Chapter VII

ADDRESSING ENVIRONMENTAL ASPECTS OF TS&D INFRASTRUCTURE

This chapter focuses on the impacts of transmission, storage, and distribution (TS&D) infrastructure on the environment, complementing the discussion in Chapter II (Increasing the Resilience, Reliability, Safety, and Asset Security of TS&D Infrastructure) of the effect of the environment on TS&D infrastructure. After a brief introduction discussing the range of environmental effects of TS&D infrastructure, the chapter briefly discusses land-use and ecosystem issues that commonly arise in connection with constructing and maintaining TS&D infrastructure. Actions to improve the siting and permitting processes that address these issues are discussed in greater detail in Chapter IX (Siting and Permitting of TS&D Infrastructure). The next two sections discuss air pollution from TS&D infrastructure, first focusing on greenhouse gas (GHG) emissions and then discussing conventional air pollutants. The following section deals with other environmental issues associated with TS&D infrastructure, including liquid fuel spills, water use, dredging, and the need for better data and analyses on environmental impacts of TS&D infrastructure. The final section of the chapter discusses how carbon dioxide (CO_2) pipelines can help enable the reduction of GHG emissions. The sections on GHG emissions, conventional air pollution, other environmental issues, and CO_2 pipelines each conclude with recommendations for further action.

FINDINGS IN BRIEF:
Addressing Environmental Aspects of TS&D Infrastructure

Transmission, storage, and distribution (TS&D) infrastructure can serve as a key enabler for—or barrier to—better environmental outcomes. Certain types of TS&D infrastructure enable improvements in system-wide environmental performance at lower cost, such as electric transmission and distribution infrastructure to access renewable energy resources and interstate natural gas pipelines, which can facilitate carbon dioxide (CO_2) emission reductions from the electric power sector.

TS&D infrastructure contributes a relatively small share of total air and water pollution from the energy sector. TS&D infrastructure covered by this installment of the Quadrennial Energy Review contributes to nearly 10 percent of U.S. greenhouse gas emissions. Many of the environmental issues related to TS&D infrastructure are subject to rules established by existing statute and regulation.

Energy infrastructure can have direct, indirect, and cumulative land-use and ecological impacts. The nature and magnitude of those impacts depend on a number of factors, including whether construction of a facility will affect endangered species or sensitive ecological areas, or cause land-use impacts such as top-soil erosion or habitat fragmentation.

Energy transport, refining, and processing infrastructure contribute to emissions of criteria air pollutants that pose risks to public health and the environment. Ports and rail yards with high densities of vehicles and congestion often have high concentrations of pollutants and increase risks to nearby urban communities. Reducing emissions of particulate matter from aircraft, locomotives, and marine vessels would have public health benefits. Low-income and minority households are two to three times more likely to be affected by freight-based diesel particulate pollution than the overall U.S. population.

Transportation of crude oil by pipeline, rail, and waterborne vessels has safety and environmental impacts. The Federal Government has a number of efforts underway to mitigate these impacts, including a rulemaking on rail transport of crude oil.

The United States currently has a network of more than 4,500 miles of carbon dioxide (CO_2) transportation pipelines that can be a critical component of a low-carbon future. The pipelines mostly transport naturally occurring CO_2, but new projects are increasingly linking captured CO_2 from electric power plants and other industrial sources to a productive use in oil fields (through CO_2 enhanced oil recovery) and potentially safe storage in deep saline formations.

The Range of Environmental Effects Associated with TS&D Infrastructure

Energy TS&D infrastructure affects the environment in a variety of ways. On the positive side, TS&D infrastructure can often enable better environmental performance of the overall energy system by providing access to cleaner energy supplies.

There is also the potential for harmful environmental effects, though, which need to be addressed. On a nationwide basis, siting, constructing, and maintaining TS&D infrastructure may have negative land-use and ecosystem impacts—especially habitat fragmentation—that are significant. While TS&D infrastructures are relatively minor sources of total air and water pollution compared to energy production and end use (which are not being addressed in this installment of the Quadrennial Energy Review [QER]), air and water pollution from TS&D infrastructure can be significant on a regional and local basis. For example, some vehicle engines used in energy transport produce particulate matter, posing local and regional public health concerns. Existing statutes and regulations address these concerns, in part. Some TS&D infrastructures also contribute to GHG emissions. Addressing leakage and venting of methane—a powerful GHG—requires a range of additional actions, including prudent regulation; research, development, and demonstration; and public-private partnerships to reduce methane emissions, promote efficiency, and improve safety. Many of these actions are underway as part of the President's "Climate Action Plan,"[1] including the Strategy to Reduce Methane Emissions.[2]

Land-Use and Ecosystem Impacts of Constructing and Maintaining TS&D Infrastructure

Given their size and complexity, many major TS&D infrastructure projects have unavoidable direct and indirect impacts on the Nation's landscapes and natural and cultural resources. The magnitude of these potential environmental impacts of TS&D infrastructure depend on a number of factors, including whether the proposed location of the facility will affect endangered species, involve sensitive ecological areas, impact cultural or historic resources, give rise to visual or aesthetic concerns, or open new areas to development. As energy infrastructures continue to expand, there is an opportunity to address these issues by improving how TS&D infrastructure is sited, built, and maintained, particularly infrastructure that enables better environmental performance.

Some of the most common land-use and ecosystem impacts of TS&D infrastructure described in this section are analyzed as part of the environmental and historic preservation review processes for energy infrastructure siting. They include those effects most often considered in the context of the National Environmental Policy Act of 1969 (NEPA) and its framework for assessing environmental impacts during the planning process before a Federal agency decides whether to fund, conduct, permit, or otherwise approve proposed TS&D infrastructure.[a] In its analysis, the permitting agency must consider mitigation requirements that may be imposed as conditions for unavoidable environmental harms.[3]

[a] Under NEPA and the Council on Environmental Quality Regulations Implementing the Procedural Provisions of the National Environmental Policy Act, any TS&D infrastructure proposal requiring a Federal agency to take an action (such as funding, permitting, or otherwise approving a pipeline or electricity transmission project) requires preparation of an environmental review that considers the environmental impact of the proposed action and any reasonable alternatives prior to the agency proposed action (42 U.S.C. §§ 4321–4347 and 40 C.F.R. §§ 1500–1508).

Cultural Resources

Cultural resources generally include important archaeological, historic, and architectural sites; structures; or places with important public and scientific uses. Section 106 of the National Historic Preservation Act requires Federal agencies to consider the effects on historic properties of projects, activities, or programs (referred to in the act as undertakings) that they carry out, assist, permit, license, or approve.[4] Resources considered as part of compliance with Section 106 are those that meet the criteria for listing on the National Register of Historic Places, which can include properties of traditional and religious importance to an Indian tribe.[5] The presence of cultural resources can present challenges for the siting of new energy transmission infrastructure.[b] Impacts are typically related to the project footprint and altered access to the area. Surveys must be conducted to identify potential archaeological and historic sites.[c] The identification of cultural resources within a proposed right of way may require moving the proposed route to avoid such resources or mitigation measures to address potential impacts to such resources.[6]

Special Status Wildlife, Fish, and Plant Species

Special status species include threatened or endangered plants or animals, the presence of which may pose a barrier to siting.[7] They also may include non-listed wildlife, fish, and plants that require special management consideration.[8, 9] The potential for impacts on threatened and endangered species of construction and operation of energy transport systems within corridors are related to the amount of land disturbance, the duration and timing of construction periods, and the habitats crossed by the corridors. In order to comply with NEPA and the Endangered Species Act, agencies may conduct inventories to ensure that they have sufficient information available to adequately assess the effects of proposed actions on special status species.

Habitat Fragmentation/Land Cover

Ecological habitats (including rangeland, forests, woodlands, wetlands, lakes, reservoirs, riparian areas, and fishable streams) may become fragmented when crossed by transmission lines or pipelines that divide the continuous natural habitat into smaller patches. Even though physical barriers are not normally erected along the majority of transmission corridors, fragmentation occurs when the habitat or land cover type in the transmission corridor is altered from its surroundings. By changing the habitat, land cover change can alter the species makeup of the local ecosystem—favoring some species and disadvantaging others.[10]

Environmental Justice

Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.[11] The responsibility of Federal agencies to consider environmental justice is set out in Executive Order No. 12898[12, 13] and typically implemented in conjunction with NEPA review, as described in the Council on Environmental Quality guidance for environmental justice.[14]

Seismic Hazards

Significant risk of ground shaking can pose a threat to human health and safety in areas where energy transmission infrastructure—particularly natural gas pipelines—exists. This risk can pose a barrier to siting new transmission. Seismic hazards include earthquakes; ground faulting; and secondary effects, such as

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[b] New transmission facility proposals initiate agency collaboration to determine an Area of Potential Effect (APE). The APE may be hundreds of feet wide or many miles wide depending on the resources, potential impacts, and decisions under consideration. Once the APE is established, the agencies review existing data and collect new data, as appropriate, within the APE.

[c] A low number of National Register of Historic Places sites for a proposed corridor may seem to indicate few siting challenges, but if only a small percent of the corridor has been surveyed, this low number of sites may not be indicative of the actual number of cultural resources present.

liquefaction and related slope failures.[15] Measurement of seismic risk depends on the chosen intensity and probability thresholds for a damaging event.[d]

Visual Resources, Specially Designated Areas, and Recreation

Negative impacts to the visual surroundings of specially designated Federal areas can create barriers to the siting of energy transmission facilities nearby (even if the proposed right of way does not intersect the designated area).[16] These specially designated areas can include, but are not limited to, national parks, national monuments, national recreation areas, national conservation areas, national park service areas, national natural landmarks, national historic landmarks, national scenic trails, national historic trails, national scenic highways, national scenic areas, national scenic research areas, national wild and scenic rivers, and national wildlife refuges. Numerous state-designated areas that are sensitive to visual disturbance also exist.

Aviation

NEPA analyses consider overhead electrical transmission wires, as they pose a threat to the low-level flight activity.[17] Special-use airspace is established in Federal regulations[18, 19] and can also involve low-altitude flight. When less than 200 feet above ground level, electric transmission lines often do not require marking or lighting, thus posing a particular hazard to aviation in areas where low-altitude flight is expected.

Cumulative Impacts

Under NEPA, cumulative impact is defined as the impacts on the environment that result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions.[20] Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.[21] Guidance issued by the Council on Environmental Quality specifies how to carry out cumulative effects analysis for identified impacts.[22] Cumulative effects should be considered for all environmental impacts in an assessment.

Additional Considerations

Additional considerations under NEPA that can create challenges for siting of TS&D infrastructure or require mitigation, minimization, or compensation for impact include Native American concerns; acoustics; air quality; land use; paleontological resources; proximity to hazardous materials; proximity to Department of Defense operations and facilities; socioeconomics; soils and geologic resources; waste management areas; and water resources, including groundwater, waterbody crossings, and wetlands. Water quality can also be affected by excavations that lead to erosion.[23] Additionally, herbicides applied to maintain clearings can have adverse effects on aquatic life.[24]

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[d] An event with a peak acceleration of 0.18 g or higher is considered potentially damaging. See: Wald, D.J. et al. "Shake Map® Manual — Technical Manual, Users Guide, and Software Guide." U.S. Geological Survey. June 19, 2006. The area of TS&D infrastructure where there is a moderate or higher potential for damage from seismic activity is defined as a 2 percent risk of a ground-shaking event exceeding 0.18 g peak acceleration in the next 50 years). See: Petersen, M.D. et al. "Documentation for the 2008 Update of the United States National Seismic Hazard Maps: Open-File Report 2008–1128." U.S. Geological Survey. 2008. pubs.usgs.gov/of/2008/1128/. Accessed February 25, 2015. See also: Federal Energy Regulatory Commission. "Final Environmental Impact Statement on Ruby Pipeline Project (Docket No. CP09-54-000): Chapter 4." p. 4–16. January 10, 2010. www.ferc.gov/industries/gas/enviro/eis/2010/01-08-10.asp. Accessed March 9, 2015.

Mitigation of Environmental Impacts

Decades of experience with siting energy infrastructure have resulted in the development of various measures and methods for offsetting impacts to affected communities and ecosystems, including avoidance, minimization, and compensation.[e] Mitigation is an important mechanism for agencies to use to avoid, minimize, rectify, reduce, or compensate the adverse environmental impacts associated with their actions.[25, 26] Federal agencies typically rely upon mitigation to reduce environmental impacts through modification of proposed actions and consideration and development of mitigation alternatives during the NEPA process.[f]

Resource-specific mitigation measures can be applied to avoid or minimize impacts from a pipeline or an electric transmission project. In order to identify and implement appropriate mitigation measures, first the potential impacts of a project on a specific resource must be assessed. Then, project-specific and site-specific factors must be evaluated to determine whether the impact can be avoided or mitigated, what action can be taken, how effective the mitigation measure will be, and the cost effectiveness of the measure.[27]

Mitigation is of particular importance to Federal agencies that manage hundreds of millions of acres of public lands, which comes with a responsibility to sustain a vast array of resources, values, and functions. For example, public lands contain important wildlife habitat and vegetative communities—in addition to recreational opportunities and ecosystem services, cultural resources, and special status species. These lands are managed for the use and enjoyment of present and future generations. The location, construction, and maintenance of energy infrastructure should avoid, minimize, and, in some cases, compensate for impacts to these public resources, values, and functions. Mitigation is also of critical importance to those agencies responsible for protecting the Nation's waters.[28] Applying this mitigation hierarchy early in the planning for TS&D infrastructure will help provide better outcomes for the impacted resources, values, and functions.[29]

The issues described in this section are not the only factors considered during the environmental and historic preservation review processes for energy infrastructure development. A more detailed description of the siting, permitting, and review process for infrastructure projects and approaches for avoiding, minimizing, or compensating for potential impacts of those projects is found in Chapter IX (Siting and Permitting of TS&D Infrastructure).

Emissions from TS&D Infrastructure

Air pollution can be associated with all stages of construction and operations of TS&D infrastructure; however, the severity of the pollution—both in type of pollutant and overall environmental load—differs significantly across the scope of infrastructure covered in the QER. Certain components within the TS&D infrastructure are sources of both conventional air pollutants and GHG emissions. The following discussion is not intended to be a comprehensive catalog of air pollution impacts from energy TS&D infrastructure, but rather a discussion of areas where actions could lead to emissions reductions. For example, analyses for the QER on GHG emissions focused on natural gas TS&D systems because there are opportunities for relatively low-cost emissions reductions, and this infrastructure is expanding significantly.

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[e] This mitigation hierarchy of "avoid, minimize, and compensate" has been developed through implementation of both NEPA (40 C.F.R. § 1508.20) and the Clean Water Act (33 U.S.C. §§ 1251–1387). See: "Memorandum for Heads of Federal Departments and Agencies." February 18, 2010. ceq.doe.gov/nepa/regs/Mitigation_and_Monitoring_Draft_NEPA_Guidance_FINAL_02182010.pdf. The final step in the hierarchy seeks to repair, rehabilitate, or restore the affected environment or resource and ultimately to compensate for, or offset, any impacts that remain. This is typically described as "compensatory mitigation."

[f] The Council on Environmental Quality's NEPA regulations require agencies to identify in their Record of Decision any mitigation measures that are necessary to minimize environmental harm from the alternative selected (40 C.F.R. § 1505.2(c)). The NEPA analysis can also consider mitigation as an integral element in the design of the proposed action. The regulations further state that a monitoring and enforcement program shall be adopted where applicable for any mitigation (40 C.F.R. § 1505.3).

TS&D infrastructure covered by this installment of the QER[g] contributes to nearly 10 percent of U.S. GHG emissions.[30] For conventional air pollutants, the TS&D systems considered in the QER are also relatively small contributors to national pollutant loads, but may have significant local and regional impacts on air quality. The facilities of the greatest concern include petroleum refineries; ethanol plants; natural gas and natural gas liquids processing plants; and natural gas compressor stations, which are located along transmission and gathering pipelines. The transportation of energy commodities also leads to air pollution, particularly in transportation hubs like ports and rail yards.

GHG Emissions from Natural Gas Systems

The two primary GHGs emitted from natural gas systems[h] are CO_2 and methane. Emissions of methane throughout the natural gas system have been declining,[31] but are expected to increase if additional action is not taken.[32] As discussed in this section, analysis for the QER identified significant opportunities for reducing these emissions in the coming decades. Methane—the primary component of natural gas—is a potent GHG, with an atmospheric lifetime of only 10 to 12 years. When integrated over 100 years, methane is more than 25 times more effective than CO_2 at trapping heat in the atmosphere.[33, i] The Environmental Protection Agency's (EPA's) national Greenhouse Gas Inventory (GHGI) estimates that, in 2012, methane contributed to roughly 10 percent of gross GHG emissions (on a CO_2-equivalent basis) from U.S. anthropogenic sources, nearly one-quarter of which were emitted by natural gas systems.[34]

While 80 percent of GHG emissions from natural gas occur at the end-use stage (from combustion by consumers),[35, 36, 37] significant methane and CO_2 emissions occur throughout natural gas infrastructures (not including end use) in almost equal amounts on a CO_2-equivalent basis. As shown in Figure 7-1, 155 million metric tons of CO_2 equivalent of methane were emitted in 2012 through routine venting,[j] as well as inadvertent leakage.[k] In the same year, a roughly equal amount of CO_2 (approximately 164 million metric tons of CO_2 equivalent) was emitted at production, processing, transmission, and storage facilities, primarily from the combustion of natural gas that is used as a fuel for compression, but also when non-hydrocarbon gases are removed during the processing stage, as well as from flaring. Figure 7-1 shows these emissions in detail from natural gas infrastructures; GHG emissions that are in scope for the QER include only those from processing, transmission and storage, and distribution segments. Methane emissions from the petroleum sector are not covered in this installment of the QER because they are almost entirely from production-stage operations.

[g] Sources of GHG emissions that are in scope for the QER include petroleum refineries; biofuel refineries; liquid fuel pipelines; natural gas processing plants; natural gas pipelines; natural gas compressor stations; and the transport of energy by pipeline, truck, rail, and marine vessel.

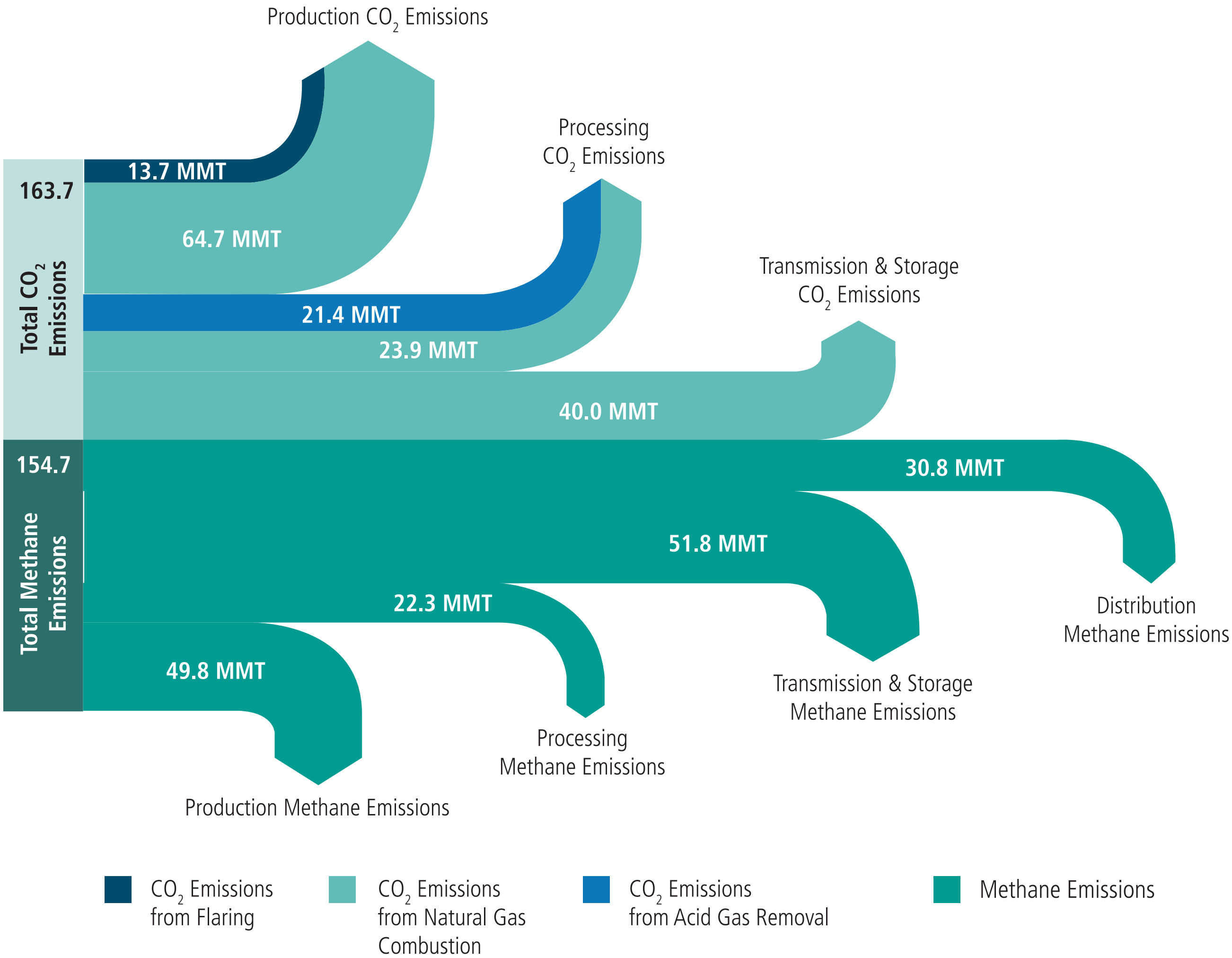
[h] Throughout this chapter, the term "natural gas system" refers broadly to natural gas production, processing, transmission, storage, distribution, and end-use consumption; the term "natural gas infrastructure" refers to all aspects of the natural gas system except for end-use consumption.

[i] Considering these impacts over such a period leads to what is called the Global Warming Potential (GWP) of a GHG. The 100-year GWP for methane from the "Intergovernmental Panel on Climate Change Fourth Assessment Report" is 25. A 20-year GWP can be used to measure the shorter-term impacts of methane emissions. GWPs compare GHGs by equating the warming potential of gases other than CO_2 to the equivalent amount of CO_2 emissions needed to achieve the same warming.

[j] Examples of routine "venting" include blowdowns (when gas is evacuated from a section of pipeline for the purpose of conducting tests, repairs, or maintenance). Natural gas is vented by a number of sources, including pneumatic devices, which operate natural gas-driven controllers and natural gas-driven pumps, both of which are used extensively throughout the oil and natural gas industry—emitting natural gas as a function of routine operation.

[k] Natural gas "leakage," also commonly referred to as "fugitive emissions," includes those emissions that occur inadvertently as a result of malfunctioning equipment (e.g., damaged seals, cracked pipelines).

Figure 7-1. 2012 GHG Emissions from Natural Gas Production, Processing, Transmission, Storage, and Distribution[38]



Both CO_2 (top of diagram) and methane (bottom of diagram) are emitted in roughly equal amounts from various sources and processes upstream of end-use consumers. Eighty percent of the GHG emissions from the natural gas system result from consumer end use of natural gas. However, these emissions are omitted from this figure to enable a more detailed picture of emissions from natural gas infrastructure.

Data from the Energy Information Administration[39] indicate that fuel use—and therefore CO_2 emissions—by natural gas processing and transmission[l] increased by 35 percent between 2005 and 2013. As natural gas infrastructure continues to expand, the Energy Information Administration projects that natural gas fuel use by TS&D systems will continue to increase in the coming decades,[40] leading to greater CO_2 and potentially other combustion-related air emissions from these facilities. Methane emissions from natural gas processing, transmission, and storage have increased by 13 percent from 2005 to 2012,[41] which is slower than increases in fuel use because new infrastructure is less prone to leakage.

Opportunities to Reduce GHG Emissions from Gas Systems

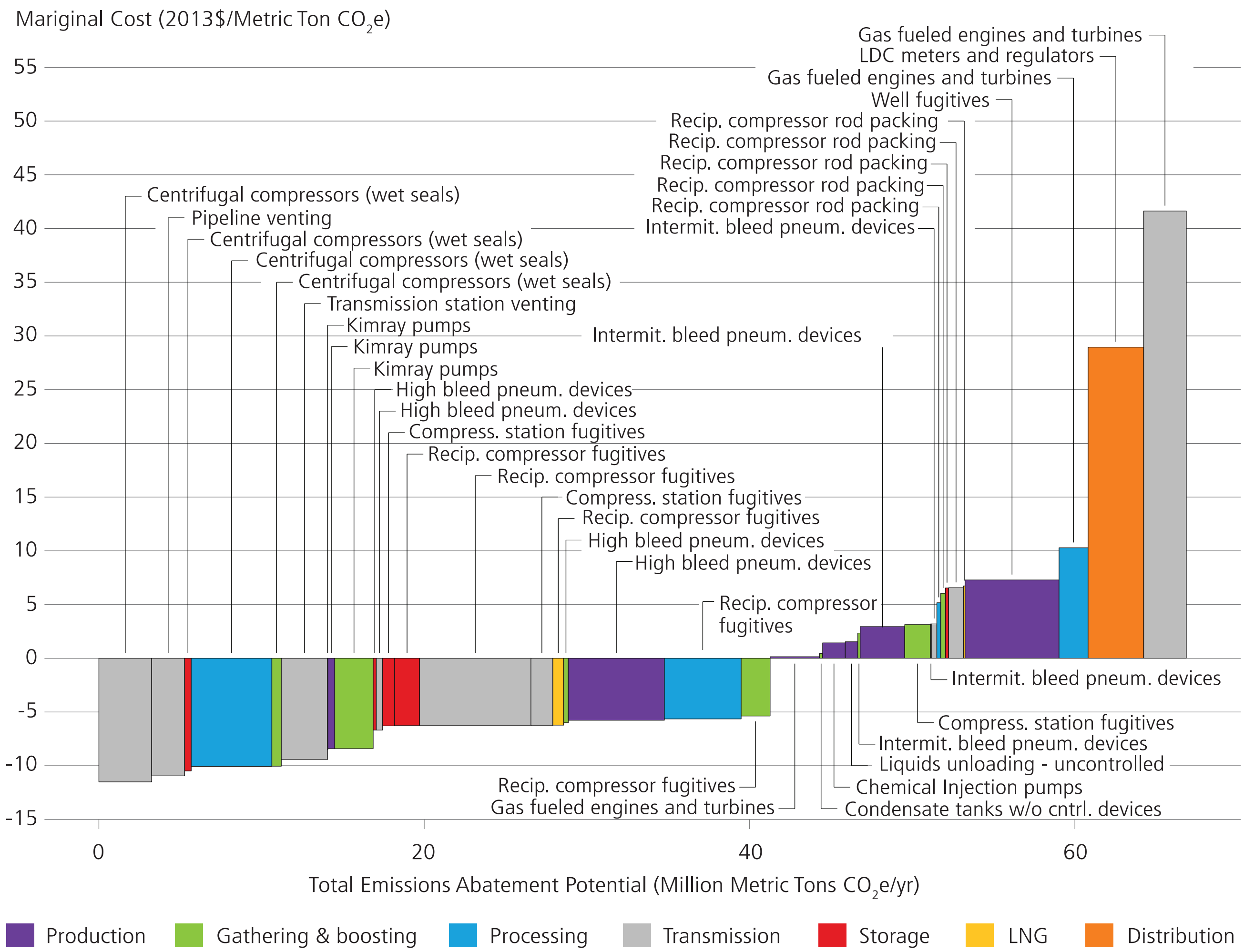
CO_2 emissions from processing, transmission, and storage facilities stem primarily from natural gas fuel consumed by compressor units during natural gas transport.[42] Most methane emissions from the processing, transmission, and storage of natural gas result from leakage and venting by compressor stations.[43] Methane emissions from natural gas distribution result mainly from leaks in meters, regulators, and distribution

[l] This includes U.S. natural gas "plant fuel consumption" and "pipeline and distribution use."

pipelines.[44] Examples of cost-effective options for reducing methane emissions from the natural gas system include (1) changing operations and maintenance practices, (2) increasing leak detection and repair, and (3) upgrading equipment (see Figure 7-2).[45, 46, 47]

There are economic, environmental and safety benefits associated with modernizing the natural gas TS&D system. Policies are needed to ensure that private companies can recover costs of such investments to improve safety and reduce emissions.[48] In addition, while a number of actions may not have net benefits when only accounting for the monetary value of conserved gas, some of these can be cost effective if the climate change and safety benefits are taken into account. To achieve these societal benefits, there is an important role for government—often in partnership with industry—to advance new technologies and encourage investments. A combination of ongoing Administration actions and QER recommendations meet this need for Federal action.

Figure 7-2. Total Emissions Abatement Potential (million metric tons CO_2-equivalent per year)[49, m]



Assuming full revenue recovered from the sale of captured natural gas, an estimated 40 million metric tons CO_2-equivalent of methane emissions abatement could be achieved at a negative marginal cost; under this scenario, at a marginal cost below the Social Cost of Carbon, all segments of natural gas infrastructure have potential opportunities for cost-effective methane abatement. Acronyms: intermittent (intermit.); pneumatic (pneum.); local distribution company (LDC); liquefied natural gas (LNG); reciprocating (recip.).

[m] The social cost of carbon is a metric that monetizes the societal benefits and costs of emitting an additional ton of carbon. The social cost of carbon at a 3 percent discount rate in year 2015 and in 2015 dollars is $43 per ton CO_2. Source: Interagency Working Group on Social Cost of Carbon, 2013. Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis – Under Executive Order 12866. May. U.S. Government.

GHGI and Methane Measurement

The White House's Strategy to Reduce Methane Emissions calls for the U.S. government to assess current emissions data and address identified data gaps.[50] The U.S. natural gas profile has dramatically changed in the last 10 years. Ongoing efforts to update the data used to calculate GHGI emissions estimates are being privately and federally funded and carried out by several researchers, including large multi-stakeholder efforts.[51] Under the 2014 "Climate Action Plan" Strategy to Reduce Methane Emissions, EPA will continue to update and enhance the data published in its annual GHGI as new scientific evidence and data sources emerge.

Improving the efficiency of equipment operating along the natural gas supply chain, especially compressors, would reduce GHG emissions and other combustion-related emissions of criteria air pollutants and ozone precursors. Additional opportunities for technical efficiency improvements include pipeline operations, sizing, layout, cleaning, and interior coatings, as well as opportunities for waste heat recovery. While the greatest opportunities for efficiency improvement lie in new systems, options do exist for improving the efficiency of existing systems as well.[52]

Reducing GHG Emissions from Refineries and Energy Transport

Petroleum refineries are among the most energy-intensive manufacturing facilities in the United States,[53] which results in substantial CO_2 emissions—both onsite and offsite of these facilities. Onsite emissions of CO_2 from petroleum refineries accounted for more than 30 percent of CO_2 emissions from U.S. manufacturing[54] and 4 percent of total CO_2 emissions from fossil energy combustion.[n] The combination of all other TS&D infrastructure—including biofuel refineries,[55] liquid fuel pipelines, and vehicles that transport energy[56] directly or indirectly (i.e., through the use of electricity)—contribute to CO_2 emissions in relatively smaller amounts. The primary means for reducing CO_2 emissions from refineries is through efficiency improvements. Analysis has also consistently found that there remain opportunities for additional efficiency improvement.[57, 58]

Administration Activities and Plans to Reduce Greenhouse Gas Emissions from Transmission, Storage, and Distribution Infrastructures

Building on the 2014 interagency Strategy to Reduce Methane Emissions, in January 2015, the President announced a national goal to reduce methane emissions from the oil and gas sector 40–45 percent from 2012 levels by 2025, as well as a set of actions to put the United States on a path to achieve this ambitious goal. These goals include the following:

Common-sense standards for methane emissions from new and modified sources. The Environmental Protection Agency (EPA) will initiate a rulemaking effort to set standards for methane and volatile organic compound emissions from new and modified oil and gas production sources and natural gas processing and transmission sources. EPA will issue a proposed rule in the summer of 2015, and a final rule will follow in 2016.

New guidelines to reduce volatile organic compounds. EPA will develop new guidelines to assist states in reducing ozone-forming pollutants from existing oil and gas systems in areas that do not meet the ozone health standard and in states in the Ozone Transport Region—an added benefit will be methane emissions reductions.

Enhancing leak detection and emissions reporting. EPA will continue to promote transparency and accountability for existing sources by strengthening its Greenhouse Gas Reporting Program to require reporting in all segments of the industry. In addition to finalizing updates to the program, by the end of 2015, EPA will explore potential regulatory opportunities for applying remote-sensing technologies and other innovations in measurement and monitoring technology to further improve the identification and quantification of emissions and improve the overall accuracy and transparency of reported data in a cost-effective manner.

n This compares direct CO_2 emissions from refineries in 2012 (210 million metric tons) with the Energy Information Administration's estimate of total CO_2 emissions from fossil fuels in 2012 (5,255 million metric tons). More information can be found on the Energy Information Administration's Environment website at www.eia.gov/environment/.

Administration Activities and Plans to Reduce Greenhouse Gas Emissions from Transmission, Storage, and Distribution Infrastructures (continued)

Leading by example on public lands. The Department of the Interior's Bureau of Land Management will update decades-old standards to reduce wasteful venting, flaring, and leaks of natural gas—primarily methane—from oil and gas wells. These standards, to be proposed in spring of 2015, will address both new and existing oil and gas wells on public lands.

Reducing methane emissions while improving pipeline safety. The Department of Transportation's Pipeline and Hazardous Materials Safety Administration will propose natural gas pipeline safety standards in 2015. While the standards will focus on safety, they are expected to lower methane emissions as well.

Modernizing natural gas transmission and distribution infrastructure. Following on its methane roundtables, the Department of Energy will continue to take steps to encourage reduced greenhouse gas emissions, including the following:

- Issuing energy efficiency standards for natural gas and air compressors
- Advancing research and development to bring down the cost of detecting leaks
- Implementing an Advanced Natural Gas System Manufacturing Research and Development Initiative
- Partnering with the National Association of Regulatory Utility Commissioners to help modernize natural gas distribution infrastructure
- Providing loan guarantees for new methane reduction technologies
- Developing a clearinghouse of information on effective technologies, policies, and strategies

Industry actions to reduce methane emissions. Several voluntary industry efforts to address these sources are underway, including EPA's plans to expand on the successful Natural Gas STAR Program by launching a new partnership in collaboration with key stakeholders later in 2015. EPA will work with the Department of Energy, the Department of Transportation, and leading companies—individually and through broader initiatives such as the One Future Initiative and the Downstream Initiative—to develop and verify robust commitments to reduce methane emissions.

Other Federal actions. The Federal Energy Regulatory Commission has issued a policy statement that will allow interstate natural gas pipelines to recover certain investments made to modernize pipeline system infrastructure in a manner that enhances system reliability, safety, and regulatory compliance. Also, in December 2014, the Council on Environmental Quality released revised draft guidance for public comment that describes how Federal departments and agencies should consider greenhouse gas emissions and climate change in their National Environmental Policy Act reviews.

QER Recommendations

REDUCING GHG EMISSIONS

Reducing GHG emissions from TS&D infrastructure includes a number of win-win opportunities from climate change and public safety perspectives. Among these are opportunities for modernizing natural gas distribution infrastructure, as discussed in Chapter II (Increasing the Resilience, Reliability, Safety, and Asset Security of TS&D Infrastructure). In addition to the measures already put in place, to further reduce methane emissions from TS&D infrastructure, we recommend the following:

Improve quantification of emissions from natural gas TS&D infrastructure. An effective strategy to significantly improve methane emission estimates in the GHGI requires additional Federal funding for new measurements to update emission factors and activity data. That is why the President's Fiscal Year 2016 Budget Request proposes $10 million to launch a Research and Analysis Program at the Department of Energy (DOE) to enhance the quantification of emissions from natural gas infrastructure to include in the national GHGI in coordination with EPA.

QER Recommendations (continued)

Specific research areas for consideration that are downstream of natural gas production include emission estimates from pneumatic devices, leaks, and the natural gas gathering and boosting sectors. Congress should approve this funding. DOE and EPA should undertake a coordinated approach, building on stakeholder input, to ensure that new research and analysis is targeted toward knowledge gaps that are not already addressed by existing databases or other ongoing measurement studies.

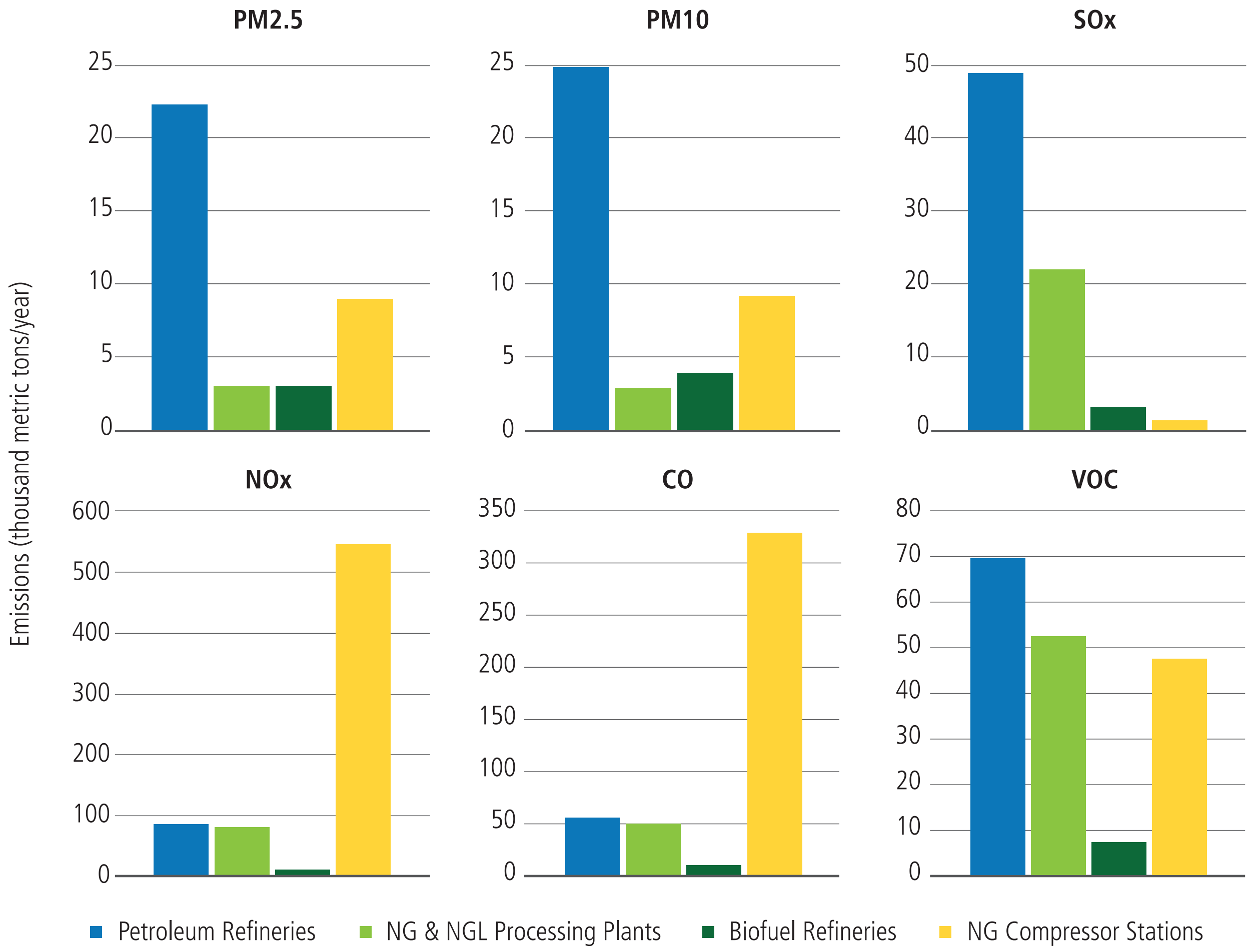
Expand natural gas transmission and distribution research and development programs. DOE should continue to develop and demonstrate cost-effective technologies to detect and reduce losses from natural gas transmission and distribution systems. The President's Fiscal Year 2016 Budget Request proposes $15 million in funding for DOE's midstream natural gas infrastructure subprogram to focus on reducing methane leaks and enhancing operational efficiencies of pipelines, storage facilities, and compressor stations, as well as on communicating results to stakeholders to mitigate methane emissions. Congress should approve this funding. DOE should leverage its research and development efforts in this area to facilitate broader air quality benefits—reducing methane losses and improving midstream infrastructure efficiency to reduce nitrogen oxides and other ozone precursors, which will help states to meet national air quality standards.

Invest in research and development to lower the cost of continuous emissions monitoring equipment. Continuous emissions monitoring can be a valuable component of leak detection and repair programs, which serve to improve safety and the operational improvement of natural gas systems. The Advanced Research Projects Agency-Energy's MONITOR program is providing $30 million for breakthrough technologies to measure methane emissions from natural gas systems. DOE should provide the additional funding needed to ensure that the most successful MONITOR projects are field tested and deployed.

Conventional Air Pollution from TS&D Infrastructure

Beyond GHGs, TS&D infrastructure also contributes to conventional air pollutants such as ozone and particulate matter. Overall, air quality in the United States has been improving for decades, and additional improvements are expected in the coming decades as a result of existing and new regulations.[59] However, given that higher temperatures are known to contribute to the formation of ground-level ozone, continued progress will be increasingly challenged by climate change.[60] Persistent challenges remain in certain areas of the country where concentrations of pollutants in the atmosphere exceed national limits set by EPA. In addition, hazardous air pollutants are regulated through different Clean Air Act requirements. Reducing emissions of these air pollutants has significant benefits for human health and the environment across broad regions of the country—particularly in populated, urban areas, where they are found in relatively high concentrations in the lower atmosphere.[61, 62] In 2012, EPA issued standards for volatile organic compounds (VOCs) from the oil and gas industry. These standards, when fully implemented, are expected to annually reduce 190,000 tons to 290,000 tons of emissions of VOCs, which pose risks to public health and the environment.[63]

Figure 7-3. Criteria Air Pollutant and Precursor Emissions from Stationary TS&D Facilities in 2011[64, o]



Refineries are the primary source of particulate matter, sulfur oxide, and VOC emissions, while natural gas compressor stations are the leading source of ozone precursor emissions (nitrogen oxides, carbon monoxide, and VOCs). Nitrogen oxides emissions shown here for refineries and natural gas processing and compression accounted for roughly 30 percent of total nitrogen oxides emissions from all industrial processes and industrial fuel combustion in 2011.

Stationary Sources of Conventional Air Pollutants from TS&D Infrastructure

In the context of emissions from TS&D infrastructure, the facilities of the greatest concern include petroleum refineries, ethanol plants, natural gas and natural gas liquids processing plants, and natural gas compressor stations, which are located along transmission and gathering pipelines. While these sources generally only account for a small portion of total U.S. emissions of each pollutant, they still are significant, particularly for surrounding areas. Nitrogen oxides emissions from these facilities (see Figure 7-3) added up to roughly 30 percent of nitrogen oxides emissions from industrial processes and industrial fuel combustion in 2011.[65] In 2013, more than 53 million people lived in U.S. counties with ground-level ozone levels above the current

[o] Air emissions from each source category were drawn from EPA's National Emissions Inventory as follows: "Petroleum Refineries" (NAICS 324110); "Natural Gas and Natural Gas Liquid Processing Plants" (NAICS 211112); "Biofuel Refineries" (NAICS 325193); and "NG Compressors" (includes emissions from all facilities listed under Pipeline Transport of Natural Gas (NAICS 486210); plus compressor station facilities listed under Natural Gas Distribution (NAICS 221210); plus county total nonpoint compressor engines (source classification codes 2310020600, 23100211(01,02,03), 23100212(01,02,03), 23100213(01,02,03), and 23100214(01,02,03)).

National Ambient Air Quality Standards,[66] and nitrogen oxides, carbon monoxide, and VOCs are all precursors to ozone. Natural gas compressors can be electrified to reduce emissions in regions with air quality problems;[67] to the degree this is done, however, interdependencies and potential vulnerabilities grow as gas transmission becomes more reliant on electricity (see discussion in Chapter II, Increasing the Resilience, Reliability, Safety, and Asset Security of TS&D Infrastructure).

While overall emissions have been declining for decades, trends are inconsistent across different sectors. For example, though still only 5 percent of the national total, nitrogen oxides emissions from the oil and natural gas sectors[p] have increased by roughly 94 percent between 2005 and 2011.[68] This is particularly striking, as EPA trends data[69] show that vehicle and power plant emissions have declined considerably.[q]

In addition to emissions of criteria air pollutants and their precursors, the petroleum and gas sectors contribute significantly to emissions of hazardous air pollutants. In particular, the petroleum sector is responsible for roughly 5 percent of industrial sources of hazardous air pollutants released annually (according to the Toxic Release Inventory).[70] A proposed rule (Proposed Petroleum Refinery Sector Risk and Technology Review and New Source Performance Standards) was published in the Federal Register[71] for public comment on June 30, 2014.[r] The rule proposes additional emission controls for storage tanks, flares, and coking units, in addition to fence-line air quality monitoring, to ensure standards are being met and that neighboring communities are not being exposed to unintended emissions. If the final rule is identical to the proposed rule and fully implemented (i.e., 3 years from the promulgation of the final rule), EPA estimates that these and other provisions will result in a reduction of 5,600 tons per year of toxic air pollutants and 52,000 tons per year of VOCs.[72]

Air Pollution from the Transport of Energy Commodities

The transportation of energy commodities also contributes to air pollution. Of particular concern is diesel exhaust—a complex mixture of pollutants and a likely carcinogen—which has health effects that include premature mortality, increased hospital admissions, and heart and lung diseases.[73] Oak Ridge National Laboratory estimates[74] that transport of energy products, as a portion of total freight transport, amounts to 28.6 percent of the total ton-miles of freight transported by rail, 5.2 percent of the total ton-miles of freight transported by truck, and 32.4 percent of the total ton-miles of freight transported by vessel. Therefore, emission estimates presented in Figure 7-3 are scaled from national totals, according to these proportions.

Among the primary energy transportation options (other than pipelines), 2011 emissions from marine vessels were higher than from other modes (see Figure 7-4), particularly with respect to nitrogen oxides, sulfur dioxide, and fine particulate matter. This is largely because ocean-going marine vessels have historically used residual (or bunker) fuel,[75] which is a less-refined energy product. Meanwhile, barges propelled by tugboats that operate on inland waterways exclusively use diesel fuel, resulting in less pollution from these vessels than from ocean-going vessels.[76] Emissions from marine vessels overall are rapidly declining, in large part due to new regulations discussed below.

As with stationary sources, while the criteria air pollutant emissions presented in Figure 7-3 generally account for only a small portion of total U.S. emissions of each pollutant, they can contribute significantly to air quality problems in certain regions and localities. For example, diesel exhaust from rail, heavy-duty trucks, and marine vessels are significant contributors to local and regional air quality problems. To help address these issues, EPA

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[p] This is based on EPA National Emissions Inventory estimates of nitrogen oxides emissions for the combination of two sectors—“petroleum and related industries” and “storage and transport”—with roughly half of these emissions coming from natural gas compressors.

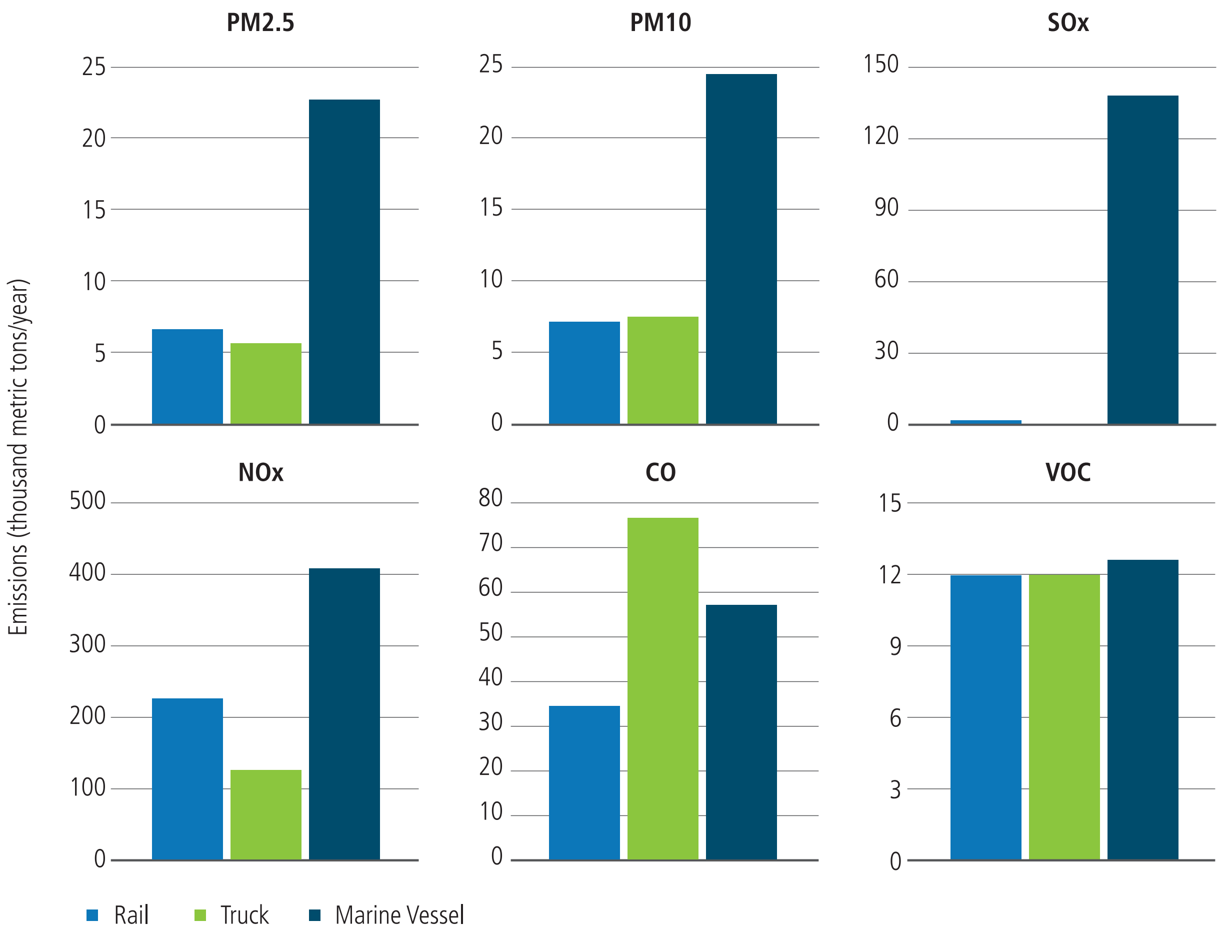
[q] EPA estimates that nitrogen oxides emissions from highway vehicles have declined by 50 percent since 1990, while electric power sector nitrogen oxides emissions are more than 70 percent lower than 1990 levels.

[r] This rulemaking is under consent decree with Air Alliance Houston and several other litigants. The consent decree requires the EPA Administrator to sign the final rule no later than June 16, 2015.

has put in place the SmartWay® Program—a public-private initiative between EPA, large and small trucking companies, rail carriers, logistics companies, commercial manufacturers, retailers, and other Federal and state agencies. Starting in 2004, the program's purpose is to improve fuel efficiency and the environmental performance (reduction of both GHG emissions and air pollution) of the goods movement supply chains. SmartWay-designated tractors and trailers can save upward of 4,000 gallons of fuel each year. To date, SmartWay partners report saving more than 120 million barrels of fuel and eliminating 51.6 million metric tons of CO_2 and almost 740,000 tons of nitrogen oxides through their participation in the program.[77]

In March 2010, the International Maritime Organization officially designated North America and the Caribbean coastal waters as emission control areas.[78] Beginning in 2015, ships are to reduce their emissions of nitrogen oxides, sulfur oxides, and fine particulate matter through use of cleaner fuels or engine technologies (e.g., scrubbers). These standards will dramatically reduce air pollution and deliver substantial air quality and public health benefits that extend hundreds of miles inland.[79]

Figure 7-4. Air Emissions from the Transportation of Coal and Liquid Fuels, by Transport Mode[80, s]

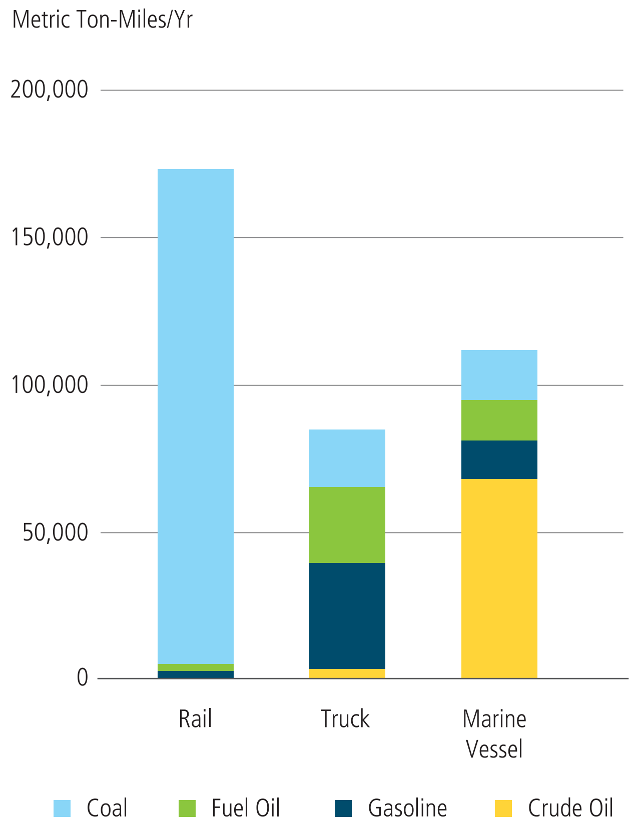


Among the primary energy transportation options (not including pipelines), marine vessels have the highest total emissions, particularly with respect to nitrogen oxides, sulfur oxide, and particulate matter. These emissions are largely the result of ocean-going marine vessels' greater reliance on residual (or bunker) fuel, which is a less-refined energy product. An important caveat is that barge transport via inland waterways can be substantially less polluting than tanker vessels; however, emissions from these two vessel types are not distinguishable in available inventory data.

[s] Since energy products only represent a portion of total freight transported by rail, truck, and marine vessel, emissions data shown here were scaled (on a ton-mile basis) in proportion to the fraction of total freight transport that is represented by energy products (according to the Oak Ridge National Laboratory's "FAF Provisional Annual Data for 2012: Freight Analysis Framework").

Figure 7-5 shows the relative scale of energy transport by vehicle type, accounting for the relative travel distances of each energy product.[t] It does not reflect the observed sharp increase in liquid fuel transport by rail and barge since 2012; it illustrates the relative importance of different transport modes for the movement of different fuel types.

Figure 7-5. Quantities of Energy Transported by Mode (other than pipeline) in 2012, by Fuel Type and Accounting for Distance Traveled (metric ton-miles per year)[81, u]



Freight by rail is the dominant mode for transporting coal within the United States. Energy freight (which does not include pipelines) for liquid fuel products is dominated by truck and marine transport modes.

Another significant area of interest related to air quality and TS&D infrastructure is criteria air pollutants in the vicinity of ports and rail yards, where the density of vehicles leads to high concentrations of pollutants and greater risks to nearby communities.[82] Studies have found that communities living in close proximity to rail yards[83] and ports[84] are exposed to significantly higher concentrations of diesel particulate matter—including fine particulate matter ($PM_{2.5}$)—which is harmful to public health. When compared with the overall U.S. population, research also has found that low-income and minority households are overrepresented in the aggregate affected population, often by a factor of two or three.[85]

[t] Data are presented as metric ton-miles to enable comparison between the relative scale of liquid fuels and coal transport. This is necessary because some energy products are transported over very short distances (e.g., liquid fuels) while others are transported over much greater distances (e.g., coal).

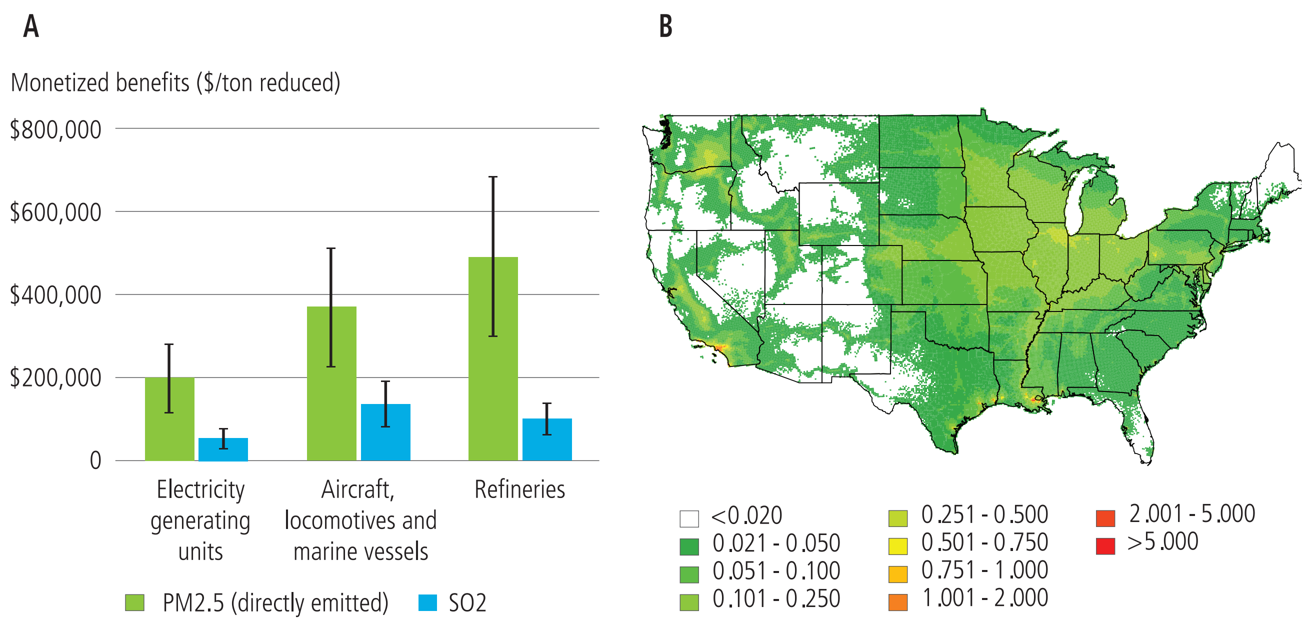
[u] "Gasoline" includes gasoline, aviation turbine fuel, and ethanol. "Fuel oil" include diesel and bunker fuels.

Vehicles that transport energy as freight—primarily coal for electric power generation, but also liquid fuels—include locomotives, as well as truck and marine vessels. Their emissions are primarily due to diesel engine combustion of diesel fuel and residual fuel oil (in the case of marine engines). Health effects from short-term exposures to diesel exhaust, a likely carcinogen, include premature mortality, increased hospital admissions, and heart and lung diseases.[86]

A recent study[87] found that each ton of $PM_{2.5}$ reductions from aircraft, locomotives, and marine vessels yielded very substantial estimated monetized benefits (in comparison to reduction of $PM_{2.5}$ in other sectors). One reason for this is that transportation hubs are often located in relatively close proximity to urban areas; therefore, emission reductions from these sources would have immediate health benefits for onsite workers and neighboring communities (see Figure 7-6).

The California Air Resources Board has issued regulations requiring a 50 percent reduction in berthed ship emissions from large ports by 2014, and an 80 percent reduction by 2018.[88] Most large California ports are implementing shore power projects as a compliance mechanism.[89] Similar regulatory efforts are underway in the European Union, which is expected to encourage retrofitting ships to use shore power.[90]

Figure 7-6. Panel A: Estimated Monetized Benefits of Reductions in $PM_{2.5}$ and $PM_{2.5}$ Precursors. Panel B: Estimated Annual Mean $PM_{2.5}$ Levels Attributable to Aircraft, Locomotives, and Marine Vessels in 2016.[91]



The benefits of reducing a ton of $PM_{2.5}$ or $PM_{2.5}$ precursor sulfur dioxide from certain TS&D sources result in relatively high monetized benefits to society, in part because these pollution sources are commonly close to human populations.

Fuel use and emissions from locomotives could be reduced by improving rail operations and infrastructure and reducing congestion—one of the biggest concerns for rail traffic—as idling and stop-and-go traffic lead to increased fuel consumption.[92] If capacity is not improved by 2035, 25 percent of rail corridors could be running near or at capacity, and 30 percent of rail corridors could be running above capacity, thus leading to increased botlenecks and fuel consumption.[93]

Administration Activities and Plans

A number of Administration initiatives reduce greenhouse gas emissions, as well as other forms of air pollution from transmission, storage, and distribution infrastructure. Examples of this include the Environmental Protection Agency's guidelines to states to reduce ozone precursors from oil and gas systems;[v] the Department of Energy's work to improve the energy efficiency of equipment powering natural gas transmission systems and other transmission, storage, and distribution infrastructure; and efforts to shift to less polluting fuels.[w]

With respect to ports and rail yards, a number of Federal programs provide grant funding for transportation-related projects that can improve air quality in ports and rail yards, including the following:

Congestion Management and Air Quality (CMAQ) program. The Department of Transportation's Federal Highway Administration manages the CMAQ program,[x] which funds state and local programs that reduce air emissions. Under the current transportation bill, the CMAQ program is funded at about $2 billion annually.[y] Typical CMAQ programs include diesel retrofits, diesel idle reduction projects, Intelligent Transportation Systems, alternative fuel vehicle projects, and intermodal freight projects.[z]

Transportation Investment Generating Economic Recovery (TIGER) grants. The Department of Transportation's TIGER program[aa] is a competitive grant program that funds state and local transportation projects across the Nation. TIGER grants have aimed at addressing key national freight rail bottlenecks and reducing truck traffic by funding improved rail access to ports, as well as many other port, rail, and road projects aimed at alleviating freight congestion. Since 2010, annual appropriations for TIGER have ranged from $475 million to $600 million.[ab]

National Clean Diesel Campaign. First authorized by the Diesel Emissions Reduction Act in 2008, the National Clean Diesel Campaign issues grants to eligible entities for projects to reduce emissions from existing diesel engines. The projects meet critical local air quality needs by deploying both proven and emerging technologies much earlier than would otherwise occur.[ac] Past annual appropriations for the Diesel Emissions Reduction Act have ranged from $20 million to $60 million.[ad]

GROW AMERICA Act. The Administration's proposed transportation legislation includes several provisions aimed at increasing investments that will improve freight performance and reduce criteria air pollutant and precursor emissions. These include the following:

- A 6-year, $18-billion competitive grant program targeted at freight infrastructure projects identified by state and local governments and key transportation stakeholders
- A collaborative freight strategic planning process, which will permit the use of formula grant funds for "game-changing" freight transportation projects
- A sharper focus for the CMAQ program on reducing emissions of fine particulates, as well as the criteria pollutants with the greatest impact on human health, and expansion of the TIGER grant program to $1.25 billion per year.

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[v] The White House. "Fact Sheet: Administration Takes Steps Forward on Climate Action Plan by Announcing Actions to Cut Methane Emissions." http://www.whitehouse.gov/the-press-office/2015/01/14/fact-sheet-administration-takes-steps-forward-climate-action-plan-anno-1. Accessed March 2, 2015.

[w] Department of Energy. "DOE Launches Natural Gas Infrastructure R&D Program." September 8, 2014. http://energy.gov/fe/articles/doe-launches-natural-gas-infrastructure-rd-program-enhancing-pipeline-and-distribution. Accessed February 27, 2015.

[x] Federal Highway Administration. "CMAQ- Air Quality." http://www.fhwa.dot.gov/environment/air_quality/cmaq/. Accessed February 27, 2015.

[y] Department of Transportation. "Fiscal Year 2014 Apportionments, Allocations and Program Information." March 2014. http://www.fta.dot.gov/printer_friendly/12910_15867.html. Accessed February 27, 2015.

[z] Federal Highway Administration. "CMAQ- Air Quality." http://www.fhwa.dot.gov/environment/air_quality/cmaq/ Accessed February 27, 2015.

[aa] Department of Transportation. "TIGER Discretionary Grants." http://www.dot.gov/tiger. Accessed February 27, 2015.

[ab] Department of Transportation. "TIGER Discretionary Grants." http://www.dot.gov/tiger. Accessed February 27, 2015.

[ac] Environmental Protection Agency. "National Clean Diesel Campaign: Funding Sources." http://www.epa.gov/cleandiesel/grantfund.htm. Accessed February 27, 2015.

[ad] Environmental Protection Agency. "Second Report to Congress Highlights of the Diesel Emissions Reduction Program." http://www.epa.gov/cleandiesel/documents/420r12031.pdf. Accessed February 27, 2015.

While the QER scope is limited to energy freight, expanding any program that reduces freight congestion would achieve emissions reductions from freight transport more broadly, with direct benefits of improved air quality for nearby urban communities and workers.

QER Recommendations

REDUCING CONVENTIONAL AIR POLLUTION

Current Administration activities and proposals before Congress have the potential to broadly benefit both communities and workers affected by conventional air pollution from TS&D infrastructures. In order to build on these ongoing activities, we recommend the following:

Provide funding to programs that reduce diesel emissions. To protect workers and nearby communities through further reductions in diesel particulate matter emissions from ports and rail yards, we recommend providing funding for the successful Diesel Emissions Reduction Act program and other Federal programs that fund complementary activities that reduce diesel emissions. Grant funding should support projects that deploy emissions control technologies, reduce bottlenecks and congestion of freight in the vicinity of these facilities, and use other methods to reduce diesel emissions.

Other Environmental Issues

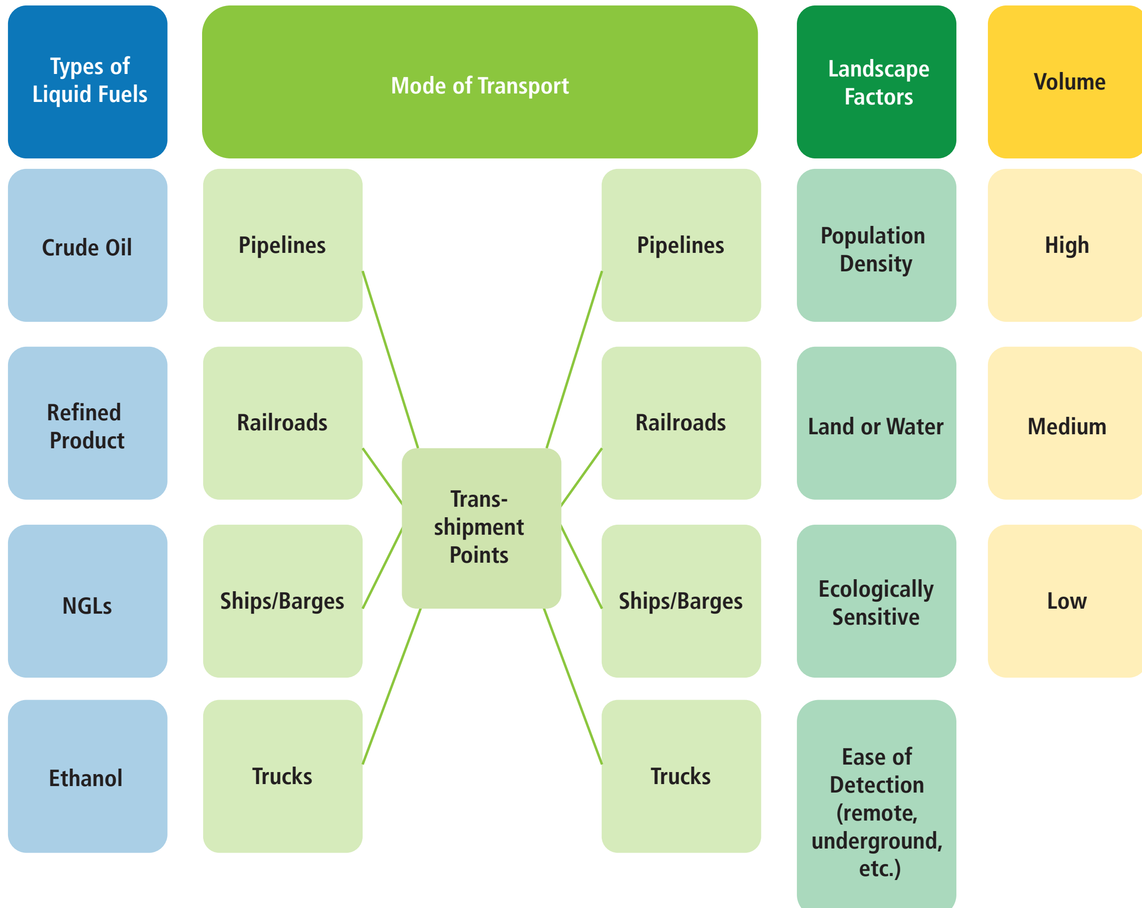
In addition to GHG emissions, conventional air pollution, and land-use issues, there are also other environmental issues related to TS&D infrastructure, such as spills, dredging materials disposal, and CO_2 pipelines.

Liquid Fuel Spills

All forms of TS&D infrastructure for petroleum and refined petroleum products present some risk of spills into the environment. It is challenging to compare marine, rail, truck, and pipeline spill statistics due to several data limitations and inherent differences between modes. For example, there is large interannual variability in the volume of reported releases of crude oil from marine and rail vessels; for rail, it ranges from less than 5 barrels to nearly 25,000 barrels per year—with the increase in shipments of crude by rail, there has been a concomitant increase in oil releases from this mode.[94] In terms of recorded impacts relevant to the environment and public health, the simplest comparative metrics are total reported incidents and volumes of spills. In general, available data indicate that releases from pipelines are relatively more significant than spills from rail transport, and the total oil spilled by pipelines is greater than that from other sources. Between 2004 and 2013, pipelines released an average of 63,069[95] barrels of oil per year. In comparison, for 1998 to 2007, average annual releases of oil by rail (1,400 barrels per year[96]), truck (9,200 barrels per year[97]), and all marine vessels (9,593 barrels per year[98]) were all considerably lower. This comparison is dominated by the fact that each mode transports different total volumes of energy product over different average distances, with pipelines carrying far larger volumes than other modes. Better data on barrels spilled per barrel-miles moved would improve our ability to compare spill statistics across modes on a common basis. This is particularly important for assessing how relative risks are changing during this dynamic period of growing domestic production of crude oil and shifting patterns of energy transport.

The environmental effects of any spill will depend on the vulnerability of the region where the spill takes place and the ease (and therefore speed) of response. Rail and marine spills result in the spill of a relatively small volume, typically aboveground. Pipeline spills, however, can go undetected for relatively long periods of time and result in higher spill volumes, typically underground. Other factors that affect the severity of a spill, both for the environment and public safety, include the season and weather, proximity to densely populated areas and sensitive ecological areas, and the type of liquid involved in the spill (see Figure 7-7).

Figure 7-7. Conditions Affecting Liquid Fuels Spill Severity[99]



Assessing risks associated with oil transport involves the consideration of a number of factors, including the variety of landscapes that could potentially be affected, the vulnerability of those landscapes to damaging impacts, and the type and extent of the incident.

Administration Activities and Plans

Environmental Protection Agency (EPA) Oil Spill Program. The EPA protects U.S. waters by preventing, preparing for, and responding to oil spills in navigable waters. This program is authorized by Section 311 of the Clean Water Act and the Oil Pollution Act of 1990. The oil pollution prevention regulations require each owner or operator of a regulated facility to prepare a Spill Prevention, Control, and Countermeasures Plan that addresses the facility's design, operation, and maintenance procedures established to prevent oil spills, as well as countermeasures to control, contain, cleanup, and mitigate the effects of an oil spill that could affect navigable waters. In addition, high-risk facility owners and operators are also required to prepare Facility Response Plans that identify response actions for discharges of oil that pose substantial harm to the environment. EPA is responsible for inland oil spills that either impact or threaten water. Typically, EPA monitors oil spills to ensure that Responsible Parties take necessary steps to contain and cleanup oil spills. EPA does have authority to direct a Responsible Party's cleanup activities or take oil spill response actions if there is no viable Responsible Party, or if a Responsible Party is unwilling to take appropriate actions. EPA utilizes the Oil Spill Liability Trust Fund to fund its actions.

Administration Activities and Plans (continued)

EPA Superfund Emergency Response and Removal Program. This program trains, equips, and deploys resources in order to contain and remove contaminants. Under the program, EPA personnel respond to or oversee the cleanup by Responsible Parties of thousands of releases, regardless of their cause. EPA manages and/or provides support for a variety of emergency responses, removal assessments, site stabilizations, and cleanup response actions. EPA maintains national and regional response centers for 24-hour reporting of hazardous material or petroleum releases. EPA deploys many advanced technologies and other assets during disaster responses, such as the Chemical, Biological, Radiological, and Nuclear Consequence Management Advisory Team; the portable laboratories; or the airborne sensor platform (which is called ASPECT).

Department of Transportation Proposed Rules. The Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA) is finalizing a proposed rule on Pipeline Safety—Safety of On-Shore Hazardous Liquid Pipelines. This rulemaking would address effective procedures that hazardous liquid operators can use to improve the protection of high-consequence areas and other vulnerable areas along their hazardous liquid onshore pipelines. PHMSA is considering whether changes are needed to the regulations covering hazardous liquid onshore pipelines, whether other areas should be included as high-consequence areas for integrity management protections, what the repair time frames should be for areas outside of the high-consequence areas that are assessed as part of the integrity management program, whether leak-detection standards are necessary, and whether valve spacing requirements are needed on new construction or existing pipelines. PHMSA should extend regulation to certain pipelines currently exempt from regulation. The Department of Transportation also published an Advanced Notice of Proposed Rulemaking on requiring oil spill response plans for high-hazard flammable trains.[ae] This was a companion to a proposed rule setting out comprehensive standards to improve the rail transportation of flammable liquids, including unit trains of crude oil and ethanol, discussed in Chapter V (Improving Shared Transport Infrastructures).[af]

National Oceanic and Atmospheric Administration (NOAA) oil spill programs. NOAA's Office of Response and Restoration is charged with responding to oil spills in coastal and marine environments, and it provides scientific support to the Federal on-scene coordinator. NOAA employs a number of tools to preemptively reduce potential risks from marine oil spills, including providing expertise on oil spill response plans, environmental sensitivity index maps, and trajectory analysis models. In addition, NOAA works with the Bureau of Ocean Energy Management, the Coast Guard, and other Federal and state actors to identify particularly sensitive marine environments in siting of energy facilities and shipping lanes. NOAA also plays a lead role in restoration efforts in the event of a marine spill.

[ae] Department of Transportation. "U.S. DOT Announces Comprehensive Proposed Rulemaking for the Safe Transportation of Crude Oil, Flammable Materials." July 23, 2014. http://www.dot.gov/briefing-room/us-dot-announces-comprehensive-proposed-rulemaking-safe-transportation-crude-oil. Accessed February 19, 2015.

[af] Department of Transportation. "U.S. DOT Announces Comprehensive Proposed Rulemaking for the Safe Transportation of Crude Oil, Flammable Materials." July 23, 2014. http://www.dot.gov/briefing-room/us-dot-announces-comprehensive-proposed-rulemaking-safe-transportation-crude-oil. Accessed February 19, 2015.

Water Use and Wastewater

Petroleum refineries consume the most water and produce the most wastewater discharge of any segment of the energy TS&D infrastructure. Despite data limitations, the relative quantities are known:

- Annual water consumption by petroleum refineries in 2005 was about 1.3 billion gallons per day[100] compared to about 4.3 billion gallons per day of total water consumed by thermoelectric power generation in 2008.[ag]
- Water withdrawals by both petroleum refineries and thermoelectric power generation are substantially greater, meaning that only a fraction of withdrawn water is consumed, while the remainder is discharged to the environment.

[ag] Based on total annual water use of 1,570 billion gallons by thermoelectric power plants in: Averyt, K. et al. "Water use for electricity in the United States: an analysis of reported and calculated water use information for 2008." Environmental Research Letters. 8(1). 2013.

- Fresh water withdrawals by petroleum refineries in 2005 were approximately 6 billion to 19 billion gallons per day,[101] while fresh and saline water withdrawals by thermoelectric power generation in 2011 were approximately 196 billion gallons per day.[102]

Discharges from refineries can also affect water quality (particularly water temperature). Such discharges are subject to EPA permitting requirements under the Clean Water Act, which requires system controls for any direct discharges to surface waters.[103]

Biofuel refineries can also consume large volumes of water. However, the quantity of water consumed during the biorefining processes is modest compared to the water consumed to grow bioenergy feedstocks in cases where irrigation is required.[104] To produce 1 gallon of ethanol, up to 1,000 gallons of irrigation water is consumed, while producing 1 gallon of biodiesel from soybeans consumes up to 750 gallons of irrigation water.[105] Meanwhile, ethanol refineries consume as much as 3 gallons of water to produce 1 gallon of ethanol,[106] which is greater on a per-gallon production basis than petroleum refining. Biodiesel refineries consume less than 1 gallon of water per gallon of biodiesel produced.[107, 108]

Nationally, total water use and wastewater production from processing of natural gas and natural gas liquids is low, although natural gas liquids facilities can have large local water withdrawal impacts. The construction and operation of TS&D infrastructure can also cause significant watershed-level changes in local and regional hydrology.

Dredging Materials

The Army Corps of Engineers oversees 25,000 miles of channels—comprising 13,000 miles of coastal harbors and channels and 12,000 miles of inland and intracoastal waterways—and dredges 225 million cubic yards of material from U.S. harbors, channels, and waterways annually.[109] The proper placement of dredged material is often a significant portion of the total cost of dredging, particularly if dredged material contains contaminants. Dredged material is typically tested, and the method of placement is chosen to minimize costs and environmental impacts. Placement of dredged material in open water is regulated by Section 404 of the Clean Water Act, and placement in ocean waters is regulated by Section 103 of the Marine Protection, Research, and Sanctuaries Act of 1972. Many techniques exist for reusing dredged material or removing potentially hazardous components from it, and dredged material is increasingly being employed for beneficial uses under Section 204 of the Water Resources Development Act of 1992. The Army Corps of Engineers has conducted research and development on treating and beneficially using or placing dredged material since the 1970s. The Corps will continue to conduct research and development on dredging and dredged material placement operations under its Dredging Operations and Environmental Research program.[110]

Environmental Data Related to TS&D Infrastructures

Finally, data that are important for understanding the environmental characteristics and impacts of TS&D infrastructures often are not available or are only available in highly aggregated formats (temporally and spatially). Furthermore, these data are often outdated and sometimes not conducive to identifying trends (e.g., they are only released every 4 years, or methodologies change so that time series are difficult to compile or are of questionable value). These limitations exist with respect to many public health, safety, and environmental quality issues, including oil spills and water use, consumption, and waste. In a 2015 report,[111] the National Transportation Safety Board noted that many types of basic data necessary for comprehensive probabilistic risk modeling of natural gas pipelines are not currently available. The Board's recommendations included the development of better-quality spatial data on pipelines that can be more easily accessed by regulators and operators. Limitations also exist with respect to data on the age of certain equipment (e.g., compressors) and infrastructure (e.g., pipelines), as well as emissions at a granular level (e.g., from different types of vessels—such as barges versus tankers—or from different kinds of compressor motors—such as reciprocating engines versus centrifugal turbines). These latter data are important to have so that appropriate priorities can be set for both research and policy.

QER Recommendations

OTHER ENVIRONMENTAL ISSUES

As noted above, the Administration has a broad range of activities and proposed rules underway in the area of addressing oil spills, so further recommendations in that area are not needed at this time. Similarly, environmental controls on wastewater discharges from TS&D infrastructure are adequate. To continue to make progress on the handling and disposal of dredging materials and to address issues involving environmental data, we recommend the following:

Conduct research needed on dredging materials. The Army Corps of Engineers, in collaboration with other appropriate Federal agencies, should continue to undertake research and development on treating dredged material and then either beneficially using or disposing of it. As efforts continue—by the Federal Government and other stakeholders—to enhance shared infrastructures for energy commodity transport, focusing on waterway and port improvements, the amount of such material may grow substantially and pose a barrier to enhancing waterborne TS&D infrastructure.

Improve environmental data collection, analysis, and coordination. DOE should work with other Federal agencies to improve data and analysis on the environmental characteristics and impacts of TS&D infrastructures. This work should be designed to fill the host of data gaps on environment, safety, and public health issues with respect to TS&D infrastructure. DOE's activities should take into account the recent recommendations by the National Transportation Safety Board on data gaps related to natural gas pipelines.

CO_2 Pipelines: Enabling Infrastructure for GHG Emissions Reductions

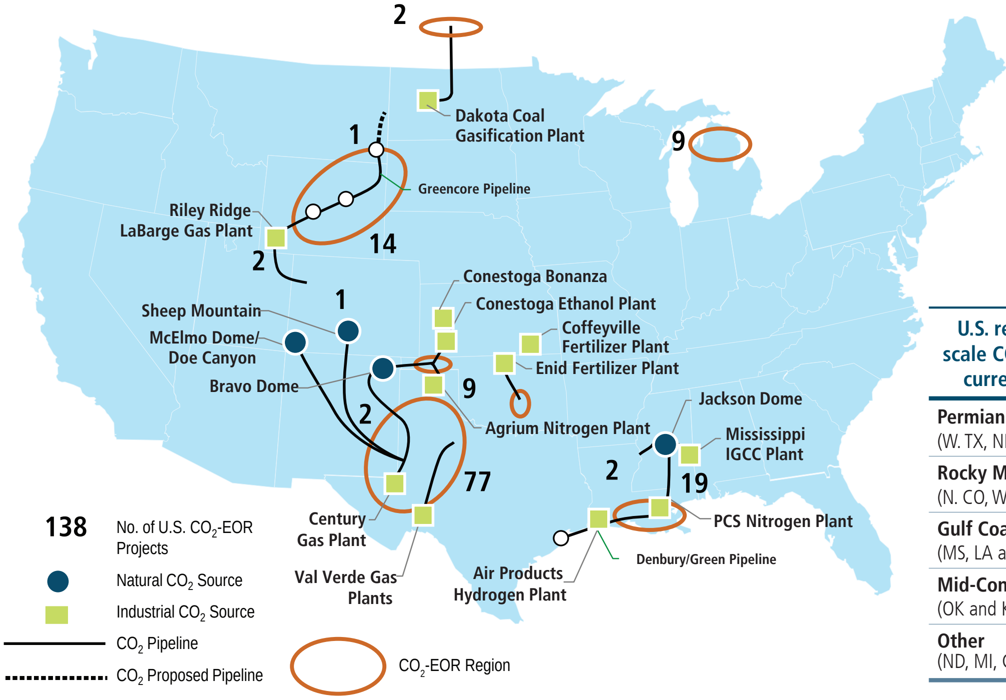
CO_2 pipelines are an important enabling infrastructure for reducing GHG emissions in the future. Carbon dioxide sequestration, particularly in connection with enhanced oil recovery (EOR),[ah] may involve moving CO_2 significant distances from power plants (or other sources) to the sequestration site or EOR field.

Spanning across more than 12 U.S. states and into Saskatchewan, Canada, a safe and regionally extensive network of CO_2 pipelines has been constructed over the past four decades. Consisting of 50 individual CO_2 pipelines, with a combined length of more than 4,500 miles (see Figure 7-8), these CO_2 transportation pipelines represent an essential building block for linking the capture of CO_2 from electric power plants and other industrial sources with its productive use in oil fields and its safe storage in saline formations. The Pipeline and Hazardous Materials Administration (PHMSA)[ai] is responsible for overseeing the safe construction and operation of CO_2 pipelines, which includes technical design specifications and integrity management requirements.

[ah] The injection of CO_2 gas into oil reservoirs at high pressure forces the CO_2 to mix with oil, which reduces the viscosity of the oil and ultimately increases the total cumulative volume of oil produced, thus the percentage of oil-in-place that is recovered.

[ai] While CO_2 is not considered a hazardous material by the Department of Transportation, CO_2 transportation pipelines are regulated under 49 C.F.R. § 195, Transportation of Hazardous Liquids by Pipeline.

Figure 7-8. Current CO_2-EOR Operations and Infrastructure[112]



U.S. regions with large-scale CO_2 pipeline systems currently in operation	Miles of Pipeline
Permian Basin (W. TX, NM, and S. CO)	2,320
Rocky Mountains (N. CO, WY and MT)	810
Gulf Coast (MS, LA and E. TX)	740
Mid-Continent (OK and KS)	480
Other (ND, MI, Canada)	215

The current CO_2 pipeline system has been built to deliver CO_2 for CO_2-EOR to oil fields in the Permian Basin of west Texas and eastern New Mexico. This system spans across more than a dozen U.S. states and into Saskatchewan, Canada.

The vast majority of the CO_2 pipeline system is dedicated to CO_2-EOR[aj] and connects natural and industrial sources of CO_2 with EOR projects in oil fields. In 2014, roughly 1,250 billion cubic feet of CO_2 (or 68 million metric tons) flowed through U.S. pipelines—roughly 80 percent of which is from natural (geologic) sources. In the next few years, several new industrial CO_2-capture facilities[ak] are expected to bring online another 1,100 billion cubic feet of CO_2, with nearly 600 miles of new pipeline by 2020. At that point, the portion of CO_2 from industrial sources would nearly exceed that from natural sources.

Currently, just more than 4 percent of total U.S. crude oil production is produced through EOR, and this is projected to increase to 7 percent by 2030.[113] Additionally, as recent trends[114] in CO_2 pipeline planning and construction have shown, there is considerable potential for low-cost CO_2 capture from ethanol refineries, other industrial facilities, and EOR in nearby oil production basins in regions of the country that do not yet have CO_2 pipeline networks in place. However, given the upfront capital costs associated with pipeline construction and the absence of policy incentives for reducing industrial carbon pollution, financial support would likely be needed to spur private investments in some regions.

A national carbon policy would create investment certainty and spur significant new investment in CO_2 pipeline infrastructure, creating incentives for electric power plants and other industrial facilities to reduce CO_2 emissions through carbon capture technologies and improving the economics for oil production through EOR.

[aj] A small fraction is used for other industrial uses, such as delivering CO_2 to the beverage industry.

[ak] For example, Air Products' PCS Nitrogen plant in Louisiana and Southern Company's integrated gasification combined cycle plant in Kemper County, Mississippi.

In a low-carbon scenario analysis case analyzed for the QER,[115] construction through 2030 would more than triple the size of current U.S. CO_2 pipeline infrastructure through an average annual build rate of nearly 1,000 miles per year.[al]

The regulation of CO_2 pipelines is currently a joint responsibility of Federal and state governments.[116] CO_2 transportation pipelines are subject to Federal safety regulations that are administered by PHMSA.[am] PHMSA directly oversees pipeline safety for all interstate lines, while intrastate pipelines are subject to state agency oversight (as long as the standards are at least as stringent as the Federal rules).[an] The Federal Energy Regulatory Commission and the Surface Transportation Board have determined that CO_2 pipelines are not within their jurisdiction.[117, 118] Otherwise, requirements for siting (including the use of eminent domain), construction, and operations of CO_2 pipelines are largely handled at the state level. If a pipeline crosses Federal land, permits from the relevant Federal agencies (e.g., rights of way) and the accompanying environmental review under NEPA are required prior to siting and construction.[ao]

State laws that are specific to CO_2 pipelines, EOR, and underground storage are varied and generally limited to those regions with CO_2-EOR projects. Texas, for example, has several laws that pertain specifically to CO_2 for EOR and geologic sequestration. A CO_2 pipeline operator in Texas may exercise its right of eminent domain if it has declared itself a common carrier, which deems the CO_2 pipeline open to transport for hire by the public.[ap] Texas also has policy incentives, including a reduction in its severance tax rate by 50 percent for oil produced from EOR using anthropogenic CO_2.[119] The Wyoming Pipeline Authority has begun to plan for and establish corridors for future CO_2 pipelines.[aq] Rather than leave future pipeline planning up to individual operators, the Wyoming Pipeline Authority is seeking to assist pipeline developers through the pipeline construction process by serving as a facilitator and information provider to industry, state government, and the public.[120, 121]

[al] The model projects 11,000 miles of new pipeline construction, which is more than half the scale that would potentially be needed by 2050, to accommodate climate stabilization scenarios modeled by Dooley et al. "Comparing Existing Pipeline Networks with the Potential Scale of Future U.S. CO_2 Pipeline Networks." Energy Procedia. 1(1). p. 1,595–1,602. February 2009.

[am] While CO_2 is not considered a hazardous material by the Department of Transportation, CO_2 transportation pipelines are regulated under 49 C.F.R. § 195, *Transportation of Hazardous Liquids by Pipeline*. This distinction is made due to the nature of the transportation pipelines, which carries the highly pressurized CO_2 in a liquid phase similar to other hazardous material transportation pipelines. Smaller CO_2 distribution lines, which transport the CO_2 from the trunk line to individual wells, generally are not subject to Federal safety standards.

[an] Other Federal agency requirements, depending upon the area involved, can include threatened and endangered species consultations and permits for wetlands fill. Currently, the Bureau of Land Management regulates CO_2 pipelines under the Mineral Leasing Act as a commodity shipped by a common carrier. See: 30 U.S.C. § 185(r); Buys and Associates, Inc. "Environmental Assessment for Anadarko E&P Company L.P. Monell CO_2 Pipeline Project." Prepared for the Department of the Interior, Bureau of Land Management. February 2003. See also: U.S. Court of Appeals. "970 F. 2d 757 – Exxon Corporation v. Lujan." July 23, 1992.

[ao] Currently, the Bureau of Land Management regulates CO_2 pipelines under the Mineral Leasing Act as a commodity shipped by a common carrier. See: 30 U.S.C. § 185(r); Buys and Associates, Inc. "Environmental Assessment for Anadarko E&P Company L.P. Monell CO_2 Pipeline Project." Prepared for the Department of the Interior, Bureau of Land Management. February 2003. See also: U.S. Court of Appeals. "970 F. 2d 757 – Exxon Corporation v. Lujan." July 23, 1992.

[ap] Texas Natural Resources Code Annotated § 111.019(a) (West); Texas Natural Resources Code Annotated § 111.002(6) (West).

[aq] The Wyoming Pipeline Authority recently announced its application to the Bureau of Land Management for a Wyoming Pipeline Corridor Initiative. See: Wyoming Pipeline Authority. "Wyoming Pipeline Corridor Initiative." www.wyopipeline.com/projects/wpci/. Accessed January 26, 2015. As described by the Wyoming Pipeline Authority, the initiative is a proposed pipeline right-of-way network designed to connect sources of CO_2 to oil fields that are suitable for EOR. The initiative, as proposed to the Bureau of Land Management, would establish 1,150 miles of corridors on Federal lands in Wyoming. The Wyoming Pipeline Authority would be the project proponent receiving the right of way, which would then be assigned to individual project proponents, which would construct and operate pipelines. See: Wyoming Pipeline Authority. "Wyoming Pipeline Corridor Initiative Plan of Development." May 2014. www.wyopipeline.com/wp-content/uploads/2014/06/WPCI_POD_may_2014.pdf. Accessed January 27, 2015.).

QER Recommendations

CO_2 PIPELINES

Meeting U.S. GHG emission goals will require a more concerted Federal policy, involving closer cooperation among Federal, state, and local governments. The development of a national CO_2 pipeline network capable of meeting Federal policy initiatives should build on state experiences, including lessons learned from the effectiveness of different regulatory structures, incentives, and processes that foster interagency coordination and regular stakeholder engagement. To expand current Federal efforts to meet these challenges, we recommend the following:

Work with states to promote best practices for siting and regulating CO_2 pipelines. Improving CO_2 pipeline siting will improve safety and environmental protection. Several states have made substantial progress on this front and provide potential models for other states. DOE, in cooperation with Federal public land agencies, should take a convening role to promote communication, coordination, and sharing of lessons learned and best practices among states that are already involved in siting and regulating CO_2 pipelines, or that may have CO_2 pipeline projects proposed within their borders in the future.

Enact financial incentives for the construction of CO_2 pipeline networks. Expanding and improving CO_2 pipeline infrastructure could enable GHG reductions through carbon capture, utilization, and storage, while promoting domestic oil production through EOR. Providing incentives such as grants or tax incentives will spur activity to link low-cost CO_2 from industrial sources to nearby oil fields and saline storage formations. The President's Fiscal Year 2016 Budget Request proposes the creation of a Carbon Dioxide Investment and Sequestration Tax Credit in order to accelerate commercial deployment of carbon capture, utilization, and storage, as well as to catalyze the development of new carbon capture, utilization, and storage technologies. Specifically, the proposal, part of the President's POWER+ Plan to invest in coal communities, would authorize $2 billion in refundable investment tax credits for carbon capture technology and associated infrastructure (including pipelines) installed at new or retrofitted electric generating units that capture and permanently "sequester" CO_2.[122] Congress should enact this proposed tax credit.

RECOMMENDATIONS IN BRIEF:

Addressing Environmental Aspects of TS&D Infrastructure

(Including environmental recommendations discussed elsewhere in this report)

Improve quantification of emissions from natural gas transmission, storage, and distribution (TS&D) infrastructure. Congress should approve the $10 million requested in the Fiscal Year 2016 Budget to help update Greenhouse Gas Inventory estimates of methane emissions from natural gas systems. The Department of Energy (DOE) and the Environmental Protection Agency should undertake a coordinated approach, building on stakeholder input, to ensure that new research and analysis is targeted toward knowledge gaps unaddressed by other researchers.

Expand research and development (R&D) programs at DOE on cost-effective technologies to detect and reduce losses from natural gas TS&D systems. DOE should leverage its R&D efforts in this area to facilitate broader air quality benefits.

Invest in R&D to lower the cost of continuous emissions monitoring equipment. To further improve safety and reduce emissions from natural gas systems, additional R&D—as proposed in the Fiscal Year 2016 Budget—is needed to reduce costs and enable deployment of continuous emissions monitoring technologies.

Support funding to reduce diesel emissions. To protect workers and nearby communities through further reductions in diesel particulate matter emissions from ports and rail yards, the Administration proposed and Congress should provide funding for the Diesel Emissions Reduction Act and other related programs.

Collaborate on R&D on the beneficial use and/or disposal of dredging material. The Army Corps of Engineers and other appropriate Federal agencies should undertake collaborative R&D on treating and then either beneficially using or disposing of dredging material.

Improve environmental data collection, analysis, and coordination. DOE should work with other Federal agencies to improve data and analysis on the environmental characteristics and impacts of TS&D infrastructures.

Work with states to promote best practices for regulating and siting carbon dioxide (CO_2) pipelines. Building on successful state models for CO_2 pipeline siting, DOE, in cooperation with Federal public land agencies, should take a convening role to promote communication, coordination, and sharing of lessons learned and best practices among states that are already involved in siting and regulating CO_2 pipelines, or that may have CO_2 pipeline projects proposed within their borders in the future.

Enact financial incentives for the construction of CO_2 pipeline networks. Congress should enact the Administration's proposed Carbon Dioxide Investment and Sequestration Tax Credit, which would authorize $2 billion in refundable investment tax credits for carbon capture technology and associated infrastructure (including pipelines) installed at new or retrofitted electric generating units that capture and permanently "sequester" CO_2.

Enhance TS&D resilience to a variety of threats, including climate change and extreme weather (discussed in Chapter II, Increasing the Resilience, Reliability, Safety, and Asset Security of TS&D Infrastructure).

Enhance natural gas safety, efficiency, and lower emissions by reducing natural gas leakage and improving the efficiency and safety of the natural gas infrastructure through support for innovative programs to upgrade natural gas distribution system performance through targeted funding to low-income consumers (discussed in Chapter II, Increasing the Resilience, Reliability, Safety, and Asset Security of TS&D Infrastructure).

Accelerate current development of uniform methods for measuring energy savings and promote widespread adoption of these methods in public and private efficiency programs (discussed in Chapter III, Modernizing the Electric Grid).

Partner with the Arctic Council on Arctic energy safety, reliability, and environmental protection (discussed in Chapter VI, Integrating North American Energy Markets).

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