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NOVA Gas Transmission Ltd. – Towerbirch Expansion Project

Review of Related Upstream Greenhouse Gas Emissions Estimates

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Canada

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Summary

This document provides an estimate of the upstream greenhouse gas (GHG) emissions associated with the NOVA Gas Transmission Ltd. (NGTL) Towerbirch Expansion Project (the Project), and a discussion of conditions under which building the Project enables additional natural gas production and upstream emissions.

NGTL proposes to construct and operate new natural gas pipeline facilities in northeastern British Columbia and northwestern Alberta to expand the existing NGTL System. This expansion would provide gas producers in the Tower Lake area of the Montney region, British Columbia, with direct access to the NGTL System, and consequently to gas markets across North America. NGTL proposes to construct a new pipeline section and a loop, totaling approximately 87 kilometers, in order to meet 24,338.3 10^3 m^3/d (859 MMcf/d) of additional receipt contracts. These new installations will also require four (4) new meter stations and one (1) expansion to an existing meter station. Approximately 82% of the Project would parallel existing linear disturbance, such as pipelines and roads. The Project will increase the total system capacity along the Groundbirch Mainline by 32,837 $10^3 m^3/d$ (1160 MMcf/d).

Environment and Climate Change Canada estimated the upstream GHG emissions in Canada associated with the production, gathering, and processing of the additional volume of natural gas corresponding to the increase in total system capacity due to the Project. The GHG emissions projections and natural gas production projections used by Environment and Climate Change Canada for this review include the estimated future impacts of the existing policies and measures that have been implemented as of September 2015. A number of important measures and targets to reduce GHG emissions from the oil and gas sector have been announced since that time, including the Government of Canada's commitment to reduce methane emissions from the oil and gas sector by 40% to 45% below 2012 levels by 2025. While this analysis focuses on policies implemented as of September 2015 and does not reflect the impact of additional federal, provincial, or territorial measures announced or under development, it is recognized that future improved practices will mitigate emissions.

The upstream GHG emissions in Canada associated with the production, gathering, and processing of the additional volume of natural gas corresponding to the increase in total system capacity along the Groundbirch Mainline due to the Project are estimated to be 3.0 megatonnes of carbon dioxide equivalent per year. For the purposes of this assessment, *upstream* is defined as all natural gas sector stages before the gas transmission system – that is, natural gas production, gathering and processing. This assessment accounts for all GHG emissions including fugitives, venting, flaring, and combustion.

Environment and Climate Change Canada has provided insight into the conditions under which the proposed Project would lead to incremental GHG emissions in Canada and globally. Natural gas production and consumption growth is forecast in Canada, the U.S. and globally, with some reports finding that production and consumption growth in the medium term could be consistent with a 2°C world. Demand growth from oil sands development, electricity generation and liquefied natural gas facilities is expected to drive forecast increases in Canadian production.

At this time, there are no alternative modes of transportation to cost-effectively move large amounts of natural gas over land from producing regions to consuming regions. As a result, in comparing a scenario in which the proposed Project is not built to a scenario in which the Project is built, it is likely that the production associated with the increase in total system capacity along the Groundbirch Mainline would be incremental and would not be produced without the Project. In this case, the upstream GHG emissions estimated would be expected to be incremental to a scenario in which the Project was not built.

Since the increase in capacity is expected to enable production in Canada, there would be impacts on North American supply and prices given the integrated nature of the continental market. In addition, if liquefied natural gas exports increase from North America, incremental Canadian natural gas supply could affect global supply and prices.

The incremental natural gas associated with the increase in total capacity along the Groundbirch Mainline would either displace natural gas from other sources that would no longer be needed or it could add to total continental or global natural gas supply. Where natural gas from other sources is displaced, the emissions impact would be the difference in well-to-market emissions between the Montney region and other producing regions. The Montney region appears to produce relatively low GHG emission natural gas compared to other Western Canadian natural gas regions owing to the low associated CO_2 in the gas and minimal processing requirements, though sources of information are limited. ECCC has not found a study that compares upstream GHG emissions from various sources of shale or tight gas across North America or globally.

The global impact of additional natural gas production and consumption from incremental production is uncertain. The net effect on global emissions is determined by the end-use of the produced natural gas.

Introduction

As part of its January 27, 2016 announcement of interim principles, the Government of Canada has committed to undertake an assessment of upstream greenhouse gas (GHG) emissions associated with projects undergoing an environmental assessment[1]. Environmental assessments of projects already include an assessment of the direct emissions caused by a project.

This assessment provides a project description and a quantitative estimation of the GHG emissions that may be released as a result of upstream gas production associated with the NOVA Gas Transmission Ltd. (NGTL) Towerbirch Expansion Project (the Project), and a discussion of conditions under which building the Project enables additional natural gas production and upstream emissions.

On March 19, 2016, Environment and Climate Change Canada (ECCC) published its proposed methodology to estimate upstream GHG emissions associated with major oil and gas projects undergoing federal environmental assessments in the *Canada Gazette*, Part I[2].

Project Description[3,4,5]

NGTL, a subsidiary of TransCanada PipeLines Limited, owns and operates the NGTL System, an integrated natural gas pipeline system comprised of approximately 24,544 kilometers (km) of pipelines and other associated facilities, located in Alberta and northeastern British Columbia. The NGTL System transports natural gas to markets in the two provinces and connects to other pipelines that deliver natural gas to markets across North America, including the TransCanada *Canadian Mainline* at Empress, Alberta and the TransCanada *Foothills System* at Caroline, Crowsnest, and McNeill, Alberta.

NGTL proposes to construct a new pipeline section and a loop, totaling approximately 87 kilometers, in order to meet existing and incremental firm service contracts for the receipt of sweet natural gas on the NGTL System as well as supply forecast requirements. These new installations will also require four (4) new meter stations and one (1) expansion to an existing meter station (See map in Appendix). The Project will provide gas producers in the Tower Lake areas of the Montney region with access to the NGTL system.

Approximately 82% of the Project would parallel existing linear disturbance, such as pipelines and roads. The new installations would consist of:

- Towerbirch Lake Section: pipeline extension (approximately 32 km)
- Groundbirch Mainline Loop: pipeline loop of the existing Groundbirch Mainline (approximately 55 km)
- New Meter Stations:
    - Tower Lake Receipt Meter Station (60 m × 60 m)
    - Dawson Creek North Receipt Meter Station
    - Dawson Creek North No. 2 Receipt Meter Station (co-located with Dawson Creek North Receipt Meter Station on area totalizing approximately 60 m × 120 m)
    - Dawson Creek East Receipt Meter Station (60 m × 60 m)

- Groundbirch East Receipt Meter Station Expansion

Additional valves, interconnection, tie-ins, crossovers, pipeline block and crossover valves, launcher and receiver facilities, cathodic protection, alternating current mitigation system, fencing, pipeline warning signs and aerial markers are also physical components that will be required for the installation of the Towerbirch Expansion Project.

At this time, the proponent is proposing to increase system capacity to meet additional receipt contracts of 24,338.3 10^3m^3/d (859 MMcf/d); if approved, the Project will increase the total system capacity along the Groundbirch Mainline by 32,837 10^3m^3/d (1160 MMcf/d).

Part A. Estimation of Upstream GHG Emissions

This assessment provides quantitative estimates of the GHG emissions released as a result of the extraction, gathering and processing of the volume of natural gas associated with the increase in total system capacity along the Groundbirch Mainline. This volume is estimated to be 32,837 10^3m^3/d (1160 MMcf/d).

The GHG emissions estimates include emissions from combustion, industrial processes, flaring, venting, and fugitive sources. The GHG emissions contain carbon dioxide, methane and nitrous oxide. These constituents of GHG emissions were combined taking into account their respective global warming potentials. The scope of this assessment does not extend to *indirect* upstream emissions, such as those related to land-use changes and those generated during the production of purchased inputs including equipment, grid electricity and fuels. Those emissions have only been considered if they are not distinguishable from the direct upstream emissions.

GHG emissions associated with the extraction, gathering and processing of natural gas vary with the basin and processes involved. The gas mix that could enter the pipeline will change during its operational life to reflect operational requirements and market demand. The Towerbirch Expansion Project is expected to transport gas produced from British Columbia into the NGTL system thus , emissions have been estimated assuming one hundred percent of the gas is from British Columbia.

The resulting estimated upstream GHG emissions associated with the increase in total system capacity, in megatonnes of carbon dioxide equivalent (Mt of CO_2 eq) per year, is presented below in Table 1.

The upstream GHG emissions in Canada associated with the production, gathering, and processing of the additional volume of natural gas corresponding to the increase in total system capacity along the Groundbirch Mainline due to the Project are estimated to be 3.0 Mt of CO_2 eq per year.

Table 1 - Upstream Emissions Estimates (rounded to the nearest hundredth)

Year	Emissions (Mt of CO_2 eq)
2018	3.02
2019	3.02
2020	3.02
2021	3.02
2022	3.02
2023	3.02
2024	3.02
2025	3.02
2026	3.02
2027	3.02
2028	3.02
2029	3.02
2030	3.02

GHG Forecast Approach

The estimates were calculated using GHG emission projections from ECCC's recently published *Canada's Second Biennial Report on Climate Change* submitted to the United Nations Framework Convention on Climate Change (UNFCCC)[6] and the National Energy Board (NEB)'s production projections from the report entitled *Canada's Energy Future 2016 – Energy Supply and Demand Projections to 2040*[7]. ECCC used the details of the projected GHG emissions and productions that were specific to the *with current measures* reference scenario[6]. This reference scenario reflects the combined impacts of actions taken by governments, consumers and businesses up to 2013, as well as the future impacts of existing policies and measures that have been implemented as of September 2015.

A number of recently announced provincial government policies, such as those outlined in Alberta's *Climate Leadership Plan*[8] and British Columbia's *Climate Leadership Plan*[9], will have an impact on Canadian GHG emissions, but were not reflected in *Canada's Second Biennial Report on Climate Change* as the details of these policies were not available at the time of publication. Alberta's *Climate Leadership Plan* includes a commitment to cap emissions from oil sands facilities at 100 Mt in any year, reduce methane emissions from oil and gas operations by 45% by 2025, set performance standards for large industrial emitters, and apply a carbon levy to fuels. British Columbia's *Climate Leadership Plan* includes a commitment to launch a strategy to reduce upstream methane emissions by 45% by 2025, to develop regulations to enable carbon capture and storage projects to proceed and commits to take action to electrify upstream natural gas projects.

On March 3, 2016, First Ministers adopted the *Vancouver Declaration on Clean Growth and Climate Change*, in which they commit to develop a concrete plan to achieve Canada's international climate

commitments and become a leader in the global clean growth economy[10]. The Government of Canada has also committed to reduce methane emissions from the oil and gas sector by 40% to 45% below 2012 levels by 2025. While this analysis focuses on policies implemented as of September 2015 and does not reflect the impact of additional federal, provincial, or territorial measures announced or under development, it is recognized that future improved practices will mitigate emissions. As measures to meet targets are implemented, they will be incorporated into future emissions projections and future upstream GHG reviews.

For the purposes of this assessment, ECCC developed emission factors representing the relative upstream emissions contributions per unit volume of gas. The gas that may enter the expanded NGTL System has an associated specific emission factor that depends on the emissions generated during its production, gathering and processing. In order to develop emission factors, ECCC divided projected GHG emissions as published in the *Canada's Second Biennial Report on Climate Change*[6], by the respective production projection obtained from the NEB[7]. The resulting emission factors are presented in Table 2.

Table 2 - GHG Emission Factors

Year	Emission Factors					
	Production		Gathering		Processing	
	(t CO_2 eq/$10^6 m^3$)	(t CO_2 eq/MMcf)	(t CO_2 eq/$10^6 m^3$)	(t CO_2 eq/MMcf)	(t CO_2 eq/$10^6 m^3$)	(t CO_2 eq/MMcf)
2018	110.83	3.13	1.53	0.043	140.91	3.98
2019	110.85	3.13	1.44	0.041	140.77	3.97
2020	110.85	3.13	1.40	0.040	140.57	3.97
2021	110.86	3.13	1.35	0.038	140.39	3.96
2022	110.86	3.13	1.32	0.037	140.29	3.96
2023	110.87	3.13	1.31	0.037	140.24	3.96
2024	110.87	3.13	1.32	0.037	140.22	3.96
2025	110.88	3.13	1.30	0.037	140.26	3.96
2026	110.89	3.13	1.29	0.036	140.31	3.96
2027	110.90	3.13	1.28	0.036	140.38	3.96
2028	110.92	3.13	1.29	0.037	140.48	3.96
2029	110.93	3.13	1.30	0.037	140.57	3.97
2030	110.94	3.13	1.31	0.037	140.64	3.97

Part B Impacts on Canadian Upstream and Global GHG Emissions

B.1 Introduction

Part A presents estimates for a range of upstream GHG emissions that could be associated with the production and processing of natural gas produced in the southern Montney formation and transported on the proposed Project. It is important to consider, however, the degree to which the Project could enable additional natural gas production and upstream emissions.

This section assesses the degree to which the natural gas production that would be carried on the pipeline could occur in the absence of the Project to determine whether these upstream emissions are incremental. It then discusses the Canadian and global upstream emissions implications of any incremental production associated with the Project. Given that incremental natural gas production will lead to incremental GHG emissions, these terms are used interchangeably.

B.2 Canadian and Global Natural Gas Outlook

B.2.1 Canadian Natural Gas Outlook

Despite increases in drilling productivity owing to technological advancements in recent years, including hydraulic fracturing and horizontal drilling, natural gas production in Canada declined from 482 $10^6 m^3/d$ [17.0 billion cubic feet per day (Bcf/d)] in 2005 to 416 $10^6 m^3/d$ (14.7 Bcf/d) in 2014.[7] Western Canadian natural gas production represented 97% of total Canadian production in 2014.

The National Energy Board's *Canada's Energy Future 2016: Energy Supply and Demand Projections to 2040* (EF 2016) Reference Case forecasts natural gas production increasing in Canada from 416 $10^6 m^3/d$ (14.7 Bcf/d) in 2014 to 507 $10^6 m^3/d$ (17.9 Bcf/d) by 2040, an increase of 22%. A large portion of the expected production increase is from tight gas production, which is forecast to supply 76% of total production in 2040. In the EF 2016 Reference Case, natural gas production from the Alberta and B.C. Montney regions increases by 187 $10^6 m^3/d$ (6.6 Bcf/d) between 2014 and 2040, from 85 $10^6 m^3/d$ (3.0 Bcf/d) in 2014 to 272 $10^6 m^3/d$ (9.6 Bcf/d) in 2040. The EF 2016 report assumes that pipeline capacity is built, as needed, to transport increases in production.

B.2.2 North American Natural Gas Trends

U.S. natural gas production has increased substantially in the past decade due to the same technological advancements noted above which have made production more profitable.[11] The uptake in production in the United States - the world's largest natural gas producer - has saturated the integrated North American natural gas market and lowered North American natural gas prices.[11,12]

While Western Canadian natural gas once supplied a large portion of demand in Ontario and the U.S. Midwest/Northeast (Eastern North America)[13], Western Canadian Sedimentary Basin (WCSB) volumes are being displaced by U.S. natural gas owing to production growth, largely from the Marcellus and Utica natural gas plays.[11,14] These plays are much closer to Eastern North American markets compared to natural gas originating from the WCSB which lowers the delivered cost of the gas.[11, 15] Increases in U.S.

natural gas exports to Ontario have been facilitated by flow reversals and new and expanded pipeline capacity from the U.S. Northeast.[14] Between 2007 and 2014, Canadian natural gas exports declined 29%, from 294 10^6m^3/d (10.4 Bcf/d) in 2007 to 209 10^6m^3/d (7.4 Bcf/d) in 2014.[7] The Energy Information Administration's (EIA) Annual Energy Outlook 2016 (AEO 2016) projects that U.S. exports of natural gas into Canada will continue at the same levels of 54 10^6m^3/d (1.91 Bcf/d) to 2040 while U.S. imports of Canadian natural gas, primarily from the WCSB, are forecast to decline from 209 10^6m^3/d (7.4 Bcf/d) in 2014[7] to 103 10^6m^3/d (3.63 Bcf/d) in 2040.[16]

In its Reference Case, the EIA AEO 2016 forecasts that U.S. natural gas production will increase from 1,995 10^6m^3/d (70 Bcf/d) in 2014 to 3,257 10^6m^3/d (115 Bcf/d). Shale gas and tight oil associated natural gas production will grow by 1,296 10^6m^3/d (46 Bcf/d) from 2014 to 2040.[a] Production in the U.S. is supported by demand for natural gas from the industrial sector, electricity generation, and liquefied natural gas (LNG) exports. The EIA projects that, by 2030, natural gas-fired electricity generation will overtake coal-fired electricity generation as the most commonly used fuel in the U.S. electricity sector; this occurs even earlier when the EIA assumes the Clean Power Plan (CPP) remains in effect. The EIA attributes the decrease in coal use to renewables subsidies and low natural gas prices which encourage fuel switching.

By 2018, the EIA expects that the U.S. will be a net exporter of natural gas and, by 2040, that 21% of total natural gas production could be net exports. Increasing natural gas production in the U.S. encourages increased U.S. LNG exports entering the global market throughout the forecast period. The U.S. launched its first major LNG export train in early 2016 and six LNG export facilities have been approved by the Federal Energy Regulatory Commission.[11]

B.2.3 Markets for Canadian Natural Gas

The proposed Project will provide natural gas from the southern Montney region, a Canadian tight gas basin, to the NGTL system, enabling access to the Alberta and B.C. markets as well as export markets across North America through pipeline interconnections. NGTL notes that the accessible markets from the NGTL system include Canadian provinces as far east as Quebec, as well as the U.S. Pacific Northwest, California, the U.S. Northeast, and the U.S. Midwest.[17] EF 2016 forecasts that Canadian natural gas production and domestic natural gas demand will grow, with demand growth supported primarily by oil sands demand, a shift from coal to natural gas-fired electricity generation, and overall Canadian economic growth.[7]

The industrial sector is the largest consumer of natural gas in Canada, followed by the residential and commercial sectors.[18] The oil sands consumed 20% of marketable natural gas production in Canada in 2014.[7,19] Natural gas is used in a variety of processes in Canada's oil sands, with the largest demand growth expected from in situ oil sands production. The EF 2016 Reference case projects natural gas use in the oils sands to increase from 53.7 10^6m^3/d (1.9 Bcf/d) in 2014 to 95.9 10^6m^3/d (3.4 Bcf/d) in 2040.[7]

[a] Numbers may not sum due to rounding

EF 2016 projections indicate that the power generation sector in Canada is expected to undergo a transition away from coal to natural gas, renewables, and other low-emitting sources.[7] The EF 2016 Reference case forecasts natural gas-fired electricity capacity to grow from a 15% share of total Canadian capacity mix in 2014 to 22% by 2040.

With strong production growth expected in the U.S., Canadian natural gas export growth is expected to be facilitated by LNG exports. The EF 2016 Reference case assumes that Canadian LNG exports begin in 2019 at 14 $10^6 m^3/d$ (0.5 Bcf/d) rising to 71 $10^6 m^3/d$ (2.5 Bcf/d) by 2023, and remaining relatively unchanged thereafter. The National Energy Board has approved just over 30 natural gas export licenses, however it is uncertain how many of these projects will be built and what amount will be exported. [20,21]

B.2.4 Global Natural Gas Outlook

According to the International Energy Agency's 2015 World Energy Outlook (IEA WEO 2015), consumption of natural gas is expected to increase to 2040. In its *New Policies Scenario*, the IEA projects world natural gas demand to grow from 9.61 10^9 m^3/d (339.2 Bcf/d) in 2013 to 10.67 10^9 m^3/d (376.6 Bcf/d) by 2020, and up to 14.14 10^9 m^3/d (499.1 Bcf/d) by 2040.[22] In this scenario, demand is anticipated to increase in most countries with the exception of the European Union, Russia and Japan. A significant portion of natural gas consumption growth is attributed to increases of natural gas-fired electricity generation as it replaces higher GHG emitting fuel sources.[23] Projections indicate that natural gas demand from countries not members of the Organisation for Economic Co-operation and Development (OECD), which overtook that of OECD countries in 2008, will account for 85% of global gas demand growth to 2040.[22]

The IEA forecasts that China and the Middle East will drive natural gas demand growth, both becoming larger consumers than the European Union, which accounted for roughly 30% of global consumption in 2015.[22,24] China's demand growth is expected to account for a quarter of global growth from 2013 through 2040; Chinese demand over this period is expected to increase by 1.15 10^9 m^3/d (40.4 Bcf/d). North America is the only OECD region where gas demand is anticipated to grow significantly, due in large part to the shift away from coal-fired electricity generation supported by a large increase in tight and shale natural gas production.[22]

Production growth is anticipated to be driven primarily by the Middle East, China and, to a lesser extent, by North America, Australia and other emerging producers. Supply growth of unconventional natural gas (shale gas, coalbed methane and tight gas) is projected to contribute more than 60% of new global gas supply. Europe is the only major region where output is anticipated to decline as production is expected to decrease in Norway, Netherlands and the United Kingdom.[22]

B.2.5 Global Trade in Liquefied Natural Gas

Between 1994 and 2014, world trade in LNG more than tripled, growing from 240.6 10^6 m^3/d (8.5 Bcf/d) to 906.5 10^6 m^3/d (32 Bcf/d).[23] While LNG trade currently accounts for 10% of global natural gas production, liquefaction capacity is anticipated to increase by up to 55% between 2016 and 2021.[23,25] Rapid growth of LNG liquefaction and regasification capacity has expanded global natural gas trade and

is expected to contribute to greater convergence of natural gas prices across major markets. While North American consumers currently pay the least for natural gas, prices in the Asia-Pacific basin have fallen due to the recent decrease in crude oil prices and the addition of new LNG plants in the region. Declining price trends have also been observed in Europe as consumption decreased by almost a quarter between 2010 and 2014 due to slower economic activity, especially in energy intensive industries.[22]

In 2014, nearly three quarters of global LNG exports were destined to Asia-Pacific region.[24] Wood Mackenzie reports that, in 2015, imports of LNG declined in Japan, South Korea and China –the three largest global LNG import markets–as a result of slower global economic growth and cheaper alternative fuels. Although Chinese environmental policies are expected to limit coastal coal-fired electricity generation, Wood Mackenzie analysis notes that coal-fired electricity generation from inland provinces could dampen LNG demand growth. Further, additional Russian natural gas pipe projects to China are also being proposed which could affect demand for LNG imports.[25,26]

While global LNG supply is expected to be ample in the medium term, declines in LNG demand growth and low LNG prices could result in LNG project deferrals. Wood Mackenzie reports that the pace of new final investment decisions (FIDs) for LNG project has slowed over the past year. Annual FIDs averaged 96.17 10^6 m^3/d (3.4 Bcf/d) between 2011 and 2015, while only 14.16 10^6 m^3/d (0.5 Bcf/d) of FIDs have been reached so far in 2016.[25]

B.3 Natural Gas and Canada's Climate Change Commitments

B.3.1 Canada's GHG emissions projections

As reported in *Canada's Second Biennial Report on Climate Change,* Canada's total annual GHG emissions is forecast to increase to 815 Mt in 2030 from 726 Mt in 2013 under the reference or *with current measures* scenario.[6] This scenario is based on historical data and actions taken by governments, consumers and businesses up to 2013, as well as the estimated future impacts of existing policies and measures that have been put in place as of September 2015 (without taking into account the contribution of the land use, land-use change and forestry sector). These estimates are based on assumptions from the National Energy Board's EF 2016 report.

The growth in emissions to 2030 is driven largely by expected growth in the upstream oil and gas sector and, in particular, from the oil sands. ECCC projections show an increase in GHG emissions from natural gas production and processing from 54 Mt in 2013 to 55 Mt in 2020 and 60 Mt in 2030. Projections also estimate 1 Mt of emissions in 2020 from LNG production which increases to 4 Mt in 2030.[6]

Canada, along with 194 other countries, reached the Paris Agreement at the 21st session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC's COP 21) in December 2015. Canada committed to reducing emissions by 30% below 2005 levels by 2030, to play its part in achieving the international agreement's goals, including limiting average temperature rise to well below 2^{o}C and pursue efforts to limit the increase to 1.5^{o}C.

The role of natural gas in a low carbon future is a source of some debate. Some have argued that abundant production of cheap natural gas could lead to higher overall energy demand and delay the development of clean technologies by reducing investment incentives in low-carbon alternatives and locking in higher carbon infrastructure.[27,28] Others have argued that natural gas is a relatively lower emissions fuel compared to other fossil fuels which could make it a potential lower carbon energy option in the medium term, with added benefits of lower air pollutant emissions relative to coal and crude oil.

Studies have assessed 2°C scenarios that show the potential for increased natural gas production in the medium-term. It is important to consider that these scenarios are driven by a number of assumptions around technological change and economic growth. In the IEA WEO's *450 Scenario*, in which the world has a 50% chance of limiting the long-term increase in average global temperatures to no more than 2°C, global natural gas demand reaches 10.33 10^9 m^3/d (364.6 Bcf/d) by 2020, with demand growth leveling off in the mid-2020s and remaining relatively constant to 2040.[22] In a study by McGlade and Ekins, a 2°C scenario is also considered in which global gas production growth persists until the mid-2020s, after which output levels stay relatively constant to 2050. McGlade and Ekins also estimate that, despite production and demand growth for natural gas, 24% of Canadian natural gas reserves – recoverable under current economic conditions– and 49%-52% of global natural gas reserves would need to remain undeveloped by 2050 to reach international targets.[28] Both studies indicate that natural gas consumption growth from today's levels could be consistent with a 2°C world.

B.4 Incremental GHG Emissions and Natural Gas Pipeline Capacity Additions

To assess the potential for incremental natural gas production as a result of building the proposed Project, this report considers a scenario in which the pipeline is not built to one in which it is built. If production that is expected to flow on the proposed pipeline would not be developed without the pipeline, that production would be considered incremental.

The key consideration in whether building the proposed natural gas pipeline Project would lead to incremental natural gas production in Canada is whether other modes of transportation could be economically employed to provide the transportation capacity. If there are circumstances under which another form of transportation could be used (e.g., hauling liquefied or compressed natural gas by truck or train), then the upstream production from the southern Montney field expected to flow on the proposed Project could occur even if the proposed pipeline were not approved and built.

At this time, there are no large-scale or widely-used alternative forms of land-based natural gas transportation that could serve as an economic alternative to the proposed pipeline Project. While there are some LNG volumes transported by truck in Canada, it is not expected that this would be a viable option for large-scale natural gas transportation in the near term at current natural gas prices.[b]

[b] Fortis BC delivers LNG by truck to communities in Canada's north, including Inuvik in the North West Territories. https://www.fortisbc.com/About/Newsletters/TheSource/Documents/TheSourceNewsletter_Tilbury_Winter2014.pdf

Without an alternative mode of transportation, if the pipeline Project were not built, any increase in natural gas production that would have been transported on this pipeline would likely not be produced. As such, the production that would be transported on the pipeline, and its associated upstream emissions, would be incremental.

B.5 North American and Global GHG Emissions Impacts

Since the additional pipeline capacity from the Project is expected to enable natural gas production from the Montney region in Canada, there would be impacts on North American supply and prices given the integrated nature of the continental market as discussed above. In addition, since LNG exports are projected to increase from North America, additional Canadian supply could affect global markets.

Incremental production from Canada to the North American and global markets could have two impacts: It could displace different (likely higher cost) sources of natural gas that would no longer be produced, or it could add to the overall supply at a given price, which could result in a slightly lower natural gas and/or LNG prices, and greater natural gas consumption over time.

Where the incremental natural gas production associated with the Project displaces other natural gas production, the GHG emissions impact would be the difference in well-to-market (WTM) emissions between the incremental Canadian natural gas production in the Montney and the natural gas production that was displaced. A study from Raj et al. compared the life cycle emissions from the Montney, Liard, Cordova and Horn River basins in Western Canada and found that the well-to-port emissions of LNG from the Montney play were the lowest of the four. This was largely due to the low CO_2 content of the gas and lower processing requirements.[30,c] While this indicates a relatively low emissions intensity from Montney gas compared to similar types of tight and shale natural gas sources, ECCC has yet to find a study comparing upstream emissions from different sources of natural gas across North America or globally.

Where incremental Canadian natural gas production leads to an increase in North American or global supply, the accompanying decrease in global LNG prices and/or North American natural gas prices could have an impact on consumption. The total GHG emissions impact from this effect could be the life cycle emissions of natural gas production, from well-to-combustion (WTC). Despite the potential for greater consumption, it is unclear what the net effect on global emissions would be since this depends on whether natural gas would reduce the use of more or less GHG intensive fossil fuels.

B.6 Conclusions

The analysis in Part B provides insight into the conditions under which the proposed Project could lead to incremental GHG emissions in Canada and globally. The discussion above finds that:

[c] Raj et. al. refer to this in the article as well-to-port emissions because they are comparing LNG life cycle emissions and are accounting for emissions associated with the movement of natural gas to an LNG facility and its liquefaction.

- Natural gas production and consumption growth is forecast in Canada, the U.S. and globally, with some reports finding that production and consumption growth in the medium term could be consistent with a 2°C world. Demand growth from oil sands development, electricity generation and LNG facilities is expected to drive forecast increases in Canadian production.

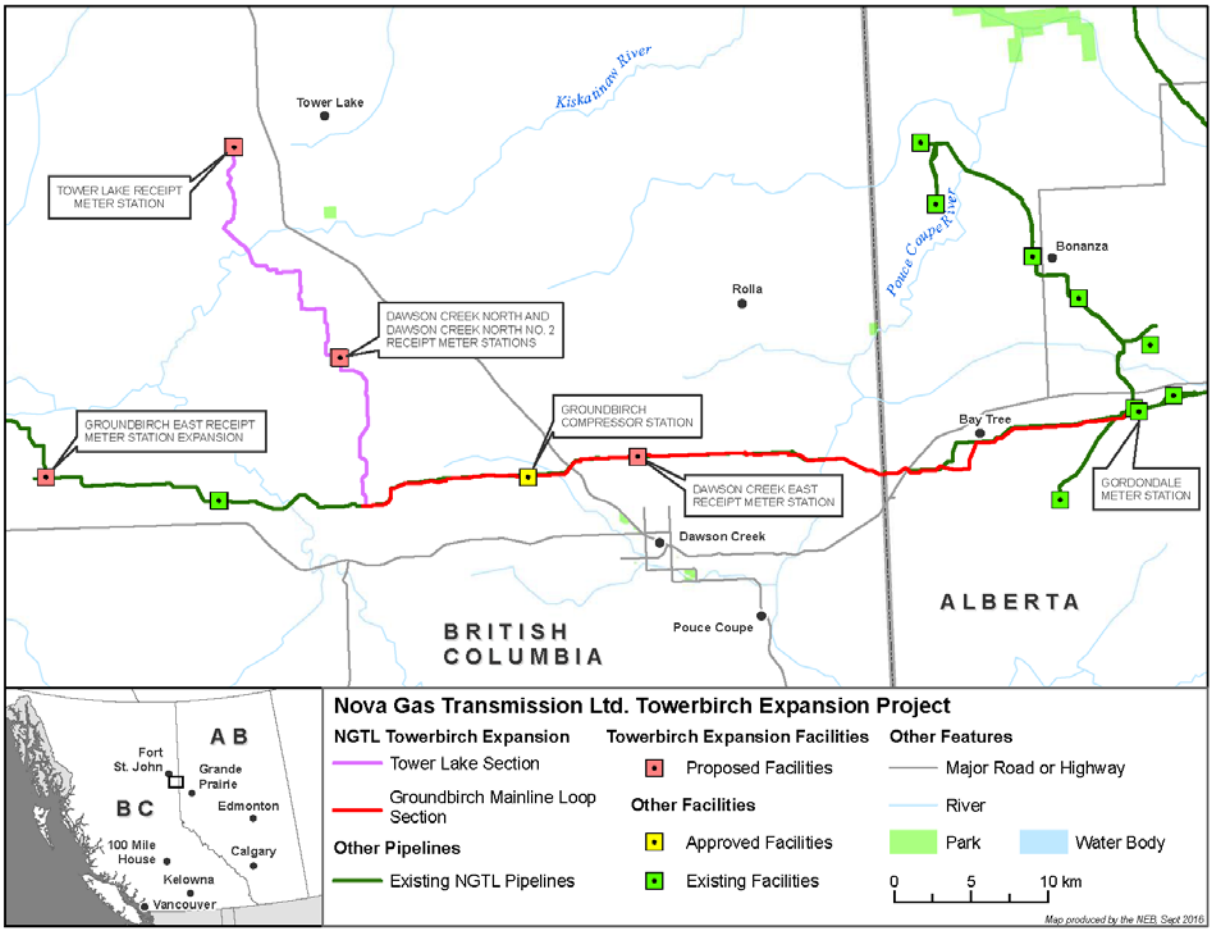
- At this time, there are no alternative modes of transportation to cost effectively move large amounts of natural gas over land from producing regions to consuming regions. As a result, it is likely that the production moving on the proposed pipeline would be incremental and would not be produced without the pipeline.

- Since the additional pipeline capacity is expected to enable production in Canada, there would be impacts on North American supply and prices given the integrated nature of the continental market. In addition, if LNG exports increase from North America, incremental Canadian natural gas supply could affect global supply and prices.

- The incremental natural gas shipped on the proposed Project would either displace natural gas from other sources that would no longer be needed or it could add to total continental or global natural gas supply. Where natural gas from other sources is displaced, the emissions impact would be the difference in well-to-market emissions between the Montney region and other producing regions. The Montney region appears to produce relatively low GHG emission natural gas compared to other Western Canadian natural gas regions owing to the low associated CO_2 in the gas and minimal processing requirements, though sources of information are limited. ECCC has not found a study of tool that compares upstream GHG emissions from various sources of shale or tight gas across North America or globally.

- The global impact of additional natural gas production and consumption from incremental production is uncertain with the net effect on global emissions determined by the end-use of the produced natural gas.

Appendix NGTL Towerbirch Expansion Project Map



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