Assessing the Greenhouse Gas Emissions Impact of New Fossil Fuel Infrastructure

An offshore oil drilling platform in Brazil © Wikimedia Commons / Agência Brasil

With growing population, incomes, and economic output, global demand for energy continues to grow, with corresponding impacts on fossil fuels use, greenhouse gas emissions, and the global climate system (IEA 2012). In response, policy-makers in several countries have designed and introduced policies, such as emissions trading, to limit the *demand* for fossil fuels. At the same time, new infrastructure investments – among them coal mine expansions, new coal and gas export terminals, and major oil sands and heavy oil extraction facilities – are poised to significantly increase the *supply* of fossil fuels.

The potential implications of these supply investments for global GHG emissions have become an increasingly pivotal factor for decision-makers and the public. For example, on June 25, 2013, U.S. President Barack Obama said he would only approve the controversial Keystone XL pipeline connecting Alberta oil sands developments with ports in the Gulf of Mexico if it "does not significantly exacerbate the problem of carbon pollution" (The White House 2013). However, there is a dearth of well-accepted analytical approaches to questions such as these.

How should the incremental emissions impact of new fossil fuel supply infrastructure be measured? In the case of Keystone XL, some have chosen to count all the emissions from burning oil that will flow through the pipeline, while others have argued these emissions should not be counted at all, because the oil would otherwise still get to market somehow. Other analytical approaches are also possible, such as considering the incremental impact of added oil supplies on global oil prices, and thus on global oil consumption. In general, as with Keystone XL, the few analyses that do quantify emissions impacts of adding or removing fossil fuel supplies from the market diverge widely in perspectives taken, methods used, and results obtained.

Risks of and responses to the new fossil fuel economy

This discussion brief is part of a two-year SEI project that aims to deepen understanding of the risks posed by new investments in fossil fuel infrastructure, and of the possible responses by policy-makers and civil society to mitigate or avoid these risks. In particular, this initiative examines major decisions regarding new investments in fossil fuel extraction and trade infrastructure, especially in venues where green growth or low-emission development strategies (LEDS) are under development or consideration. Our aim is to provide resources and tools to help planners and policy-makers assess the risks of, and responses to, fossil development, as part of low-carbon and green growth planning.

Given the stakes involved, and the importance of sound decision-making, it is crucial to better understand the emissions implications of fossil fuel infrastructure investments, and of the methods and perspectives used to quantify their impact. This discussion brief provides an overview of the approaches used to date and their findings, and makes suggestions for further work.

GHG emissions impacts of fossil fuel infrastructure

The development of new fossil fuel infrastructure can have a number of GHG emissions impacts. Here we look at different approaches to assessing the incremental impact, or the *change* in emissions between the case with the new infrastructure (the "project case") and the case without the infrastructure (a "counterfactual case" that attempts to assess what would otherwise happen if the infrastructure were not built). The types of emissions impacts that can be measured by different methods fall into three broad categories, following the "life cycle" of a fuel:

- **Emissions from fossil fuel extraction or processing**, including combustion of fossil fuels used to power on-site construction, drilling, or processing equipment, as well as any fugitive methane emissions from leaks or venting. These emissions (e.g. at wells, mines, or refineries) are relatively straightforward to estimate, though there are often large uncertainties related to fugitive methane releases.

- **Emissions from fossil fuel transportation,** such as shipping fossil fuels by ship, rail, or pipeline, including any fugitive methane releases (e.g., from natural gas pipelines).

A coal mine near Hailar in Inner Mongolia © Wikimedia Commons / Herry Lawford

- **Emissions from fossil fuel combustion**, such as burning coal or natural gas in a power plant or industrial facility.

In all cases, expansion of the supply of one particular fossil fuel (e.g. coal from the Powder River Basin of the U.S. or from the Tavan Tolgoi deposits in Mongolia) may lead not only to changes in supply from alternative sources of that fuel (e.g. China or Australia) but also to changes in the supply of other fuels (e.g., natural gas, nuclear energy, or renewable energy that may compete with coal in final energy markets).

Changes may also play out over different time scales. For example, in the near term, expansion of a particular coal sup-

ply may lead existing coal-fired power plants to use more fuel. In the long term, it could influence (through reductions in coal prices) choices about what type of electricity generation plants are built (coal vs. alternatives, such as natural gas or renewables), with longer-term emissions impacts. In principle, a fossil fuel supply project could also lead to long-term "lock-in" of specific fuels and technologies or "lock-out" of lower-GHG technologies, either because it uses up finite capital or to the extent that it contributes to social or political norms for fossil fuels (Sandén and Karlström 2007) builds in a redundancy of supply that helps to increase investor confidence in the long-term prospects of that fuel (Power and Power 2013), or contributes to economies of scale for fossil fuel processing technologies (especially for "unconventional" fossil fuels).

Approaches to quantifying GHG emissions impacts

Our on-going literature review has thus far uncovered only a handful of studies that actually quantify the GHG emissions impacts of expanded fossil fuel infrastructure. Among them, we found three broad approaches, which we term the *literalist*, the *fatalist*, and the *economist*.

The literalist perspective tends to focus on the emissions associated with ultimate combustion of the fossil fuel produced or otherwise handled by a facility. The fatalist perspective tends to focus largely on emissions associated with differences in extraction, processing, and transportation of the particular type of fossil fuel. It assumes (or finds) that the same amount of fuel would be burned regardless – either because it would otherwise still reach the market or be fully substituted by alternative fuels – and that therefore, there are no net effects from eventual combustion of the fuel. The economist perspective focuses on how fuel markets and consumers will respond to implementation of a project, considering how it might affect fuel prices, and how these prices will affect fuel choice and consumption.

Below we describe each approach in more detail using examples from the literature. A number of variations of the economist view exist, so we describe this approach with three simplified variations. To enable a rough comparison of findings across different analyses and contexts, we report GHG emissions as a ratio of tonne of net GHG emissions per tonne of carbon dioxide (CO_2) contained in each fossil fuel handled.

Finally, it is worth mentioning a less quantifiable perspective, that of the *political economist*, which may focus, instead, on the broader ramifications of decisions on whether to proceed with individual investments in fossil fuel infrastructure. Though we have not yet found any studies that quantify emissions impact from that perspective, we discuss it briefly following the review of the other three broad quantification approaches below.

The literalist: the project adds carbon to the economy and the atmosphere

The literalist perspective assigns a project the full emissions from the further processing and use (combustion) of the fuels that it produces, processes, or otherwise ships to downstream users, including, most notably, the eventual combustion of carbon contained in the fuels. We term this perspective the *literalist* because of its specific focus and logic: that because of given project, a certain amount of fuel will reach the market, that the carbon contained with the fuel

A train carries coal from the Powder River Basin in Wyoming © Flickr / Aaron Hockley

will be combusted, and that this carbon uses up the globe's remaining carbon "budget".[1]

For example, Greenpeace commissioned a study that estimated the GHG emissions in 2020 from 14 major fossil fuel infrastructure expansions currently under consideration or development (Meindertsma and Blok 2012). The authors, at Ecofys, estimated the CO_2 emissions associated with combustion of the fuels, and the GHG emissions associated with construction and operation, calculated as a fuel-specific multiplier (15% for coal and conventional oil, higher for tar sands, shale gas, and natural gas).[2] In total, the 14 projects studied were associated with emissions of over 6 gigatonnes CO_2e (Gt CO_2e), which is equivalent to about 10% of projected global emissions in 2020 (UNEP 2012). The two largest emitting activities were the expansion of coal mining in China's western provinces and in Australia, associated with 1.4 and 0.8 Gt CO_2e, respectively.

The literalist perspective tends not to analyze or quantify the avoided emissions – i.e. those that might occur in the absence of the project. In some cases, the literalist perspective is not necessarily intended as a full net emissions analysis, but rather as indicator of the potential scale of emissions associated the fuel supplied by a project (de Place 2013).

The fatalist: The project has no net impact on the global supply and consumption of fossil fuel

In this view, a proposed expansion of fossil fuel infrastructure would have no impact on global fossil fuel consumption: the project would displace another fossil fuel resource, or an alternative handling of the same fossil resource, one for one. We term it the fatalist because it finds (or assumes) that the fate

of global fuel markets – and, to large extent, associated GHG emissions – is largely unaffected by the project being assessed.

An example of this perspective is the found in the analysis commissioned by the U.S. Department of State for the Keystone XL pipeline expansion, which, when completed, would transport crude oil primarily from Alberta, Canada, to the Gulf Coast of the U.S. Analyzing this issue, EnSys stated that "global and national demand for oil is not sensitive to the availability of pipelines to export crude oil" from Western Canada. EnSys also found that within Western Canada, "production volumes were not affected by changes in assumptions about pipelines…" (Ensys 2010, p.80).[3] Based in large part on this assessment, EnSys found no change in global GHG emissions with or without the Keystone XL pipeline (Ensys 2010, p.41 in the appendix).[4]

A similar logic has been applied in the case of coal exports from the U.S., where some analysts have assumed that supplying coal to China would simply displace, one for one, China's existing coal supply (Wolak and Morse 2010), with no impact on global GHG emissions.

These examples illustrate two variants of the fatalist perspective. In one case, absent a given project (e.g. Keystone XL pipeline), the same fossil fuel resources (e.g. Western Canada crude) is assumed to still reach the market (e.g. by rail or other pipelines). The GHG impact here would only be the difference in emissions of alternative transportation mode. In the other variant, the assumption or finding is that a similar amount of a

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1   Research indicates that only a finite amount of carbon can still be emitted to the atmosphere if global warming is to be limited to 2°C – the globe's remaining carbon "budget" (Meinshausen et al. 2009). The carbon budget approach is not conceptually unique to the literalist approach (it could be applied to any accounting of emissions), but it has specifically been cited by researchers applying this viewpoint.

2   This multiplier was based on a literature review on each fuel type, not on analysis of each individual project.

3   The U.S. Department of State used this finding to support its conclusion that "approval or denial of any one crude oil transport project, including the proposed [Keystone] Project, remains unlikely to significantly impact the rate of extraction in the oil sands" (U.S. Department of State 2013, pp.1.4–1) and, by extension, GHG emissions.

4   The study did also include a "No Expansion" case, which assumed not only that Keystone XL would not be built but also that any other line not operational as of 2010 would also not be built. In this scenario, global GHG emissions would be virtually unchanged in 2020 and reduced by 20 million tonnes CO_2e in 2030, relative to if Keystone was built (Ensys 2010, p.84), or about 0.1 t CO_2 equivalent for every tonne CO_2e of crude expected to be transported by the pipeline.

Tar sands mining infrastructure in Alberta, Canada © Flickr / Julia Kilpatrick, Pembina Institute

different fossil fuel resource (e.g. Chinese coal) would otherwise come to the market in the absence of the project (e.g. U.S. coal exports terminal).[5] Here, the GHG impact would be the difference in emissions associated with extracting and delivering the alternative resources.[6]

The economist: The project decreases global prices and increases consumption of fossil fuel

In the (neoclassical) economist's view, expanding the supply of a fossil fuel will lower prices and, as a result, increase the quantities consumed.[7] For example, building an export terminal in the Western U.S. will bring a new source of coal (e.g. Powder River basin) to the Pacific coal market, competition will increase, prices in the Pacific market will decline, and power plants in China or Vietnam as well as other buyers will consume more of it (Power 2011).

The challenge for the economist is how to analyze this complicated supply and demand dynamic. In the literature, we have found three basic economic approaches applied to fossil fuel markets: a simple use of elasticities (which relate changes in price to changes in supply and/or demand), partial equilibrium models (which include elasticities and other effects), and general equilibrium models. We describe these three variations of the economist approach below.

Simple elasticities

A common way that economists analyze supply and demand relationships is through the use of price elasticity. A price elasticity is a ratio that relates changes in supply or demand of a product to changes in that product's price. Using elasticities, an analyst can estimate, assuming other factors are constant, the effects of changes in supply or demand on the consumption of a product.

An example of this approach is work commissioned by the Energy Foundation to analyze the export of coal from the Powder River Basin in the U.S. to coastal electricity gen-

erators in China (Power and Power 2013). The authors researched price elasticities of supply and demand for the specific coal market studied and used those elasticities to estimate the impact of increasing coal trade from the U.S. to coastal power plants in China. Assuming annual coal exports of 127 million tonnes into an existing import market of 600 million tonnes, they estimated that each tonne of coal exported would result in 0.7 tonnes of net increased coal usage in China, with a corresponding increase in CO_2 emissions (Power and Power 2013, p.29).

Power and Power (2013) rely largely on long-run elasticities, which are designed to take into account major capital stock decisions, e.g. among types of electric power plants.[8] In so doing, they take into account some of the important long-term effects: namely, if coal prices decline as the result of greater coal availability in the market, power plant developers will have less incentive to invest in higher-efficiency coal technologies or in other generation options such as natural gas and renewable energy, and may thus invest in, and lock in, lower-efficiency coal-based power production for an extended period. By contrast, short term elasticities assume that capital stock is fixed, and thus options for significant changes in the level of consumption are much more limited.

Partial equilibrium model

Like the use of elasticities, partial equilibrium models can assess changes in supply or demand for a particular product (in this case, fossil fuels). Compared with the simple use of elasticities, partial equilibrium models are more detailed, including market responses that occur at broader geographic scales and over different time periods. (In fact, they are often built using different elasticities for each region and time scale.) Partial equilibrium models of the energy sector often allow market actors to make investments in power plant technologies based on the model's forecasts of future energy prices.

An example of the use of a partial equilibrium model to study fossil fuel infrastructure is an analysis of alternative scenarios of coal exports in Indonesia, conducted at the German Institute for Economic Research (Haftendorn et al. 2012). The authors develop a model of world coal markets, COALMOD-World, and use it to analyze two scenarios: one where coal exports rise at business-as-usual levels to well over 200 million tonnes per year, and another in which Indonesia limits coal exports beginning in 2020 to 50 million tonnes annually, decreasing to 25 million tonnes in 2025 and to zero in 2030.

They find that, over the period analyzed (through 2030), limiting exports would reduce global CO_2 emissions by about 0.05 t CO_2 for each t CO_2 of coal not exported. This analysis assumes that exploitation of the rest of the world's coal deposits is unconstrained, and therefore substitutes for most of the lost Indonesian coal. The analysts also ran a scenario where other coal supplies were constrained to historic production levels. In this case, the same export limits in Indonesia would reduce global CO_2 emissions by about 0.13 t CO_2 for each

5   EnSys's "No Expansion" case (see footnote 5) assumed that Middle East crude would otherwise substitute for the absence of further development of the Western Canada crude resource (Ensys 2010, p.80).

6   A full life-cycle analysis would also consider emissions resulting from any differences in by-products (e.g. petroleum coke). For example, the Natural Resources Defense Council has adjusted estimates by the U.S. State Department to account for emissions associated with petroleum coke (NRDC 2013).

7   We use the term *economist* here for simplicity, recognizing that there are a range of approaches to economics and that the approached described here would perhaps be most consistent with a *neoclassical economist* view.

8   Power and Power appear to use a long-run elasticity of demand of -1.2 (Jiao et al. 2009) and an elasticity of supply of 0.5 that is between short- and long-run values (0.3 and 1.9, respectively) in the source cited (Light et al. 1999), perhaps to be conservative. They discount both the possibility that changes in prices in the export market (the U.S.) may affect substitute fuels in the U.S., as well as possibility that lower coal prices in China could increase natural gas usage in the country (due to the very low domestic supplies of natural gas in the country and limitations on import infrastructure).

t CO_2 of coal not exported.[9] In contrast the Power and Power (2013) analysis, COALMOD-World uses short run elasticities and cost functions (Haftendorn et al. 2010), which may help to explain the divergence in results (in terms of t CO_2 emitted per t CO_2 of coal added to, or removed from, the market).

General equilibrium model

General equilibrium models take into account supply and demand across a wide variety of markets, in theory modeling the global economy and all linkages between markets, such as among producers, the labor market and the energy market (Ellis 2010). Although broader in scope than partial equilibrium models, general equilibrium models (sometimes computable general equilibrium models, or CGEs) have expanded data requirements that often mean less resolution in any particular sector. This can make CGEs less well suited to analysis of expansion of a particular fossil fuel project, but better suited to assessing broad economic changes, such as a market shock or the changes to national or international economic policy, including fossil fuel subsidies.

An example of a CGE applied to analyze changes in fossil fuel production is an analysis of the removal of subsidies for coal production in Western Europe and Japan conducted by researchers in Australia (Anderson and McKibbin 2000).[10] In the G-Cubed model of the world economy, the researchers phased out coal producer subsidies in Western Europe and Japan between 1990 and 2005, while relaxing any import restrictions on coal in these countries, and modeled results through 2022 compared to a reference scenario without these policy changes.
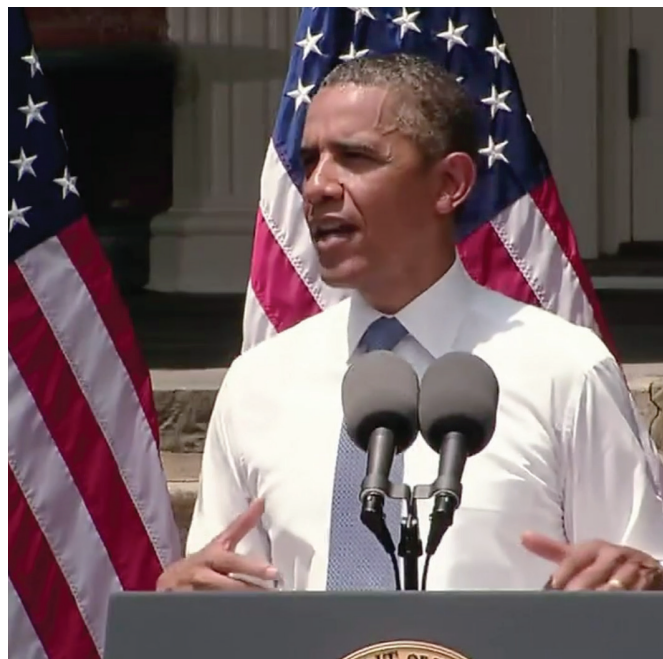
In their model, phasing out the subsidies led coal usage to drop dramatically in Western Europe, leading to reduced CO_2 emissions from coal in that region. Removal of the coal production subsidies also led to an increase in the international price of coal and, by extension, to a number of international effects, including increases in coal exports from other coal producing regions, a shift away from coal as an energy source, and decreased production of energy-intensive goods.[11] Based on their results and their cited reference case (IEA 1994), we estimate the net global emissions decrease for each tonne of CO_2 avoided from coal production in Western Europe and Japan is at least 0.8t CO_2.[12]

U.S. President Barack Obama gives an address on climate change at Georgetown University, June 2013. [Still from White House video]

Discussion and next steps

As shown in our brief review, approaches to estimating GHG emissions impact of fossil fuel infrastructure expansion (or contraction) differ greatly. Two approaches, the literalist and the fatalist, take starkly different views on emissions from combustion of the fossil fuel itself, essentially counting either all or none of the resulting CO_2. The third primary approach, the economist, uses economic logic to assess the balance of emissions from the fuel itself and any substitute fuels.

Table 1 presents a summary of the focus of each analytical approach, as well as details of an example study for each. Figure 1 depicts the sample results graphically.

As seen in Table 1 and Figure 1, results for the three different economist approaches differ greatly. Variability in results among these specific studies may be driven more by the specific policy assessed and the specific modeling choices made than fundamental differences between approaches.

For example, if using a simple economic elasticity approach, the choice of whether to use short or long-run elasticities, which can differ by up to an order of magnitude, could dramatically influence results. Similar choices exist about how to construct a partial or general equilibrium model, including not only the choice of short- and long-run elasticities but also the investment behavior and extent of economic foresight of actors in the model choosing new power plant technologies. And for all economic approaches, the choice about what constitutes a fossil fuel market could, in some cases, significantly affect results. For example, one analysis of coal exports from the U.S. to China (Power and Power 2013) was developed based on how the behavior of a set of coastal Chinese power plants is believed to differ from inland plants, a type of within-country dynamic that may not be captured by more generalized economic models.

Each approach brings a different perspective: no single one necessarily offers the "correct" perspective, nor do they necessarily attempt to answer the question. For example, the literalist approach does not attempt to address the incremental,

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9   The authors also do not analyze the possible long-term social or political impacts of CO_2 emissions of limiting coal exports; they state, "The reduction in coal consumption in Asia due to higher prices may have additional benefits as consumers will become more aware of other alternatives for their energy supply such as renewables, energy conservation and efficiency and governments might enact policies towards those ends" (Haftendorn et al. 2012, p.279)

10 Although neither of these regions have large coal reserves, Anderson and McKibbin estimated that they did have large subsidies on coal production in their analysis base year, 1990. About 70% of fossil power production in Western Europe in 1990 was from coal (IEA 1994).

11 These changes lead to a decrease in CO_2 emissions in countries that are not net coal exporters, but an increase in countries that do export coal, due to increased income and consumption. For each tonne of CO_2 reduced in Western Europe and Japan, the net global reduction was at least 0.96 t CO_2, indicating minimal leakage.

12 Anderson and McKibbin report a global decrease in CO_2 emissions of 5.3% relative to reference case in 2005. We apply these results to International Energy Agency's *World Energy Outlook 1994* (which they cite as the reference case) to estimate CO_2 reduction of -1.5 Gt CO_2. We estimate *WEO 1994* reference case emissions from coal combustion in Europe and Japan in 2005 to be 1.8 Gt CO_2. If all of these emissions were from domestic coal, and all were eliminated by the removal of domestic subsidies, then the effect of subsidy removal would be a global reduction of 1.5/1.8 = 0.8 t CO_2 for each t of CO_2 content of coal avoided. If subsidy removal did not eliminate all domestic coal production, this ratio could be higher.

Table 1: Summary of sample results and emissions included in quantification approaches

Approach	Example study			Emissions included in project and counterfactual scenarios		
	Topic and source	Project or policy evaluated	Results t CO2e of net impact per t CO2 of fuel produced, handled	Extraction and processing	Transport-ation	Combustion
"Literalist"	Global coal reserves (Meindertsma and Blok 2012	Exploitation of reserves	>1.151[13]	Project only	Project only	Project only
"Fatalist"	Keystone XL crude pipeline (Ensys 2010)	Construction of pipeline	0.0-0.1[14]	Both	Both	Assumes no change
"Economist" (simple elasticities)	U.S. coal exports (Power and Power 2013)	Export of U.S. coal to coastal China	0.7	Neither	Neither	Both (handled fuel only)
"Economist" (Partial equilibrium)	Indonesia coal exports (Haftendorn et al. 2012)	Limit (to zero) of coal exports	0.05-0.13	Neither	Neither	Both (handled fuel only)
"Economist" (General equilibrium)	Coal production in Western Europe and Japan (Anderson and McKibbin 2000)	Cessation of coal producer subsidies	>0.8	Both (in principle)	Both (in principle)	Both, by fuel

net emissions impact of the project, but instead accounts for the contribution of the fuel handled by the project to global GHG emissions. By contrast, the economist seeks to assess the net impact, but in so doing must also make assumptions about long-term economic responses that are difficult to assess. Researchers may benefit from further development of economic methods and models to assess these long-term effects.

Furthermore, the three approaches are not mutually exclusive, nor are they necessarily the only approaches possible. For example, another analyses of the Keystone XL pipeline uses detailed economic logic to justify the perspective that we otherwise would term the fatalist (Forrest and Brady 2013), while yet another (NRDC 2013) uses economic logic to argue the opposite, that approval or denial of Keystone XL has significant implications for global GHG emissions.

Finally, none of the approaches address what may be one of the most significant emissions impacts: how the development of further fossil infrastructure might further contribute to social or political norms, risk reduction, or economies of scale for fossil-based infrastructure that further contribute to its lock-in (or other fuels' or technologies' lock-out).

For example, implementation of a major new fossil fuel infrastructure project (such as development of rail infrastructure to enable development of a coal deposit in Mongolia) may create local interests and political forces that lead to further, similar developments in the future (such as development of additional coal deposits). In contrast, decisions not to implement the same project could lead other alternative energy supply industries (e.g. solar energy in the Gobi desert) to flourish and "lock in" or strengthen political momentum in the opposite direction.

Focusing solely on marginal impacts of single investments can disguise larger, systemic changes and path dependencies. Therefore, in addition to those outlined above, a fourth perspective, that of a *political economist*, is important to consider as well, though it is less likely than the other three to yield a quantifiable result. This political economist might look at the political consequences of proceeding or not proceeding with a fossil fuel infrastructure project – and of the rationale for such a decision – and how climate policies or the investment actions of other major players might be influenced.

As we wrote above, no single approach is necessarily "correct". Based on the research and approaches reviewed, however, we find it highly unlikely that the GHG emissions impact of new fossil fuel infrastructure investment is near zero, given the inevitable market responses, as well as the likelihood that projects contribute to the types of larger, systemic changes noted above. In most cases, some fraction – more than none, and less than 100% – of the added fuel supply will result in increased demand and fuel use. However, large uncertainties defy precise estimates. In some cases, the fraction could (far)

13 Based on literature review, Meindertsma and Blok assume a markup of 15% for conventional oil and coal to account for production and transportation of the fuel. Their assumed markups for tar sands, shale gas, and natural gas are higher.

14 The 0.0 example is based on EnSys's Keystone XL compared with no-Keystone XL cases. The 0.1 example is based on EnSys's Keystone XL compared with the No Expansion case, based on an assessment using the IEA's ETP Model and assuming that oil processed by Keystone XL is more emissions intensive on a life-cycle basis than that assumed in the No Expansion case.
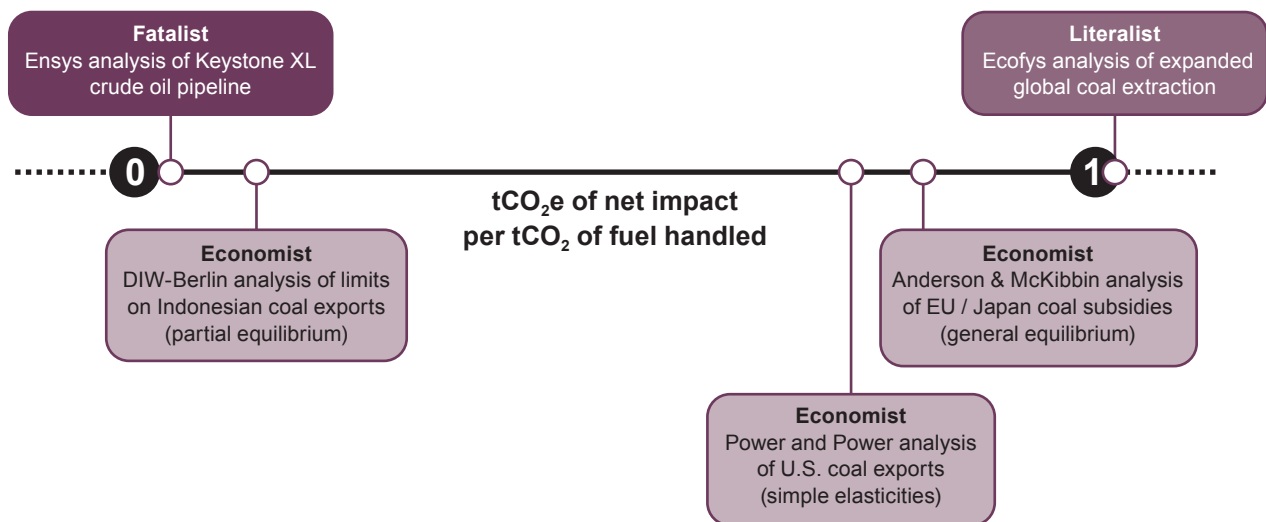
Figure 1. Sample results from analyses reviewed, on a scale from 0 to 1 (t CO_2e net impact per t CO_2 of the fuel handled)
We draw the scale here from 0 to 1, though it is possible (as in one study reviewed) that results could be greater or less than this range. For example, the Greenpeace / Ecofys analysis found a result somewhat greater than 1. In principle, a result could be less than zero, if some type of new fossil infrastructure (e.g. natural gas export terminals from the U.S. West Coast) were to displace consumption of a more carbon-intensive source (e.g. coal in China), though we found no studies analyzing such a case in our review.

exceed 100% if the project (or its avoidance) catalyzes large-scale changes, e.g. through leadership, technological learning, and other spillover effects.

Our research will continue to explore methods for assessing the incremental GHG emissions impact of new fossil fuel infrastructure. Ultimately our goal is to help develop an analytical framework that researchers and other interested parties can apply in order to better understand the potential emissions consequences of new fossil fuel supply investments. This framework may include a mix of the perspectives outlined here – e.g. the literalist's calculation of the emissions associated with use of the additional fuel supplied; the (neo-classical) economist's assessment of the dynamic response of fossil fuel markets to changes in supply and demand; and the political economist's consideration of interests and path dependencies created or strengthened. In doing so, we will likely will examine more closely the neo-classical economist's suite of assumptions and models, in particular the rationale for, and sensitivity to, the choice of short-run and long-run elasticities and use of more region and resource-specific supply curves.

Uralmash dragline excavator in the Narva oil shale open pit mine in Estonia © Wikimedia Commons / PjotrMahh1

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