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Liquefied natural gas, carbon pollution, and British Columbia in 2017

An overview of B.C. LNG issues in the context of climate change

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Summary

The development of a liquefied natural gas (LNG) export industry in British Columbia remains a controversial issue. Since 2011, when the idea was first officially promoted by the provincial government, LNG development has gained both opponents and supporters. Carbon pollution from proposed LNG export plants on the Pacific coast and associated tight gas drilling operations in the Northeast would pose a serious challenge to Canada and B.C. making good on their climate commitments. This backgrounder outlines the state of LNG development in B.C., the opportunities to improve the environmental performance of key projects currently under consideration, and the implications of a new LNG export industry for B.C.'s carbon pollution levels.

Introduction

In 2012, the Government of British Columbia set a goal of seeing three liquefied natural gas (LNG) export plants operating in Canada's westernmost province by 2020.[1] As of 2017, only one such project has received a positive final investment decision. Two much larger projects have received government approval. One is awaiting a final investment decision; the other was recently cancelled by its proponent. A host of other projects have seen early stage development but have not progressed significantly towards construction. Key factors behind delays affecting LNG projects in B.C. include legal challenges, postponed investment decisions, and low commodity prices.

Northeastern B.C. sits on large unconventional reserves of natural gas in the form of shale gas and tight gas. Using techniques such as hydraulic fracturing and directional drilling, extraction has focused on the Montney Formation near Dawson Creek and the Horn River Formation near Fort Nelson. Several pipeline proposals aim to link the gas fields with planned liquefaction plants and shipping terminals on B.C.'s North Coast, where LNG would be loaded onto tankers bound for markets in Asia.

The climate impact of natural gas

Natural gas is a fossil fuel primarily used for power generation and heating. It is also commonly used as a feedstock for industrial processes, such as for the chemical, petroleum and fertilizer industries. Like all fossil fuels, the combustion of natural gas releases carbon dioxide (CO_2) into the atmosphere. For the same amount of energy, natural gas releases about 24% less carbon pollution compared to oil, and 46% less compared to coal.[2]

Natural gas is predominately composed of methane (CH_4), a potent greenhouse gas (GHG) that has a global warming potential (GWP) 34 times higher than carbon dioxide (CO_2) on a 100-year time horizon, and a GWP of 86 on a 20-year timeframe.[3] Carbon pollution associated with natural gas can increase materially if methane is leaked or vented to the atmosphere. The largest source of industrial methane emissions is the oil and gas industry, where methane can leak from wells, pipelines, and other facilities, including LNG export terminals.

The production of natural gas — extraction, processing, transportation, and, for LNG, liquefaction — is energy and emissions intensive. Annual emissions from B.C.'s natural gas industry total around 11.6 Mt CO_2e (megatonnes of carbon dioxide equivalent), or about 18% of total provincial emissions.[4,i]

LNG export projects on the B.C. coast

There are no LNG export projects presently operating in British Columbia. Current production of natural gas products occurs at two small domestic LNG facilities, with two additional domestic facilities proposed.[5]

However, there are 18 LNG export proposals in B.C. at various stages of development. Of the export projects, only two — LNG Canada and Woodfibre LNG — have regulatory approval and are close to being realized. A third approved project, Pacific NorthWest LNG (PNW LNG), is no longer being pursued by its proponent. On July 25, 2017, the company announced that it "will not proceed as previously planned."[6]

The remainder of the LNG proposals are in the early stages of development. They have been mapped and described in more detail in a recent Sightline Institute report.[7] Most are located on the North Coast, with five projects sited on Vancouver Island and the South Coast.

[i] The major emissions sources for B.C.'s natural gas industry are: combustion for power processes (56%), formation CO_2 venting (20%), methane venting (9%), fugitive methane (7%), flaring (5%), and electricity generation (3%). These figures do not include end-use of natural gas by consumers. Source: Government of B.C., "Industrial Facility Greenhouse Gas Inventory Report" (2013). See Appendix A.

Figure 1. Location of LNG export proposals with regulatory approval in B.C.

Status report: Pacific NorthWest LNG

Pacific NorthWest LNG (PNW LNG) was considered one of the projects most likely to proceed in British Columbia, having secured export, pipeline, facility, and (conditional) environmental approvals, as well as support agreements with some local First Nations.

However, the project was also one of the most controversial. Other First Nations groups and the SkeenaWild Conservation Trust have launched court challenges in an attempt to block PNW LNG, citing issues involving the consultation of indigenous communities, impacts on fish habitat, and carbon pollution.[8] In July 2017, the proponents announced the project's cancellation, citing prolonged depressed prices and shifts in the energy industry.[9]

Although PNW LNG has been officially cancelled, various permits for the project remain valid. These include a National Energy Board export licence and a positive environmental assessment decision by the Government of Canada. As such, until the permits are forfeited or voided, the project as currently proposed and approved should still be considered a potential LNG development along B.C.'s North Coast.

Table 1. Comparison of two approved LNG export proposals in B.C.

	LNG Canada	Woodfibre LNG
Location	Kitimat	Woodfibre, near Squamish
Proponent	LNG Canada Development Inc., a joint venture led by Royal Dutch Shell plc	Woodfibre LNG Limited, a subsidiary of Singapore-based Pacific Oil & Gas Limited
Estimated capital cost	$25–40 billion[10]	$1.6 billion[11]
Capacity (million tonnes of LNG per year)	12 MTPA for Phase 1, 12 MTPA for Phase 2; total up to 24 MTPA	2.3 MTPA[12]
Shipping traffic	Up to 700 tanker visits per year[13]	Up to 40 tanker visits per year[14]
Associated pipeline project	670 km of new pipeline linking Dawson Creek to Kitimat — Coastal GasLink (TransCanada Corp.)	47 km of new pipeline linking the existing FortisBC network near Coquitlam to Woodfibre — Eagle Mountain–Woodfibre Gas (FortisBC)
Environmental assessment status and conditions	In 2015, the federal and provincial governments approved LNG Canada with 74 conditions (50 from federal review and 24 from provincial review). No conditions relating to GHG emissions and/or emissions limits were included.	In 2016, the federal government approved Woodfibre LNG with 56 conditions, including electric drives (or equally efficient technologies) to power the main liquefaction process, and leak detection and repair systems to prevent fugitive emissions.
Final investment decision status	Proponent announced the postponement of a final investment decision in 2016.[15] An investment decision is now expected in 2018.[16]	Proponent announced a decision to proceed with final investment in 2016, crediting B.C. government's offer of a "competitive electricity rate" for electric compression technology.[17]
Legal challenges and conditions	N/A	Granted an environmental certificate by the Squamish Nation in 2015. The Nation has reserved the right to revoke the certificate if the project does not meet its 13 conditions.[18] In January 2017, Woodfibre proposed to the Canadian Environmental Assessment Agency the use of air cooling rather than seawater cooling technology, thereby fulfilling one such condition.[19]

Choice of power source	Natural gas turbines for compression load, grid electricity for non-compression load	Grid electricity for both compression and non-compression loads

Not all B.C. LNG projects are created equal

Technology choices and production practices have a significant effect on the emissions intensity across the LNG supply chain, both at the terminals themselves where liquefaction occurs, and in associated upstream development. Opportunities include eliminating venting of methane and CO_2, cutting fugitive emissions in natural gas production, and using grid electricity instead of natural gas for power processes (i.e. equipment to extract, process, and transport natural gas).

At LNG terminals, using clean grid electricity is an especially important opportunity to minimise emissions, given that most emissions come from the terminal's power processes. These power processes include the non-compression load (i.e. the power needed for pumps, air coolers, lighting, and space heating) and the main gas compression load (i.e. the power needed for the main liquefaction process).

For example, the proposed LNG Canada and Woodfibre LNG terminals plan to use hydroelectric power to a significant degree in order to reduce emissions and impacts on local air quality. LNG Canada is planning to use grid electricity to power non-compression load only, and to use natural gas turbines for compression load. Woodfibre LNG is planning to use grid electricity to power both the compression and non-compression loads.

LNG projects can also be powered almost entirely with natural gas, resulting in far greater emissions than would result if the project were to use low-carbon grid electricity to meet all or a portion of demand. See Figure 2.

The shortcomings of relying almost entirely on natural gas are clearly demonstrated when assessing the emissions performance of the fully approved, but now cancelled, Pacific NorthWest LNG project. According to conditions set by the B.C. cabinet, the PNW LNG terminal was not allowed to exceed an emissions intensity of 0.22 t-CO_2e/t-LNG for Phase 1 of the project, and 0.21 t-CO_2e/t-LNG for Phase 2 (the final phase) of the project.[20] This intensity is significantly above the benchmark of 0.16 t-$CO2_e$/t-LNG set by the province in 2014 under the Greenhouse Gas Industrial Reporting and Control Act — the main law regulating GHG emissions from LNG facilities. For example, the LNG Canada project would have an emissions intensity of 0.15 t-$CO2_e$/t-LNG, or 31% better than PNW LNG.[21] The Woodfibre LNG project plans to achieve 0.054 t-$CO2_e$/t-LNG, or 74% better than PNW LNG.[22]

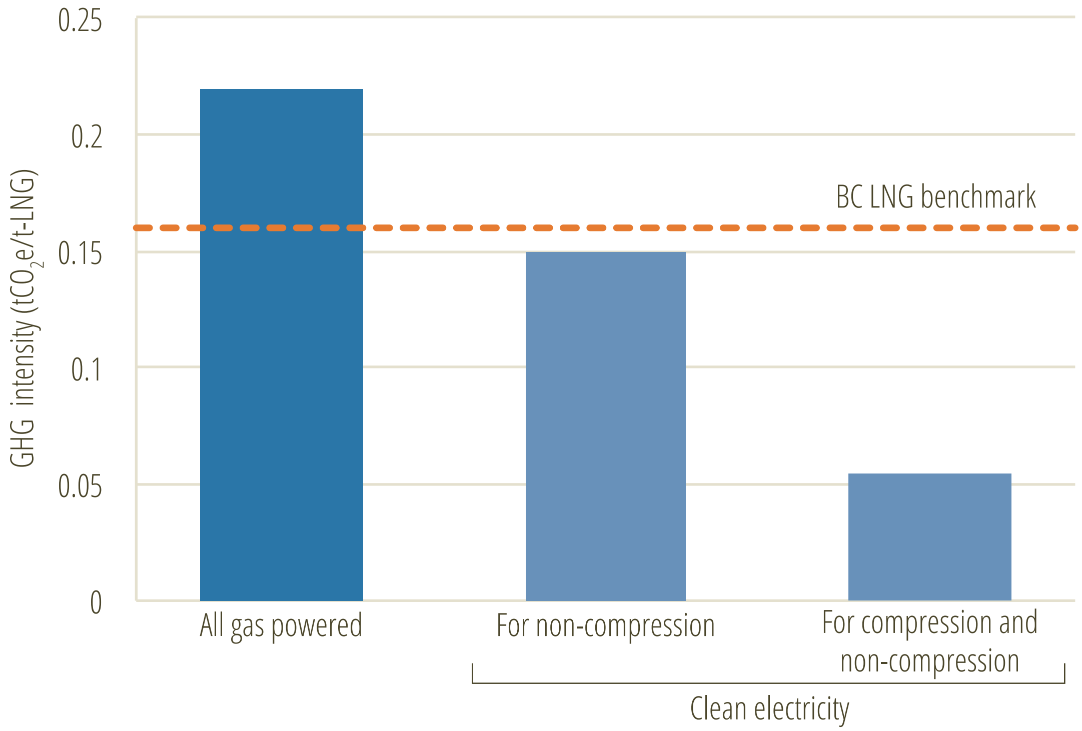

Figure 2. How different energy sources impact the GHG intensity of LNG terminals[ii,23,24,25]

In other words, the PNW LNG terminal — which can be seen as a proxy for LNG project terminals fully powered by natural gas — would have been 3.9 times more polluting per tonne of LNG produced than the cleanest LNG terminal (Woodfibre LNG) proposed for B.C. This highlights the high emissions of this technology option.[26]

Challenges to LNG plant electrification

The extent to which an LNG terminal can improve emissions performance through the use of clean electricity depends on several factors, including project location, available electric infrastructure, and the scale of the project. For example, the LNG Canada project is of such a scale that electrification of non-compression and compression loads would have a material impact on B.C.'s total electricity demand, and would not be possible without significant investments in electric generation and transmission infrastructure, which require time to complete.

While adoption of B.C. Hydro grid electricity over fossil fuel energy would reduce the emissions intensity of any proposed LNG project, there are other environmental and technical challenges

[ii] Emissions intensities are based on LNG projects proposed for B.C. (left to right): PNW LNG (all gas powered), LNG Canada (clean electricity for non-compression load, natural gas for compression load), and Woodfibre LNG (clean electricity for non-compression and compression loads).

to consider. Table 2 assesses the challenges and opportunities associated with different electricity generation options to power LNG facilities.

Table 2. Challenges and opportunities with different electrification options

Generation type	Environmental attributes	Technical challenges	Opportunities
Large hydro	Significant local environmental impacts associated with large-scale hydro include large-scale flooding. May require relocation of people, and/or loss of important sites (cultural, economic, habitat). Lower carbon pollution.	Large hydro power is likely far away, and would require significant investments in generation and transmission infrastructure. B.C. Hydro has stated the potential Site C dam will be the last large hydro project, significantly limiting the options available.[27]	Investment in long-lasting low carbon energy source.
Local renewables (wind, run-of-river hydro, solar, biomass)	Limited local environmental impacts. Due to reliance on gas peaking plants, GHG emissions will be higher compared to large hydro but lower compared to natural gas direct drive.	Intermittent nature of new renewables requires natural gas turbines (or large hydro if available) to augment this source to ensure the stable and consistent power needed by LNG facilities. This increases system complexity and capital costs. B.C. Hydro identified pump storage as not cost-effective in the region. Biomass potential in region is limited.[28]	Avoids locking in a natural gas-powered LNG facility. Could steadily increase the amount of electricity as renewables become available. Northwest B.C. has a good resource base for run-of-river hydro and wind.
Combined cycle natural gas power plant	Higher levels of carbon pollution compared to hydro or renewables, and comparable to natural gas direct drive using efficient aero-derivative turbines[29]	Capital intensive combined cycle natural gas plant would need to be constructed at a nearby site to limit electric transmission upgrades. Gas power plant may have limited operating life if transitioning to more renewable power.	Avoids locking in a natural gas-powered LNG facility. Could increase the amount of electricity supplied by renewables as they become available.

The policy context for LNG in B.C.

There are several existing and forthcoming policies in place in B.C. that are designed to reduce emissions from LNG and associated upstream development. However, these policies, summarized below, fall short of requiring projects to adopt best practices and technologies.

Table 3. Policies impacting GHG emissions from LNG projects

Policy	Description
B.C. carbon tax	B.C.'s carbon tax was introduced in 2008. The carbon tax reached its current rate of $30/tonne in 2012. The tax only applies to combustion emissions, which account for approximately 70% of B.C.'s total emissions and 61% of the natural gas sector's emissions.[30] Fugitive and vented emissions (non-combustion sources) are currently outside the scope of the tax. B.C.'s new NDP government has indicated it wants to resume raising the tax — by $5/tonne, starting in 2018 for four years — while also broadening the tax to include fugitive emissions. [31] Details on these proposed amendments are not yet available.
Federal carbon price floor	The federal government announced in 2016 an intention to set a minimum carbon price of $10/tonne in 2018, rising by $10 a year to reach $50/tonne in 2022. Provinces and territories will have flexibility in choosing either a carbon tax or cap-and-trade system, with revenues returning to those governments.[32]
LNG benchmark policy	B.C. sets an LNG emissions benchmark of 0.16 t-CO_2e/t-LNG under the Greenhouse Gas Industrial Reporting and Control Act — the main law regulating carbon pollution from LNG facilities. Facilities with emissions above this benchmark are required to purchase carbon offsets from B.C.-based emissions reduction projects, buy emissions permits from a LNG facility that performs better than the benchmark, or pay into a technology fund at $25/t-$CO_2$e.[33] The now cancelled PNW LNG project is the only project discussed in this paper that fails to achieve this benchmark. However, under the LNG Environmental Incentive Program, facilities with emissions above the benchmark but less than 0.23 t-CO_2e/t-LNG are eligible for pro-rated cash incentives that cover 50% to 100% of the compliance costs.[34] PNW LNG's project development agreement guarantees this compliance path for 25 years.
Methane regulations	B.C.'s 2016 Climate Leadership Plan calls for a 45% reduction in fugitive and vented methane emissions by 2025, through a phased-in process beginning with setting targets, then by offering transition incentives to industry, and finally by establishing regulatory standards.[35] This is in line with Canada's commitment to reduce methane emissions from the oil and gas sector by 40–45% by 2025.[36]
Upstream electrification infrastructure incentives	B.C.'s 2016 Climate Leadership Plan committed the provision of public dollars to support the development of electric infrastructure in northeast B.C., in a bid to encourage upstream oil and gas producers to electrify their production and processing operations. These incentives would support existing and planned transmission infrastructure to the Montney tight gas deposit, including the recently completed Dawson Creek/Chetwynd Area Transmission Line, and the proposed Peace Region Electricity Supply and North Montney Power Supply.[37] In the 2016 climate plan, the B.C. government also committed to developing a program to equalize the cost of electricity to that of natural gas to encourage producers to fuel

	switch to clean electricity and lower emissions. Details are scarce, and the scale and scope of this program are not known as of August 2017.
E-Drive electricity rate	B.C. Hydro offers a reduced electricity rate to LNG facilities that use grid-connected electricity to run the liquefaction process. The subsidized rate is designed to encourage projects to reduce emissions by using electric rather than natural gas compressors.[38]

In 2015, the B.C. Climate Leadership Team recommended several policy changes that would further reduce emissions from LNG projects and bring them in line with best practices. These included increasing the carbon tax by $10 per year starting in 2018 and expanding its coverage to include non-combustion sources to drive innovation and adoption of low-emissions technologies. The panel also recommended reducing fugitive and vented methane emissions by 40% in five years, and directing B.C. Hydro to commit to supplying LNG and natural gas developments with competitively priced clean electricity.[39]

LNG and B.C.'s climate targets

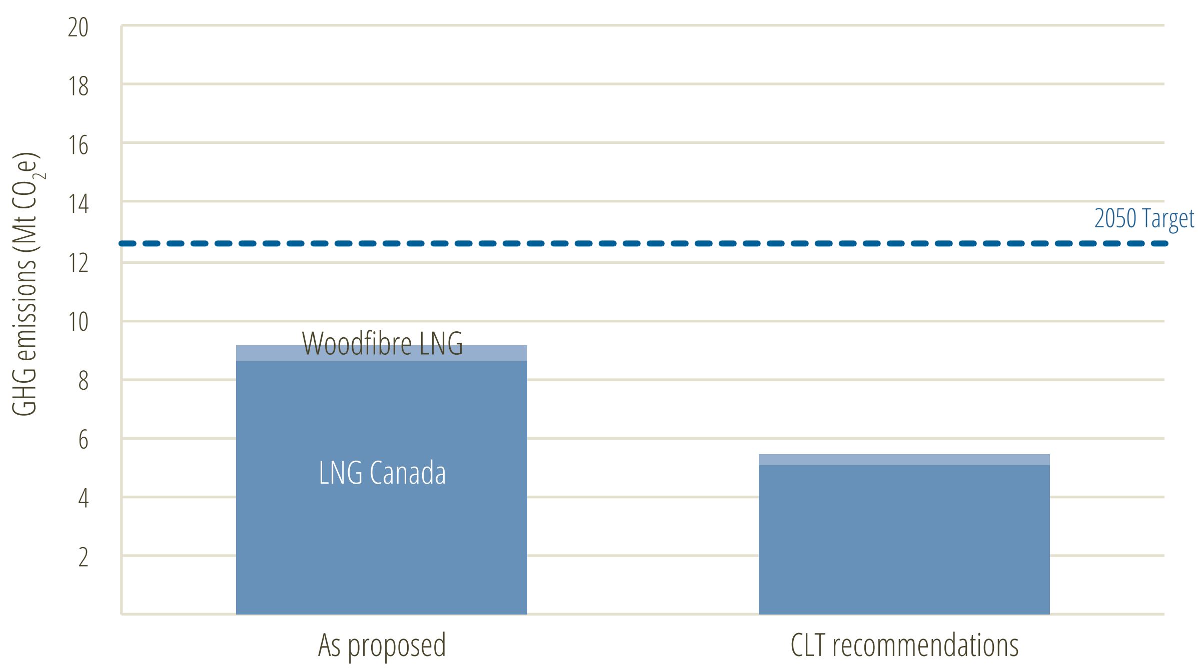

Figure 3. Emissions within B.C. from LNG terminals and associated upstream operations under as-proposed development conditions vs. using best practices (2030)[40]

According to the latest GHG emissions inventory report (2014), B.C. currently emits carbon pollution totalling around 63 Mt CO_2e/year.[41] In contrast, B.C.'s legislated GHG reduction targets call for annual emissions to be reduced to 43.5 Mt CO_2e by 2020 and to 12.6 Mt CO_2e by 2050.[42] B.C. is currently on track to miss its legislated 2020 target by a wide margin, with emissions projected to increase until at least 2030.[43] Measures in the province's Climate

Leadership Plan are forecast to bring emissions down as low as 54 Mt CO_2e by 2050, but that still falls well short of the legislated goal of 12.6 Mt CO_2e.

The development of an LNG export industry in B.C. would further widen this gap. The two approved projects analysed in this paper would collectively increase carbon pollution by 9.1 Mt CO_2e/year by 2030, further increasing to 10.2 Mt CO_2e/year by 2050 — leaving less than 3 Mt CO_2e/year for the rest of B.C.'s economy and making it virtually impossible for the province to meet its 2050 target.[44]

If the PNW LNG permits were on-sold and the project subsequently developed as originally proposed, B.C.'s emissions would increase by a further 8.7 Mt CO_2e/year by 2050, making it impossible for B.C. to meet its 2050 target.

If LNG Canada and Woodfibre LNG were built using best practices and technology — including greater electrification, as recommended by the Climate Leadership Team — emissions would be halved. However, these combined emissions would still make it very difficult for B.C. to meet its targets without drastically eliminating emissions from the rest of the economy, including transportation, buildings, and industry.

Table 4. Overview of upstream, terminal, and end-use emissions under current policies[iii]

Project	Capacity (MTPA)	2030 emissions (Mt CO_2e)			2050 emissions (Mt CO_2e)		
		Upstream	Terminal	Total B.C.	Upstream	Terminal	Total B.C.
LNG Canada	24.0	5.0	3.6	8.6	6.0	3.6	9.6
Woodfibre LNG	2.3	0.4	0.1	0.5	0.5	0.1	0.6
Total	26.3	5.4	3.7	9.1	6.5	3.7	10.2

[iii] This Pembina Institute analysis using the B.C. Shale Scenario Tool includes all existing and proposed policies, including policy commitments made in B.C.'s 2016 Climate Leadership Plan on reducing methane emissions and electrifying upstream operations. It assumes almost all incremental natural gas production to supply the LNG terminals comes from the low formation CO_2 Montney deposit. Upstream emissions increase with age, as older wells become less efficient and therefore more polluting.

Regarding emissions sources: For upstream emissions, 72% are from combustion, 9% from fugitive methane, 8% from methane venting, 6% from flaring, and 4% from formation CO_2 venting (2030). For terminal emissions, almost all emissions are from combustion. End-use emissions are not considered because they occur outside of B.C.'s jurisdiction.

B.C. LNG in the global picture

It has been argued that exporting LNG from B.C. to Asian markets has the potential to reduce overall global GHG emissions. These arguments assume that LNG would exclusively displace the use of coal, which the balance of evidence shows is more emissions-intensive than LNG (as long as methane emissions from LNG are minimized).[45] However, LNG would also compete with other sources of energy in export markets, including low-emitting sources such as nuclear, hydro, solar, and wind. [46]

The global energy landscape has been changing rapidly, including in proposed export markets, with coal use slowing and renewable energy growing rapidly.[47] This shift towards renewables is being driven by their falling costs and increasing cost competitiveness, alongside a trend of increasingly stringent climate policies, which favour lower-emissions energy sources.

Energy analysts are projecting a renewables-led transformation of the energy sector, with the International Energy Agency's (IEA) *World Energy Outlook 2016* forecasting that nearly 60% of all new power generation capacity to 2040 will come from renewables.[48] Solutions to help ease the energy supply intermittency issues of solar and wind power include demand-side management, smart load-balancing electrical grids, and an array of energy storage options. Flexible, on-demand power technologies — such as hydroelectricity, nuclear, and natural gas — will also be needed at least in the short-to-medium term to help provide system stability for intermittent energy supply.

Overarching these factors, it is clear that the policies required to avoid the worst impacts of climate change and limit warming to under 2°C will limit future demand for natural gas, and fossil fuels in general. The IEA and others refer to such scenarios as "450 scenarios," a reference to the 450 parts per million (ppm) concentration of CO_2 that is believed to represent an acceptable chance of avoiding 2°C of warming. Under the IEA's 450 Scenario, global demand for natural gas is projected to reach a peak in the late 2020s, and to start a slow decline after 2030, as shown in Figure 4.

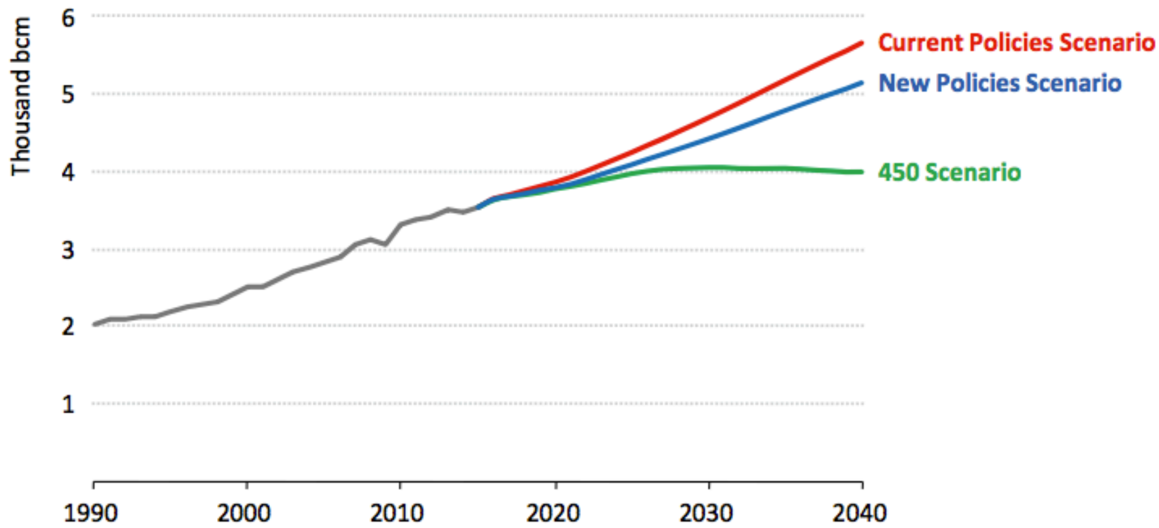

Figure 4. Global natural gas demand under current, emerging, and "450" policy scenarios

Source: International Energy Agency

As the IEA's *World Energy Outlook 2016* puts it, "this [450] scenario brings out forcibly that even gas is too carbon intensive for long-term growth in a decarbonising energy system. Gas may be a supporting fuel for the transition to a low-carbon energy system but this should not be misunderstood as a sustainable growth opportunity in a 2°C world."

Conclusion

As currently proposed, the two most advanced LNG export projects on the B.C. coast — LNG Canada and Woodfibre LNG — would together emit enough carbon pollution to make meeting B.C.'s 2050 climate target virtually impossible.

Furthermore, if the permits for Pacific NorthWest LNG were resurrected by the current or a new owner, that project would make the province's legislated target impossible to reach. Such LNG export terminals, fully powered by natural gas, are almost four times more polluting per tonne of LNG produced than terminals using clean electricity.

Nevertheless, even if LNG Canada and Woodfibre LNG and their associated upstream operations were developed using only clean energy and best practices, the greenhouse gas emissions from natural gas extraction, processing, transportation, and liquefaction would use up almost half of the total allowed emissions for all of B.C. This would make it extremely challenging for B.C. to meet its climate target without almost completely eliminating emissions from the rest of the economy. Current policies fall short of requiring projects to adopt best practices and technologies, and should be strengthened to ensure that, if development proceeds, it is with the lowest impact to the climate.

Current policy options for reducing emissions from proposed LNG development include: requiring projects to use only clean electricity supply, increasing the carbon tax and expanding its coverage to include non-combustion sources, requiring compliance with B.C.'s LNG emissions benchmark, and accelerating the timetable for reducing fugitive and vented methane emissions. Given the capacity and transmission issues associated with supplying projects with grid electricity, new sources of electricity would likely be required, with each source of electricity presenting different challenges and opportunities.

Finally, exporting B.C.'s LNG to Asian markets may have the potential to lower global GHG emissions if it displaces the use of coal in those markets. However, it is not clear that this would be the case. LNG could instead compete with low-carbon energy alternatives, including wind, solar, hydro, and nuclear. LNG is also out of step with increasingly stringent climate policies, internationally and within domestic markets. Indeed, as the International Energy Agency has confirmed, new investments in natural gas and LNG are too carbon intensive to be consistent with limiting global temperature rise to 2°C, and therefore should not be seen as a climate solution.

Appendix A: LNG supply chain emissions

The GHGs that accompany the LNG supply chain in B.C. consist primarily of methane (CH_4), which is the predominant component of natural gas itself, and carbon dioxide (CO_2). There are five main sources in this supply chain.[49]

Combustion: Natural gas is burned to power equipment to process and transport the gas, releasing CO_2. In addition to sources that already exist in B.C.'s natural gas sector, future LNG terminals could be a major new location of natural gas combustion if they are powered with natural gas.

Formation carbon dioxide venting: CO_2 that is found in natural gas (referred to as formation CO_2) is separated from the gas at processing plants and vented to the atmosphere.

Methane venting: Methane is vented from process equipment — such as pneumatic controllers, gas-driven pumps, dehydrators, and compressors — or during operations such as pipeline blow-downs, where gas is removed and vented from a section of pipeline for repair or maintenance.

Fugitive emissions: Methane leaks or is unintentionally released to the atmosphere at valves or fittings, along pipelines, and at storage tanks.

Flaring: Natural gas is flared in order to control pressure, to maintain a flare pilot light at a facility, or during well testing and completion.

Endnotes

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