Concerns about the proposed Chevron-Kitimat LNG application for a 40-year export license in consideration of Canada's long-term energy security and emissions reduction commitments

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Table of Contents

1 Introduction

The National Energy Board (NEB) has approved multiple LNG export licenses on Canada's West Coast. One of these, LNG Canada, reached a final investment decision (FID) in October, 2018, and is under construction. Kitimat LNG, a joint venture of Chevron Canada Limited (Chevron) and Woodside Energy International (Canada) Limited (Woodside), has applied to NEB for a 40-year license for a second major project to export LNG based in Kitimat. This latter application is the main focus of this report, which is considered in the context of the LNG Canada facility, the nature of Canada's remaining gas resources, and Canada- and B.C.'s-emissions reduction goals.

The principal evidence provided by Chevron to justify its 40-year export license application is '*Application for a 40-Year Gas Export License: Gas Supplies, Requirements, Implications and Surplus Assessment Report*' authored by Roland Priddle (the Priddle Report).[1] The application is for 28.23 billion cubic meters of gas per year (including a 15% tolerance), which amounts to 40 trillion cubic feet (tcf) of gas over the 40-year project life, for a throughput of 2.73 billion cubic feet per day (bcfd).[2]

This is on top of the under-construction LNG Canada project, which has a 40-year export license for 26 million tonnes of LNG per annum[3] , which amounts to 50 tcf of gas over the 40-year project life, for a throughput of 3.47 bcfd.[4]

Taken together, these two projects will require 6.2 bcfd of gas and consume 90 tcf over their 40-year project lives. This compares to average 2018 B.C. gas production of 5.1 bcfd, and remaining proved reserves of marketable gas of 41.2 tcf.[5] These two 40-year applications will exceed the 87.2 tcf cumulative total of raw gas discovered in B.C. since exploration began back in the 1950s.[5]

In order to claim that existing reserves for the KM LNG application will meet the NEB's requirement (Section 118 of the NEB Act) that:

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[1] Roland Priddle, *Chevron Canada Limited Application for a 40-Year Gas Export Licence: Gas Supplies, Requirements, Implications and Surplus Assessment Report* (November, 2018), https://apps.neb-one.gc.ca/REGDOCS/File/Download/3762075

[2] Note that the Priddle Report states that the total export request of Chevron was 35 tcf although the maximum annual rate requested would be 40 tcf over 40 years.

[3] B.C. Oil and Gas Commission, 2018, *LNG Canada Export Terminal*, https://www.bcogc.ca/node/11289/download

[4] Note that the Priddle Report states that the total export request of LNG Canada was 52.8 tcf over 40 years.

[5] B.C. Oil and Gas Commission, 2019, *2017 Gas Reserves (excel)* https://www.bcogc.ca/node/15445/download

"On an application for a license to export oil or gas, the Board shall satisfy itself that the quantity of oil or gas to be exported does not exceed the surplus remaining after due allowance has been made for the reasonably foreseeable requirements for use in Canada, having regard to the trends in the discovery of oil or gas in Canada."

The Priddle Report invokes vast quantities of 'undiscovered' resources alleged to exist in B.C. and Canada, and the fact that North American resources are large implying that U.S. and Mexican resources could be drawn upon to meet the license application requirements even though those resources are being consumed in other countries.

This report focuses on three principal concerns with the KM LNG application:

1) The surplus supply outlined in the Priddle Report is overstated, not based on evidence, and will put Canadians' future energy security at risk of possible supply disruptions and higher prices than would otherwise be the case given industry's propensity to exploit the highest quality and cheapest-to-produce resources first.

2) That this application, on top of the LNG Canada project, will further compromise any possibility of Canada meeting its emissions reduction commitments under the Paris Agreement, and make it a certainty that B.C. will not be able to meet its emissions reduction commitments under its 'Clean B.C' plan.

3) Debunking the claim of the Priddle Report that B.C. LNG will lower global emissions when considered on a 40-70 year timeframe.

2 Overstated Gas Supply Surplus

2.1 Reserves, supply and demand

Reporting of oil and gas reserves and resources is governed in Canada by National Instrument 51-101 (NI-51-101). The B.C. Oil and Gas Commission's (BCOGC) reporting of reserves corresponds to NI-51-101 as illustrated in Figure 1:

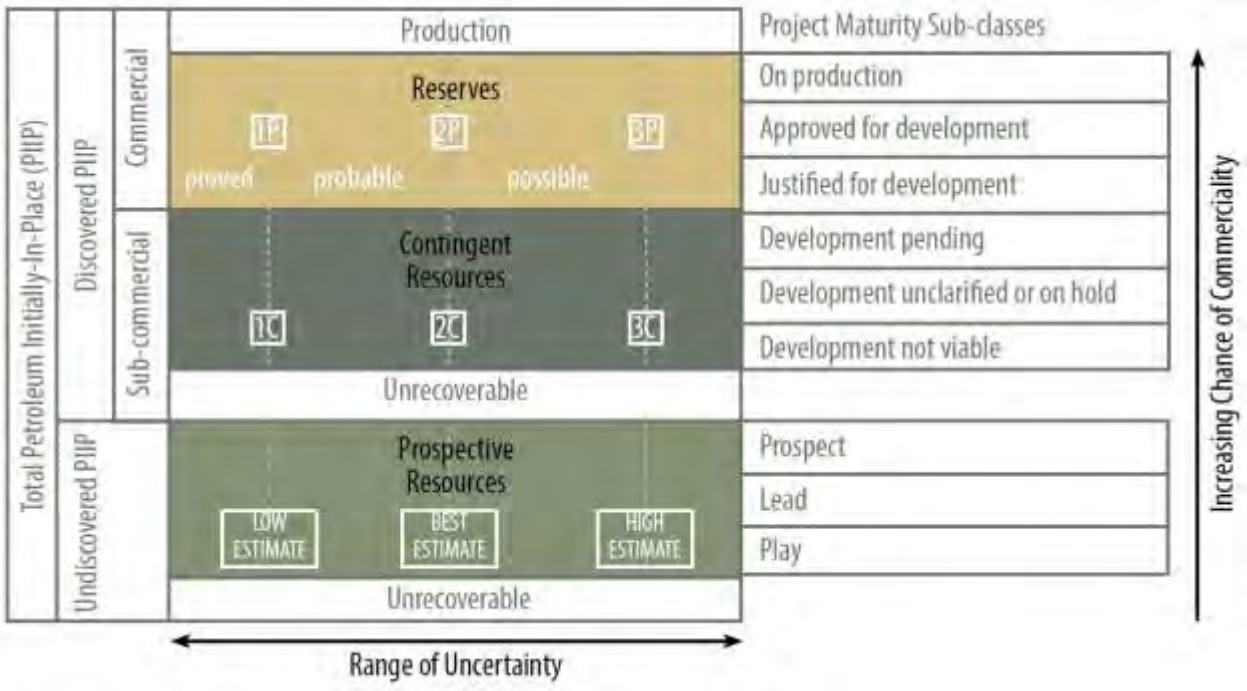

Figure 1 - Oil and gas reserves and resources reporting categories used by the BCOGC which correspond to NI-51-101.[6]

Although it is not explicitly stated, reserves reported by the BCOGC presumably correspond to P3 reserves in the NI-51-101 classification which include proved, probable and possible reserves. To be classified as a reserve, a deposit must be demonstrated to be economically recoverable with existing technology within a reasonable timeframe (five-years for a 'probable reserve').

The distribution of natural gas reserves in Canada by province, and the change in Canadian proved reserves since 2010, is illustrated in Figure 2. B.C. had 58% of Canada's total in 2018, followed by Alberta at 39%. Together, B.C. and Alberta made up 97% of Canada's total.

The advent of hydraulic fracturing coupled with horizontal drilling (fracking) in the past decade has allowed production from previously uneconomic low permeability tight- and shale-gas resources, which increased Canadian proved gas reserves through 2015. Since 2015, however, Canada's proved reserves have been in decline. Producing 90 tcf over the next 40 years to supply exports for LNG Canada and Kitimat LNG would consume 19 tcf more than Canada's current proved reserves of gas of 71 tcf. Although more drilling will likely convert some

[6] B.C. Oil and Gas Commission 2019, Figure 1 in *2017 oil and gas reserves and production report*, https://www.bcogc.ca/node/15405/download

undiscovered resources to proved reserves, attempting to recover 90 tcf for export over the next 40 years is not in the public interest considering the long-term needs of Canadians and the implications of Canada's and B.C.'s emissions reduction commitments.

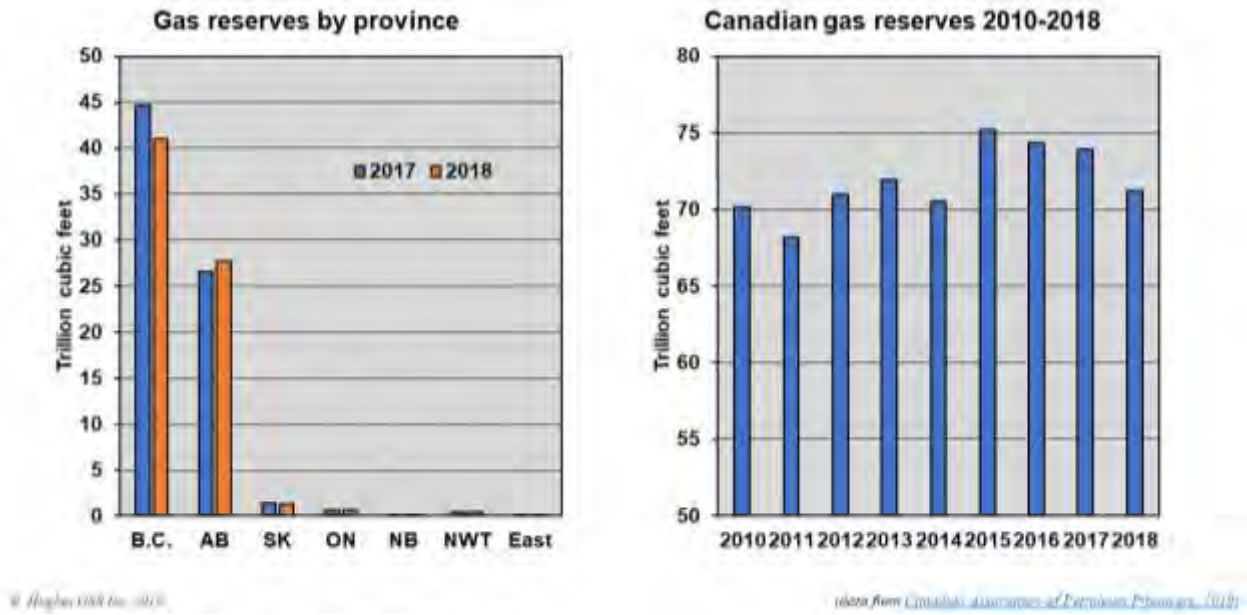

Figure 2 – Proved reserves of natural gas in Canada by province and for Canada as a whole from 2010 to 2018.[7]

Since 2000, natural gas production in all producing areas in Canada has declined except for B.C. Canadian production is down 3.4% since 2000 as of 2018 and Alberta, which produced 65% of Canadian gas in 2018, is down 22.5% (Table 1). At current production rates Canada's proved reserves of natural gas will last 12.1 years, Alberta's will last 7.2 years, and B.C.'s will last 21.9 years.

Given that B.C. has the most potential to increase production, and is closest to the proposed LNG export terminals, it is likely that most of the gas needed for LNG Canada and Kitimat LNG will be sourced from B.C. More than doubling B.C.'s current production to provide the additional 6.2 bcfd needed for both facilities will reduce the lifespan of B.C.s 2018 proved reserves to 5.3 years and the lifespan of Canada's proved reserves to 7.1 years, as illustrated in Table 1.

[7] Canadian Association of Petroleum Producers, 2019, Statistical Handbook, Table 02-08, https://www.capp.ca/publications-and-statistics/statistics/statistical-handbook

	Production change 2000-2018	2018 Production bcfd	2018 Production Tcf	2018 Reserves Tcf	Years of production at current production rates	Years of production with LNG Canada added	Years of production with LNG Canada and Kitimat LNG added
B.C.	152.1%	5.1	1.9	41.0	21.9	7.0	5.3
Alberta	-22.5%	10.5	3.8	27.7	7.2	7.2	7.2
Other Canada	-55.9%	0.5	0.2	2.5	14.3	14.3	14.3
Total Canada	-3.4%	16.2	5.9	71.3	12.1	9.9	7.1

Table 1 – Production change by region from 2000 to 2018, 2018 production, and lifespan of 2018 proved reserves at current production rates and with the additional production needed for LNG Canada and Kitimat LNG exports.[8]

Figure 3 illustrates the NEB's Canada's Energy Future 2018: Energy Supply and Demand Projections to 2040 (*EF2018)* reference case projection of Canadian production by source through 2040.[9] Production from all other sources except for the Montney Play in B.C. and Alberta, and shale gas from B.C.'s Horn River Play, decline 12% from 2018 levels through 2040. Production growth from the Montney in Alberta only serves to keep Canadian production outside of B.C. essentially flat through 2040. Production from B.C., however, is expected to more than double by 2040, which confirms that production growth for LNG exports will have to come mainly from B.C.

[8] National Energy Board, 2018, *Canada's Energy Future 2018: Energy Supply and Demand Projections to 2040*, https://www.neb-one.gc.ca/nrg/ntgrtd/ftr/2018/index-eng.html . 2000-2018 production data from National Energy Board, retrieved July, 2019. 2018 proved reserve data from CAPP statistical handbook, retrieved July, 2019.
[9] National Energy Board, 2018, *Canada's Energy Future 2018: Energy Supply and Demand Projections to 2040*, https://www.neb-one.gc.ca/nrg/ntgrtd/ftr/2018/index-eng.html .

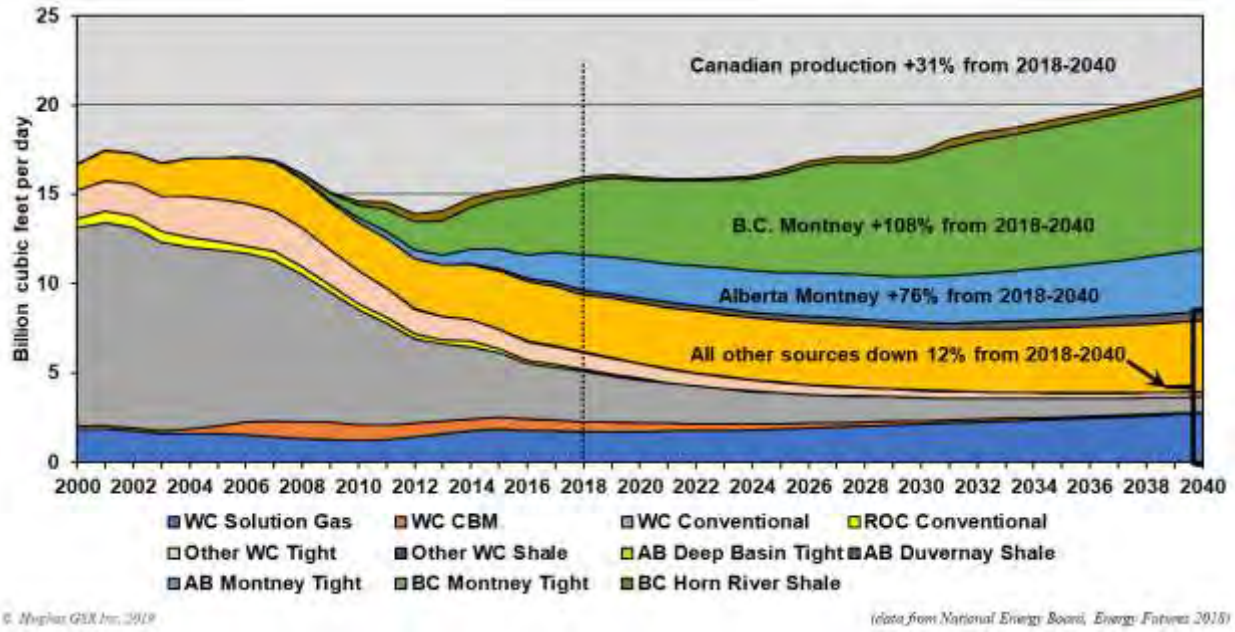

Figure 3 – NEB reference case production by source through 2040.[9]

Figure 4 illustrates the NEB's *EF2018* projection of Canadian demand through 2040 in its reference case. Although NEB has built in 3 bcfd by 2030 for LNG exports, this would only partially meet the needs of LNG Canada which requires 3.47 bcfd. And NEB accommodated LNG by shrinking pipeline exports to Canada's established customers by more than 60% from 2018 levels by 2031. Adding Kitimat LNG at full capacity in 2031 would require increasing Canada's production over NEB's projection by 15%. Even without LNG exports, NEB projects Canadian production of 135 tcf from 2018 through 2040, or nearly double Canada's existing proved reserves.

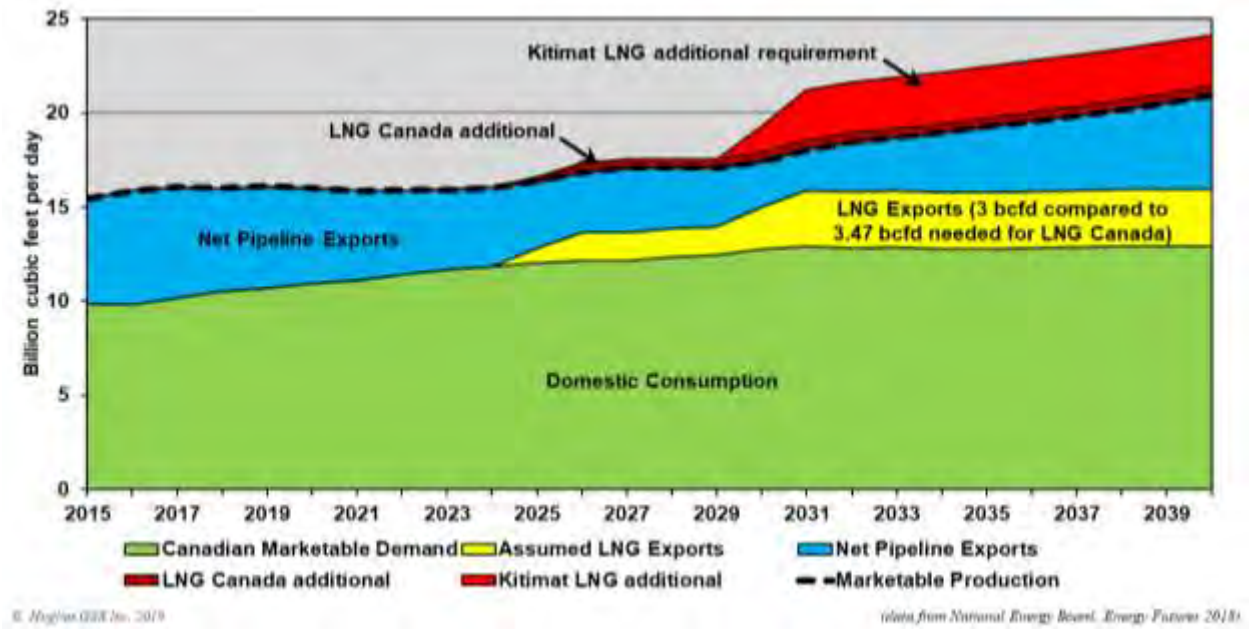

Figure 4 – Canadian demand for natural gas by source through 2040 in NEB's *EF2018* reference case.[9] Also shown is the additional natural gas production required for LNG Canada over and above the NEB projection, and the natural gas required for Kitimat LNG (see text).

2.2 Resources

As indicated in Figure 1, oil and gas resources may be 'contingent', in which case they have been discovered and are not commercially recoverable, or 'prospective', in which case they are 'undiscovered' but have been assumed to exist using sweeping assumptions across broad tracts of land – the latter have not been proved to exist, and neither 'contingent' or 'prospective' resources have been proved to be economically recoverable. Nonetheless, based on several cursory studies in conjunction with B.C. and Alberta, NEB has nearly quintupled Canada's tight gas resource estimates and more than quadrupled Canada's shale gas resource estimates in 2017 compared to 2007, as illustrated in Figure 5. These resource estimates reported by NEB are not NI 51-101 compliant, as they do not differentiate the resource categories noted in Figure 1, and must be viewed as speculative at best.

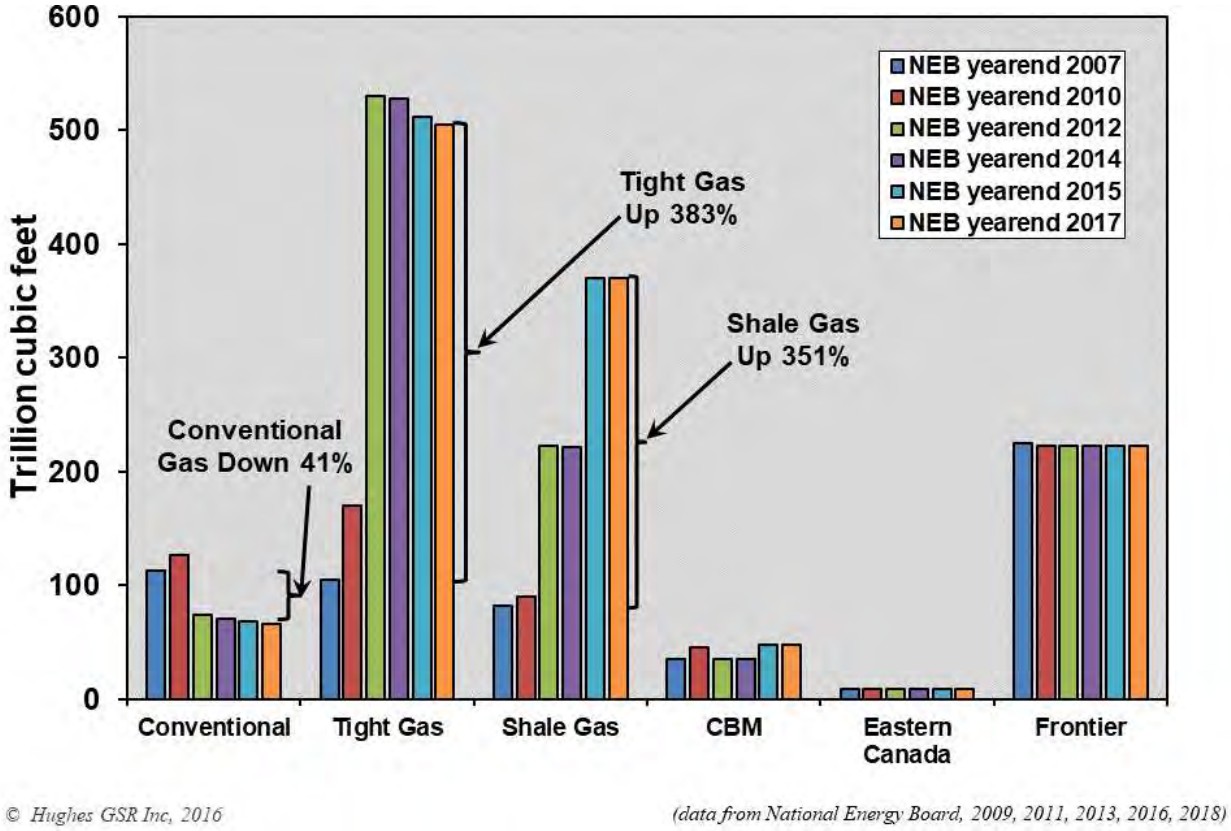

Figure 5 – Canadian marketable gas resources by type and region estimated by the NEB in its reports from 2007 through 2017.[10]

Notwithstanding that the NEB's resource estimates have not been demonstrated to be economically recoverable or even exist with reasonable certainty, or that resources in the frontier regions are unlikely to be connected to markets in the foreseeable future, the Priddle report relies on them to make a case for a surplus in gas supply for LNG export by Kitimat LNG.

2.3 Priddle Report questionable statements

The Priddle report makes many questionable and misleading statements with respect to supply and the implications of the Kitimat LNG application:

- Page 9 *"net gas exports—LNG plus pipeline—would not regain the levels of the early 2000s during the projection period"* which is incorrect. In fact, net pipeline exports plus LNG exports from LNG Canada and Kitimat LNG

[10] The most recent of these is National Energy Board, 2018, *Canada's Energy Future 2018: Energy Supply and Demand Projections to 2040*, https://www.neb-one.gc.ca/nrg/ntgrtd/ftr/2018/index-eng.html . The earlier resource estimates can be obtained from the NEB website for older Energy Future reports.

would increase by 48%, from 5.5 tcf/year in 2015 to 8.21 tcf/year in 2040, according to NEB's *EF2018* reference case forecast and the applied for LNG export volumes (see Figure 4).

- Page 10 – *"[NEB] does all of this largely with a view to making generous provision for foreseeable Canadian gas demand"*, when in fact NEB's *EF2018* reference case for domestic gas demand is flat from 2030 to 2040 (see Figure 4).

- Page 10 – *"Moreover, it is considered that the resource base is so large that it can satisfy projected Canadian requirements including those of Chevron through 2070, even were the acknowledged forecasting risks to result in a significant error on the demand side."* This statement completely ignores the uncertainty of estimates of undiscovered resources (see discussion in Section 2.2 above) and the maturity of exploration in the Western Canadian Sedimentary Basin (the 800,000 wells drilled to date have already discovered a large portion of the reserves available).

- Page 19 – *"While the export rate in this application (2.7 Bcf/d) is about double that which was approved as a result of GH-1-2011 (1.3 Bcf/d), it is a small and declining proportion of projected growing North American (Canada + U.S. + Mexico) gas supply: 2020s: ~1.9%; 2040s: ~1.6%; 2060s: ~1.4%."* Total North American gas supply is not relevant for Kitimat LNG gas supply owing to transport costs from the U.S. and/or Mexico and the fact that U.S. and Mexican gas is dedicated to other markets. This application will require increasing Canadian production by 15% above the NEB's *EF2018* reference case projection in 2030, which is significant considering that Canada's proved reserve base is less than the LNG exports being applied for.

- Page 19 – *"Given the enormous size of that [North American shale] resource, there is every reason to think that the changes it brought about will endure for decades."* In fact, shale wells experience very high production decline rates, typically between 70% and 90% over the first three years of well-life, and hence continual drilling is needed to maintain

production.[11] Sweet spots are limited and are targeted first, after which higher cost portions of plays will need to be accessed.[12] Even considering that the highest quality portions of U.S. shale plays are being exploited now, most companies are cashflow negative, which cannot continue.[13]

- Page 31 – *"the Government of British Columbia's ("BC") number of 3,400 Tcf for that province's gas resources is not included in the aggregates or as part of the ratios presented."* The Priddle Report presents this as if it is being conservative not using an 'in place' resource number than no credible analyst would use to determine potential supply. In fact, the Priddle Report uses the largest estimates of 'undiscovered' resources available to justify a 'surplus', ignoring the uncertainty with economic recoverability or even existence associated with these estimates (see page 31 of the Priddle report which states that resources of 1,087 tcf have been used for Canada and 855 tcf for the Western Canada Sedimentary Basin (WCSB) – see Figure 1 for the classification of resources as undiscovered and Figure 5 which illustrates the ramp up in reported undiscovered resources over the past decade). See Figure 2 for Canada's estimates of proved reserves of 71 tcf in 2018, which are discovered and economically recoverable under NI 51-101 reporting requirements.

- Page 31 – *"This Report prefers the Board's authoritative assessment which seems not to have been revised since EF2016."* The Board's estimates, at best, fall into the 'undiscovered' category of the NI-51-101 standard (see Figure 1). As these resources are undiscovered, the assumption that they exist and are economically recoverable and extractable in the volumes required by Canadians and LNG Canada and Kitimat LNG is at best an educated guess. The Priddle Report discounts reference to Canadian proved reserves, which LNG export applications from LNG Canada and Kitimat LNG collectively exceed, as it would destroy its case of surplus gas being available. Canada's remaining proved reserves of 71 tcf are completely

[11] Hughes, J.D., 2018, *Canada's Energy Outlook: Current realities and implications for a carbon-constrained future*, https://energyoutlook.ca/
[12] Hughes, J.D., 2018, *Shale Reality Check*, https://www.postcarbon.org/publications/shale-reality-check/
[13] Rystad Energy, May 29, 2019, *Just 10% of shale oil companies are cashflow positive*, https://www.rystadenergy.com/newsevents/news/press-releases/Just-10-percent-of-shale-oil-companies-are-cash-flow-positive/

inadequate to support the LNG Canada and Kitimat LNG export applications, which total 90 tcf, and the needs of Canadians.

- Page 33 – *"The presently-assessed resource, Canadian and North American, from which Canadians' gas requirements will be met during the applied-for licence term is enormous, approximating some 4,000 Tcf."* As noted above, the gas sourced to meet the needs of the Kitimat LNG application will very likely have to be sourced largely from B.C., mainly from the Montney Play (see Figure 3 above). Suggesting that because North American resources are large the application should be approved implies that some of the required supply will be met from U.S. and/or Mexican sources, which is extremely unlikely given transport costs from the U.S. and/or Mexico, and the fact the U.S. and Mexican gas is dedicated to other markets. Although B.C. represents Canada's best hope for growing gas production, its proved reserves of 41 tcf are entirely inadequate to meet the 40 tcf supply required by the Kitimat LNG application, along with the 50 tcf supply already approved for LNG Canada, and the needs of Canadians (as required under Section 118 of the NEB Act). B.C.'s undiscovered resources are highly uncertain as to their existence in economically extractable volumes at the rates required (see discussion in Section 2.2 above).

- Page 34 – *"Annual fluctuations in proved gas reserves data related to changing economic conditions, particularly commodity prices, should not be a concern to the Board in relation to determination of gas export surplus."* Proved gas reserves are the only estimate of economically recoverable gas that Canadians can have confidence in. Of course, the Priddle Report downplays the relevance of proved reserves as it destroys the case of a surplus to support Kitimat LNG's application for exports. The Priddle Report instead relies on 'undiscovered' resources with the uncertainties noted above, which is the only way the Priddle Report could make a case in support of the Kitimat LNG application.

- Page 40 – The Priddle Report (see its Table 1A) assumes net pipeline exports to the U.S. virtually end by 2040 (falling to 0.2 tcf/year), whereas the latest NEB *EF2018* reference projection suggests net pipeline exports will be 5.0 tcf/year in 2040 (see Figure 4 above). By doing this, the Priddle Report can claim that the Kitimat LNG application will just replace

declining pipeline exports and will not require Canadian production to increase beyond what NEB has projected in its *EF2018* reference case. The Priddle Report's assumptions try to improve Kitimat LNG's case, however, although imports from the U.S. to eastern Canada have increased, Canada remains an important gas supplier to western and midwestern states. The NEB *EF2018* reference projection illustrated in Figure 4 of this report is therefore reasonable.

- Page 41 – "*this Report adopts EF2016's high case projection of LNG exports at 6 Bcf/d through 2040*". The Priddle Report does not use the latest NEB *EF2018* reference case projection, which was available at the time of release of the Priddle Report, perhaps because the Kitimat LNG application would require an increase in Canadian production of 15% above NEB's *EF2018* reference case projection (see Figure 4 above).

- Page 50 – *"The adoption of EF2016 for relevant portions of this Report hardly needs justification: NEB's Energy Futures work is the gold standard for long-term Canadian energy and natural gas projections."* The Priddle Report ignored the latest NEB *EF2018*.[14] Why, given that *EF2018* was available at the time of publication of the Priddle Report? As noted above, the reason may be due to the fact that the projections of NEB's *EF2018* reference case do not serve the interests of Kitimat LNG's application, given that its application would require a 15% increase in 2030 production above the *EF2018* reference projection (see Figure 4 above).

- Page 50 – *"The projections of both supply and requirements are deliberately conservative."* The Priddle Report's Table 4 (page 52) requires an increase of supply in 2040 of 3.9 bcfd above the 20.9 bcfd estimated in NEB's *EF2018* reference case (see Figure 4 above), which is slightly more than required for the Kitimat LNG application. As to whether Canada's resources will allow that supply to be produced, the Priddle Report is anything but conservative, as it has adopted – as fact – speculative estimates of undiscovered resources to justify that the surplus required for Kitimat LNG exists (see page 31 of the Priddle Report which states that resources of 1,087 tcf have been used for Canada and 855 tcf for the WCSB).

[14] National Energy Board, 2018, *Canada's Energy Future 2018: Energy Supply and Demand Projections to 2040*, https://www.neb-one.gc.ca/nrg/ntgrtd/ftr/2018/index-eng.html

- Page 54 – *"The Board is also on record as responding negatively to the question 'Does the Board consider the accumulative quantity of LNG exports?'"* This is a stunning revelation.[15] The Board is charged with assuring that Canadians' long-term gas supplies are not in jeopardy under Section 118 of the NEB Act, yet the Board does not consider the cumulative impact on supply of the export projects it approves.

- Page 63 – *"The enormous resource base discussed in Section 6 above can accommodate reasonably foreseeable Canadian demand, a plausible potential increase in that demand, the exports applied-for by Chevron and a reasonable expectation as to Canadian pipeline and LNG exports in the period through at least 2070."* This 'enormous resource base' is entirely based on uncertain estimates of the economic recoverability and existence of undiscovered resources (see above discussion and discussion in Section 2.2 above). The resources that Canadians know they have for certain, which are 71tcf of proved reserves as of 2018 (see above discussion), are woefully inadequate to support 90 tcf of combined exports by LNG Canada and Kitimat LNG over 40 years, let alone the future needs of Canadians, as required under Section 118 of the NEB Act.

- Page 71 – *"As to the possible effect of the exports proposed by Chevron on the costs and prices of Canadian gas, this has not been a consideration in the Board's determinations of surplus as set out in its decisions responsive to LNG export applications."* This is another stunning revelation.[16] As noted in the Priddle Report *"The Board has elsewhere pointed out that the most prolific areas of a gas basin tend to be exploited first and, as development progresses, less productive horizons are tapped."* Of course, industry taps the most economic resources first, leaving lower productivity, higher cost resources for later. Sweet spots in the Marcellus of the eastern U.S., for

[15] National Energy Board, retrieved August 5 2019, *Frequently Asked Questions - Liquefied Natural Gas (LNG) - Export Licence Applications*, see question 7, https://www.neb-one.gc.ca/pplctnflng/mjrpp/lngxprtlcnc/lngxprtlcncfq-eng.html#s7

[16] National Energy Board, May 1989, *Reasons for Decision, Alberta and Southern Gas Co. Ltd. GH-5-88,* Section 2.2 states "[The Export Impact Assessment] is not intended to be used to protect Canadians from rising energy prices; rather its purpose is to determine whether the energy market would be able to operate in an orderly and efficient manner, were the applied-for export volumes to be licensed.", http://publications.gc.ca/collections/collection_2011/one-neb/NE22-1-1989-04-eng.pdf

example, already show declining productivity despite the application of higher volumes of fracking fluid.[17] Exporting 40 tcf via Kitimat LNG will deplete Canada's lowest cost remaining resources, leaving Canadians with higher cost gas than would otherwise be the case in the future, and potentially even supply shortfalls, in contravention of Section 118 of the NEB Act.

- Page 72 – *"It is impossible to project any price impact arising from Chevron's small proportion of the total market: 2.7 Bcf/d on a North American market which is now approaching 100 Bcf/d and which by the 2060s may approximate 170 Bcf/d. It is reasonable to conclude that there are no implications unfavourable to Canadians who have gas requirements to be met if the proposed Chevron exports are permitted and take place."* Of course it is possible to project higher prices for Canadians - if the lowest cost portions of Canada's remaining gas resources are exploited for export higher prices are a certainty, given that importing gas from the U.S. and/or Mexico would entail additional transport costs and paying higher prices than the markets to which U.S. and Mexican production is currently dedicated. Here and elsewhere, the Priddle Report claims that the North American market is available to supply the Kitimat LNG project, when in fact, given transport costs and the fact that U.S. and Mexican production already has dedicated markets, this gas will have to be provided primarily from within B.C. This means depleting B.C.'s most economically viable resources first and leaving Canadians with higher cost resources in the longer-term, along with potential supply shortfalls, in contravention of Section 118 of the NEB Act.

2.4 Summary

Canada's proved reserves of gas are 71 tcf. These are reserves that have been tested by the drill bit and have been demonstrated to be economically and technically recoverable within a reasonable timeframe. These reserves will last 12.1 years at current production rates. Increasing production by 3.47 bcfd to supply LNG Canada will reduce Canada's reserve lifetime to 9.9 years and further increasing production to supply Kitimat LNG will reduce Canada's reserve lifetime to 7.1 years. The lifespan of B.C.'s current gas reserves would be reduced

[17] Hughes, J.D., 2019, *How long will the shale revolution last?,* https://www.postcarbon.org/publications/how-long-will-the-shale-revolution-last/

from 21.9 years to 5.4 years if the 40-year applications of Kitimat LNG and LNG Canada's are sourced from B.C., as seems likely.

Broad extrapolations across wide areas have produced mean estimates of undiscovered gas resources in the Western Canada Sedimentary Basin of 988 tcf (see NEB *EF2018*). These are mainly tight- and shale-gas resources that require high-volume hydraulic fracturing and horizontal drilling to recover. As they are undiscovered, their existence and economic recoverability are highly uncertain.

Nonetheless, the claim of a sufficient surplus to allow Kitimat LNG exports of 40 tcf over 40 years is based on the assumed existence and economic viability of these undiscovered resources. Although it is likely that more drilling will discover additional gas reserves, Canadian reserves have been declining since 2015, and B.C. reserves declined in 2018. Basing a 40-year export license on the assumed existence and economic viability of undiscovered resources puts Canada's long-term energy security requirements at risk. Along with higher prices, an assured long-term gas supply for Canadians is at risk should speculative estimates of undiscovered resources not pan out, in contravention of Section 118 of the NEB Act.

Industry targets the highest quality, lowest cost, resources first, leaving lesser quality, higher cost, resources for later. This means that accelerating LNG exports through the approval of Kitimat LNG's 40-year export application will deplete the lowest cost remaining Canadian gas resources sooner and increase prices for Canadians in the longer-term, and could conceivably result in supply disruptions should the undiscovered resources the Priddle Report's surplus is based on not pan out.

Meeting the gas supply requirements of LNG Canada (3.47 bcfd) and Kitimat LNG (2.43 bcfd), will require increasing Canadian production by 6.2 bcfd. If most of this is sourced in B.C., as seems likely (see Figure 3), it will require more than doubling B.C.'s production from its current 5.1 bcfd, along with doubling the collateral environmental impacts of drilling on the landscape. The impact of such production growth on B.C.'s Clean B.C. plan and Canada's Paris Agreement emissions reduction targets is assessed in the following section.

3 Greenhouse gas emissions implications

The emissions implications of Kitimat LNG's 40-year application will compromise Canada's and B.C.'s ability to meet the greenhouse gas emissions reduction targets the Governments of Canada and British Columbia have committed to.

Climate change has been recognized by most countries to be a very serious threat and that there is an urgent need to reduce global emissions[18], and Canada has declared a climate emergency.[19] Greenhouse gas emissions reduction targets were agreed to by 197 parties in 2015 in Paris at the 21st Council of the Parties of the United Nations Framework Convention on Climate Change (UNFCCC). Canada's commitments under the Paris Agreement are to reduce emissions by 30% from 2005 levels by 2030. B.C., through its Clean B.C. Plan, has committed to reduce emissions by 40% from 2007 levels by 2030 and 80% from 2007 levels by 2050. Although the Priddle Report references provincial carbon reduction plans as possible threats to continued growth in natural gas consumption, it does not mention Canada's or B.C.'s formal emissions reduction targets.

Producing natural gas generates considerable amounts of greenhouse gas emissions, both carbon dioxide and other gases. Of particular concern, beyond carbon dioxide, are fugitive methane emissions, given that methane is many times more potent than carbon dioxide on a time horizon of 20- to 100-years. The liquefaction process used to produce LNG is also energy- and emissions-intensive.

Environment and Climate Change Canada (ECCC) produces an annual report of emissions from natural gas production in Canada that it submits to the UNFCCC, the most recent of which tabulates emissions through 2017.[20] ECCC subdivides natural gas emissions into "Natural Gas Production and Processing", "Oil and Natural Gas Transmission", and "Downstream Oil and Gas". In the case of LNG, "Downstream Oil and Gas" constitutes the liquefaction and shipping terminal in Kitimat.

The Canadian Environmental Assessment Agency (CEAA) has assessed the liquefaction terminal of LNG Canada, which will purportedly be the lowest emissions terminal in the world (less than half of the emissions per tonne of LNG

[18] See United Nations Intergovernmental Panel on Climate Change AR5 and earlier reports as well as 'Global Warming of 1.5 ºC', October, 2018, https://www.ipcc.ch/sr15/

[19] Global News, June 17, 2019, *National climate emergency declared by House of Commons*, https://globalnews.ca/news/5401586/canada-national-climate-emergency/

[20] Environment and Climate Change Canada, *2019 NATIONAL INVENTORY REPORT 1990–2017: GREENHOUSE GAS SOURCES AND SINKS IN CANADA*, https://unfccc.int/documents/194925

produced compared to the average of global LNG terminals - 0.15 t CO2e/t LNG versus a global average of 0.35 t CO2e/t LNG). Nonetheless, emissions from the LNG Canada terminal will be significant, at nearly four megatonnes per year as illustrated in Figure 6.[21] It is expected that the Kitimat LNG terminal would strive to achieve the purported emissions levels of the LNG Canada terminal.

Operation Activity	GHG Emissions (t/y)			
	CO_2	CH_4	N_2O	CO_2e
Gas turbine power generation	3,054,358	63	56	3,072,570
Incinerators	704,917	345	208	775,636
Flares	78,810	5.2	1.5	79,398
Fugitive Sources	0.89	1,002	-	25,056
Domestic Shipping Activities	5,008	0.65	0.15	5,067
Total GHG Emissions (excluding international shipping activities)	**3,843,094**	**1,415**	**266**	**3,957,728**
International Shipping Activities	83,396	0.59	4.8	84,827

Figure 6 – LNG Canada's terminal emissions at its rated capacity of 26 million tonnes of LNG per year (Table 5-1 of the CEAA assessment).[17]

Figure 7 illustrates emissions from the natural gas and LNG production sector for LNG Canada and Kitimat LNG. Emissions for the Kitimat LNG terminal are proportioned based on its rated throughput (2.73 bcfd compared to 3.47 bcfd for LNG Canada), assuming it would achieve the 0.15 t CO2e/t LNG purported for the LNG Canada terminal. Emissions from upstream production have also been reduced by 15% for each project assuming that some portion of this process will be electrified as claimed by the B.C. Government. Emissions per unit of natural gas production have been calculated using the average of 2014-2017 ECCC emissions for production and transmission based on average production data from 2014-2017 from the NEB's *EF2018*[22]. It is assumed that half of LNG Canada's rated capacity would be on line in 2026 and all of its capacity would be online by 2031. Kitimat LNG is assumed to be online at full rated capacity in 2031.

[21] Canadian Environmental Assessment Agency, 2015, *LNG CANADA EXPORT TERMINAL PROJECT ASSESSMENT REPORT*, https://www.ceaa-acee.gc.ca/050/documents/p80038/101852E.pdf

[22] National Energy Board, 2018, *Canada's Energy Future 2018: Energy Supply and Demand Projections to 2040*, https://www.neb-one.gc.ca/nrg/ntgrtd/ftr/2018/index-eng.html

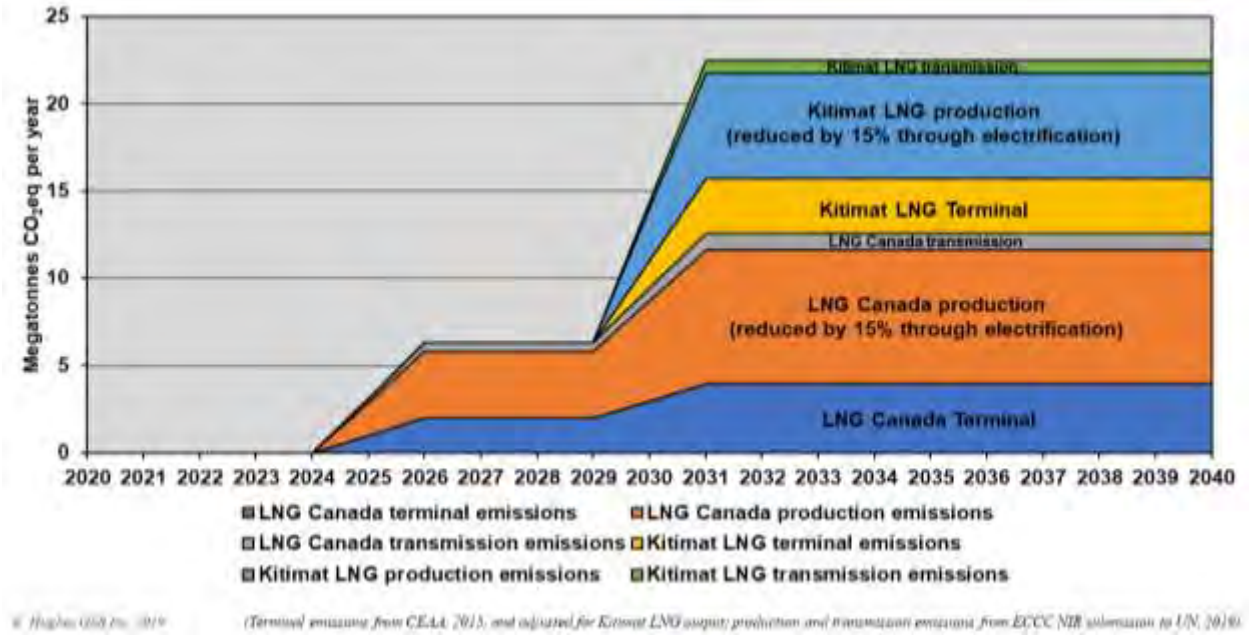

Figure 7 – Emissions from natural gas production, transmission and liquefaction for the LNG Canada and Kitimat LNG projects (see text for sources and assumptions). Emissions from the liquefaction terminals are assumed to be less than half of the global average (per CEAA[23]), and emissions from production have been reduced by 15% assuming part of the upstream production process will be electrified.

Full cycle emissions to the point of export total 22.5 megatonnes per year (12.6 megatonnes for LNG Canada at full buildout and 9.9 megatonnes for Kitimat LNG). Total Canadian emissions from all sectors through 2017 are illustrated in Figure 8, along with emissions from oil and gas production projected through 2040 using production projections from the reference case of NEB's *EF2018* (emissions are assumed to stay constant at 2040 levels through 2050). Emissions from LNG Canada and Kitimat LNG would increase total Canadian emissions from oil and gas production by 8.7% after full-buildout in 2031. As shown in Figure 8, emissions from all non-oil and gas production sectors would have to decrease 54% by 2030 in order to meet the Paris Agreement target. This is virtually impossible, considering that Canadian emissions as of 2017 were down only 2% from 2005 levels. If production continues per NEB's *EF2018* reference case projection, emissions from oil and gas production alone will be more than double ECCC's aspirational target of 80% below 2005 levels by 2050 for all sectors. In short, LNG

[23] Canadian Environmental Assessment Agency, 2015, *LNG CANADA EXPORT TERMINAL PROJECT ASSESSMENT REPORT*, https://www.ceaa-acee.gc.ca/050/documents/p80038/101852E.pdf

Canada and Kitimat LNG would make a very difficult situation in meeting Canada's emissions reduction targets even worse.

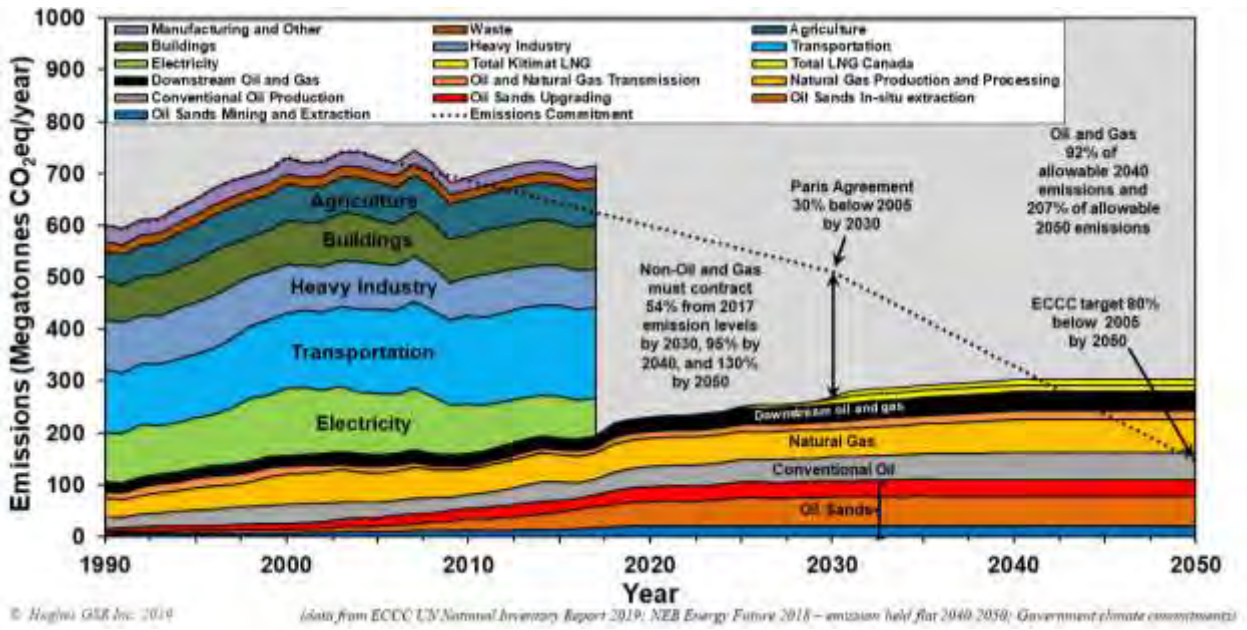

Figure 8 – Canadian emissions by sector from 1990 to 2017 from ECCC (2019).[24] Emissions for oil and gas production are projected to 2040 using the NEB *EF2018* reference case production projection.[25] Emissions are then held constant at 2040 production rates through 2050. Emissions from LNG Canada and Kitimat LNG are shown in yellow (these two projects add 8.7% to Canada's oil and gas production emissions by 2031). Also shown are Canada's commitment under the Paris Agreement through 2030 and the ECCC aspirational target of 80% below 2005 levels by 2050. The increase in emissions from oil and gas production and LNG exports will require emissions from the rest of Canada's economy to decrease by 54% by 2030 in order to meet the Paris Agreement target, 100% by 2042, and by 2050 emissions from oil and gas will be more than double ECCC's target.

As noted above, the Clean B.C. plan has committed B.C. to 40% emissions reduction from 2007 levels by 2030 and 80% reduction by 2050. Figure 9 illustrates B.C.'s emissions by sector through 2017 with projections of emissions from oil and gas production through 2040 using the NEB's *EF2018* reference projection (emissions are extended to 2050 assuming constant 2040 production).

[24] Environment and Climate Change Canada, 2019 **NATIONAL INVENTORY REPORT** 1990–2017: GREENHOUSE GAS SOURCES AND SINKS IN CANADA, https://unfccc.int/documents/194925

[25] National Energy Board, 2018, Canada's Energy Future 2018: Energy Supply and Demand Projections to 2040, https://www.neb-one.gc.ca/nrg/ntgrtd/ftr/2018/index-eng.html

Also shown are emissions from LNG Canada and Kitimat LNG (the first two trains from LNG Canada are projected to come on line in 2026 with the final two in 2031, and Kitimat LNG is projected to come on line in 2031). Note that the 3 bcfd in NEB's projection for LNG is fully assigned to LNG Canada (see Figure 4). If both of these projects are built, emissions from the non-oil and gas production sectors of B.C.'s economy would have to decrease emissions by 109% by 2031, and by 2050 emissions from oil and gas production and LNG alone would be triple B.C.'s emissions reduction target. Clearly, building LNG Canada and Kitimat LNG presents an untenable situation for the B.C. government in meeting its emissions reduction commitments.

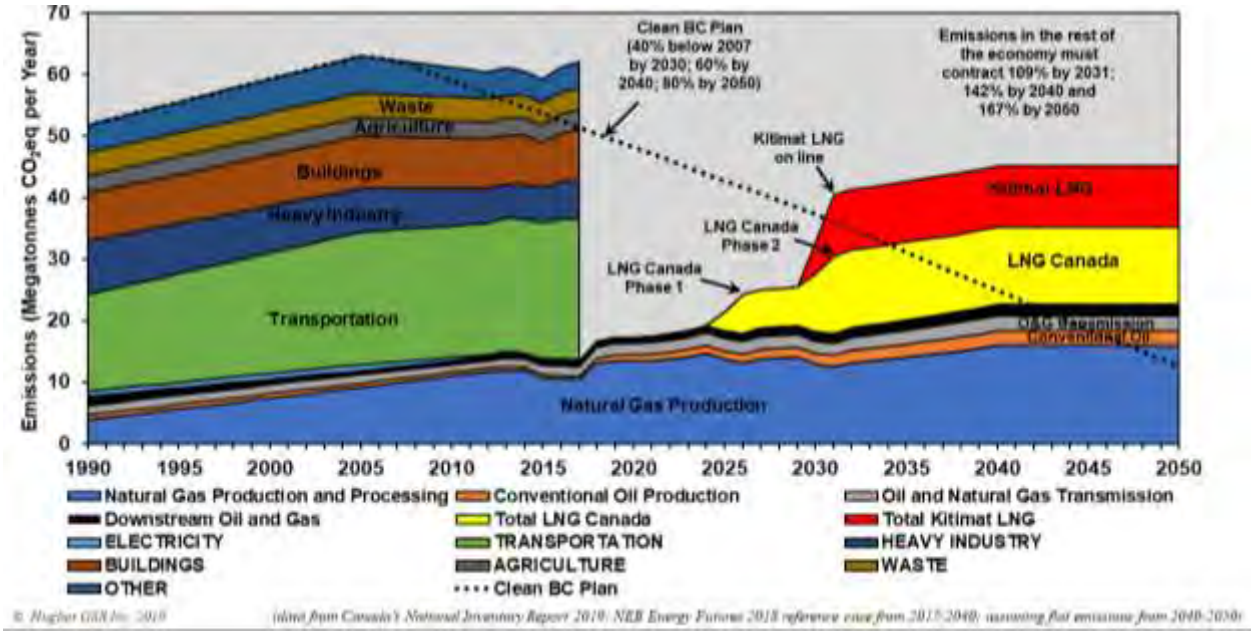

Figure 9 – B.C. emissions by sector from 1990 to 2017 from ECCC (2019).[26] Emissions for oil and gas production are projected to 2040 using the NEB *EF2018* reference case production projection.[27] Emissions are then held constant at 2040 production rates through 2050. Emissions from LNG Canada and Kitimat LNG are shown in yellow and red, respectively (these two projects nearly double oil and gas production emissions by 2040). Also shown are the Clean B.C. emissions reduction commitments through 2050. This increase in emissions from oil and gas production will require emissions from the rest of B.C.'s economy to decrease by

[26] Environment and Climate Change Canada, 2019 **NATIONAL INVENTORY REPORT** 1990–2017: GREENHOUSE GAS SOURCES AND SINKS IN CANADA, https://unfccc.int/documents/194925

[27] National Energy Board, 2018, Canada's Energy Future 2018: Energy Supply and Demand Projections to 2040, https://www.neb-one.gc.ca/nrg/ntgrtd/ftr/2018/index-eng.html

109% by 2031 and by 2050 emissions from oil and gas production and LNG will be triple the Clean B.C. target.

A best-case scenario for B.C. emissions would be if some existing production from B.C. and/or Alberta could be diverted to supply LNG Canada so less new production would be required. Given that there are limited, if any, volumes available for diversion from existing customers, a diversion of 40% of the supply needed by LNG Canada from existing Canadian production would mean that Kitimat LNG would likely require development of new production for its supply. Figure 10 illustrates this scenario in which 40% of LNG Canada's supply is diverted from existing production (all other assumptions are the same as in Figure 9). In this scenario, non-oil and gas production sectors of B.C.'s economy would have to reduce emissions by 102% by 2031 and by 2050 emissions from oil and gas alone would be nearly triple the Clean B.C. plan target – so this scenario would still eliminate any chance of meeting the Clean B.C. plan targets.

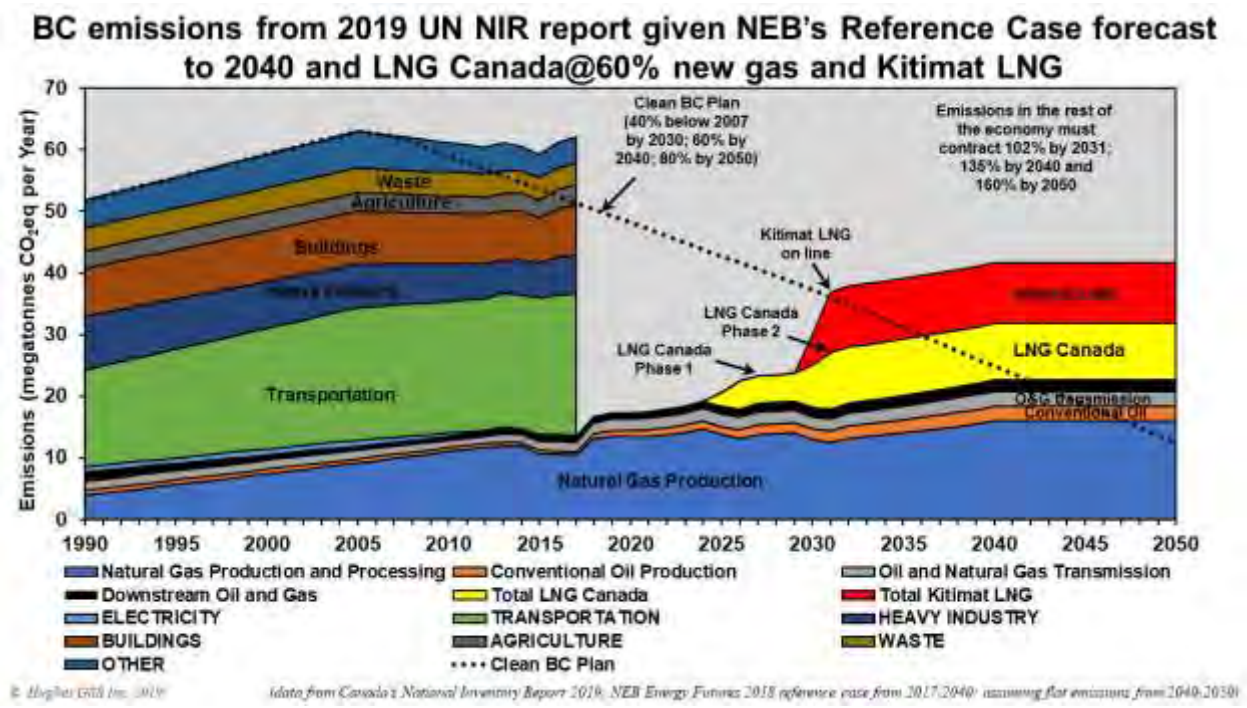

Figure 10 – B.C. emissions if 40% of the gas supply for LNG Canada is diverted from existing production (all other assumptions are the same as for Figure 9). The situation is would still eliminate any chance of meeting the Clean B.C. emissions reduction targets. Non-oil and gas production sectors of B.C.'s economy would have to reduce emissions by 102% by 2031 and by 2050 emissions from oil and gas alone would be nearly triple the Clean B.C. plan target.

3.1 Summary

Development of Kitimat LNG is incompatible with Canada's emissions reduction targets under the Paris Agreement and the longer-term target of ECCC of 80% reduction by 2050. Development of both LNG Canada and Kitimat LNG will mean emissions from non-oil and gas production sectors of Canada's economy will have to reduce by 54% from 2017 levels by 2030. Meanwhile, emissions from Canada's entire economy are only down 2% from 2005 levels. It will be virtually impossible to meet Canada's targets with LNG development and with projected production expansion of other oil and gas including the oil sands as projected in the NEB's *EF2018* reference case.

Development of Kitimat LNG and LNG Canada would also eliminate any chance of achieving B.C.'s Clean B.C. Plan targets, as emissions from non-oil and gas production sectors of B.C.'s economy would have to reduce emissions by over 100% by 2031, even if some supply can be diverted from existing production for LNG Canada.

4 Comparison of emissions from B.C. LNG and coal in Asia

The Priddle Report claims (page 64) *"LNG exports probably offer the best and largest market growth opportunity for Canadian gas. Those exports will tend predominantly to displace coal, actually and potentially, in thermal power generation. Natural gas being the lowest-carbon emitting fossil fuel, those exports will result in lower overall global GHG emissions."*

The Priddle Report's claim that B.C. LNG exports will reduce global emissions is false if full-cycle emissions are considered over a timeframe of 40-70 years. While it is true that at the burner-tip, natural gas emits only 54% of the emissions of coal[28], full-cycle greenhouse gas emissions from LNG include emissions from the production of the natural gas, pipeline transportation, liquefaction, shipping, and regasification. In replacing older, low-efficiency coal power plants, a country such as China has a choice of technologies, including renewable energy, combined-cycle natural gas (CCNG), and best-in-class ultra-supercritical coal plants. China is investing in all of these: it is the world's largest installer of renewable energy; it is importing gas by pipeline from Russian as well as LNG; and it is building ultra-efficient coal plants. As the International Energy Agency (IEA) points out "China has a large, young, and highly efficient coal-fired fleet" and that "potential savings

[28] Energy Information Administration, *How much carbon dioxide is produced when different fuels are burned?* https://www.eia.gov/tools/faqs/faq.php?id=73&t=11

of around 100 Mt CO_2 from switching [from coal to gas] are small relative to China's overall power sector emissions of 4,500 Mt CO_2."[29] The IEA also points out that gas is not competitive with coal in China unless the price is below USD$4/million btu (Mbtu), which is less than half the current cost of imported LNG. New coal capacity in China uses ultra-low emission plants.[30]

In comparing best-technology coal to best-technology gas using B.C. LNG, the following factors are key:

- *The efficiency of new plants being added.* Ultra-supercritical coal technology has typical efficiencies of 45% with the newest plants capable of 49%.[31] By comparison, new large capacity (>500 MW) combined-cycle gas plants in the U.S. had heat rates of about 7,500 btu which translates to an efficiency of 46%.[32]

- *The leakage rate of methane* in the production and transportation of gas and coal. Methane is a potent greenhouse gas that has 34 times the impact of carbon dioxide over a 100-year period and 86 times the impact over a 20-year period.[33] An overall leakage rate of about 1.4% for natural gas has been assumed by the U.S. Environmental Protection Agency, but this has been revised upwards in a comprehensive peer-reviewed report to 2.3%.[34] Of these emissions, the authors state "roughly 85% …are from production, gathering, and processing sources", or approximately 2% of total natural gas production. Howarth (2014) has reviewed estimates of fugitive methane emissions and suggests upstream emissions from unconventional (i.e. extracted by fracking) gas (such as that from the Monteney Play of northeast

[29] International Energy Agency, 2019, The Role of Gas in Today's Energy Transitions, see page 12, https://www.iea.org/publications/roleofgas/?utm_content=buffer2f1d6&utm_medium=social&utm_source=facebook.com&utm_campaign=buffer

[30] Oil Price, July 18, 2019, *China to Add More Coal Power in 2019 and 2020 To Meet Energy Demand,* https://oilprice.com/Latest-Energy-News/World-News/China-To-Add-More-Coal-Power-In-2019-And-2020-To-Meet-Energy-Demand.html

[31] General Electric, retrieved July 30, 2019, *Driving your plant towards 50% efficiency*, https://www.ge.com/power/steam/steam-power-plants/steamh

[32] Energy Information Administration, February 12, 2019, *Power blocks in natural gas-fired combined-cycle plants are getting bigger*, https://www.eia.gov/todayinenergy/detail.php?id=38312#

[33] Intergovernmental Panel on Climate Change, 2014, Fifth Assessment report, see Table 8-7, https://www.ipcc.ch/assessment-report/ar5/

[34] Alvarez, R.A., et. al., June 2018, *Assessment of methane emissions from the U.S. oil and gas supply chain,* https://www.researchgate.net/publication/325916333_Assessment_of_methane_emissions_from_the_US_oil_and_gas_supply_chain

B.C.) are considerably higher, between 2.2 and 4.3% (mean of 3.3%),[35] suggested that methane leakage from the fracking process is much higher than for conventional gas, due to flowback from the initial fracking process.

- *The Global Warming Potential (GWP) assumed for methane.* As noted above, the latest GWP estimates of the IPCC (2014) for methane are 34 times carbon dioxide over 100 years and 86 times over 20 years. In the UN submission for 2017 Canadian emissions ECCC has used the older estimate of 25 times carbon dioxide over 100 years from the IPCC's 2007 Fourth Assessment Report (AR4).[36] This means that the actual severity of emissions have been underestimated in the figures used in Section 3 of this report, and vastly underestimated if the global warming potential of methane over 20-years is considered.

- *The emissions from the rest of the supply chain*: pipeline transport, liquefaction, shipping and regasification in the case of B.C. LNG; rail transport in the case of coal.

The National Energy Technology Laboratory (NETL) of the U.S. Department of Energy analyzed life-cycle emissions of the LNG supply chain for U.S. LNG in 2014.[37] NETL looked at all phases of the LNG supply chain compared to coal in China, but underestimated fugitive methane emissions by using 1.4% instead of the latest estimate of 2.0% or, given that most of production to supply B.C. LNG will come from unconventional gas, the 3.3% unconventional gas estimate of Howarth noted above.

Table 2 illustrates a comparison in greenhouse gas emissions between a B.C. LNG fueled combined-cycle gas power plant in Shanghai, China, and an ultra-supercritical coal power plant in China. These plants are assumed to have efficiencies of 46% and 45% respectively. Fugitive emissions of methane from

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[35] Howarth, R. W., 2014, *A bridge to nowhere: methane emissions and the greenhouse gas footprint of natural gas*, Energy Science & Engineering https://onlinelibrary.wiley.com/doi/abs/10.1002/ese3.35

[36] Intergovernmental Panel on Climate Change, 2007, Fourth Assessment report, https://www.ipcc.ch/assessment-report/ar4/

[37] U.S. Department of Energy, National Energy Technology Laboratory, 2014, *Life Cycle Greenhouse Gas Perspective on Exporting Liquefied Natural Gas from the United States,* https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=2ahUKEwiF7-3M4NzjAhUS7J4KHSokCtAQFjAAegQIABAC&url=https%3A%2F%2Fenergy.gov%2Fsites%2Fprod%2Ffiles%2F2014%2F05%2Ff16%2FLife%2520Cycle%2520GHG%2520Perspective%2520Report.pdf&usg=AOvVaw2zysIo1pETJnyP8eBj2cKJ

upstream production and processing of natural gas are assumed to be 2.0% of total production based on the latest evidence discussed above. Emissions from the CEAA evaluation of the LNG Canada terminal, which are less than half of the global average, are used. Pipeline distance has been adjusted given that the Coastal Gaslink pipeline to supply LNG Canada is only 670 kilometres compared to the 971 kilometres assumed by NETL. The tanker voyage trip has also been shortened to 9,058 kilometres to reflect the shorter voyage distance from Kitimat to Shanghai, rather than the 9,997 kilometres assumed by NETL. Finally, GWP values were adjusted slightly from those used by NETL to reflect the latest IPCC AR5 values – GWP for methane was adjusted to 34 from 30 for 100-years and to 86 from 85 for 20 years[38].

Life Cycle Process	100-yr GWP		20-yr GWP	
	Kitimat, B.C. to Shanghai, China	Chinese Regional Coal	Kitimat B.C. to Shanghai, China	Chinese Regional Coal
Natural Gas/Coal Extraction and Processing	106.1	8.2	230.2	13.5
Domestic Pipeline Transport	25.2	N/A	57.8	N/A
Liquefaction	23.0	N/A	23.0	N/A
Tanker/Rail Transport	48.8	14.5	55.6	15.3
Tanker Berthing & Deberthing	1.5	N/A	1.6	N/A
LNG Regasification	21.8	N/A	45.8	N/A
Power Plant Operations	393.7	739.5	393.7	739.5
Electricity T&D	3.4	3.4	3.4	3.4
Total	623.6	765.6	811.2	771.6

Table 2 – Life cycle emissions from B.C. LNG compared to best technology coal in China based on upstream fugitive methane emissions of 2.0% utilizing assumptions noted in the text. This is based on upstream fugitive methane emissions of 2% from natural gas extraction and processing, which is below the 3.3% threshold noted by Howarth (2014) for the unconventional gas that would supply LNG Canada and Kitimat LNG.

In this case, B.C. LNG would have 5.1% greater emissions than coal at 20 years and 18.6% less emissions than coal at 100 years, meaning that exporting B.C. LNG would exacerbate the global emissions problem for at least the first 40 years after constructing a power plant in China to burn it.

[38] Intergovernmental Panel on Climate Change, 2014, Fifth Assessment report, see Table 8-7, https://www.ipcc.ch/assessment-report/ar5/

Given that much or all of the supply for LNG Canada and Kitimat LNG would come from unconventional gas in the Montney Play of northeast B.C., a more realistic value for fugitive methane is 3.3% (see above discussion). Given this case, which is illustrated in Table 3, best-technology coal would have 19.2% fewer emissions at 20 years than B.C. LNG and 15% greater emissions at 100 years. The breakeven point at which B.C. LNG would actually emit less greenhouse gas than best-technology coal would be 70 years in the future, at which point the plants burning it would be past their design lifetime.

Life Cycle Process	100-yr GWP		20-yr GWP	
	Kitimat, B.C. to Shanghai, China	Chinese Regional Coal	Kitimat, B.C. to Shanghai, China	Chinese Regional Coal
Natural Gas/Coal Extraction and Processing	133.9	8.2	338.6	13.5
Domestic Pipeline Transport	25.2	N/A	57.8	N/A
Liquefaction	23.0	N/A	23.0	N/A
Tanker/Rail Transport	48.8	14.5	55.6	15.3
Tanker Berthing & Deberthing	1.5	N/A	1.6	N/A
LNG Regasification	21.8	N/A	45.8	N/A
Power Plant Operations	393.7	739.5	393.7	739.5
Electricity T&D	3.4	3.4	3.4	3.4
Total	651.3	765.6	919.6	771.6

Table 3 – Life cycle emissions from B.C. LNG compared to best technology coal in China based on upstream fugitive methane emissions of 3.3% utilizing assumptions noted in text. Fugitive methane emissions of 3.3% is the level noted by Howarth (2014) for the unconventional gas that would supply LNG Canada and Kitimat LNG (see text).

Figure 11 summarizes the emissions data in tables 2 and 3. As noted above, at 20 years emissions from B.C. LNG would be 5% to 19% greater than best-technology coal for power generation in China at 2.0% and 3.3% levels of fugitive methane emissions, respectively. The breakeven point where B.C. LNG actually emits less greenhouse gas emissions than coal, is from 40 to 70 years in the future, depending on the level of fugitive methane emissions assumed. Given that most of the gas to supply LNG Canada and Kitimat LNG will come from unconventional gas in the Montney Play of northeast B.C., the 3.3% scenario of fugitive methane emissions is the most realistic, which means that coal is the superior choice compared to B.C. LNG for at least the next 70 years from a global emissions point of view.

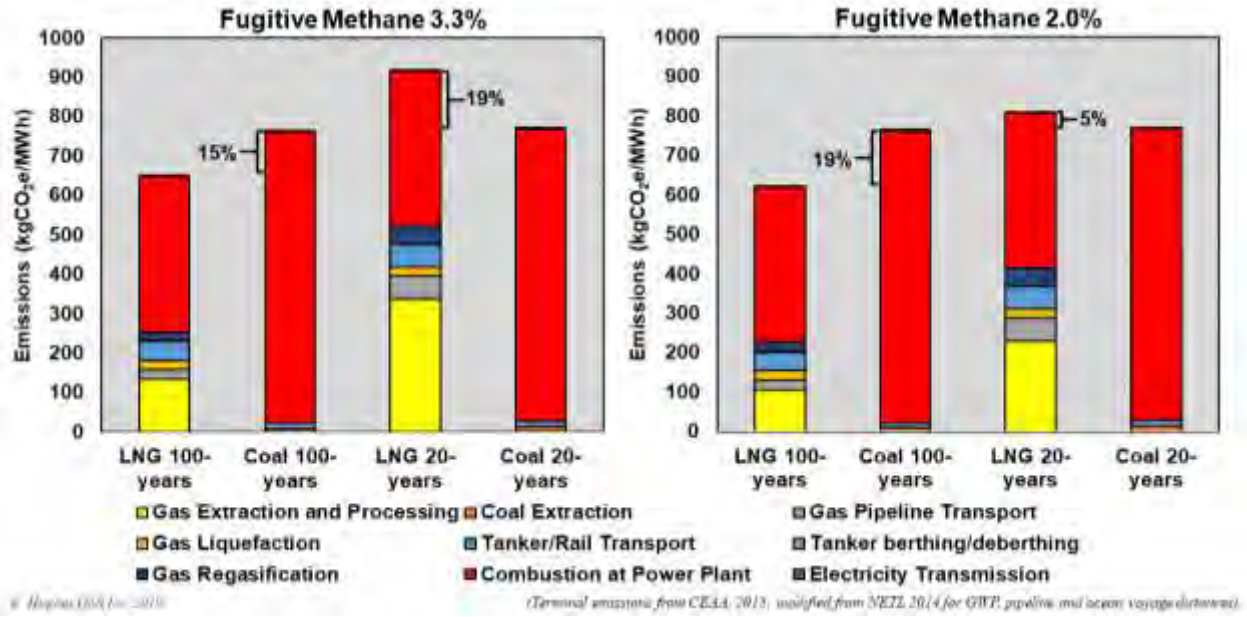

Figure 11 – Comparison of B.C. LNG and best-technology coal for power generation in China for scenarios with 3.3% (typical of unconventional gas) and 2.0% (as determined for combined conventional and unconventional gas) upstream fugitive methane emissions as enumerated in tables 2 and 3. Under both scenarios, B.C. LNG produces more emissions at 20 years than best-technology coal (see discussion in text).

4.1 Summary

Notwithstanding the Priddle Report's claim that exports of LNG applied for by Kitimat LNG "*will result in lower overall global GHG emissions",* the opposite is true if emissions are considered on a 40- to 70-year timeframe.

Over at least the first 40 years, exports of LNG from B.C. will increase global greenhouse gas emissions compared to best-technology coal in China. This is due to fugitive methane and carbon dioxide emissions during gas production and along the LNG supply chain. Methane is a much more potent greenhouse gas than carbon dioxide, being 86 times more potent than carbon dioxide over at 20-years from initial emission and 34 times more potent at 100 years.

Depending on the fugitive emissions of methane assumed, greenhouse gas emissions from B.C. LNG burned in China will be 5% to 19% higher than best-technology coal over 20 years. The lower estimate is based on overall fugitive methane emissions of 2.0% for all conventional and unconventional fugitive methane emissions. The higher estimate is based on a 3.3% estimate for fugitive

methane emissions from unconventional gas production, recognizing the most or all of the Kitimat LNG supply would be from unconventional gas.

Exacerbating the emissions problem through increasing emissions from export projects like LNG Canada and Kitimat LNG is the opposite of what is required, especially considering the urgent calls for action on greenhouse gas emissions reduction by the United Nations, the reduction of emissions committed to by Canada in the Paris Agreement and B.C. in its Clean B.C. Plan, and the declaration of a climate emergency by the Canadian government.

The greenhouse gas emissions situation over the next half-century is worse than depicted in ECCC's submissions on Canada's emissions to the United Nations, as it uses the older 100-year IPCC AR4 GWP for methane of 25 times carbon dioxide and ignores the much higher 20-year emissions factor of 86 (the AR4 100-year GWP is a UN protocol for emissions reporting for all countries). The 20-year emissions factor is, however, the most relevant, considering the urgency of the climate change problem, and if used in the figures and discussion in Section 3 of this report (which are based on the ECCC emissions data), the situation would be even more dire than depicted by them.

5 Conclusions

Kitimat LNG aspires to export 40 tcf of LNG over 40 years on top of LNG Canada's approved export volumes of 50 tcf over 40 years. The Priddle Report, used by Kitimat LNG to justify its application for exports, is based on tenuous supply assumptions which ignore Canada's and B.C.'s emissions reduction commitments and will result in higher natural gas prices and potential supply shortfalls for Canadians. These exports would compromise Canada's and B.C.'s emissions reduction targets and increase global greenhouse gas emissions.

The Priddle Report's assertions of assured supplies of Canadian gas for exports and domestic use through 2070 are based on estimates of undiscovered resources for which there is no assurance of economic recoverability or even existence. Proved Canadian reserves, which have been demonstrated to exist and to be economically recoverable, totaled just 71 tcf in 2018, and have been declining since 2015. Proved reserves are not sufficient to support even LNG Canada and provide for the longer-term needs of Canadians. Approving Kitimat LNG would mean that a total of 90 tcf of LNG exports have been approved in the face of 71 tcf of Canadian proved gas reserves. This sets Canadians up for higher prices and potential supply shortfalls, given the propensity of industry to extract the most

economic and lowest cost resources first in order to maximize profits, in contravention of Section 118 of the NEB Act.

Canada is a mature exploration region, with more than 800,000 wells drilled over the past 70 years, mainly in the three western provinces where the gas supply for LNG Canada and Kitimat LNG would be produced.[39] Although the advent of high-volume hydraulic fracturing of horizontal wells in low-permeability formations has resulted in additional proved reserves, the vastly increased resource estimates of NEB are highly speculative (see Figure 5 above). Certainly, some additional proved reserves will be added with more drilling (although Canada's proven reserves have been falling since 2015), but to commit to exporting more gas than Canada is certain it has places undue reliance on unproven, speculative resource estimates. Doing so would appear to contravene Section 118 of the NEB Act which states "*the Board shall satisfy itself that the quantity of oil or gas to be exported does not exceed the surplus remaining after due allowance has been made for the reasonably foreseeable requirements for use in Canada*". Annual production required for LNG Canada and Kitimat LNG would reduce Canada's proved reserve lifetime from 12.1 years to 7.1 years.

Emissions generated by LNG Canada and Kitimat LNG would further compromise Canada's commitments under the Paris Agreement, which are already virtually unreachable, and eliminate any chance of B.C. meeting its Clean B.C. Plan emissions reduction targets. In Canada, along with other increases in oil and gas production projected in NEB's *EF2018* reference case, these projects will require emissions in all non-oil and gas production sectors in the economy to reduce emissions by 54% from 2017 levels by 2030 to meet the Paris Agreement target, and by 2050 oil and gas production emissions alone would be more than double Canada's aspirational goal of 80% reduction below 2005 emissions levels. In B.C., along with other increases in oil and gas production projected in NEB's *EF2018* reference case, these projects will require all non-oil and gas production sectors in the economy to reduce emissions by more than 100% by 2031 to meet the Clean B.C. target, and by 2050 oil and gas production emissions alone would be triple the Clean B.C. target of 80% reduction below 2007 emissions levels. Approving Kitimat LNG on top of LNG Canada is not in the public interest if Canada and B.C. are serious about meeting emissions reduction commitments.

[39] Hughes, J.D., 2018, Canada's Energy Outlook: Current realities and implications for a carbon-constrained future, https://energyoutlook.ca/

The narrative cited in the Priddle Report that B.C. LNG exports to Asia will lower global emissions is false when considered over a timeframe of 40-70 years. Over at least the next four decades, B.C. LNG used to generate electricity in China compared to best-technology coal would increase global emissions, thereby exacerbating an already extremely serious climate problem. Depending on the level of fugitive emissions of methane assumed, greenhouse gas emissions from B.C. LNG burned in China will be 5% to 19% higher than best-technology coal at 20 years from the time of initial emission. The lower estimate is based on overall fugitive methane emissions of 2.0% for all conventional and unconventional life-cycle methane emissions. The higher estimate is based on fugitive methane emissions of 3.3% from unconventional gas production, recognizing the most or all of the Kitimat LNG supply would be from unconventional gas.

In summary, approving the Kitimat LNG terminal on top of LNG Canada is not in the public interest given long-term Canadian energy needs and climate change commitments. Approval would further compromise Canada's commitments under the Paris Agreement, which are already virtually unreachable, and eliminate any chance of B.C. meeting its Clean B.C. Plan emissions reduction targets. The narrative noted in the Priddle Report that B.C. LNG exports to Asia will lower global emissions in a meaningful timeframe is false as these exports would increase emissions over at least the next four decades.[40]

[40] Note that it is just the emissions emitted in year one of LNG shipments that may become emissions negative in year 41. Emissions in year 40 of LNG shipments will not become negative until year 80.