



Woodfibre  
LNG

# WOODFIBRE LNG'S ROADMAP TO NET ZERO

Setting a new global standard to be the world's first net zero LNG facility by 2027



Woodfibre Liquefied Natural Gas (LNG) is an LNG export facility being constructed on the former Woodfibre pulp mill site in Nexwnéwu7ts Átlk’a7tsem (Howe Sound), approximately seven kilometres south of Skwxwú7mesh (Squamish). The Project is on the historical location of a Skwxwú7mesh Úxwumixw and (Squamish Nation) village known as Swiyát. Swiyát and Nexwnéwu7ts Átlk’a7tsem (Howe Sound) are tied to the cultural well-being of Skwxwú7mesh Úxwumixw (Squamish Nation) members, their ancestors, and their descendants, and to other Indigenous groups as defined in the Project’s Provincial Environmental Assessment Certificate and Federal Decision Statement. Woodfibre LNG proudly acknowledges that Squamsh Nation is a full environmental regulator on the project, with the Squamish Nation Environmental Assessment Agreement as the first ground-breaking Indigenous-led approval process in Canada. Woodfibre LNG also recognizes the importance of these areas to the Skwxwú7mesh stélmexw (Squamish People), and other Indigenous groups. Woodfibre LNG seeks to construct and operate the Project in a manner that is respectful of Indigenous values.

Temíxwiýikw chet wa naantem chet ti temíxw Swiyát  
Chet wa sménhemswit kwis ns7éyxnitas chet ti temíxw  
We7ú chet kwis t’ichimwit iy íwas chet ek’l tti.

Our ancient ancestors named this place Swiyát  
We, as their descendants safeguard these lands  
We will continue to swim and fish in these clear waters.





ACRONYMS

- AGRU = Acid Gas Removal Unit
- EIA = Energy Information Administration
- GIIGNL = International Group of Liquefied Natural Gas Importers
- GHG = Greenhouse Gas
- HP = High Pressure
- HVAC = Heating, Ventilation, and Air Conditioning
- LNG = Liquefied Natural Gas
- LP = Low Pressure
- MRV = Monitoring, Reporting and Verification
- SNEAA = Squamish Nation Environmental Assessment Agreement
- tCO2e = tonnes of Carbon Dioxide Equivalent
- TO = Thermal Oxidizer
- WCI = Western Climate Initiative



# HIGHLIGHTS

- First approved liquefied natural gas (LNG) export facility to be powered by electric compressors using renewable hydroelectricity, resulting in 14 times fewer stationary combustion emissions than a conventional LNG facility.
- Lowest carbon intensive LNG facility in the world, with a carbon intensity of 0.04 (tonnes of carbon dioxide equivalent per tonne of LNG) based on current design.
- First LNG facility in the world to announce a comprehensive plan to become net zero.
- Facility will be net zero by the time it is operational by 2027, 23 years in advance of the Government of Canada’s requirement to be net zero (by 2050).
- Facility will also be net zero during construction, by offsetting emissions with local, nature-based carbon credits that have First Nations partners.
- First project in Canada to have an Indigenous government, Sk̓wx̓wú7mesh Úxwumixw (Squamish Nation), as an environmental regulator.
- Commitment to emissions avoidance and reduction opportunities first, consistent with Canada’s Methane Strategy and draft guidance for best-in-class GHG emissions performance by oil and gas projects.
- Partnerships with B.C. First Nations for the procurement and development of local, nature-based carbon credits to offset hard-to-abate emissions as an interim strategy to achieve net zero.







**Woodfibre  
LNG**

Roadmap to Net Zero

# 1.0 INTRODUCTION

- 1.1 About Woodfibre LNG
- 1.2 Commitments and Competitive Advantages
- 1.3 Alignment with Government Climate Plans and Frameworks
- 1.4 Engagement with Stakeholders and Indigenous Groups
- 1.5 Alignment with the International Group of Liquefied Natural Gas Importers (GIIGNL) GHG Neutral Framework



1.1 About Woodfibre LNG

The Woodfibre Liquefied Natural Gas (LNG) Project is an LNG export facility being constructed on the former Woodfibre pulp mill site in Nexwnéwu7ts Átlk’a7tsem (Howe Sound), approximately seven kilometres south of Skwxwú7mesh (Squamish). The Project is on the historical location of a Skwxwú7mesh Úxwumixw (Squamish Nation) village known as Swiyát. Swiyát and Howe Sound are tied to the cultural well-being of Squamish Nation members, their ancestors, and their descendants, and to other Indigenous groups defined in the Project's Environmental Assessment Certificates. Woodfibre LNG recognizes the importance of these areas to Squamish Nation and other Indigenous groups. Woodfibre LNG seeks to construct and operate the Project in a manner that is respectful of Indigenous values.

The Project will include one liquefaction train, a floating LNG storage and offloading unit, an air cooling system and marine docking facilities for LNG carriers during operation. The Project will produce an estimated 2.1 million tonnes of LNG per year at full build out. The Project will be operated by Woodfibre LNG Limited, which is owned 70 per cent by Pacific Energy Corporation Limited and 30 per cent by Enbridge Inc.

Woodfibre LNG will source its natural gas from Pacific Canbriam Energy, which is also a subsidiary of Pacific Energy Corporation Limited, and operates as an exploration and production company in the Western Canadian Sedimentary Basin. Its principal producing properties and acreage positions are in the Altares, Attachie, Portage and Kobes Montney regions. The gas will be transported to the Woodfibre site by pipeline, including a FortisBC pipeline expansion project from Coquitlam to Squamish called the Eagle Mountain – Woodfibre Gas Pipeline (EGP) project.

1.2 Commitments  
and Competitive Advantages

Woodfibre LNG adopts a quintuple bottom-line approach, in which results are intended to be mutually beneficial to the Community, Country, Climate, Customer and Company.

- Maximizing local benefits to the Community and Indigenous groups
- Generating revenue and establishing a strong brand for the Country (Canadian LNG)
- Supporting the global energy transition to preserve the Climate
- Considering the needs and demands of Customers and allies in Canadian and overseas markets
- Creating a showcase Project that benefits the Company

Woodfibre LNG is the first industrial project in Canada to recognize a non-treaty Indigenous government, Skwxwú7mesh Úxwumixw (Squamish Nation), as an environmental regulator. Maintaining respectful and meaningful partnerships with local First Nations underlies Woodfibre LNG’s approach to developing its net zero strategy and to constructing and operating the project in a way that will contribute to a resilient community in Squamish and a net zero future for Canada and the world.

Powered by renewable hydroelectricity from BC Hydro, Woodfibre LNG will produce the lowest emissions LNG in the world and set a new global standard of carbon intensity. Woodfibre LNG was the first electric drive (E-Drive) facility to be approved in Canada, which means the liquefaction process is powered by electric compressors rather than natural gas powered compressors, resulting in 14 times fewer stationary combustion emissions than a conventional LNG facility. The E-Drive system performs with higher reliability and efficiency and requires less maintenance compared to natural gas powered compressors.

The world will still depend on gas and LNG in the net zero economy to complement the transition to renewable energy sources, back up intermittent solar and wind power, replace coal power and produce hydrogen. LNG that is produced responsibly has a significant opportunity to contribute to global economic and energy security goals without compromising environmental and emissions reduction targets, particularly in countries that do not have access to hydroelectricity. The Woodfibre LNG Project will strive to demonstrate how LNG can be an integral part of the global energy transition while being complementary to reconciliation and climate policy objectives.

Canada and B.C. have natural, competitive advantages to supply gas to the rest of the world. These include strong regulatory and carbon pricing frameworks; shorter shipping routes to the Asia Pacific; access to renewable hydroelectricity; legislative requirements to consult and make partners with Indigenous peoples; and a diverse and skilled workforce. As a B.C.-based project that will source, transport and process gas locally, the Woodfibre LNG project has a important opportunity to support the transition to a net zero economy, both at home and abroad.

Woodfibre LNG’s approach is to ensure that the Project delivers maximum benefits to the Squamish Nation, other First Nations, the community and the region. As a result, Woodfibre LNG’s net zero strategy takes a deliberate, localized approach to ensure the benefits, beyond direct revenues and job benefits, have as much of a localized multiplier effect as is possible. The facility has gas production already committed through the company’s affiliate company, Pacific Canbriam Energy, which will be transported from northeast B.C. to the site, rather than to the United States Gulf Coast for liquefaction and export.

In June 2015, Squamish Nation issued an independent environmental assessment certificate for the Project and for the Fortis pipeline expansion project, Eagle Mountain – Woodfibre Gas Pipeline Project – identifying 25 conditions that must be achieved (13 conditions directly by Woodfibre LNG) over the duration of the Project. In October 2015, Woodfibre LNG and Skwxwú7mesh Úxwumixw (the Squamish Nation) signed an agreement called the Squamish Nation Environmental Assessment Agreement (SNEAA), which legally commits Woodfibre LNG to constructing and operating the facility in a way that respects Squamish Nation’s cultural values and unique relationship with the lands and marine environment in their traditional territory.







In 2021, Pacific Canbriam Energy was the second natural gas producer in North America to achieve EO100™ Standard Certification from Equitable Origin. Equitable Origin is a reputable standard-setting organization that certifies energy production based on third-party verification that evaluates energy producers that can demonstrate their commitment to the highest environmental, social and governance standards in their operations. Pacific Canbriam Energy is committed to continuous improvement to ensure measurable progress and accountability for emissions reduction.

### 1.3 Alignment with Government Climate Plans and Frameworks

Woodfibre LNG is fully committed to aligning with the Government of Canada’s legislated targets in the Canadian Net-Zero Emissions Accountability Act (effective June 2021) to achieve net zero emissions by 2050 and the 2030 Emissions Reduction Plan (published in March 2022) which outlines actions to reduce emissions by at least 40 percent over 2007 levels by 2030. This strategy outlines how Woodfibre LNG will achieve net zero emissions 23 years ahead of when industry is required to do so, by the time the plant is operational in 2027, 23 years in advance of the Canadian Net-Zero Emissions Accountability Act..

In addition, Woodfibre LNG’s net zero strategy aligns with Canada’s Methane Strategy, which outlines methane reduction and abatement solutions, including for the oil and gas sector, and this alignment is articulated in the Emissions Reduction Plan (section 4.1 of this strategy). On October 7, 2022, the Government of Canada announced draft guidance for best-in-class GHG emissions performance by oil and gas projects, which will serve as a foundational tool for any new projects that are seeking assessment and regulatory approval by the federal government under the Impact Assessment Act (IAA).

The draft guidance suggests requirements for project proponents to:

- Provide information regarding “Best Available Technologies” or “Best Environmental Practices” that will be part of the project to eliminate, reduce, control or offset GHG emissions, where relevant emission reduction technologies must be prioritized and offsets used as a last option; and
- Prepare and submit a credible net zero plan, if the project is to exist beyond 2050, for how the proponent will achieve net zero emissions by 2050.

Woodfibre LNG’s approach to net zero planning is consistent with the draft guidance principles, in that the project will prioritize an Emissions Reduction Plan (see section 4.1) to reduce emissions as much as possible through incremental advanced and emerging technologies, and concurrently implement an Emissions Offset Strategy (see section 4.2) to offset emissions that cannot be reduced at the outset of operations. In addition, Woodfibre LNG is committed to continuous improvement to ensure that the project integrates new technologies that become technically and commercially feasible over time.

Woodfibre LNG will align with the CleanBC Roadmap to 2030 in terms of being a new industrial operation that will be net zero by 2030, and will align with interim B.C. 2030 and 2040 emission reduction targets.

As Woodfibre LNG already has its Environmental Assessment Certificate, the net zero emissions test implemented through the new Province of British Columbia Energy Action Framework for proposed LNG projects in or entering the provincial environmental assessment process does not apply. However, the Project is proud to demonstrate how LNG can be produced responsibly and sustainability to meet the Province's objectives.

Woodfibre LNG was envisioned and planned to be a low-carbon project, powered by E-Drive, since the initial design. The Project’s Environmental Assessment Certificate, granted in 2015 by the Government of British Columbia, specified that the Project would use electrical power sourced from BC Hydro. Since then, the Project has developed and implemented additional design features that will result in incremental efficiencies and these are also described in section 4.1.



1.4 Engagement with Stakeholders and Indigenous Groups

In collaboration with our Engineering, Procurement, Fabrication and Construction (EPFC) contractor, McDermott International, equipment and technology providers and local First Nations, we are proud to have a strategy in place that will commit us to net zero well in advance of government’s requirement, while advancing economic reconciliation with Indigenous groups. The initiatives that make up our strategy reflect meaningful partnerships with First Nations, including Skwxwú7mesh Úxwumixw (Squamish Nation) who is an environmental regulator of the Woodfibre LNG Project. In developing the strategy, Woodfibre LNG engaged the following groups:



Skwxwú7mesh  
Úxwumixw

Squamish Nation

Skwxwú7mesh Úxwumixw  
(Squamish Nation)

- Ta na wa Yúus ta Stitúyntsam (Rights and Title)
- Nch’kaý Development Corporation, the economic development arm of Squamish Nation that is fully owned by the Nation



The Government of Canada

- Environment and Climate Change Canada
- Natural Resources Canada
- Innovation, Science and Economic Development Canada
- Pacific Economic Development Canada
- Privy Council Office
- Indigenous Services Canada



SQUAMISH

Local Governments

- District of Squamish



BRITISH  
COLUMBIA

The Government of  
British Columbia

- Ministry of Energy, Mines and Low Carbon Innovation
- B.C. Energy Regulator
- Ministry of Environment and Climate Change Strategy



Carbon Offset Projects  
& Developers

- Cheakamus Community Forest
- Great Bear Rainforest / Coastal First Nations
- BigCoast Forest Climate Initiative (Mosaic Forest Management)
- Wilderness Capital Corporation
- Squamish Community Forest

1.5 Alignment with the GIIGNL Framework

This strategy fully aligns with the International Group of Liquefied Natural Gas Importers (GIIGNL) GHG Neutral Framework, Version 1.0 developed in November 2021, which is a “common source of best practice principles in the monitoring, reporting, reduction, offsetting and verification of GHG emissions associated with a delivered cargo of LNG.” While use of and compliance with the framework is voluntary, it serves to provide a consistent approach for organizations across all stages of the LNG value chain to report their GHG emissions and make credible claims related to carbon neutrality associated with LNG cargoes.

The GIIGNL GHG Neutral Framework outlines five available declaration pathways, one of which is aligned with Woodfibre LNG’s net zero strategy, which is “GHG Offset LNG Cargo with Reduction Plan”. This pathway consists of a verified full or partial life cycle GHG footprint that embodies an emission reduction plan and has been offset with carbon credits that meet the criteria set out in the Framework. As part of designing a roadmap to net zero, Woodfibre LNG engaged Brightspot Climate Inc. to conduct an independent assessment to validate the Project’s expected emissions. Brightspot Climate then prepared the Emission Reduction Plan (included in section 4.1) alongside Woodfibre LNG that outlines specific actions to be undertaken by Woodfibre LNG and potential future actions that could be achieved in collaboration with government and other parties to further reduce emissions and achieve net zero.







# Woodfibre LNG

Roadmap to Net Zero

## 2.0 APPROACH

2.1 Context and Scope

2.2 Key Principles

2.3 Net Zero Roadmap



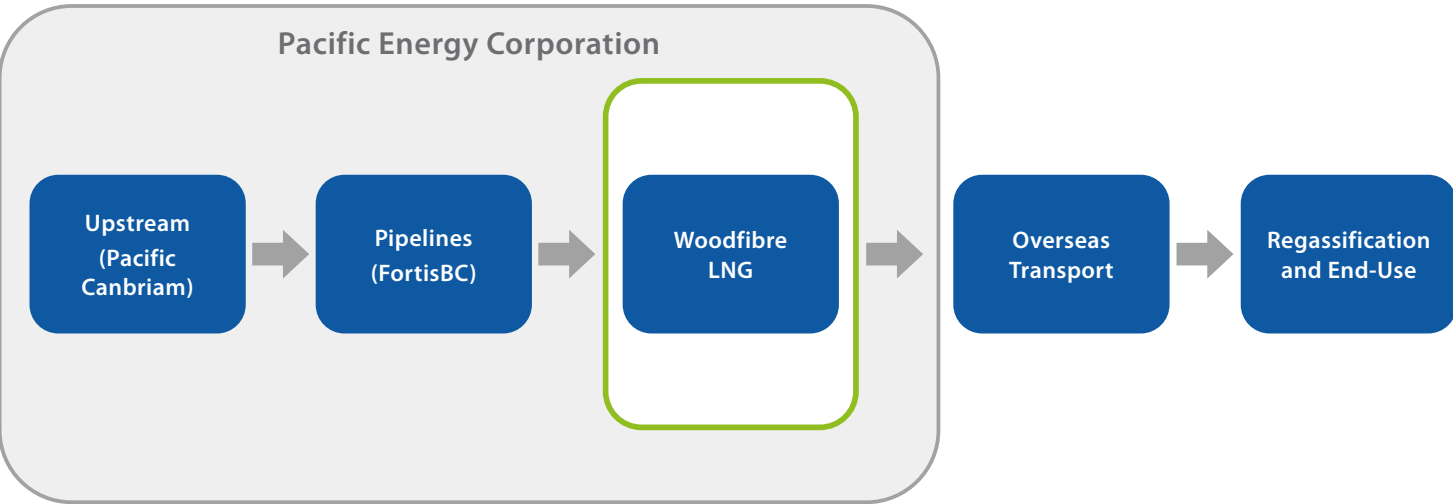
## 2.1 Context and Scope

This strategy describes the actions that Woodfibre LNG is taking to be net zero by the time the plant is operational by 2027. In addition, as a commitment to being an industry first-mover on net zero in Canada, the strategy outlines actions that Woodfibre LNG will take to be net zero during the construction phase (starting in 2023), despite no regulatory requirement for industrial operations to achieve net zero or report emissions during the construction phase.

Woodfibre LNG’s strategy is aligned with the federal government’s commitments and accountability to achieve scope 1 and 2 net zero GHG emissions by 2050. While the strategy does not currently include scope 3 activities (upstream and downstream), Woodfibre LNG is continuing to explore ways to feasibly reduce emissions from these activities.

Scope 1 is direct GHG emissions that occur from sources that are owned or controlled by Woodfibre LNG. Scope 2 is indirect GHG emissions associated with the purchase of electricity, steam, heat, or cooling for the Woodfibre LNG facility. Scope 3 is other indirect GHG emissions that are not directly associated with the Woodfibre LNG facility (upstream sources such as gas production and downstream sources such as those related to transporting, shipping and end-use). Figure 1 below illustrates the scope of influence for this strategy.

Figure 1: Woodfibre LNG Value Chain



## 2.2 Key Principles

The following key principles are foundational to Woodfibre LNG’s commitments to net zero and approach to developing a comprehensive strategy.

- A commitment to be net zero during during construction (2023-2026) and when operational (by 2027), and to developing a credible, independently validated plan.
- Alignment with the GIIGNL GHG Neutral Framework, Version 1.0 developed in November 2021.
- Collaboration with a credentialed climate consulting firm (Brightspot Climate Inc.) that uses the most current industry standards and methodologies and supported due diligence review of opportunities identified in the Emission Reduction Plan and Emission Offset Strategy.
- Alignment to government policy and regulatory frameworks and climate plans.
- Pursuit of emissions avoidance and reduction design strategies first, where commercially feasible, and then using carbon credits to offset hard-to-abate emissions, as an interim strategy while continuing to implement incremental reduction and avoidance opportunities now through operations.
- Engagement with Skwxwú7mesh Úxwumixw (Squamish Nation), all levels of government and various carbon offset projects and developers.
- Procurement of local, nature-based carbon credits that have First Nations partners.



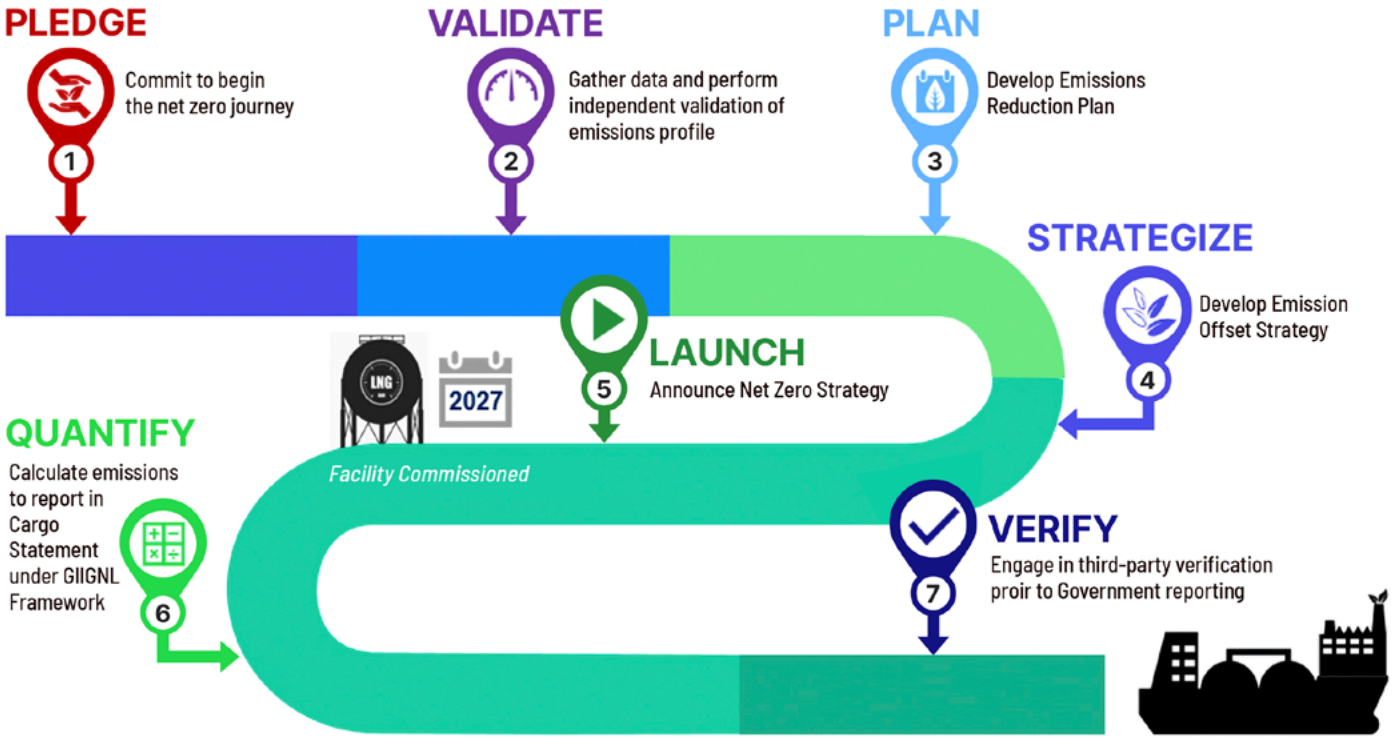




### 2.3 Net Zero Roadmap

Figure 2 below illustrates Woodfibre LNG's roadmap to net zero which includes six key phases

Figure 2: Roadmap to net zero



“We’re proud to be an original signatory on the Net-Zero Challenge, and we look forward to sharing our exciting plans to reach that goal soon,” said Woodfibre LNG president Christine Kennedy. “Government initiatives like the Net-Zero Challenge are key drivers for innovation and evolution in Canada’s natural gas industry, and one of the reasons we will be able to share the world’s lowest emission LNG with the international markets that need it most.”

**Christine Kennedy**  
President, Woodfibre LNG

**PHASE 1 | PLEDGE:** Woodfibre LNG pledged a commitment to develop a comprehensive strategy to claim and achieve net zero. This pledge is demonstrated by Woodfibre LNG’s participation in Environment and Climate Change Canada’s Net-Zero Challenge, which commits Woodfibre LNG to achieve net zero emissions by 2050, develop a net zero plan, set interim emission reduction targets and report on progress.

**PHASE 2 | VALIDATE:** Woodfibre LNG contracted a Canadian climate consulting firm, Brightspot Climate Inc., to produce a independent validation of the project’s GHG emissions (see section 3).

**PHASE 3 | PLAN:** Woodfibre LNG developed an Emissions Reduction Plan (section 4.1), which serves as a living document for how Woodfibre LNG will and could further reduce or avoid emissions through ongoing and incremental improvements to the facility design.

**PHASE 4 | STRATEGIZE:** Woodfibre LNG developed an Emissions Offset Strategy (section 4.2), which illustrates how Woodfibre LNG will procure and partner in projects that will provide carbon offset credits over the lifecycle of the project, including during construction and operations.

**PHASE 5 | LAUNCH:** Woodfibre LNG prepared and launched a net zero strategy to provide transparency to how the facility will achieve net zero emissions by the time it is operational.

**PHASE 6 | QUANTIFY:** Woodfibre LNG developed a Quantification Methodology Document (QMD) in alignment with the Western Climate Initiative (WCI) emission quantification methodologies, which are required for use and reporting by the Government of B.C. The QMD will be used to quantify annual GHG emissions from the facility, once operational.

**PHASE 7 | VERIFY:** Woodfibre LNG will contract a third-party to undertake annual verification of GHG emissions from the facility, once operational, prior to registering its GHG reporting to government under the Province of B.C.’s Greenhouse Gas Industrial Reporting and Control Act – Greenhouse Gas Emission Reporting Regulation.





**Woodfibre  
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Roadmap to Net Zero

## **3.0 EMISSIONS PROFILE**







Brightspot Climate Inc. performed a validation of Woodfibre LNG’s anticipated facility emission profile based on current design. The methodology employed in the emission validation is consistent with the specifications presented in the B.C. Ministry of Environment and Climate Change Strategy's emission reporting regulations and requirements and best practice principles for the GRII Monitoring, Reporting and Verification (MRV) and GHG Neutral Framework. This is the same expected methodology that Woodfibre LNG will use to quantify emissions once operational, on an annual basis.

The results of the validation, outlined in Table 1 below, showed that the carbon intensity of the Woodfibre LNG facility is approximately 0.04 tonnes of CO2e per tonne of LNG (tCO2e/tLNG), well below the B.C. regulatory benchmark of 0.16 tCO2e/tLNG.

Table 1: Woodfibre LNG facility estimated emissions during operations

EMISSIONS CATEGORY	TONNES OF CO2e PER YEAR
1. Stationary combustion & flaring	45,821
2. Mobile Combustion	2,919
3. Venting	13,023
4. Fugitive Losses	9,014
5. Emissions due to imported energy*	12,597
<b>TOTAL (tCO2e)</b>	<b>83,374</b>
<b>TOTAL carbon intensity (tCO2e / tLNG)</b>	<b>0.0397</b>

\*Emissions due to imported energy is related to BC Hydro, but as the 100% Clean Electricity Delivery Standard is implemented as part of CleanBC, this category would reduce to zero.

See Appendix 1 for the emission profile validation report.





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## 4.0 THE STRATEGY

4.1 Emissions Reduction Plan

4.2 Emissions Offset Strategy





Woodfibre LNG is prioritizing emission reduction and avoidance opportunities and has already implemented best-in-class technology and design upgrades to increase efficiency and reduce emissions once operational. These are explained in the Emissions Reduction Plan (section 4.1). Woodfibre LNG continues to stay current with emission reduction innovations and green solutions, including those incentivized by the federal and provincial governments (e.g., carbon capture, utilization and storage) and encouraged by emerging frameworks, such as Canada’s Methane Strategy and the draft best-in-class guidance for oil and gas projects described in section 1.3. As an interim strategy to complement emission reduction opportunities, Woodfibre LNG has developed an Emissions Offset Strategy (section 4.2) that sets out the approach to selecting and sourcing carbon offsets in a way that is complementary to corporate values, government objectives and regulatory obligations.

4.1 Emissions Reduction Plan

With support from Brightspot Climate Inc., Woodfibre LNG has prepared an Emissions Reduction Plan that will be updated on an annual basis to integrate efficiency improvements, new technologies and evolving industry practices that lead to overall GHG reductions, become commercially feasible over time and uphold Woodfibre LNG’s best-in-class standard.

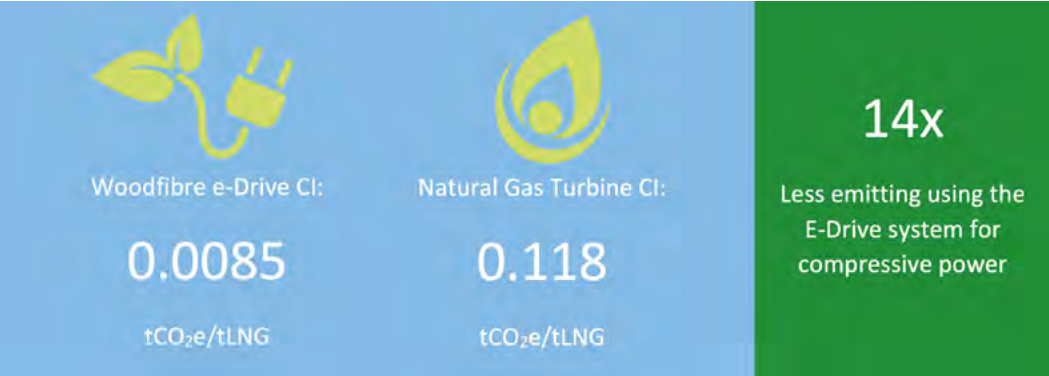
The baseline for the Emissions Reduction Plan is the validated emissions profile, and consequently, the baseline does not have an associated reporting period. Once the facility is commissioned (by 2027), the first full calendar year of operations will serve as the facility’s first baseline period and Woodfibre LNG will be able to set emission reduction targets to be achieved over time.

This section highlights the emissions reductions achieved compared to conventional LNG facilities (designed emission reductions) and includes recent decisions Woodfibre LNG has made to further reduce emissions. A description of future potential emission reduction pathways is included in Appendix 2. These opportunities could be realized in partnership with government, Canadian and local suppliers and others.

4.1.1 E-Drive System

Woodfibre LNG is able to achieve net zero in part because of early stage decisions aligned with the Indigenous led environmental assessment process conducted by Skwxwú7mesh Úxwumixw (the Squamish Nation), which resulted in the Nation’s own environmental assessment agreement related to the Project in 2015. Among these was the commitment for electric compressors using renewable hydroelectricity from BC Hydro.

The electrification eliminates the need for two gas turbines required to drive the compressor systems and as many as four gas-turbine generator sets for electric power generation. This replaces the need for natural gas and substitutes it with electricity from BC Hydro’s low emissions intensity electricity system. The electric drivers have the additional benefit of increasing energy efficiency compared to natural gas engines, thereby reducing the overall energy demand.



The E-Drive system delivers an emission intensity 14 times lower than conventional liquefaction facilities, resulting in stationary combustion emission reductions of approximately **230,470 tCO<sub>2</sub>e per year**. Accounted for in the validated emissions profile.



Woodfibre LNG’s design features an “e-drive” system that will be supplied by Siemens Energy.



4.1.2 Boil-Off Gas Re-Liquefaction

Woodfibre LNG’s design collects and re-liquefies the boil-off gas (BOG) for use by the heating medium furnace and thermal oxidizer. The equipment uses feed gas during start up and then relies on BOG as the primary fuel source, reducing the amount of feed gas required for fuel. Based on preliminary gas composition estimates, the carbon content of the BOG will be 27% lower than the feed gas. This results in a reduced emissions intensity when combusted.

Parameters

Feed gas offset with BOG	80%
Feed gas carbon content	0.59 kg C/m3
BOG carbon content	0.43 kg C/m3

The BOG re-liquefaction process delivers a stationary combustion emission reduction from the heating medium furnace and thermal oxidizer of approximately 26 percent. **The resulting emission reductions are approximately 11,714 tCO2e per year. These results assume 80 percent of the fuel gas will be boil-off gas. Accounted for in the validated emissions profile.**

4.1.4 Compressor Improvements

During the operational phase of the Project, emission activities will operate under two schemes: normal operation and upset conditions. Normal operation conditions are considered the conditions under which the facility will operate for most of the time. Upset conditions are abnormal conditions where flaring and venting of natural gas may take place.

Woodfibre LNG’s facility incorporates several compressor design parameters that will reduce flaring and venting emissions generated during normal operation and upset conditions. This will be achieved by discharging vented flow to flare and by reducing the blowdown emissions from compressors.

Upset emissions are not included in the validated emissions profile as it is expected Woodfibre LNG will operate continuously under normal conditions. The use of recycle lines will help minimize flaring during start-up and upset conditions. The purpose of the lines is to recycle off-spec gas back for re-processing, **thereby reducing the quantity of feed gas sent to flare and associated emissions by 3,579 tCO2e per year (stationary combustion and flaring). Accounted for in the validated emissions profile.**



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Zero Emission Solution**

- Gas-lubricated
- Bi-directional
- Ready-to-fit cartridge unit
- Available for following seal arrangements: single and tandem
- Co-axial primary seal
- Separation seals as CobaSeal, carbon rings or labyrinths optional

4.1.3 Compressor Dry Gas Seals

Woodfibre LNG’s design will use high-performance (low-passing) dry gas seals on the compressors rather than the conventional wet gas seal. Centrifugal compressor seals allow the rotating shaft to move freely without allowing excessive high-pressure gas to escape. The standard wet seal uses circulating oil to restrict the escape of high-pressure gas. The oil entrains some of the gas which must be removed and is typically vented to the atmosphere. A dry seal does not use oil and the high-pressure gas emission rate is much less. The following methane emission factors are references from the U.S. EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks and can be used to estimate the emission reductions achieved by using dry gas seals.

Parameters

Wet seal methane emission factor	60.75 tCH4/compresso
Dry seal methane emission factor	28.14 tCH4/compressor
Number of compressors	7

**Based on a design with seven compressors, the dry gas seal systems deliver a fugitive emission reduction of approximately 6,391 tCO2e per year. Accounted for in the validated emissions profile.**

4.1.5 Increased Frequency of Leak Detection and Repair (LDAR) Surveys

As per the Liquefied Natural Gas Facility Regulation (B.C. Reg. 146/2014), a fugitive emissions management plan (FEMP) is required. Woodfibre LNG’s FEMP will incorporate proactive and reactive measures to reduce fugitive emissions at the facility.

Fugitive emissions can be reactively managed with fugitive emission leak detection and repair (LDAR) surveys. The surveys identify where leaks are occurring to enable fast repair and prevent leaks from worsening over time. By increasing the frequency of leak detection surveys, potential fugitive sources will be identified and repaired sooner and therefore decrease their overall emissions. By conducting monthly LDAR surveys and repairs, Woodfibre LNG will **reduce emissions by 87 to 92 percent (up to 7,842 tCO2e per year).**

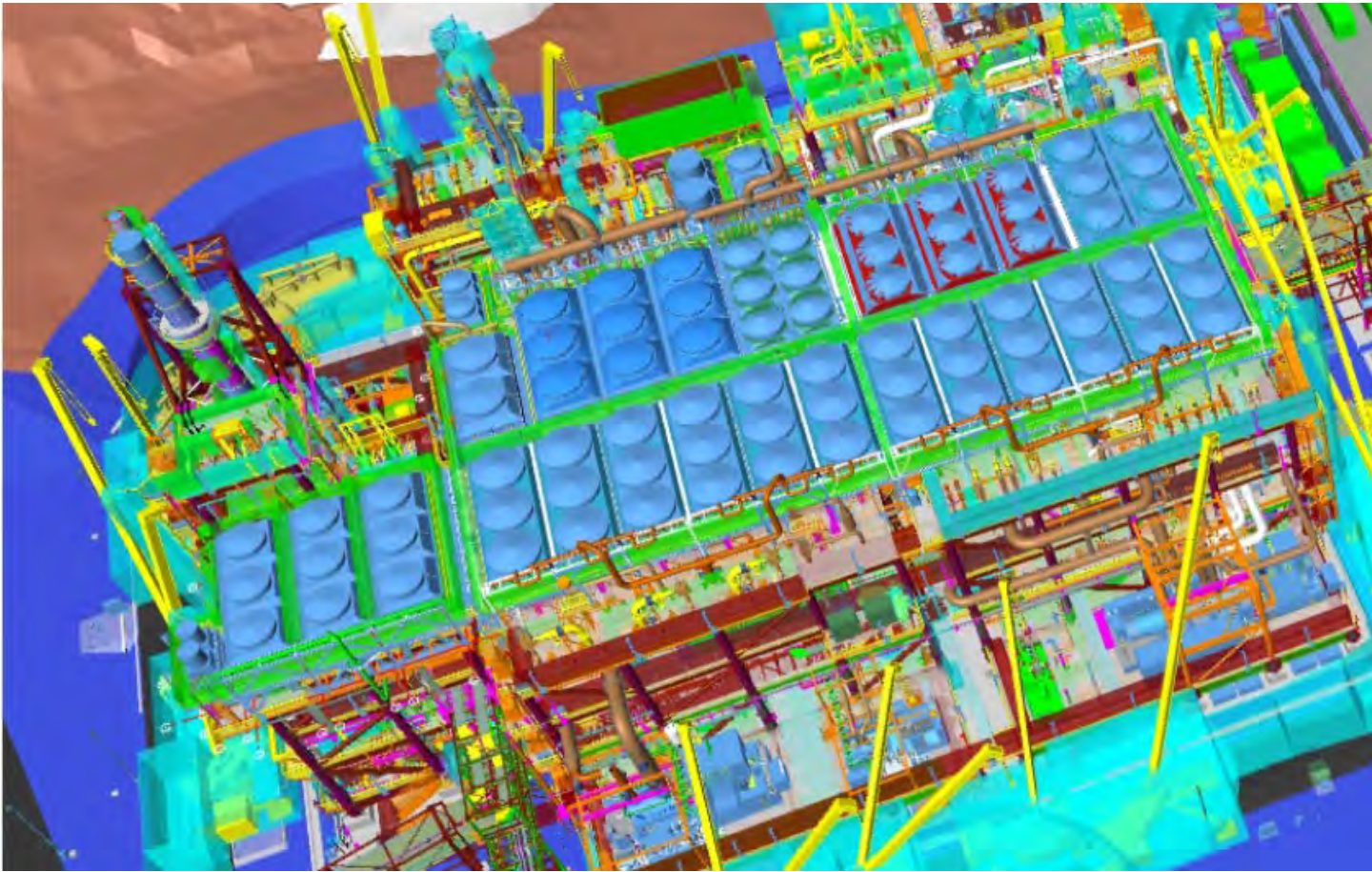


The FLIR GF320 detects hydrocarbon and volatile organic compound (VOC) emissions from natural gas production and use. With an optical gas imaging camera, inspectors can check thousands of components and see potential gas leaks in real-time. The GF320 is lightweight, offers both a viewfinder and LCD monitor and has direct access to controls. Embedded GPS data helps in identifying the precise location of faults and leaks, for faster repairs.



4.1.6 Air Cooling System

In response to concerns raised by Squamish Nation on potential impacts of a seawater cooling technology on the marine environment, Woodfibre LNG will switch to an air-cooled heat exchange system. Through an independent review conducted by Squamish Nation, air cooling technology was found to have a lesser impact on the marine environment, as seawater cooling can have a warming impact on the surrounding water due to heating during intake and potential defouling chemical release. Air cooling has no effect on the surrounding water and ecology .and reduces scope 2 emissions (BC Hydro) by **3,280 tCO2e per year**.



Air cooling system on top of the process modules. Changing from seawater cooling technology to air cooling system and commitment to E-Drive compressors were early commitments in 2015.

4.1.7 On-site Nitrogen Plant

Nitrogen is a critical part of the LNG facility that makes operations possible. Woodfibre LNG will produce low-purity nitrogen on-site, with no emissions, thereby reducing the number of truck and barge transportation of imported nitrogen, from 50 to 60 trips per month to two trips per month. While the nitrogen plant does not reduce emissions directly produced by the plant (scope 1), it will reduce scope 3 emissions associated with transportation by approximately **1,028 tCO2e per year**.

4.1.8 Linkages to Canada’s Methane Strategy

Table 2 below summarizes the linkages of some of the emissions reduction strategies described above with the abatement solutions for the oil and gas sector included in Canada’s Methane Strategy.

Table 2: Linkages to Canada’s Methane Strategy

METHANE STRATEGY LINKAGE	WOODFIBRE LNG EMISSION REDUCTION OPPORTUNITY	EMISSIONS CATEGORY	ANNUAL tCO2e AVOIDED
Leak Detection and Repair (inspection and repair using instruments to detect leak and emissions)	Quarterly LDAR inspections and repairs	Fugitive Losses	7,842 tCO2e
Compressors (replacing compressor seals to limit venting; replacing pressurized gas pumps and controller with electric / air systems)	Use of high-performance (low-passing) dry gas seals on compressors	Fugitive Losses	6,391 tCO2e
Combustion / Power Generation (improved efficiency and reduced venting from boilers and combustion equipment)	E-Drive (commitment made in 2015)	Stationary Combustion & Flaring	230,470 tCO2e
	Boil-off gas re-liquefaction	Stationary Combustion & Flaring	11,714 tCO2e
	Recycle lines	Stationary Combustion & Flaring	3,579 tCO2e

For a summary of emissions reduced through the Emission Reduction Plan, see Appendix 3.





## 4.2 Emissions Offset Strategy

As noted, the use of carbon credits is intended to be an interim strategy for hard-to-abate emissions while further reduction strategies and carbon removal technologies are made possible and scalable for B.C.’s LNG industry and specifically, Woodfibre LNG. This section describes Woodfibre LNG’s commitments to invest in B.C., nature-based offset projects in an effort to return benefits to local communities, First Nations and the environment. With support from Brightspot Climate Inc., Woodfibre LNG explored and conducted a comprehensive due diligence review of numerous options and selected offsets based on the following key considerations:

- Physical location;
- Volume of forest (hectares);
- Amount and availability of offset credits generated;
- Quality and credibility (e.g., offset protocols, vintage); and
- Environmental and social integrity (e.g., providing GHG reductions and co-benefits to local communities).

### 4.2.1 Phase 1: Construction

Woodfibre LNG has entered into a purchase agreement with Cheakamus Community Forest for carbon credits to offset emissions during the entire construction phase and as such will be a net zero entity during major construction, which is scheduled to start in fall 2023 and end by 2027. Table 3 below estimates Woodfibre LNG’s emissions profile during construction.

Table 3: Woodfibre LNG facility estimated emissions during construction

EMISSIONS CATEGORY	SOURCE	TOTAL ESTIMATED TCO2E
1. Site Preparation	Diesel equipment	8,991
2. Logistics	Diesel equipment	4,226
3. Marine and Shoreline Activities	Diesel equipment	6,038
4. Worker Accommodation (“Floatel”)	BC Hydro	665
TOTAL		19,920




# CHEAKAMUS COMMUNITY FOREST

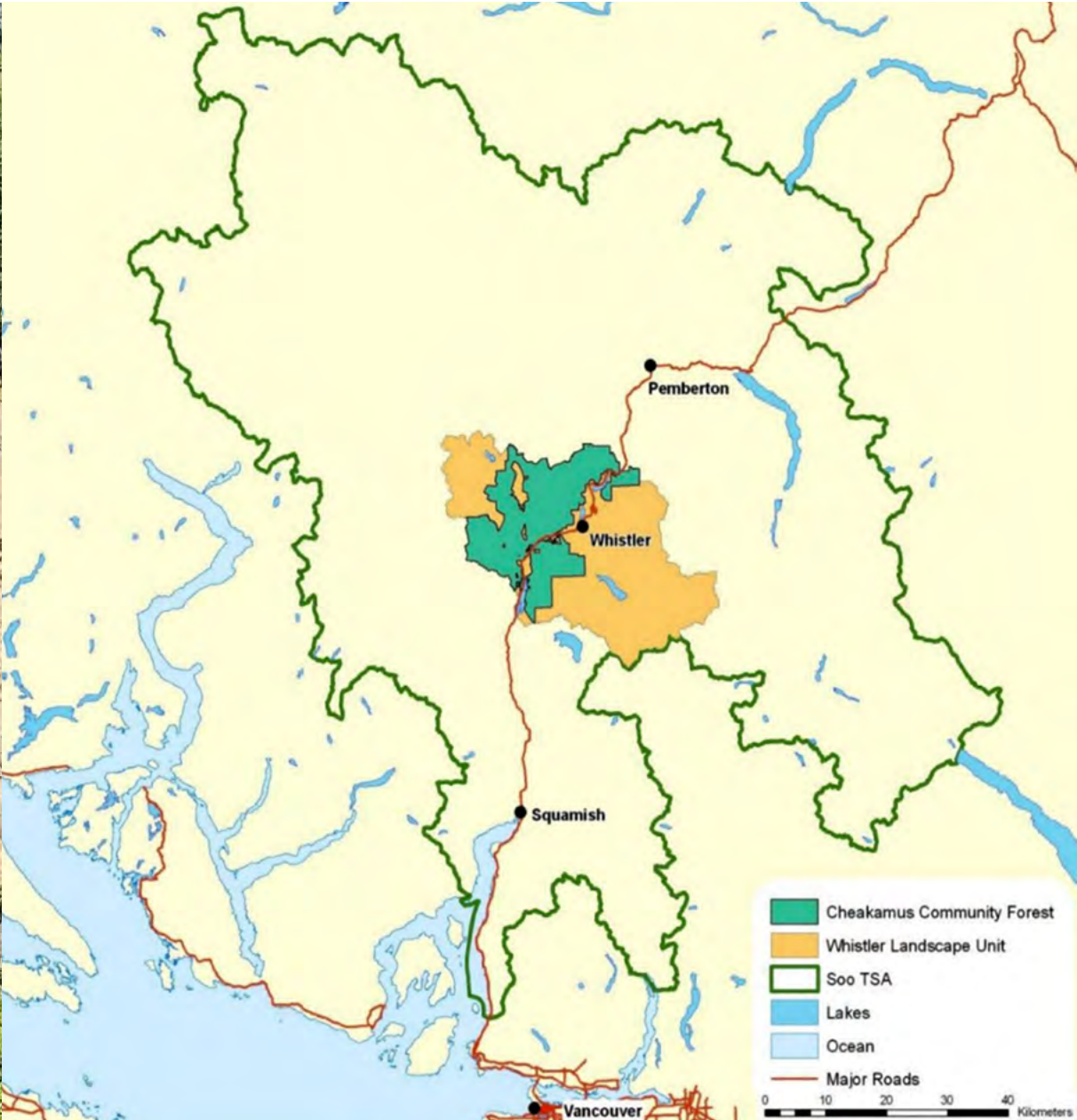
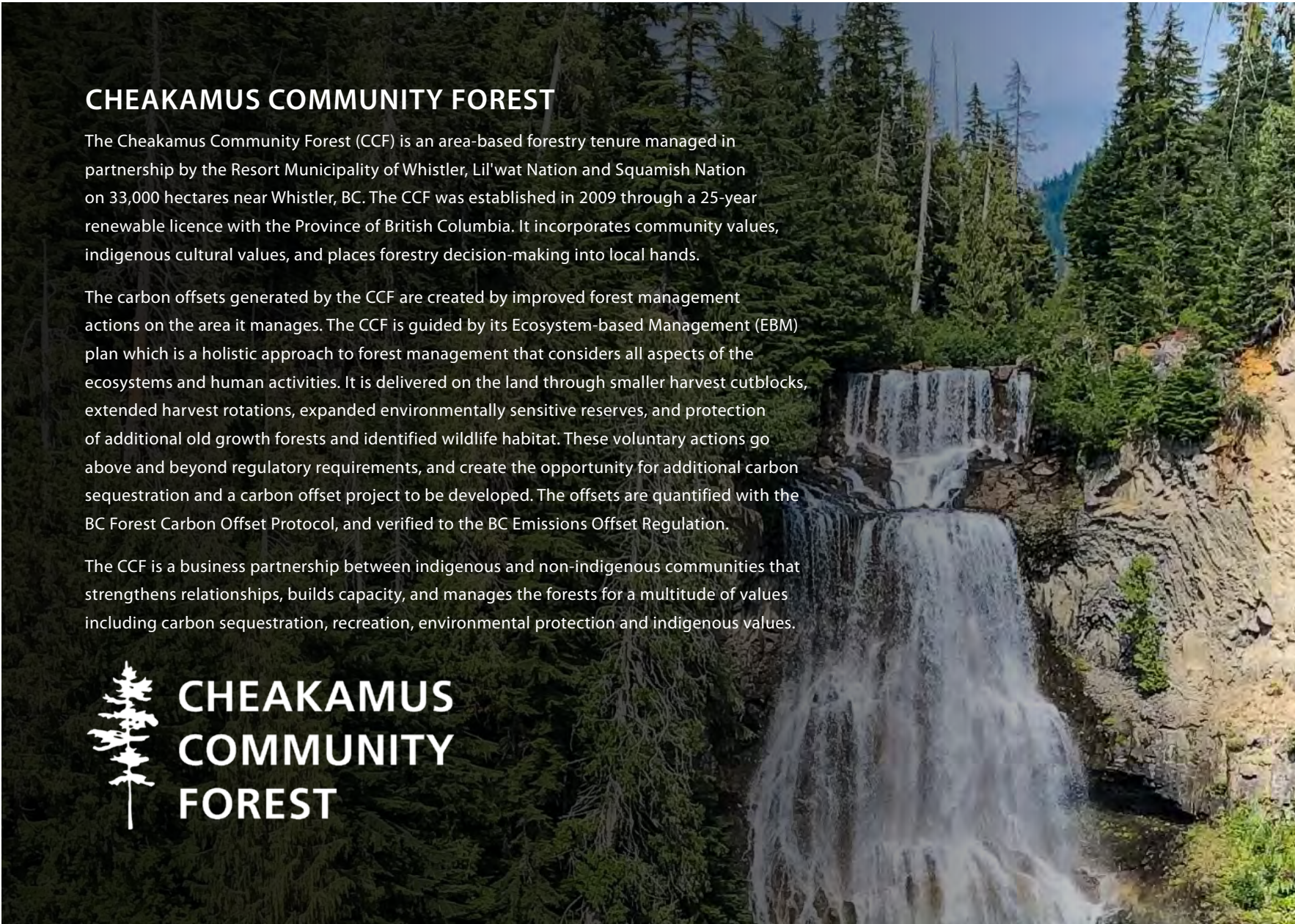
The Cheakamus Community Forest (CCF) is an area-based forestry tenure managed in partnership by the Resort Municipality of Whistler, Lil'wat Nation and Squamish Nation on 33,000 hectares near Whistler, BC. The CCF was established in 2009 through a 25-year renewable licence with the Province of British Columbia. It incorporates community values, indigenous cultural values, and places forestry decision-making into local hands.

The carbon offsets generated by the CCF are created by improved forest management actions on the area it manages. The CCF is guided by its Ecosystem-based Management (EBM) plan which is a holistic approach to forest management that considers all aspects of the ecosystems and human activities. It is delivered on the land through smaller harvest cutblocks, extended harvest rotations, expanded environmentally sensitive reserves, and protection of additional old growth forests and identified wildlife habitat. These voluntary actions go above and beyond regulatory requirements, and create the opportunity for additional carbon sequestration and a carbon offset project to be developed. The offsets are quantified with the BC Forest Carbon Offset Protocol, and verified to the BC Emissions Offset Regulation.

The CCF is a business partnership between indigenous and non-indigenous communities that strengthens relationships, builds capacity, and manages the forests for a multitude of values including carbon sequestration, recreation, environmental protection and indigenous values.



## CHEAKAMUS COMMUNITY FOREST







# BIGCOAST FOREST CLIMATE INITIATIVE

The BigCoast Forest Climate Initiative is Mosaic Forest Management's nature-based forest conservation project on Coastal British Columbia. By deferring the harvest in 40,000 hectares of old forest, the Initiative will help capture and store more than 20 million tonnes of CO<sub>2</sub>e. By converting private working forests into project lands, this initiative will not only increase carbon storage, but will also avoid future CO<sub>2</sub>e emissions from harvesting operations across an area featuring some of British Columbia's oldest trees and important ecosystems.

Maintaining these lands as old forests will help contain a vast amount of carbon as part of a natural climate solution. Global emissions are reduced while globally significant ecological and cultural features are conserved. These forests contribute to a broader regional ecosystem, which is home to wildlife, such as bears, elk, salmon and orcas. Revenue from BigCoast Forest will extend support to cultural and scientific research through the Indigenous Protected and Conserved Areas (IPCA) Innovation Program and the Pacific Salmon Foundation.



### 4.2.2 Phase 2: Operations

For the operations phase, Woodfibre LNG has explored both existing and new offset initiatives with local First Nations, including Sk̓wx̓wú7mesh Úxwumixw (Squamish Nation).

Woodfibre LNG has purchased an initial tranche of carbon credits from BigCoast Forest Climate Initiative to be retired once operations commence and has established a right of first opportunity to purchase additional offsets of newer vintage, if and as required, from BigCoast for subsequent years. As mentioned, Woodfibre LNG intends to utilize offsets as an interim strategy while it continues to realize further emission reduction and avoidance improvements that could be made to the facility over time, as technologies become more readily available, scalable and economically feasible. (see Appendix 2)

Woodfibre LNG acknowledges that even the cleanest LNG facilities have hard-to-abate emissions and therefore the project will rely on offsets to some degree over the duration of its operations to achieve and maintain net zero status.

Woodfibre LNG is exploring the opportunity of establishing a new, local, nature-based carbon project that could generate carbon credits for the Project and entities in the Squamish region. Woodfibre LNG would intend to have local, regional and Indigenous partners involved in the development of the carbon project and has offered capacity funding to Skwxwú7mesh Úxwumixw (the Squamish Nation) and the District of Squamish to undertake feasibility studies.

In addition to the purchase of carbon credits, Woodfibre LNG is committed to ensuring long-term collaborative relationships with local and regional carbon projects. Woodfibre LNG is working with Mosaic Forest Management Corporation and Cheakamus Community Forest to develop Memorandums of Understanding (MOUs) that will delineate joint research and development activities of interest and benefit to both parties. The goal is to demonstrate mutual commitments to net zero emissions and to support improved cultural and environmental understanding of the natural environment in which carbon offsets are generated.





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## 5.0 CONCLUSIONS & NEXT STEPS







This roadmap shows a tangible plan for how Woodfibre LNG will be an industry first-mover in Canada and be a net zero facility well in advance of government’s regulatory requirements for industry, while providing local benefits to British Columbians and First Nations.

As illustrated throughout the strategy, Woodfibre LNG has specific advantages that support achieving net zero and that were envisioned and decided during the environmental assessment process dating back to before 2015, to ensure the facility would contribute to a sustainable future for generations to come. This includes the use of renewable hydroelectricity to power the facility; an integrated supply chain with the ability to source, transport and process naturally low-carbon gas locally, thereby further reducing emissions; and foundational partnerships with First Nations who have made complementary commitments to net zero and climate action.

It is important to reiterate that this strategy is a living document and will be updated on a regular basis (at least annually) to reflect the evolving net zero industrial and regulatory landscape, bold government targets and plans to reduce emissions, important public policy levers to incentivize net zero actions and opportunities to implement incremental emission reduction opportunities in partnership with government and others.

Woodfibre LNG will continue to partner with First Nations, local businesses, community stakeholders and governments at all levels to drive innovation, uphold our global standard of having the lowest carbon intensity for any LNG project in the world and support our intention to be the world’s first net zero LNG facility.





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Roadmap to Net Zero

# APPENDIX 1: EMISSIONS PROFILE VALIDATION REPORT

Prepared by Brightspot Climate Inc.





Scope

According to ISO-14067: Greenhouse gases – Carbon footprint of products – Requirements and guidelines for quantification, the carbon footprint of a product (CFP) is defined as the sum of GHG emissions and GHG removals in a product system expressed as CO2 equivalents and based on a life cycle assessment (3.1.4.3) using the single impact category. A partial carbon footprint (partial CFP) is defined as the sum of GHG emissions and GHG removals of one or more selected process(es) in a product system, expressed as CO2 equivalents and based on the selected stages or processes within the life cycle.

In alignment with the requirements outlined in ISO-14067’s for partial and full CFPs, Brightspot Climate has performed this emission validation exercise for the partial CFP of the midstream WLNG liquefaction facility.

The Facility is expected to report emissions in accordance with British Columbia’s Greenhouse Gas Industrial Reporting and Control Act and associated regulations. The Global Warming Potentials (GWP) from the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report are used to be in alignment with these reporting requirements. The Project emission sources will be managed through adherence to best management practices, regulatory requirements, and guidelines. An environmental management system should be developed to oversee emission compliance requirements during Project operations, including any accidents or malfunctions. Monitoring for atmospheric emissions is expected to be required under Project permitting through the Environmental Management Act.

Previous Studies

Woodfibre LNG has performed two emission estimation calculations prior to facility commissioning. The first study greenhouse gas estimation was performed by Golder Associates in 2015, titled “Appendix 5.3-1 Greenhouse Gas Methodology ” and is publicly available on the British Columbia Environmental Assessment Office website. The second study was performed internally by WLNG in 2021.

The Golder estimates study used conservative assumptions to calculate emissions and consequently, the emissions were over estimated. The WLNG study used updated information considering emission reduction strategies developed after the release of the Golder study, thereby providing a more representative emissions profile. The carbon intensity comparison between the two studies is shown in Table 1.

The Golder study, thereby providing a more representative emissions profile. The carbon intensity comparison between the two studies is shown in Table 1.

Table 1: Emission Profile Comparison between Golder and WLNG studies

	GOLDER EMISSIONS STUDY	WLNG EMISSIONS STUDY
Emissions (tCO2e / year)	129,400	68,900
Carbon Intensity (tCO2e / t LNG)	0.059	0.032

Functional Unit (Unit of Analysis)

In order to ensure consistency in reporting, a common unit of analysis must be used. For Woodfibre LNG to offset emissions for the LNG shipped from the Woodfibre LNG terminal, the functional unit of this study is:

tonnes CO2e emitted / tonnes LNG shipped

Notations

A non-exhaustive guide to the notation is provided below.

- WLNG = Woodfibre LNG
- BC MOE = BC Ministry of Environment and Climate Change Strategy
- GIIGNL = International Group of Liquefied Natural Gas Importers
- MRV = Monitoring, Reporting and Verification
- EIA = Energy Information Administration
- WCI = Western Climate Initiative
- GHG = Greenhouse Gas
- LNG = Liquefied Natural Gas
- TO = Thermal Oxidizer
- HVAC = Heating, Ventilation, and Air Conditioning
- HP = High Pressure
- LP = Low Pressure
- AGRU = Acid Gas Removal unit
- tCO2e = tonnes of Carbon Dioxide Equivalent

Emission Sources

At entity level, six emission sources have been identified through the evaluation of the LNG Process:

Scope 1: Direct emissions

Stationary Combustion:

- Thermal Oxidizer (TO) heater
- Heating Medium Furnace
- Heating, Ventilation, and Air Conditioning (HVAC units)
- Essential Generators
- Fire Water Pumps

Flaring:

- High Pressure (HP) Flare
- Low Pressure (LP) Flare

Venting:

- Acid Gas Removal unit (AGRU)

Fugitives:

- Valves
- Connectors
- Lines

Scope 2: Indirect emissions associated with imported energy

- Marine transportation
- Electricity Consumption



## Stationary Fuel Combustion

WLNG has two stationary fuel combustion sources that utilize natural gas - the thermal oxidizer burners and the heating medium furnace.

### Thermal Oxidizer Heaters (TO Heaters)

WLNG has calculated the emissions from the thermal oxidizer heaters using the thermal oxidizer design specifications. WLNG has utilized Energy Information Administration (EIA) guidelines to calculate emissions from fuel gas combustion within the TO burners and the heating medium furnace. The emission factor utilized is obtained from the EIA Carbon Dioxide Emissions Coefficients which provide an emission factor in Kilograms CO<sub>2</sub>e Per Million Btu.

Brightspot Climate recalculated the emissions using the heating values of fuel gas and the fuel gas compositions as per the unit specifications provided by WLNG, applying the Western Climate Initiative (WCI) methodology.

The results of this analysis and the comparison with the WLNG value are found in Table 2.

It was found that WLNG has understated the emissions by approximately 2,580 tCO<sub>2</sub>e. This is primarily due to the difference in the methodology used. The EIA emission factor (1.94 kgCO<sub>2</sub>e / m<sup>3</sup> of natural gas) is comparable to the default WCI emission factor for Natural Gas (1.92 kgCO<sub>2</sub>e / m<sup>3</sup>), although the EIA factor excludes the emissions resulting from release of methane and nitrous oxide. The usage of the EIA emission factor is appropriate given the facility is not operating, however once operational, the WCI methodology in accordance with the BC GGIRCA methodology must be utilized along with the appropriate measured emission factors.

### Heating Medium Furnace

WLNG has calculated the emissions from the heating medium furnace design specifications. WLNG has utilized Energy Information Administration (EIA) guidelines to calculate emissions from fuel gas combustion within the TO burners and the heating medium furnace. The emission factor utilized is obtained from the EIA Carbon Dioxide Emissions Coefficients which provide an emission factor in Kilograms CO<sub>2</sub>e Per Million Btu.

Brightspot Climate recalculated the emissions using the heating values of fuel gas and the fuel gas compositions as per the unit specifications provided by WLNG, applying the Western Climate Initiative (WCI) methodology.

The results of this analysis and the comparison with the WLNG value are found in Table 2.

It was found that WLNG has understated the emissions by approximately 13,750 tCO<sub>2</sub>e. This is primarily due to the methodology differences as highlighted in the section above.

#### HVAC Units

WLNG will be operating an HVAC unit, rated at 800 kW power. This unit is anticipated to be used 70% of the year.

WLNG has utilized the EPA Greenhouse Gas Equivalencies Calculator to calculate the amount of fuel gas consumed by the HVAC unit.

Brightspot has recalculated the fuel gas consumption using the methodology stated in the WCI 2012 25 (b) - Fuel Consumption Monitoring Requirements, equation 20-16.

The results of this analysis and the comparison with the WLNG value are found in Table 2.

It was found that WLNG has overstated the emissions by approximately 2285 tCO<sub>2</sub>e. Brightspot believes that the value used by WLNG is overly conservative as the EPA calculation uses the Avoided Emissions and generation Tool (AVERT) U.S. national weighted average CO<sub>2</sub>e marginal emission rate to convert reductions of kilowatt-hours into avoided units of carbon dioxide emissions.

### Essential Generators

WLNG will be operating 3 diesel powered generators rated at 3 MW each in rare events when the main BC Hydro power to the facility is lost. The generators will be tested for a short period once a week for less than a few minutes.

WLNG has opted to exclude the generators from the emissions calculations as the utilization of these generators would be intermittent.

Brightspot has estimated these emissions using an estimated ten minutes of testing for

the 52 weeks in a year, using a calculated diesel fuel consumption and WCI diesel emission factors.

It was found that WLNG has understated the emissions by approximately 25 tCO<sub>2</sub>e. The results of this analysis and the comparison with the WLNG value are found in Table 2.

### Fire Water Pumps

WLNG will be operating 2 diesel powered fire water pumps and 1 electrical drive fire water pump rated at 400 kW each in the rare event if there is a fire in the facility. The pumps will be tested for a short period once a week for less than a few minutes.

WLNG has opted to exclude the pumps from the emissions calculations, as the utilization of these pumps would be intermittent.

Brightspot has estimated these emissions using an estimated ten minutes of testing for the 52 weeks in a year, using a calculated diesel fuel consumption and WCI diesel emission factors.

It was found that WLNG has understated the emissions by approximately 10 tCO<sub>2</sub>e. The results of this analysis and the comparison with the WLNG value are found in Table 2.





## Flaring

The facility will operate a high-pressure flare and a low-pressure flare. Both flares will be continuously purged with fuel gas at an estimated rate of 10 kg hour-1, to avoid oxygen ingress.

WLNG has opted to exclude emissions due to emergency flaring at this stage, recognizing that this is a last line of defense for process safety and expected to last not more than 15 minutes, categorized as emergency blowdown. The facility is designed to re-start without requiring an emergency blowdown, and the anticipated number of blowdown events have not been able to be estimated. The situations in which flaring may occur in the case of an emergency are for blocked outlets of the propane refrigerant compressor and the mixed refrigerant compressor, blowdowns, feed gas control valve failure and boil-off gas compressor failure during ship loading. WLNG has also opted to exclude emissions from the flares during start-up and shutdown at this time, but will quantify this nearer to operations and include these emissions in a future year.

WLNG has utilized EIA guidelines to calculate emissions from the HP and LP flares. The emission factor utilized is obtained from the EIA Carbon Dioxide Emissions Coefficients which provides an emission factor in Kilograms CO2e Per Million Btu.

Brightspot has estimated emissions for the continuous purge of fuel gas at the rate of 10 kg /h for the HP and LP flares. Brightspot has also estimated emissions for the start-up of the high-pressure flare at the rate of 125,000 kg hour-1, using an estimated twelve hours of start-up, twice a year.

The results of this analysis and the comparison with the WLNG value are found in Table 2.

It was found that WLNG had understated the emissions by

approximately 210 tCO2e. Brightspot believes that this is due to the usage of the EIA factor and exclusion of flaring sources as mentioned above. The EIA emission factor is for stationary fuel combustion purposes and is not appropriate for flaring. Brightspot recommends that the WCI 363 (k) flaring methodology for calculating emissions must be utilized along with the appropriate measured emission factors.

## Venting

The facility does not have a continuous hydrocarbon venting source. All compressors and jumper arms will have a seal system which will be connected to the LP flare and the vents are expected to purge with nitrogen for seal purpose during normal operations. WLNG has excluded hydrocarbon venting from the emissions calculations.

As per the WCI, the AGRU is a venting emission source and must be categorized under venting.

## Acid Gas Removal Unit (ACRU)

The AGRU is capable of destruction of 99.9% of the contaminants coming through the thermal oxidizer, emitting a stream rich in CO2.

WLNG has assumed that all the CO2e entering through the feed gas from the pipeline is released into the atmosphere. WLNG has categorized the emissions from the AGRU under stationary fuel combustion, whereas according to the WCI, it is under venting.

Brightspot has recalculated the amount of CO2e released following the WCI methodology.

The results of this analysis and the comparison with the WLNG value are found in Table 2.

It was found that WLNG has overstated the emissions by approximately 5,382 tCO2e. This is because of the assumption that all the CO2e entering through the feed gas from the pipeline is released into the atmosphere. Brightspot agrees that using the inlet CO2e as the CO2e leaving the AGRU is appropriate as it is the most conservative estimate.

## Fugitives

Fugitive emissions have been estimated for the valves, flanged connections, and sampling connections with hydrocarbon service with a methane content of more than 10%, which includes the inlet system, dehydration, fuel gas system, and liquefaction and storage. The emissions from pump and compressor seals, relief valves and open-ended lines have been excluded as there are controls in place to redirect the emissions to the flare.

WLNG has utilized emission factors from WCI 2012 Table 350-4–Default Methane Emission Factors for LNG Terminals to calculate emissions, using a speciated fugitive composition with a 53 weight% methane content.

Brightspot has utilized WCI 2012 Table 350-4–Default Methane Emission Factors for LNG Terminals in conjugation with WCI.363(n) to estimate fugitive emissions, using a 100 weight% methane content as this is assumed to be the most conservative gas composition. The WCI 2012 Table 350-4 contains emission factors that are conversions of those contained in the US EPA Subpart W Table W-5 (Table W-5A to Subpart W of Part 98 - Default Methane Leaker Emission Factors for Liquefied Natural Gas (LNG) Storage)

The results of this analysis and the comparison with the WLNG value are found in Table 2.

It was found that WLNG had understated the emissions by

approximately 6,420 tCO2e. WLNG has utilized a speciated fugitive gas composition with the methane content of 53 weight%, whereas Brightspot has utilized the fuel gas composition with a methane content of 100 weight% as this is assumed to be the most conservative gas composition. Both approaches considered all the components leaking the entire year, which is an overly conservative assumption.

While in operation, under the BC GGIRCA and as stipulated by the WCI, the facility must conduct a leak detection survey of fugitive equipment leaks from all valves, connectors, open ended lines, pressure relief valves and meters. Therefore, the currently estimated emissions using the component count methodology with continuous emission does not reflect the actual conditions of the facility, once operational.

## Marine Transportation

Once operational, two marine vessels will be used on-site – the passenger ferry and the water taxi. Brightspot and WLNG have estimated these emissions using the marine emission factors obtained from the 2005 – 2006 BC Ocean Going Vessel Emissions Inventory (BC Chamber of Shipping 2007) .

The results of this analysis and the comparison with the WLNG value are found in Table 2.

It was found that WLNG had understated the emissions by approximately 120 tCO2e. As this value is comparable and follows the same approach, no further analysis was required.



## Electricity Consumption

The peak power that the WLNG facility will utilize is 125 MW and is provided by the facility's electrical load list.

WLNG has calculated their emissions from BC Hydro consumption using the previously derived Golder emissions rate and finding the equivalent emission factors.

Brightspot has estimated the emissions from utilization of grid electricity using B.C.'s Grid Electricity GHG Emission Intensity Factors for 2022 and the peak power that the WLNG facility can utilize.

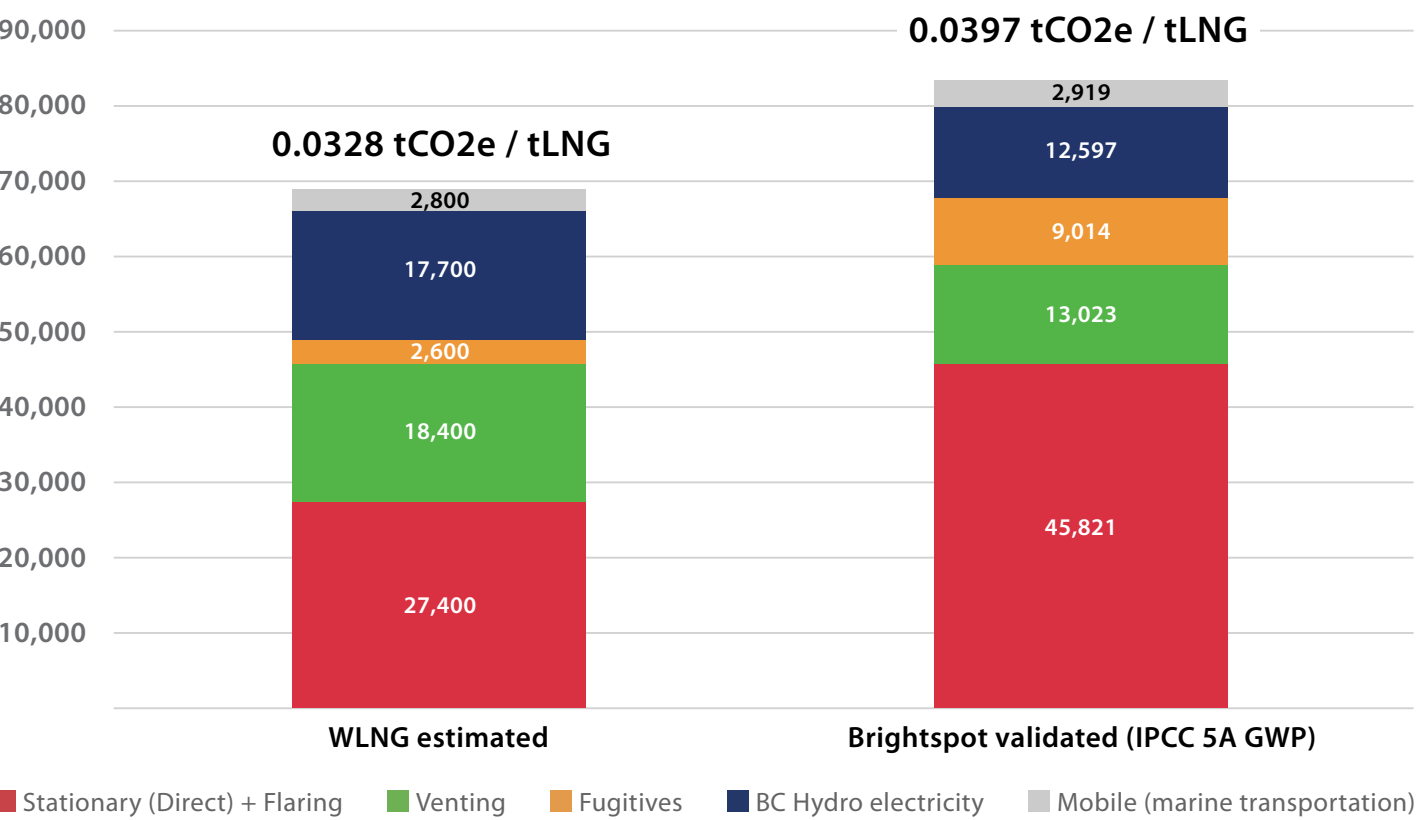
The results of this analysis and the comparison with the WLNG value are found in Table 2.

It was found that WLNG has overstated the emissions by approximately 5,100 tCO<sub>2</sub>e. This is due to WLNG's usage of the overly conservative derived emission factor for BC Hydro consumption in lieu of the current BC Hydro grid electricity emission intensity factor.

Table 2: Emission Profile Comparison between Golder and WLNG studies

EMISSIONS CATEGORY	WLNG ESTIMATED tCO <sub>2</sub> e PER YEAR	BRIGHTSPOT VALIDATED tCO <sub>2</sub> e PER YEAR
1. Stationary combustion & flaring	27,400	45,821
2. Mobile combustion	2,800	2,919
3. Venting	18,400	13,023
4. Fugitive losses	2,600	9,014
5. Emissions due to imported energy	17,700	12,597
TOTAL (tCO <sub>2</sub> e)	68,900	83,374
TOTAL CI (tCO <sub>2</sub> e / tLNG)	0.0348	0.0397

Figure 1: Emission Validation Comparison between WLNG and Brightspot



## Conclusion

The results of the validation exercise found that the carbon intensity of the liquefaction facility is exactly 0.04 tonnes CO<sub>2</sub>e per tonne of LNG, well below the BC regulatory benchmark of 0.16, and well comparable to the WLNG carbon intensity calculation, with WLNG underestimating by approximately 0.7%.

The difference is primarily attributed to the methodology differences between Brightspot's and WLNG's calculations, particularly for fugitive calculations. Brightspot utilized current industry methodology within the BC MOE emission reporting regulations, which is the expected methodology that WLNG will utilize to quantify emissions, once operational. Additionally, Brightspot utilized the GWPs from the IPCC's Fifth Assessment Report, which are the GWPs adopted by the BC Government as of March 2023.





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## APPENDIX 2: FUTURE EMISSIONS REDUCTION PATHWAYS





In addition to the emission reduction measures currently incorporated in the facility design underlying this roadmap, Woodfibre LNG is committed to exploring further reduction options. This section identifies impactful opportunities that have been analyzed and quantified in terms of their contributions to emissions reductions.

While Woodfibre LNG is committed to scope 1 and scope 2 net zero, the Project is exploring opportunities to reduce Project-related scope 3 emissions, such as those from transportation. One example is replacing the existing proposed rail system for condensate handling with a permanent storage tank and large-off loading system, which would significantly minimize construction work on the site and reduce fugitive emissions from the rail system. **This would result in 1,764 tCO2e per year of scope 3 (transportation) emissions.**

Woodfibre LNG has done initial research and analysis of technologies for post-commissioning that are not currently available for commercial use by LNG facilities but could be piloted at the Woodfibre LNG facility to test the use of hydrogen and significantly reduce stationary combustion and flaring emissions.

Near-term opportunities

TECHNOLOGY	DESCRIPTION	tCO2e REDUCED PER YEAR
Additional compressor improvements	Woodfibre LNG could route an LNG off-spec line from flare to the boil-off gas compressor, which will reduce start-up gas flaring.	2,386 (stationary combustion and flaring)
	Woodfibre LNG could design the mixed refrigerant and propane (MR/PR) compressor to start with settle-out pressure and avoid flaring after each shutdown event. This requires two design compressor motors with high voltage for start-up.	754 (stationary combustion and flaring)
Electric vessels, vehicles and construction equipment	Woodfibre LNG could electrify worker transport and supply chain transport, including crewboats, tugboats, construction equipment and vehicles, by establishing electric charging infrastructure required at site and at worker transportation docks.	2,919 (mobile combustion during operations)

Medium-term opportunities

TECHNOLOGY	DESCRIPTION	tCO2e REDUCED PER YEAR
Direct air capture and/or carbon capture, utilization and storage	Woodfibre LNG is monitoring the regulatory landscape for carbon capture solutions in Canada, but given the remote limitations of the site, any storage or underground sequestration of carbon would need to occur off-site. Woodfibre LNG will continue exploratory analysis and feasibility work in 2023, alongside government and others, before selecting practical and cost-effective options, related to storage or value-added purposes, for operations.	Up to 13,023 (venting)

Longer-term opportunities

TECHNOLOGY	DESCRIPTION	tCO2e REDUCED PER YEAR
Thermal oxidizer by hydrogen	Woodfibre LNG could design and install a hydrogen fuel generation, storage and distribution system and retrofit the thermal oxidizer to allow power by green hydrogen with hydropower produced at the site (current power infrastructure is limited) or procured from BC Hydro.	6,798 (stationary combustion and flaring)
Heating medium furnace by hydrogen	Woodfibre LNG could design and install a hydrogen fuel generation, storage and distribution system and retrofit the heating medium furnace to allow power by green hydrogen with hydropower procured from BC Hydro. The provided estimate is to debottleneck BC Hydro infrastructure for an additional 50 MW of power and a hydrogen generation unit to produce combustion fluid.	35,883 (stationary combustion and flaring)





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## APPENDIX 3: SUMMARY OF EMISSIONS REDUCTIONS





Summary of Woodfibre LNG’s Emissions  
Reduced Through Emission Reduction Plan and Future Potential Opportunities

	Independently validated tCO2e per year	Residual tCO2e with implementation of EMISSION REDUCTION PLAN opportunities	Residual tCO2e with implementation of NEAR-TERM opportunities by 2027	Residual tCO2e with implementation of MEDIUM-TERM opportunities by ~2030	Residual tCO2e with implementation of LONGER-TERM opportunities by ~2040
1. Stationary combustion & flaring	45,821	45,821	42,681	42,681	0
2. Mobile combustion	2,919	2,919	0	0	0
3. Venting	13,023	13,023	13,023	0	0
4. Fugitive losses	9,014	1,172	1,172	1,172	1,172
5. Emissions due to imported energy	12,597	12,597	12,597	12,597	0
TOTAL	83,374	75,532	69,473	56,450	1,172





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# END NOTES





The Squamish Nation is the first non-treaty First Nation in Canada to develop, conduct and implement their own rigorous review and subsequent legally binding conditions that Woodfibre LNG must adhere to throughout the construction and operations phases of the Project.

<https://talkingenergy.ca/project/eagle-mountain-woodfibre-gas-pipeline-project>

<https://iea.blob.core.windows.net/assets/4ed140c1-c3f3-4fd9-acae-789a4e14a23c/WorldEnergyOutlook2021.pdf>

[https://www.pacific-canbriam.ca/wp-content/uploads/PCE\\_SustainabilityReport-2021.pdf](https://www.pacific-canbriam.ca/wp-content/uploads/PCE_SustainabilityReport-2021.pdf)

<https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/climate-plan-overview/emissions-reduction-2030.html>

<https://publications.gc.ca/site/eng/9.915545/publication.html>

<https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/oil-gas-emissions-cap/best-class-draft-guidance.html#toc4>

[https://www2.gov.bc.ca/assets/gov/environment/climate-change/action/cleanbc/cleanbc\\_roadmap\\_2030.pdf](https://www2.gov.bc.ca/assets/gov/environment/climate-change/action/cleanbc/cleanbc_roadmap_2030.pdf)

<https://woodfibrelng.ca/about-woodfibre/regulatory/environmental-assessment/> (Woodfibre LNG BC Environmental Assessment Certificate [October 2015])

<https://giignl.org/wp-content/uploads/2021/11/MRV-and-GHG-Neutral-Framework.pdf>

<https://giignl.org/framework/>

<https://brightspot.co/>

<https://www.canada.ca/en/services/environment/weather/climatechange/climate-plan/net-zero-emissions-2050/challenge.html>

<https://www2.gov.bc.ca/gov/content/environment/climate-change/industry/reporting/quantify>

As of November 2022, the EPFC model is currently estimated at 30% completed.

[https://www2.gov.bc.ca/assets/gov/environment/climate-change/action/cleanbc/cleanbc\\_roadmap\\_2030.pdf](https://www2.gov.bc.ca/assets/gov/environment/climate-change/action/cleanbc/cleanbc_roadmap_2030.pdf)

<https://press.siemens-energy.com/global/en/pressrelease/siemens-energy-power-worlds-lowest-emission-lng-facility>

<https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2020>

It is assumed that upset will be on average twice a year with each event lasting 12 hours.

[https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/146\\_2014](https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/146_2014)

Vintage 2014-2018, which is the most currently available from Cheakamus Community Forest.

<https://www.cheakamuscommunityforest.com/>

Estimated within +/- 5% variance.

Vintage 2021, which is the most currently available from BigCoast Forest Climate Initiative

<https://www.bigcoastforest.com/>

[https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/03053\\_00](https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/03053_00)

<https://projects.eao.gov.bc.ca/api/document/58869182e036fb0105768fa0/fetch/Appendix%205.3-1%20Greenhouse%20Gas%20Methodology.pdf>

[https://www.eia.gov/environment/emissions/co2\\_vol\\_mass.php](https://www.eia.gov/environment/emissions/co2_vol_mass.php)

<https://www2.gov.bc.ca/gov/content/environment/climate-change/industry/reporting/quantify>

[https://www.eia.gov/environment/emissions/co2\\_vol\\_mass.php](https://www.eia.gov/environment/emissions/co2_vol_mass.php)

<https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator#results>

<https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references>

<https://www3.epa.gov/ttnchie1/efdocs/equiplks.pdf>

: <https://projects.eao.gov.bc.ca/api/document/58bf02ee7b72fa001cf1f270/fetch>

<https://unfccc.int/documents/461919>

