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Woodfibre Liquefied Natural Gas (LNG) Project

Review of Related Upstream Greenhouse Gas (GHG) Emissions Estimates

Summary

The Canadian Environmental Assessment Agency (the Agency) sought the following advice from Environment and Climate Change Canada (ECCC) as an expert department for the Woodfibre LNG Project: an analysis of the upstream emissions associated with the Woodfibre Project, including emissions associated with the Eagle Mountain - Woodfibre Gas Pipeline Project proposed by FortisBC, and emissions associated with the natural gas supply for the Woodfibre Project. The Agency also requested that ECCC explain the assumptions and methodology relied upon for calculating these upstream emissions.

The proposed Woodfibre LNG project near Squamish, British Columbia (BC) is a relatively small project that will produce 2.1 megatonnes (Mt) of LNG per year, using grid-generated electricity for the liquefaction process. The proponent has estimated GHG emissions in the Environmental Impact Statement for the project of 129 kilotonnes or 0.129 Mt per year of CO_2e. The Project is estimated to have a direct GHG emission intensity of 0.054 t CO2e/t LNG. The emissions from Woodfibre LNG project are not projected to vary over time, so over a 25-year lifetime the project's direct GHG emissions would be 3.2 Mt of CO_2e.

For the purposes of this review, "upstream" is defined as all natural gas sector stages before the coastal liquefaction facility – that is, natural gas production, processing, and pipeline transmission. This analysis does not try to determine whether there is any incremental natural gas production that would result from development of the Woodfibre LNG project or whether it will use natural gas production that would have otherwise occurred. The upstream GHG emissions estimated would thus represent the maximum possible incremental GHG emissions (if any). **Using several sources as set out in the table below, ECCC projects that the upstream GHG emissions in Canada associated with the natural gas production, processing and transmission of the natural gas used by the Woodfibre LNG project will be from 700 to 880 kilotonnes/year of CO_2e, or about 17.5 to 22 Mt of GHG over the 25-year lifetime of the project.** These emissions estimates should be taken as rough estimates, given the uncertainties inherent in the current analysis.

The table below summarizes several sources of upstream emissions estimates for the Woodfibre LNG project: 1) two scenarios based on the ECCC emission forecast: (a) assuming 100% of the gas is supplied from BC sources, and b) assuming 75%/25% supply of gas from BC and Alberta, respectively; 2) using the Pembina Institute's BC Shale Scenario Tool; 3) using

information from the British Columbia LNG Greenhouse Gas Life Cycle Analysis report (2014). The Pembina Institute and BC studies do not break out each upstream stage in a consistent fashion, so only a total upstream number is included. The emission factors for each methodology and info on year-to-year variability for the ECCC model are included in the Annex.

The approaches presented all estimate GHG emissions from the natural gas stages upstream of the LNG project using a similar methodology, although with some different assumptions for individual components of the calculation. These approaches, which are described in more detail in the Analysis section below, give results of a similar magnitude.

Annual Emissions (Mt CO_2e)	**ECCC Emissions Forecast (2030) Gas supply: BC: 100%**	**ECCC Emissions Forecast (2030) Gas supply BC:75% AB:25%**	**Pembina BC Shale Scenario Tool**	**BC LNG GHG LCA report**
Transmission	**0.05**	**0.06**	**0.70**	**0.74**
Production & Processing	**0.78**	**0.82**		
Total Upstream	**0.83**	**0.88**	**0.70**	**0.74**

ECCC Emissions Forecast use most recent projected GHG emissions in the current measures reference scenario.

GHG emissions along the entire life-cycle of the natural gas and LNG related to the Woodfibre project may be relevant to decision-making on the project, since GHG emissions contribute to global climate change, rather than having a local impact. In addition to direct project GHG emissions and upstream GHG emissions in Canada, the Woodfibre LNG project will also have indirect GHG emissions from electricity generation (which were taken into consideration in the project's environmental assessment), which may occur only in BC or may result in changes to the electricity supply mix and related GHG emissions in other jurisdictions. The upstream stages of natural gas production, processing and pipeline transmission will also have indirect GHG emissions from electricity production. Finally, the project may have impacts on industrial activity and related GHG emissions outside of Canada, which may be positive or negative. However, due to limited time for this analysis and lack of reliable data and methodologies, **the current analysis is restricted only to the natural gas sector lifecycle stages upstream of the LNG project**. The analysis also does not assess the significance of GHGs from the direct project or upstream natural gas stages or their contribution to global climate change.

Analysis

Woodfibre LNG is one of 21 liquefied natural gas (LNG) production and export terminals proposed for the coast of British Columbia. It is a relatively small facility projected to produce

2.1 Mt of LNG per year. Natural gas will be liquefied and shipped via LNG carriers to Asia or other markets. The facility's direct GHG emissions of 0.129 Mt/year are low compared to other proposed projects as the Woodfibre project uses electricity from the grid to drive the compressors that liquefy the natural gas, rather than using natural-gas-driven turbines.

At the request of a responsible authority, ECCC reviews the information submitted by the proponents as part of a federal environmental assessment (EA) to confirm that greenhouse gas (GHG) emissions are clearly estimated and will be mitigated to the extent possible. Typically, the scope of LNG project environmental assessments extends to the liquefaction facility and immediate auxiliary construction and operations such as storage facilities and marine tanker loading. Emission sources upstream of the project, i.e., which occur in earlier parts of the natural gas supply chain (such as from natural gas transmission pipelines, natural gas processing, gas gathering and well site production operations) are currently not included as part of the project scope and may be evaluated by various other means such as other federal or provincial EA or permitting processes.

The natural gas supply stages upstream of the Woodfibre LNG project include the natural gas transmission pipeline (this includes the 49 km FortisBC Eagle Mountain-Woodfibre Gas Pipeline Project currently undergoing a provincial EA), in addition to the existing Fortis BC/Spectra Energy natural gas transmission pipeline) and the natural gas production and processing stages of the natural gas life-cycle.

ECCC has also reviewed the background technical document for the project environmental impact assessment that describes the methodology used to estimate GHG emissions for the operation of the Eagle Mountain- Woodfibre Gas Pipeline, which were part of the provincial environmental assessment process. The methodology used for estimating GHG emissions from the operation of the pipeline is complete and well documented. Emission factors for pipeline operations are from the Western Climate Initiative, and fuel consumption for project equipment is modeled based on similar equipment in the same service. As well, the proponent has applied recognized best available technologies to the project, including use of electric motors and of dry seals for compressors. As it is not possible to distinguish the proportion of the remaining natural gas transmission pipeline emissions from those of the Eagle Mountain-Woodfibre Gas Pipeline Project, a general emission estimate is included for natural gas transmission pipeline stage of the upstream analysis.

Estimating GHG emissions from upstream stages with greater accuracy would require knowledge of the facilities producing and processing the natural gas and their GHG emissions. For the Woodfibre project, the proponent has not indicated which specific sources will supply the natural gas for liquefaction (as this information is not yet available given the stage of development of the project), but rather that a mixture of natural gas from the Western Canada

Sedimentary Basin could be the natural gas supply source, which could include natural gas from reserves in Manitoba, Saskatchewan, Alberta, BC or the Northwest Territories. BC officials currently assume that either 100% of the gas to LNG projects is supplied from BC natural gas production and processing, or that the split is 75% BC gas supply and 25% Alberta gas supply.

This analysis does not quantify the amount of incremental natural gas production for the Woodfibre project, if any, so the upstream numbers presented do not necessarily represent an incremental GHG emission. The amount of natural gas that a proposed LNG plant will use does not necessarily correspond to a certain number of new wells; the plant may use existing production capacity that would have otherwise been sold elsewhere. Also, LNG facilities operate for decades and it is likely that changes in natural gas supply as well as in upstream mitigation practices will have an effect on GHG emissions over the lifetime of the facility. For example there may be increased usage of underground injection for storage of CO_2 (especially if production increases in basins such as the Horn River with high CO_2 content in the extracted natural gas), electrification of gas production operations, or reductions in methane emissions due to more stringent requirements for leak detection and repair, equipment standards, or well completion practices. This analysis is not able to take these changes into account.

The approaches used in this analysis all estimate GHGs using a similar methodology, although with some different assumptions for individual components of the calculation. The mass of LNG produced by the Woodfibre project is used as a proxy for the natural gas supplied to the LNG project. The mass of natural gas is converted to a volume. The GHG emission factors express GHG emissions as tonnes of CO2e emitted for each unit of volume of natural gas produced, processed or transmitted by pipeline. These emission factors are multiplied by the volume of gas which is supplied to the Woodfibre LNG project to calculate the GHG emissions from each upstream stage.

ECCC GHG Forecast

ECCC used the projected GHG emissions from the natural gas production, processing, and pipeline transmission sub-sectors from ECCC's most recent GHG projections in the current measures reference scenario (a business-as-usual scenario), which will be published in Canada's Biennial Report. The emission forecast is determined based on GHG emission information in Canada's National GHG Inventory and projected production forecasts from the National Energy Board, which build in assumptions about natural gas supply mixes. The emission factors used for the natural gas production and processing sector in Canada are based upon Clearstone Engineering's 2014 work for ECCC. Clearstone Engineering was commissioned by Environment Canada to provide oil and gas sector data and emission factors to be used for the purposes of emissions inventory, internal analyses and models.

The two ECCC emission forecast cases use average emission factors applicable for each province for each of the upstream stages: natural gas production, processing, and pipeline transmission sub-sectors, and these emission factors were used to calculate the upstream emissions for this analysis. Forecasts are available only until 2030, not for the full 25-year expected lifetime of the Woodfibre LNG Project. The forecast GHG emissions for 2030 emissions were used in the summary table to allow easier comparability with other LNG projects which may not be at full capacity until 2030.

ECCC used the projected GHG emissions from the natural gas production, processing, and pipeline transmission sub-sectors from ECCC's most recent GHG projections in the current measures reference scenario (a business-as-usual scenario), which will be published in Canada's Biennial Report to generate upstream GHG emission estimates for the Woodfibre LNG project using two scenarios (a) assuming 100% of the gas is supplied from BC sources, and b) assuming 75%/25% supply of gas from BC and Alberta, respectively. For the 100% BC gas supply scenario, ECCC estimates the upstream emissions from the Woodfibre project to be 0.83 Mt of CO_2e per year, which includes 0.05 Mt of CO_2e per year from the natural gas transmission pipelines and 0.78 Mt of CO_2e per year from the natural gas production and processing part of the natural gas supply system. For the 75% BC / 25% Alberta gas supply scenario, ECCC estimates the upstream emissions from the Woodfibre project to be 0.88 Mt of CO_2e per year, which includes 0.06 Mt of CO_2e per year from the natural gas transmission pipelines and 0.82 Mt of CO_2e per year from the natural gas production and processing part of the natural gas supply system. More detailed year-by-year analysis for the 2020-2030 period is shown in the Annex. The same emission factors are used through the time period so there is little variability in the GHG emissions for a given throughput of natural gas.

The Pembina Institute / Navius Research BC Shale Scenario Tool

In 2015, the Pembina Institute released its BC Shale Scenario Tool, which is a model that predicts GHG emissions upstream of LNG facilities, and contains a range of project-specific inputs. Emission factors used are based upon Clearstone Engineering's 2014 work or the GHGenius model. The Pembina tool, which was developed with modelling support from Navius Research, is a useful and robust tool. The Pembina tool sets a default gas supply mix (*i.e.* the natural gas production basins that supply the LNG project, such as the Montney or the Horn River) but allows the user to change the assumptions about the gas supply mix. The tool has different emission factors for natural gas production/processing stage which vary based on the level of CO_2 in the raw natural gas, which is assumed to be vented to the atmosphere, but do not account for differing emissions from the production or processing facilities' GHG emission mitigation in the various basins. The tool can be used on an incremental basis to account for any number of LNG facilities coming on line in various years.

ECCC applied the BC Shale Scenario Tool to estimate upstream GHG emissions for the Woodfibre LNG project (using Pembina's default gas supply assumptions), which results in an estimate of 0.70 Mt of CO_2e per year. A break-down of production, processing or transmission emissions is not available. More detailed year-by-year analysis for 2020-2030 period is shown in the Annex. The variability is due to changing gas supply in BC.

British Columbia LNG GHG Life Cycle Analysis

In early 2014, the BC Ministry of Environment's Climate Action Secretariat released an LNG GHG life cycle analysis prepared for them by Globe Advisors. The study aimed to understand the impact of BC liquefaction plants on global GHG emissions. It used the GHGenius model to estimate GHG emissions, which makes assumptions about the natural supply mix similar to those used in the Pembina tool.

Emissions from natural gas processing were grouped together with liquefaction facility emissions, so ECCC adjusted emission factors to extract the gas processing emissions from the upstream stage from those which occur at the LNG facility, to be consistent with the other approaches. Due to the above needed adjustment, this study is less appropriate to use as a reference for an analysis of upstream-only emissions. The break-down of production, processing and transmission emissions are not clearly provided in the 2014 study. Given the adjustment by ECCC to allow calculation of an upstream-only stage, the breakdown by natural gas sub-sector is less certain so has not been included. After adjustment, the resulting upstream emissions generally align with the Pembina tool, resulting in an estimated 0.740 Mt of CO_2e per year. The GHGenius model is based on data from existing facilities and does not include an emission projection, so no year-to-year data are available.

Sources

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Greenhouse Gas Emissions Technical Report for the Proposed FortisBC Energy Inc. Eagle Mountain – Woodfibre Gas Pipeline Project

Letter of Decision: Woodfibre LNG Project. National Energy Board. December 2013.

Upstream Oil and Gas Emissions Inventory, Volume 1: Overview of the GHG Emissions Inventory, report for Environment Canada, Clearstone Engineering, March 2014.

Annex: Emission factors by upstream stage and year-to-year variability of ECCC emission estimates

Emission Factors (tonne of CO_2e per tonne of LNG produced)				
Upstream Stage	ECCC Emissions Forecast Gas supply (BC)	ECCC Emissions Forecast Gas supply (Alberta)	Pembina BC Shale Scenario Tool	BC LNG GHG LCA report
Gas Production	0.16	0.26	*Breakdown not available*	*Breakdown not available*
Gas Processing	0.21	0.20		
Gas Transmission	0.02	0.04		
Total Upstream	**0.39**	**0.50**	**0.33**	**0.35***

*adjusted to include gas processing in upstream stage

Year	Annual Upstream Emissions (Mt CO_2e)		
	ECCC Emissions Forecast Gas supply - BC: 100%	ECCC Emissions Forecast Gas supply: BC:75%, AB:25%	Pembina BC Shale Scenario Tool
2020	0.84	0.88	0.57
2021	0.83	0.88	0.58
2022	0.83	0.88	0.59
2023	0.83	0.88	0.60
2024	0.83	0.88	0.62
2025	0.82	0.88	0.63
2026	0.82	0.88	0.64
2027	0.82	0.88	0.66
2028	0.82	0.88	0.67
2029	0.82	0.88	0.69
2030	0.83	0.88	0.70

Year	Annual Upstream Emissions (Mt CO_2e)					
	ECCC Emissions Forecast Gas Supply: BC: 100%			ECCC Emissions Forecast Gas Supply: BC:75%, AB:25%		
	Production	Processing	Transmission	Production	Processing	Transmission
2020	0.34	0.44	0.06	0.39	0.43	0.06
2021	0.34	0.44	0.05	0.39	0.43	0.06
2022	0.34	0.43	0.05	0.39	0.43	0.06
2023	0.34	0.43	0.05	0.39	0.43	0.06
2024	0.34	0.43	0.05	0.39	0.43	0.06
2025	0.34	0.43	0.05	0.39	0.43	0.06
2026	0.34	0.43	0.05	0.39	0.43	0.06
2027	0.34	0.43	0.05	0.39	0.43	0.06
2028	0.34	0.44	0.05	0.39	0.43	0.06
2029	0.34	0.44	0.05	0.39	0.43	0.06
2030	0.34	0.44	0.05	0.39	0.43	0.06