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The LNG Opportunity in BC: Separating *Rhetoric* from *Reality* – Part II

In Part I of this two-part series, we reviewed the main economic critiques of LNG development in British Columbia, concluding that while there are risks and economic uncertainties with respect to LNG in the province, the critics are largely off base with their professed economic concerns. Here in Part II, we address the more analytically challenging environmental issues that have been identified by various commentators who doubt the benefits of LNG.

Environmental Consideration

The environmental critiques of LNG in British Columbia centre largely around two clusters of issues:

1. Greenhouse gas emissions and the impacts of LNG development on the province's climate change policies and initiatives; and

2. The upstream impacts of natural gas development, most notably the use of water in the extraction process.

While there are other environmental issues, such as those around ambient emissions from LNG terminals, we have not placed the same emphasis on these because the LNG critics aren't focussed on them and the relevant issues are the same as with any large industrial plant development. How to manage these localized environmental effects is well known for the most part – hazardous materials management, wastewater, noise, ambient air quality regulation, near-shore aquatic and marine issues related to construction and ongoing operations.

Greenhouse Gases and LNG

To ground the discussion, a useful starting place is to be clear about three facts:

1. Contributions of greenhouse gases from fossil fuel use are increasing globally and need to be managed in both domestic and international contexts in order to address climate change;

2. Energy markets are dynamic, with long transition periods to new technologies and new supplies, owing in part to the massive capital stocks involved in existing (and future) energy systems; and

3. Natural gas, due to supply and demand dynamics, will inevitably play an important role in the shift to a less carbon-intensive global economy, as emphasized in the latest report from the Intergovernmental Panel on Climate Change (IPCC)[1] and other leading bodies such as the International Energy Agency (IEA).

The Natural Gas Imperative

The logical necessity of increasing natural gas use to help manage climate concerns is now well-established in the literature. Looking at global energy demand and supply options, it is simply not possible to convert, *en masse* and quickly, to low/no CO2 energy sources.

The size and complexity of the existing energy infrastructure, and the relative cost of supply options to satisfy demand, make it both technically difficult and costly to convert energy

[1] IPCC WG3 AR5 Summary for Policy Makers, pg. 23.

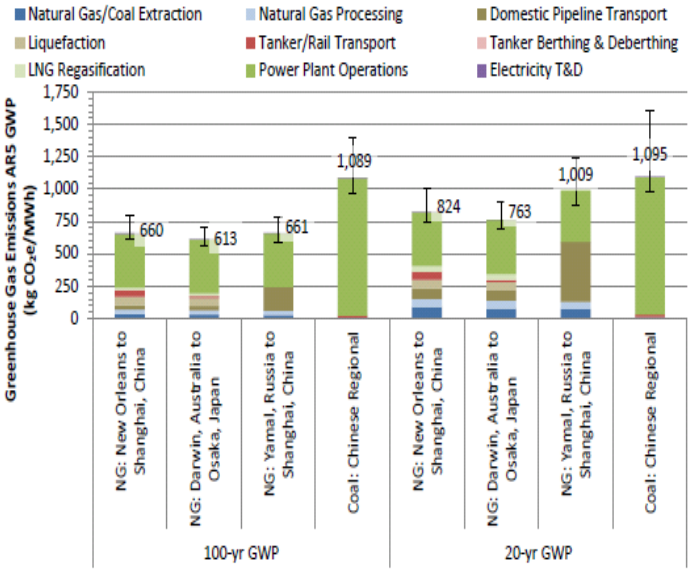
systems.[2] This is doubly true in a world where the lion's share of future growth in population, economic activity and energy consumption will be heavily concentrated in emerging market economies scattered across Asia, Latin America, the Middle East, and Africa.

As a result of these energy supply and demand realities, when climate change experts and policy advisors are asked to consider energy transition pathways, the option to increase natural gas use is almost invariably identified as a core component of the solution -- because only natural gas can serve as a relatively rapid substitute for higher CO2-emitting energy sources. This transition role for natural gas, in combination with other actions, can ratchet down an otherwise increasing global CO2 trend. The latest IPCC summary report for policy makers states this clearly:

> "*GHG emissions from energy supply can be reduced significantly by replacing current world average coal-fired power plants with modern, highly efficient natural gas combined-cycle power plants or combined heat and power plants, provided that natural gas is available and the fugitive emissions associated with extraction and supply are low or mitigated…In mitigation scenarios reaching about 450 parts per million (ppm) carbon dioxide equivalent concentrations by 2100 [those in which global warming is likely to stay within 2°C of pre-industrial levels], natural gas power generation without CCS acts as a bridge technology, with deployment increasing before peaking and falling to below current levels by 2050 and declining further in the second half of the century.*"[3]

Although is it generally agreed that natural gas has fewer GHGs than coal, a more definitive report[4] from the US Department of Energy's (DOE) National Energy Technology Laboratory confirms that, on a life-cycle basis, this is indeed true for LNG – even with long pipelines and long shipping distances to end-use markets. While the data below is for the United States, given the similarities it is reasonable to extrapolate the numbers and consider the outcomes as rough proxies for British Columbia.

Figure 1: Life Cycle GHG Emissions for Natural Gas and Coal Power in Asia



What the DOE analysis and the figure above show is that GHG lifecycle emissions, from natural gas exploration to LNG to final conversion in a power plant (in China), are 40% lower when compared to the use of coal in a Chinese coal-fired generation facility. This difference would likely be even more favourable in the case of BC as an LNG supplier, because the distance traveled from upstream through to delivery is shorter than the distance from the US (New Orleans) – and the *"transport of LNG contributes very little uncertainty to the overall result*."

This important research strongly supports LNG development in the United States and, by extension, in British Columbia.

[2] For an insightful review of energy system transitions see Peter A. O'Conner "*Energy Transitions.*"Pardee Papers, No. 12, 2010.

[3] IPCC WG3 AR5 Summary for Policy Makers.

[4] Life Cycle GHG Perspective on Exporting LNG from the US.

Meeting the 'Cleanest LNG' Commitment

While some LNG critics take issue with the entire concept of natural gas (wrongly in our view), others focus on domestic issues related to meeting provincial GHG targets and *lowering* the potential GHG output from LNG.

Part of the challenge in assessing domestic actions is that these activities need to be understood within the context of the aforementioned global nature of climate change – and, increasingly, energy markets. The practical application of this from an analytic perspective is that the BC government's commitment to the "cleanest LNG in the world" cannot be evaluated in isolation. From a global energy supply perspective, LNG exports into Asia are a net positive in terms of GHG output, due to the (previously detailed) displacement of coal emissions. The implications of this for the environment are clear: assuming a reasonably similar set of externalities, the preferred natural gas supply source for Asia would be the option with the lowest GHG footprint relative to cost and risk.[5]

From a more narrowly defined provincial perspective, LNG critics question the ability of the provincial government to implement policies that will meet the stated goal to have the cleanest LNG in the world, while respecting the province's own legislated GHG reduction targets.

This aspect of LNG and climate change analysis is not black and white; there is no simple list that compares the life-cycle analysis of various natural gas supply choices around the world, and then overlays technical (equipment) and policy (carbon pricing) options that allow these natural gas supply options to move up or down the ranking.

Rather than getting bogged down in a complex evaluation of global supply options to generate a putative precise ranking for LNG from British Columbia, critics have tended to break the evaluation down into a (global) comparative assessment at the LNG facility level and a more generalized life-cycle approach across the value chain in BC. In contrast, the provincial government has narrowed the commitment to the 'cleanest LNG' to the facility level.[6]

While there are challenges and methodological flaws with the critics' life-cycle approach, overall we find that narrowing the 'cleanest LNG' commitment to the facility level lacks policy coherence. In the end, the more pressing climate change objective is ensuring that Asian demand is filled with the 'best' natural gas supply option available.

Upon closer review, we find that both the critics and the government err on this point. The government has too narrowly construed its notion of the 'cleanest LNG', while critics have incorrectly[7] argued that the government's legislated climate change targets must be met as LNG is developed regardless of the broader global picture.

A more persuasive argument for critics would be to insist that the province's GHG targets should only be exceeded by LNG development if there is a net global benefit. To date, no LNG critic has suggested this course, with most preferring to look 'inward' at LNG development solely within the confines of BC's legislated GHG reduction targets. We believe that is too narrow a view.

However, even with a suite of conceivable policy actions to reduce LNG's GHG output, there is little doubt that building a sizable LNG sector in BC would increase the province's GHG

[5] Risk is important to include – in the absence of a secure supply, the most likely default supply options (coal, oil) have higher GHG output.

[6] This qualification has been made by both the Minister of Natural Gas Development and the Premier.

[7] On a global, net climate change basis.

footprint in a material way. Under almost any scenario, the growth in GHG emissions related to LNG development would mean that BC would not achieve a 33% decrease in GHG emissions by 2020 without some other way of offsetting emissions. The main proposals to limit emission increases suggested by environmental groups include: using electrical drives in LNG facilities that are powered by renewable energy instead of by natural gas; eliminating flaring/venting in the upstream gas industry with high pressure valves; electrifying upstream natural gas extraction; deploying various carbon capture and storage (CCS) technologies; and, purchasing GHG offsets.[8] While a detailed review of these potential actions is beyond the scope of this paper, the debate with respect to the options is generally one of cost impacts relative to competitiveness and technological risks within the industry.

On the surface, the options designed to meet the test of 'cleanest LNG in the world' are all currently technically possible, with the exception of CCS. The substantive policy question is: are these options reasonable relative to the costs and benefits derived? For example, using electric-drives would improve the operation of LNG facilities from a CO2 perspective; however, should LNG proponents be forced, via policy or legislation/regulation, to make that technology choice if it results in serious costs/risks that could negatively impact final investment decisions, or if the required capital would provide a better GHG benefit if deployed elsewhere? The answer, we believe, is 'no'.

Moreover, even if the answer is 'maybe', critics should be careful in assuming that other natural gas supply options – outside of BC – can deliver a better set of net GHG benefits on a global basis. And if the answer is 'yes', domestic considerations should also include a careful accounting for any potential losses of economic activity and revenue to the Crown that may result if the LNG industry fails to take root in BC.

Given the options available, becoming the cleanest LNG producer in the world is a complicated pursuit from a cost-relative-to-technology perspective. Some argue that given the size of the investments, using e-drives to power LNG facilities should be relatively straight forward, particularly since BC has some of the cleanest electricity in the world. However, if e-drives were the most efficient choice they would already be considered best practice and used globally – which is not the case.[9]

In terms of the broader package of CO2 reduction technologies and policies, there may be room to consider additional CO2 reduction options that both the government and the LNG critics have suggested could be implemented, including: upstream gas field electrification; high pressure valves; (further) reductions to flaring; facility-level technology benchmarking; offsets; and, possible technology funds.

Based on our review of the LNG critiques published to date, we see no compelling evidence that BC should delay or halt work on LNG purely on climate change grounds. On the contrary, despite domestic policy debates and policy-makers' understandable desire to foster a relatively clean local LNG sector, when BC is compared to other global supply alternatives it is hard to see how the province would not rank in the top tier of future energy supply choices if one is concerned about the net impact on global GHG emissions.[10]

[8] Pembina LNG page.

[9] With multi-billion dollar LNG investments, doing things differently than best global practice is risky for business. While it is true that one smaller BC LNG proposal has indicated a desire to select e-drive technology, the larger projects have all expressed a strong desire to use conventional best practice technologies.

[10] Key competitors are: Russia, Iran, Turkmenistan, North African supplies and the United States.

So what would happen if BC were to walk away from LNG and instead cede the emerging global market to other supply jurisdictions? Even without the full policy framework in place for LNG development, it is almost certain that the impact on the global environment, from a GHG perspective, would be negative (i.e., there will be slowing of emissions because of coal displacement). Furthermore, it should not be overlooked that BC also has one of the world's most advanced upstream shale gas sectors, as well as a high quality environmental regulatory system governing the energy industry. So not only would other supply jurisdictions get the downstream economic benefits if BC says 'no' to LNG, but the province would also forfeit the ability to market our regulatory expertise and the opportunity to influence how natural gas development occurs elsewhere.

Upstream Natural Gas Activities - Fracking

As noted above, BC has a sophisticated and mature upstream regulatory framework for the natural gas sector. Many other energy-producing locations in the world do not. An evaluation of the published criticisms focused on BC's natural gas sector suggests that some of the concerns are erroneously extrapolated from other jurisdictions or involve misplaced projections of incidents that do not represent the entire sector.

Hydraulic fracking or fracking is one such example. Let's be clear, fracking is not new. It was first used on an experimental basis in 1947 and deployed commercially in 1949 in Oklahoma.[11] Fracking is not revolutionary, except to the extent it was combined with horizontal drilling techniques, an innovation which has enabled access to gas which cannot be extracted using more conventional methods. This innovation (combining two known techniques) has resulted in what is now described as the shale revolution - providing substantial volumes of shale gas in a cost effective manner.

The environmental concerns about 'fracking' include:

1) water – quality and volume impacts;
2) methane leakage; and
3) earthquakes.

The research and commentary on fracking is voluminous. A simple internet search reveals hundreds of research articles, media stories, website links and even feature films on the topic. While a detailed review of this literature is beyond the scope of this short paper, on the whole the scientific research shows that a well regulated shale gas sector, using today's technologies, yields an upstream natural gas industry that can and does operate safely and with a relatively small environmental footprint.[12] More importantly, where impacts outside of acceptable parameters have been found in other jurisdictions, the analysis points to poor practices that can be resolved using best practices available – that is, the impacts can be mitigated and prevented.

Water Impacts

Fracking in BC started in the 1950s, when the first natural gas well was drilled. None of the thousands of sites drilled to date in BC have led to contaminated ground water. In reality, groundwater is located in a geological zone that is far above where gas extraction is generally occurring. The likelihood of contamination is very small – approaching zero when regulations are followed. Nevertheless, the BC Oil and Gas Commission (OGC) requires, as part of the drilling process, that pressure-tested steel casings be cemented in place to prevent hydraulic fracturing fluids from migrating. In addition, monitoring and reporting requirements mean that gas companies are obliged to ensure the integrity of the casing barrier. From a regulatory perspective, BC was the first jurisdiction to implement fracking fluid disclosure - www.FracFocus.ca.

[11] Shale World.

[12] For a relatively thorough review of fracking related issues, see Berkeley Earth.

In terms of quantity, less than one percent of the annual water supply available in the region is used for fracking. Of this, a growing percentage is recycled, with non-potable sources largely being re-injected in deep reservoirs as per the regulatory standards that have ensured no aquifer contamination.[13]

However, as LNG development stimulates an increase in upstream activity, water management and planning will become a more important consideration. Appropriately, BC's new *Water Modernization Act* provides for better groundwater regulation. This will be a key step in making what is already a high quality regulatory framework even more effective – allowing for continuous improvements as the sector grows.

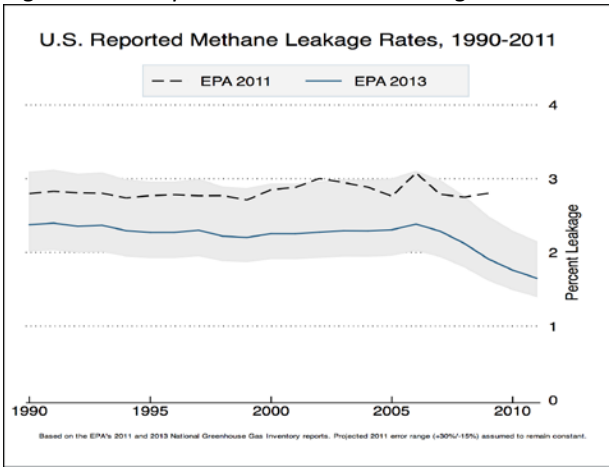
Methane leakage

There is an increasing level of scientific discussion regarding the extent to which methane leakage from shale gas drilling negates the significant CO2 benefits of burning natural gas versus both oil and coal.[14] What is not debatable is that methane leakage does occur, and that above a certain (high) percentage of leakage (roughly 4-6%), the benefits of natural gas can largely disappear in comparison to the use of other fossil fuels from a GHG emissions perspective.

As shown in the following chart, leakage rates reported in the United States are significantly below the inflection point. With a leading edge regulatory regime in place, there is no reason to believe that BC's shale gas drilling programs would have significantly higher leakages.\

A closer look at the data shows that there are a (small) number of 'super leaker' wells that can skew the data. These sites are anomalies. A focus on the right technology and regulatory activities on these sites is important; but such sites are not at all typical of what goes on in BC.

Figure 2 – Reported Methane Leakage to EPA



Nevertheless, since methane is more potent than CO2 as a greenhouse gas, methane leakage is an issue worth paying attention to – monitoring and improving upon the various mitigation options. Fortunately, there is a fortuitous convergence of incentives to continue improving outcomes given that methane leakage directly reduces the volume of natural gas available to sell. This provides an economic signal to both companies and government to act to limit leaks. As the previously cited analysis from the US government notes, on a net life-cycle basis LNG does produce significant climate change benefits – reinforcing the findings of both the IPCC and the IEA on the vital role of natural gas in long-term efforts to address climate change.

Seismic activities - earthquakes

Following up on anecdotal concerns, scientific analysis in the United States and Canada has shown that fracking processes can stimulate minor seismic activities. On rare occasions, based largely on poor site selection for waste water storage, a few jurisdictions have recorded a handful of small-scale seismic events.

The BC Oil and Gas Commission recently completed a comprehensive review of seismic activity related to shale gas development which did find some minor seismic activity induced by

[13] Factsheet: Hydraulic Fracturing in British Columbia.
[14] Cornell studies.

fracturing.[15] The report also reported no human injury or property/infrastructure damage from these events.

At first glance, the prospect of fracking-induced seismic activity is one that all parties should seek to eliminate. Research indicates that these events are rare and minor in nature, and that the potential for more significant induced seismic events can be eliminated through effective planning.

While there may be a general impression that those involved in the fracking process are indiscriminately injecting materials into the earth to crack the shale and release the gas, this is incorrect. In fact, the extraction process requires precision and work in this area has led to more innovation and a new field of study in the sector, with specialized skills in monitoring equipment/analytic tools used by professionals who are expert in what is termed 'micro-seismicity'. This is an example of leadership, technology know-how and comparative advantage that can be marketed to others who will undoubtedly continue to develop their natural gas resources.

Cumulative Impacts

A fourth and emerging area of environmental concern with respect to LNG (and other resource development) is cumulative impacts. If LNG development moves ahead, there would be a substantial increase in industrial activity in the northeast of the province and at proposed LNG facility locations on the coast.

The concerns in the northeast center around the added land, air, water and community impacts on top of what is already a significant amount of natural resource development activity in the region related to forestry, mining, wind power development, the natural gas industry, the potential impact of Site C, and the incremental expansion of shale gas. Although the Peace River area does have a completed land use plan, some critics argue that more attention needs to be paid to the cumulative impacts of industrial activity.[16] In the communities most affected by LNG development, the cumulative impact conversation is more focused on infrastructure stresses and community well-being challenges linked to potential population growth.

Overall, cumulative impacts analysis in BC is emerging slowly and the relevant policy lens is somewhat immature. There is no useful framework in BC or globally for that matter that can easily enable a comprehensive understanding of the effects on land and people from human economic activity. Policy experts are working to figure out cumulative impact assessment in real time. Given the scientific uncertainties involved, the lack of clarity can result in calls for ever more analysis and nurture a perception of LNG development that doesn't deliver a well-understood set of benefits relative to the costs.[17]

Fortunately, there are sizable benefits from LNG development that can serve to inform the planning and trade-off analysis that is required to ground a conversation about cumulative impact assessment on a regional basis. While critics often raise concerns over potential impacts and externalities, the benefit set is rarely mentioned. A rational discussion of cumulative effects cannot ignore the benefits of economic activity.

[15] BC Oil and Gas Commission.

[16] Of note, the Site C Joint Review Panel recommended that government undertake more detailed cumulative impact assessment work, regardless if Site C went ahead. (Recommendation 44).

[17] In light of both past and recent legal clarity around aboriginal rights and title, this analysis will also need to evolve in coordination and in partnership with BC's First Nations, particularly the Treaty 8 nations.

Effective planning and proactive community level engagement that is collaborative and focused on joint interests can help to ensure that the benefits from LNG are realized and distributed appropriately and fairly while properly managing the cumulative impacts.

The Path Forward

When we assess BC's opportunity to build an LNG sector, and do so from a global perspective, it is clear that the province has a number of strategic advantages with respect to market access, quality of the resource, and the comparative environmental upside.

Contrary to what some suggest, BC has many features that should give comfort that a commercially viable and environmentally responsible LNG industry can be developed here: decades of valuable on-the-ground experience in the unconventional natural gas sector; a leading-edge regulatory regime; a stable governance framework with checks and balances; an energy resource whose physical attributes make for significantly less potential water contamination and fewer demands on potable water; and a resource that is largely found in remote areas and which provides for more flexibility and (positive) engagement opportunities with First Nations. Finally, BC is strategically located on the west coast of Canada and relatively close to Asian markets, providing further benefits.

Overall, we find that the environmental critiques of LNG development in BC have largely ignored the wider global perspective. This limitation constrains the ability to undertake more complex trade-off analysis. In a nutshell, the question of how much the province should 'spend', either directly or indirectly, to achieve its climate change (and other environmental) objectives with respect to LNG is not a simple one. While critics do highlight some legitimate concerns that policy-makers need to be attentive to, we believe the overall cost-benefit analysis is favourable for LNG.

As it currently stands, the LNG critics have under-estimated the costs of undertaking more aggressive reductions in the GHG footprint of LNG in BC. In combination with potentially over-estimating the monetary benefits available to 'pay' for environmental improvements, there is a risk that BC would underperform relative to its LNG potential due to the costs inherent in the course of action advocated by LNG critics.

Ultimately, the critics raise a mixed bag of environmental concerns about LNG development in BC. Some are fairly easy to dismiss while others, primarily around options to reduce the industry's GHG footprint and manage cumulative impacts, require further evaluation.

While more analysis is needed, when we consider the substantial benefits of LNG from both an economic and environmental lens, together with the market imperatives currently at play, we conclude that the desired policy path forward is clear: BC and Canada should be moving aggressively to develop LNG.

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