651.53	1,766.94	1,773.78	1,770.57	1,786.74	1,777.53
liquids	1,036.91	1,032.47	1,033.91	1,030.97	1,030.61	1,032.78	1,033.84	1,034.44	1,031.39	1,028.44	1,044.39	1,046.22	1,041.53	1,044.12	1,034.65	1,156.40	1,151.96	1,151.22	1,149.05	1,147.03
natural gas	152.47	158.71	157.65	166.94	163.18	136.00	140.12	140.18	146.00	143.37	180.36	184.84	183.01	194.25	187.01	172.16	177.27	175.86	185.15	181.63
electricity	386.65	392.12	391.36	398.45	396.09	368.01	371.51	372.27	375.68	374.08	416.91	420.84	419.85	428.68	423.29	430.75	436.99	435.94	445.06	441.40
coal	6.67	6.62	6.61	6.59	6.56	6.57	6.54	6.53	6.54	6.51	6.68	6.64	6.65	6.59	6.58	7.63	7.55	7.54	7.48	7.46
END-USE ENERGY CONSUMPTION (quadrillion Btu)	70.29	69.92	69.90	69.59	69.57	71.26	70.89	70.87	70.66	70.61	68.84	68.56	68.64	68.25	68.43	74.98	74.60	74.59	74.25	74.26
liquids	37.85	37.84	37.82	37.84	37.83	37.75	37.74	37.75	37.81	37.80	37.74	37.71	37.77	37.73	37.81	40.67	40.66	40.65	40.64	40.64
natural gas	16.26	15.95	15.94	15.69	15.66	17.32	16.97	16.93	16.66	16.58	15.13	14.92	14.92	14.71	14.73	17.13	16.83	16.81	16.58	16.53
electricity	14.59	14.55	14.56	14.48	14.52	14.61	14.62	14.62	14.61	14.66	14.39	14.35	14.38	14.25	14.32	15.43	15.39	15.41	15.31	15.37
coal	1.59	1.58	1.58	1.57	1.57	1.58	1.57	1.57	1.57	1.57	1.58	1.57	1.57	1.56	1.56	1.74	1.73	1.73	1.72	1.72
ELECTRIC GENERATION (billion kWh)	4,926.27	4,899.77	4,902.00	4,877.85	4,883.87	4,985.61	4,970.39	4,968.96	4,955.47	4,962.16	4,805.29	4,785.02	4,792.39	4,749.29	4,771.60	5,218.96	5,192.01	5,194.85	5,161.80	5,172.17
coal	2,142.71	2,177.86	2,173.08	2,205.23	2,199.91	1,965.65	2,017.08	2,010.40	2,076.04	2,072.01	2,250.96	2,299.95	2,288.43	2,318.37	2,307.93	2,230.53	2,234.24	2,247.81	2,248.95	2,243.60
gas	1,143.09	1,075.44	1,084.20	1,020.61	1,029.93	1,418.58	1,349.39	1,356.51	1,272.85	1,275.05	878.08	797.50	812.65	731.17	762.84	1,317.28	1,273.98	1,266.15	1,220.40	1,234.87
nuclear	876.67	876.67	876.67	876.67	876.67	858.29	858.29	858.29	858.29	863.83	876.67	878.22	878.27	879.99	878.26	876.67	877.25	876.67	877.38	876.67
renewables	702.87	707.59	705.79	711.29	713.75	681.48	683.24	681.93	685.54	688.71	734.07	743.56	747.72	752.68	756.76	730.61	742.46	740.48	748.18	750.94
other	60.93	62.21	62.25	64.05	63.60	61.62	62.40	61.82	62.74	62.56	65.51	65.81	65.32	67.09	65.81	63.87	64.07	63.73	66.89	66.09
PRIMARY ENERGY (quadrillion Btu)																				
Consumption	111.05	110.88	110.85	110.69	110.76	111.50	111.37	111.37	111.45	111.46	109.71	109.57	109.69	109.18	109.59	117.72	117.47	117.54	117.22	117.23
Imports	27.93	27.63	27.67	27.60	27.46	26.80	26.78	26.86	27.04	26.99	29.22	29.38	29.42	29.45	29.40	30.26	30.04	29.97	30.09	29.72
Exports	7.91	10.13	10.13	12.29	12.32	8.18	10.39	10.40	12.58	12.62	7.54	9.74	9.72	11.88	11.94	7.97	10.17	10.18	12.32	12.36
Production	90.96	93.37	93.26	95.38	95.65	92.89	95.05	94.99	97.21	97.27	87.86	89.79	89.86	91.50	92.04	95.31	97.52	97.67	99.38	99.80
ENERGY RELATED CO_2 EMISSIONS (including liquefaction)(million metric tons)	6,114.82	6,136.49	6,131.49	6,155.61	6,152.88	6,074.00	6,103.94	6,102.31	6,151.52	6,146.61	6,084.64	6,103.94	6,106.49	6,104.89	6,120.61	6,521.09	6,517.76	6,525.31	6,521.52	6,520.16

Table B4. Differential from Base in U.S. Average Annual Values from 2025 to 2035 when Exports are Added

	Reference				High Shale EUR				Low Shale EUR				High Macroeconomic Growth			
	low/ slow	low/ rapid	high/ slow	high/ rapid	low/ slow	low/ rapid	high/ slow	high/ rapid	low/ slow	low/ rapid	high/ slow	high/ rapid	low/ slow	low/ rapid	high/ slow	high/ rapid
NATURAL GAS VOLUMES (Tcf)																
Net Exports	2.18	2.19	4.23	4.28	2.06	2.05	4.09	4.10	1.88	1.76	3.93	3.85	2.17	2.17	4.09	4.26
gross imports	0.01	0.00	0.12	0.10	0.13	0.14	0.26	0.28	0.31	0.43	0.42	0.53	0.02	0.02	0.26	0.12
gross exports	2.19	2.19	4.35	4.38	2.19	2.19	4.35	4.38	2.19	2.19	4.35	4.38	2.19	2.19	4.35	4.38
Dry Production	1.51	1.59	3.00	3.15	1.43	1.49	2.77	2.78	1.24	1.25	2.62	2.90	1.74	1.71	3.15	3.47
shale gas	1.13	1.15	2.14	2.31	1.18	1.23	2.24	2.23	0.84	0.91	1.55	1.75	1.29	1.28	2.30	2.56
other	0.38	0.44	0.86	0.84	0.25	0.25	0.53	0.55	0.40	0.35	1.07	1.16	0.45	0.43	0.85	0.91
Delivered Volumes (1)	(0.75)	(0.67)	(1.36)	(1.26)	(0.69)	(0.63)	(1.43)	(1.43)	(0.72)	(0.59)	(1.44)	(1.13)	(0.51)	(0.54)	(1.08)	(0.95)
electric generators	(0.40)	(0.32)	(0.71)	(0.61)	(0.35)	(0.25)	(0.79)	(0.70)	(0.50)	(0.37)	(0.96)	(0.69)	(0.17)	(0.19)	(0.45)	(0.28)
industrial	(0.24)	(0.25)	(0.44)	(0.46)	(0.24)	(0.27)	(0.43)	(0.53)	(0.13)	(0.15)	(0.27)	(0.28)	(0.25)	(0.27)	(0.46)	(0.49)
residential	(0.04)	(0.04)	(0.08)	(0.08)	(0.03)	(0.03)	(0.07)	(0.06)	(0.03)	(0.03)	(0.08)	(0.06)	(0.04)	(0.03)	(0.07)	(0.07)
commercial	(0.06)	(0.06)	(0.12)	(0.11)	(0.05)	(0.06)	(0.11)	(0.10)	(0.05)	(0.04)	(0.11)	(0.08)	(0.05)	(0.04)	(0.10)	(0.09)
NATURAL GAS END-USE PRICES (2009$/Mcf)																
residential	0.55	0.48	1.15	0.95	0.35	0.37	0.79	0.67	0.46	0.33	1.27	0.78	0.43	0.35	0.97	0.81
commercial	0.54	0.48	1.12	0.92	0.33	0.34	0.73	0.61	0.47	0.34	1.29	0.78	0.41	0.34	0.93	0.76
industrial	0.62	0.54	1.44	1.16	0.46	0.48	1.07	0.92	0.49	0.36	1.39	0.78	0.55	0.46	1.32	1.09
OTHER PRICES																
Natural Gas Wellhead Price (2009$/Mcf)	0.54	0.47	1.27	1.01	0.36	0.38	0.86	0.71	0.52	0.43	1.44	0.85	0.45	0.38	1.15	0.90
Henry Hub Price (2009$/MMBtu)	0.60	0.52	1.39	1.11	0.40	0.41	0.95	0.79	0.57	0.47	1.59	0.94	0.50	0.42	1.26	1.00
Coal Minemouth Price (2009$/short-ton)	0.05	(0.03)	0.22	(0.03)	0.25	0.01	0.22	0.05	0.34	0.12	(0.01)	0.08	(0.29)	(0.35)	(0.30)	(0.14)
End-Use Electricity Price (2009 cents/KWh)	0.16	0.13	0.35	0.27	0.08	0.10	0.18	0.12	0.12	0.08	0.38	0.20	0.17	0.13	0.40	0.28
NATURAL GAS REVENUES (B 2009$)																
Export Revenues (2)	17.01	16.69	37.77	36.17	12.96	13.03	28.42	27.60	22.19	21.60	49.31	45.52	18.27	17.90	39.95	38.66
Domestic Supply Revenues (3)	22.53	21.50	50.21	44.94	16.11	16.89	35.77	31.78	21.14	19.48	54.05	43.89	23.68	21.37	51.70	47.99
production revenues (4)	23.23	21.93	53.09	46.98	17.31	17.97	39.36	34.84	21.67	19.88	55.41	44.23	24.28	21.81	54.56	49.85
delivery revenues (5)	(0.71)	(0.44)	(2.88)	(2.04)	(1.21)	(1.08)	(3.58)	(3.06)	(0.53)	(0.40)	(1.36)	(0.33)	(0.60)	(0.44)	(2.86)	(1.87)
Import Revenues (6)	1.82	1.59	4.91	4.02	1.95	2.06	4.35	4.11	3.63	3.43	7.32	5.87	1.79	1.56	5.39	4.03
END-USE ENERGY EXPENDITURES (B 2009$)	7.22	6.81	20.24	13.73	8.64	10.06	16.25	9.03	10.21	2.71	25.31	3.19	6.84	3.63	19.81	10.59
liquids	(4.45)	(3.01)	(5.94)	(6.31)	1.05	1.66	(1.39)	(4.34)	1.83	(2.86)	(0.27)	(9.74)	(4.43)	(5.17)	(7.34)	(9.37)
natural gas	6.25	5.18	14.47	10.71	4.12	4.18	10.00	7.37	4.49	2.65	13.90	6.65	5.12	3.70	12.99	9.47
electricity	5.47	4.71	11.80	9.44	3.50	4.26	7.68	6.07	3.94	2.94	11.78	6.39	6.24	5.19	14.31	10.65
coal	(0.05)	(0.07)	(0.08)	(0.11)	(0.03)	(0.04)	(0.03)	(0.06)	(0.04)	(0.03)	(0.09)	(0.11)	(0.08)	(0.09)	(0.15)	(0.16)
END-USE ENERGY CONSUMPTION (quadrillion Btu)	(0.37)	(0.38)	(0.70)	(0.71)	(0.37)	(0.39)	(0.60)	(0.65)	(0.28)	(0.20)	(0.60)	(0.42)	(0.38)	(0.39)	(0.73)	(0.72)
liquids	(0.00)	(0.02)	(0.01)	(0.02)	(0.01)	0.00	0.06	0.06	(0.03)	0.03	(0.01)	0.07	(0.02)	(0.03)	(0.03)	(0.03)
natural gas	(0.31)	(0.32)	(0.57)	(0.60)	(0.35)	(0.39)	(0.65)	(0.74)	(0.21)	(0.21)	(0.42)	(0.40)	(0.30)	(0.32)	(0.54)	(0.60)
electricity	(0.04)	(0.03)	(0.11)	(0.07)	0.00	0.01	(0.00)	0.04	(0.04)	(0.01)	(0.14)	(0.07)	(0.05)	(0.02)	(0.13)	(0.07)
coal	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)	(0.03)
ELECTRIC GENERATION (billion kWh)	(26.50)	(24.27)	(48.42)	(42.40)	(15.22)	(16.66)	(30.14)	(23.45)	(20.26)	(12.90)	(55.99)	(33.69)	(26.95)	(24.11)	(57.15)	(46.78)
coal	35.15	30.37	62.53	57.20	51.43	44.76	110.39	106.36	48.98	37.46	67.41	56.97	3.71	17.28	18.42	13.07
gas	(67.65)	(58.89)	(122.48)	(113.16)	(69.19)	(62.06)	(145.72)	(143.53)	(80.58)	(65.43)	(146.91)	(115.24)	(43.30)	(51.13)	(96.88)	(82.41)
nuclear	-	(0.00)	-	-	0.00	0.00	0.00	5.55	1.54	1.60	3.32	1.59	0.58	0.00	0.71	0.00
renewables	4.72	2.92	8.41	10.87	1.76	0.46	4.07	7.23	9.49	13.65	18.61	22.69	11.85	9.87	17.57	20.33
other	1.28	1.33	3.12	2.68	0.77	0.19	1.12	0.94	0.30	(0.19)	1.58	0.31	0.20	(0.13)	3.02	2.22
PRIMARY ENERGY (quadrillion Btu)																
Consumption	(0.16)	(0.20)	(0.35)	(0.29)	(0.13)	(0.13)	(0.05)	(0.04)	(0.13)	(0.02)	(0.53)	(0.12)	(0.25)	(0.18)	(0.50)	(0.49)
Imports	(0.30)	(0.26)	(0.33)	(0.47)	(0.03)	0.05	0.23	0.19	0.16	0.20	0.23	0.18	(0.22)	(0.30)	(0.17)	(0.54)
Exports	2.21	2.21	4.37	4.41	2.21	2.22	4.40	4.43	2.20	2.19	4.35	4.41	2.20	2.21	4.35	4.39
Production	2.41	2.30	4.42	4.69	2.16	2.10	4.32	4.38	1.93	2.00	3.65	4.18	2.20	2.36	4.07	4.49
ENERGY RELATED CO_2 EMISSIONS (including liquefaction)(million metric tons)	21.67	16.67	40.79	38.07	29.94	28.31	77.52	72.61	19.31	21.85	20.25	35.98	(3.33)	4.21	0.43	(0.93)

Table B5. U.S. Annual Average Values from 2015 to 2035

	Reference					High Shale EUR					Low Shale EUR					High Macroeconomic Growth				
	baseline	low/ slow	low/ rapid	high/ slow	high/ rapid	baseline	low/ slow	low/ rapid	high/ slow	high/ rapid	baseline	low/ slow	low/ rapid	high/ slow	high/ rapid	baseline	low/ slow	low/ rapid	high/ slow	high/ rapid
NATURAL GAS VOLUMES (Tcf)																				
Net Exports	(1.31)	0.57	0.78	1.81	2.63	(0.63)	1.21	1.41	2.44	3.24	(2.40)	(0.70)	(0.60)	0.52	1.21	(1.45)	0.44	0.64	1.60	2.49
gross imports	3.31	3.35	3.35	3.42	3.43	2.84	2.94	2.95	3.01	3.04	4.13	4.36	4.46	4.44	4.59	3.40	3.45	3.45	3.59	3.53
gross exports	2.00	3.93	4.13	5.23	6.06	2.22	4.15	4.35	5.45	6.28	1.73	3.66	3.86	4.96	5.79	1.95	3.88	4.09	5.19	6.02
Dry Production	24.18	25.37	25.52	26.24	26.78	27.48	28.71	28.86	29.52	29.95	20.40	21.47	21.51	22.28	22.86	25.37	26.75	26.83	27.60	28.26
shale gas	9.65	10.51	10.63	11.10	11.56	13.70	14.67	14.79	15.30	15.67	4.56	5.23	5.37	5.64	6.08	10.47	11.48	11.58	12.08	12.62
other	14.54	14.85	14.89	15.15	15.21	13.78	14.04	14.06	14.22	14.28	15.84	16.24	16.14	16.64	16.78	14.90	15.27	15.25	15.53	15.65
Delivered Volumes (1)	23.67	22.91	22.85	22.52	22.20	26.12	25.46	25.41	25.00	24.61	21.12	20.42	20.36	19.97	19.81	24.92	24.35	24.23	24.01	23.75
electric generators	7.06	6.58	6.57	6.36	6.18	8.64	8.26	8.28	7.98	7.77	5.44	4.97	4.98	4.69	4.66	7.63	7.36	7.29	7.18	7.09
industrial	8.10	7.92	7.88	7.81	7.72	8.62	8.42	8.38	8.31	8.18	7.60	7.46	7.42	7.38	7.29	8.59	8.39	8.34	8.27	8.16
residential	4.82	4.79	4.78	4.76	4.75	4.94	4.91	4.91	4.89	4.88	4.66	4.62	4.61	4.59	4.57	4.95	4.92	4.91	4.90	4.87
commercial	3.58	3.53	3.52	3.49	3.47	3.78	3.73	3.72	3.70	3.68	3.34	3.28	3.27	3.24	3.22	3.64	3.59	3.58	3.56	3.53
NATURAL GAS END-USE PRICES (2009$/Mcf)																				
residential	12.04	12.53	12.57	12.91	13.08	10.61	10.95	11.02	11.22	11.35	14.35	14.98	15.06	15.55	15.69	12.63	13.10	13.13	13.45	13.68
commercial	9.91	10.39	10.44	10.76	10.93	8.49	8.80	8.88	9.06	9.18	12.24	12.88	12.95	13.46	13.60	10.49	10.95	10.98	11.29	11.50
industrial	6.20	6.76	6.80	7.26	7.44	4.90	5.32	5.41	5.69	5.86	8.38	9.07	9.15	9.71	9.84	6.69	7.26	7.29	7.75	7.99
OTHER PRICES																				
Natural Gas Wellhead Price (2009$/Mcf)	5.28	5.78	5.82	6.23	6.39	4.01	4.35	4.42	4.66	4.79	7.37	8.06	8.16	8.71	8.87	5.75	6.25	6.28	6.69	6.90
Henry Hub Price (2009$/MMBtu)	5.81	6.36	6.41	6.86	7.03	4.41	4.79	4.87	5.12	5.27	8.12	8.88	8.98	9.60	9.77	6.33	6.88	6.91	7.36	7.60
Coal Minemouth Price (2009$/short-ton)	33.06	33.12	33.15	33.29	33.18	32.77	33.07	32.87	32.99	33.00	33.34	33.64	33.50	33.38	33.46	33.74	33.60	33.52	33.66	33.72
End-Use Electricity Price (2009 cents/KWh)	8.94	9.08	9.08	9.19	9.22	8.56	8.63	8.67	8.70	8.70	9.65	9.81	9.83	10.00	10.02	9.29	9.46	9.45	9.60	9.62
NATURAL GAS REVENUES (B 2009$)																				
Export Revenues (2)	11.13	25.11	26.34	37.49	43.23	8.98	19.64	20.80	28.85	33.39	15.07	34.12	35.85	50.80	58.30	12.11	27.19	28.43	40.19	46.69
Domestic Supply Revenues (3)	179.79	198.43	200.12	215.08	221.64	165.83	179.88	182.38	191.82	196.70	200.15	222.46	224.55	243.87	251.43	201.24	222.30	223.13	239.62	248.66
production revenues (4)	128.46	147.79	149.40	165.76	172.31	110.87	125.92	128.47	139.27	144.50	151.06	173.98	176.05	196.01	203.32	147.54	169.19	169.97	187.82	196.82
delivery revenues (5)	51.32	50.64	50.72	49.32	49.33	54.96	53.96	53.92	52.55	52.21	49.09	48.48	48.50	47.86	48.12	53.70	53.12	53.16	51.79	51.84
Import Revenues (6)	17.77	19.53	19.69	21.37	22.03	11.92	13.52	13.84	14.94	15.61	30.84	34.49	35.15	37.10	38.16	19.97	21.90	22.09	24.07	24.58
END-USE ENERGY EXPENDITURES (B 2009$)	1,489.93	1,499.04	1,499.79	1,507.51	1,510.31	1,455.15	1,463.17	1,465.18	1,469.08	1,469.35	1,547.09	1,561.08	1,559.57	1,572.52	1,567.30	1,625.45	1,635.66	1,634.71	1,644.67	1,646.03
liquids	974.71	973.09	973.49	972.64	972.64	970.30	971.23	971.23	970.91	969.68	981.60	983.31	980.57	982.05	975.74	1,063.35	1,061.47	1,060.75	1,060.30	1,058.97
natural gas	140.16	146.09	146.41	151.27	152.79	124.61	128.76	129.62	132.45	133.62	165.55	172.70	173.21	179.55	180.30	154.27	160.27	160.24	165.41	167.51
electricity	368.28	373.10	373.13	376.85	378.14	353.56	356.51	357.67	359.05	359.38	393.11	398.26	398.98	404.14	404.50	400.29	406.41	406.21	411.48	412.09
coal	6.78	6.76	6.75	6.75	6.74	6.68	6.68	6.67	6.68	6.67	6.83	6.81	6.81	6.78	6.76	7.54	7.51	7.50	7.48	7.46
END-USE ENERGY CONSUMPTION (quadrillion Btu)	69.09	68.81	68.75	68.64	68.49	69.93	69.65	69.59	69.52	69.37	67.90	67.61	67.58	67.42	67.33	72.62	72.33	72.26	72.14	71.97
liquids	37.29	37.30	37.29	37.31	37.31	37.21	37.23	37.24	37.28	37.28	37.24	37.23	37.25	37.25	37.28	39.42	39.43	39.42	39.43	39.44
natural gas	16.15	15.90	15.85	15.76	15.61	17.04	16.76	16.69	16.58	16.41	15.18	14.95	14.89	14.82	14.69	16.81	16.55	16.49	16.41	16.23
electricity	14.02	13.98	13.98	13.95	13.95	14.05	14.05	14.04	14.04	14.06	13.85	13.81	13.81	13.74	13.74	14.64	14.60	14.61	14.55	14.56
coal	1.63	1.63	1.63	1.63	1.62	1.62	1.62	1.62	1.62	1.62	1.63	1.62	1.62	1.62	1.61	1.76	1.75	1.75	1.74	1.74
ELECTRIC GENERATION (billion kWh)	4,691.78	4,671.70	4,670.36	4,660.47	4,654.31	4,740.10	4,728.42	4,724.32	4,720.03	4,717.90	4,599.04	4,578.46	4,576.69	4,554.90	4,551.26	4,907.86	4,886.10	4,884.89	4,868.85	4,864.09
coal	2,030.24	2,078.96	2,083.33	2,100.15	2,121.75	1,860.54	1,912.06	1,912.09	1,949.35	1,977.66	2,171.63	2,216.91	2,212.07	2,221.68	2,224.94	2,114.85	2,134.13	2,149.63	2,144.11	2,158.39
gas	1,074.40	1,000.10	995.54	963.40	932.18	1,328.06	1,262.83	1,259.57	1,215.21	1,175.80	808.02	735.39	733.01	695.09	685.68	1,181.25	1,129.59	1,115.49	1,096.96	1,074.83
nuclear	871.23	871.23	871.23	871.23	871.23	854.18	854.18	854.18	854.53	859.21	871.23	872.04	872.07	872.97	872.07	871.23	871.54	871.23	871.61	871.23
renewables	655.74	660.26	658.89	663.43	666.81	636.24	637.87	637.72	639.17	643.29	684.94	690.77	696.38	700.70	704.42	678.14	688.13	686.04	691.94	695.77
other	60.17	61.15	61.37	62.26	62.34	61.08	61.49	60.76	61.77	61.93	63.21	63.35	63.16	64.47	64.16	62.38	62.71	62.50	64.24	63.86
PRIMARY ENERGY (quadrillion Btu)																				
Consumption	107.97	107.90	107.87	107.85	107.85	108.38	108.31	108.27	108.38	108.37	107.04	106.89	106.89	106.66	106.70	113.05	112.91	112.92	112.81	112.71
Imports	28.28	28.20	28.21	28.18	28.19	27.27	27.28	27.34	27.47	27.49	29.50	29.62	29.68	29.71	29.75	30.17	30.14	30.09	30.17	30.02
Exports	7.48	9.43	9.63	10.73	11.57	7.69	9.64	9.86	10.96	11.81	7.19	9.12	9.32	10.41	11.25	7.53	9.47	9.68	10.77	11.61
Production	87.04	89.04	89.18	90.30	91.17	88.73	90.66	90.77	91.94	92.73	84.52	86.20	86.35	87.18	88.04	90.24	92.09	92.35	93.26	94.16
ENERGY RELATED CO_2 EMISSIONS (including liquefaction)(million metric tons)	5,955.05	5,985.66	5,986.04	6,001.82	6,013.46	5,915.71	5,947.04	5,946.80	5,977.68	5,991.27	5,960.10	5,981.23	5,978.85	5,976.06	5,984.27	6,270.24	6,279.14	6,286.47	6,283.68	6,290.23

Table B6. Differential from Base in U.S. Average Annual Values from 2015 to 2035 when Exports are Added

	Reference				High Shale EUR				Low Shale EUR				High Macroeconomic Growth			
	low/ slow	low/ rapid	high/ slow	high/ rapid	low/ slow	low/ rapid	high/ slow	high/ rapid	low/ slow	low/ rapid	high/ slow	high/ rapid	low/ slow	low/ rapid	high/ slow	high/ rapid
NATURAL GAS VOLUMES (Tcf)																
Net Exports	1.89	2.10	3.12	3.95	1.84	2.03	3.06	3.87	1.70	1.81	2.92	3.61	1.89	2.09	3.05	3.94
gross imports	0.04	0.04	0.11	0.12	0.09	0.10	0.17	0.20	0.23	0.33	0.31	0.46	0.04	0.05	0.19	0.13
gross exports	1.93	2.14	3.23	4.07	1.93	2.14	3.23	4.07	1.93	2.14	3.23	4.07	1.93	2.14	3.23	4.07
Dry Production	1.18	1.33	2.06	2.59	1.23	1.38	2.04	2.47	1.06	1.11	1.88	2.45	1.38	1.46	2.23	2.89
shale gas	0.86	0.98	1.45	1.91	0.97	1.09	1.60	1.97	0.67	0.81	1.08	1.52	1.01	1.11	1.61	2.15
other	0.32	0.35	0.61	0.68	0.26	0.28	0.44	0.50	0.40	0.30	0.80	0.93	0.37	0.35	0.62	0.74
Delivered Volumes (1)	(0.76)	(0.82)	(1.15)	(1.47)	(0.66)	(0.71)	(1.12)	(1.51)	(0.71)	(0.77)	(1.15)	(1.31)	(0.57)	(0.69)	(0.91)	(1.17)
electric generators	(0.48)	(0.49)	(0.70)	(0.88)	(0.38)	(0.36)	(0.66)	(0.87)	(0.46)	(0.46)	(0.75)	(0.78)	(0.27)	(0.34)	(0.45)	(0.54)
industrial	(0.18)	(0.22)	(0.29)	(0.38)	(0.19)	(0.24)	(0.31)	(0.44)	(0.14)	(0.19)	(0.22)	(0.32)	(0.20)	(0.25)	(0.32)	(0.43)
residential	(0.04)	(0.04)	(0.06)	(0.08)	(0.03)	(0.04)	(0.05)	(0.06)	(0.04)	(0.05)	(0.07)	(0.09)	(0.04)	(0.04)	(0.06)	(0.08)
commercial	(0.05)	(0.06)	(0.09)	(0.11)	(0.05)	(0.06)	(0.08)	(0.10)	(0.06)	(0.07)	(0.10)	(0.12)	(0.05)	(0.06)	(0.08)	(0.11)
NATURAL GAS END-USE PRICES (2009$/Mcf)																
residential	0.49	0.53	0.87	1.04	0.33	0.41	0.60	0.73	0.64	0.71	1.20	1.34	0.47	0.50	0.82	1.05
commercial	0.48	0.52	0.84	1.02	0.31	0.39	0.57	0.69	0.64	0.71	1.22	1.35	0.46	0.49	0.80	1.02
industrial	0.56	0.60	1.07	1.24	0.42	0.51	0.79	0.96	0.69	0.77	1.33	1.46	0.57	0.60	1.06	1.30
OTHER PRICES																
Natural Gas Wellhead Price (2009$/Mcf)	0.50	0.54	0.95	1.11	0.34	0.42	0.65	0.79	0.69	0.79	1.34	1.50	0.50	0.52	0.94	1.15
Henry Hub Price (2009$/MMBtu)	0.55	0.59	1.05	1.22	0.38	0.46	0.72	0.87	0.77	0.87	1.48	1.65	0.55	0.58	1.03	1.26
Coal Minemouth Price (2009$/short-ton)	0.06	0.09	0.22	0.12	0.30	0.11	0.22	0.24	0.29	0.16	0.04	0.12	(0.14)	(0.22)	(0.08)	(0.02)
End-Use Electricity Price (2009 cents/KWh)	0.14	0.14	0.25	0.29	0.07	0.10	0.13	0.13	0.16	0.18	0.35	0.37	0.17	0.16	0.31	0.33
NATURAL GAS REVENUES (B 2009$)																
Export Revenues (2)	13.99	15.22	26.36	32.10	10.66	11.82	19.87	24.41	19.05	20.78	35.73	43.23	15.08	16.32	28.08	34.57
Domestic Supply Revenues (3)	18.64	20.34	35.29	41.85	14.05	16.55	25.99	30.88	22.30	24.39	43.72	51.28	21.06	21.88	38.37	47.42
production revenues (4)	19.33	20.94	37.29	43.84	15.05	17.60	28.40	33.63	22.92	24.98	44.95	52.25	21.64	22.43	40.28	49.28
delivery revenues (5)	(0.69)	(0.60)	(2.00)	(1.99)	(1.00)	(1.04)	(2.41)	(2.75)	(0.61)	(0.59)	(1.23)	(0.97)	(0.58)	(0.54)	(1.91)	(1.86)
Import Revenues (6)	1.76	1.93	3.60	4.26	1.60	1.92	3.02	3.69	3.65	4.31	6.26	7.31	1.93	2.12	4.11	4.61
END-USE ENERGY EXPENDITURES (B 2009$)	9.11	9.86	17.59	20.39	8.02	10.03	13.93	14.19	13.98	12.47	25.42	20.21	10.22	9.26	19.22	20.58
liquids	(1.63)	(1.22)	(2.07)	(2.07)	0.92	0.92	0.61	(0.62)	1.70	(1.04)	0.45	(5.86)	(1.88)	(2.60)	(3.05)	(4.38)
natural gas	5.94	6.26	11.12	12.63	4.15	5.01	7.84	9.01	7.15	7.66	14.00	14.75	6.00	5.98	11.14	13.24
electricity	4.82	4.86	8.57	9.87	2.95	4.11	5.49	5.82	5.15	5.87	11.03	11.39	6.12	5.92	11.19	11.80
coal	(0.02)	(0.03)	(0.03)	(0.04)	(0.01)	(0.02)	(0.00)	(0.02)	(0.02)	(0.02)	(0.05)	(0.07)	(0.03)	(0.04)	(0.06)	(0.08)
END-USE ENERGY CONSUMPTION (quadrillion Btu)	(0.28)	(0.34)	(0.45)	(0.60)	(0.27)	(0.34)	(0.41)	(0.55)	(0.29)	(0.32)	(0.48)	(0.57)	(0.30)	(0.36)	(0.49)	(0.65)
liquids	0.01	0.00	0.03	0.03	0.02	0.02	0.06	0.07	(0.01)	0.02	0.01	0.04	0.02	0.00	0.02	0.02
natural gas	(0.25)	(0.30)	(0.40)	(0.54)	(0.28)	(0.35)	(0.46)	(0.63)	(0.23)	(0.29)	(0.36)	(0.49)	(0.27)	(0.33)	(0.41)	(0.58)
electricity	(0.04)	(0.03)	(0.07)	(0.07)	(0.00)	(0.00)	(0.00)	0.02	(0.05)	(0.05)	(0.11)	(0.11)	(0.04)	(0.03)	(0.09)	(0.08)
coal	(0.00)	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.02)
ELECTRIC GENERATION (billion kWh)	(20.08)	(21.43)	(31.31)	(37.47)	(11.67)	(15.77)	(20.07)	(22.20)	(20.58)	(22.35)	(44.13)	(47.78)	(21.76)	(22.98)	(39.01)	(43.78)
coal	48.72	53.09	69.91	91.51	51.52	51.55	88.82	117.12	45.28	40.44	50.04	53.31	19.28	34.78	29.25	43.53
gas	(74.30)	(78.86)	(111.00)	(142.22)	(65.24)	(68.49)	(112.86)	(152.26)	(72.63)	(75.01)	(112.93)	(122.34)	(51.66)	(65.76)	(84.29)	(106.42)
nuclear	-	(0.00)	-	-	0.00	0.00	0.35	5.02	0.81	0.84	1.74	0.83	0.30	0.00	0.37	0.00
renewables	4.52	3.15	7.69	11.07	1.63	1.48	2.94	7.06	5.84	11.44	15.76	19.48	9.99	7.89	13.80	17.63
other	0.98	1.20	2.09	2.17	0.41	(0.32)	0.69	0.86	0.13	(0.06)	1.25	0.94	0.33	0.11	1.86	1.48
PRIMARY ENERGY (quadrillion Btu)																
Consumption	(0.07)	(0.10)	(0.12)	(0.12)	(0.06)	(0.11)	0.01	(0.00)	(0.15)	(0.15)	(0.38)	(0.34)	(0.13)	(0.13)	(0.24)	(0.34)
Imports	(0.09)	(0.08)	(0.10)	(0.10)	0.01	0.07	0.20	0.22	0.12	0.18	0.21	0.25	(0.03)	(0.07)	0.00	(0.15)
Exports	1.94	2.15	3.25	4.09	1.96	2.17	3.28	4.12	1.93	2.13	3.22	4.06	1.94	2.15	3.24	4.08
Production	2.00	2.14	3.26	4.13	1.93	2.03	3.20	4.00	1.68	1.83	2.66	3.52	1.85	2.11	3.02	3.92
ENERGY RELATED CO_2 EMISSIONS (including liquefaction)(million metric tons)	30.62	30.99	46.77	58.42	31.33	31.09	61.96	75.56	21.14	18.75	15.96	24.18	8.90	16.23	13.44	19.99

FOOTNOTES

(1) total includes components below plus deliveries to the transportation sector

(2) export volumes added for this study times the Henry Hub price plus an assumed transport fee to the liquefaction facility of 20 cents per Mcf, plus sum of all other export volumes (i.e., to Canada and Mexico) times the associated price at the border

(3) represents producer revenues at the wellhead plus other revenues extracted before final gas delivery.

(4) dry gas production times average wellhead or first-purchase price

(5) represented revenues extracted as gas moves from the first-purchase wellhead price to final delivery

(6) import volumes times the associated price at the border

Projections: EIA, Annual Energy Outlook 2011 National Energy Modeling system runs ref2011.d020911a, rflexslw.d090911a, rflexrpd.d090911a, rfhexslw.d090911a, rfhesrpd.d090911a, hshleur.d020911a, helexslw.d090911a, helexrpd.d090911a, hehexslw.d090911a, hehexrpd.d090911a, feleur.d090811a, lelexslw.d090911a, lelexrpd.d090911a, lehexslw.d090911a, lehexrpd.d090911a, fehdem.d090811a, hmlexslw.d090911a, hmlexrpd.d090911a, hmhexslw.d090911a, hmhexrpd.d090911a

Statement of
Christopher Smith
Deputy Assistant Secretary for Oil and Natural Gas
Office of Fossil Energy
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Before the

Committee on Energy and Natural Resources
United States Senate

The Department of Energy's Role in Liquefied Natural Gas Export Applications

November 8, 2011

Thank you Chairman Bingaman, Ranking Member Murkowski, and members of the Committee; I appreciate the opportunity to be here today to discuss the Department of Energy's (DOE) program regulating the export of natural gas, including liquefied natural gas (LNG).

DOE's Statutory Authority

DOE's authority to regulate the export of natural gas arises under section 3 of the Natural Gas Act, 15 USC 717b, and section 301(b) of the DOE Organization Act, 42 USC 7151. That authority is vested in the Secretary of Energy and has been delegated to the Assistant Secretary for Fossil Energy.

Section 3(a) of the Natural Gas Act sets forth the standard for review of most LNG export applications:

> – [N]o person shall export any natural gas from the United States to a foreign country or import any natural gas from a foreign country without first having secured an order of the [Secretary of Energy] authorizing it to do so. The [Secretary] shall issue such order upon application, unless after opportunity for hearing, [he] finds that the proposed exportation or importation will not be consistent with the public interest. The [Secretary] may by [the Secretary's] order grant such application, in whole or part, with such modification and upon such terms and conditions as the [Secretary] may find necessary or appropriate.

Section 3(a) thus creates a rebuttable presumption that a proposed export of natural gas is in the public interest, and requires DOE to grant an export application unless DOE finds that the record in the proceeding of the application overcomes that presumption. Section 3(a) also authorizes DOE to attach terms or conditions to the order that the Secretary finds are necessary or appropriate to protect the public interest.

In the Energy Policy Act of 1992 (EPAct 92), Congress introduced a new section 3(c) to the Natural Gas Act. Section 3(c) created a different standard of review for applications to export natural gas, including LNG, to those countries with which the United States has in effect a free trade agreement requiring the national treatment for trade in natural gas. Section 3(c) requires such applications to be deemed consistent with the public interest, and requires such applications to be granted without modification or delay.

There are currently 15 countries with which the United States has in place free trade agreements that require national treatment for trade in natural gas. These 15 countries include:

- Australia, Bahrain, Canada, Chile, Dominican Republic, El Salvador, Guatemala, Honduras, Jordan, Mexico, Morocco, Nicaragua, Oman, Peru, and Singapore.

There also are two countries—Israel and Costa Rica—that have free trade agreements with the United States that do not require national treatment for trade in natural gas. Additionally, there are three more countries—South Korea, Colombia, and Panama—that have negotiated free trade agreements with the United States. While these three free trade agreements have recently been ratified by the U.S. Senate, the agreements have not yet taken effect. However, as negotiated, the agreements require national treatment for trade in natural gas, which will have the effect of bringing applications to export LNG to those three countries under section 3(c) of the Natural Gas Act.

Because applications under section 3(c) must be granted without modification or delay and are deemed to be in the public interest, DOE does not conduct a public interest analysis of those applications and cannot condition them by the insertion of terms which otherwise might be considered necessary or appropriate.

For applications requesting authority to export LNG to countries that do not have free trade agreements requiring national treatment for trade in natural gas, DOE conducts a full public interest review. A wide range of criteria are considered as part of DOE's public interest review process, including:

- Domestic need for the natural gas proposed for export
- Adequacy of domestic natural gas supply
- U.S. energy security
- Impact on the U.S. economy (GDP), consumers, and industry
- Jobs creation
- U.S. balance of trade
- International considerations
- Environmental considerations
- Consistency with DOE's long-standing policy of promoting competition in the marketplace through free negotiation of trade arrangements
- Other issues raised by commenters and/or interveners deemed relevant to the proceeding

DOE's review of applications to export LNG to non-free trade agreement countries is conducted through a publicly transparent process. Upon receipt of an application, DOE issues a notice of the application in the *Federal Register*, posts the application and all subsequent pleadings and orders in the proceeding on its website, and invites interested persons to participate in the proceeding by intervening and/or filing comments or protests. Section 3(a) applicants are typically given an opportunity to respond to any such comments or protests and, after consideration of the evidence that has been introduced into the record, DOE issues an order either granting the application as requested, granting with additional terms or conditions, or denying the application.

Under the Natural Gas Act, DOE's orders are subject to a rehearing process that can be initiated by any party to a proceeding seeking to challenge DOE's determinations. Court review is available as well after the rehearing process is exhausted.

Recent Developments in LNG Exports

Over the last several years, domestic natural gas production has increased significantly, primarily due to the development of improved drilling technologies, including the ability to produce natural gas trapped in shale gas geologic formations. The most recent data and analysis prepared by the Energy Information Administration (EIA) within DOE shows an increasing volume of shale gas production. Specifically, EIA indicates that domestic gross gas production from shale increased to 3.4 trillion cubic feet (Tcf) in 2009, compared to 2.3 Tcf in 2008.[1] Further, in the Annual Energy Outlook 2011 (AEO 2011), EIA projected that, by 2015, annual dry shale gas production will increase to 7.2 Tcf and, by 2035, to 12.2 Tcf. Natural gas prices have declined and imports of LNG have significantly declined. Recently, the domestic price of natural gas at the Henry Hub for November 2011 delivery was $3.60 per million Btu.[2] International prices of LNG are significantly higher. Due in part to these changing market economics, DOE has begun to receive a growing number of applications to export domestically produced lower-48 natural gas to overseas markets in the form of LNG.

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[1] EIA, *Natural Gas Gross Withdrawals and Production, Release Date: October 29, 2011 http://www.eia.gov/dnav/ng/ng_prod_sum_dcu_NUS_a.htm*

[2] The November 2011 contract price as of October 24, 2011, was $3.60 per million Btu.

Insofar as these applications have involved exports to free trade agreement countries, they are by statute, deemed consistent with the public interest and DOE is required to grant them without modification or delay. To the extent the applications involve non-free trade agreement countries, as I have indicated above, DOE conducts a thorough public interest analysis and attaches terms and conditions which are necessary or appropriate to protect the public interest.

Sabine Pass Liquefaction, LLC

DOE received the first application for long-term (greater than 2 years) authority to export LNG produced in the lower-48 States to non-free trade agreement countries on September 7, 2010, from Sabine Pass Liquefaction, LLC (Sabine Pass), a subsidiary of Cheniere Energy, Inc. This followed on DOE's earlier issuance of authority to Sabine Pass to export a like volume of natural gas to free trade agreement countries on September 7, 2010. A notice of the non-free trade agreement export application was published in the *Federal Register* and the public was provided 60 days to intervene and/or protest the application.

Sabine Pass' non-free trade agreement export application sought authority to export the equivalent of up to 2.2 billion cubic feet per day (Bcf/d) of natural gas, equivalent to about 3.3 percent of current domestic consumption. In its application, Sabine Pass pointed to several economic and public benefits likely to follow on a grant of the requested authorization, including:

– Creation of several thousand temporary and permanent jobs, both through direct and indirect job formation; and

– Improvement in U.S. balance of payments valued at approximately $6.7 billion from LNG exports and the impact of increased production of natural gas liquids.

Additionally, Sabine Pass addressed the question of the domestic need for the gas to be exported; the volume of domestic supplies; and the likely impact of the proposed exports on natural gas prices. To this end, it included with its application several economic and technical reports indicating that any increase in natural gas prices from the proposed exports would be relatively modest and not detrimental to domestic energy security.

Sabine Pass's application was opposed by the Industrial Energy Consumers of America and the American Public Gas Association. Those groups challenged Sabine Pass' claims of economic benefits and no detrimental impact on domestic energy security. However, neither opponent of the application introduced economic or technical studies to support their allegations.

DOE closely analyzed the evidence introduced by the applicant and by those opposing the application. Mindful of the statutory presumption favoring a grant of the application, the agency found that:

– The studies introduced by applicant indicated LNG exports will result in a modest projected increase in domestic market price for natural gas, which reflects the increasing marginal costs of domestic production; and

– The public record supported the conclusion that the requested authorization will yield tangible benefits to the public whereas the allegations of negative impacts submitted by interveners opposing the application were not substantiated on the record. In particular, the interveners failed to offer any rebuttal studies of natural gas supply, demand and/or price analysis to support their claim the application was not consistent with the public interest.

Following a review of the record in this proceeding, DOE concluded that the opponents of the application had not demonstrated that a grant of the requested authorization would be inconsistent with the public interest, and DOE granted the requested authorization subject to several terms and conditions.

Pending LNG Export Applications

As indicated above, applicants are increasingly seeking authorization from DOE to export domestic supplies of natural gas as LNG to higher priced overseas markets. The Natural Gas Act favors granting applications to export to non-free trade agreement countries unless it can be demonstrated that a proposed export is inconsistent with the public interest. In the case of exports of LNG to free trade agreement countries that require national treatment for trade in natural gas, DOE is without any authority to deny, condition, or otherwise limit such exports.

Mindful of the growing interest in exporting domestically produced LNG, DOE recognized in the Sabine Pass order that the cumulative impact of Sabine Pass and additional future LNG export authorizations could pose a threat to the public interest. DOE stated that it would monitor the cumulative impact and take such action as necessary in future orders.

DOE presently has before it four long-term applications to export lower-48 domestically produced LNG to countries with which the United States does not have a free trade agreement that requires national treatment for trade in natural gas. The volumes of LNG that could be authorized for export in these non-free trade agreement applications, including the 2.2 Bcf/d authorized for export in Sabine Pass, would total 6.6 Bcf/d, which represents 10 percent of total current domestic natural gas daily consumption in the United States. Consistent with the Natural Gas Act, DOE already has granted authorization from these five facilities to export this same volume to free trade agreement countries.

In order to address the potential cumulative impact of a grant of the pending applications, DOE has commissioned two studies: one by the EIA and the other by a private contractor. Taken together, these studies will address the impacts of additional natural gas exports on domestic energy consumption, production, and prices, as well as the cumulative impact on the U.S. economy, including the effect on gross domestic product, jobs creation, and balance of trade, among other factors. We anticipate that these studies will be completed in the first quarter of calendar year 2012. In this regard, we are mindful of the need for prompt action in each of the proceedings before us. However, we believe that a sound evidentiary record is essential in order to proceed to a decision and that the studies being undertaken are important elements of such a record.

Conclusion

I am happy to answer any questions that you may have.

Will LNG Exports Benefit the United States Economy?

January 23, 2013

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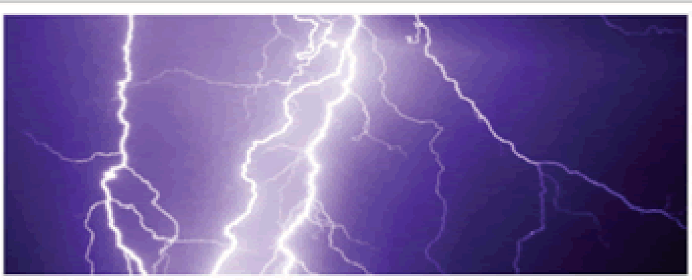

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1. Overview

DOE is considering whether large scale exports of liquefied natural gas (LNG) are in the public interest. As part of that inquiry, DOE has commissioned a team of researchers from NERA Economic Consulting, led by W. David Montgomery, to prepare a report entitled "Macroeconomic Impacts of LNG Exports from the United States" (hereafter, the NERA Report) in December 2012.[1] Unfortunately, that report suffers from serious methodological flaws which lead it to significantly underestimate, and, in some cases, to entirely overlook, many negative impacts of LNG exports on the U.S. economy.

NERA finds that LNG exports would be very good for the United States in every scenario they examined:

> …the U.S. was projected to gain net economic benefits from allowing LNG exports. Moreover, for every one of the market scenarios examined, net economic benefits increased as the level of LNG exports increased. (NERA Report, p.1)

The measure of benefits used by NERA, however, reflects only the totals for the U.S. economy as a whole. In fact, the NERA study finds that natural gas exports are beneficial to the natural gas industry alone, at the expense of the rest of the U.S. economy—reducing the size of the U.S. economy excluding LNG exports.

This white paper examines the NERA Report, and identifies multiple problems and omissions in its analyses of the natural gas industry and the U.S. economy:

- NERA's own modeling shows that LNG exports in fact cause GDP to decline in all other economic sectors.
- Although NERA does not calculate employment figures, the methods used in previous NERA reports would indicate job losses linked to export of tens to hundreds of thousands.
- NERA undervalues harm to the manufacturing sector of the U.S. economy.
- NERA ignores significant economic burdens from environmental harm caused by export.
- NERA ignores the distribution of LNG-export benefits among different segments of society, and makes a number of questionable and unrealistic economic assumptions:
    - In NERA's model, everyone who wants a job has one; by definition, LNG exports cannot cause unemployment.
    - All economic benefits of LNG export return to U.S. consumers without any leakage to foreign investors.
    - Changes to the balance of U.S. trade are constrained to be very small.

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[1] W. David Montgomery, et al., *Macroeconomic Impacts of LNG Exports from the United States,* December 2012. http://www.fossil.energy.gov/programs/gasregulation/reports/nera_lng_report.pdf

- NERA's modeling of economic impacts is based entirely on the proprietary N_{ew}ERA model, which is not available for examination by other economists.
- NERA's treatment of natural gas resources and markets makes selective use of data to portray exports in a favorable light. In some cases, the NERA Report uses older data when newer revisions from the same sources were available; at times, it disagrees with other analysts who have carefully studied the same questions about the gas industry.

Even if NERA's flawed and incomplete analysis were to be accepted at face value, its conclusion that opening LNG exports would be good for the United States as a whole is not supported by its own modeling. Instead, NERA's results demonstrate that manufacturing, agriculture, and other sectors of the U.S. economy would suffer substantial losses. The methodology used to estimate job losses in other NERA reports, if applied in this case, would show average losses of wages equivalent to up to 270,000 jobs lost in each year.

2. LNG exports: Good for the gas industry, bad for the United States

According to the NERA Report, LNG exports would benefit the natural gas industry at the expense of the rest of the U.S. economy. Two sets of evidence illustrate this point: a comparison of natural gas export revenues with changes in gross domestic product (GDP), and a calculation, employed by NERA in other reports, of the "job-equivalents" from decreases in labor income. Applying this calculation to the NERA Report analysis suggests that opening LNG exports would result in hundreds of thousands of job losses. These losses would not be confined to narrow sections of U.S. industry, as NERA implies.

The NERA Report presents 13 "feasible" economic scenarios for LNG export, with projections calculated by NERA's proprietary N_{ew}ERA model for 2015, 2020, 2025, 2030, and 2035. The scenarios differ in estimates of the amount of natural gas that will ultimately be recovered per new well: seven scenarios (with labels beginning with USREF) use the estimate from the federal Energy Information Administration's AEO 2011; five (beginning with HEUR) assume 150 percent of the AEO level; and one (beginning with LEUR) assumes 50 percent of the AEO level. In the LEUR scenario, LNG exports are barely worthwhile; in the HEUR scenarios, exports are more profitable than in the USREF scenarios.

LNG exports cause U.S. GDP (excluding LNG exports) to fall

Careful analysis of these LNG export scenarios reveals that the gain in GDP predicted by the NERA Report is driven—almost entirely—by revenues to gas exporters and gas companies; the remainder of the economy declines.

On average (across the five reporting years), export revenues were 74 percent or more of GDP growth in every scenario; in the eight scenarios with average or low estimated gas recovery per well, export revenues averaged more than 100 percent of GDP growth. In the median scenario, export revenues averaged 169 percent of GDP growth; in the worst case, export revenues averaged 240 percent of GDP growth.

Table 1 compares natural gas export revenues to the increase in GDP for each scenario.[2] When export revenues are greater than 100 percent of GDP growth, the size of the U.S. economy, excluding gas exports, is shrinking. For instance, for the year 2035 in the first two scenarios in Table 1, LNG export revenues are almost $9 billion higher than in the reference case, while GDP—which includes those export revenues along with everyone else's incomes—is only $3 billion higher. Thus, as a matter of arithmetic, everyone else's incomes (i.e., GDP excluding LNG export revenues) must have gone down by almost $6 billion. (If your favorite baseball team scored 3 more home runs this year than last year, and one of its players scored 9 more than he did last year, then it must be the case that the rest of the team scored 6 fewer.)

Similarly, in every case where natural gas export revenues exceed 100 percent of the increase in GDP—cases that appear throughout Table 1—the export revenues are part of GDP, so the remainder of GDP must have gone down.

Table 1: LNG Exports as a Share of GDP Gains[3]

Scenario	Exports as Percent of GDP Gains					
	2015	2020	2025	2030	2035	average
USREF_D_LSS	72%	75%	193%	225%	286%	170%
USREF_D_LS	50%	89%	193%	225%	286%	169%
USREF_D_LR	62%	112%	257%	338%	429%	240%
USREF_SD_LS	50%	77%	204%	258%	468%	211%
USREF_SD_LR	59%	90%	244%	258%	702%	271%
USREF_SD_HS	50%	67%	140%	216%	429%	180%
USREF_SD_HR	59%	75%	158%	216%	501%	202%
HEUR_SD_LSS	19%	38%	69%	109%	152%	77%
HEUR_SD_LS	24%	40%	82%	109%	152%	81%
HEUR_SD_LR	31%	42%	82%	123%	152%	86%
HEUR_SD_HS	24%	37%	64%	106%	142%	74%
HEUR_SD_HR	28%	39%	74%	111%	142%	79%
LEUR_SD_LSS	0%	164%	*NA*	*NA*	158%	107%

NA - not applicable (GDP did not increase over the no-export reference case)
Source: Author's calculations based on NERA Report, Figures 144-162.

As Table 1 demonstrates, export revenues exceed GDP growth: GDP (not including gas exports) is shrinking by 2030 or earlier in all scenarios, and by 2025 or earlier in all scenarios using the AEO assumption about gas recovery per well (i.e., USREF). In other words, after the initial years of construction of export facilities, when construction activities may create some local economic

[2] The increase in GDP is the difference between the scenario GDP projections and the GDP in the corresponding no-export reference case (for USREF, HEUR, or LEUR assumptions). Data from NERA Report, pp.179-197.

[3] In the second term in the scenario names, international cases are defined by increases in global demand and/or decreases in global supply: D=International Demand Shock, SD=International Supply/Demand Shock. In the third term in the scenario names, export cases for quantity/growth are defined as follows: LSS=Low/Slowest, LS=Low/Slow, LR=Low/Rapid, HS=High/Slow, HR=High/Rapid.

benefits, gas exports create increased income for the gas industry, at the expense of everyone else.[4]

Loss of labor income from LNG exports is equivalent to huge job losses

NERA avoids predicting the employment implications of LNG export, and downplays the aggregate billions of dollars in decreased labor income predicted by its report. In fact, using NERA's own methods, the following analysis shows the potential for hundreds of thousands of job losses per year.

In other reports using the N_{ew}ERA model, NERA has reported losses of labor income in terms of "job-equivalents." This may seem paradoxical, since the N_{ew}ERA model assumes full employment, as discussed later in this white paper. As NERA has argued elsewhere, however, a loss of labor income can be expressed in terms of job-equivalent losses, by assuming that it consists of a loss of workers earning the average salary.[5] In other words, a given decrease in labor income can be interpreted as a loss of workers who would make that income.

This method can be applied to the losses of labor income projected for each of the 13 scenarios in the NERA Report. These losses are expressed as percentages of gross labor income; we have assumed that NERA's "job-equivalent losses" represent the same percentage of the labor force. For example, we assume the loss of 0.1 percent of gross labor income in scenario HEUR_SD_HS in 2020 is equivalent to job losses of 0.1 percent of the projected 2020 labor force of 159,351,000 workers, or roughly 159,000 job-equivalent losses.[6]

The results of this analysis are shown in Table 2. Job-equivalent losses, averaged across the five reporting years, range from 36,000 to 270,000 per year; the median scenario has an average job-equivalent loss of 131,000 per year. We do not necessarily endorse this method of calculation of labor impacts, but merely note that NERA has adopted it in other reports using the same model. If NERA had used this method in the NERA Report analysis, it would have shown that LNG exports have the potential to significantly harm employment in many sectors.

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[4] Other modeled results in the record cast further doubt on NERA's study. See Wallace E. Tyner, "Comparison of Analysis of Natural Gas Export Impacts," January 14, 2013. http://www.fossil.energy.gov/programs/gasregulation/authorizations/export_study/30_Wallace_Tyner01_14_13.pdf

[5] See, e.g., NERA's Economic Implications of Recent and Anticipated EPA Regulations Affecting the Electricity Sector, October 2012, p. ES-6: "Job-equivalents are calculated as the total loss in labor income divided by the average salary." http://www.nera.com/nera-files/PUB_ACCCE_1012.pdf

[6] The Bureau of Labor Statistics projects annual growth of the civilian labor force at 0.7% per year from 2010 to 2020 (Mitra Toosi. "Labor force projections to 2020: a more slowly growing workforce." Monthly Labor Review, January 2012. http://www.bls.gov/opub/mlr/2012/01/art3full.pdf.) We have used the same annual growth rate to project the labor force through 2035.

Table 2: Employment equivalents of reduced labor income

	Job-equivalent loss, NERA method					
	2015	2020	2025	2030	2035	average
USREF_D_LSS	15,000	77,000	108,000	77,000	62,000	68,000
USREF_D_LS	31,000	77,000	108,000	77,000	62,000	71,000
USREF_D_LR	108,000	92,000	108,000	77,000	62,000	89,000
USREF_SD_LS	31,000	200,000	169,000	139,000	123,000	132,000
USREF_SD_LR	123,000	215,000	169,000	139,000	123,000	154,000
USREF_SD_HS	31,000	185,000	292,000	292,000	246,000	209,000
USREF_SD_HR	108,000	292,000	308,000	292,000	246,000	249,000
HEUR_SD_LSS	15,000	62,000	108,000	108,000	92,000	77,000
HEUR_SD_LS	15,000	169,000	139,000	108,000	92,000	105,000
HEUR_SD_LR	108,000	169,000	139,000	108,000	92,000	123,000
HEUR_SD_HS	15,000	154,000	246,000	215,000	200,000	166,000
HEUR_SD_HR	92,000	385,000	292,000	231,000	200,000	240,000
LEUR_SD_LSS	0	92,000	77,000	0	0	34,000
Labor force	*153,889,000*	*153,889,000*	*153,889,000*	*153,889,000*	*153,889,000*	

Source: Author's calculations based on NERA Report, Figures 144-162.

NERA downplays their estimated shifts in employment from one sector to another saying that is smaller than normal rates of turnover in those industries, but, of course, normal labor turnover is enormous. It is true that job losses caused by LNG exports will be less than the annual total of all retirements, voluntary resignations, firings, layoffs, parental and medical leaves, new hires, moves to new cities and new jobs, and switching from one employer to another for all sorts of reasons: Throughout the entire U.S. labor force normal turnover amounts to almost 40 million people each year.[7] The comparison of job losses to job turnover is irrelevant.

Harm to U.S. economy is not confined to narrow sections of industry, as NERA implies

The NERA Report emphasizes the fact that only a few branches of industry are heavily dependent on natural gas (NERA Report, pp.67-70). This discussion is described as an attempt "to identify where higher natural gas prices might cause severe impacts such as plant closings" (p.67). The NERA Report makes two principal points in this discussion. First, it quotes a 2009 study of the expected impacts of the Waxman-Markey proposal for climate legislation, which found that only a limited number of branches of industry would be harmed by higher carbon costs; NERA argues that price increases caused by LNG exports will have an even smaller but similarly narrow effect on industry. Second, NERA observes that industries where value added (roughly the sum of wages and profits) makes up a large fraction of sales revenue are unlikely to have high energy costs, while industries with high energy costs probably have a low ratio of value added to sales.

[7] "Job Openings and Labor Turnover," Bureau of Labor Statistics, November 2012, Table 3. http://www.bls.gov/news.release/pdf/jolts.pdf

Both points may be true, but they are largely irrelevant to the evaluation of LNG exports. NERA's use of the Waxman-Markey study is inappropriate, as Representative Markey himself has pointed out, because that proposed bill directed significant resources to industries harmed by higher costs to mitigate any negative impact.[8] No such mitigation payments are associated with LNG export, so relying upon Waxman-Markey examples to downplay potential economic damage is inappropriate. If those exports increase domestic gas prices, industry will be harmed both by higher electricity prices and by higher costs for direct use of natural gas. Further, it is true that direct use of natural gas is relatively concentrated, but it is concentrated in important sectors; as the natural gas industry itself explains, "Natural gas is consumed primarily in the pulp and paper, metals, chemicals, petroleum refining, stone, clay and glass, plastic, and food processing industries."[9] These are not small or unimportant sectors of the U.S. economy.[10] In any case, discussion of sectors where higher natural gas prices might cause "severe impacts such as plant closings" is attacking a straw man; NERA's own calculations imply moderate harm would be imposed throughout industry, both by rising electricity prices and by the costs of direct gas consumption—offset by benefits exclusively concentrated in the hands of the natural gas industry.

Similarly, it does not seem particularly important to know whether industries that use a lot of natural gas have high or low ratios of value added to sales. Are aluminum, cement, fertilizer, paper, and chemicals less important to the economy because they have many purchased inputs, and therefore low ratios of value added to sales?

3. Costs and benefits from LNG exports are unequally distributed

As the results above show, LNG exports essentially transfer revenue away from the rest of the economy and into the hands of companies participating in these exports. This shift has significant economic implications that are not addressed in the NERA Report's analysis.

The NERA Report asserts that "all export scenarios are welfare-improving for U.S. consumers" (NERA Report, p.55). While LNG exports will result in higher natural gas prices for U.S. residents, NERA projects that these costs will be outweighed by additional income received from the exports—and thus, "consumers, in aggregate are better off as a result of opening LNG exports." (NERA Report, p.55) Or, to put this another way, the gains of every resident of the United States, added together, will be greater than the losses of every resident of the United States, added together. The distribution of these benefits and costs—who will suffer costs and who will reap gains—is discussed only tangentially in the NERA Report, but is critical to a complete understanding of the effects of LNG exports on the U.S. economy. A closer look reveals that LNG exports benefit only a very narrow section of the economy, while causing harm to a much broader group.

[8] Letter from Rep. Markey to Secretary Steve Chu (Dec. 14, 2012).
[9] http://www.naturalgas.org/overview/uses_industry.asp.
[10] Other commenters also point out that NERA does not even appear to have included some gas-dependent industries, including fertilizer and fabric manufacture, in its analysis. *See* Comments of Dr. Jannette Barth (Dec. 14, 2012).

Focus on "net impacts" ignores key policy issues

The results presented in the NERA Report focus on the net impacts on the entire economy—combining together everyone's costs and benefits—and on the "welfare" of the typical or average family, measured in terms of equivalent variation.[11] NERA dismisses the need to discuss the distribution of the costs and benefits among groups that are likely to experience very different impacts from LNG exports, stating that: "[t]his study addresses only the net economic effects of natural gas price changes and improved export revenues, not their distribution." (NERA Report, p.211) NERA alludes to an unequal distribution of costs and benefits in its results, but does not present a complete analysis:

> Although there are costs to consumers of higher energy prices and lower consumption and producers incur higher costs to supply the additional natural gas for export, these costs are more than offset by increases in export revenues along with a wealth transfer from overseas received in the form of payments for liquefactions services. The net result is an increase in U.S. households' real income and welfare. (NERA Report, p.6)

Instead, the NERA Report combines the economic impacts of winners and losers from LNG exports. In the field of economics, this method of asserting that a policy will improve welfare for society as a whole as long as gains to the winners are greater than costs to the losers is known as the "Kaldor-Hicks compensation principle" or a "potential Pareto improvement." The critiques leveled at cost-benefit analyses that ignore important distributional issues have as long a history as these flawed methods. Policy decisions cannot be made solely on the basis of aggregated net impacts: costs to one group are never erased by the existence of larger gains to another group. The net benefit to society as a whole shows only that, if the winners choose to share their gains, they have the resources to make everyone better off than before—but not that they *will* share their gains. In the typical situation, when the winners choose to keep their winnings to themselves, there is no reason to think that everyone, including the losers, is better off.

As previous congressional testimony by W. David Montgomery—the lead author of the NERA Report—on the impacts of cap-and-trade policy support explained it: "There are enough hidden differences among recipients of allowances within any identified group that it takes far more to compensate just the losers in a group than to compensate the average. Looking at averages assumes that gainers compensate losers within a group, but that will not occur in practice."[12]

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[11] One of the complications in estimating the costs and benefits of a policy with the potential to impact prices economy-wide, is that simply measuring changes in income misses out on the way in which policy-driven price changes affect how much can be bought for the same income. (For example, if a policy raises incomes but simultaneously raises prices, it takes some careful calculation to determine whether people are better or worse off.) The NERA Report uses a measure of welfare called "equivalent variation," which is the additional income that the typical family would have to receive today (when making purchases at current prices) in order to be just as well off as they would be with the new incomes and new price levels under the proposed policy. It can be thought of as the change in income caused by the policy, adjusted for any change in prices caused by the policy.

[12] Prepared Testimony of W. David Montgomery, before the Committee on Energy and Commerce Subcommittee on Energy and Environment, U.S. House of Representatives, Hearing on Allowance Allocation Policies in Climate Legislation, June 9, 2009.
http://democrats.energycommerce.house.gov/Press_111/20090609/testimony_montgomery.pdf.

Wage earners in every sector except natural gas will lose income

In every scenario reviewed in the NERA Report, labor income rises in the natural gas industry, and falls in every other industry.[13] Economy-wide, NERA finds that "capital income, wage income, and indirect tax revenues drop in all scenarios, while resource income and net transfers associated with LNG export revenues increase in all scenarios." (NERA Report, p.63)[14] Even without a detailed distributional analysis, the NERA Report demonstrates that some groups will lose out from LNG exports:

> Overall, both total labor compensation and income from investment are projected to decline, and income to owners of natural gas resources will increase… Nevertheless, impacts will not be positive for all groups in the economy. Households with income solely from wages or government transfers, in particular, might not participate in these benefits. (NERA Report, p.2)

NERA's "might not participate in these benefits" could and should be restated more accurately as "will bear costs." Although NERA doesn't acknowledge it, most Americans will not receive revenues from LNG exports; many more Americans will experience decreased wages and higher energy prices than will profit from LNG exports.

Wage earners in every major sector except for natural gas will lose income, and, as domestic natural gas prices increase, households and businesses will have to pay more for natural gas (for heat, cooking, etc.), electricity, and other goods and services with prices that are strongly impacted by natural gas prices. The NERA Report briefly mentions these price effects:

> Natural gas is also an important fuel for electricity generation, providing about 20% of the fuel inputs to electricity generation. Moreover, in many regions and times of the year natural gas-fired generation sets the price of electricity so that increases in natural gas prices can impact electricity prices. These price increases will also propagate through the economy and affect both household energy bills and costs for businesses. (NERA Report, p.13-14)

Additional analysis required to understand electricity price impacts

There are no results presented in the NERA Report to display the effect of changes in electricity prices on consumers. Negative effects on the electricity sector itself are shown in NERA's Figure 38, but changes in electric rates and electricity bills, and the distributional consequences of these changes, are absent from the results selected for display in this report. NERA certainly could have conducted such an analysis. NERA's October 2012 report on recent and anticipated EPA regulations affecting the U.S. electricity sector using the N_{ew}ERA model displayed electricity price impacts for eleven regions and three scenarios.[15]

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[13] See NERA Report, Figure 39.
[14] See NERA Report, Figure 40.
[15] Harrison, et al., Economic Implications of Recent and Anticipated EPA Regulations Affecting the Electricity Sector, October 2012. NERA Economic Consulting. See Table 17. http://www.nera.com/67_7903.htm.

Dr. Montgomery previous testimony also presents increases in household electric utility bills.[16] He describes a "decline in purchasing power" for the average household, claiming that "the cost for the average family will be significant" and "generally the largest declines in household purchasing power are occurring in the regions with the lowest baseline income levels."[17] A careful distributional analysis would greatly improve the policy relevance of the NERA Report's economic impact projections.

Benefits of stock ownership are not as widespread as NERA assumes

There is no evidence to support NERA's implication that the benefits of stock ownership are broadly shared among U.S. families across the economic spectrum—and therefore no evidence that they will "participate" in benefits secured by LNG exports.

NERA's claim of widespread benefits is not supported by data from the U.S. Census Bureau. In 2007, just before the financial crash, only about half of all families owned any stock, including indirect holdings in retirement accounts. Indeed, only 14 percent of families with the lowest incomes (in the bottom 20 percent) held any stock at all, compared to 91 percent of families with the highest incomes (the top 10 percent).[18]

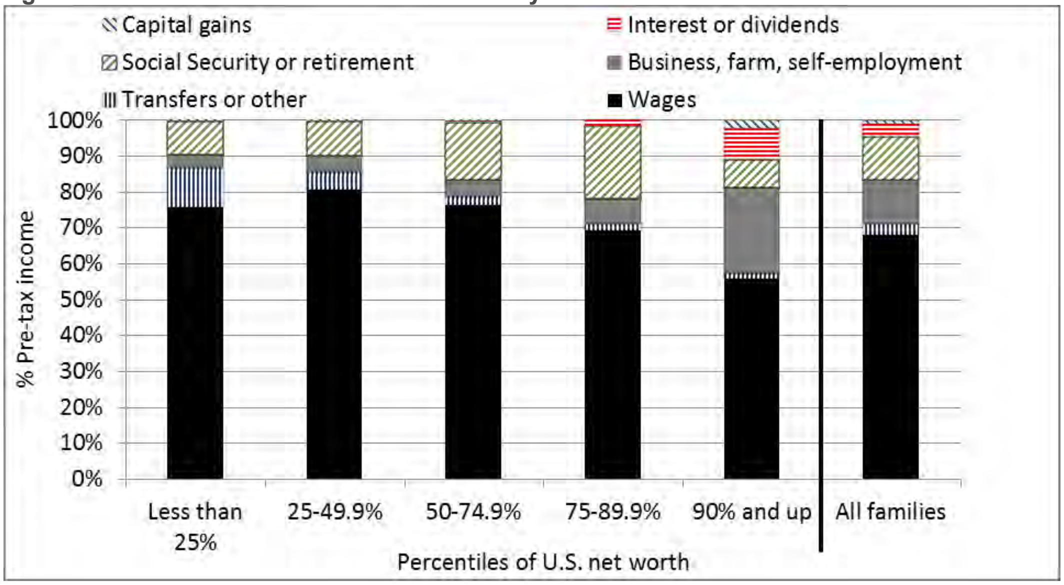
For most households the primary source of income is wages. According to the Federal Reserve, 68 percent of all family income in 2010 (the latest data available) came from wages, while interest, dividends and capital gains only amounted to 4.5 percent (see Figure 1). Families with the least wealth (the bottom 25 percent) received 0.2 percent of their income from interest, dividends, and capital gains, compared to 11 percent for the wealthiest families (the top 10 percent).

[16] Prepared Testimony of W. David Montgomery, before the Committee on Energy and Commerce Subcommittee on Energy and Environment, U.S. House of Representatives, Hearing on Allowance Allocation Policies in Climate Legislation, June 9, 2009.
http://democrats.energycommerce.house.gov/Press_111/20090609/testimony_montgomery.pdf.

[17] Ibid.

[18] U.S. Census Bureau, Statistical Abstract of the United States: 2012, 2012. See Table 1211.
http://www.census.gov/compendia/statab/2012/tables/12s1211.pdf.

Figure 1: U.S. Households Source of Income by Percentile of Net Worth in 2010



Source: Federal Reserve, Changes in U.S. Family Finances from 2007 to 2010: Evidence from the Survey of Consumer Finances, Table 2.

And yet the NERA Report appears to assume that the benefits of owning stock in natural gas export companies are widespread, explaining that:

> U.S. consumers receive additional income from…the LNG exports provid[ing] additional export revenues, and…consumers who are owners of the liquefaction plants, receiv[ing] take-or-pay tolling charges for the amount of LNG exports. These additional sources of income for U.S. consumers outweigh the loss associated with higher energy prices. Consequently, consumers, in aggregate, are better off as a result of opening up LNG exports. (NERA Report, p.55)

In the absence of detailed analysis from NERA, it seems safe to assume that increases to U.S. incomes from LNG exports will accrue to those in the highest income brackets. Lower income brackets, where more income is derived from wages, are far more likely to experience losses in income—unless they happen to work in the natural gas industry—and natural gas extraction currently represents less than 0.1 percent of all jobs in the United States.[19] At the same time, everyone will pay more on their utility bills.

[19] Share of jobs in oil and gas extraction. Data for the share of jobs in the natural gas industry alone is not available but would, necessarily, be smaller. Support activities for mining represents an additional 0.25 percent of jobs, petroleum and coal products 0.08 percent, and pipeline transportation 0.03 percent. Taken together, these industries, which include oil, coal and other mining operations, represent 0.5 percent of all U.S. employment. Bureau of Economic Analysis, Full-Time and Part-Time Employees by Industry, 2011 data. http://bea.gov/iTable/iTable.cfm?ReqID=5&step=1

NERA's assumption that all income from LNG exports will return to U.S. residents is incorrect

In the N_{ew}ERA analysis, two critical assumptions assure that all LNG profits accrue to U.S. residents. First, "Consumers own all production processes and industries by virtue of owning stock in them." (NERA Report, p.55) The unequal distribution of stock ownership (shown as interest, dividend, and capital gains income in the Federal Reserve data in Figure 1) is not made explicit in the NERA Report, nor is the very small share that natural-gas-related assets represent in all U.S.-based publically traded stock.[20] In discussing impacts on households' wealth, NERA only mention that "if they, or their pensions, hold stock in natural gas producers, they will benefit from the increase in the value of their investment." (NERA Report, p.13) A more detailed distributional analysis would be necessary to determine the exact degree to which LNG profits benefit different income groups; however, it is fair to conclude that lower-income groups and the middle class are much less likely to profit from LNG exports than higher-income groups that receive a larger portion of income from stock ownership.

Second, the NERA Report assumes that "all of the investment in liquefaction facilities and natural gas drilling and extraction comes from domestic sources." (NERA Report, p.211) This means that the N_{ew}ERA model implausibly assumes that all U.S.-based LNG businesses are solely owned by U.S. residents. There is no evidence to support this assumption. On the contrary, many players in this market have significant foreign ownership shares or are privately held, and may be able to move revenues in ways that avoid both the domestic stock market and U.S. taxes. Cheniere Energy, the only LNG exporter licensed in the United States, is currently building an export terminal on the Gulf of Mexico for $5.6 billion—$1 billion of which is coming from investors in China and Singapore.[21] Cheniere's largest shareholders include holding companies in Singapore and Bermuda, as well as a hedge fund and a private equity firm, which in turn have a mix of domestic and foreign shareholders.[22] This situation is not atypical. As illustrated in Figure 2, 29 percent (by Bcf/day capacity) of the applications for U.S. LNG export licenses are foreign-owned, including 6 percent of total applications from foreign governments. Additionally, 70 percent of domestic applicants are publicly owned and traded, most of which have both domestic and foreign stock holders. Gas extraction companies, similarly, operate with a diverse mix of foreign and domestic investment, and of public and private ownership structures. NERA's claim that profits from LNG exports will be retained in the United States is unfounded.

NERA certainly could have addressed this issue in its analysis. Dr. Montgomery's previous testimony on cap-and-trade assumed that "all auction revenues would be returned to households,

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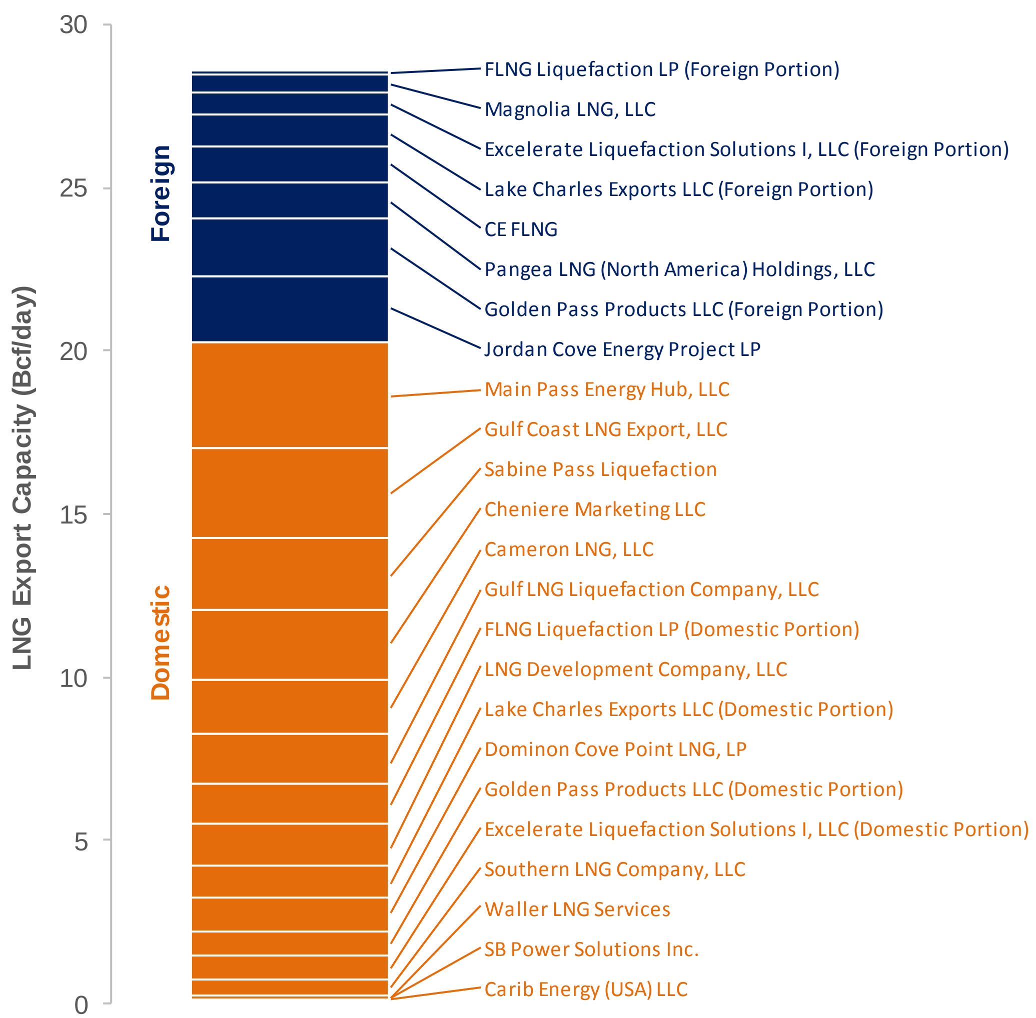
[20] NYSE companies involved in LNG export applications account for 5.8 percent of the total market capitalization, but this includes the value of shares from Exxon Mobil—by itself 2.9 percent of the NYSE market cap—as well as several other corporations with diverse business interests, such as General Electric, Dow, and Seaboard (owner of Butterball Turkeys among many other products). Reuters Stocks website, downloaded January 22, 2013 (following marketclose), http://www.reuters.com/finance/stocks. World Federation of Exchanges, "2012 WFE Market Highlights" (January 2013), page 6. http://www.world-exchanges.org/files/statistics/2012%20WFE%20Market%20Highlights.pdf.

[21] "UPDATE 2-China, Singapore wealth funds invest $1 bln in US LNG export plant-source." Reuters, August 21, 2012. http://www.reuters.com/article/2012/08/21/cic-cheniere-idUSL4E8JL0SC20120821

[22] Ownership data from NASDAQ for Cheniere Energy, Inc. (LNG). http://www.nasdaq.com/symbol/lng/ownership-summary#.UPmZgCfLRpU.

except for the allowance allocations that are given to foreign sources."[23] This assumption led him to conclude that, for the cap-and-trade program, a "large part of the impact on household costs is due to wealth transfers to other countries."[24] This level of analytical rigor should have been applied when estimating the U.S. domestic benefits from opening natural gas exports.

Figure 2: Applicants for LNG Export Licenses



[23] Prepared Testimony of W. David Montgomery, before the Committee on Energy and Commerce Subcommittee on Energy and Environment, U.S. House of Representatives, Hearing on Allowance Allocation Policies in Climate Legislation, June 9, 2009, http://democrats.energycommerce.house.gov/Press_111/20090609/testimony_montgomery.pdf.

[24] Ibid.

Source: See Appendix A for a full list of sources.

Opening LNG export will also incur environmental costs

The discussion of LNG exports in the NERA Report, and most of our analysis of the report, is concerned with monetary costs and benefits: Exports cause an increase in natural gas prices, boosting incomes in the natural gas industry itself while increasing economic burdens on the rest of the economy. There are, in addition, environmental impacts of natural gas production and distribution that do not have market prices, but may nonetheless become important if LNG exports are expanded. Increases in exports are likely to increase production of natural gas, entailing increased risks of groundwater pollution and other environmental problems potentially associated with hydraulic fracturing ("fracking"). Increases in production, transportation of natural gas from wells to export terminals, and the liquefaction process itself, all increase the risks of leaks of natural gas, a potent greenhouse gas that contributes to global warming. These environmental impacts should be weighed, alongside the monetary costs and benefits of export strategies, in evaluation of proposals for LNG exports.

Clearly, as NERA itself acknowledges, the NERA Report would benefit from more detailed analysis of the distribution of costs and benefits from opening LNG exports: "Although convenient to indicate that there are winners and losers from any market or policy change, this terminology gives limited insight into how the gains and losses are distributed in the economy." (NERA Report, p.211)

4. Dependence on resource exports has long-run drawbacks

The harm that LNG exports cause to the rest of the U.S. economy, even in NERA's model, are consistent with an extensive body of economic literature warning of the dangers of resource-export-based economies.

If NERA's economic modeling is accepted at face value, it implies that the United States should embrace resource exports, even at the expense of weakening the rest of the economy. GDP, net incomes, and "welfare" as measured by NERA would all rise in tandem with LNG exports. There would be losses in manufacturing and other sectors, especially the energy-intensive sectors of paper and pulp, chemicals, glass, cement, and primary metal (iron, steel, aluminum, etc.) manufacturing (NERA Report, p. 64). But NERA asserts that these would be offset by gains in the natural gas industry. There would be losses of labor income, equivalent to a decline of up to 270,000 average-wage jobs per year. But, according to NERA, these losses would be offset by increased incomes for resource (natural gas) owners.

For those who are indifferent to the distribution of gains and losses—or who imagine that almost everyone owns a share of the natural gas industry—the shift away from manufacturing and labor income toward raw material exports could be described as good for the country as a whole. (So, too, could any shift among types of income, as long as its net result is an increase in GDP.) The rising value of the dollar relative to other currencies would allow affluent Americans to buy more imports, further increasing their welfare, even as the ability of industry to manufacture and export from the United States would decline.

There is, however, a longer-term threat of LNG exports to the U.S. economy: NERA's export scenarios would accelerate the decline of manufacturing and productivity throughout the country, pushing the nation into increased dependence on raw material exports. Developing countries have often struggled to escape from this role in the world economy, believing that true economic development requires the creation of manufacturing and other high-productivity industries. International institutions such as the IMF and the World Bank have often insisted that developing countries can maximize their short-run incomes by sticking to resource exports.

NERA is in essence offering the same advice to the United States: Why strive to make things at home, if there is more immediate profit from exporting raw materials to countries that can make better use of them? Europe, China, Japan, and Korea have much more limited natural resources per capita, but they are very good at making things out of resources that they buy from the United States and other resource-rich countries. In the long run, which role do we want the United States to play in the world economy? Do we want to be a resource exporter, with jobs focused in agriculture, mining, petroleum and other resource-intensive industries? Or do we want to export industrial goods, with jobs focused in manufacturing and high-tech sectors?

Economists have recognized that resource exports can impede manufacturing, even in a developed country; the problem has been called the "resource curse" or the "Dutch disease." The latter name stems from the experience of the Netherlands after the discovery of natural gas resources in 1959; gas exports raised the value of the guilder (the Dutch currency in pre-Euro days), making other Dutch exports less competitive in world markets and resulting in the eventual decline of its manufacturing sector.[25] In other countries, the "resource curse" has been associated with increased corruption and inequality; countries that depend on a few, very profitable resource exports may be less likely to have well-functioning government institutions that serve the interests of the majority.[26] Protecting an economy against the resource curse requires careful economic management of prospective resource exports.

In particular, it may be more advantageous in the long run to nurture the ability to manufacture and export value-added products based on our natural resources—even if it is not quite as profitable in the short run. The NERA Report is notably lacking in analysis of this strategy; there are no scenarios exploring promotion of, for example, increased use of natural gas in the chemical industry and increased exports of chemicals from the United States. The 25-year span of NERA's analysis provides for scope to develop a longer-term economic strategy with a different pattern of winners and losers. The benefits in this case might extend well beyond the narrow confines of the natural gas industry itself.

5. Unrealistic assumptions used in NERA's N$_{ew}$ERA model

Despite its sunny conclusions, the NERA Report indicates that LNG exports pose serious challenges to the U.S. economy. It is troubling, then, that the underlying modeling in the report is notably difficult to assess, and is reliant on a number of unrealistic assumptions.

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[25] "The Dutch Disease." *The Economist*, November 26, 1977, pp. 82-83.

[26] Papyrakis and Gerlagh. "The resource curse hypothesis and its transmission channels." *Journal of Comparative Economics*, 2004, 32:1 p.181-193; Mehlum, Moene and Torvik. "Institutions and the Resource Curse." *The Economic Journal*, 2006, 116:508 p.1-20.

The NERA Report relies on NERA Consulting's proprietary model, called N_{ew}ERA. Detailed model assumptions and relationships have never been published; we are not aware of any use of the model, or even evaluation of it in detail, by anyone outside NERA.

According to the NERA Report, N_{ew}ERA is a computable general equilibrium (CGE) model. Such models typically start with a series of assumptions, adopted for mathematical convenience, that are difficult to reconcile with real-world conditions. The base assumptions of the N_{ew}ERA model are described as follows: "The model assumes a perfect foresight, zero profit condition in production of goods and services, no changes in monetary policy, and full employment within the U.S. economy." (NERA Report, p. 103)

Here we discuss the implications of each of these assumptions, together with two additional critical modeling assumptions described elsewhere in the NERA Report: limited changes to the balance of trade, and sole U.S. financing of natural gas investments.

Full employment

The full employment assumption, common to most (though not all) CGE models, means that in every year in every scenario, anyone who wants a job can get one. This assumption is arguably appropriate—or at least, introduces only minor distortions—at times of very high employment such as the late 1990s. It is, however, transparently wrong under current conditions, when unemployment rates are high and millions of people who want jobs cannot find them.

The NERA Report expands on its Pollyannaish vision of the labor market, saying:

> The model assumes full employment in the labor market. This assumption means total labor demand in a policy scenario would be the same as the baseline policy projection… The model assumes that labor is fungible across sectors. That is, labor can move freely out of a production sector into another sector without any adjustment costs or loss of productivity. (NERA Report, p.110)

It also includes, in its "Key Findings," the statement that: "LNG exports are not likely to affect the overall level of employment in the U.S." (NERA Report, p.2)

In fact, this is an assumption—baked into the model—and not a finding. N_{ew}ERA, by design, never allows policy changes to affect the overall assumed level of employment. The unemployment rate must, by definition, always be low and unchanging in NERA's model.

For this reason, the potential economic impact that is of the greatest interest to many policymakers, namely the effects of increased LNG exports on jobs, cannot be meaningfully studied with NERA's model. Addressing that question requires a different modeling framework, one that recognizes the existence of involuntary unemployment (when people who want jobs cannot find them) and allows for changes in employment levels. (Despite N_{ew}ERA's full employment assumption, NERA has used the model results to calculate the "job-equivalents" lost to other environmental policies, as discussed above. Had NERA seriously addressed the question, as we discussed earlier, it might have discovered serious job loss potential.)

Perfect foresight

N_{ew}ERA, like other CGE models, assumes that decision-makers do not make systematic errors (that is, errors that bias results) when predicting the future. This is a common assumption in economic modeling and, while more complex theories regarding the accuracy of expectations of the future do exist, they only rarely enter into actual modeling of future conditions.

Zero profit condition

A more puzzling assumption is the "zero profit condition," mentioned in the quote above. Analyzing fossil fuel markets under the assumption of zero profits sounds like a departure from the familiar facts of modern life. The picture is less than clear, since the N_{ew}ERA model includes calculations of both capital income and "resource" income (the latter is received by owners of resources such as natural gas); these may overlap with what would ordinarily be called profits. Without a more complete description of the N_{ew}ERA model, it is impossible to determine exactly how it treats profits in the fossil fuel industries. In any case, the business media are well aware of the potential for profits in natural gas; a recent article, based in part on the NERA Report, includes the subheading "How LNG Leads to Profits."[27]

Invariable monetary policy

N_{ew}ERA also assumes that economy-wide interest rates and other monetary drivers will stay constant over time. Changes to monetary policy could, of course, have important impacts on modeling results, but forecasting these kinds of changes may well be considered outside of the scope of NERA's analysis. That being said, several of NERA's classes of scenarios involve supply and demand shocks to the economy as a whole: exactly the kind of broad-based change in economic conditions that tends to provoke changes in monetary policy.

Limited changes to the balance of trade

NERA's treatment of foreign trade involves yet another unrealistic assumption:

> We balance the international trade account in the N_{ew}ERA model by constraining changes in the current account deficit over the model horizon. The condition is that the net present value of the foreign indebtedness over the model horizon remains at the benchmark year level. (NERA Report, p.109)

Although U.S. exports increase in many scenarios, NERA assumes that there can be very little change in the balance of trade. Instead, increases in exports largely have the effect of driving up the value of the dollar relative to other currencies (NERA Report, p. 110). This assumption results in a benefit to consumers of imports, who can buy them more cheaply; conversely, it harms exporters, by making their products more expensive and less competitive in world markets.

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[27] Ben Gersten, "Five U.S. Natural Gas Companies Set to Soar from an Export Boom," December 14, 2012. http://moneymorning.com/tag/natural-gas-stocks/

Sole U.S. financing of natural gas investments

Finally, NERA assumes that all income from natural gas investments will be received by U.S. residents: "[F]inancing of investment was assumed to originate from U.S. sources." (NERA Report, p.5) This improbable assumption, discussed in more detail above, means that benefits of investment in U.S. LNG export facilities and extraction services return, in full, to the United States. As discussed earlier, under the more realistic assumption that LNG exports are in part financed by foreign investors, some of the benefits of U.S. exports would flow out of the country to those investors.

6. Use of stale data leads to underestimation of domestic demand for natural gas

An additional important concern regarding the NERA Report is its use of unnecessarily outdated data from the rapidly changing U.S. Energy Information Administration (EIA) *Annual Energy Outlook* natural gas forecasts. Inexplicably, the NERA Report failed to use the EIA's most recent data, even though it had done so in prior reports.

The following timeline of EIA data releases and NERA reports illustrates this point:

- April 2011: EIA's Final **AEO 2011**[28] published
- December 2011: EIA's **AEO 2012**[29] Early Release published
- June 2012: EIA's Final **AEO 2012**[30] published
- October 2012: NERA's "Economic Implications of Recent and Anticipated EPA Regulations Affecting the Electricity Sector"[31] N$_{ew}$ERA model report published using **AEO 2012** data
- December 3, 2012: NERA's "Macroeconomic Impacts of LNG Exports from the United States"[32] N$_{ew}$ERA model report published using **AEO 2011** data
- December 5, 2012: EIA's **AEO 2013** Early Release published[33]

NERA's October 2012 N$_{ew}$ERA report on regulations affecting the electricity sector used AEO 2012 data, but its December 2012 report on LNG exports used older, AEO 2011 data. Days after NERA's December 2012 release of its LNG analysis, EIA released its AEO 2013 data.

By choosing to use stale data in its report, NERA changed the outcome of its analysis in significant ways. There have been important changes to EIA's natural gas forecasts in each recent AEO release. Even between AEO 2011 (used in NERA's LNG analysis) and AEO 2012 (which was available but not used by NERA), projected domestic consumption, production, and export of

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[28] EIA, Annual Energy Outlook 2011, 2011. http://www.eia.gov/forecasts/archive/aeo11/er/
[29] EIA, *Annual Energy Outlook 2012 Early Release*, 2012. http://www.eia.gov/forecasts/archive/aeo12/er/
[30] EIA, *Annual Energy Outlook 2012,* 2012. http://www.eia.gov/forecasts/aeo/pdf/0383(2012).pdf
[31] David Harrison, et al., *Economic Implications of Recent and Anticipated EPA Regulations Affecting the Electricity Sector*, October 2012. http://www.nera.com/nera-files/PUB_ACCCE_1012.pdf
[32] W. David Montgomery, et al., *Macroeconomic Impacts of LNG Exports from the United States*, December 2012. http://www.fossil.energy.gov/programs/gasregulation/reports/nera_lng_report.pdf
[33] EIA, *Annual Energy Outlook 2013 Early Release*, 2013. http://www.eia.gov/forecasts/aeo/er/

natural gas rise, imports fall, and projected (Henry Hub) gas prices take a deeper drop in the next decades than previously predicted.

NERA's use of the older AEO 2011 data results in an underestimate of domestic demand for natural gas. The assumed level of domestic demand for natural gas is critical to NERA's modeling results; higher domestic demand—as predicted by more recent AEO data—would decrease the amount of natural gas available for export and would increase domestic prices. Domestic natural gas prices—both in the model's reference case baseline and its scenarios assuming LNG exports—are a key determinant of U.S. LNG's profitability in the global market.

7. Conclusions and policy recommendations

NERA's study of the macroeconomic impacts of LNG exports from the United States is incomplete, and several of its modeling choices appear to bias results towards a recommendation in favor of opening LNG exports. NERA's imagined future clashes with the obvious facts of economic life.

NERA's own modeling shows that LNG exports depress growth in the rest of the U.S. economy.

- NERA's results demonstrate that when LNG exports are opened, the size of the U.S. economy (excluding these export revenues) will shrink. An example helps to illustrate this point: In some cases, when LNG export revenues are $9 billion, GDP is $3 billion larger than in the no-export reference case. This means that GDP excluding gas exports has shrunk by almost $6 billion.
- Using a methodology adopted by NERA in other N_{ew}ERA analyses, job-equivalent losses from opening LNG exports can be estimated as ranging from 36,000 to 270,000 per year; the median scenario has an average job-equivalent loss of 131,000 per year.
- NERA's assumption that all income from LNG exports will return to U.S. residents is simply incorrect, and results in an overestimate of the benefits that will accrue to U.S.-based resource owners.
- Most American households do not own significant amounts of stock in general, and natural gas stocks represent just a tiny fraction of total stock ownership. The benefits to the typical American household from a booming gas industry are too small to measure.
- Higher prices for natural gas and electricity, and declining job prospects outside of the natural gas industry, would cause obvious harm to people throughout the country.
- NERA's export strategy would have the effect of maximizing short-run incomes at the expense of long-term economic stability. If NERA's export scenarios were to be carried out as federal policy, the result would be an acceleration of the decline of U.S. manufacturing and productivity, and an increased national dependence on raw material exports. Too strong of a dependence on resource exports—a problem often called the "resource curse" or the "Dutch disease"—can weaken the domestic manufacturing sector, even in a developed country.
- In the long run, it may prove more advantageous to nurture U.S. manufacture and export of value-added products made from our natural resources—even if it is not quite as

profitable in the short run. For example, surplus natural gas could be used to increase the U.S. manufacture and export of products, such as chemicals, that use natural gas as a raw material.

- The NERA Report has significant methodological issues. The proprietary N_{ew}ERA model is not available for examination by reviewers outside of NERA. The application of this type of closed-source model to U.S. federal policy decisions seems inappropriate.
- The limited documentation provided by NERA points to several unrealistic modeling assumptions, including: decision-makers' perfect foresight regarding future conditions; zero profits in the production of goods and services; no change to monetary policy, even in the face of economy-wide demand and supply shocks; and constraints on how much the U.S. balance of trade can shift in response to opening LNG exports.
- Full employment—also assumed in NERA's modeling—is not guaranteed, and nothing resembling full employment has occurred for quite a few years. At the writing of this white paper, the U.S. unemployment rate stood at 7.8 percent of the labor force (that is, of those actively employed or seeking work).[34] Furthermore, unemployed factory workers do not automatically get jobs in natural gas production, or in other industries.
- The NERA Report used outdated AEO 2011 data when AEO 2012 data were available. These older data underestimate U.S. domestic consumption of natural gas. Accurate modeling of domestic demand for natural gas is essential to making a creditable case for the benefits of opening LNG exports.

The Department of Energy is charged with determining whether or not approving applications—and thus opening U.S. borders—for LNG exports is in the public interest. At this important juncture in the development of U.S. export and resource extraction policy, a higher standard for data sources, methodology, and transparency of analysis is clearly required. Before designating LNG exports as beneficial to the U.S. public, the Department of Energy must fully exercise its due diligence by considering a far more complete macroeconomic analysis, including a detailed examination of distributional effects.

[34] December 2012 unemployment rate; U.S. Bureau of Labor Statistics, *Labor Force Statistics from the Current Population Survey*, Series ID: LNS14000000, Seasonal Unemployment Rate. http://data.bls.gov/timeseries/LNS14000000.

Appendix A

This appendix contains source information for Figure 2: Applicants for LNG Export Licenses.

Table A-1: Source information for Figure 3

Company	Status	Publicly traded?	Source	Quantity	FTA Applications (Docket Number)	Non-FTA Applications (Docket Number)
Golden Pass Products LLC	Foreign / Domestic	yes: XOM ExxonMobil	Golden Pass Products LLC is a joint venture between ExxonMobil Corp and Qatar Petroleum http://online.wsj.com/article/SB10000872396390444375104577595760678718068.html#articleTabs%3Darticle	2.6 Bcf/d(d)	Approved (12-88 -LNG)	Under DOE Review (12-156-LNG)
Lake Charles Exports, LLC	Foreign / Domestic	yes: SUG Southern Union Company, Foreign: BG Bg Group on London Stock Exchange	Lake Charles Exports LLC is a jointly owned subsidiary of Southern Union Company and BG Group http://www.fossil.energy.gov/programs/gasregulation/authorizations/2011_applications/11_59_lng.pdf	2.0 Bcf/d (e)	Approved (11-59-LNG)	Under DOE Review (11-59-LNG)
Freeport LNG Expansion, L.P. and FLNG Liquefaction, LLC (h)	Foreign / Domestic	Foreign: stock 9532:JP (Osaka Gas Co., Japan)	Osaka Gas's subsidiary Turbo LNG, LLC has a 10% stake in FLNG Development, which is a parent company for Freeport LNG Expansion, L.P, which in turn is a parent company of FLNG Liquafaction LP http://www.freeportlng.com/ownership.asp	1.4 Bcf/d (d)	Approved (12-06-LNG)	Under DOE Review (11-161-LNG)
Main Pass Energy Hub, LLC	Domestic	yes: MMR Freeport-MacMoRan Exploration Co.	Freeport-MacMoRan Exploration Co. owns a 50% stake in Main Pass Energy Hub, LLC http://www.fossil.energy.gov/programs/gasregulation/authorizations/2012_applications/12_114_lng.pdf	3.22 Bcf/d	Approved (12-114-LNG)	n/a
Gulf Coast LNG Export, LLC (i)	Domestic	privately held	97% owned by Michael Smit, 1.5 % each by trusts http://www.fossil.energy.gov/programs/gasregulation/authorizations/2012_applications/12_05_lng.pdf	2.8 Bcf/d(d)	Approved (12-05-LNG)	Under DOE Review (12-05-LNG)
Sabine Pass Liquefaction, LLC	Domestic	yes: CQP Cheniere Energy Partners L.P	Sabine Pass Liquefaction is a subsidiary of Cheniere Energy Partners L.P http://www.cheniereenergypartners.com/liquefaction_project/liquefaction_project.shtml	2.2 billion cubic feet per day (Bcf/d) (d)	Approved (10-85-LNG)	#N/A
Cheniere Marketing, LLC	Domestic	yes: LNG Cheniere Energy Inc.	Cheniere Marketing is a subsidiary of Cheniere Energy Inc. http://www.cheniere.com/corporate/about_us.shtml	2.1 Bcf/d(d)	Approved (12-99-LNG)	Under DOE Review (12-97-LNG)

Table A-1: Source information for Figure 3 (Continued)

Company	Status	Publicly traded?	Source	Quantity	FTA Applications (Docket Number)	Non-FTA Applications (Docket Number)
Cameron LNG, LLC	Domestic	yes: SRE Sempra Energy	Cameron LNG is a Sempra affiliate http://cameron.sempralng.com/about-us.html	1.7 Bcf/d (d)	Approved (11-145-LNG)	#N/A
Gulf LNG Liquefaction Company, LLC	Domestic	yes: KMI Kinder Morgan and GE General Electric (GE Energy Financial Services, a unit of GE)	KMI owns 50 pct stake in Gulf LNG Holdings http://www.kindermorgan.com/business/gas_pipelines/east/LNG/gulf.cfm. GE Energy Financial Services, directly and indirectly, controls its 50 percent stake in Gulf LNG http://www.geenergyfinancialservices.com/transactions/transactions.asp?transaction=transactions_archoldings.asp	1.5 Bcf/d(d)	Approved (12-47-LNG)	Under DOE Review (12-101-LNG)
Excelerate Liquefaction Solutions I, LLC	Foreign / Domestic	Foreign: stock RWE.DE domestic: privately held	Owned by Excelerate Liquefaction Solutions, source: http://www.gpo.gov/fdsys/pkg/FR-2012-12-06/html/2012-29475.htm . Those are owned by Excelerate Energy, LLC (same source). THAT is owned 50% by RWE Supply & Trading and 50% by Mr. George B. Kaiser (an individual). George Kaiser is the American $10B George Kaiser: http://en.wikipedia.org/wiki/George_Kaiser and http://excelerateenergy.com/about-us	1.38 Bcf/d(d)	Approved (12-61-LNG)	Under DOE Review (12-146-LNG)
LNG Development Company, LLC (d/b/a Oregon LNG)	Domestic	privately held	Owned by Oregon LNG source: http://www.gpo.gov/fdsys/pkg/FR-2012-12-06/html/2012-29475.htm	1.25 Bcf/d(d)	Approved (12-48-LNG)	Under DOE Review (12-77-LNG)
Dominion Cove Point LNG, LP	Domestic	yes: D Dominion	source: https://www.dom.com/business/gas-transmission/cove-point/index.jsp	1.0 Bcf/d (d)	Approved (11-115-LNG)	#N/A
Southern LNG Company, L.L.C.	Domestic	yes: KMI Kinder Morgan	KMI owns El Paso Pipeline Partners source: http://investor.eppipelinepartners.com/phoenix.zhtml?c=215819&p=irol-newsArticle&id=1624861 . El Paso Pipeline Partners owns El Paso Pipeline Partners Operating Company source: http://investing.businessweek.com/research/stocks/private/snapshot.asp?privcapId=46603039 . El Paso Pipeline Partners Operating Company owns Southern LNG page 2 of http://www.ferc.gov/whats-new/comm-meet/2012/051712/C-2.pdf	0.5 Bcf/d(d)	Approved (12-54-LNG)	Under DOE Review (12-100-LNG)

Table A-1: Source information for Figure 3 (Continued)

Company	Status	Publicly traded?	Source	Quantity	FTA Applications (Docket Number)	Non-FTA Applications (Docket Number)
Waller LNG Services, LLC	Domestic	privately held	Wholly owned by Waller Marine: http://www.marinelog.com/index.php?option=com_content&view=article&id=3196:waller-marine-to-develop-small-scale-lng-terminals&catid=1:latest-news . Waller Marine private: http://www.linkedin.com/company/waller-marine-inc.	0.16 Bcf/d	Approved (12-152-LNG)	n/a
SB Power Solutions Inc.	Domestic	yes: SEB Seaboard	p. 2 of http://www.fossil.energy.gov/programs/gasregulation/authorizations/Orders_Issued_2012/ord3105.pdf	0.07 Bcf/d	Approved (12-50-LNG)	#N/A
Carib Energy (USA) LLC	Domestic	privately held	http://companies.findthecompany.com/l/21346146/Carib-Energy-Usa-Llc-in-Coral-Springs-FL	0.03 Bcf/d: FTA 0.01 Bcf/d: non-FTA (f)	Approved (11-71-LNG)	#N/A

Foreign Invested:

- **Freeport LNG Expansion, L.P. and FLNG Liquefaction, LLC (1.4 Bcf/d)**
  - Freeport LNG Expansion, LP, (FLNG) is a Delaware limited partnership and a wholly owned subsidiary of Freeport LNG Development, LP. FLNG Liquefaction is a Delaware limited liability company and a wholly owned subsidiary of FLNG Expansion. The principal place of business for both is TX.
    - FLNG Development is a Delaware limited partnership with 4 limited partners: (1) Freeport LNG investments, LLLP, a Delaware limited liability limited partnership, which owns a 20% limited partnership interest in FLNG Development; (2) ZHA FLNG Purchaser LLC, a Delaware limited liability company and wholly owned subsidiary of Zachary American Infrastructure, LLC which owns a 55% limited partnership interest in FLNG Development; (3) Texas LNG Holdings LLC, a Delaware limited liability company and wholly owned subsidiary of The Dow Chemical Company, which owns a 15% limited partnership interest in FLNG Development; and (4) Turbo LNG, LLC, a Delaware limited liability company and wholly owned subsidiary of Osaka Gas Co., Ltd. (Japanese gas company traded on the Tokyo Stock Exchange), which owns a 10% limited partnership interest in FLNG Development.
    - In addition to the limited partners, FLNG Development has one general partner that manages the company, Freeport LNG-GP, Inc., a Delaware corporation, which is owned 50% by an individual, Michael S. Smith, and 50% by ConocoPhillips Company.
  - **http://www.freeportlng.com/ownership.asp**

- **Lake Charles Exports, LLC (2.0 Bcf/d)**

  Lake Charles Exports, LLC, is a jointly-owned subsidiary of Southern Union Company (NYSE: SUG) and BG Group.
  - Southern Union Group: Headquartered in Houston, a subsidiary of ETP Holdco.
  - BG Group: Headquartered in the UK. BG Group is a publicly listed company on the London Stock Exchange and is also listed on the US over-the-counter market known as "International OTCQX".
  - http://www.energytransfer.com/ownership_overview.aspx
  - http://www.bg-group.com/AboutBG/Profile/Pages/BGProfile.aspx

- **Jordan Cove Energy Project, L.P. (1.2 Bcf/d: FTA; 0.8 Bcf/d: non-FTA)**
  - Jordan Cove Energy Project is being developed by Veresen Inc.(formerly Fort Chicago Energy L.P.)
    - Veresen is a Calgary, Alberta based company listed on the Toronto Stock Exchange (TSE: VSN) active in the energy infrastructure investment sector.
  - http://www.jordancoveenergy.com/about.htm

- **Golden Pass Products LLC (2.6 Bcf/d)**
    - Golden Pass Products, is a partnership of foreign state owned Qatar Petroleum International (70%) and ExxonMobil affiliates (30%).
    - http://goldenpassproducts.com/

- **CE FLNG, LLC (1.07 Bcf/d)**
    - CE FLNG is a subsidiary of Cambridge Energy Holdings, LCC (CEH) which is owned by Cambridge Energy Group Limited (CEGL). CE FLNG's affiliate Cambridge Energy, LCC (CE) is a marketer of natural gas.
    - Cambridge Energy Group Limited (CEGL) is a Bermuda-incorporated energy company listed on the Bermuda Stock Exchange (BSX) at CEGL.
    - http://www.bsx.com/CompanyDisplay.asp?CompanyID=1099937826

- **Pangea LNG (North America) Holdings, LLC (1.09 Bcf/d)**
    - The exact legal name of Pangea is Pangea LNG (North America) Holdings, LLC. Pangea is a wholly owned subsidiary of Pangea LNG B.V., a Netherlands-based company that is developing floating LNG liquefaction and storage solutions around the globe. Pangea LNG B.V.'s ordinary shares are owned by DSME (70%), D&H Solutions AS (20%) and NextDecade International Coöperatief U.A. ("NextDecade International") (10%).
    - DSME is a South Korea-based company whose major shareholders consist of Korea Development Bank (31.27%) and Korea Asset Management Corporation (19.11%), with the remaining shares being widely-held (with no individual entities holding five (5) percent or more of DSME's shares). Treasury shares comprise 1.2% of the total shares of DSME. D&H Solutions AS is a Norwegian-based joint venture company that is owned by Hemla II AS (50%) and DSME (50%). NextDecade International is a Netherlands based cooperative and has six (6) individual investors from the United States, Spain and The Netherlands.
    - Consistent with an executed Letter of Intent, Pangea is working closely with Statoil North America, Inc. ("Statoil") on the development of the ST LNG Project. Statoil North America, Inc. operates as a holding company. The company, through its subsidiaries, engages in the exploration and development of oil and gas deposits in the Gulf of Mexico. It offers crude oil, petrol, propane, and butane. The company was incorporated in 1987 and is based in Stamford, Connecticut. Statoil North America, Inc. operates as a subsidiary of Statoil ASA.
    - Statoil ASA (NYSE: STO) , trading as Statoil and formerly known as StatoilHydro, is a Norwegian oil and gas company. The Government of Norway is the largest shareholder in Statoil with 67% of the shares.
    - Statoil and Pangea are in active negotiations with respect to Statoil North America procuring up to a 50% equity stake in the ST LNG Project and utilizing up to 50% of the liquefaction and export capacity of the ST LNG Project.

- http://www.fossil.energy.gov/programs/gasregulation/authorizations/2012_applications/12_174_lng.pdf
- http://en.wikipedia.org/wiki/Statoil
- http://www.nyse.com/listed/sto.html

- **Magnolia LNG, LLC (0.54 Bcf/d)**
  - Magnolia LNG, LLC, a limited liability company organized under the laws of Delaware, and a wholly owned indirect subsidiary of Liquefied Natural Gas Limited ("LNG Limited"). Magnolia LNG's principal place of business is in Perth Western Australia. LNG Limited is a publicly listed Australian company with the objective of identifying and developing LNG projects in Australia and overseas.
  - http://www.lnglimited.com.au/IRM/Company/ShowPage.aspx/PDFs/1815-78684834/PositionSecuredintheDynamicUSALNGMarket
  - http://www.fossil.energy.gov/programs/gasregulation/authorizations/2012_applications/12_183_lng.pdf

Domestically Owned:

- **Sabine Pass Liquefaction, LLC (2.2 Bcf/d)**
  - Sabine Pass Liquefaction LLC is a subsidiary under Cheniere Energy Partners, L.P.
  - Cheniere Energy Partners, L.P (NYSE: CQP) is a Delaware limited partnership formed by Cheniere Energy, Inc. Through its wholly owned subsidiary, Sabine Pass LNG, Cheniere LP owns and operates the Sabine Pass LNG receiving terminal.
  - Cheniere Energy, Inc. (NYSE Amex Equities: LNG), a Delaware corporation, is a Houston-based energy company primarily engaged in LNG-related businesses. Owns and operates the Sabine Pass LNG receiving terminal in Louisiana through its 89.3% ownership interest in and management agreements with Cheniere Energy Partners, L.P. (NYSE: CQP), which is a publicly traded partnership created in 2007.
  - References: http://www.cheniereenergypartners.com/liquefaction_project/liquefaction_project.shtml
  - http://www.cheniere.com/corporate/about_us.shtml

- **Carib Energy (USA) LLC (0.03 Bcf/d: FTA; 0.01 Bcf/d: non-FTA)**
  - Carib is a Delaware limited liability company, with principal base of business in Coral Springs, Florida. Stock in Carib is held equally by Everything for Gas International LLC d/b/a EFG Industries, a Florida limited liability company based in Coral Springs, Florida, and Argosy Transportation Group, Inc., a Texas limited liability company based in Bellaire Texas.
  - http://www.fossil.energy.gov/programs/gasregulation/authorizations/2011_applications/11_141_lng.pdf

- **Dominion Cove Point LNG, LP (1.0 Bcf/d)**
    - DCP is a limited partnership organized in Delaware with its principal place of business in MD and VA. DCP currently owns the Cove Point LNG Terminal. DCP is a subsidiary of Dominion Resources, Inc., one of the nation's largest producers and transporters of energy. Dominion Resources, Inc. is a publically traded company organized in VA and traded on the NYSE with ticker D.
    - **http://www.fossil.energy.gov/programs/gasregulation/authorizations/2011_applications/11_115_lng.pdf**

- **Cameron LNG, LLC (1.7 Bcf/d)**
    - Affiliate of Sempra LNG, subsidiary of Sempra Energy, (NYSE: SRE), an American natural gas utilities holding company based in San Diego, California.
    - http://cameron.sempralng.com/

- **Gulf Coast LNG Export, LLC (2.8 Bcf/d)**
    - Gulf Coast LNG Export, LLC is a Delaware limited liability company. 97% of Gulf Coast stock is owned by Michael Smith, an individual. The Kaily Morgan Smith Irrevocable Trust and the Tara Marielle Smith Irrevocable Trust each own 1.5%. Mr. Smith is the founder and former Chairman and CEO of Basin Exploration Company. Mr. Smith is also the founder and current Chairman and CEO of Freeport LNG Development, LP.
    - http://www.fossil.energy.gov/programs/gasregulation/authorizations/2012_applications/12_05_lng.pdf

- **Gulf LNG Liquefaction Company, LLC (1.5 Bcf/d)**
    - GLLC is a wholly owned subsidiary of Gulf LNG Holdings Group, LLC ("Gulf LNG Holdings"). El Paso LLC (acquired by U.S. publically owned Kinder Morgan , NYSE: KMI), through its directly-owned subsidiary, Southern Gulf LNG Company, LLC, owns a 50% interest in Gulf LNG Holdings.
    - GE Energy Financial Services, a unit of GE (U.S. public, NYSE: GE), directly and indirectly owns a (46%) interest in Gulf LNG Holdings. Other investors, including, Atlas Energy, LP (a publicly traded master limited partnership NYSE: ATLS), Magnetar Capital (private company headquartered in IL), Tortoise Capital Resources Corp. (publically traded at the NYSE under TTO, changed to CORR in 12/2012) and Triangle Peak Partners Private Equity, LP, as well as funds and accounts under management by BlackRock Investment Management, LLC, (publically traded as NYSE: BLK) indirectly own the remaining four percent interest of Gulf LNG Holdings.
    - http://www.fossil.energy.gov/programs/gasregulation/authorizations/2012_applications/12_47_lng.pdf
    - http://www.atlasenergy.com/about-atlas-energy/
    - http://www.tortoiseadvisors.com/tto.cfm

- **LNG Development Company, LLC (d/b/a Oregon LNG) (1.25 Bcf/d)**
  - Oregon LNG has its principal place of business in Warrenton, Oregon and is headquartered in Vancouver, Washington.
  - http://www.fossil.energy.gov/programs/gasregulation/authorizations/2012_applications/12_48_lng.pdf
  - http://www.oregonlng.com/index.php

- **SB Power Solutions Inc. (0.07 Bcf/d)**
  - SPS is a Delaware corporation with its principal base of business in Merriam, Kansas. Stock in SPS is held wholly by Seaboard Corporation, a corporation incorporated in the State of Delaware.
  - http://www.fossil.energy.gov/programs/gasregulation/authorizations/Orders_Issued_2012/ord3105.pdf

- **Southern LNG Company, L.L.C (0.5 Bcf/d)**
  - SLNG is a wholly owned subsidiary of El Paso Pipeline Partners Operating Company, LLC. El Paso Pipeline Partners Operating Company, LLC is a wholly owned subsidiary of El Paso Pipeline Partners, LP (EPB). EPB is a Delaware master limited partnership publically traded on the NYSE as EPB. El Paso Pipeline Partners is a Kinder Morgan Company (NYSE: KMI).
  - http://www.fossil.energy.gov/programs/gasregulation/authorizations/2012_applications/12_54_lng.pdf
  - http://www.eppipelinepartners.com/

- **Excelerate Liquefaction Solutions I, LLC (1.38 Bcf/d)**
  - Excelerate Liquefaction Solutions I, LLC, is a limited liability company organized under the laws of Delaware and a wholly-owned subsidiary of Excelerate Liquefaction Solutions, LLC. Principal place of business of ELS is TX.

- **Cheniere Marketing, LLC (2.1 Bcf/d)**
  - Cheniere Marketing, LLC is an indirect subsidiary of Cheniere Energy, Inc. and is affiliated with the developers of the CCL Project. Cheniere Energy, Inc. (NYSE Amex Equities: LNG), a Delaware corporation, is a Houston-based energy company primarily engaged in LNG-related businesses.

- **Main Pass Energy Hub, LLC (3.22 Bcf/d)**
  - Main Pass Energy Hub, LLC is jointly owned (50%) by New Orleans, LA based Freeport-McMoRan Energy, LLC (FME) a subsidiary of McMoRan Exploration Co. (NYSE: MMR) and (50%) by Houston, TX based United LNG, LP (ULNG).
  - http://www.fossil.energy.gov/programs/gasregulation/authorizations/2012_applications/12_114_lng1.pdf

- http://www.unitedlng.com/mpeh-llc/

- **Waller LNG Services, LLC (0.16 Bcf/d)**
  - Waller LNG Services, LLC is doing business as Waller Point LNG. Waller Point LNG is a limited liability company formed under the laws of TX and authorized to transact business in Louisiana. Waller Point LNG is a wholly owned subsidiary of Waller Energy Holdings, LLC, a TX limited liability company. Waller Energy Holdings, LLC is a wholly owned subsidiary of Waller Liquefaction, L.P, a TX limited partnership, of which the General Partner is Waller LNG GP, LLC, a TX limited liability company wholly owned by Waller Marine, Inc., a TX corporation. Waller Marine is a developer of LNG terminals and LNG storage and transportation vessels, and is the developer of the Waller Point LNG Terminal. Waller Point LNG is authorized to do business in the States of TX and LA.
  - http://www.fossil.energy.gov/programs/gasregulation/authorizations/2012_applications/12_152_lng.pdf
  - http://www.wallermarine.com/index.php

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2008

Article

***1** RISK EQUITY: A NEW PROPOSAL

Matthew D. Adler [FNa1]

Introduction

How does distributive justice--for short, "equity"--bear on the regulation of health and safety risks? And what are the analytical tools that risk regulators should use to incorporate equity concerns into their decisionmaking? This Article proposes an answer to these vital questions which is novel, but also firmly grounded in the social-welfare-function tradition in welfare economics. The distributive impacts of risk regulation policies should be evaluated with reference to a social welfare function, with the status quo and each possible policy conceptualized as a probability distribution across population profiles consisting of lifetime income-health-longevity histories for each member of the population.

No clear paradigm for equity analysis has yet emerged in governmental practice. The contrast with risk assessment and cost-benefit analysis is stark. Highly sophisticated procedures for risk assessment and cost-benefit analysis currently exist. These procedures are employed by regulators, carefully ***2** monitored by oversight bodies, and supported by large bodies of scholarly work. [FN1] Equity analysis, on the other hand, is inchoate and haphazard. Executive Order 12,866, the chief legal instrument governing agency policy analysis, states that agency regulations should maximize net benefits and then proceeds to explain that benefits include “distributive impacts” and “equity.” [FN2] But the net-benefits-maximization test of traditional cost-benefit analysis is insensitive to distributional considerations. Executive Order 12,866 provides no guidance about the meaning of “distributive impacts” and “equity,” nor about how these considerations should be incorporated into cost-benefit analysis. The Office of Management and Budget (“OMB”) guidance document regarding compliance with Executive Order 12,866 is lengthy and, on many issues, quite specific. When it comes to distributive analysis, however, the OMB guidance is brief and vague. [FN3]

Equity considerations are more specifically discussed by a different presidential directive. Executive Order 12,898, the Environmental Justice order, states that: “[t]o the greatest extent practicable and permitted by law, . . . each Federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States.” [FN4] This order adopts a particular conception of risk equity: namely, a social-gradient conception of equity, which sees an inequitable policy as one whose impacts on socially disadvantaged groups are less favorable than its impacts on socially advantaged groups. Further, Executive Order 12,898 is quite specific in identifying low-income and minority status as the relevant markers of social disadvantage. [FN5]

However, techniques for implementing an environmental justice/social gradient conception of risk equity in agency decisionmaking remain unsettled. The scholarly literature on environmental justice, which is now quite substantial, has focused on testing factual hypotheses about whether waste dumps, hazardous waste processors, sources of air pollution, or other risk ***3** sources tend to be located in minority or low-income areas, and whether such skews are caused by racial or socioeconomic bias. [FN6] Less work has been done creating tools to measure the degree of inequality between members of advantaged and disadvantaged groups with respect to the effects of health and safety hazards, and for measuring the equity impact of policies that mitigate these hazards. [FN7] EPA, the largest of the federal agencies that regulate health and safety risks, and generally the most advanced in the development of policy tools, has given some attention to implementing environmental justice. There is an environmental justice office within EPA, and a number of guidance documents and letters have been issued. [FN8] Yet environmental justice analysis still plays a very small role within EPA decisionmaking--as compared to cost-benefit analysis, let alone risk assessment, which is pervasive. [FN9] Nor has the agency resolved upon a set of concrete procedures and metrics for structuring the analysis. [FN10]

***4** Academic scholarship about risk equity has also failed to advance very far. An important exception, already mentioned, is the literature on environmental justice. The social-gradient model, developed in that literature, does provide a relatively clear conception of distributive justice. However, as I shall argue below, the conception is a problematic one. Relatively little academic work has been done to develop and make workable competing conceptions of risk equity. At least in the United States, neither economists nor the toxicologists and other scholars who write about risk assessment have done so to any substantial degree.

Health economists abroad, particularly in Britain, have discussed the possible use of equity weights in QALY-based policy analysis. [FN11] This work has had no influence on U.S. governmental bodies, and appears to have had little influence on academic economists in the United States. Economists in this country have done some work quantifying the “incidence” of the costs of environmental policies on different groups, and have also written about the possible use of “distributional weights” within cost-benefit analysis. [FN12] But the volume of economic writing on these equity matters is fairly small compared to the vast U.S. literature on cost-benefit analysis. Finally, some scholarship within risk assessment does address equity issues, in particular suggesting that regulatory attention to “individual risk” rather than population risk (total deaths) is required by equity. [FN13] However, scholarship of this sort represents a small fraction of the corpus of work produced by risk assessment scholars, and has not succeeded in producing an influential conception of equity.

The inattention to risk equity by U.S. economists may reflect the old and still lingering view that welfare economics becomes subjective and inappropriately value-laden once it goes beyond endorsing Pareto-efficiency. The risk assessors' inattention may reflect their self-understanding as scientists who make no normative claims whatsoever. Whatever the cause, risk equity as a topic of scholarly discourse remains something of a vacuum.

This Article is intended to help fill that vacuum by advancing a new conception of risk equity. I suggest that health and safety agencies might evaluate the equity impacts of their policies by applying a variety of plausible utility functions and equity-regarding social welfare functions ("SWFs"), with the recognition that health, longevity and income are all important determinants of individual well-being, and the understanding that both the status quo and any given policy have an uncertain effect on individuals' longevity, health, and income. The status quo should be understood as a probability distribution across population profiles, each consisting of a lifetime health and income history for each member of the population. A policy ***5** would perturb this distribution and lead to a different set of probabilities for possible profiles. A utility function assigns a lifetime utility to each individual's longevity-health-income history. With this utility function in hand, the equity analyst can convert each population profile of individual longevity-health-income histories into a population profile of individual lifetime utilities. The status quo, and each policy, become probabilistic packages of population utility profiles. Plausible SWFs are then applied to these packages.

I will call this conception of risk-equity analysis "probabilistic population profile analysis" ("PPPA"). This conception is firmly grounded in the notion of an SWF: a construct that has been developed within a branch of welfare economics which is comfortable making normative claims about equity, and that has been mainly applied to questions of optimal tax policy. The contribution of this Article is to explain how the SWF notion might be operationalized in the domain of risk regulation, through PPPA, and to defend that approach as feasible (at least in the foreseeable future) and normatively attractive.

Part I of the Article criticizes existing approaches to risk equity: the environmental-justice or social-gradient paradigm; the notion that equity concerns the distribution of individual risks; QALY-based analysis with equity weights; incidence analysis; "inclusive" equality measurement; and cost-benefit analysis with distributional weights.

Part II defends the PPPA approach. I summarize the notion of an equity-regarding SWF, which grounds the approach. I then describe PPPA in detail and argue that the approach is foreseeably, if not immediately, feasible. Techniques would need to be developed to predict the impact of policies on each individual's lifetime "holdings" of both income and health/longevity. However, such techniques represent an incremental, not radical, extension of existing risk assessment and incidence analysis methodologies. Optimal tax scholarship has already provided a range of plausible SWFs. In particular, PPPA should rely on the so-called Atkinsonian family of SWFs, as well as the rank-weighted SWF, in analyzing risk policies.

Existing scholarly literatures do not contain the information needed to calibrate the utility function that would map individuals' longevity-health-income histories onto utility numbers--the utility numbers that are the arguments for the SWF. This gap can and should be filled through survey research. Until such research takes place, one possibility is to ignore health as a component of utility, and to employ the "constant relative risk aversion" utility function to attach utilities to life histories (now understood as lifetime income sequences). The constant relative risk aversion functional form has been extensively studied by economists, and estimates of the coefficient of relative risk aversion are available. Another possibility is to assume that lifetime utility as a function of health and income is additive across periods and multiplicative within periods, i.e., takes the form of

TABULAR OR GRAPHIC MATERIAL SET FORTH AT THIS POINT IS NOT DISPLAYABLE

***6** where $h_{i,t}$ is individual i's health in period t, $y_{i,t}$ is her income in period t, and $q(h_{i,t})$ and $v(y_{i,t})$ are "subutility" functions measuring the value of health and income, respectively, in each period. [FN14] It could then be assumed that $v(y_{i,t})$ takes the constant relative risk aversion form. Existing data about individual willingness-to-pay and willingness-to-accept for health could be used to estimate the within-period health function $q(h_{i,t})$.

PPPA represents a social-welfare-function approach to equity analysis that is quite general and can extend beyond risk regulation--for example, to estimate the equity impacts of tax-and-transfer policies, or of spending to fund public goods. But decision-cost and measurement considerations mean that the general approach will be developed differently in different areas. For example, in the case of a policy that funds or defunds national parks, it would be crucial to include individuals' recreational activities as a determinant of their utilities. In the case of risk regulation, where the main effects on individual well-being occur via changes in health, longevity, and income, recreational activities as an input to individual utility, and therewith the SWF, can (plausibly) be ignored. The Article therefore focuses on risk regulation and risk equity, elaborating the application of a social-welfare-function approach to that particular policy domain in the form of PPPA.

I. Existing Approaches to Risk Equity

A. Environmental Justice

Executive Order 12,898, as well as much of the scholarly writing under the heading of environmental justice, adopts a social-gradient conception of risk equity. [FN15] A policy implicates environmental justice insofar as it has a disproportionately negative impact on certain socially disadvantaged groups. The policy (1) imposes costs on at least some group members; and (2) those costs are disproportionately larger than the costs it imposes on non-members. [FN16]

***7** In focusing on disadvantaged groups and disparate impact, this social-gradient conception of risk equity is similar to the view that the Equal Protection Clause of the U.S. Constitution proscribes laws that have a disparate impact on racial minorities--a view which the Supreme Court has not incorporated into its justiciable doctrines enforcing that Clause, [FN17] but is arguably reflected in employment discrimination statutes. [FN18] The social-gradient conception is also adopted in much of the literature on health equity. [FN19] Environmental justice scholars typically focus their attention on toxic hazards or environmental disamenities, while the health equity literature typically concerns social skews in health generally or in health care. But these two literatures share, as their basic normative concern, the principle that members of socially disadvantaged groups ought not to fare especially badly with respect to health or longevity.

A fundamental difficulty with the environmental justice/social gradient approach is that it overlooks inequalities among individuals who are not members of the groups counted as socially disadvantaged. Consider the framework of Executive Order 12,898, which enjoins agencies to address disproportionately high health effects on minority populations and low-income populations. Under this framework, the distribution of health and longevity among non-impoverished white individuals--those who fall into neither of the two categories highlighted by the Executive Order--is not seen as an equity concern.

For example, a deregulatory policy that raises air pollutant levels might increase death and morbidity among individuals with respiratory diseases, including some individuals who are neither racial minorities nor have low incomes. Another example: permitting a dangerous product might cause some children to die, including some non-impoverished white children. These look like potential inequities, simply by virtue of the impact of the policies within the subpopulation of non-impoverished white individuals, and quite apart from their effect on poor individuals or racial minorities.

***8** This is not to say that a policy's impact on poor individuals or racial minorities is not an equity concern. Of course it is. It is rather to say that there is an additional equity concern in these examples, which Executive Order 12,898--framed in terms of disparate impact on minority and low-income groups--does not capture. In the pollution example, some non-impoverished whites have the further advantage of good health; others in this group do benefit from being white and having adequate incomes, but have the misfortune to suffer chronic diseases. The gap between their well-being and that of their luckier counterparts is increased by the deregulatory policy. Similarly, in the dangerous product example, some non-impoverished whites have the further advantage of living a full lifespan while others suffer the misfortune of premature death. Permitting the dangerous product has the effect of expanding the size of this unfortunate group.

The objection might be framed as follows. There are various measurable dimensions of well-being, from D_1 to D_K. The benefit of being white in a society with a history of oppression of non-whites is one such "dimension." So is income. So is health. So is longevity. The disparate-impact analysis set forth by Executive Order 12,898 focuses on a subset of these dimensions, D_1 to D_J, where J<K. That analysis takes a dimension D_i within the subset and asks whether a hazard increases skews in well-being or aspects of well-being between those who are at a high level with respect to D_i and those who are at a low level. What this approach ignores are inequalities among those individuals who are all at a reasonably high level for each D_i with $i <= J$, but some of whom are at a low level for some D_i with $i > J$.

The environmental justice theorist has two possible responses to this objection. The first is to expand the set of dimensions along which policy skews are measured. We might say that a policy triggers environmental justice concerns if it has a disparate impact on racial minorities, low-income groups, or women, disabled individuals, those in poor health, children, or the aged. Indeed, some of the scholarly literature pushes in this direction. [FN20] The problem here is how to aggregate a policy's equity effects along these multiple dimensions to arrive at an overall equity evaluation of the project. Imagine that we have some measure, S, of disparate impact. (The existing literature on health equity offers a variety of proposals as to what S might be.) [FN21] A policy might have a high S score with respect to D_1, a low S score with respect to D_2, and so forth. That is to say, it might impose costs on individuals with low D_1 levels that tend to be much greater, in absolute or proportional terms, than its costs for individuals with higher D_1 levels; but also impose costs on individuals with low D_2 levels that tend to be the same or even lower (in absolute or proportional terms) than its costs for individuals with higher D_2 levels. The policy has a highly disparate impact along the ***9** D_1 axis, but a zero or reverse disparate impact along the D_2 axis--and so forth for axes D_3 through D_K.

If all the measurable dimensions of well-being are included as potential axes for disparate impact, the straightforward answer to this inter-axis aggregation problem is to move away from dimension-specific disparate-impact measures to a single population-wide measure of inequality. Since a skew in well-being or aspects of well-being between those at a low and those at a high level with respect to any one of the D_i raises a distributive concern, why not ask how each individual fares, all things considered, as a consequence of her various attainments along the various dimensions D_1 through D_K; and then apply some metric of inequality to the population distribution of these overall attainments? The environmental-justice approach thereby morphs into the PPPA approach.

But the environmental justice theorist need not be led down this path. Instead, she might insist that the attributes highlighted by Executive Order 12,898 are distinctive. Being a racial minority, or lacking an adequate income, are not merely determinants of well-being. These characteristics are socially salient and have a particular social function that renders them uniquely important as a matter of distributive justice. As Paula Braveman, a leading health-equity scholar, and a co-author explain:

> [e]quity in health . . . [is] the absence of systematic disparities in health . . . between social groups who have different levels of social advantage/disadvantage--that is, different positions in a social hierarchy.

. . . .

Underlying social advantage or disadvantage refers to wealth, power, and/or prestige--that is, the attributes that define how people are grouped in social hierarchies. [FN22]

Being black or low-income is socially disadvantaging; these characteristics lower social status. And, in Braveman's view, it is health disparities between high-social-status and lower-social-status individuals that health-equity measures should seek to capture. [FN23]

Perhaps the fullest elaboration and defense of this view is provided by the philosopher Iris Marion Young. She argues that “claims about social justice that invoke equality usually require comparison of groups on measures of well-being or advantage . . . . Assessment of inequality in terms of the comparison of individuals yields little basis for judging injustice.” [FN24] Young's argument rests on two premises about the connection between distributive justice and inequality. The first is that unjust inequalities involve ***10** an absence of choice and responsibility on the part of the worse-off individuals. “If the causes of an inequality lie in the uncoerced and considered decisions and preferences of the less well-off persons, for example, then the inequality is probably not unjust.” [FN25] The second premise is that inequalities which are not socially caused are also not unjust, or at least not as seriously unjust as socially caused inequalities. “To the extent that injustices are socially caused, . . . [the correct] conception of justice claims that democratic political communities are responsible collectively for remedying such inequalities, perhaps more than they are obliged to remedy the effects of so-called ‘brute luck.”' [FN26] These two premises lead Young to conclude that an inequality must be a “structural inequality”--a difference in well-being or advantage as a result of social hierarchy--to be a central concern of distributive justice. Such differences are, clearly, both socially caused and not the responsibility of the low-status individuals.

> Structural inequality . . . consists in the relative constraints some people encounter in their freedom and material well-being as the cumulative effect of the possibilities of their social positions, as compared with others who in their social positions have more options or easier access to benefits. . . . Unlike the individualized attributes of native ability that often concern equality theorists, . . . structural inequalities are socially caused. [FN27]

Further, “individuals alone are not responsible for the way they are enabled or constrained by structural relations.” [FN28]

On the issue of individual choice and responsibility, Young's analysis involves a non sequitur. The fact that some individuals are worse off than others by virtue of differing ranks in the social hierarchy is a sufficient condition for the worse-off individuals to lack responsibility for the inequality. But it is not a necessary condition. Individuals who have a high place in the social hierarchy--they are white, male, and have decent incomes-- can surely suffer “brute luck” with respect to other determinants of well-being, for example by ingesting a toxin or being thrown from an automobile, and end up worse off than others through no fault of their own. [FN29]

***11** The second aspect of Young's argument, one I cannot fully address here, involves the distinction between social and nonsocial causation. [FN30] If an asteroid containing extraterrestrial carcinogens strikes Missouri without warning, then the inequality between those Missourians who incur cancer as a result of the asteroid, and healthy residents of Missouri or the other forty-nine states, is not (it would seem) socially caused. Does that mean that society has no moral obligation to redress the inequality? Imagine that the bark of a rare tree turns out to be uniquely effective in combating the extraterrestrial toxins, and is also effective for some widespread, nonserious symptom (an annoying rash). Is the choice of how to use the bark simply a matter of overall well-being or efficiency?

A plausible answer is no. One might agree that (1) morally significant inequality involves an absence of responsibility on the part of the affected individuals; and that (2) the moral obligation to redress such inequality falls on governmental bodies and other powerful actors, rather than individuals who are powerless to redress it ("ought implies can"); without accepting the further proposition that (3) governmental bodies and other powerful actors lack a moral obligation to redress inequalities that are not socially caused. A different response to Young's argument is to accept this last proposition--to accept the moral importance of social causation--but also insist that social causation is present for most of the health and safety impacts that risk regulators address, even if it is not for the Missouri asteroid. For example, deaths to high-status individuals because of chemical toxins in a waste dump are not caused by the social hierarchy, or by the individuals' position in it, but these deaths are partly caused by a legal regime (a kind of social product) that permitted the establishment of the dump in the first place.

In sum, the environmental justice/social gradient account of risk equity is surely correct to insist that differences in well-being flowing from differences in social position are a major concern of distributive justice. Where the account goes awry is in suggesting that these differences are the sole concern of distributive justice. Differences between individuals who have the same social status can also be unfair--for example, differences in health or longevity among equal-status individuals. Environmental justice is therefore an incomplete conception of risk equity.

B. "Individual Risk" Thresholds and Distributions

An "individual risk" test measures the risk of fatality, disease, or injury imposed on some specified person by a hazard. Such tests are a key component of the regulation of carcinogens and radiation by U.S. agencies. [FN31] For example, EPA's criteria for mitigating the risks of abandoned waste sites ***12** require that a clean-up occur if the incremental lifetime cancer risk to the person maximally at risk from a site exceeds 1 in 10,000, and that any clean-up bring that risk to within the range of 1 in 10,000 to 1 in 1 million. [FN32] FDA regulates carcinogens in food additives by refusing to license an additive which imposes an incremental lifetime cancer risk on the person consuming a large amount of the additive (specifically, the 90^{th} percentile consumer) exceeding 1 in 1 million. [FN33] The Clean Air Act requires that EPA set pollution levels for carcinogenic pollutants by first using a technology-based approach and then considering a lower level if the incremental lifetime cancer risk to the maximally exposed individual exceeds 1 in 1 million. [FN34] OSHA will not intervene to reduce the levels of a toxin currently present in the workplace unless the incremental lifetime cancer risk to a worker exposed to the toxin for his entire working life exceeds (or at least is not too far below) 1 in 1,000. [FN35] One of the Nuclear Regulatory Commission's principal safety goals for structuring the licensure and regulation of nuclear plants has been that individuals living close to plants not incur an annual risk of dying in a reactor accident that exceeds 1 in 2 million. [FN36] Many similar examples could be provided.

Risk assessment scholars sometimes suggest that regulatory attention to "individual risk" levels is justified by equity considerations. [FN37] The current regime, as just described, typically incorporates "individual risk" thresholds. These require or preclude regulation, or require further regulatory deliberation, depending on whether the "individual risk" of some person in the exposure distribution is above or below a numerical cut-off such as 1 in 1,000, 1 in 10,000, or 1 in 1 million. A different sort of regime might attempt to equalize "individual risk" levels. We might characterize the distribution of individual fatality risks imposed by a toxic hazard, and apply an inequality metric to that distribution. A large literature in economics seeks to measure the inequality of income, using metrics such as the Gini coefficient, the coefficient of variation, the Theil index, or the Atkinson index. [FN38] A "distributional" variant of the "individual risk" conception of risk equity ***13** could apply some such inequality metric to the distribution of "individual risk." [FN39]

There are serious difficulties with the "individual risk" conception of risk equity, whether in the threshold form or in the distributional form. To begin, the "individual risk" levels that currently figure in regulatory decisionmaking are incremental fatality risks. [FN40] EPA, in cleaning up waste dumps, is concerned with the risk to nearby residents of dying as a result of carcinogens in the dump. FDA, in licensing toxic food additives, is concerned with the risk to consumers of dying as a result of carcinogens in their food. The incremental fatality risk to person P from toxins of type X during period T (a year, a lifetime) is the probability that X-type toxins cause P's death during T--or some such construct. [FN41] X-type toxins could be all toxins in a particular dump, air pollutants from a particular industrial category, a particular food additive or additives generally, and so forth.

Incremental fatality risks are the wrong currency for risk equity. This is true whether or not the appropriate time-slice for distributive justice is a whole lifetime or a temporal fraction of a lifetime. My own view is a whole-lifetime view, and that view will provide part of the philosophical foundation for PPPA. [FN42] On the whole-lifetime view, the difficulty with incremental fatality risk tests is that P's incremental risk from X-type toxins during any period, even a whole lifetime, may have very little connection to P's total lifetime risk package. For example, the individual maximally exposed to a ***14** dump, a particular kind of air pollution, a food additive, a radiation source, or a workplace carcinogen may have a low lifetime risk of dying from cancer or a high life expectancy, even though his incremental risk from the dump, air pollution, etc. is above a stipulated threshold or higher than the incremental risks imposed on others in the population.

But even if we shift to a sublifetime account of distributive justice--for example, a view which tries to equalize how individuals fare during each year-- there clearly can be slippage between an individual's total risk package during the sublifetime and his incremental sublifetime fatality risk from a particular source. P's risk of dying during a given year could be low even though his risk of dying during the year as a result of exposure to X-type toxins is above a stipulated threshold, or high relative to the risk of dying from X-type toxins suffered by the rest of the population.

This problematic, incrementalist feature of the "individual risk" conception of equity could be cured by construing the category of X-type toxins very expansively, to encompass all carcinogens or all toxins to which individuals might be exposed from any source (rather than toxins in a given dump, air pollution from a particular industrial category, a particular food additive, or a particular workplace toxin). "Individual risk," thus construed, would come closer to focusing on an individual's total sublifetime or lifetime risk package. But two difficulties would remain with the "individual risk" approach.

First, "individual risks" are fatality risks. They ignore other important and measurable components of individual well-being, in particular income and health. Consider a test for risk equity which looks at how a policy intervention changes the distribution of life expectancy or the distribution of the chance of dying within the coming year, within the population generally or in particular age cohorts. These approaches are appropriately holistic rather than incremental with respect to the sources of fatality. Yet they remain problematic in presupposing that an individual's redistributive claim is just a function of his longevity. Individuals with chronic non-fatal diseases, or low but above-subsistence incomes, can have comparatively high life expectancies or low probabilities of dying in the next year, but poor prospects for annual or lifetime well-being, all things considered. An overweight and physically inactive high-income white male in his 50s can have a relatively short life expectancy but relatively high expected lifetime well-being.

Second, a conception of equity that focuses on the "individual risk" of fatality from particular sources, or overall, adopts an ex ante rather than ex post approach to equity. Chris Sanchirico and I have argued at length elsewhere for an ex post conception of egalitarianism under uncertainty. [FN43] The basic idea is this; given some component Z of individual well-being or advantage (which might be income, health, longevity, or utility as a function of all three), plus some measure M of equality, plus uncertainty about individual***15** attainments with respect to Z, we might (1) apply M to individual expectations with respect to Z; or instead

(2) determine the expectation of M, applied to individuals' actual attainments with respect to Z. Formally, if Z_i is a random variable representing the attainment of individual i with respect to Z, and there are N individuals, and E(.) is the expected value, we might (1) calculate $M(E(Z_1), E(Z_2), \ldots, E(Z_N))$ or instead (2) calculate $E(M(Z_1, Z_2, \ldots, Z_N))$. The first approach is the ex ante approach, while the second is the ex post approach.

To see how the "individual risk" approach to equity involves an ex ante conception of equality under uncertainty, and to understand how this difficulty is distinct from the problem of incrementalism versus holism, let us consider an appropriately holistic version of the "individual risk" approach--for example, measuring the distribution of the chance of dying within the coming year within an age cohort. [FN44] Z is then an indicator variable which takes the value 1 if the individual dies within the following year and 0 if she does not. Assume that M is the coefficient of variation, i.e., the standard deviation divided by the mean--a very standard measure of inequality. Then the "individual risk" approach determines whether a policy improves equity by comparing the coefficient of variation of $(E(Z_1), E(Z_2), \ldots, E(Z_N))$ in the status quo and given the policy, where $E(Z_i)$ is individual i's chance of dying in the following year. The problem here is that a policy can reduce the coefficient of variation of $(E(Z_1), E(Z_2), \ldots, E(Z_N))$, but leave unchanged or increase the expected coefficient of variation, that is, $E(M(Z_1, \ldots, Z_N))$. If, for example, the policy does not change the number of individuals who die in the following year in any given state of the world, but simply shifts around the identity of those individuals, $M(E(Z_1), E(Z_2), \ldots, E(Z_N))$ may decrease, but $E(M(Z_1, \ldots, Z_N))$ will stay the same. A similar deviation between ex ante and ex post approaches characterizes other standard inequality metrics, such as the Gini coefficient, the Theil index, or the Atkinson index, and indeed any metric M which is not just a linear function of the Z_i. [FN45]

The argument for the ex post approach to the measurement of equality under uncertainty hinges on the "sure thing" principle, which many theorists take to be a compelling principle of both individual and social rationality. The argument also appeals to a principle of dynamically consistent choice. I will not try to summarize the argument for the ex post approach here, but refer the reader to my work with Sanchirico. [FN46] If one accepts the argument, an "individual risk" conception of equity is inexorably flawed--not only ***16** in its incrementalist versions, but also in more "holistic" versions that consider a wider range of causes of death.

C. QALY-Based Equity Analysis

The QALY (quality adjusted life year) approach to health policy decisionmaking employs a single measure of health that incorporates both morbidity and longevity. Surveys are used to rank health states on a zero-to-one scale, with 1 corresponding to perfect health and 0 corresponding to death. The QALY value of an individual's health history during some stretch of time or over a lifetime can then be calculated as

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where $l(h_{i,t})$ is the quality of individual i's health in period t on a zero-to-one scale. [FN47] Policy-analytic tools that incorporate QALYs are widely used in the literature on health economics and by governments abroad, and have garnered increasing interest in the United States, particularly at the FDA. QALY-based analysis often takes the form of cost-effectiveness analysis, but can also take other forms. [FN48]

Health economists, particularly in Britain, have discussed at length the possibility of inequality measures, or distributively-sensitive policy-analytic tools, that make use of QALYs. [FN49] One suggestion is to apply the Gini coefficient, coefficient of variation, Theil index, Atkinson index, or some other inequality metric to the population distribution of expected QALYs. [FN50]

Another is to evaluate policies by using an SWF that takes individuals' QALY levels, rather than income levels, as its arguments. [FN51] Yet another is to incorporate equity weights into QALY-based cost-effectiveness analysis. [FN52]

***17** QALY-based equity analysis improves upon the deficiencies of the environmental justice and "individual risk" approaches. Unlike the environmental justice approach, it is not committed to a social-gradient conception of equity. Inter-individual differences in QALYs or expected QALYs can be counted as an inequality even if the individuals involved have the same social position. Unlike the "individual risk" approach, QALY-based equity analysis is sensitive to inequalities in health as well as longevity. Furthermore, unlike that approach, QALY-based equity analysis is not committed to an ex ante conception of egalitarianism under uncertainty. Many of the health economists who write about QALYs and equity do, in fact, adopt an ex ante conception; [FN53] but the basic construct of a QALY, as an integrated measure of health and longevity, is just as amenable to the ex post approach. If M is an inequality metric--for example, the Gini coefficient--and Z_i is a random variable representing an individual's lifetime QALYs, one could calculate $E(M(Z_1, \ldots Z_N))$: the expected inequality of the distribution of lifetime QALYs, as calculated considering various possible states of the world and the Gini coefficient of the population distribution of QALYs in each state. The same is true, of course, for other inequality metrics.

However, QALY-based equity analysis is problematic because it overlooks inequalities arising from differences in income. It shares this flaw with the "individual risk" approach. Consider, first, the variant of QALY-based analysis just discussed: calculating the value of $E(M(Z_1, \ldots Z_N))$ for the status quo and for policy alternatives, with M an inequality metric and Z_i a random variable representing individual i's lifetime QALYs. In this format, individuals are solely characterized in terms of their lifetime QALYs, which subsume their health and longevity but not their incomes. A policy might reduce the expected Gini coefficient of lifetime QALYs, but increase the expected Gini coefficient of lifetime income or of lifetime utility (defined as a function of health, longevity and income). A parallel critique applies to the proposal to use QALYs as arguments for a social welfare function. [FN54]

What about the proposal to incorporate equity weights in QALY-based cost-effectiveness analysis? QALY-based cost-effectiveness analysis evaluates policies by measuring health or longevity impacts in QALYs, and by measuring other impacts in dollars. Cutoff ratios are specified (such as $100,000 per QALY), and the decision rule is to implement a policy if its cost/QALY ratio is below the cutoff. [FN55] Normally, the QALY benefits of a policy are calculated by determining the expected increase in total QALYs. ***18** Equity weights would adjust this calculation by giving greater weight to QALY changes affecting those at a lower level of lifetime or sublifetime QALYs.

Income impacts are not completely ignored by this framework. The income-reduction effect of a policy will show up as dollar costs; ceteris paribus, a policy that produces a larger reduction in incomes will have a higher cost/QALY ratio. The difficulty, rather, is that the framework ignores inequalities in income. Imagine two policies which have identical health impacts and which also have the same aggregate monetary costs. In one case, those costs are borne by high-income individuals. In the other case, they are borne by low-income individuals. QALY based cost-effectiveness analysis, both in the traditional form and in the equity-weighted form, will not distinguish between the policies. The equity weights are a function of individual QALY levels and come into play in determining the denominator of the cost/QALY ratio for a policy; they are not a function of individual income levels and do not change the numerator of that ratio.

D. Incidence Analysis

The framework of "incidence analysis" characterizes taxes as progressive, regressive, or proportional, depending on whether the tax burden as a proportion of income increases, decreases, or remains the same as individual income increases. [FN56] Some scholarly work employing this framework has been undertaken in the area of risk regulation. [FN57] It has typically focused on the incidence of environmental taxes; but incidence analysis is also applicable to other sorts of policy measures, and indeed in a few cases has been undertaken for non-tax environmental measures, such as tradeable emissions permits. A non-tax measure that raises or lowers firms' costs of production will affect employee wages, shareholder incomes, and consumer surplus. The income equivalent of these changes can be calculated for representative members of different income groups (defined by annual or lifetime income), [FN58] and that burden as a fraction of the individual's total income can be calculated.

Incidence analysis in the environmental area has typically ignored health and longevity impacts. The burden of a tax or non-tax measure on a given individual has typically been understood as the income equivalent of the change in her tax payments, wages, consumer surplus, and/or profits received as a firm shareholder, excluding the benefits or costs resulting from a change in her fatality risk or health state. The flaw here is reciprocal to the flaw in QALY-based equity analysis. The equity impact of a risk regulation ***19** is a function both of its impact on the distribution of income (which the QALY-based approaches ignore), and of its impact on the distribution of health and longevity (which incidence analysis, as just described, ignores).

This flaw is not an inevitable feature of incidence analysis. The analyst could characterize the total effect of an environmental measure on members of different income groups, including its effect on their health, longevity, wages, shareholder earnings, and any other measurable aspect of well-being. The income equivalent of that effect could then be determined. The measure could be characterized as progressive, regressive, or proportional depending on whether this inclusive burden as a proportion of income increases, decreases, or remains the same with increasing income. [FN59]

However, this inclusive template for incidence analysis remains problematic. One large problem is that the approach provides no guidance in balancing equity against the improvement of overall well-being. A measure may be regressive but still morally justified, all things considered, if the gain to overall welfare is sufficiently large. Second, although it seems feasible to make incidence analysis inclusive in measuring burdens (the "numerator" for determining progressivity/regresssivity), it is much less clear how incidence analysis would be rendered inclusive with respect to the "denominator" for incidence analysis. What if a measure creates burdens that increase as a fraction of incomes as individual incomes increase (thus is progressive using this denominator), but decrease as a fraction of lifetime QALYs as lifetime QALYs increase (thus is regressive using this denominator)? In this sort of case, the incidence analyst either uses income as the denominator (in which case the analysis overlooks the possibility that some individuals at a relatively high level of income are at a relatively lower level of well-being, given poor health or short longevity, or vice versa), or she uses something like utility as a function of health, longevity, and income as the denominator (in which case it is unclear why the analyst doesn't simply move beyond the incidence-analysis framework, and use utility numbers as inputs for an inequality metric [FN60] or PPPA).

E. Inclusive Equality Measurement

As already discussed, inequality metrics such as the Gini coefficient, coefficient of variation, Theil index, or Atkinson index might be used in the risk regulation domain. [FN61] One possibility is to measure the inequality of "individual risks"; another possibility is to measure the inequality of individuals' expected QALYs or (even better) the expected inequality of individuals' QALYs.

We have seen that these particular proposals are problematic because they ignore incomes. But inequality metrics are not necessarily focused on ***20** health and longevity to the exclusion of incomes, or on incomes to the exclusion of health and longevity. An inclusive inequality-measurement tool sensitive to the distribution of health, longevity, and income could be developed using "utility functions"--a device elaborated below, in connection with PPPA. [FN62] The status quo and the policy could be seen as probability distributions across population profiles of individual utilities, where each individual's utility is in turn a function of her longevity, health, and income. We could calculate the expected Gini coefficient (for example) of individual utility, for both the status quo and the policy; if the policy has a lower value, it reduces expected inequality.

The inclusive inequality-measurement approach to risk equity, thus structured, would seem to be an improvement on the incidence-analysis approach. Unlike incidence analysis, it readily yields an overall verdict about the equality impact of policies whose fractional burdens move in one direction as individuals are made better off with respect to some dimensions of well-being (e.g., income), but a different direction as individuals are made better off with respect to other dimensions (e.g., health).

However, inclusive inequality measurement shares an important flaw with incidence analysis. Inequality metrics can tell us whether a proposed policy's distribution of individual well-being is more or less equal than the status quo distribution. Inequality metrics cannot tell us whether the policy is better or worse than the status quo, all things considered. They cannot yield a final verdict concerning the policy, given its impacts both on the distribution of well-being and on overall well-being. A policy analyst might find that cost-benefit analysis (a good proxy for overall well-being) favors the status quo, while the policy reduces the expected degree of inequality as measured by some inequality metric. Inequality metrics provide no guidance in making this sort of choice--in balancing distributive and aggregative concerns. [FN63]

By contrast, PPPA does provide the requisite guidance. PPPA subsumes both a concern for overall well-being and a concern for the equal distribution of well-being. At the same time, PPPA can provide exactly the sort of information provided by inequality metrics, if we find that information useful: namely how policies compare purely as a matter of equality. These points will be elaborated below. [FN64]

F. Cost-Benefit Analysis with Distributive Weights

Cost-benefit analysis ("CBA") compares a policy to the status quo by summing the monetary amounts that individuals who are benefited by the policy are willing to pay ("WTP") for it, and subtracting the amounts that ***21** individuals made worse off by the policy are willing to accept ("WTA") in return for it. [FN65] Economists have periodically suggested that cost-benefit analysis could be sensitized to equity by multiplying individual WTP/WTA amounts by a weighting factor that decreases with greater individual income. [FN66] Although this approach has not been adopted by U.S. governmental bodies, it has been adopted in Britain and, in the past, at the World Bank. [FN67]

At first blush, distributively-weighted CBA seems to provide a very attractive approach to risk equity. It takes a "population" rather than a social gradient approach: individuals with different incomes but identical social positions will receive different weights. It is inclusive with respect to the determinants of well-being: one can calculate individual WTP/WTA amounts, not merely for changes that directly affect income (such as changes in prices, wages, or earnings received as a firm shareholder), but also for changes in health and in longevity risks. Similarly, it is possible in principle to make the weighting factor for a given individual's WTP/WTA amounts a function of her health and longevity as well as her income. Finally, by contrast with incidence analysis and inequality measurement, distributively-weighted CBA provides guidance in balancing equity with overall welfare. The sum of weighted WTP/WTA amounts is meant to indicate whether, on balance, a policy should be pursued, given both distributive and aggregative considerations.

However, the proponents of distributively weighted CBA must confront a number of difficult issues involving the identification and application of weights. To begin, what determines the choice of weights? Consider the simplest sort of case, in which individuals are all healthy and long-lived, and differ only in their incomes. In the status quo, there are equal numbers of rich and poor individuals: the rich with annual incomes of $100,000, the poor with annual incomes of $20,000. A policy benefits the poor but makes the rich worse off. Each poor individual is WTP $250 for the policy, while each rich individual is WTA $300. From the perspective of unweighted CBA, the policy is a net social loss. From the perspective of weighted CBA, it will be a net social gain, if the weighting factor applied to poor individuals' WTP/WTA amounts is more than 6/5 (300/250) the weighting factor applied to rich individuals' WTP/WTA amounts. But should the ratio of the weighting factors be larger or smaller than 6/5?

Second, the straightforward procedure of assigning each individual a weight depending on her level of welfare-relevant characteristics in the status quo (her status quo income, health, longevity, etc.) must be revised for policy choices that involve large changes in some of those characteristics. ***22** Again, assume healthy and equally long-lived individuals and imagine that the status quo and the policy each, with certainty, produce a given distribution of annual income. In one case, the policy produces a small change in each individual's annual income; in the second case, it produces a large change in the annual income of some individuals.

"Small" Policy

Individual	Status Quo Income	Income with Policy	WTP/WTA FN [FN68]
1	$100,000	$98,000	-$2,000
2	$100,000	$98,000	-$2,000
3	$ 20,000	$21,000	$1,000
4	$ 20,000	$21,000	$1,000

"Large" Policy

Individual	Status Quo Income	Income with Policy	WTP/WTA
1	$100,000	$98,000	-$ 2,000
2	$100,000	$50,000	-$50,000
3	$ 20,000	$21,000	$ 1,000
4	$ 20,000	$70,000	$50,000

Assume that we have somehow developed a set of weights for WTP/WTA amounts as a function of annual income. The weight w_{100K} is the weight for an annual income of $100,000. In addition, assume (as seems plausible) that w_{100K} w_{98K}, and that w_{20K} w_{21K}. It is then straightforward to evaluate the small policy. The $2,000 annual losses of individuals 1 and 2 can be weighted by either w_{100K} or w_{98K} (which are approximately equal), and then subtracted from the $1,000 gains of individuals 3 and 4, weighted by either w_{20K} or w_{21K} (once more, approximately equal). But it is not straightforward to evaluate the large project. Should we weight individual 2's WTP/WTA amount ($50,000) by the weight for his annual income in the status quo, w_{100K}, or by the weight for his annual income in the policy outcome, w_{50K}? Similarly, should we weight individual 4's WTP/WTA amount (also *23 $50,000) by the weight for his annual income in the status quo, w_{20K}, or by the weight for his annual income in the policy outcome, w_{70K}?

A third and related problem concerns the application of weights under conditions of uncertainty. It is highly unrealistic to assume that the policymaker knows for sure which outcome would result from each choice available to her. More realistically, each choice leads to a probability distribution across outcomes rather than a particular, certain outcome. But then the problem of identifying a weight for each individual becomes yet thornier. With respect to income, for example, each choice leads to an array of state-dependent incomes for each individual. Even with a function from income levels to weights in hands, how are we to apply this function under conditions of uncertainty, given that neither the status quo nor the policy produces a single income level for any given individual?

In short, the proponent of distributively-weighted CBA needs a normative account of equality, sufficient to provide answers to these sorts of questions about the specification and application of weights. The only plausible such account which has been proposed in the literature on distributive weighting is the SWF account: distributive weights should be attached to WTP/WTA amounts so as to mimic the application of a social welfare function. [FN69]

Is it true that for any given SWF we can calculate WTP/WTA amounts and assign distributive weights so as to replicate the choices of the SWF? The answer is not obvious. Further, even if a particular SWF can be mimicked through weighted WTP/WTA amounts, it is far from clear why SWFs should be applied indirectly via the mediating device of weighted CBA, rather than directly. One argument for indirect application, that distributively-weighted CBA is a simpler procedure, is undercut by the above examples. For any given individual, her weighted WTP/WTA amount for a policy choice will be a function of the array of state-dependent determinants of well-being (income, health, longevity) that she would face if the policy were chosen, and the array of these state-dependent determinants that she would face if the status quo were chosen. This is just the information that the direct application of an SWF requires. Finally, even if weighted CBA does ultimately prove to be a simpler and more administrable decision procedure for incorporating equity, we should experiment with the direct application of SWFs, to help build the social knowledge base regarding the workings of SWFs that would be needed to develop a functioning system of weighted CBA.

A different difficulty, specifically relevant to distributively weighted CBA as a conception of risk equity, concerns the way in which CBA values longevity. In current practice, CBA translates longevity impacts into WTP/*24 WTA amounts using the "value of statistical life" ("VSL") approach, which asks what individuals are willing to pay or accept for changes in their risk of premature death. [FN70] If social choice under uncertainty should follow the ex post rather than ex ante approach, then the VSL approach is problematic. There will be cases where CBA using the VSL approach will fail to track the judgments of any social welfare function applied in an ex post manner. [FN71]

The following example illustrates the point. In one case a population of N individuals is exposed to a toxin in the status quo. The individuals are identical, except that only one unknown individual is susceptible to the toxin and will die prematurely for sure if it is not eliminated. In the second case, a small subpopulation of L within this broader population is exposed to the toxin. In this second case, one unknown individual in the subpopulation is susceptible to the toxin and will die prematurely for sure if it is not eliminated. In each case, there is a policy to eliminate the toxin, with costs TC borne by T taxpayers who (for simplicity) are identical and external to the population of N individuals. Imagine that each individual's WTP not to be exposed to a 1-in-N risk of dying from the toxin is V and that each individual's WTP not to be exposed to a 1-in-L risk of dying from the toxin is V*.

Unweighted CBA using the VSL approach will value the policy in the first case as NV - TC. It will value the policy in the second case as LV* - TC. Since WTP is not proportional to the risk reduction for large risk reductions, these need not be the same amount and may indeed differ dramatically. (Imagine that N is 1 million and L is 5.) Weighted CBA, let us imagine, employs weights that are sensitive to individual income and expected longevity, and therefore has different weights for taxpayers (designate the weight for taxpayers as w^T), members of the population who are exposed to a 1-in-N risk of dying from the toxin (w^N), and members of the population who are exposed to a 1-in-L risk of dying from the toxin (w^L), with $w^L >= w^N$. [FN72] So weighted CBA will value the first policy as $N \times w^N \times V - T \times w^T \times C$. Weighted CBA will value the second policy as $L \times w^L \times V^* - T \times w^T \times C$. Again, the two valuations can differ.

Because both unweighted and weighted CBA can give different valuations to the two policies, it is possible that both unweighted and weighted CBA will yield different choices in the two cases: favoring the policy in one case but the status quo in the other. But any social welfare function which is sensitive to distribution and is applied in an ex post manner will treat the two ***25** cases as identical. [FN73] The ex post account of social choice under uncertainty views equity as a matter of the distribution of realized, not expected, well-being. Each status quo involves the same distribution of realized well-being: taxpayers reach a certain level, members of the population reach a different level, and the unfortunate individual who dies from the toxin yet a different level. [FN74] Each policy also produces the same distribution of realized well-being: now everyone in the population reaches the same level of well-being, and the taxpayers reach a different level.

In short, CBA using the VSL approach--even CBA incorporating distributive weights--is a less than fully accurate proxy for any distributively sensitive SWF applied in an ex post manner under uncertainty.

II. A New Approach: Probabilistic Population Profile Analysis

This Part describes in detail how equity considerations could be brought to bear on risk policy choices via a technique I call “probabilistic population profile analysis” (“PPPA”).

PPPA represents one particular format for analyzing policy choices through the application of a social welfare function. Section A summarizes the philosophical basis for PPPA. Section B describes PPPA itself, and discusses its feasibility. Section C clarifies the connection between PPPA, equality measurement, and cost-benefit analysis.

A. Social Welfare Functions and the Philosophical Basis for PPPA

The SWF approach to distributive issues has been developed within theoretical welfare economics [FN75] and has been used in the optimal tax literature to study tax policies. [FN76] SWFs have also been used, in a few academic works, to evaluate environmental regulation. [FN77]

***26** The approach is welfarist. It assumes that individual well-being is the sole morally relevant information about outcomes, and that principles of equality govern the distribution of well-being. This might be seen as a limitation of the approach. But "welfare" can be construed broadly, to encompass anything that improves the quality of an individual's life. More precisely, the welfare-enhancing or welfare-reducing features of a life might plausibly be understood as those features that individuals with full information and good deliberative conditions would converge in preferring or dispreferring. Individual well-being, on this ideal-preference account, arguably encompasses the quality of an individual's experiences, health states, intellectual life, practical accomplishments, relationships with friends and family, and standing and participation in the broader community. [FN78] To be sure, measuring all these items is a big challenge. But the crucial point to understand here is that the SWF framework is potentially inclusive with respect to the constituents of welfare.

The SWF approach employs a characteristic mathematical formalism to represent welfarist moral judgment. Each outcome [FN79] is mapped onto a vector of "utility numbers," representing each individual's well-being in that outcome. A given SWF is, in turn, a particular mathematical function that takes the utility vector for each outcome and assigns it a single number. That social welfare number represents how good or bad the outcome is, morally speaking, as compared to other outcomes.

THE SWF FRAMEWORK

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In what way is the SWF framework sensitive to distributive concerns? A crucial point is that the set of possible social welfare functions includes not merely the utilitarian SWF, which simply adds up individual utilities, but ***27** also a wide array of distributively sensitive or "equity regarding" SWFs. The formal expression of distributive sensitivity is the so-called "Pigou-Dalton" principle. This principle stipulates that shifting utility from someone at a higher utility level to someone at a lower level, without changing total utility, must increase the value of the SWF. [FN80]

THE PIGOU-DALTON PRINCIPLE

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Anyone proposing to employ the SWF framework for policy choice must confront a number of basic philosophical issues. First, which distributively-sensitive SWF should drive the analysis? While there is only one utilitarian SWF, an infinite number of SWFs satisfy the Pigou-Dalton principle. The optimal-tax literature has focused on a particular family of distributively-sensitive SWFs, the "Atkinsonian" family. As I will elaborate below, this family of distributively sensitive SWFs indeed has attractive properties, and PPPA should principally draw on SWFs within this family. The rank-weighted SWF, a different sort of distributively sensitive SWF, might also be used. [FN81]

A second basic question involves the time slice. Is equality a matter of equalizing individuals' lifetime well-being, or rather of equalizing well-being during some temporal fraction of their lives, such as annual or momentary well-being? Formally, do the individual utility numbers upon which SWFs operate represent lifetime utilities or "sublifetime" utilities? I have argued at length elsewhere for the lifetime view and will not repeat those arguments here. [FN82]

A third question involves the application of SWFs under conditions of uncertainty. Absent uncertainty, each policy choice available to a decisionmaker corresponds to a particular vector of lifetime utilities: the particular***28** outcome that the choice would produce. Given uncertainty, each policy choice corresponds to a set of vectors of lifetime utilities: the set of possible outcomes that the choice might produce, each assigned a probability. Formally, each individual's lifetime utility is a random variable U_i, and an outcome is a realization of random variables U_1 through U_N, with N individuals in the population. The question then arises whether the social welfare function should be applied to a given choice in an ex post or exante manner. As mentioned, Chris Sanchirico and I have elsewhere defended the ex post approach. [FN83] If W is the social welfare function, and E is the expectation operator, the ex post approach is to calculate $E(W(U_1, \ldots, U_N))$ for each choice, while the ex ante approach is to apply the social welfare function to the vector of expected utilities associated with each choice, i.e., to calculate $W(E(U_1), E(U_2), \ldots, E(U_N))$ for each choice.

Ex Ante Versus Ex Post Application of an SWF: An Example

W = the sum of the square root of individual utilities. There are 2 individuals in the population, Jim and June. A policymaker is choosing between the status quo (which has two equiprobable outcomes, A and B), and a policy (which also has two equiprobable outcomes, C and D). The numbers in the tables are the individuals' utilities in each possible outcome.

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B. PPPA, Step by Step

PPPA represents a concrete attempt to operationalize the SWF framework described in Section A: namely, one that employs an equity-regarding SWF which is applied to lifetime utilities, and which is applied in an ex post rather than ex ante manner.

PPPA begins by specifying a population of interest. This might be limited to U.S. citizens who are currently alive, or it might include other individuals, such as foreign citizens or future or past generations. For simplicity, I will focus on the case in which the population of interest comprises current ***29** U.S. citizens. In that case, there are N 300 million individuals in the population, and the same N exist in all possible outcomes. [FN84]

Each individual i has different possible life histories. Each possible outcome O_k is a possible combination or "population profile" of life histories, one for each of the N individuals. If there are K such possible combinations, then there are K possible outcomes $\{O_1, \ldots, O_K\}$. Each outcome has the form $(L_1, L_2, \ldots, L_N)$, where L_1 is a possible life history for individual 1, L_2 a possible life history for individual 2, and so forth. Let us say that $L_{i,k}$ is the particular life history that individual i lives in outcome O_k.

Each possible life history $L_{i,k}$ is a description of certain welfare-relevant facts about individual i's life. What facts exactly? I propose that each $L_{i,k}$ include those facts about individual i that are readily measurable given current available metrics. In particular, at least for purposes of analyzing the equity implications of risk policy, $L_{i,k}$ should include all the various facts highlighted by the different literatures on risk equity described in Part I: health, longevity, income, and perhaps readily measurable markers of social position (paradigmatically, race and gender). The QALY and "individual risk" literatures underscore the measurability of impacts on health and longevity, and the importance of health and longevity for individual well-being. The incidence-analysis literature underscores the measurability of income impacts, and the importance of income for individual well-being. Finally, as regards the literature on environmental justice, one can reject the social-gradient approach but preserve the insight that social position can impair individual flourishing.

In short, $L_{i,k}$ consists of the following sorts of facts.

-- The life-span of individual i in outcome O_k

-- The income of individual i during each period she is alive in outcome O_k

-- The health state of individual i during each period she is alive in outcome O_k

-- Measurable markers of individual i's social position (such as race and gender)

This template for $L_{i,k}$ is not meant to be rigid. To begin, there are important constituents of well-being, such as the individual's experiential states (happiness), relationships with friends and family, or accomplishments at work or in the community, that are not included on the list because they are more difficult to measure with current metrics. [FN85] Reciprocally, income is not ***30** a direct constituent of well-being but is on the list. Income is a "resource" or "primary good" that allows individuals to advance their well-being in various ways, and income measurement techniques are very well developed. Different variants of PPPA might replace income with consumption or omit both income and consumption and conceptualize each life history as a set of facts concerning the individual's longevity, health, experiential life, social position, friendships and family relationships, and the other attributes of human lives that are directly constitutive of well-being. However, the longevity-health-income-social position characterization seems more tractable for now.

The construct of a population profile is one of the key building blocks of PPPA. Another is a utility function, U, that maps each individual $L_{i,k}$ onto a lifetime utility number $U(L_{i,k})$. The final one is a social welfare function W that maps a vector of N lifetime utilities onto a single "social welfare" number.

Using these building blocks, PPPA proceeds as follows. (1) A policy choice situation, consisting of the status quo choice of inaction plus at least one alternative, is given exogenously. [FN86] (2) Each available policy choice corresponds to a probabilistic population profile, that is, to a probability distribution across population profiles. In other words, if $\{O_1, \ldots, O_K\}$ is the set of all possible outcomes, i.e., all possible population profiles, then each choice corresponds to a probability distribution across these outcomes. Risk assessment techniques and techniques for estimating the income impact of policy choices are used to determine which probabilistic population profile corresponds to a given choice. (3) The utility function U is used to transform each possible population profile O_k of individual longevity-health-income-social position histories, O_k = (L,L,...,L»»»»), i»»»nto an N-entry vector of lifetime utilities, one for each individual in the population. Each choice therefore becomes a probability distribution across lifetime utility vectors. (4) The social welfare function W is applied to each choice--characterized as a probability distribution across lifetime utility vectors--in an ex post manner. The choice with the greatest expected W-value is that choice which is best, on balance, given both equity concerns and concerns about overall well-being.

Even if this approach is philosophically well-grounded, is it truly feasible? I will discuss the various steps of the approach in turn.

***31** 1. The Predictive Step: Mapping Choices onto Probabilistic Population Profiles

PPPA characterizes each choice as a probability distribution or lottery across population profiles, where each profile or outcome has the form $O_k = (L_{1,k}, L_{2,k}, \ldots, L_{N,k})$ and each $L_{i,k}$ includes information about individual i's lifespan, her health states in all the periods in which she is alive, her income in all the periods in which she is alive, and her measurable social position. For simplicity, I will assume that the relevant periods are years.

One aspect of this task is characterizing the effect of policy choices on each individual's possible income sequences over her lifetime. That task would presumably involve general equilibrium modeling. We have a model of the economy in the status quo, with some random elements, producing a probability distribution across population profiles. Each profile has information about each of the N individuals' wages, capital income, and perhaps other sources of earnings, in each period. A policy intervention perturbs this model in some way, leading to a different distribution of incomes.

General-equilibrium modeling is an established technique, [FN87] and a substantial number of studies have been undertaken that employ such models in the environmental context: to characterize the incidence of policies' burdens on different groups; to determine whether policies have net costs or benefits; and, in a few cases, to evaluate environmental policies with reference to an SWF. [FN88] Most relevant for my purposes, here, is the fact that general equilibrium models have been used to estimate the effect of policies on the distribution of lifetime incomes. A particularly thorough and impressive example is work by Fullerton and Rogers, who engage in modeling to characterize the progressivity of various taxes with respect to lifetime income. As they summarize their approach:

> [W]e build a general equilibrium simulation that encompasses all major U.S. taxes, many industries, both corporate and noncorporate sectors within each industry, and consumers identified by both age and lifetime income. It is not a model of annual decisionmaking, but a life-cycle model in which each individual receives a particular inheritance, a set of tax rules, a wage profile, and a transfer profile. Each then plans an entire lifetime of labor supply, savings, goods demands, and bequests. We also look at each industry's use of labor, capital, and intermediate inputs. We can then simulate the effects of a tax change on each economic decision through time. We calculate new labor supplies, savings, capital stocks, outputs, and prices. . . .

***32** . . . [W]e evaluate the effects of each U.S. tax by comparing its estimated burdens with those of a proportional tax . . . . In our lifetime framework, a progressive tax is one in which the lifetime tax burden as a fraction of lifetime income rises as lifetime income rises, and a regressive tax is one in which the lifetime tax burden as a fraction of lifetime income falls as lifetime income [rises]. [FN89]

Fullerton and Rogers are engaged in lifetime-income incidence analysis, while I am advocating a different approach to equity analysis, namely PPPA. What their work demonstrates, for my purposes, is that the kinds of models and techniques that would be required to estimate population profiles of individual income sequences, and changes in such profiles caused by policies, are already in use. [FN90]

What about the health and longevity characteristics of individual life histories? Describing the health and longevity characteristics of a given population, such as the U.S. citizenry, is already the focus of a large amount of work by public health scholars and organizations. [FN91] Describing the change in status quo morbidity and premature mortality that would result from policies falls under the rubric of risk assessment--also a large area of existing work. [FN92]

Of course, neither population health characterization, nor risk assessment, currently focuses on the particular sort of information required by PPPA--namely, a probability distribution across population profiles. Ignoring lifetime-income information for the moment, PPPA would presumably work along something like the following lines. Existing population data would be used to calibrate a lifetime health-and-longevity model for the N individuals in the population. The model would assign an annual probability of both death and morbidity (perhaps summarized in a QALY value) to each individual. These probabilities could be a function not only of the individual's age but also of other characteristics. Running the N models once would produce a particular population health-and-longevity profile. Doing this repeatedly would produce a probability distribution across population health-and-longevity profiles for the status quo. A policy's effect consists in changing mortality and/or morbidity probabilities for some individuals in some years. Running the altered N models repeatedly would produce a probabilistic population health-and-longevity profile associated with the policy.

The approach to generating probabilistic population health-and-longevity profiles just described, although certainly not a standard format for public ***33** health work, is surely feasible with existing tools. [FN93] Microsimulation models that model lifetime histories of an entire population are already in use, particularly in evaluating the impacts of tobacco and cancer policy. [FN94] For example, Tammy Tengs and co-authors estimated the total change in QALYs that would result over 50 years from federal policy requiring safer cigarettes, by using the Tobacco Policy Model.

> The Tobacco Policy Model is a flexible system dynamics computer simulation model . . . [that is] designed to calculate the public health gains or losses from any change in the hazards or patterns of cigarette use.

To start the present simulation, we initialized the model with the number of people in the U.S. population in the year 2003. We divided the population into cohorts according to gender, initial age . . . and smoking status (current, former, or never smoker). . . . The model then simulates annual transitions such as birth, death, aging, net migration, and changes in smoking behavior in the U.S. population over 50 years with transition probabilities varying by age, gender, smoking status, and year.

. . . .

In our model, gains or losses in an individual's health are measured with quality-adjusted-life-years (QALYs). . . . Quality of life data for current, former, and never smokers of various ages and genders were obtained from [survey data]. We estimated mortality hazard functions using mortality data for each gender . . . and smoking status . . . . [FN95]

A bigger challenge for PPPA is integrating the income and health-and-longevity elements. Imagine that, using a general equilibrium model, we have generated a baseline probability distribution across population profiles each consisting of an income history for each of the N individuals in the population and a perturbation in that distribution occasioned by the policy. Similarly, using risk assessment techniques and information about population health, we have generated a baseline probability distribution across population profiles each consisting of a health-and-longevity history for each of the N individuals in the population and a perturbation in that distribution ***34** occasioned by the policy. How do we synthesize this information to produce the requisite characterization of the status quo and the policy as probability distributions over profiles that contain information both about each individual's health/longevity and about her income?

The simplest approach would be to assume that the income and the health/longevity components of population profiles occur independently. In other words, the probability of a given combined profile, with information both about each individual's income and about each individual's health and longevity, is simply the product of the probabilities of the constituent income profile and health/longevity profile. This approach is very crude, of course, because morbidity (and mortality!) will change an individual's income. The practice of PPPA might commence using this approach; but certainly techniques should be developed to incorporate interactions between morbidity/mortality and income in predicting individual longevity-health-income histories and population profiles of these histories. Existing work on health equity in the "social gradient" tradition may be helpful here. Much of this work documents correlations between income and health/longevity [FN96] and could well be helpful in calibrating sophisticated composite life-cycle models that include both characteristics.

I have discussed techniques for characterizing population profiles with respect to individual health, longevity and income. Adding information about measurable social position, such as race and gender, should not pose a large challenge. Sophisticated models that estimate individual longevity-health-income histories might already include race and gender as one predictor of these attributes. [FN97] In any event, there is much existing information about the correlation of race and gender with income, health and longevity. [FN98]

2. The Well-Being Step: Identifying a Utility Function

PPPA requires a utility function U that maps each possible individual life history $L_{i,k}$ onto a lifetime utility number, thereby converting a population profile of life histories $O_k = (L_{1,k}, L_{2,k},...,L_{N,k})$ into a vector of lifetime utilities $(U(L_{1,k}),U(L_{2,k}),...,U(L_{N,k})) = (U_{1,k}, U_{,k},...,U_{,k}$»»»). Where does this utility function come from? Let us place to one side, for the moment, the difficult and controversial problem of incorporating measurable social position in ***35** the determination of utility. Consider the problem of specifying a utility function that assigns a lifetime utility number to each $L_{i,k}$ as a function of its income, health, and longevity attributes.

The best approach to specifying that function would involve surveys, where randomly selected members of the general public are placed in a favorable informational and deliberative state and are asked to rank different hypothetical longevity-health-income histories, and perhaps lotteries over these histories, with respect to well-being. Utility numbers, in turn, would be the numbers (unique up to some transformation) that represent respondents' well-informed preferences over the histories and lotteries. In previous work, I have discussed the use of utility surveys as a way to generate utility numbers that could improve the practice of CBA. [FN99] Here, I propose utility surveys as a way to generate the numbers that equity analysis would require.

Estimating utilities based on surveys inquiring about lifetime health-and-income histories is a less utopian enterprise than it may seem. Surveys are already widely employed to elicit information about individual well-being that is useful for policy analysis. [FN100] The three chief examples are "contingent valuation" surveys, which ask individuals about their WTP/WTA amounts for different policies; happiness surveys, which ask individuals to quantify their happiness or their satisfaction with their lives; and QALY surveys, which ask individuals to measure the quality of health states on a zero-to-one scale. The lifetime-health-and-income survey contemplated here is roughly analogous to a QALY survey, with two crucial differences. First, individuals should be asked to rank temporally extended histories rather than particular health states (which is what the QALY method focuses on). Second, individuals should be asked to rank histories that encompass both income and longevity/health.

Neither of these innovations represents a huge step beyond existing survey formats. As for the first, some survey work has already been done by public health researchers that departs from the standard QALY format and inquires about preferences over temporally extended health histories. [FN101] As ***36** for the second, contingent-valuation surveys that ask about WTP/WTA for health effects or mortality risks are routinely conducted, [FN102] and these surveys do require respondents to make tradeoffs between income and health or longevity. Indeed, the theoretical literature on contingent-valuation surveys often assumes that respondents answer with reference to a utility function. In the case of a survey asking about WTP/WTA for health effects, this means a utility function that takes both health and income as its arguments. In the case of a survey asking about WTP/WTA for mortality risks, this means a utility function that is sensitive to the length of time for which a respondent is alive and can enjoy her income.

What particular survey format should be used to determine the utility value of longevity-health-income histories? This is a matter for experimentation. One possibility builds on the "standard gamble" format, widely employed in eliciting QALY valuations. The QALY standard gamble asks the respondent to identify the indifference probability q, such that she is indifferent between living some given period of time in a health state h, and a lottery with probability q of living for that period of time in perfect health and 1-q of dying instantly. Similarly, one might use a lifetime standard gamble to determine lifetime utilities. Specify a nearly perfect longevity-health-income history (one hundred years in full health and a high income) and a perfectly awful one (one hundred years in a health state no better than death and a subsistence income). For a given life-history $L_{i,k}$, ask the respondent for the probability u that makes her indifferent between getting the life-history for sure and a lottery with probability u of the nearly perfect life history and probability 1-u of the perfectly awful one. Set $U(L_{i,k}) = u$.

The lifetime standard gamble format is theoretically appealing because a strong case can be made that the utility numbers emerging from this format would be the correct numbers to use as inputs into the social welfare function. [FN103] However, the format might prove cognitively overwhelming, and other formats should be experimented with. Along with the standard gamble, so-called "time tradeoff" questions are routinely employed in QALY surveys. Ann Holmes has experimented with the use of time tradeoff questions to elicit respondent preferences with respect to both health and non-health characteristics. [FN104]

Another possibility is to constrain the form of the utility function. Health economists often assume that the utility of health and consumption or ***37** income is additive across periods and multiplicative within periods. [FN105] In other words,

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where individual i lives for T periods in outcome O_k; $h_{i,t}$ is her health state in period t; $y_{i,t}$ is her income or consumption in period t; and $q(h_{,t}»»)$ and $v(y_{i,t})$ are "subutility" functions measuring the value of health and income/consumption, respectively, in each period. [FN106] Bleichrodt and Quiggin have shown that this functional form follows from a set of preference axioms. [FN107] I have argued that $U(L_{i,k})$ might take a different form. If different axioms are satisfied, $U(L_{i,k}) = Q(H_{i,k}) \times V(Y_{i,k})$, where $H_{i,k}$ is individual i's lifetime health history in outcome O_k and $Y_{i,k}$ is her lifetime income history. [FN108] Surveys might be conducted to test whether the preferences of well-informed individuals regarding longevity-health-income histories tend to satisfy either set of axioms. [FN109] If one axiom set is more or less satisfied, surveys designed to establish the parameters of the particular functional form $U(L_{i,\ k})$ grounded on that set can then be undertaken. Surveys of this sort would presumably be less cognitively demanding than lifetime standard gambles. For example, if

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then surveys regarding preferences for hypothetical health-and-income combinations during a period (not whole lifetime histories) would be needed to estimate the $q(h_{i,t})$ and $v(y_{i,t})$ functions.

The utility function U should, ideally, represent the convergent preferences of well-informed respondents contemplating hypothetical longevity-health-income histories. But what if survey respondents diverge in their answers? ***38** After all, interrater convergence in the case of existing QALY surveys is often not very high. [FN110] This important question raises large issues about interpersonal comparisons, incommensurability, and the meaning of utility numbers, which I have grappled with elsewhere and cannot address at length here. [FN111] A first-cut response is to stress that well conducted surveys should attempt to debias respondents and provide them with information. If divergence persists, median or average values should be used, as a reasonable estimate of what respondents under yet more ideal conditions would converge in preferring.

I have suggested that surveys asking respondents about their preferences over hypothetical longevity-health-income histories would be very helpful in calibrating the utility function U. But survey data of this sort does not yet exist. How should PPPA be undertaken in the interim? An initial possibility is to ignore health in the analysis. The appropriate form of the utility function in the case where it is conceptualized as a function of income (or consumption) alone has been discussed at length in various subfields of economics. A standard assumption is that the utility function has the "constant relative risk aversion" form $U(y) = y^{1-e}/(1-e)$, or log (y) where e = 1. [FN112] The British government, which now recommends distributive weighting in CBA, adopted this assumption in deriving recommended weights. [FN113] The parameter e can be estimated based on individual behavior as well as surveys, and substantial work of this sort has been undertaken. [FN114] One review of this literature concludes that policymakers should use a range of 0.7 to 1.5 for the value of e; [FN115] another suggests a broader range, namely 0.5 to 4.0. [FN116] ***39** Using this constant-relative-risk-aversion function, utility would be assigned to a life-history as

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that is, by adding up the individual's income utility in all periods until she dies.

It should also be possible to employ existing data from health contingent-valuation surveys to estimate the shape of U, particularly if

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in accordance with the Bleichrodt and Quiggin axioms. The amount of money that an individual is willing to accept to move from one health state to a worse state (her WTA for that move), or the amount of money that she is willing to pay to move from one health state to a better state (her WTP amount), depends on the marginal utility of income in the two states. From WTP/WTA data, then, we can estimate the marginal utility of income in different health states, and thus the shape of the function $q(h_{i,t})$. By assuming further that the function $v(y_{i,t})$ is the constant relative risk aversion form with risk aversion parameter e, we have concrete specifications for both the q and v functions and can apply these to a given $L_{i,k}$ to calculate $U(L_{i,k})$. Viscusi and Evans have undertaken pioneering work that employs WTP/WTA data to estimate the marginal utility of income in different health states, [FN117] and more work of this kind would be very useful in estimating U for purposes of PPPA.

Finally, what about social position? Socioeconomic status automatically enters into PPPA, even without separate attention to social position, since an individual's life-history includes information about her income. Insofar as PPPA employs an SWF that is equity-regarding rather than utilitarian, or a utility function with diminishing marginal income utility, PPPA will automatically be sensitive to the distribution of income. It is not, however, automatically sensitive to the racial or gender characteristics of those who benefit or are harmed by policies. Should it be?

Incorporating social position as a determinant of individual lifetime utility--as a separate element of an individual's life-history--is a double-edged sword. On the one hand, this adjustment means that low-status individuals have stronger redistributive claims. Redistributing a unit of lifetime utility from a high- to a low-status individual with identical income, longevity, and health characteristics increases the value of an equity-regarding ***40** SWF, but would not do so if social position were ignored. On the other hand, incorporating social position may mean that income, longevity, and health have greater marginal utility when possessed by high-status rather than low-status individuals. Imagine that lifetime utility is of the form

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where s_i is a positive number that measures status, increasing as status increases. Then a given increment in health or income in some period has a greater effect on lifetime utility for a high-status individual, as does a given extension of longevity. A utilitarian SWF would, therefore, end up shifting health, longevity, and income to higher-status individuals. An equity-regarding SWF could also do so, depending on how it balanced distributive considerations with overall well-being. Further, the degree to which race and gender currently correspond to lower-status social positions is a complicated and controversial question.

For these reasons, incorporating social position as a separate determinant of individual lifetime utility will be politically controversial, and agencies (and even academics) undertaking PPPA may hesitate to do so. Bracketing political constraints, social position should be incorporated in life histories as a separate determinant of individual lifetime utility. The double-edged impact of social position on welfarist analysis, described in the preceding paragraph, does not--to my mind--show the contrary. [FN118] But the best is the enemy of the good, and it is certainly possible to structure PPPA so that race and gender information is (1) wholly ignored, or (2) employed only at the predictive stage, to improve estimates of the probability of different population profiles, which are described as combinations of individual longevity-health-income histories rather than individual longevity-health-income-social position histories.

3. The Social Welfare Step: Identifying an SWF

The final step of PPPA is applying an equity-regarding SWF, or family of SWFs, to the probabilistic population profile in the status quo and resulting from each policy. This may seem like a hopeless task. There are countless functions from utility vectors to social welfare numbers that satisfy the Pigou-Dalton principle and therefore count as equity-regarding. How does the PPPA analyst know which one(s) to use?

This problem is more tractable than it may seem at first glance. The academic scholarship that has actually employed SWFs to study concrete ***41** policy questions often uses the so-called Atkinsonian family of SWFs. [FN119] This family has the form

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where y is the so-called inequality-aversion parameter and y>= 0, y 1.

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[FN120]

The set of SWFs comprised of SWFs within the Atkinsonian family and increasing transforms thereof [FN121] are the only SWFs that satisfy two plausible axioms in addition to the basic Pigou-Dalton axiom: separability and ratio-rescaling-invariance. [FN122] Separability means that the particular utility level of ***42** an individual who has the same utility in two outcomes being compared is irrelevant to the SWF's rankings of those outcomes. This axiom is a formal expression of the philosophical position known as "prioritarianism," which many philosophers of equality now adopt. [FN123] Ratio-rescaling-invariance means that the ranking of utility vectors should not change if we multiply all utilities by a common positive constant. In other words, if W assigns a greater value to $(U_1, U_2, \ldots, U_N)$ than to (U*, U» »*,»*,» .» . .,U_N*), then it must assign a greater value to $(kU_1, kU_2, \ldots, kU_N)$ than to $(kU_1^*, kU_2^*, \ldots, kU_N^*)$. Ratio-rescaling-invariance is very plausible, since welfarist theory currently provides no basis for thinking that there are genuine, measurable, and morally significant aspects of individual well-being which are captured by some vector of utility numbers representing a given outcome but lost if we multiply everyone's utility by a common positive constant. [FN124]

To be sure, the Atkinsonian SWFs are an entire family of SWFs, parameterized by the inequality-aversion parameter y. At one extreme, with y= 0, the Atkinsonian SWF becomes the utilitarian SWF. At the other extreme, with y = >>>, the Atkinsonian SWF becomes the "leximin" social ordering, which gives absolute priority to improving the well-being of worse-off individuals. [FN125] So which value of y should be used?

***43** A first cut at this problem is to use the entire range of values of y. [FN126] This might be illuminating. Larger values of ytranslate into a stronger social preference for equality. [FN127] If PPPA using the Atkinsonian family prefers one policy to another for all values of y, or for all values below a high value of y, or for all values above a low value of y, then the first policy is probably the best policy, all things considered. Conversely, if PPPA's ranking of the two policies is sensitive to the choice of y, then the case for one or the other policy is unclear.

A second cut at this problem is to isolate some range of values of yas particularly plausible through normative analysis, surveys, or reverse engineering. A given value of yhas policy implications. Normative analysis, in the standard reflective equilibrium mode, means making these policy implications explicit and deciding whether the analyst finds them intuitively acceptable or unacceptable. Atkinson long ago suggested a "leaky bucket" thought experiment for specifying a social welfare function, [FN128] and a number of other authors have since seconded his suggestion. [FN129] Leaky-bucket thought experiments have different variants, [FN130] the simplest being as follows. Imagine that one individual h is at well-being level U_h, and a second, less well-off individual l is at well-being level U_l. A policy reduces the first individual's well-being by a små amount, u, and improves the second's by du, with d less than or equal to 1. If d is equal to 1, then anyone but the utilitarian will count the policy as an improvement. Imagine decreasing the value of d from 1. At what value of d do you think that the policy and the status quo are equally good? Your answer fixes a value of y.

A different sort of thought experiment asks about sacrifices to overall well-being for the sake of equalizing well-being. [FN131] Specify an unequal population distribution of well-being, (U_1, . . .,U_N), and identify the level of ***44** well-being U^+ such that the initial distribution and the distribution (U^+, U^+, . . ., U^+) are equally good. The level U^+ fixes a value for y. [FN132]

Normative analysis to specify a value of yis no more "indeterminate" or "subjective" than normative philosophical scholarship generally, and should be undertaken by scholars, whether philosophers or welfare economists. A different tack is to conduct a "policy survey"--in effect, to invite the public to engage in normative analysis. "Policy surveys" invite respondents to evaluate policies, not from the stand-point of their own well-being, but from a more disinterested perspective. [FN133] Much survey work of this sort has been undertaken, including surveys about health and risk policy. [FN134] Some economists have in fact used policy surveys to estimate the degree of inequality-aversion of an Atkinsonian SWF: Amiel asks a leaky-bucket question, Lindholm an equalization question. [FN135]

Finally, "reverse engineering" the value of ymeans establishing that value implied by existing policies--for example, existing tax-and-transfer policies. [FN136]

Although the case for limiting PPPA analysis to Atkinsonian SWFs should be very persuasive to those who hold a "prioritarian" understanding of equality-- who accept the separability axiom--it will be less persuasive to non-prioritarians. The debate between prioritarians and nonprioritarians continues apace in the philosophical literature, with no clear winner. [FN137] Ideally, then, SWF analysis should test policies using both Atkinsonian SWFs and a plausible nonprioritarian SWF. One appealing possibility is to use the rank-weighted SWF. Take a utility vector $(U_1, ..., U_N)$. Set W equal to a sum consisting of N times the smallest utility in this vector, plus (N-1) times the next-smallest utility, plus (N-2) times the third-smallest utility, and so forth, up to 1 times the largest utility. This rank-weighted SWF satisfies the Pigou-Dalton principle, is ratio-rescaling-invariant, and (as it happens) generates***45** the Gini coefficient as the corresponding measure of inequality, [FN138] but it does not satisfy the separability principle. A utility transfer from a high-utility to a low-utility individual increases social value (thus the Pigou-Dalton principle is satisfied); but the size of the increase depends on the ranks of the two individuals in the whole population distribution, not their utility levels taken alone.

C. PPPA, Cost-Benefit Analysis, and Equality Measurement

PPPA produces an integrated assessment of policies, sensitive to both overall well-being and equity. Equity-regarding SWFs such as the Atkinsonian SWFs or the rank-weighted SWF are sensitive to equity because they satisfy the Pigou-Dalton axiom. [FN139] At the same time, they are sensitive to overall well-being in that (1) Pareto superior outcomes are always preferred [FN140] and more generally (2) holding constant the degree of inequality, an equity-regarding SWF will prefer the outcome with greater total utility. [FN141]

These observations raise the question of how PPPA relates to cost-benefit analysis (CBA), on the one hand, and inequality measurement, on the other. Eric Posner and I have defended CBA as a proxy for overall well-being. [FN142] PPPA is more flexible than CBA. PPPA can yield a verdict about overall well-being, by inserting a utilitarian SWF into the format. Yet, as just explained, PPPA (unlike CBA) can yield a judgment about whether the policy is better than the status quo on balance, given both overall-well-being and equity concerns. This occurs automatically when PPPA employs an equity-regarding rather than utilitarian SWF.

***46** At some point PPPA might displace CBA. But that is not the proposal here. CBA is widely employed by agencies, and its techniques are now highly developed. PPPA is novel and untested. My proposal, therefore, is that agencies and policy analysts employ PPPA in conjunction with CBA. If both CBA and PPPA favor one policy over a second, then the case for the first policy is strong. If CBA favors the first policy but PPPA favors the second, then it would appear that overall well-being favors the first policy but that the overall balance of moral considerations-- overall well-being plus equity-- favors the second. The case for the first policy is weaker; the case for the second policy is stronger, although not yet necessarily clear, because PPPA itself is an experimental procedure. In this event, it may be appropriate for the agency to undertake a more intensive CBA or PPPA, or perhaps to elicit guidance from Congress or the President.

What about the connection between PPPA and inequality measurement? PPPA yields an integrated assessment of policies, but agencies may find it useful to ascertain how policies compare purely as a matter of equality. PPPA readily yields that sort of evaluation. Economists of inequality have developed the important insight that any equity-regarding SWF generates a corresponding inequality metric. For a given social welfare function W, there is a corresponding inequality metric M^W, which ranges from zero (no inequality) to 1 (maximal inequality), defined as follows. For any utility vector $(U_1, U_2, ..., U_N)$, identify U^+ such that $W(U_1, U_2, ..., U_N) = W(U^+, U^+, ..., U^+)$. In other words, a perfectly equal outcome in which every individual receives the same amount of utility, U^+, has the same W-value as the initial vector. Then

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The denominator of the

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fraction is the total well-being associated with the initial vector; the numerator is the amount of total well-being which, if equally distributed, would have the same W-value as the initial vector. The smaller this fraction is, the larger the fraction of the total well-being associated with the initial vector that could be lost in an equalizing redistribution while still holding social welfare constant, and thus the larger the degree of inequality. [FN143]

With this insight, PPPA can be straightforwardly adapted to provide a judgment about the change in expected inequality produced by a policy. The status quo is a probability distribution across lifetime utility vectors; the policy is a different distribution. For each possible status quo vector, we determine its inequality as measured by M^W. The expected status quo inequality ***47** is simply the sum of each vector's inequality, discounted by its probability. The same series of calculations yields the expected degree of inequality for the policy.

Conclusion

This Article presents a novel approach to considering the equity impacts of risk regulation policies. This approach, "probabilistic population profile analysis" (PPPA), is rooted in the SWF view of social choice--specifically, in a particular version of the SWF approach for which I have provided a full philosophical defense elsewhere, one that focuses on lifetime well-being and that adopts an ex post rather than ex ante view of choice under uncertainty. From this perspective, PPPA is a large improvement on existing approaches to risk equity, described in Part I. PPPA adopts a population-wide approach to equity, unlike the social gradient view adopted by environmental justice scholars. It attends to the impact of both income and health/longevity on individuals' (lifetime) well-being. (By contrast, "individual risk" tests focus solely on longevity; QALY analysis handles income impacts imperfectly; and incidence analysis handles health/longevity impacts imperfectly.) PPPA addresses uncertainty in an ex post manner, unlike "individual risk" tests or CBA using the VSL method. And PPPA is sensitive to both overall well-being and the distribution of well-being, unlike inequality metrics or incidence analysis (or, for that matter, "individual risk" tests or the disparate-impact tests employed in the environmental justice literature).

Nor is PPPA a utopian project. The SWF approach has already been employed to study tax policies and, in a few cases, environmental policies. Part II describes in detail how PPPA would be implemented. It discusses both the information that would be needed to bring the approach to full fruition (such as surveys to calibrate utility functions, and more survey work to calibrate the SWF), as well as the steps that policymakers can take in the interim.

Only utilitarians believe that policy choice should be solely a function of overall well-being. Only utilitarians, then, should be comfortable with the current state of policy analysis, as practiced by governmental agencies and supported by the existing scholarly literature. Cost-benefit analysis, which is a workable measure of overall well-being, [FN144] is now very highly developed and widely employed by agencies. Equity analysis garners much less scholarly attention and is rarely used in government. We need to develop implementable and philosophically well-grounded tools for evaluating the equity impacts of policies. PPPA is one such tool and, I believe, a particularly promising one.

[FNa1]. Leon Meltzer Professor of Law, University of Pennsylvania Law School. Thanks to Scott Farrow, Adam Finkel, John

Graham, James Hammitt, Olof Johansson-Stenman, Daniel Markovits, Andrew Oswald, Eric Posner, Chris Sanchirico, Cass Sunstein, and Jonathan Wiener, for very helpful comments.

[FN1]. For citations to the scholarly literature on risk assessment, and to descriptions of the use of risk assessment by governmental bodies, see Matthew D. Adler, Against "Individual Risk": A Sympathetic Critique of Risk Assessment, 153 U. Pa. L. Rev. 1121, 1128-29 nn.28-29 (2005) [hereinafter Adler, Against "Individual Risk"]. On cost-benefit scholarship, see, for example, A. Myrick Freeman III, The Measurement of Environmental and Resource Values (2d ed. 2003). On the use of cost-benefit analysis in the federal government, see generally Matthew D. Adler & Eric A. Posner, New Foundations of Cost-Benefit Analysis 1-4, 101-23 (2006), and sources cited therein.

[FN2]. Exec. Order No. 12,866 § 1(a), 58 Fed. Reg. 51,735, 51,735 (Oct. 4, 1993). The recent amendments to Executive Order 12,866, by Executive Order 13,422, do not change the substantive requirements imposed on agency rules by Executive Order 12,866 and, in particular, do not change its content regarding "distributive impacts" and "equity." Exec. Order. No. 13,422, 72 Fed. Reg. 2763 (Jan. 23, 2007).

[FN3]. See Circular A-4, Off. Mgmt. & Budget (Sept. 17, 2003), available at http://www.whitehouse.gov/omb/circulars/a004/a-4.pdf.

[FN4]. Exec. Order No. 12,898 § 1-101, 59 Fed. Reg. 7629, 7629 (Feb. 11, 1994).

[FN5]. Id.

[FN6]. A number of these empirical studies are cited in William Bowen, An Analytical Review of Environmental Justice Research: What Do We Really Know?, 29 Envtl. Mgmt. 3, 13-15 (2002) and in Evan J. Ringquist, Assessing Evidence of Environmental Inequities: A Meta-Analysis, 24 J. Pol'y Anal. & Mgmt. 223, 245-47 (2005). Other scholarship about environmental justice is cited or excerpted in Clifford Rechtschaffen & Eileen Gauna, Environmental Justice: Law, Policy, and Regulation (2002); Sheila R. Foster, Meeting the Environmental Justice Challenge: Evolving Norms in Environmental Decisionmaking, 30 Envtl L. Rep. 10992 (2000); and Robert Kuehn, A Taxonomy of Environmental Justice, 30 Envtl. L. Rep. 10681 (2000).

[FN7]. On environmental justice tools, see, for example, EPA, Science Advisory Board: Review of Disproportionate Impact Methodologies (1998); Feng Liu, Environmental Justice Analysis: Theories, Methods, and Practice (2001); Transportation Research Board of the Nat'l Academies, Effective Methods for Environmental Justice Assessment (2004). As discussed below, there are close parallels between the environmental justice and health equity literatures, see infra text accompanying notes 15-19; and that latter literature has developed a variety of metrics for quantifying social skews in health. See, e.g., Johan P. Mackenbach & Anton E. Kunst, Measuring the Magnitude of Socio-economic Inequalities in Health: An Overview of Available Measures Illustrated with Two Examples from Europe, 44 Soc. Sci. Med. 757 (1997).

[FN8]. For a critical review of environmental justice policy at EPA, see EPA, Office of the Inspector General, EPA Needs to Consistently Implement the Intent of the Executive Order on Environmental Justice, Report No. 2004-P-00007 (2004). See also Richard J. Lazarus & Stephanie Tai, Integrating Environmental Justice into EPA Permitting Authority, 26 Ecology L.Q. 617 (1999); Bradford C. Mank, The Draft Title VI Recipient and Revised Investigation Guidances: Too Much Discretion for EPA and a More Difficult Standard for Complaints?, 30 Envtl. L. Rep. 11144 (2000) [hereinafter Mank, The Draft Title VI Recipient]; Bradford C. Mank, Executive Order 12,898, in The Law of Environmental Justice 107-14, 125-29 (Michael B. Gerrard ed., 1999) [hereinafter Mank, Executive Order 12,898]. On environmental justice policy at other federal agencies, see Denis Binder et al., A Survey of

Federal Agency Response to President Clinton's Executive Order No. 12898 on Environmental Justice, 31 Envtl. L. Rep. 11133 (2001); Mank, Executive Order 12,898, supra, at 114-23, 129-31.

[FN9]. On risk assessment at EPA, see, e.g., Adler, Against "Individual Risk," supra note 1, at 1149-64; id. at 1148 n.91 (citing sources). On cost-benefit analysis, see, for example, Economic Analyses at EPA (Richard D. Morgenstern ed., 1997).

[FN10]. See EPA, Office of the Inspector General, supra note 8, at 19-26 (discussing differing approaches to identifying disparate impacts on low-income and minority communities employed by EPA regional offices and EPA's failure to establish a single approach). EPA's guidance on incorporating distributional concerns into cost-benefit analysis is lengthier than OMB's in Circular A-4, see supra note 3; but it still fails to recommend specific policy metrics for quantifying the degree of distributional skew or balancing distributive concerns with efficiency/overall welfare. See EPA, Guidelines for Preparing Economic Analyses 139-74 (2000).

[FN11]. See infra Part I.C.

[FN12]. See infra Parts I.D, I.F.

[FN13]. See infra Part I.B.

[FN14]. For non-economists, what this formula means is that we assign the individual's health state and income state in each period a value. We next multiply these two numbers, arriving at a total value for each period. These period values are then summed to determine lifetime utility.

[FN15]. On this conception within the environmental justice literature, see, e.g., Kuehn, supra note 6, at 10683-84. The recent EPA Inspector General report claims that EPA itself is resistant to the social-gradient conception of risk equity. See EPA, Office of the Inspector General, supra note 8, at 10-11. EPA, however, has officially adopted this conception in various documents. See, e.g., EPA, EPA Guidance for Consideration of Environmental Justice in Clean Air Act Section 309 Reviews (1999); Mank, The Draft Title VI Recipient, supra note 8, at §1.3.

[FN16]. Scott Farrow has proposed a related approach to equity--namely that a policy not only pass the test of Kaldor-Hicks efficiency, but that actual compensation be provided to members of a "sensitive group," such as low-income or minority groups. Scott Farrow, Environmental Equity and Sustainability: Rejecting the Kaldor-Hicks Criteria, 27 Ecological Econ. 183, 185-86 (1998). This proposal, like the disparate-impact tests considered in the text, is vulnerable to the objection that it ignores inequalities among individuals who do not belong to the "sensitive group."

[FN17]. See Washington v. Davis, 426 U.S. 229 (1976).

[FN18]. See, e.g., 42 U.S.C. 2000e-2(k) (2006). I say "arguably" because it is plausible (although certainly not uncontroversial) to take the view that federal prohibitions on practices with a disparate impact are grounded in Congress's power to enforce the Equal Protection Clause, under Section 5 of the Fourteenth Amendment. See, e.g., Richard A. Primus, Equal Protection and Disparate Impact: Round Three, 117 Harv. L. Rev. 493, 494-95 & n.4 (2003).

[FN19]. See, e.g., Sudhir Anand, The Concern for Equity in Health, in Public Health, Ethics, and Equity 15, 19-20 (Sudhir Anand et al. eds., 2004); Paula Braveman, Health Disparities and Health Equity: Concepts and Measurement, 27 Ann. Rev. Pub. Health 167, 169-70 (2006); C.J.L. Murray et al., Health Inequalities and Social Group Differences: What Should We Measure?, 77 Bull. World Health Org. 537, 537-38 (1999); Adam Wagstaff & Eddy van Doorslaer, Overall Versus Socioeconomic Health Inequality: A Measurement Framework and Two Empirical Illustrations, 13 Health Econ. 297, 297 (2004); WHO Task Force on Research Priorities for Equity in Health & The WHO Equity Team, Priorities for Research to Take Forward the Health Equity Policy Agenda, 83 Bull. World Health Org. 948, 948 (2005).

[FN20]. See Liu, supra note 7, at 95-96; Transportation Research Board, supra note 7, at 19.

[FN21]. See supra sources cited in note 7.

[FN22]. Paula Braveman & Sofia Gruskin, Defining Equity in Health, 57 J. Epidemiology & Cmty. Health 254, 254 (2003) (emphasis removed). For a similar analysis, see Braveman, supra note 19, at 180-82.

[FN23]. See Braveman & Gruskin, supra note 22, at 256; Braveman, supra note 19, at 180-88.

[FN24]. Iris Marion Young, Equality of Whom? Social Groups and Judgments of Injustice, 9 J. Pol. Phil. 1, 7 (2001).

[FN25]. Id. at 8.

[FN26]. Id. at 16.

[FN27]. Id. at 15 (emphasis omitted).

[FN28]. Id. at 16.

[FN29]. Much of the recent philosophical literature on equality has tried to articulate a conception of equality that is sensitive to individual responsibility--a concern triggered by Ronald Dworkin's famous work on equality of resources, which distinguishes between “brute luck” and “option luck.” See, e.g., Richard J. Arneson, Welfare Should be the Currency of Justice, 30 Can. J. Phil. 497 (2000) (citing Ronald Dworkin, What is Equality? Part 1: Equality of Welfare, 10 Phil. & Pub. Aff. 189 (1981); Ronald Dworkin, What is Equality? Part 2: Equality of Resources, 10 Phil. & Pub. Aff. 283 (1981); Ronald Dworkin, What is Equality? Part 3: The Place of Liberty, 73 Iowa L. Rev. 1 (1987)).

[FN30]. See, e.g., Derek Parfit, Equality or Priority?, in The Ideal of Equality 81, 95-97 (Matthew Clayton & Andrew Williams eds., 2000) (discussing egalitarian views that do not object to natural inequality).

[FN31]. See Adler, Against “Individual Risk,” supra note 1, at 1149-79.

[FN32]. See id. at 1155-58.

[FN33]. More precisely, FDA takes this approach for carcinogens exempt from the Delaney Clause. See id. at 1164-69.

[FN34]. See id. at 1150-52.

[FN35]. See id. at 1169-71.

[FN36]. See id. at 1173-78.

[FN37]. See, e.g., Adam M. Finkel, Comparing Risks Thoughtfully, 7 Risk: Health, Safety & Env't 325, 342-44 (1996); John D. Graham, Making Sense of Risk: An Agenda for Congress, in Risks, Costs, and Lives Saved 183, 190-91 (Robert W. Hahn ed., 1996). See also Matthew D. Adler, Risk, Death and Harm: The Normative Foundations of Risk Regulation, 87 Minn. L. Rev. 1293, 1423-31 (2003) (discussing environmental-justice account that attends to skews with respect to "individual risk" levels).

[FN38]. For overviews of the literature on measuring the inequality of income, see Hilde Bojer, Distributional Justice: Theory and Measurement 63-134 (2003); Peter Lambert, The Distribution and Redistribution of Income 13-132 (3d ed. 2001); Amartya Sen, On Economic Inequality 24-46 (expanded ed. 1997); F.A. Cowell, Measurement of Inequality, in 1 Handbook of Income Distribution 87 (A.B. Atkinson & F. Bourguignon eds., 2000). As I explain in Part II of the Article, my position is that risk regulation policies should be evaluated with reference to an Atkinsonian social welfare function, which can in turn be decomposed into an Atkinsonian measure of inequality and overall welfare. See infra Part II.C.

[FN39]. Shortly before publication of this Article, I became aware of empirical work by Jonathan Levy and collaborators that does precisely this. See Jonathan I. Levy et al., Quantifying the Efficiency and Equity Implications of Power Plant Air Pollution Control Strategies in the United States, 115 Envtl. Health Persp. 743 (2007). The approach (which the authors see as applicable to health as well as mortality risks) is also described in Jonathan I. Levy et al., Incorporating Concepts of Inequality and Inequity into Health Benefits Analysis, 5 Int'l J. Equity in Health 2 (2006). Although I argue for a different approach here, Levy and his collaborators are to be commended for analyzing the equity implications of air pollution policies in a rigorous and novel way, focusing on population-wide inequality rather than social gradients, and applying inequality metrics developed in the income-inequality literature to risk regulation.

[FN40]. See W. Kip Viscusi, Risk Equity, in Cost-Benefit Analysis: Legal, Economic, and Philosophical Perspectives 7, 25-31 (Matthew D. Adler & Eric A. Posner eds., 2001) (criticizing conception of risk equity that focuses on incremental risk).

[FN41]. There are different ways to define the incremental fatality risk to person P from toxins of type X during period T: (1) the risk that X-type toxins cause P's death during T; (2) the difference in the risk that P dies during T, conditional on his exposure to X-type toxins, and the risk that P dies during T, conditional on non-exposure; and (3) the difference in the risk that P dies in the manner characteristic of deaths caused by X-type toxins (e.g., dies from cancer), conditional on his exposure to X-type toxins, and the risk that P dies in that manner conditional on non-exposure. If T is less than a full lifetime, all three definitions are possibilities. If T is a full lifetime, the first and third are. My critique of an approach to risk equity that focuses on incremental fatality risks does not depend on which precise definition of incremental risk is adopted.

[FN42]. See Matthew D. Adler, Well-Being, Inequality, and Time: The Time-Slice Problem and its Policy Implications (Univ. of Pa. Inst. for Law & Econ., Research Paper No. 07-17, 2007), available at http://ssrn.com/abstract=1006871; see also infra text accompanying note 82.

[FN43]. See Matthew D. Adler & Chris William Sanchirico, Inequality and Uncertainty: Theory and Legal Applications, 155 U. Pa. L. Rev. 279 (2006).

[FN44]. This particular variant of the "individual risk" approach is chosen simply for the sake of illustration. Other holistic variants of the "individual risk" approach also involve an ex ante conception of equality under uncertainty--for example, measuring the distribution of the risk of death during some time period other than a year, or measuring the distribution of the lifetime risk of death in a particular manner (e.g., cancer), or measuring the distribution of life expectancy.

[FN45]. See Adler & Sanchrico, supra note 43, at 304-34.

[FN46]. See id. at 334-50.

[FN47]. I use $l(h_{i,t})$ here, rather than $q(h_{i,t})$, as in the additive-across-periods/multiplicative-within-periods representation of lifetime utility as a function of health and income, see infra text accompanying notes 105-107, because it is an open question what the connection is between the l function, i.e., the zero-to-one scaling of health states elicited through QALY surveys, and the q function.

[FN48]. See generally Matthew D. Adler, QALYs and Policy Evaluation: A New Perspective, 6 Yale J. Health Pol'y L. & Ethics 1, 1-16 (2006) (describing QALY metric, discussing current governmental use, and reviewing and citing scholarship).

[FN49]. See generally Franco Sassi et al., Equity and the Economic Evaluation of Healthcare, 5 Health Tech. Assessment 1, 16-28 (2001) (summarizing this literature).

[FN50]. See Emmanuela Gakidou et al., Defining and Measuring Health Inequality: An Approach Based on the Distribution of Health Expectancy, 78 Bull. World Health Org. 42 (2000).

[FN51]. See, e.g., Paul Dolan, The Measurement of Individual Utility and Social Welfare, 17 J. Health Econ. 39 (1998); Lars Lindholm & Måns Rosén, On the Measurement of the Nation's Equity Adjusted Health, 7 Health Econ. 621 (1998); Lars Peter Osterdal, Axioms for Health Care Resource Allocation, 24 J. Health Econ. 679 (2005); Adam Wagstaff, QALYs and the Equity-Efficiency Trade-Off, 10 J. Health Econ. 21, 35-38 (1991); Alan Williams, Intergenerational Equity: An Exploration of the 'Fair Innings' Argument, 6 Health Econ. 117 (1997).

[FN52]. See Sassi, supra note 49, at 19-21.

[FN53]. See, e.g., Gakidou et al., supra note 50, at 43-44; Magnus Johannesson, Should We Aggregate Relative or Absolute

Changes in QALYs?, 10 Health Econ. 573, 574-75 (2001); Williams, supra note 51, at 120-21.

[FN54]. Namely, a policy might reduce the expected value of a given social welfare function taking individual lifetime QALYs as its arguments, but increase the expected value of that same social welfare function now taking individual utility as a function of individual longevity, health, and income as its arguments. This latter approach is just PPPA.

[FN55]. More precisely, the decision rule compares the incremental cost-effectiveness of policies with cutoff ratios. See Adler, supra note 48, at 8-9, 85-88.

[FN56]. See Don Fullerton & Diane Lim Rogers, Who Bears the Lifetime Tax Burden? 1-17 (1993).

[FN57]. See generally Ian W.H. Parry et al., The Incidence of Pollution Control Policies 10-19 (Resources for the Future, Discussion Paper 05-24, June 2005) (reviewing literature), available at http:// www.rff.org/rff/Documents/RFF-DP-05-24.pdf.

[FN58]. See id. at 5-6, 14.

[FN59]. See id. at 25.

[FN60]. See infra Part I.E.

[FN61]. See supra text accompanying note 50.

[FN62]. See infra Part II.B.2.

[FN63]. See Louis Kaplow, Why Measure Inequality? 5-6 (Harvard Law Sch. Olin Discussion Paper No. 386, 2002).

[FN64]. See infra Part II.C.

[FN65]. See Adler & Posner, supra note 1, at 1-5.

[FN66]. See Olof Johansson-Stenman, Distributional Weights in Cost-Benefit Analysis--Should We Forget About Them?, 81 Land Econ. 337 (2005).

[FN67]. See H.M. Treasury, The Green Book: Appraisal and Evaluation in Central Government 24-25, 91-96 (2003), available at http://www.hm-treasury.gov.uk/media/3/F/green_book_260907.pdf; Jean Drèze, Distribution Matters in Cost-Benefit Analysis: Comment on K.A. Brekke, 70 J. Pub. Econ. 485, 486 (1998).

[FN68]. These are the changes in annual income amounts in the policy outcome that make the individual indifferent between the status quo and the policy. Strictly speaking, these changes are not WTP/WTA amounts--since an individual's WTP/WTA is usually understood as a present, one-time payment sufficient to make her indifferent between the policy and the status quo. To calculate WTP/WTA amounts in this standard sense, we would need to know how long the individuals live and what the discount rate is. For simplicity, then, my example uses WTP/WTA defined as compensating changes to annual income. The point of the example--namely, that large changes in individual incomes pose difficulties for the specification of weights-- is unaffected by the choice of annual versus one-time compensation measures.

[FN69]. See Johansson-Stenman, supra note 66, at 337-38, 340-42; Parry, supra note 57, at 26-29. See also Liqun Liu, Combining Distributional Weights and the Marginal Cost of Funds: The Concept of Person-Specific Marginal Cost of Funds, 34 Pub. Fin. Rev. 60, 63-64 (2006) (discussing use of SWF to set the marginal cost of funds).

[FN70]. See Adler, Against “Individual Risk,” supra note 1, at 1197-98, 1198 n.300.

[FN71]. See also James K. Hammitt & Nicolas Treich, Statistical Versus Identified Lives in Benefit-Cost Analysis, 35 J. Risk & Uncertainty 45 (2005) (showing that CBA, using the VSL method, may deviate from a utilitarian SWF that maximizes the sum of expected utilities because that method is sensitive to information about the distribution of individual fatality risks that the utilitarian SWF would ignore).

[FN72]. I say that $w^L >= w^N$ to accommodate both the possibility that the weights for the exposed individuals are determined by their attributes in the status quo (in which case $w^L > w^N$) and the possibility that those weights are determined by their attributes with the policy (in which case $w^L = w^N$). However these weights are set, weighted CBA can deviate from an SWF applied in an ex post manner.

[FN73]. For that matter, a utilitarian SWF which is applied in an ex post or ex ante manner will treat the two cases as identical. From the ex post perspective, the two cases are identical; and a utilitarian SWF always reaches the same verdicts whether applied ex post or ex ante. See Adler and Sanchirico, supra note 43, at 307. Only a distributively-sensitive SWF applied in an ex ante manner might treat the two cases as different.

[FN74]. To be sure, this is only true if the amount and distribution of fear in the two cases are the same. See generally Matthew D. Adler, Fear Assessment: Cost-Benefit Analysis and the Pricing of Fear and Anxiety, 79 Chi-Kent L. Rev. 977 (2004). The hypothetical should therefore be structured so that no individual experiences a different fear state in the status quo in the first case than in the second case, and so that no individual experiences a different fear state with the policy in the first case than in the second case. In particular, it might be assumed that the exposed populations in the two cases are unaware of their exposures.

[FN75]. See Robin Boadway & Neil Bruce, Welfare Economics 137-69 (1984).

[FN76]. See Matti Tuomala, Optimal Income Tax and Redistribution 1-14 (1990); Nicholas Stern, The Theory of Optimal Commodity and Income Taxation: An Introduction, in The Theory of Taxation for Developing Countries 22 (David Newberry & Nicholas Stern eds., 1987).

[FN77]. See Parry et al., supra note 57, at 26-28. A recent article by Marc Fleurbaey addresses issues of health equity using the

SWF framework. See Marc Fleurbaey, Health Equity and Social Welfare, 83/84 Annales d'Economie et de Statistique 21 (2006). Unfortunately, I became aware of Fleurbaey's article as this Article was going to press and was not able to revise the Article to discuss how it bears on my analysis.

[FN78]. See Adler & Posner, supra note 1, at 25-39; Matthew D. Adler, Welfare Polls: A Synthesis, 81 N.Y.U. L. Rev. 1875, 1904-05, 1959-68 (2006).

[FN79]. By "outcome," I mean a set of possible worlds that is homogenous with respect to each individual's well-being. A possible world is a completely specified possible history of the universe. A different definition of outcome is also conceivable: one might just define an outcome as a single possible world and conceptualize SWFs as operating on utility vectors corresponding to each possible world. But this definition unnecessarily inflates the number of outcomes, since every possible world within each set of possible worlds homogeneous with respect to each individual's well-being would have the same utility vector.

[FN80]. See Adler & Sanchirico, supra note 43, at 296-304.

[FN81]. See infra Part II.B.3.

[FN82]. See Adler, supra note 42.

[FN83]. See Adler & Sanchirico, supra note 43.

[FN84]. Variable-population issues pose a difficult set of problems for social choice theory which I will not attempt to engage here. See generally Charles Blackorby et al., Population Issues in Social Choice Theory, Welfare Economics, and Ethics (2005). Extending PPPA to the variable-population case is a topic for further research.

[FN85]. To be sure, there is a burgeoning literature on the measurement of happiness, but I take it that data on the current population distribution of happiness, and on how policies perturb that, is still thinner than data on health and income. In any event, as mentioned immediately below, PPPA certainly could be modified to incorporate happiness data and have lifetime utilities be partly determined by happiness. Crucially, however, happiness is not the sole component of well-being. For citations to the happiness literature and a discussion of the connection between happiness and well-being, see Matthew D. Adler & Eric A. Posner, Happiness Research and Cost-Benefit Analysis (Univ. of Pa. Inst. for Law & Econ., Research Paper No. 07-15, 2007), available at http://ssrn.com/abstract=999928.

[FN86]. Our best-developed policy-analytic tools, such as CBA, provide rigorous guidance in choosing among a given set of options, not in identifying the initial choice set. See Matthew D. Adler, Rational Choice, Rational Agenda-Setting, and Constitutional Law: Does the Constitution Require Basic or Strengthened Public Rationality?, in Linking Politics and Law 109, 113-14 (Christoph Engel & Adrienne Héritier eds., 2003). PPPA is similar to CBA in this regard.

[FN87]. See EPA, Guidelines for Preparing Economic Analyses 126-30 (2000).

[FN88]. See id.; Parry, supra note 57; Klaus Conrad, Computable General Equilibrium Models in Environmental and Resource Economics, in The International Yearbook of Environmental and Resource Economics 2002/2003 66, 66 (Tom Tietenberg & Henk Folmer eds., 2002).

[FN89]. Fullerton & Rogers, supra note 56, at 4-5.

[FN90]. Another example of the use of simulation models to estimate policy effects on lifetime incomes is Jan H.M. Nelissen, Annual Versus Lifetime Income Redistribution by Social Security, 68 J. Pub. Econ. 223 (1998). Further examples are discussed id. at 224-25.

[FN91]. See generally Summary Measures of Population Health (Christopher J.L. Murray et al. eds., 2002).

[FN92]. See generally sources cited supra note 1.

[FN93]. See Michael Wolfson & Geoff Rowe, On Measuring Inequalities in Health, 79 Bull. World Health Org. 553, 557-58 (2001) (describing use of microsimulation modeling to estimate population health inequality and stating that existing modeling methods are "more than adequate").

[FN94]. On tobacco policy, see, for example, Sajjad Ahmad & John Billimek, Estimating the Health Impacts of Tobacco Harm Reduction Policies: A Simulation Modeling Approach, 25 Risk Anal. 801 (2005); Tammy O. Tengs et al., Federal Policy Mandating Safer Cigarettes: A Hypothetical Simulation of the Anticipated Population Health Gains or Losses, 23 J. Pol'y Anal. & Mgmt. 857 (2004) and sources cited therein. On cancer policy, see David Fone et al., Systematic Review of the Use and Value of Computer Simulation Modelling in Population Health and Health Care Delivery, 25 J. Pub. Health Med. 325, 332 (2003).

[FN95]. Tengs et al., supra note 94, at 860.

[FN96]. See, e.g., Tony Blakely & Nick Wilson, Shifting Dollars, Saving Lives: What Might Happen to Mortality Rates, and Socio-Economic Inequalities in Mortality Rates, if Income Was Redistibuted?, 62 Soc. Sci. Med. 2024, 2024-25 (2006); Braveman, supra note 19, at 169-70, 172; Ulf-G. Gerdtham & Magnus Johannesson, Income-Related Inequality in Life-Years and Quality-Adjusted Life-Years, 19 J. Health Econ. 1007, 1007-08 (2000). See also Angus Deaton, Health, Inequality, and Economic Development, 41 J. Econ. Lit. 113, 113-14 (2003) (discussing literature concerning connection between income inequality and health).

[FN97]. For example, the Tobacco Policy Model described above uses gender as one predictor of annual transitions. See Tengs et al., supra note 94, at 860.

[FN98]. See, e.g., Braveman, supra note 19, at 170-72; Peter Franks et al., The Burden of Disease Associated with Being African-American in the United States and the Contribution of Socio-Economic Status, 62 Soc. Sci. & Med. 2469, 2469-70 (2006).

[FN99]. See Adler, supra note 78, at 1965-68; Adler, supra note 48, at 53-57, 55 n.184.

[FN100]. See generally Adler, supra note 78.

[FN101]. See Adler, supra note 48, at 19-20, 47; Aki Tsuchiya & Paul Dolan, The QALY Model and Individual Preferences for Health States and Health Profiles over Time: A Systematic Review of the Literature, 25 Med. Decision Making 460 (2005). To be sure, surveys to elicit respondents' preferences regarding longevity-health-income histories must be designed to be feasible, given respondents' cognitive limitations. Respondents cannot be asked to evaluate every possible history. On this score, it should be noted that the proposal of some health scholars to use a survey format which would value health histories--the "healthy year equivalent" or "HYE" format--has been criticized as infeasible. See id. at 465-67. However, it is not clear why using surveys to assign values to temporally extended histories is qualitatively less feasible than using surveys to value momentary states, which is what the QALY format does. Just as it is impossible for a cognitively limited respondent to consider all possible histories, so it is impossible for her to consider all possible momentary states. QALY survey designers circumvent this difficulty in various ways. For example, they may use standardized "health state classification systems" to describe health states as a combination of locations on a discrete number of dimensions, and ask each respondent to value a sample of the total set of possible states, so as to estimate a function that maps each combination of locations along the dimensions to a QALY value. See, e.g., Adler, supra note 48, at 48-50. It is not clear why similar devices could not be used to elicit valuations of temporally extended histories.

[FN102]. See, e.g., Adler, supra note 48, at 40-41 n.133 (citing surveys of health-related contingent valuation studies).

[FN103]. In particular, Harsanyi's account of interpersonal comparisons, which reduces judgments of overall well-being to preferences over lotteries of possible life histories, provides a theoretical basis for the lifetime standard gamble. See Adler, supra note 48, at 17-24 (presenting Harsanyi's account).

[FN104]. See Ann M. Holmes, A Method to Elicit Utilities for Interpersonal Comparisons, 17 Med. Decision Making 10 (1997).

[FN105]. See James K. Hammitt, How Much is a QALY Worth? Admissible Utility Functions for Health and Wealth 2 (May 2002) (unpublished manuscript, on file with the Harvard Environmental Law Review).

[FN106]. Strictly, $h_{i,t}$ should be $h_{i,t,k}$ and $y_{i,t}$ should be $y_{i,t,k}$, but to avoid unwieldy symbols I have omitted the "k" subscript.

[FN107]. See Han Bleichrodt & John Quiggin, Life-Cycle Preferences over Consumption and Health: When Is Cost-Effectiveness Analysis Equivalent to Cost-Benefit Analysis?, 18 J. Health Econ. 681, 683-90 (1999).

[FN108]. See Adler, supra note 48, at 25-30. More precisely, $U(L_{i,k}) = Q(H_{i,k}) \times V(B_{i,k})$, where $B_{i,k}$ is the "background" or non-health characteristics of individual i in outcome O_k (such as income, social position, family relationships, or professional accomplishment). If PPPA ignores background characteristics other than income, then $Q(H_{i,k}) \times V(B$»») be»comes $Q(H^{i,k}) \times V(Y^{i,k})$.

[FN109]. Cf. William N. Evans & W. Kip Viscusi, Estimation of State-Dependent Utility Functions using Survey Data, 73 Rev. Econ. & Stat. 94 (1991) (using contingent-valuation surveys to estimate the structure of utility as a function of health and income); W. Kip Viscusi & William N. Evans, Utility Functions that Depend on Health Status: Estimates and Economic Implications, 80 Am. Econ. Rev. 353 (1990) (same); Beatrice Rey & Jean-Charles Rochet, Health and Wealth: How Do They Affect Individual

Preferences?, 29 Geneva Papers on Risk & Ins. Theory 43 (2004) (discussing possible test to discriminate between different health-and-wealth utility functions).

[FN110]. See, e.g., Paul Dolan et al., The Time Trade-Off Method: Results from a General Population Survey, 5 Health Econ. 141, 150 (1996).

[FN111]. See, e.g., Adler, supra note 48, at 21-22; Adler & Posner, supra note 1, at 49-50, 161-62, 161 n.28; Matthew D. Adler, Incommensurability and Cost-Benefit Analysis, 146 U. Pa. L. Rev. 1371, 1401-08 (1998).

[FN112]. See, e.g., Tuomala, supra note 76, at 47; Olof Johansson-Stenman, On the Value of Life in Rich and Poor Countries and Distributional Weights Beyond Utilitarianism, 17 Envtl. & Resource Econ. 299, 302-03 (2000); Christian Gollier, The Economics of Risk and Time 27 (2001).

[FN113]. See David J. Evans, The Elasticity of Marginal Utility of Consumption: Estimates for 20 OECD Countries, 26 Fiscal Studies 197, 200 (2005).

[FN114]. See Frank A. Cowell & Karen Gardiner, Welfare Weights 25-29 (STICERD, London School of Economics, 1999); Evans, supra note 113; David Pearce & David Ulph, A Social Discount Rate for the United Kingdom 9-15 (CSERGE Working Paper GEC 95-01, 1995). See also Louis Kaplow, The Value of a Statistical Life and the Coefficient of Relative Risk Aversion, 31 J. Risk & Uncertainty 23 (2005) (discussing high values of e estimated in literature on “equity premium,” and the inconsistency between those values and existing estimates of the income elasticity of the value of statistical life); Louis R. Eeckhoudt & James K. Hammitt, Background Risks and the Value of a Statistical Life, 23 J. Risk and Uncertainty 261, 276-77 (2001) (discussing relation between income elasticity of VSL and coefficient of relative risk aversion). For an interesting recent study that uses a Harsanyi-style veil of ignorance format to estimate e, see Olof Johansson-Stenman et al., Measuring Future Grandparents' Preferences for Equality and Relative Standing, 112 Econ. J. 362 (2002).

[FN115]. Pearce & Ulph, supra note 114, at 14-16. These authors focus on the range of e appropriate for policymaking in the United Kingdom.

[FN116]. Cowell & Gardiner, supra note 114, at 33. See also Johansson-Stenman et al., supra note 114, at 363 (noting that “values in the interval 0.5-2 [for relative risk aversion] are often referred to”).

[FN117]. See Viscusi & Evans, supra note 109, at 363-67. See also Frank A. Sloan et al., Alternative Approaches to Valuing Intangible Health Losses: The Evidence for Multiple Sclerosis, 17 J. Health Econ. 475, 478, 489-90 (1998).

[FN118]. As already mentioned, Ann Holmes has conducted surveys where respondents are asked to value hypothetical lives described both in terms of health and in terms of other characteristics. The additional characteristics include gender. See Holmes, supra note 104.

[FN119]. See Tuomala, supra note 76, at 28-29; Johansson-Stenman, supra note 112, at 302-03; Samuel Fankhauser et al., The Aggregation of Climate Change Damages: A Welfare Theoretic Approach, 10 Evntl. & Resource Econ. 249, 257 (1997). In some of this literature, the social welfare function is an Atkinsonian function that takes individual incomes rather than utilities as its arguments. See Parry et al., supra note 57, at 26-28; Louis Kaplow, Concavity of Utility, Concavity of Welfare, and Redistribution of Income 2 (Harvard L. Sch. Discussion Paper No. 437, 2003). Atkinsonian SWFs are also used in the health economics literature that discusses applying SWFs to QALYs. See sources cited supra note 51.

[FN120]. See, e.g., Bojer, supra note 38, at 110. The formula for the Atkinsonian SWF is sometimes multiplied by 1/N, where N is the population size. Where N is the same in all outcomes--as assumed throughout this Article, see supra text accompanying note 84--that formula is equivalent to the one given in the text, both in its ranking of utility vectors and in its ranking of policies. In the case where y= 1, the formula for the Atkinsonian SWF is sometimes given as the product of individuals' utilities rather than the sum of the logarithms of utilities. These formulations are increasing transformations of each other (see, e.g., Fankhauser, supra note 119, at 257-58) and therefore order utility vectors (but not necessarily policies) the same way. See infra note 121.

[FN121]. Take an Atkinsonian SWF

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with yspecified. Consider W*, which is an increasing transformation of W. (In other words, $W^*(U_1,U_2,...,U_N)$ = $g(W(U_1,U_2,...,U_N))$, where g is what's known as an "increasing" or "monotonically increasing" function, which means that the graph of g always slopes up). Because W* is an increasing transformation of W, W* and W order utility vectors the same way. However, W* and W applied in an ex post fashion to policies (probability distributions over utility vectors) may not order these policies the same way. This raises the difficult question, which I cannot address here, about how one identifies the appropriate transformation to use in PPPA, once one has specified y. That identification involves determining the degree to which policymakers should be risk averse in social welfare. As an initial matter, I suggest, PPPA should assume risk-neutrality in social welfare, i.e., simply use the Atkinsonian SWF itself rather than some nonlinear transformation. But the issue certainly deserves more exploration.

[FN122]. See Lambert, supra note 38, at 94-102; Anthony Atkinson, On the Measurement of Inequality, 2 J. Econ. Theory 244, 244-45, 249-52 (1970). It is important to note that the Atkinsonian family of SWFs is not attractive if individuals' lifetime utilities can be negative. With negative utilities, the function $U_i^{1-y}/(1-y)$ is either undefined or, if defined, is either decreasing or strictly convex. Therefore, the SWF will not satisfy both the Pareto principle and the Pigou-Dalton principle. Identifying an appropriate SWF that can allow for negative utilities is a difficult task that I will not attempt to resolve here. See Campbell Brown, Matters of Priority 192-197 (Mar. 2005) (unpublished Ph.D. thesis, The Australian National University) (on file with the Harvard Environmental Law Review) (proving that no SWF has the prioritarian form of summing an increasing, strictly concave function of individual utilities and has an unrestricted domain and is invariant to a ratio transformation); Amartya Sen, Social Choice Theory, in 3 Handbook of Mathematical Economics 1073, 1127 & n.74 (Kenneth J. Arrow & Michael D. Intriligator eds., 1986). As for utility vectors that include zeros, the Atkinsonian SWF will be defined only for y< 1.

[FN123]. See Adler & Sanchirico, supra note 43, at 300-02.

[FN124]. Harsanyi-style utility numbers, the expectations of which represent well-informed individuals' convergent preferences over lotteries of life histories, will be unique up to an affine transformation. It is a well-known feature of such "von-Neumann/ Morgenstern" utilities, meant to represent decisions under risk or uncertainty, that they are unique up to an affine transformation. In other words, given a utility function U which maps life histories onto utilities, such that the expected utility numbers calculated using these utilities accurately represent a well-informed individual's preferences over lotteries of those histories, we can multiply

U by a positive constant c and add a constant d. Expectations with respect to these new utilities will produce the very same ordering of lotteries as expectations with respect to the original utilities.

By taking a morally significant zero point--for example, a life no better than nonexistence--and giving it a utility of zero, we can narrow down the set of admissible utility functions. Consider a function U* that represents the well-informed individual's ordering of lotteries and assigns a value of zero to the zero point. Any admissible function will have to be produced by taking U* and multiplying it by a positive constant. However, that transformation remains admissible. Any new function produced by multiplying U* by a positive constant will still assign zero to the zero point, and expectations formed with respect to this new function will still order lotteries of life histories correctly.

To preclude multiplying utilities assigned to life histories by a positive constant, we would need to have morally significant information beyond (1) well-informed individuals' (convergent) ordering of life histories and lotteries of life histories, and (2) their (convergent) identification of the zero point. It is hard to see what that information would be.

[FN125]. See, e.g., Lambert, supra note 38, at 99-102; Kristof Bosmans, Extreme Inequality Aversion Without Separability, 32 Econ. Theory 589, 592 (2007).

[FN126]. See Fankhauser et al., supra note 119, at 257-59. Many studies use a smaller range of values of y, often in the context of an SWF that takes incomes rather than utilities as its arguments. See Lambert, supra note 38, at 129; Parry, supra note 57, at 28.

[FN127]. For any unequal distribution of utilities, there is an amount U^+ of utility which, if equally distributed, has the same social welfare value as the unequal distribution. That amount, U^+, is lower the greater the value of y. Also, for a given pair of individuals at utility levels High and Low, the ratio between the marginal social value of Low's utility and High's utility increases with y.

[FN128]. See Yoram Amiel et al., Measuring Attitudes Towards Inequality, 101 Scandinavian J. Econ. 83, 86-88 (1999) (discussing Atkinson's proposal).

[FN129]. See, e.g., Cowell & Gardiner, supra note 114, at 15-16; Pearce & Ulph, supra note 114, at 14-15; Stern, supra note 76, at 47-48. A closely related kind of question asks about the choice between benefiting some individual by a certain amount and a better-off individual by a greater amount. See Dolan, supra note 51, at 51-52.

[FN130]. Other variants could specify the two individuals' health, income and longevity positions and ask about leaky transfers of health, income or longevity. Given a utility function from longevity-health-income histories to utility, answers to these sorts of question will also fix or help fix a y.

[FN131]. See, e.g., Lindholm & Rosén, supra note 51; Williams, supra note 51.

[FN132]. It should be stressed that leaky-bucket and equalization thought experiments are only two particularly straightforward forms of normative reflection about the value of y. Any analysis of the implications of a given yfor some principle that the analyst endorses, or some scenario about which the analyst has intuitions, could be helpful in specifying y. See, e.g., Fankhauser et al., supra note 119, at 259-62 (identifying values of yconsistent with use of uniform per-unit global warming damages).

[FN133]. On the distinction between policy surveys and welfare polls, see Adler, supra note 78.

[FN134]. See, e.g., Paul Dolan et al., QALY Maximisation and People's Preferences: A Methodological Review of the Literature, 14 Health Econ. 197 (2005).

[FN135]. See Amiel et al., supra note 128, at 86; Lindholm & Rosén, supra note 51. For related survey work, see Ignacio Abasolo & Aki Tsuchiya, Exploring Social Welfare Functions and Violation of Monotonicity: An Example from Inequalities in Health, 23 J. Health Econ. 313 (2004); Louis Gevers et al., Professed Inequality Aversion and its Error Component, 81 Scandinavian J. Econ. 238 (1979); Herbert Glejser et al., An Econometric Study of the Variables Determining Inequality Aversion Among Students, 10 Eur. Econ. Rev. 173 (1977); Magnus Johannesson & Ulf-G. Gerdtham, A Note on the Estimation of the Equity-Efficiency Trade-off for QALYs, 15 J. Health Econ. 359 (1996); Magnus Johannesson & Ulf-G. Gerdtham, A Pilot Test of Using the Veil of Ignorance Approach to Estimate a Social Welfare Function for Income, 2 Applied Econ. Lett. 400 (1995).

[FN136]. See Lambert, supra note 38, at 129; Cowell & Gardiner, supra note 114, at 24-25.

[FN137]. See Adler & Sanchirco, supra note 43, at 296-302.

[FN138]. See Adler & Sanchirico, supra note 43, at 302. Actually, there are many different variations on the simple rank-weighted SWF described in the text. Consider any SWF which ranks utilities from lowest to highest, multiplies each by a positive weight which is a decreasing function of rank, and sums the weighted utilities. Any such SWF will be ratio-rescaling-invariant, satisfy the Pareto principle, and satisfy the Pigou-Dalton principle. So an equity analyst who is conducting a particularly full PPPA analysis might want to consider evaluating policies using different rank-weighted SWFs within this general family. See generally Blackorby et al., supra note 84, at 75-82, 99-100 (discussing rank-weighted family of SWFs).

[FN139]. See supra text accompanying notes 80-81.

[FN140]. Although it is possible to have “non-Paretian” SWFs--SWFs that sometimes fail to prefer a Pareto-superior outcome--the case for the Pareto principle is powerful, and it is certainly possible for SWFs to both satisfy the Pigou-Dalton principle and be Paretian. In particular, Atkinsonian SWFs and the rank-weighted SWF have both characteristics See Adler & Sanchirico, supra note 43, at 291-304; Blackorby et al., supra note 84, at 69-82.

[FN141]. The ordering of outcomes produced by a given equity-regarding SWF W is the same as that produced by assigning each utility vector a number equaling

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is total utility and M^W is an inequality measure generated by the SWF. See Marc Fleurbaey, Equality versus Priority: How Relevant is the Distinction?, in Fairness and Goodness in Health (Daniel Wikler et al. eds., World Health Organization) (forthcoming). Holding constant the degree of inequality, i.e., the value of M^W, outcomes with greater total utility are preferred.

[FN142]. See Adler & Posner, supra note 1.

[FN143]. See, e.g., Lambert, supra note 38, at 94-102; Sen, supra note 38, at 38-39; Bojer, supra note 38, at 108-11; Cowell, supra note 38, at 113-15.

[FN144]. See Adler & Posner, supra note 1.

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The White House

Office of the Press Secretary

For Immediate Release December 10, 2012

Remarks by the President at the Daimler Detroit Diesel Plant, Redford, MI

Daimler Detroit Diesel Plant
Redford, Michigan

2:29 P.M. EST

THE PRESIDENT: Hello, Redford! (Applause.) It is good to be back in Michigan. (Applause.) How is everybody doing today? (Applause.)

Now, let me just start off by saying we have something in common -- both our teams lost yesterday. (Laughter.) I mean, I would like to come here and talk a little smack about the Bears, but we didn't quite get it done. But it is wonderful to be back. It is good to see everybody in the great state of Michigan. (Applause.)

A few people I want to acknowledge -- first of all, the Mayor of Detroit here -- Dave Bing is in the house. (Applause.) We've got the Redford Supervisor -- Tracey Schultz Kobylarz. (Applause.) We've got some outstanding members of Congress who are here -- please give them a big round of applause. (Applause.)

I want to thank Martin for hosting us. I want to thank Jeff and Gibby for giving me a great tour of the factory. (Applause.) I've got to say I love coming to factories.

AUDIENCE MEMBER: I love you!

THE PRESIDENT: I love you. (Applause.)

So in addition to seeing the best workers in the world -- (applause) -- you've also got all this cool equipment. (Laughter.) I wanted to try out some of the equipment, but Secret Service wouldn't let me. (Laughter.) They said, you're going to drop something on your head, hurt yourself. (Laughter.) They were worried I'd mess something up. And Jeff and Gibby may not admit it, but I think they were pretty happy the Secret Service wouldn't let me touch the equipment. (Laughter.)

Now, it's been a little over a month since the election came to an end. (Applause.) So it's now safe for you to turn your televisions back on. (Laughter.) All those scary political ads are off the air. You can answer your phone again -- nobody is calling you in the middle of dinner asking for your support. But, look, I have to admit there's one part of the campaign that I miss, and that is it is a great excuse for me to get out of Washington and come to towns like this and talk to the people who work so hard every day and are looking out for their families and are in their communities, and just having a conversation about what kind of country do we want to be; what kind of country do we want to leave behind for our kids. Because ultimately, that's what this is about.

And I believe -- and I've been saying this not just for the last six months or the last year, but ever since I got into public office -- I believe America only succeeds and thrives when we've got a strong and growing middle class. (Applause.) That's what I believe. I believe we're at our best when everybody who works hard has a chance to get ahead; that they can get a job that pays the bills; that they've got health care that they can count on; that they can retire with dignity and respect, maybe take a vacation once in a while -- nothing fancy, just being able to pack up the kids and go someplace and enjoy time with people that you love; make sure that your kids can go to a good school; make sure they can aspire to whatever they want to be.

That idea is what built America. That's the idea that built Michigan. That's the idea that's at the heart of the economic plan I've been talking about all year long on the campaign trail. I want to give more Americans the chance to earn the skills that businesses are looking for right now, and give our kids the kind of education they need to succeed in the 21st century. I want to make sure America leads the world in research and technology and clean energy. I want to put people back to work rebuilding our roads and our bridges and our schools. (Applause.) That's how we grow an economy.

WATCH THE VIDEO

December 10, 2012 9:12 PM

President Obama Speaks on the Economy and Middle-Class Tax Cuts

BLOG POSTS ON THIS ISSUE

January 23, 2013 12:45 PM EST

Fireside Hangouts: Vice President Biden Joins a Conversation on Reducing Gun Violence

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January 23, 2013 10:40 AM EST

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January 21, 2013 3:26 PM EST

Be a Part of the Next Four Years

The President's second term will offer many ways

I want us to bring down our deficits, but I want to do it in a balanced, responsible way. And I want to reward -- I want a tax code that rewards businesses and manufacturers like Detroit Diesel right here, creating jobs right here in Redford, right here in Michigan, right here in the United States of America. (Applause.) That's where we need to go. That's the country we need to build. And when it comes to bringing manufacturing back to America -- that's why I'm here today.

Since 1938, Detroit Diesel has been turning out some of the best engines in the world. (Applause.) Over all those years, generations of Redford workers have walked through these doors. Not just to punch a clock. Not just to pick up a paycheck. Not just to build an engine. But to build a middle-class life for their families; to earn a shot at the American Dream.

For seven and a half decades, through good times and bad, through revolutions in technology that sent a lot of good jobs -- manufacturing jobs -- overseas, men and women like you, your parents, maybe even your grandparents, have done your part to build up America's manufacturing strength. That's something you can all be proud of. And now you're writing a new proud chapter to that history. Eight years ago, you started building axles here alongside the engines. That meant more work. That meant more jobs. (Applause.) So you started seeing products -- more products stamped with those three proud words: Made in America.
Today, Daimler is announcing a new $120 million investment into this plant, creating 115 good, new union jobs building transmissions and turbochargers right here in Redford -- (applause) -- 115 good new jobs right here in this plant, making things happen. That is great for the plant. It's great for this community. But it's also good for American manufacturing. Soon, you guys will be building all the key parts that go into powering a heavy-duty truck, all at the same facility. Nobody else in America is doing that. Nobody else in North America is doing that.

And by putting everything together in one place, under one roof, Daimler engineers can design each part so it works better with the others. That means greater fuel efficiency for your trucks. It means greater savings for your customers. That's a big deal. And it's just the latest example of Daimler's leadership on this issue.

Last year, I was proud to have your support when we announced the first-ever national fuel-efficiency standards for commercial trucks, which is going to help save consumers money and reduce our dependence on foreign oil. That's good news. (Applause.)

But here's the other reason why what you guys are doing, what Daimler is doing, is so important. For a long time, companies, they weren't always making those kinds of investments here in the United States. They weren't always investing in American workers. They certainly weren't willing to make them in the U.S. auto industry.

Remember, it was just a few years ago that our auto industry was on the verge of collapse. GM, Chrysler were all on the brink of failure. And if they failed, the suppliers and distributors that get their business from those companies, they would have died off, too. Even Ford could have gone down -- production halted. Factories shuttered. Once proud companies chopped up and sold off for scraps. And all of you -- the men and women who built these companies with your own hands -- would have been hung out to dry. And everybody in this community that depends on you -- restaurant owners, storekeepers, bartenders -- (laughter and applause) -- their livelihoods would have been at stake, too.

So I wasn't about to let that happen. I placed my bet on American workers. We bet on American ingenuity. I'd make that same bet any day of the week. (Applause.) Three and a half years later, that bet is paying off. This industry has added over a quarter of a million new jobs. Assembly lines are humming again. The American auto industry is back.

And companies like Daimler know you're still a smart bet. They could have made their investment somewhere else, but they didn't. And if you ask them whether it was a tough call, they'll tell you it wasn't even close. So the word is going out all around the world: If you want to find the best workers in the world, if you want to find the best factories in the world, if you want to build the best cars or trucks or any other product in the world, you should invest in the United States of America. This is the place to be. (Applause.)

See, you're starting to see the competitive balance is tipping a little bit. Over the past few years, it's become more expensive to do business in countries like China. Our workers have become even more productive. Our energy costs are starting to go down here in the United States. And we still have the largest market. So when you factor in everything, it makes sense to invest here, in America.

And that's one of the reasons why American manufacturing is growing at the fastest pace since the 1990s. And thanks in part to that boost in manufacturing, four years after the worst economic crisis of our lifetimes, our economy is growing again. Our businesses have created more than 5.5 million new jobs over the past 33 months. So we're making progress. (Applause.) We're moving in the right direction. We're going forward.

So what we need to do is simple. We need to keep going. We need to keep going forward. We should do everything we can to keep creating good middle-class jobs that help folks rebuild security for their families. (Applause.) And we should do everything we can to encourage companies like Daimler to keep investing in American workers.

And by the way, what we shouldn't do -- I just got to say this -- what we shouldn't be doing is trying to take away your rights to bargain for better wages and working conditions. (Applause.) We shouldn't be doing that. (Applause.) These so-called "right to work" laws, they don't have to do with economics; they have everything to do with politics. (Applause.) What they're really talking about is giving you the right to work for less money. (Applause.)

You only have to look to Michigan -- where workers were instrumental in reviving the auto industry -- to see how unions have helped build not just a stronger middle class but a stronger America. (Applause.) So folks from our state's capital, all the way to the nation's capital, they should be focused on the same thing. They should be working to make sure companies like this manufacturer is able to make more great products. That's what they should be focused on. (Applause.) We don't want a race to the bottom. We want a race to the top. (Applause.)

America is not going to compete based on low-skill, low-wage, no workers' rights. That's not our competitive advantage. There's always going to be some other country that can treat its workers even worse. Right?

AUDIENCE: Right!

THE PRESIDENT: What's going to make us succeed is we got the best workers -- well trained, reliable, productive, low turnover, healthy. That's what makes us strong. And it also is what allows our workers then to buy the products that we make because they got enough money in their pockets. (Applause.)

So we've got to get past this whole situation where we manufacture crises because of politics. That actually leads to less certainty, more conflict, and we can't all focus on coming together to grow.

AUDIENCE MEMBER: That's right!

THE PRESIDENT: And the same thing -- we're seeing the same thing in Washington. I'm sure you've all heard the talk recently about some big deadlines we're facing in a few weeks when it comes to decisions on jobs and investment and taxes. And that debate is going to have a big impact on all of you. Some of you may know this: If Congress doesn't act soon, meaning in the next few weeks, starting on January 1st, everybody is going to see their income taxes go up.

AUDIENCE: No!

THE PRESIDENT: It's true. You all don't like that.

AUDIENCE: No!

THE PRESIDENT: Typical, middle-class family of four will see an income tax hike of around $2,200. How many of you can afford to pay another $2,200 in taxes? Not you?

AUDIENCE: No!

THE PRESIDENT: I didn't think so. You can't afford to lose that money. That's a hit you can't afford to take. And, by the way, that's not a good hit for businesses, either -- because if Congress lets middle-class taxes go up, economists will tell you that means people will spend nearly $200 billion less than they otherwise would spend. Consumer spending is going to go down. That means you've got less customers. Businesses get fewer profits. They hire fewer workers. You go in a downward spiral. Wrong idea.

Here is the good news: We can solve this problem. All Congress needs to do is pass a law that would prevent a tax hike on the first $250,000 of everybody's income -- everybody. (Applause.) That means 98 percent of Americans -- and probably 100 percent of you -- (laughter) -- 97 percent of small businesses wouldn't see their income taxes go up a single dime. Even the wealthiest Americans would still get a tax cut on the first $250,000 of their income. But when they start making a million, or $10 million, or $20 million you can afford to pay a little bit more. (Applause.) You're not too strapped.

So Congress can do that right now. Everybody says they agree with it. Let's get it done. (Applause.)

So that's the bare minimum. That's the bare minimum we should be doing in order to the grow the economy. But we can do more. We can do more than just extend middle-class tax cuts. I've said I will work with Republicans on a plan for economic growth, job creation, and reducing our deficits. And that has some compromise between Democrats and Republicans. I understand people have a lot of different views. I'm willing to compromise a little bit.

But if we're serious about reducing our deficit, we've also got to be serious about investing in the things that help us grow and make the middle class strong, like education, and research and development, and making sure kids can go to college, and rebuilding our roads and our infrastructure. (Applause.) We've got to do that.

So when you put it all together, what you need is a package that keeps taxes where they are for middle-class families; we make some tough spending cuts on things that we don't need; and then we ask the wealthiest

Americans to pay a slightly higher tax rate. And that's a principle I won't compromise on, because I'm not going to have a situation where the wealthiest among us, including folks like me, get to keep all our tax breaks, and then we're asking students to pay higher student loans. Or suddenly, a school doesn't have schoolbooks because the school district couldn't afford it. Or some family that has a disabled kid isn't getting the help that they need through Medicaid.

We're not going to do that. We're not going to make that tradeoff. That's not going to help us to grow. Our economic success has never come from the top down; it comes from the middle out. It comes from the bottom up. (Applause.) It comes from folks like you working hard, and if you're working hard and you're successful, then you become customers and everybody does well.

Our success as a country in this new century will be defined by how well we educate our kids, how well we train our workers, how well we invent, how well we innovate, how well we build things like cars and engines -- all the things that helped create the greatest middle class the world has ever known. That's how you bring new jobs back to Detroit. That's how you bring good jobs back to America. That's what I'm focused on. That's what I will stay relentlessly focused on going forward. (Applause.)

Because when we focus on these things –- when we stay true to ourselves and our history, there's nothing we can't do. (Applause.) And if you don't believe me, you need to come down to this plant and see all these outstanding workers.

In fact, as I was coming over here, I was hearing about a guy named Willie. (Applause.) Where's Willie? There's Willie right here. There's Willie. (Applause.) Now, in case you haven't heard of him, they actually call him "Pretty Willie." (Laughter.) Now, I got to say you got to be pretty tough to have a nickname like "Pretty Willie." (Laughter.) He's tough.

On Wednesday, Willie will celebrate 60 years working at Detroit Diesel -- 60 years. (Applause.) Willie started back on December 12, 1952. I was not born yet. (Laughter.) Wasn't even close to being born. He made $1.40 an hour. The only time he spent away from this plant was when he was serving our country in the Korean War. (Applause.) So three generations of Willie's family have passed through Detroit Diesel. One of his daughters works here with him right now -- is that right? There she is. (Applause.)

In all his years, Willie has been late to work only once. It was back in 1977. (Laughter.) It's been so long he can't remember why he was late -- (laughter and applause) -- but we're willing to give him a pass.

So Willie believes in hard work. You don't keep a job for 60 years if you don't work hard. Sooner or later, someone is going to fire you if you don't work hard. He takes pride in being part of something bigger than himself. He's committed to family; he's committed to community; he's committed to country. That's how Willie lives his life. That's how all of you live your lives.

And that makes me hopeful about the future, because you're out there fighting every day for a better future for your family and your country. And when you do that, that means you're creating value all across this economy. You're inspiring people. You're being a good example for your kids. That's what makes America great. That's what we have to stay focused on.

And as long as I've got the privilege of serving as your President, I'm going to keep fighting for you. I'm going to keep fighting for your kids. I'm going to keep fighting for an America where anybody, no matter who you are, no matter what you look like, no matter where you come from, you can make it if you try here in America. (Applause.)

Thank you very much, everybody. God bless you. (Applause.)

END
2:51 P.M. EST

Remarks of President Barack Obama – As Prepared for Delivery
Address to Joint Session of Congress
Tuesday, February 24th, 2009

(en español)

Madame Speaker, Mr. Vice President, Members of Congress, and the First Lady of the United States:

I've come here tonight not only to address the distinguished men and women in this great chamber, but to speak frankly and directly to the men and women who sent us here.

I know that for many Americans watching right now, the state of our economy is a concern that rises above all others. And rightly so. If you haven't been personally affected by this recession, you probably know someone who has – a friend; a neighbor; a member of your family. You don't need to hear another list of statistics to know that our economy is in crisis, because you live it every day. It's the worry you wake up with and the source of sleepless nights. It's the job you thought you'd retire from but now have lost; the business you built your dreams upon that's now hanging by a thread; the college acceptance letter your child had to put back in the envelope. The impact of this recession is real, and it is everywhere.

But while our economy may be weakened and our confidence shaken; though we are living through difficult and uncertain times, tonight I want every American to know this:

We will rebuild, we will recover, and the United States of America will emerge stronger than before.

The weight of this crisis will not determine the destiny of this nation. The answers to our problems don't lie beyond our reach. They exist in our laboratories and universities; in our fields and our factories; in the imaginations of our entrepreneurs and the pride of the hardest-working people on Earth. Those qualities that have made America the greatest force of progress and prosperity in human history we still possess in ample measure. What is required now is for this country to pull together, confront boldly the challenges we face, and take responsibility for our future once more.

Now, if we're honest with ourselves, we'll admit that for too long, we have not always met these responsibilities – as a government or as a people. I say this not to lay blame or look backwards, but because it is only by understanding how we arrived at this moment that we'll be able to lift ourselves out of this predicament.

The fact is, our economy did not fall into decline overnight. Nor did all of our problems begin when the housing market collapsed or the stock market sank. We have known for decades that our survival depends on finding new sources of energy. Yet we import more oil today than ever before. The cost of health care eats up more and more of our savings each year, yet we keep delaying reform. Our children will compete for jobs in a global economy that too many of our schools do not prepare them for. And though all these challenges went unsolved, we still managed to spend more money and pile up more debt, both as individuals and through our government, than ever before.

In other words, we have lived through an era where too often, short-term gains were prized over long-term prosperity; where we failed to look beyond the next payment, the next quarter, or the next election. A surplus became an excuse to transfer wealth to the wealthy instead of an opportunity to invest in our future. Regulations were gutted for the sake of a quick profit at the expense of a healthy market. People bought homes they knew they couldn't afford from banks and lenders who pushed those bad loans anyway. And all the while, critical debates and difficult decisions were put off for some other time on some other day.

Well that day of reckoning has arrived, and the time to take charge of our future is here.

Now is the time to act boldly and wisely – to not only revive this economy, but to build a new foundation for lasting prosperity. Now is the time to jumpstart job creation, re-start lending, and invest in areas like energy, health care, and education that will grow our economy, even as we make hard choices to bring our deficit down. That is what my economic agenda is designed to do, and that's what I'd like to talk to you about tonight.

WATCH THE VIDEO

February 24, 2009 4:30 PM

The President Addresses Joint Session of Congress: February 24, 2009

BLOG POSTS ON THIS ISSUE

January 23, 2013 12:45 PM EST

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January 21, 2013 3:26 PM EST

Be a Part of the Next Four Years

The President's second term will offer many ways

It's an agenda that begins with jobs.

As soon as I took office, I asked this Congress to send me a recovery plan by President's Day that would put people back to work and put money in their pockets. Not because I believe in bigger government – I don't. Not because I'm not mindful of the massive debt we've inherited – I am. I called for action because the failure to do so would have cost more jobs and caused more hardships. In fact, a failure to act would have worsened our long-term deficit by assuring weak economic growth for years. That's why I pushed for quick action. And tonight, I am grateful that this Congress delivered, and pleased to say that the American Recovery and Reinvestment Act is now law.

Over the next two years, this plan will save or create 3.5 million jobs. More than 90% of these jobs will be in the private sector – jobs rebuilding our roads and bridges; constructing wind turbines and solar panels; laying broadband and expanding mass transit.

Because of this plan, there are teachers who can now keep their jobs and educate our kids. Health care professionals can continue caring for our sick. There are 57 police officers who are still on the streets of Minneapolis tonight because this plan prevented the layoffs their department was about to make.

Because of this plan, 95% of the working households in America will receive a tax cut – a tax cut that you will see in your paychecks beginning on April 1st.

Because of this plan, families who are struggling to pay tuition costs will receive a $2,500 tax credit for all four years of college. And Americans who have lost their jobs in this recession will be able to receive extended unemployment benefits and continued health care coverage to help them weather this storm.

I know there are some in this chamber and watching at home who are skeptical of whether this plan will work. I understand that skepticism. Here in Washington, we've all seen how quickly good intentions can turn into broken promises and wasteful spending. And with a plan of this scale comes enormous responsibility to get it right.

That is why I have asked Vice President Biden to lead a tough, unprecedented oversight effort – because nobody messes with Joe. I have told each member of my Cabinet as well as mayors and governors across the country that they will be held accountable by me and the American people for every dollar they spend. I have appointed a proven and aggressive Inspector General to ferret out any and all cases of waste and fraud. And we have created a new website called recovery.gov so that every American can find out how and where their money is being spent.

So the recovery plan we passed is the first step in getting our economy back on track. But it is just the first step. Because even if we manage this plan flawlessly, there will be no real recovery unless we clean up the credit crisis that has severely weakened our financial system.

I want to speak plainly and candidly about this issue tonight, because every American should know that it directly affects you and your family's well-being. You should also know that the money you've deposited in banks across the country is safe; your insurance is secure; and you can rely on the continued operation of our financial system. That is not the source of concern.

The concern is that if we do not re-start lending in this country, our recovery will be choked off before it even begins.

You see, the flow of credit is the lifeblood of our economy. The ability to get a loan is how you finance the purchase of everything from a home to a car to a college education; how stores stock their shelves, farms buy equipment, and businesses make payroll.

But credit has stopped flowing the way it should. Too many bad loans from the housing crisis have made their way onto the books of too many banks. With so much debt and so little confidence, these banks are now fearful of lending out any more money to households, to businesses, or to each other. When there is no lending, families can't afford to buy homes or cars. So businesses are forced to make layoffs. Our economy suffers even more, and credit dries up even further.

That is why this administration is moving swiftly and aggressively to break this destructive cycle, restore confidence, and re-start lending.

We will do so in several ways. First, we are creating a new lending fund that represents the largest effort ever to help provide auto loans, college loans, and small business loans to the consumers and entrepreneurs who keep this economy running.

Second, we have launched a housing plan that will help responsible families facing the threat of foreclosure lower their monthly payments and re-finance their mortgages. It's a plan that won't help speculators or that neighbor down the street who bought a house he could never hope to afford, but it will help millions of Americans who are struggling with declining home values – Americans who will now be able to take advantage of the lower interest rates that this plan has already helped bring about. In fact, the average family who re-finances today can save nearly $2000 per year on their mortgage.

Third, we will act with the full force of the federal government to ensure that the major banks that Americans depend on have enough confidence and enough money to lend even in more difficult times. And when we learn that a major bank has serious problems, we will hold accountable those responsible, force the necessary adjustments, provide the support to clean up their balance sheets, and assure the continuity of a strong, viable institution that can serve our people and our economy.

I understand that on any given day, Wall Street may be more comforted by an approach that gives banks bailouts with no strings attached, and that holds nobody accountable for their reckless decisions. But such an approach won't solve the problem. And our goal is to quicken the day when we re-start lending to the American people and American business and end this crisis once and for all.

I intend to hold these banks fully accountable for the assistance they receive, and this time, they will have to clearly demonstrate how taxpayer dollars result in more lending for the American taxpayer. This time, CEOs won't be able to use taxpayer money to pad their paychecks or buy fancy drapes or disappear on a private jet. Those days are over.

Still, this plan will require significant resources from the federal government – and yes, probably more than we've already set aside. But while the cost of action will be great, I can assure you that the cost of inaction will be far greater, for it could result in an economy that sputters along for not months or years, but perhaps a decade. That would be worse for our deficit, worse for business, worse for you, and worse for the next generation. And I refuse to let that happen.

I understand that when the last administration asked this Congress to provide assistance for struggling banks, Democrats and Republicans alike were infuriated by the mismanagement and results that followed. So were the American taxpayers. So was I.

So I know how unpopular it is to be seen as helping banks right now, especially when everyone is suffering in part from their bad decisions. I promise you – I get it.

But I also know that in a time of crisis, we cannot afford to govern out of anger, or yield to the politics of the moment. My job – our job – is to solve the problem. Our job is to govern with a sense of responsibility. I will not spend a single penny for the purpose of rewarding a single Wall Street executive, but I will do whatever it takes to help the small business that can't pay its workers or the family that has saved and still can't get a mortgage.

That's what this is about. It's not about helping banks – it's about helping people. Because when credit is available again, that young family can finally buy a new home. And then some company will hire workers to build it. And then those workers will have money to spend, and if they can get a loan too, maybe they'll finally buy that car, or open their own business. Investors will return to the market, and American families will see their retirement secured once more. Slowly, but surely, confidence will return, and our economy will recover.

So I ask this Congress to join me in doing whatever proves necessary. Because we cannot consign our nation to an open-ended recession. And to ensure that a crisis of this magnitude never happens again, I ask Congress to move quickly on legislation that will finally reform our outdated regulatory system. It is time to put in place tough, new common-sense rules of the road so that our financial market rewards drive and innovation, and punishes short-cuts and abuse.

The recovery plan and the financial stability plan are the immediate steps we're taking to revive our economy in the short-term. But the only way to fully restore America's economic strength is to make the long-term investments that will lead to new jobs, new industries, and a renewed ability to compete with the rest of the world. The only way this century will be another American century is if we confront at last the price of our dependence on oil and the high cost of health care; the schools that aren't preparing our children and the mountain of debt they stand to inherit. That is our responsibility.

In the next few days, I will submit a budget to Congress. So often, we have come to view these documents as simply numbers on a page or laundry lists of programs. I see this document differently. I see it as a vision for America – as a blueprint for our future.

My budget does not attempt to solve every problem or address every issue. It reflects the stark reality of what we've inherited – a trillion dollar deficit, a financial crisis, and a costly recession.

Given these realities, everyone in this chamber – Democrats and Republicans – will have to sacrifice some worthy priorities for which there are no dollars. And that includes me.

But that does not mean we can afford to ignore our long-term challenges. I reject the view that says our problems will simply take care of themselves; that says government has no role in laying the foundation for our common prosperity.

For history tells a different story. History reminds us that at every moment of economic upheaval and transformation, this nation has responded with bold action and big ideas. In the midst of civil war, we laid railroad tracks from one coast to another that spurred commerce and industry. From the turmoil of the Industrial Revolution came a system of public high schools that prepared our citizens for a new age. In the wake of war and depression, the GI Bill sent a generation to college and created the largest middle-class in history. And a twilight struggle for freedom led to a nation of highways, an American on the moon, and an explosion of technology that still shapes our world.

In each case, government didn't supplant private enterprise; it catalyzed private enterprise. It created the conditions for thousands of entrepreneurs and new businesses to adapt and to thrive.

We are a nation that has seen promise amid peril, and claimed opportunity from ordeal. Now we must be that nation again. That is why, even as it cuts back on the programs we don't need, the budget I submit will invest in the three areas that are absolutely critical to our economic future: energy, health care, and education.

It begins with energy.

We know the country that harnesses the power of clean, renewable energy will lead the 21st century. And yet, it is China that has launched the largest effort in history to make their economy energy efficient. We invented solar technology, but we've fallen behind countries like Germany and Japan in producing it. New plug-in hybrids roll off our assembly lines, but they will run on batteries made in Korea.

Well I do not accept a future where the jobs and industries of tomorrow take root beyond our borders – and I know you don't either. It is time for America to lead again.

Thanks to our recovery plan, we will double this nation's supply of renewable energy in the next three years. We have also made the largest investment in basic research funding in American history – an investment that will spur not only new discoveries in energy, but breakthroughs in medicine, science, and technology.

We will soon lay down thousands of miles of power lines that can carry new energy to cities and towns across this country. And we will put Americans to work making our homes and buildings more efficient so that we can save billions of dollars on our energy bills.

But to truly transform our economy, protect our security, and save our planet from the ravages of climate change, we need to ultimately make clean, renewable energy the profitable kind of energy. So I ask this Congress to send me legislation that places a market-based cap on carbon pollution and drives the production of more renewable energy in America. And to support that innovation, we will invest fifteen billion dollars a year to develop technologies like wind power and solar power; advanced biofuels, clean coal, and more fuel-efficient cars and trucks built right here in America.

As for our auto industry, everyone recognizes that years of bad decision-making and a global recession have pushed our automakers to the brink. We should not, and will not, protect them from their own bad practices. But we are committed to the goal of a re-tooled, re-imagined auto industry that can compete and win. Millions of jobs depend on it. Scores of communities depend on it. And I believe the nation that invented the automobile cannot walk away from it.

None of this will come without cost, nor will it be easy. But this is America. We don't do what's easy. We do what is necessary to move this country forward.

For that same reason, we must also address the crushing cost of health care.

This is a cost that now causes a bankruptcy in America every thirty seconds. By the end of the year, it could cause 1.5 million Americans to lose their homes. In the last eight years, premiums have grown four times faster than wages. And in each of these years, one million more Americans have lost their health insurance. It is one of the major reasons why small businesses close their doors and corporations ship jobs overseas. And it's one of the largest and fastest-growing parts of our budget.

Given these facts, we can no longer afford to put health care reform on hold.

Already, we have done more to advance the cause of health care reform in the last thirty days than we have in the last decade. When it was days old, this Congress passed a law to provide and protect health insurance for eleven million American children whose parents work full-time. Our recovery plan will invest in electronic health records and new technology that will reduce errors, bring down costs, ensure privacy, and save lives. It will launch a new effort to conquer a disease that has touched the life of nearly every American by seeking a cure for cancer in our time. And it makes the largest investment ever in preventive care, because that is one of the best ways to keep our people healthy and our costs under control.

This budget builds on these reforms. It includes an historic commitment to comprehensive health care reform – a down-payment on the principle that we must have quality, affordable health care for every American. It's a commitment that's paid for in part by efficiencies in our system that are long overdue. And it's a step we must take if we hope to bring down our deficit in the years to come.

Now, there will be many different opinions and ideas about how to achieve reform, and that is why I'm bringing together businesses and workers, doctors and health care providers, Democrats and Republicans to begin work on this issue next week.

I suffer no illusions that this will be an easy process. It will be hard. But I also know that nearly a century after Teddy Roosevelt first called for reform, the cost of our health care has weighed down our economy and the conscience of our nation long enough. So let there be no doubt: health care reform cannot wait, it must not wait, and it will not wait another year.

The third challenge we must address is the urgent need to expand the promise of education in America.

In a global economy where the most valuable skill you can sell is your knowledge, a good education is no longer just a pathway to opportunity – it is a pre-requisite.

Right now, three-quarters of the fastest-growing occupations require more than a high school diploma. And yet, just over half of our citizens have that level of education. We have one of the highest high school dropout rates of any industrialized nation. And half of the students who begin college never finish.

This is a prescription for economic decline, because we know the countries that out-teach us today will out-compete us tomorrow. That is why it will be the goal of this administration to ensure that every child has access to a complete and competitive education – from the day they are born to the day they begin a career.

Already, we have made an historic investment in education through the economic recovery plan. We have dramatically expanded early childhood education and will continue to improve its quality, because we know that the most formative learning comes in those first years of life. We have made college affordable for nearly seven million more students. And we have provided the resources necessary to prevent painful cuts and teacher layoffs that would set back our children's progress.

But we know that our schools don't just need more resources. They need more reform. That is why this budget creates new incentives for teacher performance; pathways for advancement, and rewards for success. We'll invest in innovative programs that are already helping schools meet high standards and close achievement gaps. And we will expand our commitment to charter schools.

It is our responsibility as lawmakers and educators to make this system work. But it is the responsibility of every citizen to participate in it. And so tonight, I ask every American to commit to at least one year or more of higher education or career training. This can be community college or a four-year school; vocational training or an apprenticeship. But whatever the training may be, every American will need to get more than a high school diploma. And dropping out of high school is no longer an option. It's not just quitting on yourself, it's quitting on your country – and this country needs and values the talents of every American. That is why we will provide the support necessary for you to complete college and meet a new goal: by 2020, America will once again have the highest proportion of college graduates in the world.

I know that the price of tuition is higher than ever, which is why if you are willing to volunteer in your neighborhood or give back to your community or serve your country, we will make sure that you can afford a higher education. And to encourage a renewed spirit of national service for this and future generations, I ask this Congress to send me the bipartisan legislation that bears the name of Senator Orrin Hatch as well as an American who has never stopped asking what he can do for his country – Senator Edward Kennedy.

These education policies will open the doors of opportunity for our children. But it is up to us to ensure they walk through them. In the end, there is no program or policy that can substitute for a mother or father who will attend those parent/teacher conferences, or help with homework after dinner, or turn off the TV, put away the video games, and read to their child. I speak to you not just as a President, but as a father when I say that responsibility for our children's education must begin at home.

There is, of course, another responsibility we have to our children. And that is the responsibility to ensure that we do not pass on to them a debt they cannot pay. With the deficit we inherited, the cost of the crisis we face, and the long-term challenges we must meet, it has never been more important to ensure that as our economy recovers, we do what it takes to bring this deficit down.

I'm proud that we passed the recovery plan free of earmarks, and I want to pass a budget next year that ensures that each dollar we spend reflects only our most important national priorities.

Yesterday, I held a fiscal summit where I pledged to cut the deficit in half by the end of my first term in office. My administration has also begun to go line by line through the federal budget in order to eliminate wasteful and ineffective programs. As you can imagine, this is a process that will take some time. But we're starting with the biggest lines. We have already identified two trillion dollars in savings over the next decade.

In this budget, we will end education programs that don't work and end direct payments to large agribusinesses that don't need them. We'll eliminate the no-bid contracts that have wasted billions in Iraq, and reform our defense budget so that we're not paying for Cold War-era weapons systems we don't use. We will root out the waste, fraud, and abuse in our Medicare program that doesn't make our seniors any healthier, and we will restore a sense of fairness and balance to our tax code by finally ending the tax breaks for corporations that ship our jobs overseas.

In order to save our children from a future of debt, we will also end the tax breaks for the wealthiest 2% of Americans. But let me perfectly clear, because I know you'll hear the same old claims that rolling back these tax breaks means a massive tax increase on the American people: if your family earns less than $250,000 a year, you will not see your taxes increased a single dime. I repeat: not one single dime. In fact, the recovery plan provides a tax cut – that's right, a tax cut – for 95% of working families. And these checks are on the way.

To preserve our long-term fiscal health, we must also address the growing costs in Medicare and Social Security. Comprehensive health care reform is the best way to strengthen Medicare for years to come. And we must also begin a conversation on how to do the same for Social Security, while creating tax-free universal savings accounts for all Americans.

Finally, because we're also suffering from a deficit of trust, I am committed to restoring a sense of honesty and accountability to our budget. That is why this budget looks ahead ten years and accounts for spending that was left out under the old rules – and for the first time, that includes the full cost of fighting in Iraq and Afghanistan. For seven years, we have been a nation at war. No longer will we hide its price.

We are now carefully reviewing our policies in both wars, and I will soon announce a way forward in Iraq that leaves Iraq to its people and responsibly ends this war.

And with our friends and allies, we will forge a new and comprehensive strategy for Afghanistan and Pakistan to defeat al Qaeda and combat extremism. Because I will not allow terrorists to plot against the American people from safe havens half a world away.

As we meet here tonight, our men and women in uniform stand watch abroad and more are readying to deploy. To each and every one of them, and to the families who bear the quiet burden of their absence, Americans are united in sending one message: we honor your service, we are inspired by your sacrifice, and you have our unyielding support. To relieve the strain on our forces, my budget increases the number of our soldiers and Marines. And to keep our sacred trust with those who serve, we will raise their pay, and give our veterans the expanded health care and benefits that they have earned.

To overcome extremism, we must also be vigilant in upholding the values our troops defend – because there is no force in the world more powerful than the example of America. That is why I have ordered the closing of the detention center at Guantanamo Bay, and will seek swift and certain justice for captured terrorists – because living our values doesn't make us weaker, it makes us safer and it makes us stronger. And that is why I can stand here tonight and say without exception or equivocation that the United States of America does not torture.

In words and deeds, we are showing the world that a new era of engagement has begun. For we know that America cannot meet the threats of this century alone, but the world cannot meet them without America. We cannot shun the negotiating table, nor ignore the foes or forces that could do us harm. We are instead called to move forward with the sense of confidence and candor that serious times demand.

To seek progress toward a secure and lasting peace between Israel and her neighbors, we have appointed an envoy to sustain our effort. To meet the challenges of the 21st century – from terrorism to nuclear proliferation; from pandemic disease to cyber threats to crushing poverty – we will strengthen old alliances, forge new ones, and use all elements of our national power.

And to respond to an economic crisis that is global in scope, we are working with the nations of the G-20 to restore confidence in our financial system, avoid the possibility of escalating protectionism, and spur demand for American goods in markets across the globe. For the world depends on us to have a strong economy, just as our economy depends on the strength of the world's.

As we stand at this crossroads of history, the eyes of all people in all nations are once again upon us – watching to see what we do with this moment; waiting for us to lead.

Those of us gathered here tonight have been called to govern in extraordinary times. It is a tremendous burden, but also a great privilege – one that has been entrusted to few generations of Americans. For in our hands lies the ability to shape our world for good or for ill.

I know that it is easy to lose sight of this truth – to become cynical and doubtful; consumed with the petty and the trivial.

But in my life, I have also learned that hope is found in unlikely places; that inspiration often comes not from those with the most power or celebrity, but from the dreams and aspirations of Americans who are anything but ordinary.

I think about Leonard Abess, the bank president from Miami who reportedly cashed out of his company, took a $60 million bonus, and gave it out to all 399 people who worked for him, plus another 72 who used to work for him. He didn't tell anyone, but when the local newspaper found out, he simply said, "I knew some of these people since I was 7 years old. I didn't feel right getting the money myself."

I think about Greensburg, Kansas, a town that was completely destroyed by a tornado, but is being rebuilt by its residents as a global example of how clean energy can power an entire community – how it can bring jobs and businesses to a place where piles of bricks and rubble once lay. "The tragedy was terrible," said one of the men who helped them rebuild. "But the folks here know that it also provided an incredible opportunity."

And I think about Ty'Sheoma Bethea, the young girl from that school I visited in Dillon, South Carolina – a place where the ceilings leak, the paint peels off the walls, and they have to stop teaching six times a day because the train barrels by their classroom. She has been told that her school is hopeless, but the other day after class she went to the public library and typed up a letter to the people sitting in this room. She even asked her principal for the money to buy a stamp. The letter asks us for help, and says, "We are just students trying to become lawyers, doctors, congressmen like yourself and one day president, so we can make a change to not just the state of South Carolina but also the world. We are not quitters."

We are not quitters.

These words and these stories tell us something about the spirit of the people who sent us here. They tell us that even in the most trying times, amid the most difficult circumstances, there is a generosity, a resilience, a decency, and a determination that perseveres; a willingness to take responsibility for our future and for posterity.

Their resolve must be our inspiration. Their concerns must be our cause. And we must show them and all our people that we are equal to the task before us.

I know that we haven't agreed on every issue thus far, and there are surely times in the future when we will part ways. But I also know that every American who is sitting here tonight loves this country and wants it to succeed. That must be the starting point for every debate we have in the coming months, and where we return after those debates are done. That is the foundation on which the American people expect us to build common ground.

And if we do – if we come together and lift this nation from the depths of this crisis; if we put our people back to work and restart the engine of our prosperity; if we confront without fear the challenges of our time and summon that enduring spirit of an America that does not quit, then someday years from now our children can tell their children that this was the time when we performed, in the words that are carved into this very chamber, "something worthy to be remembered." Thank you, God Bless you, and may God Bless the United States of America.

U.S. House of Representatives

Committee on Natural Resources

Washington, DC 20515

December 14, 2012

The Honorable Steven Chu
Secretary
Department of Energy
1000 Independence Avenue, S.W.
Washington, DC 20585

Dear Secretary Chu,

I write to convey my disappointment in the deeply flawed methodology utilized in a Department of Energy (DOE)-commissioned study that was intended to analyze the economic impacts associated with the export of liquefied natural gas (LNG) from the United States and to request that this analysis be appropriately updated. The economic analysis performed by NERA Economic Consulting (NERA) and released last week found that LNG exporting will lead to higher domestic energy prices and will have significant negative impacts on American manufacturing and workers, similar to the conclusions reached by previous studies.[1] But I was disappointed to find fundamental flaws with the study that I fear may have led to conclusions that severely underestimate the negative impacts of large-scale natural gas exporting. Given the important role this study may play in determining U.S. natural gas export policy, I strongly urge that the study's methodology be reevaluated in some key areas, that the most recent projection data available be utilized in the model, and that the model be re-run and re-analyzed.

There are several fundamental flaws associated with the NERA study:

1) **NERA's model used energy projection data from the Energy Information Administration's (EIA's) 2011 World Energy Outlook, which was published in 2010. This data badly underestimates the growth that has already occurred in domestic natural gas demand as well as demand that is expected in the future.**

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[1] EIA, "Effect of Increased Natural Gas Exports on Domestic Energy Markets," January 2012. Available at: http://www.eia.gov/analysis/requests/fe/pdf/fe_lng.pdf. Deloitte, "Made in America: The Economic Impact of LNG Exports from the United States," 2011. Available at: http://www.deloitte.com/assets/Dcom-UnitedStates/Local%20Assets/Documents/Energy_us_er/us_er_MadeinAmerica_LNGPaper_122011.pdf

I am concerned that because of its utilization of 2010 data that have already been shown to be grossly inaccurate, the NERA study fails to fully grasp the pace and scope with which the boom in shale gas production is transforming major sectors of the American economy. The electricity sector is rapidly switching from coal to cleaner burning natural gas. Heavy industrial users—already consumers of 40 percent of total U.S. natural gas supplies—are making tens of billions of dollars of additional capital investments in energy-intensive manufacturing that will create huge amounts of new domestic natural gas demand. And natural gas vehicles are now expected to be significant drivers of new domestic natural gas demand. Yet the NERA study failed to capture this new economic reality because it used natural gas demand projections for these rapidly changing sectors that are significantly out of date.

The older data used in the NERA study projects a much different future for natural gas than the most recent projections from the Energy Information Administration (EIA):

- The data used by NERA projected that natural gas use in the U.S. power sector would actually *decline* between 2010 and 2020. In reality, natural gas use in the power sector has already grown by 27 percent since 2010, and the latest EIA projections are that it will grow 11 percent between 2010 and 2020.[2]

- The data used by NERA projected that natural gas use in the industrial sector would grow by 1.46 quadrillion BTU between 2010 and 2035. The latest EIA projections, however, are that industrial demand will grow by 47 percent more than that, or by 2.15 quadrillion BTU, over this period.[3]

- The data used by NERA projected annual natural gas use in the transportation sector would grow to 160 billion cubic feet in 2035. But the latest EIA projections are that it will grow to more than *seven times* that level by 2035.[4]

I understand that data from EIA's 2013 Annual Energy Outlook (AEO) was not available at the time the NERA study was conducted. But 2012 AEO data certainly was available, and that data did assume marginally higher levels of U.S. natural gas demand relative to the 2011 AEO. So I am puzzled why NERA chose to use the older 2011 WEO data..

Further, even EIA's most recent 2013 AEO projections for domestic natural gas demand fail to capture many of the more than 100 newly announced natural gas-intensive manufacturing projects that have been announced over the past 18 months. Those projects represent over $90 billion in investment and billions of cubic feet of additional future daily natural gas use. Studies

[2] EIA, Annual Energy Outlook 2013.

[3] Id.

[4] Id.

from other analysts, such as IHS CERA, foresee natural gas demand in America growing far more than what EIA assumes even in their most recent 2013 AEO. A thorough and comprehensive exporting analysis should have examined these types of higher future domestic demand scenarios, especially at a time when projections are changing so quickly year-to-year. Yet while the NERA study acknowledged that "the potential exists for significant increases in natural gas demand across the U.S. economy," it failed to consider that potential in any of its modeling. The only context in which NERA considered higher domestic natural gas demand was in the context of higher general economic growth and a scenario in which ultimately recoverable shale resources were relatively high. While it makes sense to assume greater shale gas supplies will lead to lower prices and ultimately higher incremental domestic demand, this should not be the only method for considering higher future domestic demand.

I therefore request that new economic modeling be done that utilizes the 2013 AEO data or a similar data set developed in the past six months. In addition, I request that you provide me with a copy of any document (such as the contract or scoping documents for the study) in the Department's possession that describes the task and data NERA was expected to utilize.

2) The NERA study fundamentally misinterpreted a key report on the impact of energy cost increases on America's energy-intensive trade-exposed manufacturers and failed to delineate the impact of natural gas exporting on specific manufacturing sectors.

In order to better understand how energy-intensive trade-exposed (EITE) manufacturers (such chemical, fertilizer, glass, and steel manufacturers) can be impacted by higher energy costs, NERA cited extensively from a 2009 study that looked at potential impacts of the Waxman-Markey energy and climate legislation, H.R. 2454, on U.S. manufacturers. This report, "The Effects of H.R. 2454 on International Competitiveness and Emission Leakage in Energy-Intensive Trade-Exposed Industries," (Interagency Report) was an interagency government effort responding to a request from several U.S. senators about my bill.[5] Based on this report, apparently, and NERA's own modeling of natural gas exports, NERA concluded that "The cap-and-trade program in the Waxman-Markey bill would have caused increases in energy costs and impacts on EITE even broader than would the allowing of LNG exports because the Waxman-Markey bill applied to all fuels and increased the costs of fuels used for about 70% of electricity generation." The NERA analysis was correct in looking to the Interagency Report because the impacts of natural gas exporting on EITE manufacturers are potentially similar to those resulting from greenhouse gas regulation. Unfortunately, NERA's conclusion based on its review of this report is unequivocally wrong.

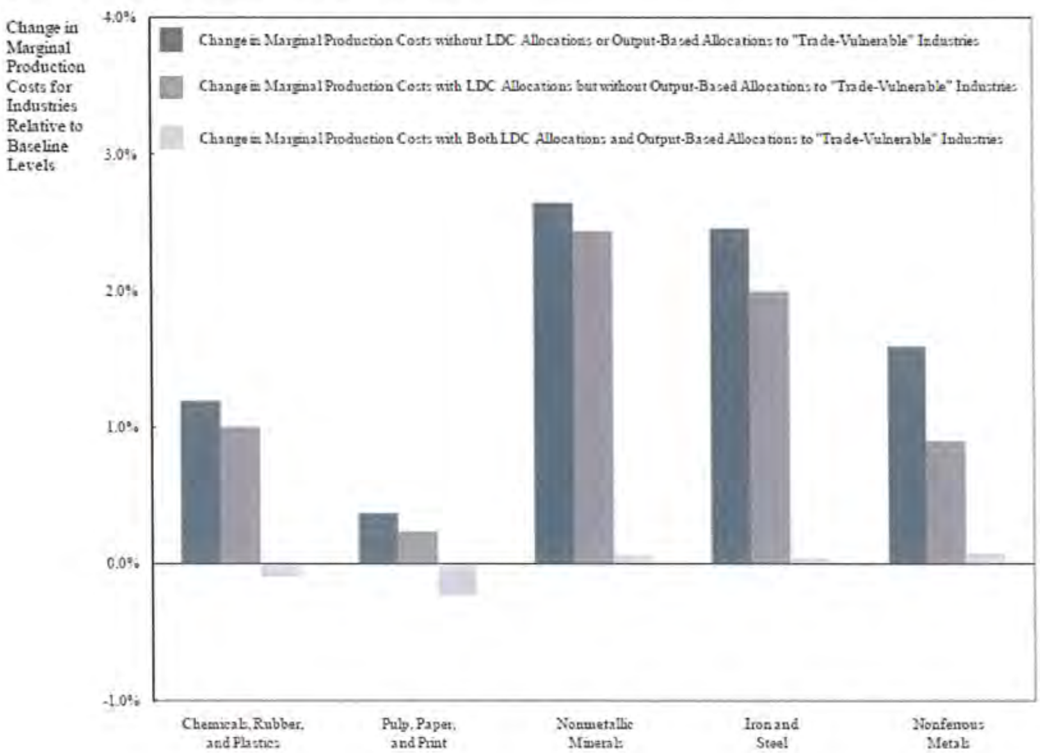
[5] U.S. Government Agencies, "The Effects of H.R. 2454 on International Competitiveness and Emission Leakage in Energy-Intensive Trade-Exposed Industries," December 2, 2009. Available at: http://www.epa.gov/climatechange/Downloads/EPAactivities/InteragencyReport_Competitiveness-EmissionLeakage.pdf

In crafting H.R.2454, Energy and Commerce Committee Chairman Henry Waxman and I were well aware of and very concerned about the impacts of greenhouse gas regulation on America's manufacturing competitiveness. That's why in the cap-and-trade portion of the bill, we included a detailed allowance allocation plan to ensure that EITE manufacturers were not put at a disadvantage relative to foreign competitors, while still incentivizing reductions in greenhouse gas emissions. Industries verified to be energy-intensive and trade-exposed were allotted allowances under the cap-and-trade program to neutralize any cost increases associated with emissions from their direct energy consumption. They were also allocated allowances to neutralize any cost increases resulting from the indirect emissions associated with their electricity use.

The conclusion of the Interagency Report was that the cap-and-trade program would have very little impact, no impact, or potentially *positive* impact on EITE manufacturers. Figure 14 from the Interagency Report and its explanation below detail these findings:

> "Yet, as Figure 14 indicates, together, the LDC allocations and output-based rebates can, in fact, fully — and potentially more than fully — mitigate the increase in production costs borne by energy-intensive trade-exposed industries, and the associated competitiveness impacts, even after accounting for the program's indirect effects."

Figure 14. Effect of Domestic Cap-and-Trade Program on Marginal Production Costs of Energy-Intensive Trade-Exposed Industries without and with Allocations to Local Distribution Companies and Output-Based Allocations to "Trade-Vulnerable" Industries



Largely as a result of the fair way in which American manufacturing was treated in the bill, energy-intensive manufacturers like DuPont, GE, Dow, Alcoa, and many others supported Waxman-Markey.[6] With natural gas exports, however, there are no analogous policies to those contained in the Waxman-Markey legislation to help maintain affordable energy for consumers and help American manufacturers maintain global competitiveness. This is the key point the NERA analysis seemed to miss. The Interagency Report was clear that without the mitigating measures included in Waxman-Markey, some EITE industries would have been exposed to production cost increases of 2.5 percent or more. The potentially crippling cost increases that could have hit up to 12 percent of U.S. manufacturing output and affected 780,000 workers were neutralized by the allocation system contained in Waxman-Markey. However, similar impacts on EITE industries resulting from large-scale natural gas exports would not be neutralized and therefore should be more fully accounted for in an analysis of natural gas exports.

It is very important for us to know exactly which of the EITE industries would be deeply affected by natural gas exporting. Unfortunately, the NERA study also fell short in that regard. The NERA study concludes the discussion on EITE industries by saying that "competitive impacts of higher natural gas prices attributable to LNG exports will be very narrow, but it was not possible to model impacts on each of the potentially affected sectors." I find this unacceptable. The Interagency Report modeled sector-by-sector impacts of cap-and-trade, and it is imperative that a similar modeling of sector-by-sector impacts resulting from natural gas exports be conducted as well. Further, since the manufacturing sector has endured both a crushing economic recession and a dynamic resurgence (driven at least in part by low natural gas prices) in the last five years, sector-by-sector impacts should be modeled using more recent data than that used for the Interagency Report, which used data from 2007.

I therefore request modeling be done that looks at the impact of natural gas exporting on U.S. manufacturing on a sector-by-sector basis using the most recent data available.

3) The NERA report failed to assess the relative economic impacts associated with domestic industrial utilization of natural gas compared to exporting, and it made inaccurate assumptions regarding who would benefit through exporting.

According to Dow Chemical, the value of every unit of energy used by the manufacturing sector is multiplied by a factor of 20 within the economy because of the production it stimulates throughout the value chain.[7] In addition, for every manufacturing job created on the factory

[6] "Building the American Clean Energy Economy," page 27, July, 30, 2012. Available at: http://globalwarming.markey.house.gov/files/WEB/ACESPacket/ACESCleanEnergyPlan.pdf

[7] Dow Chemical Company, press release, December 6, 2012. Available at: https://media.gractions.com/EE3B35BC4057E0B833E10AB0A1E1F8B9EC78B9DF/72575bdb-20f2-49b0-aa77-1869d9081e56.pdf

floor, five to eight more jobs are created in the larger economy. On the other hand, exporting our energy provides a narrow benefit to natural gas producers and exporters and has little to no domestic value multiplier for the American economy. The NERA analysis goes into detail in explaining why it believes that the fertilizer, chemical, iron and steel, and other EITE industries are both low value-added industries and susceptible to international competition. But it does not explain how the loss of these industries would impact U.S. employment or the supply chains in which these industries are intricately tied.

I am particularly concerned about the assumption in the NERA study that financing of natural gas investments would originate from U.S. sources and that the investment benefits would accrue to Americans widely. This is an important assumption in determining both net U.S. economy-wide costs and benefits as well as distributional impacts, and I believe this assumption is inaccurate and misleading.

Many foreign corporations, either directly or through partnerships, produce oil and gas in the United States utilizing foreign financing arrangements. Many of these foreign companies are actually *owned by foreign governments*. In fact, because of an oil company court challenge, many foreign state-owned companies are already producing billions of dollars worth of oil and gas in U.S. waters in the Gulf of Mexico without paying a dime in royalties to U.S. taxpayers. Beneficiaries include Italy's state-owned company ENI, Brazil's Petrobras, Norway's Statoil, and Columbia's Ecopetrol.[8]

Even in the case where natural gas exporting leads to increased gas production by American companies, the vast majority of Americans will see no investment income from natural gas exporting. The NERA report says "Different socioeconomic groups depend on different sources of income, though through retirement savings an increasingly large number of workers share in the benefits of higher income to natural resource companies whose shares they own." Polls suggest that roughly half of Americans own stock.[9] The Americans that own stock in natural gas companies, in particular, is likely much lower than that. And the vast majority of those Americans are likely exposed to the natural gas sector only through diversified mutual funds, meaning their ownership stake is very small.

The dividends and capital gains received from natural gas investments will go mostly to the people that benefit from dividends and capital gains already: the wealthy. According to The Washington Post, more than 50 percent of all capital gains over the past two decades have

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[8] House Natural Resources Committee Democrats, press release, September 18, 2012. Available at: http://democrats.naturalresources.house.gov/press-release/markey-chinese-oil-deal-would-expand-foreign-oil-company-access-free-drilling-gulf-rob

[9] Dennis Jacobe, Gallup, "In U.S., 54% Have Stock Market Investments, Lowest Since 1999," April 20, 2011. Available at: http://www.gallup.com/poll/147206/stock-market-investments-lowest-1999.aspx

accrued to the wealthiest 0.1 percent of taxpayers.[10] The richest five percent of Americans receive 80 percent of all capital gains. Similarly, over a third of dividends go to the top one percent of earners of the population. And 72 percent of dividends go to households that earn more than $100,000 a year. More simply, the minority of Americans with significant ownership stakes in natural gas production—the wealthy—will likely see benefits from exporting, while for the majority of Americans, higher energy bills and diminished job prospects mean natural gas exporting reduces economic wellbeing. Further, the vast majority of shale gas reserves are on private lands, which means royalties on increased gas production will tend to go to private landowners rather than to the U.S. Treasury where the benefits would be more widely shared.

I therefore request that modeling and analysis be done to look at the impact of natural gas exporting on U.S. employment. Please also examine how, on average, the costs and benefits of natural gas exporting are distributed to Americans, based on geography and income level.

The flaws in the NERA study indicate that we still have a long way to go before we can be confident that large-scale LNG exporting is truly in America's interest and can be done in a way that protects American consumers and manufacturers. It is critical that policy makers and the American people have a true understanding of the full impacts of exporting domestically produced natural gas before the Department moves forward in granting additional LNG export permits. Please respond to my request for the Department to ensure that economic models are re-run based on the most recent data, that new and important areas are added to the model, that inaccurate assumptions are corrected, and that analysis and findings are updated to reflect these important changes.

I thank you for your attention to this issue. Please direct questions on this matter to Jonathan Phillips on my staff at jonathan.phillips@mail.house.gov or (202) 225-6065.

Sincerely,

Edward J. Markey

Edward J. Markey
Ranking Member
Committee on Natural Resources

[10] Steven Mufson and Jia Lynn Yang, Washington Post, "Capital Gains Tax Rates Benefiting Wealthy Feed Growing Gap Between Rich and Poor," September 11, 2011. Available at: http://www.washingtonpost.com/business/economy/capital-gains-tax-rates-benefiting-wealthy-are-protected-by-both-parties/2011/09/06/gIQAdJmSLK_story.html

United States Senate

WASHINGTON, DC 20510

January 10, 2013

The Honorable Steven Chu
Secretary
U.S. Department of Energy
1000 Independence Avenue SW
Washington, DC 20585

Dear Secretary Chu:

After reviewing the recently released NERA Economic Consulting study[1] commissioned by the Department, I remain deeply concerned about the Department of Energy's approval process for liquefied natural gas ("LNG") export applications. The Natural Gas Act ("NGA") requires the Department to determine whether approving an application to export LNG is in the "public interest," and the Department has indicated that this report will be central to the approval process for these applications. Export applications, which are typically for 20 years or more, and the associated LNG export terminals will reshape the North American natural gas market for years to come. The shortcomings of the NERA study are numerous and render this study insufficient for the Department to use in any export determination. The NERA study would need to be updated with new EIA projections, more realistic market assumptions, regional impacts of the proposed actual export terminals, and evaluations of the actual impacts on consumers and businesses of exporting LNG.

The NERA study's most glaring shortfall is its reliance on two-year-old domestic energy market projections that diverge widely from the government's current understanding of future supply and demand. The study used the Energy Information Administration's (EIA) Annual Energy Outlook 2011 ("AEO2011") reference case, which was released in 2010, as the foundation for its own LNG study. However, on the same day the NERA study was released, the EIA issued its Annual Energy Outlook Reference Case for 2013 ("AEO2013"). There are significant differences between the two EIA AEO reference cases, including projections for gas consumption, energy prices and electric sector energy consumption that render the NERA study inaccurate in reflecting the current sector conditions necessary to inform today's decision-making. Among the most notable data differences are:

- <u>More homes and businesses will rely on natural gas-fired electricity</u>: U.S. net electricity generation by coal power plants in 2035 is projected to be 22.7% lower in AEO2013 than in AEO2011; a majority of this power will be replaced by natural gas-fired generation, which is 15.2% more in AEO2013 than AEO2011;
- <u>Overall natural gas consumption will be higher</u>: The AEO2013 predicts U.S. natural gas consumption will be 8% higher in 2035 than the AEO2011 figure used by NERA.

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[1] W. David Montgomery, et al., "Macroeconomic Impacts of LNG Export from the United States," NERA Economic Consulting, December, 2012, http://www.fossil.energy.gov/programs/gasregulation/reports/nera_lng_report.pdf. Referred to hereafter as "NERA study."

- EIA assumed LNG would be *imported*: Perhaps the most illustrative deviation between the two sets of data is that EIA still expected the U.S. to import LNG in its AEO2011 projections adding to U.S. supplies. The AEO2013 projects there will be net exports of LNG, reducing U.S. supplies.

Even if NERA were to use the new EIA projections, the model it employed for this study has additional deficiencies that would need to be addressed before it could be relied upon to serve as a basis for the statutory findings required by the Natural Gas Act. For example:

1) The NERA study evaluates dozens of scenarios representing different market conditions, but it does not consider the significant domestic demand growth that outside experts and private industry expect to occur over the next decade. By excluding these sources of demand, NERA, like the EIA's Annual Energy Outlooks, is significantly understating demand from emerging segments of the natural gas market. Two overlooked examples are as follows:

- Natural gas is expected to become major transportation fuel: Outside experts suggest EIA has greatly underestimated the use of natural gas by the transportation sector. Citi projected that heavy trucks alone could use 3.3 Bcf/D of natural gas by 2020, displacing up to 600,000 barrels of diesel fuel every day.[2] The Citi estimate is more than 20 times what EIA projected in its AEO2011, which, in turn, is one-fourth of the agency's AEO2013 projection. The railroad industry is also reported to be studying a switch to natural gas-fueled locomotives, which would further drive up demand.[3]
- Projected industrial growth is not fully accounted for by EIA or NERA: The growth in natural gas production and low prices have attracted 100 proposed industrial projects, representing $90 billion in investment and tens of thousands of new jobs, according to Dow Chemical. The proposed projects identified in the Dow analysis represent an estimated increase in demand of 8 Bcf/d. Dow expects near term industrial demand growth to reach 11 Bcf/d. The AEO2011 does not account for these projects, nor does the AEO2013. EIA actually projects non-electric related industrial natural gas demand to decline.[4]

2) The NERA study purports to treat the U.S. and Canada as a single North American market, but its assumptions ignore the potential effect of Canadian LNG exports. The study ignores this important market development, even though Canada's National Energy Board has already approved two LNG export projects in British Columbia. The board also is considering a third LNG export project submitted over the summer by Royal Dutch Shell. Published reports suggest these projects could result in 9 billion cubic feet per day ("Bcf/D") of exports, beginning as early as 2014.[5]

3) LNG terminals use a substantial amount of energy in the liquefaction process. This energy is largely derived from natural gas, representing an amount equivalent to as much as 10% of the amount of natural gas ultimately processed into LNG during the conversion. Both the EIA and NERA appear to have

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[2] Ed Morse, et al., "Energy 2020: North America, the New Middle East?," *Citi*, March 20, 2012.
[3] Zain Shauk, "Natural gas could be cheaper way to run a railroad," *Houston Chronicle*, October, 9, 2012, http://www.chron.com/business/energy/article/Natural-gas-could-be-cheaper-cleaner-way-to-run-3933795.php.
[4] Dow Chemical, "DOE Report on LNG Exports Short Changes Manufacturing and U.S. Competitiveness," December 6, 2012, http://www.dow.com/news/press-releases/article/?id=6138.
[5] Martin O'Rourke, "Canada expects to start LNG exports from late 2014: energy minister," *Platts*, September 18, 2012, http://www.platts.com/RSSFeedDetailedNews/RSSFeed/NaturalGas/8731348.

misrepresented the use of natural gas by LNG terminals for this purpose, which in turn understates the overall gas demand attributable to LNG exports:

- EIA understated natural gas consumption by LNG terminals: In its analysis of LNG exports released in January 2012,[6] the EIA reduced the amount of LNG that would actually be exported under its projections by 10% to account for this additional consumption of natural gas during conversion. (NERA uses the same low and high export cases of 6 Bcf and 12 Bcf.) Under the EIA's 6 Bcf/D export case, only 5.4 Bcf/D would actually be exported; in its 12 Bcf/D case, only 10.8 Bcf/D would actually be exported. DOE export permits are for actual export quotas. Thus, actual exports at those nominal 6 Bcf/D and 12 Bcf/D levels would require adding 10% to overall natural gas demand above and beyond the export volumes. The EIA analysis subtracts the gas used for processing.
- The NERA study also underestimates LNG terminal demand: The NERA study states that 9% of the LNG produced at the terminals will be "burned off" for liquefaction,[7] which is likely a mischaracterization of the actual gas usage for liquefaction. High value LNG would not be used to power the conversion plant. While there will be some boil off loses after LNG is produced, the larger issue is the additional natural gas demand resulting from gas consumption during the liquification conversion process and how the NERA study factors this additional demand into the full exporting lifecycle process. Gas that is used for liquefaction, regardless of its source, needs to be added to the overall demand for natural gas attributable to export volumes approved in the export permits and placed on board LNG tankers. It does not appear that the NERA study does so. The NERA study further errs by pricing the cost of the additional conversion gas at the wellhead price of natural gas despite the fact that gas used for liquefaction will need to be processed and physically transported by pipeline to the LNG terminal location at higher cost and likely impacting transportation and hub and regional prices along the way.

Although the NERA study acknowledges that some sectors of the economy will be hurt by exports, the NERA study fails to fully assess the impacts of rising natural gas prices on homeowners and businesses. The report recognizes negative consequences of LNG exports, but spends only a few paragraphs of its 230-page report actually examining them in detail. Still, they are notable:

- There is a massive wealth transfer between manufacturing and residential consumers that benefits the natural gas industry but "raises energy costs and, in the process, depresses both real wages and the return on capital in all other industries."[8]
- Labor, investment and tax income would fall $10 billion in 2015 as a result of LNG exports; they are reduced by more than $30 billion in 2020 and more than $40 billion in 2025, 2030 and 2035.[9]

[6] Energy Information Administration, "Effect of Increased Natural Gas Exports on Domestic Energy Markets," January, 2012, http://www.eia.gov/analysis/requests/fe/pdf/fe_lng.pdf.
[7] NERA Study at 86
[8] NERA study at 7
[9] *Ibid.*, at 8

- "Households will be negatively affected by having to pay higher prices for the natural gas they use for heating and cooking. Domestic industries for which natural gas is a significant component of their cost structure will experience increases in their cost of production, which will adversely impact their competitive position in a global market and harm U.S. consumers who purchase their goods."[10]
- "In many regions and times of the year natural gas-fired generation sets the price of electricity so that increases in natural gas prices can impact electricity prices. These price increases will also propagate through the economy and affect both household energy bills and costs for businesses."[11]
- With minimal analysis, the study concludes that a "narrow" group of energy-intensive, trade-exposed industries would be experience "serious competitive impacts."[12] The study tries to downplay the economic importance of these manufacturing industries by saying they represent ½% of total U.S. employment;however, that equaled 1.2 million jobs at the end of November. Given the number of current employees and future expected growth, these impacts deserve further study.
- Regional gas prices are expected to increase with higher demand and an increase in wellhead natural gas prices, leading to a decline in U.S. consumption of natural gas.[13]

Despite these serious impacts that are acknowledged within the study, NERA has not conducted further in-depth inquiry into how these impacts will actually be felt in the economy. Appendix F of the study identifies a number of critical factors that the study simply did not consider, without which the report represents a wholly insufficient basis for approving individual export applications which will have significant national, regional and local impacts. These significant gaps in analysis are best explained by the text included in Appendix F[14] itself:

- "Where Production or Export Terminals Will be Located – There are proposals for export facilities in the Mid-Atlantic, Pacific Northwest, and Canada, all of which could change basis differentials and potentially the location of additional natural gas production, with corresponding regional impacts. To analyze alternative locations of export facilities it would be necessary to repeat both the EIA and the NERA analyses with additional scenarios incorporating demand for natural gas exports in different regions."
- "Regional Economic Impacts – Since EIA assumed that all demand for domestic production-associated LNG exports was located in the Gulf region, it was not possible in this study to examine regional impacts on either natural gas prices or economic activity. The Gulf Coast is not necessarily a representative choice given the range of locations now in different applications, so that any attempt to estimate regional impacts would be misleading without more regional specificity in the location of exports."
- "Effects on Different Socioeconomic Groups – Changes in energy prices are often divided into 'effects on producers' and 'effects on consumers.' … The ultimate incidence of all price changes is on individuals and households, for private businesses are owned ultimately by people. Price

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10 *Ibid.*, at 13
11 *Ibid.*, at 13
12 *Ibid.*, at 12
13 *Ibid.*, at 35-36
14 *Ibid.*, at 210-211

changes affect not only the cost of goods and services purchased by households, but also their income from work and investments, transfers from government and the taxes they pay. More relevant indicators of the distribution of gains and losses include real disposable income by income category, real consumption expenditures by income category, and possibly other measures of distribution by socioeconomic group or geography. This study only addresses the net economic effects of natural gas price changes and improved export revenues, not their distribution."

As the Department has acknowledged when it elected to insert the NERA study into the docket of each pending LNG export application, the Department is statutorily required to assess the impact of the individual applications as well as the total impact of proposed export volumes. The NERA study provides no insight into the regional market impacts of these applications, and very little information on the effects of proposed exports on different socioeconomic groups. As such, it is not an adequate basis upon which to approve those individual applications.

As I stated in my previous letter, I remain deeply concerned that the Department has not articulated a set of criteria or procedures that will allow it to meet its obligations under the Natural Gas Act to make the required public interest determinations. Proper, transparent mechanisms must be in place to effectively evaluate all LNG export applications – prior to their approval – to gauge whether each application is in the public interest. The inadequacies of the NERA study only underscore the need for the Department to establish those criteria and procedures in a transparent and accurate manner informed by data that most accurately reflects the world today.

Sincerely,

Ron Wyden

Ron Wyden
United States Senator

U.S. ENERGY INSECURITY

Why Fracking for Oil and Natural Gas Is a False Solution

food&water watch

About Food & Water Watch

Food & Water Watch works to ensure the food, water and fish we consume is safe, accessible and sustainable. So we can all enjoy and trust in what we eat and drink, we help people take charge of where their food comes from, keep clean, affordable, public tap water flowing freely to our homes, protect the environmental quality of oceans, force government to do its job protecting citizens, and educate about the importance of keeping shared resources under public control.

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U.S. ENERGY INSECURITY

Why Fracking for Oil and Natural Gas Is a False Solution

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Executive Summary

Promoters of modern drilling and fracking celebrate the industry's newfound ability to extract oil and natural gas from shale and other tight rock formations, calling it an energy "revolution," a "paradigm-shifter," a "rebirth" and a "game changer."[1] One recent report claims that North America might soon become "the new Middle East," a net exporter of oil and natural gas.[2] In April 2012, ConocoPhillips's CEO at the time called shale gas a "blessing."[3]

But for whom is it really a blessing? Loose talk about domestic oil and natural gas abundance in order to justify and promote widespread drilling and fracking gives Americans a false sense of energy security. Hinging U.S. energy policy on fracking, and thus betting America's future on the supposed abundance of oil and natural gas, would simply perpetuate America's destructive dependence on the oil and gas industry. The only security that would be enjoyed is the security of the industry's profits.

In this report, Food & Water Watch exposes the misconceptions, falsehoods and misleading statements behind the claims that modern drilling and fracking for oil and natural gas can deliver U.S. energy security.

Briefly, Food & Water Watch finds that:

- The popular claim that the United States has 100 years worth of natural gas presumes not only that no place would be off-limits to drilling and fracking, but also that highly uncertain estimates of domestic natural gas resources are accurate;
- Even assuming that the industry's dreams of unrestricted drilling and fracking for natural gas come true and that resource estimates prove accurate, plans to increase the rate of consumption of U.S. natural gas easily cut the claim to 50 years, well within the lifetime of college students today;
- Among these plans are 19 proposals, as of October 26, 2012, to sell U.S. natural gas on foreign markets to maximize oil and gas profits. Combined, these proposals alone mean that annual natural gas exports could reach the equivalent of over 40 percent of total U.S. consumption of natural gas in 2011; and
- Even if the highly uncertain estimates of "tight oil" reserves prove accurate, and even if the oil and gas industry wins unrestricted access to drill and frack for oil, the estimated reserves would amount to a supply of less than seven years.

The United States can transition off of fossil fuels, but it will require remaking the U.S. energy system around proven clean energy solutions: conservation, efficiency and renewables. Such a remaking would underpin broad-based and sustained economic growth, circumvent the environmental and public health costs of extracting and burning fossil fuels and usher in an era of true U.S. energy security, independence and resilience.

The threat is that the fossil fuel industry — empowered by its deep pockets, armed with increasingly intensive extraction methods and bolstered by entrenched infrastructure and demand for its product — will succeed in delaying the necessary transformation for decades, just to protect its bottom line. Now is the time for the United States to declare independence from the oil and gas industry.

Introduction

Americans consume vast amounts of oil and natural gas, and the United States faces energy insecurity as global demand for these fossil fuels increases. Despite the hype, modern drilling and fracking will not change these facts.

The only responsible way to ensure U.S. energy security for future generations is to rapidly transition off of fossil fuels. Yet the American economy currently depends heavily on these dirty sources of energy, and burns them extremely inefficiently. (See box on page 4 and Figure 1 on page 5 for an overview of the U.S energy system.) The United States can and will achieve a transition off of fossil fuels through conservation and through the deployment of proven energy efficiency and renewable energy technologies. The question is whether this transition will take place before or after the fossil fuel industry lays waste to the water we drink, the air we breathe, the communities we love and the climate on which we all depend.

Of course, the true solutions to America's energy challenges — conservation, efficiency and renewables — run counter to the profit motives of the fossil fuel industry. What is their false solution? Develop increasingly intensive methods to extract fossil fuels, deny or dismiss the ways in which extracting and burning these fuels is negatively impacting public health and the environment and continue to rake in extraordinary profits.

In the United States, high-volume hydraulic fracturing, or "fracking," combined with horizontal drilling, is the most prominent and controversial method in the oil and gas industry's arsenal. After drilling down to a targeted rock formation, and then drilling sideways through the targeted layer of rock, operators inject millions of gallons of water mixed with sand and chemicals underground, at extreme pressure, to fracture the rock.[4] The fractures, which after pressure is released are held open by the injected sand, provide pathways for oil and natural gas to flow into the well; otherwise, the oil and natural gas near the drilled well would remain tightly held in the rock.[5]

The oil and gas industry is engaged in a public relations campaign to promote drilling and fracking as good for energy security and energy independence, good for the economy and, in the case of natural gas, even good for the environment.[6] The economic benefits of drilling and fracking are consistently overstated, usually in the form of rosy job projections that, among other details, neglect the long-term costs to local communities.[7] And while natural gas does burn more cleanly than oil and coal, the claims of environmental benefit ignore harmful pollution both during and in the wake of drilling and fracking.[8] As for global climate change, the growing scientific consensus is that natural gas is a false solution.[9]

In this report, Food & Water Watch exposes the misconceptions, falsehoods and misleading statements behind the claims that drilling and fracking for oil and natural gas is the path to American energy security and energy independence.

Within the United States, foreign companies are acquiring stakes in oil resources that can now be extracted with fracking,[10] but regardless of where the oil is produced and who produces it, the price of oil is set on the global market.[11] Such globalization means that widespread drilling and fracking for oil in the United States will do nothing for American consumers who are paying the high price of oil. The only way that Americans can insulate themselves against high oil prices is to consume less oil. But doing so by using natural gas creates its own set of problems, and serves the oil and gas industry's bottom line by prolonging America's destructive dependence on fossil fuels.

Terms of the Debate

What do the terms *energy security* and *energy independence* mean, and how are the two concepts related?

Energy security: The U.S. Congressional Budget Office defines U.S. energy security as "the ability of U.S. households and businesses to accommodate disruptions of supply in energy markets."[31] The CBO goes on to explain, "Households and businesses are 'energy secure' with respect to a particular source of energy if a disruption in the supply of that source would create only limited additional costs."[32]

Energy independence: Energy independence typically refers to U.S. independence from foreign sources of oil, or oil self-sufficiency, and the term is commonly but mistakenly equated with energy security.[33]

As long as large amounts of oil fuel the American economy, American consumers will be at the mercy of growing global demand for oil and the high costs of extracting the oil that remains underground.[34] This is because the price of oil is set on a global market, and American consumers pay this price through gasoline and other refined oil products regardless of where the oil was produced.[35] Reduced oil consumption, not reduced oil imports, must therefore be the focus if the United States is to achieve energy security *with respect to oil*, in the sense defined by the CBO.

The U.S. Energy System

Energy Sources

Petroleum: The U.S. Energy Information Administration estimates that in 2011, burning liquid fuels derived from oil, such as gasoline, diesel, jet fuel and fuel oils, accounted for over 28 percent of total U.S. energy consumption.[12] Gasoline alone accounted for about 16 percent of total U.S. energy consumption, not counting ethanol energy content.[13] The energy content of all petroleum liquid fuels, not just those combusted, was about 36 percent of total U.S. energy consumption in 2011.[14]

Natural Gas, Coal and Nuclear: Natural gas, coal and nuclear, respectively, accounted for about 26 percent, 21 percent and 8 percent of the estimated total of 2011 U.S. energy consumption.[15] Coal and nuclear sources of energy are used predominantly to generate electricity, whereas only about 31 percent of U.S. natural gas consumption in 2011 went toward electricity generation.[16]

Renewables: Consumption of renewable energy, such as wind and solar power, grew the fastest among all energy sources from 2010 to 2011. Renewables, including hydropower, made up 7 percent of total U.S. energy consumption, primarily to generate electricity, although this counts only marketed electricity from renewables.[17]

Energy Uses and Losses

Electricity: An estimated 41 percent of the total U.S. energy consumption in 2011 was used to generate electricity, but about two-thirds of this energy consumed for electricity was wasted.[18] Energy content of nuclear and fossil fuels is wasted during the generation of electricity through heat losses as turbines are driven, for example, by steam or other pressurized gas.[19] On average, U.S. electricity generation results in the loss of about 51 percent of natural gas energy content and 64 percent of coal energy content.[20] In addition to energy wasted during electricity generation, 7 percent of generated electricity is lost along transmission lines and through other distribution infrastructure.[21] Unlike nuclear and fossil fuels, there are no environmental or public health costs associated with wasted wind, solar or other renewable sources of energy.

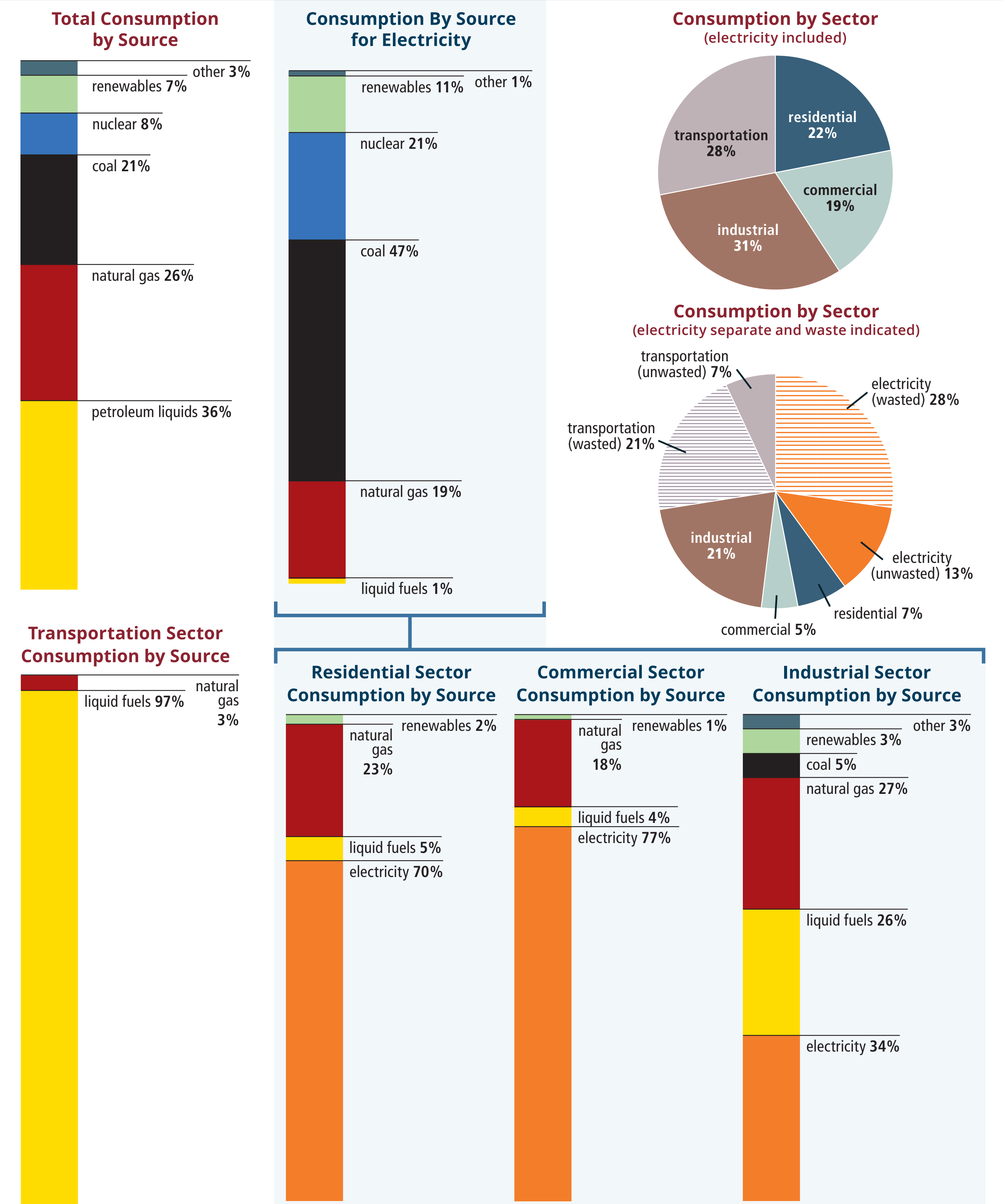
Transportation: The transportation sector accounted for an estimated 28 percent of total U.S. energy consumption.[22] Almost all of this consumption (about 97 percent) was of oil, in the form of various refined petroleum products.[23] According to Lawrence Livermore National Laboratory, about 75 percent of all energy consumed in the transportation sector is wasted.[24]

Residential, Commercial and Industrial: Electricity is consumed in large amounts by the residential, commercial and industrial sectors, but these sectors also directly consume varying amounts of natural gas and varying amounts of liquid fuels derived from oil.[25] Electricity generation accounted for an estimated 70 percent of residential energy consumption, 77 percent of commercial energy consumption and 34 percent of industrial energy consumption.[26] In the industrial sector, direct use of liquid fuels and natural gas amounted to an estimated 26 and 27 percent, respectively, of energy consumption.[27] Meanwhile, in addition to natural gas consumed indirectly in the form of electricity, direct use of natural gas amounted to 23 and 18 percent of total energy consumption within the residential and commercial sectors, respectively.[28]

Fossil Energy's Consequences

Almost all U.S. greenhouse gas emissions come from extracting and burning oil, natural gas and coal.[29] The United States is already experiencing the impact of global climate change due to these emissions, including episodes of extremely hot weather, severe storm events and changes in the timing of seasons.[30] Continuing to burn fossil fuels will only worsen the future consequences and societal costs of global climate change.

Figure 1. 2011 U.S. Energy Consumption



SOURCE: Government Accountability Office; U.S. Census Bureau

Oil and Natural Gas Basics

The U.S. Energy Information Administration (EIA) defines crude oil as a liquid mixture of "hydrocarbons" — molecules composed of hydrogen and carbon atoms.[44] Natural gas is simply a mixture of these hydrocarbons in the gas phase, consisting primarily of methane. Having just one carbon atom, methane is the simplest of hydrocarbons, and it is known to be a potent greenhouse gas contributing to global warming.[45]

Additional household names of hydrocarbons include ethane (two carbon atoms), propane (three carbon atoms) and butane (four carbon atoms). Together, these and heavier hydrocarbons (i.e., more than four carbon atoms per hydrocarbon molecule) form the so-called "natural gas liquids."[46] Natural gas and natural gas liquids are commonly associated with and produced along with crude oil.

Discussion of oil consumption is complicated by general use of the term "oil" to refer to both crude oil and natural gas liquids.[47] The EIA's estimates of total oil production, for instance, include natural gas liquids and crude oil.[48] As a broader term, "petroleum" encompasses crude oil, natural gas liquids and the refined products of these liquids, ranging from gasoline and diesel to jet fuel and asphalt.[49]

Crude oil, natural gas liquids and natural gas are present in underground "source rocks" as the buried and broken-down remnants of organisms that lived hundreds of millions of years ago. Over millennia, since the formation of these fossil fuels, a large amount has migrated away from source rock, seeping through sandstone or other permeable bedrock either to the Earth's surface or to a geological trap, where it can collect over time to form an isolated reservoir.[50]

Historically, oil and gas development has relied on finding such reservoirs. Now, in sharp contrast, modern drilling and fracking allows the industry to extract the oil and gas straight out of source rocks, bypassing the need to find geological traps containing any oil and gas that left those source rocks.[51]

Of course, not all of the oil or natural gas held in a source rock can be extracted. Only a fraction of the in-place resources are considered "technically recoverable" using current technology, and this is without taking into consideration the costs of extracting the resources.[52]

Using natural gas to displace oil for transportation, or to displace coal for electricity, is playing a zero-sum energy security game. Building the infrastructure necessary to displace significant quantities of oil consumed by the transportation sector requires enormous investments.[36] Likewise, increased use of natural gas for electricity generation also requires large, long-term investments in infrastructure.[37] Such investments would guarantee U.S. dependence on natural gas for decades.

However, given large uncertainties in estimates of natural gas reserves,[38] serious environmental and public health risks posed by drilling and fracking[39] and notorious volatility in natural gas prices,[40] locking-in decades of U.S. dependence on natural gas could prove to be a colossal mistake, resulting in a net negative for U.S. energy security with respect to natural gas. And such investments are likely to preclude the long-term public investments needed to modernize the U.S. energy system and transition off of fossil fuels.[41]

The Decline of Conventional Oil and Natural Gas Production

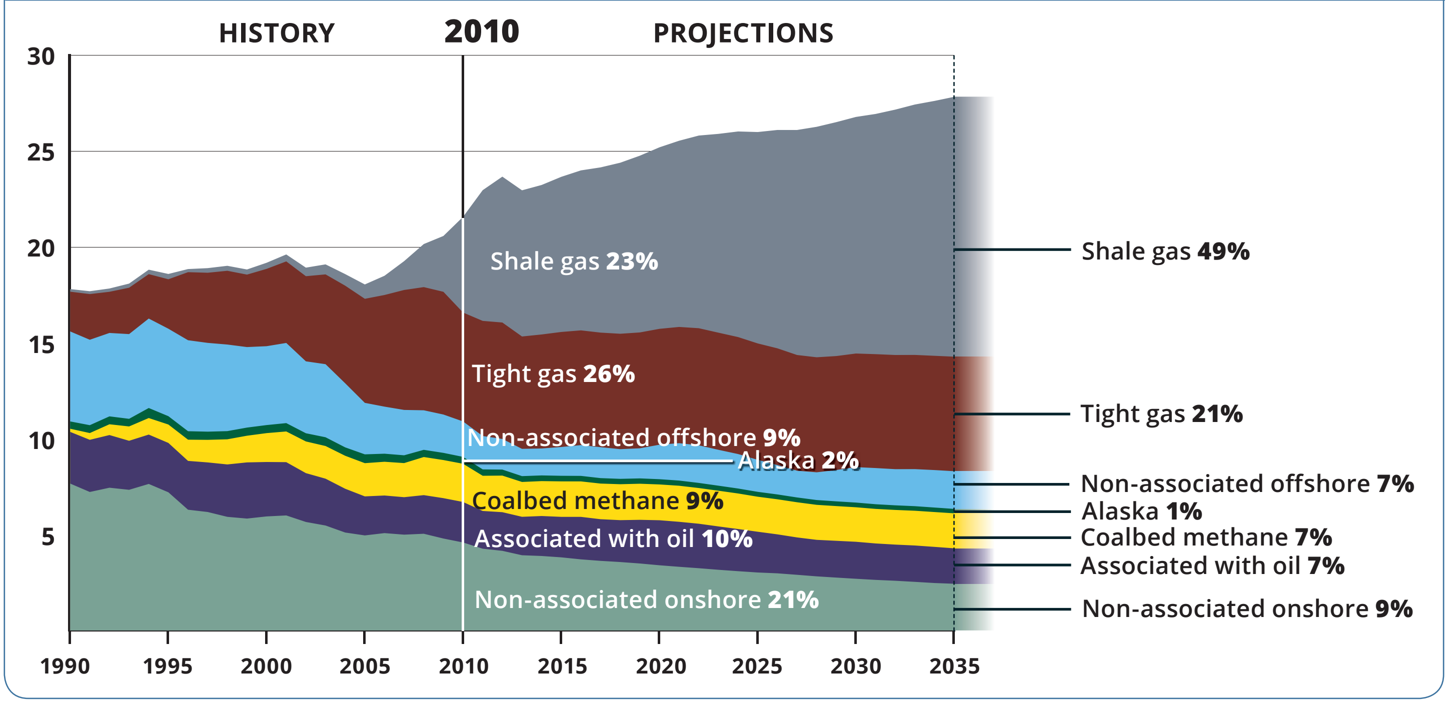
Modern drilling and fracking is best understood in the context of the oil and gas industry's struggle to compensate for declining production from already-discovered oil fields, and in the context of the industry's need to make up for lack of access to much of the world's supply, about 80 percent of which is controlled by foreign governments.[42] Many of these governments are either unstable or unfriendly to international oil corporations.[43]

It has been over 40 years since the discovery of the last of the 40 "super-giant" oil fields — conventional oil fields estimated to have between 5 and 50 billion barrels of "technically recoverable resources" of oil (see box at left for basic background on oil and gas).[53] For perspective, the United States consumed an estimated 6.9 billion barrels worth of petroleum products and crude oil in 2011 alone.[54]

According to one peer-reviewed analysis of global oil production published in 2012, "More than two thirds of current crude oil production capacity may need to be replaced by 2030, simply to keep production constant."[55] This means that there is a growing gap between increasing global demand for oil and what can be supplied by conventional, relatively low-cost methods of extracting oil.[56] Energy analysts have described this new reality as the "end of cheap oil."[57]

In the United States and in almost all European members of the Organisation for Economic Co-operation and

Figure 2. Past and Projected U.S. Natural Gas Production, 1990–2035
TRILLION CUBIC FEET



Growing Dependency on Fracking: *As U.S. production of natural gas from conventional sources declines, the EIA projects that production from shale and other tight rock formations that require fracking will increase.*[58] **SOURCE:** U.S. EIA

Development (OECD), the story is similar with respect to natural gas.[59] Conventional natural gas production is on the decline (see Figure 2) at the same time that global demand for natural gas is expected to grow.[60]

Reduced oil and gas consumption — through conservation, efficiency and renewables — would make Americans less vulnerable to the economic consequences of the growing gap between global demand and conventional supply. But the oil and gas industry's prescription is to try to bridge declines in conventional supply with ever-more intensive methods of extracting oil and natural gas, methods that become profitable as prices climb. They aim to keep "peak oil" production at a plateau for as long as possible.

The Rise of Modern Drilling and Fracking

In the Bakken formation beneath parts of North Dakota and Montana, in the Utica and Marcellus shale beneath Pennsylvania and surrounding states and in the Barnett and Eagle Ford plays in Texas, the oil and natural gas is held tightly, stuck in place and unable to flow. Numerous other states from New York to Florida to California also lie above oil and natural gas source rock.[61]

When operators drill a new shale well, they can only really hope to extract the natural gas that just happens to be ingrained within the part of the source rock that they drill into, or that is present in any faults or natural fractures that the new well passes through. In general, any oil and natural gas in the shale or other tight rock formation that surrounds a well will remain stuck there, unless and until fracking creates a pathway for it to flow out.

Over the past decade, relatively high natural gas prices spurred the industry to develop new drilling and fracking technologies, building on decades of publicly funded research.[62] These technologies, now also being applied to extract oil, make drilling and fracking source rock potentially profitable, depending on the prices of oil and natural gas.

Source rocks such as shale tend to be much more expansive than they are thick.[63] Now, with new drilling technologies, operators are able to drill down several miles to reach a targeted layer of shale, and then drill horizontally through it as far as two miles or more.[64] (See Figure 3, page 8.) Drilling horizontally through shale or other tight rock formations exposes much more of the relatively thin layer of source rock to the well, compared to simply fracking a well that is drilled vertically through this thin layer. Once drilling is finished, operators have the technology to isolate and frack multiple sections along the horizontal leg of a well. In the Bakken formation, for example, operators are now capable of fracking the horizontal portion of a well in up to 40 different stages.[65]

Drilling and fracking for "shale gas" — natural gas trapped in underground shale rock formations — has boomed since about 2005, resulting in significant growth in natural gas production.[67] While advances in technology have brought down costs, modern drilling and fracking for oil and natural gas is significantly more cost-intensive than conventional oil and gas development.[68] As a consequence, shale gas development requires higher natural gas prices in order to actually be profitable.[69] Yet, for a variety of reasons discussed below, the shale gas industry became detached from this reality.

By April 2012, increased natural gas production, combined with lower demand due to a sputtering economy and an abnormally warm 2012 winter, had driven the "wellhead price" for natural gas down from a recent high of over $10 per thousand cubic feet (mcf) in July 2008 to under $2 per mcf.[70] In 2010, ExxonMobil bought into the shale gas boom, becoming the largest producer of natural gas in the country with its purchase of XTO Energy, but by June 2012 CEO Rex Tillerson stated that because of low natural gas prices, "We are all losing our shirts today.... We're making no money [on natural gas]. It's all in the red."[71] That is because natural gas price levels were far below those needed for the industry to break even, given the cost of drilling and fracking new shale gas wells.

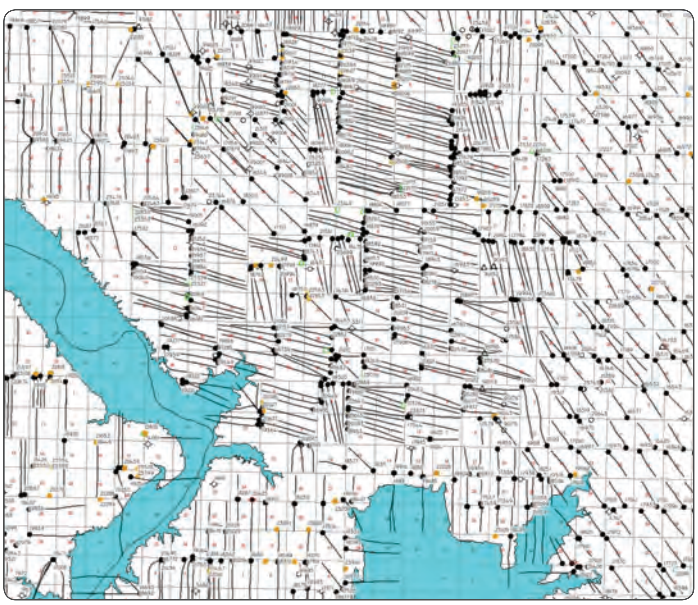


Figure 3. *Coming to a watershed near you?*
Fracked horizontal wells tunnel beneath Lake Sakakawea on the Upper Missouri River, turning the landscape of western North Dakota into a pincushion of oil wells.[66] *Each dashed square is one square mile.*

SOURCE: North Dakota Department of Minerals Management

The natural gas price that a specific company needs to break even depends on how productive its specific portfolio of wells will be. Well productivity varies significantly both within a shale gas play and between plays,[72] and drilling costs can also vary from play to play due to differences in the respective depths of the targeted formations or other local factors, such as land values.[73] As a consequence, break-even prices likewise vary within and between plays.

Analysis of production from shale wells in the Barnett, Fayetteville and Haynesville plays has suggested that the average break-even price in each play is above $8 per mcf.[74] This is more than four times what the wellhead price of natural gas was in April 2012. Excluding the cost of securing leases and general and administrative expenses, the estimated break-even price for these plays was about $6 per mcf.[75] Similarly, the International Energy Agency estimated the cost of producing shale gas in 2010 at between $4 and $9 per mcf.[76] Now, this does not mean that if prices are below $4 per mcf that no shale gas wells will be profitable; a highly productive well drilled into a "sweet spot" may be, especially if it produces natural gas liquids. But it is misleading to suggest, as some analysts do, that because of these sweet spots, the break-even price for producing shale gas is lower than $4 per mcf.[77]

A number of factors contributed to the industry continuing to drill and frack for natural gas despite low natural gas prices.[78] A primary reason is that the terms of many leases required operators to actively drill or else these leases would expire.[79] To generate enough money to actually pay for the drilling and fracking, some companies flipped leases they held or entered into joint ventures with foreign companies, who were either interested in learning modern drilling and fracking methods or interested in gaining access to U.S. natural gas resources (see box on page 9). In a revealing call with investors in October 2008, Chesapeake Energy CEO Aubrey McClendon said, "I can assure you that buying leases for X and selling them for 5X or 10X is a lot more profitable than trying to produce gas at $5 or $6 mcf."[80] The oil and gas industry's thirst for hydrocarbon reserves — a proxy for future earning potential — in the face of declines in conventional oil and gas may explain the eagerness to buy such leases.[81]

Drilling and fracking for tight oil, primarily in the Bakken formation in North Dakota and Montana and the Eagle Ford shale in Texas, and for natural gas liquids in so-called "wet" shale gas plays, has allowed the industry to capitalize on high prices of oil, as well as apparently buy time until U.S. natural gas prices rise.[95] According to Baker Hughes, from 2000 until the summer of 2009, at least three-quarters of all drilling rigs operating in the United States were drilling natural gas wells, and the rest were drilling for oil.[96] But since mid-2009, drilling rigs have fled natural gas plays to drill instead for oil.[97] By late August 2012, just 25 percent are listed as drilling for natural gas and 75 percent are drilling for oil.[98]

Natural gas production remains high despite reduced drilling in the "dry" shale gas plays, in part because significant amounts of natural gas are produced along with tight oil and natural gas liquids.[99] Locking-in future increases in demand for U.S. natural gas — through increased consumption in the transportation and electricity sectors and through increased exports to foreign markets — appears to be part of the industry's long-term strategy for ensuring that natural gas prices are high enough to make shale gas development profitable.

Foreign Companies With Stakes in U.S. Shale Gas and Tight Oil Plays

Netherlands:	Royal Dutch Shell[82]
United Kingdom:	BP[83]
	BG Group[84]
Norway:	Statoil[85]
France:	Total SA[86]
Spain:	Repsol YPF SA[87]
India:	GAIL (India) Limited[88]
China:	Sinopec[89]
	China National Offshore Oil Corp.[90]
Japan:	Sumitomo Corp.[91]
	Marubeni Corp.[92]
	Mitsui & Co.[93]
Australia:	BHP Billiton[94]

Shale Gas Euphoria: America's False Sense of Energy Security

The oil and gas industry's plans to export shale gas, America's supposed ticket to energy security, reveal that the only thing the industry seeks to secure is its bottom line. But the oil and gas industry's push to increase U.S. dependence on natural gas in the transportation and electricity sectors is perhaps even more insidious.

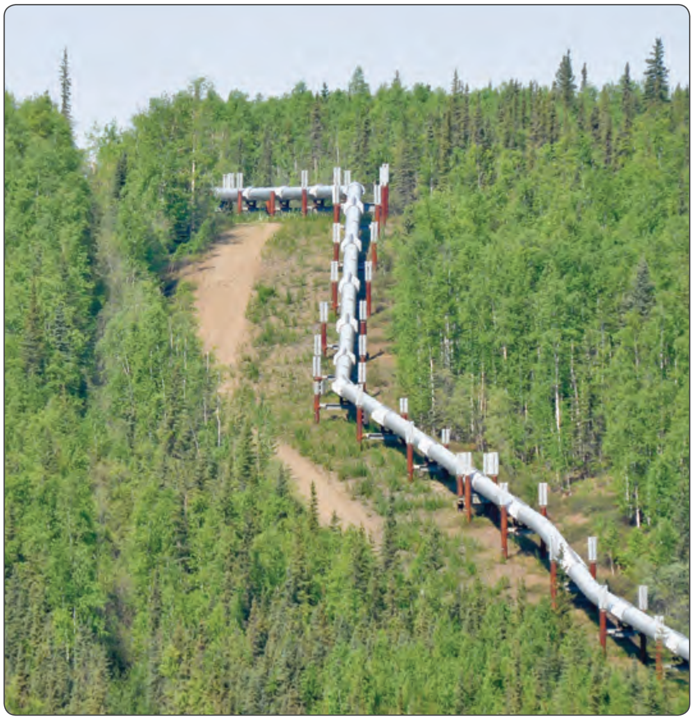
After as much natural gas as possible is extracted from the United States, the country's dependence on natural gas to fuel transportation and generate electricity would persist. Decades from now this dependence could leave the country in need of natural gas imports. American consumers would then be exposed to global demand for natural gas just as they currently are for oil. The United States would also be left behind those countries that chose to invest, instead, in clean energy solutions.[100]

It is true that modern drilling and fracking have contributed to significant increases in the EIA's estimate of technically recoverable natural gas resources in the past decade.[101] A popular claim is that, as a result, the United States has enough natural gas to last it 100 years.[102] However, Food & Water Watch took a close look at this claim and found that it assumes that the industry gets its wish of completely unrestricted access throughout Alaska, throughout the lower 48 states and all along the U.S. coastline. The claim also sweeps under the rug significant uncertainties that are inherent to estimating technically recoverable shale gas resources.

Nonetheless, even if the oil and gas industry gets its wish of unrestricted access and even if preliminary estimates of shale gas reserves prove accurate, Food & Water Watch calculates that the industry's plans to increase demand for U.S. natural gas could easily cut in half the claim of a 100-year supply.

Justification for the claim of a 100-year supply comes from taking the EIA's January 2012 estimate of the total "proved" and "unproved" amounts of technically recoverable natural gas resources — about 2,214 trillion cubic feet (tcf) — and dividing by the amount of natural gas consumed in the United States in 2010, which was about 24.1 tcf.[103] So, assuming that Americans consume the same amount each year, the EIA's estimate of 2,214 tcf of natural gas would last about 92 years.

It is important to realize that shale gas accounts for only about a quarter of the estimated 2,214 tcf of natural gas; specifically, the EIA estimate of 2,214 tcf includes 60 tcf of proved shale gas reserves[104] and 482 tcf of unproved shale gas reserves,[105] for a total of 542 tcf. Under the assumption that annual U.S. consumption stays constant at the 2010 rate, 542 tcf equates to about 22 years worth of shale gas.



These calculations raise three important questions:

- If shale gas makes up 22 years out of the estimated 92 years of natural gas, where is the other 70 years of supposed natural gas supply?
- How uncertain are unproved technically recoverable natural resources?
- Even if all of the unproved technically recoverable resources of natural gas could be extracted, how long would the natural gas actually last in light of plans to export it overseas and plans to use more of it to fuel transportation and generate electricity?

U.S. natural gas "abundance" presumes that the industry will drill and frack everywhere

The oil and gas industry dreams of unrestricted drilling access in Alaska and along the entire U.S. coastline, not just within the lower 48 states.[106] The claim of 100 years of natural gas is nothing but a repackaging of this dream.

Taking the EIA's estimate of 2,214 tcf of natural gas and subtracting its estimate of 542 tcf in shale gas yields 1,672 tcf of technically recoverable natural gas that is not tied up in shale.[107] According to the National Petroleum Council, there is about 300 tcf in Alaska and about 400 tcf from the *entire* U.S. Outer Continental Shelf and other offshore areas in the lower 48 states, including the Great Lakes.[108] Presumably, this approximately 700 tcf — or about 30 of the projected 92 years — is included among the 1,672 tcf of non-shale technically recoverable natural gas resources. Extracting all of it entails giving the oil and gas industry unrestricted access to drill not only throughout Alaska but also all along the Pacific, Gulf of Mexico and Atlantic coasts.

The National Petroleum Council acknowledges, "The technical challenges to developing domestic gas resources are compounded by urban growth, competing land use, and changing public values that increasingly constrain existing and new natural gas development."[109] The claim of about 100 years of natural gas, however, completely ignores this reality. It envisions an America so dependent on the oil and gas industry that no place is off-limits to drilling.

U.S. natural gas "abundance" relies on highly uncertain resource estimates

According to a 2010 Congressional Research Service report, "proved reserves" are defined as: "The quantities of hydrocarbons estimated with reasonable certainty to be commercially recoverable from known accumulations under current economic conditions, operating methods, and government regulations. Current economic conditions include prices and costs prevailing at the time of the estimate."[110] By contrast, "unproved reserves" are "[q]uantities of hydrocarbon resources that are assessed based on geologic and engineering information similar to that used in developing estimates of proved reserves, but technical, contractual, economic, or regulatory uncertainty precludes such reserves from being classified as proved."[111]

To arrive at an estimate of the technically recoverable resources in an emerging shale gas or tight oil play, the EIA uses the total area of the play and the expected density of wells within the play to calculate a total number of expected wells.[112] This total number of wells is adjusted by additional parameters to account for the portion of the play that is untested (i.e., for which there is no production data), and for the portion of the play believed to have production potential.[113] The total reserve estimate then follows from taking the resulting hypothetical number of expected wells, and multiplying by the "estimated ultimate recovery" (EUR) of oil, or natural gas, expected over the lifetime of each well, presumed to be 30 years.[114]

EUR is the primary source of uncertainty in estimates of oil and natural gas technically recoverable from shale and other tight rock formations.[115] This is in large part because there is no long-term production data — since shale gas and tight oil development are so new, and each shale play is different — to serve as a basis for predicting how rapidly shale gas or tight oil production will decline over time for a collection of wells within a specific play.[116] Projecting what gradual decline might look like 30 years out, based on just a few initial years of steeply declining production, is a highly uncertain process.[117]

The EIA takes the latest data on how much oil or natural gas is produced from a collection of wells and then extrapolates from these data over time, using a specific shape of decline given by a "hyperbolic" function.[118] The steep declines in production of a typical shale gas well over the first few years means that new wells must be drilled and fracked each year just to maintain production — this has been likened to a treadmill.[119]

While calculating EURs for conventional oil and gas reserves is an established science,[120] many of the assumptions on which this science is based are violated in the context of extracting oil and natural gas from shale and other tight rock formations.[121] The uncertainty surrounding EUR calculations lies at the root of a June 2011 investigation by the *New York Times*, which was full of revelations, including; "An internal Energy Information Administration document says companies have exaggerated 'the appearance of shale gas well profitability,' are highlighting the performance of only their best wells and may be using overly optimistic models for projecting the wells' productivity over the next several decades."[122]

As stated in the discussion of break-even prices, the amount of shale gas that can be produced from a well varies significantly within a shale gas play.[123] As a consequence, as "sweet spots" in the play are identified, operators drill and frack the most productive portions of the play first, leaving the less productive and thus less profitable portions of the play for later. Since within a play, the cost of drilling and fracking a well is essentially the same, the less productive portions of plays may only become profitable once natural gas prices rise. While these portions of the play hold shale gas that is technically recoverable, the gas is not economically recoverable.

This pattern in well productivities means that just to sustain a constant level of shale gas production, the rate of drilling and fracking must increase — it's an accelerating treadmill. And extracting all of the estimated U.S. shale gas resource presumes that operators can increase the pace of drilling and fracking indefinitely; they must always be able to access and profitably tap new but less productive source rocks as natural gas prices rise. This is what widespread drilling and fracking means: a future in which the United States is turned into a pincushion of oil and gas wells. As these wells age over decades, a large fraction of them will fail to contain methane and other hydrocarbon gases, in many cases putting at risk underground sources of drinking water.[124]

How quickly might U.S. natural gas be consumed?

Even if the oil and gas industry gets its wish of unrestricted access, and even if preliminary estimates of shale gas reserves prove accurate, drilling and fracking will not deliver long-term U.S. energy security. Food & Water Watch calculates that the EIA's baseline projection of future domestic consumption, current proposals to export natural gas and plans to increase natural gas demand in the transportation and electricity sectors would drastically reduce the period of time that estimated reserves could last, further undercutting the industry's claims about U.S. energy security (see box).

100 years worth of natural gas?
Not likely and no thanks

Even assuming that the oil and gas industry wins unrestricted access to drill and frack and assuming that estimates of unproven resources are accurate, increased demand for U.S. natural gas could easily cut in half the claim of a 100-year supply.

Popular claim:
100 years

Holding consumption constant at 2010 level:
92 years

Using the EIA's projected growth in rate consumption:
78 years

And supposing, from 2026 to 2045, liquefied natural gas exports reach 60 percent of currently proposed capacity:
72 years

And supposing that, by 2025, natural gas displaces the energy equivalent of 40 percent of 2011 demand for gasoline and diesel:
58 years

And supposing that, by 2025, natural gas is used to generate electricity equivalent to 50 percent of the electricity generated by coal in 2011:
50 years

First, when the EIA estimates that there is 92 years worth of technically recoverable natural gas, it does not factor in its own baseline projection of increased natural gas consumption; recall that the estimate assumes that natural gas consumption would be the same each year as it was in 2010. The EIA, however, currently projects that between 2010 and 2035, U.S. natural gas consumption will increase, on average, by 0.4 percent annually.[125] **Incorporating this projection, and further assuming that consumption continues to grow at this rate beyond 2035, Food & Water Watch calculates that the estimated 2,214 tcf of proved and unproved technically recoverable natural gas resources, if accurate, would last about 78 years.**

But the 0.4 percent annual growth rate is for domestic consumption, and it is a baseline figure based on current laws and regulations.[126] For instance, it does not account for the rapidly growing number of applications to the U.S. Department of Energy seeking authorization to export liquefied natural gas (LNG) to foreign markets (see table on page 13).

As opposed to oil, the supply chain for natural gas is not yet globalized.[127] Large regional price differences — due in part to natural gas prices being linked to oil prices in some markets — explain the oil and gas industry's recent interest in exporting natural gas from the United States.[128] In mid-July 2012, for example, *The Economist* reported, "Whereas American gas currently costs about $2.50 [per million British thermal units (mBtu)], European oil-indexed pipeline gas goes for around $12 [per] mBtu, and in Asia LNG can fetch $16 [per] mBtu or more."[129] Note that 1 million Btu of natural gas is approximately equivalent to 1,000 cubic feet of natural gas.[130] According to *The Economist*, "Liquefying the gas, carrying it to its destination and regasifying it can cost between $4 and $7 [per] mBtu",[131] so the industry has an opportunity to make significant profits exporting natural gas.

Such exports clearly belie the industry's patriotic rhetoric on U.S. energy security and energy independence, revealing profit as the true motive. In addition to foreign interests having stakes in U.S. shale gas plays,[132] some have already signed contracts, or are pursuing contracts to import U.S. natural gas.[133] This raises questions about whether these foreign interests will influence how much natural gas gets exported overseas. Meanwhile, American communities would be left with the potentially costly legacy of environmental pollution in the wake of drilling and fracking.[134]

As of October 26, 2012, the U.S. Department of Energy had received applications to export a combined total of 28.39 billion cubic feet of natural gas per day.[135] If all applications were to be approved, this capacity would amount to about 10 tcf per year, which is about 40 percent of all U.S. natural gas consumption in 2011.[136]

To demonstrate how such exports might impact the "92 years of supply" claim, Food & Water Watch conservatively assumes a scenario in which LNG exports, from 2016 to 2026, ramp up to 60 percent of the export capacity proposed as of October 26, 2012, reaching about 6 tcf. This of course neglects any additional applications after October 26, 2012. Food & Water Watch further assumes that LNG exports stay at 60 percent of currently proposed capacity for 20 years, from 2026 through to 2045, followed by a 20-year period in which LNG exports decline steadily down to zero to reflect the likely convergence in natural gas prices around the world.[137]

Food & Water Watch calculates that the estimated 2,214 tcf in proved and unproved technically recoverable natural gas resources, if accurate, would last about 72 years under such an LNG export scenario, along with the EIA's projection of 0.4 percent growth in annual U.S. consumption.

Finally, plans to stimulate increased U.S. demand for natural gas in the transportation and electricity sectors would further cut into the claimed 100 years of natural gas.[138]

To illustrate the effect that such plans might have, Food & Water Watch first assumed a scenario in which, on top of the EIA's projected baseline consumption, the use of natural gas as a transportation fuel increases gradually

Proposed LNG Export Capacity Amounts to Over 40 Percent of 2011 U.S. Natural Gas Consumption

Applications Received by the Department of Energy to Export Domestically Produced LNG From the Lower 48 States (as of October 26, 2012)

Company	Initial application date filed	Proposed export capacity (billion cubic feet per day)	Facility location (if applicable)
Sabine Pass Liquefaction, LLC	August 11, 2010	2.2	Cameron Parish, LA
Freeport LNG Expansion, LP and FLNG Liquefaction, LLC	December 17, 2010	1.4	Quintana Island, TX
Lake Charles Exports, LLC	May 6, 2011	2.0	Lake Charles, LA
Carib Energy (USA) LLC	June 6, 2011	0.04	third-party liquefaction
Dominion Cove Point LNG, LP	September 1, 2011	1.0	Calvert County, MD
Jordan Cove Energy Project, LP	September 22, 2011	2.0	Coos Bay, OR
Cameron LNG, LLC	November 10, 2011	1.7	Cameron Parish, LA
Freeport LNG Expansion, LP and FLNG Liquefaction, LLC	December 20, 2011	1.4	Quintana Island, TX
Gulf Coast LNG Export, LLC	January 10, 2012	2.8	Brownsville, TX
Gulf LNG Liquefaction Company, LLC	May 2, 2012	1.5	Pascagoula, MS
LNG Development Company, LLC	May 3, 2012	1.25	Warrenton, OR
SB Power Solutions Inc.	May 7, 2012	0.07	third-party liquefaction
Southern LNG Company, LLC	May 15, 2012	0.5	Savannah, GA
Excelerate Liquefaction Solutions I, LLC	May 25, 2012	1.38	Calhoun County, TX
Golden Pass Products, LLC	August 17, 2012	2.6	Sabine Pass, TX
Cheniere Marketing, LLC	August 31, 2012	2.1	Corpus Christi, TX
Main Pass Energy Hub, LLC	September 11, 2012	3.22	16 miles offshore LA
CE FLNG, LLC	September 21, 2012	1.07	Plaquemines Parish, LA
Waller LNG Services, LLC	October 12, 2012	0.16	Cameron Parish, LA
Daily total (billion cubic feet per day)		**28.39**	
Annual total (trillion cubic feet per year)		**10.36**	
U.S. consumption of natural gas, 2011 (trillion cubic feet)		**24.5**	

SOURCES:

Export capacities: U.S. Department of Energy, Office of Fossil Energy. "Summary of LNG export applications." November 1, 2012.

2012 Applications: "2012 LNG Import/Export Authorization Applications." Available at http://www.fossil.energy.gov/programs/gasregulation/authorizations/2012_Long_Term_Applications.html, accessed November 1, 2012.

2011 Applications: "2011 LNG Import/Export Authorization Applications." Available at http://www.fossil.energy.gov/programs/gasregulation/authorizations/2011_Long_Term_Applications.html, accessed November 1, 2012.

2010 Applications: "2010 LNG Import/Export Authorization Applications." Available at http://www.fossil.energy.gov/programs/gasregulation/authorizations/2010_Long_Term_Applications.html, accessed November 1, 2012.

until 2025, reaching 40 percent of current demand for motor gasoline and distillate fuels, and that the use of natural gas in transportation stays at this level thereafter. **Food & Water calculates that the estimated 2,214 tcf in proved and unproved technically recoverable natural gas resources, if accurate, would last about 58 years under such a scenario of natural gas displacing oil for transportation fuels.**[139]

As for using natural gas instead of coal to generate electricity, Food & Water Watch assumes that natural gas consumption by the electricity sector increases steadily over the baseline so that, by 2025 and beyond, 50 percent of the amount of electricity generated using coal in 2011 is generated instead using natural gas. **Adding this assumption to the above scenarios, and accounting for differences in efficiencies between coal-fired and natural gas-fired electricity genera-**

tion,[140] such an increase in natural gas consumption would mean that the estimated 2,214 tcf in proved and unproved technically recoverable natural gas resources, if accurate, would last about 50 years.[141]

This sequence of simple calculations demonstrates that, even if the oil and gas industry is granted unrestricted access to extract any and all natural gas it can find, the current estimated supply is far from the energy panacea the industry claims. If allowed to write its own policies, the oil and gas industry will simply extract as much as possible, as fast as possible, for maximum profit, while fighting to prolong America's destructive dependence on fossil fuels. Then, once U.S. natural gas is gone, the global oil and gas industry will likely be well positioned to import foreign sources of fracked natural gas to feed this dependence; Royal Dutch Shell and ExxonMobil, in particular, are invested in building a global natural gas supply chain.[142] Their strategic plans for such a global supply chain serve as an illustration of how Big Oil sees an opportunity, not a threat, in using natural gas in addition to oil to fuel transportation.[143]

Tight Oil Euphoria: Empty Promises of Oil Independence

Amid the fervor over drilling and fracking for tight oil, Americans are hearing empty promises that U.S. energy independence is within reach.[144] In a 2012 report, Citigroup, a global financial institution, went so far as to suggest that North America could become the "new Middle East by the next decade; a growing hydrocarbon net exporting center...."[145] But consider that foreign companies are buying stakes in U.S. tight oil plays, establishing joint ventures with U.S. companies and providing the capital necessary to drill and frack.[146] These foreign companies stand to profit, of course, as tight oil from the wells in which they have a stake is sold on the global market. So, when American consumers buy the gasoline or diesel from this tight oil, are they really consuming domestic oil, or are they consuming foreign oil?

With respect to energy security, it doesn't matter. The globalized market for oil means that reducing oil consumption is the only way American consumers can inoculate themselves against the high oil prices that will result from increased global demand for oil, coupled with increased costs to extract the oil that remains underground.[147] Another consequence of the globalized oil market is that, regardless of whether the oil Americans consume is produced domestically or produced abroad, so long as Americans consume a lot of it, the United States is likely to spend billions of dollars, if not tens of billions of dollars, on military operations to secure Middle East oil shipments in an effort to ensure stable global oil prices.[148]

But the reality is that tight oil from drilling and fracking is just a drop in the bucket of U.S. oil consumption. The United States consumed about 18.8 million barrels of oil per day in 2011,[149] yet it produced only an estimated 0.55 million barrels of tight oil per day.[150] The EIA does project that tight oil production will increase, but to only about 1.2 million barrels per day between now and 2020, peaking at 1.33 million barrels per day in 2029 before starting to decline.[151] This peak would amount to only about 7 percent of the 18.8 million barrels per day consumed in the United States in 2011.

And then there is the reality on the ground of what it would take to achieve such levels of production. An analysis of hundreds of wells producing tight oil from the Bakken formation illustrates that production follows the pattern not just of a treadmill, but of an accelerating treadmill — just to sustain a constant level of production, a larger number of new wells must be drilled and fracked each year.[152]

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As for reserves, the EIA estimates that there is 33.2 billion barrels of technically recoverable tight oil, with all the caveats and uncertainties outlined above for similar estimates of shale gas.[153] For perspective, 33.2 billion barrels of tight oil wouldn't last seven years if consumed at a rate of 15 million barrels per day, well below the current rate of U.S. consumption. In 2011, the United States accounted for over 20 percent of global oil consumption, but it contributed only about 9 percent of global oil production and possessed less than 2 percent of the world's proved oil reserves.[154]

Clearly, the promises are empty that U.S. oil independence is within reach, thanks to drilling and fracking. It is also clear that widespread drilling and fracking for tight oil will do next to nothing for American consumers.[155] In fact, while these consumers pay historically high prices at the pump, the industry is maximizing their profits by exporting record amounts of gasoline and diesel.[156]

Peter Orszag, former director of the Office of Management and Budget in the Obama administration and now currently at Citigroup, has put forward a slightly different argument, suggesting that the development of tight oil could push down global oil prices by loosening concerns over declining world oil supplies.[157] Leonardo Maugeri, an Italian oil executive currently at Harvard's Kennedy School of Government as a research fellow, has added, "The U.S. shale/tight oil could be a paradigm-shifter for the oil world, because it could alter its features by allowing not only for the development of the world's still virgin shale/tight oil formations, but also for recovering more oil from conventional, established oilfields...."[158]

Bestowing such faith on the oil and gas industry, and on the global oil market, is misguided, perhaps most importantly because it ignores the threat of global climate change. But even if such speculation about the potential of tight oil proved correct, the result would get the United States nowhere in its quest for energy security. Facilitated by low oil prices, high consumption would persist once the tight oil in the country is gone, and the United States would be right back where it started: it would be dependent on foreign sources of oil — it's just that the foreign oil being imported would be tight oil, or other oil produced by unconventional methods. Meanwhile, the global oil and gas industry would continue to profit from America's dependence on it.

Fracking Euphoria: A Threat to Long-term U.S. Energy Security and Independence

The EIA estimates that extracting the technically recoverable resources of shale gas and tight oil would require drilling and fracking over 630,000 new wells.[159] But what happens after that?

Modern drilling and fracking, together with deepwater drilling and tar sands oil, are just the current generation of the industry's unconventional extraction methods.[160] As oil and natural gas become increasingly valuable on global markets, these approaches will intensify and new, even more costly extraction methods will be pushed by the industry.[161] Oil shale (as opposed to shale oil), ultra-deep offshore oil, Arctic oil and methane hydrates are all in the oil and gas industry's sights.[162] For the oil and gas industry, drilling and fracking simply provide a bridge to the next generation of its false solutions to America's energy challenges.

It is not too late for the United States to avoid going down this self-destructive path. Long-term U.S. energy security and independence can actually be achieved, but the country needs to act now to deploy existing energy efficiency and renewable energy solutions and invest in future technologies that expand these solutions.[163]

These solutions will eliminate the hidden costs of burning fossil fuels, resulting in enormous environmental and public health benefits.[164] Acting now will also help to ensure that the United States is a global leader in supplying clean energy technologies to the rest of the world.[165] In addition, building and maintaining local, resilient energy systems that are characterized by energy efficiency and that rely on distributed renewable power generation — instead of on centralized, wasteful and polluting fossil fuel power — will create and sustain local jobs.[166] Such energy systems will also spare communities

the inevitable economic drag that future oil and natural gas price increases will cause as global demand grows and global supply is consumed.[167]

But remaking how energy is produced and consumed in the United States requires large investments in infrastructure and aggressive changes in policy.[168] Currently, the fossil fuel industry's established infrastructure — its pipelines, power plants and transmission lines — makes it difficult if not impossible for clean, renewable energy resources to compete.[169] Over a trillion dollars in "sunk" costs in such infrastructure favors the status quo of dependence on the oil and gas industry, serving as a barrier to the remaking of the U.S. energy system.[170]

The oil and gas industry has been supported, directly or indirectly, by decades of federal policies favorable to the industry.[171] This includes billions of dollars in tax breaks annually,[172] low costs charged by the government when the industry leases public lands,[173] federal spending on research and development beneficial to the industry[174] and limits on liability that allow the industry to foist operational risk onto the federal government.[175] Such giveaways to the oil and gas industry dwarf the total federal incentives received by the renewable energy sector.[176]

Oil and gas companies continue to enjoy corporate welfare in the form of permanent tax breaks; at the same time, uncertainty over whether Congress will renew clean energy tax incentives, or will let them expire, throws a wrench in private investments in clean energy.[177] This contrast highlights the extent to which the fossil fuel industry has skewed American energy policy to further its bottom line.[178]

On the one hand, the fossil fuel industry is funding an array of groups pushing to allow renewable energy production tax credits to expire.[179] On the other hand, the oil and gas industry's generous campaign donations are proving to be a good investment, particularly given the outcome of the March 2012 vote in the U.S. Senate on whether or not to end tax subsidies to the oil and gas industry, which are estimated to cost the American public $24 billion in forgone revenues over the next decade.[180]

During the 2011–2012 election cycle alone, the oil and gas sector gave about $2.2 million in campaign contributions to the 47 Senators who voted to keep the tax subsidies in place, compared to a total of $674,160 to the 51 Senators who voted in favor of ending the subsidies (60 votes were required to end the filibuster).[181] Including all campaign donations from 1989 to early September of 2012, the same 47 Senators had raked in a total of about $24.4 million from the oil and gas sector, while the 51 Senators who voted in favor of ending the subsidies had been given a total of about $6.1 million.[182]

Despite the entrenched advantages that the fossil fuel industry enjoys, wind energy can now outcompete coal and has become competitive with natural gas on a "levelized" cost basis for new power installations.[183] However, the potential expiration of production tax credits, generally low electricity demand due to a struggling economy and the currently low prices of natural gas all combine to threaten the domestic wind industry.[184] In particular, the looming end of production tax credits is creating a rush to finish installations by the end of 2012, which could be disruptive to the industry in 2013.[185]

The fossil fuel industry further benefits, and the clean energy industry suffers, from the overall failure of the market, vis-à-vis energy prices, to account for the true societal costs of the industry's pollution, particularly the current and future costs of global climate change.[186]

Conclusion and Recommendations

Drilling and fracking simply serve the myth — a very profitable myth for the oil and gas industry, and a very destructive one for the American public — that the United States can drill its way to energy security and energy independence.

The popular claim of a 100-year supply of natural gas is based on the oil and gas industry's dream of unrestricted access to drill and frack, and it presumes that highly uncertain resource estimates prove accurate. Further, the claim of a century's worth of natural gas ignores plans to export large amounts of it overseas and plans for more domestic use of natural gas to fuel transportation and generate electricity. Even if the oil and gas industry's dreams come true and even if the uncertain resource estimates prove accurate, increasing production to feed global demand for exports and meet planned increases in domestic consumption could easily cut the 100-year-supply claim in half.

As for oil, drilling and fracking for tight oil in the United States is just a drop in the bucket of global oil production, and since oil is priced on a global market, drilling and fracking will do next to nothing for American consumers.

The United States can transition off of fossil fuels, and in the process achieve long-term energy security, independence and resilience, by remaking the U.S. energy system. To this end, Food & Water Watch urges state and local governments and the federal government to:

- Enact aggressive energy conservation policies, including large public transportation investments and widespread deployment of energy efficiency solutions, to reduce energy demand;
- Establish ambitious programs for deploying and incentivizing existing renewable energy technologies to increase clean energy supply;

- Modernize the U.S. electrical grid so that it caters to distributed renewable power generation;
- Make sweeping investments in research and development to overcome technological barriers to the next generation of clean energy solutions; and
- Terminate all public funding, including tax expenditures, that not only pads the profits of the fossil fuel industry but also further entrenches America's dependence on fossil fuels.

The time is now for Americans to end their destructive dependence on the fossil fuel industry.

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Mining the Data: Analyzing the Economic Implications of Mining for Nonmetropolitan Regions

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Extractive industries such as logging and mining are generally expected to bring significant economic benefits to rural regions, but a growing number of findings have now challenged that common expectation. Still, it is not clear whether the findings of less-than-desirable economic outcomes are isolated or representative. In this article, we assemble literally all of the relevant quantitative findings on mining that we have been able to identify in published and/or technical literature from the United States. In the interest of rigor, we limit the assessment to cases in which strictly nonmetropolitan mining regions are compared against other nonmetropolitan regions and/or against those regions' own experiences over time. Overall, 301 findings meet the criteria for inclusion. Contrary to the long-established assumptions, but consistent with more recent critiques, roughly half of all published findings indicate negative economic outcomes in mining communities, with the remaining findings being split roughly evenly between favorable and neutral/indeterminate ones. Positive findings are more likely to be associated with incomes than with poverty or (especially) unemployment rates, and they are more likely to come from the western United States, where much of the mining involves relatively large, new coal strip mines. Over half of all positive findings come from the years prior to 1982. In virtually all other categories, the plurality or majority of findings have been negative. When the patterns of findings are subjected to one-sample means tests, the only way to produce a significantly positive outcome is by combining all neutral/indeterminate findings with the positive ones, while focusing exclusively on incomes; by contrast, in the case of poverty or unemployment rates—as well as for the overall body of findings—the results are consistently and significantly negative, whether the neutral/indeterminate findings are combined with negative ones or omitted from the equations altogether. Until or unless future studies produce dramatically different findings, there appears to be no scientific basis for accepting the widespread, "obvious" assumption that mining will lead to economic improvement.

Both in academic and popular discourse, the common assumption has long been that the potential environmental threats from extractive industries such as logging and mining will be accompanied by economic benefits for the industries' host regions (see, e.g., Imrie 1992; Thompson and Blevins 1983, p. 153; cf. Humphrey et al.1993; see also Lewan 1993). Indeed, particularly for areas that are remote from urban agglomerations and industrial development, the extraction of raw materials from nature is often seen to be the only hope for economic

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development. At least in principle, it would seem reasonable to expect a rich natural resource endowment to translate into increased prosperity, because resource-dependent industries have significantly less locational flexibility than do most other industrial activities. New mines, for example, can only have a realistic opportunity to be profitable in locations where actual mineral deposits are available. In recent years, however, the common assumptions have begun to be undercut by a growing body of findings.

To date, it is not clear whether the findings of less-than-desirable socioeconomic outcomes are idiosyncratic or systematic. In this article, accordingly, we seek to provide a comprehensive summary and assessment of the accumulated findings, focusing on mining-dependent communities. We begin with a qualitative review of the existing literature, including known technical reports and other "gray" literature as well as the findings published in peer-reviewed journals. We follow with a quantitative analysis of the key categories of available socioeconomic findings—those on income, unemployment, and poverty rates—that permit "apples to apples" comparisons of the experiences of nonmetropolitan mining regions against those of nonmetropolitan comparison regions and/or against their own experiences over time. The closing section considers this study's implications for future research on natural resource development in nonmetropolitan regions.

Overview of the Literature

Over the past several decades, researchers have begun to question the once-common assumption that mining would bring socioeconomic prosperity to host regions. The questioning appears to have begun outside of the United States, when authors such as Frank (1966, 1967) began to draw attention to "underdevelopment," which was argued to be due in part to unfavorable terms of trade—with raw materials being sent out from extractive regions at relatively low prices, in unequal exchange for finished products that needed to be imported at high prices. In subsequent years, other international studies (see, e.g., Barham and Coomes 1993; Bunker 1985; Repetto 1995; Schurman 1993) have indicated further reasons for concern. Indeed, careful quantitative analyses have found that—even after controlling statistically for other variables, ranging from the openness of a national economy, to the efficiency of national bureaucracy, to the degree of inequality in national income concentration—nations with high rates of natural resource exports have had abnormally low rates of subsequent economic growth (see, e.g., Sachs and Warner 1995; for a careful review of the larger literature on this "resource curse," see especially Ross 1999).

The work of Corden and Neary (1983) helped to draw increased attention to the paradoxical implications of extractive industries in industrialized countries, highlighting what the authors called "Dutch disease": Holland's massive North Sea oil revenues were actually found to be associated with declining rather than improving economic fortunes. At least initially, however, such findings received relatively little attention in U.S. community studies. As many rural community leaders have been quick to point out, after all, jobs in logging and mining tend to pay far higher wages than do service jobs such as cleaning hotel rooms or serving fast-food hamburgers. This point is not simply a widespread belief with no empirical support; instead, the nationwide study by Mills (1995), for example, found that earnings per worker were higher in mining than in many other economic sectors—whether considering metropolitan or nonmetropolitan regions, and whether focusing on the "mining boom time" of 1980 or on the nonboom years of 1970 and 1990. In important respects, accordingly, it has long seemed "obvious" to many commentators that extractive industries should be associated with significantly increased local prosperity. In addition, while examinations of the economic characteristics of mining communities have had a long history in the social sciences (for a review, see Field and Burch 1991), few studies seriously questioned the common assumptions and expectations until the 1980s.

Moreover, in one of the first studies to look at the topic in a broad-brush fashion, Bender et al. (1985) obtained results that were reasonably consistent with the usual expectations. Drawing data largely from the 1980 Census of Population and Housing and using a definition that would later be followed by many other authors—with "mining-dependent" counties being those where 20 percent or more of total labor and proprietor income came from mining—Bender et al. found that mining-dependent counties had higher population growth rates, higher incomes, and fewer people receiving social security than the nonmetropolitan average of the times. The study did note, however, that "the variations among counties . . . were large," and that decreases in demand for fuels and minerals between 1979 and the time of their study in 1985 had "produced income and population declines" that did not show up in their study's quantitative analyses (Bender et al. 1985, p. 9).

The subsequent trends were soon to be documented more systematically. Hady and Ross (1990), both of whom were coauthors on the original Bender et al. study, conducted an update, examining the differences between counties that were mining-dependent by the same definition in 1979 (during the height of the energy crisis and mineral prices) and in 1986 (after both a recession and a drop in mineral prices). In the 7 years between 1979 and 1986, mining employment in the nonmetropolitan United States declined by 14 percent; 50 counties ceased being mining-dependent, while only 19 others became mining-dependent during that period. On average, whether focusing on the counties that were mining-dependent in 1979, 1986, or both, the follow-up study found declining personal incomes and increasing unemployment from 1979 to 1986.

Other researchers soon found evidence that less-than-favorable findings were not limited to a 7-year period. In a more comprehensive review of natural-resource-oriented industries, for example, Weber, Castle, and Shriver (1987) found that, while counties with energy-related mining experienced growth in both employment and earnings during the generally "booming" years of 1969–1985, counties with metal mining experienced declines in both indicators, even during those years.

These kinds of results have raised questions about the degree to which the findings from Bender et al. (1985) may have been influenced by the extraordinary conditions in energy extraction that happened to be approaching their peak around the time period considered in that initial study. One of the points that has become quite clear, for example, is that the areas of the United States having the highest levels of long-term poverty, outside of those having a history of racial inequalities, tend to be found in the very places that were once the site of thriving extractive industries—most notably in Appalachia (Gaventa 1980), but to a lesser extent also in other one-time mining and logging areas such as the "cutover region" of the Upper Midwest (see, e.g., Landis 1938; Lisheron 1991; cf. Schwarzweller and Lean 1993). Perhaps more ominously, the reasons for concern are not limited simply to the implications of ultimate shutdowns or "busts." Several studies have found evidence of problems even while extraction is occurring (e.g., Cook 1995; Drielsma 1984; Elo and Beale 1985; Freudenburg and Gramling 1994; Krannich and Luloff 1991; Peluso et al. 1994; Tickamyer and Tickamyer 1988).

In subsequent years, a number of studies have compared census data from different regions and times. Perhaps the most systematic of these analyses can be found in the work of Nord and Luloff (1993), who offered three kinds of comparisons—comparing data from the 1980 and 1990 censuses, from three regions of the country (the west, the south, and the Great Lakes), and from three different sectors of the mining industry (coal, petroleum, and "other," the last of which includes metal mining and quarrying). These authors' analyses mirrored the findings of Bender et al. in showing that conditions were relatively favorable at the time of the 1980 census, but further analyses showed that the economic implications of mining in all three regions of the country, and in all sectors of the mining industry, had deteriorated since that time. Except in the western region, in fact, unemployment was found to be consistently higher in mining counties than in other nonmetropolitan counties, in each respective region of the country, both in 1980 and in 1990. By 1990, in all but the western region, mining-dependent counties had lower incomes and more persons in poverty than did the nonmining counties. In all regions of the country, including the west, mining-dependent counties experienced greater increases in poverty rates from 1980 to 1990 than did other nonmetropolitan counties. All in all, the only favorable findings associated with mining areas in the 1990 census were found in the western United States—and even there, the findings provided less reason for optimism than had appeared to be the case in 1980.

Other studies have found that local residents' widespread expectations for improved employment may be particularly problematic. In analyzing a decade's worth of data compiled by Weber et al. (1987), for example—a period that included both the "boom years" of extractive industries in the late 1970s and the "agricultural crisis" years of the early 1980s—Krannich and Luloff (1991) found that mining-dependent counties had higher levels of unemployment than did agriculture-dependent counties, in every single year, even during this period. In addition, there is at least suggestive evidence that mining communities' economic problems tend to become increasingly pronounced over time, exacerbated by the volatility of commodity prices, the potential for a cost–price squeeze, and the problem of "flickering" (i.e., the periodic shutting down of extractive operations, as prices fluctuate above and below the costs of operation in specific locations—see Hibbard and Elias 1993). This flickering can contribute to problems of unemployment and poverty, given that laid-off workers will often choose to remain in the area, sometimes for extended periods, in the hope or belief that the high-wage jobs will ultimately return (see, e.g., Freudenburg 1992; Krannich and Luloff 1991).

Perhaps in part because of findings such as the ones being summarized here, there is a potentially telling contrast in two types of studies that have gauged the reactions of local leaders. In regions that are expecting increased mining or just beginning to experience a "boom," it is common to find what Gulliford (1989) calls "euphoria." Unfortunately, in regions that have actually experienced natural resource extraction, local leaders have been found to view their economic prospects less in terms of jubilation than of desperation (e.g., Krannich and Luloff 1991; Freudenburg 1992; Gulliford 1989; Peluso et al. 1994; cf. Cottrell 1951, 1955; Gaventa 1980). Thus, while the largest of the nine working groups established by the Rural Sociological Society's Task Force on Rural Poverty was the one that focused on natural resources, the working group ultimately identified resource extraction not as an antidote to poverty, but as something more like a cause or correlate. In the authors' terminology, they found resource extraction to have a "systematic relationship" with "the impoverization of rural people"—so much so that the bulk of their review was devoted to an effort to identify "social forces at work in resource-dependent rural communities that lead to the creation of relative and/or absolute poverty" (Humphrey et al. 1993, pp. 137–8; see also the responses to this report, including Freudenburg and Gramling 1994; Peluso et al. 1994; Nord and Luloff 1993).

Quantitative Analysis of Available Findings

While even a qualitative literature review can illustrate the need for caution, there is clearly also a need for a more systematic assessment of the relevant evidence. Mining would appear to deserve particularly close attention in that, to repeat, jobs in mining tend to be associated with some of the highest incomes in any economic sector (Mills 1995). In response, we have sought to bring together and analyze the available findings in a way that would be more systematic, and yet that could be reported in a manner that is as straightforward as possible.

As suggested by the foregoing review, there are many differences across the available studies—a fact with a number of important implications. First and most clearly, differences in the units of analysis and the operationalization of variables mean that any comparisons need to be interpreted with caution—as being indicative of overall patterns, rather than as providing definitive or clearcut answers. Second, the available findings are not independent; instead, there are multiple overlaps but also differences across studies. In terms of overlaps, for example, many authors use statistics from the Census and/or the Bureau of Labor Statistics, but at the same time, there are many differences in the time periods and specific sets of counties being considered. In terms of differences, some authors distinguish carefully between "community-level" versus "county-level" data, while others use the terms more or less interchangeably, and some authors focus on officially "rural" communities (those with fewer than 2,500 residents), while many other studies include nonmetropolitan regions more broadly.

Such overlaps and differences would make it inappropriate and potentially misleading to perform extensive statistical transformations or analyses; instead, the more responsible approach is to assess the findings in terms of simple and easy-to-understand categories. In the analyses that follow, accordingly, we have classified the results in terms of a three-way typology—as indicating, in other words, conditions that are more favorable, less favorable, or no different from the conditions prevailing in relevant nonmining areas and/or during earlier time periods. In the effort to avoid the imposition of our own views, we have deferred to the original authors' interpretations of the data whenever such interpretations are available. A "favorable" finding, for example, thus usually reflects the judgement of those who wrote the report or article in question, whether the judgement was based on statistical analyses or on simple comparisons of descriptive data.

It is also important to recognize that the available literature poses still other challenges for an effort that is intended to be both careful and conservative. In particular, while the overall body of literature addressing the economic well-being of mining-dependent areas is vast, the number of studies explicitly offering systematic, quantitative data on the impacts of mining in the rural United States is actually much smaller. In the process of selecting the findings for analysis, accordingly, we needed to proceed in two main steps. The first step was to conduct an extensive search of articles published in peer-reviewed journals, books and chapters, technical reports, and governmental documents and publications. Because of this process, we ultimately identified several hundred reports and publications in all. In the second step, however, we found it necessary to deal with the potentially misleading variations across studies by requiring an appropriate degree of consistency in the studies that were selected for more detailed examination. This process ultimately led to the identification of four relatively stringent criteria that were necessary to permit direct and meaningful comparisons and to the elimination of all studies that were unable to meet the criteria.

The first criterion was the most straightforward. The studies needed to present enough comparative data—whether across locations, across time, or both—to permit a reasonable assessment of net economic impacts for the areas affected. Second, the studies needed to provide quantitative assessments of the impacts of mining activity in nonmetropolitan communities or regions in the United States. This criterion alone was enough to eliminate roughly half of the otherwise "available" studies (e.g., those from other nations), and even in the remaining studies, there were a number of variations in the definitions of "mining" and mining dependency. Most studies have used broad definitions, encompassing the full range of metal, coal, and oil-extraction activities, as well as quarrying, while a smaller number have focused on one type of mineral. Nearly half of the studies defined "mining dependency" according to the criterion used by Bender et al. (1985), including only those counties that received at least 20 percent of their total labor and proprietor income from mining during the period specified. The remaining studies followed one or more mining areas over time, required that a given percentage of local employment be from mining, or relied on measures involving a mixture of income and employment from mining.

The third criterion also requires additional discussion: For purposes of comparability, the data in question needed to present at least one of the three variables most commonly included in such studies—namely, incomes, unemployment rates, and poverty rates—corresponding closely to the three kinds of local economic benefits that are commonly expected to be associated with mining. Even among the studies meeting this criterion, however, there proved to be a number of variations, particularly in the definitions of "poverty" and "income." In the comparisons that follow, accordingly, the "poverty" category will include all findings regarding the percentage of persons in poverty, the percentage of children in poverty, and the percentage of families in poverty, while the "income" category includes studies that provide data on median household income, per capita income, and/or wage and salary earnings. The measures of "unemployment," by contrast, involve fewer variations, usually referring to the percentage of the workforce unemployed at the time of data collection, although a few studies use analyses of unemployment insurance payments.

The fourth and final criterion proved to be particularly conservative. Even after the application of the first three criteria, there were still 363 known, quantitative findings in the available literature. The fourth criterion, however, required the exclusion of all areas that were merely "predominantly" rural or nonmetropolitan, although many people think of predominantly rural states, such as North Dakota, or cultural regions, such as upstate New York or Appalachia, as being "rural." The reason was straightforward: Given that metropolitan areas tend to have significantly stronger economic conditions than do nonmetropolitan areas, important biases might be created by comparing (genuinely) nonmetropolitan mining regions against "control" regions that actually included one or more metropolitan areas (e.g., by comparing the nonmetropolitan mining counties in a given location against the average for the entire region, or for the United States as a whole). The net effect of this fourth criterion was to lower by 51 the number of "adverse" findings on the economic implications of mining, while lowering "positive" findings by only 11. Still, even after the application of this fourth and final criterion, there remained 301 of the "more conservative," quantitative findings, derived from 19 separate studies.

As indicated by Figure 1A, by far the most common findings in the literature are those involving adverse economic outcomes in mining regions. The dashed-line totals indicate that adverse findings constitute an outright majority of the "known" findings (those meeting all but the fourth criterion). Even after the imposition of the fourth and most conservative criterion, just under half of the findings that remain—139 of the remaining 301 findings, in other words, or 46.1 percent of them—indicate the economic conditions in mining regions to be worse than those in the relevant comparison regions. The remaining findings are split roughly evenly between neutral and favorable outcomes, at 74 (24.6%) and 88 (29.2%), respectively. For purposes of clarity, Figure 1B includes only the "more conservative" 301 findings, and in the remainder of this article as well, we will analyze only the 301 findings that meet all four criteria for inclusion. What Figures 1A and 1B show, at least at an overall level, is that favorable or improving economic conditions need to be recognized as being considerably less common in the empirical literature to date than are unfavorable or declining conditions.

Still, to leave the matter there might be too simple. As could be expected on the basis of the preceding literature review, there are a number of variations in the relationships between mining and economic well-being. While the variations among available studies suggest that more detailed analyses should be undertaken only with caution, as noted earlier, there are three types of additional comparisons that are particularly worthy of attention. First are those that focus on the differences that emerge from examining specific indicators of socioeconomic conditions (i.e., incomes, unemployment, and/or poverty rates); second are those that deal with regional variations; and third are those that offer insights into change over time. We will discuss the three in that order. In the interest of conservatism, all of the more detailed comparisons that follow will use only the

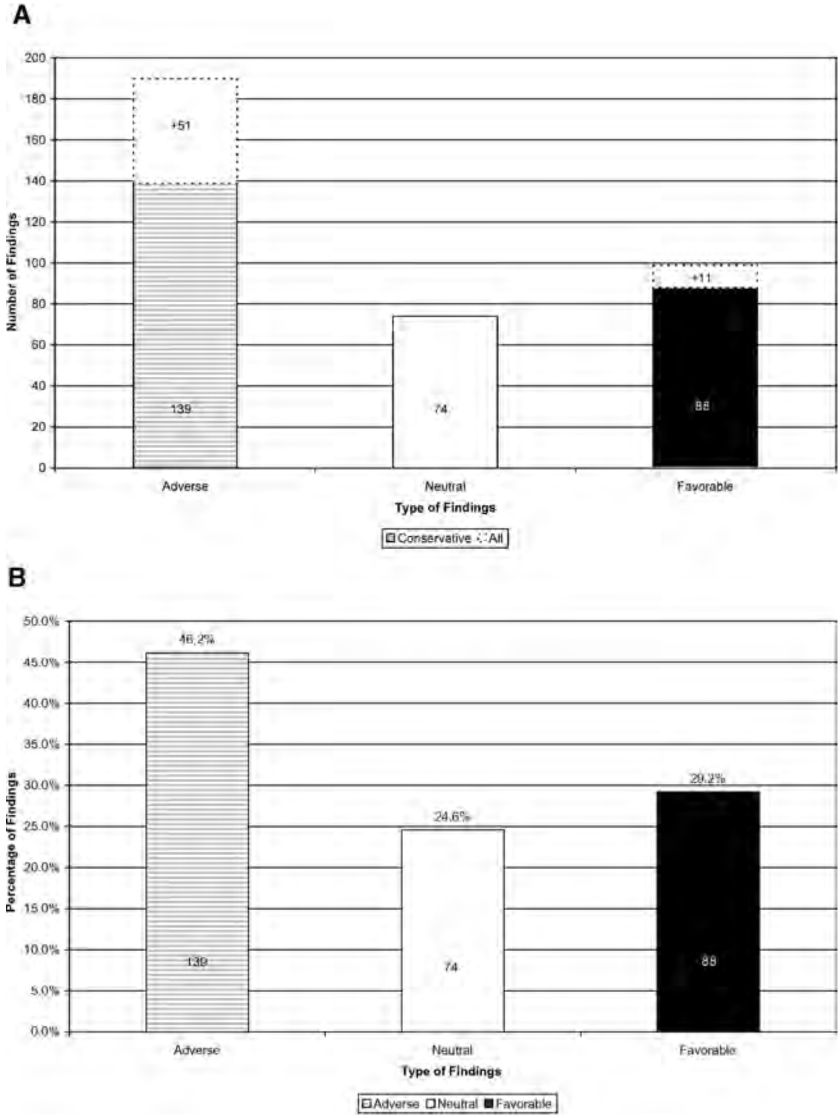

Figure 1
(A) All findings versus "conservative findings." (B) Summary of findings (used in final analysis).

301 findings that meet all four of the criteria for inclusion, and tests of statistical significance will be presented only for the overall totals and for the comparisons involving overall socioeconomic measures or indicators.

Differences across Indicators

The first set of more detailed comparisons involve differences across the three different socioeconomic indicators noted above—income, unemployment rates, and poverty rates. Of the three indicators, the most positive picture emerges from studying incomes, as illustrated in Figure 2. The available studies provide 118 quantitative findings on income differences; in 56 of these cases, or nearly half of the time, mining activity has been associated with higher incomes than in nonmining areas or in previous time periods. Incomes are lower in about one-third of the findings (40, or 33.9%) while the remaining 22 findings (18.6%) indicate a situation that is "no different." Thus, while it may not be literally accurate to describe mining as leading to improved incomes, more findings do fall into the "favorable" category than into the other two, suggesting that mining has indeed been associated with higher income levels in many cases.

A less favorable picture emerges, however, when we consider the fuller range of economic findings. Despite the fact that impoverished rural communities often expect mining to reduce their poverty rates, for example, the findings fail to

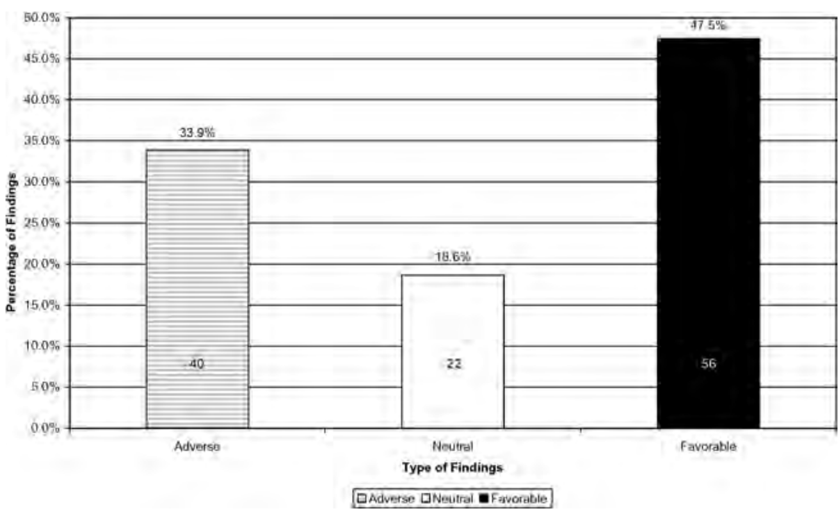

Figure 2
Summary of income findings.

support this common assumption. As can be seen from Figure 3, only about 20 percent of the 59 available findings on the topic indicate mining areas to be associated with lower poverty rates. Instead, more than twice as many findings—26 findings, or 44.1 percent—indicate higher levels of poverty in mining areas, while the remaining 21 findings (35.6%) indicate poverty levels that are neither higher nor lower than in the relevant comparison areas. Likewise, despite the usual assumption that mining will reduce the unemployment problems of rural areas, studies to date have actually tended to find higher levels of unemployment in mining areas than elsewhere. As can be seen from Figure 4, which summarizes the available findings on unemployment rates, a clear majority of the available findings (73 of the 124 findings, or 58.9%) indicate higher levels of unemployment in areas characterized by high levels of mining activity, while another 25 percent of the findings (31) point to conditions that do not differ between mining and comparison areas. Despite the widespread expectation that mining will lower local unemployment rates, actual findings of such favorable conditions prove to be relatively rare, making up the smallest category of all, with just 20 findings (16.1%) suggesting unemployment rates to be lower in mining areas than in comparison areas.

In addition to the graphic presentation of evidence in Figures 1–4, we have provided a quantitative summary and a set of significance tests in Table 1. The

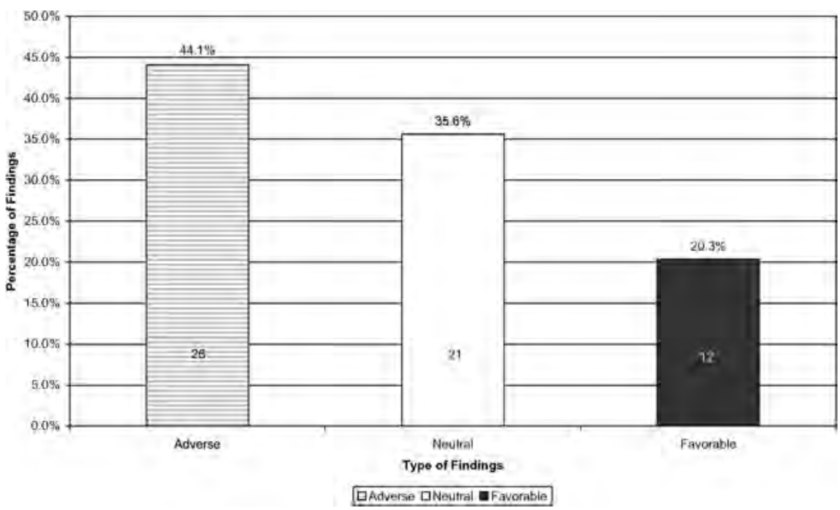

Figure 3
Summary of poverty findings.

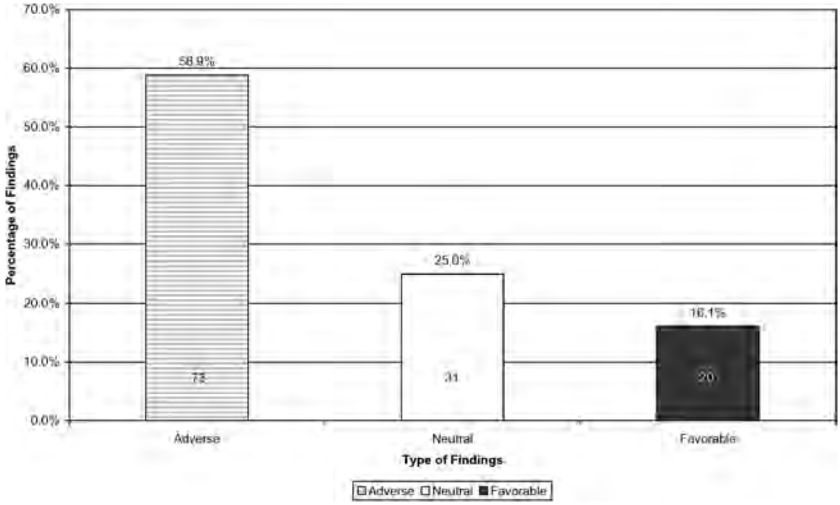

Figure 4
Summary of unemployment findings.

top three lines of the table focus on the overall findings from Figure 1; for the convenience of those who prefer a more detailed examination, the remaining lines of the table summarize the findings in more specific ways. The first column reports the raw number of findings of each type. The second column expresses this number as a percentage of the findings within a given category—that is, as a proportion of all the relevant findings on income, poverty, and unemployment rates—thus repeating the information from Figures 1–4 in tabular form. The final column of the table provides new information, expressing each subcategory of findings (e.g., adverse findings on income, or favorable findings on unemployment rates) as a percentage of the grand or overall total of 301 findings that meet all four of the criteria for inclusion in this analysis.

For each panel of the table, we also present the result of statistical significance tests. Before we turn to the tests themselves, however, four warnings are in order. First, as statistical textbooks routinely note, tests of "statistical significance" should not necessarily be taken as indicating "substantive significance." The tests, instead, are meant to assess the relative consistency of (and hence the degree of statistical confidence that can be placed in) any given pattern. Second, because we are looking at findings from the existing research literature on the three main categories of findings (i.e., incomes, poverty, and unemployment rates), the statistical tests reported here can only be generalized to the research literature addressing these comparative, quantitative results from mining-dependent, nonmetropolitan regions of the United States. Third, given our earlier warning that outcomes reported in the existing literature are often not independent of one another, an important degree of caution is needed in drawing even these inferences; the major advantages of the significance tests have to do with clarifying and systematizing the available findings. Fourth and finally, in keeping with our earlier warning about the need for caution in interpreting the relatively small number of some of the more specific findings, we will perform the statistical tests only for the largest categories of findings, namely, those already noted—the results on incomes, poverty and unemployment rates, and overall patterns.

The simplest possible approach for testing the statistical significance of these findings is to focus on what are technically known as "binomial" outcomes—that is, those that allow for just two possible outcomes. In accordance with the need for caution, the "cost" of this simplicity is that the tests can be carried out in three different ways—with the neutral findings being combined with positive ones, with negative ones, or being omitted altogether.

In Table 1, we present information on statistical significance only for those comparisons that produced significant results. For the overall findings that are summarized in the top panel of Table 1, for example, the binomial tests show adverse findings to be significantly more common than favorable findings according to two of the three possible comparisons—those where the neutral findings are combined with the adverse findings or where they are omitted from the analysis—although not when the neutral findings are combined with positive ones. For the most favorable of the available sets of findings, by contrast—those for incomes—the only way to obtain significantly more favorable findings than negative ones, according to normal standards of statistical significance, is to treat all of the neutral or indeterminate findings as being "favorable" ones, as well. Finally, unlike the case for the income findings, there prove to be significantly more adverse findings than favorable ones in the cases of poverty and unemployment, whether the neutral findings are treated as being negative or are removed from the analysis altogether. In the case of the unemployment findings, in fact, adverse findings prove to be so much more numerous than positive ones that there are significantly more negative than positive findings even if the neutral or indeterminate findings are explicitly treated as positive ones.

In response to reviewer concerns about the extent to which this overall pattern might be shaped by methodological anomalies of one or more studies—whether through shifts in units of analysis or definition of variables, or simply by having one or two studies that contribute a significant fraction of the findings—we have conducted the additional analysis summarized in Figure 5. As can be seen from the dashed horizontal line and the bar at the far right end of this figure, the overall average, across all studies, is for negative findings to be 1.58 times as

Table 1
Percentages of Adverse/Neutral/Favorable Findings, Overall and by Measure

	No. of Findings	% of Category	% of Total
Overall			
Type of Finding			
Adverse	139	NA	46.2
Neutral	74	NA	24.6
Favorable	88	NA	29.2
Total All Findings	301	NA	
"Adverse Findings" are significantly more likely than "Favorable Findings" by two of three tests:			
$t = -7.907$, $p < .000$ when neutral findings are coded as negative.			
$t = -3.466$, $p = .001$ when neutral findings are excluded.			
By Measure			
Income Findings			
Adverse	40	33.9	13.3
Neutral	22	18.6	7.3
Favorable	56	47.5	18.6
Total Income	118	100.0	39.2
"Favorable Findings" are significantly more likely than "Adverse Findings" by one of three tests:			
$t = 3.679$, $p < .000$ when neutral findings are coded as positive.			
Poverty Findings			
Adverse	26	44.1	8.6
Neutral	21	35.6	7.0
Favorable	12	20.3	4.0
Total Poverty	59	100.0	19.6

(continued)

Table 1 *(continued)*

	No. of Findings	% of Category	% of Total
"Adverse Findings" are significantly more likely than "Favorable Findings" by two of three tests:			
$t = -5.612$, $p < .000$ when neutral findings are coded as negative.			
$t = -2.411$, $p = .021$ when neutral findings are excluded.			
Unemployment Findings			
Adverse	73	58.9	24.3
Neutral	31	25.0	10.3
Favorable	20	16.1	6.6
Total Unemployment	124	100.0	41.2
"Adverse Findings" are significantly more likely than "Favorable Findings" by all three tests:			
$t = -1.999$, $p = .048$ when neutral findings are coded as positive.			
$t = -6.652$, $p < .000$ when neutral findings are excluded.			
$t = -10.213$, $p < .000$ when neutral findings are coded as negative.			
Total across Measures	301	NA	100.0

common as positive ones. As can also be seen, however, there are very few cases in which the removal of a study or studies could be said to exert major or undue influences on the overall pattern of results.

The largest change in ratios would come from dropping the study of Mills (1995)—removing this study would increase the overall ratio of negative to positive findings from 1.58:1 to 1.82:1—yet such a change would scarcely be surprising: Mills focuses on incomes, and as noted earlier, incomes provide a consistently more favorable picture of overall socioeconomic outcomes than do

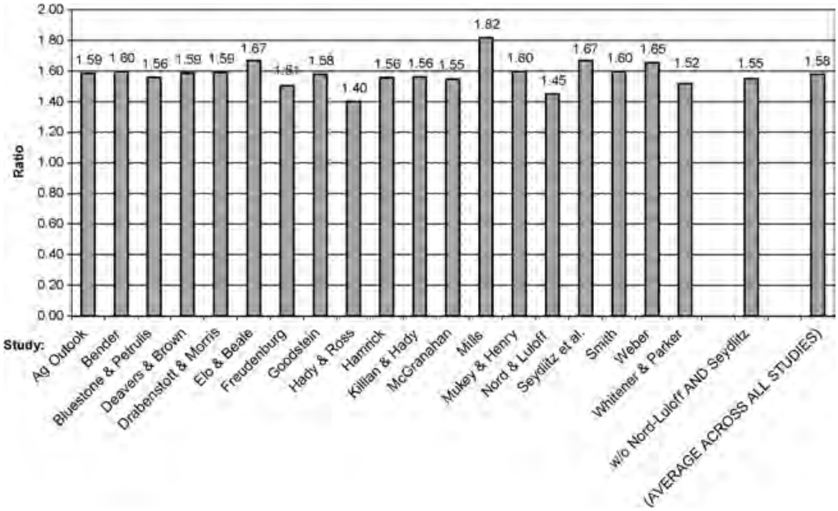

Figure 5

Ratios of adverse to favorable findings without the indicated sources.

poverty or unemployment rates, or for that matter, the overall distributions of findings. The greatest reduction in the overall ratio would come from omitting Hady and Ross (1990); as noted earlier, this study was done as an update to the original report by Bender et al. (1985), and thus it includes a strong emphasis on the years from 1980 onward, when findings have tended to be significantly more negative than in earlier years. Finally, the two studies contributing the largest number of findings are those of Nord and Luloff (1993) and of Seydlitz, Jenkins, and Hampton (1995); these two studies, in combination, provided 141 of the 301 findings just analyzed, but neither of the two studies exerts as much influence in changing the overall total as do Mills (1995) or Hady and Ross (1990), and in combination, the two studies' effects largely counterbalance one another. As can be seen from Figure 5, in other words, the effect of removing the Nord and Luloff findings would be to reduce the overall average from 1.58:1 to 1.45:1, while the effect of removing Seydlitz et al. would be to increase the overall ratio to 1.67:1. As shown by the bar near the extreme right end of the figure, the net effect of removing both studies would be a degree of shift in the overall ratio of negative to positive findings that is remarkably small—a reduction from 1.58:1 to 1.55:1.

Still, in the interest of caution, it should be noted that there would be one clear effect of removing one or both of these studies that is not reflected in Figure 5: Partly because both Nord and Luloff (1993) and Seydlitz et al. (1995) used tests of statistical significance to assess whether findings were positive, negative, or indeterminate, these two studies reported a higher proportion of "indeterminate" outcomes than for the studies that did not use statistical significance tests. Except for these apparently minor variations, however, the simple form of sensitivity analysis presented in Figure 5 shows a considerable degree of robustness in the comparison that is likely to prove most salient to readers, involving the ratio between negative and positive findings. Indeed, there is no other study of the 19 included in the final analysis that has enough of an effect on the overall findings that the removal of that study would shift the overall ratio of negative to positive findings by as much as 0.10; instead, the overall ratio would stay within the range of 1.58 (± 0.10):1.

Variations by Region and Era

Despite the fact that the overall patterns of findings appear to be relatively robust, the existing literature suggests that more finely grained patterns may be present, as well. Given our earlier warnings about the many variations across studies, plus the exploratory nature of any further comparisons, our judgement is that further tests of statistical significance would be inappropriate for these more fine-grained assessments, but there is still a need to ask whether the findings differ systematically in other ways. In particular, given the number of findings that have come from the western "energy boomtowns" of the late 1970s and early 1980s, there is a need to consider whether the available findings differ systematically by region and/or by era.

Regional Variation. As noted by Nord and Luloff (1993), the question of regional differences is particularly relevant in light of the number of mines in the western United States that are new, that use open-pit mining techniques, and that exploit particularly rich deposits of easily accessible coal. As can be seen from Figure 6A, which summarizes the variations in findings across regions, the western mines are indeed associated with the most favorable economic findings. Only in the western United States, in other words, do the available studies provide more favorable findings than adverse ones; in the west, just over half of the 73 available findings are favorable, while 27.4 percent are adverse, and the remaining 20.5 percent are neutral. Findings from the south point to greater economic distress, with 37.2 percent of the findings indicating adverse conditions in mining regions, but only 15.4 percent indicating favorable conditions. The 31 available findings from the Great Lakes region point to even greater distress: Only two of the quantitative findings from this region (6.5%) indicate mining to be associated with favorable economic outcomes; instead, most of the available findings are split into roughly equal numbers of "neutral" and "adverse" outcomes. Finally, the results from "other" regions of the country, or from the nation as a whole, point to conditions in mining areas that are more than twice as likely to be adverse (63.0%) than to be favorable (30.3%), while the remaining 6.7% of the findings show no differences.

Differences across Eras. Figure 6B responds to another need that was pointed out earlier—the need to assess potential changes in the relationships between mining and economic well-being over time. Although the preliminary findings from Bender et al. (1985) were relatively favorable, for example, subsequent studies indicated that those preliminary findings may have reflected the unusually prosperous or "boom" conditions that existed in many mining regions during the mid- to late-1970s.

As any number of authors have noted (see, e.g., Gulliford 1989), the era of "western energy boomtowns" came to an unexpectedly abrupt halt on a date that many residents of the Rocky Mountain region still remember as "Black Sunday"—May 2, 1982—when Exxon shut down its massive oil shale operations near Parachute, Colorado, and the mining-dependent portions of the region suddenly found themselves in a deep bust, with no "next boom" on the horizon. While many oil-extraction regions managed to avoid a serious bust for a few more years, largely because oil prices initially avoided the declines that characterized so many other commodities during the early 1980s, world oil prices ultimately dropped from $24.51 to just $9.39 per barrel in the 6 months between December 1985 and June 1986, bringing the end of the boom for oil regions as well (Freudenburg and Gramling 1998). Findings from the era that ended by the early 1980s, accordingly, might be expected to be quite different from those that have been documented in more recent years—a possibility that will be considered next.

Two main types of temporal comparisons are included in the available studies. The first involves longitudinal analyses—those that assess change over time within a given mining region or locality. The second involves cross-sectional comparisons—that is, between mining counties/communities and a matched or "control" set of counties/communities, at a given point in time. In the interest of simplicity, we use the end of 1982, after the end of "boom times" in most U.S. mining regions, as our cutoff point, comparing the findings from data collected during the years up through 1982 against those from data collected in 1983 or thereafter. Given that the overall conclusions from longitudinal analyses are inherently shaped by the conditions that prevail at the end of the study period, any longitudinal studies that straddle the 1982–1983 cutoff point are classified here with the other studies in the "1983 and thereafter" category, while the longitudinal studies that began and ended before 1982 are analyzed with the other "1982 and earlier" findings.

As shown in Figure 6B, the era of data collection does indeed appear to exert an important influence on the favorability of findings. In the years up through 1982, there were more favorable findings (52 of the 123 findings, or

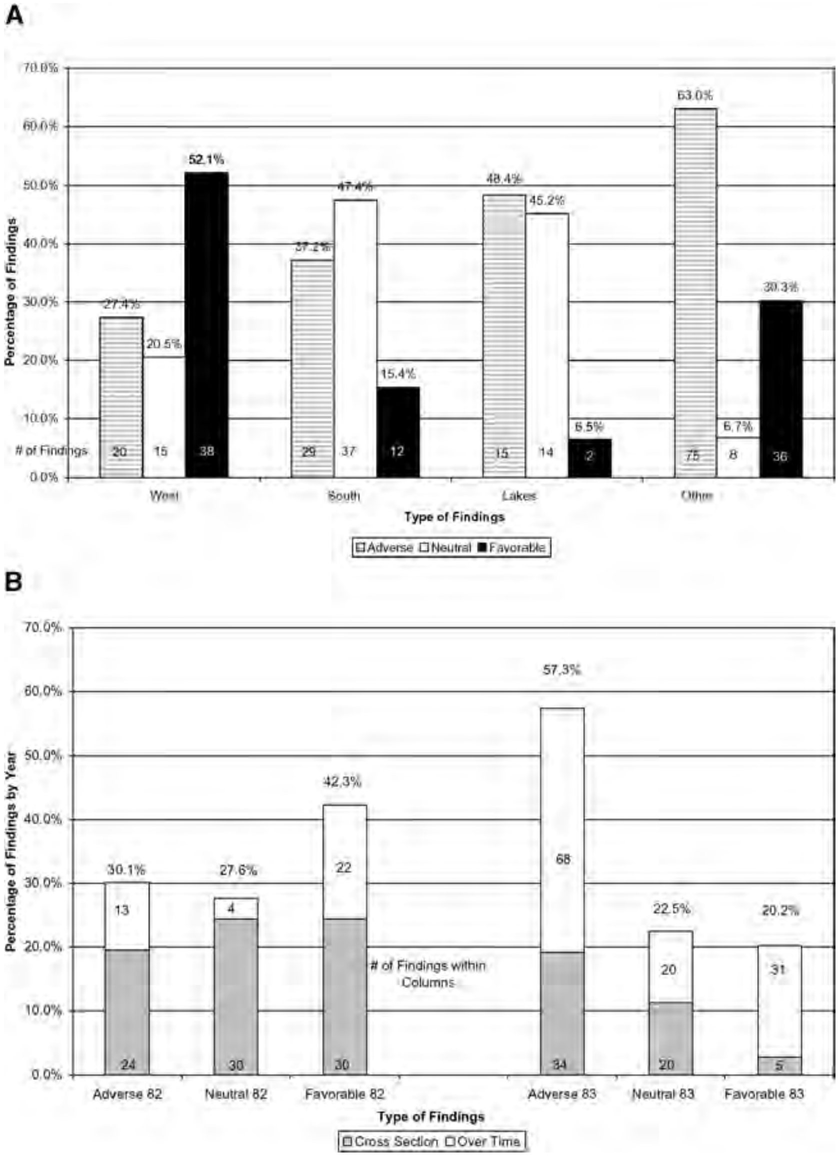

Figure 6
(A) Summary of findings by region. (B) Summary of findings by time.

42.3% of the total) than adverse or neutral ones (37 and 34 findings, or 30.1% and 27.6% of the total, respectively). In the years since then, however, the picture has been much less favorable. An outright majority of the findings since 1982 have been adverse, with 102 adverse findings constituting 57.3 percent of the 178 available findings for the era since 1982. While favorable findings were the most common category for studies that focused on the "boom" conditions that existed up until early 1982, in fact, favorable findings make up the smallest category of the findings since then—just 36 such findings, or 20.2 percent of the total—meaning that there are only about one-third as many favorable findings as adverse ones in studies using data from the years since 1982.

While the cross-sectional findings do not allow us to assess actual change over time in mining areas, a small number of studies have reported "before and after" or longitudinal findings; these findings are reported in the unshaded portions of the bars of Figure 6B, and they do indeed indicate mining to be associated with declining local economic conditions. Intriguingly, save for the fact that the longitudinal studies appear to have produced fewer neutral findings, proportionately, than have the cross-sectional studies (particularly for findings from 1982 and earlier), Figure 6B shows that the overall conclusions suggested by the two different types of methods appear broadly similar to one another, particularly with respect to the dramatic differences between findings from the "boom" era that ended in roughly 1982 and the less "euphoric" times (Gulliford 1989) that have characterized U.S. mining regions ever since. The 68 adverse findings from longitudinal studies, for example, represent 56.2 percent of the 121 longitudinal findings for the period from 1983 to present, while the 34 adverse findings using cross-sectional data represent 57.6 percent of the 59 cross-sectional findings for the same period.

Table 2 presents a summary of the comparisons that are illustrated in Figure 6, doing so in a format that mirrors that of Table 1. As can be seen from a closer examination of the findings from the two tables, most of the more favorable conclusions about economic conditions in mining areas come from a relatively small subset of the available findings—principally those focusing on incomes, in the western United States, before the end of 1982. As shown earlier by Table 1, in other words, only 88 of the 301 findings indicate favorable economic conditions in mining regions, and the clear majority of those findings (56 of the 88, or 63.6% of all favorable findings) involve incomes. Of the greater number of findings that have to do with poverty or unemployment, less than one-fifth—just 32 of the 183 (12+20 of the 59+124), or 17.5 percent—are favorable.

As shown in the top half of Table 2, similarly, it is only in the data from the western United States that favorable outcomes make up as many as one-third of the available findings; across the other regions of the United States as a whole, only 50 of the 228 remaining findings, or 21.9 percent of the total, are favorable, while another 119 findings—52.2 percent, or an actual majority of the remaining 228 findings—point to adverse economic conditions in mining areas. As just noted, finally, the bottom half of Table 2 shows that findings of favorable economic conditions in mining regions have become relatively rare since 1982, making up only about 20 percent of the available findings that come from 1983 and thereafter, while adverse findings make up nearly three times that number, or 57.3 percent of the overall total, for the same era.

Discussion and Conclusions

These analyses strongly support the warnings of those who have expressed skepticism about the socioeconomic benefits of mines. There are clearly more positive than negative findings for incomes, but the only way for this pattern to be statistically significant is for the neutral findings to be treated explicitly as positive ones. By contrast, for the other three main categories of findings—those for poverty, unemployment, and overall—the test results are strongly significant, statistically, in the opposite direction, indicating that adverse economic outcomes are significantly more likely in the accumulated research literature to date than are positive ones. These findings for poverty, unemployment, and overall patterns remain significant when neutral findings are omitted from the analysis, and not just when the neutral findings are treated as negative ones.

Our findings also reinforce the warnings of Nord and Luloff (1993), who note the importance of analyzing the differences in findings across regions and across time; like Nord and Luloff, we find the problems to be particularly severe in the older eastern and nonfuel mining areas. In addition, our findings mirror what Elo and Beale (1985) called a "curious anomaly"—with mining-dependent counties in that study having had higher median incomes, but also higher proportions of households living in poverty. Our results, in other words, also indicate that, even when higher incomes are associated with mining, those incomes do not prove sufficient to alleviate the problems of poverty and unemployment so often associated with mining-dependent regions.

As a reviewer has noted, one partial explanation for the "anomaly" may involve the mechanization that has had particularly strong impacts on mining employment and income inequality in Appalachia. Mechanization has become associated with relatively high wages in most U.S. mining operations today, but only for the smaller number of workers still employed; many other workers once employed in mining have been displaced by the mechanization. This pattern may well be reinforced by the increasing number of "mining workers" whose jobs are professional and/or technical in nature—geologists, engineers, computer specialists, and so forth—such that the traditional blue-collar "mining jobs" are decreasing in proportion as well as in number.

Table 2
Percentages of Adverse/Neutral/Favorable Findings, by Region and Era

	No. of Findings	% of Category	% of Total
Region			
West			
Adverse	20	27.4	6.6
Neutral	15	20.5	5.0
Favorable	38	52.1	100.0
Total West	73	100.0	24.2
South			
Adverse	29	37.2	9.6
Neutral	37	47.4	12.3
Favorable	12	15.4	4.0
Total South	78	100.0	25.9
Lakes			
Adverse	15	48.4	5.0
Neutral	14	45.2	4.7
Favorable	2	6.5	0.7
Total Lakes	31	100.1	10.4
Other/Nation			
Adverse	75	63.0	24.9
Neutral	8	6.7	2.7
Favorable	36	30.3	12.0
Total Other/Nation	119	100	39.6
Total across Regions	301	NA	100.1
Era			
1982 and before			
Adverse	37	30.1	12.3
Neutral	34	27.6	11.3
Favorable	52	42.3	17.3
Total 1982 and before	123	100.0	40.9

(continued)

Table 2 *(continued)*

	No. of Findings	% of Category	% of Total
1983 and after			
Adverse	102	57.3	33.9
Neutral	40	22.5	13.3
Favorable	36	20.2	12.0
Total 1983 and after	178	100.0	59.1
Total across Eras	301	NA	100.0

Another potential factor behind the apparent anomaly may involve methodological variations: Unlike data on poverty and unemployment rates, which are almost always collected at the level of the households and hence in the communities or counties where people actually live, income data are often collected at the level of the firm—that is, where people work, rather than where they live. The potential importance of this distinction is illustrated by the recently closed White Pine Mine of Michigan's Upper Peninsula (see Wilson 2001). Income data coded by place of work show this mine's county (Ontonagon) to have had far higher incomes than those of Michigan's Upper Peninsula as a whole, but income data based on place of residence, taking cross-county commuting into account, show the same county as being at or below the average of the Upper Peninsula. As shown by recent fieldwork by one of the authors of this article, a key reason is that a significant fraction of the mine's workers lived in different counties or even a different state.

When looking toward the future, perhaps the logical starting point is to note again what this article's analyses do not support–namely, the widespread expectation that mining can be expected to increase the prosperity of isolated rural communities. Indeed, this is perhaps the central implication of our analysis, and one that will require additional examination in future research.

To date, sociologists have offered a number of attempts to explain distressed socioeconomic conditions in resource-dependent areas, drawing on theories of segmented economy, underinvestment in human capital, deindustrialization, and changes in the global economy, as well as on more resource-related or "resource contingency" approaches. Given that the findings of the present study show the experiences of mining communities to have differed significantly from the experiences of other rural regions in recent years, there appears to be a particular need for greater attention to be paid to the last of these approaches—analyzing communities' relationships with the characteristics of natural resources themselves and with the specific technologies that are developed to exploit the resources.

As past studies have noted, most nonmetropolitan communities have little direct control over broader social, demographic, and economic trends, which can include industrial restructuring, the aging of the population, and global recessions (see, e.g., Humphrey et al. 1993; Fitchen 1995; Gaventa 1990). Still, a growing body of research indicates that certain characteristics tend to have important effects on how local economies fare within the broader changes (see, e.g., Baum 1987; Drabenstott and Smith 1995; Garkovich 1989; Malecki 1994). What has been noted in previous work on "resource contingency" (see, e.g., Freudenburg 1992; Freudenburg and Gramling 1998), in a line of logic that is reinforced by the present study's findings, is that there is a need for the range of "local characteristics" to be extended, to include the examination of characteristics of the actual natural resources and of the ways in which they are extracted. To be more specific, there appears to be a need to pay greater attention to the dynamics of resource dependency, over time, such as the potential that, as mines age, the costs of production may rise (and/or the incentive to invest in newer and more efficient technologies may drop). Such changing relationships could well contribute to what Hibbard and Elias (1993) have termed "flickering" operations (characterized by shutdowns during periods of low prices) and to what Freudenburg (1992) has termed the "extraction of concessions"—with workers, communities, and regulators being asked to make wage, tax, and/or regulatory concessions to mining operations in the interest of keeping the mines open.

While we believe our assessment is by far the most systematic appraisal ever to become available for the existing body of research, it is important that our findings be kept in perspective; other studies or methods could potentially come up with more (or less) favorable results—and in any case, it is important that the needed future research in fact be carried out. Our findings, in short, should be interpreted with caution. What is abundantly clear, however, is that caution is also in order for a set of conclusions that have rarely been treated with caution in the past—namely, the common conclusion or in some cases even the strongly asserted conviction that mining must be good for local economies. Despite the intensity with which such beliefs are often stated, the present analysis has shown that there is remarkably little evidence to support them; instead, most of the more systematic approaches to the data point instead to the opposite conclusion, often at high levels of statistical significance.

For the future, in short, it is important that more research be done; for the present, what is perhaps more important is to recognize that it can no longer be responsibly asserted that the socioeconomic impacts of mining for rural communities will be favorable ones. Such findings have always been sporadic at best, and at least since 1982, they have become quite rare. To the extent to which past experience is to be our guide, in other words, there is surprisingly little evidence that mining will bring about economic good times, while there is a good deal of evidence for expecting just the opposite.

ENDNOTES

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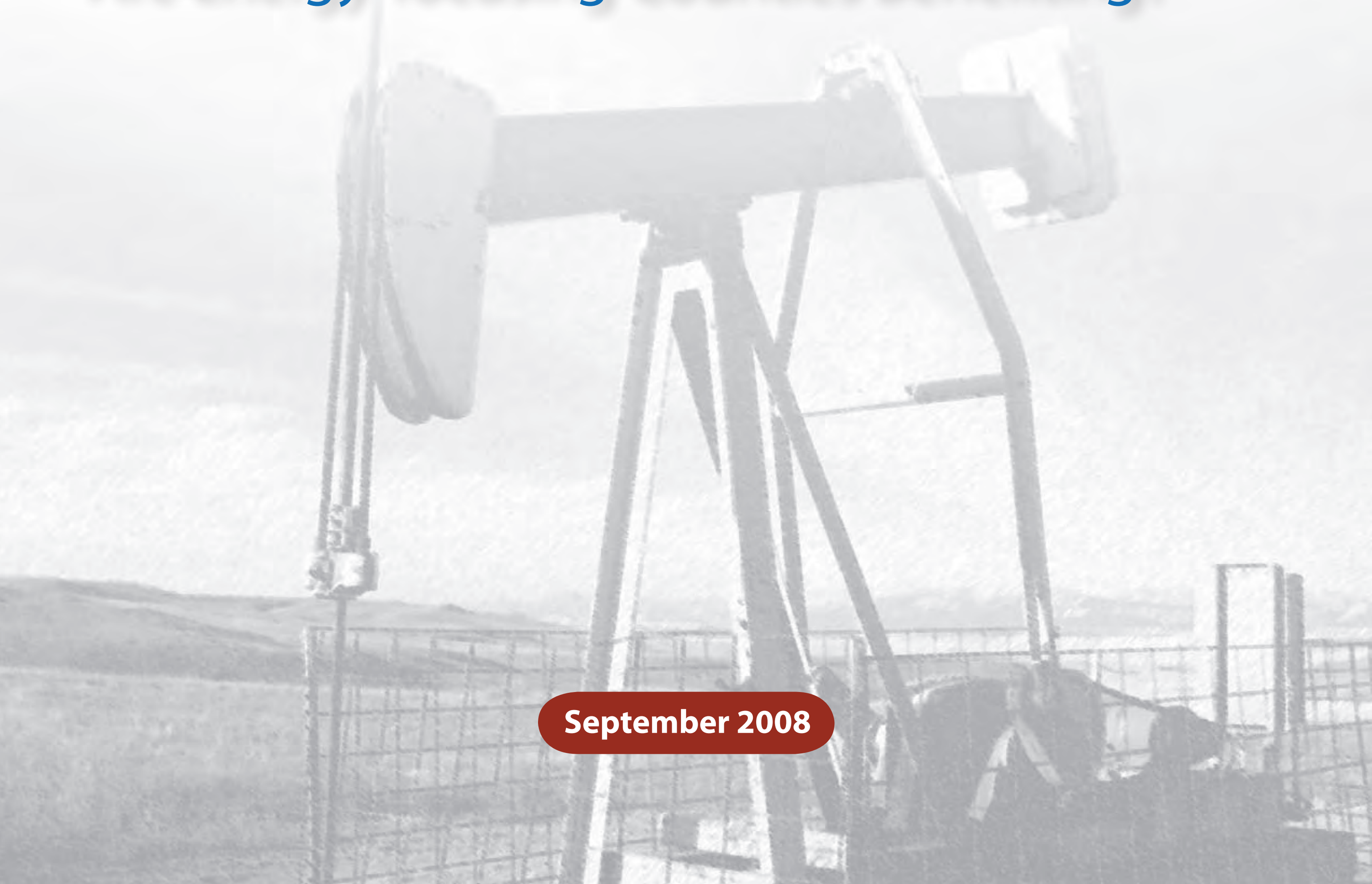

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INTRODUCTION

A rapid rise in the price for oil, natural gas, and coal, and a political climate that has favored energy development on public lands has made it possible for some counties in the West to use energy development as a strategy for economic development.

In this report in our *Energy and the West* series, we examine the consequences of focusing on fossil fuel extraction as an economic development strategy. Has it benefited counties in the long run?

The recent rise in fossil fuel development in the West is happening in the context of an economy that has already made a significant shift, away from a historic dependence on resource extraction, to an economy that today is driven primarily by service industries and knowledge-based occupations, and retirement and investment dollars. As a consequence, the economic role of public lands, where much of today's energy development is taking place, has also shifted.

In the past, the principal economic contribution from Bureau of Land Management (BLM), Forest Service, and state lands in the West came from the raw materials that were extracted and exported from the region. Today, there is an additional economic role for public lands. For many communities, the recreational opportunities and scenery provided by public lands are essential components of the quality of life that attracts and retains people and business, as well as retirees and investment income. The scenery, wildlife, and recreation-oriented lifestyle, in which public lands play a critical role, are now economic assets, and a key component of the West's competitive advantage.

The information provided in this report can help those entrusted with the management of the lands in the West to understand the consequences, and potential tradeoffs, of energy development.

Questions Answered in this Report:

1. Has an economic focus on energy development benefited counties of the West?
2. Is today's energy surge any different from the energy boom of the 1970s?
3. Why do energy-focusing counties underperform relative to their peers?

SUMMARY FINDINGS

Key Term: Energy-focusing

We use the term "energy-focusing," abbreviated "EF" in this report, to refer to the 26 rural counties in the West that concentrate their economic development on the extraction of fossil fuels. These counties have a relatively high proportion of total jobs (7% or more) in the county that are involved in the extraction of fossil fuels (natural gas, oil, and coal). We use the term "peers" to describe the remaining 254 western counties of similar size (57,000 people or less). For a full definition of "energy-focusing" (EF) counties and their "peers" see the Methods section on page 4.

Counties that have focused on energy development are underperforming economically compared to peer counties that have little or no energy development.

It is well documented that counties focused on energy extraction as an economic development strategy have historically gone through periods of boom and bust—that their economies are volatile. What is less well understood is how these counties fare economically in the long term.

In the long run, the economies of energy-focusing (EF) counties grow more slowly than the economies of their peers that are not pursuing energy extraction as an economic development strategy.

From 1990 to 2005, for example, the average rate of growth of real personal income in EF counties was 2.3 percent per year, compared to 2.9 percent in the peers. In terms of employment, the average annual growth of EF counties over the same time period was 1.8 percent, compared to 2.3 percent for their peers.

An energy development surge no longer guarantees strong economic performance.

In the energy boom that began in the 1970s and ended in the early 1980s, counties that were focused on energy development, with a high portion of jobs in fossil fuel development, were some of the top economic performers in the West. In today's energy surge, this is no longer the case.

As measured by average annual job growth, only one of 26 EF counties ranks among the top 30 economic performers in the West, while during the last energy boom half were top performers. In addition, more than half of EF counties are losing population in the midst of today's energy surge.

In EF counties, the share of total jobs in energy-related fields has declined, from 23 percent in 1982 (past energy boom) to 14 percent in 2005 (current energy surge). In recent years, jobs unrelated to energy extraction are growing rapidly and the western economy is much larger than in the past.

A heavy reliance on fossil fuel extraction may point to diminished future competitiveness.

As the West develops its fossil fuel energy resources, an ongoing challenge is increasing the competitiveness of local economies, especially in sectors unrelated to energy development.

Compared to their peers in the West that have not pursued energy development as an economic strategy, EF counties over the long term are characterized by:

- Less economic diversity and resilience
- Lower levels of education in the workforce
- A greater gap between high and low income households
- A growing wage disparity between energy-related workers and all other workers
- Less ability to attract investment and retirement dollars

These long-term indicators suggest that relying on fossil fuel extraction may not be an effective economic development strategy for competing in today's growing and more diverse western economy.

METHODS: THE DEFINITION OF ENERGY-FOCUSING (EF) COUNTIES

We define those counties that concentrate their economic strategy on the development of fossil fuels as "energy-focusing" (EF) counties. These are counties where a relatively high proportion of total jobs in the county are involved in the extraction of fossil fuels (natural gas, oil, and coal). Fossil fuel extraction includes the following codes from the North American Industrial Classification System (NAICS): drilling and extracting oil and gas reserves, extracting coal reserves, and support activities related to these. These NAICS codes are shown in Table 1 and are defined in more detail in the Appendix.[1]

Table 1.Description of Data Used to Show Employment and Personal Income Related to Energy Development, by North American Industrial Classification System (NAICS) Code

Description	NAICS Code
Oil and Gas	
Oil and gas extraction	211
Drilling oil and gas wells	213111
Support activities for oil and gas operations (e.g., contract drilling, surveying, mapping, operating oil and gas fields on a contract basis)	213112
Coal	
Coal mining	2121
Support activities for coal mining (e.g., geophysical surveying, mapping)	213113

We define a county as energy-focusing (EF) if more than 7 percent of total private-sector employment in the county was engaged in energy development—natural gas, oil, and coal—in 2005. The 7 percent cut-off was selected for two reasons: (1) below this threshold, the percent of employment in fossil fuel energy sectors in counties across the West falls off rapidly, and (2) any less energy activity as a share of total employment does not reflect a significant concentration on this single industry.

There are 26 EF counties in the West. Table 2 shows the list of EF counties, and their relative concentration in oil and natural gas versus coal extraction. They are all counties with small populations—fewer than 57,000 people. There is one exception: San Juan County, New Mexico. We eliminated San Juan County, New Mexico from the list because it is more than twice as large as the next largest EF county, and we wanted to compare EF counties, which are overwhelmingly rural, with their rural counterparts in the West.

There are 254 "peer" counties in the West. These are western counties of similar size (57,000 people or less) that do not have significant employment devoted to the extraction of oil, natural gas, and coal (less than 7% of total private employment). EF counties (yellow), along with their non-energy "peers" (blue), are shown in Map 1 (page 6).

Of the 26 EF counties in the West, 12 had between 10 percent and 15 percent of all employment engaged in fossil fuel extraction (light green in Table 2), and another eight had more than 15 percent involved in energy development (dark green in Table 2). Four counties had more than 20 percent of all employment in energy development, and one, Campbell County, Wyoming, had a third of its workforce employed directly in energy development.[2]

We used County Business Patterns data, from the Bureau of the Census, to define EF counties. This data does not include individual proprietors (the self-employed), so the actual number of energy workers in a given county will be larger. The ratio of wage and salary workers to proprietors is fairly consistent across industries, so using wage and salary employment numbers does not significantly alter the overall employment share for each industry.[3]

Definition of Mining

When we use the term "mining" in our *Energy and the West* series, we refer primarily to jobs and income associated with the development and extraction of oil, natural gas, and coal (the fossil fuels). Because of restrictions placed on the level of detail available from the U.S. Department of Commerce and the Bureau of the Census, it is sometimes not possible to separate minerals mining from fossil fuels mining. In the energy-focusing counties analyzed in this report, the bulk (over 80%) of "mining" is in energy development.

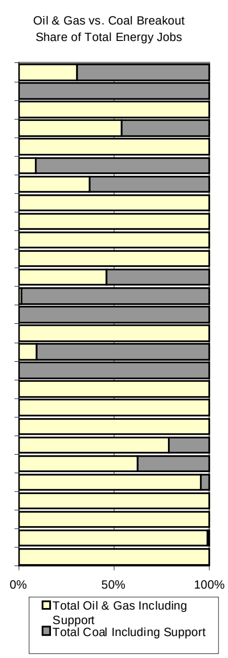
Table 2. Energy-focusing Counties in the West, 2005

			Oil and Gas Jobs:				Coal Jobs:			
	Energy Jobs in 2005	**Energy Jobs Share of Total Jobs in 2005**	Total Oil & Gas Including Support	Oil and Gas Extraction	Drilling Oil and Gas Wells	Support Activities for Oil and Gas Operations	Total Coal Including Support	Coal Mining	Support Activities for Coal Mining	Population in 2005
Campbell, Wyoming	5,436	**30.0%**	1,656	455	211	990	3,780	3,709	71	37,420
Emery, Utah	668	**24.5%**	2	-	-	2	667	660	7	10,711
Cheyenne, Colorado	99	**21.5%**	99	13	70	15	-	-	-	1,952
Rio Blanco, Colorado	343	**20.9%**	185	49	29	107	158	158	-	6,000
Uinta, Wyoming	1,163	**17.5%**	1,163	247	-	916	-	-	-	19,873
Big Horn, Montana	354	**16.7%**	32	2	-	31	322	322	-	13,076
Converse, Wyoming	610	**16.4%**	227	71	14	142	384	384	-	12,743
Hot Springs, Wyoming	233	**15.4%**	233	36	1	196	-	-	-	4,568
Fallon, Montana	124	**14.9%**	124	72	-	52	-	-	-	2,709
Blaine, Montana	133	**14.1%**	133	-	70	63	-	-	-	6,634
Sublette, Wyoming	309	**14.0%**	309	108	4	197	-	-	-	6,965
Lincoln, Wyoming	639	**13.6%**	294	37	7	250	345	345	-	15,940
Moffat, Colorado	507	**13.5%**	8	2	-	6	499	499	-	13,397
Rosebud, Montana	359	**13.4%**	-	-	-	-	359	359	-	9,279
Lea, New Mexico	2,065	**12.3%**	2,065	447	699	919	-	-	-	56,650
Carbon, Utah	807	**11.5%**	75	44	15	15	733	731	2	19,459
Gunnison, Colorado	689	**11.4%**	-	-	-	-	689	689	-	14,182
Weston, Wyoming	179	**11.2%**	179	87	14	78	-	-	-	6,642
Uintah, Utah	824	**10.9%**	824	195	60	569	-	-	-	27,129
Eddy, New Mexico	1,835	**10.5%**	1,835	798	210	827	-	-	-	51,269
San Juan, New Mexico	3,534	9.5%	2,786	671	500	1,615	748	748	-	125,820
Sweetwater, Wyoming	1,344	**9.0%**	841	217	32	592	502	502	-	38,019
Richland, Montana	317	**8.8%**	303	47	7	249	14	14	-	9,163
Yuma, Colorado	204	**8.4%**	204	17	152	35	-	-	-	9,785
Toole, Montana	124	**7.8%**	124	72	35	17	-	-	-	5,174
Big Horn, Wyoming	175	**7.3%**	174	23	-	150	1	1	-	11,325
Duchesne, Utah	293	**7.0%**	293	99	19	175	-	-	-	15,328

Energy Jobs over 15% of Total
Energy Jobs over 10% of Total

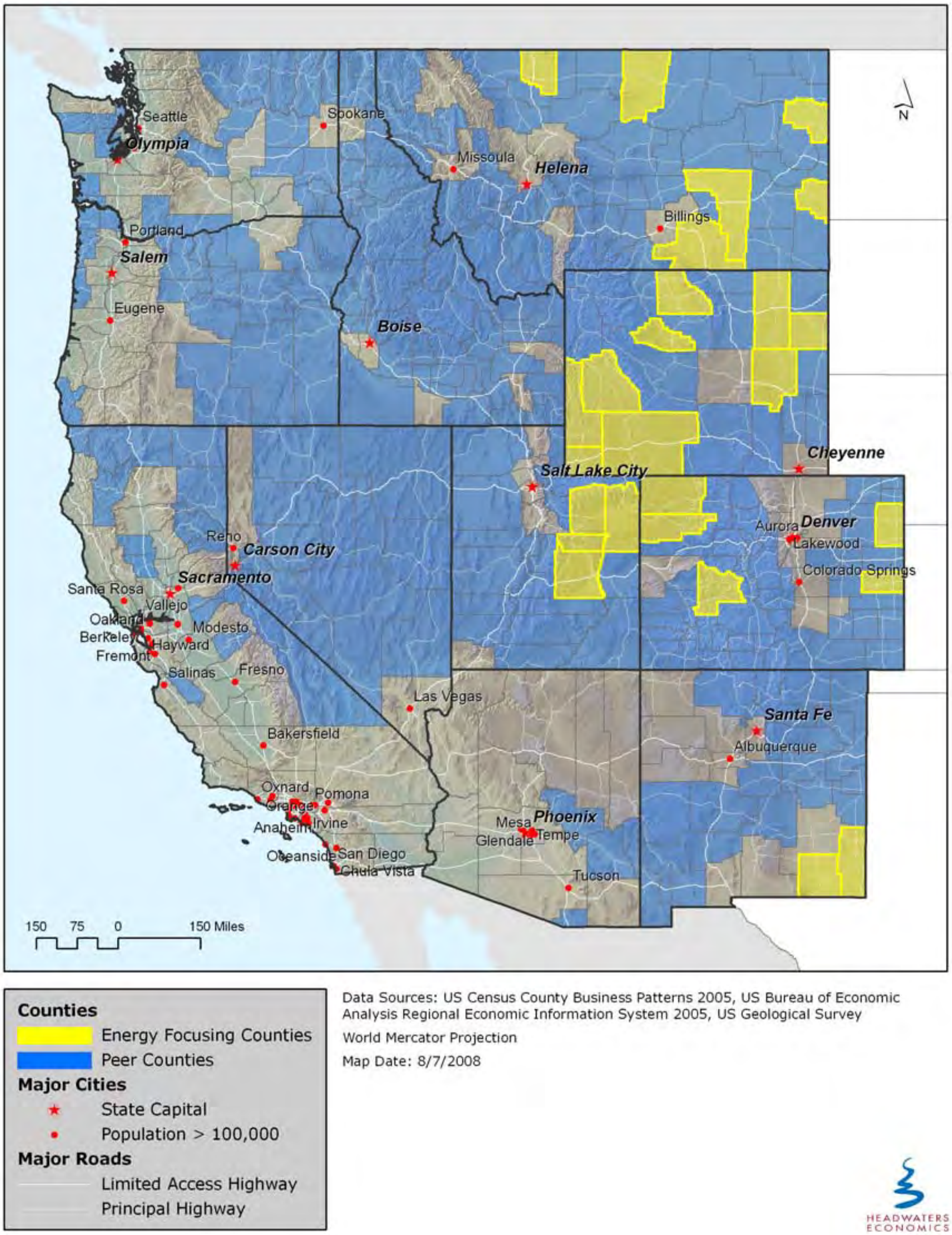
Maximum Population (excl. San Juan) 56,650

San Juan, NM was excluded because population is much larger and we want to focus on small rural communities that are heavily dependent on energy.



EF counties and their peers are shown in Map 1.

Map 1. Energy-focusing Counties and their Rural Peers



HAS AN ECONOMIC FOCUS ON ENERGY DEVELOPMENT BENEFITED COUNTIES OF THE WEST?

In order to answer this question, we compared the economic performance of energy-focusing (EF) counties, measured in a variety of ways, to their rural peers.

We use three time periods for analysis:

1970–1982 A period of economic growth, culminating in a national recession. This period also captures an energy development "boom" period in the West.

1982–1990 A period of recovery in the national economy, but decline, or energy "bust" period, for EF counties in the West.

1990–2005 The beginning of a new period of growth in the national economy, dominated by a shift to a service and knowledge-based economy, an increasingly mobile workforce, and the advent of new technology (personal computers, the Internet, telecommunications). This period also captures the most recent energy surge for parts of the West, which began approximately in 2000.

We use these periods for comparison because they frame starkly different economic stages, and highlight differences as well as emerging similarities between EF counties and their peers.

The measures of performance we used to compare EF counties to their rural peers are:

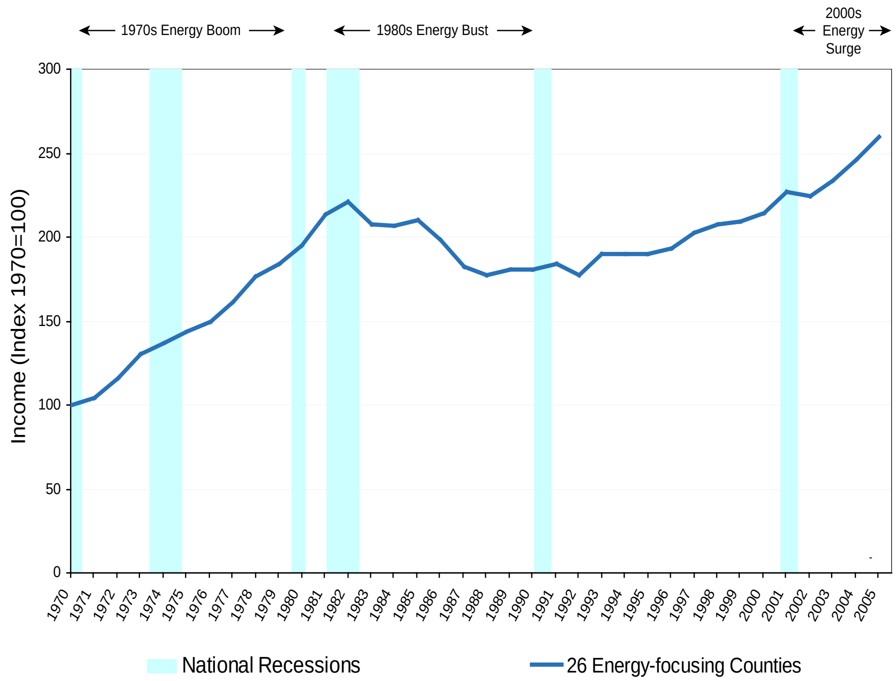
- Total personal income
- Average earnings per job
- Population
- Per capita income
- Employment

Throughout this report all dollars figures are in real terms, i.e., adjusted for inflation.

We begin by looking at the long-term economic history of EF counties. Figure 1 shows the growth and decline of real personal income from 1970 to 2005 in EF counties (in aggregate). Light blue vertical bars illustrate periods of national recession.

The economic history of EF counties is characterized by tremendous volatility. The boom in the 1970s was followed by a bust that lasted a decade in the 1980s. In the 1990s, EF counties recovered. This recovery was fueled by sectors unrelated to energy development, and represents a significant departure from the experience of the 1980s. The steady growth in the 1990s was extended and accelerated in the 2000s, when the current energy surge took root.

Figure 1. Total Personal Income in Energy-focusing (EF) Counties in the West, 1970–2005 (Indexed 1970=100)



Next we examine EF counties as compared to their peers from a historical perspective. Figure 2 shows the trends in personal income, by source (industry and non-labor income sources) from 1970 to 2000, for the aggregate of the 26 EF counties in the West. Figure 3 shows the same information for the aggregate of the 254 rural peer counties in the West.

The differences between the economic experience of EF counties and their peers are starkly evident. While EF counties went through a discernable boom/bust cycle, their peer counties saw a much steadier growth.

From 1970 to 1982, total personal income in EF counties, driven by mining, which includes energy development, grew rapidly. For the rest of the 1980s, mining and energy development contracted severely and brought the rest of the economy down with it. By the 1990s, however, with mining and energy development still declining though beginning to stabilize, the rest of the economy grew—this time independent of the fortunes of mining and energy extraction. Growth in the 1990s was driven by the rise in personal income from people employed in service and professional industries, and the even-faster increase of non-labor income (retirement, investments, government transfer payments, etc.).

For EF counties, the 1990s represented a period of economic diversification. The fact that the economies of EF counties began to diversify, even in the face of rapid declines in the mining (mostly energy development), is an important point. It underscores the economic shift that took place in the rural West between the 1980s and the 1990s, and shows that the context for today's energy surge is an economy that is both larger and more diverse that in the past.

Figure 2. Historical Trends in Personal Income by Source, Energy-focusing (EF) Counties in the West, 1970–2000 [4]

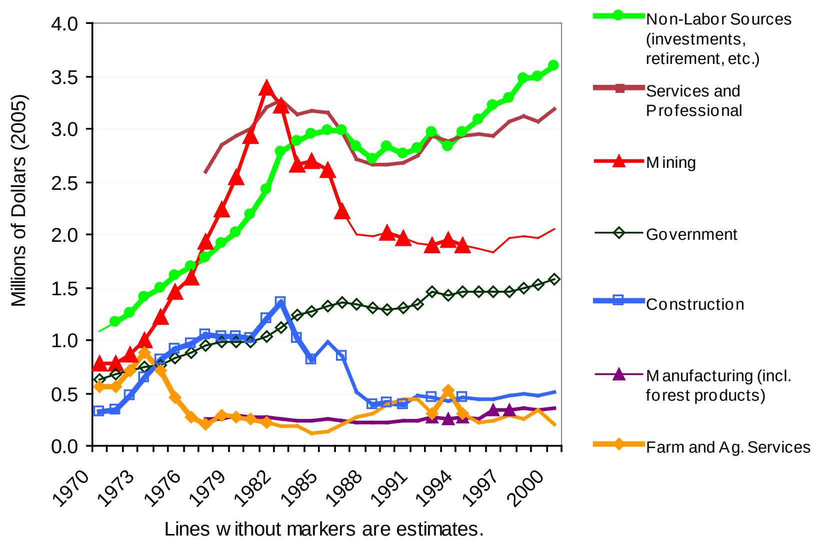
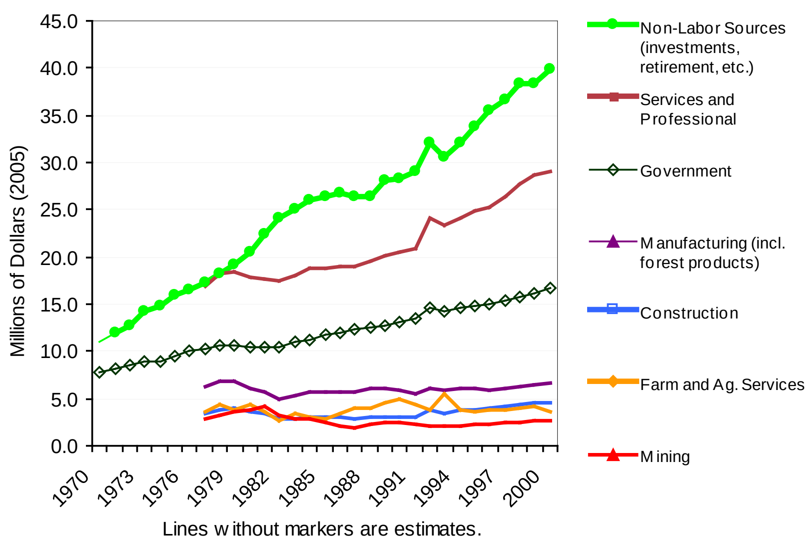


Figure 3: Historical Trends in Personal Income by Source, Peer Counties in the West, 1970– 2000 [5]

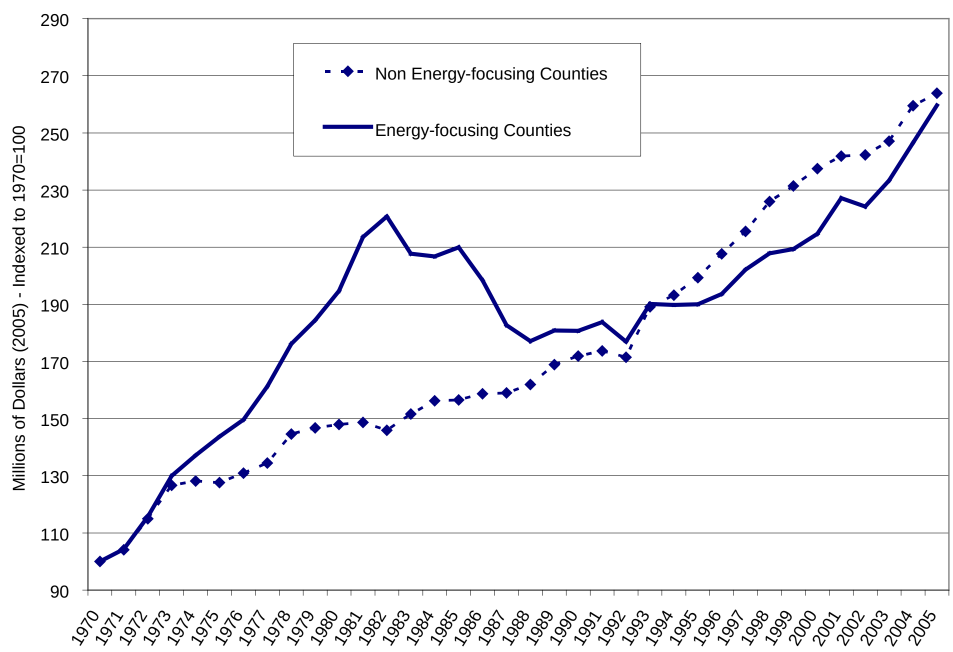


In contrast to EF counties, the non-energy peer counties saw a long and continued growth in real personal income, with no slowdown following the 1982 recession. Traditional industries, ranging from agriculture to manufacturing and construction, were all flat, while service and professional industries, non-labor income, and government enterprises accounted for the growth in personal income.

This tortoise-versus-the-hare comparison shows that it is not necessarily the case that rural counties in the West need to develop energy resources (if they have them) in order to succeed. Both sets of counties—EF counties and their peers—grew their economies at the same rate over the long term. This point is illustrated by Figure 4, which shows the long-term trend in personal income, comparing EF counties to their peer counties. The figure is indexed to 1970 in order to show relative rates of growth.

While the rate of growth in EF counties is characterized by fast acceleration and fast deceleration, the peer counties pursued a steadier expansion, with higher rates of income growth since the early 1990s. From 1990 to 2005, the average rate of real personal income growth in EF counties was 2.3 percent per year, compared to 2.9 percent in the peer counties. For the same time period, the average annual employment growth of EF counties was 1.8 percent, compared to 2.3 percent for the peer counties.[6]

Figure 4. Growth of Total Personal Income, Energy-focusing (EF) Counties versus Peer Counties in the West, Indexed, 1970–2005



These findings show that EF counties have historically gone through periods of boom and bust, outperforming their non-energy peers during the boom, and underperforming during the subsequent bust. They also show that EF counties began to grow and diversify their economies in the 1990s independent of mining and energy development. And, finally, over the last 15 years, EF counties have been falling behind in economic performance compared to their peers.

IS TODAY'S ENERGY SURGE ANY DIFFERENT FROM THE ENERGY BOOM OF THE 1970S?

Figure 5 (page 13) shows measures of economic performance (change in personal income, employment, average earnings per job, population, and per capita income), comparing EF counties to their peers. The vertical bar charts show the difference in growth rates for each measure between the two county types. In the chart, bars above 0.0% (the x-axis) indicate a period when EF counties outperformed the non-EF counties. Bar charts below 0.0% refer to episodes when EF counties underperformed compared to their peers.[7]

During the past energy boom period (1970–1982) EF counties showed fast rates of growth in personal income, employment, average earnings per job, population, and per capita income. This is consistent with Figure 4 that showed a much higher growth rate for EF counties during the 1970s. During the ensuing bust (1982–1990), the reverse occurred, and EF counties saw significant declines in all economic performance indicators relative to their peers.

The most interesting finding of Figure 5 is what occurred from 1990 to 2005, after the last energy bust and before and during the current energy surge, and how different the comparative performance is between the two sets of counties when contrasted with the earlier boom period of the 1970s. Compared to their peer counties in the West, EF counties saw a decline in personal income, employment, and population, and a rise in average earnings per job and per capita income from 1990 to 2005. This means that relative to their peers, EF counties underperformed in terms of the growth of real personal income, employment, and population, and outperformed in terms of the growth in earnings per job and per capita income. In other words, in today's economy there is no guarantee that counties that develop fossil fuel reserves have any significant advantage over those counties without those resources.

What Figure 5 also shows is that economically today's energy surge is different from those of the past. Until 1990, the pattern for EF counties was to do very well during a boom and very poorly during a bust. After 1990, this pattern changed, and it is no longer the case that an energy surge causes those counties with a higher share of economic activity devoted to energy development to outperform their rural peers. In three of the five economic indicators, the EF counties did worse than their peers. For the measures where they outperformed—average earnings per job and per capita income—there was only a modest performance difference (0.6% per year from 1990 to 2005).

The reasons for the difference in relative performance are explored in the next section. In brief, one reason is that the economy of the rural West has grown substantially in the last few decades, and as a result new energy jobs now make up a much smaller percent of total employment than in the past. Figure 6 shows that in EF counties at the peak of the last boom, in 1982, energy-related jobs were 23 percent of total employment (the green line, and right axis in the figure), whereas, in 2005, energy-related jobs in EF counties were 14 percent of total employment.[8] In other words, the relative share of energy jobs in EF counties has declined.

In addition, today's energy surge, driven in part by ready access to public lands, is occurring in a different context. Over the last three decades the economic role of public lands has changed significantly, from a repository of raw materials, to a haven for recreationists, tourists, retirees, and mobile businesses whose owners choose to locate in areas with a high quality of life. The economic transition, from a resource-based economy, to one focused on services, knowledge-based occupations, retirement, and investment dollars, has already taken place.

To put this in perspective, for the West as a whole, service-based occupations and non-labor income constitute 86 percent of the growth in the economy during the last three decades. And today, 45 percent of total personal income comes from wages earned by people employed in service-related occupations, while another 27 percent is from non-labor sources, such as retirement and investments.[9]

Of particular note, given that a new energy development surge started around the beginning of this decade, is the fact that mining, which includes oil, natural gas, and coal development, is still a relatively small component of the economy of the West, providing 1 percent of total personal income in 2005.[10]

The West is the most urbanized part of the U.S., with 90 percent of people living in metropolitan areas.[11] As a result, these trends largely represent urban phenomena. A closer look at the rest of the West—the rural West without metropolitan areas—reveals similar findings.

In the non-metropolitan West, a third of personal income in 2005 was generated by service-related industries. Non-labor income was relatively larger than in the rural West, making up more than 40 percent of total personal income.[12] Mining, including oil and natural gas, constituted less than 5 percent of total personal income and 2 percent of employment.[13]

For a thorough discussion of the economy of the West and the relative role of energy development, please consult another report in our *Energy and the West* series, *Energy Development and the Changing Economy of the West*.

Figure 5. Annual Rates of Growth of Key Economic Indicators, Shown as the Difference in Growth Rates Between Energy-focusing (EF) Counties and their Peers in the Rural West

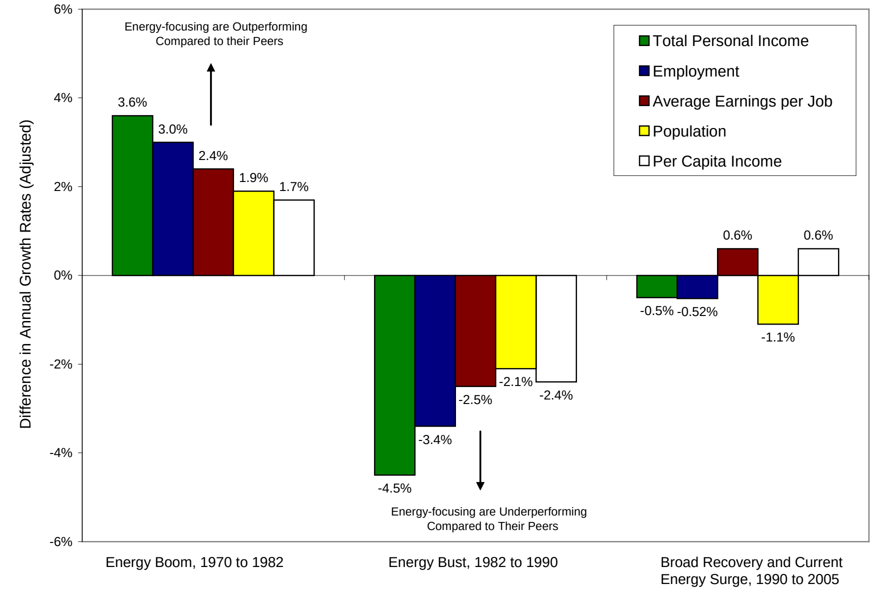
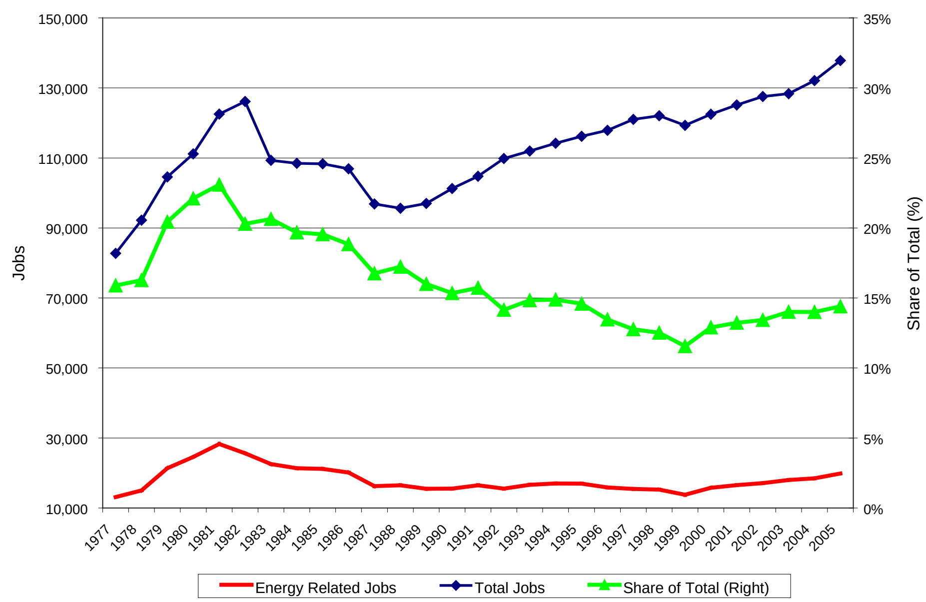


Figure 6. Energy-related Jobs in the Energy-focusing (EF) Counties in the West, as Share of Total, 1977–2005



The scale of the recent economic transition means that it is more difficult today for energy development, by itself, to turn county economies into top economic performers. This is illustrated in Table 3, which ranks EF counties among all counties in the West according to the annual growth of jobs during three time periods. In the energy boom that took place from 1970 to 1982, 10 of the 26 EF counties were in the top 30 counties in the West in terms of job growth (light green). Only one, Toole County, Montana, was among the bottom 30 counties (orange).[14]

During the ensuing bust, from 1982 to 1990, 12 of 26 EF counties ranked among the bottom 30 counties in the West in terms of job growth, and none were top performers. This is consistent with previous figures that showed significant economic decline for EF counties during this period.

The current energy surge has not created a rising tide lifting all EF boats as in the past. Only one county, Sublette County, Wyoming, ranks among the top economic performers in the West, in terms of job growth. Campbell County, Wyoming, the most energy-focusing county in the West, had the third highest rate of growth in the past energy boom, but ranks 85th in overall job growth in the current surge. Emery County, Utah ranked fifth in the past boom, and is 331st in the current surge. Even Sweetwater County, Wyoming, which is in the midst of a boom in natural gas development, ranks 254 out of 411 in terms of job growth during the current energy surge, as compared to fourth in the last boom.

Table 3. Ranking of Energy-focusing Counties Among all Counties in the West, in Terms of Average Annual Job Growth

			Rank among 411 western counties, based on average annual job growth during:		
Sorted by Energy Dependence:	Energy Jobs in 2005	Energy Share of Total (2005)	Old Boom: 1970-1982	Bust: 1982-1990	Recent Boom: 2000-2005
Campbell, Wyoming	5,436	30.0%	3	402	85
Emery, Utah	668	24.5%	5	385	331
Cheyenne, Colorado	99	21.5%	240	327	384
Rio Blanco, Colorado	343	20.9%	31	411	237
Uinta, Wyoming	1,163	17.5%	6	370	139
Big Horn, Montana	354	16.7%	296	348	202
Converse, Wyoming	610	16.4%	14	391	112
Hot Springs, Wyoming	233	15.4%	161	380	304
Fallon, Montana	124	14.9%	280	399	301
Blaine, Montana	133	14.1%	367	270	366
Sublette, Wyoming	309	14.0%	157	326	28
Lincoln, Wyoming	639	13.6%	149	353	110
Moffat, Colorado	507	13.5%	23	358	221
Rosebud, Montana	359	13.4%	7	390	375
Lea, New Mexico	2,065	12.3%	87	403	228
Carbon, Utah	807	11.5%	29	405	327
Gunnison, Colorado	689	11.4%	54	274	36
Weston, Wyoming	179	11.2%	116	382	215
Uintah, Utah	824	10.9%	28	393	88
Eddy, New Mexico	1,835	10.5%	136	351	224
Sweetwater, Wyoming	1,344	9.0%	4	386	254
Richland, Montana	317	8.8%	104	408	321
Yuma, Colorado	204	8.4%	289	131	398
Toole, Montana	124	7.8%	386	299	372
Big Horn, Wyoming	175	7.3%	205	374	278
Duchesne, Utah	293	7.0%	22	375	102

Top 30 (out of 411 Western Counties)
Bottom 30 (out of 411 Western Counties)

In spite of the recent rise in energy development activity, most EF counties are experiencing population losses. Table 4 (page 16) shows that of the 26 EF counties, 10 (38%) have seen an increase in population from 2000 to 2007 (highlighted in green). This includes some of the most heavily energy-focusing counties in Wyoming, Utah, and Colorado. Surprisingly, 16 (62%) of the energy-focusing counties lost population during the same period.[15]

Strangely, six of the counties that lost population at the same time added over 100 new jobs (not counting proprietors), from 2000 to 2005, in energy-related fields. These are: Blaine, Richland, and Rosebud counties, Montana; Eddy and Lea counties, New Mexico; and Uinta County, Wyoming.

Why are these counties losing population in the midst of an energy surge? One possible explanation may be the rising cost of living, which we discuss in more detail in the case study reports. As new jobs are created in the fields of oil, natural gas, and coal mining, workers move in, the cost of labor rises, and with a limited supply of housing, the cost of housing rises along with it. Non-energy workers, unable to compete for housing and a higher cost of living, leave. For example, rental prices in Rock Springs, Wyoming, in Sweetwater County, an EF county that is growing rapidly because of energy development, increased by 100% between 2000 and 2007.[16]

Further Reading

For more detail on the impacts of rapid energy development, see the two reports in the *Energy and the West* series listed below. They are available at: www.headwaterseconomics.org/energy.

Impacts of Energy Development in Colorado, with a Case Study of Mesa and Garfield Counties

Impacts of Energy Development in Wyoming, with a Case Study of Sweetwater County

Another possible explanation is that communities in the midst of an energy surge may displace other residents, retirees for example, who do not wish to live in what is becoming for many former rural towns a fast-paced industrial landscape. There may be other reasons for the loss of population that have nothing to do with energy development, and more to do with the plight of rural communities in general. Regardless of the reasons, there appears to be no guarantee that making a choice to focus economic activity on energy development will stem the loss of population that is so common in the rural West.

Table 4 . Net Migration per Thousand People per Year in Energy-focusing (EF) Counties, 2000–2007

	Migration 2000 to 2007 (People per 1000 per year)
Sublette, Wyoming	36.9
Campbell, Wyoming	14.8
Lincoln, Wyoming	8.0
Uintah, Utah	7.1
Converse, Wyoming	4.6
Duchesne, Utah	4.6
Weston, Wyoming	4.5
Gunnison, Colorado	2.7
Rio Blanco, Colorado	0.5
Lea, New Mexico	-1.8
Moffat, Colorado	-2.0
Sweetwater, Wyoming	-2.2
Big Horn, Wyoming	-2.9
Hot Springs, Wyoming	-4.4
Eddy, New Mexico	-4.7
Yuma, Colorado	-5.6
Uinta, Wyoming	-5.9
Richland, Montana	-6.0
Fallon, Montana	-8.2
Toole, Montana	-9.2
Carbon, Utah	-10.6
Big Horn, Montana	-10.9
Rosebud, Montana	-13.0
Emery, Utah	-15.9
Blaine, Montana	-16.5
Cheyenne, Colorado	-32.6
Unweighted Average	-2.6

These findings show that rural economies focusing on energy development today are very different than in the past. Unlike the past, EF counties are underperforming compared to their rural peers. EF counties are not the West's top economic performers they used to be. Today, only one EF county ranks among the top 30 economic performers in the West, while during the last energy boom half were top performers. Energy development also plays a smaller relative role in EF counties than in the past. The share of total jobs in energy-related fields in EF counties has declined, from a high of 23 percent in 1982 (peak of last energy boom) to 14 percent in 2005 (in the midst of today's energy surge). At the same time, 62 percent of EF counties are losing population in the midst of today's energy surge.

WHY DO ENERGY-FOCUSING COUNTIES UNDERPERFORM RELATIVE TO THEIR PEERS?

In this section, we explore answers to the question of why EF counties underperform economically.

Energy-focusing Counties are Less Economically Diverse

The more diverse the economy of a county, the better it is able to adapt to the constantly changing conditions of the global and national economy.[17]

There are indications that EF counties are diversifying. Figure 2 (page 9), for example, shows a rise in certain sectors of the economy, such as services and non-labor income, despite declines in mining, including energy development. Figure 2 shows that the relative contribution of mining is declining, in part, because the overall non-energy related portion of the economy is growing. In spite of this diversification, by 2000 (the beginning of the current surge) EF counties were still much less diverse economically than their non-EF peers.

To measure economic diversity we developed a specialization index for the aggregate economy of all 26 EF counties and compared that to one developed for the 254 peer counties in the West.[18] This index is commonly used as a measure of industrial specialization in the economy. Counties with a high specialization index are less economically diverse, more susceptible to volatility, and less innovative.[19] The most diverse score possible would be one that exactly emulated the U.S. economy, and would have a score of 0.0.[20]

Our findings show that in 2000, the specialization index for EF counties was 280, compared to a score of 106 for their peer counties. The principal ways EF counties are different from the U.S. are: a heavy reliance on mining and energy development (11.8% of total compared to 0.4% for the U.S.); under-reliance on manufacturing (4.3% compared to 14.1% for the U.S.); and under-reliance on professional scientific and technical services (2.4% compared to 5.9% for the U.S.). The main ways the peer counties in the West differ from the U.S. are: under-reliance on manufacturing (7.9%); over-reliance on agriculture, forestry and fishing (7.2% compared to 1.5% for the U.S.), and over-reliance on accommodation and food services (8.6% compared to 6.1% for the U.S.).[21]

Another way to represent economic diversity is to assess those industries that are growing, and those that are in decline. Table 5 shows the growth of jobs during the current energy surge (2000 to 2005), comparing EF counties to their peers in the West.[22]

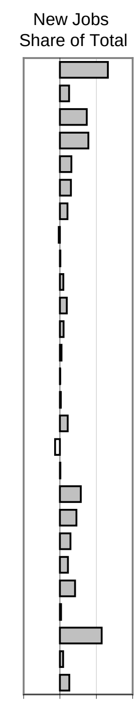
In EF counties, the principal growth (indicated in light green when over 5% of new jobs) was in direct energy-related occupations (energy, mining, support activities for oil and natural gas operations) and largely in occupations indirectly associated with energy development (manufacturing, construction, transportation, warehousing, and professional and scientific services). Other sectors, such as retail trade, health care and social assistance, and accommodation and food services also grew.

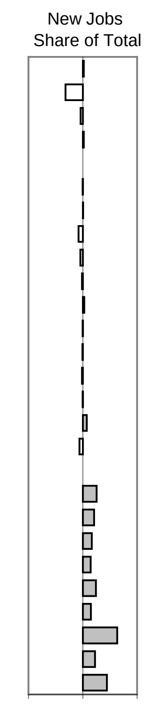
In the peer counties, the bulk of the job growth came from service-related occupations, with the largest growth in health and social assistance, and accommodation and food services. Other areas in which the peer counties grew include construction, transportation and warehousing, retail trade, real estate, and other services. In addition, other data, detailed below, show that peer counties are more successfully attracting investment and retirement dollars, and diversifying their economies with these income streams.[23]

The difference in types of growth can be seen in the column at the far right of Table 5. EF counties are specializing, adding those sectors that are necessary for the exploration, development, extraction, and transportation of fossil fuels. They do not create many new jobs that characterize the broader economic shift in the western economy over the last several decades, namely the development of a service-based and knowledge-based economy.

Table 5. New Jobs by Industrial Sector Comparing Energy-focusing Counties to Peer Counties in the West, 2000–2005

	26 Energy-Focusing Counties		254 Non Energy-Focusing Counties	
Industry	New Jobs 2000-2005	New Jobs Share of Total	New Jobs 2000-2005	New Jobs Share of Total
	15,312	100.0%	62,320	100.0%
Energy	4,043	26.4%	643	1.0%
Manufacturing	775	5.1%	(9,873)	-15.8%
Mining	2,249	14.7%	(1,234)	-2.0%
Support Activities for Oil and Gas Operations	2,387	15.6%	599	1.0%
Management of Companies and Enterprises	969	6.3%	103	0.2%
Drilling Oil and Gas Wells	922	6.0%	(7)	0.0%
Oil and Gas Extraction	632	4.1%	170	0.3%
Unclassified	(108)	-0.7%	(2,392)	-3.8%
Forestry, Fishing, Hunting, and Agriculture Support	38	0.3%	(1,440)	-2.3%
Information	284	1.9%	(416)	-0.7%
Other Services (except Public Administration)	567	3.7%	830	1.3%
Utilities	293	1.9%	(60)	-0.1%
Educational Services	131	0.9%	(187)	-0.3%
Wholesale Trade	12	0.1%	(523)	-0.8%
Support Activities for Coal Mining	76	0.5%	(125)	-0.2%
Finance and Insurance	652	4.3%	2,360	3.8%
Auxiliaries, except Corporate, Subsidiary, and Regional M	(412)	-2.7%	(1,930)	-3.1%
Coal Mining	25	0.2%	6	0.0%
Construction	1,756	11.5%	7,969	12.8%
Transportation and Warehousing	1,382	9.0%	6,466	10.4%
Retail Trade	892	5.8%	5,187	8.3%
Administrative and Support and Waste Management and	669	4.4%	4,533	7.3%
Professional, Scientific, and Technical Services	1,261	8.2%	7,484	12.0%
Real Estate and Rental and Leasing	100	0.7%	4,660	7.5%
Health Care and Social Assistance	3,510	22.9%	19,682	31.6%
Arts, Entertainment, and Recreation	262	1.7%	7,026	11.3%
Accommodation and Food Services	789	5.2%	13,778	22.1%





Green if over 5%, Brown if under -5%.

Overall Wages Have Not Increased at the Same Rate as Energy Industry Wages

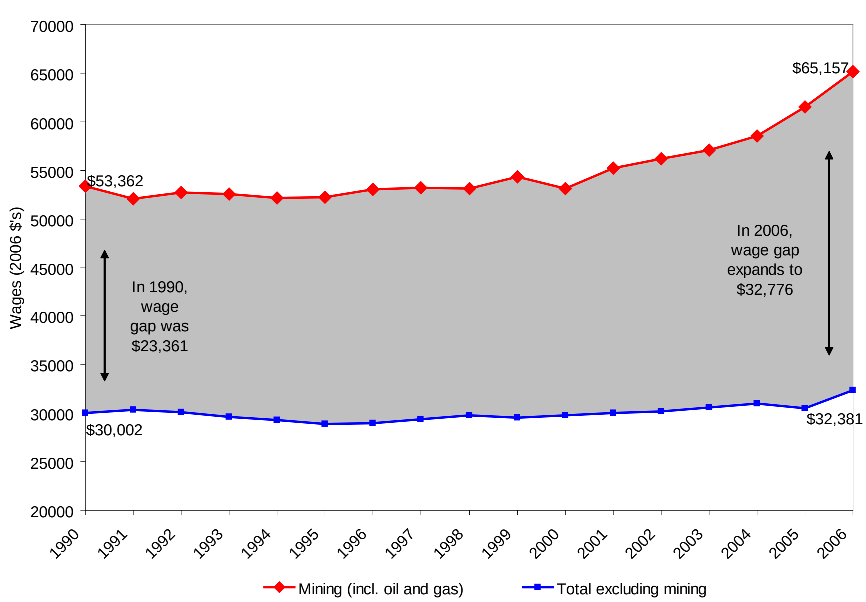
Another possible reason for the relatively lower performance of EF counties is a growing gap between what mine workers earn ("mine" includes energy-related fields in this report) compared to those working in other sectors of the economy.

Figure 7 shows average annual wages of mine workers (primarily oil and natural gas workers) in EF counties, compared to wages in the rest of the economy. In 1990, the wage gap was $23,361; mine workers earned $53,362 per year, on average, while those in other sectors earned, on average, a little over $30,000 per year. Wages in non-mining sectors have not changed much since then. From 1990 to 2006, they grew (in real terms) by 7.9 percent, to $32,381 in 2006. During that time, average annual wages for the mining sector grew by 22 percent, to over $65,000 per year in 2006. The wage gap grew to a difference of $32,776, which is $9,414 more than it was in 1990.[24]

It is possible that the 7.9 percent growth in non-mining wages would not have happened if there weren't any mining activity. From 1990 to 2006, average annual wages in the peer counties grew more slowly, by 6 percent. In 2006, average annual wages in non-mining sectors in the peer counties was $30,555, lower than that of the EF counties, at $32,381.[25]

The growing wage gap in EF counties between mine and all other workers—from $23,361 in 1990 to $32,776 in 2006—is not a healthy sign. The danger is that more people, including teachers, nurses, and farm workers, will be left behind if renewed energy development increases the general cost of living, especially the cost of housing, in a place. We explore this issue in more depth in the case study reports in the *Energy and the West* series.

Figure 7. Average Annual Wages in Mining, including Energy Development, Compared to the Rest of the Economy, in Energy-focusing Counties in the West, 1990-2006



Energy-focusing Counties Have Less Equitable Wealth Distribution

A community where everyone is doing comparatively well stands a higher chance of being able to adapt to change and grow.[26] We measured the gap between "high income" and "low income" by counting the number of households earning more than $150,000 per year ("high income") divided by the number of households earning less than $30,000 per year ("low income") .[27]

At the end of the last energy bust cycle and before EF counties started their economic recovery, in 1990, EF counties had a large gap between high income and low income households: for every household earning over $150,000 per year, there were 108 household earning less than $30,000 per year. By comparison, that same year in the peer counties, for every household earning more than $150,000 per year, there 87 households earning less than $30,000. This means that at the beginning of the recovery period that started in the 1990s, EF counties had a relatively less equitable distribution of wealth; i.e., there were many more "low income" relative to "high income."

Fortunately, by 2000 (at the beginning of the current energy surge, and at the end of the recovery that took place during the 1990s) the high income-low income ratio declined significantly for both county types.[28] In EF counties, for every high income household, there were 27 low income households (a ratio of 1:27; for the peer counties in 2000 the ratio was 1:17).

That EF counties had a larger gap between high income and low income than their peers at the end of a bust period and before embarking on economic recovery (i.e., 1990) is related to the fact that EF counties have not diversified their economies and developed a more mixed suite of service-related industries. By 2000, after a decade of more balanced economic growth, EF counties had improved their earnings distribution, but still lagged behind their peers.

In the current energy surge, EF counties are once again developing an earnings gap among residents. This is attributable to the widening gap between earnings of mine workers and the rest of the economy, a gap that is growing and was over $32,000 in 2006. If cost-of-living factors are considered, it is likely that people on fixed income or earning lower average wages are falling even further behind.

It is premature to estimate what income distribution will look like in EF counties after the current surge, but it is plausible that the gap between the high income and low income households will continue to widen for counties that focus on energy development as a rural development strategy.

Energy-focusing Counties Have Less Educated Workforces

An important condition for economic success in today's U.S. economy is an educated workforce.[29] We look at the percent of the adult population with and without a high school and college education.

At the end of the last energy bust cycle and before EF counties started their economic recovery, in 1990, EF counties had somewhat less educated workforces compared to their peers. In 1990, 24 percent of the adult population in EF counties did not have a high school diploma, which is slightly higher than their peer counties (23%). By 2000, 19 percent of the adult population in the EF counties did not have a high school diploma, an improvement from the previous decade, but still higher than their peers (17%).[30]

In terms of college education, in 1990 the percent of the adult population with a college degree was about equal among the two county types, although slightly less (14% compared to 16%) for EF counties. By 2000, at the end of the 1990s recovery, the percent of the population with a college degree increased slightly for EF counties (to 16%), but remained lower than in the non-EF peers (20%).

These statistics show that counties focused on energy development lag behind their peers in terms of workforce education levels. Even though all counties are experiencing increases in workforce education levels, the proportion of college-educated workers in EF counties at the beginning of this century had been reached by their non-energy peers a decade earlier.

Energy-focusing Counties Attract Fewer Retirement and Investment Dollars

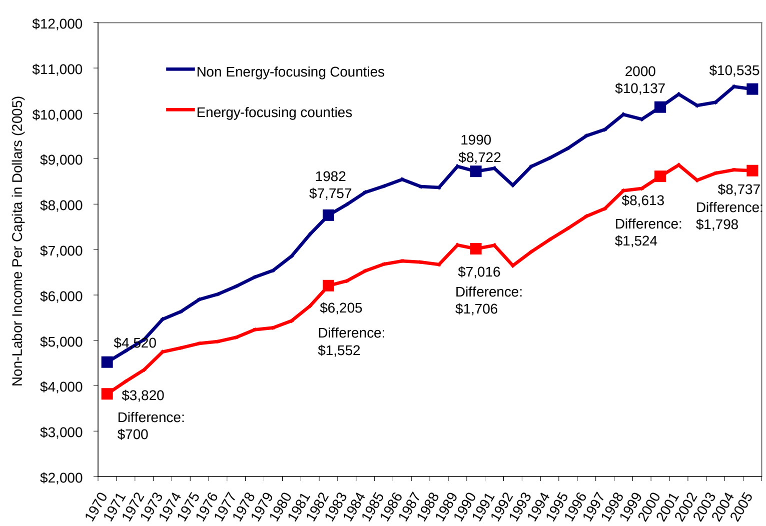
The importance of non-labor sources of income shows no signs of diminishing in the near future. As Americans generate more wealth and our population ages, more people will use their savings, investments, and programs like Social Security to sustain their livelihoods, whether they are still working or retired. By 2005, more than 40 percent of total personal income in the rural West was from non-labor sources, including transfer payments, dividends, interest, and rent.

Non-labor income, when measured on a per capita basis, is a measure of a community's ability to attract and retain this fast-growing segment of the economy.

Figure 8 shows the growth of per capita non-labor income, comparing EF counties to their peers in the West. In 1970, per capita non-labor income was similar between the two county types, with only a $700 difference. By 2005, the difference was $1,798.

These figures show that in the midst of today's energy development surge, counties focusing on energy extraction are less able to attract retirement and investment dollars than their peers.[31]

Figure 8. Growth of Per Capita Non-Labor Income, Energy-focusing Counties Compared to Peers, 1970–2005



These findings show that today's energy surge is different than in the past, and in several important ways EF counties today are less well positioned to compete economically. EF counties are less diverse economically, which makes them less resilient but also means they are less successful at competing for new jobs and income in growing service sectors where most of the West's economic growth has taken place in recent decades. EF counties are also characterized by a greater gap between high and low income households, and between the earnings of mine and energy workers and all other workers. And EF counties are less well educated and attract less investment and retirement income, both important areas for future competiveness.

CONCLUSIONS

In the West today, it is less certain that energy development will bring the prosperity it once did, and reason to be concerned that a concentration on fossil fuel extraction may impair a local economy's ability to grow and compete successfully in today's more diverse economy.

In the past, the pattern of development for counties with fossil fuel reserves was to grow quickly, reach a peak, and then decline sharply—the so-called boom and bust cycle. Beginning in the 1990s, it became clear that the economy in the West was diversifying, with especially rapid job growth occurring in service- and knowledge-based sectors, and that much of the real growth in personal income was associated with this service economy, and an aging population and the influx of retirement and investment dollars.

The implications of these changes—the growth and diversification of the western economy as a whole, including rural areas—is that energy development today does not have the same impact it had in the past. In the 1970s and early 1980s, there were few economic alternatives in rural communities. The discovery and development of oil and natural gas, or coal, created new high-wage jobs where in many cases there had been few or none. By the early 2000s, the West had, with a few exceptions, decoupled from its reliance on resource extraction, and enjoyed a wider range of economic choices than ever before.

The current surge in energy development takes place in this changed economic context. In counties that have pursued energy extraction as an economic development strategy—places we call energy-focusing (EF) in this report—the long-term indicators suggest that relying on fossil fuel extraction is not an effective economic development strategy for competing in today's growing and more diverse western economy.

When compared to their rural peer counties, EF counties suggest an analogy to the fable of the tortoise and the hare. While EF counties race forward and then falter, the non-energy peer counties grow steadily. At the finish line, counties that have focused on broader development choices are better off, with higher rates of growth, more diverse economies, better-educated populations, a smaller gap between high and low income households, and more retirement and investment income.

Economics is the study of how people make choices in a constrained environment. The findings in this report show state and rural leaders, as well as managers of public lands (where much of the energy development is taking place in the West today), that a concentration on fossil fuel development can undercut the competitive position of a regional or local economy.

Further Reading in our Energy and the West *Series*

Learn how energy development impacts:

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- The economic and fiscal well-being of energy-producing states, with emphasis on Colorado, New Mexico, Montana, and Wyoming.

To access our *Energy and the West* series, visit: www.headwaterseconomics.org/energy.

APPENDIX

NORTH AMERICAN INDUSTRIAL CLASSIFICATION SYSTEM (NAICS) DEFINITIONS

The language below is copied verbatim from the U.S. Census Bureau's 2002 NAICS Manual
http://www.census.gov/epcd/naics02/index.html

211 Oil and Gas Extraction

Industries in the Oil and Gas Extraction subsector operate and/or develop oil and gas field properties. Such activities may include exploration for crude petroleum and natural gas; drilling, completing, and equipping wells; operating separators, emulsion breakers, desilting equipment, and field gathering lines for crude petroleum and natural gas; and all other activities in the preparation of oil and gas up to the point of shipment from the producing property. This subsector includes the production of crude petroleum, the mining and extraction of oil from oil shale and oil sands, and the production of natural gas, sulfur recovery from natural gas, and recovery of hydrocarbon liquids.

Establishments in this subsector include those that operate oil and gas wells on their own account or for others on a contract or fee basis. Establishments primarily engaged in providing support services, on a fee or contract basis, required for the drilling or operation of oil and gas wells (except geophysical surveying and mapping, mine site preparation, and construction of oil/gas pipelines) are classified in Subsector 213, Support Activities for Mining.

213111 Drilling Oil and Gas Wells

This U.S. industry comprises establishments primarily engaged in drilling oil and gas wells for others on a contract or fee basis. This industry includes contractors that specialize in spudding in, drilling in, redrilling, and directional drilling.

213112 Support Activities for Oil and Gas Operations

This U.S. industry comprises establishments primarily engaged in performing support activities on a contract or fee basis for oil and gas operations (except site preparation and related construction activities). Services included are exploration (except geophysical surveying and mapping); excavating slush pits and cellars, well surveying; running, cutting, and pulling casings, tubes, and rods; cementing wells, shooting wells; perforating well casings; acidizing and chemically treating wells; and cleaning out, bailing, and swabbing wells.

2121 Coal Mining

This industry comprises establishments primarily engaged in one or more of the following: (1) mining bituminous coal, anthracite, and lignite by underground mining, auger mining, strip mining, culm bank mining, and other surface mining; (2) developing coal mine sites; and (3) beneficiating (i.e., preparing) coal (e.g., cleaning, washing, screening, and sizing coal).

213113 Support Activities for Coal Mining

This U.S. industry comprises establishments primarily engaged in providing support activities for coal mining (except site preparation and related construction activities) on a contract or fee basis. Exploration for coal is included in this industry. Exploration includes traditional prospecting methods, such as taking core samples and making geological observations at prospective sites.

ENDNOTES

[1] U.S. Bureau of the Census, North American Industrial Classification System (NAICS): http://www.census.gov/epcd/www/naics.html.

[2] U.S. Bureau of the Census, *County Business Patterns (CBP), 2008*. Washington, D.C.

[3] The data were derived from statistics published by the Bureau of the Census, in their publication *County Business Patterns* (CBP). We used this data sources primarily because it is devoid of disclosure restrictions. Disclosure restrictions are data gaps, where a government agency will not release information to protect the confidentiality of individual firms, and occur most frequently with data in the Regional Economic Information System (REIS) of the U.S. Department of Commerce. The disadvantage of CBP is that, unlike REIS data, it does not include the self-employed or government employment. If a relative measure is used (i.e., percent of total), as we did, the exclusion of the self-employed or proprietors does not make a significant difference. Some mining sectors employ very few single-owner proprietors, so the inclusion of proprietor's data, if it were available, would actually lower the size of mining relative to other sectors. "Coal mining" and "support activities for mining" are both examples of this, where only 8 percent of the industry is made up of proprietors. Other sectors employ more proprietors than average so the inclusion of proprietors would raise their shares. "Oil and gas extraction" is an example of this, where 12 to 14 percent of employment is in proprietors. Our definition of energy includes all three sectors. Together the differences offset each other and the resultant values for energy's share of total are not affected by the exclusion of proprietors. By using a data set that does not count government employment as part of total, our energy share of total calculations are higher than they would otherwise be, especially in some communities that have a lot of government. If we were to calculate energy shares using both proprietors and government, we expect the results would report shares that were the same or lower.

[4] U.S. Department of Commerce, *Regional Economic Information System (REIS)*, *2008*. Bureau of Economic Analysis. Washington, D.C.

[5] Ibid.

[6] CBP 2008.

[7] Data for figure derived from REIS 2008.

[8] Data for figure derived from CBP 2008.

[9] Ibid, REIS 2008. Mining personal income based on estimates. Employment based on non-disclosed data from Bureau of Labor Statistics, *Quarterly Census of Employment and Wages* (QCEW).

[10] Ibid, REIS 2008.

[11] Bureau of the Census 2008. Calculations based on dividing the total number of people living in metropolitan statistical areas (MSAs) by the total population of the West.

[12] Ibid, REIS 2008.

[13] Ibid, REIS 2008. Mining personal income based on estimates. Employment based on non-disclosed data from Bureau of Labor Statistics, QCEW.

[14] Employment data in table from REIS 2008 and CBP 2008.

[15] Figures in table derived from U.S. Bureau of the Census, 2008.

[16] Housing Data, State of WY Dept of Economic Analysis and Info. http://eadiv.state.wy.us/housing.

[17] For a useful review of the academic literature on economic diversity, see Sterling, Andrew. 1998. "On the Economics and Analysis of Diversity." Electronic Working Papers Series, University of Sussex. http://www.sussex.ac.uk/Units/spru/publications/imprint/sewps/sewp28/sewp28.pdf. More narrowly, consult Malizia, E. E. and K. Shanzai. 2006. "The Influence of Economic Diversity on Unemployment and Stability." Journal of Regional Science. 33(2): 221-235.

[18] The specialization index was calculated by summing the squares of the difference between the aggregate (i.e., 26 EF counties, 254 peer counties) and the U.S. economy:

SPECIALit = ∑ ((EMPijt/EMPit)-(EMPusjt/EMPust)) 2 where,
SPECIALit = specialization of economy in county i in year t
EMPijt = employment in industry j in county i in year t
EMPit = total employment in county i in year t
EMPusjt = employment in industry j in U.S. in year t
EMPust = total employment in U.S. in year t
n = number of industries

[19] For an example of the application of a similar specialization index by the Federal Reserve, see Ozcan-Kalemlt S., B.E. Sorensen and O. Yosha. 2000. "Risk-sharing and Industrial Specialization: Regional and International Evidence." RWP 00-06. Kansas City: Federal Reserve Bank of Kansas City.

[20] The data and calculations for the specialization indices can be found on page 23 of the EF and peer profiles, located on: www.headwaterseconomics/energy.

[21] Data from U.S. Bureau of the Census, 2000, File SF#, Table P48.

[22] Data for the table derived from CBP 2008.

[23] REIS 2008.

[24] Data for figure from Bureau of Labor Statistics (BLS). *Quarterly Census of Employment and Wages (QCEW), 2008.* Washington, D.C. The category "mining" consists primarily of workers involved in the development and extraction of oil, natural gas and coal.

[25] Ibid, BLS 2008.

[26] For a review of the academic literature on the relationship between income distribution and economic growth, see: http://micro5.mscc.huji.ac.il/~melchior/html/Income%20Distribution.htm. More narrowly, consult Henry, C.W. 1998. "Income Inequality, Human Capital Accumulation and Economic Performance." *The Economic Journal*. 108 (Jan): 44-59.

[27] Data from the Bureau of the Census, 1990 and 2000 Decennial Census of Population, and Housing.

[28] The improved ratios were not because there were significantly fewer low-income families in 2000. Rather, the number of high-income families, in both sets of counties, increased. In 1990, 0.9% of household in the EF counties were high-income. By 2000, 2.3% were "rich." By comparison, in 1990 1.1% of the households in the peer counties were high-income. By 2000, 5.4% were high-income.

[29] According to the Bureau of Labor Statistics, earnings are higher and the unemployment rate is lower for people who have high levels of education: http://www.bls.gov/opub/ted/2003/oct/wk3/art04.htm. See also Ray, M. and M. Tucker. 1992. *Thinking for a Living: Education and the Wealth of Nations*. Basic Books, New York, New York.

[30] Data from the Bureau of the Census, 1990 and 2000 Decennial Census of Population, and Housing.

[31] REIS 2008.

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SUBLETTE COUNTY SOCIOECONOMIC IMPACT STUDY
PHASE II – FINAL REPORT

SUBLETTE COUNTY, WYOMING

September 28, 2009

Prepared for
Sublette County Commissioners

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It can be a difficult task to balance the positive effects of energy development and simultaneously maintain a high level of satisfaction with quality of life. The interest and dedication of all those who contributed to the Sublette County Socioeconomic Impact Study will help sustain and improve that balance. The information contained in this report will help foster an improved understanding of the social and economic contributions and challenges that lie ahead in this wonderful part of Wyoming.

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LIST OF ACRONYMS

Abbreviation	Title
AJEs	Annual Job Equivalents
BEA	Bureau of Economic Analysis
BLS	Bureau of Labor Statistics
BLM	Bureau of Land Management
CBM	Coal Bed Methane
CBNG	Coal Bed Natural Gas
CREG	Consensus Revenue Estimating Group
DCI	Division of Criminal Investigation
DEIS	Draft Environmental Impact Statement
EMS	Emergency Medical Services
EPA	Environmental Protection Agency
EPS	Economic Profile System
ERG	Ecosystem Research Group
FMR	Federal Mineral Royalties
FSEIS	Final Supplemental Environmental Impact Statement
FTE	Full Time Equivalent
FY	Fiscal Year
GDP	Gross Domestic Product
HQ	Headquarters
IMPLAN®	IMpact Analysis for PLANning
ISA	Industrial Siting Act
JIDP	Jonah Infill Drilling Project
LOP	Life of Plan
LUPH	Land Use Planning Handbook
MIG	Minnesota IMPLAN® Group
NEPA	National Environmental Policy Act
NAICS	North American Industry Classification System
NRA	Net Residential Adjustment
PAPA	Pinedale Anticline Project Area
PFO	Pinedale Field Office
REIS	Regional Economic Information System
RMP	Resource Management Plan
ROD	Record of Decision
SCRHCD	Sublette County Rural Health Care District
SIC	Standard Industrial Classification
SLIB	State Lands and Investment Board
SEIS	Supplemental Environmental Impact Statement

Abbreviation	Title
USDI	United States Department of Interior
USFS	United States Forest Service
WOGGC	Wyoming Oil and Gas Conservation Commission
WYDOT	Wyoming Department of Transportation

EXECUTIVE SUMMARY

The Phase I Sublette County, Wyoming Socioeconomic Impact Study was finalized in January of 2008 (Ecosystem Research Group 2008c). The Phase I report documented concerns over insufficient socioeconomic analyses in the National Environmental Policy Act (NEPA) process for both the Bureau of Land Management's (BLM) planning level Pinedale Field Office (PFO) Resource Management Plan (RMP) and the project level Final Supplemental Environmental Impact Statement (FSEIS), which analyzed an additional 4,399 wells in the Pinedale Anticline Project Area (PAPA). The lack of forewarning of significant socioeconomic impacts to the infrastructure of the county is particularly troublesome. County officials currently react to these impacts after the fact rather than plan for them. The county commissioners firmly believe that they need more notice and a better understanding of potential impacts to their county.

As Wyoming Governor Dave Freudenthal and U.S. Senator Mike Enzi stated in their October 30, 2008 letter to Sublette County Commissioner Joel Bousman characterizing the recent BLM socioeconomic analyses for the NEPA processes noted above:

> What emerged from these federal processes was a realization that the National Environmental Policy Act (NEPA) is ill-equipped to deal with this important topic. The state has also attempted to help offset impacts to local governments with specific impacted communities funding. Our perception is that these efforts have provided some help, but judging from the mail and telephone calls we have received, they too are seen as insufficient. Thus, there is a clear need for a meeting specifically dedicated to discussing the socio-economic issues facing Sublette County in this exciting and challenging time.

Senator Enzi stressed that whenever possible, actual data should be used for analysis as opposed to data obtained through models or approximations. The Senator's comment underscores a problem common to estimations or assumptions: they should be checked frequently as the process unfolds to ensure that they remain valid and to afford the earliest opportunity for corrections. If assumptions are not consistently monitored, unintended consequences often develop.

The Phase II report analyzes many socioeconomic indicators including population, housing, employment, wages, unemployment, personal and household income, education, roads and transportation, crime and law enforcement, medical services, and water and sanitary waste. The IMpact Analysis for PLANning (IMPLAN®) modeling software is used for projections as well as verification of past trends. Particular attention is devoted to population trends, governmental revenues, and governmental expenditures. Specifically, Phase II of the Sublette County Socioeconomic Impact Study focuses on these areas:

- Identifying and quantifying the impacts of energy development
- Determining the cost of mitigating those impacts
- Developing ongoing monitoring and mitigation strategies to refine the processes.

During the course of the Phase II Socioeconomic Impact Study, the economic situation has changed in the United States. Media sources ranging from the Casper Star Tribune (Gearino 2009) to the New York Times (Krauss 2009) report that energy companies are decreasing drilling activity nationally as well as locally. This downturn indicates potential variation in the data that ERG received during the initial stages of Phase II research, especially in the area of anticipated production and drilling schedules.

PUBLIC INPUT AND REVIEW

A Preliminary Draft Report of the Phase II Socioeconomic Impact Study was released in April, 2009 to the Sublette County commissioners and clerk, the mayors and clerks of Big Piney, Marbleton, and Pinedale, and the Sublette Community Partnership. Face-to-face meetings were held in May, 2009 with the clerks of Big Piney, Marbleton, Pinedale, and Sublette County to verify financial data contained in the report. Corrections were noted and the report was revised accordingly.

A Draft Report of the Phase II Socioeconomic Impact Study was released in June, 2009 to local government as described above; 23 energy companies operating within Sublette County; the Petroleum Association of Wyoming; and local, state, and national BLM offices. 40 copies of the Draft Report were distributed. No comments or corrections were received.

The Draft Report of the Phase II Study was posted on the Sublette County web site in July, 2009 for public review. No comments or corrections were received.

KEY FINDINGS

- The current structure of revenue generation and distribution does not adequately fund the energy-impacted infrastructure improvements required in Sublette County.

- Energy operators in Sublette County paid approximately $1.1 billion in taxes on oil and gas production in 2008. Of these receipts, Sublette County and its municipalities directly received 5.86% or $66.4 million.

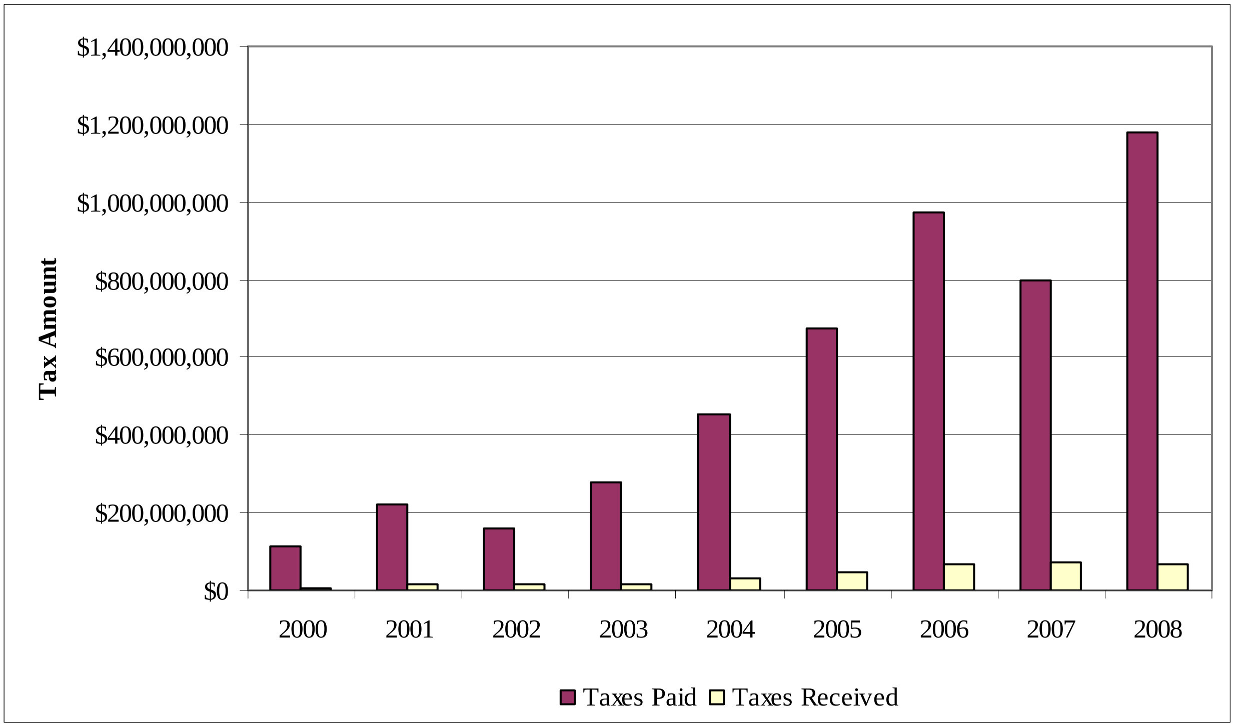


Figure ES-1 Operator-paid taxes on production in Sublette County and taxes directly received by Sublette County 2000–2008 (Federal Mineral Management Service 2009; Wyoming Department of Revenue 2009; Wyoming Legislative Handbooks 2009; Wyoming State Treasurer's Office 2009)

- Although Sublette County and the towns of Pinedale, Marbleton, and Big Piney have spent approximately $60.6 million over the past four years on capital improvements, more than $160 million is still needed to address currently identified projects.

POPULATION

- From 2000 to 2007 there was a 34% increase in Sublette County population with an average annual population growth of 286 people.
- Historically, annual population changes averaged 48 people per year between 1930 and 1990, and 108 people a year from 1990 to 2000.

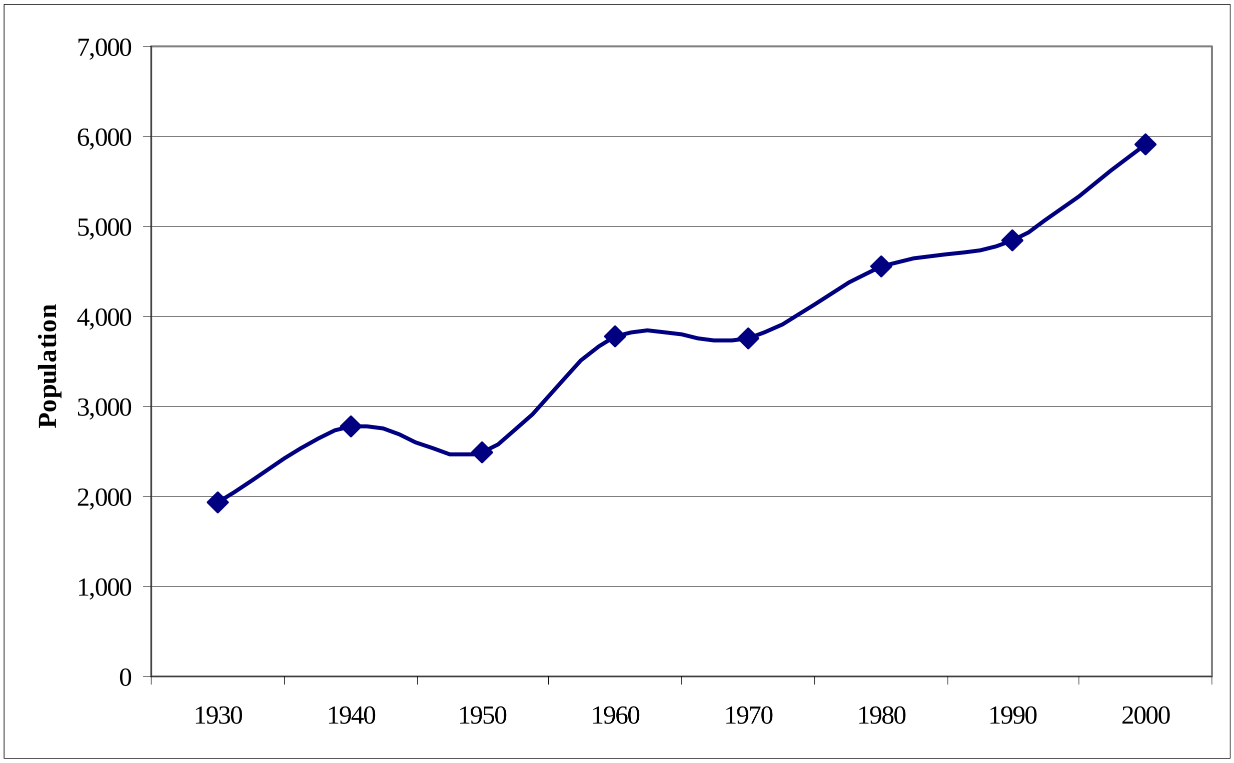


Figure ES-2 Sublette County U.S. Census Bureau population counts 1930 to 2000 (Wyoming Department of Administration and Information 2002, 2009)

REVENUES

The pace of oil and gas activity has surged in the past decade. Street and road repairs, sewer and water system upgrades, and renovations to municipal facilities are just some of the items on the long list of urgent infrastructure projects. The towns of Big Piney, Marbleton, and Pinedale and Sublette County still need $160 million to address current infrastructure needs, despite having already spent $60.6 million (Table ES-4). Money is scarce for such a wealthy county. The Pinedale Anticline Final Supplemental Environmental Impact Statement (FSEIS), Record of Decision (ROD), and approved PFO RMP allow for an additional 7,000 wells in the area (USDI 2008). Growing populations will be prevalent for years to come, as will the need for infrastructure upgrades.

Sublette County and its municipalities are experiencing problems that stem from the oscillation between the positive and negative effects of growth. To provide stability, Sublette County should determine (a) if overall revenues from energy development are sufficient to cover additional costs associated with energy development, and (b) if Sublette County receives enough of the overall revenues to cover costs associated with energy development. If revenues do not cover the cost of development, tax rates should be examined and adjusted. If overall revenues are adequate, then the tax structure should be reviewed so the county receives a large share of revenues.

- Revenues flowing into Sublette County and its municipalities originate from several sources. Some revenue streams, such as county ad valorem taxes and state sales and use taxes, are paid by residents, local businesses, and the oil and gas industry. Other sources of revenue, such as severance and federal mineral royalties (FMR), are paid solely by energy operators.

- Of particular financial interest is the analysis of taxes paid by energy operators within Sublette County and the distribution of those taxes back to the county. The impacts of energy development and the costs to mitigate them are generally assumed to be offset by the increased revenues from development activities. This does not hold true for Sublette County and is a major focal point of this report. A careful review of revenues, expenditures, and energy-related impacts finds that the current structure of revenue generation and distribution does not adequately fund infrastructure improvements required in Sublette County. This is not to say that the taxes paid by energy companies are insufficient to compensate for their impact in local communities. Rather, an insufficient percentage of those taxes are returned to or retained by Sublette County. Chapters 3 and 4 provide detailed support for this assertion.

- Table ES-1 summarizes the taxes paid on oil and gas production and related activities within Sublette County. Federal Mineral Royalties (FMR) are federal levies of which 49% is returned to the state of origin. Severance taxes are state levies, of which the majority is retained by state government. County ad valorem taxes are levied by and remain in the county of origin. Sales and use taxes are levied by the state and municipalities. Approximately 30% of these revenues are returned to local government.

- In 2008, energy operators paid approximately $1.1 billion in taxes on natural gas and oil production within Sublette County.

Table ES-1 Summary of taxes paid by energy operators in Sublette County (Federal Mineral Management Service 2009; Wyoming State Treasurer's Office 2009; Wyoming Department of Revenue 2009, Wyoming Legislative Service Office 2009)

Fiscal Year	FMR Taxes Paid on Production in Sublette County	Severance Taxes Paid on Production in Sublette County	Sublette County Ad Valorem Taxes Paid by Energy Operators	Sales and Use Taxes Paid by Energy Operators in Sublette County	Total Tax Payments Made by Energy Operators in Sublette County
2000	$80,846,655	$25,173,752	$4,466,583	N/A	$110,486,990
2001	$161,208,285	$51,516,927	$8,840,008	N/A	$221,565,220
2002	$87,492,172*	$43,178,377	$11,649,816	$9,877,876	$152,198,241
2003	$194,961,976	$60,764,273	$9,544,782	$9,324,467	$274,595,498
2004	$293,976,937	$122,970,304	$22,559,972	$14,158,341	$453,665,554
2005	$403,520,197	$180,937,557	$32,812,443	$18,615,522	$635,885,719

Fiscal Year	FMR Taxes Paid on Production in Sublette County	Severance Taxes Paid on Production in Sublette County	Sublette County Ad Valorem Taxes Paid by Energy Operators	Sales and Use Taxes Paid by Energy Operators in Sublette County	Total Tax Payments Made by Energy Operators in Sublette County
2006	$599,015,975	$279,800,999	$49,992,730	$26,543,808	$955,353,512
2007	$474,725,255	$224,587,719	$45,485,890	$39,215,156	$784,014,020
2008	$781,627,816	$269,440,380	$40,892,723	$41,612,387	$1,133,573,306

* January 2002 to May 2002 data not available due to federal litigation issues

- Table ES-2 summarizes the operator-paid taxes that are received in or distributed to Sublette County. Two points are important in this table. First, the total of operator-paid taxes received in the county is significantly smaller than the total taxes paid by the operators. In 2008, Sublette County and its municipalities received 5.86% of the total taxes paid by operators working within the county. Second, the majority of taxes received in the county come from the ad valorem and sales and use receipts. This is in stark contrast of Table ES-1, which shows that the operators paid significantly more in FMR and severance taxes than the combined ad valorem and sales and use taxes.

Table ES-2 Summary of county-wide operator-paid taxes received county-wide in Sublette County (Wyoming Department of Revenue 2009; Wyoming State Treasurer's Office 2009)

Fiscal Year	FMR Taxes Received in Sublette County	Severance Taxes Received in Sublette County	Ad Valorem Taxes Received in Sublette County	Sales and Use Taxes Received in Sublette County	Total Taxes Received in Sublette County
2000	$299,052	$186,700	$4,466,583	$2,467,703	$7,420,038
2001	$294,583	$409,120	$8,840,008	$4,293,007	$13,836,718
2002	$307,205	$233,209	$11,649,816	$5,801,045	$17,991,275
2003	$282,688	$181,820	$9,544,782	$6,111,266	$16,120,556
2004	$283,168	$185,594	$22,559,972	$8,351,600	$31,380,334
2005	$288,421	$185,373	$32,812,443	$11,636,591	$44,922,828
2006	$295,254	$191,305	$49,992,730	$16,278,557	$66,757,846
2007	$311,926	$194,402	$45,485,890	$23,753,863	$69,746,081
2008	$324,594	$185,008	$40,892,723	$24,973,536	$66,375,861

- Each jurisdiction within Sublette County collects taxes from local residents and businesses. Big Piney, Marbleton, and Pinedale assess municipal levies in addition to the ad valorem taxes assessed by Sublette County. All jurisdictions exhibit a positive trend in the growth of annual receipts, but there is a marked difference in the rate of growth and overall income between the county and the municipalities.

- In Figure ES-3, the combined municipal income for Big Piney, Marbleton, and Pinedale is charted against Sublette County ad valorem income for the years 1989–2008. Growth in municipal income is insignificant for the towns compared to the increase in county ad valorem tax revenue.

- The impact of oil and gas development has had little effect on municipal income in the towns of Big Piney, Marbleton, and Pinedale. This places the towns at a distinct financial disadvantage when addressing the effects of increased population and the accompanying strain on infrastructure and services. For example, Marbleton receipts grew 82% over two decades, but this amounted to only a $24,000 increase in annual municipal revenue. In practical terms, this amount of money barely covers the annual cost of wages and benefits for a single employee.

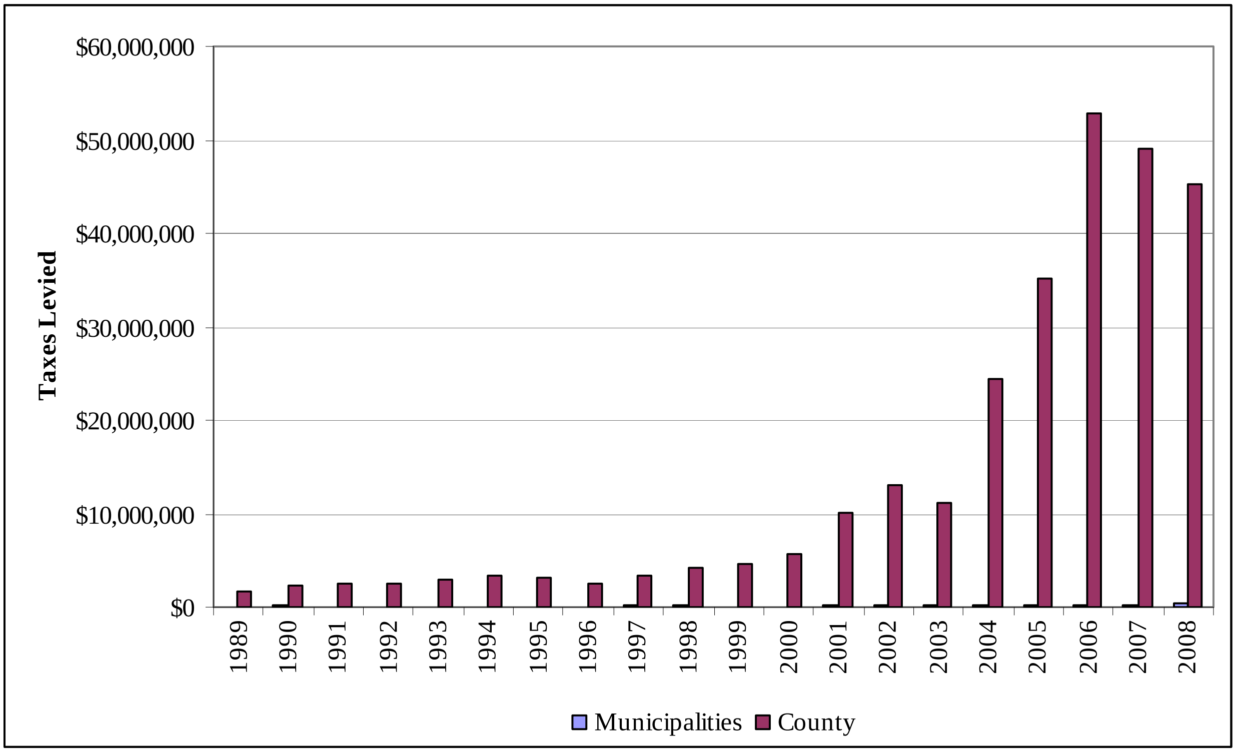


Figure ES-3 County and combined municipal taxes levied 1989–2008 (Wyoming Department of Revenue 2009)

EXPENDITURES

In recent years, county and town financial reports have shown an increased level of capital expenditures. As mentioned earlier, the county and towns have spent approximately $60.6 million in infrastructure improvements between 2005 and 2008 as summarized in Table ES-3. However, the 49 pending capital projects totaling approximately $160 million have yet to begin. Funding for infrastructure improvements is the biggest challenge facing local governments in Sublette County. The outstanding projects are summarized in Table ES-4 and detailed in Chapter 4. The accompanying map of Sublette County shown in Figure ES-6 contains additional financial information on the most urgently needed infrastructure projects. This map is located at the end of this Executive Summary.

Table ES-3 Completed capital projects in Sublette County 2005–2008 (Sublette County, Town of Pinedale, Town of Marbleton, Town of Big Piney 2005, 2006, 2007, 2008)

County/Town	2005	2006	2007	2008
Big Piney	$1,093	$7,712	$194,269	$382,155
Marbleton	$767,109	$2,094,780	$1,928,706	$1,163,609
Pinedale	$687,247	$5,998,416	$3,559,623	$1,478,429
Sublette County	$3,038,078	$6,713,520	$7,789,970	$24,792,794
Total	$4,493,527	$14,814,428	$13,472,568	$27,816,987
Cumulative Total	**$60,597,510**			

Table ES-4 Sublette County and towns anticipated capital expenditures (Arthur 2008; Hurd 2008; Lankford 2008; Murphy 2008; Ninnie 2008)

County/ Town	Projects	Total Cost	Funds Available
Big Piney	One groundwater maintenance project Seventeen road/sewer replacement projects	$9,256,754	$400,000
Marbleton	Two water well projects Two sewer treatment projects One water line project Two sewer line projects One curb/gutter/paving project One sidewalk project	$13,279,855	$3,700,797
Pinedale	Six sewer line projects Three water treatment and metering projects Five street projects One sewer treatment project	$82,267,068	$10,000,000
Sublette County	Eight road maintenance projects	$55,400,000	$3,000,000
Total		**$160,203,677**	**$17,100,797**

ENERGY INDUSTRY WORKFORCE

- Population is a primary factor in determining the extent of socioeconomic impacts. Drilling activity occurs during the initial stages of well development and involves the greatest number of personnel. Current projections anticipate the drilling of over 7,000 wells in the Pinedale Anticline and Jonah fields, the majority of them over the next ten to twelve years. Two thousand workers are expected to be employed in Sublette County through 2018, the peak employment year. Drilling rates are expected to decline between 2018 and 2025, with an accompanying drop in population. Figure ES-4 shows the expected worker counts for the current Jonah and Pinedale Anticline drilling schedules. The red bars indicate the workers performing drilling activities.

- The production phase is expected to last 40 years per well and requires fewer workers as indicated by light blue lines in Figure ES-4. When all drilling activity is complete, approximately 250 production workers will remain in Sublette County.

- Reclamation activity is the least labor-intensive task and is performed when production ceases. Reclamation is expected to begin in 2048 and continue through 2065. Population impacts from this phase of development are very small.

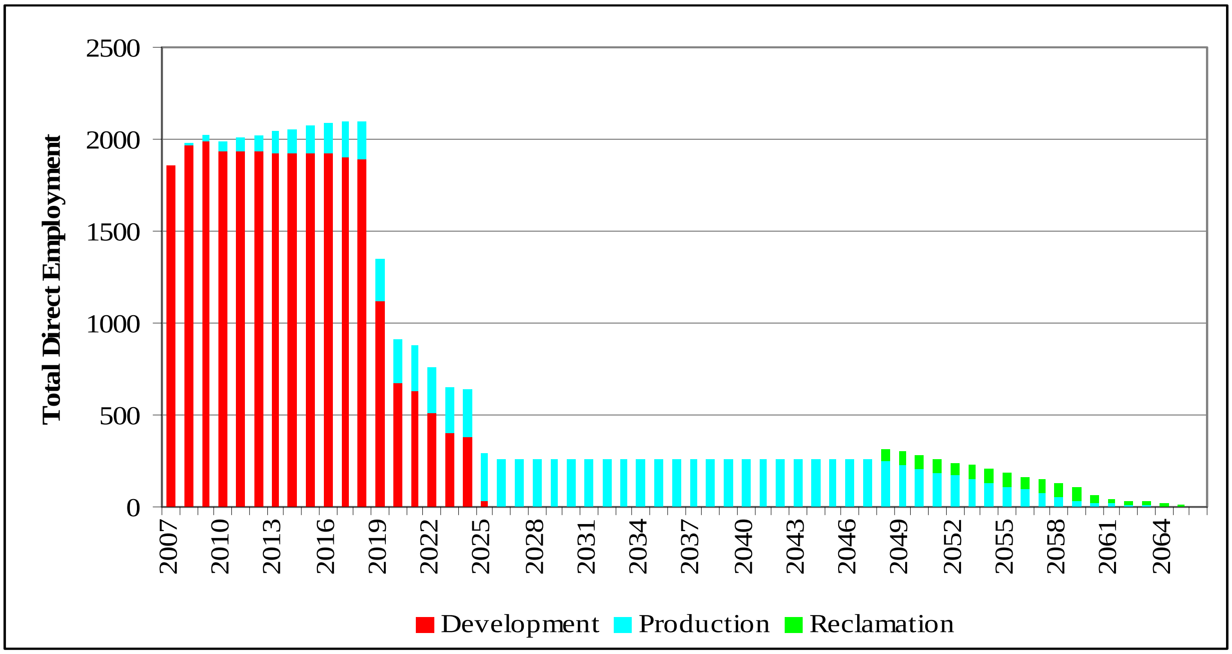


Figure ES-4 Projected total annual FTE employment for current Jonah and Pinedale Anticline drilling schedules (USDI 2006a, 2006b)

- At this time, Jonah and Pinedale Anticline drilling schedules have the most impact on population. Absent additional development to what is planned, energy-related population in Sublette County should increase slowly over the next ten years.

- Local governments should monitor pending projects as well as existing production schedules to anticipate changes in population.

INDUSTRY SURVEY

In November and December, 2008, Ecosystem Research Group (ERG) sent data requests to 23 oil and gas companies operating in Sublette County, Wyoming. The questionnaires asked for detailed information on employee projections, employee and family housing, short- and long-term anticipated operations, and recent taxes/assessments paid by each company for energy production in Sublette County. Table ES-5 lists the companies who received the survey.

Table ES-5 Energy companies surveyed regarding activity in Sublette County (Ecosystem Research Group 2008a)

Anschutz Corporation	Berry Petroleum	BP
Cimarex	Grynberg Petroleum Company	Questar E&P
Devon Energy Production	Marathon Oil Company	Shell
EnCana Corporation	Merit Energy Company	Stone Energy
EOG Resources	Newfield Exploration	Ultra Petroleum
ExxonMobil	Ominex	Berco Resources
Gasco Energy, Inc.	Chevron/Texaco	Plains Exploration & Production Company
Williams Field Services Co., LLC & Wamsutter, LLC	Yates Petroleum Corporation	

- Responses were received from eight companies. To maintain confidentiality, all responses are aggregated. Information on taxes paid by the companies for 2007 and 2008 are summarized in Table ES-6. The reported taxes paid are consistent with information reported by federal, state, and local governments.

Table ES-6 Total taxes paid by energy operators in Sublette County (Ecosystem Research Group 2008a)

Year	Reported Taxes Paid
2006	$716,629,548
2007	$710,895,571

EMPLOYMENT AND PERSONAL INCOME

- Economic development in Sublette County between 2003 and 2007 has been substantial with employment rising 62% in four years. More remarkable are growth rates in household income at 128% and total personal income at 81%. Figure ES-5 shows the growth in average annual wages by sector from 2001 to 2007.

- Unemployment in Sublette County has declined since 2003. Although this trend parallels the state and nation, the county's 1.5% unemployment rate is lower than Wyoming's 3% rate and much lower than the nation's 4.6% rate. According to letters from the towns of Marbleton and Big Piney, employers in Sublette County often struggle to find employees to fill vacancies because unemployment levels are so low.

- Sublette County has the second highest cost of living index in Wyoming; a typical bundle of goods costs more in Sublette County than in any other county in Wyoming except for Teton County.

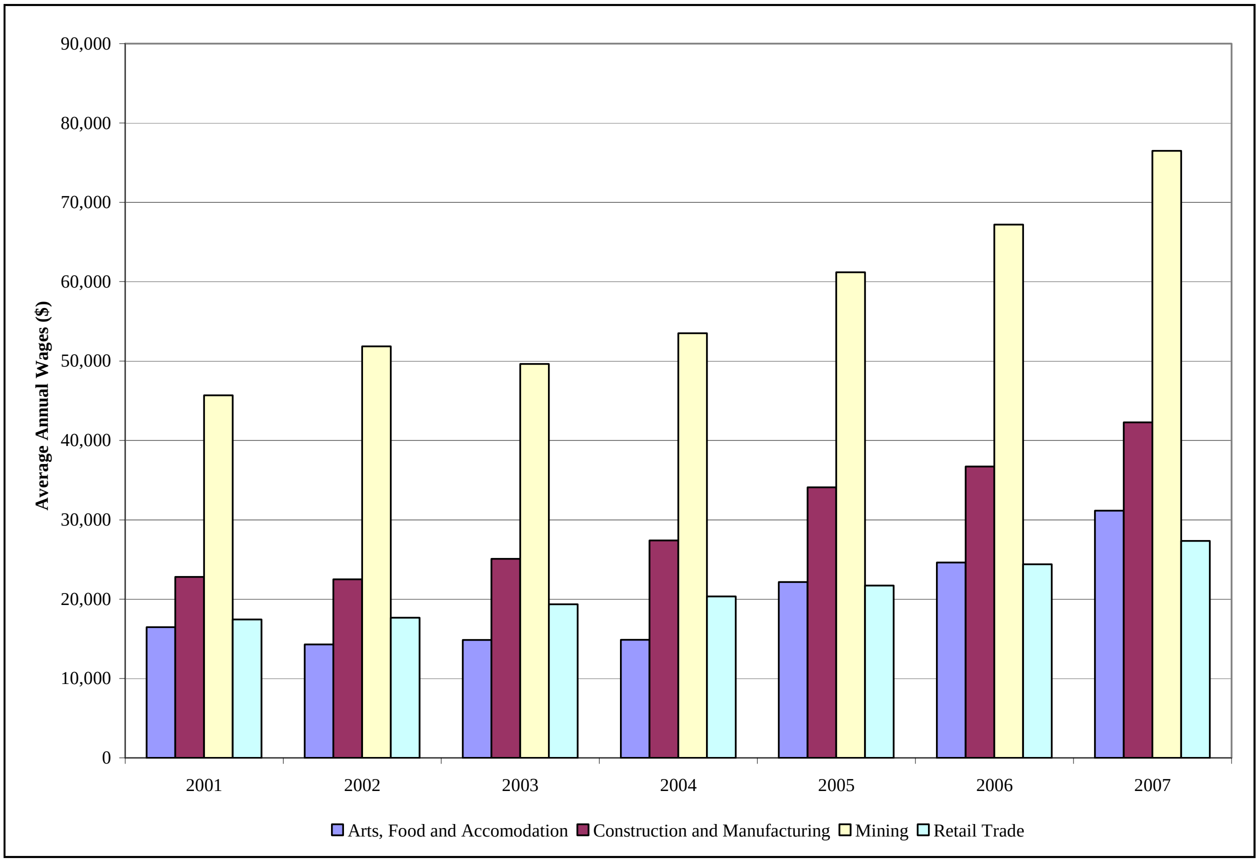


Figure ES-5 Average annual wages by sector, 2001–2007 (Bureau of Labor Statistics 2008)

- In accordance with wage increases, inflation in southwest Wyoming has consistently been above both the state of Wyoming and the nation since the 4^{th} quarter of 2004.

- This document proposes a set of indicators to track social and economic change generated by oil and gas development. The monitoring plan outlined in this document is intended to provide an annual update to communities, local governments, and federal agencies interested in and involved with management of energy-related impacts.

HOUSING AND SOCIAL SERVICES

- Periods of high drilling activity can bring over 1,500 workers to the county, all of whom require living quarters of some kind. Sublette County has a limited amount of temporary housing, so workers and their employers have had to deal, at times creatively, with the housing shortage. From 2003 to 2007, population in Sublette County increased 28% yet households decreased 20%. However, the housing shortage is believed to be easing, as evidenced by a drop in building permits issued in 2008 (Meyers 2009).

- Of nine businesses who provide temporary housing in Sublette County, five indicated that over 75% of their visitors are from the oil and gas industry, with two businesses quoting a figure of 90%. Most establishments indicated a slight decrease in business during the winter months.

- Housing prices have increased since oil and gas development arose in Sublette County with a trend of $21,207 annually (Wyoming Community Development Authority 2009).

- Increasing traffic is a statewide matter in Wyoming, but Sublette County's growth surpasses the statewide average. Traffic in Sublette County increased 86% from 2000 to 2007 while Wyoming increased 19% over the same time period (Wyoming Department of Transportation 2008).

- The number of juvenile arrests annually increased from 13 in 2000 to 25 in 2007 (U.S. Department of Justice 2007).

- The Sublette County Rural Health Care District expects a deficit of approximately $5 million for FY2009-10 which they plan to finance with their depleting savings (Gatzke 2009).

MITIGATION STRATEGIES

Several methods have been discussed to mitigate the lack of funding to address infrastructure impacts as a result of energy development on public lands. The following points have been discussed among the commissioners as possible mitigation strategies.

- Make changes to the Federal Mineral Royalties distribution. Ask the Wyoming Congressional delegation to allow more of the federal monies to come back to the states and to ensure that monies are directed to impacted communities.

- Establish a fund directly related to oil and gas development that specifically benefits communities or regions experiencing growth. A permanent fund could be developed that reflects the same principles as used by the Norwegian Government Pension Fund or the Permanent Fund established in Alaska. In these examples, revenues from energy development are retained for future investment and growth. Distributions are made to residents while retaining a majority of fund principal.

- Create a coalition of energy-impacted counties to be a vehicle for the exchange of ideas as well as a presence in the state legislative process. A coalition of county officials could serve as a forum for education and a catalyst for introducing change. Efforts in this area could be made by hired lobbyists.

- Consider procedural options under Wyoming's Industrial Siting Act (ISA) (Wyoming Statute 35-12-101). Socioeconomic reporting requirements differ between ISA and the BLM Land Use Planning Handbook

(LUPH) (H-1601-1) Appendix D (USDI 2005). While similar in nature, each document has a different focus: the ISA was developed "to execute an application/permit procedure that will help protect the natural environment and quality of life within the state of Wyoming," whereas the BLM's goal is to "understand and reconcile differing perspectives" while "balancing the competing needs, interests, and values" of the public. Given the lack of success of the BLM's planning level and project level analysis, ISA could provide better socioeconomic requirements.

- Reallocate Wyoming state severance tax receipts so that additional funds are directed toward energy-impacted counties.

PRIORITY INFRASTRUCTURE PROJECTS

Local governments in Sublette County have worked together to create a single priority list of their most urgent infrastructure needs. The estimated cost to implement this list is $71.1 million, of which the county and towns are short $62.6 million.

In a February, 2009 letter to Wyoming Governor Freudenthal, the collective jurisdictions of Big Piney, Marbleton, Pinedale, and Sublette County described the urgent infrastructure projects in detail. The following excerpts of this letter illustrate the challenges faced by local government.

Sewer and Water Repair and Maintenance

Pinedale's existing sewer infrastructure is 80 years old and disintegrating. Current sewer and water lines are made of clay that is cracked and broken throughout the system. All lines within Pinedale will be replaced by 2014. Phases 5 and 6 of the Pinedale Sewer Replacement Project will replace 32,000 linear feet of pipe. At the same time, roads affected by these phases will be repaired or resurfaced. Marbleton's existing sewer lagoon freezes during the winter and has been out of compliance with the State of Wyoming's Department of Environmental Quality standards for at least the past eight years (Murphy 2008). Big Piney's water and sewer lines are 50 years old and made of cast iron. Lines are broken throughout the system and must be replaced. Big Piney has already replaced the town's sewer lines and is in the process of replacing all water lines. At the same time, affected roads will be repaired or resurfaced.

Table ES-7 lists the highest priority sewer and water repair and maintenance projects in Sublette County's towns. Additionally, the overall project costs, the funds currently available for each project, and the shortfall for each project are identified.

Table ES-7 Sewer and water repair and maintenance costs (Arthur 2008; Hurt 2008; Murphy 2008; Ninnie 2008)

Location	Project	Project Cost	Funds Available	Shortfall
Big Piney	Water Line Replacement	$9.1 million	$400,000	$8.7 million
Marbleton	Aerated Sewer Lagoon	$5.1 million	$2.9 million	$2.2 million

Location	Project	Project Cost	Funds Available	Shortfall
Pinedale	Sewer Repair, Phases 5 and 6	$16.4 million	$2.0 million	$14.4 million
Total		**$30.6 million**	**$5.3 million**	**$25.3 million**

Water Supply and Treatment

Two water towers serve the town of Marbleton and are the only sources of water for energy operators in the area. One of Marbleton's two water towers is very old and structurally unreliable, requiring replacement. In addition, Marbleton recently drilled an additional well to provide domestic and commercial water but found that fluoride levels were unacceptably high. Treatment is required to remove the excess fluoride. Pinedale's drinking water is obtained from Fremont Lake. The Environmental Protection Agency requires all surface water to be filtered or otherwise treated for microbes. Big Piney has two historic landfills that must be monitored to maintain water quality. Table ES-8 lists the highest priority water supply and treatment projects in Sublette County.

Table ES-8 Water supply and treatment costs (Murphy 2008; Ninnie 2008)

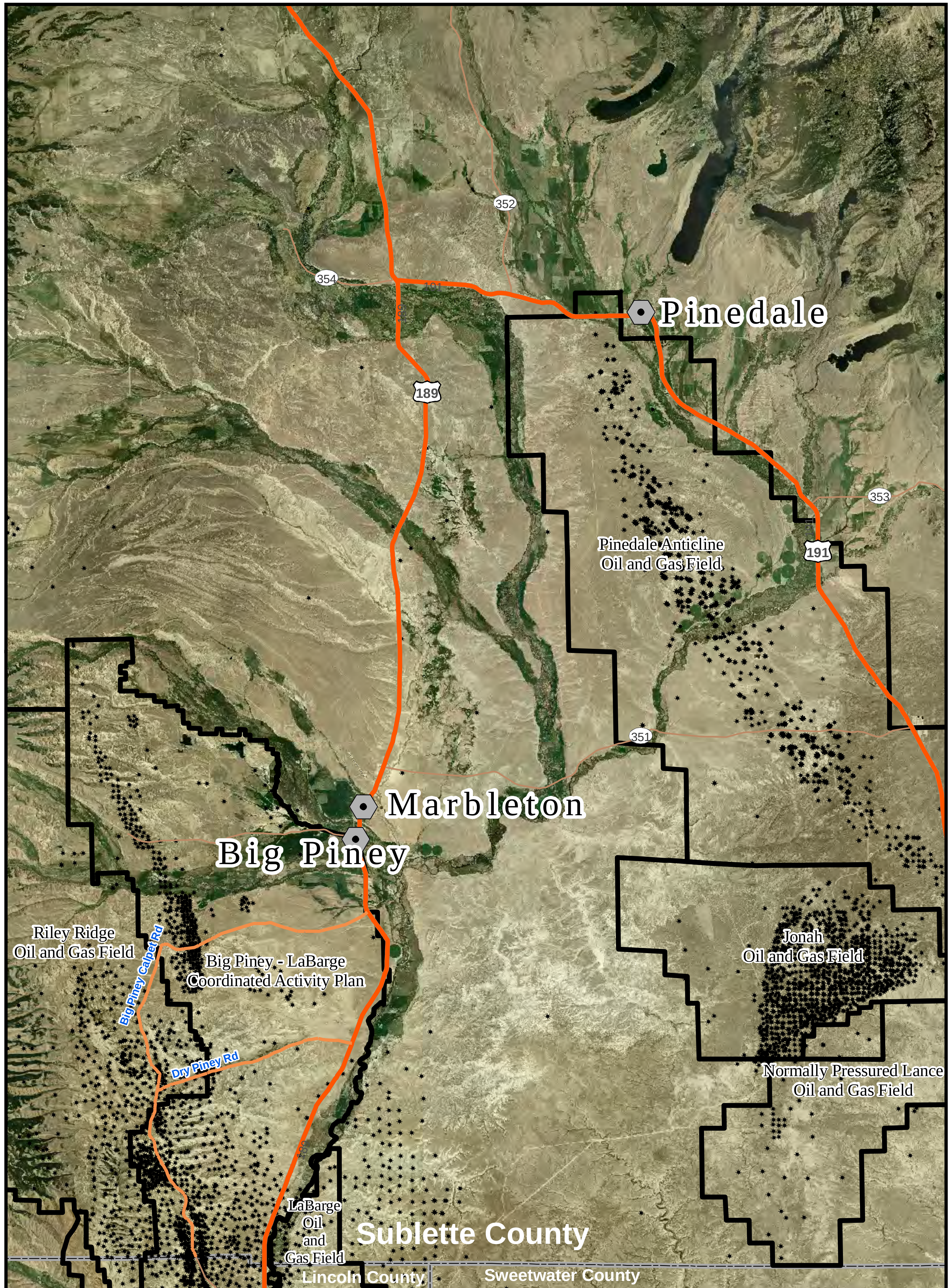
Location	Project	Project Cost	Funds Available	Shortfall
Big Piney	DEQ-Mandated Groundwater Monitoring	$125,000	None	$125,000
Marbleton	Fluoride Treatment, Water Tower Replacement	$1.6 million	$249,000	$1.4 million
Pinedale	EPA-Mandated Ultraviolet Water Treatment	$3.8 million	None	$3.8 million
Total		**$5.5 million**	**$249,000**	**$5.3 million**

Road Repair and Maintenance

Traffic on the Calpet Highway and the Dry Piney Road has increased tremendously since 2000, turning them into high-use roads with an accelerated need for maintenance. A substantial number of vehicles travel these roads annually, with 20% being larger than a pickup. The cost of paving is approximately $1.1 million per mile. Table ES-9 lists the highest priority road repair in Sublette County.

Table ES-9 Road repair (Lankford 2008)

Location	Project	Project Cost	Funds Available	Shortfall
Sublette County	Repave Calpet Highway and Pave Dry Piney Road (32 miles)	$35 million	$3 million	$32 million



Sublette County and Towns Projected Infrastructure Projects September 2009

Marbleton Upcoming Infrastructure Projects

Priority	Project	Estimated Cost	Time Frame	Budget Source	Budget Amount	Shortfall
1st	Well House #7 Fluoride Treatment	$639,243	2009	Town	$48,596	$590,647
1st	Aerated Lagoon System with Power	$4,600,000	2009-10	Town	$2,679,582	$1,920,418
1st	Wind Turbines for Aerated Lagoon System	$500,000	2009-10	Town	$172,619	$327,381
1st	50,000 Gallon Water Tower Replacement	$979,800	2010-11	Town	$200,000	$779,800
2nd	Main Water Line East to West	$497,000	2009-10	Town	$100,000	$397,000
2nd	South Sewer Line Extension	$229,000	2009-10	Town	$100,000	$129,000
2nd	Alsade Drive Curb, Gutter, and Paving	$413,406	2009-10	Town	$50,000	$363,406
3rd	Eiden Subdivision Curb, Gutter, and Paving	$2,685,894	2011-12	Town	$150,000	$2,535,894
4th	Phase III of the Marbleton Street Project Sidewalks	$2,735,512	2012-13	Town	$200,000	$2,535,512
	Total	**$13,279,855**			**$3,700,797**	**$9,579,058**

Data Source: Murphy, Anita. 2008. [Personal communication]. Town of Marbleton Clerk, Marbleton, WY.

Sublette County Upcoming Infrastructure Projects

Priority	Project	Estimated Cost	Time Frame	Budget Source	Budget Amount	Shortfall
1st	Calpet Highway	$25,000,000	2009-10	County	$3,000,000	$22,000,000
1st	Dry Piney Road	$10,000,000	2009-10	County	$0	$10,000,000
2nd	Guios Road	$6,000,000	2009-10	County	$0	$6,000,000
2nd	Horse Creek Road	$600,000	2009-10	County	$0	$600,000
3rd	Fremont Lake Road Bridge	$600,000	2010-11	County	$0	$600,000
4th	Middle Piney Road	$7,000,000	2011-12	County	$0	$7,000,000
4th	North Piney Road	$5,000,000	2011-12	County	$0	$5,000,000
5th	Fremont Lake Road	$1,200,000	Not defined	County	$0	$1,200,000
	Total	**$55,400,000**			**$3,000,000**	**$52,400,000**

Data Source: Lankford, Mary. 2008. [Personal communication]. Sublette County Clerk, Pinedale, WY.

Pinedale Upcoming Infrastructure Projects

Priority	Project	Estimated Cost	Time Frame	Budget Source	Budget Amount	Shortfall
1st	Phase V Sewer	$7,491,037	2010	Sales/Use tax	$2,000,000	$5,491,037
1st	Phase VI Sewer	$8,924,640	2010	Sales/Use tax	$0	$8,924,640
1st	EPA-Mandated Water Treatment	$3,800,000	2010	None	$0	$3,800,000
2nd	Street Repair/Improvements	$6,602,000	2010	None	$0	$6,602,000
2nd	Street Repair/Improvements	$5,182,000	2011	None	$0	$5,182,000
2nd	Phase VII Sewer	$7,486,384	2011	Sales/Use tax	$2,000,000	$5,486,384
2nd	Street Repair/Improvements	$4,544,000	2012	None	$0	$4,544,000
3rd	Phase VIII Sewer	$7,694,490	2012	None	$2,000,000	$5,694,490
3rd	Street Repair/Improvements	$4,307,000	2013	None	$0	$4,307,000
4th	Phase IX Sewer	$6,111,828	2013	Sales/Use tax	$2,000,000	$4,111,828
4th	Water Meter System	$3,200,000	2013	None	$0	$3,200,000
4th	Street Repair/Improvements	$1,368,000	2014	None	$0	$1,368,000
5th	Phase X Sewer	$2,755,689	2014	Sales/Use tax	$2,000,000	$755,689
5th	Town Hall	$5,500,000	2014	None	$0	$5,500,000
5th	Sewer Lagoon Expansion	$4,500,000	2014	None	$0	$4,500,000
5th	Water Meter System	$2,800,000	2014	None	$0	$2,800,000
	Total	**$82,267,068**			**$10,000,000**	**$72,267,068**

Data Source: Ninnie, Eugene. 2008. [Personal communication]. Town of Pinedale Engineer, Pinedale, WY.

Big Piney Upcoming Infrastructure Projects

Priority	Project	Estimated Cost	Time Frame	Budget Source	Budget Amount	Shortfall
1st	Landfill groundwater monitoring	$125,000	Ongoing	Wyo Star	$0	$125,000
1st	Black Avenue	$856,650	2009	Town	$50,000	$806,650
1st	Mickelson Street	$520,525	2009	Town	$50,000	$470,525
1st	Noble Street	$323,375	2009	Town	$50,000	$273,375
1st	Fish Street	$320,688	2009	Town	$50,000	$270,688
1st	P.L. Lane	$634,325	2009	Town	$50,000	$584,325
1st	Miller Lane	$283,500	2009	Town	$50,000	$233,500
1st	Circle Way	$263,875	2009	Town	$50,000	$213,875
1st	Beck Street	$132,650	2009	Town	$50,000	$82,650
1st	Engineering	$767,185	2009	Town	$0	$767,185
1st	Highway 189	$361,128	2010	SLIB*/ Town	$0	$361,128
1st	Piney Drive	$486,030	2010	SLIB/ Town	$0	$486,030
1st	Smith Avenue	$1,003,975	2010	SLIB/ Town	$0	$1,003,975
1st	Fish Street	$101,750	2010	SLIB/ Town	$0	$101,750
1st	Noble Street	$313,943	2010	SLIB/ Town	$0	$313,943
1st	Mickelson Street	$363,005	2010	SLIB/ Town	$0	$363,005
1st	Engineering	$521,801	2010	SLIB/ Town	$0	$521,801
1st	Piney Drive	$632,900	2011	SLIB/ Town	$0	$632,900
1st	Milleg Lane	$893,400	2011	SLIB/ Town	$0	$893,400
1st	Engineering	$351,049	2011	SLIB/ Town	$0	$351,049
	Total	**$9,256,754**			**$400,000**	**$8,856,754**

Data Sources: Arthur, Jackie. 2008. [Personal communication]. Town of Big Piney Clerk and Treasurer, Big Piney, WY.
Hurd, Todd. 2008. [Personal communication]. Forsgren & Associates, Evanston, WY.

*State Lands & Investment Board

Legend

- Road Projects
- Oil and Gas Wells
- Oil and Gas Fields

www.ecosystemrg.com

Projection:
NAD 83 UTM
Zone 12N

0 2.5 5 10 Miles

1. INTRODUCTION

1.1 SUMMARY OF PHASE I REPORT

In 2007, Ecosystem Research Group (ERG) was retained by the County Commissioners of Sublette County, Wyoming, to conduct a review of the Resource Management Plan (RMP) Draft Environmental Impact Statement (DEIS) for the Pinedale Field Office, which was being written at that time. The commissioners were concerned that the DEIS did not adequately assess the socioeconomic impacts to Sublette County as required by the National Environmental Policy Act (NEPA). ERG performed a detailed socioeconomic impact analysis and identified specific areas where Sublette County and its municipalities were impacted by energy development. ERG released the Phase I Report of the Sublette County Socioeconomic Impact Study in early 2008. In particular, ERG reported the following:

- Population rose 24% between 2000 and 2006, in contrast to a historical increase of 2% annually. The considerable increase in population directly affects the availability and price of housing; compromises the capacity and longevity of water, sewer, and waste facilities; and increases the load on emergency medical services, law enforcement, county and municipal government, and the legal system.

- As a consequence of significant population increases, Sublette County and its municipalities require large capital projects to address the associated infrastructure impacts. Basic services such as road and bridge maintenance and adequate water and sewer facilities now consume significant portions of annual budgets. The three largest municipalities in Sublette County have allocated between 60% and 90% of their general fund budgets to capital improvement projects in 2007–2008, compared to a range of 8% to 28% in 2000 and 2001.

- In 2006, the averages sales price of a house in Sublette County was 30% higher than the rest of the state. For many residents of Sublette County, the average annual wage of $20,000-$30,000 was not sufficient to purchase a home at this increased price. The lack of affordable housing in turn affected employee recruitment and retention, as workers could not find reasonably priced living accommodations.

- Arrests rose by 93% between 2000 and 2006, increasing demand for law enforcement personnel and affecting the workload of the local judicial system.

- Vehicle traffic grew 79% between 2000 and 2006. In addition to creating congestion where none had previously existed, this traffic increased premature wear on road surfaces and increased dust abatement treatment on unpaved roads throughout the county. Heavy trucks were a large component of this increase.

- Emergency medical response calls rose by 168% during this time period, necessitating the construction of a new ambulance building, hiring of additional EMS staff, and purchase of new equipment. The two medical clinics within Sublette County were renovated to increase capacity for patient treatment.

Revenues to the county and towns increased during this time period, but did not increase sufficiently to pay for the necessary capital improvements. The local governments of Sublette County simply were neither prepared nor financially able to address the infrastructure impacts of natural gas development in the area.

Between 2005 and 2008, Sublette County and its municipalities invested approximately $60.6 million in infrastructure improvements, of which the state contributed $15 million through State Lands and Investment Board (SLIB) funding (Norman 2008). Representatives from all local jurisdictions met in December, 2008 and January, 2009 to compile a single list of urgent infrastructure projects deemed essential for the continued health, safety, and well-being of those who live and work within the county and towns. The cost to implement these projects totals $71.1 million. At this time, local government is able to allocate $8.5 million to complete these improvements. Additional funding of $62.6 million is needed.

1.2 PURPOSE OF PHASE II REPORT

Phase II of the Sublette County Socioeconomic Impact Study focuses on quantifying the impacts of energy development, determining the cost of mitigating those impacts, and developing ongoing monitoring and mitigation strategies to maintain socioeconomic stability in Sublette County throughout this period of energy development. Through detailed budget analysis, computer modeling, trend analysis, and meetings and communication with government officials, ERG has calculated the operational and infrastructure costs required to provide basic municipal services to residents, employers, and workers in Sublette County. These costs are significant, and the present system of revenue generation and distribution does not adequately fund the anticipated projects, equipment, and personnel needed to accomplish this task.

The remainder of this report provides a comprehensive analysis of social and economic impacts experienced by Sublette County and its municipalities in the presence of energy development.

1.3 BACKGROUND AND METHODS

1.3.1 Study Area

Sublette County is located in western Wyoming and covers approximately 3.2 million acres, 80% of which is public land. One of 23 counties in the state, Sublette County ranks sixth in geographical size. The Wind River Range runs north to south along the eastern portion of the county, the Gros Ventre Wilderness lies to the north, and the Wyoming Range runs along the western side. The central portion of the county is a valley comprised of a sagebrush steppe eco-region. Elevation ranges from 6,280 feet in the valley to 13,400 feet in the Wind River Range.

1.3.1.1 *Sublette County History*

Sublette County, the youngest county in Wyoming, was created in 1921. It was named after the fur trapper and explorer William L. Sublette and carved from land that was previously parts of Lincoln and Fremont counties. Long before the county's incorporation, however, the area was important for fur trapping as well as sheep and cattle ranching. The area held a number of historic fur-trading rendezvous between 1824 and 1840 which brought together native populations and some of the West's most famous mountain men and explorers. Permanent populations of cattle and sheep ranchers began to settle the area in the mid to late 1800s.

Geographically isolated from railroads and population centers, the county retained its "frontier" culture for far longer than many areas of Wyoming and the West, and it remained one of the least densely populated areas in the state until well into the 20th century. Today the county has three incorporated towns: Big Piney, Marbleton, and Pinedale.

1.3.1.2 *Big Piney and Marbleton*

One of the first settlements in the area was the town of Big Piney, which was formally incorporated on July 5, 1913, though it was well-established by the late 1880s. According to one historical account, by 1890 "the burgeoning frontier town boasted a general store, dance hall, blacksmith shop, and a saloon dubbed 'Bucket of Blood'" (Blevins et al. 2005). In 1930, the town was given the distinction of being called the "Ice Box of the Nation", recording the lowest temperatures in the country.

The town of Marbleton was founded about a mile to the north of Big Piney in the early 1900s to escape flooding problems in Big Piney, but the new settlement stayed smaller in size until the mid- to late-20th century. The two towns, while close in proximity, continue to retain separate governments. Today, the towns are comprised largely of descendants of the original settlers, and a number of working cattle ranches surround the town's boundaries. A Public Broadcast System television documentary titled "Do You Mean There Are Still Real Cowboys?" was filmed in Big Piney in 1987, and cattle drives down the town's streets are still a common occurrence.

Oil and natural gas fields were discovered in southwestern Sublette County and northeastern Lincoln County early in the 20th century but they were not developed in earnest until the 1950s and 1960s, and with greater intensity again during the late 1970s and early 1980s. The Calpet and Riley Ridge fields placed growth pressures on Big Piney and Marbleton during these times, especially the early 1980s. The two towns saw industry infrastructure and businesses move into the region, along with increases in permanent and temporary residents. Gas processing plants were constructed in northern Lincoln County, and a gas and oil operator (today called EOG Resources) placed its headquarters in Big Piney. The company constructed a series of houses for its employees; EOG still uses them for this purpose today. A "tent city," also known as a "man-camp," was constructed south of town to accommodate temporary workers.

The "boom" in Big Piney and Marbleton was relatively short-lived, occurring primarily between the late 1970s and early 1980s, but the intense growth, lasting infrastructure, and long-term jobs in the area changed the culture of the towns to reflect the "boom and bust" mentality. Toward the end of the era, the towns began to plan for large growth only to see the activity dry up as Exxon's "Phase II" failed to materialize (Blevins et al. 2005). As a testament to the influence of oil and gas, Big Piney constructed old drilling derricks in a town park along U.S. Highway 189, and the Marbleton town logo includes a cowboy riding a pumping oil well.

1.3.1.3 *Pinedale*

The more northern town of Pinedale was established in 1912. Also largely a ranching town (along with some logging and forestry operations at the time), it was chosen over Big Piney to be the county seat soon after the county's establishment in 1921 in what was a very close and contested election. Various illegal voting activities were alleged, and Pinedale's selection as county seat strained relations between the county's two population centers. Pinedale later became a tourist destination for hunting, fishing, and hiking, as well as a stopover for tourists on their way to nearby Grand Teton and Yellowstone National Parks. Pinedale also is comprised of descendants of many of the original settlers, although the outlying areas of the town and northern Sublette County have seen slow but steady growth, largely due to second-home owners and retirees attracted to the viewsheds, wildlife, and small town atmosphere.

Natural gas reserves were discovered in the Pinedale Anticline in the 1950s, but they were not extensively developed until half a century later. Even when development increased in the 1970s and 1980s, Pinedale and the more northern portions of the county did not see nearly as many impacts from the oil and gas activity as did the southwestern portion of the county. While the mining culture and the mentality of "boom and bust" were incorporated into Big Piney and Marbleton, the town of Pinedale retained its small town culture of ranching, mountaineering, and frontierism, and it began to cultivate the growing interest from the tourism industry in the area's abundance of available recreation opportunities.

1.3.1.4 *Sublette County Today*

Sublette County contains more than 1,300 lakes, a small percentage of which feed tributaries forming the Green River. As many of the lakes are remote, they provide solitary recreation opportunities for fishing and camping. Boating is possible on the more accessible lakes and on the Big Sandy Reservoir located at the south end of the county. Some of these water sources are necessary to the productive farms and ranches in the area.

Eighty percent of the county is public land including BLM, State, and U.S. Forest Service (USFS). As shown in Table 1-1, the county's largest land owner is the BLM, followed closely by the USFS. Private lands make up the third largest land ownership category, followed by state of Wyoming lands.

Table 1-1 Sublette County land ownership (Wyoming Geographic Information Science Center 2007)

Owner	Acres	Percent
BLM	1,272,968	40%
USFS	1,142,994	36%
Private Lands	596,237	19%
State of Wyoming	122,999	4%
Other (open water)	32,888	1%
Total	**3,168,086**	**100%**

* Data from GIS Land Cover dataset does not specify ownership of water coverage

Two major wilderness areas in Sublette County include the Bridger Wilderness and the Gros Ventre Wilderness. The county's federal lands offer a wealth of recreational opportunities, including hiking, mountain biking, rock climbing, snowmobiling, hunting, and downhill and cross-country skiing.

According to the U.S. Census Bureau, Sublette County's estimated population was 7,925 in 2007. In addition to Big Piney, Marbleton, and Pinedale, other Sublette County towns include Cora, Daniel, Boulder, and Bondurant. Pinedale is the county seat and the largest town in the county with an estimated population of 2,043 in 2007. After grade school, students from LaBarge (in Lincoln County) attend high school in the Sublette County School District No. 9. (Note: School attendance numbers will include La Barge residents; otherwise, La Barge data were not incorporated into the document.)

1.3.2 Data Sources

For the purpose of analyzing recent trends, current data for Sublette County were requested from state and county personnel. Much of the county-specific data were provided by Jeffery Jacquet, former socioeconomic analyst for Sublette County, and Laurie Latta, coordinator of the Sublette Community Partnership. Additional data were gathered from federal, state, and county database clearinghouses; related reports; and personal communication with county and town personnel and employees and representatives of the private sector. The results are summarized in tables and figures throughout the document. Trends and statistics are presented, and projections are quantified and explained for multiple subject areas.

In certain areas of the report, requested data either was not supplied or was supplied too late to be incorporated. While ERG received information from all companies with extensive oil and gas production in Sublette County, the industry questionnaire discussed in Appendix A was not returned by many of the smaller companies in Sublette or surrounding counties.

1.3.2.1 *Industry*

Data regarding industry development were supplied by the Wyoming Oil and Gas Conservation Commission, eight oil and gas companies operating in Sublette County, and the Pinedale Bureau of Land Management (BLM) Office. Data were taken from related NEPA documents as well, including the Pinedale RMP, the Jonah Infill Drilling Project (JIDP) Final Environmental Impact Statement (FEIS), and the Pinedale Anticline Final Supplemental Environmental Impact Statement (FSEIS).

1.3.2.2 *Population*

Population information came from the following sources:

- United States Census Bureau (2009)
- Wyoming Department of Administration and Information Economic Analysis Division (2009)
- Wyoming Department of Revenue (2009)

1.3.2.3 *Employment*

Statistics for employment were collected from the U.S. Department of Labor, Bureau of Labor Statistics (BLS) website (United States Department of Labor 2008b). In 2001, the federal government changed the classification system used to report employment and wages. It was changed from the Standard Industrial Classification (SIC) to the North American Industry Classification System (NAICS). At this time, some industry classifications were broken into smaller categories, some were combined into larger categories, and some were reclassified into a different industry sector. Because of this, employment and wage data by sector were not directly compared with any data before 2001. At the time of collection for this report, 2007 data were the most up-to-date data available.

Customized tables were created from the State and County Employment and Wages section of the BLS website, which supplies data for the Quarterly Census of Employment and Wages (2001 forward). Our query specified all private establishments within Sublette County. For each major industry (with a two-digit NAICS code) ERG selected five attributes to compare: number of employees, number of establishments, total wages in thousands, average weekly pay, and average annual wage.

Since each BLS employment sector made up a considerably smaller percentage of the employment population than the Mining Sector, some employment sectors were combined for overall comparison with the Mining Sector. For example, Chapter 6 shows the largest employment sectors (aside from mining) are Construction and Manufacturing (combined BLS sectors NAICS 23, 31, 32, and 33), Retail Trade (combined BLS sectors NAICS 42, 44, and 45), and Arts, Food and Accommodations (combined BLS sectors NAICS 71 and 72).

Unemployment data came from the United States Department of Labor and the State of Wyoming Department of Employment.

1.3.2.4 *Public Services/Quality of Living*

Housing numbers were derived from information from the United States Census Bureau, Wyoming Community Development Authority, Wyoming Department of Administration and Information Economic Analysis Division, and the Wyoming Department of Revenue. Median family income information was obtained from the U.S. Department of Housing and Urban Development. Housing costs were collected from the Wyoming Department of Administration and Information Economic Analysis Division; additional information was gathered from the Wyoming Community Development Authority.

Information regarding school enrollment numbers came from the district offices at School District No. 1 and School District No. 9. Supplemental statistical information came from the Wyoming Department of Education.

Data for the Transportation section were collected from the Wyoming Department of Transportation (WYDOT) statewide database, the Pinedale WYDOT office, and the Sublette County Road and Bridge Department. Traffic count information was supplied by WYDOT in the form of a statewide database. The database was queried for selected points along roads and highways in Sublette County. The WYDOT traffic count database provided year-by-year traffic estimates specific to sections of highways and offered traffic estimates both for all vehicles and for heavy trucks alone.

General crime data came from the Unified Crime Reports and Wyoming Attorney General’s Office, Division of Criminal Investigation. Current data or county-specific data not included in the reports were supplied by Richard Russell, Wyoming Unified Crime Reporting program manager. Circuit court data were extracted from the Circuit Court Monthly Activity Reports; however, information regarding circuit court appearances came from Curt Haws, Circuit Court judge, Circuit Court of the Ninth Judicial District in Sublette County. Data for the Sublette County Jail were supplied by Lieutenant Wes Johnston of the Sublette County Sheriff’s Department. Data regarding emergency medical services and patient visits were collected from the Sublette County Rural Health Care District.

Water and sanitary waste data were collected from the clerk at the Big Piney town offices and from the assistant clerk at the Marbleton town offices. The town of Pinedale was unable to supply usage data for its water and sewer. However, Pinedale recently upgraded its sewer treatment plantto accommodate the increase in population.
Data sources for solid waste included Rick Hoffman, Sublette County supervisor, who supplied data on tonnage for the Sublette County Landfill and Materials Analysis Reports by Account; Colleen Grandsen, owner/operator of BNC Trash Service; and Marti Seipp, Sublette Citizens for Recycling Impact Analysis.

Data regarding social and cultural changes from the natural gas development are largely qualitative in nature, consisting of interviews and surveys performed by the University of Wyoming and other state agencies, as well as interviews that have appeared in the media.

1.3.2.5 *Economy and Revenue*

Information regarding Sublette County and municipal revenues was collected from the Wyoming Department of Revenue and the Wyoming Legislative Service Office. County and municipal expenditures were extracted from the Sublette County budgets and the municipal budgets for Big Piney, Marbleton, and Pinedale.

1.3.3 Data Analysis

Analyses of past and current trends in population, employment and income, public services and quality of living, and economy and revenues are summarized in tables and figures throughout the document. As data were available, trends from 1990 onward and from 2000 onward are presented and compared. Qualitative and anecdotal information supplemented quantitative information where data were lacking.

ERG estimated the economic effects resulting from oil and gas development in Sublette County using the IMPLAN® economic impact modeling system. Scenarios were analyzed for 2009 to 2018 using figures from the JIDP FEIS and Pinedale Anticline FSEIS ranging from 555 new wells in 2009 to 529 new wells in 2018. Economic effects on Sublette County including direct, indirect, and induced effects were reported. Indirect effects include employment effects arising from inter-industry effects. Induced effects result from household expenditures in the input/output analysis. Direct-hire labor force for drilling and production was based on the JIDP FEIS and Pinedale Anticline FSEIS. All numbers are reported in average job equivalents (AJEs).

1.3.4 Public Input and Review

A Preliminary Draft Report of the Phase II Socioeconomic Impact Study was released in April, 2009 to the Sublette County commissioners and clerk, the mayors and clerks of Big Piney, Marbleton, and Pinedale, and the Sublette Community Partnership. Face-to-face meetings were held in May, 2009 with the clerks of Big Piney, Marbleton, Pinedale, and Sublette County to verify financial data contained in the report. Corrections were noted and the report was revised accordingly.

A Draft Report of the Phase II Socioeconomic Impact Study was released in June, 2009 to local government as described above; 23 energy companies operating within Sublette County; the Petroleum Association of Wyoming; and local, state, and national BLM offices. Forty copies of the Draft Report were distributed. No comments or corrections were received.

The Draft Report of the Phase II Study was posted on the Sublette County web site in July, 2009 for public review. No comments or corrections were received.

2. POPULATION

2.1 POPULATION TRENDS

Since its inception in 1921, Sublette County has maintained its position as one of the least populated counties in Wyoming, both in total population and in population per square mile. Between 1930 and 1990, Sublette consistently ranked in the bottom three of Wyoming's 23 counties in overall population. During the same time period the county ranked either 22nd or 23rd in population density, never rising above one person/square mile. The 2000 census showed small movement in these categories when Sublette County population reached 5,920 residents, rising to 20th of 23 in total population and attaining a population density of 1.21 persons/square mile.

Despite the low overall population numbers, the number of residents in Sublette County has grown at a relatively rapid pace over the past 15 years. A main contributor to population growth is oil and gas development in and around the county. In the early 1990s a struggling economy in California caused a large outflow of population from that state (Liu 2007). This outflow went mainly into neighboring states and the nearby Rocky Mountain region (Liu 2007). From 1991 to 1995, the state of Wyoming showed a 1% yearly increase in population, which for the prior decade (1981 through 1990) had declined about 1% per year. This trend decreased as the California economy strengthened in the late 1990s (Liu 2007). However, as the emigration from California into Wyoming was declining, the oil and gas industry was growing in and around Sublette County, causing the population to remain on the rise. Based on historical trends, the county's population would be expected to increase 20% between 2000 and 2010; however, with the increased growth rate from 2000 to 2006 due to the oil and gas activity, population is expected to rise 30% between 2000 and 2010 (Jacquet 2006). The population has increased to the point that it is stressing the infrastructure designed to support it (Jensen 2007; Town of Big Piney 2007a; Town of Marbleton 2007a). From county offices to local diners, businesses are short staffed and/or require more space to operate under the increased workload (Jensen 2007; Lankford 2007; Town of Big Piney 2007a; Town of Marbleton 2007a). Compounding the problem is the transient nature of much of the oil and gas workforce, which makes the population difficult to track and the impact to county infrastructure hard to determine. (Town of Marbleton 2007a).

Since 2000, county population has increased from 5,920 people in 2000 to an estimated 7,925 people in 2007. The town of Pinedale holds the largest portion of the population with 2,043 people in 2007, followed by Marbleton at 919 and Big Piney at 476. Table 2-1 shows the population trends for Big Piney, Marbleton, Pinedale, and Sublette County from 2000 to 2007. Overall growth within the county was slightly under 34% during this period, averaging an annual gain of 286 people.

Table 2-1 Population for Sublette County and Municipalities 2000–2007 (Wyoming Department of Administration and Information 2008)

Year	Big Piney	Marbleton	Pinedale	Sublette County
2000	408	720	1,402	5,920
2001	404	712	1,383	5,897
2002	421	742	1,433	6,145
2003	431	762	1,479	6,317
2004	438	780	1,545	6,575
2005	451	806	1,647	6,880
2006	453	848	1,818	7,241
2007	476	919	2,043	7,925
Percentage Growth	16.67%	27.64%	45.72%	33.86%

In contrast to the 34% population growth seen in Sublette County during this decade, the historical population growth was much smaller. As seen in Table 2-2, the county gained an average of 48 residents each year between 1930 and 1990, increasing to 108 residents each year between 1990 and 2000.

Table 2-2 Population growth in Sublette County 1930–2000 (Wyoming Department of Administration and Information 2002, 2008)

Year	Sublette County Population
1930	1,944
1940	2,778
1950	2,481
1960	3,778
1970	3,755
1980	4,548
1990	4,843
2000	5,920

Sublette County's growing population correlates with the increase in oil and gas drilling in the area as oil industry workers and their families relocate to the area. While energy development is not the only factor influencing population growth, the industry does influence the county's population. Figure 2-1 illustrates a relationship between population and energy activity, displaying annual population counts and the annual number of wells drilled within the county. Both trends show a marked change between 2000 and 2002, showing an increase in the annual rates of population change and the number of wells drilled.

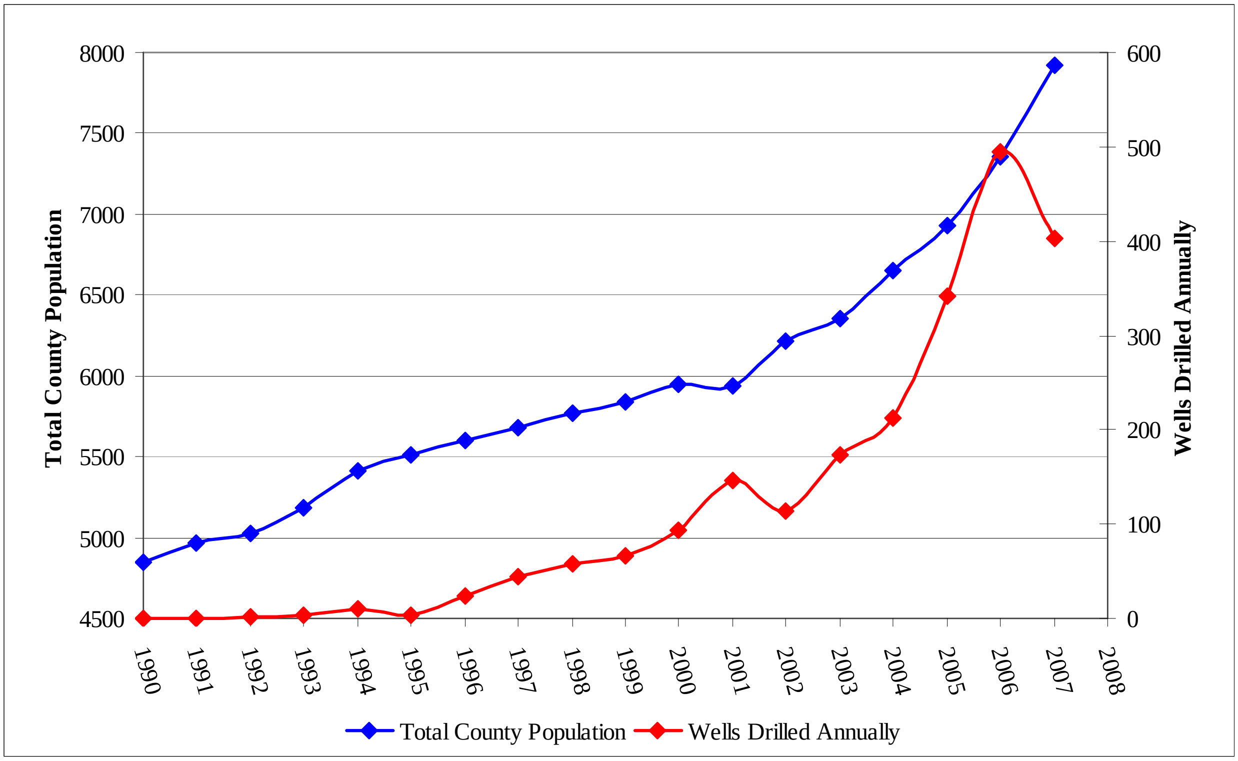


Figure 2-1 Population change and wells drilled annually 1990–2007 (Wyoming Oil and Gas Commission 2007)

2.1.1 Age Demographics

As a component of population growth, age demographics are changing in Sublette County. The number of young workers is rising as energy development increases, notably in the population segment between the ages of 15 and 24. Figure 2-2 shows that the 15–24 age group in Sublette County grew approximately 60% between 2000 and 2007. This contrasts with statewide demographics showing that the proportion of young people remained relatively stable during the same time period, even decreasing in the 25–44 age group.

In addition, Figure 2-2 shows that the 55–64 age group increased over 50% during the current decade. It is unknown whether the growth in this demographic segment is linked to the energy industry. While it is not likely that the energy industry employs a large number of workers in this age group, it is a possibility. It is also reasonable to assume that retirees or those nearing retirement age would choose to relocate to Sublette County, regardless of any industry affiliation.

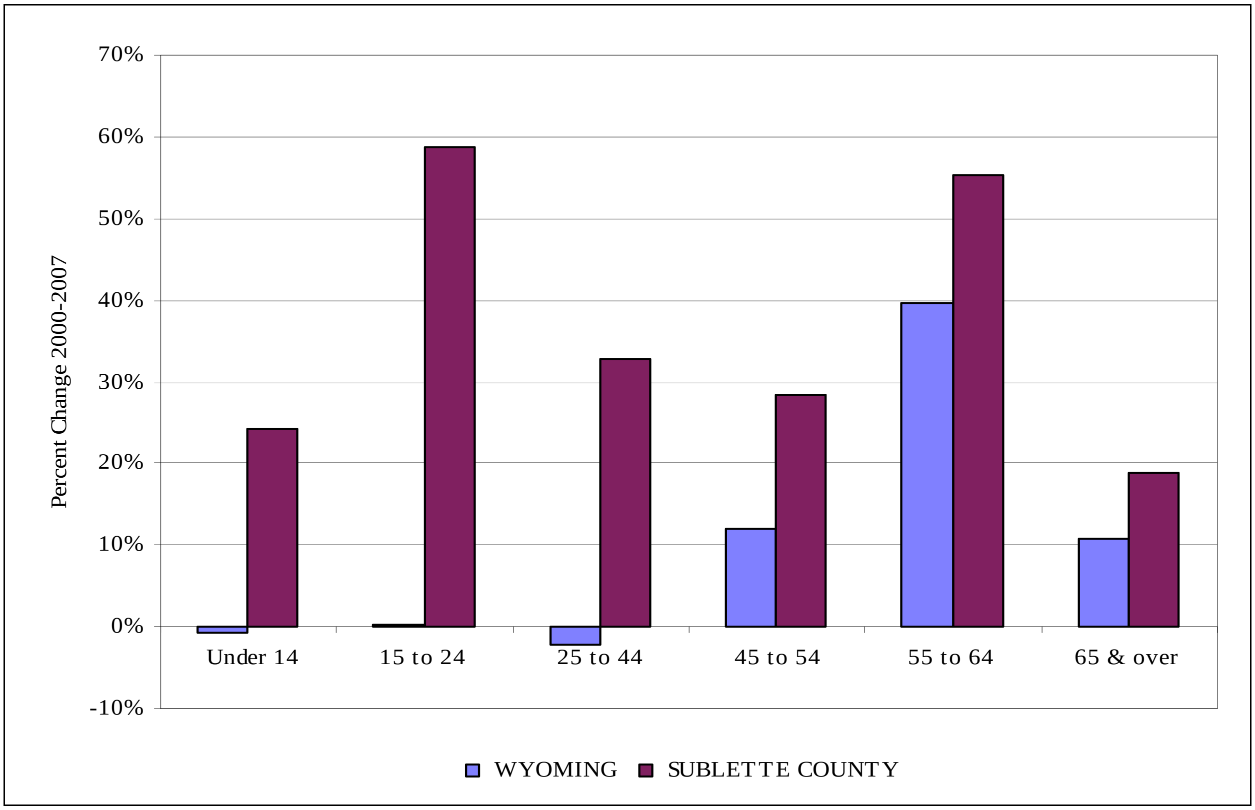


Figure 2-2 Sublette County and the State of Wyoming population age classes percent change 2000–2007 (United States Census Bureau 2007)

2.1.2 Organic vs. Energy-Related Growth

As stated previously, population in Sublette County increased by an average of 48 residents per year between 1930 and 1990, and then grew by approximately 108 new residents annually between 1990 and 2000. Following this most recent growth trend, Sublette County's population would be expected to increase by 749 persons by the year 2007 to total 6,679 residents. However, the actual population growth began substantially deviating from that trend in 2004, and by 2007 the population was 1,243 people higher than would have been expected. This change can be strongly correlated with the presence of the energy industry.

The difference between the natural, or organic, population growth rate of the 1990s and the energy-impacted growth rate of the 2000s is illustrated in Figure 2-3. The latest surge in oil and gas drilling commenced in 2000 and rose sharply to reach 100 wells per year by 2004. The organic population growth line closely follows the actual population count until 2004, and then also sharply rises. The increases in well drilling and population are similar in timing and rate, strongly suggesting cause and effect. Drilling activity in Figure 2-3 reflects actual figures to present, then projected figures based on estimated drilling schedules in the Jonah and Pinedale Anticline fields.

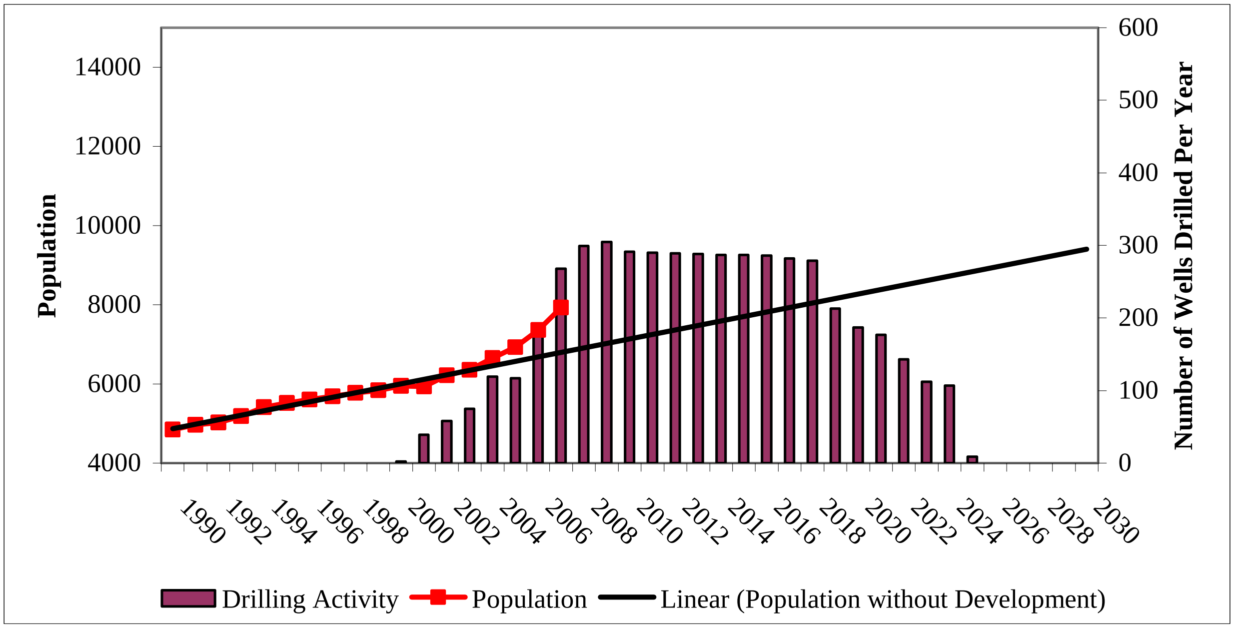


Figure 2-3 Organic population growth and energy-impacted population growth compared with annual well completions (Wyoming Department of Administration and Information 2002, 2008)

2.2 PROJECTIONS THROUGH LIFE OF PLAN

2.2.1 State of Wyoming Population Projections

Sublette County's population is expected to continue increasing through 2018, the estimated peak employment year. The Wyoming Department of Administration and Information estimates county populations through 2030 using U.S. Census Bureau data. As the last official census was in 2000, before the latest surge in energy development in Sublette County, these estimates likely underestimate Sublette County's population. However, these estimates are supplied in Table 2-3 for 2010, 2015, 2018, and 2020. It is interesting to note that the Department of Administration and Information projects an annual population increase of 420 persons between 2010 and 2020, which is even larger than the 286-person increase seen between 2000 and 2007.

Table 2-3 Population projections through 2020 (Wyoming Department of Administration and Information 2008)

Year	Big Piney	Marbleton	Pinedale	Sublette County
2010	551	1,063	2,364	9,170
2015	673	1,299	2,887	11,200
2018	748	1,445	3,212	12,460
2020	803	1,550	3,447	13,370

2.2.2 Energy Industry Population Projections

Oil and gas companies operating in Sublette County, Wyoming were recently surveyed regarding drilling projections, personnel counts, and other business-related issues. Complete results from this survey are tabulated in Appendix A of this report. Pertinent information from the industry survey is also included throughout the report. Regarding population, the questionnaire stated, "Please provide the following: total number of employees (contract, subcontract, part- and full-time) working in Sublette County during 2007 and 2008 and projected for 2009, including information you may have regarding families who accompany employees to the area" (Ecosystem Research Group 2008a). Some respondents supplied data that included employee and family size numbers. When companies did not include family size information ERG assumed an average family size of 3.1 persons, which is the value used by several companies who provided family size estimates.

The industry responses indicated an increase of personnel living in the county between 2007 and 2008 with a slight drop in 2009. Table 2-4 presents summarized responses. Note that industry responses were limited to the eight of 23 companies operating within Sublette County; data is limited accordingly. Worker and family member count was 1,478 in 2007, 1,702 in 2008, and 1,630 in 2009. It is important to note that these estimates do not include responses from all companies surveyed, as some companies either provided incomplete or no information.

Table 2-4 Number of personnel and family members living in Sublette County (Ecosystem Research Group 2008a)

Year	Workers and Family Members
2007	1,478
2008	1,702
2009	1,630

The U.S. Census Bureau conducts population counts each decade and estimates population growth for the subsequent ten-year period until another count is conducted. It is likely the current intercensal population estimates do not include energy workers or their families, as the 2000 census was taken before oil and gas development in Sublette County gained a strong presence. Table 2-5 shows the intercensal and industry population estimates for 2009 to 2018. For 2010 to 2018, ERG estimated the industry workforce from industry's estimates for 2007–2009. Recognizing that these values are only approximations, ERG treated the sum as a midpoint with a deviation of plus or minus 15%. Thus the total population projection value of 10,380 residents in 2009 could range from a low of 8,823 to a high of 11,937.

Table 2-5 Sublette County total population estimates (Ecosystem Research Group 2008a; Wyoming Department of Administration and Information 2008)

Year	Census Estimate	Industry Estimate	Total Population Estimate	Low Population Projection	High Population Projection
2009	8,750	1,630	10,380	8,823	11,937
2010	9,170	1,638	10,808	9,187	12,429
2011	9,600	1,552	11,152	9,479	12,825
2012	10,050	1,524	11,574	9,838	13,310
2013	10,420	1,557	11,977	10,180	13,774
2014	10,800	1,141	11,941	10,150	13,732
2015	11,200	1,122	12,322	10,474	14,170
2016	11,600	1,116	12,716	10,809	14,623
2017	12,020	1,109	13,129	11,160	15,098
2018	12,460	1,122	13,582	11,545	15,619

3. FINANCIAL TRENDS – REVENUES

3.1 INTRODUCTION

The oil and gas industry has long been a fixture in the state of Wyoming. Since the beginning of oil and gas exploration in the late 1800s, Wyoming's petroleum industry has been an important, and often vital, economic component affecting state, county, town, and individual finances.

With a state population of 515,000 and almost 98,000 square miles of land, the ratio of five residents per square mile suggests that activities such as creating and maintaining infrastructure and providing social services to rural residents would place a heavy burden on taxpayers. However, mineral revenues (including those from oil and gas production) contribute significantly to an array of infrastructure elements such as building roads, constructing schools, providing social services, developing water systems, and funding local and state government operations. At an average of 59.051 mills in 2008, taxpayers in Sublette County have one of the lowest mill levies in the state, approximately 4.252 mills lower than the 2008 statewide average levy of 64.303 mills.

Revenues flowing into Sublette County and its municipalities originate from several sources and vary widely in their overall contribution to government revenues. Some income streams, such as county ad valorem taxes and state sales and use taxes, are paid by residents, local businesses, and the oil and gas industry operating within the county. Other sources of revenue, such as severance taxes, federal mineral royalties, and payments in lieu of taxes, are paid solely by energy operators and/or the federal government. This section describes the major revenue sources in Sublette County and analyzes their historical changes.

Of particular interest in this section is the analysis of taxes paid by energy operators within Sublette County. Communities often assume that the impacts of energy development and the cost to mitigate them are offset by the increased revenues generated by development activities. This assumption does not hold true for Sublette County and is a focus of this report. A careful review of revenues, expenditures, and energy-related impacts finds that the current structure of revenue generation and distribution does not adequately fund the necessary infrastructure improvements required in Sublette County. This is not to say the taxes paid by energy companies are insufficient to compensate for their impact in local communities. Rather, an insufficient percentage of those taxes are returned to or retained by Sublette County. Chapter 3, in conjunction with the discussion of fiscal expenditures contained in Chapter 4, provides detailed support of this assertion.

3.2 SALES AND USE TAX

Wyoming collects sales taxes on goods purchased within its borders and assesses a use tax on items purchased outside Wyoming but destined for use within the state. The base rate of taxation on these transactions is 4%. Sales and use taxes are collected and distributed by the state, with distributions allocated as follows (State of Wyoming 2008):

- 30% is returned to the originating county and/or municipality;
- 1% is retained for state-wide distribution and administrative overhead; and
- 69% is retained for usage by the state.

In addition, counties have the option to assess an additional 1% optional sales tax and/or 1% capital facilities tax, subject to voter approval. Where assessed, the state retains 1% of these funds for administrative overhead and the remaining 99% is returned to the originating jurisdiction. These optional levies are not assessed by Sublette County at this time, which gives county residents one of the lowest tax rates in Wyoming. Fremont, Park, and Washakie counties join Sublette in assessing the minimal sales and use tax rate of 4% (Wyoming Economic Analysis Division 2008).

Table 3-1 and Figure 3-1 provide historical data on sales and use tax distributions between 1989 and 2008. In all cases this revenue stream increased noticeably in 1998 and 2001 and maintained rapid growth between 2003 and 2007. Overall, receipts grew exponentially during this twenty year period, ranging from a low of 3,182% for Big Piney to 5,600%–5,900% for Marbleton, Pinedale, and Sublette County. It should be noted that the revenue generated through sales and use tax is the major stream of income for the towns in Sublette County. Figure 3-1 displays county-wide sales and use tax distributions.

Table 3-1 Sales and use tax annual distributions, 1989–2008 (Wyoming Department of Revenue 2009)

Fiscal Year	Big Piney	Marbleton	Pinedale	Sublette County	County-wide Sales and Use Distributions
1989	$51,880	$52,593	$104,384	$236,467	$445,324
1990	$71,579	$72,563	$144,019	$326,255	$614,416
1991	$71,287	$73,587	$145,467	$328,761	$619,102
1992	$60,194	$84,092	$156,685	$341,443	$642,414
1993	$57,918	$80,913	$150,761	$328,534	$618,126
1994	$63,285	$88,410	$164,730	$358,975	$675,400
1995	$73,719	$102,986	$191,889	$418,160	$786,754
1996	$70,914	$99,068	$184,590	$402,253	$756,825
1997	$96,901	$135,351	$252,168	$549,552	$1,033,972
1998	$200,973	$289,555	$513,892	$1,139,434	$2,143,854
1999	$216,458	$302,278	$563,076	$1,227,229	$2,309,041
2000	$231,331	$323,049	$601,767	$1,311,557	$2,467,704

Fiscal Year	Big Piney	Marbleton	Pinedale	Sublette County	County-wide Sales and Use Distributions
2001	$402,442	$562,000	$1,046,881	$2,281,686	$4,293,009
2002	$399,802	$705,533	$1,383,628	$3,312,084	$5,801,047
2003	$418,178	$737,961	$1,447,224	$3,507,905	$6,111,268
2004	$567,647	$1,010,272	$2,044,204	$4,729,477	$8,351,600
2005	$789,003	$1,401,281	$2,831,643	$6,614,682	$11,636,609
2006	$1,105,566	$1,958,458	$3,980,769	$9,233,764	$16,278,557
2007	$1,620,713	$2,862,616	$5,771,071	$13,499,463	$23,753,863
2008	$1,702,453	$3,008,499	$6,074,692	$14,187,892	$24,973,536

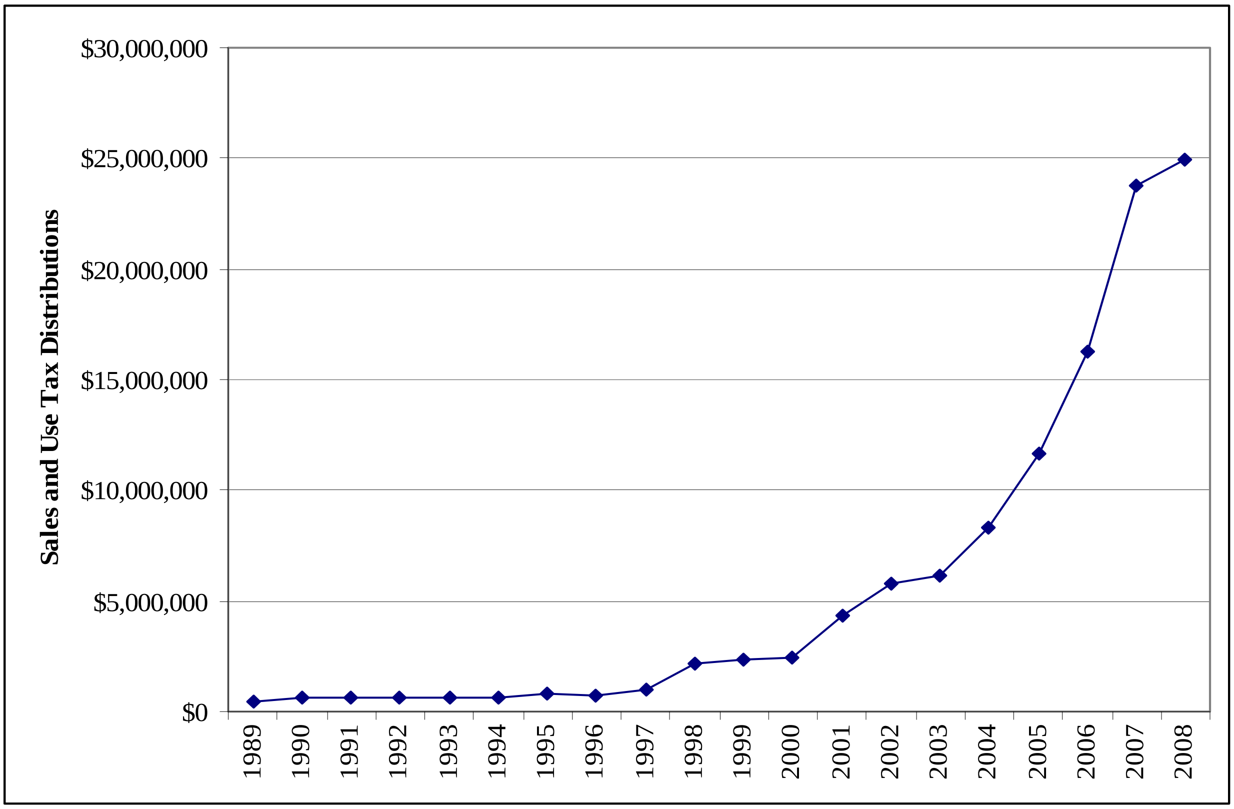


Figure 3-1 County-wide historical sales and use tax distributions, 1989–2008 (Wyoming Department of Revenue 2009)

In 2002 the Wyoming Department of Revenue began to provide detailed information on sales and use tax receipts by business class. Table 3-2 shows the Mining Sector is responsible for approximately half of the sales and use taxes generated within Sublette County. Thus, the Mining Sector is a major contributor to the revenue stream from sales and use tax receipts.

Table 3-2 County-wide sales and use taxes by business class, 2002–2008 (Wyoming Department of Revenue 2009)

Fiscal Year	County-wide Sales and Use Taxes	County-wide Sales and Use Taxes Generated by Mining Sector	Percentage of Sales and Use Taxes Generated by Mining Sector
2002	$21,059,373	$9,877,876	47%
2003	$21,082,472	$9,324,467	44%
2004	$28,291,190	$14,158,341	50%
2005	$37,580,227	$18,615,522	50%
2006	$52,568,766	$26,543,808	50%
2007	$76,905,734	$39,215,156	51%
2008	$80,826,078	$41,612,387	51%

3.3 MUNICIPAL AND COUNTY AD VALOREM TAXES

3.3.1 Assessed Value and Millage

The Wyoming Department of Revenue administers ad valorem taxes on behalf of local counties and municipalities. For county residents and business owners, this tax is levied on industrial property, homes, and personal property. Assessors in each county determine the fair market value for homes and property and then take 11.5% of that value to determine the taxable or assessed value of industrial property and 9.5% of that value to determine the taxable or assessed value of homes and other real property. The taxable value is then multiplied by the appropriate mill levy, where each mill is equal to one-thousandth of the taxable value. For example, a home with a fair market value of $1,000,000 would have a taxable value of $95,000 ($1,000,000*9.5%). An assessment of 59.051 mills on this home (the 2008 mill levy in Sublette County) would result in a tax of $95,000*.059051, amounting to $5609.85.

For energy operators, this tax is levied on minerals (including crude oil and natural gas) at 100% of the fair market value. Thus, natural gas production valued at $1,000,000 taxed at 59.051 mills would result in a tax of $1,000,000*.059051, or $59,051.

Table 3-3 shows the historical assessed values for Sublette County from 1989 through 2008. The cumulative assessed value increased almost 80% between 2000 and 2001 and has remained in the $2 billion to $4 billion dollar range in recent years.

Table 3-3 County-wide assessed value, all property (Wyoming Department of Revenue 2009)

Fiscal Year	Grand Total Assessed Value
1989	$145,323,076
1990	$198,335,636

Fiscal Year	Grand Total Assessed Value
1991	$217,877,301
1992	$203,104,237
1993	$238,687,180
1994	$275,647,391
1995	$262,350,711
1996	$216,400,442
1997	$274,762,732
1998	$376,372,362
1999	$379,275,654
2000	$475,836,429
2001	$851,302,215
2002	$1,097,146,541
2003	$934,678,199
2004	$2,039,132,508
2005	$2,924,020,029
2006	$4,401,618,317
2007	$4,085,698,722
2008	$3,773,650,926

Millage varies by jurisdiction and by the financial need of each taxing jurisdiction. For example, counties in Wyoming are permitted to assess a maximum of 12 mills and municipalities are allowed a maximum of 8 mills. Table 3-4 shows the 2008 mill levies assessed by tax districts within Sublette County. Table 3-5 shows historical mill levies assessed within the County from 1980 to 2008.

Table 3-4 Sublette County mill levies, 2008 (Sublette County Assessor 2008)

Tax District	101	102	111	112	113	150	900	914	950	951
Area	**Rural**	**SW COR**	**HOB RAN**	**BLDR LAKE**	**RED UP GR**	**PINED ALE**	**RURAL**	**MEAD CAN**	**BIG PINEY**	**MARB LETON**
County # Prefix	**01**	**03**	**11**	**12**	**13**	**02**	**09**	**14**	**08**	**07**
Fund										
Library	0.197	0.197	0.197	0.197	0.197	0.197	0.197	0.197	0.197	0.197
Fair	0.145	0.145	0.145	0.145	0.145	0.145	0.145	0.145	0.145	0.145
Museum	0.117	0.117	0.117	0.117	0.117	0.117	0.117	0.117	0.117	0.117
Airport	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049	0.049
Recreation	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
Other General Fund	10.474	10.474	10.474	10.474	10.474	10.474	10.474	10.474	10.474	10.474
Total County General	**11.482**	**11.482**	**11.482**	**11.482**	**11.482**	**11.482**	**11.482**	**11.482**	**11.482**	**11.482**
County Fire	0.518	0.518	0.518	0.518	0.518	0.518	0.518	0.518	0.518	0.518
Rural Health	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000	2.000

Tax District	101	102	111	112	113	150	900	914	950	951
Area	Rural	SW COR	HOB RAN	BLDR LAKE	RED UP GR	PINED ALE	RURAL	MEAD CAN	BIG PINEY	MARB LETON
County # Prefix	01	03	11	12	13	02	09	14	08	07
Weed & Pest	0.229	0.229	0.229	0.229	0.229	0.229	0.229	0.229	0.229	0.229
Upper Gr Cemetery	0.105	0	0.105	0.105	0.105	0.105	0	0	0	0
Big Piney Cemetery	0	1.014	0	0	0	0	1.014	1.014	1.014	1.014
Improve District	0	0	8.000	8.000	6.000	0	0	0	0	0
Town General	0	0	0	0	0	8.000	0	0.000	8.000	8.000
School Foundation	12.000	12.000	12.000	12.000	12.000	12.000	12.000	12.000	12.000	12.000
School Operating	25.000	25.000	25.000	25.000	25.000	25.000	25.000	25.000	25.000	25.000
School Mandatory 6	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000	6.000
BOCES	0.500	0.500	0.500	0.500	0.500	0.500	0.600	0.600	0.600	0.600
School Recreation	1.000	1.000	1.000	1.000	1.000	1.000	0.500	0.500	0.500	0.500
Total School Levy	**44.500**	**44.500**	**44.500**	**44.500**	**44.500**	**44.500**	**44.100**	**44.100**	**44.100**	**44.100**
Total Mill Levy	**58.834**	**59.743**	**66.834**	**66.834**	**64.834**	**66.316**	**59.343**	**59.343**	**66.825**	**66.825**

Table 3-5 Mill levies since 1980 (Sublette County Assessor 2009)

Fiscal Year	North Rural 101	SW Corner 102	Hoback 111	Boulder Lake 112	Redstone Upper Gr 113	Pinedale 150	South Rural 900	Meadow Canyon 114	Big Piney 950	Marbleton 951
1980	61.242	58.583	0	0	0	81.101	56.229	0	63.731	81.306
1981	54.699	54.377	0	0	0	73.527	66.780	0	74.444	92.234
1982	58.162	56.205	0	0	0	75.254	58.687	0	66.291	78.225
1983	58.866	58.380	0	0	0	77.130	63.150	0	70.625	75.407
1984	59.237	58.453	0	0	0	69.372	63.119	0	70.220	80.140
1985	68.181	66.035	0	0	0	81.294	72.726	0	79.155	86.596
1986	62.869	60.464	0	0	0	77.083	63.080	0	70.492	77.640
1987	69.754	68.795	77.754	0	0	83.441	71.830	0	79.002	86.398
1988	69.750	68.266	77.750	0	0	83.861	67.802	0	74.802	82.295
1989	66.668	64.107	74.668	0	0	80.868	66.359	0	73.359	81.318
1990	63.653	60.934	71.653	0	0	78.905	69.396	0	68.667	87.589
1991	65.827	63.212	73.827	0	0	79.847	68.196	0	68.196	82.963
1992	64.141	62.885	72.141	72.141	0	78.680	70.299	0	77.474	85.617
1993	65.576	64.767	73.576	73.576	0	72.576	68.927	0	75.927	85.247
1994	63.671	62.581	71.671	71.671	0	71.059	64.841	0	72.229	80.508

Fiscal Year	North Rural 101	SW Corner 102	Hoback 111	Boulder Lake 112	Redstone Upper Gr 113	Pinedale 150	South Rural 900	Meadow Canyon 114	Big Piney 950	Marbleton 951
1995	63.569	62.581	71.569	71.569	0	70.749	66.369	0	73.549	80.839
1996	65.017	64.376	73.017	73.017	0	72.090	69.612	0	76.685	84.738
1997	66.219	65.085	74.239	74.239	0	73.519	68.903	0	75.903	83.918
1998	60.842	60.634	68.842	68.842	0	67.842	62.750	0	69.750	76.726
1999	59.382	59.336	67.382	67.382	0	66.467	63.335	0	70.420	70.420
2000	59.447	59.564	67.447	67.447	0	88.846	62.232	70.232	69.631	69.631
2001	58.819	58.987	66.819	66.819	66.819	66.262	61.559	69.559	69.002	69.002
2002	58.248	58.450	66.248	66.248	66.248	65.248	61.150	69.150	68.150	68.150
2003	58.456	58.852	66.456	66.456	66.456	65.934	62.817	70.817	70.295	66.295
2004	58.654	58.723	66.654	66.654	66.654	66.345	60.509	68.509	68.200	64.200
2005	58.219	58.984	66.219	66.219	66.219	65.820	59.084	67.084	66.685	62.685
2006	58.294	58.979	66.294	66.294	66.294	66.086	69.079	67.079	66.871	65.871
2007	59.173	59.882	67.173	67.173	67.173	66.428	59.482	67.482	66.737	66.737
2008	58.834	59.743	66.834	66.834	64.834	66.316	59.343	59.343	66.825	66.825

3.3.2 Assessed Taxes

In Sublette County, the ad valorem revenue from oil and gas entities is the most financially significant component assessed for taxation. Table 3-6 displays the historical 12-mill ad valorem revenues for Sublette County. Between 2000 and 2008, the energy industry contribution to county taxes increased from 78% to over 90%.

Table 3-6 Sublette County ad valorem taxes assessed, 2000–2008 (Sublette County 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008; Wyoming Department of Revenue 2009)

Fiscal Year	Total Ad Valorem Taxes Assessed	Ad Valorem Taxes Paid by Energy Operators	Industrial and Personal Property Taxes	Percentage of Ad Valorem Taxes Paid by Energy Operators
2000	$5,702,263	$4,466,583	$1,235,680	78.33%
2001	$10,207,862	$8,840,008	$1,367,854	86.60%
2002	$13,150,261	$11,649,816	$1,500,445	88.59%
2003	$11,206,742	$9,544,782	$1,661,960	85.17%
2004	$24,463,210	$22,559,972	$1,903,238	92.22%
2005	$35,078,515	$32,812,443	$2,266,072	93.54%
2006	$52,812,941	$49,992,730	$2,820,211	94.66%
2007	$48,999,127	$45,485,890	$3,513,237	92.83%
2008	$45,260,346	$40,892,723	$4,367,623	90.35%

Natural gas is the primary mineral produced within Sublette County, with oil a distant second. Two components determine the taxable value of produced minerals: the amount of mineral produced and the market value of that mineral. Natural gas production is measured in millions of cubic feet (mcf) and oil is measured in barrels (bbl). As seen in Table 3-8, approximately 935 million units of natural gas were taxed in 2008 at a market value of $3.61/unit, totaling slightly over $3 billion in taxable value. Crude oil had a much higher market value in 2008, with prices of $54.74/bbl for normally producing wells and $51.92/bbl for stripper wells. Note than stripper wells are defined as those who produce less than 10 barrels of oil a day or 60,000 to 75,000 cubic feet of natural gas a day. The Wyoming Department of Revenue identifies oil-producing stripper wells but not gas-producing stripper wells.

Table 3-7 Number of wells in production in Sublette County (Wyoming Oil and Gas Conservation Commission 2008)

Year	Wells in Production
2000	1,733
2001	1,930
2002	2,114
2003	2,306
2004	2,339
2005	2,625
2006	3,035
2007	3,436
2008	4,274

Table 3-8 Taxable values per units and total assessed valuation, 2001–2008 (Wyoming Department of Revenue 2009)

Fiscal Year	Mcf of Taxable Natural Gas	Value per Mcf	Taxable Value of Natural Gas	Barrels of Taxable Oil	Value per Barrel (Crude)	Value per Barrel (Stripper)	Taxable Value of Oil
1989	41,128,147	$1.53	$61,294,407	993,984	$12.42	$13.10	$14,604,970
1990	164,166,733	$1.16	$108,242,786	1,119,967	$15.33	$16.27	$19,358,349
1991	190,571,783	$1.16	$127,434,897	971,851	$20.32	$22.76	$20,490,880
1992	192,356,500	$1.06	$117,574,163	906,930	$17.06	$19.58	$16,213,153
1993	181,973,239	$1.13	$143,330,148	923,951	$16.18	$18.73	$16,381,422
1994	178,464,995	$1.32	$176,419,309	901,702	$13.02	$15.18	$14,972,639
1995	177,214,149	$1.11	$161,886,490	954,010	$12.50	$15.49	$15,958,743
1996	163,031,459	$0.86	$109,148,027	1,135,340	$14.28	$16.46	$20,027,642
1997	170,344,696	$1.19	$154,159,492	1,460,198	$18.17	$19.11	$29,593,476
1998	203,097,634	$1.44	$245,693,162	1,930,650	$15.89	$17.09	$37,058,944
1999	218,342,931	$1.29	$255,842,028	2,148,333	$9.56	$9.94	$26,310,216
2000	242,364,103	NA*	$325,135,208	2,705,264	NA	NA	$47,232,889
2001	278,566,815	$2.60	$649,534,420	3,321,822	$24.47	$26.61	$87,042,840
2002	335,670,667	$2.80	$888,651,595	3,609,541	$19.53	$20.65	$82,918,541
2003	421,361,317	$1.63	$699,588,667	4,229,104	$20.40	$21.87	$96,521,338
2004	512,010,402	$3.20	$1,758,636,617	4,488,555	$24.74	$24.98	$121,548,006
2005	603,172,194	$4.02	$2,564,144,305	4,655,819	$32.82	$33.19	$170,447,231
2006	808,530,579	$5.22	$3,915,189,492	5,144,424	$42.60	$44.35	$250,566,079
2007	888,533,277	$4.34	$3,469,877,790	5,731,150	$49.70	$53.49	$321,338,404
2008	935,946,345	$3.61	$3,007,854,575	7,026,826	$54.74	$51.92	$399,677,772

*2000 data not available from Mineral Tax Division

In addition to county-wide levies, each jurisdiction within Sublette County collects taxes from local residents and businesses. Historical data on these assessments are shown in Figure 3-2 through Figure 3-5 for the municipalities and the county. Each jurisdiction exhibits a positive trend in the growth of annual receipts, but there is a marked difference between the county and municipalities.

Table 3-9 Municipal and county taxes levied, 1992–2008 (Wyoming Department of Revenue 2009)

Fiscal Year	Big Piney	Marbleton	Pinedale	Total Municipal Taxes	County Taxes
1992	$10,024	$26,762	$60,507	$97,293	$2,431,599
1993	$10,959	$26,667	$37,905	$75,531	$2,856,598
1994	$11,170	$27,332	$43,338	$81,840	$3,302,572
1995	$10,883	$28,211	$51,502	$90,596	$3,140,300
1996	$10,710	$27,906	$61,972	$100,588	$2,586,772
1997	$11,050	$28,973	$67,773	$107,796	$3,285,492
1998	$11,103	$29,935	$69,843	$110,881	$4,228,094
1999	$11,837	$15,681	$71,916	$99,434	$4,539,936
2000	$12,118	$16,599	$74,756	$103,473	$5,702,263
2001	$12,368	$17,679	$81,470	$111,517	$10,207,862
2002	$13,535	$19,373	$91,084	$123,992	$13,150,261
2003	$15,247	$11,504	$105,737	$132,488	$11,206,742
2004	$16,575	$13,657	$121,324	$151,556	$24,463,210
2005	$19,230	$14,857	$146,052	$180,139	$35,078,515
2006	$31,687	$28,775	$184,523	$244,985	$52,812,941
2007	$39,654	$43,648	$230,881	$314,183	$48,999,127
2008	$31,577	$50,678	$280,115	$362,370	$45,260,346
Overall Change 1992-2008	215%	89%	363%	272%	1,761%

During the 16 year period depicted in the figures, Big Piney, Marbleton, and Pinedale receipts increased 215%, 89%, and 363%, respectively. However, these figures are somewhat misleading. Big Piney's annual municipal tax revenue increased from $10,024 in 1992 to $31,577 in 2008. Thus, the 215% increase in receipts amounted to an actual increase of only $21,553. Marbleton's situation changed in a similar fashion—the 89% increase in receipts translated to $23,916. In contrast, Sublette County tax levies grew over 1761% during the same time frame, jumping from approximately $2.4 million in 1992 to $45.3 million in 2008.

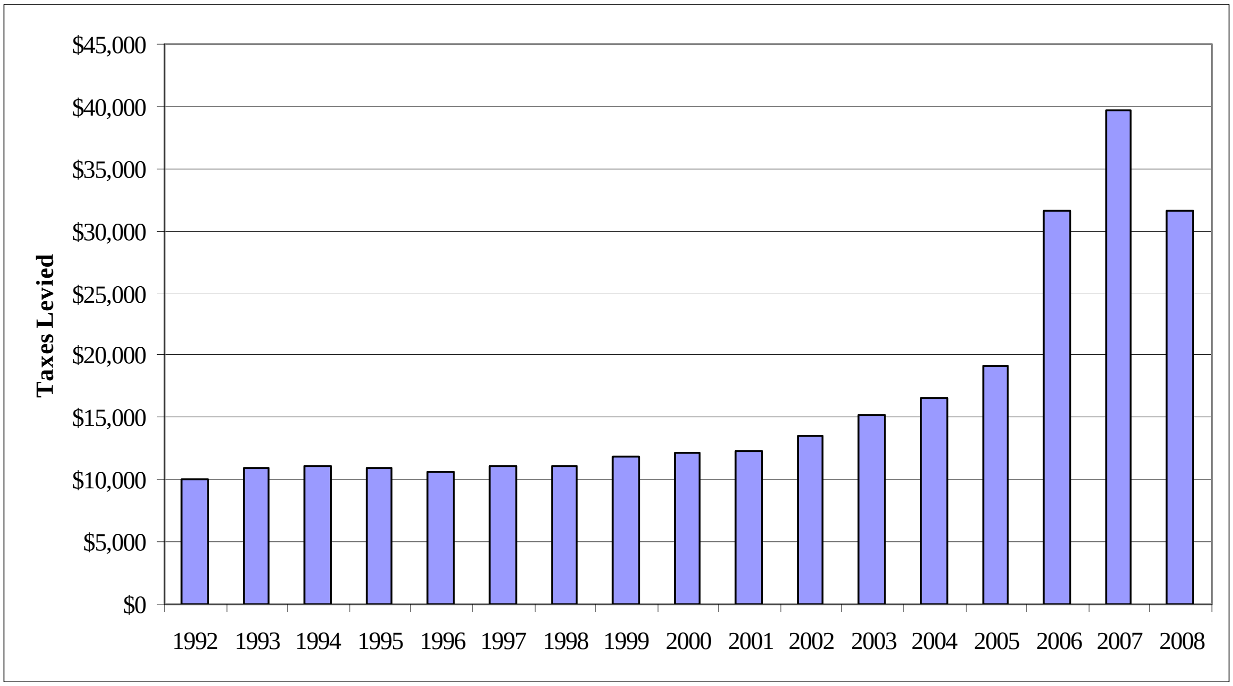


Figure 3-2 Big Piney municipal taxes levied, 1992–2008 (Wyoming Department of Revenue 2009)

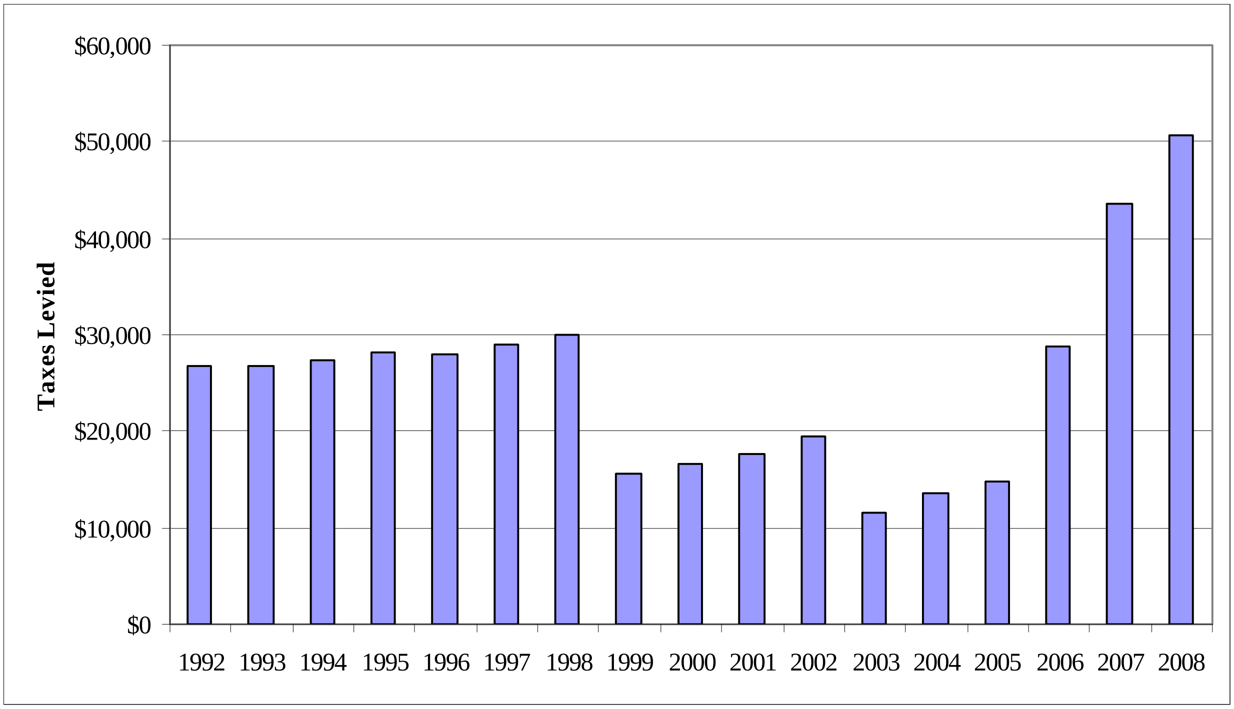


Figure 3-3 Marbleton municipal taxes levied, 1992–2008 (Wyoming Department of Revenue 2009)

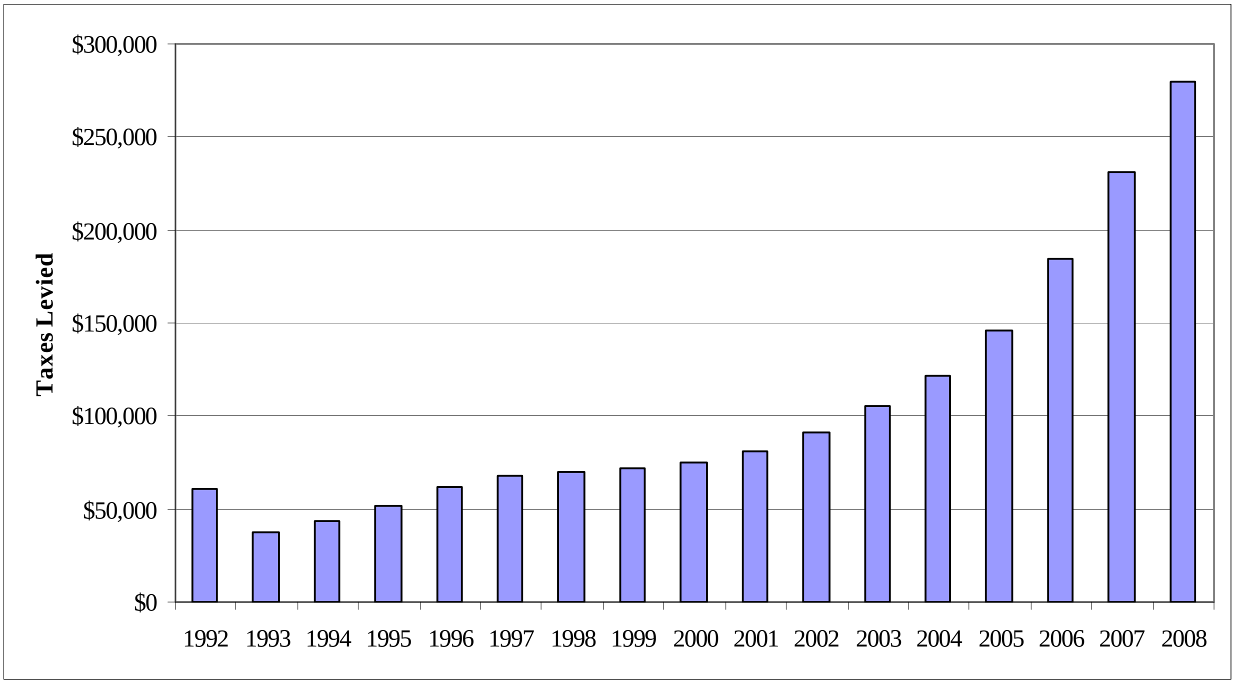


Figure 3-4 Pinedale municipal taxes levied, 1992–2008 (Wyoming Department of Revenue 2009)

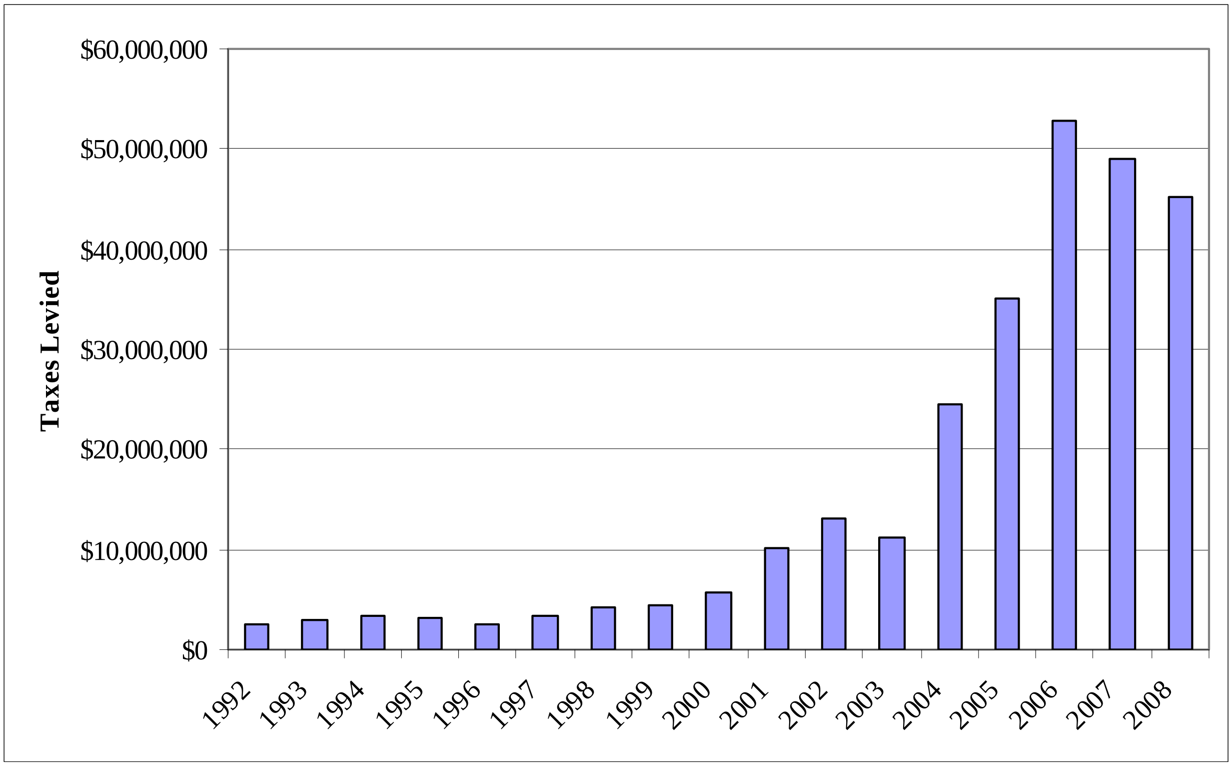


Figure 3-5 Sublette County taxes levied, 1992–2008 (Wyoming Department of Revenue 2009)

The disparity in revenue increases between Sublette County and its municipalities is more prominently displayed in Figure 3-6. Combined municipal income for Big Piney, Marbleton, and Pinedale is charted against Sublette County ad valorem income for the years 1992–2008. County revenue is easy to see in this figure, but municipal revenues are much less in comparison and are visible as small bars. Viewed in this manner, municipal income growth is insignificant compared to the increase in county ad valorem tax revenue. The reader should note that between 1992 and 2001, the energy industry had little presence in the county. Energy development activity increased beginning in 2002.

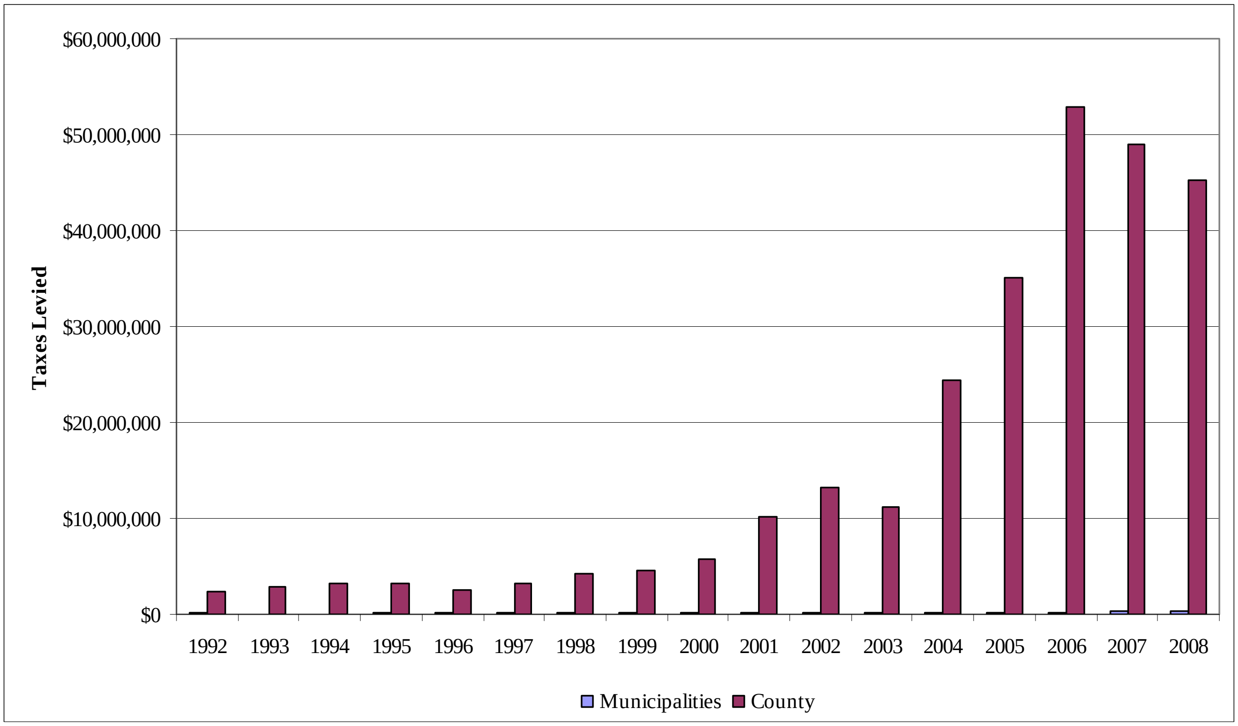


Figure 3-6 County and combined municipal taxes levied, 1992–2008 (Wyoming Department of Revenue 2009)

Clearly, the impact of oil and gas development has had little effect on municipal income to the towns of Big Piney, Marbleton, and Pinedale as the towns can only tax within the city limits and to date, oil and gas production has taken place outside of city limits. However, the towns bear the majority of impacts from the oil and gas industry and workers, notably in the infrastructure areas of streets, water lines, and sewer lines. This places the towns at a distinct financial disadvantage when addressing the effects of increased population and the accompanying strain on infrastructure and services. As discussed earlier, Marbleton gained approximately $24,000 in annual municipal revenue over a 16 year period. In practical terms, this amount of money barely covers the annual cost of wages and benefits for a single employee. Yet by the end of fiscal year 2008, Marbleton had identified over $13 million in needed infrastructure projects to address energy-related impacts. These needs and projects are more fully discussed in Chapter 4 of this report.

3.4 PAYMENT IN LIEU OF TAXES

In 1976, congress authorized federal land management agencies to share income with states and counties with the payment in lieu of taxes (PILT) program. Forty-nine percent of Wyoming is owned and managed by the Federal government and this payment helps to offset lost revenue that states and counties would otherwise receive from private land (University of Wyoming 2009). Sublette County's PILT distributions from 2000 to 2008 are provided in Table 3-10. PILT is distributed according to the number of entitlement acres; Sublette County has 2,431,285 entitlement acres (University of Wyoming 2009).

Table 3-10 Sublette County PILT revenue, 2000–2008 (University of Wyoming 2009)

Fiscal Year	Payment per Entitlement Acre	PILT Revenue
2000	$0.11	$256,483
2001	$0.15	$371,922
2002	$0.16	$391,914
2003	$0.18	$442,097
2004	$0.19	$461,105
2005	$0.20	$481,089
2006	$0.20	$491,999
2007	$0.20	$487,682
2008	$0.20	$484,197

3.5 TAX STRUCTURES SPECIFIC TO THE ENERGY INDUSTRY

3.5.1 Federal Mineral Royalty Taxes

The state of Wyoming and its counties benefit financially from oil and gas extraction operations conducted on federal lands. Production is assessed at an average royalty rate of approximately 12.5%. The federal government retains 51% of these fees and returns the remaining 49% to the state (Etchart 2009). Wyoming distributes Federal Mineral Royalty (FMR) receipts as follows (Temte 2007):

- The first $200 million is distributed among the University of Wyoming; School Foundation Program; Highway Fund; County Roads Fund; cities and towns; cities, towns, and counties capital construction; and school account; with 1% allocated to the state General Fund.
- One-third of the remaining funds are distributed to the School Foundation Program.
- Two-thirds of the remaining funds are distributed to the state Budget Reserve Account.

While Wyoming distributes a small amount of FMR monies directly to towns within the state, counties do not receive direct FMR funding. Distribution is based on population.

The Federal Minerals Management Service is responsible for managing FMR funds. Funds are tracked several ways, including by county of origin. Table 3-11 shows the historical return of FMR taxes to Wyoming, identifying funds attributed to production in Sublette County. The percentage of total Wyoming FMR attributed to Sublette County energy extraction increased between 1996 and 2000. FMR distributions attributed to production in Sublette County from January to May 2002 are not available due to litigation issues related to the Cobell vs. Norton lawsuit regarding alleged mismanagement of Individual Indian Monies (IMM) trust accounts.

Table 3-11 FMR funds returned to Wyoming (Federal Mineral Management Service 2009)

Fiscal Year	Total FMR Distributed to Wyoming	FMR Distributed to Wyoming Attributed to Production in Sublette County	Percentage of Returned FMR Attributed to Production in Sublette County
1996	$199,332,807	$8,778,314	4.40%
1997	$239,027,489	$16,897,025	7.07%
1998	$237,179,528	$23,811,308	10.04%
1999	$231,453,518	$21,659,476	9.36%
2000	$319,648,502	$40,423,327	12.65%
2001	$448,774,537	$80,604,143	17.96%
2002	$359,386,326*	$43,746,086*	12.17%
2003	$467,266,554	$97,480,988	20.86%
2004	$564,332,554	$146,988,469	26.05%
2005	$878,524,871	$201,760,098	22.97%
2006	$1,072,479,293	$299,507,988	27.93%
2007	$925,261,906	$237,362,628	25.65%
2008	$1,270,987,013	$390,813,908	30.83%

* January to May 2002 data not available due to federal litigation issues.

Table 3-12 FMR taxes paid on production in Sublette County (Federal Mineral Management Service 2009)

Fiscal Year	FMR Taxes Paid on Production in Sublette County
1996	$17,556,329
1997	$33,794,063
1998	$47,622,547
1999	$43,318,953
2000	$80,846,655
2001	$161,208,285
2002	$87,492,172*
2003	$194,961,976
2004	$293,976,937
2005	$403,520,197
2006	$599,015,975
2007	$474,725,255
2008	$781,627,816

* January to May 2002 data not available due to federal litigation issues.

Final distribution of FMR funds to Sublette County municipalities is summarized in Table 3-13. While Sublette County operators paid over $781.6 million in FMR taxes during 2008, only $324,594, or 0.04%, was directly returned to the area. Furthermore, even though the total amount of FMR funds returned to

Wyoming in 2008 was $1,270,987,013, the combined percentage distributed to Big Piney, Pinedale, and Marbleton was 0.03%.

Table 3-13 Historical State FMR tax distributions to Big Piney, Marbleton, and Pinedale (Federal Mineral Management Service 2009; Wyoming State Treasurer's Office 2009)

Fiscal Year	Total FMR Distributed to Wyoming	FMR Distributed to Big Piney	FMR Distributed to Marbleton	FMR Distributed to Pinedale	Total County-wide FMR Distribution	Percentage of Total FMR Received
2000	$319,648,502	$65,833	$85,987	$147,232	$299,052	0.09%
2001	$448,774,537	$62,245	$85,014	$147,324	$294,583	0.07%
2002	$359,386,326	$57,118	$89,326	$160,761	$307,205	0.09%
2003	$467,266,554*	$53,180	$82,376	$147,132	$282,688	0.06%
2004	$564,332,554	$53,257	$82,512	$147,399	$283,168	0.05%
2005	$878,524,871	$54,101	$84,001	$150,319	$288,421	0.03%
2006	$1,072,479,293	$55,198	$85,938	$154,118	$295,254	0.03%
2007	$925,261,906	$57,876	$90,664	$163,385	$311,926	0.03%
2008	$1,270,987,013	$59,911	$94,255	$170,428	$324,594	0.03%

*January to May 2002 data not available due to federal litigation issues.

3.5.2 State Severance Taxes

State severance taxes are administered through the Wyoming Department of Revenue and are assessed on the current year's mineral production. Taxpayers submit monthly reports and remittance based on the taxable value of the current month's production. Minerals are taxed at 100% of their actual value, referred to as the assessed valuation, at the point where production is complete but before the extract is processed or transported. The actual value of the product varies depending on the current market price of the extract.

The state severance tax was introduced in 1969 and has fluctuated over the years, ranging from 1% to the current 6% of the taxable value. The majority of revenue is retained by the state, distributed as follows (Temte 2007):

- 2.5% to the Permanent Wyoming Mineral Trust Fund
- $155 million to counties, cities, and towns; state highway and water departments; state general fund; and county road departments
- One-third of the remaining funds to the state General Fund
- Two-thirds of the remaining funds to the state Budget Reserve Account.

Table 3-14 describes severance tax information for 2000 through 2008, which bears a strong similarity to trends seen with FMR payments. Mineral extraction in Sublette County has risen from just over 9% in

2000 to approximately 25% of 2008's statewide mineral taxable valuation. Accordingly, energy operators paid just over $250 million to the state of Wyoming in severance tax receipts during 2008.

Table 3-14 Historical Wyoming severance tax collections (Wyoming Department of Revenue 2009; Wyoming Legislative Service Office 2009)

Fiscal Year	Statewide Severance Tax Revenues	Severance Taxes Paid on Production in Sublette County	Sublette County Percentage of Mineral Taxable Valuation
2000	$275,122,976	$25,173,752	9.15%
2001	$447,973,278	$51,516,927	11.50%
2002	$299,433,961	$43,178,377	14.42%
2003	$429,126,222	$60,764,273	14.16%
2004	$563,566,928	$122,970,304	21.82%
2005	$726,656,854	$180,937,557	24.90%
2006	$1,001,076,918	$279,800,999	27.95%
2007	$863,798,920	$224,587,719	26.00%
2008	$1,093,952,011	$269,440,380	24.63%

As seen with FMR funds, severance distributions to Sublette County and its municipalities ranged from 0.02% to 0.09% of statewide revenues over the past seven years. Table 3-15 depicts state severance tax revenues and Sublette County/municipality distributions from 2000 through 2008.

Table 3-15 Severance tax distributions to Sublette County and municipalities (Wyoming Legislative Service Office 2009; Wyoming State Treasurer's Office 2009)

Fiscal Year	Statewide Severance Tax Revenues	Big Piney Distribution	Marbleton Distribution	Pinedale Distribution	Sublette County Distribution	Total Distribution	Percent of Total Revenue
2000	$275,122,976	$25,161	$35,136	$65,451	$60,952	$186,700	0.06%
2001	$447,973,278	$47,812	$71,604	$135,662	$154,042	$409,120	0.09%
2002	$299,433,961	$21,790	$38,453	$75,412	$97,554	$233,209	0.08%
2003	$429,126,222	$18,377	$32,430	$63,599	$67,414	$181,820	0.04%
2004	$563,566,928	$17,788	$31,390	$61,559	$74,857	$185,594	0.03%
2005	$726,656,854	$18,227	$32,165	$63,079	$71,902	$185,373	0.02%
2006	$1,001,076,918	$19,040	$33,599	$65,892	$72,776	$191,305	0.02%
2007	$863,798,920	$19,492	$34,398	$67,459	$73,055	$194,402	0.02%
2008	$1,093,952,011	$18,584	$32,796	$64,316	$69,314	$185,008	0.02%

3.6 SUMMARY OF REVENUE SOURCES

Big Piney, Marbleton, and Pinedale municipal revenues are generated by the taxes discussed previously in this chapter along with other taxes, fees, and revenue sources such as building permits, franchise fees, and interest. Table 3-16, Table 3-17, and Table 3-18 show the receipts from major revenue sources as well as overall revenue from 2000 to 2008.

Table 3-16 Big Piney Major Revenue Streams and Overall Revenues (Town of Big Piney 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008; Wyoming Department of Revenue 2009; Wyoming State Treasurer's Office 2009)

Fiscal Year	Sales and Use	Taxes Levied	Severance	FMR	Overall Revenue
2000	$231,331	$12,118	$25,161	$65,833	$531,673
2001	$402,442	$12,368	$47,812	$62,245	$784,175
2002	$399,802	$13,535	$21,790	$57,118	$867,612
2003	$418,178	$15,247	$18,377	$53,180	$667,522
2004	$567,647	$16,575	$17,788	$53,257	$803,071
2005	$789,003	$19,230	$18,227	$54,101	$1,146,539
2006	$1,105,566	$31,687	$19,040	$55,198	$1,590,737
2007	$1,620,713	$39,654	$19,492	$57,876	$2,151,729
2008	$1,702,453	$31,577	$18,584	$59,911	$8,490,223

Table 3-17 Marbleton Major Revenue Streams and Overall Revenues (Town of Marbleton 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008; Wyoming Department of Revenue 2009; Wyoming State Treasurer's Office 2009)

Fiscal Year	Sales and Use	Taxes Levied	Severance	FMR	Overall Revenue
2000	$323,049	$16,599	$35,136	$85,987	$695,985
2001	$562,000	$17,679	$71,604	$85,014	$981,004
2002	$705,533	$19,373	$38,453	$89,326	$1,736,198
2003	$737,961	$11,504	$32,430	$82,376	$1,180,412
2004	$1,010,272	$13,657	$31,390	$82,512	$1,479,651
2005	$1,401,281	$14,857	$32,165	$84,001	$2,037,514
2006	$1,958,458	$28,775	$33,599	$85,938	$2,347,588
2007	$2,862,616	$43,648	$34,398	$90,664	$3,958,405
2008	$3,008,499	$50,678	$32,796	$94,255	$10,596,170

Table 3-18 Pinedale Major Revenue Streams and Overall Revenues (Town of Pinedale 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008; Wyoming Department of Revenue 2009; Wyoming State Treasurer's Office 2009)

Fiscal Year	Sales and Use	Taxes Levied	Severance	FMR	Overall Revenue
2000	$601,767	$74,756	$65,451	$147,232	NA*
2001	$1,046,881	$81,470	$135,662	$147,324	$2,515,668
2002	$1,383,628	$91,084	$75,412	$160,761	$2,818,487
2003	$1,447,224	$105,737	$63,599	$147,132	$2,476,017
2004	$2,044,204	$121,324	$61,559	$147,399	$3,409,898
2005	$2,831,643	$146,052	$63,079	$150,319	$4,599,119
2006	$3,980,769	$184,523	$65,892	$154,118	$9,455,784
2007	$5,771,071	$230,881	$67,459	$163,385	$12,295,034

Fiscal Year	Sales and Use	Taxes Levied	Severance	FMR	Overall Revenue
2008	$6,074,692	$280,115	$64,316	$170,428	$14,135,087

*Pinedale 2000 actual expenditures report is unavailable

Sublette County's tax structures are slightly different than the towns, as shown in Table 3-19.

Table 3-19 Sublette County Major Revenue Streams and Overall Revenues (Federal Mineral Management Service 2009; Sublette County 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008; Sublette County Treasurer's Department 2009; University of Wyoming 2009; Wyoming Department of Revenue 2009)

Fiscal Year	Sales and Use	Taxes Levied	Severance	PILT	Overall Revenue
2000	$1,311,557	$5,702,263	$60,952	$256,483	$11,859,212
2001	$2,281,686	$10,207,862	$154,042	$371,922	$18,083,581
2002	$3,312,084	$13,150,261	$97,554	$391,914	$25,809,350
2003	$3,507,905	$11,206,742	$67,414	$442,097	$25,154,218
2004	$4,729,477	$24,463,210	$74,857	$461,105	$37,767,643
2005	$6,614,682	$35,078,515	$71,902	$481,089	$61,180,587
2006	$9,233,764	$52,812,941	$72,776	$491,999	$93,086,497
2007	$13,499,463	$48,999,127	$73,055	$487,682	$103,099,555
2008	$14,187,892	$45,260,346	$69,314	$484,197	$96,184,513

3.7 DISTRIBUTION OF TAXES PAID BY ENERGY OPERATORS IN SUBLETTE COUNTY

Overall taxes paid by energy operators in Sublette County between 2000 and 2008 are detailed in Table 3-20. As mentioned earlier, sales and use tax breakouts by industry were not available prior to 2002. The combined payments from FMR, severance, ad valorem, and sales and use taxes totaled approximately $152 million in 2002 and increased six-fold by 2008, resulting in approximately $1.1 billion in taxes paid that year. Of these four tax levies, FMR and severance taxes accounted for nearly 90% of the cumulative payments.

Table 3-20 Summary of taxes paid by energy operators in Sublette County (Federal Mineral Management Service 2009; Wyoming State Treasurer's Office 2009; Wyoming Department of Revenue 2009; Wyoming Legislative Service Office 2009)

Fiscal Year	FMR Taxes Paid on Production in Sublette County	Severance Taxes Paid on Production in Sublette County	Sublette County Ad Valorem Taxes Paid by Energy Operators	Sales and Use Taxes Paid by Energy Operators in Sublette County	Total Tax Payments Made by Energy Operators in Sublette County
2000	$80,846,655	$25,173,752	$4,466,583	N/A	$110,486,990
2001	$161,208,285	$51,516,927	$8,840,008	N/A	$221,565,220
2002	$87,492,172*	$43,178,377	$11,649,816	$9,877,876	$152,198,241
2003	$194,961,976	$60,764,273	$9,544,782	$9,324,467	$274,595,498
2004	$293,976,937	$122,970,304	$22,559,972	$14,158,341	$453,665,554

Fiscal Year	FMR Taxes Paid on Production in Sublette County	Severance Taxes Paid on Production in Sublette County	Sublette County Ad Valorem Taxes Paid by Energy Operators	Sales and Use Taxes Paid by Energy Operators in Sublette County	Total Tax Payments Made by Energy Operators in Sublette County
2005	$403,520,197	$180,937,557	$32,812,443	$18,615,522	$635,885,719
2006	$599,015,975	$279,800,999	$49,992,730	$26,543,808	$955,353,512
2007	$474,725,255	$224,587,719	$45,485,890	$39,215,156	$784,014,020
2008	$781,627,816	$269,440,380	$40,892,723	$41,612,387	$1,133,573,306

* January to May 2002 data not available due to federal litigation issues.

Table 3-21 displays income received by Sublette County and the towns of Big Piney, Marbleton, and Pinedale from the same four revenue streams. In direct contrast to taxes paid by energy companies, ad valorem and sales and use taxes comprise over 90% of monies received by local governments in the county. Perhaps the most striking statistic is the comparison of taxes paid by operators versus the percentage of those payments that were received by local government in Sublette County as presented in Table 3-22.

Table 3-21 Summary of county-wide operator-paid taxes received in Sublette County (Wyoming Department of Revenue 2009; Wyoming State Treasurer's Office 2009)

Fiscal Year	FMR Taxes Received County-wide	Severance Taxes Received County-wide	Ad Valorem Taxes Received County-wide	Sales and Use Taxes Received County-wide	Total Taxes Received County-wide
2000	$299,052	$186,700	$4,466,583	$2,467,703	$7,420,038
2001	$294,583	$409,120	$8,840,008	$4,293,007	$13,836,718
2002	$307,205	$233,209	$11,649,816	$5,801,045	$17,991,275
2003	$282,688	$181,820	$9,544,782	$6,111,266	$16,120,556
2004	$283,168	$185,594	$22,559,972	$8,351,600	$31,380,334
2005	$288,421	$185,373	$32,812,443	$11,636,591	$44,922,828
2006	$295,254	$191,305	$49,992,730	$16,278,557	$66,757,846
2007	$311,926	$194,402	$45,485,890	$23,753,863	$69,746,081
2008	$324,594	$185,008	$40,892,723	$24,973,536	$66,375,861

Table 3-22 Comparison of taxes paid by energy operators in Sublette County to operator-generated taxes received in Sublette County (Wyoming Department of Revenue 2009; Wyoming State Treasurer's Office 2009)

Fiscal Year	Total Taxes Paid by Operators in Sublette County	Total Operator-Generated Taxes Distributed to Sublette County	Percentage of Overall Taxes Received
2000	$110,486,990	$7,420,038	6.72%
2001	$221,565,220	$13,836,718	6.24%

Fiscal Year	Total Taxes Paid by Operators in Sublette County	Total Operator-Generated Taxes Distributed to Sublette County	Percentage of Overall Taxes Received
2002	$152,198,241*	$17,991,275	11.82%
2003	$274,595,498	$16,120,556	5.87%
2004	$453,665,554	$31,380,334	6.92%
2005	$635,885,719	$44,922,828	7.06%
2006	$955,353,512	$66,757,846	6.99%
2007	$784,014,020	$69,746,081	8.90%
2008	$1,133,573,306	$66,375,861	5.86%

* January to May 2002 FMR data not available due to litigation issues.

3.8 REVENUE PROJECTIONS

The State of Wyoming closely monitors mineral production and pricing trends through its Consensus Revenue Estimating Group (CREG). CREG issues regular reports describing current trends as well as near-term projections. Of significance in CREG reports from October 2008 through May 2009 is that production projections for natural gas and crude oil through 2014 do not show large decreases. From these projections, it appears that wells currently in production will remain in that state. However, the drilling rate for new wells has dropped by more than 50% in Sublette County in recent months, as shown in Table 3-23.

Table 3-23 Rigs working per month in Sublette County (Baker Hughes 2009)

Month, Year	Rigs per Month
October 2008	47.00
November 2008	44.25
December 2008	44.50
January 2009	39.80
February 2009	37.00
March 2009	30.75
April 2009	26.00
May 2009	24.25
June 2009	21.00

In addition to CREG's projected oil and gas production, the Pinedale Anticline and Jonah fields are expected to continue growing. Table 3-24 reports the expected additional wells in the Pinedale Anticline and Jonah fields along with the current total of wells in Sublette County.

Table 3-24 Expected increase in wells from the PAPA and Jonah fields (USDI 2006; Wyoming Oil and Gas Conservation Commission 2009)

Fiscal Year	Expected Wells Drilled	Total Wells
2009	445	4,719
2010	470	5,189
2011	469	5,658
2012	395	6,053
2013	264	6,317
2014	264	6,581
2015	269	6,850
2016	288	7,138
2017	347	7,485
2018	315	7,800

Fiscal Year	Expected Wells Drilled	Total Wells
2019	430	8,230
2020	345	8,575

CREG's production projections for the state of Wyoming show steady increases through 2014, as outlined in Table 3-25. Sublette County's production is estimated at 2008's average production per well of 267,588 mcf/well times the estimated number of total wells shown in Table 3-24 (Wyoming Oil and Gas Conservation Commission 2009). The state production estimates by CREG do not include the increases in wells estimated from the PAPA and Jonah fields in Sublette County.

Table 3-25 Natural gas production projections as of May 2009 (mcf) (CREG 2009)

Fiscal Year	State Production	Sublette County Production
2009	2,540,300,000	1,262,747,772
2010	2,616,500,000	1,388,514,132
2011	2,695,000,000	1,514,012,904
2012	2,775,900,000	1,619,710,164
2013	2,859,200,000	1,690,353,396
2014	2,945,200,000	1,760,996,628

Table 3-26 Natural gas price projections (CREG 2009)

Fiscal Year	Price
2009	$2.75
2010	$3.20
2011	$3.75
2012	$4.75
2013	$5.25
2014	$5.75

Given CREG's natural gas price projections reported in Table 3-26 and the estimated production in Table 3-25, Table 3-27 reports the state and Sublette County's projected assessed value through 2014.

Table 3-27 Projected assessed value of natural gas in Wyoming and Sublette County (CREG 2009; Wyoming Oil and Gas Conservation Commission 2009)

Fiscal Year	Wyoming Assessed Value	Sublette County Assessed Value
2009	$6,985,825,000	$3,472,556,373
2010	$8,372,800,000	$4,443,245,222
2011	$10,106,250,000	$5,677,548,390
2012	$13,185,525,000	$7,693,623,279
2013	$15,010,800,000	$8,874,355,329
2014	$16,934,900,000	$10,125,730,611

4. FINANCIAL TRENDS—EXPENDITURES

4.1 HISTORICAL TRENDS - OPERATING AND CAPITAL COSTS

The central question to the socioeconomic analysis of energy-related impacts in Sublette County can be asked very simply: Do the increased revenues generated by the oil and gas industry pay for the necessary improvements to infrastructure and increase in services provided by local governments? The preceding discussion on revenue growth clearly demonstrates that local revenues have increased as a direct effect of oil and gas production in the area. This section analyzes government spending, which has also increased as a direct effect of oil and gas production.

ERG conducted a detailed evaluation of operating and capital expenditures for the towns of Big Piney, Marbleton, Pinedale, and Sublette County. For purposes of this report, operating costs are defined as recurring expenses related to the operation of local governments. Items such as salary, insurance, general office equipment, and utilities are examples of this expense category. Capital costs are considered one-time, fixed expenses incurred in the process of rendering government-provided services. Road construction, the purchase of land or buildings, construction, and acquisition of big-ticket items are all considered capital expenditures.

When analyzing energy-related trends within Sublette County, the data show that the impact of oil and gas development became evident in the early 2000s. The year 2002 often surfaces as a turning point between pre-energy and energy-impacted trends and will be used throughout this discussion as such. When possible, data between 1995 and 2002 were used to establish organic, or non-energy-impacted trends. Data from 2002 and later reflect the presence of the oil and gas industry and are categorized as energy-impacted. In addition to historical analysis, this section identifies projected trends in operating and capital expenditures.

4.1.1 Big Piney

Big Piney financial data were available from 1995 to present. Table 4-1 describes annual expenditures in Big Piney between 1995 and 2008, divided into operating and capital categories. Big Piney's annual expenses are much lower than those of Sublette County, consistent with its lower population and smaller physical size. Operating and capital costs were evenly matched for many years with the exception of 1997–2000, which showed few capital expenses.

Capital expenses did not show a significant increase until 2008, as Big Piney has had to save funds for needed capital projects. They are planning to implement many capital projects in the next few years (see Section 4.4.1).

Table 4-1 Big Piney operating and capital expenditures, 1995-2008 (Town of Big Piney 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008)

Fiscal Year	Operating Expenditures	Capital Expenditures	Total Annual Expenditures	Ratio of Operating/Capital Expenditures	Annual Percentage Growth
1995	$260,266	$12,935	$273,201	20.12	N/A
1996	$251,032	$269,121	$520,153	0.93	90.39%
1997	$226,664	$185,192	$411,856	1.22	-20.82%
1998	$224,171	$23,096	$247,267	9.71	-39.96%
1999	$260,470	$482	$260,952	540.39	5.53%
2000	$323,375	$35,847	$359,222	9.84	37.66%
2001	$346,958	$133,565	$480,523	2.60	33.77%
2002	$342,322	$16,676	$358,998	20.53	-25.29%
2003	$391,242	$40,737	$431,979	9.60	20.33%
2004	$404,627	$183,612	$588,239	2.20	36.17%
2005	$414,906	$14,461	$429,367	28.69	-27.01%
2006	$450,645	$17,468	$468,113	25.80	9.02%
2007	$460,772	$241,245	$701,967	1.91	49.96%
2008	$634,876	$1,179,540	$1,814,416	0.54	158.48%

Big Piney per capita expenditures are calculated in Table 4-2, with trend analysis shown in Figure 4-1 and Figure 4-2. Operating expenses per capita demonstrate an annual organic growth trend of $48.69 both before and after 2002.

Per capita capital expenditures showed no definite linear organic trend but increased exponentially beginning in 2006, during energy production.

Table 4-2 Big Piney operating and capital expenditures per capita, 1995–2008 (Town of Big Piney 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009; Wyoming Department of Administration and Information 2008)

Fiscal Year	Big Piney Population	Operating Expenditures per Capita	Capital Expenditures per Capita
1995	449	$580	$29
1996	442	$568	$609
1997	434	$522	$427
1998	427	$525	$54
1999	417	$625	$1
2000	408	$793	$88
2001	404	$859	$331
2002	421	$813	$40
2003	431	$908	$95

Fiscal Year	Big Piney Population	Operating Expenditures per Capita	Capital Expenditures per Capita
2004	438	$924	$419
2005	451	$920	$32
2006	453	$995	$39
2007	476	$968	$507
2008	501	$1,267	$2,355

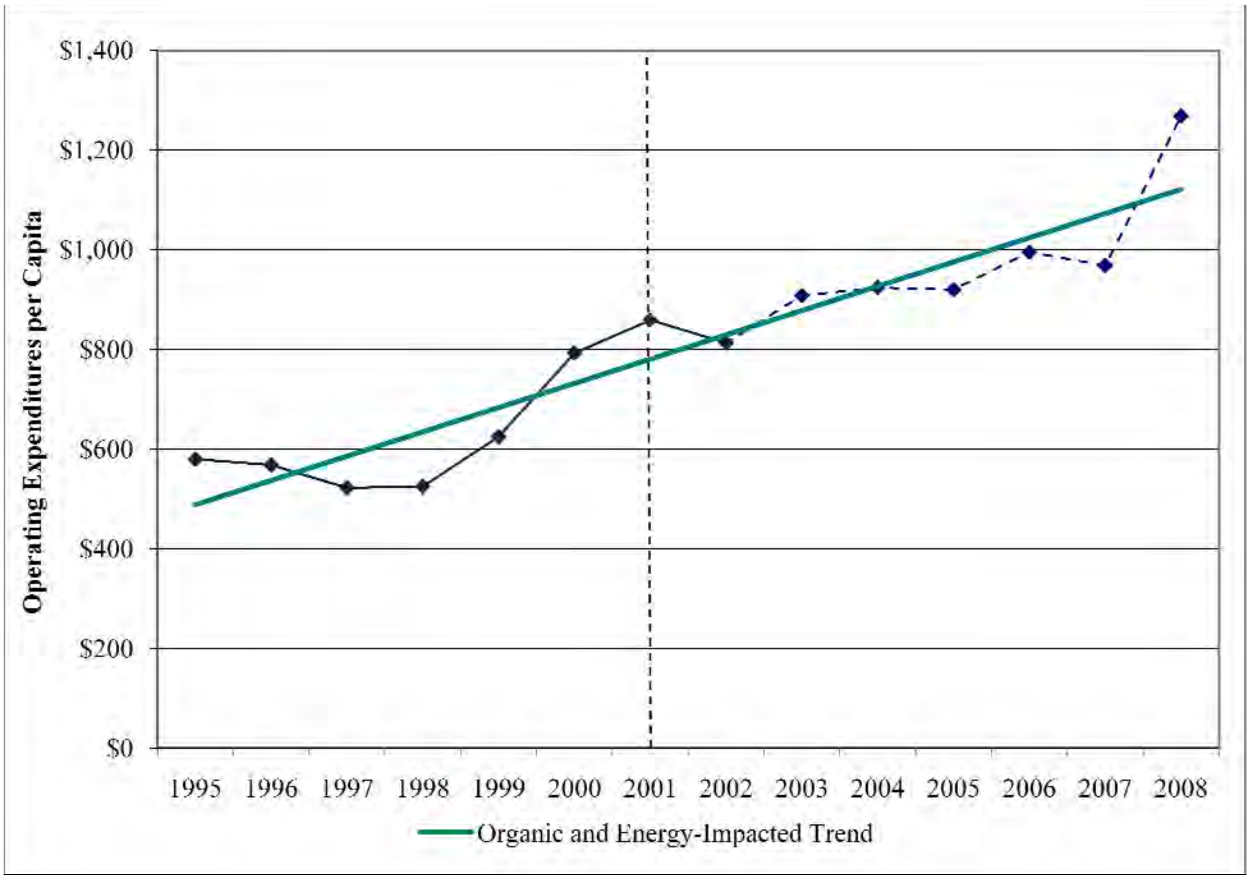


Figure 4-1 Big Piney operating expenditures per capita, 1995–2008 (Town of Big Piney 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009; Wyoming Department of Administration and Information 2008)

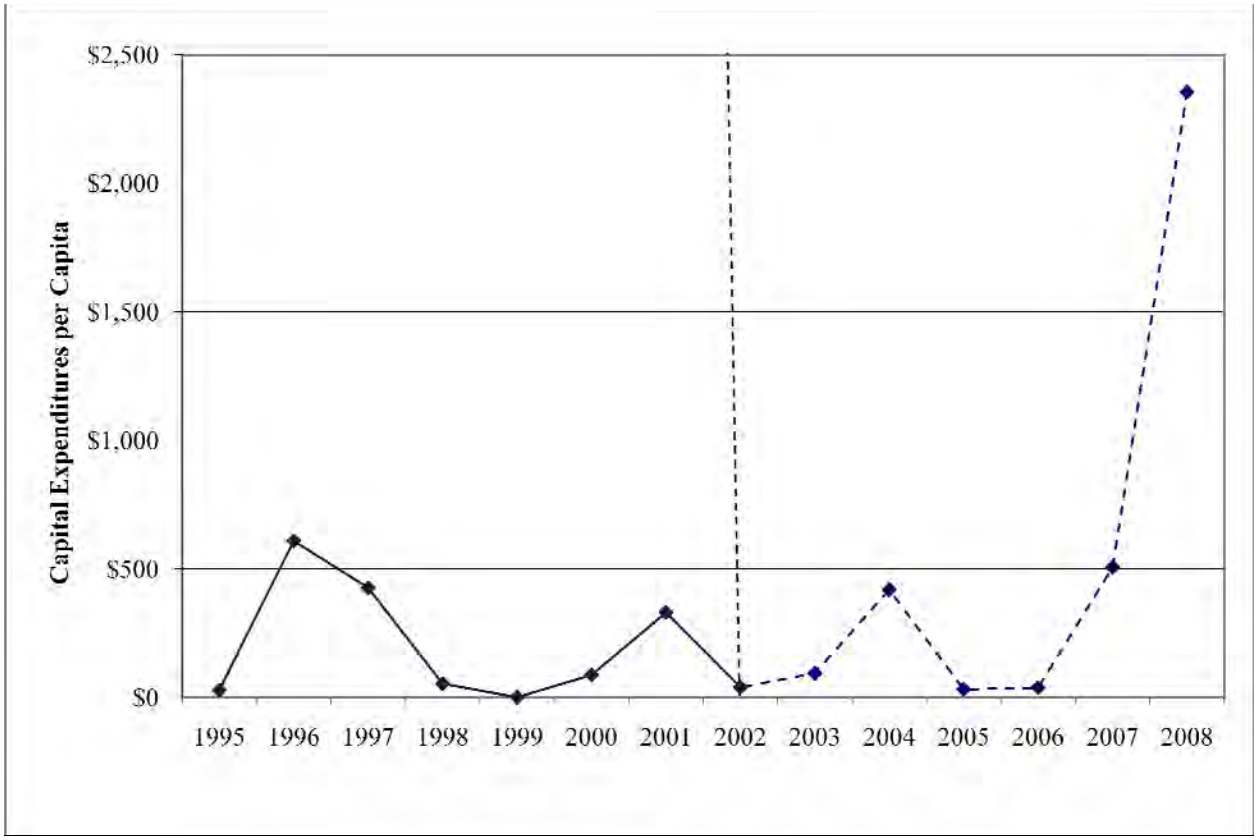


Figure 4-2 Big Piney capital expenditures per capita, 1995–2008 (Town of Big Piney 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009; Wyoming Department of Administration and Information 2008)

4.1.2 Marbleton

Financial data for the town of Marbleton were available from 1995 to present. Table 4-3 describes expenditures in the town from 1995 to 2008, split into operating and capital categories. Annual expenses in Marbleton are similar to those in Big Piney and grew from $437,646 in 1995 to $2,625,007 in 2008. Operating costs outweighed capital costs until 2002, when capital items predominated except for 2003 and 2004. Operating expenses between 1995 and 2008 ranged from $300,000 to $850,000. Capital expenditures during this period increased from $43,143 to $1,885,883.

Table 4-3 Marbleton operating and capital expenditures, 1995–2008 (Town of Marbleton 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009)

Fiscal Year	Operating Expenditures	Capital Expenditures	Total Annual Expenditures	Ratio of Operating/Capital Expenditures	Annual Growth–Expenditures
1995	$394,503	$43,143	$437,646	9.14	N/A
1996	$359,540	$91,069	$450,609	3.95	2.96%
1997	$370,938	$136,912	$507,850	2.71	12.70%
1998	$333,985	$133,239	$467,224	2.51	-8.00%
1999	$349,984	$108,493	$458,477	3.23	-1.87%
2000	$400,134	$97,700	$497,834	4.10	8.58%
2001	$411,382	$112,174	$523,556	3.67	5.17%
2002	$514,696	$632,812	$1,147,508	0.81	119.18%
2003	$512,316	$232,191	$744,507	2.21	-35.12%
2004	$546,464	$190,056	$736,520	2.88	-1.07%
2005	$716,286	$817,269	$1,533,555	0.88	108.22%
2006	$623,444	$2,268,744	$2,892,188	0.27	88.59%
2007	$817,369	$2,115,696	$2,933,065	0.39	1.41%
2008	$739,124	$1,885,883	$2,625,007	0.39	-10.50%

Marbleton per capita expenditures are listed in Table 4-4, with trend analysis shown in Figure 4-3 and Figure 4-4. Organic per capita operating expenses showed a linear trend of $15.87 annually. Energy-impacted growth demonstrated a larger per capita trend of $28.73 annually.

Per capita capital expenditures demonstrated a linear organic trend of $65.10 annually, then increased exponentially after 2002 (Figure 4-4). Marbleton's energy-impacted expenditures showed no definite linear organic trend but increased exponentially with some variance after the start of energy production.

Table 4-4 Marbleton operating and capital expenditures per capita, 1995–2008 (Town of Marbleton 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009; Wyoming Department of Administration and Information 2008)

Fiscal Year	Marbleton Population	Operating Expenditures per Capita	Capital Expenditures per Capita
1995	702	$567	$62
1996	696	$512	$130
1997	707	$525	$194
1998	713	$468	$187
1999	715	$489	$152
2000	720	$556	$136
2001	712	$578	$158
2002	742	$694	$853
2003	762	$672	$305

Fiscal Year	Marbleton Population	Operating Expenditures per Capita	Capital Expenditures per Capita
2004	780	$701	$224
2005	806	$889	$1,014
2006	848	$735	$2,675
2007	919	$889	$2,302
2008	967	$764	$1,950

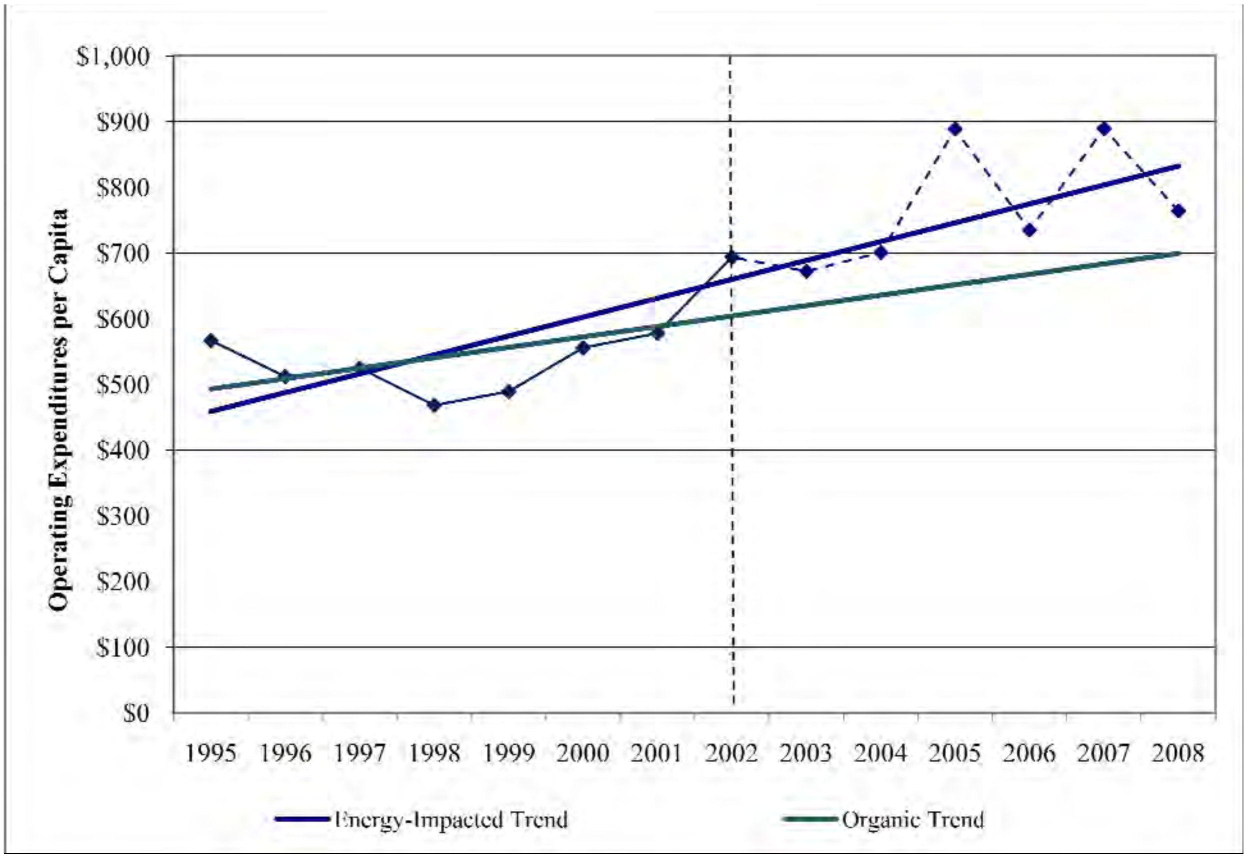


Figure 4-3 Marbleton operating expenditures per capita, 1995–2008 (Town of Marbleton 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009)

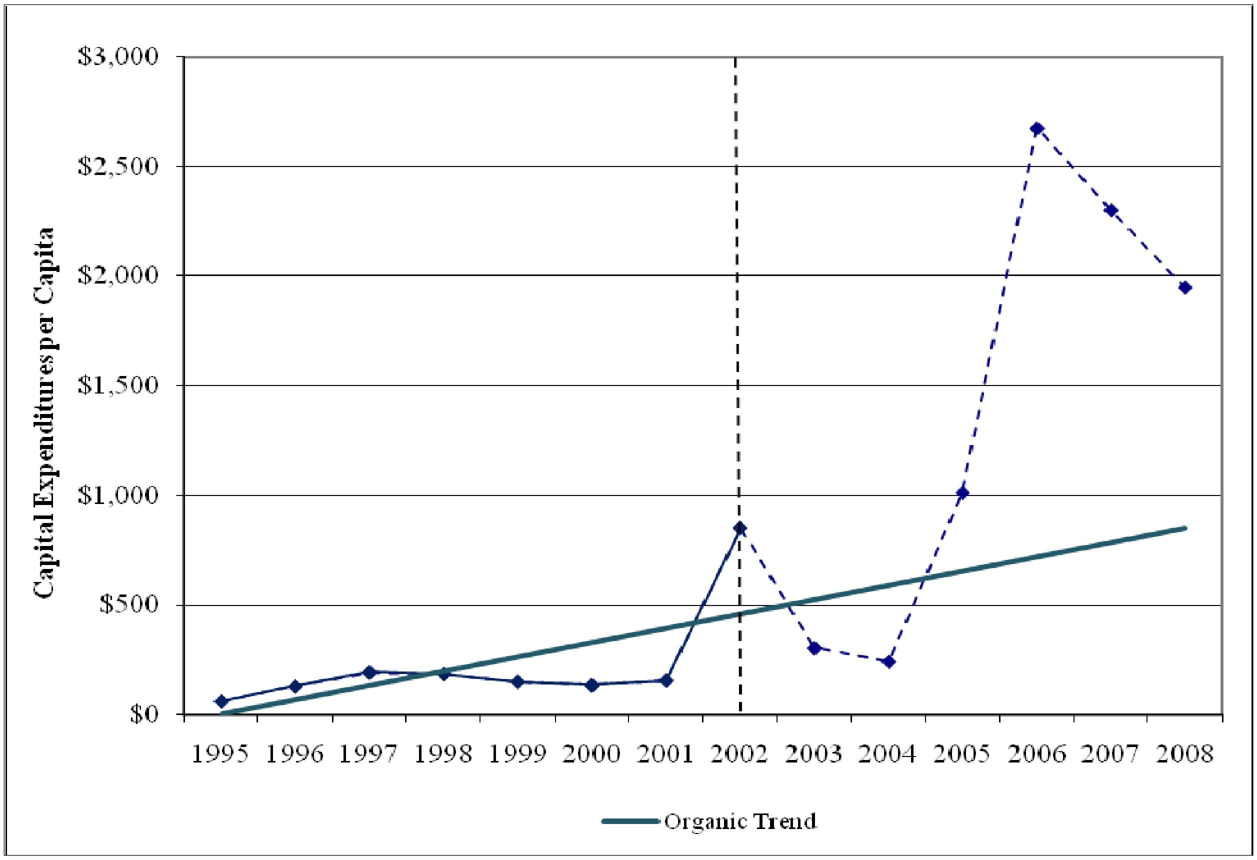


Figure 4-4 Marbleton capital expenditures per capita, 1995–2008 (Town of Marbleton 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009)

4.1.3 Pinedale

Pinedale provided financial data from 1995 to present. Table 4-5 describes expenditures in the town between 1995 and 2008, divided into operating and capital categories. As the largest town in Sublette County, Pinedale's expenses are higher than both Marbleton and Big Piney. Although Pinedale's operating to capital expenditures ratio is quite variable, they do show a higher ratio of capital expenditures in recent years with energy development. Pinedale's figures for the year 2000 are budget estimates rather than actual expenditures as their 2000 fiscal report with actual expenditures was unavailable.

Table 4-5 Pinedale operating and capital expenditures, 1995–2008 (Town of Pinedale 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009)

Fiscal Year	Operating Expenditures	Capital Expenditures	Total Annual Expenditures	Ratio of Operating/Capital Expenditures	Annual Growth–Expenditures
1995	$753,516	$917,647	$1,671,163	0.82	N/A
1996	$625,208	$399,258	$1,024,466	1.57	-38.70%
1997	$768,478	$192,026	$960,504	4.00	-6.24%
1998	$861,174	$357,845	$1,219,019	2.41	26.91%
1999	$876,205	$3,165,750	$4,041,955	0.28	231.57%
2000	$1,272,165	$385,293	$1,657,458	3.30	-58.99%
2001	$1,774,066	$731,028	$2,505,094	2.43	51.14%
2002	$2,007,011	$413,501	$2,420,512	4.85	-3.38%
2003	$1,074,319	$1,010,707	$2,085,026	1.06	-13.86%
2004	$1,435,522	$963,902	$2,399,424	1.49	15.08%
2005	$1,665,021	$1,479,400	$3,144,421	1.13	31.05%
2006	$1,360,172	$6,273,440	$7,633,612	0.22	142.77%
2007	$1,737,371	$4,441,054	$6,178,425	0.39	-19.06%
2008	$2,516,288	$3,715,214	$6,231,502	0.68	0.86%

Per capita expenditures are presented in Table 4-6, Figure 4-5, and Figure 4-6. Pinedale's operating expenditures per capita did not show enough of a pattern in these few years to explore a linear trend, but appear to have slightly increased on average since energy development.

Pinedale's capital expenditures per capita showed increased capital expenditures since energy development. Pre-2002 expenditures showed a linear trend of $9.17. The trend increased to $134.45 with energy development.

Table 4-6 Pinedale operating and capital expenditures per capita, 1995–2008 (Town of Pinedale 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009; Wyoming Department of Administration and Information 2008)

Year	Pinedale Population	Operating Expenditures per Capita	Capital Expenditures per Capita
1995	1,330	$567	$690
1996	1,348	$464	$296
1997	1,365	$563	$141
1998	1,383	$623	$259
1999	1,395	$628	$2,269
2000	1,402	$907	$275
2001	1,383	$1,283	$529
2002	1,433	$1,401	$289

Year	Pinedale Population	Operating Expenditures per Capita	Capital Expenditures per Capita
2003	1,479	$726	$683
2004	1,545	$929	$624
2005	1,647	$1,011	$898
2006	1,818	$748	$3,451
2007	2,043	$850	$2,174
2008	2,150	$1,170	$1,728

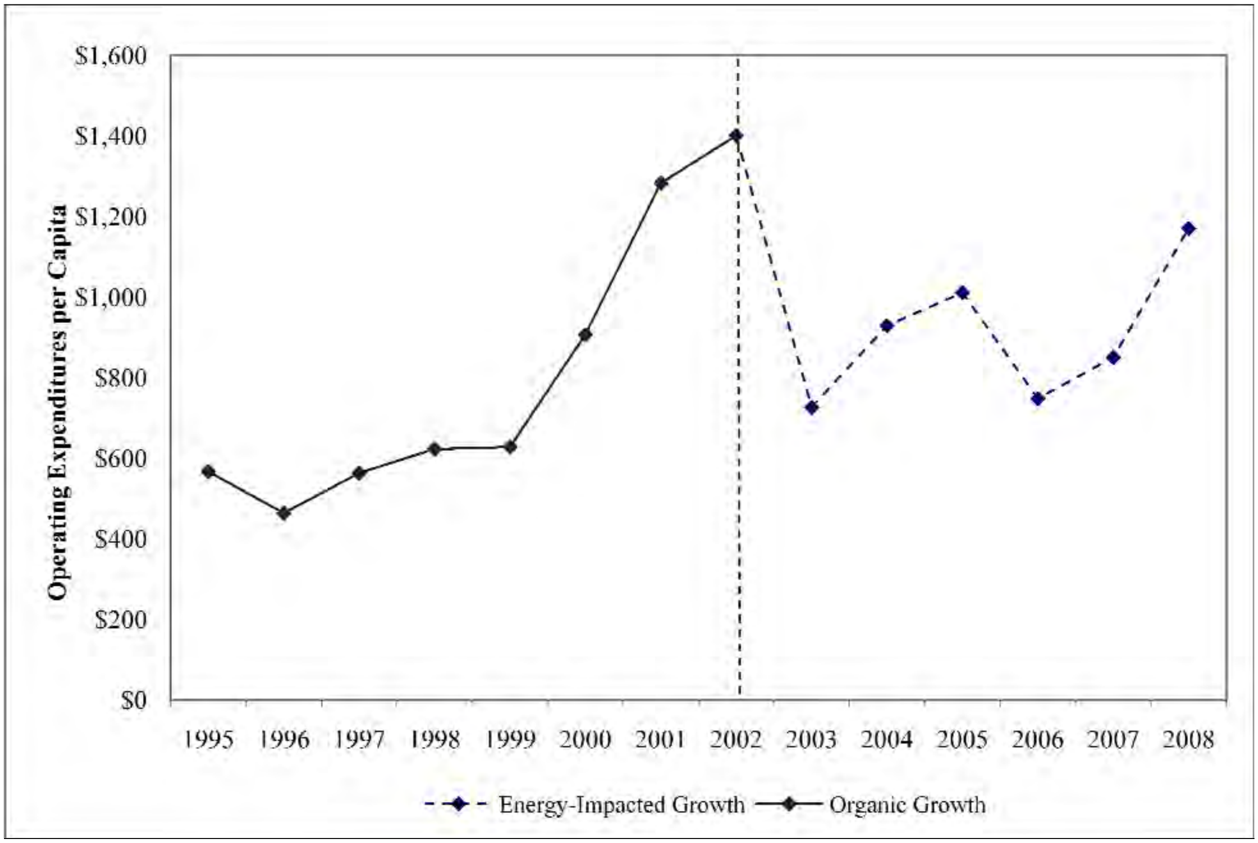


Figure 4-5 Pinedale operating expenditures per capita, 1995–2008 (Town of Pinedale 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009)

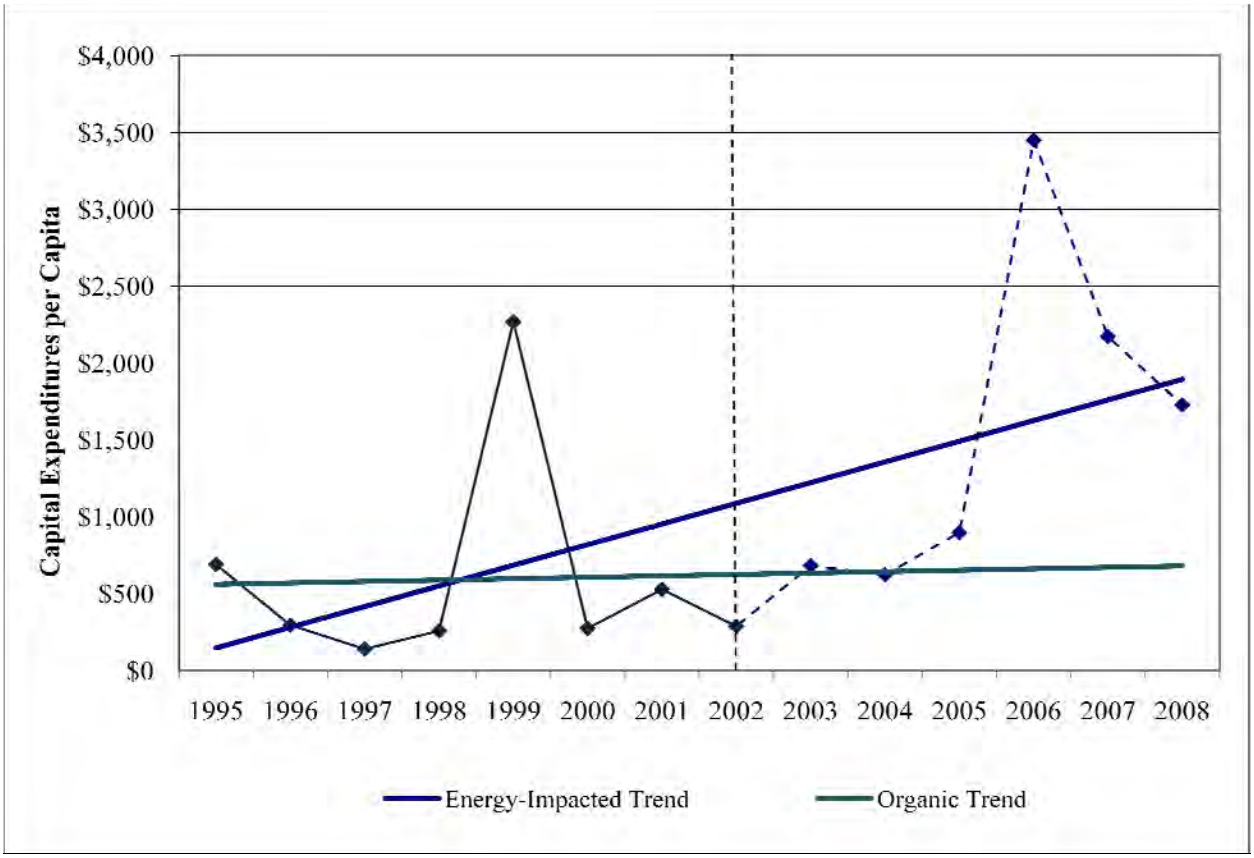


Figure 4-6 Pinedale capital expenditures per capita, 1995–2008 (Town of Pinedale 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009)

4.1.4 Sublette County

Financial data from Sublette County were available from 1999 to present. Table 4-5 describes Sublette County's annual expenditures between 1999 and 2008 divided into operating and capital categories. Prior to 2002 annual operating expenditures exceeded capital expenditures, as indicated by the ratio of operating/capital expenditures. (Values greater than one indicate a greater portion of operating expenditures, values near one indicate that operating and capital expenditures are similar, and values less than one indicate more capital costs.) This is the expected pattern for organic growth; a "normal" environment will have relatively few large purchases or projects.

The year 2002 marked a shift in the ratio between operating and capital costs, and from this point forward capital items consumed a larger portion of overall expenses, except in 2004 when they were approximately equal.

Table 4-7 Sublette County operating and capital expenditures, 1999–2008 (Sublette County 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009)

Fiscal Year	Operating Expenditures	Capital Expenditures	Total Annual Expenditures	Ratio of Operating/Capital Expenditures	Annual Growth–Expenses
1999	$4,467,286	$1,262,258	$5,729,544	3.54	N/A
2000	$4,993,938	$2,290,538	$7,284,476	2.18	27.14%
2001	$5,234,284	$1,900,615	$7,134,899	2.75	-2.05%
2002	$6,491,810	$4,517,073	$11,008,883	1.44	54.30%
2003	$7,144,194	$8,733,297	$15,877,491	0.82	44.22%
2004	$9,692,066	$9,150,794	$18,842,860	1.06	18.68%
2005	$11,160,937	$12,508,948	$23,669,885	0.89	25.62%
2006	$15,750,596	$9,002,775	$24,753,371	1.75	4.58%
2007	$20,499,267	$23,752,524	$44,251,791	0.86	78.77%
2008	$23,663,740	$29,464,673	$53,128,413	0.80	20.06%

Sublette County per capita expenditures are calculated in Table 4-8, with trend analyses shown in Figure 4-7 and Figure 4-8. The trend from 1999 to 2002 was a linear annual growth of $91.4 in operating expenditures per capita. Capital expenditures per capita over the same period also showed a positive linear trend of $149.20.

From 2002 to 2008, Sublette County's annual operating expenditures per capita showed a positive linear trend of $238.28. Annual capital expenditures per capita also showed a positive linear trend of $339.31.

Table 4-8 Sublette County operating and capital expenditures per capita, 1999–2008 (Sublette County 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009; Wyoming Department of Administration and Information 2008)

Fiscal Year	County Population	Operating Expenditures per Capita	Capital Expenditures per Capita
1999	5,835	$766	$216
2000	5,952	$844	$387
2001	5,936	$888	$322
2002	6,218	$1,056	$735
2003	6,352	$1,131	$1,383
2004	6,650	$1,474	$1,392
2005	6,926	$1,622	$1,818
2006	7,359	$2,175	$1,243
2007	7,925	$2,587	$2,997
2008	8,340	$2,837	$3,533

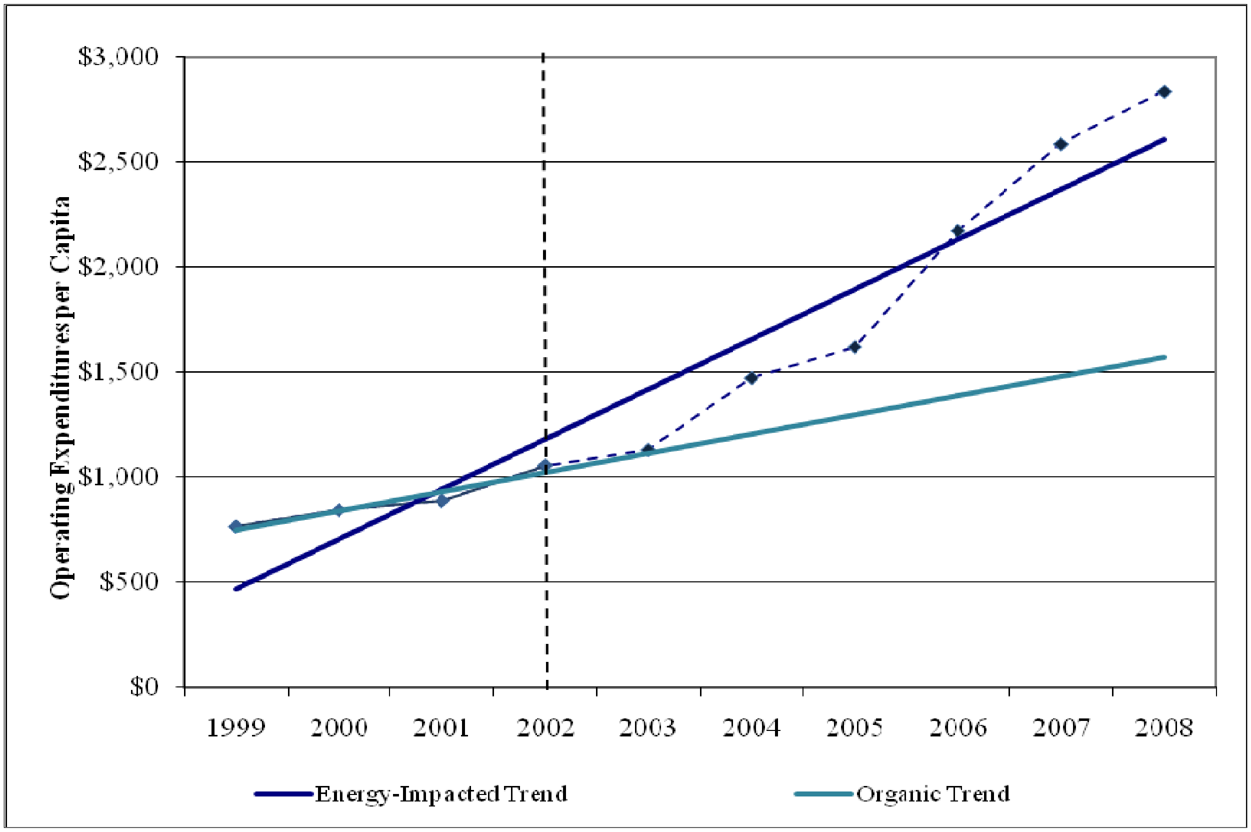


Figure 4-7 Sublette County operating expenditures per capita, 1999-2008 (Sublette County 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009)

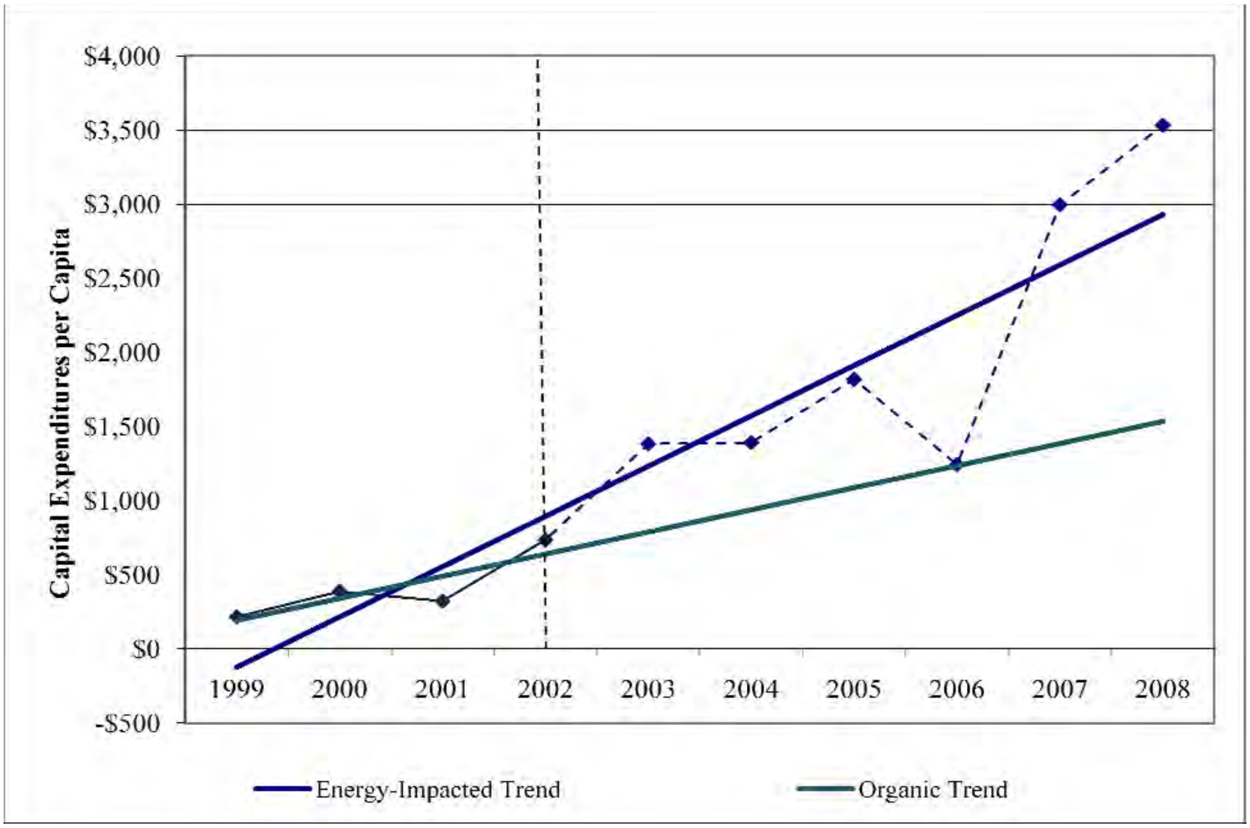


Figure 4-8 Sublette County capital expenditures per capita, 1999-2008 (Sublette County 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009)

4.1.5 Summary – Historical Expenditures

Table 4-9 and Table 4-10 provide summaries of Sublette County's average operating and capital expenditures per capita with and without the presence of oil and gas development. Between 1995 and the early 2000s, annual expenses were directed toward recurring operational items. Capital purchases took place during this period but were the exception rather than the rule. After energy industry activity picked up in the early 2000s, capital expenditures were much more common.

Table 4-9 Average operating expenditures per capita pre- and through energy development (Sublette County, Town of Pinedale, Town of Marbleton, Town of Big Piney 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009)

County/ Municipality	Pre-Development Operating Expenses	Operating Expenses Through Development	Increase
Town of Big Piney	$639	$805	$166
Town of Marbleton	$528	$646	$118
Town of Pinedale	$719	$848	$129

County/ Municipality	Pre-Development Operating Expenses	Operating Expenses Through Development	Increase
Sublette County	$889	$1,538	$649
Overall average	**$694**	**$959**	**$265**

Table 4-10 Average capital expenditures per capita pre- and through energy development (Sublette County, Town of Pinedale, Town of Marbleton, Town of Big Piney 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009)

County/Municipality	Pre-Development Capital Expenses	Capital Expenses Through Development	Change
Town of Big Piney	$220	$359	$139
Town of Marbleton	$146	$739	$593
Town of Pinedale	$637	$1,022	$385
Sublette County	$415	$1,403	$988
Overall Average	**$355**	**$881**	**$526**

The contrast between organic and energy-impacted capital costs is striking, particularly for the towns. Considerable amounts of money, approximately $60.6 million, have been spent recently on capital projects within the county limits, as noted in Table 4-11. However, local governments still have large lists of needed capital projects waiting for funding. Table 4-21, located at the end of this chapter, identifies over $160 million in needed yet unfunded infrastructure projects critical to the health and safety of those who work and live in Sublette County.

For example, the town of Big Piney has obtained engineering estimates to replace the town's aging sewer lines at a cost of approximately $9 million. Big Piney's major revenue stream is sales and use tax, which generated $1.7 million in 2008. If the town is able to set aside even half of those revenues annually, it will take over ten years to accumulate funding for the sewer project. Similar scenarios exist for all jurisdictions within Sublette County.

Table 4-11 Completed capital projects in Sublette County, 2005–2008 (Sublette County, Town of Pinedale, Town of Marbleton, Town of Big Piney, 2005, 2006, 2007, 2008, 2009)

Project	2005	2006	2007	2008
Big Piney				
North/Beach/Norris Street Paving	$1,093	$7,712	$87,257	$138,624
Land Acquisition-Lesley Lane			$40,000	
Paving of Lesley Lane			$40,000	$123,725
Sewer Line			$27,012	
Town Hall Remodeling				$6,940
Park Improvement Project-Piney Drive				$2,874
Quealy Ave. Paving				$59,814
Dodge Street Repair				$40,228

Project	2005	2006	2007	2008
Removal of Well House #7				$5,858
Landfill #1 & #2 Monitoring				$4,092
Subtotal	$1,093	$7,712	$194,269	$382,155
Marbleton				
Capital Expense Well	$70		$119,951	$161,097
Sewer Project		$5,738	$5,080	$89,565
Street Infrastructure	$596,243		$1,008,816	$899,250
Senior Citizen	$3,500	$3,500	$5,000	$6,000
New Town Hall	$167,296	$2,085,542	$789,859	$7,697
Subtotal	$767,109	$2,094,780	$1,928,706	$1,163,609
Pinedale				
Tyler Avenue, Water Fund		$210,828		
Tyler Avenue Water, County-Funded	$111,217	$711,805	$2,202,305	
Sublette Avenue, Water Fund		$156,088	$10,202	
Sewer Lagoon, Sewer Fund		$4,134,654	$271,602	
Sewer Lagoon, County-Funded	$176,978		$393,669	
Capital Improvement Sublette, Water Fund		$189,798	$534,295	$290
Tyler Avenue, Sewer Fund		$8,758	$2,160	
Tyler Avenue Sewer, County-Funded				
Sublette Avenue, Sewer Fund	$271,730	$290,135	$134,738	
West Pinedale Main, Sewer Fund				$431,724
South Main Sewerline, Sewer Fund				$1,040,023
Paved Street Maintenance, General Fund	$32,750	$70,762	$10,402	$6,314
Unpaved Street Maintenance, General Fund	$5,322	$1,238	$250	$78
Capital Improvement Curbs/Gutters, General Fund	$89,250	$224,350		
Subtotal	$687,247	$5,998,416	$3,559,623	$1,478,429
Sublette County				
Retirement Center Land Purchase	$1,750,000			
Senior Citizen Facilities	$1,288,078	$155,280	$127,309	$792,202
Big Piney Recreation Center, including Nichols Land		$231,204		$1,159,841
Library Addition		$27,036	$320,485	$2,315,249
Pinedale Clinic			$2,710,944	$5,560,826
Marbleton Clinic			$668,684	$3,325,964
Pinedale Ambulance Barn			$1,090,180	$423,429
Marbleton Projects, Clinic Land Purchase			$1,250,000	
Marbleton Area Sewer and Water				$32,604
Marbleton Airport Hangar			$19,712	$2,740,371
Marbleton Ambulance Barn				$46,150
Tyler Street		$3,000,000		
Mesa Road				$2,500,000
Sand Draw Ambulance Barn			$664,966	$543,340
Visitor Center			$937,690	

Project	2005	2006	2007	2008
Road and Bridge Shop		$3,300,000		
Facilities Maintenance Building				$3,200,000
Land from Doyles, Pinedale				$700,350
Land from Richardson, Pinedale				$1,319,500
Search and Rescue				$132,968
Subtotal	$3,038,078	$6,713,520	$7,789,970	$24,792,794
Total	**$4,493,527**	**$14,814,428**	**$13,472,568**	**$27,816,987**
Cumulative Total	**$60,597,510**			

4.2 MUNICIPALITY QUESTIONNAIRE; PROJECTED EXPENDITURES; PERSONNEL AND OPERATING BUDGETS

4.2.1 Survey Instrument

In 2008, ERG administered a survey to Big Piney, Marbleton, Pinedale, and Sublette County regarding projected expenditures through 2018, the estimated peak employment year. A compilation of the questionnaire results and follow-up planning meetings follows.

4.2.2 Big Piney

The town of Big Piney also expects budgetary increases through 2018. Big Piney has not made estimates for number of personnel needed during this timeframe (Ecosystem Research Group 2008b).

4.2.3 Marbleton

The town of Marbleton does not anticipate hiring additional staff between 2009 and 2018. However, they expect budgetary growth, estimating their FY2010 budget at $11 million, FY2011 budget at $12 million, and FY2012 budget at $13 million (Ecosystem Research Group 2008b).

4.2.4 Pinedale

Like Sublette County, the town of Pinedale returned their questionnaires by department including the Clerk's Office, Mayor's Office, Planning and Zoning, Engineering, Municipal Court, and Public Works. Anticipated staff increases by department are shown in Table 4-12. In December 2008, Pinedale had 21 employees (Hogarty 2009).

Table 4-12 Pinedale anticipated staff increases, 2008–2018 (Ecosystem Research Group 2008b)

Department	Staff Increase 2008-2018
Planning and Zoning	0.5
Engineering	2.0
Municipal Court	1.0
Public Works	1.5
Total	**5.0**

4.2.5 Sublette County

Sublette County's questionnaires were distributed to all county departments, including the County Assessor, County Commissioners, Drug Court, Emergency Management, GIS, Road and Bridge, Treasury, Zoning and Planning, County Clerk, County Engineer, Elections, Environmental Health, Public Health, County Sheriff and Law Enforcement, Waste Management, and the Clerk of Court. Responses indicate that many departments expect continued growth until 2018. Total anticipated staff increases from 2008 to 2018 are shown in Table 4-13. Departments which did not expect staff increases were not included in the table. Operating budgets are expected to increase as well, in tandem with additional staff and population growth.

Table 4-13 Sublette County anticipated staff increases, 2008–2018 (Ecosystem Research Group 2008b)

Department	Staff Increase 2008-2018
County Assessor	1.0
Drug Court	2.0
Road and Bridge	10.0
Treasury	2.0
Zoning and Planning	1.0
County Clerk	1.0
Environmental Health	0.5
Public Health	2.0
County Sheriff/Law Enforcement	10.0
Waste Management	4.0
Clerk of Court	4.0
Total	**37.5**

4.3 CUMULATIVE PROJECTED PERSONNEL AND OPERATING BUDGETS

Using the linear trend of increases in operational expenditures per capita through oil and gas development, Sublette County and its municipalities' operating budgets are estimated through 2018 below.

Table 4-14 Estimated operating expenditures, 2009–2018 (United States Census 2009; Town of Big Piney, Town of Marbleton, Town of Pinedale, Sublette County 2009)

Fiscal Year	Big Piney	Marbleton	Pinedale	Sublette County
2009	$583,976	$875,601	$3,850,946	$20,349,263
2010	$619,664	$973,446	$4,211,307	$22,922,249
2011	$656,722	$1,077,526	$4,592,531	$25,668,192
2012	$695,174	$1,189,207	$5,000,165	$28,620,792
2013	$735,777	$1,296,414	$5,383,693	$31,488,302
2014	$771,177	$1,409,429	$5,786,742	$34,516,584
2015	$807,915	$1,529,802	$6,215,437	$37,744,560
2016	$846,771	$1,655,045	$6,659,444	$41,111,792
2017	$886,265	$1,788,132	$7,130,627	$44,692,644
2018	$927,942	$1,929,429	$7,630,136	$48,497,560

4.4 MUNICIPALITY QUESTIONNAIRE—PROJECTED CAPITAL EXPENDITURES

4.4.1 Big Piney

In their questionnaire, Big Piney estimated the cost of their paving and infrastructure projects at $9.3 million between 2008 and 2018. A detailed list of their projected expenditures outlined in the follow-up meetings is included in Table 4-15.

Table 4-15 Big Piney upcoming infrastructure projects (Arthur 2008; Hurd 2008)

Priority	Project	Estimated Cost	Time Frame	Budget Source	Budget Amount	Shortfall
1st	Landfill groundwater monitoring	$125,000	Ongoing	Wyo Star savings	$0	$125,000
1st	Black Avenue	$856,650	2009	Town	$50,000	$806,650
1st	Mickelson Street	$520,525	2009	Town	$50,000	$470,525
1st	Noble Street	$323,375	2009	Town	$50,000	$273,375
1st	Fish Street	$320,688	2009	Town	$50,000	$270,688
1st	P.L. Lane	$634,325	2009	Town	$50,000	$584,325
1st	Miller Lane	$283,500	2009	Town	$50,000	$233,500
1st	Circle Way	$263,875	2009	Town	$50,000	$213,875
1st	Beck Street	$132,650	2009	Town	$50,000	$82,650
1st	Engineering	$767,185	2009	Town	$0	$767,185

Priority	Project	Estimated Cost	Time Frame	Budget Source	Budget Amount	Shortfall
1st	Highway 189	$361,128	2010	SLIB/Town	$0	$361,128
1st	Piney Drive	$486,030	2010	SLIB/Town	$0	$486,030
1st	Smith Avenue	$1,003,975	2010	SLIB/Town	$0	$1,003,975
1st	Fish Street	$101,750	2010	SLIB/Town	$0	$101,750
1st	Noble Street	$313,943	2010	SLIB/Town	$0	$313,943
1st	Mickelson Street	$363,005	2010	SLIB/Town	$0	$363,005
1st	Engineering	$521,801	2010	SLIB/Town	$0	$521,801
1st	Piney Drive	$632,900	2011	SLIB/Town	$0	$632,900
1st	Milleg Lane	$893,400	2011	SLIB/Town	$0	$893,400
1st	Engineering	$351,049	2011	SLIB/Town	$0	$351,049
	Total	**$9,256,754**			**$400,000**	**$8,856,754**

4.4.2 Marbleton

In the questionnaire, Marbleton listed their capital projects for 2009–2018 as a sewer line, new sewer facility, new water tower, truck, and lawn equipment. A detailed list of Marbleton's projected infrastructure expenditures outlined in follow-up meetings is included in Table 4-16.

Table 4-16 Marbleton upcoming infrastructure projects (Murphy 2008)

Priority	Project	Estimated Cost	Time Frame	Budget Source	Budget Amount	Shortfall
1st	Well House #7 Fluoride Treatment	$639,243	2009	Town	$48,596	$590,647
1st	Aerated Lagoon System with Power	$4,600,000	2009-10	Town	$2,679,582	$1,920,418
1st	Wind Turbines for Aerated Lagoon System	$500,000	2009-10	Town	$172,619	$327,381
1st	50,000 Gallon Water Tower Replacement	$979,800	2010-11	Town	$200,000	$779,800
2nd	Main Water Line East to West	$497,000	2009-10	Town	$100,000	$397,000
2nd	South Sewer Line Extension	$229,000	2009-10	Town	$100,000	$129,000
2nd	Alsade Drive Curb, Gutter, and Paving	$413,406	2009-10	Town	$50,000	$363,406

Priority	Project	Estimated Cost	Time Frame	Budget Source	Budget Amount	Shortfall
3rd	Eiden Subdivision Curb, Gutter, and Paving	$2,685,894	2011-12	Town	$150,000	$2,535,894
4th	Phase III of the Marbleton Street Project Sidewalks	$2,735,512	2012-13	Town	$200,000	$2,535,512
	Total	**$13,279,855**			**$3,700,797**	**$9,579,058**

4.4.3 Pinedale

In the questionnaire, Pinedale identified spatial expansion for the Clerk's Office, Planning and Zoning Department, and Municipal Court along with some Publics Works projects summarized in Table 4-17.

Table 4-17 Pinedale capital needs from questionnaire (Ecosystem Research Group 2008b)

Department	Capital Items	Spatial Expansion
Clerk's Office	None	$115-150,000 additional office space
Planning and Zoning	GIS database	County maintenance facility, 3 new parks of 230 acres added to town maintenance
Municipal Court	None	Facility expansion of $50–100,000
Public Works	SCADA water treatment system, water treatment facility and upgrades, and sludge removal and re-line	None

A series of meetings detailed Pinedale's sewer, water treatment, street, and facility needs through 2014. The complete list is included in Table 4-18.

Table 4-18 Pinedale upcoming infrastructure projects (Ninnie 2008)

Priority	Project	Estimated Cost	Time Frame	Budget Source	Budget Amount	Shortfall
1st	Phase V Sewer	$7,491,037	2010	Sales/Use tax	$2,000,000	$5,491,037
1st	Phase VI Sewer	$8,924,640	2010	Sales/Use tax	$0	$8,924,640
1st	EPA-Mandated Water Treatment	$3,800,000	2010	None	$0	$3,800,000
2nd	Street Repair/Improvements	$6,602,000	2010	None	$0	$6,602,000
2nd	Street Repair/Improvements	$5,182,000	2011	None	$0	$5,182,000
2nd	Phase VII Sewer	$7,486,384	2011	Sales/Use tax	$2,000,000	$5,486,384

Priority	Project	Estimated Cost	Time Frame	Budget Source	Budget Amount	Shortfall
2nd	Street Repair/Improvements	$4,544,000	2012	None	$0	$4,544,000
3rd	Phase VIII Sewer	$7,694,490	2012	None	$2,000,000	$5,694,490
3rd	Street Repair/Improvements	$4,307,000	2013	None	$0	$4,307,000
4th	Phase IX Sewer	$6,111,828	2013	Sales/Use tax	$2,000,000	$4,111,828
4th	Street Repair/Improvements	$1,368,000	2014	None	$0	$1,368,000
4th	Water Meter System	$3,200,000	2013	None	$0	$3,200,000
5th	Phase X Sewer	$2,755,689	2014	Sales/Use tax	$2,000,000	$755,689
5th	Town Hall	$5,500,000	2014	None	$0	$5,500,000
5th	Sewer Lagoon Expansion	$4,500,000	2014	None	$0	$4,500,000
5th	Water Meter System	$2,800,000	2014	None	$0	$2,800,000
	Total	**$82,267,068**			**$10,000,000**	**$72,267,068**

4.4.4 Summary of Results—Sublette County

Sublette County government departments listed estimated departmental spatial expansion and capital items in their responses to ERG's questionnaires. These estimated needs are summarized in Table 4-19.

Table 4-19 Sublette County capital needs from questionnaire (Ecosystem Research Group 2008b)

Department	Capital Items	Spatial Expansion
Assessor	16 computers, software, 2 copiers, and 5 printers	500 square foot expansion increases existing space by 30%
Drug Court	3 computers, office furniture, upgraded urinalysis testing machinery, drug monitoring technology, and GPS locators	Double office space, add small lab facilities in new justice center
Emergency Management/ Sheriff's Office	Vehicles and support equipment	New law enforcement complex
GIS	Computer and plotter	None
Road and Bridge	Road project and construction equipment	None
Treasury	None	Space needed

Department	Capital Items	Spatial Expansion
Zoning and Planning	1 Computer per year	None
Elections	2 file cabinets, 2 computers, and trailer equipment	None
Environmental Health	2 computer stations, office furniture, bacteria water testing lab	400 square foot facility expansion triples existing space
Public Health	None	Spatial increase of 10% in conjunction with county building remodel
Waste Management	Cell construction for landfill air space, various equipment, and loader/dozer/trash compactor	20 acre expansion increases existing space by 50%

In follow-up meetings, Sublette County identified road projects anticipated through 2012 and potentially beyond. A detailed list of these projects follows in Table 4-20.

Table 4-20 Sublette County upcoming infrastructure projects (Lankford 2008)

Priority	Project	Estimated Cost	Time Frame	Budget Source	Budget Amount	Shortfall
1st	Calpet Highway	$25,000,000	2009-10	County	$3,000,000	$22,000,000
1st	Dry Piney Road	$10,000,000	2009-10	County	$0	$10,000,000
2nd	Guios Road	$6,000,000	2009-10	County	$0	$6,000,000
2nd	Horse Creek Road	$600,000	2009-10	County	$0	$600,000
3rd	Fremont Lake Road Bridge	$600,000	2010-11	County	$0	$600,000
4th	Middle Piney Road	$7,000,000	2011-12	County	$0	$7,000,000
4th	North Piney Road	$5,000,000	2011-12	County	$0	$5,000,000
5th	Fremont Lake Road	$1,200,000	Not defined	County	$0	$1,200,000
	Total	**$55,400,000**			**$3,000,000**	**$52,400,000**

4.5 CUMULATIVE PROJECT EXPENDITURES—CAPITAL ITEMS

Sublette County and towns anticipate spending a total of $160,203,677 in capital projects in the next few years to keep up with the pace of population growth. They currently have $17,106,797 available for these projects, resulting in a shortfall of $143,096,880. These needs are summarized in Table 4-21.

Table 4-21 Sublette County and Towns anticipated capital expenditures (Arthur 2008; Hurd 2008; Lankford 2008; Murphy 2008; Ninnie 2008)

County/ Town	Projects	Total Cost	Funds Available
Sublette County	Eight road maintenance projects	$55,400,000	$3,000,000
Big Piney	One groundwater maintenance project Seventeen road/sewer replacement projects	$9,256,754	$400,000
Marbleton	Two water well projects Two sewer treatment projects One water line project Two sewer line projects One curb/gutter/paving project One sidewalk project	$13,279,855	$3,700,797
Pinedale	Six sewer line projects Three water treatment and metering projects Five street projects One sewer treatment project	$82,267,068	$10,000,000
Total		**$160,203,677**	**$17,100,797**

5. ENERGY INDUSTRY WORKFORCE

5.1 INTRODUCTION

A detailed analysis of energy industry employment is needed to fully understand its impact on population. This section discusses traditional elements of workforce analysis such as full time equivalents (FTE), and direct, indirect, and induced employment positions. Unique elements of the energy industry, such as highly mobile workers, are also covered.

Determining the number of energy workers in place during the development phase of energy production which includes activities such as well pad construction, drilling, hydraulic treatments, and completion is surprisingly difficult. While a given operator may be responsible for overall operations of an oil and gas well, the majority of development phase tasks are assigned to contractors and subcontractors who, along with their employees, are based in locations both domestic and abroad. Worker counts are calculated through a variety of mechanisms such as operator workforce estimates, employment reports, modeling and trend analysis, and housing surveys. ERG used a combination of these methods to arrive at workforce numbers, as discussed below.

5.2 TRANSIENT WORKFORCE

A segment of those employed in the oil and gas industry is very mobile and generally not counted when population values are determined. These workers are often based out of state and are transported onto the work site for a period of one or two weeks. They then return to their home for an equal length of time before resuming work. Employees in this category, termed transient workers, do not maintain permanent residence in a project area although they are part of the workforce. By definition, these workers are difficult to count. For the purposes of this report, the transient population is estimated to be approximately 27.5 direct workers per active rig and includes drilling and hydraulic fracturing crews (Jacquet 2009). Using this formula with a count of 55 rigs, Sublette County's transient population is estimated at 1,513 workers.

5.3 TEMPORARY HOUSING SURVEY

Transient workers in Sublette County have no permanent housing and must rely on hotels, motels, employer-supplied housing, or other living arrangements. Based on the prior discussion of transient worker counts, periods of high drilling activity can bring over 1,500 workers to the county, all of whom require living quarters of some kind. Sublette County has not had sufficient temporary housing available for this many people, so workers and their employers have had to deal, at times creatively, with the housing shortage.

Traditional temporary housing usually consists of hotels and motels. When these are unavailable, workers turn to non-traditional options including camping (both tent and recreational vehicle), sleeping in personal cars, trailers, or company vehicles, and sleeping outdoors as the weather permits. Operators occasionally provide housing ranging from company apartments to tent and trailer complexes.

In 2008 and 2009, ERG administered a telephone survey to hotels, motels, and campgrounds in Sublette County. The results are summarized in Table 5-1. Respondents indicate that business has increased since 2000. Of the nine businesses contacted in Sublette County, five indicated that over 75% of their visitors are from the oil and gas industry, with two businesses quoting a figure of 90%. Most establishments reported a slight decrease in business during the winter months.

Table 5-1 Temporary housing survey (Ecosystem Research Group 2008d)

Hotel	Average Summer Visitors from Oil and Gas Industry Per Night
Baymont	148
Best Western Pinedale	94
Half Moon Motel	31
Lodge at Pinedale	69
Pine Creek Inn	32
Rivera Lodge	2
Teton Court Motel	20
Daniel Junction	5
Marbleton Inn	70
Total	**471**

Other temporary housing in the area includes EnCana's workforce facility, a semi-permanent tented housing area currently located in Jonah field that houses 150 to 200 people (Teeuwen 2009). Other oil and gas companies plan to house an additional 110 workers in similar facilities (Ecosystem Research Group 2008a).

Operators also house employees in company apartments, bunkhouses, townhouses, and trailers. Industry estimated housing 55 people in this manner during 2007, 2008, and 2009 (Ecosystem Research Group 2008a).

Based on results of the telephone survey and industry questionnaire, approximately 856 people stay in temporary housing each night during the summer. With a 20% reduction in hotel occupancy during the winter, this number decreases to approximately 762 people (Table 5-2). According to Jacquet's estimate of 1,513 transient workers, this leaves approximately 657 people unaccounted for each night during the summer when peak drilling takes place. Many workers commute daily from Rock Springs and others stay in RVs and trailers outside of zoned campgrounds and trailer parks (Coburn 2009).

Table 5-2 Transient worker count by housing type and season (Ecosystem Research Group 2009)

Housing Type	Summer	Winter
Hotel	471	377
Workforce Facility	385	385
Total	**856**	**762**

5.4 COMMUTERS

5.4.1 Intra-State Commuters

The 2000 Census reports inflow and outflow of commuters in Sublette County, indicating how many people live elsewhere and commute to Sublette County to work (inflow) and how many people live in Sublette County and commute elsewhere to work (outflow). The inflow values from the census are likely lower than actual values, as the 2000 Census predated Sublette County's increase in energy development and the accompanying rise in employment and population. While Table 5-3 and Table 5-4 show Sublette County had a net outflow of 175 workers in 2000, the following discussion of net residential adjustment demonstrates that net outflow commuting has decreased since 2000.

Table 5-3 Commuting inflow by county of residence for Sublette County's workforce (United States Census Bureau 2000)

Place of Residence	Number of Workers	% Total
Converse County	2	0.07%
Fremont County	13	0.46%
Lincoln County	75	2.68%
Natrona County	13	0.46%
Sublette County	2,598	92.92%
Sweetwater County	40	1.43%
Teton County	9	0.32%
Uinta County	10	0.36%
Outside of Wyoming	36	1.29%
Total	**2,796**	

Table 5-4 Commuting outflow by county of work for Sublette County's residents (United States Census Bureau 2000)

Place of Work	Number of Workers	% Total
Carbon County	3	0.10%
Fremont County	9	0.30%
Lincoln County	103	3.47%
Natrona County	3	0.10%
Park County	6	0.20%

Place of Work	Number of Workers	% Total
Sheridan County	4	0.13%
Sublette County	2,598	87.45%
Sweetwater County	45	1.51%
Teton County	134	4.51%
Uinta County	2	0.07%
Outside of Wyoming	64	2.15%
Total	**2,971**	

5.4.2 Net Residential Adjustment

Another component of oil and gas workers, termed in-commuters, permanently reside nearby and commute from outside Sublette County to work. Though these employees work within the county, their wages are spent elsewhere and represent a loss of money to county finances. The effect of commuters on wages that remain within the county is determined by the net residential adjustment (NRA) calculation. NRA is the total amount of money taken out of a county less the total amount of money brought in by commuters. A positive NRA indicates that more wages are taken out of the county than brought in. A negative NRA indicates that more wages are brought into the county than taken out. Table 5-5 and Figure 5-1 show Sublette County's net residential adjustment between 1995 and 2006, adjusted for inflation. Historically, the net residential adjustment in Sublette County has been positive meaning that more money is flowing out of Sublette County than in through commuters' wages. However, the amount has been decreasing since 2002, indicating that in-commuting has risen relative to out-commuting with oil and gas development. It is important to note that overall wages within the county have risen in step with energy development, which also affects net residential adjustment calculations.

Table 5-5 Sublette County net residential adjustment in thousands of dollars (1995$) (Bureau of Economic Analysis 2008)

Year	Net Residential Adjustment
1995	$4,313
1996	$4,241
1997	$4,647
1998	$5,193
1999	$6,326
2000	$6,137
2001	$6,490
2002	$6,552
2003	$6,363
2004	$5,716
2005	$3,795
2006	$2,170

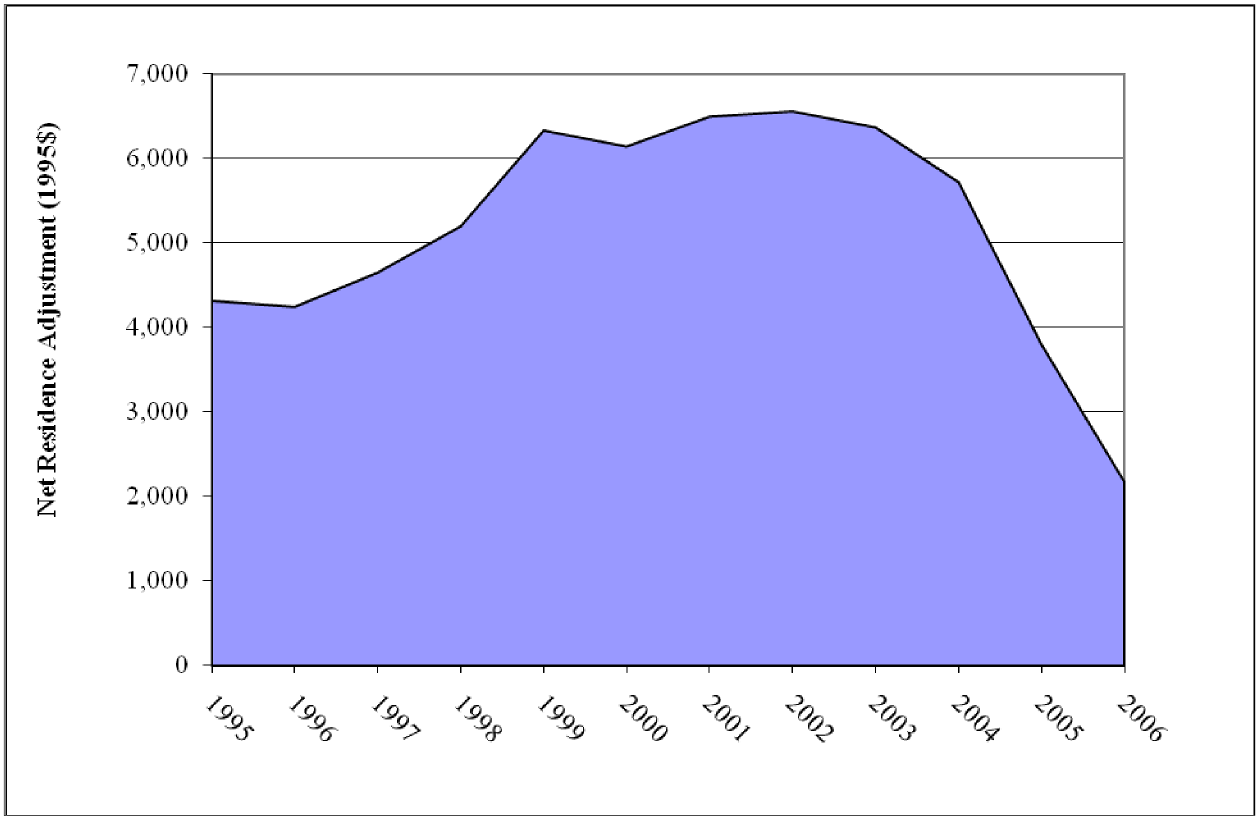


Figure 5-1 Sublette County net residential adjustment in thousands of dollars (1995$)

5.4.3 Inter-State Commuters

The Wyoming Department of Employment, Research, and Planning analyzed inter-state commuter patterns in Sublette County. Data were collected by determining worker residence location by state from drivers' license information and work location by company. The department found evidence of net commuter inflow, which supports the rise in Sublette County's transient worker population. Figure 5-2 shows the total net commuter inflow of workers in Sublette County between 2000 and 2005. The totals shown in the table are four-quarter moving averages of the inflow minus the outflow of workers. As depicted, Sublette County net worker inflow increased over 1,000 workers during this time period. In 2005, Sublette County's net resident inflow averaged a positive influx of 893.25 workers compared to 2000's negative outflow of 166.5 workers. This trend strongly follows the estimates of transient worker population. It should be noted that this count does not include Wyoming commuters who live outside of Sublette County—these workers fall into the Intra-State Commuter category.

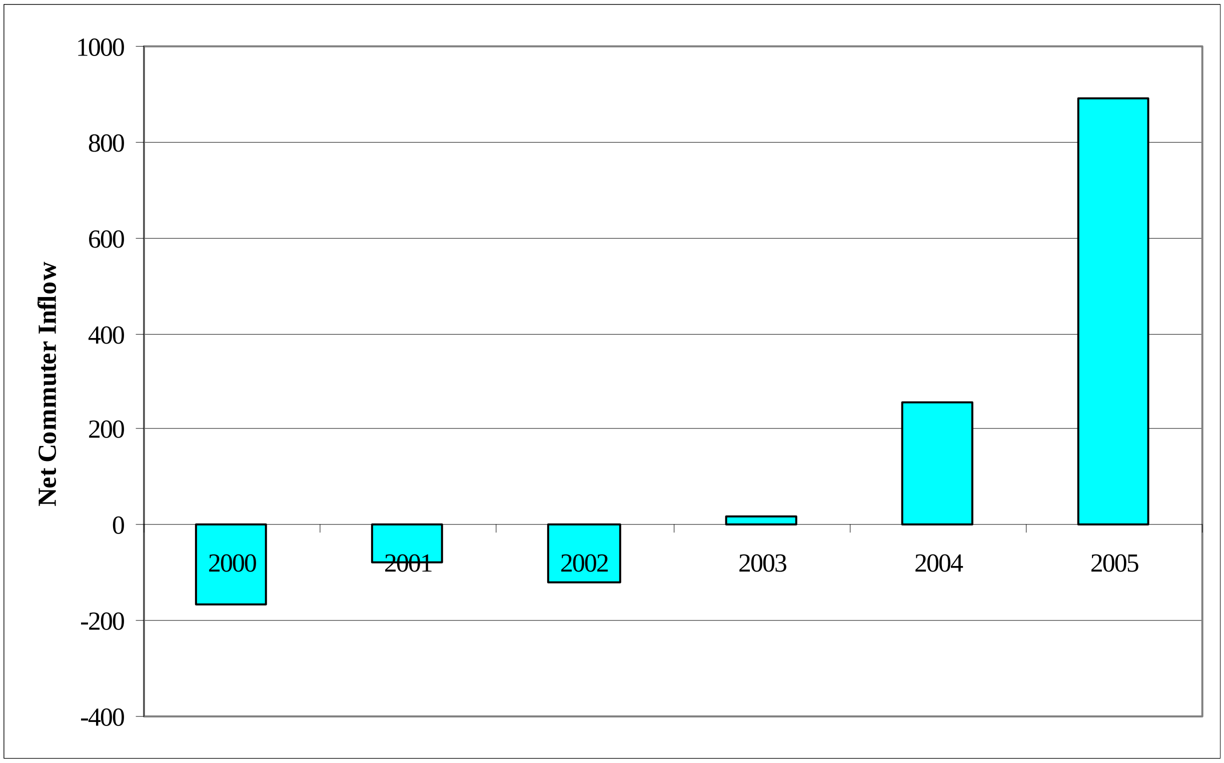


Figure 5-2 Sublette County's net commuter inflow of inter-state workers (Wyoming Department of Employment, Research, & Planning 2007)

Sublette County's net commuter inflow of workers with out-of-state drivers' licenses has increased since 2000 (Table 5-6). According to the 2000 U.S. Census, 93% of Sublette County's workforce resided in the county and 87% of Sublette County's residents worked in the county. In 2000, Sublette County had a larger proportion of worker out-flow than in-flow. However, this was before oil and gas development in the area. With the development of these industries, in-commuting has directly increased. The 2005 net-commuter inflow of only out-of-state workers was approximately 1,060 workers more than the 2000 count (Wyoming Department of Research & Planning 2009). More recent data is unavailable.

Table 5-6 Sublette County out-of-state net commuter inflow (Wyoming Department of Research & Planning 2009)

	2000	2001	2002	2003	2004	2005
Net Commuter Inflow	-166.50	-77.75	-118.00	19.75	254.50	893.25
Annual Change		88.75	-40.25	137.75	234.75	638.75

5.4.4 License Plate Survey

Michael Coburn, Socioeconomic Analyst for the Sublette Community Partnership, administered traffic counts at the intersection of State Route 351 and Paradise Road and the intersection of Luman Road and British Petroleum Jonah OC in Sublette County, Wyoming. At the intersection of Paradise Road and State Route 351, 506 of the 612 vehicles counted (82.7%) had Wyoming licenses, 77 (12.6%) vehicles had out-of-state license plates, and 29 (4.7%) were unknown due to poor license plate visibility. The data had a standard error of 0.014 or 1.4% indicating that the real percentage of in-state vehicles ranged from 81.3% to 84.1% and the real percentage of out-of-state vehicles ranged from 11.2% to 14.0% during this survey. At the intersection of Luman Road and British Petroleum Jonah OC, 342 of the 407 vehicles counted (84.0%) had Wyoming license plates, 42 (10.3%) had out-of-state licenses, and 23 vehicles (5.7%) were unidentifiable due to poor license plate visibility. The data had a standard error of 0.016 or 1.6% indicating that the real percentage of in-state vehicles ranged from 82.4% to 85.6% and the real percentage of out-of-state vehicles ranged from 8.7% to 11.9% during this survey.

5.5 INDUSTRY QUESTIONNAIRE

5.5.1 Survey instrument

In 2008/2009, ERG administered a survey to oil and gas companies operating in Sublette and surrounding counties. A total of 23 companies were contacted. The survey requested information including the number of workers per well per year for the drilling, production, reclamation phases, and workover maintenance; the production life span of a well; the companies' future schedule of operations for one, five, and ten-year timeframes; the total number of employees working in Sublette County during 2007, 2008, and projected for 2009 including information about family members who accompany workers to the area; the number of employees housed by the company including the housing location and type; any proposed camp and employee housing construction; and the total tax amount paid on energy production in Sublette County. The survey instrument and comprehensive results are found in Appendix A. To maintain confidentiality, all results are summarized.

5.5.2 Summary of Results

Survey responses were received from eight of the 23 operators, some with high levels of production and others with low or no production levels in Sublette County. Results indicate that employment is expected to remain relatively stable until 2013. At that time employment will decrease by approximately 500 employees and remain at that level until 2018. Table 5-7 and Figure 5-3 present this information, separated into development phases or work tasks. Note that these operator-supplied employment estimates are lower than those calculated from the Pinedale Anticline FSEIS and JIDP FEIS, which are discussed later in this section. The recent downturn in oil and gas prices could contribute to this difference in employment projections.

Table 5-7 Total FTE projections by phase as supplied by operators, 2009–2018 (Ecosystem Research Group 2008a)

Phase	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Development Phase										
Drilling	1,137	1,176	1,199	1,217	1,238	713	689	666	642	642
Completion	151	151	151	108	108	108	108	108	108	108
Production	377	390	404	420	437	454	470	486	501	515
Reclamation and Pad Construction	210	194	127	94	90	78	61	61	61	61
Other										
Workover	53	53	59	66	73	74	74	75	75	76
Miscellaneous Employment	85	85	0	0	0	0	0	0	0	0
Total Employment	**2,012**	**2,047**	**1,940**	**1,905**	**1,946**	**1,426**	**1,403**	**1,395**	**1,387**	**1,402**

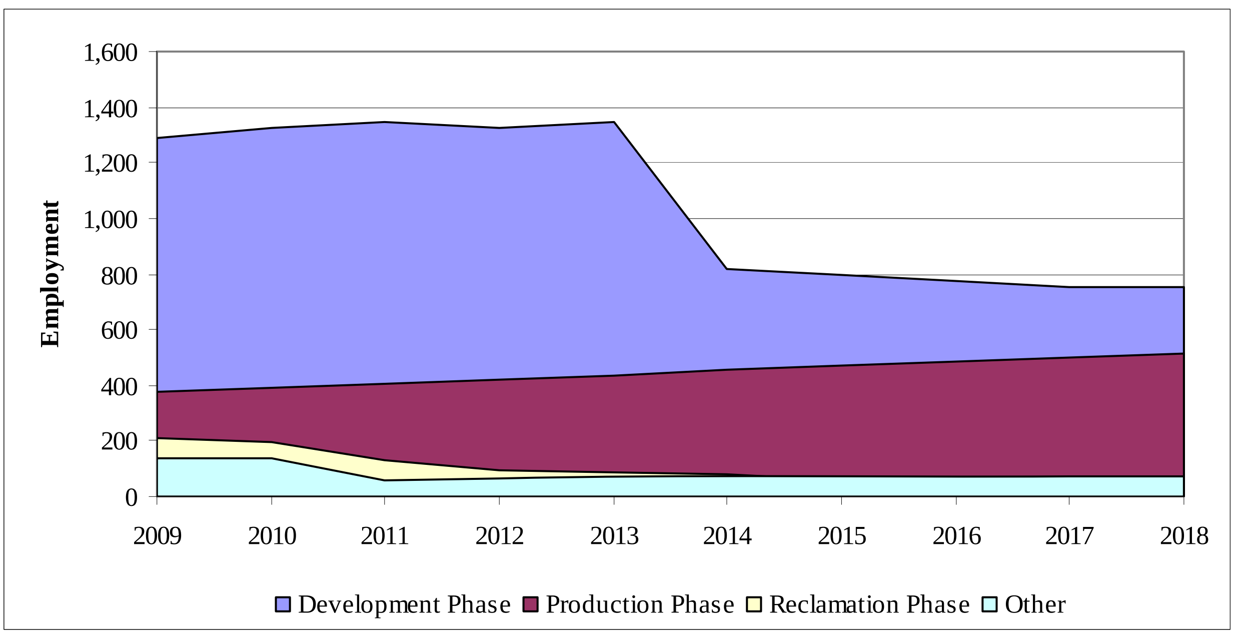


Figure 5-3 Total FTEs by phase as supplied by operators (Ecosystem Research Group 2008a)

The most labor-intensive period of oil field activity occurs in the development phase, as depicted in Figure 5-3. Industry respondents anticipate approximately a 30% decrease in personnel between 2013 and 2014 as drilling activity slows. The drop in drilling is accompanied by a slow but steady increase in production workers as activity shifts to the production phase. Personnel needs are lower during production as this phase requires less hands-on work. Reclamation is the least labor-intensive task and becomes almost a negligible component as time goes on. Well workovers occur roughly every 10 years throughout the production phase and are a steady segment of employment throughout the normal 40-year production cycle for wells in Sublette County.

5.6 IMPLAN® WORKFORCE ESTIMATES

5.6.1 IMPLAN® Methodology

IMPLAN® (IMpact analysis for PLANning) was developed in 1979 by the USDA Forest Service, Federal Emergency Management Agency, and the USDI Bureau of Land Management for land and resource management planning. It was privatized in 1993 by Minnesota IMPLAN® Group (MIG), Inc., who still manages and maintains the software.

IMPLAN® functions as a regional economic impact model that provides an input-output analysis of the flow of dollars and commodities through an economy (MIG, Inc. 2004b). National datasets are generated annually and are granular at a county level. Figures from 2005 are not included as IMPLAN® did not publish a dataset for Sublette County that year.

For this study, ERG used IMPLAN® to model indirect and induced employment effects of oil and gas development in Sublette County. Direct effects take place only in the immediately affected industry, indirect effects concern inter-industry effects, and induced effects measure the effects of the changes in household income. For example, direct workers would be those who actually perform drilling and construction tasks, indirect workers would perform support tasks such as hydraulic and perforation services, and induced employment would be found in local restaurants that serve the increased population of direct and indirect workers.

5.6.2 Employment Projection

The Pinedale RMP states that “Pinedale Anticline operators have indicated that approximately 60% of their drilling and completion labor force does not live within the study area” (USDI 2006a). ERG’s IMPLAN® figures are based on this 40% local/60% non-local estimate of workers. ERG estimated the employment effects for 2009 through 2018 using drilling schedule information presented in the JIDP FEIS and Pinedale Anticline FSEIS. The total number of wells drilled is estimated at 555 in 2009 and decreases slightly until 2018 with an estimated 529 wells drilled. IMPLAN® measures workers in terms of annual job equivalents (AJEs). The estimated AJE represents 12 months of full-time employment made up of full- and part-time jobs. For example, one AJE could represent one job for 12 months or three jobs for four months; the numbers are not transferable to census numbers. This contrasts with full time equivalents (FTE), which assumes a single person works during the entire year.

Table 5-8 shows IMPLAN®-projected total employment and employment per well figures for 2009 through 2018 based on drilling estimates from the Pinedale Anticline FSEIS and JIDP FEIS. The direct employment figure is divided into local and non-local workers using the 40%/60% ratio discussed earlier. In the Pinedale Anticline FSEIS, indirect and induced AJEs were estimated from spending per well while ERG's AJEs were configured from operator-provided FTE figures provided in both the Pinedale Anticline FSEIS and JIDP FEIS. These methodological differences explain the AJE differences between documents. As shown in the table, total employment increases slightly from 2009 to 2018, the estimated peak employment year.

Table 5-8 Employment projections, 2009–2018 (MIG, Inc. 2007)

Year	Direct Local	Direct Non-local	Indirect	Induced	Total
2009	810	1,215	470	257	2,752
2010	798	1,196	433	255	2,682
2011	803	1,206	471	258	2,738
2012	810	1,215	478	262	2,765
2013	816	1,224	484	265	2,789
2014	822	1,233	507	279	2,841
2015	830	1,244	496	272	2,842
2016	836	1,254	502	276	2,868
2017	838	1,256	506	278	2,878
2018	842	1,261	511	281	2,895

5.6.3 IMPLAN® Data Summaries

The following is an overview of recent economic growth and activity in Sublette County, based on IMPLAN® data. All indicators suggest rapid economic development, particularly as a result of increased drilling. Table 5-9 shows growth in population and employment from 2003 to 2007. Such gains, while creating economic prosperity and wealth, also results in pressure on infrastructure and social services.

Economic development in Sublette County between 2003 and 2007 has been substantial with employment rising 62% in four years. More remarkable are growth rates in household income at 128% and total personal income at 81%. Alternatively, population has increased 28% while the number of households decreased 20%. Note that a household is defined as a group of people (not necessarily related) living at the same address with common housekeeping, sharing either a living room or sitting room, or at least one meal a day.

Table 5-9 Sublette County overview 2003, 2004, 2006, and 2007 (MIG, Inc. 2003, 2004a, 2006, 2007)

Growth Category	2003	2004	2006	2007	Percent Change (2003–2007)
Population	6,191	6,654	7,359	7,925	28%
Employment	4,551	5,251	6,405	7,384	62%
Households*	3,678	2,666	2,925	2,925	-20%
Number of Industries	115	120	127	120	4%
Income per Household	$58,664	$90,659	$133,599	$133,599	128%
Total Personal Income**	**$215,800,000**	**$241,700,000**	**$390,800,000**	**$390,800,000**	**81%**

*a group of people (not necessarily related) living at the same address with common housekeeping, sharing either a living room or sitting room, or at least one meal a day
**income accruing to one person (income from job, investments, government payments, etc.)

Mining output and employment has increased since 2003. Figure 5-4 shows actual figures for mining output and employment for 2003 through 2007. The Sublette County IMPLAN® dataset is not available for 2005.

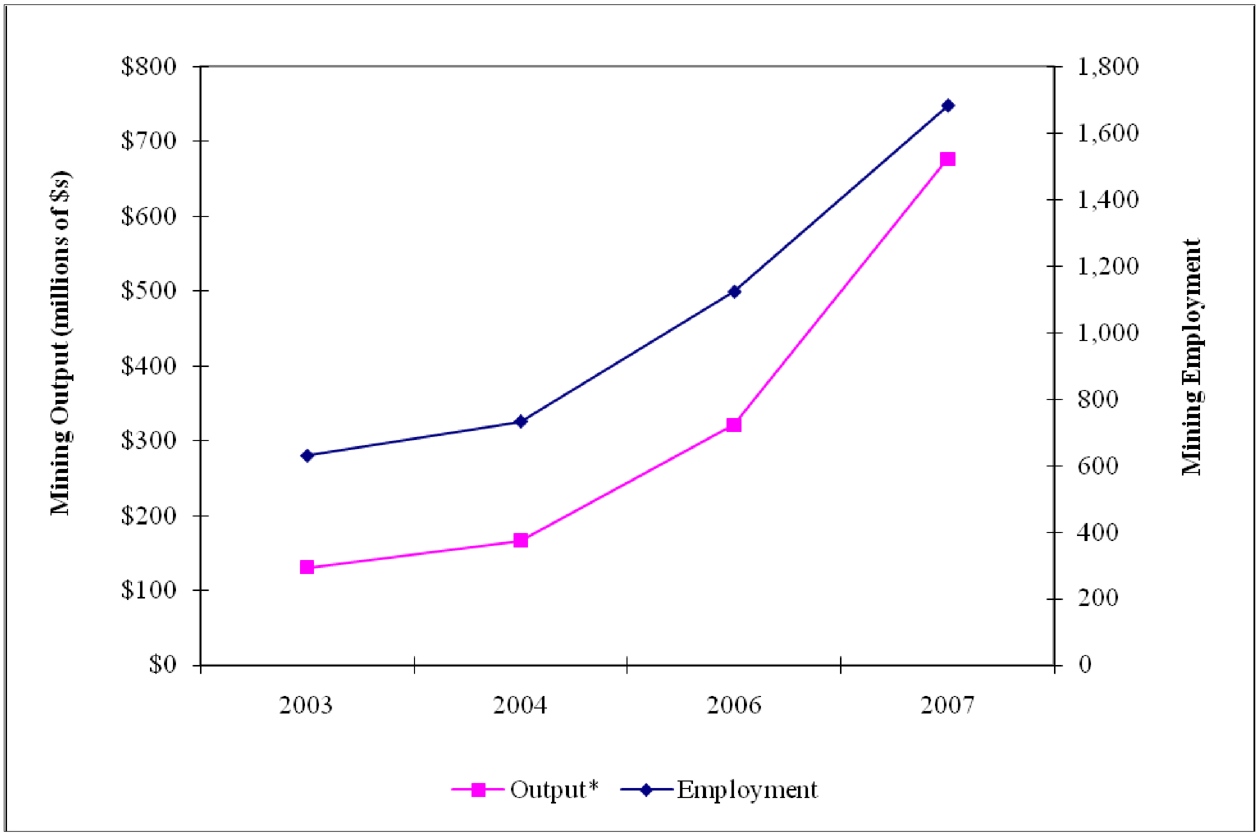


Figure 5-4 Mining Sector output and employment (MIG, Inc. 2003, 2004a, 2006, 2007)

Three industries closely related to oil and gas development are listed in Table 5-10. Sector 27 (Drilling Oil and Gas Wells) showed tremendous growth in output (change in domestic production from one year to the next, usually measured by gross domestic product [GDP]), value added (through processing along the supply chain), and employment between 2003 and 2007. Sectors 19 (Oil and Gas Extraction) and 28 (Support for Oil and Gas) showed increases in all categories, though not as dramatically. The three IMPLAN® sectors are bridged with the NAICS code classifications as follows:

- IMPLAN® Sector 19, Oil and Gas Extraction = NAICS Code 211, Oil and Gas Extraction
- IMPLAN® Sector 27, Drilling Oil and Gas Wells = NAICS Code 213111, Drilling Oil and Gas Wells
- IMPLAN® Sector 28, Support for Oil and Gas = NAICS Code 213112, Support for Oil and Gas

Although the NAICS codes are bridged with the IMPLAN® sectors for reference, IMPLAN® employment data were derived from several sources and provide estimates for non-disclosed data. The numbers will not always directly correlate with employment data from other sources. These data were derived from IMPLAN® and are reflected in nominal dollars.

Table 5-10 Output, value added, and employment by IMPLAN® sector 2003, 2004, 2006, 2007 (MIG, Inc. 2003 2004a, 2006, 2007)

Industry Sector	2003	2004	2006	2007	Percent Change (2003–2007)
Sector 19 Oil and Gas Extraction (Sector 20: 2007 dataset)					
Extraction Output*	81.97	85.53	129.47	135.55	65.4%
Employment	147.00	159.00	240.00	205.00	39.5%
Employee Compensation*	14.6	17.05	28.9	27.4	87.7%
Proprietor Income*	0.24	0.87	3.77	6.33	2537.5%
Other Property Income*	23.13	25.15	41.73	39.79	72.0%
Indirect Business Tax*	4.83	4.94	7.92	8.12	68.1%
Total Value Added*	42.8	48	82.32	81.63	90.7%
Sector 27 Drilling Oil and Gas Wells (Sector 28: 2007 dataset)					
Drilling Output*	0.98	0.52	20.18	239.7	24359.2%
Employment	13.00	2.00	30.00	241.00	1753.8%
Employee Compensation*	0.24	0.05	2.06	23.96	9883.3%
Proprietor Income*	0.04	0.01	0.51	0.96	2300%
Other Property Income*	0.22	0.17	3.75	99.61	45177.2%
Indirect Business Tax*	0.05	0.02	0.82	2.51	4920%
Total Value Added*	0.56	0.25	7.18	127.04	22585.7%
Sector 28 Support for Oil and Gas (Sector 29: 2007 dataset)					
Support Output*	47.86	80.37	171.13	301.37	529.7%
Employment	470.00	572.00	853.00	1,237.00	163.2%
Employee Compensation*	20.24	24.53	50.69	89.58	342.6%
Proprietor Income*	2.83	3.43	7.82	4.06	43.5%
Other Property Income*	15.12	34.56	96.62	26.51	75.3%
Indirect Business Tax*	2.70	3.546	7.05	3.68	36.3%
Total Value Added*	40.89	66.06	162.18	123.83	202.8%

*millions of dollars

5.7 PROJECTED DRILLING TABLES FROM PAPA AND JONAH ESTIMATES

Direct FTE employment numbers were projected based on information provided in the Pinedale FSEIS and the JIDP FEIS. After direct employment was estimated, IMPLAN® was used to estimate indirect and induced employment figures.

5.7.1 Projection of Direct Employment

The schedule for well drilling was derived from the JIDP FEIS and Pinedale Anticline FSEIS Preferred Alternative. Information from the same documents was used to project number of employees needed to complete drilling, production, and reclamation phases.

5.7.2 Development (Drilling) Phase

The development phase consists of well pad and access road construction, rig transportation and setup, drilling, completion testing, and pipeline construction. Based on the JIDP FEIS, 830 worker days are needed to complete a well over a 54 day period, averaging 15.4 workers per day per well, or annualized to 2.3 FTE workers per well per year for development. According to the Pinedale Anticline FSEIS, 1,640 worker days are needed per well over a 72 day period, averaging 22.8 workers per day per well, or annualized to 4.5 FTE workers per well per year. The difference in estimates between fields may be due to the distance between wells and pads (for moving rigs and building roads), the depth to gas underground, and the use of vertical versus directional drilling. ERG estimated that Jonah field development makes up 41% (3,100) of the wells to be drilled, while the Pinedale Anticline makes up 59% (4,399) of the wells based on those two proposals (USDI 2006a, 2006b). Using these estimates, the number of wells to be drilled in each field and the number of workers needed to complete the wells was calculated for each year. Figure 5-5 shows the annual number of employees needed to complete the development phase for the Jonah and Pinedale Anticline fields.

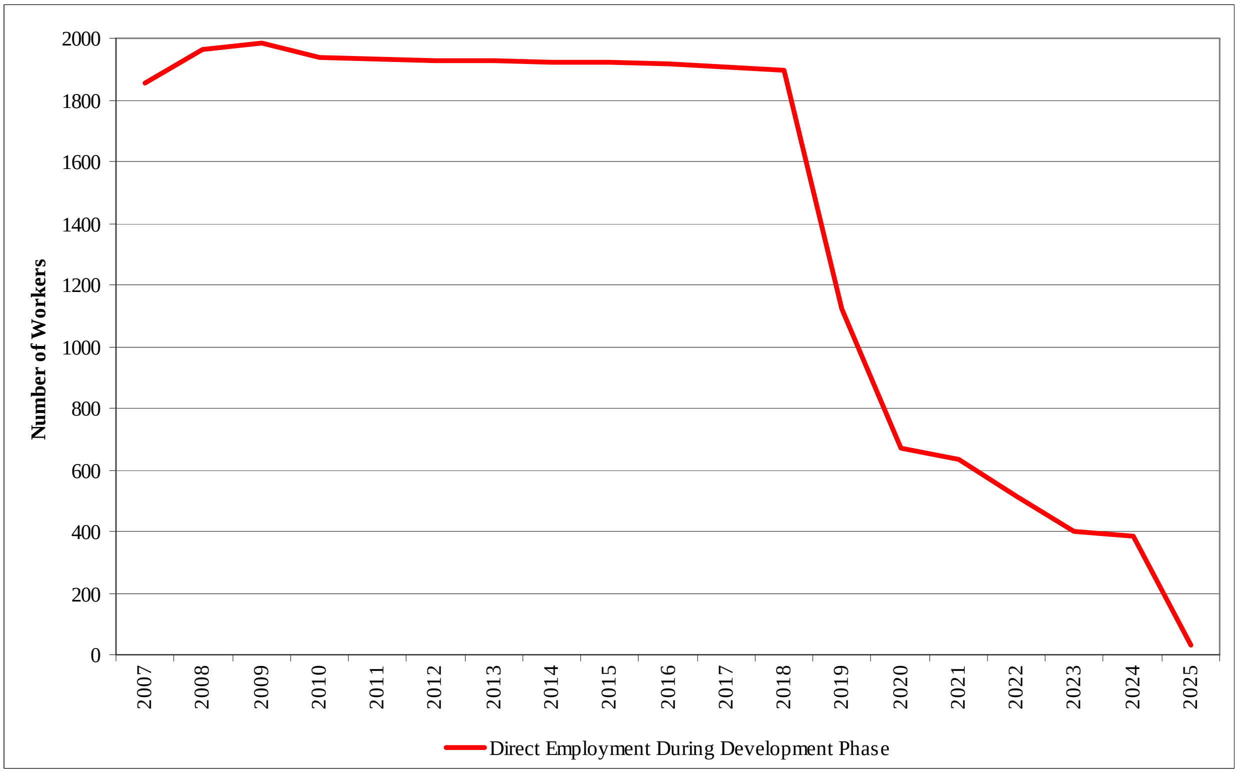


Figure 5-5 Annual number of FTE employees needed to complete the development phase (USDI 2006a, 2006b)

5.7.3 Production Phase

The estimated number of workers needed during the production phase was provided only in the JIPD FEIS and were assumed to be similar for both fields because data specific to the Pinedale Anticline were not available to ERG. According to the JIDP FEIS, 515 worker days are needed for production and maintenance over the 40 year life of a well, which annualizes to 0.035 FTE workers per year per well for 40 years. Figure 5-6 shows the estimated number of workers needed per year to complete the production phase.

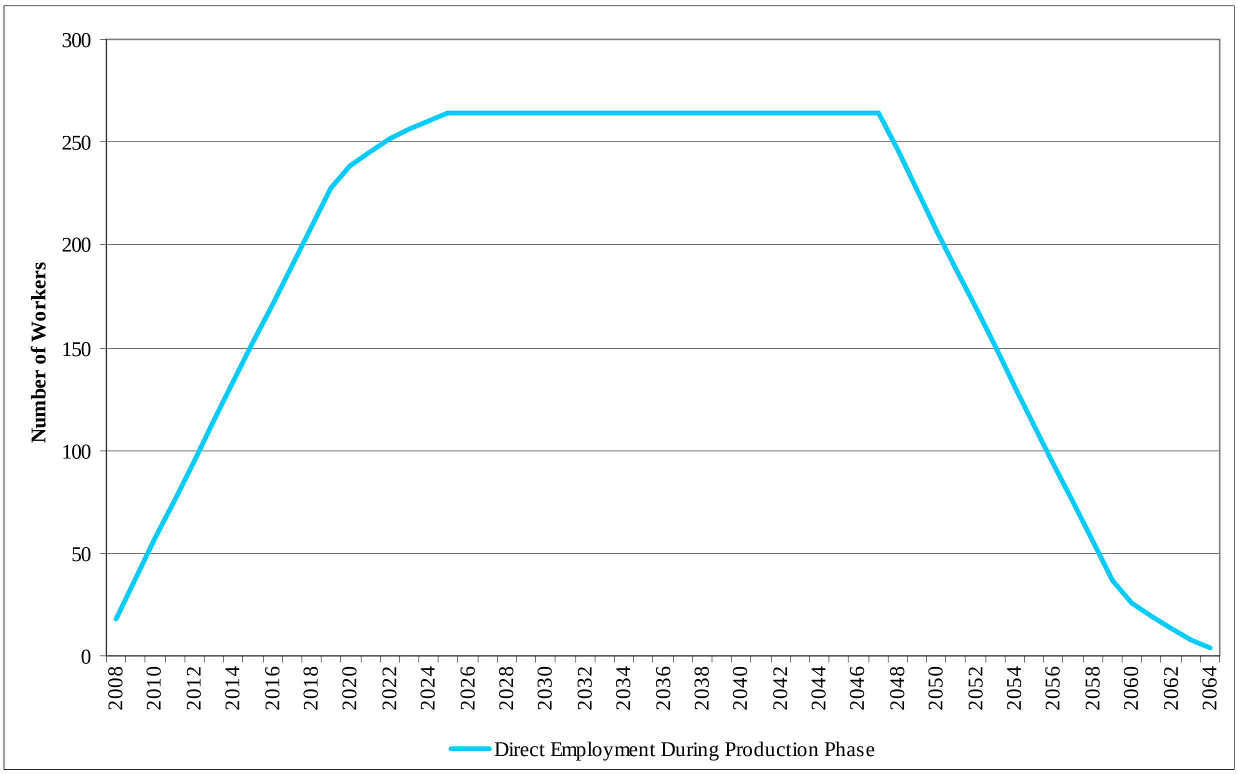


Figure 5-6 Annual number of FTE employees needed to complete the production phase (USDI 2006a, 2006b)

5.7.4 Post-production/Reclamation Phase

Reclamation estimates were provided only in the JIDP FEIS and were assumed to be similar for both fields because data specific to the Pinedale Anticline were not available to ERG. According to the document, 50 workers (ten people for five days) are needed to complete reclamation, which is equivalent to 0.14 FTE workers per well per year. Figure 5-7 shows the estimated number of workers needed per year to complete the reclamation phase.

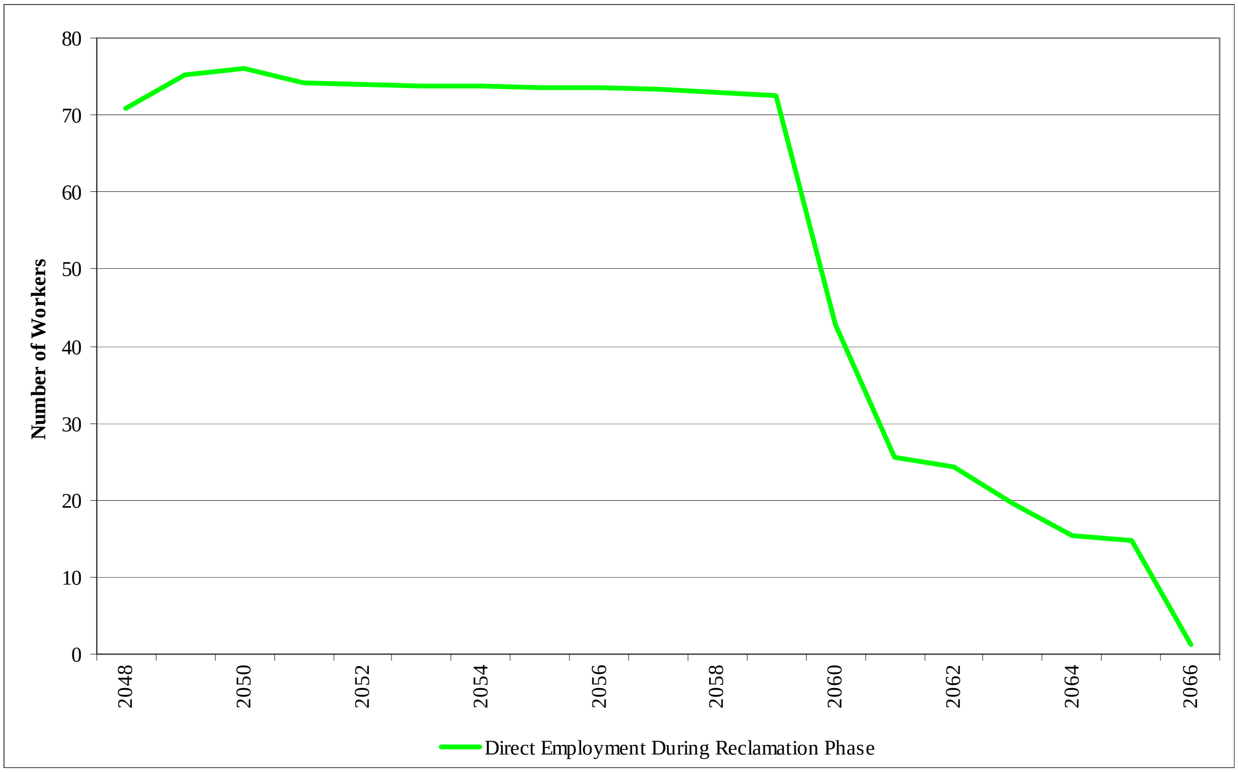


Figure 5-7 Annual number of FTE employees needed to complete the post-production/reclamation phase (USDI 2006a, 2006b)

5.7.5 Life of Plan

Total FTE employment over the life of the plan (Pinedale Anticline FSEIS Preferred Alternative) begins with an estimate of 1,854 employees in 2007. Estimated employment peaks in 2018 with approximately 1,894 FTE development workers and 209 FTE production workers totaling 2,103 workers for that year. Employment drops quickly after 2018 as drilling comes to an end. The expected largest decrease in employment would occur around 2019 when approximately 750 FTE workers from the previous year will no longer be needed. Figure 5-8 depicts the estimated number of FTE employees needed annually to complete all three phases of field development. Viewed another way, Figure 5-9 illustrates the contribution to total employment for each phase, with employment peaking in 2018 with approximately 2,103 workers.

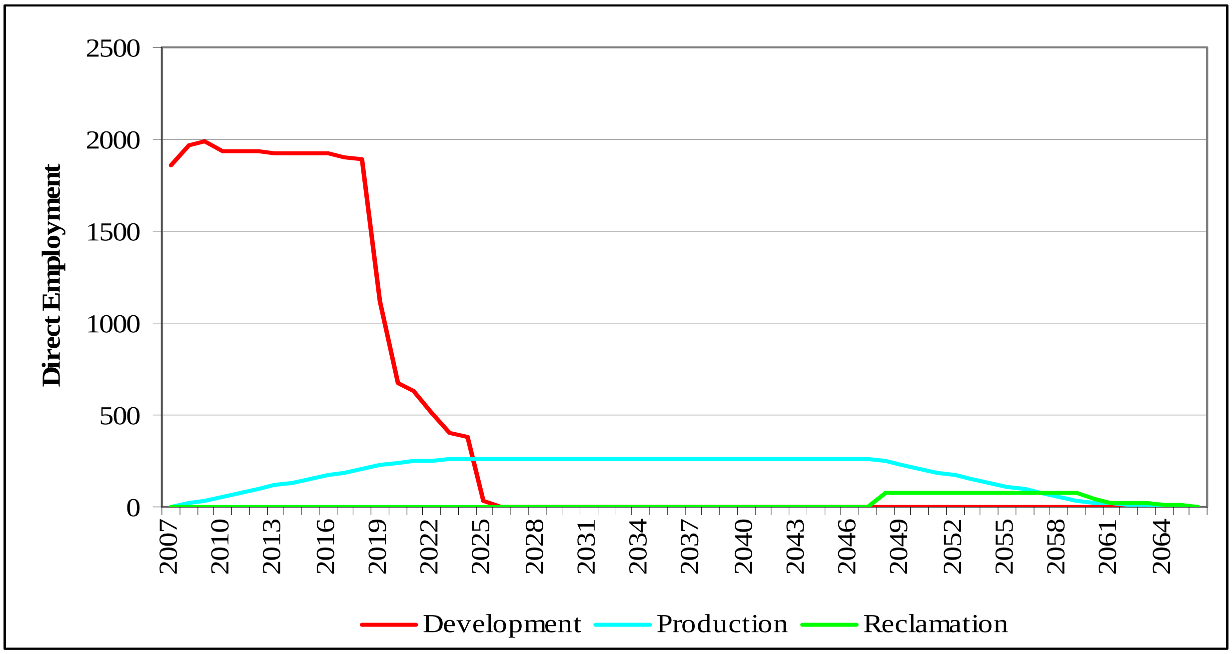


Figure 5-8 Annual number of FTE employees needed to complete development, production, and post-production/reclamation phases (USDI 2006a, 2006b)

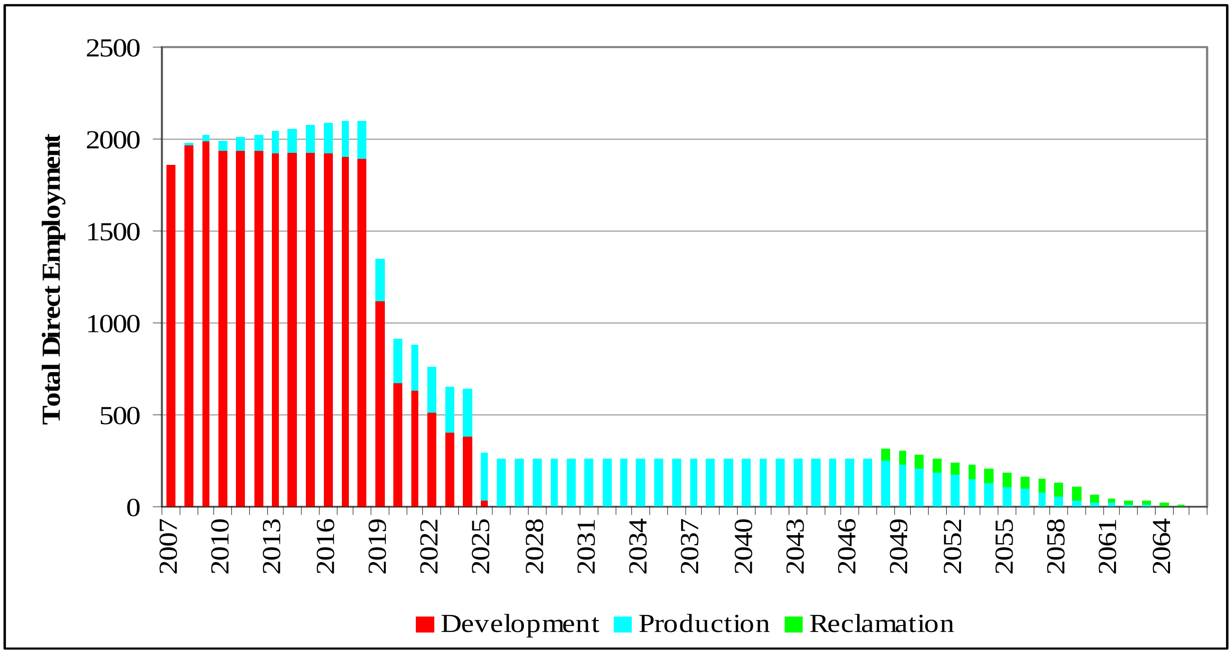


Figure 5-9 Projected total annual FTE employment over the life of the plan (USDI 2006a, 2006b)

5.8 CUMULATIVE IMPACTS TABLE – SUMMARY

The Pinedale RMP defines cumulative impacts as follows (USDI 2006a):

> Cumulative impacts result from the incremental impact of an action when added to the past, present, and reasonably foreseeable future actions, regardless of which agency (federal or nonfederal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions that take place over time.

A comprehensive table is included in Appendix B of the document. This table shows oil and gas-related projects by field office, including the Bridger-Teton National Forest. Additionally, it lists projects within Sublette County and surrounding counties that may affect Sublette County. Some figures, such as development on private land, were not supplied.

6. EMPLOYMENT AND PERSONAL INCOME

6.1 INTRODUCTION

Mining, including oil and gas, was the largest private employment sector in Sublette County in 2007 (United States Department of Labor 2008b). Average wages and earnings in all sectors, and especially the mining sector, appear to be influenced by the influx of high-paying mining industry jobs. Significant wage variation exists between industry-related jobs and other employment sectors across the county. This is of concern to permanent Sublette County residents who work outside of the Mining Sector, as higher average wages for temporary and transient workers can drive up the cost of living, including housing and services. This inflation can make it difficult for non-mining industry residents to maintain their standard of living. The following sections describe the worker distribution in the county's four major employment sectors (Mining; Construction and Manufacturing; Arts, Food, and Accommodation; and Wholesale and Retail Trades), the county's unemployment rate compared to the state, and wages earned by workers in the four major sectors.

This discussion focuses on private sector employment, which is affected to a greater degree by local economic pressures than government employment. Overall, government employees comprise 12.1% of the 2007 county-wide workforce, with private industry making up the remaining 87.9% (Bureau of Economic Analysis 2008).

Classifications discussed in this section are based on the North American Industry Classification System (NAICS). This standard was introduced in 1997 and became widely used by federal and state governments in 2004. The purpose of NAICS and its predecessor, the Standard Industrial Classification (SIC), is to establish a consistent method of identifying business establishments for economic and financial analysis. For purposes of this discussion, it is useful to note that the NAICS Mining Sector includes four sub sectors: NAICS 211, Oil and Gas Extraction; NAICS 212, All Mining except Oil and Gas; NAICS 213, Support Activities for Mining; and NAICS 213112, Support for Oil and Gas.

6.2 EMPLOYMENT BY SECTOR

The top four employment sectors in Sublette County are Mining; Retail Trade; Arts, Food and Accommodation; and Construction and Manufacturing. Other sectors, such as Transportation; Utilities; Finance; Professional Services; and Agriculture employ a smaller segment of the working population. Figure 6-1 shows historical employment levels for various sectors between 2001 and 2007. The figure depicts a definite grouping of the major employment sectors separated from minor sectors.

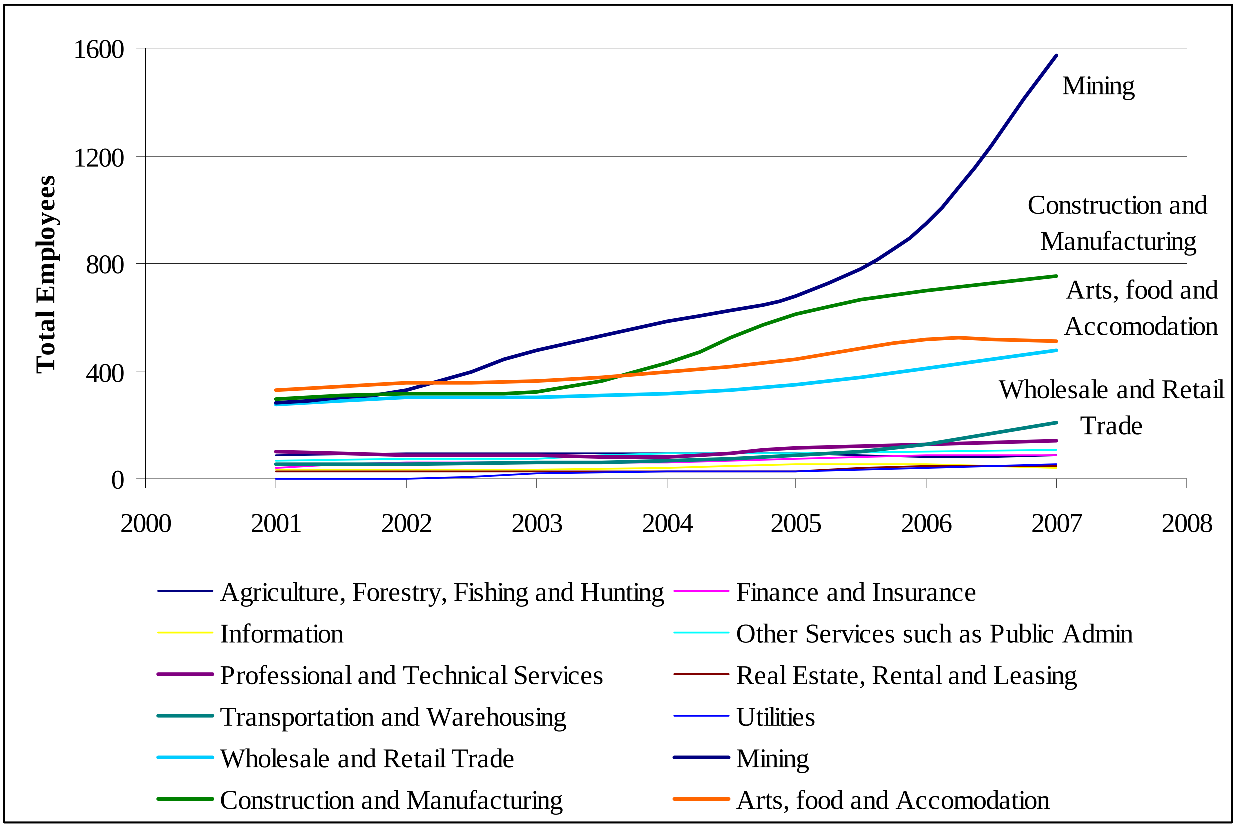


Figure 6-1 Total employees per sector (United States Department of Labor 2008b)

Table 6-1 Total employees per sector (United States Department of Labor 2008b)

Sector	2001	2002	2003	2004	2005	2006	2007	% Change 2001 to 2007
Agriculture, Forestry, Fishing and Hunting	88	91	94	92	93	79	85	-3.4%
Finance and Insurance	42	61	61	63	71	86	90	114.3%
Information	33	35	32	37	57	51	37	12.1%
Other Services such as Public Administration	68	71	74	92	94	99	105	54.4%
Professional and Technical Services	100	86	87	83	112	131	139	39.0%
Real estate, Rental and Leasing	27	29	27	25	29	44	46	70.4%
Transportation and Warehousing	51	54	60	64	88	127	206	303.9%
Utilities	0	0	23	24	30	41	56	N/A
Wholesale and Retail Trades	275	301	301	314	347	408	477	73.5%
Mining	279	329	478	583	680	946	1570	462.7%

Sector	2001	2002	2003	2004	2005	2006	2007	% Change 2001 to 2007
Construction and Manufacturing	297	316	321	433	613	701	752	153.2%
Arts, Food and Accommodation	328	354	361	398	441	518	514	56.7%

In recent years, sectors with a small number of employees make up a smaller percent of total employment though the actual employment numbers within those sectors are either staying relatively constant or increasing. The gap between mining employment and other sectors commenced in 2002–2003 and has increased since.

Employment in the Mining Sector has increased markedly during the 2000s, as reflected in Figure 6-1 and Table 6-1. Data were not available to calculate the exact percentage of oil and gas employment in the Mining Sector; however, available data show that much of the employment in the Mining Sector is related to oil and gas development.

Table 6-2 Number of employees in oil- and gas-related sectors (United States Department of Labor 2008b)

Employment Sector	2001	2002	2003	2004	2005	2006	2007
NAICS 21: Mining	279	329	478	583	680	946	1,570
NAICS 211: Oil and Gas Extraction	119	118	131	ND*	ND	ND	ND
NAICS 212: All Mining except Oil and Gas	ND	ND	ND	ND	ND	ND	ND
NAICS 213: Support Activities for Mining	160	211	347	439	508	737	1,335
NAICS 213112: Support for Oil and Gas	ND	ND	ND	ND	ND	ND	ND

*Not disclosed

6.3 UNEMPLOYMENT

As might be expected, unemployment in Sublette County has declined since 2003. Although this trend parallels the state and nation, the county's 1.5% unemployment rate is lower than Wyoming's 3% rate and much lower than that of the nation's 4.6% rate (Figure 6-2). According to correspondence from the towns of Marbleton and Big Piney, employers in Sublette County often struggle to find employees to fill vacancies because unemployment levels are low (Town of Big Piney 2007a; Town of Marbleton 2007a).

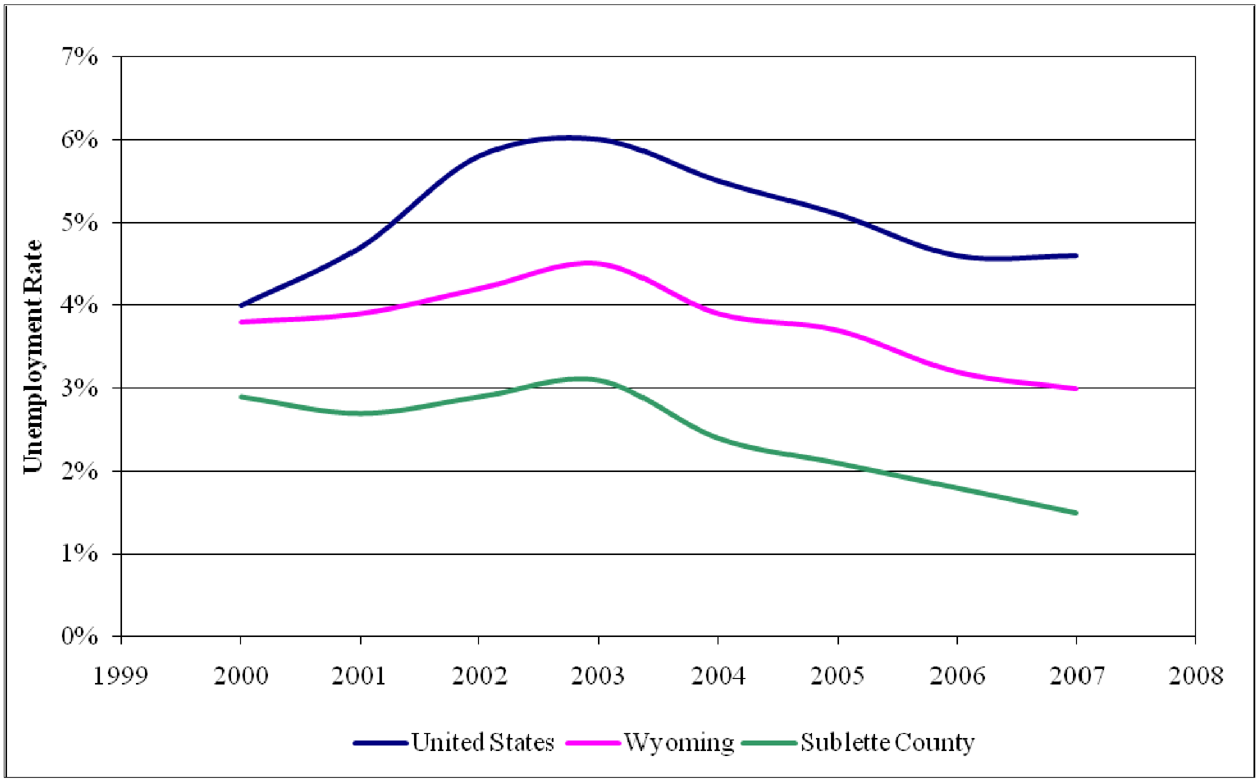


Figure 6-2 Unemployment rates for the United States, Wyoming, and Sublette County, 2000–2007 (United States Department of Labor 2008a)

6.4 INCOME AND WAGES

Wages in the Mining Sector are much higher than other sectors in Sublette County and have steadily increased over time. Figure 6-3 depicts average annual wages by sector in Sublette County between 2001 and 2007. Although lower in comparison with the Mining Sector, wages in the Arts, Construction, and Retail Sectors have consistently increased over the last few years.

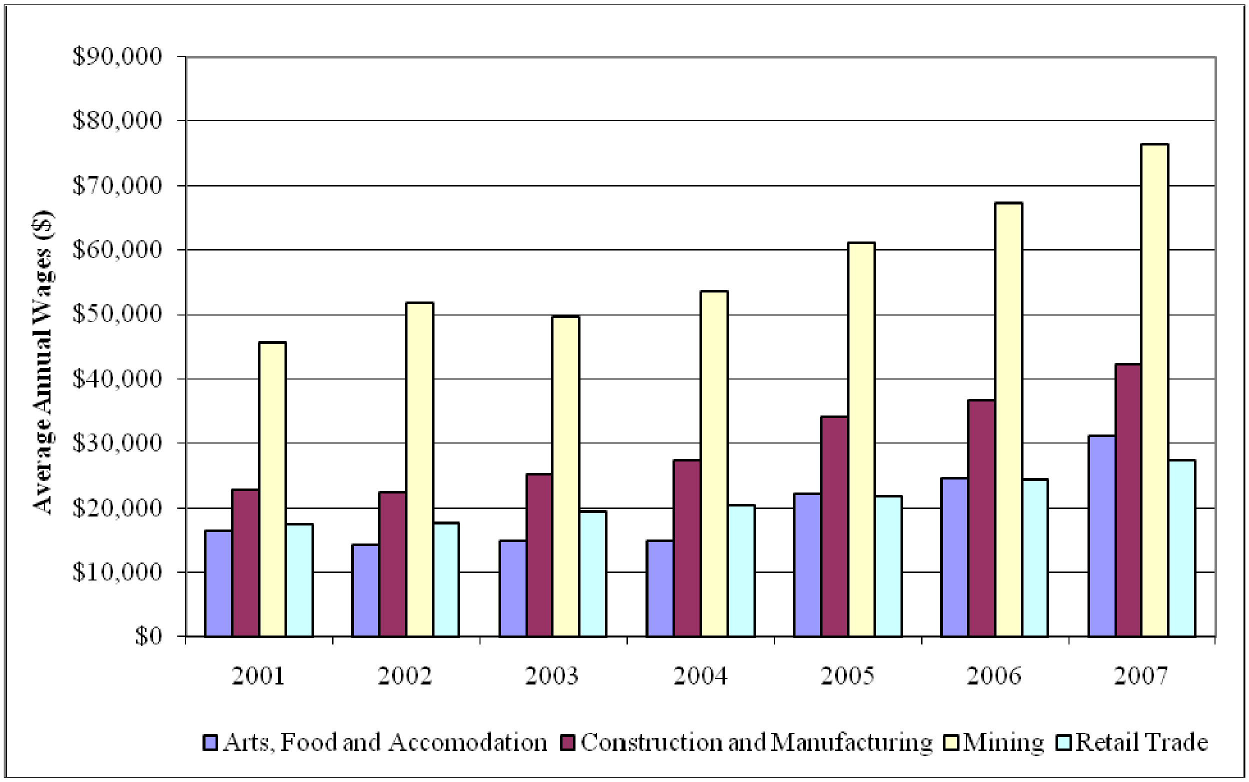


Figure 6-3 Average annual wages for Sublette County (United States Department of Labor 2008b)

As mentioned previously, high wages in the Mining Sector drive up wages in other industries. This can affect small businesses by forcing them to raise prices on goods and services to maintain a profit. Higher wages also mean that employees have more disposable income, leading to higher demand for many products, also driving up prices. These factors, combined with the county's housing shortage, have led to localized inflation that has raised the average cost of living (Jacquet 2006). Sublette County has the second-highest cost of living index in Wyoming, with Teton County ranked the highest (Section 6.5) (State of Wyoming 2007).

Workers in sectors with lower average wages may find it difficult to keep up with the cost of living. This is apparent in the service industry, where starting wages, although high for the rest of the state, are low in Sublette County when compared to the cost of living. For other industries, low average wages and high cost of living can discourage new employees from moving to the area.

Localized inflation can influence the ability of the local government to maintain and develop the infrastructure needed to support the growing population. As the cost of supplies and labor increases, so does the cost of infrastructure projects such as road maintenance and water and sewer expansion. This can lead to increased and unforeseen municipal expenditures, potentially offsetting the benefit of energy taxes.

In accordance with wage increases, inflation in southwest Wyoming (comprised of Lincoln, Sublette, Sweetwater, and Uinta counties) has consistently been above both the state of Wyoming and the nation since the 4th quarter of 2004. Figure 6-4 demonstrates this trend. The increase in inflation has resulted in an increase in the cost of living for Sublette County.

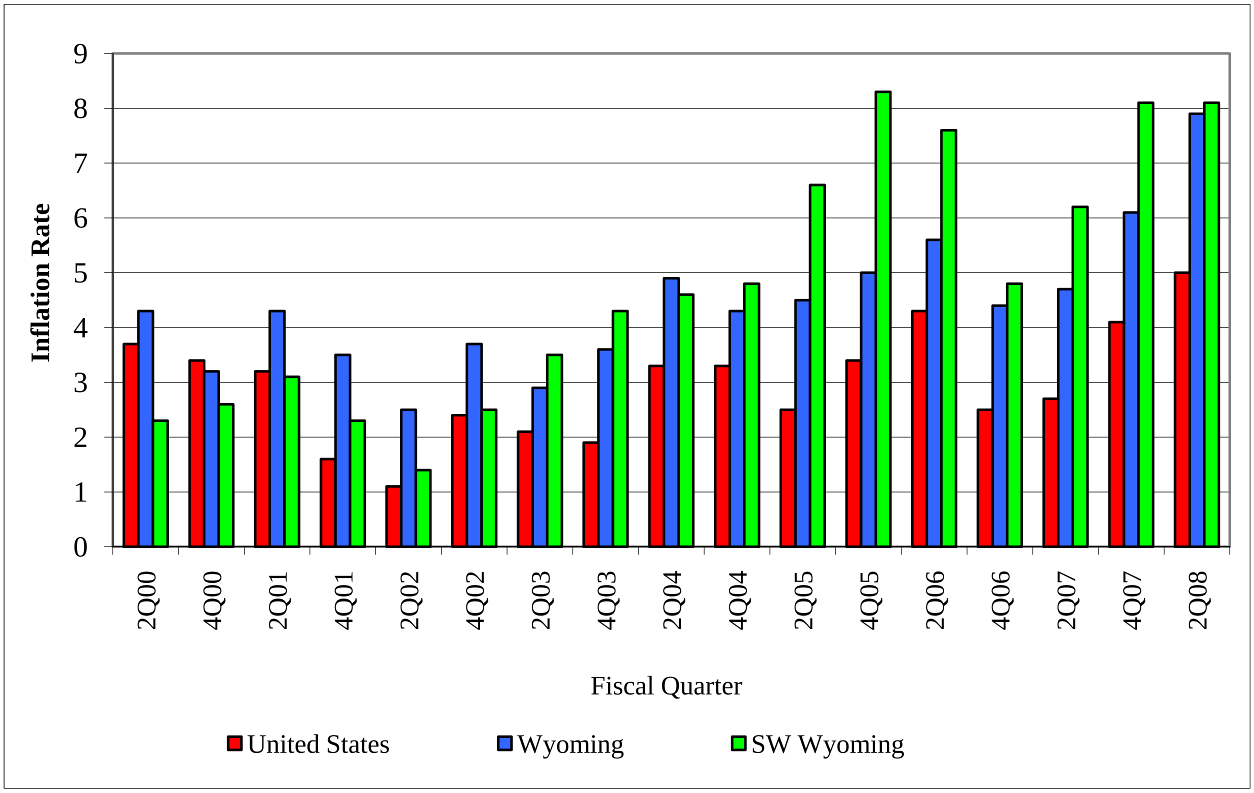


Figure 6-4 Inflation rates for the United States, Wyoming, and southwest Wyoming (State of Wyoming 2007)

6.5 COST OF LIVING

A cost of living index is a measure of how much money is required for a consumer to maintain a certain standard of living over time. Sublette County currently has the second highest cost of living index in Wyoming; a typical bundle of goods costs more in Sublette County than in any other county in Wyoming except for Teton County. This trend is displayed in Table 6-3, which presents the cost of living indices for 2000 and 2008.

Table 6-3 Cost of living index by Wyoming County, 4th quarter 2000 and 2nd quarter 2008 (Wyoming Economic Analysis Division 2009)

County	4Q 2000 Index	2Q 2008 Index
Teton	141	138
Sublette	106	115
Campbell	103	111
Sweetwater	97	107
Sheridan	105	105
Natrona	97	101
Carbon	96	101
Johnson	106	100
Lincoln-Afton	92	100
Laramie	102	97
Albany	104	96
Fremont	96	94
Lincoln-Kemmerer	92	93
Uinta	98	93
Park	100	93
Converse	93	91
Goshen	92	90
Weston	90	90
Crook	91	90
Washakie	92	89
Big Horn	91	88
Hot Springs	92	87
Niobrara	89	85
Platte	94	84

7. HOUSING, SOCIAL SERVICES, AND QUALITY OF LIFE PROJECTIONS

7.1 HOUSING

Housing is a critical component in evaluating quality of life, and Sublette County has struggled in this area. Affordable housing is lacking in Sublette County, as apparent by the steep increase in housing and rental costs in the past five years, the increase in population, and the comparatively low wages earned by many residents of the county. Housing prices have been increasing with a trend of $21,207 per year from 1997 to 2007. In Figure 7-1 the average annual sales price of a home in Sublette County is graphed against the cumulative number of wells drilled within the county. As shown in this figure, 2003 marks a shift in sales price trends, with annual prices increasing at a higher rate from that year forward. Table 7-1 shows the average annual sales price of homes in Sublette County.

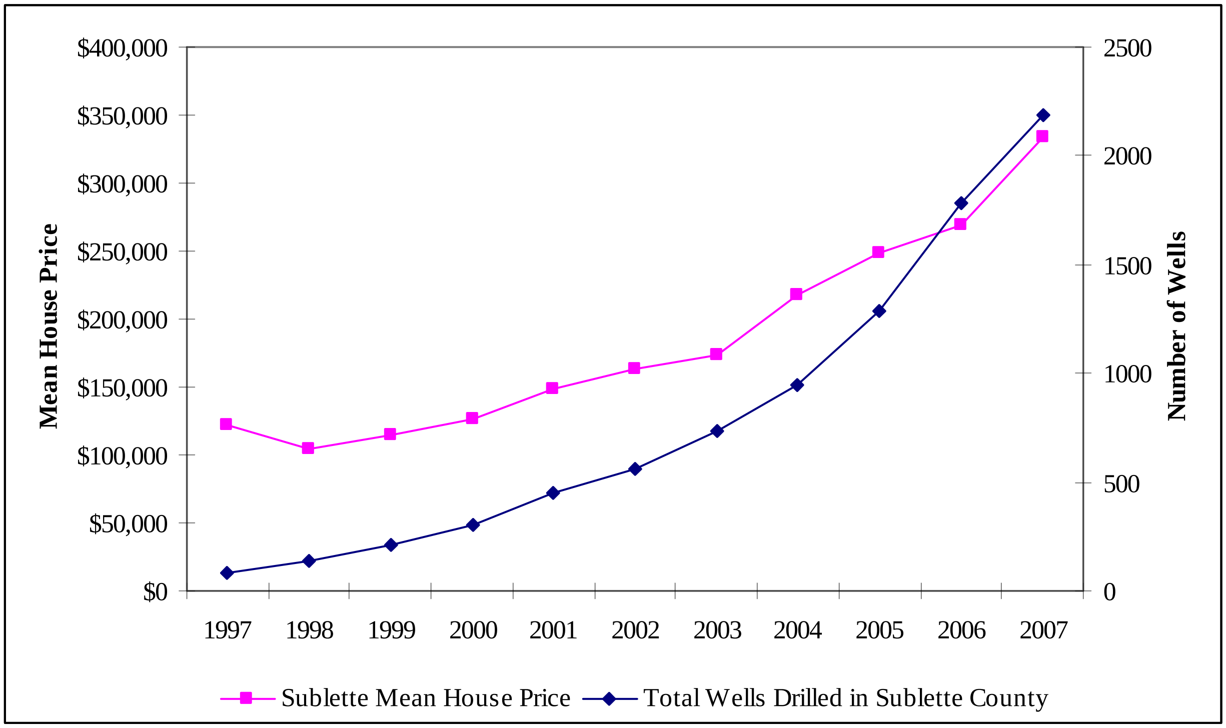


Figure 7-1 Housing prices vs. cumulative number of wells drilled (Wyoming Community Development Authority 2009; Wyoming Oil and Gas Conservation Commission 2009)

Table 7-1 Average annual sales price of homes in Sublette County (Wyoming Community Development Authority 2009)

Year	Sublette County Average Sales Price	Annual Percent Change Sublette County	Statewide Average Sales Price	Annual Percent Change Statewide
1997	$122,608	NA	$91,714	NA
1998	$104,375	-14.87%	$96,906	5.66%
1999	$114,020	9.24%	$101,517	4.76%
2000	$125,922	10.44%	$111,437	9.77%
2001	$149,179	18.47%	$116,469	4.52%
2002	$163,473	9.58%	$121,140	4.01%
2003	$173,116	5.90%	$132,708	9.55%
2004	$218,343	26.13%	$142,501	7.38%
2005	$249,029	14.05%	$159,776	12.12%
2006	$269,795	8.34%	$187,869	17.58%
2007	$334,073	23.82%	$239,019	27.23%
Change 1997–2007	$211,465	172.47%	$147,305	160.61%
Change 1997–2003	$50,508	41.19%	$40,994	44.70%
Change 2003–2007	$160,957	92.98%	$106,311	80.11%

The overall percentage change in statewide sales prices is somewhat misleading. The average sales price in Teton County increased over $600,000 between 2006 and 2007, which skews statewide averages. Excluding Teton County from the 2007 statewide average sales price results in an average of $184,378 over the remaining 22 counties. Accordingly, the statewide change between 2003 and 2007 is 56.66% when excluding Teton County.

7.1.1 Housing Affordability

Housing affordability is a calculation that estimates the minimum income required to purchase a house of a given price. Using the average sales prices listed in Table 7-1, ERG determined the minimum income necessary to purchase a house at the average sales price in Sublette County. The following calculations assumed a 30-year fixed loan of 6% with the buyer providing 20% of the price as a down payment. Standard amortization schedules were used to determine the monthly payment, and this value was multiplied by 48 to arrive at the minimum qualifying income (National Association of Realtors 2009). Data are provided in nominal prices.

Table 7-2 Minimum qualifying income needed to purchase average home in Sublette County and Wyoming (Wyoming Community Development Authority 2009)

Year	Sublette County Average Sales Price	Minimum Qualifying Income in Sublette County	Median Family Income in Sublette County	Statewide Average Sales Price	Minimum Qualifying Income in Wyoming	Median Family Income in Wyoming
1997	$132,769	$28,224	$36,700	$91,714	$21,120	$48,412
1998	$141,904	$24,048	$36,700	$96,906	$22,320	$51,897
1999	$151,620	$26,256	$37,900	$101,517	$23,376	$55,624
2000	$174,653	$28,992	$40,400	$111,437	$25,680	$55,859
2001	$188,409	$34,368	$40,400	$116,469	$26,832	$58,541
2002	$195,077	$37,632	$40,400	$120,314	$27,888	$57,148
2003	$239,657	$39,840	$54,400	$130,294	$30,576	$56,065
2004	$264,384	$50,256	$56,300	$147,588	$32,784	$54,935
2005	$277,479	$57,312	$56,300	$160,497	$36,960	$55,250
2006	$334,073	$62,112	$59,400	$187,869	$43,248	$58,800
2007	$132,769	$76,896	$59,100	$265,044	$61,008	$58,500

As seen in Table 7-2, the qualifying income for the average home in Sublette County was lower than the median family income through 2004. In 2005, the qualifying income surpassed the median family income by approximately $1,000. The gap between qualifying and median family incomes has continued to increase so that by 2007, the qualifying income to purchase an average house outpaced the median family income by over $17,000. If this trend continues fewer and fewer families will be able to afford an average house in Sublette County. Comparable statewide figures show that through 2006, the minimum qualifying income to purchase the average house in Wyoming was much less than the median statewide family income.

To present this information in another manner, Figure 7-2 shows the average annual wages by employment sector and the qualifying annual income needed to buy the average home in Sublette County between 2001 and 2007. In 2001, the Mining Sector was the only sector whose average annual income exceeded the qualifying income to buy a $149,000 home, which was the average sales price for that year. From 2001 to 2006, the Mining Sector continued to be the only sector whose average annual income exceeded the qualifying income. All other employment sectors had average annual incomes significantly below that required to buy a house. By 2007, the qualifying income to buy a home caught up with the Mining Sector income and was still far above the average income of all other sectors. The average annual qualifying income to purchase a $334,000 home was $76,896 in 2007. The Mining Sector, with by far the largest average annual income, had an average annual income of $76,495.

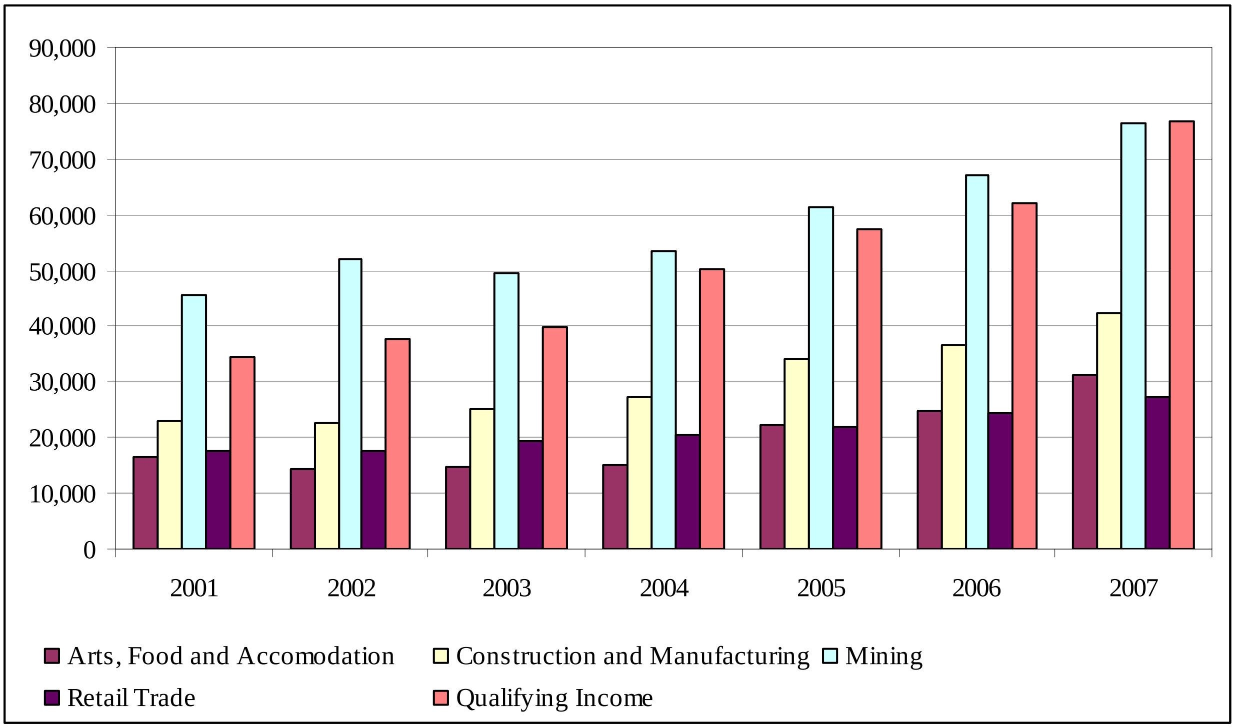


Figure 7-2 Sublette County average annual income by sector and minimum qualifying income to purchase average home (Wyoming Community Development Authority 2009)

7.1.2 Average Rental Prices

The Wyoming Community Development Authority conducts semi-annual surveys on housing trends in the state, including data collection of rental prices in each county. Rental units are categorized as homes, apartments, mobile home lots, and homes on a mobile home lots. Table 7-3 shows historical information on Sublette County rental prices between 1998 and 2008. In contrast to home prices, 2003 was not as significant a turning point in rental rates in Sublette County. Rental rates for houses increased to a greater degree than the remaining categories, but the overall trend shows a much flatter rise than the average sale price of homes.

Table 7-3 Average rental prices in Sublette County (Wyoming Community Development Authority 2009)

Reporting Period	Apartment	Mobile Home Lot	House	Mobile Home on a Lot
1998-1	$387	$150	$546	$415
1998-2	$501	$150	$575	$365
1999-1	$425	$150	$588	$338
1999-2	$463	$175	$581	$371
2000-1	$433	$175	$624	$435

Reporting Period	Apartment	Mobile Home Lot	House	Mobile Home on a Lot
2000-2	$464	$165	$566	$325
2001-1	$455	$165	$608	NA
2001-2	$441	$175	$613	$350
2002-1	$472	$200	$611	NA
2002-2	$534	$165	$655	$457
2003-1	$520	$200	$769	$472
2003-2	$611	$200	$794	$548
2004-1	$647	$225	$808	$624
2004-2	$765	$240	$888	$600
2005-1	$699	$240	$882	$590
2005-2	$728	$275	$1,083	$595
2006-1	$781	$265	$1,195	$643
2006-2	$750	$275	$1,238	$693
2007-1	$822	$275	$1,338	$667
2007-2	$860	$275	$1,387	$674
2008-1	$872	$275	$1,390	$675
Percent Change 1998(1)–2008(1)	125.32%	83.33%	154.58%	62.65%
Percent Change 1998(1)–2003(1)	34.37%	33.33%	40.84%	13.73%
Percent Change 2003(1)–2008(1)	67.69%	37.50%	80.75%	43.01%

7.1.3 Building Permit Trends

Residential construction has increased since 2000, as demonstrated by the increased number of residential building permits issued in Sublette County between 2000 (54 permits) and 2007 (263 permits). Residential permits are subdivided into the following categories: single family, duplex, tri- and fourplex, and multiplex (greater than four aggregate dwellings). Historical trends in building permits are summarized in Table 7-4. As illustrated, the greatest increase occurred in the single family category with 613 permits issues between 2005 and 2007. However, the number of building permits decreased over 60% between 2007 and 2008. Applications for building permits can increase when housing prices are high, often as a response to housing shortages. The decrease in building permits could indicate a decrease in the housing shortage (Meyers 2009).

Table 7-4 Building permits in Sublette County (Sublette County Planning and Zoning 2008; U.S. Census Bureau 2009)

Year	Single-Family Permits	Duplex Permits	Tri- and Fourplex Permits	Multiplex Permits	Total Residential Permits	Annual Percentage Increase in Residential Permits
2000	54	0	0	0	54	
2001	72	4	0	0	76	40.74%
2002	74	6	8	0	88	15.79%
2003	79	4	8	0	95	7.95%
2004	77	12	4	0	93	-2.11%
2005	179	0	0	6	185	98.92%
2006	177	0	0	20	197	6.49%
2007	257	6	0	0	263	33.50%
2008	100	2	3	0	105	-61.09%

7.1.4 Rental Vacancy Rates

In recent years, the Sublette County housing market has had a low vacancy rate for rental units compared to the state of Wyoming. As part of its semi-annual survey, the Wyoming Community Development Authority collects data on rental vacancy rates throughout the state. Rental units are defined as homes, apartments, mobile home lots, and mobile home lots with homes. Table 7-5 shows the vacancy rates for 2000–2008.

Table 7-5 Rental vacancy rates in Sublette County and Wyoming (Wyoming Community Development Authority 2009)

Reporting Period	Sublette County Vacancy Rates	Wyoming Vacancy Rates
2001-1	4.88%	4.21%
2001-2	NA	4.36%
2002-1	NA	4.73%
2002-2	5.41%	4.62%
2003-1	4.00%	3.56%
2003-2	3.64%	4.10%
2004-1	1.69%	3.81%
2004-2	5.33%	4.81%
2005-1	4.17%	3.30%
2005-2	4.55%	3.51%
2006-1	1.89%	2.67%
2006-2	0.64%	2.44%
2007-1	2.29%	1.45%
2007-2	0.90%	1.81%
2008-1	2.84%	2.89%
2008-2	3.44%	3.93%

7.1.5 Housing Projections and Estimates

In February 2008, Collins Planning Associates (Collins) released a report which assessed current housing conditions in Sublette County. Based on their analysis, Collins predicts that the lack of available housing in the county is near its peak. BLM-supplied data on actual and projected rig counts suggested, to Collins, that 2011 would be the peak year for drilling activity with an active rig count of 71. BLM projections indicate a decrease in rig counts from that point, with fewer than five active rigs in 2024. As discussed in Chapter 2, the drilling activity in oil and gas development is the most labor intensive phase and has the greatest impact on population. ERG agrees with Collins' conclusion that drilling rates directly affect population trends. Therefore, the best way to anticipate population impacts is for local governments to routinely query oil and gas operators regarding projected short- and long-term drilling activities.

7.2 EDUCATION

7.2.1 School District Enrollment and Capacity

Sublette County is served by two school districts: Sublette No. 1, located in Pinedale and Bondurant and Sublette No. 9, located in Big Piney and La Barge. Both districts have four schools (high school, middle school, and two elementary schools) with one of the elementary schools located outside of the major population centers and the other schools located within the major population centers. Between 2000 and 2009, both districts have seen increased enrollment and staffing needs as well as decreased facilities capacity.

According to Sharon Ziegler, Executive Secretary to the Superintendent of District No. 1, in 2009 the school district had 240 new students, which is 24% of the school district's enrollment of 1,010 students. In the past four or five years, they have had an annual turnover of 40 to 50 students, up from 30 students in the early 2000s. The school district currently has eleven Spanish-speaking students; five years ago they had none. District No. 9 has seen an increase of 300% in non-English speaking students and has hired three full-time English language literacy positions to address this need (Anschutz 2007).

School District No.1's elementary, middle, and high school each has a capacity of 320 students. Both the middle school and high school have a count of just under 320 students (Seipp 2009). The elementary school, however, currently has over 500 students, and the 5th and 6th grades have been moved into temporary buildings. The school district has contracted to create an 81,000 square foot elementary school, which is expected to begin construction in June or July of 2009 and is scheduled to open in

September 2010. The square footage and capacity of District No. 1 facilities is shown in Table 7-6. District No. 9 did not provide this information despite repeated requests.

Table 7-6 School District No. 1 square footage and capacity (Seipp 2009)

School	Square Footage	Capacity
Elementary School	47,000	320
Middle School	52,000	320
High School, Auditorium, and Administration Building	89,000	320
Wrangler Gymnasium	45,000	NA

Table 7-7 shows historical enrollment figures for Sublette County school districts. Between 1991 and 1999, student population exhibited relatively flat increases and/or decreases. District No. 1 enrollment increased approximately 6%, while District No. 9 showed the opposite trend with a 6% decrease. Student counts began to show a sharper rise in 2000. By 2007, District No. 1's enrollment had risen approximately 47% with District No. 9 showing a smaller, but substantial, increase of nearly 20%.

Table 7-7 Sublette County school district enrollment history (Wyoming Department of Education 2008)

Year	District No. 1 Enrollment	Annual Percent Change	District No. 9 Enrollment	Annual Percent Change
1991	592	NA	640	NA
1992	602	1.69%	638	-0.31%
1993	651	8.14%	652	2.19%
1994	676	3.84%	702	7.67%
1995	676	0.00%	682	-2.85%
1996	641	-5.18%	655	-3.96%
1997	642	0.16%	669	2.14%
1998	637	-0.78%	655	-2.09%
1999	627	-1.57%	604	-7.79%
2000	639	1.91%	569	-5.79%
2001	630	-1.41%	587	3.16%
2002	671	6.51%	571	-2.73%
2003	689	2.68%	592	3.68%
2004	701	1.74%	592	0.00%
2005	767	9.42%	617	4.22%
2006	841	9.65%	646	4.70%
2007	940	11.77%	680	5.26%
Change 1991–1999	35	5.91%	-36	-5.63%
Change 2000–2007	301	47.10%	111	19.51%

School district staffing has increased with the number of new students in the county. As shown in Table 7–8, District No. 1's staffing increased by 24% and District No. 9's increased by 11% between 2000 and 2007. State-wide staffing increases were 5% during a similar time-frame.

Table 7-8 Sublette County Instructional staff by district (FTE) (Wyoming Department of Education 2008)

Year	District No. 1	District No. 9	State-wide
2000	63.4	70.5	9,803.6
2001	73.0	70.3	9,829.6
2002	70.0	75.0	9,979.6
2003	70.5	71.3	10,055.7
2004	68.8	74.2	9,985.2
2005	73.6	73.4	10,087.3
2006	80.0	86.1	10,300.3
2007	78.5	78.5	NA*
% Change 2000–2007	23.82%	11.35%	5.07%

*Not available

7.2.2 School Valuation and Budget

Like other social services, the increased population from oil and gas development stresses Sublette County's school districts. However, in many ways the presence of the oil and gas industry has also positively affected Sublette County's school districts. Increased enrollment creates more jobs, increases job security, utilizes facilities more fully, and can create a more diverse population. Moreover, energy production has increased the tax base in Sublette County, especially in District No. 1, which contains the Jonah and Pinedale Anticline fields. Between 1995 and 2007, Wyoming as a whole saw a 166% increase in total district assessed valuation (the value assigned to property for use in tax calculations), but this increase is overwhelmed by the more than 1,045% increase seen in Sublette District No. 1 for the same time-frame (Table 7-9).

Table 7-9 Assessed valuation for Sublette County by school district (Wyoming Department of Education 2008)

Year	District No. 1	District No. 9	State-wide
1995	$154,289,846	$162,659,154	$6,231,800,000
1996	$140,778,407	$112,594,535	$6,423,400,000
1997	$165,691,195	$158,929,276	$7,145,900,000
1998	$235,102,441	$209,452,411	$7,441,500,000
1999	$246,445,300	$194,884,240	$7,025,500,000
2000	$303,349,383	$240,483,089	$7,896,900,000
2001	$547,481,173	$411,597,321	$10,542,100,000
2002	$741,509,427	$449,236,435	$11,169,300,000

Year	District No. 1	District No. 9	State-wide
2003	$709,120,432	$277,780,164	$10,340,000,000
2004	$1,655,510,817	$487,860,020	$13,679,500,000
2005	$2,390,969,127	$676,213,100	$16,445,000,000
2006	$3,788,604,732	$800,720,001	$20,978,700,000
2007	$3,475,556,647	$765,598,659	$21,491,267,438
% Increase 1995–2000	96.61%	47.84%	26.72%
% Increase 2000–2007	1,045.73%	218.36%	172.15%

This larger tax base is directly reflected in district general fund revenues from local, county, state, and federal sources, as seen in Table 7-10.

Table 7-10 Total Sublette County general fund revenues from local/county/state/federal sources by school district (Wyoming Department of Education 2008)

Year	District No. 1	District No. 9	State-wide
2000	$7,971,133	$6,466,289	$660,610,023
2001	$3,193,583	$4,329,430	$664,657,985
2002	$10,656,932	$7,188,453	$717,117,801
2003	$11,406,847	$7,959,120	$768,273,957
2004	$10,889,071	$6,349,572	$759,619,270
2005	$20,608,469	$11,872,933	$840,452,300
2006	$29,550,743	$15,434,603	$898,107,584
2007	$45,512,992	$19,663,401	$1,115,203,990
% Increase 2000–2007	471%	204%	69%

Of particular interest to Sublette County government is the increase in general fund expenditures for both districts. Compared to a state-wide increase of only 65%, school district expenses in Sublette County experienced triple-digit increases from 2000–2007. This information is presented in Table 7-11 below.

Table 7-11 Sublette County general fund expenditures by school district (Wyoming Department of Education 2008)

Year	District No. 1	District No. 9	State-wide
2000	$5,701,686	$5,369,907	$661,500,425
2001	$5,581,358	$5,918,867	$673,591,640
2002	$8,355,265	$7,591,107	$724,206,123
2003	$13,721,364	$8,213,946	$750,746,628
2004	$11,292,016	$7,149,790	$756,193,461
2005	$16,968,439	$8,548,722	$803,732,619
2006	$31,136,408	$12,048,771	$907,392,493
2007	$47,001,426	$24,114,226	$1,093,446,068
% Increase 2000–2007	724%	349%	65%

7.2.3 Amendment B

Until November 2006, both districts in Sublette County were extremely well-funded. Wyoming law permitted districts to keep 25% of excess special school district property tax revenues each year while returning 75% to the state. In 2005, Pinedale retained $14.2 million, and Big Piney retained $4.1 million. Pinedale put this money directly into technology purchases (Gruver 2006). Each 5th grade student received a new laptop, and all classroom teachers now have a Smart Board$_{TM}$ and projector in their rooms. In 2006, Pinedale retained approximately $22 million, which was earmarked for a new aquatic center and a middle school expansion project (Gruver 2006).

The general election in November 2006 brought about a tremendous funding change for districts rich in natural gas production. Amendment B to the constitution required that all excess funding be returned to the state for redistribution to other districts. However, existing state statue 21-13-102(c), which permitted districts to retain 25% of excess funding, was not modified or repealed at that time. To resolve this conflict, the 2008 state legislature enacted Senate File 54 which accomplished two things: it repealed 21-13-102(c) thus permitting the state to take possession of all excess funds; and it made the capture of excess funds retroactive to encompass the 2006–2007 and 2007–2008 school years.

Both Sublette County school districts, in addition to school districts in Campbell, Fremont, and Lincoln counties, were part of a lawsuit against the State Superintendent of Public Instruction over repayment of the 2006–2007 and 2007–2008 monies. The State Supreme Court sided with the school districts and ruled that the districts were entitled to retain excess revenues from 2006–2008 (Wyoming State Law Library 2008). However, with the start of the 2008–2009 school year, all excess revenues are subject to the provisions of Senate File 54 and are returned to the state.

In the future, the districts will have to rely on local levies to increase budgets above the currently legislated education levies of six mills per county, 25 mills per district, and 12 mills state-wide. With continued natural gas production expected for the foreseeable future, losing the excess revenues may leave Sublette County school districts in a poor position to deal with expected increases in the student population.

7.3 ROADS AND TRANSPORTATION

Increased traffic is a state-wide matter in Wyoming but is of particular concern in Sublette County due to unprecedented growth. Overall traffic in Sublette County increased 86% between 2000 and 2007, while travel in Wyoming increased 19% over the same time period. This section investigates the impacts of natural gas development on transportation volume, road safety, and road conditions in Sublette County.

7.3.1 Traffic Patterns

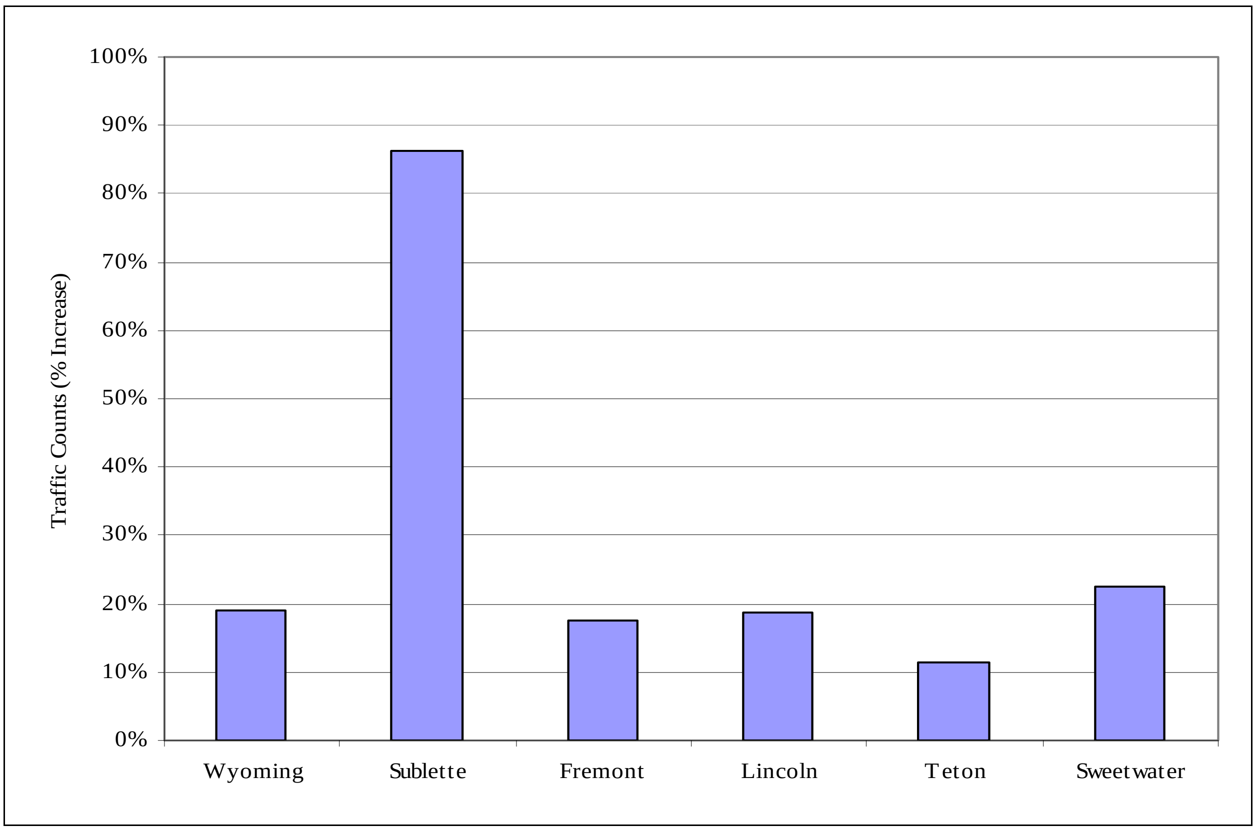


Figure 7-3 Percent increase in traffic counts from 2000–2007, state-wide and by county (Wyoming Department of Transportation 2008)

The disparity between the state-wide and Sublette County traffic increases is evident when comparing Sublette to surrounding counties. While Sublette County's traffic counts rose 86% from 2000 to 2007, surrounding counties' traffic counts escalated at rates similar to Wyoming, ranging from 11% in Teton County to 23% in Sweetwater County. Figure 7-3 above illustrates Sublette County's traffic percent change compared with surrounding counties and the state of Wyoming.

Automobile accidents have increased with traffic in Sublette County. Figure 7-4 describes the number of accidents and the percent change in accidents for the county. Between 1995 and 2007, traffic accidents have more than doubled. Of the accidents in 2007, 2% resulted in death and 26% resulted in injury (Wyoming Department of Transportation 2009).

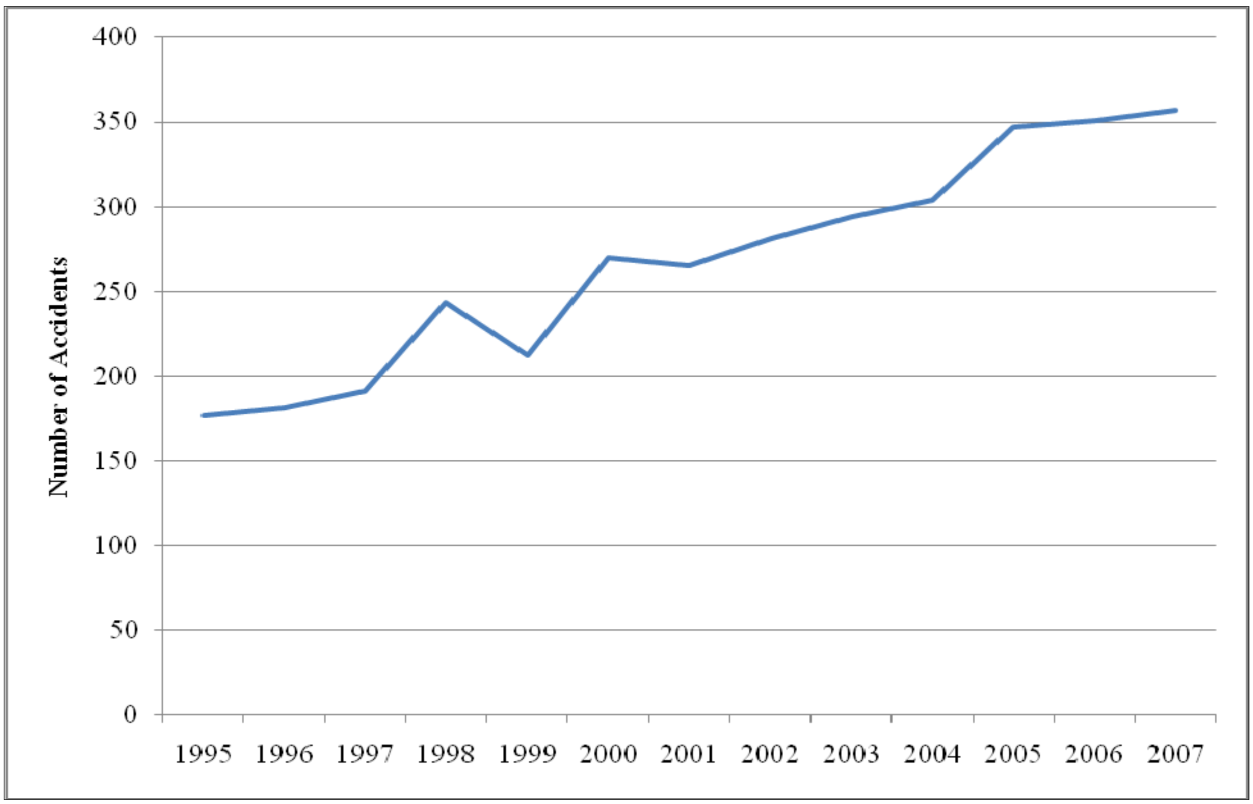


Figure 7-4 Vehicle-related accidents in Sublette County, 1995–2007 (Wyoming Department of Transportation 2009)

WYDOT data from 50 traffic counters across Sublette County show traffic increasing by 993 vehicles per day overall during the past five years (Wyoming Department of Transportation 2007). Figures 7-5, 7-6, and 7-7 show changes in traffic counts from 2000 to 2007 at specific locations across Sublette County and into adjacent counties. Vehicle traffic increased noticeably toward the central and southern portion of the county. The largest concentration of traffic occurs within the same proximity as the concentration of wells. Data is separated into big truck traffic and all other vehicles, with a big truck defined as any vehicle larger than a standard pickup.

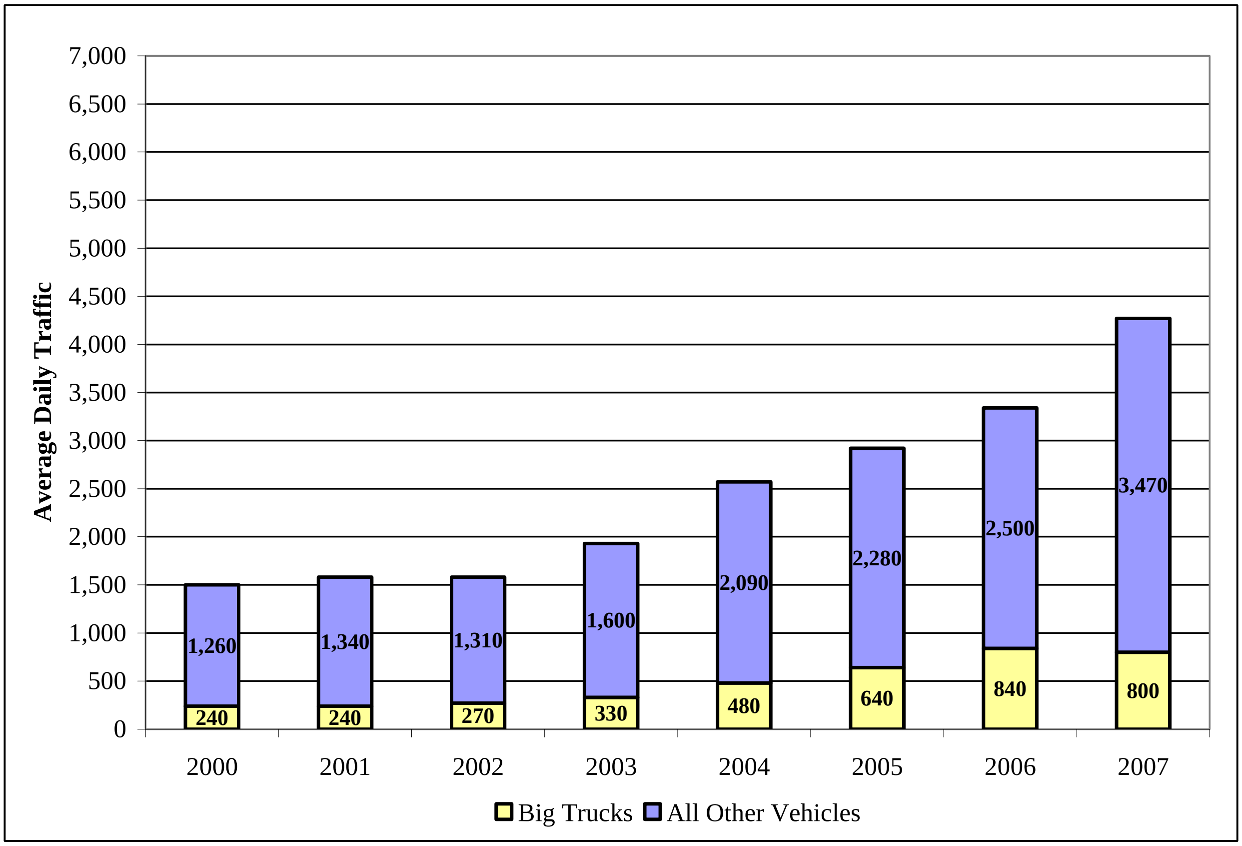


Figure 7-5 Average daily traffic—Sublette/Sweetwater County line, Highway 191 (Wyoming Department of Transportation 2008)

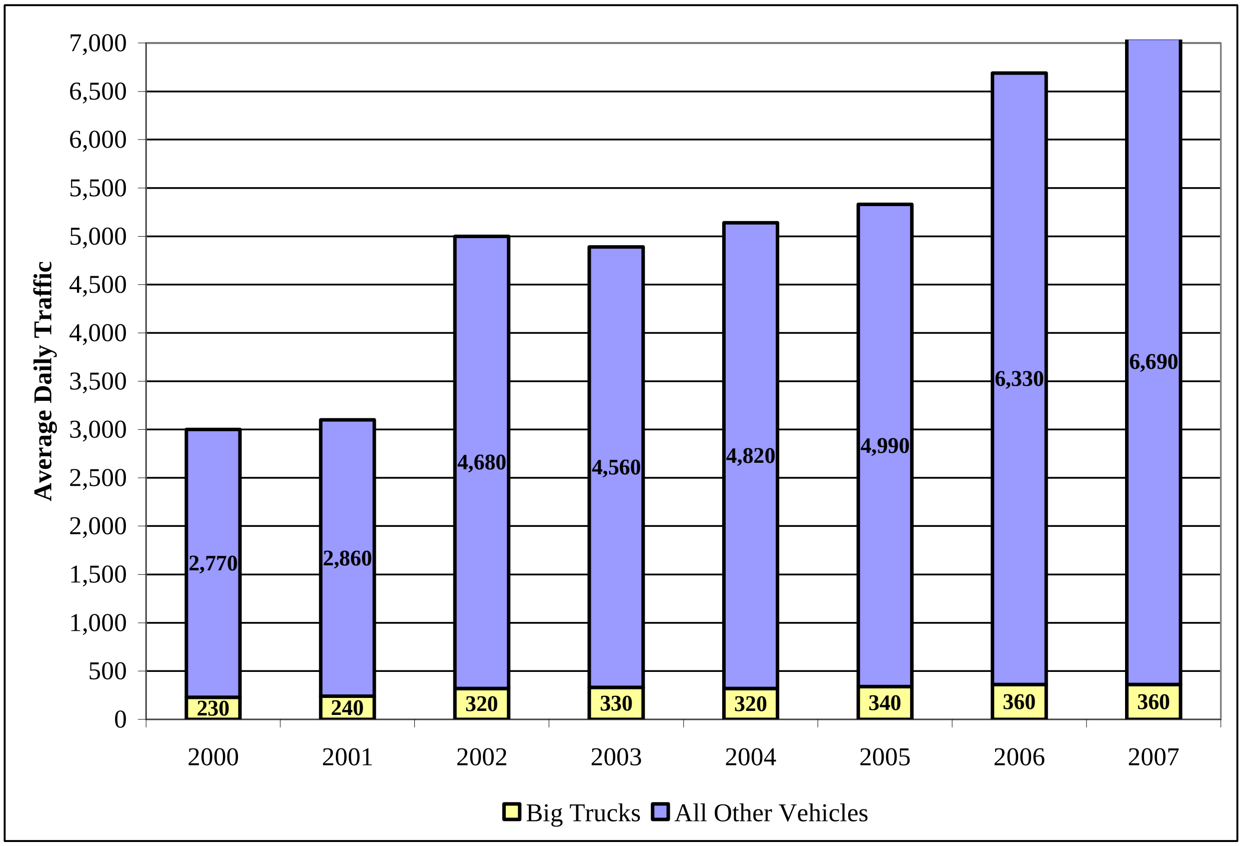


Figure 7-6 Average daily traffic—NW Pinedale town limits, Highway 191 (Wyoming Department of Transportation 2008)

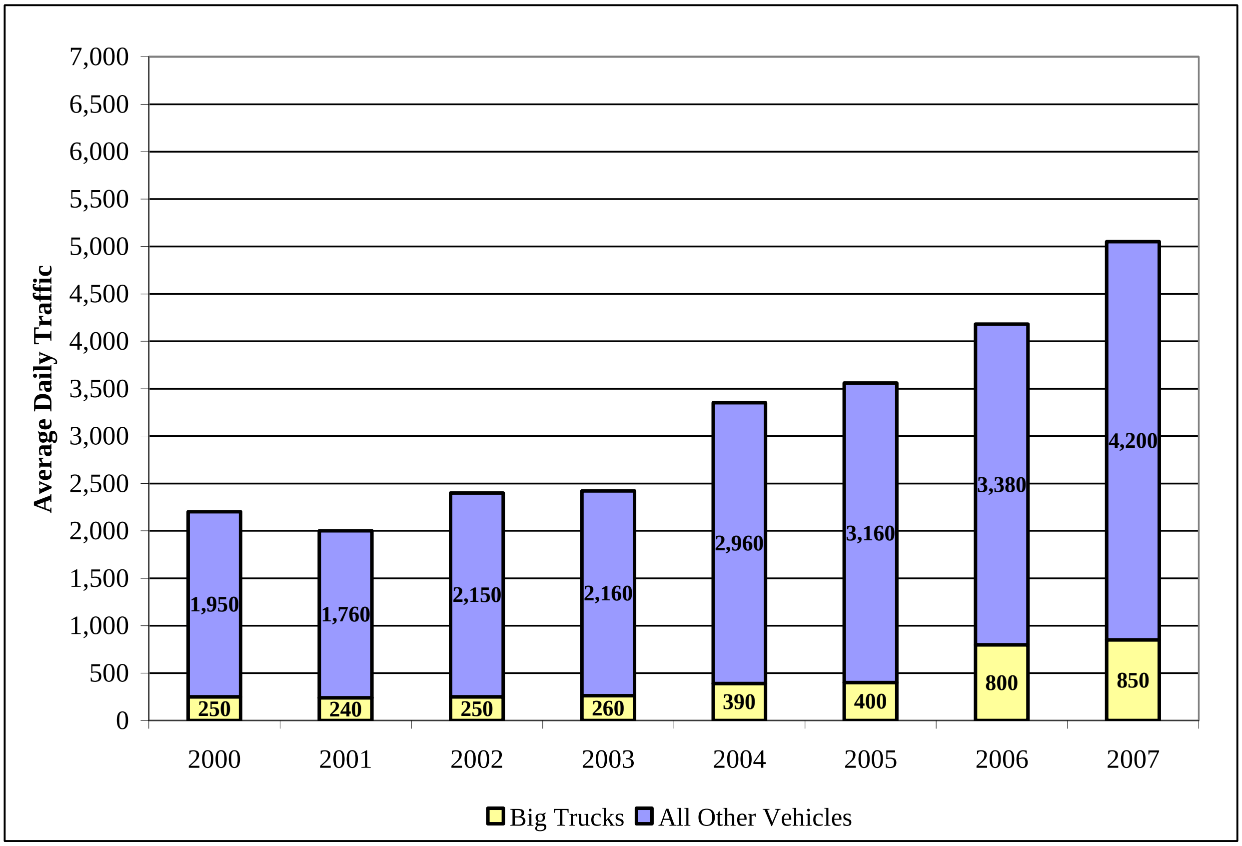


Figure 7-7 Average daily traffic—southern Big Piney town limits, Highway 189 (Wyoming Department of Transportation 2008)

Truck traffic at Big Piney's southern town limit has increased 240% since 2000. Pinedale truck traffic has not risen as much, but total traffic counts at Pinedale's northwest town limit have grown 104% over the same time period. As a result of the traffic, road improvement needs have increased. Sublette County's most pressing road improvement projects are Calpet Highway and Dry Piney Road, which total 32 miles. Traffic on the Calpet Highway and Dry Piney Road has increased since 2000, turning them into high-use roads with an accelerated need for maintenance. A substantial number of vehicles travel these roads annually, with 20% of this traffic being larger than a pickup. Figure 7–8 shows the percentage change in vehicle traffic for several points in and near Sublette County between 2000 and 2007. Traffic in Pinedale and areas south increased 95% to 137% during this period.

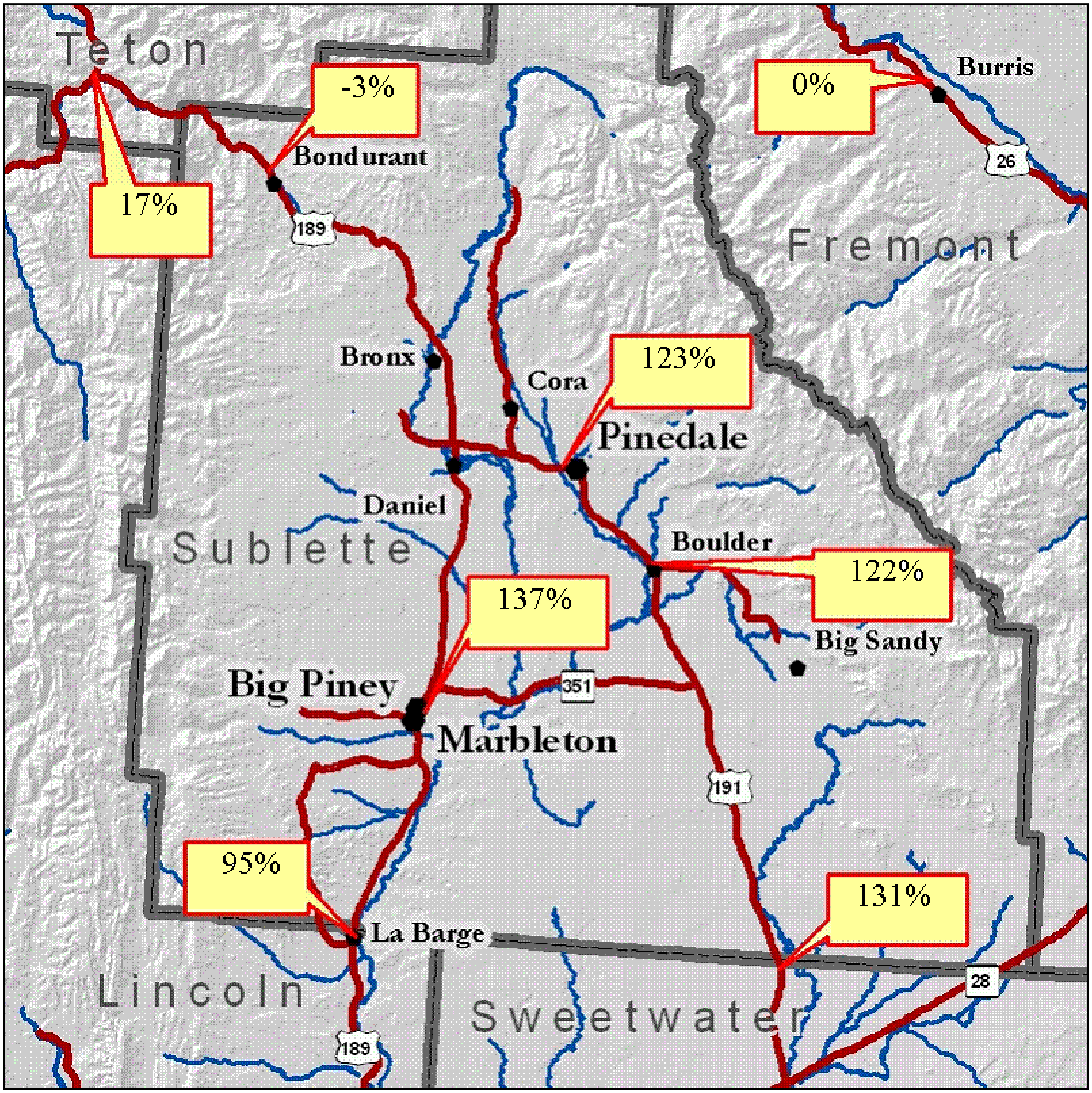


Figure 7-8 Percent increase in traffic, 2000–2007 (Wyoming Department of Transportation 2008)

7.3.2 Upcoming Road Projects within Sublette County

Big Piney, Marbleton, Pinedale and Sublette County have projected their road improvement projects through the next few years and estimate their costs at $4.3 million, $5.8 million, $22 million, and $55.4 million, respectively. The total cost for county and municipal projects is $87.5 million (Table 7-12).

Table 7-12 Projected road project costs for Sublette County and municipalities

Year	Big Piney	Marbleton	Pinedale	Sublette County	Total
2009–2010	$2,478,835	$413,406	$6,602,000	$41,600,000	**$51,094,241**
2010–2011	$1,772,400	$0	$5,182,000	$600,000	**$7,554,400**
2011–2012	Not planned	$2,685,894	$4,544,000	$12,000,000	**$19,229,894**
2012+	Not planned	$2,735,512	$5,675,000	$1,200,000	**$9,610,512**
Total	**$4,251,235**	**$5,834,812**	**$22,003,000**	**$55,400,000**	**$87,489,047**

The average life expectancy for an asphalt road is 20 years, even though some are still in service after 40 years. Roads can deteriorate faster with more traffic and harsh weather (Dixon 2009).

7.4 CRIME AND LAW ENFORCEMENT

Historically, the crime rate in Sublette County has been low when compared with the rest of the nation. However, crime has been rising in the last few years. Index crimes are used to determine the crime rate for an area. As described in the Unified Crime Report, “The offenses which comprise the Crime Index are all serious, either by their nature or by the frequency with which they occur, and each presents a common law enforcement problem” (U.S. Department of Justice 2006). From 2000 to 2007, total index crimes in Sublette County increased by 44%. Crimes within the index are classified as violent crimes (murder, forcible rape, robbery, and aggravated assault) or property crimes (burglary, larceny-theft, and motor vehicle theft.

Violent index offenses, including murder and non-negligent manslaughter, forcible rape, and aggravated assault, increased from two in 2000 to 17 in 2007. Property index offenses remained relatively stable, even slightly decreasing, with 25 offenses in 2000 and 22 in 2007. Table 7-13 below compares the number of offenses committed by adults and juveniles in 2000 and 2007.

Table 7-13 Adult and juvenile offenses, 2000 and 2007 (U.S. Department of Justice 2007)

Classification of Offense	2000 Adult	2000 Juv.	2007 Adult	2007 Juv.
Murder and Non-Negligent Manslaughter	0	0	0	0
Forcible Rape	0	0	2	0
Robbery	0	0	0	0
Aggravated Assault	1	1	14	1
Burglary	6	3	7	1
Larceny-Theft	9	4	10	1

Classification of Offense	2000 Adult	2000 Juv.	2007 Adult	2007 Juv.
Motor Vehicle Theft	3	0	2	1
Total Index Offense Arrests	**19**	**8**	**35**	**4**
Manslaughter by Negligence	0	0	0	0
Arson	1	0	0	0
Other Assaults	33	0	43	5
Forgery and Counterfeiting	0	0	0	0
Fraud	9	0	5	0
Embezzlement	0	0	0	0
Stolen Property; Buy, Receive, Possess	0	0	0	0
Vandalism	5	0	2	0
Weapons; Carry, Possess, etc.	0	0	0	0
Prostitution and Commercialized Vice	0	0	0	0
Sex Offenses (Except Rape and Prostitution)	2	0	1	0
Drug Abuse Violations	14	1	40	0
(1) Sale/Manufacture Subtotal	0	0	5	0
(2) Possession Subtotal	14	1	35	0
Gambling Offenses	0	0	0	0
Offenses Against Family and Children	1	0	6	0
Driving Under the Influence	63	0	95	0
Liquor Laws	28	2	63	11
Drunkenness	3	0	6	0
Disorderly Conduct	0	0	4	0
Vagrancy	0	0	0	0
All Other Offenses (Except Traffic)	52	1	177	3
Suspicion	0	0	0	0
Curfew and Loitering Law Violations	NA	0	NA	0
Run-Aways	NA	0	NA	2
Total Arrests by Age Group	**244**	**13**	**517**	**25**
Total Arrests by Year	**257**		**542**	

The number of juvenile arrests rose 92% from 2000 to 2007. According to Dayle Read-Hudson of Pine Creek Family Counseling in Pinedale, the last few years have produced more accounts of children bearing witness to violent crimes. Total arrests in Sublette County increased by 111% between 2000 and 2007. The county added 15 law enforcement officers between 2000 and 2006, but because of the increased arrest rate the number of major arrests per officer stayed constant at around 13.

The Circuit Court data tell a similar story but in a different way (Table 7-14 and Table 7-15). The court groups its cases in two categories, citations and non-citations. Citations involve "tickets" given by an officer, while non-citations are actual charges brought by the county prosecutor. Therefore, the non-citation cases are more serious. Data for 2007 on citations and non-citations were available only through June 30; however, total non-citations through June 2007 were already 89% of the total non-citations for 2006. DUI non-citations for the first half of 2007 surpassed the DUI non-citations for all of 2006. For circuit court citations, traffic citations have seen the greatest increase, from 28 in 2000 to 3,787 in 2006.

Table 7-14 Circuit court citation totals (Boynton et al. 2007)

Year	DUI	Felony	Game & Fish	Other	Traffic	Total
2000	16	1	2	11	28	58
2001	24	9	3	30	49	115
2002	49	5	57	115	760	986
2003	20	9	82	114	2,883	3,108
2004	17	6	100	104	2,726	2,953
2005	20	0	122	98	3,055	3,295
2006	50	3	131	231	3,815	4,230
2007*	3	3	26	65	1,982	2,079
Total Change 2000–2006	34 (213%)	2 (200%)	129 (6,450%)	220 (2,000%)	3,787 (13,525%)	4,172 (7,193%)

* 2007 numbers through June 30, 2007

Table 7-15 Circuit court non-citation totals (Boynton et al. 2007)

Year	DUI	Felony	Game & Fish	Other	Traffic	Total
2000	2	3	3	30	11	49
2001	0	7	1	38	24	70
2002	8	23	0	84	58	173
2003	72	58	0	180	101	411
2004	104	47	18	170	99	438

Year	DUI	Felony	Game & Fish	Other	Traffic	Total
2005	111	63	1	260	126	561
2006	59	51	8	207	72	397
2007*	60	30	0	130	132	352
Total Change 2000–2006	57 (2,850%)	48 (1,600%)	5 (167%)	177 (590%)	61 (555%)	348 (710%)

* 2007 numbers through June 30, 2007

According to Curt Haws, Circuit Court judge, the Circuit Court of the Ninth Judicial District in Sublette County had 107 court events in April 2007 (a "court event" includes any formal appearance or activity in the courtroom). Of those 107 events, 65 (61%) involved people who work in the gas and oil fields. "This number does not include people that are working in jobs that support the energy industry—food, lodging, etc.—but only those who are working for one of the energy companies" (Haws 2007a). As an example, Figure 7-9 shows the relationship between oil and gas drilling (depicted by drilling rig counts) and traffic citations.

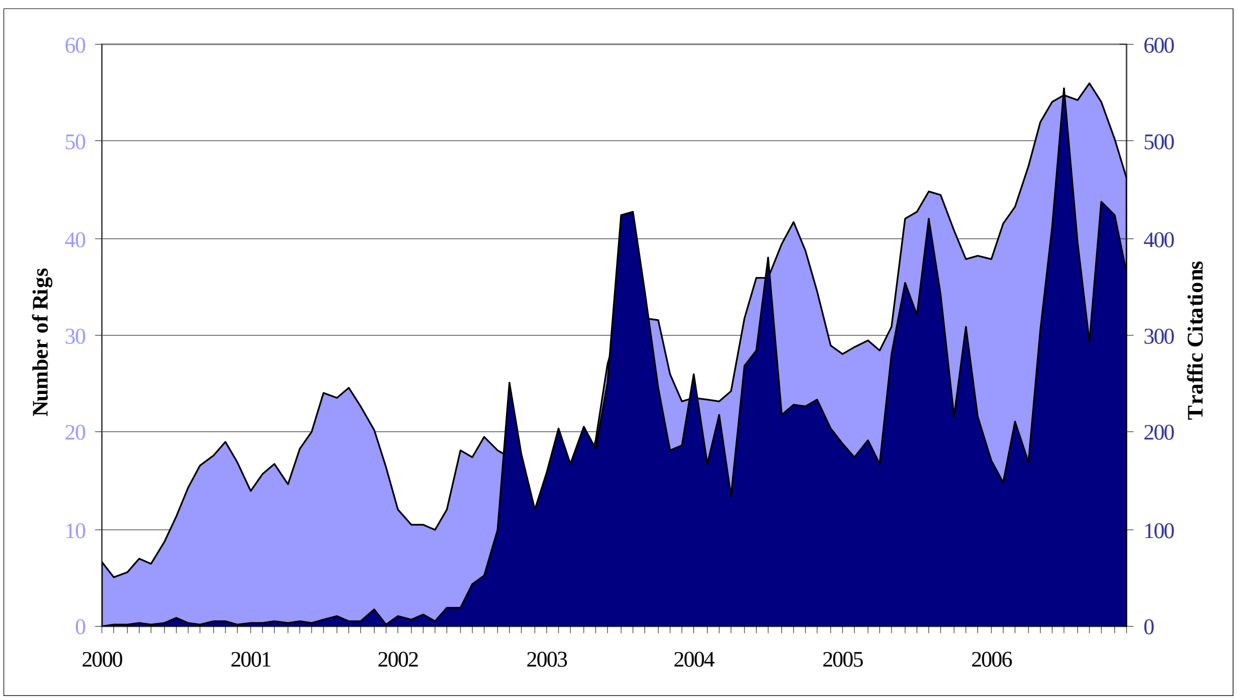


Figure 7-9 Rig counts correlated with traffic citations (Boynton et al. 2007; Sublette Community Partnership 2007)

The current capacity of the Sublette County jail is 52 individuals: 40 males, six females, and four juveniles, with an additional two beds in the isolation cells. In 2000, the average daily inmate population was 7.9 and increased to a daily average of 24.2 by 2005. In 2006, these numbers reduced to an average of 19.6. However, in April 2006, typically a slow time for incarcerations, the inmate population at the jail reached 40 people, more than 75% of its capacity. As the jail is not accredited for juveniles, this number does not include juveniles who cannot be held overnight (Johnston 2007). If the detention center reaches its maximum of 52 inmates, the county will have to house inmates out-of-county (incurring housing and transportation costs) or build an additional detention complex to increase their capacity. The 2008 inmate count showed a daily average population of 19.4. Figure 7-10 illustrates the average daily jail population from 2000 to 2008.

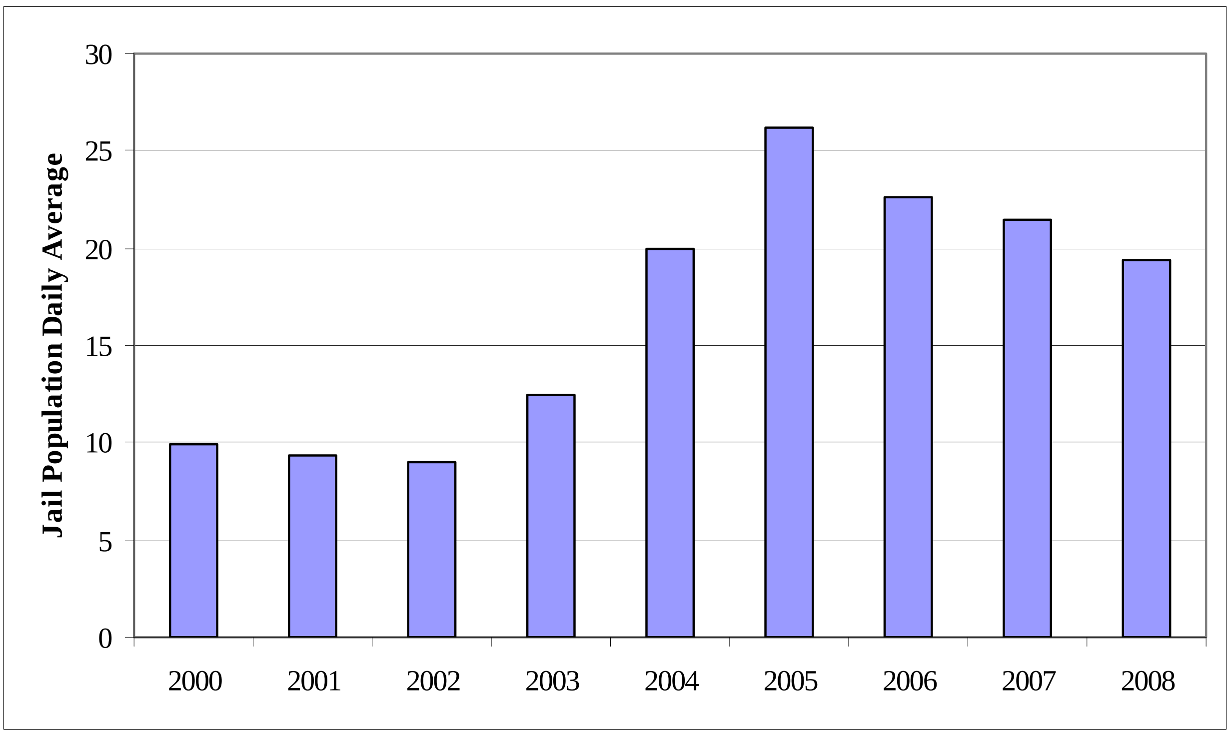


Figure 7-10 Daily average jail population (Johnston 2009)

7.5 MEDICAL SERVICES AND FACILITIES

With a population density of 1.2 people per square mile, Sublette County cannot reasonably support a hospital to serve such a low number of residents. Instead, the majority of county residents travel approximately 80 miles to St. John's Medical Center, a 52-bed hospital located in Jackson, Wyoming. For critical injuries, patients can be transported to larger hospitals in Utah, Idaho, Colorado, and Montana.

7.5.1 Clinics

Sublette County has experienced increased health needs in recent years as a result of a larger population. Prior to 2005, the county was served by two publicly funded medical clinics located in Pinedale and Marbleton-Big Piney. At 14,700 and 16,560 square feet respectively, the clinics were operated by private practice physicians. In May 2005, the Sublette County Rural Health Care District (District) took over operations of the Marbleton-Big Piney clinic at a cost of $2,570,293. In July 2006, the District acquired operation of the Pinedale clinic. The District's FY 2006–2007 costs totaled $7,103,848, which included clinic operating costs and salaries for physicians, nurses, administrative personnel, and ancillary personnel (Gatzke 2009).

As the county population continued to grow, Sublette County funded a new clinic to replace the existing clinic in Pinedale in 2007. The costs of equipping and supplying the clinic were taken on by the District; FY 2007–2008 District costs totaled $10,551,278 (Gatzke 2009).

In 2008, Sublette County funded a new clinic to replace the existing clinic in Marbleton, increasing the District's FY 2008–2009 budget to an estimated $12,558,008, not including emergency medical services (EMS) costs. Operating budgets include wages for 10 full-time administrative personnel and 44 full-time clinical workers. The District still needs additional technicians, but the positions remain unfilled (Gatzke 2009).

As the capacity of the District expands to meet increasing health care needs, monetary needs have risen. The District expects to receive $7,354,254 in mill levies from Sublette County in 2009 and is working to collect outstanding billings. The number of patients without health insurance has increased in tandem with oil and gas development (Gatzke 2009). Based on the current budget, the District expects a deficit of approximately $5 million for FY 2009-2010 (Gatzke 2009). Their deficit is composed of total revenues minus total expenditures. In 2008 and anticipated for 2009, the District supplemented their budget with cash reserves, which decreased from over $14 million in 2007 to an expected two million dollar balance in 2009 (Gatzke 2009). Figure 7-11 shows the District's income less expenditures from 2002–2009, which includes a deficit of $7,450,000 in 2009. Note that expenditures include operating and capital expenditures for both clinics and EMS.

Table 7-16 Sublette County Rural Health Care District net income (Gatzke 2009)

Year	Net Income
2002	$540,000
2003	$960,000
2004	$410,000
2005	$1,680,000
2006	$1,710,000

Year	Net Income
2007	$1,310,000
2008	-$2,880,000
2009	-$7,450,000

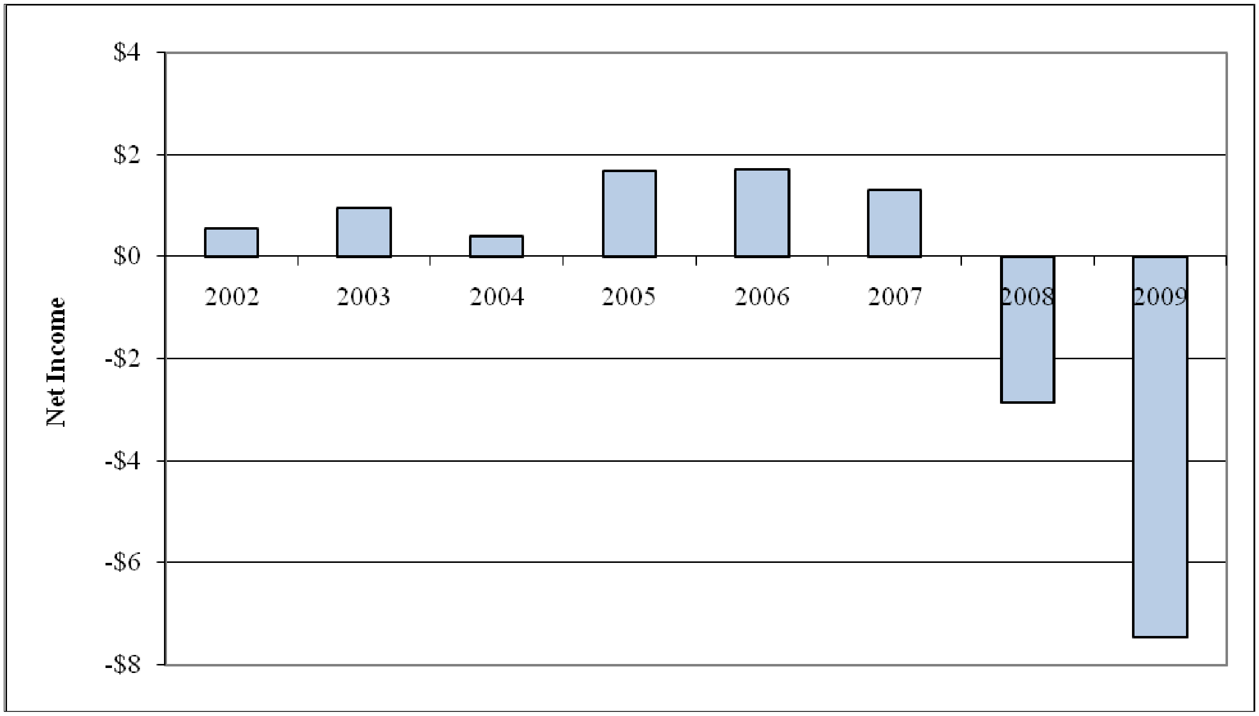


Figure 7-11 Sublette County Rural Health Care District net income (Gatzke 2009)

7.5.2 Emergency Medical Services (EMS)

District staffing needs continued to increase as EMS facilities expanded. Prior to 2001, the District consisted of two all-volunteer EMS units located in Pinedale and Marbleton, which were operating at full capacity. In March 2001, the District hired two full-time and one half-time emergency medical technicians in Pinedale and began the same program in Marbleton in July 2001. In October 2003, Pinedale added four full-time positions at their location, with Marbleton following suit in July 2004. In 2006, the District hired approximately 12 more full time EMTs. In October, 2007 the Sand Draw facility was built at a cost of $1.4 million (Gatzke 2009). The county contributed $500,000 and local industry paid $900,000 for the facility and necessary equipment (Gatzke 2009). The facility is open 24 hours a day to provide coverage for the Jonah gas field and South Anticline. The number of EMS runs has steadily increased through 2007, as illustrated in Figure 7-12 and Table 7-17.

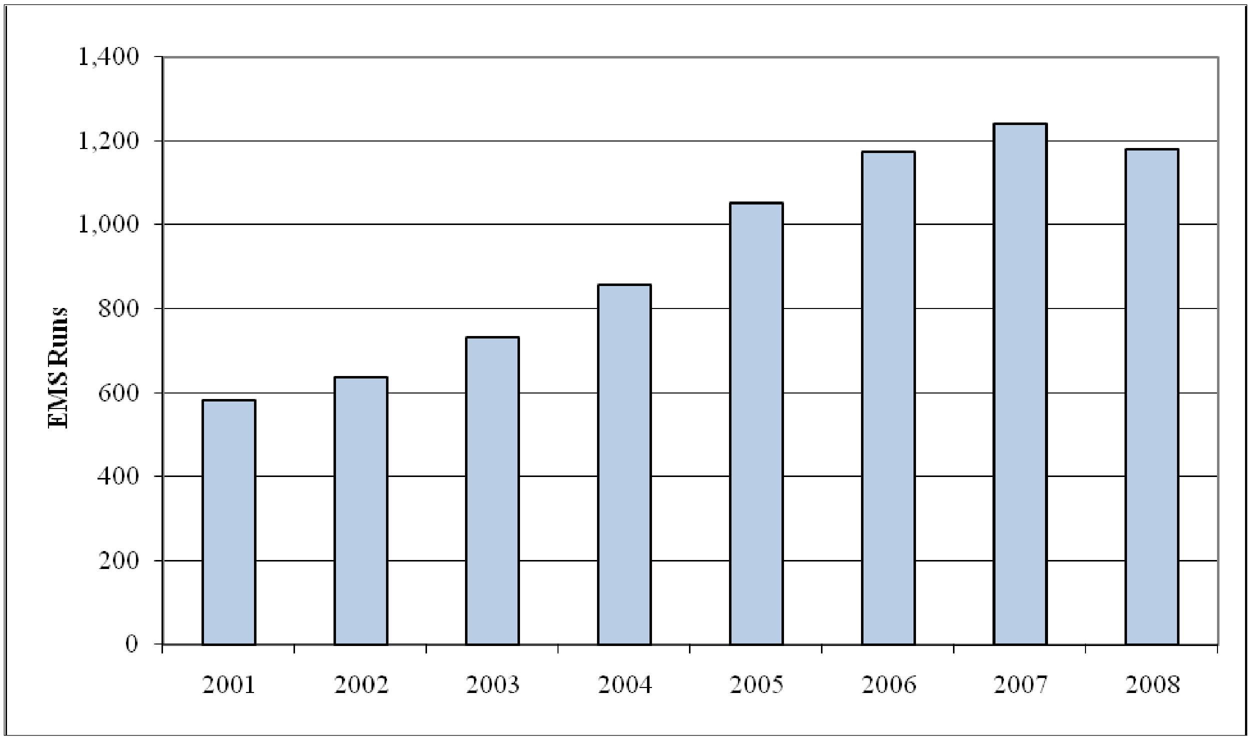


Figure 7-12 Total EMS runs in Sublette County 2001–2008 (Gatzke 2009)

Table 7-17 EMS Runs by Facility 2001–2008 (Gatzke 2009)

Year	Pinedale		Marbleton-Big Piney		Sand Draw	
	Total	% Change	Total	% Change	Total	% Change
2001	382	NA	199	NA	NA	NA
2002	415	8.64%	221	11.06%	NA	NA
2003	514	23.86%	218	-1.36%	NA	NA
2004	576	12.06%	280	28.44%	NA	NA
2005	717	24.48%	333	18.93%	NA	NA
2006	810	12.97%	364	9.31%	NA	NA
2007	824	1.73%	387	6.32%	29	NA
2001–2007 Change	442	115.71%	188	94.47%	29	NA
Average Annual Change	74	19.29%	31	15.75%	5	NA

Overall, it appears that medical services are financially stressed, largely in relation to the presence of the oil and gas industry, both from population increasing the number of patients and from the inherently dangerous nature of drilling gas wells (Gatzke 2009). The District has experienced, and will likely continue to experience, a growth in health-care needs.

7.6 WATER, SANITARY, AND SOLID WASTE

As population grows in relation to energy development, housing developments are increasing. As discussed in Section 7.1.3, residential housing permits have increased 387% since 2000 to accommodate new families in the area. Construction of new housing strains existing sewer and water systems and landfill capacity. As a result, the towns of Big Piney, Marbleton, and Pinedale have been forced to reevaluate their water, sewer, and landfill infrastructure.

Increased infrastructure needs are one of the most apparent effects of population growth in Sublette County. For example, Pinedale's existing sewer infrastructure is 80 years old and disintegrating. Current sewer and water lines are made of clay; they are cracked and broken throughout the system. All sewer and water lines within Pinedale will be replaced by 2014. At the same time, roads affected by these sewer and water projects will be repaired or resurfaced. In Marbleton, the existing sewer lagoon freezes during the winter and has been out of compliance with the State of Wyoming's Department of Environmental Quality standards for at least the past eight years. A new sewer lagoon has been designed and will be constructed in the near future. Directly to the south, Big Piney's water and sewer lines are 50 years old and made of cast iron. Lines are broken throughout the system and must be replaced. The town has already replaced all sewer lines and is in the process of replacing all water lines. At the same time, affected roads will be repaired or resurfaced. Table 7-18 lists the projected water and sewer projects for Sublette County municipalities with estimated costs.

Domestic and commercial water supplies are another area of concern. Two water towers serve the town of Marbleton and are the only source of water for energy operators in the area. One of Marbleton's two water towers is very old and structurally unreliable, requiring replacement. In addition, Marbleton recently drilled an additional well to provide domestic and commercial water but found fluoride levels in the new well unacceptably high. Treatment is required to remove the excess fluoride. The cost to drill a water well varies according to the depth of the well. A single water well of average depth and piping is estimated at $250,000 (Hurd 2009). That figure does not include the cost of a water tank, which ranges in price according to the size of the tank. An average 200,000 gallon tank costs $825,000 and can function with multiple water wells (Hurd 2009). In contrast to Marbleton, Pinedale's drinking water is obtained from Fremont Lake. The EPA requires all surface water used as a domestic or commercial water source to be filtered or otherwise treated for microbes (Environmental Protection Agency 2002). Addition of this treatment to the town's water distribution system is scheduled for 2010 at a cost of $3.8 million. In addition, Big Piney's two historic landfills must be monitored to maintain water quality.

Table 7-18 Water and sewer projects for Sublette County's municipalities (Town of Big Piney; Town of Marbleton; Town of Pinedale 2009)

Town	Project	Estimated Cost	Time Frame
Big Piney	Historic Landfills 1&2. Groundwater Monitoring (DEQ Mandated)	$125,000	Ongoing
Marbleton	Aerated Lagoon System with Power	$4,600,000	2009
Marbleton	Wind Turbines for Aerated Lagoon System	$500,000	2009
Marbleton	Main Water Line East to West	$497,000	2009
Marbleton	South Sewer Line Extension	$229,000	2009
Marbleton	Well House #7 Fluoride Treatment	$639,243	2009
Marbleton	50,000 Gallon Water Tower Replacement	$979,800	2010
Pinedale	Phase V Sewer	$7,491,037	2010
Pinedale	Phase VI Sewer	$8,924,640	2010
Pinedale	EPA-Mandated Water Treatment	$3,800,000	2010
Pinedale	Phase VII Sewer	$7,486,384	2011
Pinedale	Phase VIII Sewer	$7,694,490	2012
Pinedale	Phase IX Sewer	$6,111,828	2013
Pinedale	Water Meter System	$3,200,000	2013
Pinedale	Phase X Sewer	$2,755,689	2014
Pinedale	Sewer Lagoon Expansion	$4,500,000	2014
Pinedale	Water Meter System	$2,800,000	2014
Total		**$62,334,111**	

Finally, solid waste disposal services and facilities are struggling to meet the demands of county residents. Three waste service companies operate in Sublette County. One is new to the area, and the other two did not keep customer records before 2005. Colleen Grandsen, who owns and operates the BNC Trash Service in Pinedale with her husband, said, "Before now, there wasn't the need" (Grandsen 2007). However, since 1999 when they bought the business, the Grandsens have seen their customer base more than double. Today, BNC Trash Service cannot accommodate any additional customers. The company has added three new disposal trucks to its fleet since July 2006, however the Grandsens find hiring affordable workers to operate these trucks nearly impossible.

Before September 2004, complete records were not kept at the Sublette County landfill, which is located in Marbleton. As described in Table 7-19, waste tonnage measured from the Pinedale Transfer Station and from the surrounding areas ("all others") increased up to August 2007 and remained high through August 2008.

Table 7-19 Sublette County landfill tonnage per year (Hoffman 2008)

Year	Pinedale	All Others
Sept 2004–Aug 2005	4,385	7,991
Sept 2005–Aug 2006	5,224	8,603

Year	Pinedale	All Others
Sept 2006–Aug 2007	5,983	11,589
Sept 2007–Aug 2008	5,979	11,470

In February 2005, Nelson Engineering completed an annual cost analysis for the county landfill to aid in future planning. The report projected total volume for the landfill in 2005 at 36,463 tons. According to the County Materials Analysis Reports, the total tonnage from January 2005 through December 2005 exceeded the projections by 8,132 tons, 22% more than anticipated. The daily tonnage forecast in the Nelson analysis, based on six days a week, eight hours a day, was 114 tons. According to Rick Hoffman, Sublette County Waste Management Supervisor, the 2006 average daily tonnage was already 147 tons/day (Hoffman 2007).

In 2004, 2005, and 2006 combined, Sublette County recycled 941 tons of material, which included an increase of approximately 5% per year. In addition, Sublette Citizens for Recycling representative Marti Seipp estimates that approximately 200 tons worth of material could be recycled from oil and gas developments alone each year (Seipp 2007). According to Rick Hoffman, Sublette County Waste Management Supervisor, "There needs to be an increased effort in recycling and a major renovation of the Pinedale Transfer Station" (Hoffman 2007).

7.7 SOCIAL SERVICE PROJECTIONS

Medical, law enforcement, and waste management are just a few of the community services necessary to ensure public well-being and a good quality of life. Providing these services now and in the future requires assessing the current population, reviewing staffing and facilities needs, and anticipating future trends in these areas.

Projecting future needs in most areas of social service first requires defining the current load, or number of residents served per employee. In some cases the load is defined on a unit basis, such as number of detention beds, gallons of water, or cubic yards of landfill space. For example, there are six physicians practicing in Sublette County at the present time. The county has an estimated population of 8,750 residents in 2009, thus each physician has a current load of 1,458 patients. Assuming the current level of service is adequate, Sublette County will need 9.2 physicians in 2020 to meet the expected demands of 13,370 residents (Wyoming Department of Administration and Information 2009). Similar calculations are tabulated in Table 7-20 for medical and law enforcement services.

Table 7-20 Sublette County current and projected service needs (Ecosystem Research Group 2009; Gatske 2009)

Service	2009 FTE or unit of measure	Acceptable Load (2009)	2020 FTE Required or units anticipated
Physicians	6.0	1,458	9.2
Physician Assistants	2.0	4,375	3.1
Nurses	2.5	3,500	3.8
Dentists	3.5	2,500	5.3
Emergency Medical Technicians	13.0	673	19.9
EMS calls	1211.0	7	1,850.0
Sheriff's Office and Law Enforcement	80.0	109	122.3

7.8 QUALITY OF LIFE ISSUES

The social and cultural effects of the oil and gas industry on Sublette County are mixed, especially between areas of the county that have previously experienced oil and gas development and areas that have not. The customs and culture of mining industry newcomers are changing the complexion and history of the town of Pinedale and northern areas of the community, an area not accustomed to rapid growth from labor in-migration. The shift from a ranching- and recreation-based culture to a mining-based culture has been well documented in the national media (Clarren 2007; Kenworthy 2006; Ring 2005; Wilkinson 2005). In southern Sublette County, the recent increases in activity in the towns of Big Piney and Marbleton are more aligned with the existing cultural history of the area.

As natural gas development continues and gains intensity, these impacts can be expected to continue. Newcomers related to the gas industry will continue moving to the area until the development stage is completed. Correspondingly, anxiety from existing residents regarding population growth and planning is likely to continue. However, the initial "shock" of the cultural and economic changes to the area felt by residents will likely lessen as the development continues. Both current residents and newcomers will become more accustomed to one another as time passes. The series of community satisfaction surveys on the boom town of Delta, Utah found that the largest drop in community satisfaction occurred during the initial two years of growth, even though the majority of population growth was yet to occur (Brown et al. 2005). The researchers found that many of the residents may have been able to reconcile their feelings with the new and growing community over time (Brown et al. 2005).

At the conclusion of the development stage as the projects shift to production and fewer workers are required, many of the newcomers will likely migrate out of the region. The area will likely experience an economic downturn associated with the out-migration of temporary and permanent residents. This has the potential to decrease community satisfaction and social cohesiveness, depending on the severity of the downturn. The study of Delta, Utah found that the second largest drop in community satisfaction occurred during the "bust" years, and community satisfaction did not return to pre-boom levels until nearly ten years after the bust, when the population remained relatively stable (Brown et al. 2005). The "busy-ness" of town will likely decrease, as fewer demands will be put on local service industry, accommodation, and government sectors. However, hundreds of long-term gas industry production jobs will remain in the area for the life of well production on the gas fields (through approximately 2065), and Sublette County's culture can be expected to reflect the residency of these workers and the prior influx in drilling activity.

8. MITIGATION STRATEGIES

8.1 SOCIOECONOMIC MONITORING INDICATORS

Western Wyoming is currently experiencing rapid economic growth, associated with the development of oil and gas resources. This document proposes a set of indicators to track social and economic change generated by oil and gas development. The monitoring plan outlined in this document is intended to provide an annual update to communities, local governments, and federal agencies interested in and involved with management of energy-related impacts.

Draft 1 was prepared by Rob Winthrop, Senior Social Scientist, BLM Washington Office[1], in response to the May 18, 2008 Mitigation Workshop sponsored by Sublette County. Subsequent revisions reflect input from Roy Allen, Regional Economist, BLM Wyoming State Office, and Jeffrey Jacquet, former Sublette County Socioeconomic Analyst. The current document contains additional development and research by ERG.

The items contained in Table 8-1 are presented to satisfy reporting requirements and facilitate discussion by citizens, local and state government officials, operators, BLM managers and staff, and other interested parties. It does not represent BLM policy, nor does it imply a commitment by the BLM to provide funds or staffing for a monitoring effort. The indicators are prioritized in three tiers. Priority 1 provides the most limited monitoring program, Priority 3 the most extensive and most costly. Priority 2 includes indicators listed under Priority 1 and Priority 3 includes indicators listed under Priorities 1 and 2.

The indicators were selected using several criteria:

- Balance. The indicators should reflect both the benefits and the challenges of oil and gas development, as well as other drivers of economic change.
- Consistency. The indicators selected should be broadly consistent with any existing monitoring objectives.
- Comparability. At least some of the indicators should be applicable to any area of the country in order to facilitate the implementation of a consistent social and economic monitoring strategy across the lands administered by the BLM. Economic and demographic indicators should use readily available Federal or State data, to the extent feasible. Federal data sources provided through the BLM-funded Headwaters Economics Economic Profile System are particularly useful.[2]

The following items should be taken into consideration when deciding what indicators to monitor:

[1] Division of Decision Support, Planning and NEPA (WO-210); 202-557-3587
[2] The Economic Profile System application and database as well as county-level reports can be downloaded free of charge at www.headwaterseconomics.org/eps.

- Cumulative effects. How should the monitoring effort consider (a) oil and gas development on non-BLM lands and (b) other industrial activities within the monitoring area?

- Sources of data. If timeliness of data is important, federal data and data provided by the Economic Profiling System may require supplementation with other data which may be more recent.[3]

- Use of projections. Most of the indicators listed below are retrospective in that they measure what has happened. To the extent that future oil and gas activity can be estimated, such data could be used to project many of these indicators forward, which would make the monitoring effort much more valuable as a basis for local planning for facilities and services.[4]

- Staffing and coordination. It may be appropriate to request that the county's Socioeconomic Analyst assume certain responsibilities for conducting monitoring activities under this plan. Depending on the specifics of the final monitoring plan, available skills, and level of funding for the position, this role could involve providing data, analyzing data, coordinating monitoring activities, or preparing the monitoring report.

- Benchmarking. Designated categories (●) could also be compared with data for a benchmark county selected for minimal oil and gas activity.

Section 8-2 provides an example of a current monitoring report based on the indicators outlined in Table 8-1.

[3] Jeffrey Jacquet, former sociologist for Sublette County, suggests that because most federal data will be two to three years old, the monitoring program may need to rely more on state data. "The Wyoming Department of Administration and Information, Economic Analysis Division and the Wyoming Department of Employment, Research, and Planning offer similar statistics that are typically only six months to one year old."

[4] Jeffrey Jacquet: "The BLM is 'supposed to be' providing yearly 10-year development projections for both the Anticline and the Jonah Field. Could the monitoring program take into account these development scenarios and then project the impacts to the selected indicators? As well as track the changes in field development and the changes in the development projections—such as when 'the bust' is scheduled to hit, etc…"

Table 8-1 Socioeconomic Monitoring Indicators

Priority	Indicator	Source(s)	Significance	Notes	Current Data
1	Oil and natural gas prices	Wyoming sweet gas prices available from the U.S. Energy Information Administration http://www.eia.doe.gov/ (U.S. Energy Information Administration 2009) and directly from Wyoming Economic Analysis Division http://eadiv.state.wy.us/ (Linn 2009).	Price trends may provide an early indicator of shifts in exploration activity. Higher prices could suggest increases in exploration and production activities, while flat or decreasing prices could indicate maintaining current/decreasing levels of activity.	Data are available on a monthly basis.	Wyoming 2008 average sweet first purchase price: $88.40 per barrel (U.S. Energy Information Administration 2009).
1	Rig months, oil and gas wells (1) in operation and (2) 10-year projected drilling activity	Operators, Wyoming Oil and Gas Conservation Commission at http://wogcc.state.wy.us/, BLM at http://www.blm.gov/	Projected drilling activities will be helpful in anticipating population impacts.	Request information from operators. Current data may be available from WOGGC. Data are updated on a weekly and monthly basis. Custom reports are available upon request.	The 2007 count for total oil and gas wells in production in Sublette County is 2,186 wells (Wyoming Oil and Gas Conservation Commission 2007). .

Priority	Indicator	Source(s)	Significance	Notes	Current Data
1	10-year projected oil and gas production	Operators	This information in conjunction with projected prices of oil and gas would provide the basis for estimating county mineral-related revenues.[5] Revenue estimates will help local governments plan to address anticipated infrastructure and personnel impacts.	To protect proprietary data, submissions could be aggregated by a third party. Data could be collected annually or more often if economic conditions warrant.	2009: 1,262,747,772 mcf 2010: 1,388,514,132 mcf 2011: 1,514,012,904 mcf 2012: 1,619,710,164 mcf 2013: 1,690,353,396 mcf 2014: 1,760,996,628 mcf
1	Population: county trend compared with benchmark county and state ●	Wyoming Department of Administration and Information at http://ai.state.wy.us/, Economic Analysis Division at http://eadiv.state.wy.us/	Shifts in population are important in anticipating adequate staffing levels for public services, including police, fire, education, medical, and government. In addition, housing needs are directly linked to population numbers.	Use Census estimates which are available annually at the end of March.	2007 Sublette County population: 7,925

[5] Roy Allen, BLM Economist: "By including [production projections] in the monitoring plan, the impacted counties and communities would be able to project earnings, employment and population by 10 year increments that would then be updated annually based on industry submissions. They would also be able to estimate taxes and royalties on the same 10 year basis as a fluctuation of industry provided by production estimates and these projections would also be kept current by sending out an annual request to industry for this information."

Priority	Indicator	Source(s)	Significance	Notes	Current Data
2	Oil and gas workers and dependents, by county	Operators; Wyoming Department of Employment, Research, and Planning at http://doe.state.wy.us/; Wyoming Department of Transportation at http://dot.state.wy.us/	Where industry-supplied housing is available, worker and family member counts will indicate whether adequate housing is present.	These numbers may be estimated using workforce requirements on a per-well or per-rig basis. Methodology would depend on field and project conditions.[6]	2007: 1,478 workers and family members 2008: 1,702 workers and family members 2009: 1,630 workers and family members
1	Estimated oil and gas industry employment including subcontractors	Operators[7]; BLS NAICS sectors 211, 212, 213 at http://www.bls.gov/; IMPLAN®	Collecting population data from multiple sources is helpful in determining how well differing sources agree and in assessing accuracy of data and/or estimates.	BLS State and County Employment and Wages Reports are released monthly, approximately one month after collected. BLS website has schedule (Bureau of Labor Statistics 2009). IMPLAN® datasets are released annually and must be purchased from the Minnesota IMPLAN® Group. IMPLAN® datasets are generally released in October for the preceding year.	2009: 2,012 workers 2010: 2,010 workers 2011: 1,940 workers 2012: 1,905 workers 2013: 1,946 workers 2014: 1,426 workers 2015: 1,403 workers 2016: 1,395 workers 2017: 1,387 workers 2018: 1,402 workers

[6] Comment by Jeffrey Jacquet re: estimating number of oil and gas workers and dependents by county: "The operators do not have this information. The gas field organization and employment residency is too complex and decentralized for the operators to provide this information. The only so-far proven way of obtaining these numbers is to estimate them using workforce requirements on a per-well or per-rig basis, et cetera. The operators do not have qualified staff to provide these numbers. The monitoring program will have to work with the operators and various subcontractors to put together a methodology to estimate the workers and dependents accurately."
For Sublette County analysis, ERG used workers per well as estimated by the operators and documented in BLM reports. The Wyoming DERP can provide estimates of inter- and intra-state commuting trends. The WYDOT can provide information on applications for and surrendered driver's licenses.
[7] Out-of-state subcontractors must be contacted directly for their employment counts as BLS statistics only include in-state counts.

Priority	Indicator	Source(s)	Significance	Notes	Current Data
1	Employment by sector ●	BEA REIS Table CA25N – NAICS at http://bea.gov/regional/reis/	Shifts in major employment sectors will in turn affect personal and household income values. Wide gaps in income between sectors can contribute to disparate financial opportunities for residents.	Local Area Personal Income 2007 Reports (including CA25N) will be available April 23, 2009. See BEA website for other release dates.	2007 Mining Sector employment: 1,570. For other sectors, see Section 8.2.3.2.
1	Personal income by sector; non-labor income ●	BEA REIS Table CS05N – NAICS and Table CA30 at http://bea.gov/regional/reis/ or EPS Sublette County Profile at http://www.headwaterseconomics.org/ (Headwaters Economics 2008)	Non-labor income is broadly classified into investment-related (interest, dividends, and rent) and transfer payments (retirement, disability, and government payments to individuals such as Medicare and unemployment). This information in conjunction with demographic data can help determine socioeconomic characteristics of the local population.	Local Area Personal Income 2007 Reports will be available April 23, 2009. See BEA website for other release dates (Bureau of Economic Analysis 2009).	In 2006, personal income was 70% labor income and 30% non-labor income (Headwaters Economics 2008). For personal income by sectors, see Section 8.2.3.3.
2	Income distribution ●	Headwaters Economics EPS datasets at http://www.headwaterseconomics.org/, U.S. Census at http://www.census.gov/	These data can be used to compare the number of high-earning households to those at a lower income level.[8]	Data are available every ten years from the Census.	"In 1999, for every household that made over $100,000, there were 5.1 households that made under $30,000." (Headwaters Economics 2009).

[8] For this study's purposes, ERG has followed the EPS format of comparing the number of households making over $100,000 to those making under $30,000.

Priority	Indicator	Source(s)	Significance	Notes	Current Data
1	Unemployment rate compared with benchmark county, state, and nation ●	BLS at http://www.bls.gov/	Low unemployment rates can indicate a lack of available workers in the area. At times, this can result in competition for available workers, often with an increase in local pay scales.	BLS statistics only include in-state counts. BLS State and County Employment and Wages Reports are released monthly, approximately one month after collection. Refer to BLS website for schedule (Bureau of Labor Statistics 2009).	Sublette County's 2007 unemployment rate was 1.5%.
2	Employment diversity/ specialization	Headwaters Economic EPS at http://www.headwaterseconomics.org/	These values measure the range of employment opportunities and can be used to compare regional patterns against state or national patterns. In addition, these data can indicate if employment is heavily weighted toward a particular industry, affording planners the opportunity to anticipate employment changes if that industry presence decreases.	Refer to index discussed in EPS which uses data from the U.S. Census Bureau[9] (available every 10 years). EPS annual reports are generally released in February (Headwaters Economics 2009).	Sublette County is specialized with a specialization score of 430 The nation as a whole has a specialization score of 0. (Headwaters Economics 2009).

[9] The specialization index used in the EPS is calculated as:
n
SPECIALit = Σ ((EMPijt/EMPit)-(EMPusjt/EMPust)) 2
j=1
Where, SPECIALit = specialization of economy in county i in year t
EMPijt = employment in industry j in county i in year t
EMPit = total employment in county i in year t
EMPusjt = employment in industry j in US in year t
EMPust = total employment in US in year t
n = number of industries
A high specialization index indicates a lack of economic diversity.

Priority	Indicator	Source(s)	Significance	Notes	Current Data
2	Recreation use: Recreation days by category	BLM Recreation Management Information System http://www.blm.gov/	Trends in this area can measure changes in usage patterns.	Contact BLM directly	Available by area
3	Tourism: Visitor origin, recreation use, and spending	Intercept survey targeting visitors	Trends in this area can measure changes in usage patterns.	Contact landowner directly (i.e. Forest or Park Service)	Available by area
1	Wyoming share of FMR	Wyoming Treasurer's Office Annual Reports at http://treasurer.state.wy.us/ (Wyoming Treasurer's Office 2009), Federal Mineral Management Service at http://www.mms.gov/ (Federal Mineral Management Service 2009)	FMR distributions are not currently a significant source of revenue to Sublette County local government.	Treasurer's Office reports are generally released in January for the previous fiscal year. Federal Mineral Management Service custom reports are available upon request.	Total FMR distributed to Sublette County in 2008 was $324,594.
1	Wyoming severance tax	Wyoming Treasurer's Office Annual Reports at http://treasurer.state.wy.us/ (Wyoming Treasurer's Office 2009), Wyoming Legislative Handbook at http://legisweb.state.wy.us/ (Wyoming Legislative Service Office 2007, 2009)	Severance distributions are not currently a major source of revenue to Sublette County local government.	Treasurer's Office reports are generally released in January for the previous fiscal year. Legislative handbooks are available in odd-numbered years at the beginning of the legislative session.	Total severance distributed to Sublette County in 2008 was $185,008.

Priority	Indicator	Source(s)	Significance	Notes	Current Data
1	County property tax revenues by source including ad valorem oil and gas production tax	County Assessor, Wyoming Department of Revenue Annual Reports at http://revenue.state.wy.us/ (Wyoming Department of Revenue 2009)	This is a major revenue stream for county government and is useful in determining available funding for operating and capital expenditures.	Contact County Assessor directly, Department of Revenue reports are generally released in the third or fourth quarter for the previous fiscal year.	Total ad valorem received by Sublette County in 2008 was $40,892,723. Sales and use tax received by Sublette County in 2008 was $24,973,536.
1	Value of proposed and current growth-related capital improvements by jurisdiction (i.e. sewer, water, roads, public facilities)	Provided by counties and municipalities	Comparison of these values against all revenue streams will indicate whether current funding mechanisms are adequate to mitigate necessary capital improvements.	Contact County and Municipal government	Cost estimates: Big Piney $9,256,754 Marbleton $13,279,855 Pinedale $82,267,068 Sublette County $55,400,000 For details see Section 8.2.5.1.
2	Traffic accidents by county ●	The Crash at http://dot.state.wy.us/ (Wyoming Department of Transportation 2007; Wyoming Treasurer's Office 2009)	Changes in traffic accident counts can indicate the need for safety-related improvements to public transportation networks.	Annual reports released in June.	Sublette County had 357 traffic accidents in 2007.
1	Housing availability: rental occupancy rates by category of housing ●	Housing Database Partnership biannual reports at http://www.wyomingcda.com/ (Wyoming Community Development Authority 2009)	The availability of rental units in conjunction with estimates of population who need rental housing will indicate if supply is adequate.	Generally released in August and February of each year.	Sublette County rental vacancy rate was 3.44% in the second quarter of 2008.

Priority	Indicator	Source(s)	Significance	Notes	Current Data
1	Housing availability: existing stock and new construction of housing units by category ●	County Assessor, Housing Database Partnership biannual reports at http://www.wyomingcda.com/, U.S. Census Bureau at http://www.census.gov/	The availability of housing units in conjunction with estimates of population interested in purchases will indicate if supply is adequate.	The most timely online data source is the Housing Database Partnership.	Sublette County released 100 building permits in 2008, decreasing 61% since 2007.
1	Housing affordability ●	County Assessor, Headwaters Economics EPS Housing Affordability Index at http://www.headwaterseconomics.org/	This value in conjunction with personal, household, or family income averages indicates how affordable regional housing is. When the minimum qualifying income is greater than the typical family can afford, purchased housing is essentially out of reach for a segment of the population.	County Assessor can provide annual sales information. EPS provides Housing Affordability Index using data from U.S. Census Bureau (available every 10 years). EPS annual reports are generally released in February (Headwaters Economics 2009).	In 2007, the minimum qualifying income to purchase an average home in Sublette County exceeded the median family income by $17,796.
2	Temporary (operator provided) housing: worker-months occupied	Operators; Area hotels, motels, RV parks, and campgrounds	Occupancy rates can be used by operators to adjust available housing.		Summer transient workers estimated at 856 in 2008. Winter transient workers estimated at 762 in 2008.
1	Crimes charged, adult and juvenile ●	U.S. Dept. of Justice, Uniform Crime Report at http://www.usdoj.gov/ Wyoming Attorney General's Office, DCI at http://attorneygeneral.state.wy.us/	Trends can indicate the need for changes in law enforcement and court-related personnel and infrastructure, as well as detention facility capacities.	DCI is available quarterly for the current year and annually for historical data.	Sublette County had 517 adult arrests and 25 juvenile arrests.

Priority	Indicator	Source(s)	Significance	Notes	Current Data
2	Circuit Court cases	Wyoming Attorney General's Office, DCI at http://attorneygeneral.state.wy.us/	Trends can indicate the need for changes in law enforcement and court-related personnel and infrastructure, as well as detention facility capacities.	Analysis should highlight categories of particular interest, which could include drug offenses, domestic violence, etc. These reports could provide more detail than federal Uniform Crime Reports.	Sublette County documented 4,230 citations and 397 non-citations in 2006.
3	Quality of life survey	Question template in Michael S. Coburn's *Community Satisfaction and Quality of Life Survey for Long-Term Residents of Sublette County* (Coburn 2008)[10] at http://www.sublette-se.org/	Survey responses will indicate resident satisfaction in the area. Trends can be used to monitor cause-and-effect, especially when administered regularly.		See Section 8.2.7.3

[10] A quality of life survey would be most useful if administered on a regular basis (i.e. annually or semi-annually) based on a random sample of residents. The questions should be closed-ended and limited in number. Attitudinal questions should be scaled (typically on a 5 point scale, "strongly agree" to "strongly disagree."). An example: "Overall, energy development has benefited county residents." These should be accompanied by demographic questions which include income, education, sector of employment, and years of county residence.

Priority	Indicator	Source(s)	Significance	Notes	Current Data
3	Focus groups to address particular issues related to energy development	Local and/or affected residents and workers.	A focus group is valuable for interpreting existing information (e.g., explaining changes in patterns of tourism and recreation) or eliciting suggestions for solving problems (e.g., how to accommodate growing housing demand by oil and gas workers). For issues related to energy development, focus groups should include both long-term residents and shorter-term oil and gas workers		One example of a focus group is the Sublette County Childcare Coalition which formed as a result of population growth and an overcrowding of daycares (Sublette County Childcare Coalition 2009)

8.2 MONITORING PLAN

8.2.1 Oil and Gas Activity

8.2.1.1 *Oil and Natural Gas Prices*

Wyoming sweet first purchase price has been decreasing since June 2008. Table 8-2 and Figure 8-1 illustrate this trend.

Table 8-2 Wyoming sweet first purchase prices, 2008 (Energy Information Administration 2009)

Time	Dollars per Barrel
Jan-2008	$82.87
Feb-2008	$84.59
Mar-2008	$94.62
Apr-2008	$103.25
May-2008	$115.99
Jun-2008	$123.81
Jul-2008	$122.59
Aug-2008	$106.34
Sep-2008	$90.07
Oct-2008	$61.68
Nov-2008	$44.94
Dec-2008	$30.06

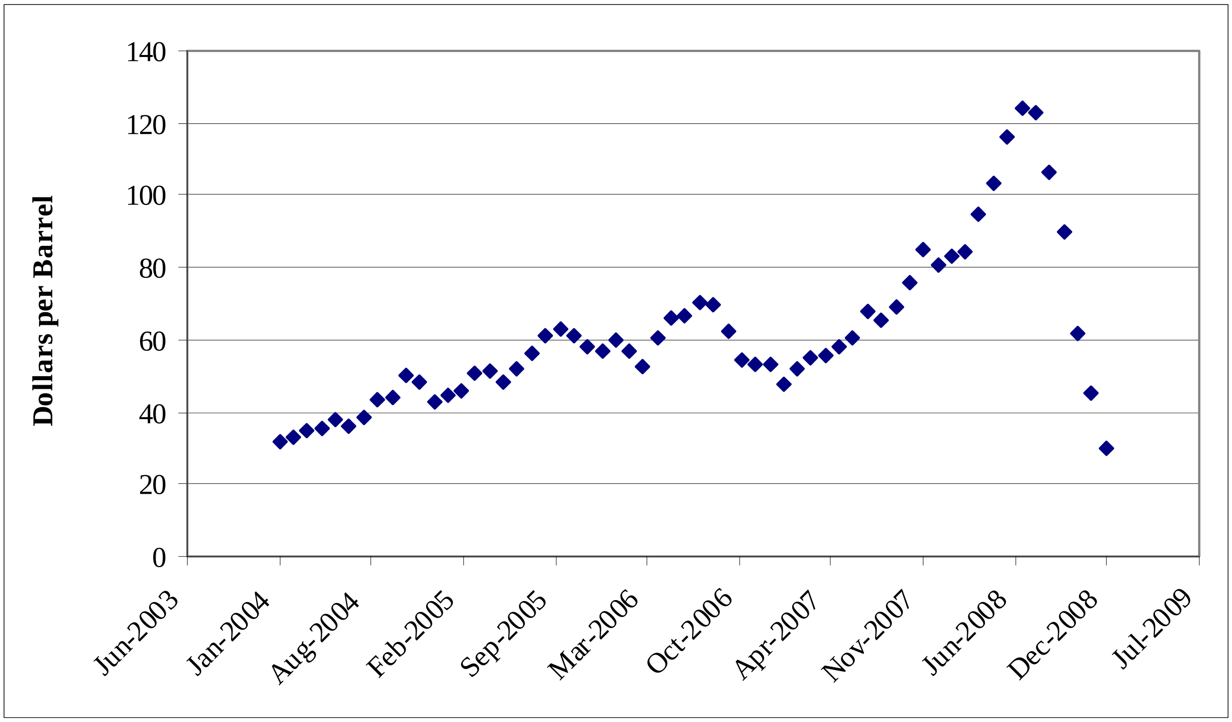


Figure 8-1 Wyoming sweet first purchase prices, January 2004–December 2008 (Energy Information Administration 2009)

8.2.1.2 *Rig months, oil and gas wells (1) in operation and (2) 10-year projected drilling activity*

Table 8-3 reports recent rig counts in Sublette County and Table 8-4 shows the total oil and gas wells in operation from 2009 to 2020.

Table 8-3 Rigs working per month in Sublette County (Baker Hughes 2009)

Month, Year	Rigs per Month
October 2008	47.00
November 2008	44.25
December 2008	44.50
January 2009	39.80
February 2009	37.00
March 2009	30.75
April 2009	26.00
May 2009	24.25
June 2009	21.00

Table 8-4 Oil and gas wells in operation, 2000–2008 (Wyoming Oil and Gas Commission 2007)

Year	Wells in Production
2000	1,733
2001	1,930
2002	2,114
2003	2,306
2004	2,339
2005	2,625
2006	3,035
2007	3,436
2008	4,274

Table 8-5 Expected increase in wells from the PAPA and Jonah fields and in Sublette County as a whole (USDI 2006; Wyoming Oil and Gas Conservation Commission 2009)

Fiscal Year	Expected Wells Drilled	Total Wells in Sublette County
2009	445	4,719
2010	470	5,189
2011	469	5,658
2012	395	6,053
2013	264	6,317
2014	264	6,581
2015	269	6,850
2016	288	7,138
2017	347	7,485
2018	315	7,800
2019	430	8,230
2020	345	8,575

Sublette County's production is estimated at 2008's average production per well of 267,588 mcf/well times the estimated number of wells (Wyoming Oil and Gas Conservation Commission 2009). The state production estimates by CREG do not include the increases in wells estimated from the PAPA and Jonah fields in Sublette County.

Table 8-6 Natural gas production projections as of May 2009 (mcf) (CREG 2009)

Fiscal Year	State Production	Sublette County Production
2009	2,540,300,000	1,262,747,772
2010	2,616,500,000	1,388,514,132
2011	2,695,000,000	1,514,012,904
2012	2,775,900,000	1,619,710,164
2013	2,859,200,000	1,690,353,396
2014	2,945,200,000	1,760,996,628

8.2.2 Demographics

8.2.2.1 *Population*

Census population counts are made every ten years; population counts in intermediate years are estimates (2001-2010 below).

Table 8-7 Population estimates for Sublette County and Municipalities 2000-2010 (Wyoming Department of Administration and Information 2008)

Year	Big Piney	Marbleton	Pinedale	Sublette County
2000	408	720	1,402	5,920
2001	404	712	1,383	5,897
2002	421	742	1,433	6,145
2003	431	762	1,479	6,317
2004	438	780	1,545	6,575
2005	451	806	1,647	6,880
2006	453	848	1,818	7,241
2007	476	919	2,043	7,925
2008	501	967	2,150	8,340
2009	526	1,015	2,256	8,750
2010	551	1,063	2,364	9,170
Percentage Growth	35.0%	47.6%	68.6%	54.9%

8.2.2.2 *Oil and Gas Workers and Dependents*

Table 8-8 Number of personnel and family members living in Sublette County (Ecosystem Research Group 2008a)

Year	Workers and Family Members
2007	1,478
2008	1,702
2009	1,630

Table 8-9 shows the intercensal and industry population estimates for 2009 to 2018. For 2010 to 2018, ERG estimated the industry workforce from industry's estimates for 2007–2009. Recognizing that these values are only approximations, ERG treated the sum as a midpoint with a deviation of plus or minus 15%. Thus the total population projection value of 10,380 residents in 2009 could range from a low of 8,823 to a high of 11,937.

Table 8-9 Sublette County total population estimates (Ecosystem Research Group 2008a; Wyoming Department of Administration and Information 2008)

Year	Census Estimate	Industry Estimate	Total Population Estimate	Low Population Projection	High Population Projection
2009	8,750	1,630	10,380	8,823	11,937
2010	9,170	1,638	10,808	9,187	12,429
2011	9,600	1,552	11,152	9,479	12,825
2012	10,050	1,524	11,574	9,838	13,310
2013	10,420	1,557	11,977	10,180	13,774
2014	10,800	1,141	11,941	10,150	13,732
2015	11,200	1,122	12,322	10,474	14,170
2016	11,600	1,116	12,716	10,809	14,623
2017	12,020	1,109	13,129	11,160	15,098
2018	12,460	1,122	13,582	11,545	15,619

8.2.3 Economic Activity (by county unless otherwise noted)

8.2.3.1 *Estimated Oil and Gas Industry Employment Including Subcontractors*

Oil and gas industry employment projections are from industry responses to ERG's survey (see Appendix A). Survey responses were received from eight of the 23 companies surveyed. Results indicate that employment is expected to remain relatively stable until 2013. At that time employment will decrease by approximately 500 employees and remain at that level until 2018. Table 8-10 and Figure 8-2 present this information, separated into development phases or work tasks. Note that these estimates are subject to change due to economic conditions and/or changes in gas or oil prices.

Table 8-10 Total FTE projections by phase, 2009-2018 (Ecosystem Research Group 2008a)

Phase	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Development Phase										
Drilling	1,137	1,176	1,199	1,217	1,238	713	689	666	642	642
Completion	151	151	151	108	108	108	108	108	108	108
Production	377	390	404	420	437	454	470	486	501	515
Reclamation and Pad Construction	210	194	127	94	90	78	61	61	61	61
Other										
Workover	53	53	59	66	73	74	74	75	75	76
Miscellaneous Employment	85	85	0	0	0	0	0	0	0	0
Total Employment	**2,012**	**2,047**	**1,940**	**1,905**	**1,946**	**1,426**	**1,403**	**1,395**	**1,387**	**1,402**

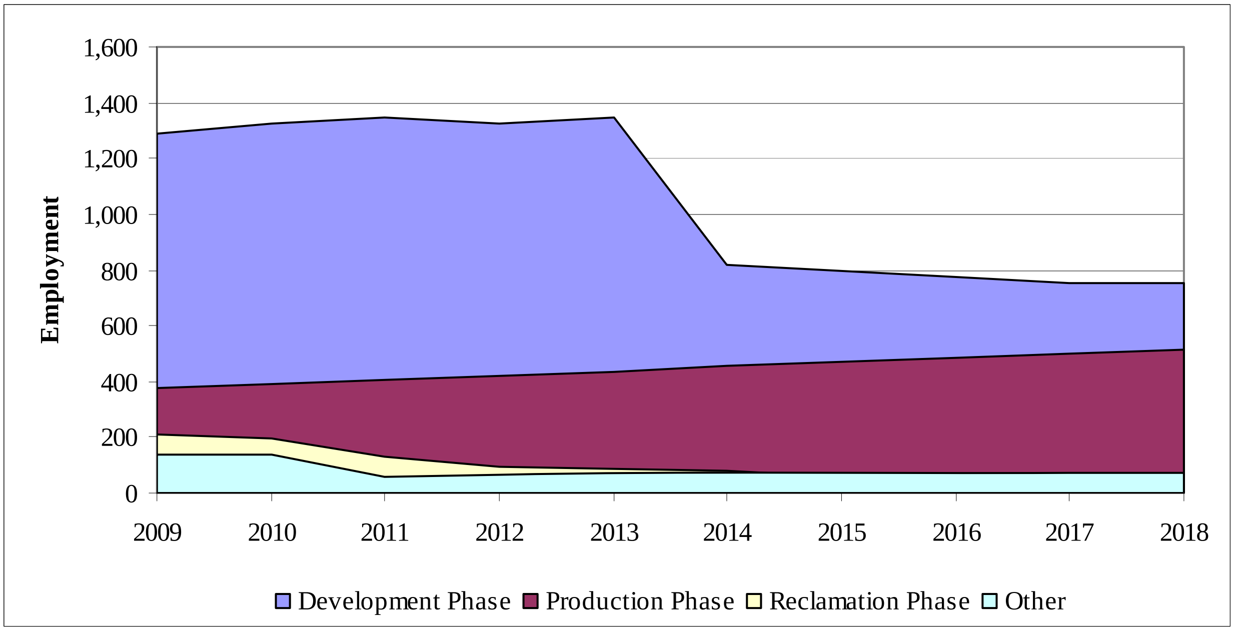


Figure 8-2 Total FTE projections by phase, 2009-2018 (Ecosystem Research Group 2008a)

8.2.3.2 *Employment by Sector*

The top four employment sectors in Sublette County are Mining; Retail Trade; Arts, Food and Accommodation; and Construction and Manufacturing. Other sectors, such as Transportation; Utilities; Finance; Professional Services; and Agriculture employ a smaller segment of the working population. Table 8-11 shows historical employment levels for various sectors between 2001 and 2007.

Table 8-11 Total employees per sector (United States Department of Labor 2008b)

Sector	2001	2002	2003	2004	2005	2006	2007	% Change 2001 to 2007
Agriculture, Forestry, Fishing and Hunting	88	91	94	92	93	79	85	-3.4%
Finance and Insurance	42	61	61	63	71	86	90	114.3%
Information	33	35	32	37	57	51	37	12.1%
Other Services such as Public Administration	68	71	74	92	94	99	105	54.4%
Professional and Technical Services	100	86	87	83	112	131	139	39.0%
Real estate, Rental and Leasing	27	29	27	25	29	44	46	70.4%
Transportation and Warehousing	51	54	60	64	88	127	206	303.9%

Sector	2001	2002	2003	2004	2005	2006	2007	% Change 2001 to 2007
Utilities	0	0	23	24	30	41	56	N/A
Wholesale and Retail Trades	275	301	301	314	347	408	477	73.5%
Mining	279	329	478	583	680	946	1,570	462.7%
Construction and Manufacturing	297	316	321	433	613	701	752	153.2%
Arts, Food and Accommodation	328	354	361	398	441	518	514	56.7%

The Mining Sector shows an employment increase of 462.7% from 2001 to 2007. As people working in the Mining Sector report large annual incomes, increases in employment in this sector change the dynamics in Sublette County; people commute and move into the area for work and those working in the Mining Sector earn more than those in other sectors (see Table 8-12).

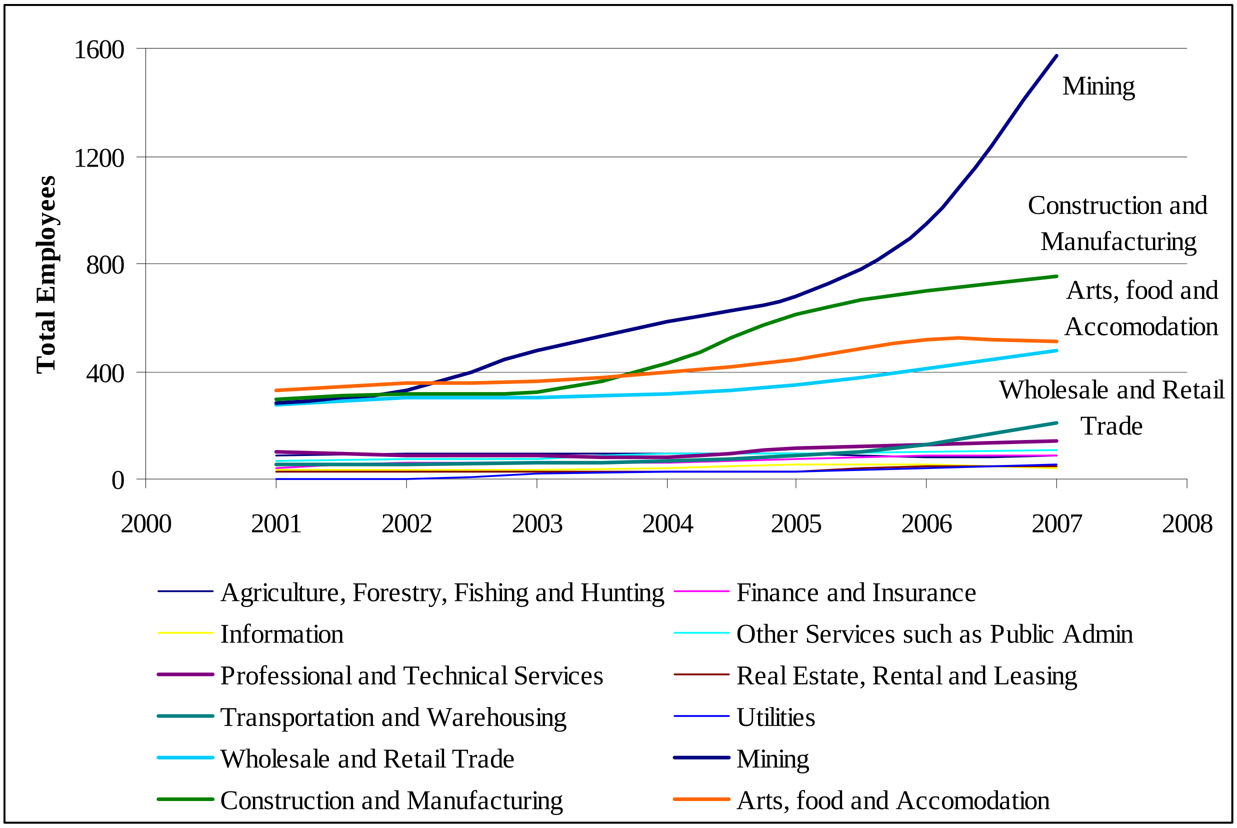


Figure 8-3 Total employees per sector (United States Department of Labor 2008b)

8.2.3.3 *Personal Income by Sector and Non-Labor Income*

Wages in the Mining Sector are much higher than other sectors in Sublette County and have steadily increased over time. Table 8-12 and Figure 8-4 depict average annual wages by sector in Sublette County between 2001 and 2007. Although lower in comparison with the Mining Sector, wages in the Arts, Construction, and Retail Sectors have consistently increased over the last few years.

Table 8-12 Average annual wages by sector for Sublette County (United States Department of Labor 2008b)

Sector	2001	2002	2003	2004	2005	2006	2007
Arts, Food and Accommodation	$16,492	$14,309	$14,848	$14,889	$22,157	$24,616	$31,147
Construction and Manufacturing	$22,798	$22,493	$25,097	$27,397	$34,101	$36,711	$42,294
Mining	$45,668	$51,845	$49,636	$53,501	$61,196	$67,205	$76,495
Retail Trade	$17,443	$17,668	$19,362	$20,353	$21,727	$24,384	$27,357

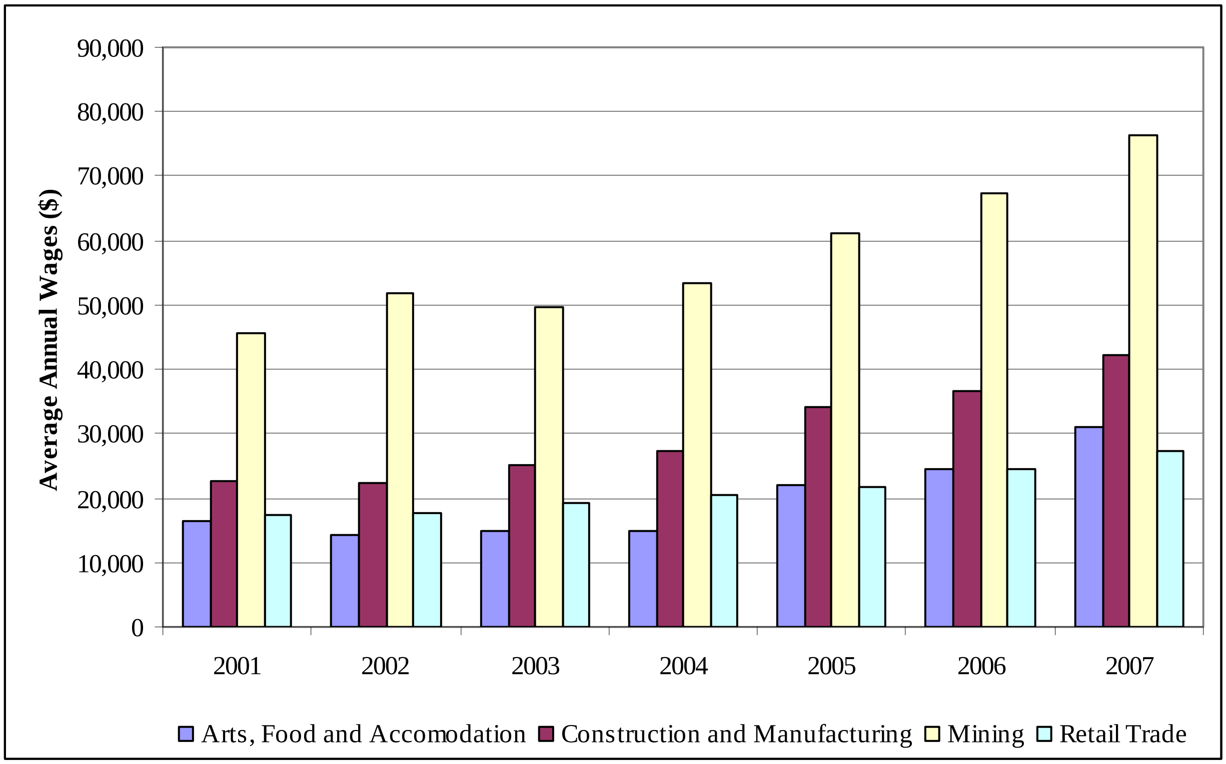


Figure 8-4 Average annual wages by sector for Sublette County (United States Department of Labor 2008b)

Non-labor income consists of money earned from investments and payments from governments to individuals such as Medicare, Social Security, unemployment compensation, disability insurance payments, and welfare (Headwaters Economics 2008). The proportion of non-labor income earned in Sublette County has fallen since 1995, indicating higher labor-earned income; this proportion peaked in the late 1990s and early 2000s, right before the Mining Sector emerged in Sublette County with high income and employment.

Table 8-13 Labor and Non-Labor Income (Headwaters Economics 2008)

Income in Millions of 2006$[11]	1995	1995 % of Total	2006	2006 % of Total
Total Personal Income	149	100%	355	100%
Labor Sources	87	58%	250	70%
Non-Labor Sources	62	42%	105	30%

[11] Percentages do not add to 100 because of adjustments made by BEA, such as residence, social security, and others.

8.2.3.4 *Income Distribution*

Income in Sublette County is becoming more evenly distributed, as indicated by Sublette County's EPS Profile (Headwaters Economics 2009). Sublette County's changes in income distribution correlate with rises in income and a reduction in the unemployment rate, as more Sublette County residents are able to find employment.

> In 1999, for every household that made over $100,000, there were 5.1 households that made under $30,000. Ten years earlier [in 1999], for every household that made over $100,000, there were 17.2 households that made under $30,000.

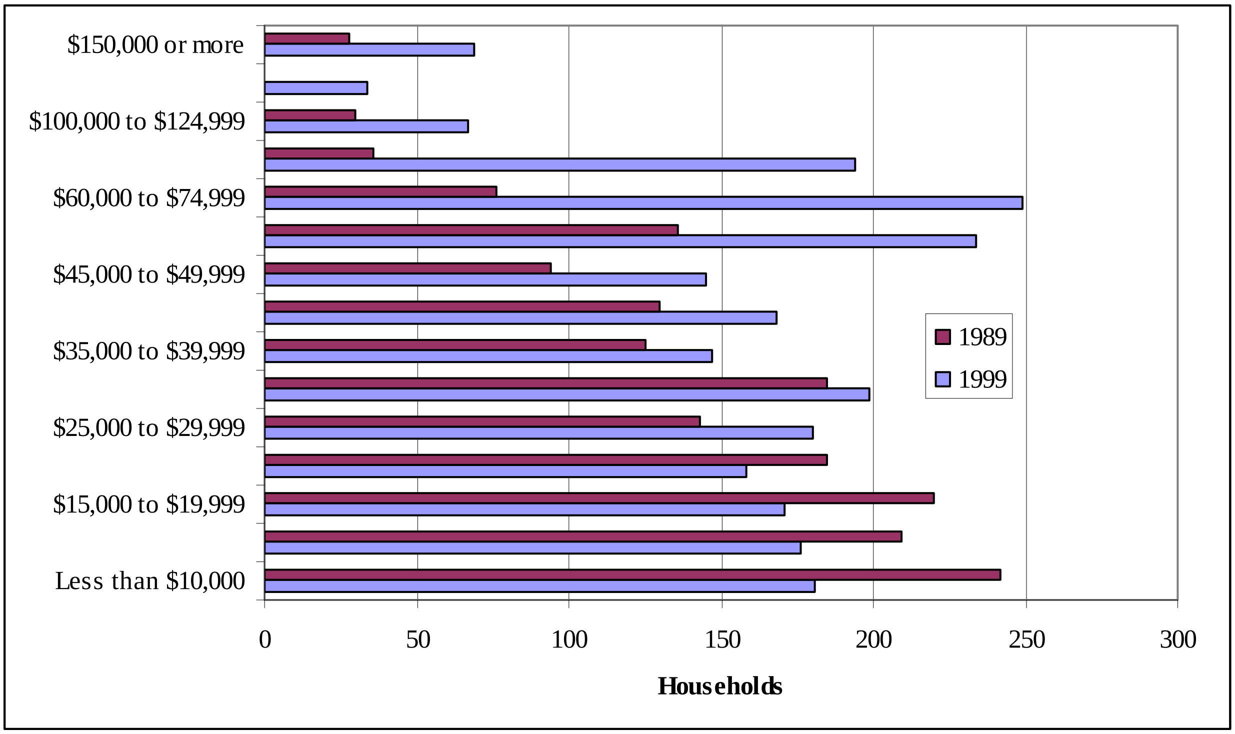


Figure 8-5 Housing income distribution not adjusted for inflation (Headwaters Economics 2008)

8.2.3.5 *Unemployment Rate*

Unemployment in Sublette County has declined since 2003. Although this trend parallels the state and nation, the county's 1.5% unemployment rate is lower than Wyoming's 3% rate and much lower than that of the nation's 4.6% rate. According to letters from the towns of Marbleton and Big Piney, employers in Sublette county often struggle to find employees to fill vacancies because unemployment levels are so low (Town of Big Piney 2007a; Town of Marbleton 2007a).

Table 8-14 Unemployment rates for the United States, Wyoming, and Sublette County, 2000–2007 (United States Department of Labor 2008b)

Fiscal Year	Sublette County	Wyoming	United States
2000	2.9%	3.8%	4.0%
2001	2.7%	3.9%	4.7%
2002	2.9%	4.2%	5.8%
2003	3.1%	4.5%	6.0%
2004	2.4%	3.9%	5.5%
2005	2.1%	3.7%	5.1%
2006	1.8%	3.2%	4.6%
2007	1.5%	3.0%	4.6%

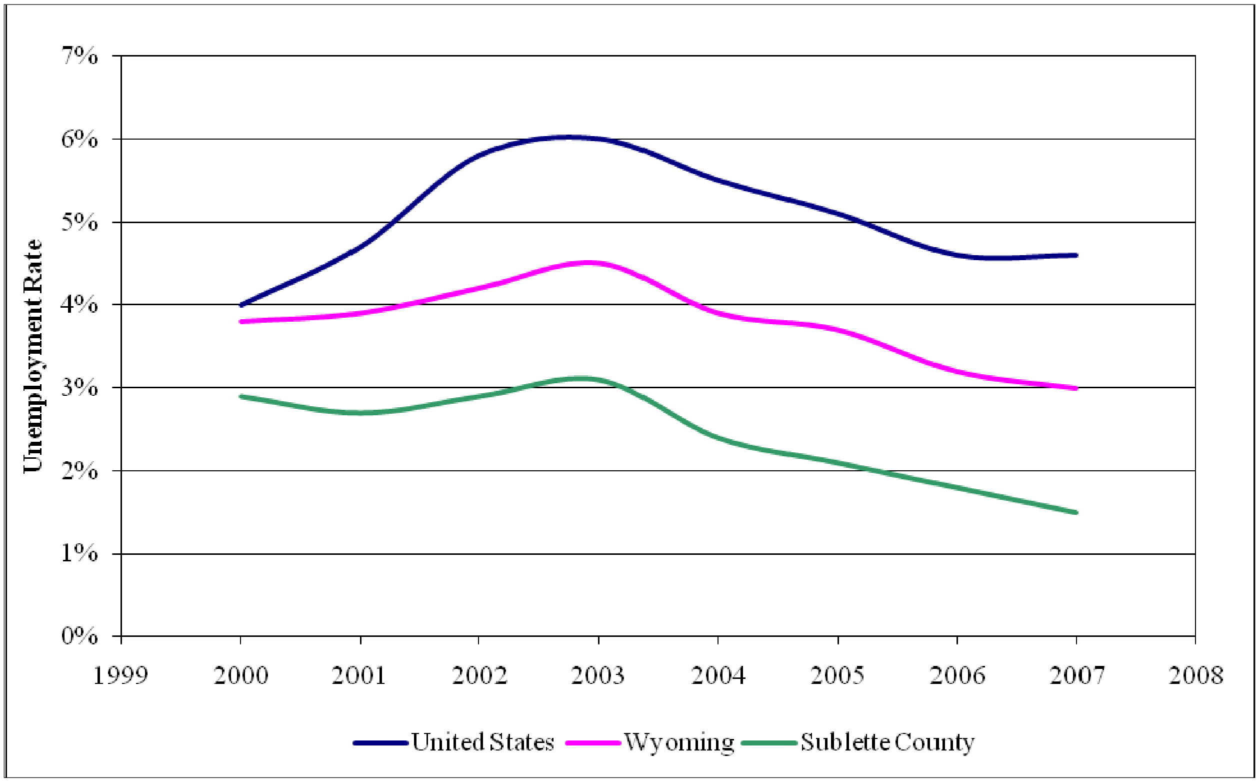


Figure 8-6 Unemployment rates for the United States, Wyoming, and Sublette County, 2000–2007

8.2.3.6 *Employment Diversity/ Specialization*

Sublette County is specialized with a specialization score of 430. A diverse county (structurally identical to the U.S. as a whole) would have a score of 0. Employment diversity indicates that a county is more able to adapt to changing economic conditions. However, Sublette County is by no means the most specialized county in the United States, as the largest score is 3,441 (Headwaters Economics 2009).

8.2.4 Revenues

8.2.4.1 *Wyoming Share of FMR*

The Federal Minerals Management Service is responsible for managing receipt and disbursement of FMR dollars. Funds are tracked several ways, including by county of origin. Table 8-15 shows the historical return of FMR taxes to Wyoming, identifying those funds attributed to production in Sublette County. As the data indicate, the percentage of total Wyoming FMR attributed to Sublette County energy extraction increased between 1996 and 2008.

Table 8-15 FMR funds returned to Wyoming (Federal Mineral Management Service 2009)

Fiscal Year	Total FMR Returned to Wyoming	FMR Returned to Wyoming Attributed to Production in Sublette County	Percentage of Returned FMR Attributed to Production in Sublette County
1996	$199,332,807	$8,778,314	4.40%
1997	$239,027,489	$16,897,025	7.07%
1998	$237,179,528	$23,811,308	10.04%
1999	$231,453,518	$21,659,476	9.36%
2000	$319,648,502	$40,423,327	12.65%
2001	$448,774,537	$80,604,143	17.96%
2002	$359,386,326	$43,746,086*	12.17%
2003	$467,266,554	$97,480,988	20.86%
2004	$564,332,554	$146,988,469	26.05%
2005	$878,524,871	$201,760,098	22.97%
2006	$1,072,479,293	$299,507,988	27.93%
2007	$925,261,906	$237,362,628	25.65%
2008	$1,270,987,013	$390,813,908	30.83%

* January to May 2002 data not available due to federal litigation issues.

Table 8-16 FMR taxes paid on production in Sublette County (Federal Mineral Management Service 2009)

Fiscal Year	FMR Taxes Paid on Production in Sublette County
1996	$17,556,329
1997	$33,794,063
1998	$47,622,547
1999	$43,318,953
2000	$80,846,655
2001	$161,208,285
2002	$87,492,172*
2003	$194,961,976

Fiscal Year	FMR Taxes Paid on Production in Sublette County
2004	$293,976,937
2005	$403,520,197
2006	$599,015,975
2007	$474,725,255
2008	$781,627,816

* January to May 2002 data not available due to federal litigation issues.

Final distribution of FMR funds to Sublette County municipalities is summarized in Table 8-17. Note that FMR funds are distributed only to municipalities and not to counties. It is interesting to see that while Sublette County operators paid over $781.6 million in FMR taxes during 2008, only $324,594, or 0.04%, was directly returned to the area. Furthermore, even though the total amount of FMR funds returned to Wyoming in 2008 was $1,270,987,013, the percentage distributed to Big Piney, Pinedale, and Marbleton was 0.03%.

Table 8-17 Historical State FMR distributions to Big Piney, Marbleton, and Pinedale (Wyoming State Treasurer's Office 2009)

Fiscal Year	Total FMR Distributed to Wyoming	FMR Distributed to Big Piney	FMR Distributed to Marbleton	FMR Distributed to Pinedale	Total County-wide FMR Distribution	Percentage of Total FMR Received
2000	$319,648,502	$65,833	$85,987	$147,232	$299,052	0.09%
2001	$448,774,537	$62,245	$85,014	$147,324	$294,583	0.07%
2002	$359,386,326	$57,118	$89,326	$160,761	$307,205	0.09%
2003	$467,266,554	$53,180	$82,376	$147,132	$282,688	0.06%
2004	$564,332,554	$53,257	$82,512	$147,399	$283,168	0.05%
2005	$878,524,871	$54,101	$84,001	$150,319	$288,421	0.03%
2006	$1,072,479,293	$55,198	$85,938	$154,118	$295,254	0.03%
2007	$925,261,906	$57,876	$90,664	$163,385	$311,926	0.03%
2008	$1,270,987,013	$59,911	$94,255	$170,428	$324,594	0.03%

8.2.4.2 *Wyoming Severance Tax*

Table 8-18 describes severance tax information for 2000 through 2008, which bears a strong similarity to trends seen with FMR payments. Mineral extraction in Sublette County has risen from just over 9% in 2000 to approximately 25% of 2008's statewide mineral taxable valuation. Accordingly, energy operators paid just over $250 million to the state of Wyoming in severance tax receipts.

Table 8-18 Historical Wyoming severance tax collections (Wyoming Legislative Handbooks 2007, 2009)

Fiscal Year	Statewide Severance Tax Revenues	Severance Taxes Paid on Production in Sublette County	Sublette County Percentage of Mineral Taxable Valuation
2000	$275,122,976	$25,173,752	9.15%
2001	$447,973,278	$51,516,927	11.50%
2002	$299,433,961	$43,178,377	14.42%
2003	$429,126,222	$60,764,273	14.16%
2004	$563,566,928	$122,970,304	21.82%
2005	$726,656,854	$180,937,557	24.90%
2006	$1,001,076,918	$279,800,999	27.95%
2007	$863,798,920	$224,587,719	26.00%
2008	$1,093,952,011	$269,440,380	24.63%

As seen with FMR funds, severance distributions to Sublette County and its municipalities ranged from 0.02% to 0.09% over the past seven years. Table 8-19 depicts state severance tax revenues and Sublette County/municipality distributions from 2000 through 2008.

Table 8-19 Severance tax distributions to Sublette County and municipalities (Wyoming Department of Revenue 2009; Legislative Handbooks 2007, 2009)

Fiscal Year	Statewide Severance Tax Revenues	Big Piney Distribution	Marbleton Distribution	Pinedale Distribution	Sublette County Distribution	Total Distribution	Percent of Total Revenue
2000	$275,122,976	$25,161	$35,136	$65,451	$60,952	$186,700	0.06%
2001	$447,973,278	$47,812	$71,604	$135,662	$154,042	$409,120	0.09%
2002	$299,433,961	$21,790	$38,453	$75,412	$97,554	$233,209	0.08%
2003	$429,126,222	$18,377	$32,430	$63,599	$67,414	$181,820	0.04%
2004	$563,566,928	$17,788	$31,390	$61,559	$74,857	$185,594	0.03%
2005	$726,656,854	$18,227	$32,165	$63,079	$71,902	$185,373	0.02%
2006	$1,001,076,918	$19,040	$33,599	$65,892	$72,776	$191,305	0.02%
2007	$863,798,920	$19,492	$34,398	$67,459	$73,055	$194,402	0.02%
2008	$1,093,952,011	$18,584	$32,796	$64,316	$69,314	$185,008	0.02%

8.2.4.3 *County Property Tax Revenues by Source Including Ad Valorem Oil and Gas Production Tax*

The Wyoming Department of Revenue administers the county ad valorem tax. For county residents, this is generally known as property taxes levied on homes and personal property. For the energy industry, this revenue stream is based on the taxable value of minerals (as determined by the Department of Revenue) produced during the previous calendar year and the applicable tax district mill levy (as set by the county and each tax district). The ad valorem tax is billed and collected annually by each county and is often reported as a component of property tax. In Sublette County, the ad valorem revenue from oil and gas entities is the most financially significant component assessed for taxation. Table 8-20 displays recent ad valorem revenues for Sublette County, delineating the contribution from the energy industry.

Table 8-20 Sublette County ad valorem taxes assessed, 2000–2008 (Wyoming Department of Revenue 2009)

Fiscal Year	Total Ad Valorem Taxes Assessed	Ad Valorem Taxes Paid by Energy Operators	Industrial and Personal Property Taxes	Percentage of Ad Valorem Taxes Paid by Energy Operators
2000	$5,702,263	$4,466,583	$1,235,680	78.33%
2001	$10,207,862	$8,840,008	$1,367,854	86.60%
2002	$13,150,261	$11,649,816	$1,500,445	88.59%
2003	$11,206,742	$9,544,782	$1,661,960	85.17%
2004	$24,463,210	$22,559,972	$1,903,238	92.22%
2005	$35,078,515	$32,812,443	$2,266,072	93.54%
2006	$52,812,941	$49,992,730	$2,820,211	94.66%
2007	$48,999,127	$45,485,890	$3,513,237	92.83%
2008	$45,260,346	$40,892,723	$4,367,623	90.35%

Table 8-21 provides historical data on sales and use tax distributions between 1989 and 2008. Detailed distribution data are not available from the Wyoming Department of Revenue for 1996. In all cases this revenue stream increased noticeably in 1998 and 2001 and maintained double-digit growth between 2003 and 2007. Overall, receipts grew exponentially during this twenty year period, ranging from a low of 3,182% for Big Piney to 5,600%-5,900% for Marbleton, Pinedale, and Sublette County. It should be noted that the revenue generated through sales and use tax is the major stream of income for the towns in Sublette County.

Table 8-21 Sales and use tax annual distribution and change (Wyoming Department of Revenue 2009)

Fiscal Year	Big Piney	Marbleton	Pinedale	Sublette County	County-wide Sales and Use Distributions
1989	$51,880	$52,593	$104,384	$236,467	$445,324
1990	$71,579	$72,563	$144,019	$326,255	$614,416
1991	$71,287	$73,587	$145,467	$328,761	$619,102
1992	$60,194	$84,092	$156,685	$341,443	$642,414
1993	$57,918	$80,913	$150,761	$328,534	$618,126
1994	$63,285	$88,410	$164,730	$358,975	$675,400
1995	$73,719	$102,986	$191,889	$418,160	$786,754
1996	$70,914	$99,068	$184,590	$402,253	$756,825
1997	$96,901	$135,351	$252,168	$549,552	$1,033,972
1998	$200,973	$289,555	$513,892	$1,139,434	$2,143,854
1999	$216,458	$302,278	$563,076	$1,227,229	$2,309,041
2000	$231,331	$323,049	$601,767	$1,311,557	$2,467,704
2001	$402,442	$562,000	$1,046,881	$2,281,686	$4,293,009

Fiscal Year	Big Piney	Marbleton	Pinedale	Sublette County	County-wide Sales and Use Distributions
2002	$399,802	$705,533	$1,383,628	$3,312,084	$5,801,047
2003	$418,178	$737,961	$1,447,224	$3,507,905	$6,111,268
2004	$567,647	$1,010,272	$2,044,204	$4,729,477	$8,351,600
2005	$789,003	$1,401,281	$2,831,643	$6,614,682	$11,636,609
2006	$1,105,566	$1,958,458	$3,980,769	$9,233,764	$16,278,557
2007	$1,620,713	$2,862,616	$5,771,071	$13,499,463	$23,753,863
2008	$1,702,453	$3,008,499	$6,074,692	$14,187,892	$24,973,536

In 2002 the Wyoming Department of Revenue began to provide detailed information on sales and use tax receipts by business class. Table 8-22 illustrates that the Mining Sector is responsible for approximately half of the sales and use taxes generated within Sublette County. Thus, as sales and use tax receipts are the primary source of revenue for the towns, it follows that the Mining Sector is a major contributor of this revenue stream.

Table 8-22 Sublette County sales and use tax gross receipts by business class (Wyoming Department of Revenue 2009)

Fiscal Year	County-wide Sales and Use Taxes	County-wide Sales and Use Taxes Generated by Mining Sector	Percentage of Sales and Use Taxes Generated by Mining Sector
2002	$21,059,373	$9,877,876	47%
2003	$21,082,472	$9,324,467	44%
2004	$28,291,190	$14,158,341	50%
2005	$37,580,227	$18,615,522	50%
2006	$52,568,766	$26,543,808	50%
2007	$76,905,734	$39,215,156	51%
2008	$80,826,078	$41,612,387	51%

In 1976, congress authorized federal land management agencies to share income with states and counties with the payment in lieu of taxes (PILT) program. Forty-nine percent of Wyoming is owned and managed by the Federal government and this payment helps to offset lost revenue that states and counties would otherwise receive from private land (University of Wyoming 2009). Sublette County's PILT distributions from 2000 to 2008 are provided in Table 8-23. PILT is distributed according to the number of entitlement acres; Sublette County has 2,431,285 entitlement acres (University of Wyoming 2009).

Table 8-23 Sublette County PILT revenue, 2000–2008 (University of Wyoming 2009)

Fiscal Year	Payment per Entitlement Acre	PILT Revenue
2000	$0.11	$256,483
2001	$0.15	$371,922

Fiscal Year	Payment per Entitlement Acre	PILT Revenue
2002	$0.16	$391,914
2003	$0.18	$442,097
2004	$0.19	$461,105
2005	$0.20	$481,089
2006	$0.20	$491,999
2007	$0.20	$487,682
2008	$0.20	$484,197

Table 8-24 displays income received by Sublette County and the towns of Big Piney, Marbleton, and Pinedale from the same four revenue streams. In direct contrast to taxes paid by energy companies, ad valorem and sales and use taxes comprise over 90% of monies received by local governments in the county.

Table 8-24 Summary of county-wide operator-paid taxes received in Sublette County (Wyoming Department of Revenue 2009; Wyoming State Treasurer's Office 2009)

Fiscal Year	FMR Taxes Received County-wide	Severance Taxes Received County-wide	Ad Valorem Taxes Received County-wide	Sales and Use Taxes Received County-wide	Total Taxes Received County-wide
2000	$299,052	$186,700	$4,466,583	$2,467,703	$7,420,038
2001	$294,583	$409,120	$8,840,008	$4,293,007	$13,836,718
2002	$307,205	$233,209	$11,649,816	$5,801,045	$17,991,275
2003	$282,688	$181,820	$9,544,782	$6,111,266	$16,120,556
2004	$283,168	$185,594	$22,559,972	$8,351,600	$31,380,334
2005	$288,421	$185,373	$32,812,443	$11,636,591	$44,922,828
2006	$295,254	$191,305	$49,992,730	$16,278,557	$66,757,846
2007	$311,926	$194,402	$45,485,890	$23,753,863	$69,746,081
2008	$324,594	$185,008	$40,892,723	$24,973,536	$66,375,861

8.2.5 Demand on Public Services

8.2.5.1 *Value of Proposed and Current Growth-Related Capital Improvements by Jurisdiction*

8.2.5.1.1 *Big Piney*

In their questionnaire, Big Piney estimated the cost of their paving and infrastructure projects at $7,000,000 between 2008 and 2018. A detailed list of their projected expenditures outlined in the follow-up meetings is included in Table 8-25.

Table 8-25 Big Piney upcoming infrastructure projects (Arthur 2008; Hurd 2008)

Priority	Project	Estimated Cost	Time Frame	Budget Source	Budget Amount	Shortfall
1st	Landfill groundwater monitoring	$125,000	Ongoing	Wyo Star savings	$0	$125,000
1st	Black Avenue	$856,650	2009	Town	$50,000	$806,650
1st	Mickelson Street	$520,525	2009	Town	$50,000	$470,525
1st	Noble Street	$323,375	2009	Town	$50,000	$273,375
1st	Fish Street	$320,688	2009	Town	$50,000	$270,688
1st	P.L. Lane	$634,325	2009	Town	$50,000	$584,325
1st	Miller Lane	$283,500	2009	Town	$50,000	$233,500
1st	Circle Way	$263,875	2009	Town	$50,000	$213,875
1st	Beck Street	$132,650	2009	Town	$50,000	$82,650
1st	Engineering	$767,185	2009	Town	$0	$767,185
1st	Highway 189	$361,128	2010	SLIB/Town	$0	$361,128
1st	Piney Drive	$486,030	2010	SLIB/Town	$0	$486,030
1st	Smith Avenue	$1,003,975	2010	SLIB/Town	$0	$1,003,975
1st	Fish Street	$101,750	2010	SLIB/Town	$0	$101,750
1st	Noble Street	$313,943	2010	SLIB/Town	$0	$313,943
1st	Mickelson Street	$363,005	2010	SLIB/Town	$0	$363,005
1st	Engineering	$521,801	2010	SLIB/Town	$0	$521,801
1st	Piney Drive	$632,900	2011	SLIB/Town	$0	$632,900
1st	Milleg Lane	$893,400	2011	SLIB/Town	$0	$893,400
1st	Engineering	$351,049	2011	SLIB/Town	$0	$351,049
	Total	**$9,256,754**			**$400,000**	**$8,856,754**

8.2.5.1.2 *Marbleton*

In the questionnaire, Marbleton listed their capital projects for 2009-2018 as a sewer line, new sewer facility, new water tower, truck, and lawn equipment. A detailed list of Marbleton's projected infrastructure expenditures outlined in follow-up meetings is included in Table 8-26.

Table 8-26 Marbleton upcoming infrastructure projects (Murphy 2008)

Priority	Project	Estimated Cost	Time Frame	Budget Source	Budget Amount	Shortfall
1st	Well House #7 Fluoride Treatment	$639,243	2009	Town	$48,596	$590,647
1st	Aerated Lagoon System with Power	$4,600,000	2009-10	Town	$2,679,582	$1,920,418
1st	Wind Turbines for Aerated Lagoon System	$500,000	2009-10	Town	$172,619	$327,381
1st	50,000 Gallon Water Tower Replacement	$979,800	2010-11	Town	$200,000	$779,800
2nd	Main Water Line East to West	$497,000	2009-10	Town	$100,000	$397,000
2nd	South Sewer Line Extension	$229,000	2009-10	Town	$100,000	$129,000
2nd	Alsade Drive Curb, Gutter, and Paving	$413,406	2009-10	Town	$50,000	$363,406
3rd	Eiden Subdivision Curb, Gutter, and Paving	$2,685,894	2011-12	Town	$150,000	$2,535,894
4th	Phase III of the Marbleton Street Project Sidewalks	$2,735,512	2012-13	Town	$200,000	$2,535,512
	Total	**$13,279,855**			**$3,700,797**	**$9,579,058**

8.2.5.1.3 *Pinedale*

In the questionnaire, Pinedale identified spatial expansion for the Clerk's Office, Planning and Zoning Department, and Municipal Court along with some Publics Works projects summarized in Table 8-27.

Table 8-27 Pinedale capital needs from questionnaire (Ecosystem Research Group 2008b)

Department	Capital Items	Spatial Expansion
Clerk's Office	None	$115-150,000 additional office space
Planning and Zoning	GIS database	County maintenance facility, 3 new parks of 230 acres added to town maintenance
Municipal Court	None	Facility expansion of $50-100,000

Department	Capital Items	Spatial Expansion
Public Works	SCADA water treatment system, water treatment facility and upgrades, and sludge removal and re-line	None

A series of meetings detailed Pinedale's sewer, water treatment, street, and facility needs through 2014. The complete list is included in Table 8-28.

Table 8-28 Pinedale upcoming infrastructure projects (Ninnie 2008)

Priority	Project	Estimated Cost	Time Frame	Budget Source	Budget Amount	Shortfall
1st	Phase V Sewer	$7,491,037	2010	Sales/Use tax	$2,000,000	$5,491,037
1st	Phase VI Sewer	$8,924,640	2010	Sales/Use tax	$0	$8,924,640
1st	EPA-Mandated Water Treatment	$3,800,000	2010	None	$0	$3,800,000
2nd	Street Repair/Improvements	$6,602,000	2010	None	$0	$6,602,000
2nd	Street Repair/Improvements	$5,182,000	2011	None	$0	$5,182,000
2nd	Phase VII Sewer	$7,486,384	2011	Sales/Use tax	$2,000,000	$5,486,384
2nd	Street Repair/Improvements	$4,544,000	2012	None	$0	$4,544,000
3rd	Phase VIII Sewer	$7,694,490	2012	None	$2,000,000	$5,694,490
3rd	Street Repair/Improvements	$4,307,000	2013	None	$0	$4,307,000
4th	Phase IX Sewer	$6,111,828	2013	Sales/Use tax	$2,000,000	$4,111,828
4th	Street Repair/Improvements	$1,368,000	2014	None	$0	$1,368,000
4th	Water Meter System	$3,200,000	2013	None	$0	$3,200,000
5th	Phase X Sewer	$2,755,689	2014	Sales/Use tax	$2,000,000	$755,689
5th	Town Hall	$5,500,000	2014	None	$0	$5,500,000
5th	Sewer Lagoon Expansion	$4,500,000	2014	None	$0	$4,500,000
5th	Water Meter System	$2,800,000	2014	None	$0	$2,800,000
	Total	**$82,267,068**			**$10,000,000**	**$72,267,068**

8.2.5.1.4 *Sublette County*

Sublette County government departments listed estimated departmental spatial expansion and capital items in their responses to ERG's questionnaires. These estimated needs are summarized in Table 8-29.

Table 8-29 Sublette County capital needs from questionnaire (Ecosystem Research Group 2008b)

Department	Capital Items	Spatial Expansion
Assessor	16 computers, software, 2 copiers, and 5 printers	500 square foot expansion increases existing space by 30%
Drug Court	3 computers, office furniture, upgraded urinalysis testing machinery, drug monitoring technology, and GPS locators	Double office space, add small lab facilities in new justice center
Emergency Management/ Sheriff's Office	Vehicles and support equipment	New law enforcement complex
GIS	Computer and plotter	None
Road and Bridge	Road project and construction equipment	None
Treasury	None	Space needed
Zoning and Planning	1 Computer per year	None
Elections	2 file cabinets, 2 computers, and trailer equipment	None
Environmental Health	2 computer stations, office furniture, bacteria water testing lab	400 square foot facility expansion triples existing space
Public Health	None	Spatial increase of 10% in conjunction with county building remodel
Waste Management	Cell construction for landfill air space, various equipment, and loader/dozer/trash compactor	20 acre expansion increases existing space by 50%

In follow-up meetings, Sublette County identified road projects anticipated through 2012 and potentially beyond. A detailed list of these projects follows in Table 8-30.

Table 8-30 Sublette County upcoming infrastructure projects (Lankford 2008)

Priority	Project	Estimated Cost	Time Frame	Budget Source	Budget Amount	Shortfall
1st	Calpet Highway	$25,000,000	2009-10	County	$3,000,000	$22,000,000
1st	Dry Piney Road	$10,000,000	2009-10	County	$0	$10,000,000
2nd	Guios Road	$6,000,000	2009-10	County	$0	$6,000,000

Priority	Project	Estimated Cost	Time Frame	Budget Source	Budget Amount	Shortfall
2nd	Horse Creek Road	$600,000	2009-10	County	$0	$600,000
3rd	Fremont Lake Road Bridge	$600,000	2010-11	County	$0	$600,000
4th	Middle Piney Road	$7,000,000	2011-12	County	$0	$7,000,000
4th	North Piney Road	$5,000,000	2011-12	County	$0	$5,000,000
5th	Fremont Lake Road	$1,200,000	Not defined	County	$0	$1,200,000
	Total	**$55,400,000**			**$3,000,000**	**$52,400,000**

8.2.5.2 *Traffic Accidents by County*

Automobile accidents have increased with traffic in Sublette County. Figure 8-7 describes the number of accidents and the percent change in accidents for the county. Between 1995 and 2007, traffic accidents have more than doubled. Of the accidents in 2007, 2% resulted in death and 26% resulted in injury (Wyoming Department of Transportation 2009).

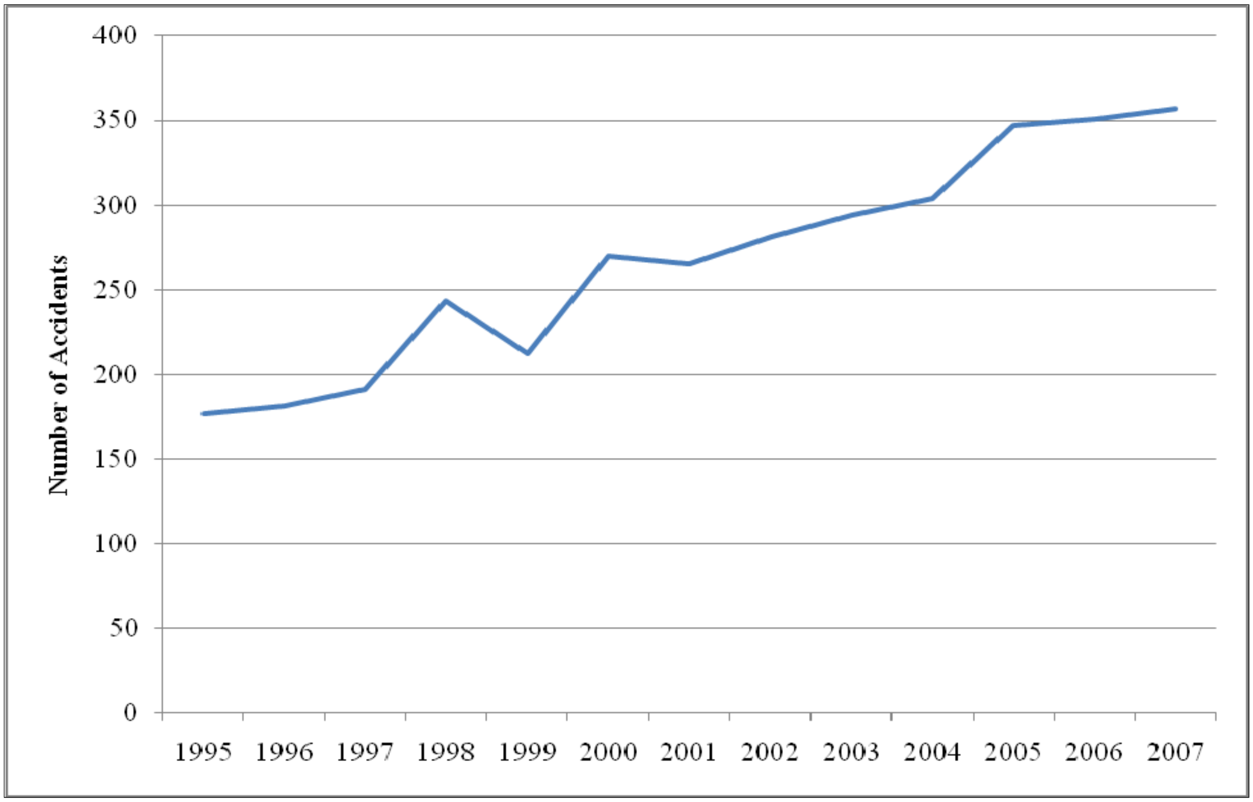


Figure 8-7 Vehicle-related accidents in Sublette County, 1995–2007 (Wyoming Department of Transportation 2009)

8.2.6 Housing

8.2.6.1 *Housing Availability: Rental Occupancy Rates*

In recent years, the Sublette County housing market has had a low vacancy rate for rental units compared to the state of Wyoming. As part of its semi-annual survey, the Wyoming Community Development Authority collects data on rental vacancy rates throughout the state. Rental units are defined as homes, apartments, mobile home lots, and mobile home lots with homes. Table 8-31 shows the vacancy rates for 2000–2008. Note that data were unavailable for the last half of 2001 and the first half of 2002 for Sublette County. Throughout the state, vacancy rates for the last half of the year are generally higher than that for the first part of the year.

Table 8-31 Rental vacancy rates in Sublette County and Wyoming (Wyoming Community Development Authority 2009)

Reporting Period	Sublette County Vacancy Rates	Wyoming Vacancy Rates
2001-1	4.88%	4.21%
2001-2	NA	4.36%
2002-1	NA	4.73%
2002-2	5.41%	4.62%
2003-1	4.00%	3.56%
2003-2	3.64%	4.10%
2004-1	1.69%	3.81%
2004-2	5.33%	4.81%
2005-1	4.17%	3.30%
2005-2	4.55%	3.51%
2006-1	1.89%	2.67%
2006-2	0.64%	2.44%
2007-1	2.29%	1.45%
2007-2	0.90%	1.81%
2008-1	2.84%	2.89%
2008-2	3.44%	3.93%

8.2.6.2 *Housing Availability: Existing Stock and New Construction of Housing Units by Category*

Residential construction has increased since 2000, as demonstrated by the increased number of residential building permits issued in Sublette County between 2000 (54 permits) and 2007 (263 permits). Residential permits are subdivided into the following categories: single family, duplex, tri- and fourplex, and multiplex (greater than four aggregate dwellings). Historical trends in building permits are summarized in Table 8-32. As illustrated, the greatest increase occurred in the single family category with 613 permits issues between 2005 and 2007. However, the number of building permits decreased over 60% between 2007 and 2008. Applications for building permits can increase when housing prices are high, often as a response to housing shortages. The decrease in building permits could indicate a decrease in the housing shortage (Meyers 2009).

Table 8-32 Building permits in Sublette County (Sublette County Planning and Zoning 2008; U.S. Census Bureau 2009)

Year	Single-Family Permits	Duplex Permits	Tri- and Fourplex Permits	Multiplex Permits	Total Residential Permits	Annual Percentage Increase in Residential Permits
2000	54	0	0	0	54	
2001	72	4	0	0	76	40.74%
2002	74	6	8	0	88	15.79%
2003	79	4	8	0	95	7.95%
2004	77	12	4	0	93	-2.11%
2005	179	0	0	6	185	98.92%
2006	177	0	0	20	197	6.49%
2007	257	6	0	0	263	33.50%
2008	100	2	3	0	105	-61.09%

8.2.6.3 *Housing Affordability*

Housing affordability is a calculation that determines the minimum income required to purchase a house of a given price. Using the average sales prices listed in Table 8-33, ERG determined the minimum income necessary to purchase a house at the average sales price in Sublette County. The following calculations assumed a 30-year fixed loan of 6% with the buyer providing 20% of the price as a down payment. Standard amortization schedules were used to determine the monthly payment, and this value was multiplied by 48 to arrive at the minimum qualifying income (National Association of Realtors 2009).

Table 8-33 Minimum qualifying income needed to purchase average home in Sublette County and Wyoming (Wyoming Community Development Authority 2009)

Year	Sublette County Average Sales Price	Minimum Qualifying Income in Sublette County	Median Family Income in Sublette County	Statewide Average Sales Price	Minimum Qualifying Income in Wyoming	Median Family Income in Wyoming
1997	$132,769	$28,224	$36,700	$91,714	$21,120	$48,412
1998	$141,904	$24,048	$36,700	$96,906	$22,320	$51,897
1999	$151,620	$26,256	$37,900	$101,517	$23,376	$55,624
2000	$174,653	$28,992	$40,400	$111,437	$25,680	$55,859
2001	$188,409	$34,368	$40,400	$116,469	$26,832	$58,541
2002	$195,077	$37,632	$40,400	$120,314	$27,888	$57,148
2003	$239,657	$39,840	$54,400	$130,294	$30,576	$56,065
2004	$264,384	$50,256	$56,300	$147,588	$32,784	$54,935
2005	$277,479	$57,312	$56,300	$160,497	$36,960	$55,250

Year	Sublette County Average Sales Price	Minimum Qualifying Income in Sublette County	Median Family Income in Sublette County	Statewide Average Sales Price	Minimum Qualifying Income in Wyoming	Median Family Income in Wyoming
2006	$334,073	$62,112	$59,400	$187,869	$43,248	$58,800
2007	$132,769	$76,896	$59,100	$265,044	$61,008	$58,500

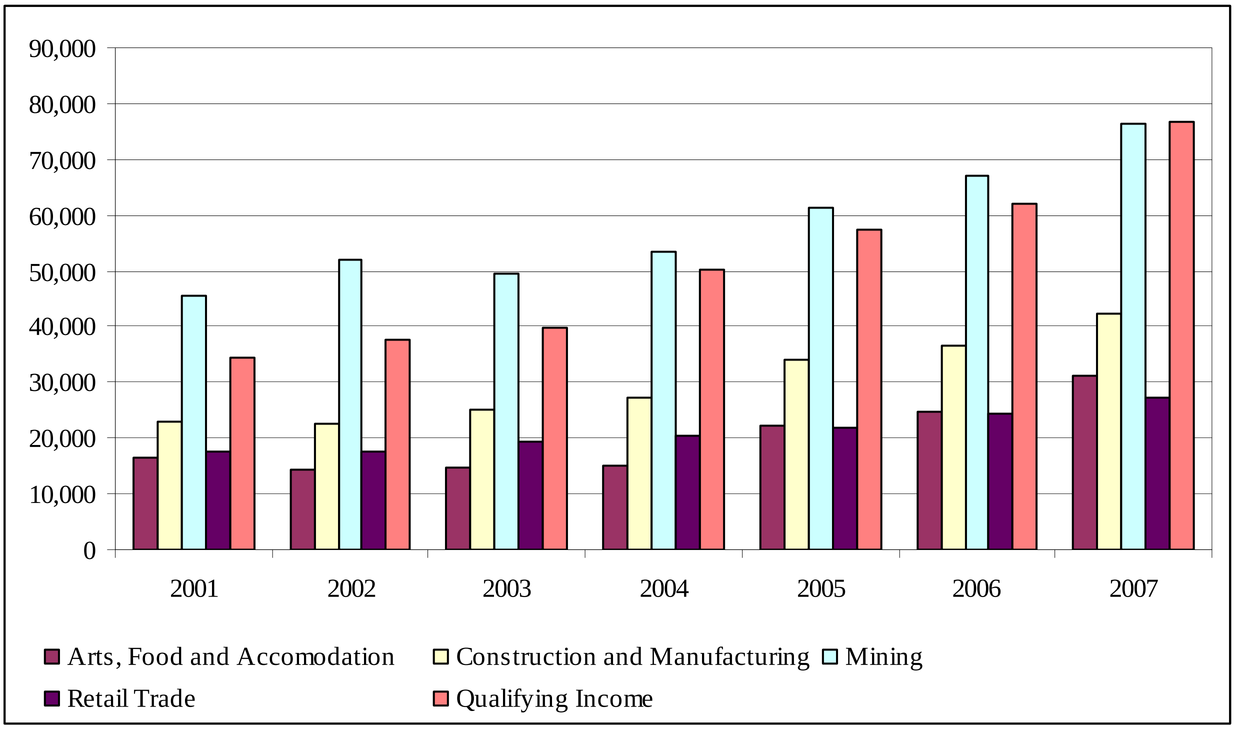


Figure 8-8 Sublette average annual income by sector and minimum qualifying income to purchase average home (Wyoming Community Development Authority 2009)

8.2.6.4 *Temporary Housing*

In 2008 and 2009, ERG administered a telephone survey to hotels, motels, and campgrounds in Sublette County. The results are summarized in Table 8-34. Respondents indicate that business has definitely increased since 2000. Of the nine businesses contacted in Sublette County, five indicated that over 75% of their visitors are from the oil and gas industry, with two businesses quoting a figure of 90%. Most establishments indicated a slight decrease in business during the winter months.

Table 8-34 Temporary housing survey (Ecosystem Research Group 2008d)

Hotel	Average Summer Visitors from Oil and Gas Industry Per Night
Baymont	148
Best Western Pinedale	94
Half Moon Motel	31
Lodge at Pinedale	69
Pine Creek Inn	32
Rivera Lodge	2
Teton Court Motel	20
Daniel Junction	5
Marbleton Inn	70
Total	**471**

Other temporary housing in the area includes EnCana's workforce facility, a semi-permanent tented housing area currently located in Jonah field that houses 150 to 200 people (Teeuwen 2009). Other oil and gas companies plan to house an additional 110 workers in similar facilities (Ecosystem Research Group 2008a). Operators also house employees in company apartments, bunkhouses, townhouses, and trailers. Industry estimated housing 55 people in this manner during 2007, 2008, and 2009 (Ecosystem Research Group 2008a).

Based on results of the telephone survey and industry questionnaire, approximately 856 people stay in temporary housing each night during the summer. With an 80% reduction in hotel occupancy during the winter, this number decreases to approximately 762 people (Table 8-35). According to Jacquet's estimate of 1,513 transient workers, this leaves approximately 657 people unaccounted for each night during the summer when peak drilling takes place. Many workers commute daily from Rock Springs and others stay in RVs and trailers outside of zoned campgrounds and trailer parks (Coburn 2009).

Table 8-35 Transient worker count by housing type and season (Ecosystem Research Group 2009)

Housing Type	Summer	Winter
Hotel	471	377
Workforce Facility	385	385
Total	**856**	**762**

8.2.7 Social Impacts

8.2.7.1 *Crimes Charged, Adult and Juvenile*

Violent index offenses including murder and non-negligent manslaughter, forcible rape, and aggravated assault, increased from two in 2000 to 17 in 2007. Property index offenses remained relatively stable, even slightly decreasing, with 25 offenses in 2000 and 22 in 2007. Table 8-36 compares the number of offenses committed by adults and juveniles in 2000 and 2007.

Table 8-36 Adult and juvenile offenses, 2000 and 2007 (U.S. Department of Justice 2007)

Classification of Offense	2000 Adult	2000 Juv.	2007 Adult	2007 Juv.
Murder and Non-Negligent Manslaughter	0	0	0	0
Forcible Rape	0	0	2	0
Robbery	0	0	0	0
Aggravated Assault	1	1	14	1
Burglary	6	3	7	1
Larceny-Theft	9	4	10	1
Motor Vehicle Theft	3	0	2	1
Total Index Offense Arrests	**19**	**8**	**35**	**4**
Manslaughter by Negligence	0	0	0	0
Arson	1	0	0	0
Other Assaults	33	0	43	5
Forgery and Counterfeiting	0	0	0	0
Fraud	9	0	5	0
Embezzlement	0	0	0	0
Stolen Property; Buy, Receive, Possess	0	0	0	0
Vandalism	5	0	2	0
Weapons; Carry, Possess, etc.	0	0	0	0
Prostitution and Commercialized Vice	0	0	0	0
Sex Offenses (Except Rape and Prostitution)	2	0	1	0
Drug Abuse Violations	14	1	40	0
(1) Sale/Manufacture Subtotal	0	0	5	0
(2) Possession Subtotal	14	1	35	0
Gambling Offenses	0	0	0	0
Offenses Against Family and Children	1	0	6	0
Driving Under the Influence	63	0	95	0

Classification of Offense	2000 Adult	2000 Juv.	2007 Adult	2007 Juv.
Liquor Laws	28	2	63	11
Drunkenness	3	0	6	0
Disorderly Conduct	0	0	4	0
Vagrancy	0	0	0	0
All Other Offenses (Except Traffic)	52	1	177	3
Suspicion	0	0	0	0
Curfew and Loitering Law Violations	NA*	0	NA	0
Run-Aways	NA	0	NA	2
Total Arrests by Age Group	**244**	**13**	**517**	**25**
Total Arrests by Year	**257**		**542**	

* Not applicable

8.2.7.2 *Circuit Court Cases*

The number of juvenile arrests rose 92% from 2000 to 2007. According to Dayle Read-Hudson of Pine Creek Family Counseling in Pinedale, the last few years have produced more accounts of children bearing witness to violent crimes. Total arrests in Sublette County increased by 111% between 2000 and 2007. The county added 15 law enforcement officers between 2000 and 2006, but because of the increased arrest rate the number of major arrests per officer stayed consistent at around 13.

The Circuit Court data tells a similar story but in a different way (Table 8-37 and Table 8-38). The court groups its cases in two categories, citations and non-citations. Citations involve “tickets” given by an officer, while non-citations are actual charges brought by the county prosecutor. Therefore, the non-citation cases are more serious. Data for 2007 on citations and non-citations are available only through June 30; however, total non-citations through June 2007 are already 89% of the total non-citations for 2006. DUI non-citations for 2007 already have surpassed the DUI non-citations for 2006. For circuit court citations, traffic citations have seen the greatest increase, from 28 in 2000 to 3,787 in 2006.

Table 8-37 Circuit court citation totals (Boynton et al. 2007)

Year	DUI	Felony	Game & Fish	Other	Traffic	Total
2000	16	1	2	11	28	58
2001	24	9	3	30	49	115
2002	49	5	57	115	760	986
2003	20	9	82	114	2,883	3,108

Year	DUI	Felony	Game & Fish	Other	Traffic	Total
2004	17	6	100	104	2,726	2,953
2005	20	0	122	98	3,055	3,295
2006	50	3	131	231	3,815	4,230
2007*	3	3	26	65	1,982	2,079
Total Change 2000–2006	34 (213%)	2 (200%)	129 (6,450%)	220 (2,000%)	3,787 (13,525%)	4,172 (7,193%)

Table 8-38 Circuit court non-citation totals (Boynton et al. 2007)

Year	DUI	Felony	Game & Fish	Other	Traffic	Total
2000	2	3	3	30	11	49
2001	0	7	1	38	24	70
2002	8	23	0	84	58	173
2003	72	58	0	180	101	411
2004	104	47	18	170	99	438
2005	111	63	1	260	126	561
2006	59	51	8	207	72	397
2007*	60	30	0	130	132	352
Total Change 2000–2006	57 (2,850%)	48 (1,600%)	5 (167%)	177 (590%)	61 (555%)	348 (710%)

8.2.7.3 *Social Service Projections*

Projecting future needs in most areas of social service first requires defining the current load, or number of residents served per employee. In some cases the load is defined on a unit basis, such as number of detention beds, gallons of water, or cubic yards of landfill space. For example, there are six physicians practicing in Sublette County at the present time. The county has an estimated population of 8,750 residents in 2009, thus each physician has a current load of 1,458 patients. Assuming the current level of service is adequate, Sublette County will need 9.2 physicians in 2020 to meet the expected demands of 13,370 residents (Wyoming Department of Administration and Information 2009).

Table 8-39 Sublette County current and projected service needs (Ecosystem Research Group 2009; Gatske 2009)

Service	2009 FTE or unit of measure	Acceptable Load (2009)	2020 FTE Required or units anticipated
Physicians	6.0	1,458	9.2

Service	2009 FTE or unit of measure	Acceptable Load (2009)	2020 FTE Required or units anticipated
Physician Assistants	2.0	4,375	3.1
Nurses	2.5	3,500	3.8
Dentists	3.5	2,500	5.3
Emergency Medical Technicians	13.0	673	19.9
EMS calls	1211.0	7	1,850.0
Sheriff's Office and Law Enforcement	80.0	109	122.3

8.2.7.4 *Quality of Life Survey*

Community Satisfaction and Quality of Life Survey of Long-Term Residents of Sublette County is available online at http://www.sublette-se.org/.

The major findings of the survey are:

1. Overall satisfaction is slightly less than eight to 10 years ago which is mostly attributed to oil and gas development and the diversity of residents within the county.
2. People still feel most satisfied with their people/family/friends and the physical setting of Sublette County.
3. Newcomers, while seen as good people, are reported to lack friendliness and be the greatest change in the county of the past eight to 10 years.
4. Negative effects were almost exclusively brought by industry and growth.
5. The largest change occurred at the beginning of the boom.
6. Positive aspects perceived as non-industry/growth related.
7. The most salient issue for the county in the next 5 years is growth management.
8. Older respondents perceive financial betterment an effect of energy development more often than the young population.
9. Residents have a negative view of future county expansion at the current growth rate.
10. Half of all respondents reported negative impacts from environmental impacts.
11. Social relations decreased with energy growth.

9. LIST OF PREPARERS

Table 9-1 List of Preparers

Name/Role	Agency/Firm	Education	Years Experience
Travis Benton Environmental Scientist	Ecosystem Research Group	B.S. Forestry	11
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Morgan Davies Environmental Scientist Wildlife Biologist	Ecosystem Research Group	M.S. Ecology and Natural Resources B.S. Biology	8
Ryan Hanavan Senior Environmental Scientist	Ecosystem Research Group	Ph.D. Entomology M.S. Forest Entomology B.S. Resource Conservation A.A.S. Forest Technology	10
Hayley Hesseln Resource Economist Associate Professor	Ecosystem Research Group Associate	Ph.D. Forest Economics Bachelor of Commerce	16
Meredith Holden Office Manager References	Ecosystem Research Group	B.S. Business Management	15
Jeffrey Jacquet Socioeconomic Analyst	Sublette County	M.A. Sociology B.A. Sociology	6
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Rosemary Moore Economist	Ecosystem Research Group	B.A. Economics M.A. Economics in progress	1
Simon Weseen Professional Research Associate	Ecosystem Research Group Associate	M.S. Agricultural Economics B.S. Biology B.S.A. Environmental Science	10

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APPENDIX A. INDUSTRY RESPONSE MEMO

In November and December, 2008, Ecosystem Research Group (ERG) sent data requests to all major oil and gas companies operating in Sublette County and surrounding counties. The companies were identified by the Bureau of Land Management's (BLM) Pinedale Field Office. A total of 23 companies were contacted. Responses were received from eight of the 23 companies surveyed. The data request follows.

DATA REQUEST

On November 14, 2008, Governor Freudenthal and Senator Enzi hosted a meeting in Pinedale, Wyoming between representatives of Sublette County, local municipalities, and the major energy operators in the county to discuss socioeconomic impacts from energy development. Much of the discussion focused on the importance of reliable information and the data needed to correctly understand and best characterize socioeconomic impacts. As part of the meeting, the energy operators in attendance agreed to provide data and projections for the county's upcoming Phase II report, which is available online at http://www.ecosystemrg.com.

In early 2008, ERG completed the first phase of a Socioeconomic Impact Study for Sublette County on behalf of the Sublette County Commissioners. The purpose of the first phase of the study was to identify the current socioeconomic impacts of energy industry development in Sublette County. This phase was completed with the best data available at the time of the report.

The purpose of the second phase is to estimate the net socioeconomic effects in Sublette County resulting from continued oil and gas development in both Sublette and surrounding counties. Forecasts of population growth and infrastructure requirements are estimates based on the best available information, making it important that the oil and gas industry be involved in the analysis.

The following data will help us formulate estimates that will more accurately project the net effects of economic development within Sublette County. This information is important because partial population estimates will be derived from employment effects. IMPLAN®, an economic modeling program, estimates the indirect and induced employment effects using the direct changes in employment by sector. ERG understands that there may be data the companies would like us to keep confidential. With our original company data requests and revisions on December 12, 2007, we handed out draft confidentiality agreements. We are including these signed agreements for your review and signature.

Please provide the following:

1. Number of workers per well per year (drilling phase)

2. Number of workers per well per year (production phase)

3. Number of workers per well per year (reclamation phase)

4. Number of workers per well per year (workover maintenance)

5. Production life span of well

6. Schedule of operations – drilling, production, reclamation, and workover projections for one, five, and ten-year timeframes

7. Total number of employees (contract, subcontract, part- and full-time) working in Sublette County during 2007 and 2008 and projected for 2009, including information you may have regarding families who accompany employees to the area.

8. Number of employees housed by company with location and type of company housing

9. Proposed camp and employee housing construction, including location, type of housing, and number of employees accommodated.

10. Total amount of taxes or other assessments on energy production in Sublette County paid in 2006 and 2007 to federal, state, or local government entities.

RESPONSES

Survey responses were received from eight of the 23 companies surveyed. Results indicate that employment is expected to remain relatively stable until 2013. At that time employment will decrease by approximately 500 employees and remain at that level until 2018. Table A-1 and Figure A-1 present this information, separated into development phases or work tasks. Note that these estimates are subject to change due to economic conditions and/or a fall in gas or oil prices.

Table A-1 Total FTE projections by phase, 2009–2018 (Ecosystem Research Group 2008a)

Phase	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Development Phase										
Drilling	1,137	1,176	1,199	1,217	1,238	713	689	666	642	642
Completion	151	151	151	108	108	108	108	108	108	108
Production	377	390	404	420	437	454	470	486	501	515
Reclamation and Pad Construction	210	194	127	94	90	78	61	61	61	61
Other										

Phase	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Workover	53	53	59	66	73	74	74	75	75	76
Miscellaneous Employment	85	85	0	0	0	0	0	0	0	0
Total Employment	**2,012**	**2,047**	**1,940**	**1,905**	**1,946**	**1,426**	**1,403**	**1,395**	**1,387**	**1,402**

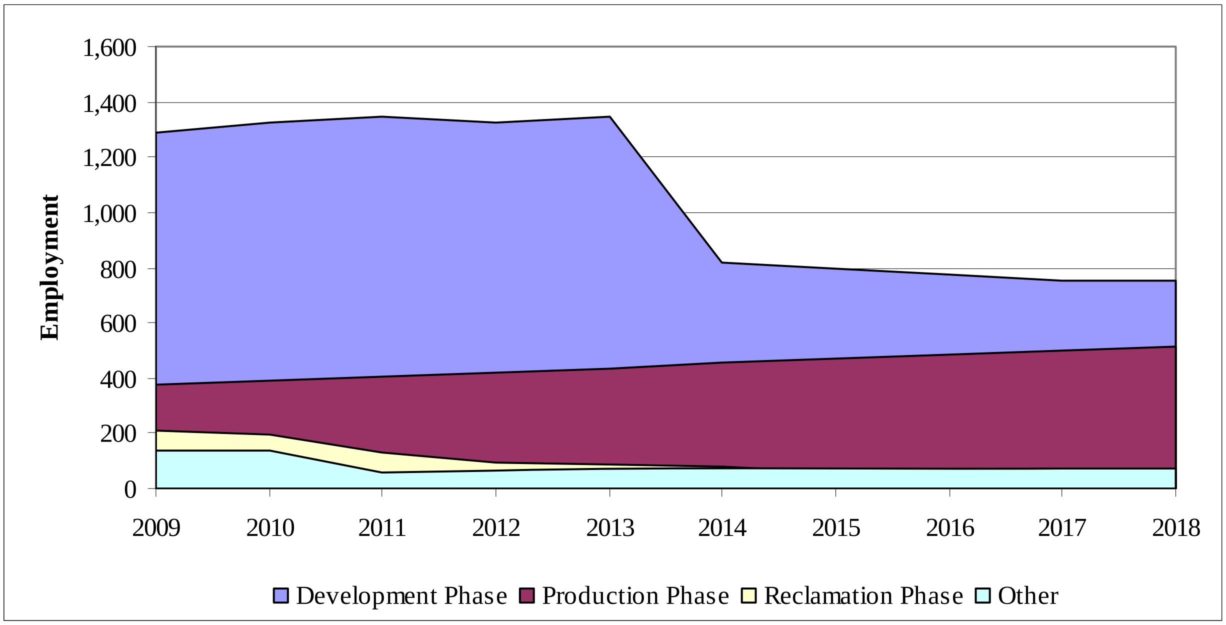

Figure A-1 Total FTE projections by phase, 2009–2018 (Ecosystem Research Group 2008a)

The most labor-intensive component of oil field development occurs in the early phase of development, as depicted in Figure A-1. Industry respondents anticipate approximately a 30% decrease in personnel between 2013 and 2014 as drilling activity slows. The drop in drilling is accompanied by a slow but steady increase in production workers as activity shifts to the production phase. Personnel needs are much lower during production as this phase requires much less hands-on work. Reclamation is the least labor-intensive task and becomes almost a negligible component as time goes on. Well workovers occur roughly every 10 years throughout the production phase and are a steady segment of employment throughout the normal 40-year production cycle for wells in Sublette County.

Energy operators also reported their taxes paid in 2006 and 2007. Table A-2 reports total taxes to honor the confidentiality of the operators. These numbers include responses from eight of the 23 companies surveyed.

Table A-2 Reported taxes paid by energy operators (Ecosystem Research Group 2008a)

Year	Reported Taxes
2006	$716,629,548
2007	$710,895,571

The industry responses indicated an increase of personnel living in the county between 2007 and 2008 with a slight drop in 2009. Table A-3 presents summarized responses. Worker and family member count was 1,478 in 2007, 1,702 in 2008, and 1,630 in 2009.

Table A-3 Number of personnel and family members living in Sublette County (Ecosystem Research Group 2008a)

Year	Workers and Family Members
2007	1,478
2008	1,702
2009	1,630

Industry also estimated the total production lifespan of a single well. Estimates varied from zero to 50 years, with the majority of the responses estimating between 30 and 50 years.

APPENDIX B. CUMULATIVE IMPACTS

Table B-1 identifies oil and gas-related NEPA projects by field office and the Bridger-Teton National Forest that have been reviewed by the BLM Pinedale Field Office (Zebulske 2008). When available, the number of possible wells, project area, life of plan (LOP), and drilling time have been specified. Project area is in acres and LOP and drilling time are in years unless otherwise specified.

Table B-1 Cumulative impact NEPA projects

BLM Office	Project	Year Initiated	Number of Wells	Project Area (Acres)	LOP (Years)	Drilling Time (Years)
Pinedale	Big Piney/LaBarge Coordinated Activity Plan	1991	600–900 (no limit specified)	NA	NA	NA
	LaBarge Platform	In discussion	NS	NS	NS	NS
	Jonah II Natural Gas Project	1998	497	29,200	NS	NS
	South Piney Natural Gas Development Project	2003	210	31,230	NS	7
	Jonah Infill Drilling Project	2006	3,100	30,500	63–105	13
	Pinedale Anticline Oil & Gas Exploration & Development Project	2007	4,399	198,037	60	15
	Liquids Gathering Anticline	2008	NS	NS	NS	NS
	Paradise 230kV Project	2008	NA	910	30 weeks	NA
	Rand's Butte Sour Gas Startup (Cimarex Energy Helium Development at Riley Ridge Field)	2008	9	618	28 months	4
	Rand's Butte Sour Gas Ongoing (Cimarex Energy Helium Development at Riley Ridge Field)	2008	4	618	40	NA
	Passive Seismic Project	2008	NA	NS	ND	NA
	Jonah 3D Seismic Project	NS	NA	NS	NS	NA
	Farley Oil (Private Land)	NS	NS	NS	NS	NS
	Gasco (Private Land)	NS	NS	NS	NS	NS
	True Oil (Private Land)	NS	NS	NS	NS	NS
	Wexpro (Private Land)	NS	NS	NS	NS	NS
	EOG (Private Land)	NS	NS	NS	NS	NS
	Intrepid Energy (Private Land)	NS	NS	NS	NS	NS
	Shell Anticline Seismic Project	2008	NA	NS	NS	NA
	Questar Year-Round Drilling Proposal	2004	700	197,345	NS	≥18

BLM Office	Project	Year Initiated	Number of Wells	Project Area (Acres)	LOP (Years)	Drilling Time (Years)
	Riley Ridge Natural Gas Project	1984	NS	NS	NS	NS
	EnCana Worker Camp	2008	NA	NA	NA	NA
Rawlins	South Baggs Area Natural Gas Development Project	2000	50 new 43 existing	12,352	35	10
	Seminoe Road CBM Pilot Project	2001	19	8,320	5–30	NS
	Blue Sky POD Coalbed Methane Project (Jack Sparrow)	2002	25	NS	10–20	0.5–1
	Scotty Lake Coalbed Natural Gas Pilot Project	2004	18 new 3 existing	2,880	25	3
	Wind Dancer Natural Gas Development Project	2004	12 new 6 existing	6,400	10–30	1
	Hay Reservoir CBNG Pilot Project	2005	8	1,920	20–30	NS
	Jolly Roger POD	2005	27	3,926	10–20	NS
	Brown Cow II POD Coalbed Natural Gas	2006	12 existing 12 new	3,692	10–20	0.5–1
	Seminoe Road Gas Development Project	2006	1,240	137,000	30-40	12
	Continental Divide - Creston Natural Gas Project	2006	8,950 new 2,305 existing	1,061,200	30–50	20
	Atlantic Rim Natural Gas Field Development Project	2007	2,000	270,080	30–50	20
	Hanna Draw Coalbed Natural Gas Pilot Project	2007	15	399	10–20	1.5
	Hay Reservoir Unit Natural Gas Infill Development	2007	17 already permitted 8 new	11,620	10–30	3
	Pathfinder Pipeline Project	2007	In EIS-to be completed	NS	NS	NS
	Catalina Unit CNBG Produced Water Disposal	2007	In discussion	NS	NS	NS
	Overland Pass Pipeline Project	2008	In reclamatio n	NS	NS	NA
	Chokecherry and Sierra Madre Wind Energy Project	2008	0	Decision in process	NA	NA
	Saratoga Well Field and Transmission Line	2008	5	NS	6 months	NA
	Cherokee West 3D Geophysical Project	2005	NA	87,304	NS	NA

BLM Office	Project	Year Initiated	Number of Wells	Project Area (Acres)	LOP (Years)	Drilling Time (Years)
	Creston/Blue Gap II Natural Gas Development Project	2005	1,250	184,000	30–50	10–15
	Pittsburg & Midway Coal Mining Co. Exchange Proposal	2005	NA	NA	NA	NA
	Brown Cow POD	2004	12	1,600	10–20	NS
	Desolation Flats Natural Gas Field Development Project	2004	592	233,542	20	NS
	Doty Mountain Plan of Development	2004	24 exploratory, 2 deep injection	1,920	10 –20	NS
	Red Rim Plan of Development	2004	16 exploratory, 2 deep injection	3,200	10 –20	NS
	Cow Creek POD	2002	14 exploratory CBM 2 injection	2,050	10–15	NS
	Continental Divide/Wamsutter II Natural Gas Project	2000	2,130	1,061,200	30–50	20
Rock Springs	Fontenelle Natural Gas Infill Drilling	1995	2,392	179,760	NS	NS
	Continental Divide/Wamsutter II Natural Gas Project	2000	2,130	1,061,200	30–50	20
	Vermillion Basin Natural Gas Exploratory & Development Project	2002	56	92,490	50	5
	Desolation Flats Natural Gas Field Development Project	2003	385 new 592 previously approved	233,542	30–50	20
	Lower Bush Creek Coal Bed Methane Exploratory Pilot Project	2003	20	3,500	NS	NS
	Little Monument Natural Gas Project	2003	31	3,857	15–20	3
	Copper Ridge Shallow Gas Exploration & Development Project	2003	89	24,953	15–20	4

BLM Office	Project	Year Initiated	Number of Wells	Project Area (Acres)	LOP (Years)	Drilling Time (Years)
	Pacific Rim Shallow Gas Exploration & Development Project	2004	120	47,597	15–20	4
	Bitter Creek Shallow Oil and Gas Development Project	2005	61	17,961	15–20	4
	Monell Enhanced Oil Recovery Project	2006	126 new, 146 existing, 123 of those plugged	10,120	20–25	6
	Hiawatha Regional Energy Development Project	2006	4,208	157,361	60	30
	East LaBarge Gas Exploration & Development Project	2007	184 new 99 existing	13,698	50	10
	Devon Energy Drilling Proposal	2008	2	NS	NS	NS
	Luman Rim Project	2008	58 new 8 existing	20,828	30	5
	Normally Pressured Lance Natural Gas Development Project	2008	85 new 14 existing	70,155	30	5
	Puma Prospect	2008	13 new 2 existing	9,600	30	5
	Desolation Road Exploratory Gas Well	2009	2	NS	NS	NS
	Horseshoe Basin 3D Seismic Survey	2008	NA	30 sq. miles	NS	NA
	Rubicon 3D Seismic Survey Project	2008	NA	140	NS	NA
	Pit 14 Coal Lease-By-Application	2006	NS	1,399	20	NS
	Dickie Springs Placer Gold Exploration Project	2005	NA	14	NS	NS
	Hay Reservoir 3D Geophysical Project	2004	NA	178,560	NS	NA
	Monell CO2 Pipeline Project	2003	NA	NA	NA	NA
	South Jonah 3D Vibroseis Project	2002	NA	262,400	NS	NA

BLM Office	Project	Year Initiated	Number of Wells	Project Area (Acres)	LOP (Years)	Drilling Time (Years)
	Ten Mile Rim Coal LBA & ROW	2004	NS	2,242	NS	NS
	West Flank (Wild Bunch) 3D Geophysical Exploration Project	2004	NA	135,040	NS	NA
	Kennedy Oil Pilot Exploratory Coal Bed Methane Project	2002	NS	10,240	NS	NS
	Jim Bridger Power Plant Flue Pond Expansion Project	2002	NA	267	30–40	NA
	Quantum Adobe Town 2D Geophysical Project	2002	NA	NA	NS	NA
	Wolverine Exploratory Drilling Proposal	2001	3	NS	NS	NS
	FMC Corporation's Proposed Haul Road Project	2000	NA	NA	NS	NA
Kemmerer	Horsetrap Natural Gas Project	2001	26	12,400	NS	2
	Jonah Bridger to Opal Natural Gas Project	2006	0	13,680	±30	NS
	Bear Canyon Exploratory Development	2007	1	47,058	NS	NS
	Moxa Arch/Moxa Arch Area Infill Gas Development Project	2008	1,861	475,808	40	10
	Bell Butte Water Pipeline Project	2007	NA	369,992	NS	NA
	Absaroka Ridge 3D Geophysical Project	2005	NA	51 sq. miles	NS	NA
	Three Forks 3D Geophysical Project	2005	NA	11,456	NS	NA
	Hams Fork 3-D Geophysical Project	2004	NA	45.3sq.miles	NS	NA
	Smiths Fork Road Improvement Project	2002	NA	NA	NS	NA
Lander	66 Water Pipeline Project	2008	NA	NA	NS	NA
	Beaver Creek CBNG Project	2008	228	16,518	NS	NS
	Gun Barrel, Madden Deep, Iron Horse Natural Gas Project	2008	1,470	147,335	50–55	10–15

BLM Office	Project	Year Initiated	Number of Wells	Project Area (Acres)	LOP (Years)	Drilling Time (Years)
	Pappy Draw Exploratory CBNG Pilot Project	2008	NS	48,350	NS	NS
	Devon Bairoil to Beaver Creek CO2 Pipeline Project	2007	NA	48 miles	NS	NA
	Crooks Gap Seismograph Project	2002	NA	155 miles	NS	NA
	WesternGeCo Geophysical Project	2001	NA	NS	NS	NA
Bridger-Teton National Forest	Plains Exploration Field Development	2007	137	14,080	NA	NA
	Lower Valley Energy Natural Gas Pipeline Project	2006	NA	NA	NS	NA
	Geothermal Leasing	2009	NA	NS	NS	NA
	North Zone OHV Project	2009	NA	NS	NS	NA
	Hoback Basin Non-Recreation Permit Renewals	2008	NA	NA	NA	NA
	Oil and Gas Leasing Decision	2008	NS	44,720	NS	NS
	Gros Ventre Mineral Exploration	2008	NS	NS	NS	NS

NA = Not available
NS = Not supplied

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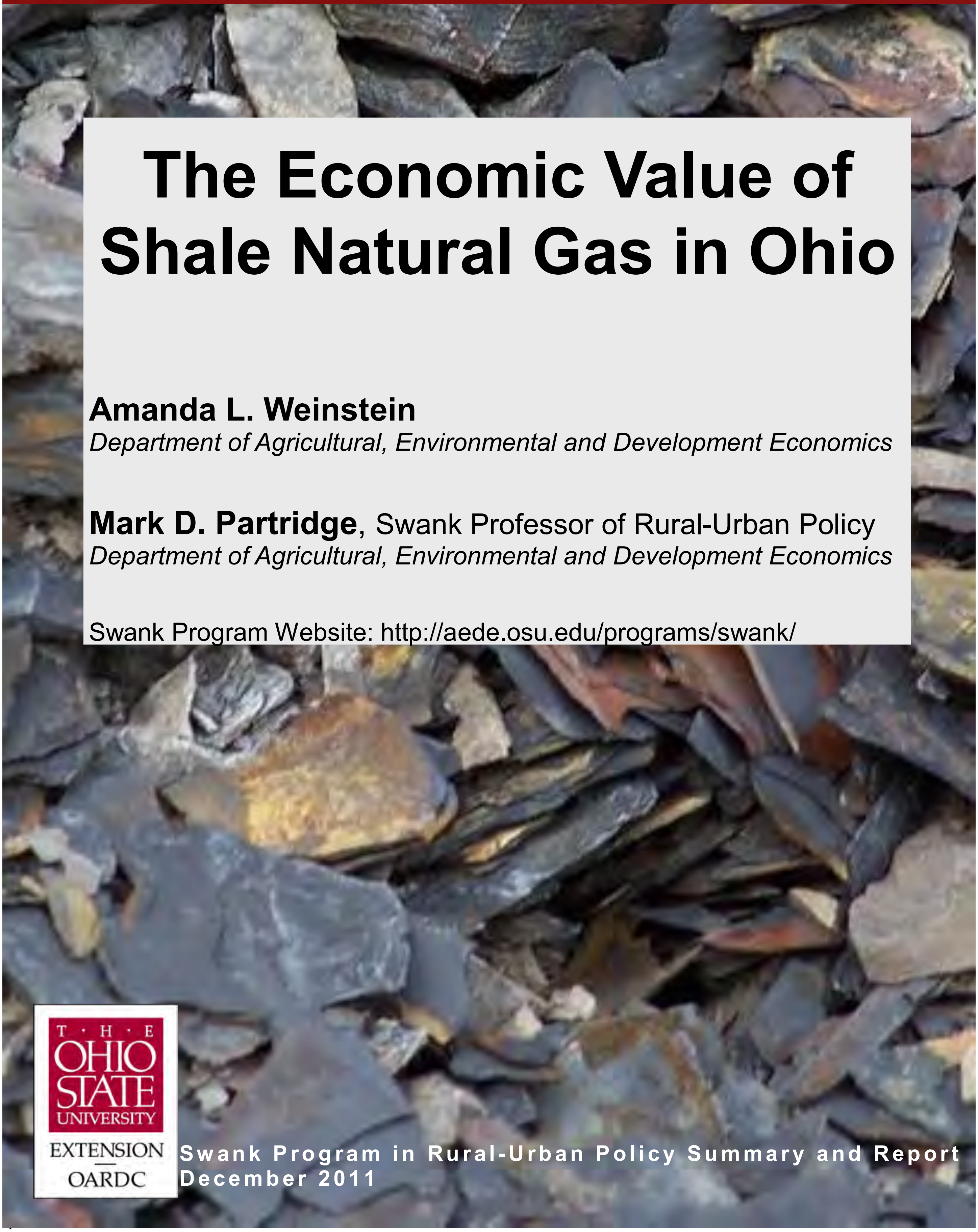

The Economic Value of Shale Natural Gas in Ohio

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Swank Program Website: http://aede.osu.edu/programs/swank/

THE OHIO STATE UNIVERSITY EXTENSION — OARDC

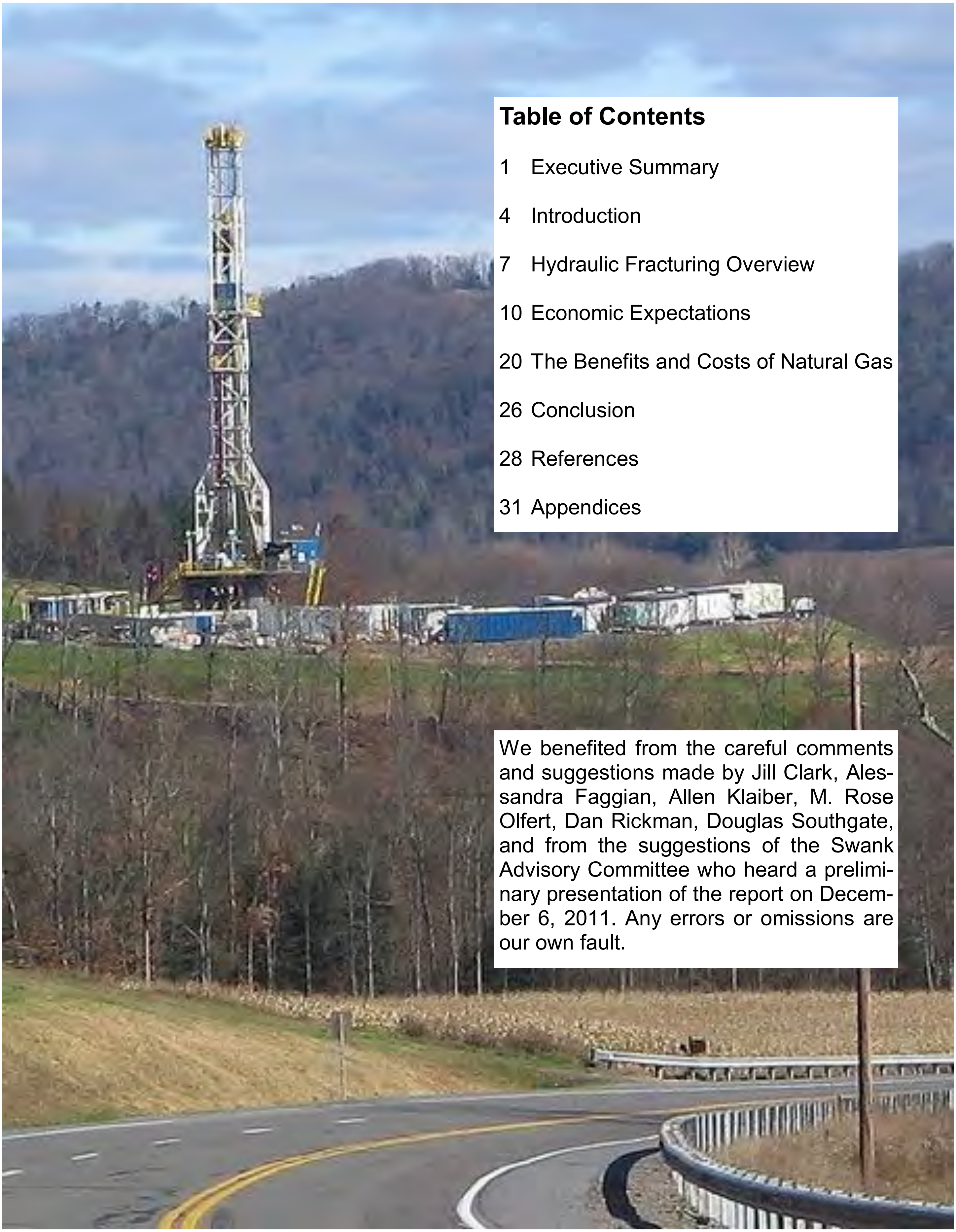
Swank Program in Rural-Urban Policy Summary and Report
December 2011

Mark Partridge Short Biography

Dr. Mark Partridge is the Swank Chair of Rural-Urban Policy at Ohio State University. He is a Faculty Research Affiliate, City-Region Studies Centre, University of Alberta, an Affiliate of the Martin Prosperity Center at the University of Toronto, and an adjunct professor at the University of Saskatchewan. Professor Partridge is Managing Co-Editor of the *Journal of Regional Science* and is the Co-editor of new the *Springer Briefs in Regional Science* as well as serves on the editorial boards of *Annals of Regional Science, Growth and Change, Letters in Spatial and Resource Sciences, The Review of Regional Studies, and Region et Developpement*. He has published over 100 scholarly papers and coauthored the book *The Geography of American Poverty: Is there a Role for Place-Based Policy?* Dr. Partridge has consulted with OECD, Federal Reserve Bank of Chicago, Federal Reserve Bank of Cleveland, and various governments in the U.S. and Canada, and the European Commission. Professor Partridge has received funding from many sources including the Appalachian Regional Commission, Brookings Institution, European Commission, Infrastructure Canada, Lincoln Institute of Land Policy, U.S. National Science Foundation, U.S. National Oceanic and Atmospheric Administration, and Social Science and Humanities Research Council of Canada. His research includes investigating rural-urban interdependence and regional growth and policy. Dr. Partridge served as President of the Southern Regional Science Association in 2004-05 and is currently on the Executive Council of the Regional Science Association International (the international governing board).

Amanda Weinstein Short Biography

Amanda Weinstein is a PhD student in the Department of Agricultural, Environmental, and Development Economics at The Ohio State University. Her research as the C. William Swank Graduate Research Associate includes policy briefs about the employment effects of energy policies and general regional growth and policy issues. She is an OECD consultant advising on the economic impacts of alternative energy policies on rural communities. Her other research interests include women's role in economic development examining women's effect on regional productivity growth. She was awarded the Coca-Cola Critical Difference for Women Graduate Studies Grant to continue her work on gender issues in economics. She is also conducting research on the skills most valued during a recession and the impact of military service on intergenerational mobility. Before starting her PhD at OSU, she was a commissioned officer in the United States Air Force after graduating from the United States Air Force Academy. As a Scientific Analyst in the Air Force and then as a Sr. Management Analyst for BearingPoint, she advised Air Force leadership on various acquisition and logistics issues. She is currently an adjunct faculty member of Embry-Riddle University and DeVry.



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We benefited from the careful comments and suggestions made by Jill Clark, Alessandra Faggian, Allen Klaiber, M. Rose Olfert, Dan Rickman, Douglas Southgate, and from the suggestions of the Swank Advisory Committee who heard a preliminary presentation of the report on December 6, 2011. Any errors or omissions are our own fault.

Tower for drilling horizontally into the Marcellus Shale Formation for natural gas in Lycoming County, Pennsylvania.

The Economic Value of Shale Natural Gas in Ohio

The Ohio State University
Swank Program in

Executive Summary

Increased production of US natural gas in recent years has helped to meet the growing demands of American customers and has reduced natural gas imports. Natural gas is also a cleaner burning fuel when compared to its most realistic substitute, coal. This substantial increase in production has been attributed in large part due to the development of shale gas through a process called hydraulic fracturing. Hydraulic fracturing has enabled the expansion of natural gas extraction into new undeveloped areas. The Marcellus shale in Pennsylvania has experienced impressive growth in its natural gas industry and neighboring Ohio is beginning down the same path. Proponents argue that among the many purported advantages, natural gas production is associated with significant amounts of new economic activity.

Economists have 150 years of experience in examining energy booms and busts throughout the world to form their expectations of how energy development affects regional economies. Generally, economists find that energy development is associated with small or even negative long-run impacts. They refer to a ―natural resources curse" phenomenon associated with the surprisingly poor performance of resource abundant economies. There appears to be more examples like Louisiana, West Virginia, Venezuela, and Nigeria of energy economies seemingly underperforming and few examples of places such as Alberta and Norway of relative over performance. This backdrop needs to be considered in forming good policy in Ohio in order to avoid being in the former group.

In supporting energy development, the natural gas industry has funded its own studies of economic performance. For example, utilizing assumptions derived from Pennsylvania economic impact studies, Kleinhenz & Associates (2011) estimate that the natural gas industry could help ―create and support" over 200,000 jobs to Ohio and $14 billion in spending in the next four years. These figures are about the same size as those for Pennsylvania (in industry funded studies). As we outline in this report, impact studies such as those employed by the industry are typically flawed due to the following reasons:

1. Possible double counting economic effects from drilling activities and royalties/lease payments to landowners. Most important, these studies have multipliers well above what independent economists would normally expect.
2. Including unrealistic assumptions about the percentage of spending and hiring that will remain within the state.
3. Ignoring the costs of natural gas extraction on other sectors through higher wages, and land costs that will make them less competitive (e.g., Dutch Disease), as well as environmental damage that limits tourism and other activities. It will also displace coal mining—i.e. more natural gas jobs come at the expense of fewer jobs in coal mining.
4. Often employing out-of-date empirical methodologies that academic economists have long abandoned for better methodologies in terms of evaluation of economic effects.

Many of the same reasons why alternative energy has not been (will not be) a major job creator also applies to natural gas (Weinstein et al., 2010):

1. The energy industry and specifically the natural gas industry‘s employment share is small and by itself is not a major driver of job growth for an entire state the size of Ohio or Pennsylvania. During the one year span October 2010-October 2011, U.S. Bureau of Labor Statistics data reports that Ohio‘s unemployment rate fell from 9.7 to 9.0% or 0.7% (without shale development), while Pennsylvania‘s unemployment rate only fell from 8.5% to 8.1% or 0.4% (with shale development). Ohio also had faster job growth during the span (1.3% versus 1%), showing that shale development by itself is not shaping their growth.
2. It is a capital-intensive industry versus labor-intensive—or a dollar of output is associated with significantly fewer workers.

The costs of natural gas include the effects it has on other industries. Some of these effects include displacement of other forms of economic activity, the effects of pollution that drive out residents who are worried about its effects and the higher wages and land/housing costs that make other sectors less competitive. For example, the tourism industry will likely be adversely affected by fears of pollution and higher wages and costs as other sectors have to compete for workers with the higher paying natural gas sector. In Pennsylvania, for instance, the tourism industry employed approximately 400,000 in 2010 (though a much smaller number is immediately near the shale development) compared to only 26,000 in

a broad definition of the natural gas industry (Barth, 2010; BLS). Similar concerns should also apply to Ohio across various sectors of the economy.

Our broad analysis shows the expected employment effects of natural gas are modest in comparison to Ohio's 5.1 million nonfarm employee economy. We show this through (1) an assessment of impact analysis, (2) comparison of drilling counties with similarly matched non-drilling counties in Pennsylvania, (3) statistical regressions on the entire state of Pennsylvania, (4) employment comparisons with North Dakota's Bakkan shale region, and (5) an examination of the employment life cycle effects of natural gas and coal per kilowatt of electricity. Specifically, we estimate that Pennsylvania gained about 20,000 direct, indirect, and induced jobs in the natural gas industry between 2004-2010, which is a far cry fewer than the over 100,000 jobs reported in industry-funded studies (and the 200,000 expected in Ohio by 2015). Given the anticipated size of the boom, Ohio is expected to follow the Pennsylvania's experience. We believe 20,000 jobs would be a more realistic starting point for what to expect in Ohio over the next four years and is in line with what other independent assessments have suggested. However, our 20,000 job estimate does not account for displacement losses in other industries such as tourism, and we also note that local economic effects could appear larger in heavily impacted areas. Moreover, we find that mining counties had considerably faster per-capita income growth than their non-drilling peers, which likely results from royalties/lease payments and the high wages in the industry. Thus, we expect the near-term boom to be associated with frothy increases in income but more temperate job effects.

There are several reasons why the industry-funded studies produce employment results that are considerably different from our estimates. Foremost, impact studies are not viewed as best practice by academic economists and would be rarely used in peer reviewed studies by urban and regional economists. Instead, best practice usually tries to identify a counterfactual of what would have happened <u>without</u> the natural gas industries and compare to what did happen (we adopt two of these approaches). One advantage of identifying the counterfactual is that the estimated effects use actual employment data and are not the estimated outcome of an impact computer model. Yet, like virtually every other economic event, there are winners (e.g., landowners or high-paid rig workers) and losers (e.g., those who can no longer afford the high rents in mining communities and communities dealing with excessive demands on their infrastructure).

Moreover, the boom/bust history of the energy economy is that drilling activity usually begins with a wave of drilling and construction in the initial phases, followed by a significant slowdown in jobs as the production phase requires a much smaller number of permanent employees. Indeed Ohio has a long history of energy booms that illustrates that booms too often have few lasting effects. Ohioans need to be aware of this cycle if they are to make prudent decisions and try to gain sustainable gains after the boom has ended. The fundamental problem here is that the time distribution of jobs resulting from a new development is often ignored and it is important. For example it matters whether there are 1,000 jobs distributed as 1,000 for one year and then none, versus 100 additional jobs for 10 consecutive years, or 10 additional jobs for the next 100 years. Yet, ‗impact' analysis such as that used by the energy industry typically does not differentiate among these scenarios and the whole topic is usually ignored by the media. Professional economists note that long-term regional economic development requires <u>permanent</u> jobs, and thus independent economists place considerably less weight on the initial construction phase associated with energy development. Policies need to be developed to ensure long-term success.

Natural gas extraction is also associated with potential environmental degradation. Pennsylvania and other areas have reported numerous incidents of water contamination; most notably in Dimock, PA, which was featured in the controversial documentary *Gasland*. Because hydraulic fracturing occurs at levels far below the aquifer level, it is most likely not to blame for contamination, but any contamination is instead likely caused by a casing/tubing failure or other part of the drilling process. Thus, the EPA exempted natural gas extraction using hydraulic fracturing from the Safe Drinking Water Act and Clean Water Act in 2005. However, recognizing increasing concerns over the impact on drinking water and ground water, in 2010 Congress directed the EPA to study the effects of hydraulic fracturing on the environment with results expected by the end of 2012. Until the federal government acts on this issue, state regulations are necessary to ensure natural gas extraction is performed in a safe manner protecting the environment and residents. Yet, coal mining is also associated with high localized environmental costs, indicating that if natural gas mining is not done, there will still be environmental problems that will need to be addressed because more coal mining will be required.

We argue that the focus on whether the industry creates jobs is misguided in assessing its true value and is not how economists typically evaluate the effectiveness of a program or policy. Rather, the focus should be placed on the true costs and benefits of natural gas especially compared to coal (its main substitute in electricity production). *Compared to coal, natural gas is cheaper and emits less carbon and both industries have their own inherent localized environmental costs in their production.* Independent economists would note that neither industry is associated with large numbers of jobs due to their capital-intensive nature. Making a true assessment of the costs and benefits will require qualified independent analysis. Likewise, ensuring that Ohioans benefit long after the energy boom requires innovative planning that unfortunately, most locations that have experienced such booms have failed to do over the last 150 years. These findings also illustrate that Ohio will need to continue to make economic reforms if it is to prosper in the long term because no one industry—in this case energy development—will be its long-term savior.

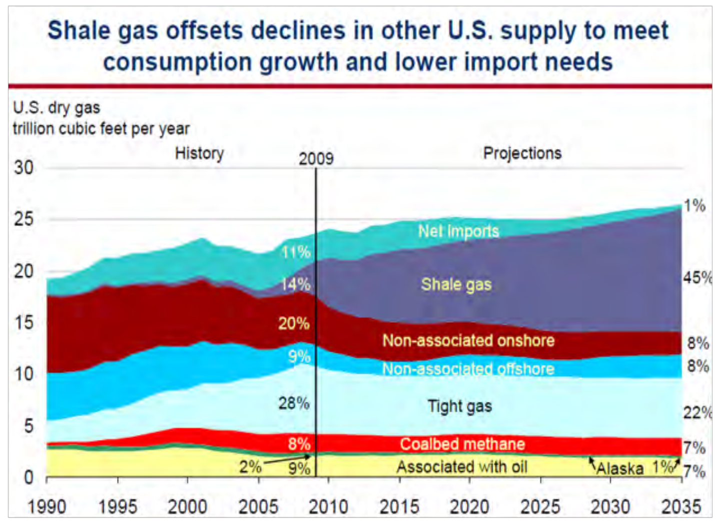
Introduction

With the US economy still struggling to recover from the Great Recession, many are looking for a quick fix to create jobs and generate income. Politicians often turn to the latest economic fad to solve unemployment problems, such as aiming to become the next Silicon Valley or, more recently, the next green energy hub. Employment effects are often overstated to justify various policies rather than having a real conversation about the true benefits and costs of a policy.[1] For example, the job creation benefits of green jobs were optimistically asserted while ignoring the high capital intensity of alternative energy and the displacement effect of jobs no longer needed in the fossil fuels industry, especially coal. In response, the fossil fuels energy industry has now put forward its own solution to unemployment and growing energy demands: natural gas from shale, which also provides its own set of environmental costs and benefits.

In their –Short-Term Energy Outlook,” the US Energy Information Administration (EIA) expects that total natural gas consumption will grow by 1.8% in 2011. Despite the increase in consumption, recent increases in natural gas production have met these demands and reduced natural gas imports. Thus, shale gas proponents claim that newly accessible reserves could provide a new level of energy independence for the US. The 2010 EIA –Annual Energy Outlook” found that natural gas production reached its highest levels since 1973 at 21.9 trillion cubic feet (Tcf). This increase in production is mainly attributed to the increase in natural gas extraction from shale resources. From 2009 to 2010 shale gas production more than doubled from 63 billion cubic meters to 137.8 billion cubic meters. This trend in rising natural gas production, especially shale gas production, is likely to continue. Figure 1 below shows the increasing shale gas production the US has experienced, along with future expectations.

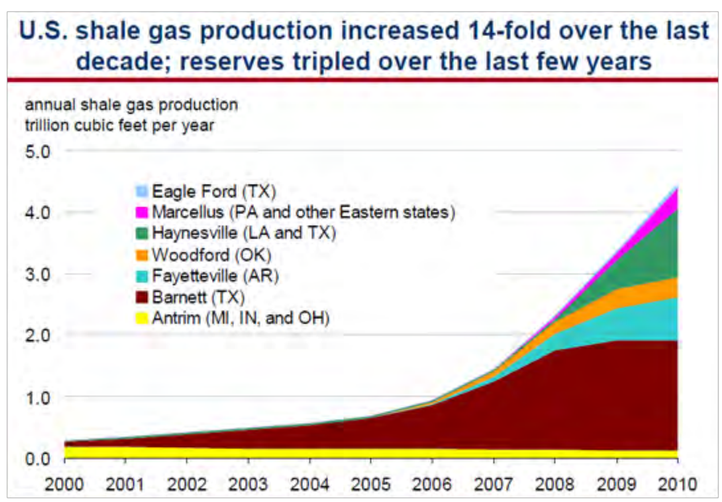
The dramatic increase in shale gas production since 2005 is shown below in Figure 2 separated by the area where shale gas has been developed. Recent technological advancements in a method called hydraulic fracturing, or –fracking”, have made extracting natural gas from shale more efficient and cost effective. This has brought natural gas potential to new areas as evidenced by the increased drilling in Pennsylvania. Although still a small percentage compared to Texas, growth in shale gas production in Pennsylvania is growing rapidly and provides a roadmap for how production in Ohio will evolve.

With these innovations, shale gas potential is now growing in neighboring Ohio, which shares the same Marcellus shale with Pennsylvania. Many have already begun to speculate what this could mean in terms of the job benefits to Ohio. An industry-funded study by Kleinhenz & Associates (2011) suggests that new Ohio natural gas production could –create and support” over 200,000 jobs



Source: US EIA Annual Energy Outlook 2011

Figure 1: Shale Gas Prospects



Source: US EIA Annual Energy Outlook 2011

Figure 2: Shale Gas Areas of Production

1. Independent economists have long complained about hyped up numbers from various industry impact reports. For a tongue-in-cheek look see Leach (2011). http://www.theglobeandmail.com/report-on-business/economy/economy-lab/the-economists/who-needs-pipelines-the-oil-bucket-brigade-is-ready/article2268015/

and $14 billion injected into the state economy over the next 4 years (Gearino, 2011).[2] In this manner, Chesapeake Energy CEO Aubrey McClendon stated, ―This will be the biggest thing in the state of Ohio since the plow" (Vardon, 2011). Obviously, there is considerable hype surrounding the economic effects of shale oil production

To see if these expectations are realistic, we examine the impacts that natural shale gas has had on Pennsylvania to draw comparisons to Ohio. Many industry funded studies of the economic impacts of the Marcellus shale development in Pennsylvania are consistent with the Kleinhenz & Associates (2011) predictions, which is reasonable in the sense that the early stages of Ohio‘s development is expected to mimic what happened in Pennsylvania.

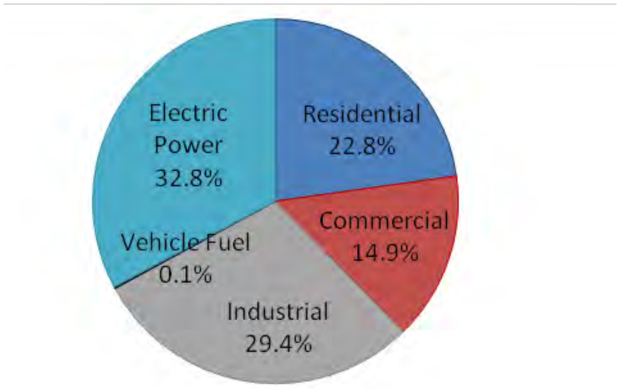
Unlike the industry funded reports, Barth (2010) doubts whether there is any net positive economic impact of drilling in Pennsylvania. She contends that previous industry-funded reports have focused on the benefits while ignoring the costs and risks associated with natural gas extraction. She claims industry funded studies haven‘t properly accounted for other impacts, including the costs of environmental degradation. Although replacing coal or oil with natural gas can significantly reduce carbon emissions, rising concerns have mounted, most notably in the controversial 2010 documentary *Gasland,* about the potential environmental impacts of natural gas mining on nearby water sources. This has become more of a concern as hydraulic fracturing and natural gas extraction occurs closer to both water sources and population centers in Pennsylvania and Ohio. These concerns have not yet been fully alleviated by the US EPA or the natural gas industry. In 2005, hydraulic fracturing methods were exempted from the Safe Drinking Water Act and Clean Water Act. However, recognizing increasing concerns over the impact on drinking water and ground water, in 2010 Congress directed the U.S. Environmental Protection Agency (EPA) to study the effects of hydraulic fracturing on the environment.

Barth (2010) also argues that previous industry-funded studies have not properly accounted for the impact on infrastructure, property values, and the ―displacement" impact pollution can have on other industries such as tourism and fishing. In 2010, tourism employed approximately 400,000 people in Pennsylvania whereas the natural gas industry employed closer to 26,000 (Barth, 2010; BLS). If tourism suffers as a result of the natural gas industry, then a bigger industry could be put at risk from expansion of the natural gas industry, though we note that much of Pennsylvania‘s tourism industry is not near the mining activity.

Economists have long argued that energy development has limited overall impacts on the economy. There is a longstanding literature that refers to a ―natural resources curse" that limits growth from energy development. One reason for the limited effects of energy development is Dutch Disease, which broadly refers to the higher taxes, wages, land rents, and other costs associated with energy development that make other sectors less competitive (including currency appreciation at the national level). These higher costs also reduce the likelihood new businesses will locate in the affected location. Previous research has found evidence of a natural resources curse and Dutch Disease suggesting that a natural resource boom can occur at the cost of other sectors and general long-run economic growth. For example, Papyrakis and Gerlagh (2007) found that US states with a higher degree of reliance on natural resources experience lower economic growth.[3] Kilkenny and Partridge (2009) and James and Aadland (2011) also found evidence of this resource curse at the US county level.

Figure 3 on the next page shows that most natural gas is still used to supply electricity. Thus, with rising electricity demands, increasing natural gas production will lower the need for electricity generation from coal—i.e., we will have more natural gas jobs that are offset by fewer coal jobs. Only 0.1% of natural gas is used as vehicle fuel, which is derived from oil as opposed to coal. Thus, <u>new</u> natural gas will not significantly decrease US reliance on foreign oil unless, as publicly suggested by T. Boone Pickens, the US considers converting more buses, trucks and other vehicles to natural gas. Thus, its effects on ―energy security" are rather limited in the foreseeable future as increased electrical demand and the growing reliance on US natural gas will primarily be at the expense of US coal.[4]

2. Kleinhenz & Associates (2011) specify that over 200,000 jobs will be *created* or *supported* but they do not clearly define the difference between ―created" and ―supported" jobs. In terms of long-term economic development, permanent job creation would be necessary—or does natural gas development create more permanent jobs than what would have happened without the energy development? The latter counterfactual question is not addressed in that report.
3. Dutch Disease refers to natural gas development in the Netherlands in the 1960s and 1970s. The ensuing boom raised costs and appreciated the Dutch currency, rendering Dutch manufacturers less competitive on international markets. After the initial boom settled down, not only were there less employment in the natural gas industry, but Dutch manufactures found it hard to regain their market share on international markets, producing a permanent cost on their economy.
4. The recent expansion of shale development did reduce natural gas imports, but going forward, its main influence will be as a substitute for other sources of electricity, primarily coal.



Source: US EIA

Figure 3: 2010 Natural Gas Consumption by End Use

Even with a significant conversion of vehicles to natural gas, the energy sector as a whole has an employment share that is simply too small to significantly impact the high unemployment rates the US is experiencing. In 2010, the natural gas industry accounted for less than 0.4% of national employment, so even if the sector doubled in size—which is quite a stretch—overall U.S. employment would only be marginally effected (BLS).[5] This is not surprising as natural gas like much of the energy sector (including alternative energy) is quite capital intensive, which reduces the employment effects of natural gas compared to the broader economy.

The pursuit of economic fads is often justified by overpromising jobs while ignoring the displacement effects on other sectors of the economy as well as other costs on the economy. The benefits should be appropriately weighed against the costs, but this requires a better understanding of both the benefits and costs. It should not be based on the overblown hype of either side. Using previous experience from Pennsylvania, we will produce realistic estimates what Ohio should expect from shale gas development over the next four years. We find that although the employment advantages of shale gas have generally been overstated by the industry, there are clear benefits of natural gas production when compared to coal (which has its own environmental risks). The biggest advantages are that natural gas is more cost-effective than coal and can reduce carbon emissions. Coal forms the natural benchmark because in the medium term, natural gas production would displace coal production as the alternative source for electricity.

5. The calculation of total natural gas employees uses the methodology of IHS Global described in more detail in note 7 and we use U.S. Bureau of Labor Statistics Data to derive the employment figures.

Hydraulic Fracturing Overview

Innovations in hydraulic fracturing are the reasons natural gas extraction has recently been developing in the Marcellus shale regions in Pennsylvania and Ohio and now expanding to the Utica shale regions in Ohio. Before investigating the impacts of shale gas development, it is important to understand the hydraulic fracturing method that has made natural gas extraction from shale economically feasible.

Shale is a fine-grained sedimentary rock that can trap petroleum and natural gas well below the surface. Horizontal drilling and hydraulic fracturing now allow the energy industry to extract this trapped gas. Commercial hydraulic fracturing began in 1949, though it took decades of use for innovations to make shale gas extraction more cost effective. Horizontal drilling can cost 3 to 4 times more than conventional drilling, but has the potential of reaching substantially more reserves. Figure 4 from the EIA compares horizontal drilling and hydraulic fracturing to conventional methods of natural gas extraction. Figure 5, further depicts the hydraulic fracturing process.

Horizontal wells and hydraulic fracturing in conjunction with advances in micro-seismic technology aiding both exploration and the drilling process have allowed the energy industry to extract natural gas at greater depths. According to the EPA (Jun., 2010), horizontal wells are drilled to a depth between 8,000 and 10,000 feet. Hydraulic fracturing extracts natural gas from shale using a pressurized injection of fluid composed mostly of water and a small portion of sand and chemical additives that vary by site. This pressure causes the shale to fracture, requiring sand or other propping agents to keep the fissures open and allow gas to escape. Between 15 to 80% of the fluids are recovered from the well before the natural gas is collected. This water called ―produced water" can be reused in other wells, but will need to be treated or disposed of at some point.

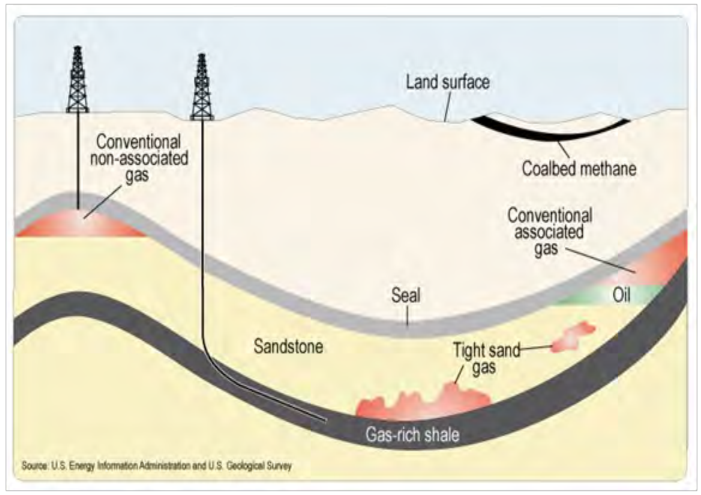
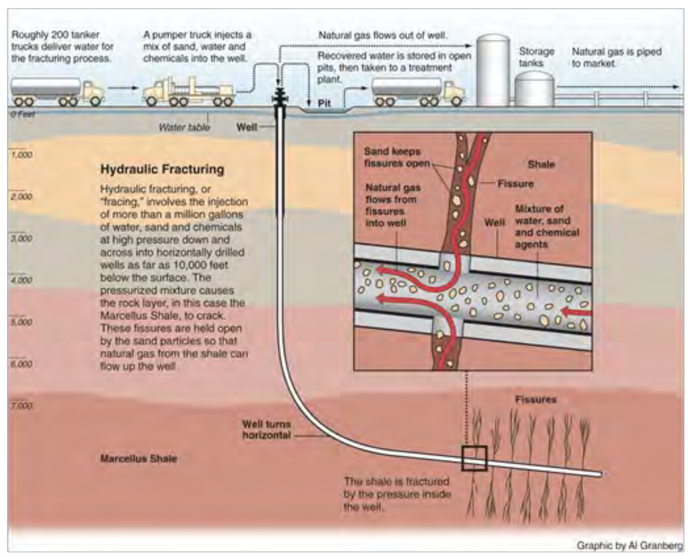


Figure 4: Natural Gas Mining Methods

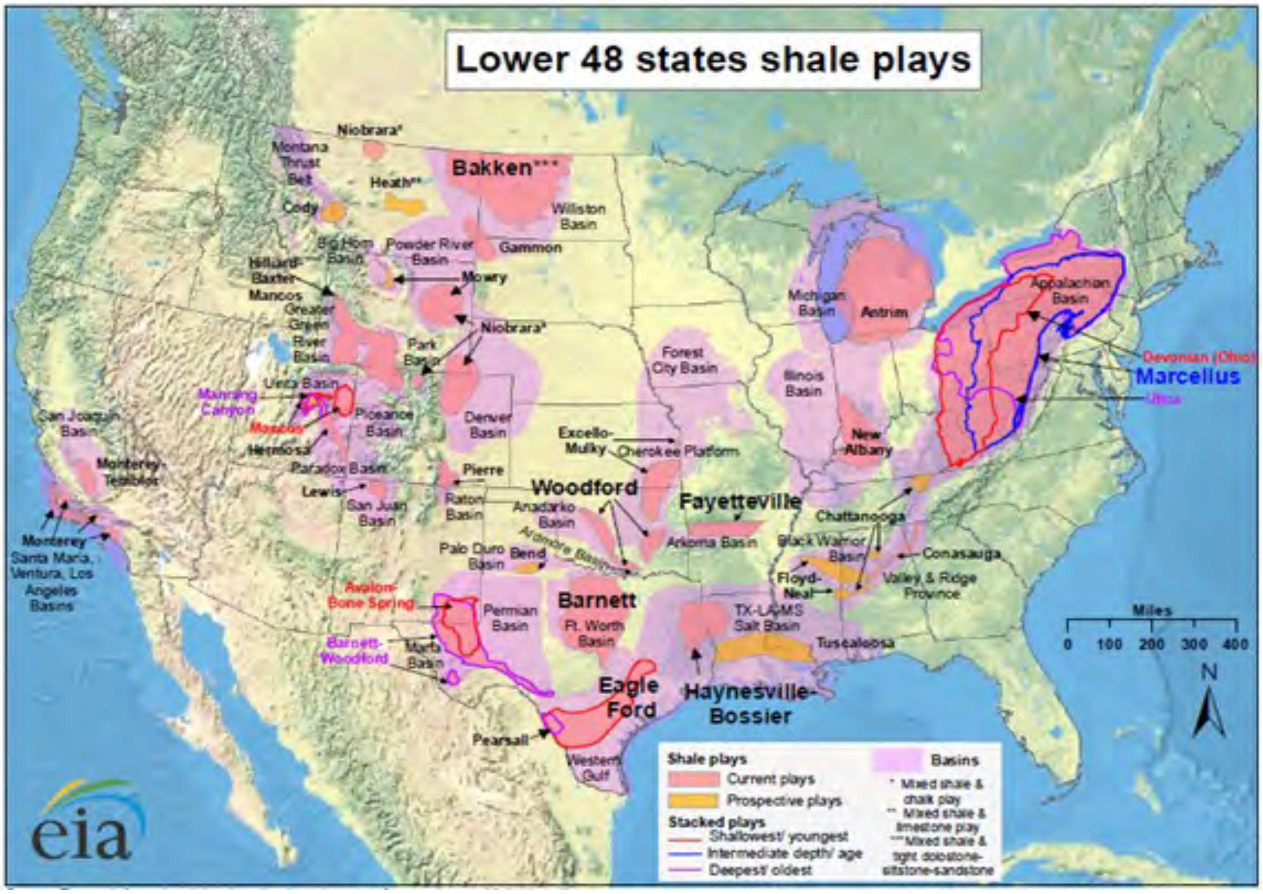


Source: ProPublica

Figure 5: Hydraulic Fracturing

Natural Gas Development in the US:

In the 1980s, the Barnett shale in Texas became the first natural gas producing shale. More than a decade of production from the Barnett shale in Texas has helped improve the hydraulic fracturing process, leading the way for it to be used in other areas such as the Marcellus shale in Pennsylvania and the Utica Shale in Ohio. The Marcellus shale is more than 60 million acres and is significantly larger than the Barnett. The EIA estimates that there are 410 Tcf of recoverable gas in the Marcellus shale alone. Figure 6 on the next page shows the location of US shale plays including the Barnett in Texas and the Marcellus and Utica in Pennsylvania and Ohio. Figure 6 clearly shows that shale natural gas is a national phenomenon that will dramatically alter natural gas availability and pricing nationally. Indeed, EIA data further documents that shale plays are a global phenomenon that will likely reduce world-wide natural gas prices.

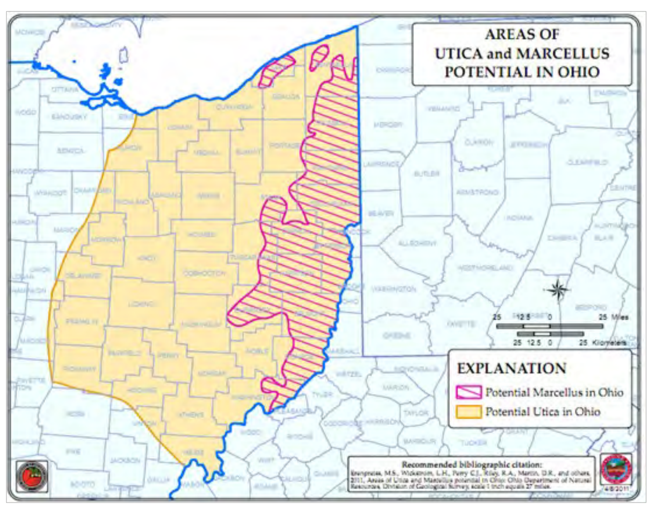


Source: US EIA

Figure 6: US Shale Resources

The large potential of the Marcellus shale, and more recently the Utica shale, has made Pennsylvania and Ohio highly attractive for mining of natural gas reserves. Figure 7 below provides a more detailed look at areas in Ohio that may be directly affected by natural gas resources. In an interview, Douglas Southgate of The Ohio State University's Subsurface Energy Resource Center states that shale resources in Ohio can provide a reliable, cheap, and local source of energy for Ohio. He explains that much of the attention has been on the Marcellus formation, though it is becoming clear that the Utica is more important. In the long term, the latter is expected to supply oil in significant quantities (Dezember and Lefebvre, 2011). It is also an important source of natural gas liquids (NGLs) such as ethane, which is converted into the ethylene used to manufacture a wide array of chemical products (American Chemistry Council, 2011). Thus, Southgate and others argue that shale deposits in and around Ohio are an important source of various hydrocarbons, not just the methane used to heat homes, generate electricity, and so forth.

Ohio shale development is just beginning. Figure 8 on the next page shows specific Marcellus and Utica well activity in Ohio from 2006 through August, 2011. It was recently reported that Chesapeake Energy has its first 4 active Utica shale wells in Ohio producing between 3 and 9.5 million cubic

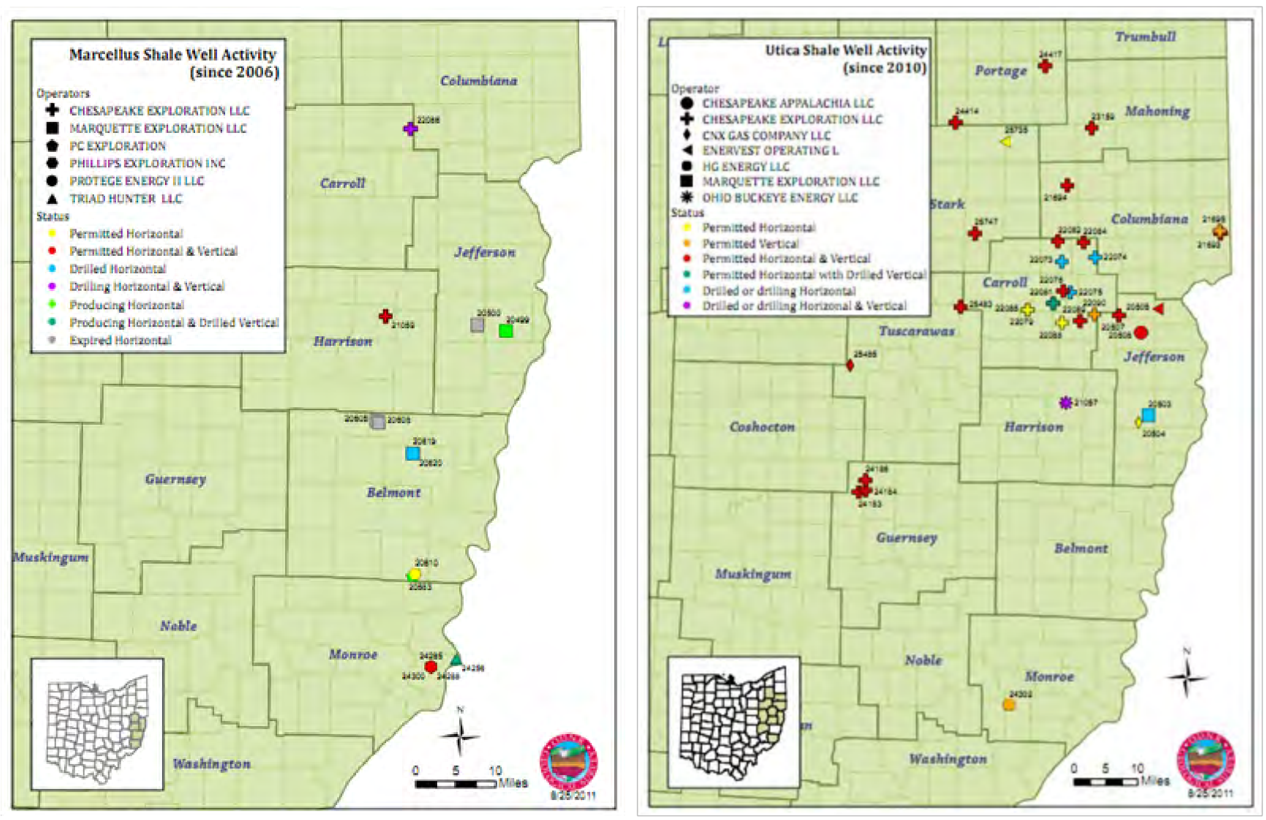


Source: ODNR

Figure 7: Ohio Shale Resources

feet of natural gas per day (Gearnino, 2011). A conventional well might produce between 100,000 and 500,000 cubic feet per day, but the Marcellus and Utica shale wells are expected to produce between 2 to 10 million cubic feet of natural gas per day. Chesapeake plans to increase the number of wells to 20 by the end of 2013.

Although shale development has already begun in Ohio, it is still nascent compared to Pennsylvania. The projected impacts on Ohio are still being debated. For example, Kleinhenz & Associates (2011) projected natural gas development in Ohio would lead to 200,000 jobs and $14 billion in spending. Much of their analysis uses assumptions derived from recent Pennsylvania impact studies such as Considine et al. (2009; 2010; 2011). Kleinhenz & Associates (2011) projected that 4,000 wells will be drilled in Ohio by 2015. Overall, they produced economic results that are similar to the industry-funded estimates for Pennsylvania.



Source: ODNR (Aug, 2011)

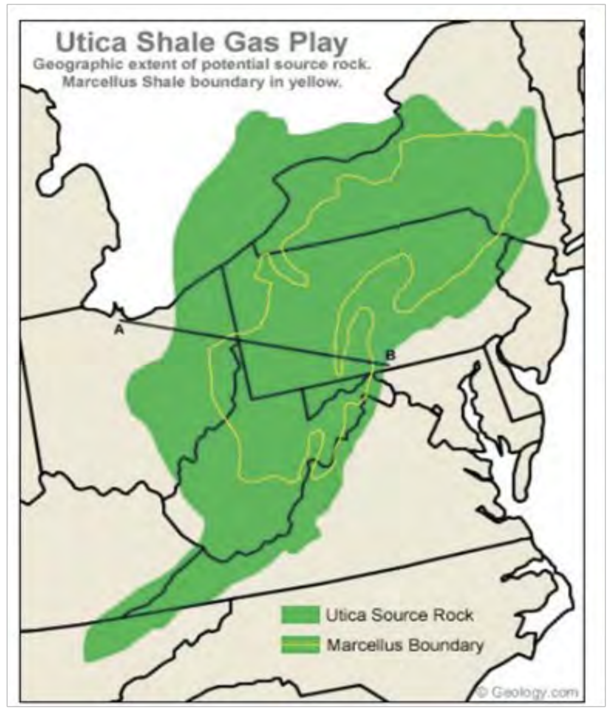
Figure 8: Marcellus and Utica Well Activity in Ohio

Economic Expectations

Pennsylvania is a particularly good gauge to predict what the impacts of shale gas will be on Ohio because they share much of the same natural resources. They are also very proximate and have similar economic structures. Figure 9 shows the Marcellus and Utica shale running through both states. Besides being neighbors, Pennsylvania and Ohio are the 6th and 7th most populous states. For both states, the shale resources are mainly located in rural areas, though there are larger population centers that are affected.

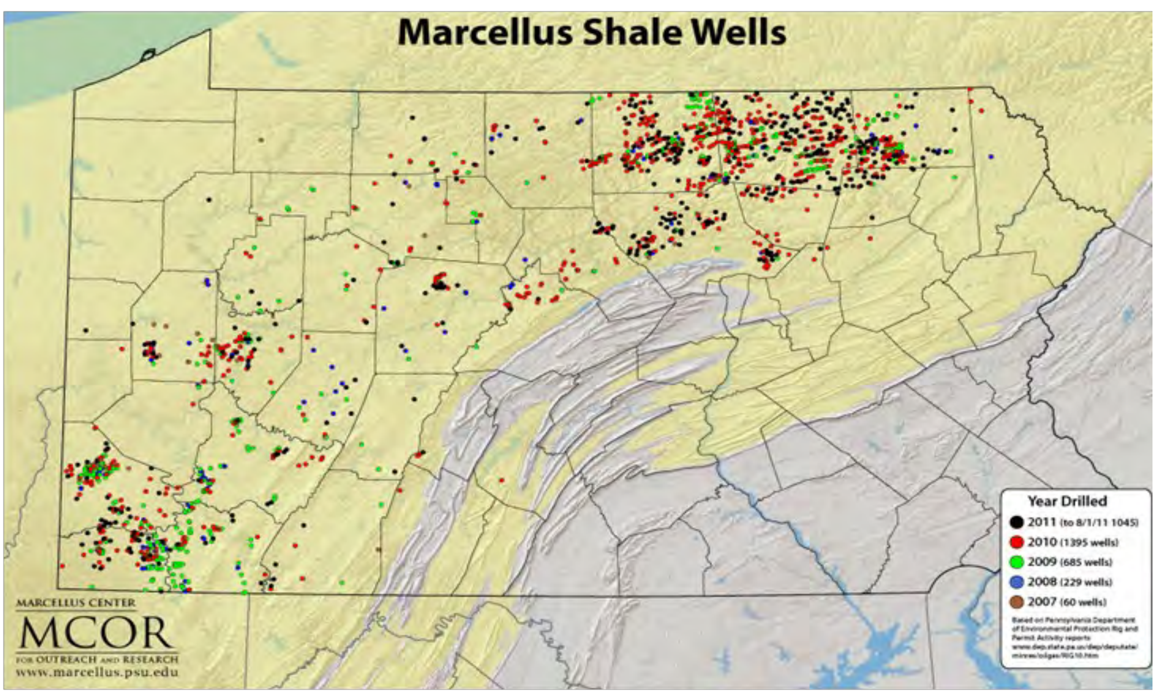
In 2005, the first well in the Marcellus shale in Pennsylvania began producing natural gas. Since then, most of the wells have been located in the northeast and southwest in Pennsylvania. Figure 10 shows the location of wells across the state by year. The number of shale wells drilled grew from 60 in 2007 to 1,395 in 2010. Considine (2010) finds that 36% of the 229 wells drilled in 2008 were horizontal and that percentage is expected to rise.

As the number of wells drilled dramatically increased, so did natural gas production in Pennsylvania, especially in the northeast region. Figure 11 on the next page shows the notable increase in production.



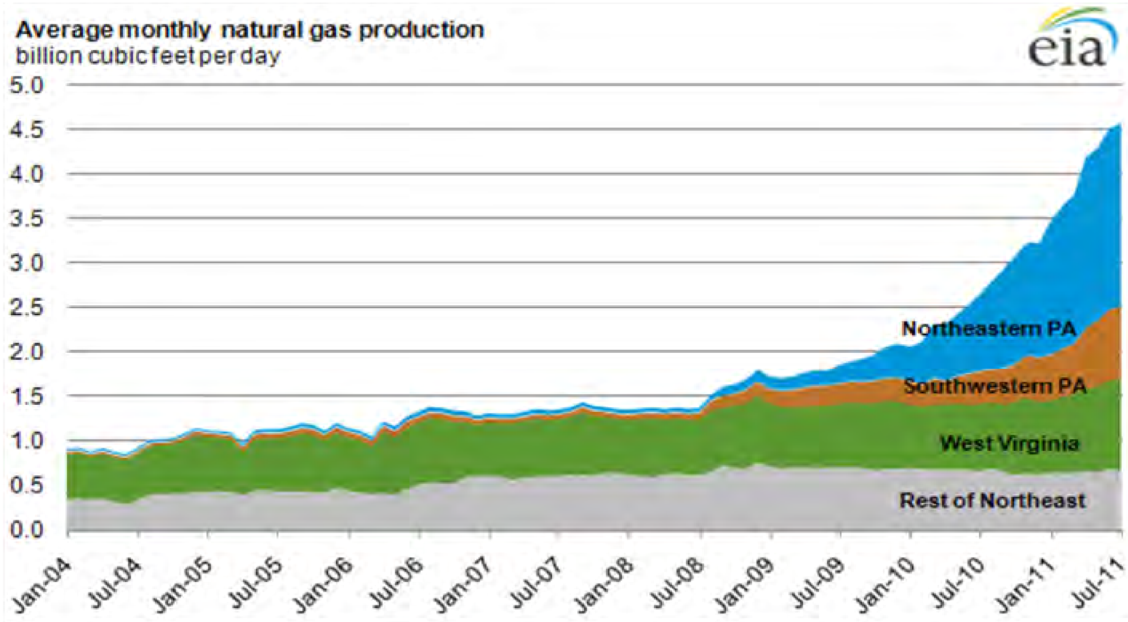
Source: Ohio EPA

Figure 9: Marcellus and Utica Shale Plays



Source: PSU

Figure 10: Marcellus Shale development 2007-2011



Source: US EIA

Figure 11: Northeast Natural Gas Production

Pennsylvania Natural Gas Employment:

Studies of natural gas's role in national and regional economies typically use impact studies (though this is not considered best practice for evaluating economic effects). Impact studies, such as the ones we describe, typically estimate three types of employment effects: (1) direct effects of the jobs directly employed in the activity (in this case natural gas mining); (2) indirect effects that would include inputs to the direct activity (such as pipeline construction); and (3) induced effects due to the added household income (e.g., workers purchasing items in the local economy) (see IMPLAN.com for more details). Summing across the three categories, if done correctly, would produce the total number of jobs "supported" by the industry (not new jobs created). As we describe below, estimating the number of new jobs created would need to assess what would have happened in the absence of natural gas mining—i.e., develop the counterfactual—which is not done in standard impact analysis.

One source of confusion is that impact studies do not produce continuous employment numbers. If an impact study says there are 200,000 jobs, this does not mean 200,000 workers are continuously employed on a permanent basis. For example, there are workers who do site preparation. Then there is another group who do the drilling followed by another group who maintains the well when it is in production. Finally, there is an entirely different group doing pipeline construction, and so on. So, while the public is likely more interested in continuous ongoing employment effects, impact studies are producing total numbers of supported jobs that occur in a more piecemeal fashion.

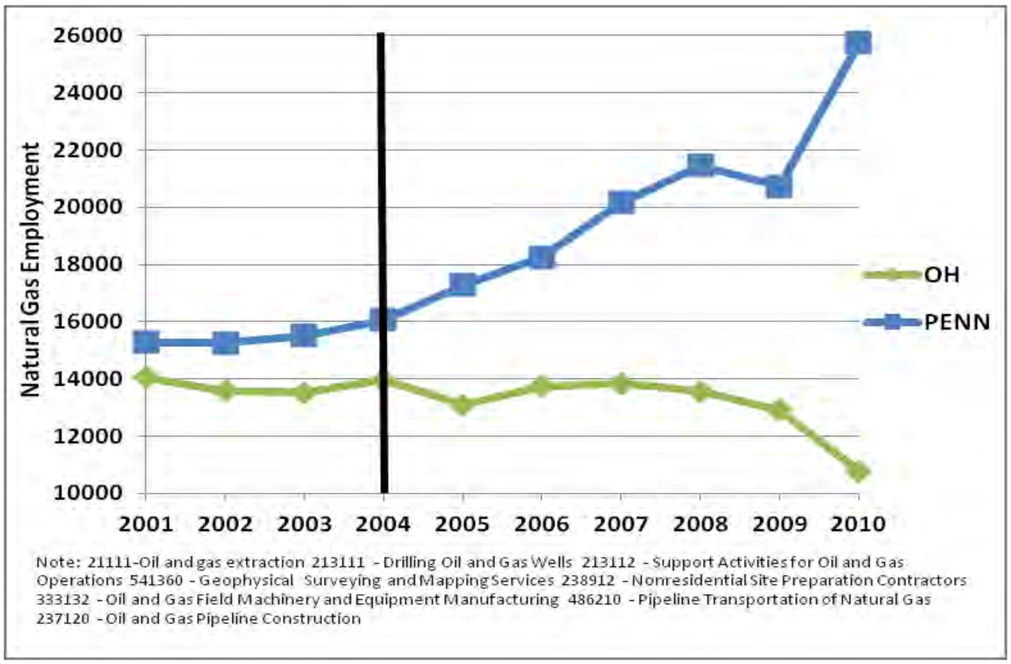
Impact analysis is usually based on an old input-output technology that is typically not used today by economists to estimate actual economic effects. Impact studies do not include various displacement effects and do not reflect the true counterfactual of comparing what would have happened without natural gas drilling. For example, oil and natural gas drilling would lead to higher local wages and land costs, which reduce employment that would have occurred elsewhere in the economy. Likewise, the environmental effects may reduce activity in the tourism sector and other residents may not want to live near such degrading activity. Finally, greater natural gas employment means that there are fewer jobs in coal that would have occurred without the increase in natural gas employment. As described below, best practice economics uses other approaches that try to adjust for displacement effects to derive more accurate estimates of actual effects (see Irwin et al. (2010) for a discussion of the weaknesses of impact studies).

Figure 12 on the next page shows the direct and much of the indirect employment in natural gas and other related sectors in Ohio and Pennsylvania.[6]

6. For the direct effect of natural gas mining, we also include some indirect suppliers that are related to natural gas drilling, which overstates the direct effects. However, not all of the indirect industries are included in Figure 12. When we use a multiplier below, because we already include some indirect effects, we would overstate the total number of supported jobs for the industry.

Since some of the sectors reported in Figure 12 include other sectors—primarily oil—we assume that all of the gain in Pennsylvania employment is due to new natural gas production. Also, we do not include ―energy related" sectors in Figure 12 if they showed a large decrease in employment because we believe that would understate the importance of new natural gas production in Pennsylvania (those declines would likely be due to other factors). Thus, if anything, we believe that any measurement ―errors" would work to overstate the importance of new gas production employment.[7] From Figure 12, with these assumptions, we assume that from 2004-2010, there was a gain of about 10,000 direct and indirect jobs in the natural gas industry in Pennsylvania.

The typical multiplier would take direct employment and multiply it by the multiplier to arrive at the total effects, including indirect and induced effects. Since the 10,000 number derived above includes some of indirect effects such as pipeline construction, using the standard multiplier would likely lead to an overstatement of the total employment effects of new production. Nonetheless, assuming the standard multiplier of 2 (which is on the high end), the natural gas industries would still have led to about 20,000 direct, indirect, and induced jobs from 2004 to 2010 in Pennsylvania, though this ignores employment losses in other sectors displaced by natural gas.[8] By comparison, Considine et al.'s (2011) industry funded study suggested that natural gas was associated with 140,000 Pennsylvania jobs during 2010.



Source: BLS

Figure 12: Ohio and Pennsylvania Natural Gas Employment[9]

7. IHS Global Insight (2009) notes that employment in these sectors also includes employment in the oil sector and other sectors (not just natural gas). They calculate some national estimates of natural gas's share of overall employment in each sector. For example, they estimate natural gas's employment share for the following industries as follows: (1) 2111-Oil and gas extraction, 213111 - Drilling Oil and Gas Wells, and 213112 - Support Activities for Oil and Gas was 74% in 2008; (2) 237120 - Oil and Gas Pipeline Construction was 68% in 2008; (3) 333132 - Oil and Gas Field Machinery and Equipment Manufacturing was 65% in 2008 and (4) 238912 - Nonresidential Site Preparation Contractors was 16% in 2008). We could have used IHS Global Insight's shares in our calculations, but we believe this would **understate** the increase in the size of the natural gas sector in Pennsylvania because some of the gains would be attributed to other sectors.
8. Academic economists generally use a multiplier of 2 as an upper bound multiplier. For example, Stabler and Olfert (2002) describe a range of employment multipliers in the 1.1 to 1.5 range. Hughes (2003) describes that *output* multipliers above 2.5 are likely very questionable. Likewise, Kelsey et al. (2009) found an output multiplier for natural gas in Pennsylvania to be in the 1.86 to 1.90 range, further showing that our 2.0 multiplier is reasonable. Indeed, as the economy becomes more global, fewer employment gains are on-shore or local, which would reduce employment multiplier effects. Likewise, with outsourcing and increasingly fragmented supply chains, firms are further shifting their purchases outside the firm, which further reduces the amount purchased locally. Further, keep in mind that the energy sector is highly capital intensive which would work to reduce the employment effects and increase the output effects in a multiplier. Thus, we believe our use of an employment multiplier of 2 would be viewed as ―generous" by independent academic economists.
9. The direct effects would commonly include the drilling and extraction activities while indirect effects would normally include inputs such as pipeline construction and field equipment manufacturing. Hence, this is why we state that we are already including some of the key inputs as direct employment in Figure 12.

We believe that independent and academic economists in regional and urban economics would view our 20,000 employment estimate as reasonable and some may view it on the high end of actual job creation.[10] For example, Barth (2010) notes that other studies found a multiplier for oil and gas as low as 1.4. She also notes that in similar input-output studies, other industries were found to have higher multipliers than oil and gas, with agriculture having one of the highest multipliers. If shale development adversely effects employment in (say) coal mining, agriculture, and tourism, then those numbers should be subtracted from these numbers to derive the actual employment effects (including any multiplier effects in those sectors). To be sure, we only calculate an impact style estimate to give a feel of the overestimated effects produced by industry consultants (and others who produce impact studies). There are much better approaches than impact studies to calculate actual effects, which we describe below.

One other issue is that proponents of natural gas expansion in Ohio often claim that lower natural gas prices will provide a major stimulus to overall employment, especially in manufacturing. While we will not assess whether natural gas prices are a sufficient share of a typical firm‘s cost structure to make a tangible difference, we do note that there are reasons to be skeptical of those claims (though we hope we are wrong). Foremost, to make a difference on Ohio‘s relative competitive edge compared to the rest of the United States and the rest of the world, it would have to be an event that helps Ohio‘s businesses much more than in the rest of the world. However, as we note in the discussion surrounding Figure 6, shale natural gas is a global phenomenon, meaning that falling natural gas prices will benefit a significant share of Ohio‘s global competitors. Thus, there is no ―edge" given to Ohio‘s businesses that would make them tangibly more competitive than their national and international competitors.

Economists typically subject their forecasts to ―smell tests" by making comparisons to similar events. In our case, comparing energy development around North Dakota‘s Bakken shale formation in the far northwestern part of the state is good benchmark to assess whether our 20,000 job forecast for Ohio makes sense. Specifically, development of North Dakota‘s Bakken shale region has been about the same magnitude as the energy development in Pennsylvania and should produce somewhat comparable job effects on both states.[11] During the October 2007-October 2011 period (or a four year period that corresponds to Kleinhenz & Associates‘ Ohio study), the entire state of North Dakota added about 39,000 jobs. It is highly unlikely that this is all due to energy as high commodity prices (for example) have supported North Dakota‘s relatively large farm economy. Further, we would expect that the Bismarck metropolitan area (which is relatively close to the mining activity) to be more impacted by the energy boom, while the Fargo and Grand Forks metropolitan areas that are hundreds of miles away on the Minnesota border to be considerably less affected. In this comparison, Bismarck added 4,600 jobs during this four-year period, while Fargo and Grand Forks metropolitan areas respectively added 4,400 and 1,600 jobs. These figures strongly suggest that North Dakota‘s relative prosperity is more widespread than just an energy boom in the Bakken region. So, even if all 39,000 North Dakota jobs were due to energy (which we have already shown is highly unlikely), this would be a far cry short of the 200,000 jobs that have been forecasted for Pennsylvania and Ohio despite the comparable size of the three states‘ energy booms.[12] Thus, our forecast of 20,000 jobs over the next four years is further supported as a reasonable forecast based on the North Dakota experience.

Although Pennsylvania‘s natural gas employment gains are impressive, they still represent just a small share of total state employment. From 2004 to 2010, the employment share of oil and natural gas related sectors shown in Figure 12 increased from 0.30% to 0.48% (see Figure 13). This small employment share is simply not enough to have a significant effect on total jobs and on unemployment for the state.[13] Despite the significant increase in natural gas jobs from 2009 to 2010,

10. For example, there are many factors affecting the actual employment number. If there are workers from out of state, Ohio‘s employment number would be lower. Conversely, if more landowners are in state compared to Pennsylvania, that would increase the employment number. Other factors are harder to predict such as mining‘s effect on agriculture and timber.
11. U.S. Bureau of Labor Statistics Data (Current Employment Statistics) suggests that between October 2007 and October 2011, mining employment (which is due to the direct energy production) increased by about 12,000 in both states. The other employment numbers referred to here are from the same source.
12. U.S. Bureau of Labor Statistics Data shows that North Dakota had an October 2011 unemployment rate of 3.5%, which seems quite low compared to the 9.0% national rate. However, North Dakota always has very low unemployment rates due to long-term structural reasons (Partridge and Rickman, 1997a, 1997b). For example, it was an even lower 3.0% in October 2001, well before the energy and commodity price boom of recent years, illustrating that the energy boom is only a partial reason for North Dakota‘s current low unemployment rate.
13. To give a further feel for the size of the natural gas sector in Pennsylvania, Barth (2010) finds that in January 2010 there were 48,777 Walmart employees in Pennsylvania (almost double that of the natural gas industry broadly defined) and approximately 400,000 jobs in the tourism industry.

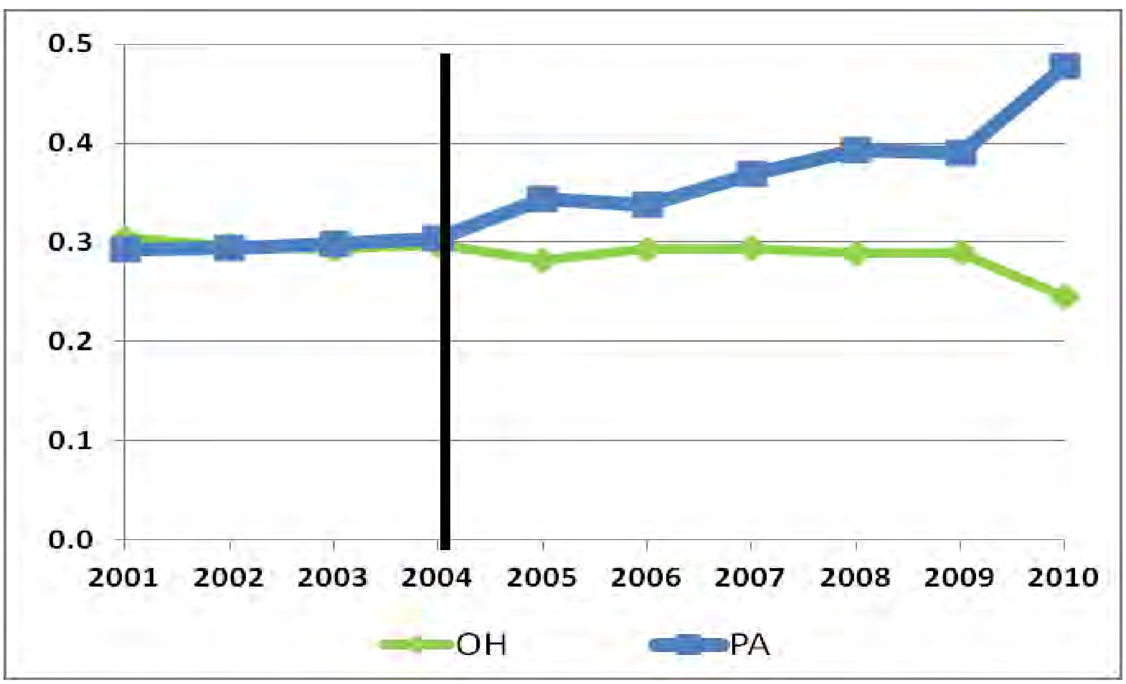
Pennsylvania's unemployment rate still increased from 8.0% to 8.7% during this time (BLS: U.S. Department of Labor, Bureau of Labor Statistics). At most, natural gas employment effects would be localized. Conversely, Ohio's unemployment rate remained unchanged at 10.1% from 2009 to 2010 (BLS) despite a loss in the energy sector jobs in Figure 12, illustrating that natural gas employment is not driving either state's economy.

Concerns with the Economic Impact Studies of Natural Gas Development:

Impact studies are typically associated with overstatements of the employment effects of new development. For example, the Considine et al. (2011) study appears to include indirect and induced jobs before applying the multiplier effect, which double-counts effects and blows up the estimated effects. Direct jobs should include those jobs directly associated with drilling the wells and extracting the natural gas. Indirect jobs include the jobs associated with various inputs required by the industry such as pipelines. Induced jobs should include those jobs and services required by the workers such as restaurants and entertainment.[14] The final two categories should be the outcome of the multiplier process.

Second, Considine et al. assumes that 95% of natural gas industry spending will occur in Pennsylvania. Kleinhenz & Associates assumes a slightly more conservative 90% of all spending will be spent in Ohio. In global economies in which state economies are integrated with national and international economies, such assumptions would not be credible for independent economists. Moreover, because the industry is relatively new and undeveloped, more of the inputs would be brought in from outside of the state, e.g., from Texas.[15]

There are other problems with impact studies because, in reality, more of the money leaks out. For example, Kelsey et al. (2011) found 37% of the Marcellus employment has gone to non-Pennsylvania residents and that landowners save or invest approximately 55% of the money they make from royalties/lease payments rather than spending it in the local economy. They use these



Source: BLS

Figure 13: Ohio and Pennsylvania Natural Gas Employment Shares of Total State Employment

14. Examples of jobs that should not be categorized as direct to natural gas mining are Finance & Insurance, Educational Services, Health, Arts & Entertainment, Hotel & Food Services, etc. By including these jobs as direct jobs, Considine et al. is essentially double counting the employment effects. While we do not have Considine et al.'s programming we believe one source of the double counting derives from how household spending from lease payments/royalties are treated. Even using the job estimates of Considine et al., it is still not a significant portion of the total employment in Pennsylvania.
15. We believe a more reasonable approach would have been to use the default state spending shares from the IMPLAN software (i.e., Considine et al. overruled IMPLAN's default numbers and incorporated 95%). In the absence of detailed and regional I-O data, other shortcuts have been used such as payroll to sales ratios (Oakland et al., 1971; Rioux and Schofield, 1990; Wilson, 1977) or Value-added to gross outlays by industry (Stabler and Olfert, 1994).

	Population 2005	Per Capita Income 2005	Employment Growth Rate 2001-2005	Employment Growth Rate 2005-2009	Income Growth Rate 2001-2005	Income Growth Rate 2005-2009
Non-Drilling Counties	255,508	$32,187	5.3%	-0.4%	12.6%	13.6%
Drilling Counties	124,928	$27,450	1.4%	-0.6%	12.8%	18.2%

Source: BEA

Table 1: Pennsylvania County Descriptive Statistics

more realistic findings to develop a better estimate of the economic impacts of shale development in Pennsylvania. Using IMPLAN, Kelsey et al. (2011) find that in 2009, Marcellus shale development economic impact was over 23,000 jobs and more than $3.1 billion. Our estimate of 20,000 jobs then closely corresponds to Kelsey et al.'s estimates (2011).

Finding Counterfactuals to Assess Growth:

The key problem with impact studies is that they do not estimate the actual number of jobs created by mining because of all of the displacement effects. They are not the true counterfactual and economists have not viewed them as best practice for decades (Irwin et al., 2010). Economists have developed other more credible approaches in developing a counterfactual, such as difference in difference approaches. One of these approaches is to match drilling counties to non-drilling counties that otherwise would have had similar employment patterns if there was no drilling. Thus, the goal is to find counties that would have looked similar to the drilling counties in the absence of drilling. We describe this approach below.

Although natural gas employment does not seem to have had a significant impact on the state as a whole, it may still have a sizeable impact on the specific counties, many of them rural. Table 1 presents data for Pennsylvania counties before and after drilling. Table 1 shows that before 2005, drilling counties are notably struggling more than non-drilling counties. Drilling counties on average are less populated, more rural, have lower per capita income and less employment growth. Natural gas leases also provide an additional source of income for landowners. Landowners that choose to lease their land to natural gas companies generally receive an upfront payment per acre and royalties on the gas produced from the well. Although the payout varies, it can be quite sizeable. From Table 2, it seems natural gas development is positively related to per capita income growth rates for drilling counties.

Table 1 highlights the fact that drilling counties on average look very different than most non-drilling counties. Thus, we look specifically at 3 significant high-drilling counties in the northeast (Tioga, Bradford, and Susquehanna) and 3 in the southwest (Washington, Greene, and Fayette).[16] We then match each of these two sets of mining counties to similar non-mining counties (as of 2009) based on population and similar employment and income dynamics *before* 2005 and the advent of shale drilling.[17] Figure 14 shows the mining and non-mining counties that were chosen. Figure 14 shows that the matches are divided into the Northeast quadrant of the state and the southern part of the state. The appendix provides additional graphs directly comparing each drilling county with its matched

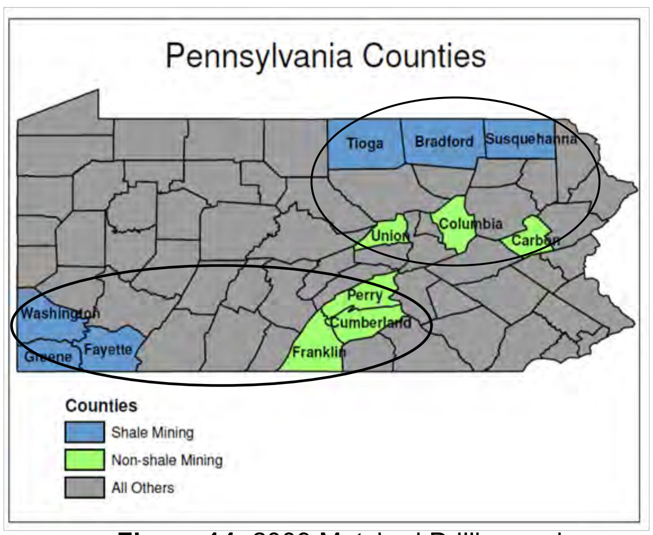


Figure 14: 2009 Matched Drilling and Non-drilling Counties

16. Drilling counties were matched to non-drilling counties on the basis of population and general urbanization as well as region (either north or south).
17. Matching studies can employ other mathematical approaches to finding matches. As will be apparent, our choice of non-drilling counties will appear to be good matches.

non-drilling county.

Using BEA employment and income data, the shale mining counties are compared to the non-mining counties with 2004 marking the point immediately before drilling activities began. One of the key features of the employment and income data is that both mining and non-mining counties are on similar growth paths prior to drilling, suggesting there they are good comparisons (see Figures 15-18 in the next pages). Figure 15 suggests that mining counties may have had faster job growth in the Southern region, but Figure 16 shows that the opposite applies in the Northeastern region. Overall, there are no clear employment effects for heavily drilled counties. We are not saying there are no drilling employment effects, but that they are not large enough to be detected in this commonly used matching approach. One reason may be that many of the new jobs may go to people outside the state who have previous experience in natural gas extraction.[18] Conversely, the positive impacts on incomes are more clear. Figures 17 and 18 show the per capita income impact of natural gas drilling appears to be positive in both Southern and Northeastern regions. While the effects may differ in longer-run periods, our four year window conforms to Kleinhenz & Associates' four year forecast for Ohio.

To be sure, there are many things happening in these county economies, but such efforts to form the true counterfactual are more in line with best economic practice than the impact studies that are often used by economic consultants. In particular, one especially appealing feature is that our approach is based on actual employment and income data and not based on the assumptions of computer software.

For further comprehensive analysis to appraise whether our previous matched results are correct, we now perform a statistical analysis on all counties within Pennsylvania. To control for county-specific effects, we use a difference-in-difference approach to find the impact of drilling on the change in employment after drilling compared to the change in employment before drilling. Details of the difference-in-difference methodology are provided in the appendix, but essentially we are examining whether having more natural gas wells is associated with more job and income growth, but this time we are considering all Pennsylvania counties. This approach accounts for the fact that drilling and non-drilling counties may have systematic differences (fixed effects) for a variety of reasons - and we are adjusting for these differences. Table 2 shows that the number of wells drilled since 2005 has no statistically significant effect on employment.[19] Overall, we believe that there have been modest employment effects in drilling counties, but they are not large enough to statistically ascertain (most likely due to some of the offsetting factors we just described). The upshot is decision makers who are interested in the actual job creation effects of natural gas need to take much more seriously the displacement effects throughout the economy.

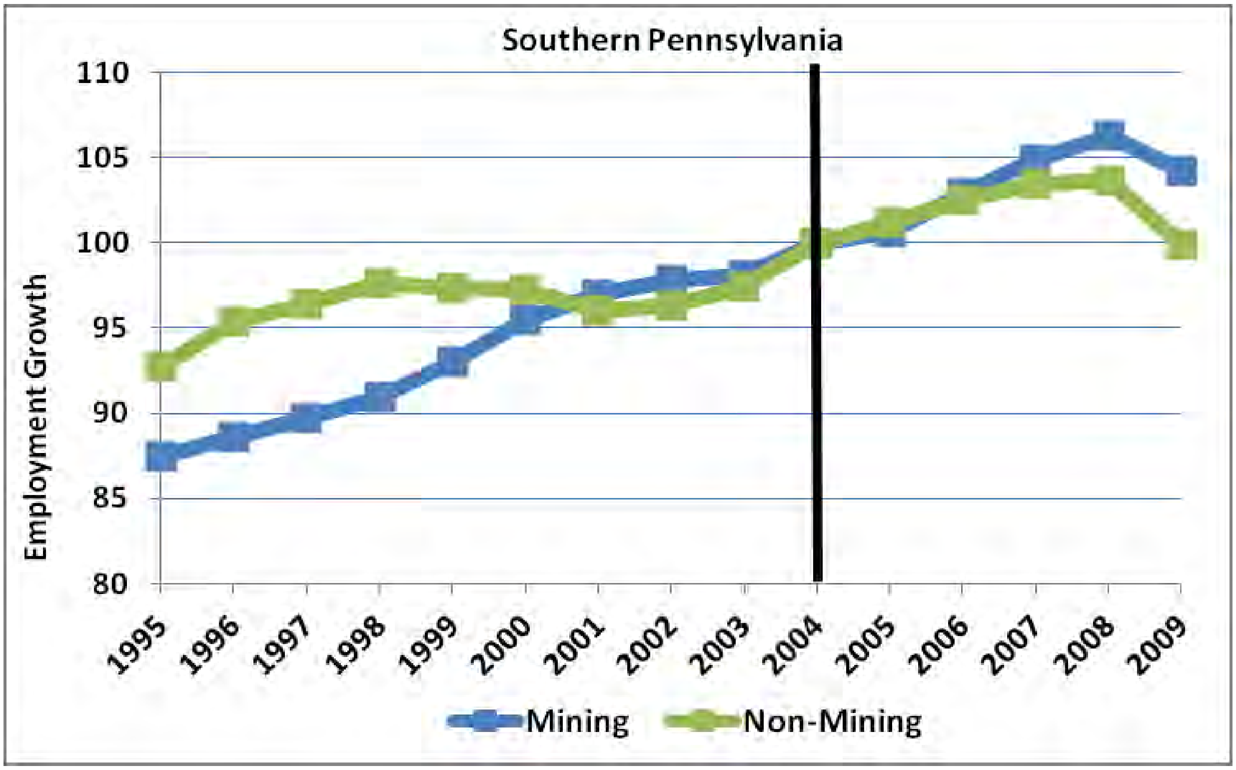
There are many important reasons why we would expect natural gas' impact on employment to be small or insignificant, which explains the findings in Figures 15 and 16 and in Table 2. Besides displacement, one reason is the production technology of natural gas. Like other fossil fuel energy industries, natural gas is rather capital intensive.

	Change in Percent Employment Growth 2005-2009 Compared to 2001-2005	
	Parameter Estimate	t-value
Total Wells 05-09	**1.769E-05**	**1.14**
2001 Log Population	0.023	2.64
2001 Log Per Capita Income	-0.096	-1.55
N	67	
R2	0.118	
Adjusted-R2	0.076	

Source: BEA and Pennsylvania DEP Data. See the appendix for more details.

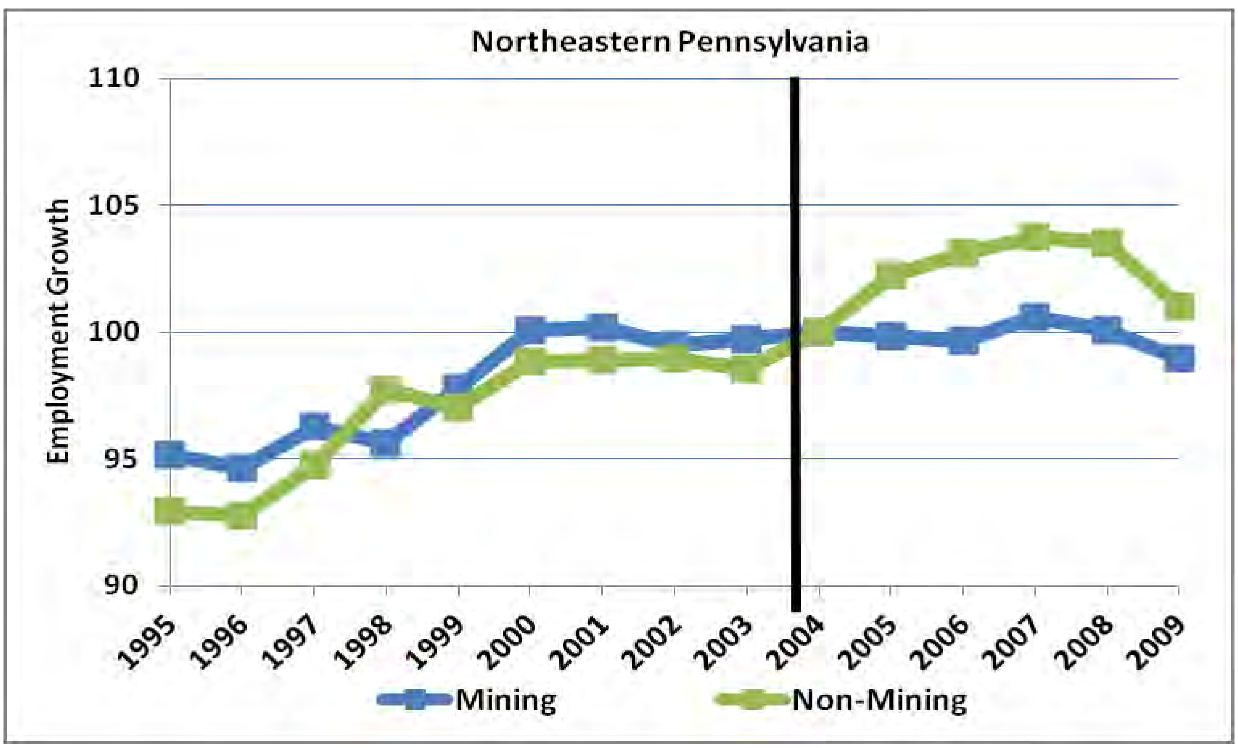
Table 2: Employment Effects of Drilling

18. Pennsylvania and Ohio residents may not have the skills and experience needed to meet the demands of the natural gas industry and royalty/lease monies may not be spent locally. Similarly with natural gas spending, Pennsylvania may not have the services and supply chain the energy industry requires initially. Along with other displacement effects, this may explain the lack of employment response.
19. We also considered that possibility that there are threshold effects (or other nonlinearities) in which drilling does not affect economic growth until a certain number of wells are drilled. We did this by adding a number of wells drilled squared term to the model. This variable's coefficient was negative and statistically insignificant in both the income and employment growth models, suggesting that there are no nonlinear effects. Additionally, these numbers don't account for people switching from part time to full time employment.



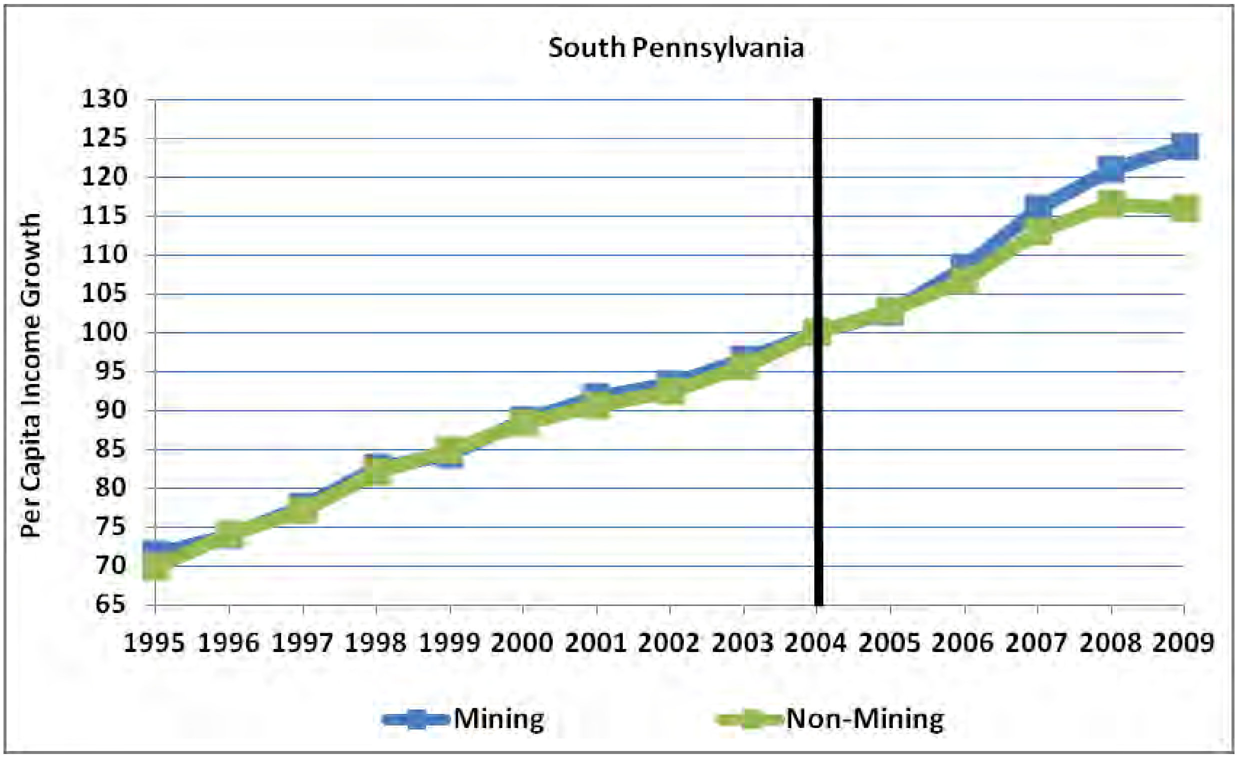
Source: BEA Mining counties (Washington, Greene, and Fayette) Non-mining counties (Perry, Franklin, Cumberland)

Figure 15: Drilling and Non-drilling Employment Comparison (2004=100)



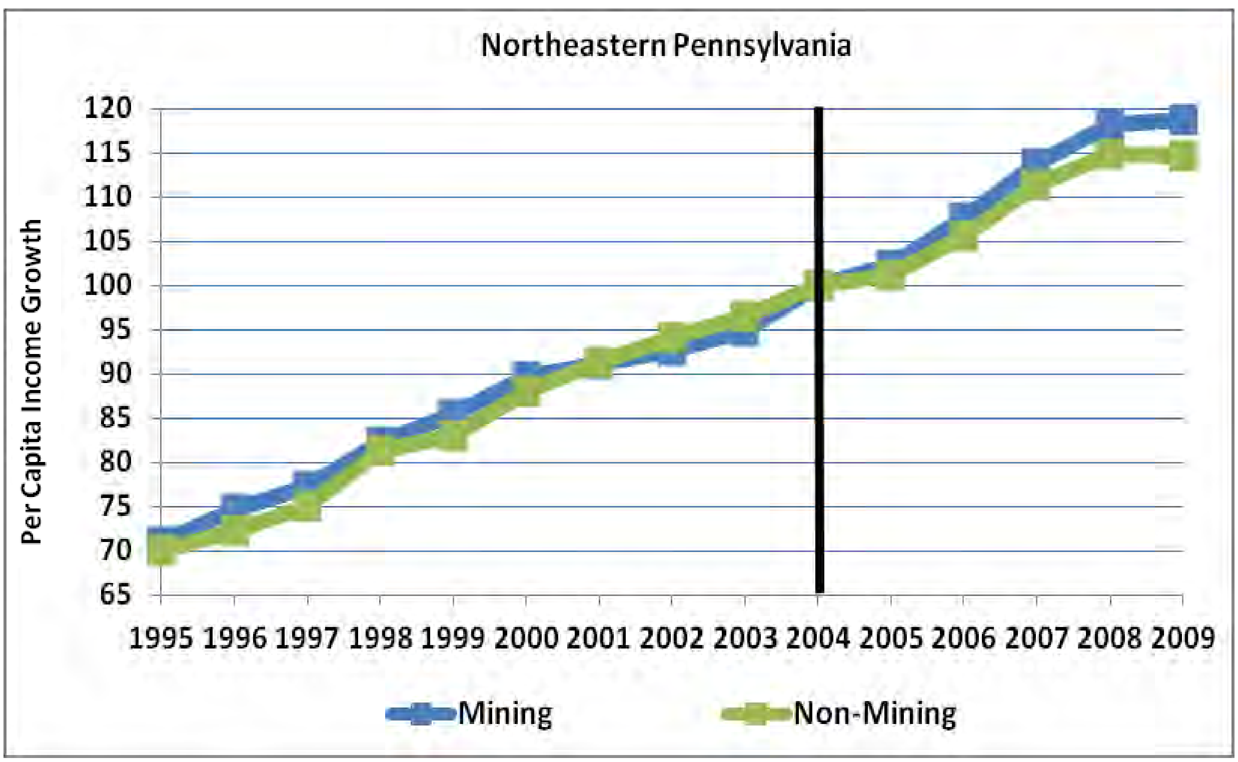
Source: BEA. Mining counties (Tioga, Bradford, and Susquehanna) Non-mining counties (Union, Columbia, Carbon)

Figure 16: Drilling and Non-drilling Employment Comparison (2004=100)



Source: BEA. Mining counties (Washington, Greene, and Fayette) Non-mining counties (Perry, Franklin, Cumberland)

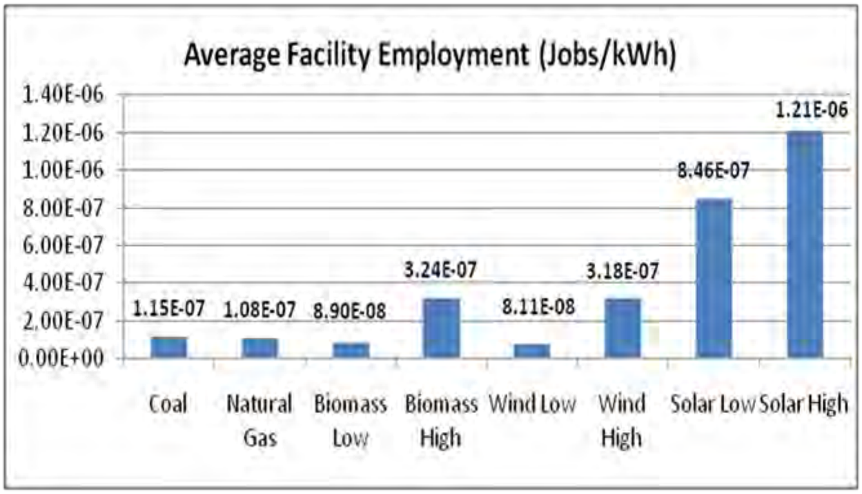
Figure 17: Drilling and Non-drilling Per Capita Income Comparison (2004=100)



Source: BEA. Mining counties (Tioga, Bradford, and Susquehanna) Non-mining counties (Union, Columbia, Carbon)

Figure 18: Drilling and Non-drilling Per Capita Income Comparison (2004=100)

Figure 19 shows the estimated number of jobs required to produce a kWh of electricity. Natural gas actually requires fewer jobs to produce a given amount of electricity than coal. The job requirements for natural gas electricity production are low because it is efficient at producing a kWh. In this case, fewer jobs created is actually a good thing for the overall competitiveness of the economy because that implies low-cost electricity, but it means that natural gas drilling has smaller employment impacts.



Source: Weinstein et al. (2010) chart using data from Kammen et al. (2004)

Figure 19: Jobs Requirements to Produce a kWh by Energy Source

As figure 3 shows, most natural gas resources (32.8%) are used for electricity. When switching from coal to natural gas, there will be significant displacement effects in addition to the effects of natural gas being more productive than coal in producing a kWh. Using the same technique shown in Weinstein et al. (2010), Table 3 shows the approximate employment effects of even large shifts (25% of the kWh produced from coal to kWh generated from natural gas) are rather small. In both cases, there are small employment losses with Ohio having more employment losses due to a higher percentage of electricity being generated from coal.

	Total kWh from Coal 2009	Change in Jobs	Change in Energy Costs (millions)	Change in Emissions (lbs)
Ohio	113,711,997,000	-195	-$491,804	-23,822,663,372
Pennsylvania	105,474,534,000	-181	-$456,177	-22,096,914,873

Source: EIA and Weinstein et al. (2010)

Table 3: Effects of Displacing Coal with Natural Gas

	Change in Percent income Growth	
	Parameter Estimate	t-value
Total Wells 05-09	**2.515E-05**	**2.11**
2001 Log Population	0.084	2.53
2001 Log Employment	-0.086	-2.76
N	67	
R2	0.205	
Adjusted-R2	0.167	

Source: BEA and Pennsylvania DEP Data

Table 4: Income Effects of Drilling

Table 4 shows the regression results for a difference-in-difference for county per-capita income. In this case, the income injected into the economy by the natural gas industry through leases and wages appears to have a significant positive effect on per capita income. These results, along with the employment regression results, verify our previous analysis using matched drilling and non-drilling counties. Drilling seems to have a positive and significant effect on income in drilling counties - but not on employment.

The Benefits and Costs of Natural Gas

Once the realistic expectations of the employment and income effects of shale natural gas development are properly assessed, these impacts can be included when weighing the benefits and costs of shale gas.

The Benefits of Natural Gas:

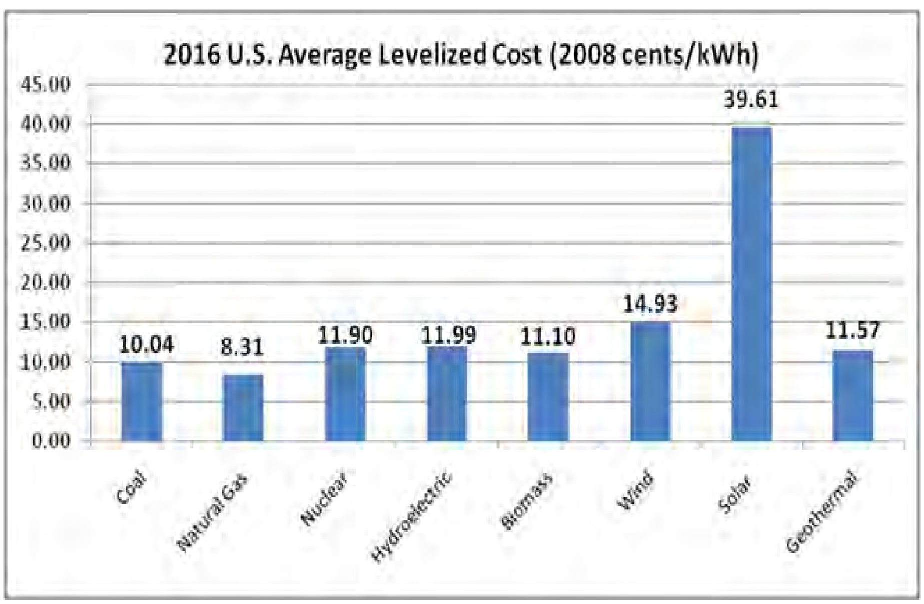
Other than the income effects and modest employment impacts, additional benefits to natural gas include lower energy prices, natural gas imports, and carbon emissions (especially compared to coal). First, Figure 20 below shows the average levelized cost to produce a kWh. As shown in Table 3, natural gas decreases electricity costs for end users. However, if natural gas prices are too low it will be less economical to pursue shale gas.[20]

Pennsylvania and Ohio are also good locations to produce natural gas as there is significant natural gas infrastructure in the area and large population and industry centers that require natural gas as shown in Figure 21 on the next page. This proximity further decreases energy costs by reducing transportation costs.

Increasing domestic sources of natural resources are reducing the demand for foreign gas. The EIA reports that 87% of the natural gas consumed in 2009 was produced domestically. Figure 22 on the next page shows that since 2007, natural gas imports have been declining. However, as already noted, future increases in natural gas production will have very little effect on “energy security” as our largest problem relates to oil imports.

The potential benefits of natural gas have been touted by both the industry and the US EIA. However, the ability to supply the country‘s energy‘s needs may have been overstated. In the 2011 Annual Energy Outlook, the EIA estimates that 2,543 Tcf of potential natural gas resources could supply the U.S. for approximately 100 years at the 2010 level of annual consumption. However, this does not account for the increasing trends in consumption. Accounting for the trend in consumption from 1974 to 2010, this estimate falls to 65 years. Using a more recent trend from 1986 to 2010, the estimate falls to 52 years. Despite the significant reserves, natural gas energy strategies still suffer from typical fossil fuels problems such as nonrenewability.

The Environmental Benefits and Costs:

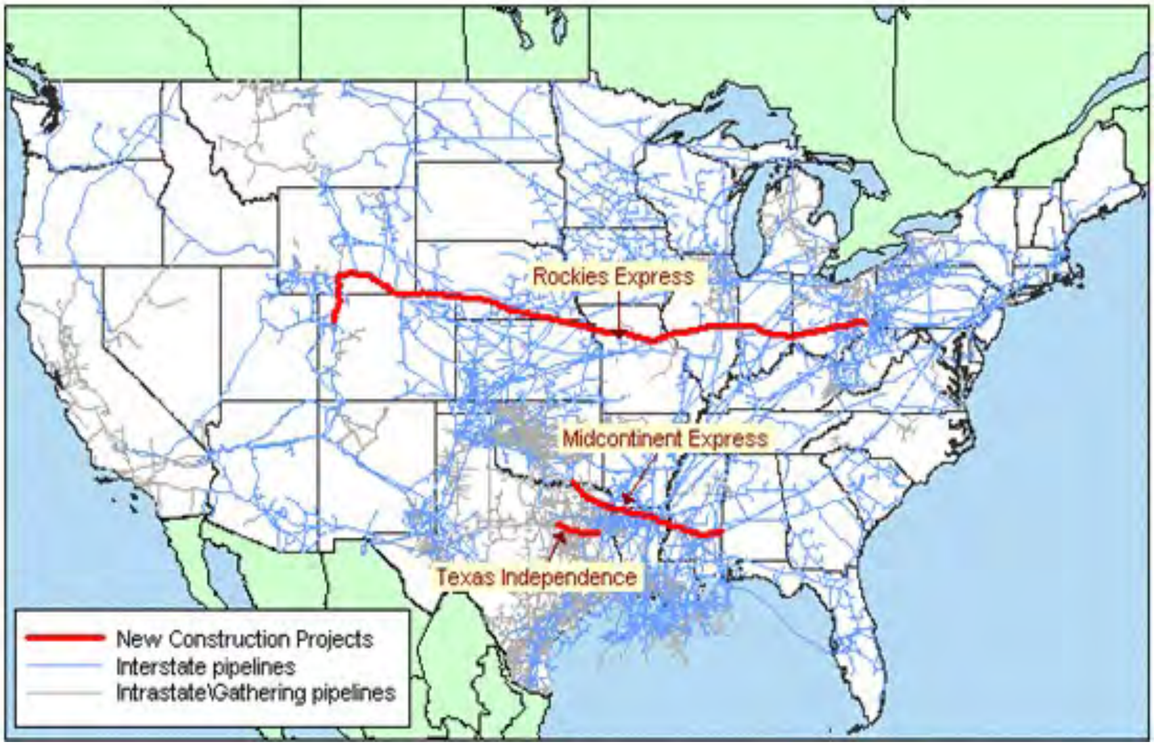


Source: Weinstein et al. (2010) using data from the EIA

Figure 20: Energy production costs by energy source[21]

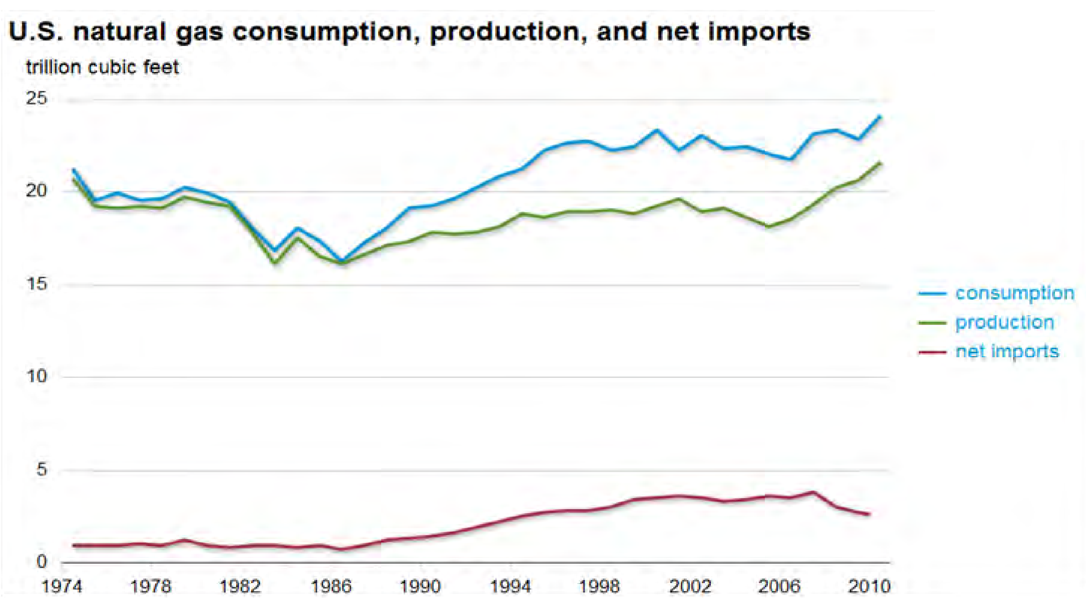
Natural gas is often viewed as a bridge between a reliance on carbon emitting fossil fuels and an energy industry comprised of some mix of alternative energy sources with far less reliance on foreign energy and carbon emitting energy sources. Figure 23 on page 22 shows the life cycle emissions rates for various sources of electricity generation. Although natural gas emits significantly more carbon than nuclear and alternative energy sources, it does emit far less than coal. Thus, as table 3 showed, switching from coal to natural gas will not only save money on energy costs it will also reduce carbon emissions. Natural gas combustion emits lower levels of carbon dioxide, nitrogen oxide, and sulfur dioxide than both coal and oil. Yet,

20. It should also be noted that a decoupling of natural gas prices from oil prices has realigned markets (Southgate and Daniels, 2011).
21. The average levelized cost is the present value of all costs including building and operating the plants.



Source: EIA, GasTran Natural Gas Transportation Information System.

Figure 21: Natural Gas Infrastructure



Source: EIA

Figure 22: Increasing Production Reduces Imports

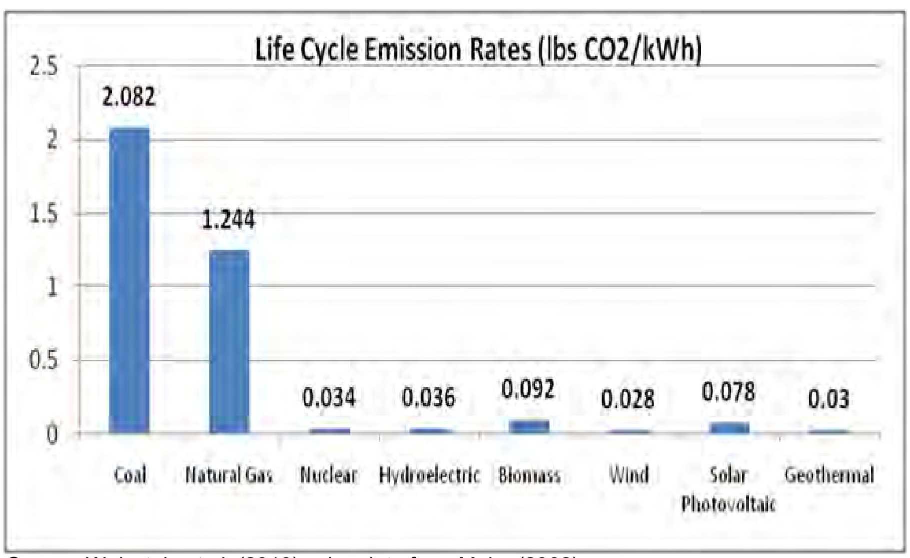
Howarth et al. (2011) find that the carbon emission benefits of natural gas are less when it extracted using hydraulic fracturing compared to conventional methods because of the water and wastewater transportation.

Despite the potential emissions advantages of natural gas, significant concerns have been raised about the environmental impact of natural gas extraction with a Duke University study finding elevated levels of methane in water near drilling sites (Osborn et al., 2011) and the EPA's recent announcement that hydraulic fracturing chemicals polluted water sources in Wyoming (The Associated Press).

The environmental concerns with natural gas have been focused on the hydraulic fracturing process and its impact on water sources. The importance of understanding the hydraulic fracturing process is essential in understanding its potential environmental effects. If cracks aren't able to be controlled or predicted during hydraulic fracturing or somehow disturb the ground, then natural gas or fracturing fluid containing toxic chemicals may shift or migrate to aquifers affecting drinking water. However, hydraulic fracturing typically occurs at depths well below the level of aquifers and drinking water. At thousands of feet below water sources, it is unlikely that hydraulic fracturing would contaminate water sources in Ohio. A 2004 EPA report found that, although fluids migrated unpredictably, hydraulic fracturing did not affect underground drinking water and posed no health risk. Representatives of the natural gas industry have made similar claims that hydraulic fracturing has never contaminated drinking water sources. These claims were used to exempt the natural gas industry from the Clean Water Act and the Safe Drinking Water Act when Congress enacted the 2005 Energy Policy Act.

Although the hydraulic fracturing method of injecting fluids deep below the aquifer level may not be a source of contamination, this level and aquifers themselves must be drilled through. Casing failures in the drilling process may cause fracturing fluids or natural gas to escape and pollute aquifers and local water sources. There are also concerns over spills that can occur during transport or impoundment failures. Thus, whether hydraulic fracturing has contaminated water sources becomes an issue of semantics as to whether the cause is the actual hydraulic fracturing or the drilling, extracting, and spills. Because of the potential impacts on water sources, it is important to be aware of the location of water sources compared to the location of shale resources. Figures 24 and 25 on the next page show the water resources of the US (aquifers are differentiated by various colors). US water resources and shale resources are clearly geographically overlapping though they are at different depths (including in Ohio and Pennsylvania).

In addition to accidental contamination in the drilling and extraction process, water use and disposal are also concerns. The hydraulic fracturing method requires at least a million gallons of water per well that is combined with chemicals and sand. Sapien (2009) notes that approximately 9 million gallons of wastewater per day were produced from Pennsylvania wells in 2009, and this amount is expected to increase. This water byproduct contains elements and chemicals such as cadmium and benzene that are known to cause cancer. There may be other toxic chemicals in the hydraulic fracturing fluid mix though energy companies have continually refused to disclose these chemicals for proprietary reasons. Water byproducts also contain Total Dissolved Solids (TDS) that can make the water five times as salty as



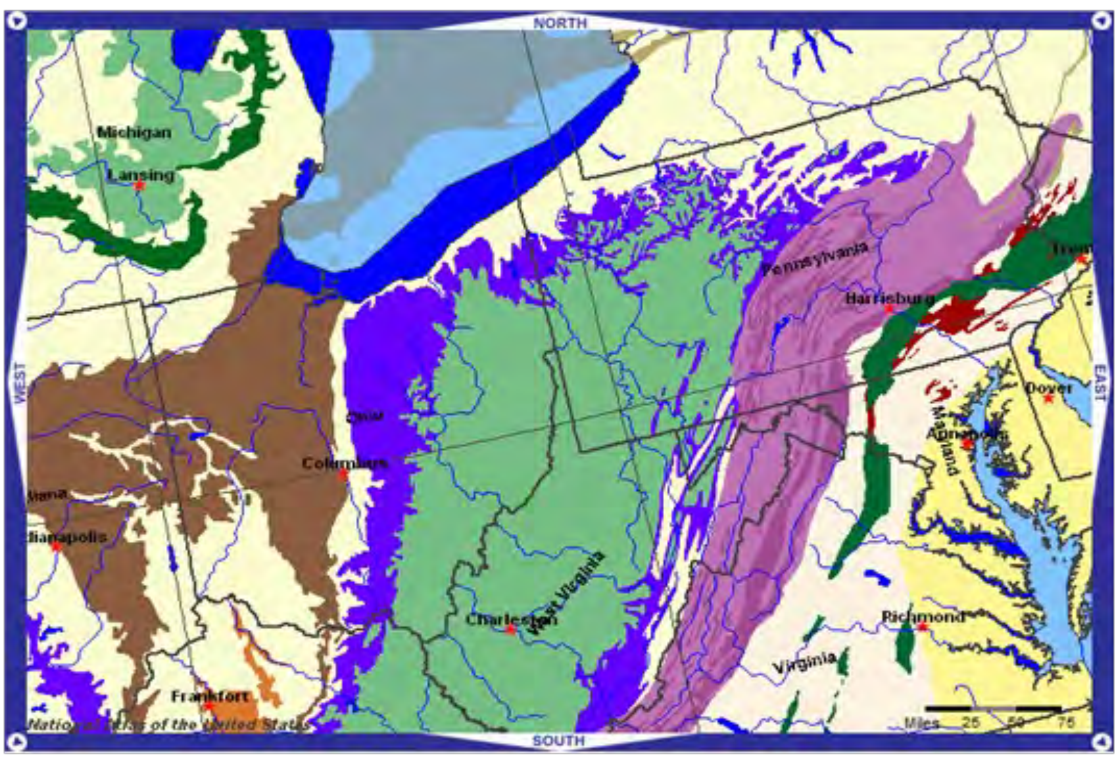
Source: Weinstein et al. (2010) using data from Meier (2002)

Figure 23: Carbon Emissions by Electricity Source[22]

22. Life cycle emissions rates include the total aggregated carbon emissions over the life cycle of the fuel, including extraction, production, distribution, and use.

Source: NationalAtlas.Gov

Figure 24: US Aquifer, Stream, and Waterbed Resources



Source: NationalAtlas.Gov

Figure 25: Ohio and Pennsylvania Aquifer, Stream, and Waterbed Resources

seawater. Although some of this water is left behind and some can be reused, there is still a significant amount that must be treated and disposed. Water byproducts must be stored in either open wells, closed containment wells, or injected back into the ground. Open wastewater wells can lead to air pollution as it evaporates and water contamination if the lining fails, but this method is less expensive than other methods. There are additional air pollution concerns with the increased traffic resulting from water transportation, flaring, etc.

There are also environmental costs in the form of noise pollution. Ohio residents may simply not want to look at or hear natural gas rigs in their backyard or heavy equipment driving through the countryside. Hydraulic fracturing does limit the number of rigs used compared to conventional methods.

The potential environmental impact of hydraulic fracturing on water in Ohio needs to be accounted for when estimating the economic costs of natural gas. Just as the employment and income effects for Ohio were estimated using Pennsylvania as a case study, the potential environmental impacts of hydraulic fracturing and natural gas drilling on Ohio can be approximated by examining incidents in Pennsylvania. Whether the source of contamination is from the migration of fluids and gas underground, drilling or extraction accidents, or improper disposal of water byproducts, it is important to understand what Pennsylvania residents have experienced. After gaining a better understanding of the environmental impacts, then it is important to determine the source of the contamination, how it can be prevented, and whether new regulations are needed to protect the Ohio environment and its drinking water.

Pennsylvania Environmental Concerns:

In 2008, Lustgarten noted that more than 1,000 cases of suspected contamination have been documented in Colorado, New Mexico, Alabama, Ohio, and Pennsylvania. Incidents of contamination have been most publicized in Dimock, PA. Dimock is located in Susquehanna County in northeastern Pennsylvania where natural gas development is most pronounced. Dimock is a struggling rural area with approximately 1,300 residents and nearly 1 in 7 is unemployed. Residents hoped the natural gas industry would turn their economy around. Instead, the controversial documentary *Gasland* contends it environmentally turned it upside down.[23] The documentary begins and ends in Dimock and includes footage of residents lighting their tap water on fire. After natural gas drilling began in Dimock, Lustgarten notes that several of the residents‘ wells have exploded. Affected residents now buy water from outside sources. The Pennsylvania Department of Environmental Protection (DEP) believes a casing failure is to blame for the drinking water contamination and is holding Cabot Oil responsible. Cabot Oil has agreed to supply clean water to some of the affected residents and has been required to pay compensation to many residents. In September of 2009, Cabot Oil spilled nearly 8,000 gallons of fracturing fluids that seeped into a nearby creek.

Evidence of fracturing fluid has now been found in drinking water sources including the Monongahela River. In response to these cases and others, the natural gas industry has been quick to label these events as unfortunate but highly unlikely implying that these cases are the result of just a few ―bad apples.” In some cases they claim methane has always existed in these water sources, but simply went unnoticed until now. Without conducting baseline water testing before drilling, the burden of proof required by the courts in many cases cannot be met to prove otherwise.

The *New York Times* publicized recent peer-reviewed research by Duke University showing an association between drinking water contamination and natural gas extraction. The study by Osborn et al. (2011) conducted research at 68 private water wells in Pennsylvania and New York finding that methane concentrations were 17 times higher for wells near active drilling, with some wells having methane levels requiring ―immediate action.” However, the study found no evidence of fracturing fluid contamination in these wells. The prevalence and commonality of these incidents, coupled with the devastating impacts, seem to suggest the need for caution. Some chemicals, particularly in the produced water, may be harder for residents to detect than methane, especially when the industry refuses to disclose all of the components of the fracturing fluid mixture. Regardless, it is clear that more information on the environmental impacts of natural gas is needed in deciding any need for further regulations.

Recent EPA Action:

Recognizing the need to further understand the true impacts of natural gas extraction, specifically hydraulic fracturing, Congress directed the EPA to

23. It should be noted that *Gasland* did not undergo the scientific scrutiny of a peer-reviewed journal article and because no baseline testing was conducted in *Gasland* or any research thus far, it is difficult to discern the source of contamination and whether it came from gas industry activity. Hopefully, US EPA research will answer these questions in 2012.

study the impact hydraulic fracturing has on drinking water and groundwater. The EPA (2011) identified seven case studies, three of which are in Pennsylvania, to examine the lifecycle of a well and whether hydraulic fracturing affects drinking water. The EPA will also collect information from computer modeling, laboratories, and other data from the industry, states, and communities. Initial results of this study are expected in late 2012. Hence, it is unlikely that there will be any national regulations in the near future, while Ohio hydraulic fracturing in the Marcellus and Utica has already begun. Until Congress or the EPA acts, the regulation of hydraulic fracturing is left to the states.[24]

Ohio Environmental Protection:

Because the EPA and Congress have essentially relegated any regulatory authority to the states, this increases the importance of the Ohio EPA and the Ohio Division of Mineral Resources Management (ODNR) for environmental regulations. The Ohio EPA (2011) states that ODNR has primary regulatory authority over natural gas drilling, including the treatment and disposal of wastewater in the hydraulic fracturing process. The Ohio EPA also has water quality certification requirements to help preserve wetlands, streams, rivers, and other water sources. The appendix includes a list of the regulatory authority between ODNR and the Ohio EPA.

The Ohio Farm Bureau‗s Dale Arnold contends that Ohio has better regulatory authority over the oil and gas industry compared to Pennsylvania. Although the Cuyahoga River fire in 1969 in Cleveland, OH was not associated with fracturing, Scott (2009) notes it was a catalyst not only for Ohio environmental regulations, but also the national Clean Water Act in 1972 and the creation of the US EPA (and Ohio EPA). Dale Arnold reckons that even before the Cuyahoga fire, Ohioans had built a ―collective consciousness," learning from past oil and gas industry experiences, preparing themselves for future waves.

Ohio‗s collected experiences and advanced environmental regulations have certainly left the state better prepared to handle the wastewater produced from hydraulic fracturing than Pennsylvania. Much of the wastewater from Pennsylvania comes to Ohio injection wells. Hunt (2011) notes that in June of 2010, Ohio quadrupled out-of-state fees to limit brine coming in from Pennsylvania and other states while anticipating the increased disposal needs of Ohio‗s own burgeoning natural gas industry. Despite the increased prices, nearly half of the brine in Ohio injection wells came from Pennsylvania after its officials banned 27 treatment plants from dumping brine into streams. This highlights the importance of Ohio properly addressing the issue of wastewater.

Ohio has made strides in environmental regulations through the drilling permitting process. Permits or ―frac tickets" are required for gas companies planning on using hydraulic fracturing to extract natural gas. A frac ticket requires that companies disclose the chemicals used in the fracturing fluid. If a spill or casing failure should occur, Ohio will know many of the possible contaminants for testing. Ohio‗s permitting also allows residents to more easily prove their water has been contaminated with fracturing fluid.

Because many of the residents that will be most affected by shale gas development are farmers, the Ohio Farm Bureau is advising farmers and residents on the leasing process and is recommending that residents establish independent baseline water and soil quality measures that have been so notably missing from Pennsylvania and elsewhere. In addition, it is now standard practice in Ohio for gas companies to do their own baseline testing on all residents‗ water within 3,000 yards of the drilling site.

Even with better regulations, accidents may happen. Lustgarten (2009) recounts a 2007 incident of a house explosion in Bainbridge, OH. In a later report, ODNR found that a faulty concrete casing failure from a nearby natural gas well caused methane to be pushed into an aquifer during hydraulic fracturing, which then found its way into the plumbing, building up in the basement of the house.

The Cuyahoga fire itself and other serious environmental incidents have a more profound impact than just on the environment. Congressmen Louis Stokes said in regards to the Cuyahoga fire, ―It portrayed a totally different image of Cleveland than the image of a productive, progressive city that was making news of a progressive nature" (as quoted in Scott, 2009). The lessons of the Cuyahoga fire resonate for natural gas development. The negative impacts on the environment can affect communities in lasting ways that cannot be exactly quantified but still require consideration.

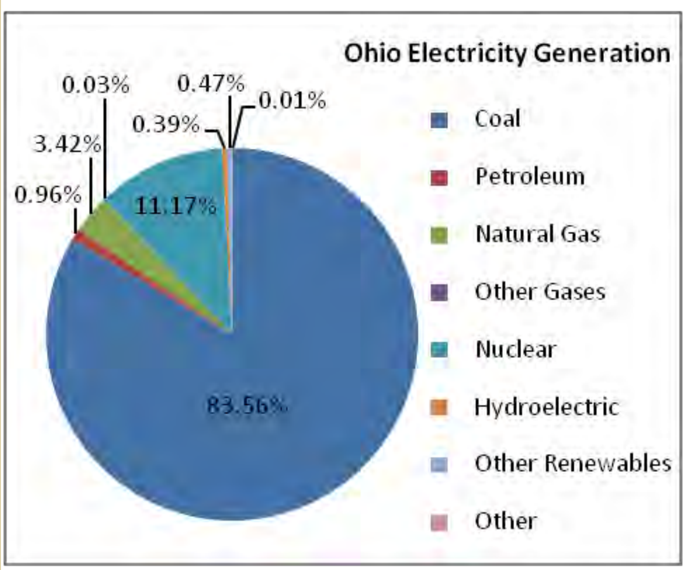
24. In 2009, members of Congress introduced the Fracturing Responsibility and Awareness of Chemicals Act, also called the ―Frac Act," to undo the natural gas industry‗s exemption from the Safe Drinking Water Act and require the industry to disclose the chemicals used in the fracturing process. Though reintroduced in March of 2011, it is not expected to pass.

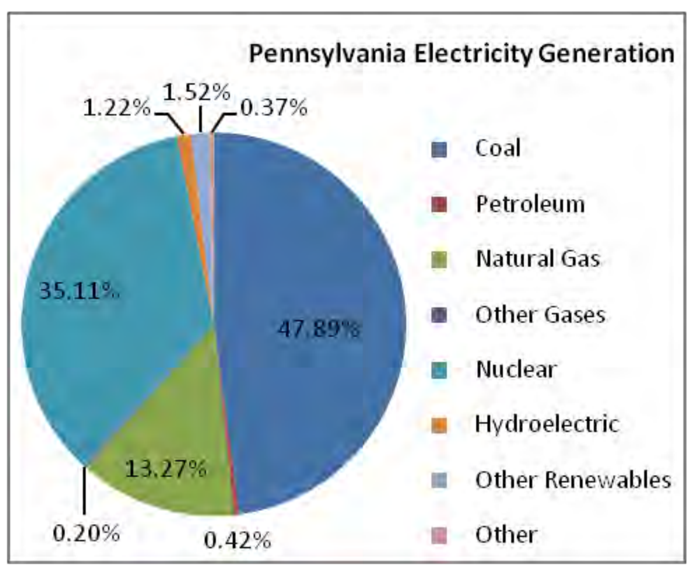
Conclusion

Hydraulic fracturing has made natural gas extraction possible and more productive in shale resources that were previously deemed uneconomical. This has brought a new wave of natural gas extraction to Ohio and other areas. However, recent experiences with hydraulic fracturing have also opened a new debate about the costs and benefits of natural gas extraction. Gary Walzer, Principle Engineer at EMTEC, states that natural gas has the potential to be a substantial source of domestic energy that is cleaner than coal with lower emissions. This has the potential to decrease US reliance on coal. Compared to Pennsylvania, Ohio clearly has a less diversified energy portfolio that relies heavily on carbon emitting coal. Based on electricity generation alone, Ohio is emitting significantly more carbon than Pennsylvania. Natural gas could be a significant first step for Ohio to diversify its energy portfolio and reduce carbon emissions.

Compared to coal, natural gas is not only cleaner but also less expensive to produce electricity. Producing energy in close proximity to where it is needed further lowers energy prices for consumers and industry. Unlike alternative energy, there are market forces pushing for the production of natural gas without the use of inefficient subsidies, though all of the social costs of natural gas (and coal) are not sufficiently priced. Low natural gas prices provide evidence that it is highly efficient for producing electricity. This efficiency is one reason why natural gas is associated with fewer jobs than coal—but the lower costs make the rest of the economy more competitive.

Does all of this also mean that natural gas will create significant numbers of job for Ohioans? Previous studies on the economic impacts of natural gas appear to have widely overstated the economic impacts. This is not surprising, as these studies are typically industry-funded and industry-funded studies are usually not the best sources of information for economic effects (regardless of the industry). One reason for the overstatement is the energy industry is generally very capital intensive. Alan Krueger, Chief Economist and Assistant Secretary for Economic Policy at the US Department of Treasury stated in 2009, ―The oil and gas industry is about 10 times more capital intensive than the US economy as a whole… suggesting these tax subsidies are not effective means for domestic job creation" (US Department of Treasury). The energy industry as a whole also does not account for a significant share of employment. Even if the natural gas industry experiences significant job growth, its employment share is too small to have any significant effect on unemployment rates and on the economy (with the exception of remote rural areas such as in rural Western North Dakota). Previous studies on the economic impacts also fail to account for the displacement effects that the natural gas industry will have on other industries. Finally, from a national perspective greater natural gas production will displace other fossil fuels and their workers as they are no longer needed, in





Source: US EIA

Figure 26: 2009 Electricity Generation Profiles

particular coal.

We use Pennsylvania as a case study to estimate the employment effects of drilling that Ohio can realistically expect. Our analysis shows the employment effects of natural gas are modest given the size of the Ohio and Pennsylvania economy. We show this through (1) an assessment of impact analysis, (2) by comparing drilling counties with similarly matched non-drilling counties in Pennsylvania, (3) statistical regressions on the entire state of Pennsylvania, (4) employment comparisons with North Dakota's Bakkan shale region, and (5) an examination of the employment life cycle effects of natural gas and coal per kilowatt of electricity. Our results are not unexpected as the economic literature has long pointed to the adverse effects of natural resource development through phenomenon such as the “natural resources curse” and Dutch Disease. Likewise, a recent Cornell University study found similar overstatements by the oil industry in terms of job forecasts for the Keystone XL pipeline (Cornell University ILR School Global Labor Institute, 2011). On the other hand, our approaches suggest that natural gas activity will increase per-capita income. We expect this is primarily among landholders receiving royalties/lease payments and through higher wages in the industry. Thus, we expect a short-term infusion of income in affected economies.

As Christopherson and Rightor (2011) point out, it is important to realize these are fairly short-term estimates and may still not account for the cycle of the natural resource boom. The initial boom causes competition for labor in the short-term, bidding up wages. This makes the area less competitive and “crowds out” other sectors, especially those that rely on low cost labor such as agriculture and tourism. As housing prices are bid up, this will also further displace low-income workers. In the long-run, the business climate may suffer as there are fewer businesses that are unrelated to the oil and gas industry, which makes the local economy less diverse and more vulnerable to economic shocks. Our advice to counties experiencing drilling activity is to ensure they properly pay for infrastructure needs upfront, place monies in reserves for after the boom, and build up local assets such as schools in order to produce lasting benefits from energy development.

Finally, the environmental costs of natural gas need to be realistically addressed by the industry and regulators. Although natural gas can reduce carbon emissions compared to coal and other fossil fuels, there are concerns about its effect on drinking water. Because Ohio has been able to learn from Pennsylvania's experiences with the oil and gas industry, Ohio seems better prepared to deal with the environmental risks. Nevertheless, a realistic assessment of the environmental costs of natural gas should also include the environmental opportunity cost of natural gas. Natural gas mainly displaces coal, which emits even more carbon and also has additional environmental and safety concerns. A Clean Air Task Force report unequivocally states that “coal irreparably damages the environment.” Coal poses significant health risks to both miners and nearby residents. Despite the number of years the US has been extracting coal, there are still significant issues with its waste products. Most recently on Oct. 31, 2011 a bluff collapse caused coal ash to be spilled into Lake Michigan (Jones and Behm, 2011). In 2008, the *New York Times* reported that experts called the Tennessee ash flood that dumped over 1.1 billion gallons of coal ash waste “one of the largest environmental disasters of its kind” (Dewan, 2008). We are not understating the environmental costs of natural gas, but rather putting it into perspective in relation to the environmental costs of coal, which is natural gas's main competitor.

Although we should not expect natural gas to be a big job creator, there are significant benefits to producing natural gas that are getting lost in the hype of job creation. Raising expectations that natural gas will not be able to meet is setting Ohio residents up to be disappointed. The true benefits of natural gas need to be highlighted while putting the costs into perspective. Likewise, Ohio needs to plan today about how to make some of the gains from the energy boom permanent. Among many things, this will require innovative policies and funding models to ensure that infrastructure is paid for today and there is adequate funding to maintain that infrastructure in the future.

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Appendix 1: County Comparison Mining (blue) vs. Non-Mining (green)

See notes to figures 15-18 for more details. Southern drilling counties include Washington, Greene, and Fayette. Southern non-drilling counties include Franklin, Perry, and Cumberland. Northeastern drilling counties include Tioga, Bradford, and Susquehanna. Northeastern non-drilling counties include Union, Columbia, and Carbon.

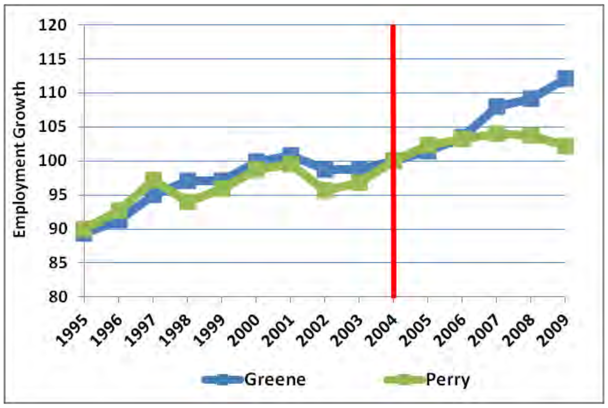

Figure 27: Employment Growth Comparison Greene vs. Perry

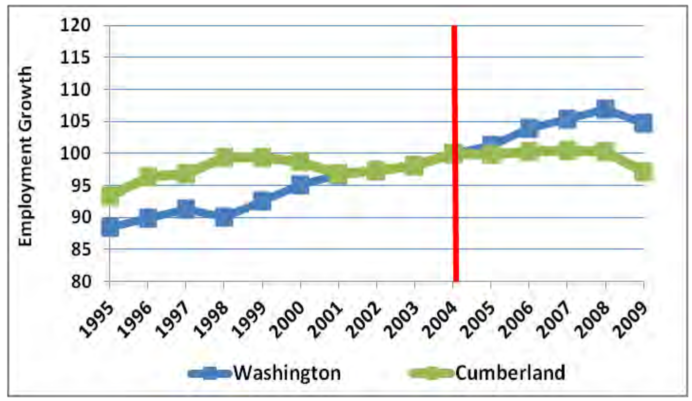

Figure 28: Employment Growth Comparison Washington vs. Cumberland

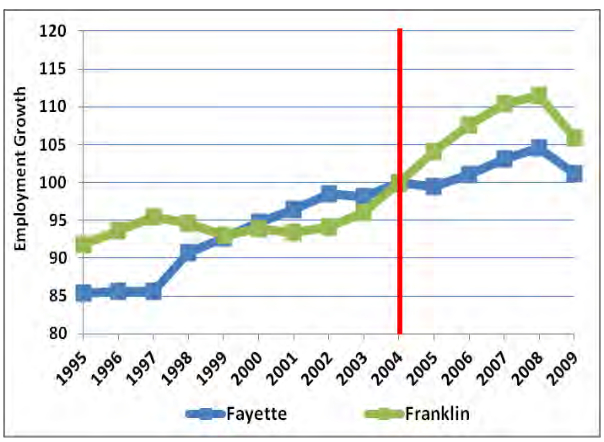

Figure 29: Employment Growth Comparison Fayette vs. Franklin

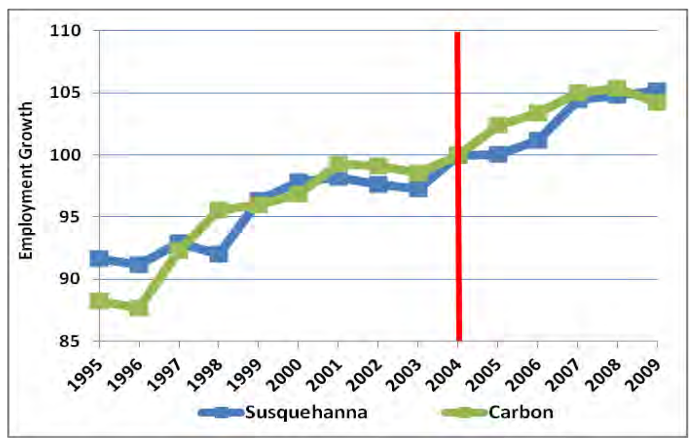

Figure 30: Employment Growth Comparison Susquehanna vs. Carbon

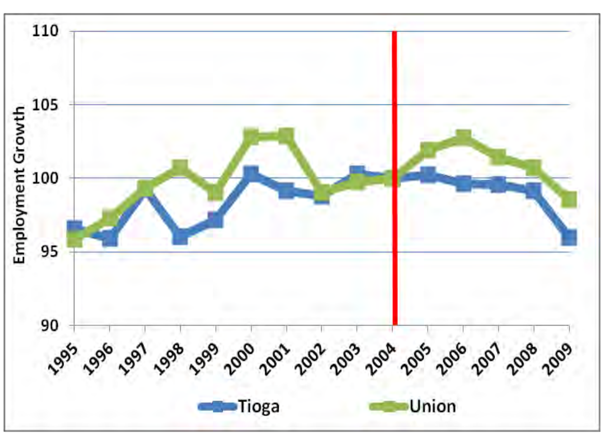

Figure 31: Employment Growth Comparison Tioga vs. Union

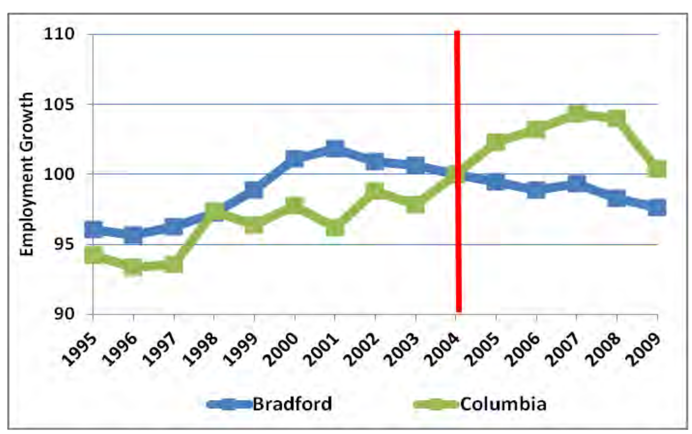

Figure 32: Employment Growth Comparison Bradford vs. Columbia

Appendix 1: County Comparison Mining (blue) vs. Non-Mining (green)

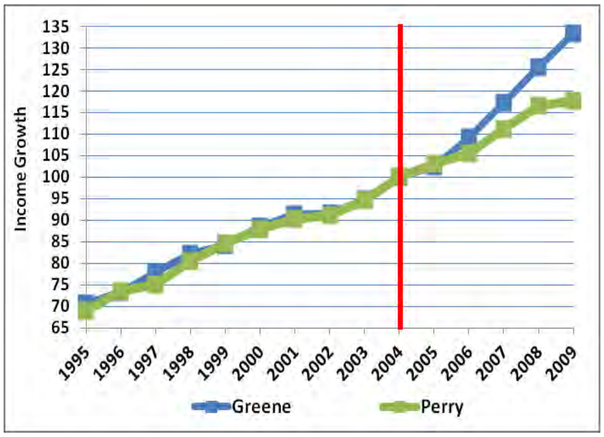

Figure 33: Per Capita Income Growth Comparison
Greene vs. Perry

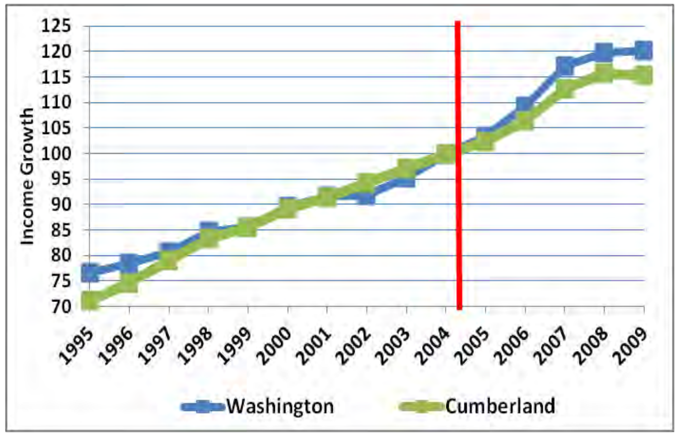

Figure 34: Per Capita Income Growth Comparison
Washington vs. Cumberland

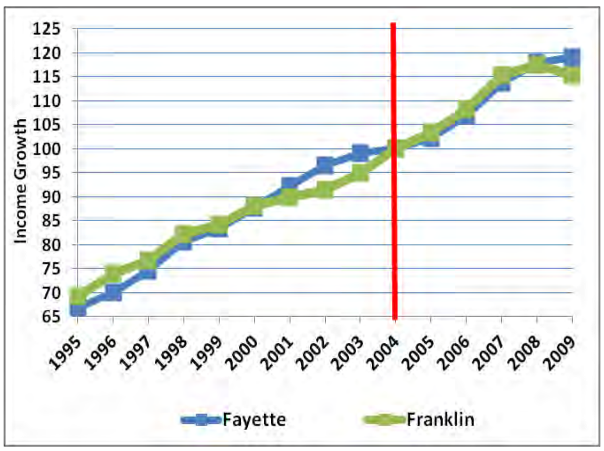

Figure 35: Per Capita Income Growth Comparison
Fayette vs. Franklin

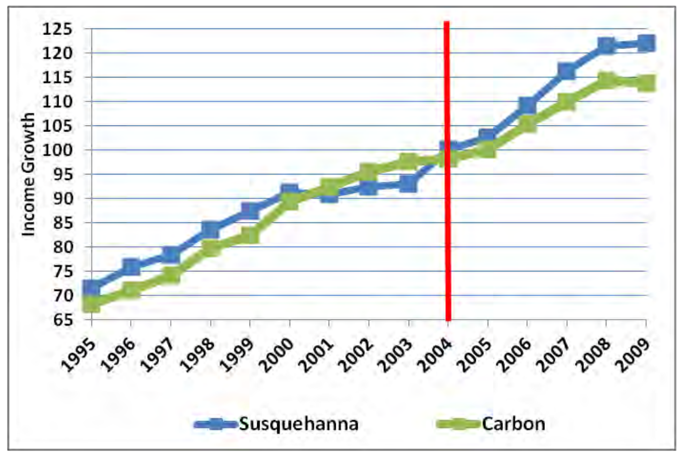

Figure 36: Per Capita Income Growth Comparison
Susquehanna vs. Carbon

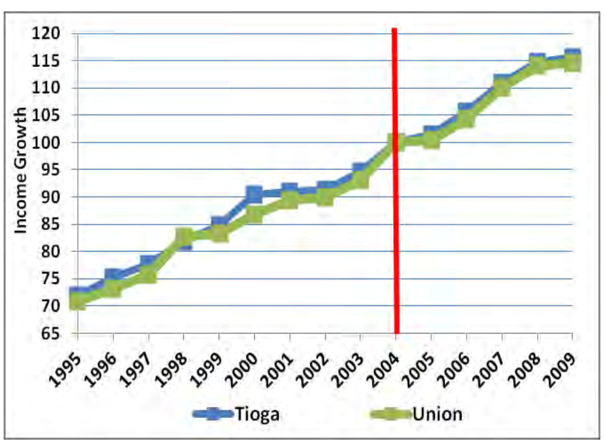

Figure 37: Per Capita Income Growth Comparison
Tioga vs. Union

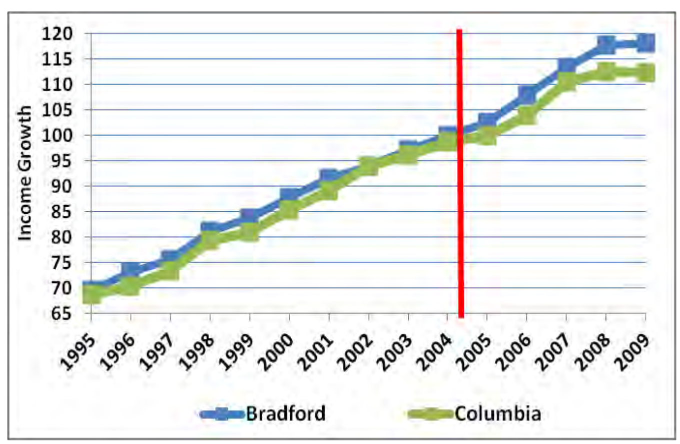

Figure 38: Per Capita Income Growth Comparison
Bradford vs. Columbia

Appendix 2: Statistical Methodology

In 2005, drilling began in Pennsylvania in a number of counties with natural gas potential due to the location of resources in the Marcellus shale. The choice of county to develop shale gas was based on the random occurrence of natural resources and not prior economic conditions. However, there may be other inherent county differences between drilling and non-drilling counties. For example, counties with drilling tend to be rural. Likewise, counties tend to have many factors that influence their economic growth such as the quality of its government, distance to urban centers, and educational and demographic attributes of the population. These factors are either constant or change very slowly. We treat these as county fixed effects on county growth.

We want to measure the economic impacts of drilling. Equation 2 shows the impact of the number of wells on the percent employment growth (Y_{i1}) for county i in period 1 (2005-2009). However, the empirical estimation of this impact would not be able to account for county fixed effects (C_i). This could bias the estimates of the impact of drilling by omitting relevant variables that differentiate drilling counties from non-drilling counties. Thus, equation 3 estimates the impact of drilling since 2005 on the difference in employment growth between period 1 and period 0 (2001-2005). The county fixed effect is differenced out and thus there should not be omitted variable bias.

Table 5 shows the results of this estimation using the total number of well drilled since 2005. We also include additional controls to better account for differences in the way larger or wealthier counties may have reacted to shale development, or more importantly, how wealthier or more urban counties were differentially affected by effects of the housing bubble/bust and the Great Recession. Using the total number of wells parameter estimate, Table 5 shows that drilling has a small and statistically insignificant impact on percent employment growth.

$$Y_{i0}= \beta_0 + \beta_1(\text{Number of Wells})_{i0} + C_i + \varepsilon_{i0} \quad (1)$$
$$Y_{i1}= \beta_0 + \beta_1(\text{Number of Wells})_{i1} + C_i + \varepsilon_{i1} \quad (2)$$
$$Y_{i1}- Y_{i0}= \beta_0 + \beta_1(\Delta \text{ Number of Wells}) + \varepsilon_i \quad (3)$$

A similar method is used to empirically estimate the impact of drilling on per capita income with results presented Table 6. In this case, drilling has a statistically significant impact on percent per capita income growth.

2005-09 Percent Employment Growth Minus 2001-05 Percent Employment Growth	Parameter Estimate	t-value
	Difference in Employment Change	
Total Wells 05-09	**1.769E-05**	**1.14**
2001 Log Population	0.023	2.64
2001 Log Per Capita Income	-0.096	-1.55
N	67	
R2	0.118	
Adjusted-R2	0.076	

Table 5: Impact of drilling on employment

2005-2009 Percent Income Growth Minus 2001-05 Percent Income Growth	Parameter Estimate	t-value
	Difference in Income Change	
Total Wells 05-09	**2.515E-05**	**2.11**
2001 Log Population	0.084	2.53
2001 Log Employment	-0.086	-2.76
N	67	
R2	0.205	
Adjusted-R2	0.167	

Table 6: Impact of drilling on income

Another method to develop a counterfactual to compare how drilling counties would have done if there was no drilling is to use a difference in difference approach. The difference in differences approach treats drilling as a treatment in a natural experiment. The difference in differences estimates the causal effect of the difference between the treatment and control group before and after treatment (drilling). This is shown below in equation 4 where i=0 represents non-drilling counties and i=1 represents drilling counties; t=0 is still the first time period (2001-2005) and t=1 is the second time period (2005-2009).

$$[E(Y_{11})-E(Y_{01})] - [E(Y_{10})-E(Y_{00})] \quad (4)$$

To measure the impact of drilling on the employment growth of county i in time period t (Y_{it}), a control group needs to be established (non-drilling counties). This is further expanded in equation (5). The main effect of the treatment group, β_1 controls for the difference between the treatment and control in period 0. The main effect of the second period, β_2 controls for the difference between the effects of the second period compared to the first period. The parameter of interest, β_3 estimates equation 4: the impact of the number of wells had on counties since drilling began in 2005. Through asymptotics, it can be shown that the probability limit of the estimate of β_3 is equivalent to equation 4.

$$Y_{it} = \beta_0 + \beta_1(\text{Number of Wells}_{it}) + \beta_2 t + \beta_3(t^*\text{Number of Wells}_{it}) + \varepsilon_i \qquad (5)$$

Table 7 shows the empirical estimation of equation 4 for employment growth. The results are similar to those in Table 5 with the impact of drilling on employment being small and statistically insignificant. Table 8 reports the estimates of equation 5 for per capita income growth. Similar to Table 6, it shows that drilling appears to have had a positive statistically significant impact on per capita income growth.

Percent Employment Growth	Parameter Estimate	t-value
Time Period*Total Wells	**1.763E-05**	**0.91**
Time Period	-0.05	-4.12
Total Wells	-3.240E-06	-0.23
Log Population	-0.005	-0.85
Log Per Capita Income	0.066	1.69
N	134	
R2	0.125	
Adjusted-R2	0.091	

Table 7: Impact of drilling on employment

Percent Income Growth	Parameter Estimate	t-value
Time Period*Total Wells	**3.119E-05**	**2.52**
Time Period	0.0253	3.51
Total Wells	-3.310E-06	-0.37
Log Population	0.009	0.55
Log Employment	-0.007	-0.43
N	134	
R2	0.205	
Adjusted-R2	0.167	

Table 8: Impact of drilling on income

Appendix 3: Ohio Environmental Regulatory Authority

Summary of ODNR and Ohio EPA regulatory authority over oil/gas drilling and production activities

	Ohio Department of Natural Resources	Ohio Environmental Protection Agency
Drilling in the shale deposits	✓ Issues permits for drilling oil/gas wells in Ohio. ✓ Sets requirements for proper location, design and construction of wells. ✓ Inspects and oversees drilling activity. ✓ Requires controls and procedures to prevent discharges and releases. ✓ Requires that wells no longer used for production are properly plugged. ✓ Requires registration for facility owners with the capacity to withdraw water at a quantity greater than 100,000 gallons per day.	✓ Requires drillers obtain authorization for construction activity where there is an impact to a wetland, stream, river or other water of the state. ✓ Requires drillers obtain an air permit to install and operate (PTIO) for units or activities that have emissions of air pollutants.
Wastewater and drill cutting management at drill sites	✓ Sets design requirements for on-site pits/lagoons used to store drill cuttings and brine/flowback water. ✓ Requires proper closure of on-site pits/lagoons after drilling is completed. ✓ Sets standards for managing drill cuttings and sediments left on-site.	✓ Requires proper management of solid wastes shipped off-site for disposal.
Brine/flowback water disposal	✓ Regulates the disposal of brine and oversees operation of Class II wells used to inject oil/gas-related waste fluids. ✓ Reviews specifications and issues permits for Class II wells. ✓ Sets design/construction requirements for Class II underground injection wells. ✓ Responds to questions/concerns from citizens regard safety of drinking water from private wells from oil/ natural gas drilling.	
Brine/flowback water hauling	✓ Registers transporters hauling brine and oil/gas drilling-related wastewater in Ohio.	
Pumping water to the drill site from a public water supply system		✓ Requires proper containment devices at the point of connection to protect the public water system.

Source: EPA (2011)

Working Paper Series

A Comprehensive Economic Impact Analysis of Natural Gas Extraction in the Marcellus Shale

December 2010

Hammer Down: A Guide to Protecting Local Roads Impacted by Shale Gas Drilling

CJ Randall

photo/David Keeler, *Rocket-Courier*, Wyalusing, PA

Summary: What is the issue?

There are engineering, logistical and legal obstacles to insuring good management of local roads in the face of the high-intensity truck travel associated with Marcellus Shale gas drilling. This policy brief lays out the effects of shale gas drilling on local roads and draws on best practices from states already affected by shale gas drilling to develop recommendations for local officials.

Keywords

Marcellus Shale, Local Roads, Economic Development

Author

CJ Randall is a graduate student in the Master's in Regional Planning Program in The Department of City and Regional Planning at Cornell University

Introduction

Dust, noise, and road damage from industry truck travel are tops on the list of citizen complaints in areas where shale gas is extracted via shale gas drilling. A typical Marcellus well requires 5.6 million gallons of water during the drilling process, in almost all cases delivered by truck. Liquid additives are shipped to the well site in federal DOT-approved plastic containers on flatbed trucks; hydrochloric acid and water are delivered – and flowback is hauled away – in tanker trucks. Millions of gallons of liquid used in the short (weeks-long) initial drilling period account for half of the estimated 890 to 1340 truckloads required per well site.[1] Because of its weight, the impact of water hauled to one site (364 trips) is the equivalent of nearly 3.5 million car trips.[2,3] Few roads at the town level in New York State have been built to withstand this volume of heavy of truck traffic. Local road quality management effectively functions as one barometer of municipal capacity to manage the pace and scale of natural gas extraction.

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[1] Impacts of Community Character of Horizontal Drilling and High Volume Hydraulic Fracturing in Marcellus Shale and Other Low-Permeability Gas Reservoirs, prepared for New York State Energy Research and Development Authority by NTC Consultants, September 16, 2009

[2] Denton County Oil and Gas Task Force Summary Report, June 1, 2005.

[3] Equivalent Single Axle Load formula

From broadcasts on CNN[4] to full spreads in *National Geographic*,[5] the public face of natural gas drilling is the enormous volume of truck traffic and the resultant impact on municipalities and their citizens. Officials in Pennsylvania, trying to play catch-up with truck routing, have spent "tens of thousands of dollars just on signs," according to Rick Mason of PennDOT District 3-0.[6] Pennsylvania Department of Environmental Protection's Secretary John Hanger told Pittsburgh's National Public Radio, "I wish I was exaggerating when I say that there are roads that are being destroyed and that have been literally turned into mud and made impassable for all motorists including emergency responders."[7] In West Virginia, Department of Transportation officials recently proposed that natural gas companies post road repair bonds ranging from $25,000 per graveled mile to $100,000 per paved mile.[8] Roads resuscitated year after year with a seal coating have neither the width nor depth to handle sustained pummeling by heavy trucks; sinkholes, 6" to 10" of rutting, and complete road failures are not uncommon. Unlike state highways and primary county roads that are designed and engineered to last a specific length of time based on predicted traffic, local roads are generally not built to stringent guidelines.

What does this mean for New York?

Under New York State's Environmental Conservation Law[9] oversight of the actions of the gas industry is relegated to the state. Power over local roads is, however, ceded to local jurisdictions. Steven Messmer, Project Manager at Delta Engineering of Endwell, NY, estimates risk of damage to state roads is approximately 5% (negligible); the risk at the county level is approximately 20% (low); the risk to the roads built by towns and municipalities is approximately 90% (high).[10] For example, the impact of 1000 extra trucks per year on a county road (3" asphalt, 6" base, and 12" sub-base totaling 21" total pavement thickness) represents .13% of that road's lifespan; the resultant impact of those same trucks on a town road (2" asphalt and 12" base totaling 14" total pavement thickness) represent 2% of that road's life.[11]

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[4] http://money.cnn.com/galleries/2010/news/1010/gallery.pennslyvania/index.html
[5] http://news.nationalgeographic.com/news/2010/10/photogalleries/101022-energy-shale-gas-drilling-pictures/#/energy-marcellus-shale-environment04-gas-truck_27066_600x450.jpg
[6] West Virginia DOT memorandum, August 20, 2010
[7] http://wduqnews.blogspot.com/2010/09/fracnet-and-trashnet-to-expand.html
[8] http://www.transportation.wv.gov/highways/policies/Documents/InterimOilandGasPolicy.pdf
[9] New York State Environment and Conservation Law §23- 0303(2)
[10] 'Preservation of Local Roads – Road Use Agreements and Local Law,' presentation by Steve Messmer of Delta Engineering, and Todd Mathes, attorney with Whiteman, Osterman, and Hanna, LLP, June 22, 2010, Conklin, NY.
[11] 'Preserving Municipal Roads: What are Your Options?,' presentation by David P. Orr, P.E., Cornell Local Roads Program at the NYS County Highway Superintendents Association Winter Meeting, January 20, 2010, Albany, NY.

Despite the need, there are engineering, logistical and legal obstacles to insuring good management of local roads in the face of abrupt, high-intensity truck travel. Following is a set of best practices tailored to New York municipalities, drawing from the experience of other states and shale plays:

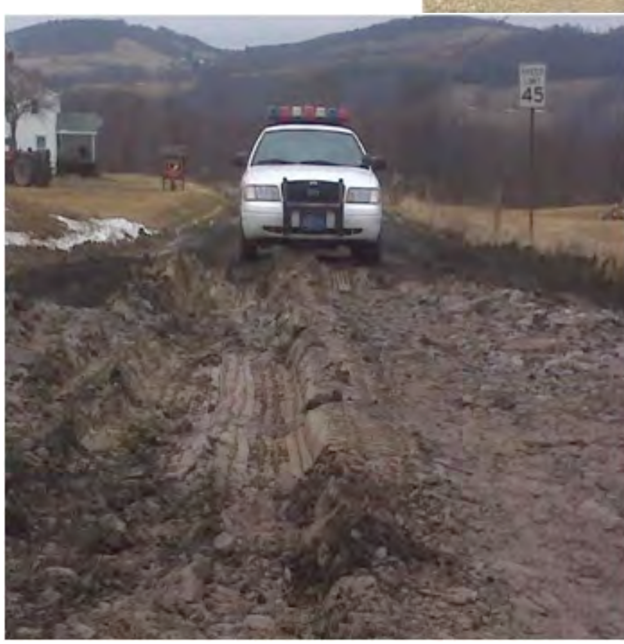
- Conduct a comprehensive traffic impact study with the assistance of a certified traffic engineer (or firm) that takes into consideration the ability of the roads to withstand the volume of traffic anticipated (estimated cost $6000-$9000)
- Document *baseline* road conditions and calculate value of remaining road life
- Sign a *Road Use Agreement* (RUA) with the operator at the time of permitting to require that the operator offset the predicted loss of useful life at current reconstruction costs (estimated cost $900-$1200 for drafting)
- Develop and implement a system for *haul route management*, post roads accordingly (estimated cost $3000-$9000, dependent on route analysis in town and/or county)
- Enforce load zoning, ranging from routine patrol to high-intensity, multi-agency enforcement sweeps

Comprehensive traffic impact study

Local government should hire an engineering company to assess the structural condition of roads, measuring response to loads, predicting remaining life, and calculating required strengthening. A thorough study should include sampling of cores; a sample of gravel is not enough. The assessment may also include a seismic pavement test (different from that of geologic purposes). Consideration should be given to school bus routes, the geometrics of noise, and the sight distances around curves. Cornell Local Roads Director Lynne Irwin cites the following reasons not to test the roads in the worst part of spring thaw: 1.) There may be a frozen layer underneath the surface of the road, and base cores may behave more like water than a solid, leading to an incorrect picture of the performance of the road. 2.) Testing is more expensive during spring thaw because of demand; test early- to mid-May and then again in August or September to collect a full range of data. This data is critical to developing an accurate model of the road's strength. If the budget doesn't allow for testing twice, test between the beginning of June and the end of October. [12]

[12] 'Marcellus Shale: Local Roads Impacts' - presented by Lynne Irwin and David Orr, Cornell Local Roads Program, Cornell University, June 23, 2010.

A complete study will weigh different criteria to produce a structural measure, which determines the total number of Equivalent Single Axle Loads (wheel loads of various magnitudes and repetitions) that a particular road can support. Variations in temperature change the stability of a road; upstate New York's freeze and thaw cycle exacerbates road damage. Frozen roads are very strong and can carry a very large number of heavy loads; the same volume of trucks on a rural road during a dynamic spring thaw can wreak havoc, as illustrated by before and after photos of SR 3020 in Towanda Township, Bradford County, PA:



photo/PennDOT Engineering District 4-0

Document baseline road conditions

Video and photographic documentation of pre-development road conditions helps to bolster the case made by the aforementioned engineering study. Divide roads into manageable segments and keep it simple. Take an inventory of current road conditions by driving slowly while taking video, being careful to indicate rate of speed and where the video documentation begins and ends geographically. Gather measurements of length, width, sight distance, sharp curves, and thickness. Pavement management software is available for a nominal fee ($25) from the Cornell Local Roads Program.[13]

Road Use Agreements (RUAs)

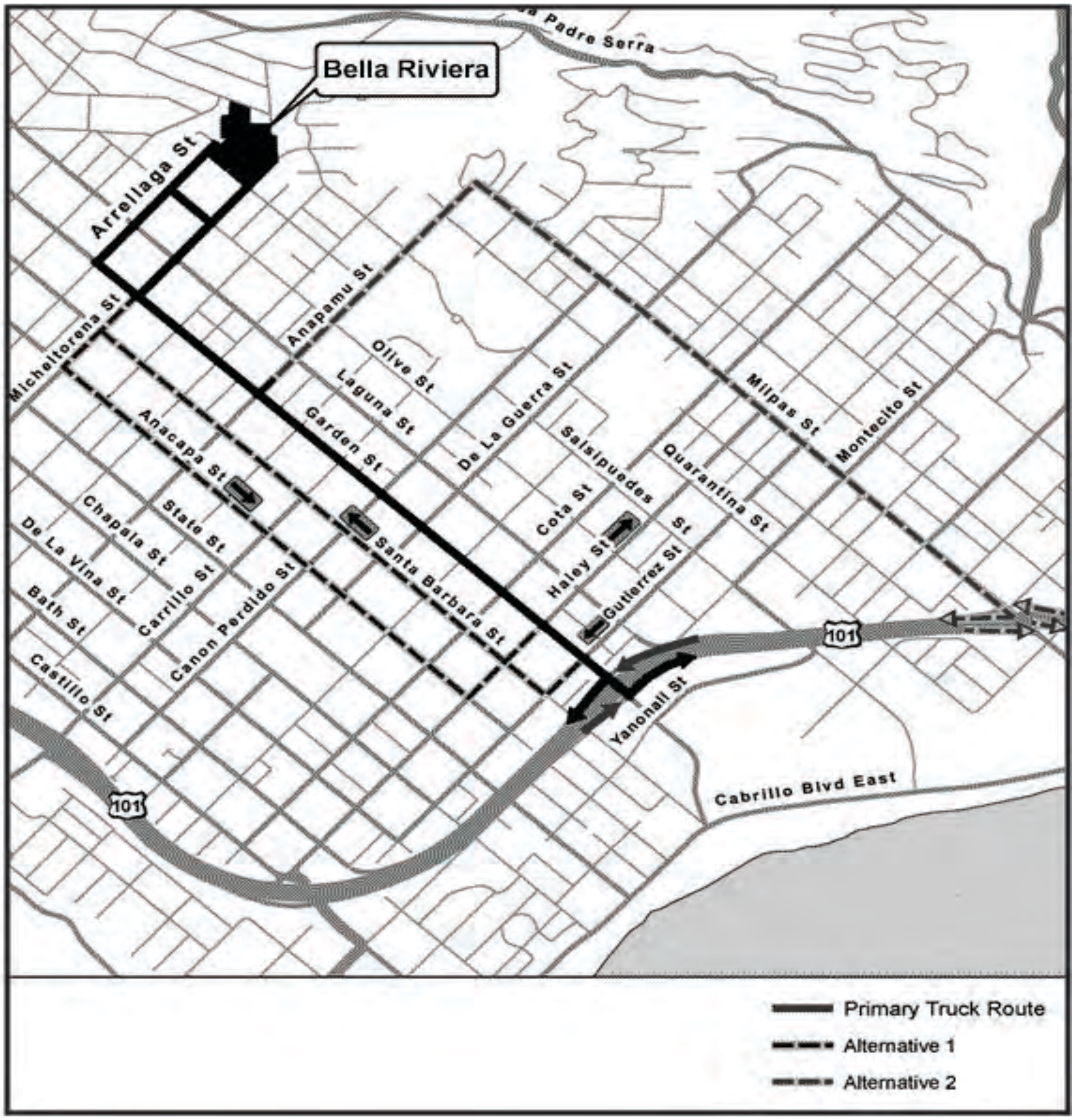
At present, there is a patchwork of Road Use Agreements at the town and county level throughout New York State with no central repository. Some RUAs are complex documents conceived from a road impact study; others are simple, built on the bones of contracts established years or decades ago. Any Road Use Agreement between the municipality and the operator should be placed on file with NYSDEC, as recommended by the draft SGEIS.[14] This is currently the only guidance on RUAs at the state level. It is unclear whether NYSDEC will commit resources to develop a database of RUAs or provide technical assistance to municipalities. A comprehensive RUA includes items such as trigger clauses that require developers to submit haul routes to a town before a permit is issued, effectively connecting a RUA to road use. Road Use Agreements are ineffective unless enforceable; thorough legal vetting is key to developing a RUA an operator will sign and abide by. Operators are not legally obligated to enter into a RUA, but are legally bound by a RUA once signed.

Haul route management

Identify acceptable truck routes that utilize the strong portion of the road system. Use load zoning to keep heavy trucks off most vulnerable roads; legal load limits must be based on a structural evaluation, rather than determined arbitrarily by weight. Each county in New York State has the planning capacity to conduct a GIS (Geographic Information System) analysis to route rigs and trucks on primary county and state roads suited for heavily-laden

[13] http://www.clrp.cornell.edu/Library/Compsoftware.htm
[14] Draft sGEIS 7-109-7-111.

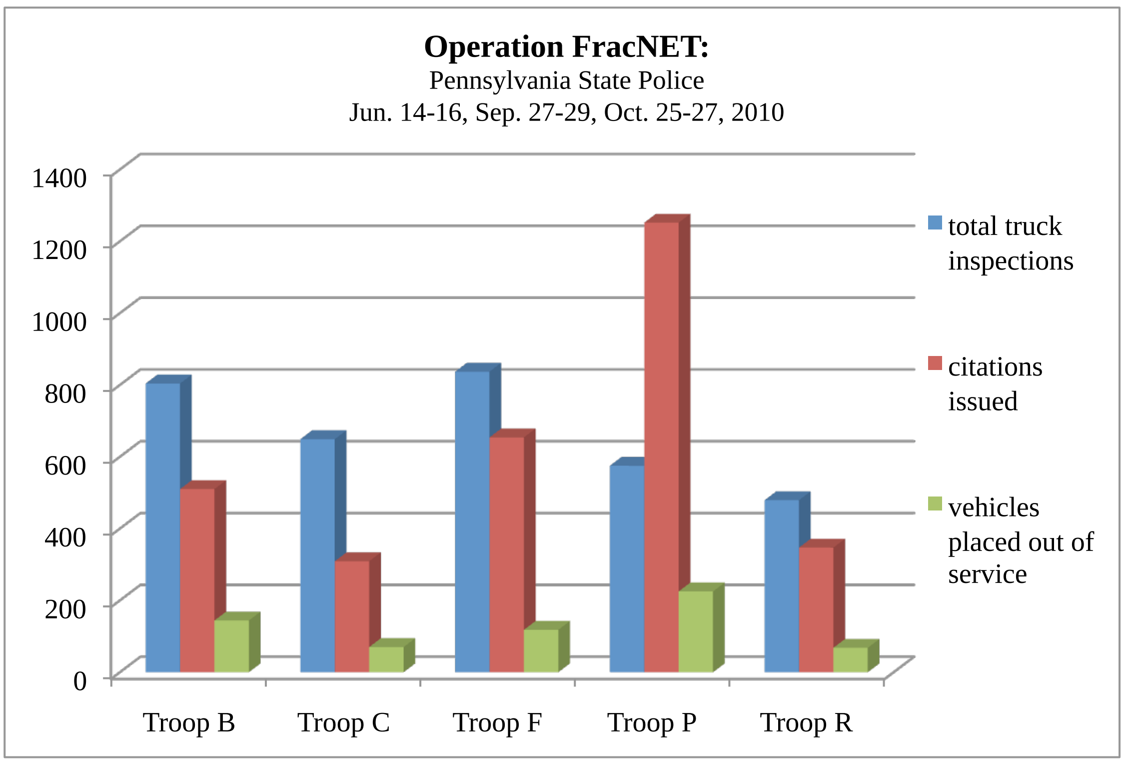
vehicles, using the shortest route on town and village roads for reaching their final destination, as characterized in this example:



Enforcement

At the legal limit, a semi-trailer truck weighs 80,000 pounds. A large body of evidence from Pennsylvania's Northern Tier suggests that natural gas operators are running trucks carrying loads past the legal limit. Similar circumstances have been reported in the

Fayetteville shale play in Arkansas.[15] Pennsylvania State Police Commissioner Frank Pawlowski has attributed much of that state's road damage to overweight trucks serving the gas industry. A February enforcement effort in Susquehanna County found more than half of 194 trucks checked were found to be over the weight limit; fifty percent of the trucks were also cited for safety violations.[16] With frustrations mounting over the condition of rural roads and damage caused by overweight vehicles related to the natural gas industry,[17,18,19,20,21,22] the Pennsylvania State Police, Pennsylvania Department of Environmental Protection, Pennsylvania Public Utility Commission, and the federal Motor Carrier Safety Administration inspected nearly 3500 trucks over three weekends (June 14-16, September 27-29, and October 25-27, 2010) and issued more than 2600 citations:[23,24]



[15] http://thecabin.net/news/local/2010-08-02/county-judges-irked-road-damage-caused-gas-drillers
[16] http://www.oilandenergynews.com/2010/05/increased-gas-drilling-activities.html , May 24, 2010
[17] http://www.stargazette.com/article/20100210/NEWS01/2100367/Truck-bound-for-drilling-site-49-7-tons-overweight-company-fined-31-304
[18] http://gantdaily.com/2010/06/22/dep-fines-grand-water-rush-llc-for-solid-waste-transportation-violations/
[19] http://www.stargazette.com/article/20100128/NEWS01/1280385
[20] http://www.pressconnects.com/article/20100204/NEWS11/2040374/0/NEWS01&theme=GASLEASE
[21] http://74.95.82.237:591/rconline/FMPro?-find=&-format=record_detail.html&-recid=12637109&-db=rconline.fp5
[22] 'Roads Under Siege,' W. David Keeler, Wyalusing Rocket-Courier, March 4, 2010
[23] Pennsylvania State Police press releases, June 23, October 6, and November 9, 2010
[24] Troop B: Allegheny, Fayette, Greene, and Washington counties
Troop C: Clarion, Clearfield, Forest, Elk, Jefferson, and McKean counties
Troop F: Cameron, Clinton, Lycoming, Montour, Northumberland, Potter, Snyder, Union, and Tioga counties
Troop P: Bradford, Sullivan, Wyoming, and Luzerne counties
Troop R: Lackawanna, Pike, Susquehanna, and Wayne counties

Enforcement comes at a price, however; Pennsylvania's DEP has funded these unannounced roadside inspection blitzes for $550,000 from the state's Waste Transportation Safety Account.[25]

A legal primer

Any municipal traffic regulation excluding trucks must be based on necessity, rather than an attempt to confine a particular company (or industry). For a local traffic regulation to pass muster in a court of law it has to be deemed *reasonable*. Is the proposed truck route regulatory or prohibitory? Thorough documentation of structural and functional road conditions (through a traffic impact study and the documentation of present road conditions) helps to lessen liability to the locality. Load zoning and haul route management is permitted, provided that the route provides access to all state routes entering or leaving town.[26] Consider that industry executives may prefer that costs be consistent, and therefore accept fees as a cost of doing business, but may dispute the *legality* of being 'singled out'; restrictions must apply to all trucks, not just those serving natural gas drilling rigs.[27] Municipalities may not pass or enforce ordinances that impose a tax or fee for the use of public roads,[28] but comprehensive road use agreements that link capacity of the road to a permitting for heavy use may be implemented with the expressed intent of preservation of the road and/or public safety. The safety of passenger and commercial vehicle operators on rural roads is of concern even before adding heavy traffic; half of fatal accidents in New York State occur on rural roads[29] although only 7% of New York's population resides in rural areas.[30]

Some guidance on exclusionary traffic regulations can be found in *People v. Grant*[31], a case in which residents in a Long Island town objected to a high volume of through traffic from a particular company. The New York State's highest court ruled that while local municipalities have authority to adopt local laws under the Municipal Home Rule Law[32], they may not do so if the ordinance conflicts with the state constitution. Although it was

[25] http://wduqnews.blogspot.com/2010/09/fracnet-and-trashnet-to-expand.html
[26] N.Y. Veh. & Traf. Law Art. 41 § 1660, paragraphs 10 and 17
[27] Sarah Fullenwider."If We Knew Then What We Know Now….A Decade of Lessons Learned from Urban Drilling in Fort Worth," Webinar presented by Penn State College of Agricultural Studies Cooperative Extension, May 20, 2010.
[28] N.Y. Veh. & Traf. Law Art. 41 § 1604
[29] http://www-nrd.nhtsa.dot.gov/Pubs/810996.PDF NHTSA Rural/Urban Comparison, 2007
[30] Jeryl Mumpower and Warren Frederick Ilchman, *New York State in the year 2000*, p. 138
[31] *People v. Grant,* 306 N.Y. 258 (1954)
[32] Municipal Home Rule Law §10[2]

decided in 1954, that case is still considered good law with respect to restrictive ordinances.[33] Municipal attorneys interested in further clarification of how Municipal Home Rule Law, Vehicle and Traffic Law, and the Environmental Conservation Law[34] statutory language – "local jurisdiction over local roads" – should be interpreted may request an informal opinion from the state Attorney General's office, Division of Appeals and Opinions.[35]

A handful of municipalities have hired engineering firms together as part of a cooperative deal to defray some of the costs of conducting road studies and drafting legislation. Feedback from this process is ongoing, yet decentralized; technical assistance is available from the Cornell Local Roads Program (see 'Further Resources'). Evidence from Pennsylvania, West Virginia, and Arkansas suggests that municipalities lacking traffic ordinances are severely impacted when shale gas drilling commences. The short-term costs of developing a comprehensive plan – based on the likelihood of sudden, high-volume truck traffic as a result of shale gas drilling – more than offset the anticipated cost to municipal road crews, whose budgets are toward regular maintenance, not major repairs and construction.

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[33] "Town board's limited power to exclude certain vehicles from certain highways – general discussion," 1980 N.Y. Op. Atty. Gen. (Inf.) 209 (see appendix)
[34] New York State Environment and Conservation Law §23- 0303(2)
[35] http://www.ag.ny.gov/bureaus/appeals_opinions/guideline_informal.html

Further Resources

American Association of State Highway and Transportation Officials (AASHTO) – http://www.transportation.org/

American Society of Highway Engineers (ASHE) – Central New York Section Officers:
Charles T. Liggett, CDM, Syracuse, NY; (315) 427-7380; Liggettct@cdm.com
Mark D. Premo, P.E., OCDOT, Syracuse, NY; (315) 435-3205; MarkPremo@ongov.net
Donald P. Blasland, PW Labs, E. Syracuse, NY; (315) 437-1420; pwlabsinc@hotmail.com

The Cornell Local Roads Program provides a range of technical assistance to New York State municipalities, including Road Surface Management System software; (607) 255-8033 http://www.clrp.cornell.edu

The Cornell Local Roads Program recently enlisted the legal expertise of former New York State Assistant Attorney General Jim Gelormini to develop model ordinances for municipalities; those ordinances and has made those available to the public at http://www.clrp.cornell.edu/resourcesLinks/model_ordinances.htm

Delta Engineers, Architects & Land Surveyors, P.C. (http://www.deltaengineers.com) of Endwell, NY has contracted with Sullivan County and Schyuler County as well as the towns of Fenton in Broome County and Danby and Dryden in Tompkins County

Google map of Road Destruction in Tioga County, PA

Appendices

Guidelines and Standards for Classifying Roads and Streets, Cornell Local Roads Program, March 2008

"Town board's limited power to exclude certain vehicles from certain highways – general discussion," 1980 N.Y. Op. Atty. Gen. (Inf.) 209

Framework for Assessing Water Resource Impacts from Shale Gas Drilling

by Susan J. Riha and Brian G. Rahm

In 2009, 23 percent of total energy, including 40 percent of electricity, consumed in the United States was derived from natural gas. About 88 percent was produced within the United States (with most of the remainder coming from Canada). Since 2007, the proportion of domestic gas supplies from shale has steadily increased and is expected to continue to increase, relieving the need to meet demand in the near future with imports. The Marcellus Shale, which is a geologic formation found under much of southern New York, may contain more recoverable natural gas than any other shale formation in the United States. Recoverable reserves of natural gas in the Marcellus was estimated in one study to be more than 20 times the total amount consumed in the United States in 2009.

Drilling Activities

Activities associated with the recovery of natural gas from shale have significant impacts on water resources and, therefore, necessarily draw the attention of water resource regulators and managers. These activities include establishment and construction of multi-acre drill pads; vertical drilling, often through potable groundwater supplies; and horizontal drilling through the shale gas formation for possibly thousands of feet. During these operations, millions of gallons of water need to be acquired and transported to the drilling site, mixed with a number of chemicals, and pumped in stages under pressure into the well bore in order to fracture the rock (hydraulic fracturing). Some of this water, which has now interacted with native constituents of the shale formation, is relatively quickly brought back to the surface (flowback water), where it is sometimes reused for hydraulic fracturing of other gas wells. Flowback water that is not reused, as well as water that is returned to the surface over the life of the gas well (produced water), must be stored and then treated. The constituents removed or remaining after treatment of wastewater must be disposed of either in landfills or by injection into deep wells.

Water resource regulators and managers are concerned with minimizing the impacts associated with the above activities. However, developing a clear understanding of potential impacts is difficult given the array of activities and risks that occur during shale gas development. Anecdotal reports of contaminated wells and fish kills attract attention, but are difficult to evaluate without a more comprehensive understanding of shale gas drilling impacts. To help provide clarity, and to assist regulators and managers, the New York Water Resources Institute has developed a relatively simple framework for considering important water resource impacts from natural gas drilling.

Categorizing Water Impacts

One simple way to categorize gas drilling impacts on water resources is to distinguish between impacts that are instigated through activities taking place at the surface and those caused by activities occurring below ground.

Surface activities include:
- well pad, road and pipeline construction
- water withdrawals (whether from surface or groundwater)
- treatment and disposal of flowback and produced wastewaters
- surface spills that may occur during transportation, storage and handling of chemicals and waste

Subsurface activities include:
- drilling, casing and fracturing
- underground injection of waste

The distinction between surface and subsurface activities that impact water resources could be useful in determining who should be responsible for regulating various aspects of shale gas drilling. Gas drilling impacts on water resources can also be classified as arising from ***deterministic*** or ***probabilistic*** events. Deterministic events are certain to occur and their magnitude is directly related to the extent and pace of gas drilling development. Deterministic events, such as water withdrawals and wastewater production, can be anticipated, planned for, and closely regulated. Probabilistic events can be anticipated in the sense that they are likely to occur at some point, but their occurrence and consequences are highly uncertain over time and space. The likelihood of a probabilistic event occurring must be inferred or estimated using historic data associated with similar events, if it is available. Probabilistic events include surface runoff, spills and leaks, as well as subsurface events related to gas well integrity. The distinction between deterministic and probabilistic events could be useful for developing and prioritizing strategies for preventing, mitigating and monitoring for water resource impacts.

Impacts from Deterministic Events

Deterministic events generally occur at the surface, and reflect the overall pace and magnitude of drilling activity. Water withdrawal, and the subsequent storage, handling and treatment of water and waste fluids all represent deterministic events. They are a necessary part of shale gas drilling activities, and so it is in the best interest of both industry and regulators to have accurate data and comprehensive strategies for addressing the water resource impacts of these activities. Clear policies regarding when and where water withdrawals will be permitted and how disposal of waste fluids will occur provide industry with planning certainty. From the perspective of policy makers and regulators, water resource impacts as a result of deterministic activities represent an opportunity to influence the pace of gas drilling activity through established permitting and compliance

Graphic by Laura Buerkle

Deterministic events are certain to occur and their magnitude is directly related to the extent and pace of gas drilling.

systems. Central to the success of minimizing or mitigating the impact of deterministic events on water resources is the availability of accurate data regarding water volumes being used, as well as descriptions of waste fluid flows and compositions.

The water withdrawal permitting structure established by the Susquehanna River Basin Commission (SRBC) is a good example of how the impacts of shale gas water withdrawals can be evaluated in the context of basin wide consumptive use of water. The SRBC system addresses the spatial and temporal impacts of water withdrawals by managing and in some cases restricting locations and timing of withdrawals so as to ensure minimum required passby flows *(see SRBC's article, page 28)*. A similar system should be established in other river basins of New York outside of the Susquehanna and Delaware Basins.

Throughout the Marcellus Shale region, a major challenge remains the handling and treatment of flowback and produced wastewaters. In New York, gas drilling flowback water has usually been stored in open, albeit lined, pits but some companies drilling in the Marcellus in Pennsylvania are now using closed loop systems in which all wastewater, at least at the drilling pad, is containerized. Currently, gas drilling flowback and produced water from more traditional gas drilling activities is either treated at permitted POTWs (publicly owned treatment works) or shipped to specialized treatment plants in other states. Due to the high concentration of total dissolved solids (TDS) and overall volume of fluids produced from Marcellus Shale activities, however, it appears that most POTWs are not likely to be interested in or capable of treating these new wastewaters, due in part to possible disruption of the treatment process that shale wastewater may cause. Additionally, to remove the soluble salts contained in flowback and produced water requires using evaporation or reverse osmosis and, therefore, will not generally be removed in a POTW but could be released to surface water if sufficiently diluted.

Mobile or temporary water treatment plants, designed specifically for treating water from shale gas operations, could be built in New York. In the face of increasing reuse of flowback and produced wastewaters by companies seeking to increase the efficiency of their operations, a temporary or flexible approach to developing these facilities might be particularly appropriate. If the wastewater is desalinized, the question of the disposal of brine remains. Reinjection of brine into other geologic formations is a possibility, but sites for reinjection in Pennsylvania and New York are apparently limited.

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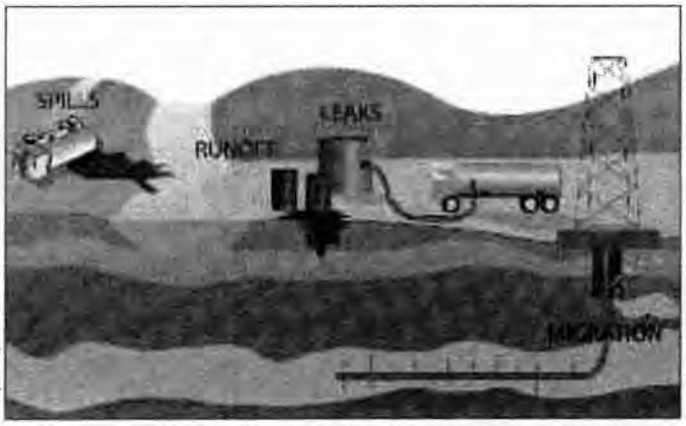

Graphic by Laura Burkle

Probabilistic events are likely to occur, but their occurrence and consequences are highly uncertain over time and space.

continued from page 17

Disposal of solid wastes, including drilling muds and cuttings, as well as suspended solids recovered from wastewaters, also remains a concern. Due to inherent characteristics of the Marcellus Shale in southern New York, these wastes are likely to contain elevated levels of naturally occurring radioactive materials (NORMs) and so may not be acceptable for disposal in non-hazardous landfills. More experience and testing will be needed as Marcellus Shale activity grows to determine if solids disposal will require special consideration.

Impacts from Probabilistic Events

Probabilistic events arising from gas drilling activities at the surface that have the potential to impact water resources are not fundamentally different than those of other industries. Surface impacts essentially result from leaks and spills, which can be defined as any unintended release of hazardous material. While spills may result from a wide variety of activities, they can be simplified by categorizing them according to the risk they pose to water resources. Regardless of where a spill originates, three basic characteristics should be considered: ***containment, toxicity and volume.***

If a spill is contained, there is little chance it will pose a threat to water resources. Uncontained spills, such as those that enter soils or water bodies, must be further evaluated.

Toxicity refers to the degree to which a material can damage organisms, while volume simply describes the quantity of material released. These last two parameters can be used together to determine the risk any uncontained spill may pose. Highly toxic spills present a risk regardless of their volume. Conversely, high volume spills may pose a risk regardless of their toxicity. Viewing spills as a combination of these characteristics - containment, toxicity and volume - results in a reasonably simple and robust approach to assessing and minimizing the risk an event poses to water resources.

Preventing spills from impacting water resources requires containment. Some industry operators and service companies are developing and implementing best management practices with respect to containment, and efforts should continue until such practices are routine. The extra effort to build containment measures into storage and handling areas onsite is worthwhile when compared to the potential negative consequences of spills. However, some spills cannot be contained, and must be managed and remediated in other ways. Timely data on toxicity and volume of spills is essential for the mobilization of effective spill responses from both industry and regulators. A fast, reliable and transparent reporting system is crucial for making sure that all stakeholders have the right data to respond to spills effectively. Reducing or restricting the use of highly toxic chemicals and taking precautions against high volume spills are additional preventive actions that could minimize risk to water resources.

Subsurface probabilistic events that have the potential to impact water resources may not be as likely to occur as surface events, but appear to be the type of events that most concern the public. Direct contamination of groundwater as a result of fracturing procedures appears to be highly unlikely. However, subsurface impacts as a result of faulty well bore cementing practices and improper balancing of well pressures can and has occurred. While these events may be rare, they can have significant impacts on drinking water sources, resulting in elevated levels of methane and turbidity, as well as other constituents associated with gas drilling and shale formation fluids.

Testing of private drinking water wells pre and post gas drilling is necessary for establishing a link between drinking water quality and drilling related impacts. Industry, regulators, and private and academic institutions all appear to recognize the value of this type of monitoring and have helped to make it an increasingly accepted practice. Regulators could take other precautionary steps to reduce the risk of subsurface impacts, such as requiring cement logs to ensure the integrity of the well and the proper separation of drilling fluids and drinking water. Also, the use of highly toxic chemicals in drilling and hydraulic fracturing could be discouraged or in some cases banned to further reduce risk to water resources.

Moving Forward Using Protective Management

The framework presented here can be used to help stakeholders better understand the wide range of events associated with shale gas drilling that will or could potentially impact water resources. Distinguishing between deterministic and probabilistic events associated with shale gas activity is important from both a public policy and communications perspective. Deterministic events (water withdrawal and waste disposal) can be managed and regulated to minimize or avoid impairments to surface and groundwater, as well as to control and monitor the scale and pace of development. Regulations and best practice guidelines should also be developed to reduce or minimize the impact of probabilistic events on water resources, and should be carefully focused on those events of relatively high likelihood and risk.

Unfortunately, events having negative impacts on water resources will occur. There will also continue to be events that capture the public's attention. However, events of interest to the public may not always match events that generate negative impacts. It is likely that the public will suspect that events have occurred when they have not, and it is also possible that industry will dismiss the possibility of certain events despite strong public sentiment to the contrary. Therefore, it is and will remain a challenge to communicate the true risks associated with events while conveying a sense of oversight and safety with respect to shale gas drilling activities.

Though efforts to encourage drinking water testing and development of surface water monitoring systems are unlikely to prevent or change the occurrence of certain negative events, they are nevertheless likely to be helpful in communicating the role of water resource regulators and managers to the public. Creation of a highly accessible and informative database that includes reports on gas well permits, inspections and chemical spills is also important for addressing the perceived risks to water resources of gas drilling, and should be a top priority within New York.

Moving forward, New York has the opportunity to learn from and improve upon its own history with gas drilling, as well as the more recent experience of Pennsylvania with the Marcellus Shale. Industry and regulators can employ systems that address and manage the range of possible negative impacts on water resources associated with shale gas drilling, as well as develop transparent monitoring and reporting systems that ensure the public that shale gas drilling is occurring in a manner that protects our water resources.

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Gas field workers cited in Pa. hospital's losses

Written by Associated Press
Jan. 23

pressconnects.com

JERSEY SHORE, Pa. – The first operating loss in about five years at a north-central Pennsylvania hospital is a sign of the influx of natural gas field workers without health insurance, the facility’s CEO said.

Jersey Shore Hospital president and CEO Carey Plummer told the Sun-Gazette of Williamsport that many subcontractors attracted to the area’s Marcellus Shale drilling boom do not cover employees.

That has brought a growing number of uninsured people to the community-owned, nonprofit hospital, Plummer said.

“We had a loss,” Plummer said. “I don’t think it’s a sign of the economy. I think it’s the influx of the gas, industry and those who lack insurance.”

The hospital reported an operating loss of $770,000 while providing more than $3 million in care to people unable to pay in its most recent fiscal year. The uncompensated care figure is the highest it has ever seen.

Other significant factors contributing to the hospital’s losses include cuts in Medicaid reimbursements, employee salary increases and higher pension costs, Plummer said.

Jersey Shore is about 65 miles north of Pennsylvania’s capital of Harrisburg. The hospital says its service area covers about 45,000 people in Clinton and Lycoming counties. It reported 3,260 acute care days, 67,691 outpatient visits and 14, 835 emergency room visits in the most recent fiscal year.

With about 660 wells, Lycoming County is the fourth most heavily drilled county in the Marcellus Shale rush that began in earnest in 2008, according to state records. The footprint in Clinton County is smaller, with just under 100 since then. The state’s two most heavily drilled counties, Tioga and Bradford, are neighbors of Lycoming County.

Natural Gas Drilling in the Marcellus Shale:
Potential Impacts on the Tourism Economy of the Southern Tier

Andrew Rumbach[1]

Introduction

The Marcellus Shale is a geologic formation that lies under large portions of New York, Pennsylvania, and West Virginia, and smaller parts of Ohio and Virginia. Contained within the Shale formation are reserves of natural gas, which have only recently become recoverable due to a process known as horizontal drilling and hydraulic fracturing ("fracking"). While estimates of the total untapped gas reserves vary widely, it is generally agreed that they are significant - as many as 500 trillion cubic feet of gas might be recovered from the formation, enough natural gas to meet the domestic needs of the United States for over 20 years (Engelder 2009).

Drilling in the Marcellus Shale has quickly become the center of controversy in New York; proponents argue that gas development could provide much-needed jobs, tax revenues, and royalties for land-owners, and would be a local source for a natural resource that accounts for 30% of New York's power consumption. Opponents argue that the fracking process poses a danger to the local and regional environment and threatens to contaminate the surface and ground water reservoirs that supply drinking water to cities and communities across the state.

While much of the debate over gas drilling in the Marcellus Shale focuses on the potential environmental impacts, there is also concern that gas extraction will create a "boom-bust" economic development pattern seen in many resource rich regions and countries (e.g. Jacquet 2009, Barth 2010, Christopherson 2011). Shale gas drilling in states like Wyoming, Texas, and Pennsylvania has had serious economic consequences for adjacent industries like agriculture and tourism, because of the widespread industrial activity that accompanies drilling.

This report centers on the potential impacts of gas drilling on the tourism industry in the three-county region served by the Southern Tier Central Regional Planning and Development Board (STC). Tourism is an important and diverse sector of the economy of the Southern Tier, and understanding some of the potential impacts of gas drilling on the tourism industry is important for business owners, elected officials, and planners concerned with economic development in the region. This paper addresses three major questions: 1) What is the value of the tourism sector to the economy of the STC region? 2) In what ways might gas drilling in the Marcellus Shale impact the tourism economy, now and into the future? 3) If gas drilling could

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[1] Prepared for the Southern Tier Central Regional Planning and Development Board, with support from the Appalachian Regional Commission. Andrew Rumbach is a doctoral candidate in the Department of City and Regional Planning at Cornell University.

potentially harm the tourism sector, what policies or strategies might help to mitigate those negative impacts?

This report is divided into four sections. After a brief introduction to the geography of the STC region and a description of the research methods used, the size and scope of drilling activity in the region is discussed. Next, a profile of the tourism economy is presented, including data on the economic impact of tourism and a discussion of the non-monetary importance of tourism amenities for quality of life in the region. Third, many of the potential impacts of gas drilling on the tourism economy are discussed. Finally, some recommendations for policy and planning are offered.

The STC Region

STC serves Chemung, Schuyler, and Steuben Counties, in the Southern Tier region of upstate New York. The region encompasses 2,151 square miles and has both urban and rural communities. It is home to several small cities and towns, including Bath, Corning, Elmira, Watkins Glen-Montour Falls, Hornell, and Wayland, as well as more than 2,300 farms (USDA 2007).

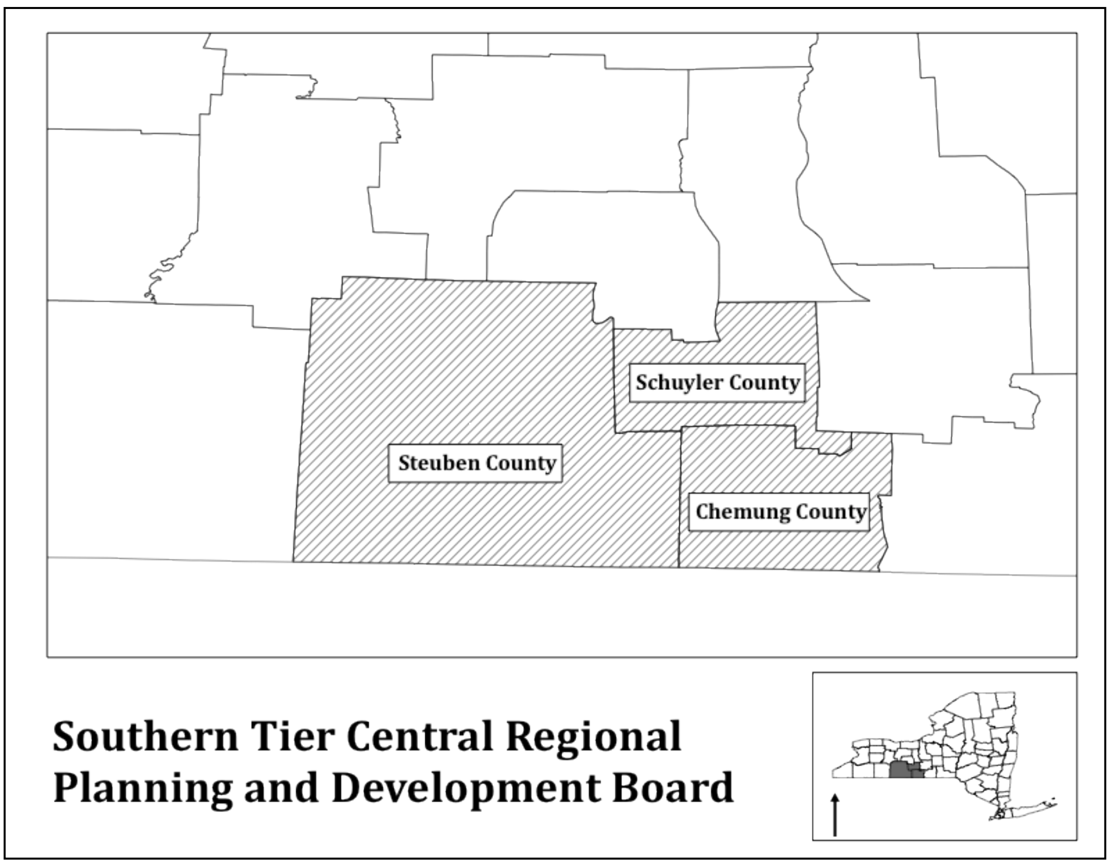

Figure 1: The STC region
Source: The New York State GIS Clearinghouse. Map created by author on 4/14/2011

Data and Methods

This report is based on information and data obtained from the following sources:

1. Published reports, news articles, and studies related to gas drilling in the Marcellus Shale
2. Data from the U.S. Census, the American Community Survey, County Business Patterns, and other sources for information relevant to gas drilling and tourism
3. Geospatial data from the New York State GIS Clearinghouse as well as agency sources
4. Interviews with public officials, gas drilling experts, organizations, advocacy groups, business owners and operators, and other local stakeholders (see Appendix A)

In addition, the report has greatly benefited from ongoing collaboration with the Marcellus Shale research team at Cornell University, led by Dr. Susan Christopherson in the Department of City and Regional Planning.

New York has issued a statewide moratorium on permits for hydraulic fracturing that lasts till at least August 2011, so drilling activity has yet to begin. Much of the analysis of the potential economic, environmental, and social impacts presented here and elsewhere is therefore speculative. In order to try and understand what may happen in New York should the moratorium be lifted, it is advantageous to study cases from other states and communities that have seen widespread shale drilling.

This report refers often to the Northern Tier of Pennsylvania, including Bradford County, for several reasons. First, the Northern Tier, and Pennsylvania generally, has seen widespread gas drilling since 2007, on a scale similar to what we might expect in New York. Second, compared to cases in Wyoming, Colorado, or Texas, northern Pennsylvania has a similar topography and environment to that of the Southern Tier of New York. Third, the Northern Tier economy has important agriculture and tourism sectors, similar to the STC region. One important difference between the two regions, however, is that the Southern Tier has several small cities, whereas Bradford County does not. The Southern Tier's urban assets may help shape the outcomes of gas drilling differently than what is seen in northern Pennsylvania.

Size and Scope of Drilling Activities

Though it is impossible to predict exactly how many gas wells will be drilled in the Southern Tier, given its location in the greater Marcellus formation, it is reasonable to assume that drilling will be widespread in the STC region, especially in Chemung and Steuben counties.

Figure 2: The Marcellus Shale Formation
Source: The American Association of Petroleum Geologists

Natural gas drilling is certainly not new to the region. According to the Annual Report of the Division of Mineral Resources of the New York State Department of Conservation, Chemung, Schuyler, and Steuben Counties are all in the top 10 gas producing counties of New York State (NY DEC 2008; Barth 2010). As of 2008, Steuben County had 69 actively producing vertically drilled gas wells, while Chemung County had 43 and Schuyler County 18.

Though horizontal drilling and hydrofracturing are not permitted in New York, a number of conventional, vertical gas wells have been drilled or permitted in the New York portions of the Marcellus formation. According to the NYDEC, 80 permits have been issued for vertical gas drilling in the Marcellus formation in the STC (as of February 2011), 23 of which are currently producing gas.[2]

Horizontal drilling of the Marcellus Shale, however, is much different than the gas drilling traditionally done in New York State (Jacquet 2011). Because horizontal gas

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[2] For the most up-to-date information available on well permits, well production, and volumes of gas produced, visit http://www.stcplanning.org/index.asp?pageId=153 and http://www.dec.ny.gov/cfmx/extapps/GasOil/search/wells/index.cfm.

extraction requires directional drilling and hydraulic fracturing, drilling will be a much more industrial process than traditional gas development done in the Southern Tier. Based on the development of other unconventional shales in the United States that required fracking, and on drilling activity in Pennsylvania thus far, the number of Marcellus Shale wells will likely far exceed the number of traditional wells in the region. Bradford County, PA, just across the state line, has seen a rapid proliferation in gas wells and well permits since 2007-2008:

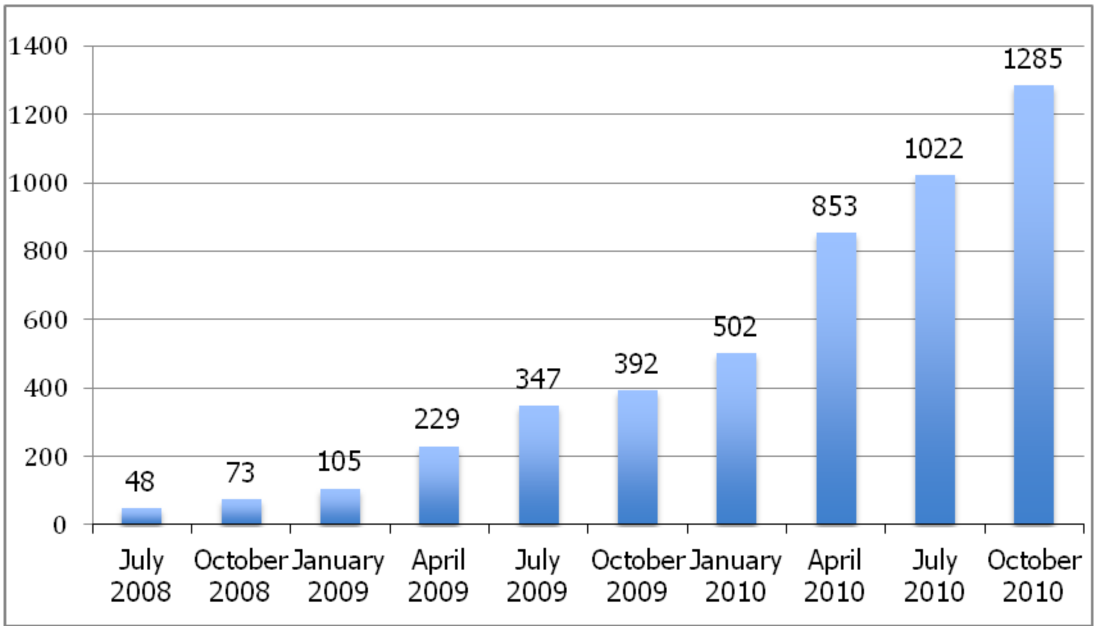

Figure 3: Permitted wells in Bradford County, PA (2008-2010)
Source: PA DEP, Bradford County

The proliferation of wells in Bradford County mirrors a trend happening in much of northeast and southwest Pennsylvania, and to a lesser extent, most of the state.[3]

The New York State Department of Environmental Conservation's (NYDEC) Draft Supplemental Generic Environmental Impact Statement (SGEIS) estimated that the maximum number of wells drilled per year in New York would be 500, though they do not describe how they reached that number (NYDEC 2009). In the three Pennsylvania counties south of the STC region (Tioga, Bradford, Susquehanna), energy companies were projected to drill double this amount in 2010 (Jacquet 2010).

A great many factors could influence the scale of drilling activity in the STC region, from state environmental policy and permitting processes to market demand and the availability of drilling equipment. Given the STC region's location in the

[3] Bradford County is above one of several "sweet spots" in the Marcellus formation under Pennsylvania, where gas production is pronounced. For an animated map of Marcellus shale permits issued in Pennsylvania statewide, see http://www.marcellus.psu.edu/images/well_animation.gif.

Marcellus fairway and its proximity to the equipment and labor force in Pennsylvania, it would seem prudent to plan for widespread drilling activity over the course of the next decade.

Tourism in the STC region

The STC region has a diverse range of tourism assets, both urban and rural in character. The Corning Museum of Glass, perhaps the most well known of the region's tourism destinations, attracts hundreds of thousands of visitors to Corning per year. The Wings of Eagles Discovery Center (formerly called the National Warplane Museum) in Horseheads, the Center for Mark Twain Studies at Elmira College, and the Watkins Glen International are among the many attractions in the region. The area is also known for its rural tourism destinations, like the National Soaring Museum, the Newtown Battlefield State Park, and many waterfalls, including Tinker Falls, Watkins Glen State Park, and Stony Brook State Park. There are a host of outdoor recreational and sporting venues in the region, from hunting and fishing to camping and bird watching. Seneca Lake in Schuyler County and Keuka Lake in Steuben County offer numerous boating and water sports opportunities.

The tourism "brand" of the Southern Tier is very much intertwined with agriculture; rolling hills, scenic farmlands, rural vistas, and viticulture are major contributors to the tourism draw here. Farmers markets, agricultural fairs, and family-owned restaurants can be found in almost every town and city. The Finger Lakes wine industry has rapidly become one of the most popular wine destinations in the eastern United States, with dozens of vineyards, tasting rooms, and bed & breakfasts that stretch from the Southern Tier counties to north of the Finger Lakes.

Supporting and growing the tourism sector is a key component of economic development strategies for the counties in the STC over the next several decades. Besides the significant tourism assets already in place, vineyards, viniculture, and wine tourism are a major focus for economic investment and growth.

Monetary and Non-Monetary Values of Tourism

Tourism is an important part of the present and future economy of New York. The importance of tourism for the STC economy is significant and growing. In 2008 visitors spent more than $239 million in the STC region, across a diverse range of sectors including food and beverage, lodging, retail and service stations, transportation, recreation, and second homes.[4] Visitor spending increased in all three STC counties from 2007-2008, year over year: by 10.6% in Chemung County, 2.9% in Schuyler County, and 12.8% in Steuben County (Tourism Economics 2009, p. 28).

[4] Spending varied significantly across counties: Chemung ($89.2 million), Schuyler ($26.4 million) and Steuben ($123.5 million). See Tourism Economics (2009), p. 25.

Employment and Wages

The tourism and travel sector accounted for 3,335 direct jobs and nearly $66 million in labor income in the STC region in 2008. When indirect and induced employment is considered, the tourism sector was responsible for 4,691 jobs and $113.5 million in labor income (see Tables 1 and 2).[5] Tourism accounted for 1,923 direct, indirect, or induced jobs in Chemung County in 2008, or 7.2% of all jobs. In Schuyler County, tourism accounted for 562 jobs, or 11.7% of the total. In Steuben County, it accounted for 2,206 jobs, or 5.9% of all jobs.

Area	Travel & Tourism: All Industry Groups 2008[6]			
	Direct	Total Jobs[7]	% Share (Direct)	% Share (Total)
Chemung	1,421	1,923	5.0%	7.2%
Schuyler	389	562	8.1%	11.7%
Steuben	1,525	2,206	4.1%	5.9%
STC Region	3,335	4,691	4.7%	6.7%

Table 1: Direct and Total Employment in the Tourism Sector, 2008
Source: Tourism Economics (2009)

[5] To reach these figures, Tourism Economics used Regional Economic Information System (REIS) data from the Bureau of Economic Analysis, U.S. Department of Labor. To determine direct, indirect, and induced impacts of tourism on employment and wages, Tourism Economics used the INPLAN input-output model for New York State. For a complete description of data and methods, see Tourism Economics 2009 (p. 39).
[6] These statistics likely *underestimate* the value of tourism in the STC region, because they do not include vineyards and wine production, a major emerging industry in the area. See discussion following.
[7] Total jobs include direct, indirect, and induced employment. Direct employment is attributed to persons and companies directly providing goods and services to travelers. Indirect employment is secondary employment in the suppliers of goods and services to the direct employment companies. Induced employment is a share of the tertiary benefit to the local economy as incomes in the previous two levels of employment are spent on goods and services in the local economy. For example, when a restaurant employee spends his wages at the grocery store, it generates additional employment and economic output. See Tourism Economics 2009 (p. 39).

Area	Labor Income - Travel & Tourism 2008			
	Direct	**Total**	**Share (Direct)**	**Share (Total)**
Chemung	$27,255,000	$46,326,000	2.0%	3.4%
Schuyler	$6,639,000	$11,285,000	4.6%	7.9%
Steuben	$32,895,000	$55,912,000	1.9%	3.2%
STC Region	$66,789,000	$113,523,000	2.1%	3.5%

Table 2: Labor Income generated by the tourism sector, 2008
Source: Tourism Economics (2009)

According to the New York DOL, 93 individual firms operated in the Travel and Tourism sector in 2010. This does not include sole proprietorships, which may increase the number of firms by as much as 20% (see NYDOL (2011) and Tourism Economics 2009, p. 36).

Employment numbers for the tourism and travel industries exclude wine production and vineyards, because they are traditionally included in measures of the food processing sector of the economy. Wine and wine tourism is an emerging industry in the STC region, however, and employment in the industry is largely driven by tourism dollars. According to the New York State Department of Labor, 18 firms in the STC region were classified as "wineries" in 2010 and employed 275 people. An additional 8 firms were classified as "grape vineyards" and employed 63 people.[8]

Tax Revenues

Tourism is also an important source of revenue for state and local governments; in 2008, tourism in New York State generated more than $7 billion in state and local tax revenues (Tourism Economics 2009). In the STC region, the travel and tourism sector generated nearly $16 million in state taxes and $15 million in local taxes, for a total of almost $31 million in tax revenue. This equates to a tax benefit of $1,181 per household in the region.

[8] Estimations were made using data from the Quarterly Census of Employment and Wages (QCEW), in the 6-digit categories of Wineries (312130) and Grape Vineyards (111332).

Area	Travel & Tourism: All Industry Groups 2008			
	State Taxes	**Local Taxes**	**Total**	**Region Share**
Chemung	$5,805,894	$5,552,950	$11,358,844	36.9%
Schuyler	$1,761,258	$1,642,030	$3,403,288	11.1%
Steuben	$8,325,524	$7,693,489	$16,019,013	52.0%
STC Region	$15,892,676	$14,888,469	$30,781,145	100%

Table 3: State and Local Taxes generated by the tourism sector, 2008
Source: Tourism Economics (2009)

Discussion

Though the tourism sector creates a significant number of jobs in the STC region, it is likely that the value of gas drilling, measured simply by jobs created and wages generated, will exceed the value of tourism in the short term. It is also likely that many tourism related businesses, including hotels, restaurants, and shopping venues, would benefit from the influx of gas workers. These observations come with two major caveats, however.

First, tourism brings many non-monetary benefits to the STC region and its communities. Most important, tourism amenities improve the quality of life of residents. Restaurants, shops, parks and outdoor recreation areas, campgrounds, wineries, festivals, museums, and other related amenities are beneficial to local residents as well as visitors. These amenities also make a region more attractive for economic investment; they are some of the crucial resources that allow an area to attract economically mobile populations, like young professionals and retirees (Markusen 2003, 2004). The preservation and maintenance of rural and outdoor assets is also an important component of sustainable economic development strategies; these assets are a renewable resource for the region, and tourism creates a financial incentive to protect them.

Second, whereas many tourism related businesses are locally owned and operated and are thus part of a long-term economic development trajectory for the region, the employment "boom" in gas drilling will be relatively short-term and non-local (see Appendix B).

Tourism is a significant sector in the STC economy and one that is an important component of the long-term economic development in the region. At the same time, natural gas contained in the Marcellus Shale is an important and valuable resource owned by the citizens of the STC counties, and its extraction could offer substantial benefits.[9] Based on these observations, two important questions emerge: 1) Will drilling have a negative effect on tourism and tourism development? 2) Can gas drilling and tourism co-exist?

The Potential Impacts of Gas Drilling on the Tourism Industry

One of the central questions confronting the tourism industry is whether drilling will permanently damage the carefully developed "brand" of the region, as a pristine and picturesque destination for wine lovers, outdoor enthusiasts, and budget conscious travelers. This question is different from asking if drilling will hurt the tourism economy generally. During the short-term drilling phase, the surge in out-of-town workers will likely benefit many tourism-related businesses. Gas workers will fill up hotels and motels, patronize restaurants, bars, and music venues, shop at local businesses, and so on.[10] But given the short-term nature of the drilling "boom," how might drilling and its attendant effects impact the tourism sector in the long run? In the next section, I discuss a number of ways that widespread natural gas drilling might transform the reputation of the region. Individually, they are unlikely to have serious and long-term consequences. Cumulatively, however, they threaten to do serious damage to the tourism sector by degrading visitor experiences and creating an industrial landscape that far outlives the profitability of gas extraction.

Accommodations[11]

An influx of out-of-town gas workers will likely strain the available supply of hotel/motel rooms, RV parks, campgrounds, and other short-term accommodations in the region. Given that many drilling-phase workers are transitory, they are less likely to purchase homes or avail themselves of long-term accommodations. As a result, even a few thousand workers can overwhelm the carrying capacity of rural communities and quickly tie up hotel rooms in much larger cities (Jacquet, personal communication 2011). For example, gas drilling has been a boon for hotels and motels in northern Pennsylvania, as occupancy rates have soared to over 95%, despite the nationwide recession. Some businesses, like the Towanda Motel in Bradford County, PA have become completely occupied by gas workers, and most have a significant gas worker presence.[12]

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[9] For a discussion of the short and long-term economic costs and benefits of gas development, see Christopherson and Rightor (2010).
[10] Based on drilling labor studies in Pennsylvania and other gas plays, many transient workers will support families that live out of state, and so their general spending habits are not directly comparable to local residents and workers.
[11] In addition to the strain placed on short-term lodging, an influx of gas workers might strain other tourism infrastructure such as shopping and eating establishments. See NPS 2009.
[12] Though not directly related to tourism, soaring hotel occupancy rates can also have a negative impact on social services and emergency management capacity. Hotel rooms are

The influx of gas workers tends to stress other types of short-term and affordable accommodations as well. Because the busy season for drilling is during the warmer months, many gas workers find accommodation in recreational areas, like RV parks, campgrounds, and vacation rentals. Unfortunately, this coincides with peak travel and tourism demand for the same amenities (for evidence from Wyoming, see Jacquet 2006).

Even as gas workers have filled these temporary accommodations across northern Pennsylvania, demand is still outstripping supply. Many hotels in the Southern Tier of New York are now housing gas workers, and Chesapeake Energy has recently completed a $7 million "man camp" in Athens Township, Bradford County, PA to alleviate the acute housing shortage (Rubinkam 2010).

For the tourism planners and officials, several major concerns have emerged. First, high occupancy rates in hotels, motels, campgrounds, and other locations make it more difficult for visitors to find accommodations. This is especially worrisome during major festivals and events, when a large influx of visitors is expected. For example, Pennsylvania hotels were forced to turn away attendees of the Little League World Series in 2010 (Beauge 2010). While some gas workers did temporarily vacate hotels to make room for Little League fans, there is no guarantee that the same will happen during future events. Uncertainty about the hotel and motel capacity of an area could plausibly lead to event organizers choosing alternative locations.

Demand for hotel rooms naturally leads to higher prices as well. While gas companies may be capable of absorbing higher prices for rooms, cost-conscious travelers may not, and may choose alternative destinations.

Second, hotel and motel operators report that gas workers are a different category of guest than the typical overnight businessperson or vacationing family, and can cause greater wear-and-tear on rooms and facilities. This is because 1) gas drilling is often hard, outdoor, physical labor, and workers return to their rooms with muddy or soiled work-boots and clothing; 2) gas workers spend larger amounts of time per day in their room than the typical overnight or weekend guest, as they are using the hotel as their primary residence in the region; 3) the rooms are often occupied by multiple workers simultaneously; and 4) workers often sleep in shifts, so the room is in continuous use.

Third, it is likely that hotel and motel companies will build additional capacity in the region to meet the growing demand from the natural gas workforce (either through hotel/motel expansion or construction of new locations.) There is a concern that such construction will leave the region with a glut of corporately owned hotel

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often used for temporary sheltering, and lack of availability has created problems in towns near gas plays (i.e. Jacquet 2006).

rooms once the "boom" period of drilling is over. An oversupply of rooms could lead to artificially depressed prices that could, in turn, make it difficult for bed and breakfasts and other independently owned businesses to compete and survive.

Room Tax

A second, and related, issue deals with the collection of room (occupancy) taxes. The room tax is collected on all hotel and motel room sales in New York State, and is levied at both the state and county level. At the county level, the rate and conditions of the tax are established by county legislatures but tend to be very similar. This tax is in addition to state and local sales taxes, which also may be added to the base price of a room.

Revenues from room taxes are crucial to the tourism sector in the STC region. They fund tourism development offices, including staff salaries and tourism promotion, and sometimes help to subsidize or incubate events. Revenues are also used to invest in, or pay down debt on, tourism facilities.

The key area of concern is the "permanent resident exclusion," a stipulation in both state statute and county ordinance that exempts individuals who occupy hotel/motel rooms for more than a threshold number of consecutive days (90 days for the state tax in New York, 30 days for most counties) from paying the room tax. This exclusion typically exempts the hotel resident from paying the tax for the *entire* period of their stay.[13]

In **Schuyler County**, the room tax rate is 4% (increased from 2% in 2005). The tax generated $242,446 in 2008 and $295,153 in 2009 and is projected to generate more than $325,000 in 2011 (Schuyler County 2011).

In **Steuben County**, the room tax rate is also 4%. The tax generated $685,368 in 2006 and $680,528 in 2007. In 2008, the last year that information is available, more than $700,000 in revenue was expected (Steuben County 2008). In 2007, room tax revenues supported a host of tourism development activities, including funding the Steuben County Conference and Visitors Center, the Finger Lakes Tourism Alliance, the Dairy Festival, the ARTS of The Southern Finger Lakes, and the Finger Lakes Wine Tourism Marketing Association (Steuben County Treasurer 2008).

In **Chemung County**, the room tax rate is 4%. According to the Chemung County Budget statement, revenues from the room tax have increased significantly in the past two years as a result of spillover from natural gas drilling activity in the northern tier of Pennsylvania, as well as from other corporate customers (particularly Sikorsky Aircraft). According to Chemung County officials, the natural

[13] Once occupants have achieved the "permanent resident" threshold of continuous days stay, the occupancy taxes levied on them prior to that point are refundable. See NYS DTF.

gas industry has “chosen [Chemung] County as a hub of operations” (Chemung County 2011). The tax brought in approximately $565,000 in revenue in 2010, and is expected to raise $700,000 in 2011.[14]

Gas companies who house their workers in hotels/motels often book the rooms in long-term blocks to take advantage of the exclusion. For example, in Wyoming County, PA, which is directly adjacent to Bradford County, PA, more than 50% of the hotel occupants were falling under the “30-day” exclusion in late 2010, and were thus exempt from the room tax. According to local sources, this was due almost entirely to the influx of gas workers. So, while gas drilling has been a boon for northern PA hotels in general, room tax revenues are lagging far behind where they would typically be with such high occupancy rates (Schillinger 2010). The same issue is likely to arise in the STC region, unless county room tax laws are changed.

Visual Impacts

Part of the appeal of the STC region as a tourism destination is the rural character of its landscape; rolling hills, pristine forests, and farmlands create incredible view-sheds across the area. There is great concern that drilling activity will mar this unique visual landscape.

The visual impacts of drilling are somewhat localized around the different sites associated with gas development: well pads, drilling rigs, compressor stations, water storage, gravel pits, equipment depots, water extraction sites, disposal areas, etc. Drilling rigs, which can reach heights of 150 feet or more, are the most visible signs of gas activity. From a relatively short distance, they stand in stark contrast to the surrounding environment. During the drilling phase, these rigs operate 24-hours per day, creating additional night-time impacts, including rig lighting and open flaring, which may degrade night-sky resources (see figure 3).

[14] Clearly, not all gas workers staying in Chemung County qualify for permanent residence exclusion, as tax revenues continue to rise. Whether revenues are keeping pace with occupancy, however, is an important question and difficult to answer with the data available.

Figure 3: Drilling rigs in Washington County, PA
Source: www.marcellus-shale.us

From a greater distance, however, drilling sites have less of an overall impact than might be feared. A visual impact assessment of drilling in Bradford County, PA in 2010 found that at distances of more than 0.5 miles, rigs became difficult to see in the surrounding landscape (see Appendix D). In fact, other common manufactured features in the landscape, like power lines, cell phone towers, and windmills, can be more visually impactful than drilling equipment (Upadhyay and Bu, 2010). Beyond drilling, however, natural gas transportation infrastructure and storage facilities will also have a long-term visual impact. For example, pipeline construction can create deforestation, utility easement cuts, and possible decommission of agricultural land.

What is most important, however, is the *cumulative* impact of drilling activity across the entire STC region. The greater the extent of drilling, the more intense and pronounced the impacts will be on the visual environment. More wells drilled means more rigs, brine pits or the water treatment facilities that have begun to replace them, water storage, water extraction points, compressor stations, pipelines, newly cut access roads, heavy equipment storage, and dozens of other small impacts to the visual environment that combine to create an *industrial*, rather than scenic, landscape.[15]

Thus, the most important factors that will determine the visual impact of drilling sites, especially in scenic view-sheds, are 1) the overall levels of drilling activity; 2) the spacing restrictions between drill pads; 3) the distance of drilling sites from roadways, scenic overlooks, parks, vineyards, and other places visitors tend to go, and 4) the efforts made by drilling companies at the site of drilling activities, storage facilities, compressor stations, etc. Sites that are visually camouflaged, hidden from roadways, and quickly restored will have much less of an impact than those that are not (see Findings and Recommendations).

Truck Traffic

Truck traffic may be one of the most worrisome dimensions of gas drilling for tourism in the STC region. A typical well in the Marcellus Shale requires 5.6 million gallons of water during the drilling process, almost always delivered by truck (Randall, 2010). Trucks are also used to ship liquid additives to the well and to haul away flowback water. "Because of its weight, the impact of water [on roads, physically] hauled to one site (364 trips) is the equivalent of nearly 3.5 million car trips" (Ibid., p. 2). [16]

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[15] For additional photographs of visual impacts of drilling in Bradford County, PA and other locations, see Appendix D.

[16] There are new technologies for recycling flowback water on-site during the drilling phase that may help to eliminate a portion of truck traffic to and from the site; these technologies are not yet standard in the industry, however, though they are becoming more common in the northeast.

Truck traffic is at its peak during the drilling and hydro-fracturing of wells, operations that continue 24-hours per day for up to 2-3 weeks.[17] By one count, a vehicle arrived or departed an active drilling site in Bradford County *every 3-5 minutes* (Upadhyay and Bu 2010). A New York State Energy Research and Development Authority report estimates that for a single well, between 890 and 1340 18-wheeler truck trips are necessary, in addition to support vehicles, equipment transportation, and automobile traffic (NTC 2009).

Overall, truck and vehicle traffic is the least localized of drillings immediate effects, because the vehicles share the same infrastructure as citizens and visitors. Heavy truck traffic associated with drilling will likely have multiple negative effects on the STC region, and significantly degrade the tourism visitor experience. These effects will include: 1) heavier road traffic, on highways, secondary roads, and city streets; 2) increased air pollution; 3) increased noise pollution; 4) increased traffic accidents and safety risks; and 5) damage to roads, especially secondary roads (see Randall 2010).

Figure 4: Increased traffic congestion in Bradford County, PA due to Marcellus drilling. Source: Source: www.marcellus-shale.us

[17] This is for a single well; while multiple wells might be drilled per well pad, only a single well is drilled and fracked at a time.

Figure 5: Before and after photos of SR 3020 in Bradford County, PA, due to heavy truck traffic during the dynamic spring thaw. Source: PA DOT.

Hunting, Fishing and Outdoor Recreation

Hunting, fishing, and other outdoor recreation contributes more than $6 billion to the New York economy annually, and are important components of the tourism economy in the STC region. Outdoor recreation and sporting amenities are also valuable assets for STC residents, improving the quality of life for families and communities.[18] Without proper planning, widespread drilling in the Marcellus Shale will likely have numerous negative impacts on waterways, forests and open space, and as a result, on hunting, fishing and other outdoor activities, as well as on the businesses that support them.

Gas drilling introduces significant human activity to rural land, from new roads and truck traffic to noise and pollution. As a result, native habitats and ecosystems may be disturbed, possibly for years after the end of drilling activities. In Sublette County Wyoming, for example, drilling activity in the Jonah Field and the Pinedale Anticline has disrupted the migratory patterns of antelope, mule deer and other indigenous species, with herds down as much as 50% in the past decade (Albert 2011). As a result, non-resident licenses for mule deer have fallen from 1,400 to 800. Gary Amerine, owner of Greys River Trophies in Daniel, Wyoming, says that non-resident hunters are going other places, because of the diminished opportunities. Sportsmen for Responsible Energy Development document similar stories from across the western states, where natural gas development has been in full swing for close to a decade (SRED 2009).

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[18] For a map of state parks, historic sites, waterways, and other outdoor and recreation facilities, see Appendix C.

Drilling activity also threatens fishing and other stream, lake, and water recreation. Chief among the concerns is water pollution due to spills, accidents, and runoff during the fracking process. Accidents in Pennsylvania have already caused limited fish kills and waterway contamination; for example, more than 8,000 gallons of drilling fluid were spilled near Dimock, PA in 2009, leading to water contamination and a fish kill in nearby creeks (see Lustgarten, 2009). In 2011, a well blowout in Bradford County, PA led to several thousand gallons of drilling fluids to flow onto nearby farmland and streams and prompted the evacuation of eight families from the area (Legere 2011). Even if spills and accidents are minimized, clearing thousands of well pads will affect runoff patterns, which may disrupt fish and aquatic habitats. Another concern is the extraction of fresh water needed for drilling. In many rural areas, the only available water sources are streams, creeks, and lakes, and conservationists worry that too much extraction will endanger waterways and fish populations (for example, see Licata 2009).

Widespread gas drilling will likely have a negative impact on outdoor amenities generally. The National Park Service (NPS) warned in a recent report that shale-gas development and its attendant industrial activity may degrade visitor experience by negatively impacting air, water, and sound quality, affect night sky resources, and strain tourism infrastructure such as shopping, lodging, and eating establishments (NPS 2008). Such impacts could negatively affect visitor levels, especially if drilling occurs near park boundaries or is allowed to occur inside of parks or state forests.[19]

One critical variable in the level of impact of drilling on outdoor amenities in parks or forests is whether the State of New York allows drilling within them. In Pennsylvania, the state has only recently begun to allow drilling permits within parks, which has sparked widespread controversy (e.g. Gilliland 2011). While proponents argue that gas resources under state-owned lands is a valuable commodity and a boon to the economy, organizations like the Sierra Club worry that drilling will damage or destroy some of state's most valuable outdoor resources. Similar debates are bound to take place in the STC counties, given the number of parks and forests within the vicinity.[20]

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[19] Many of the region's recreational resources are contained in state parks, managed by the Office of Parks, Recreation, and Historic Preservation, and state forests, managed by the DEC. While drilling in state parks is less likely, drilling already occurs regularly in state forests, which are also managed for other resources like timber and game (Hautaniemi 2011).

[20] Historically, New York State has allowed some gas drilling, storage, and infrastructure within state parks; for example, Allegany State Park contains gas storage ponds, a portion of a natural gas pipeline, and a compression station. The gas stored is used locally by the park and industry as well as transported through the pipeline to customers in New York and Pennsylvania. So, while gas development has taken place within parks, the caveat remains that horizontal drilling and fracturing is a more industrial process than traditional drilling.

Labor Supply

While most drilling phase gas workers will be non-local, planners still worry about the overall supply of labor in the STC region. Many of the tourism assets and facilities in the region, including the burgeoning numbers of vineyards, the Watkins Glen International, hotels/motels. Bed and Breakfasts, RV campgrounds, restaurants, and other service-related businesses, already face a challenging labor environment and struggle to fill lower-wage and temporary positions. Two key concerns emerged when talking with economic development planners and business owners. First, will the gas drilling labor market put additional strains on the labor supply by offering better paying jobs than tourism related businesses can afford? From an economic development perspective, better paying jobs are generally seen as a plus. From a small business owner perspective, however, there is worry that paying workers higher wages to compete with gas companies is not economically feasible. Second, will the opening of additional hotels, restaurants, and other service related businesses, to meet the demand of gas workers, be possible given the limited labor supply in the region?

Discussion & Recommendations

The Cumulative Impacts of Drilling

In order to gauge the true impact of gas drilling in the Marcellus Shale on tourism and tourism development, we need to look at the cumulative impact of drilling across the STC region. Individual gas wells and drilling activity, while disruptive at a local scale, will likely have very little impact on the tourism sector. Cumulatively, however, the regional industrialization associated with widespread drilling could do substantial damage to the region's "brand," threatening the long-term growth of tourism here. Increased truck traffic, automobile traffic, air pollution, noise pollution, and industrial accidents, decreased availability of hotel/motel rooms, campground spaces, and RV parking, negative visual impacts from multiple drilling rigs in rural view-sheds, storage facilities, gravel pits, and compressor stations, disruptions to wildlife and hunting grounds, fears over lake and stream pollution and many other associated impacts of drilling will change the character of the region from pristine and rural to gritty and industrial. If so, the region's ability to attract tourism may be damaged in the long-term, as the perception (and reality) of the region as an industrial landscape may far outlast the employment and monetary benefits of gas drilling.

The Pace and Scale of Gas Drilling are Crucial

The pace and scale of gas drilling will be a crucial determinant of the overall impact on the tourism economy in the Southern Tier.[21] Nearly every negative impact of drilling discussed here could be more or less disruptive depending on the pace and scale of drilling; fewer permits per year means a lower volume of truck traffic on primary and secondary roads, fewer visual impacts and less chance of multiple rigs in view-sheds, an increased but not overwhelming demand on hotel rooms and short-term accommodations, fewer pressures placed on the local labor supply (and more time to train a local workforce to take advantage of drilling phase jobs), and so on.

There are natural determinants on how widespread drilling will be in a particular county or town, mostly around the performance of wells in that area. The most productive Marcellus wells tend to be in the "fairway," the deepest and most highly pressurized areas of the Shale and the most promising area for gas exploration (CCE 2009). In the STC region, Chemung and Steuben County will likely see more gas drilling activity than Schuyler County, at least initially, because of their location relative to the fairway. There are some industry-side constraints on pace and scale as well, like the availability of drilling equipment and work crews.

Despite similar natural and industry constraints, Pennsylvania is currently experiencing the effects of rapid and widespread drilling activity. The landscape has quickly shifted from rural and agricultural to industrial. In addition to these physical changes, Bradford County, PA officials are also struggling to cope with an increase in rents, 30% more emergency calls, rising traffic, and busier courts and jails due to increased drilling activity, all without an increase in associated funding for services (Legere 2010).

The natural gas that lies beneath the STC region will remain there until drilling occurs, and once it occurs, the region will have just one chance at maximizing the long-term benefits of such a valuable natural resource (Christopherson 2010). If drilling is to occur, a slower and more deliberate approach seems to be the most prudent path; from the perspective of tourism and tourism development, a controlled pace of drilling should be far preferable to the pace and scale of activity in places like Pennsylvania and Wyoming.

Local Governments Have the Tools to Mitigate Some Drilling Impacts

Municipal and County governments have many tools at their disposal to help mitigate the impacts of gas development. Municipalities have the ability to regulate many of the industrial developments associated with gas drilling, like drilling rigs,

[21] Pace refers to the time frame within which gas extraction takes place; scale refers to the number of wells drilled in the region annually (Christopherson and Rightor, 2011).

compressor stations, pipelines, water storage, gravel pits, equipment depots, water extraction sites, and waste disposal areas. Regulations may be imposed through comprehensive planning and zoning, or during the site planning process. These regulations might address the location, size, appearance, or operation of gas related infrastructure, buildings and sites, and should be developed and passed with the intention of mitigating the impacts of gas development on tourism as well as other economic sectors and the local environment.

Municipalities approving large development plans related to industry, such as hotels, motels, man-camps, and office buildings, should include conditions regarding possible changes to design and use after drilling activity ends. Advanced planning for local needs will help maximize the utility of these investments in capital and infrastructure for the needs of local residents in the long-term.

Municipal governments can also ensure that when gas leases are drawn up, drilling companies are required to restore and make improvements to the well pad and drilling site at the end of the lease. Site restoration can help ensure that the visual impacts of drilling are minimized at the end of the drilling phase.

With regards to the impacts on roads and traffic congestion, it is important that governments conduct a comprehensive truck traffic impact study and document baseline road conditions that would calculate the monetary value of remaining road life. Governments should consider developing road use agreements (RUA) at the time of permitting that would require operators to offset the predicted loss of life of roadway infrastructure (for details, see Randall 2010). Municipalities should also consider developing systems for route management, including agreements on by-pass routes that would serve the industry while relieving pressure on heavily trafficked roads.

Changes Are Needed in the Room Tax

The permanent resident exclusion in the room tax laws of the STC counties is an area where immediate action could be taken to protect the resources necessary for tourism promotion and development. Even if tax revenues increase from gas drilling business, they will likely not keep pace with overall occupancy levels, as is the case in Bradford County, PA (see above). These additional revenues will be crucial resources for tourism promoters as they struggle to counteract the negative impacts of gas drilling. Counties should eliminate the permanent resident exclusion in room tax laws, in order to capture all revenues associated with hotel and motel room sales.

Before counties make changes to their room tax laws, however, two points should be considered. First, changing the law might negatively impact some businesses that use the exclusion when housing short-term employees. For example, Corning Incorporated houses their summer interns in local hotel rooms and benefits from permanent resident status. It is worth explaining to them the greater community benefit to be gained from eliminating the exclusion. Second, changing the law will likely negatively impact low-income individuals and households who rely on daily or weekly hotel/motel rentals as their primary option for housing, as well as protective housing agencies and emergency services organizations (e.g. the Red Cross) that house displaced families in hotel and motel rooms. Appropriate measures should be taken to ensure a supply of temporary housing for those agencies and to protect vulnerable populations from sudden housing price increases.

Common Sense Measures Will Reduce the Visual Impacts of Drilling

Some common-sense steps in site design and operations should be taken by the gas companies to reduce the visual impacts of drilling activity. Drilling rigs, pads, compressor stations, wellheads, retention ponds, and other drilling equipment can be camouflaged or hidden from view. Compressor stations that have structures built around them produce much less noise pollution. Equipment and buildings that are painted in natural colors are much less visually intrusive than those that are not (see figure 3). Drilling pads and equipment can be hidden from view of the road through the construction of earthen berms, which also protect against wastewater spills and reduce overall levels of noise pollution. Well pads that are quickly and carefully restored also take less of a visual toll. Many of these measures could be included in regulations developed by local governments.

Tourism Firms and Organizations Should be Proactive

Tourism businesses and related organizations and agencies (e.g. Chambers of Commerce) should take steps to mitigate the impacts of drilling and attendant influxes of gas workers. Given that other gas drilling areas have seen a dramatic decrease in the availability of hotel and motel rooms, businesses and agencies can begin working to secure agreements with hotels and other lodging establishments to reserve a percentage of rooms for non-gas related customers during annual festivals and other large tourism events, when demand reaches its peak. If gas drilling in the STC region does proceed, the tourism sector will have the opportunity to access new markets. Tourism development strategies that successfully target gas workers and their families will capture and keep local some of the gas revenues that otherwise would leave the region, and might help to alleviate some of the insider-outsider tensions that are prevalent in other gas producing regions.

Appendix A: Information on Qualitative Interviews

In addition to the economic, spatial, and comparative research referenced in the above report, I consulted with the following individuals and organizations who were generous with their time and expertise related to tourism and/or gas drilling:

- Marcia Weber, Executive Director of Southern Tier Central Regional Planning and Development Board
- Susan Christopherson, Professor of City and Regional Planning at Cornell University
- Christian Harris, Labor Market Analyst at the New York State Department of Labor
- Jeffrey Jacquet, PhD candidate in the Department of Natural Resources at Cornell University
- George Frantz, Principal at George R. Frantz & Associates
- C.J. Randall, Cornell University
- Tom Knipe, Cornell University
- Peggy Coleman, President of the Steuben County Conference & Visitors Bureau
- Fred Bonn, Director of the Ithaca / Tompkins County Convention & Visitors Bureau
- Andrew Zepp, Executive Director of the Finger Lakes Land Trust
- Danielle Hautaniemi, Director of Planning & Community Development for Cornell Cooperative Extension, Schuyler County
- Meghan Thoreau Jacquet, Planner at Southern Tier Central Regional Planning and Development Board

I also spoke with several small business owners in Bradford County, PA, all of whom wished to remain anonymous in the findings of this report. I thank them for their participation.

Appendix B: Employment in the Gas Drilling Industry

The vast majority of the employment generated by natural extraction is concentrated in the "drilling phase," a labor intensive period where well pads are cleared, drilled, fracked, and restored, and gas pipelines are laid. A recent study of drilling in Pennsylvania, for example, found that the drilling phase accounted for 98% of the gas industry workforce (MSETC 2009, MSETC 2010). Depending on the overall pace and scale of drilling and the production performance of wells, the "drilling phase" will likely last 10-15 years. Because job growth is so concentrated in this relatively short drilling phase, and because drilling activity can quickly increase and decline in a given area, natural gas development can conform to a pattern of boom and bust observed in other types of natural resource development activities (Jacquet 2009, Christopherson 2010).

As compared to local tourism employment, job growth from drilling in the STC region will likely benefit mostly non-local workers. During the drilling phase, many of the 1150 full time equivalent (FTE) local positions created per 100 wells will go to drilling crews coming from outside the region (Jacquet 2006, 2011). In Pennsylvania, for example, the Marcellus shale industry has relied heavily on "out-of-town" workforces to meet their needs (Jacquet 2011). While "production phase" jobs tend to be longer term, locally hired, and well paid, they represent only a small portion of the overall natural gas workforce.

Not surprisingly, across the United States, job growth from gas extraction is concentrated in states where energy companies are headquartered, as engineers, lawyers, corporate managers, and consultants tend to cluster in those cities and states (see figure 2).

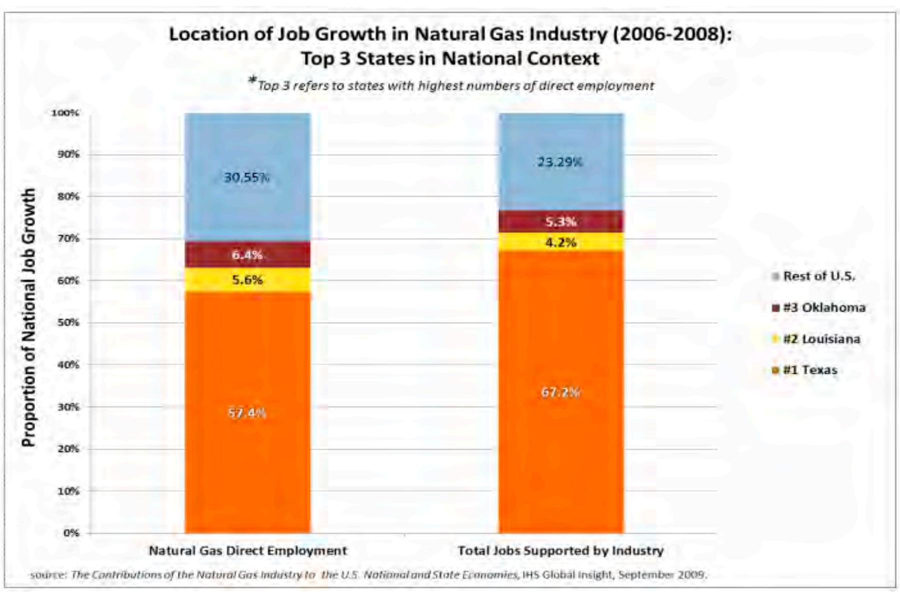
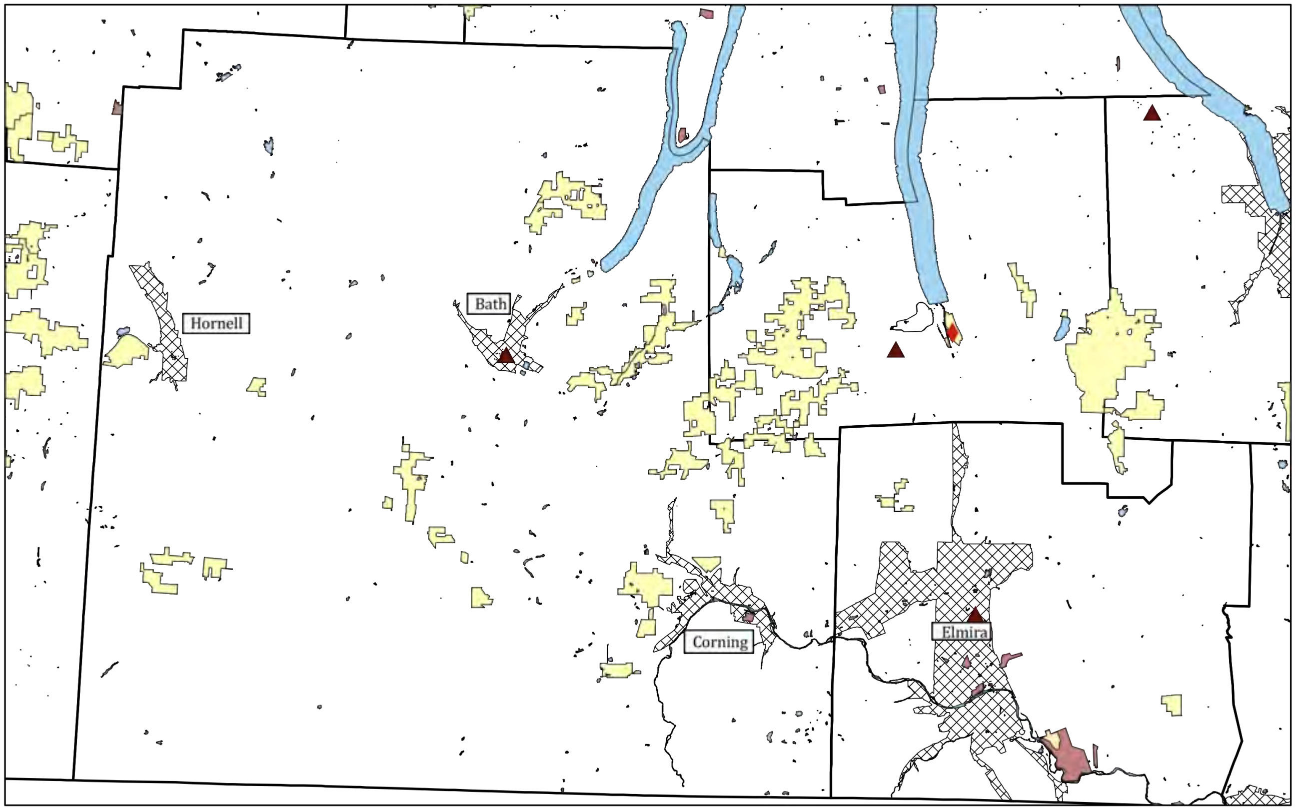
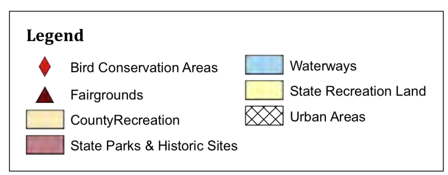


Figure 2: Location of Job Growth in Natural Gas Industry 2006-2008
Source: IHS Global Insight (2009)

Appendix C:

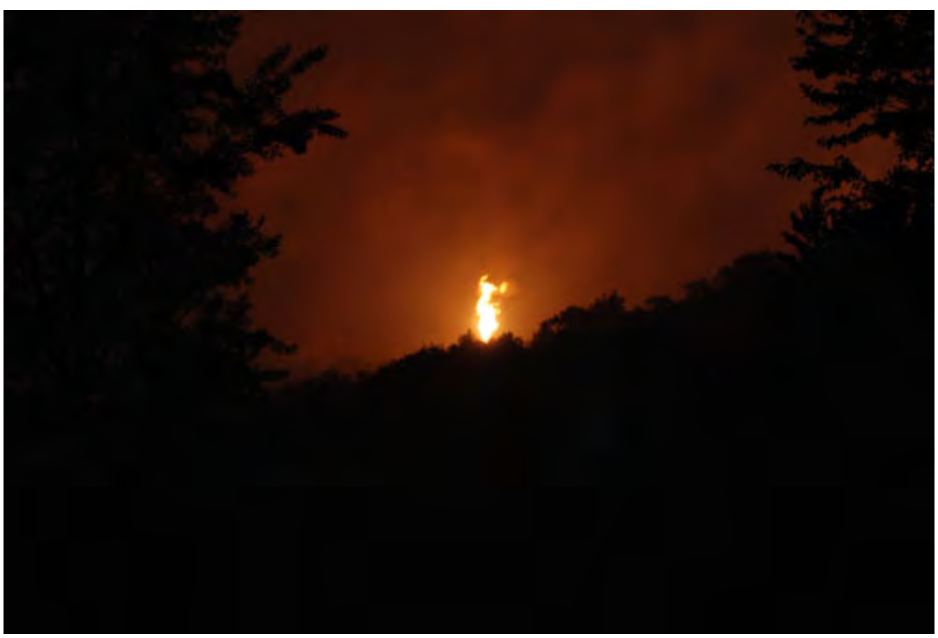


Parks, Waterways, Outdoor Recreation Land and Other Amenities in the STC



Appendix D: Visual Impact Images[22]

Water impoundment site



Nighttime "open flaring" of a gas well

[22] All images are from Bradford County, Pennsylvania and are courtesy of George Frantz, Sarita Rose Upadhyay and Min Bu (2010).

Water Withdrawal Site

Gas Compressor Station

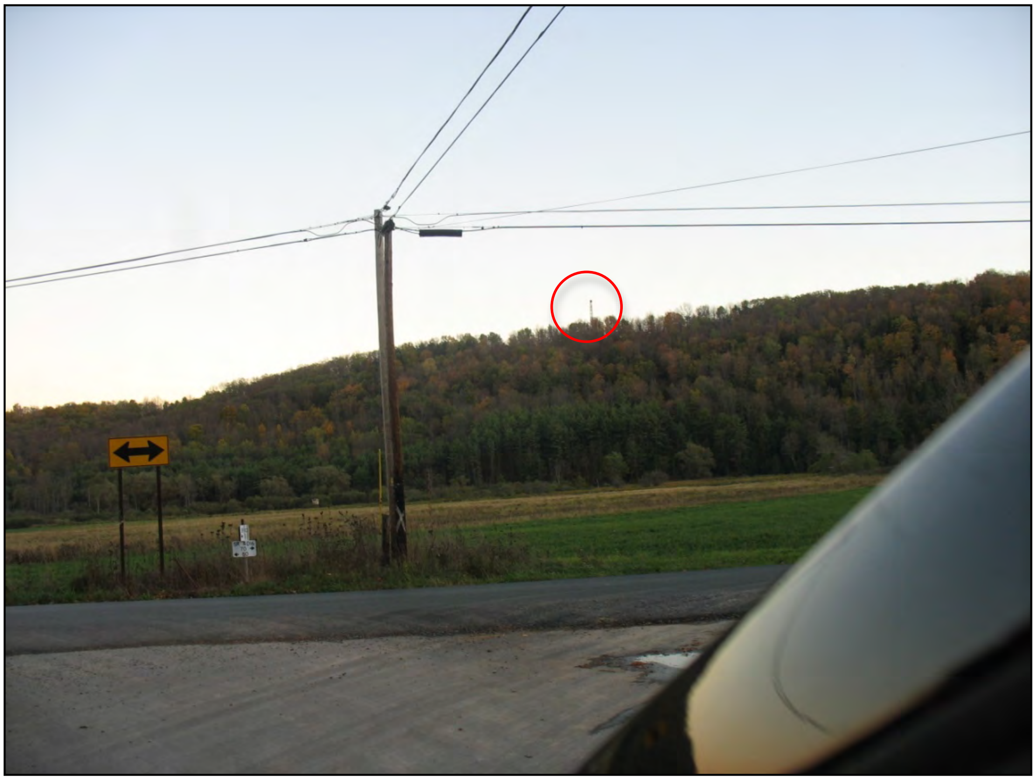
Well pads and brine pits

Well pad from scenic overview in PA

Natural Gas Pipeline

Pipeline Construction (photo Carol Chock)

Well Pad Preparation (photo Carol Chock)



Distance 1.0 miles

Distance: 1,500 feet

Distance: 1,000 feet

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