2016

Clearing the Air: How Canadian LNG Exports Could Help Meet World Greenhouse Gas Reduction Goals

James W. Coleman
Southern Methodist University, Dedman School of Law

Sarah Marie Jordaan
Johns Hopkins University

INSTITUT C.D. HOWE INSTITUTE
Essential Policy Intelligence | Conseils indispensables sur les politiques

E-BRIEF

August 24, 2016

ENERGY AND NATURAL RESOURCES

Clearing the Air: How Canadian LNG Exports Could Help Meet World Greenhouse Gas Reduction Goals

by
James W. Coleman and Sarah Marie Jordaan

- With a glut of natural gas in North America, Canada's natural gas sector is looking to reach new global markets for liquefied natural gas (LNG) exports. The federal government will likely rule soon on environmental assessments of LNG exports facilities on Canada's west coast.
- If LNG from Canada serves coal-dependent countries, mostly in Asia, Canadian LNG will likely lower global greenhouse gas emissions. However, LNG exports to less coal-dependent countries could result in a net emissions increase.
- It is impractical for regulators to assess how individual LNG export facilities will affect overseas greenhouse gas emissions because of uncertainty in markets, which presently makes it nearly impossible to predict exactly where the natural gas will be consumed. Instead, Canadian governments should look to reduce domestic emissions and work toward international partnerships that lower greenhouse gas emissions from the entire energy production and use life cycle.

The future of Canada's natural gas industry could hinge on the success of exports of liquefied natural gas (LNG) from its west coast. With the ongoing shale revolution, the United States is importing less natural gas, so Canada needs new markets for its natural gas. Could the global expansion of LNG markets also drive the world's energy and greenhouse gas (GHG) futures?

The authors thank Benjamin Dachis of the C.D. Howe Institute and several anonymous reviewers for comments on an earlier draft. They retain responsibility for any errors and the views expressed here.

Some experts argue that the increased use of LNG could help solve the world's environmental problems by reducing use of coal (Dews 2014); others say that it would only make GHG emissions worse (Sierra Club 2014). Determining the answer is a critical step for reducing the overall impacts of expanding LNG trade. If greater use of LNG increases the global amount of GHGs, LNG projects could prove to be risky long-term investments that either put GHG reduction goals out of reach or become unprofitable if subject to strict GHG regulations.

This E-Brief, relying on new research by an interdisciplinary team, shows how the impact of LNG exports on GHG emissions would depend on what power sources they replace if used in electricity generation, and suggests ways Canada can make its policy on LNG export facilities align with its economic and environmental goals. In our view, assessing the downstream emissions of a particular LNG project is impractical because it is difficult to predict where the LNG will be sent. We suggest, instead, that national and provincial governments and regulators, within the limits of their respective authorities, could maximize the climate benefit of LNG by:

- encouraging importers of Canada's LNG to reduce their use of coal power through diplomacy and regulations that ratchet up to reward trading partners that implement their own GHG pricing policies; and
- focusing on the emissions they can control and reducing upstream emissions from the development of natural gas projects.

The World's Energy and Climate Future Could Depend on LNG

The world's energy future presents a perplexing dilemma: how to expand energy access while addressing global climate and environmental problems. World electricity consumption will continue to rise in coming decades as developing nations extend increasingly reliable electricity to their growing populations. According to the International Energy Agency (IEA 2014), world electricity capacity will double by 2040, even as older power plants are retired and replaced. The result, according to the IEA, will be 7,200 gigawatts (GW) of new electricity generation capacity. How will this new electricity capacity be generated? As developing countries grow richer, their populations will demand cleaner air, meaning power generation from greenhouse-gas-intensive sources will become increasingly problematic. Meanwhile, aggressive action on GHG emissions will be needed to meet the GHG reduction goals agreed to at the 2015 United Nations Framework Convention on Climate Change in Paris.

Many analysts believe a global natural gas boom, enabled by burgeoning LNG markets, could be the key to addressing these issues (IEA 2011; MIT 2011, IEA 2011), and give several reasons to expect "a Golden Age for Gas," as the International Energy Agency calls it. Natural gas-fired electricity generating plants can be built in many places at a reasonable cost. They are free from the geographic restrictions of geothermal or hydro power and the massive upfront costs and safety risks of nuclear. They do not create the smog problems that plague urban areas relying on coal power. Unlike solar and wind power, natural gas plants can be run at any time on demand. Such plants even work well with solar and wind because they are easy to ramp up or down to match power demand by supplementing the intermittent power these renewable sources provide.

What, then, would be the impact of an LNG export boom on global greenhouse gas emissions? Could natural gas help reduce emissions by displacing coal power in importing countries? Or would the increased use of natural gas merely delay the transition to renewable sources such as solar and wind, or even increase emissions by replacing existing, almost GHG-free, sources such as nuclear and hydro power?

Recent research estimates the marginal life cycle of GHG emissions due to LNG exports from Canada and considers the sources of power that LNG exports likely would displace (see Coleman et al. 2015). Results suggest that such exports could lower emissions in some Asian countries but raise emissions in other countries.

The Effect of LNG Exports on GHG Emissions Might Depend on Where They Are Sent

Determining whether a particular fuel will raise or lower global GHG emissions can be tricky. Consider the example of ethanol from corn. Burning ethanol produces carbon dioxide (a greenhouse gas), but growing corn removes carbon dioxide from the air, while converting wetlands into cornfields produces greenhouse gases. To measure the total impact of corn ethanol, one must estimate and balance all the impacts associated with the fuel's production, use, and disposal. The quantitative tool that scientists use to estimate the net effect of all these stages is called "life cycle assessment." This tool is increasingly employed by regulators around the world, but, as with any model, it relies on uncertain estimates and assumptions.

To perform a life cycle assessment of LNG exports from Canada, Coleman et al. (2015) collected from the existing literature measurements and estimates of emissions at each stage of the natural gas life cycle: production at the well, processing, mid-stream infrastructure operations, liquefaction, transport, regasification, and end use. These estimates included GHGs emitted by the power sources necessary to drive each step, as well as fugitive emissions that leak into the atmosphere during each step. Fugitive emissions are particularly important because natural gas is largely composed of methane, a potent greenhouse gas. The study focuses on natural gas production in British Columbia, because that province has committed to expanding LNG exports dramatically, and initially promised that "LNG development in B.C. can have lower life cycle greenhouse gas emissions than anywhere else in the world" (British Columbia 2012). More recently, the province has scaled back that promise to a commitment to have the cleanest LNG facilities in the world (British Columbia 2014).

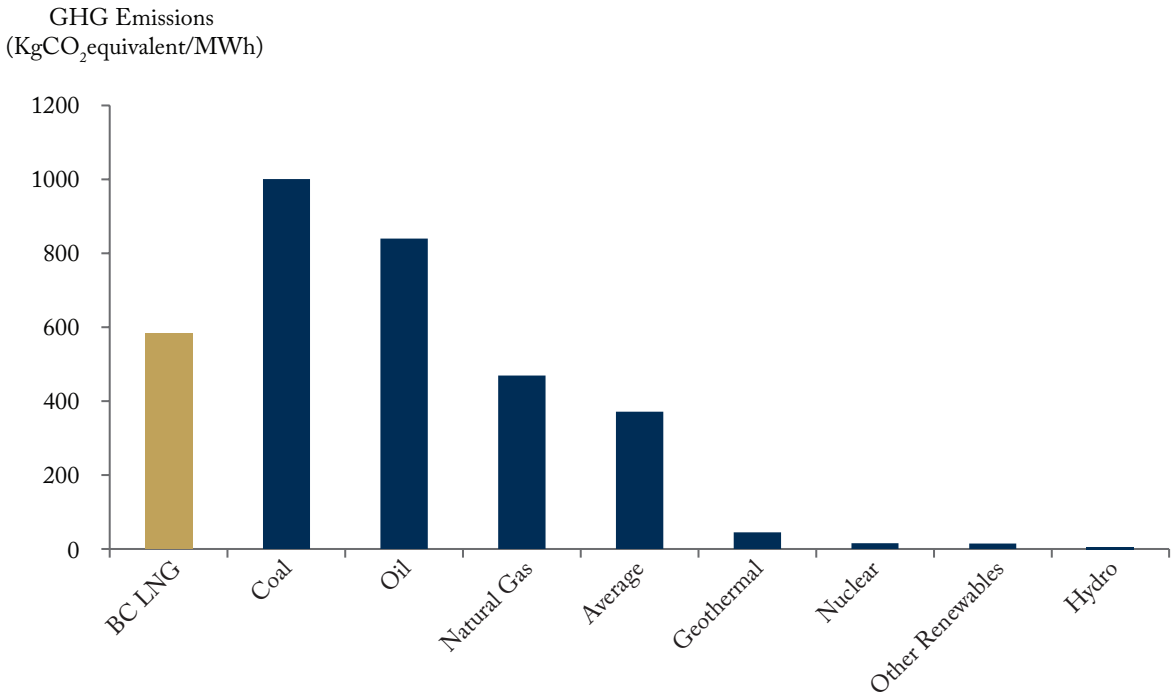
The life cycle assessment shows that importing countries could lower their greenhouse gas emissions by replacing their coal or oil-fired power plants with plants that burn natural gas from Canada (Figure 1). On the other hand, GHG emissions would increase if Canadian LNG displaced low-GHG sources such as renewables, nuclear, and hydro power.[1]

In short, the impact of Canadian LNG exports on emissions would depend on what sources of power they displaced. This, in turn, would depend on the destination of those exports. Of course, one could assume that, regardless of where LNG is sent, it would simply displace a representative fraction of world electricity generated by other power sources. But this would not be a sensible way to estimate the impact of LNG exports, for two reasons.

First, natural gas markets, unlike oil markets, have strong regional differences. Tankers can easily bring oil overseas to serve new demand centres that raise the local price of oil; natural gas, in contrast, is comparatively expensive to ship overseas. It must be cooled most of the way to absolute zero until it becomes a liquid, then loaded onto a quarter-billion dollar refrigerated vessel that can carry it to a destination country where it can be turned into a gas again, then piped to an end-user and burned.

1 For sources other than Canadian LNG, Coleman et al. (2015) report the median estimated emissions from the life cycle assessment collected by the Intergovernmental Panel on Climate Change (IPCC 2012). Life cycle emissions from British Columbia LNG are higher than the median life cycle emissions from natural gas because of the energy cost of liquefying and transporting LNG.

Figure 1: Median Life Cycle Greenhouse Gas Emissions from Different Sources of Electricity



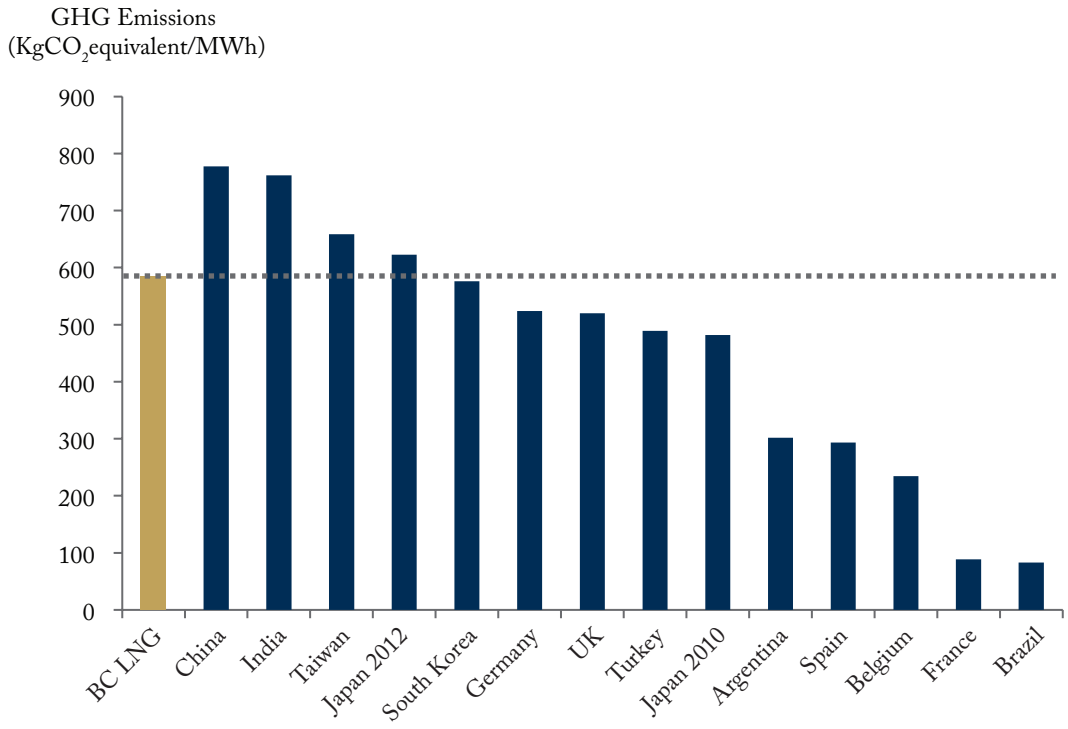
Note: Median corresponds to the 50th percentile for each technology.
Source: Coleman, Kasumu, Liendo, Li, and Jordaan (2015).

Second, only a few countries – principally Argentina, Belgium, Brazil, China, France, Germany, India, Japan, South Korea, Spain, Taiwan, Turkey, and the United Kingdom – have the potential to import large amounts of LNG, and each uses a unique mix of power sources for electricity generation.[2] Coleman et al. (2015) suggest that exporting LNG to China, India, Japan, and Taiwan would lower global GHG emissions because those countries rely so much on power from coal and oil. Exporting LNG to the other major potential markets, however, would increase net GHG emissions because those countries rely on low-GHG sources for a significant portion of their power needs. Figure 2 compares life cycle emissions from Canadian LNG and weighted average life cycle emissions by the power sector in the 13 major import markets.

Of course, one can never say with certainty how importing more LNG would affect the fuel mix in destination countries. As in any life cycle assessment, one must rely on uncertain estimates and assumptions. LNG might displace either coal or low-GHG sources; indeed, natural gas plants are ideally suited to replace coal plants, and, as noted, might actually facilitate an expansion of renewable sources such as solar and wind by being able to

2 See Coleman et al. (2015) for details on these potential markets and why they were selected for the study.

Figure 2: Life Cycle Greenhouse Gas Emissions from Electricity Generation in Major Potential Markets for Canadian LNG



Source: Coleman, Kasumu, Liendo, Li, and Jordaan (2015).

ramp up or down to complement these renewable sources' intermittent output. Countries could also use natural gas as a crutch to help them phase out nuclear power. Alternatively, they could use natural gas, rather than expanding renewables, to meet new demand or replace old facilities.[3]

These divergent theories – that LNG exports would tend disproportionately to displace either coal or low-GHG sources – have opposite implications for the reduction of GHG emissions. If, in fact, LNG exports tended to displace low-GHG sources, then net GHG emissions from the use of more LNG would be higher than we estimate. If LNG exports tended to displace higher-GHG-emitting fossil fuels, net GHG emissions from the use of more LNG would be lower than we estimate.

3 Natural gas from LNG imports could also be used for home-heating use, replacing traditional heating fuels such as oil and coal, which could reduce GHG emissions. Here, however, we consider LNG only as a source of electricity production.

Maximizing the Benefits of Canadian LNG

There is good reason to think that Canadian LNG exports could help meet the GHG emissions reduction targets set at the Paris climate change conference. British Columbia's LNG industry is particularly well positioned to support this effort because of its relatively easy ocean access to energy markets in Asian countries that could cut their GHG emissions significantly by replacing coal-fired power with natural gas. Our life cycle assessment suggests, however, that it is far from certain that Canadian LNG exports would reduce global GHG emissions. Nine of the 13 likely markets for increased LNG exports, in fact, would increase their emissions if they replaced a representative slice of their power generation with Canadian LNG. Additionally, the measurement and estimation of fugitive emissions remain uncertain, suggesting the need to improve measurements and the use of cost-effective controls.

How could policymakers in British Columbia and at the federal level align their natural gas and LNG policies with their aim of lowering global GHG emissions? Our life cycle assessment suggests three ways.

Focus on domestic emissions rather than on how individual LNG projects will affect GHG emissions overseas

First, regulators should not focus on how LNG exports will impact GHG emissions overseas – as described in the next recommendation, this is better left to international negotiations. The full impact of an individual facility on global emissions is nearly impossible to estimate unless regulators know where the LNG will be sent when they approve a project, or how evolving market conditions may change the original estimation of the impact.

Thus, British Columbia's initial promise to export LNG with the lowest GHG emissions "on a life cycle basis" was unwise and perhaps even impossible: the life cycle impact of LNG depends crucially on what it replaces, and British Columbia cannot ensure that it will always replace coal, so it cannot make such a guarantee. On the other hand, to the extent that LNG exports from British Columbia are more likely to go to coal-dependent Asian countries, they might play a greater role in emissions reductions than LNG facilities in eastern Canada and the United States, which may be more likely to serve importers in Europe (United States 2015a).

Promote the use of LNG in coal-using countries

Second, because Canada's LNG exports would have the greatest impact on reducing GHG emissions if they are used to replace coal, Canada should use diplomacy to encourage importers of its LNG to retire coal power. This could be achieved through bilateral or multilateral agreements with major importers, similar to the recent GHG emissions reduction agreement between the United States and China.

Alternatively, the federal government could work, along with US negotiators, to encourage other Asian countries to reduce their reliance on coal-fired power. Canadian regulators could also adopt unilateral measures to encourage other countries to reduce their emissions, such as commitments to ratchet up the stringency of Canadian regulations in response to emissions reduction regulations elsewhere (Coleman 2014). For example, China has recently committed to adopting a cap-and-trade system for GHG emissions (United States 2015b). As China implements this plan, and the cost of GHG emissions in that country rises, British Columbia could commit to corresponding increases in its carbon tax.

Focus on cost-effective ways to reduce domestic emissions

Third, provincial regulators should focus on the portion of the life cycle that is unambiguously within their power to control – namely, upstream emissions from natural gas production, processing, and liquefaction. British

Columbia has taken steps to address some of these emissions with its new and updated Liquefied Natural Gas Facility Regulation and Flaring and Venting Reduction Guideline, adopted under the *Oil and Gas Activities Act*. Nevertheless, there are gaps in the coverage of these emissions – particularly in addressing methane leaked during transport and GHGs vented during processing (Horne and MacNab 2014). Provincial regulators should address these gaps and ensure that regulations keep pace with changing technology for reducing fugitive and combustion emissions.

Conclusion

Liquefied natural gas exports could prove to be crucial for Canada's natural gas industry and for the world's energy future. To ensure that exports are compatible with global efforts to address climate change, Canadian regulators need to recognize the limits of their authority, use negotiations and incentives to encourage compatible GHG reduction strategies in other countries, and carefully control GHG emissions within their own jurisdictions. If they do so, Canadian LNG can play a positive role in addressing the world's economic and environmental problems.

References

British Columbia. 2012. Ministry of Energy and Mines. "British Columbia's Natural Gas Strategy: Fuelling B.C.'s Economy for the Next Decade and Beyond." Victoria. Available online at http://www.gov.bc.ca/ener/popt/down/natural_gas_strategy.pdf.

———————. 2014. "B.C. to have world's cleanest LNG facilities." Press release. Victoria, October 20. Available online at https://news.gov.bc.ca/stories/bc-to-have-worlds-cleanest-lng-facilities.

Dews, Fred. 2014. "Larry Summers Argues Case for Lifting the Crude Oil Export Ban." Washington, DC: Brookings Institution, September 9. Available online at http://www.brookings.edu/blogs/brookings-now/posts/2014/09/larry-summers-lift-crude-oil-export-ban.

Coleman, James. 2014. "Unilateral Climate Regulation." *Harvard Environmental Law Review* 38 (1): 87–126.

Coleman, James, Adebola Kasumu, Jeanne Liendo, Vivian Li, and Sarah Jordaan. 2015. "Calibrating Liquefied Natural Gas Export Life Cycle Analysis: Accounting for Legal Boundaries & Post-Export Markets." Occasional Paper 49. Calgary: Canadian Institute of Resources Law.

Horne, Matt, and Josha MacNab. 2014. "Liquefied Natural Gas and Climate Change: The Global Context." Victoria, BC: Pacific Institute for Climate Solutions, October. Available online at http://www.pembina.org/pub/lng-and-climate-change-the-global-context.

IEA (International Energy Agency). 2011. *World Energy Investment Outlook 2014: Are We Entering a Golden Age for Gas?* Paris. Available online at http://www.worldenergyoutlook.org/media/weowebsite/2011/weo2011_goldenageofgasreport.pdf.

———————. 2014. *World Energy Investment Outlook 2014*. Paris. Available online at https://www.iea.org/publications/freepublications/publication/WEIO2014.pdf.

IPCC (Intergovernmental Panel on Climate Change). 2012. *Renewable Energy Sources and Climate Change Mitigation: Special Report of the Intergovernmental Panel on Climate Change*. Geneva. Available online at http://srren.ipcc-wg3.de/ report/IPCC_SRREN_Full_Report.pdf.

MIT (Massachusetts Institute of Technology). 2014. *The Future of Natural Gas*. Cambridge, MA. Available online at http://energy.mit.edu/wp-content/uploads/2011/06/MITEI-The-Future-of-Natural-Gas.pdf.

Sierra Club. 2014. Letter to United States Department of Energy Secretary Moniz. San Francisco, July 21. Available online at http://www.energylawprof.com/wp-content/uploads/2015/09/Sierra-Club-LNG-Letter.pdf.

United States. 2015a. Federal Energy Regulatory Commission. "North American LNG Import/Export Terminals Approved." Washington, DC. Available online at https://www.ferc.gov/industries/gas/indus-act/lng/lng-approved.pdf.

————————. 2015b. White House. Office of the Press Secretary. "U.S.-China Joint Presidential Statement on Climate Change." Washington, DC, September 25. Available online at https://www.whitehouse.gov/the-press-office/2015/09/25/us-china-joint-presidential-statement-climate-change.

This E-Brief is a publication of the C.D. Howe Institute.

James W. Coleman is Assistant Professor, Southern Methodist University, Dedman School of Law.

Sarah Marie Jordaan is Assistant Professor of Energy, Resources, and Environment, School of Advanced International Studies, Johns Hopkins University.

This E-Brief is available at www.cdhowe.org.