5.3 Greenhouse Gas Management

5.3.1 Introduction

Greenhouse gas management is included in the EAC Application because construction, operation, and decommissioning of the Project will produce and release GHGs to the atmosphere. This assessment follows the guidelines of the CEA Agency method for incorporating GHG considerations in environmental assessments (CEA Agency 2003) and global best practices for estimating the quantities of GHGs that may be released. The releases of Project GHG emissions are quantified in the context of an industry profile and existing provincial, national and global GHG emission levels.

LNG Canada recognizes the world continues to face the critical challenge of how to meet increasing global energy demands while reducing the quantities of GHGs being released to the atmosphere. The world must develop a range of energy sources—from fossil fuels to renewable resources—with a substantial increase in energy efficiency. Natural gas, the cleanest burning fossil fuel, could play an important role in meeting this demand. LNG Canada is supportive of measures, to be implemented by governments, that drive responsible investment into more efficient and lower carbon technologies, while maintaining industry competitiveness. LNG Canada will strive to integrate social, economic and environmental performance, and will aspire to be one of the most energy efficient LNG producers in the world.

The potential effects of other Project emissions of atmospheric contaminants (e.g., criteria air contaminants) are addressed in Section 5.2, Air Quality. Effects of climate change on the Project (e.g., change in sea level, increased frequency of storms) are addressed in Section 11, Effects of the Environment on the Project.

5.3.2 Scope of Assessment

This assessment is guided by recommended procedures of the CEA Agency (2003) for incorporating GHG considerations in environmental assessments (see Table 5.3-1).

Table 5.3-1: Method for Incorporating GHG Considerations in Environmental Assessments

Procedures	Objective
Preliminary scoping for GHG considerations	Use of readily accessible information to scope out general GHG considerations and the level of detail required
Identify GHG considerations	Identify jurisdictional considerations (GHG-related policies, plans, or programs), project specifics, and industry profile (if available); as well, assess provincial, federal, and global GHG inventories
Assess project GHG emissions	Quantify Project GHG emissions (construction and operation of the liquefied natural gas (LNG) facility and shipping activities)
GHG management and mitigation	Describe jurisdictional requirements, corporate GHG emissions policy, and project mitigation measures
Follow-up and monitoring	List jurisdictional requirements following commissioning and management of reduction measures

Based on the CEA Agency method for incorporating GHG considerations in environmental assessments, “the environmental assessment process cannot consider the bulk of GHG emitted from already existing developments. Furthermore, unlike most project-related environmental effects, the contribution of an individual project to climate change cannot be measured” (CEA Agency 2003). A measurement of significance of a project potential effect on climate change cannot be assessed quantitatively. Concurrent with CEA Agency guidance, this GHG assessment provides a review of the current and anticipated policy and regulatory environments, applicable baseline conditions, industry profile, and a summary of the proposed direct (scope 1) emissions of the Project during construction and normal operation (at full build out the Project is expected to produce approximately 26 mtpa of LNG). The assessment also includes an estimate of GHG emissions resulting from land clearing activities as well as indirect (scope 2) emissions from purchased electricity. The Project’s estimated annual GHG emissions are compared against the established industry profile, as well as provincial, national and global GHG emission inventories.

LNG Canada recognizes that changes to GHG management could be required if new GHG legislation or policy is developed in the future.

5.3.2.1 Regulatory and Policy Setting

The federal and provincial governments have indicated a desire to address increases in GHG emissions and have created strategic-level plans for some sectors. While some legislative action has been taken in the area of reporting and taxation, policies, legislation and initiatives regarding emissions levels from specific industry sectors are still being developed. However, binding policies, targets or caps in the oil and gas sector have not yet been implemented and as a result, there is considerable regulatory uncertainty on how proposed GHG legislation and policy will apply during Project operation.

5.3.2.1.1 Climate Change and Policy Development

Climate change is a global issue involving complex environmental, energy, economic and political challenges. The science of climate change has continued to evolve to better understand cause and effect but has not advanced to the point where a clear cause and effect relationship can be established between project-specific releases and measurable changes to global climate. However, the increases in global emissions of GHGs from anthropogenic sources over the past 100+ years have very likely contributed to global climate change (IPCC 2013).

GHGs are released to the atmosphere from a number of natural and anthropogenic sources. Anthropogenic GHG emissions are reported annually by different levels of government (e.g., annual national emissions are reported to the United Nations Framework Convention on Climate Change (UNFCCC)) and emission trends are actively discussed at the provincial, national and global levels.

Climate change can be attributed to various causes; the primary factors are:

- variations in the earth's orbital characteristics (elliptical orbit, tilt of axis and wobble). Computer models and historical evidence suggest that changes in the Earth's orbital characteristics and cycles produce climate changes over long cycles (tens of thousands of years).
- volcanic eruptions. Climatologists have established a link between large volcanic eruptions and short-term, but likely reversible, climate changes.
- variations in solar output. Changes in the solar energy output can lead to climate changes because the sun is the fundamental source of energy that drives the Earth's climate system. Many of the solar energy output changes are cyclic and poorly understood.
- increase in GHG concentrations. Climate models that include the above drivers of climate change cannot fully reproduce the observed temperature trend on Earth (over the past century or more) without including the effects of the increased concentrations of GHGs at the lower levels of the Earth's atmosphere, generally attributed to anthropogenic sources, such as land clearing, and the burning of fossil fuels.

Because climate change is a complex global phenomenon, quantifying potential effects of discrete GHG emissions from individual projects to climate change cannot be measured (CEA Agency 2003); this is unlike other VCs in this Application. Instead, environmental importance of a specific project should be assessed in the context of applicable policies and regulations. This approach provides the decision makers with the ability to place the estimated increases in GHG emissions within a regional context. Existing GHG policies and applicable regulatory drivers are discussed below.

5.3.2.1.2 International Regulation and Policy

The UNFCCC was established in 1992 as an outcome of the Earth Summit in Rio de Janeiro. The Kyoto Protocol was the first international agreement linked to the UNFCCC that implemented a regulated cap-and-trade scheme for GHG emission allowances. Under the Protocol, which was adopted in 1997 and implemented in 2005, developed (Annex I) countries committed to reducing their collective GHG emissions by 5.2% from 1990 levels. Notably, the United States did not ratify the Protocol due to issues with disparity between countries (e.g., China and India being considered developing).

The first commitment period ended in 2012. Canada exercised its legal right to formally withdraw from the Kyoto Protocol in December 2011. Although Canada withdrew from Kyoto, it remains a part of the UNFCCC process for negotiating the next implementation period (post-2020). The Kyoto Protocol has been extended until 2020, with a more stringent reduction target of 18% below the 1990 levels. The composition of parties in the second commitment period; however, is different from the first. At present, UNFCCC members (now including the United States, China and India) are negotiating the Durban Platform for Enhanced Action towards a new climate agreement, which is planned to be ratified by 2015 and implemented by 2020.

5.3.2.1.3 National Regulation and Policy

Since Canada withdrew from the Kyoto Protocol, the federal government has set a voluntary target under the Copenhagen Accord (in line with the United States) to reduce, by 2020, Canada's total GHG emissions by 17% from 2005 levels (EC 2013). Canada reports its national GHG emissions annually to the UNFCCC according to the reporting guidelines for Annex 1 countries. The most recently reported data, for the year 2012, showed that Canada emitted 699 million tonnes carbon dioxide equivalents (CO_2e) (EC 2014).

To meet its national GHG reduction target, Canada is implementing a sector-by-sector approach to GHG regulation and has already announced regulations in two sectors: transportation (light- and heavy-duty vehicles) and electricity (coal-fired electricity generation). Specific GHG regulations for the oil and gas sector have yet to be defined by the government. At present, GHGs are regulated by Environment Canada (EC) under Schedule 1 of the *Canadian Environmental Protection Act* (EC 1999). As part of the GHG emissions reporting program, EC requires facilities of all industries emitting more than 50,000 tonnes of CO_2e to report their annual GHG emissions.

5.3.2.1.4 British Columbia Provincial Regulation and Policy

In 2007, the Government of BC passed the *Greenhouse Gas Reduction Targets Act*, which sets legislated targets for reducing GHG emissions. Under the Act, provincial GHG emissions are to be reduced by at least 33% below 2007 emission levels by 2020, and 80% below 2007 emission levels by

2050 (Government of BC 2007). However, as of yet, the BC government has not established industry specific regulations for GHG emission management.

Besides the *Greenhouse Gas Reduction Targets Act*, the Government of BC has designed and, in some cases, implemented a suite of policy measures to reduce emissions across the province. Applicable to the Project are the following measures:

- *GHG Reduction (Cap and Trade) Act* (GGRCTA) (Government of BC 2008a) provides a legislative basis for a market-based cap-and-trade framework. It provides the authority for a mandatory GHG reporting program (*Reporting Regulation*), which requires facilities emitting more than 10,000 tonnes CO_2e per year to report their emissions. Facilities emitting more than 25,000 tonnes of CO_2e per year are also required to have their emissions verified by a third party (Government of BC 2009a).
- A price on carbon in the form of a provincial revenue-neutral carbon tax was introduced in 2008 through the *Carbon Tax Act.* This provides an economy-wide incentive to use less fossil fuel and reduce emissions. It is a broad-based tax that applies to the purchase and subsequent combustion of fuels such as gasoline, diesel, natural gas, heating fuel, propane, and coal (Government of BC 2008b). As of 2012, the tax rate was $30 per tonne of CO_2e.
- *Venting and Flaring Reduction Guideline,* released by the BC Oil and Gas Commission (BC OGC 2013) under the *Oil and Gas Activities Act* (Government of BC 2008c), provides requirements and guidance for reducing, measuring, and reporting vented, incinerated, and flared gas. The guideline applies to well sites, facilities and pipelines regulated under the *Oil and Gas Activities Act*.
- *BC Energy Plan* has set a goal to "eliminate all routine flaring at oil and gas producing wells and production facilities by 2016, with an interim goal to reduce routine flaring by 50% by 2011" (Government of BC 2009b).
- *Clean Energy Act* (Government of BC 2010a), which came into force in 2010, encourages the development of BC's clean and renewable resources and promotes energy self-sufficiency, independent power production, and reductions in GHG emissions.
- *Zero Net Deforestation Act* (Government of BC 2010b) sets reporting on net deforestation to start in 2012 and achieve net zero deforestation by 2015. The Government is currently working on developing and implementing a plan to achieve the goal of zero net deforestation.
- *BC Natural Gas Strategy,* and its complimentary strategy focussing specifically on the development of the LNG sector (*LNG Strategy*), was released in 2012 (BC Ministry of Energy and Mines 2012). The LNG Strategy identifies specific actions, such as coordinating and permitting approval processes among agencies and investing in critical infrastructure to power future LNG facilities and pipelines, thus supporting development of the LNG sector. The LNG Strategy also describes actions to reduce GHG emissions from LNG facilities, including reducing natural gas flaring using innovative solutions, implementing practices and emission reduction technologies, and promoting the use of carbon capture and storage in BC.

As outlined in the Climate Action Plan (BC MOE 2008), the province's climate action initiatives were originally estimated to meet 73% of its 33% 2020-reduction target. When setting this target, the province did not account for the potential scale and pace of shale gas development in northeast BC, including the large numbers of LNG export facilities, which was in its infancy stage at the time of policy development. With the increase in emissions that will occur from natural gas development and, in the absence of new applicable provincial measures to address emissions from this and other sectors, it will likely be challenging to achieve the original 2020 reduction targets (Lee 2012; Bryant 2013).

5.3.2.2 Consultations' Influence on the Identification of Issues and the Assessment Process

Concerns regarding the Project's potential contribution to current GHG emissions were identified by Aboriginal Groups, government departments (i.e., BC Climate Action Secretariat), and the public. GHG management is included in the Application as a result of these concerns. An assessment of the potential effect of the Project GHG emissions on the overall BC, national and global GHG emission inventories was requested during consultation. Land-clearing related emissions are assessed, as requested by the BC Climate Action Secretariat.

In addition, through LNG Canada's consultation program, potentially affected Aboriginal Groups have identified issues and concerns with respect to GHG emissions, which are considered, as appropriate, in this assessment as well as in Part C where they relate to potential adverse effects on Aboriginal Interests (Section 14) or Other Matters of Concern to Aboriginal Groups (Section 16).

5.3.2.3 Traditional Knowledge and Traditional Use Incorporation

At the time of Application submission, there was no specific TK or TU information available relevant to the assessment of GHGs.

5.3.2.4 Selection of Effects

As stipulated in the AIR (BC EAO 2014), this assessment quantifies GHG emissions associated with the LNG facility and emissions related to shipping activities, while in port and along the marine access route for the Project. GHG emissions readily disperse from the source and mix well within the atmosphere. The Project's effect associated with the release of GHGs is, therefore, assessed in the context of the global atmosphere.

In a typical assessment of Project effects on the environment, potential effects are assessed by defining discrete criteria for the characterization of residual effects and determination of significance. As per the CEA Agency Guidance (2003), potential effects of GHG emissions on the environment cannot be assessed meaningfully for a single project such as this Project. The GHG management assessment focusses on quantifying Project emissions and introducing engineering solutions that aim to reduce emissions and make this Project best-in-class.

In addition, this assessment compares estimated annual Project GHG emissions with provincial, federal and global emission inventories.

5.3.2.5 Selection of Measurable Parameters

Based on previous project assessments, published literature, and guidance from regulators, as well as the AIR (BC EAO 2014), the following GHGs are considered as potential measurable parameters for this assessment:

- Carbon dioxide (CO_2) is released through natural processes such as volcanic eruptions, and through human activities such as burning of fossil fuels, land use changes, and oil and gas processing.
- Methane (CH_4) is a hydrocarbon gas produced through natural sources and is the main component of natural gas. It is also produced by human activities, including the burning of fossil fuels, fugitive sources, and venting activities. Methane has a higher global warming potential (GWP) than CO_2 but is much less abundant in the atmosphere.
- Nitrous oxide (N_2O) is a powerful GHG that is produced as a by-product of the combustion of fossil fuel and biomass burning.
- Sulphur hexafluoride (SF_6) is a human-made, synthetic gas, which is heavier than air and, therefore, remains close to the earth's surface. Sulphur hexafluoride is very stable and has a particularly high GWP. In Canada, the most substantial use of SF_6 is in industrial processes that use it as a cover gas or insulating gas.
- Hydrofluorocarbons (HFCs) are synthetic gases that have a high GWP because of their long atmospheric lifetimes. The main source of HFCs is refrigerant fluids in industrial processes, where they are used as an alternative to ozone-depleting substances.
- Perfluorocarbons (PFCs) are human-made gases, which were introduced as an alternative to ozone-depleting substances. PFCs have a high GWP and are primarily used in the manufacturing industry.

In general, CO_2 and CH_4 are the main GHGs that accompany LNG production. Carbon dioxide constitutes the majority of GHG emissions for a typical LNG project because combustion processes predominate.

Methane releases originate mainly from fugitive emissions. Advanced technology (i.e., detection and monitoring as well as newer designs for valves) removes or reduces the likelihood of leaks. Methane emissions will also arise as a result of unburnt hydrocarbons due to incomplete combustion. Flaring usually occurs to control pressure, maintain a pilot light and during testing and or completion. Flaring and incineration of acid gas as well as inherent CO_2 emissions from the natural gas will hence contribute to overall CO_2 and CH_4 emissions.

Releases of N_2O are a by-product of combustion (i.e., originating from internal combustion engines) but engine design and maintenance techniques have been improved to reduce these emissions to typically very low levels. Even when considering the higher GWP of N_2O, these emissions are typically insubstantial as a fraction of total GHG emissions for an LNG facility (e.g., in this assessment N_2O emissions are below 1% of total operational GHG emissions).

Project activities will not release SF_6, HFCs, and PFCs and, therefore, these GHGs are not considered further in this assessment. Although insulating gas used in the electric breakers may contain SF_6, the SF_6 will be contained in sealed systems designed not to leak and, therefore, will have negligible fugitive emissions.

Therefore, the measurable parameters selected for detailed GHG assessment are CO_2, CH_4 and N_2O, reported as CO_2e (see Table 5.3-2). Individual GHG are usually aggregated into CO_2e, which represents an equivalent amount of CO_2 that would cause the same amount of global warming as the aggregated gases over a certain time period (usually one hundred years). CO_2e estimates are calculated by multiplying the Project emission rate of each GHG by its GWP relative to CO_2. The GWP of a gas depends on the gas' ability to absorb infrared radiation, its spectral location, and atmospheric lifetime. The GWP of the measurable parameter GHGs are CO_2 = 1; CH_4 = 25; and N_2O = 298 (IPCC 2007). The CO_2e is equal to:

$$(CO_2 \text{ mass emissions x } 1.0) + (CH_4 \text{ mass emissions x } 25) + (N_2O \text{ mass emissions x } 298).$$

Table 5.3-2: Potential Project Effects on GHG Management and Measurable Parameters

Potential Adverse Effects	Measurable Parameters
Emission of GHG from the LNG facility and shipping	▪ GHG emissions (CO_2,CH_4,N_2O, expressed as CO_2e) from Project activities

5.3.2.6 Boundaries

5.3.2.6.1 Spatial Boundaries

In recognition of the characteristic of GHGs to mix well within the atmosphere and to readily disperse from the source, Project GHG emissions are compared with provincial, federal and global GHG emissions totals.

5.3.2.6.2 Temporal Boundaries

Based on the current Project schedule, the temporal boundaries are:

- construction, Phase 1 (trains 1 and 2) to be completed approximately five to six years following issuance of permits, the subsequent phase(s) (trains 3, 4) to be determined based on market demand
- operation, minimum of 25 years after commissioning, and
- decommissioning, approximately two years at the end of the Project life.

All Project phases, from construction to decommissioning, are addressed in this GHG management assessment. However, GHG emissions from decommissioning are not quantified because no reasonable estimate of emissions can be determined at this time.

5.3.2.6.3 Administrative and Technical Boundaries

Administrative boundaries for GHG management are those defined by government jurisdictional policies. GHG emissions from the LNG facility and Project marine shipping are compared to provincial, federal and global GHG jurisdictional inventories and, where possible, reduction targets.

The technical boundaries for the assessment include the inherent uncertainty in estimating emission rates from the Project at an early stage of engineering design. This inherent uncertainty, however, does not impede the effects assessment. The emissions estimates used in the assessment are conservatively high to capture worst-case conditions.

5.3.2.7 Residual Effects Description Criteria

The description of residual effects of GHG uses the criteria defined in Table 5.3-3.

Table 5.3-3: Characterization of Residual Effects for GHG Management

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Characterization of Residual Effects		
Magnitude	The expected size or severity of the effect. Low magnitude effects may have negligible to little effect, whereas high magnitude effects may have a substantial effect.	**Low**—Negligible change in provincial, national, and global GHG emissions. **Medium**—Although measurable, based on CEA Agency guidance (2003), professional judgment and the industry profile, relatively small changes are expected in provincial, national, and global GHG emissions. **High**—Based on CEA Agency guidance (2003), professional judgment, and the industry profile, a notable change in provincial and national emissions, while change to global emissions will still be small.

Characterization	Description	Quantitative Measure or Definition of Qualitative Categories
Geographic Extent	The spatial scale over which the residual effects of the Project are expected to occur. The geographic extent of effects can be local or regional. Local effects may have a lower effect than regional effects.	**Provincial**—residual effect is within the provincial extent **National**—residual effect is within the national extent **Global**—residual effect is within the global extent
Duration	The length of time the residual effect persists. The duration of an effect can be short term or longer term.	**Short-term**—residual effect restricted to construction phase only **Medium-term**—residual effect extends through lifetime of the Project **Long-term**—residual effect extends through the lifetime of the Project and beyond decommissioning
Frequency	How often the effect occurs. The frequency of an effect can be frequent or infrequent. Short-term or infrequent effects may have a lower effect than long-term or frequent effects.	**Single event**—residual effect occurs only once **Multiple irregular event**—residual effect occurs sporadically at irregular intervals throughout construction, operation or decommissioning phases **Multiple regular event**—occurs on a regular basis and at regular intervals throughout construction, operation, or decommissioning phases **Continuous**—residual effect occurs continuously throughout the life of the Project
Reversibility	Whether the residual effect can be reversed once the physical work or activity causing the disturbance ceases. Effects can be reversible or permanent. Reversible effects may have lower effect than irreversible or permanent effects.	**Reversible**—Will recover after Project closure and reclamation. **Irreversible**—Permanent.
Context	Refers primarily to the sensitivity and resilience of the VC. Consideration of context draws heavily on the description of existing conditions of the VC, which reflect cumulative effects of other projects and activities that have been carried out, and information about the effect of natural and human-caused trends on the condition of the VC. Project effects may have a greater effect if they occur in areas or regions that have already been adversely affected by human activities (i.e., disturbed or undisturbed), or are ecologically fragile and have little resilience to imposed stresses (i.e., fragile)	**Undisturbed—**atmosphere relatively or not affected by human activity (anthropogenic sources). **Disturbed—**atmosphere has been previously disturbed by human activity (anthropogenic sources).
Likelihood of Residual Effects		
Likelihood	Whether a residual effect is likely to occur	**Low—**Low likelihood that there will be a residual effect. **Medium**—Moderate likelihood that there will be a residual effect. **High—**High likelihood that there will be a residual effect.

5.3.2.8 Significance Thresholds for Residual Effects

Provincial and federal policies and regulations do not identify specific thresholds or standards that could be used to determine significance when assessing residual effects from Project GHG emissions. For context, the contribution of Project emissions is compared with emissions from other facilities in the same sector and with provincial, national and global GHG emission totals. However, the residual effect is only assessed at the global level.

The CEA Agency guidance (2003) recommends ranking Project emissions contribution into low, medium or high categories; however, low, medium and high thresholds are not clearly defined quantitatively. Based on this guidance, if the emissions magnitude is predicted to be medium or high, then a GHG management plan is required.

5.3.3 Baseline Conditions

5.3.3.1 Baseline Data Sources

Reported provincial and federal totals of GHG emissions were obtained from the BC GHG Inventory and EC National Inventory, respectively. These inventories are used as baseline data for this assessment and are limited by their specific scope and assessment methods. The more complete BC inventory report is published every other year (BC MOE 2014), but a GHG summary table is published each year. The EC National Inventory Report (NIR) is part of the UNFCCC reporting requirement and is published every year; the most recent report summarizes data from 2012 (EC 2014).

Estimated global emissions were obtained from the World Resource Institute (WRI). The WRI combines different non-governmental data sources from the Carbon Dioxide Information Analysis Centre, the International Energy Agency, and the US EPA, among others, to present a summary of global GHG emissions. WRI combines data of the six major GHGs (see Section 5.3.2.4) for 186 countries for the period from 1990 to 2010 (WRI 2013).

The industry profile provided below draws information from the existing global LNG industry and profiles from newly approved and proposed global LNG facilitie., As well; a well-to-wire study conducted by Shell Global Solutions Inc. (2014) is incorporated. The information is limited by the scope and assessment methods for each of the sources used.

5.3.3.2 International, National, and Provincial Greenhouse Gas Emissions Inventory

Total reported GHG emissions from BC and Canada for selected years are listed in Table 5.3-4. The table also includes estimated provincial and national targets for 2020.

Table 5.3-4: GHG Emissions Released in BC and Canada

Year	BC GHG Inventory Report[1]	National GHG Inventory Report[2]	
	BC Total Reported[a] (tonnes CO_2e/year)	BC Total Reported[a] (tonnes CO_2e/year)	Canada Total Reported (tonnes CO_2e/year)
Applicable Future Reduction Targets			
2020	43,093,060[b]	NA	610,880,000[c]
Past GHG Emissions (1990–2012)			
2012	61,500,000	60,100,000	699,000,000
2011	61,618,000	60,100,000	701,000,000
2010	61,216,000	59,700,000	699,000,000
2007	64,318,000	NA	749,000,000
2005	65,353,000	62,300,000	736,000,000
2000	66,113,000	62,100,000	721,000,000
1990	55,569,000	49,400,000	591,000,000

NOTE:

[a] The Provincial Inventory Report includes BC-specific emissions currently not reported at the provincial level in the NIR. These emission sources and sinks are reported under the “land use, land-use change and forestry” sector. Net deforestation and other land conversions from this category are included in B.C.’s emissions total, while forest, crop, wetland and grassland management are not but are re-ported separately for transparency. The provincial inventory also includes a recalculation of: (i) oil and gas fugitives; and (ii) solid waste disposal on land – line items presented in the NIR. As a result, reported emissions are 1.4 million tonnes (2.3%) higher than the emissions of 60.1 million tonnes reported for B.C. in the NIR.

[b] The *Greenhouse Gas Reduction Targets Act* of BC has set the provincial target to be 33% below 2007 levels by 2020. The 2020 emission levels presented above are calculated based on this target.

[c] The Copenhagen Target is to be 17% below the 2005 emission level by 2020. The 2020 emission levels presented above are calculated based on this target

Sources:

1. *BC Greenhouse Gas Emissions by Sector 1990 to 2012 (*BC MOE 2014)
2. *National Inventory Report 1990 to 2012: Greenhouse Gas Sources and Sinks in Canada* (EC 2014)

The most recent NIR indicates that Canada emitted about 699 million tonnes CO_2e in 2012, excluding land use, land-use change and forestry (LULUCF) estimates. The LULUCF sector was a net source of 41 million tonnes CO_2e in 2012.

The numbers reported for BC differ slightly from the NIR due to different reporting methods. To be conservative and to rather over- than underestimate the percentage increase of the Project on the provincial emission totals, the numbers from the NIR are used for this assessment. Based on the latest numbers for BC from the NIR (EC 2014), the province generated 60.1 million tonnes CO_2e in 2012, which is 8.6% of the Canadian total.

Canada's Emission Trends report (EC 2013) estimates that national CO_2 emissions from fuel combustion will decrease to 1.6% of global emissions in 2020, down from 2.1% in 2005. This report further estimates that, with current measures (which includes action taken since 2005), GHG emissions will reach 734 million tonnes CO_2e by 2020. BC's emission rate is estimated to be 64 million tonnes CO_2e by 2020.

Table 5.3-4 includes provincial and national targets for 2020. To meet the BC provincial reduction target of 33% (Government of BC 2008b) in 2020, the provincial GHG inventory will need to be approximately 43 million tonnes CO_2e by 2020. Similarly, if Canada's voluntary Copenhagen reduction target of 17% from 2005 levels is to be met, the total GHG inventory will need to be approximately 612 million tonnes CO_2e nationally by 2020.

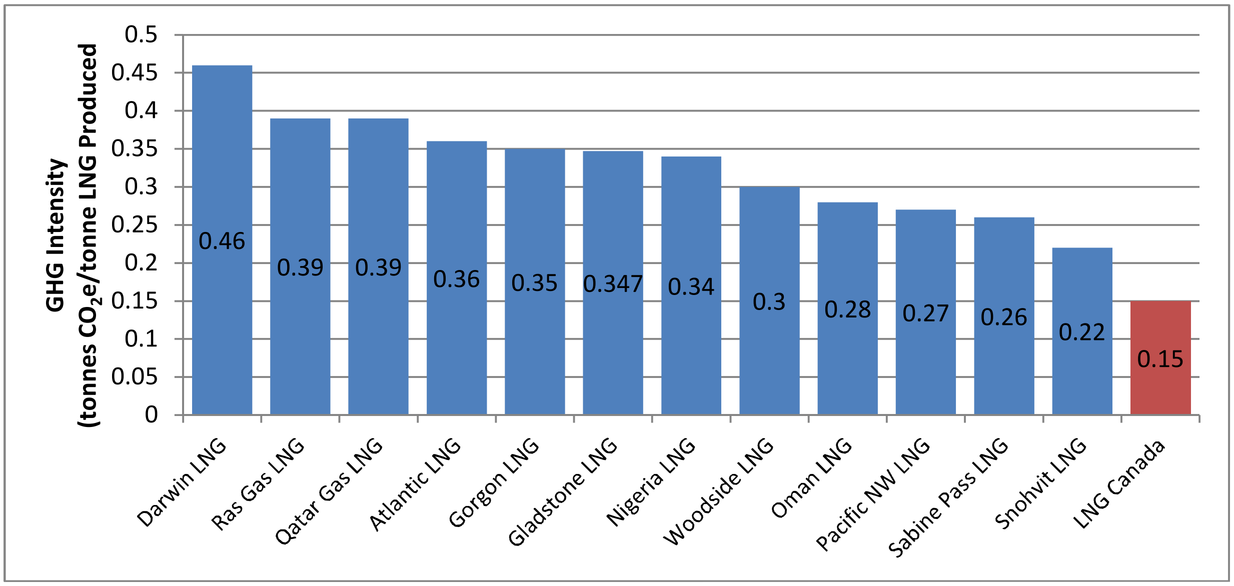
Global GHG emissions are based on an analysis completed by WRI. For CO_2 emissions only, the global total for 2010 was estimated at 32,899 million tonnes CO_2 (WRI 2013), which corresponds with the 33,000 million tonnes CO_2 reported by the PBL Netherlands Environmental Assessment Agency in their report on trends of global CO_2 emissions (PBL NEAA 2013). Including non-CO_2 emissions, the WRI analysis estimated that total global emissions were 43,967 million tonnes CO_2e in 2010 (WRI 2013). This total excludes LULUCF emissions. Canadian emissions were less than 2% of total global emissions in 2010 (EC 2014).

5.3.3.3 Industry Profile

The CEA Agency (2003) recommends comparing project GHG emissions with representative industry sector information as a means of assessing a project relative to current industry standards and industry peers. In this way, a proponent can assess the effectiveness of its engineering design measures to achieve and exceed the latest industry and jurisdictional standards. In Canada, the LNG industry is in its infancy, with both provincial and federal jurisdictions working proactively to establish guidelines and policies that encourage lower GHG intensity for newly proposed projects. There are no existing LNG export facilities in Canada from which to establish a meaningful industry profile. In order to provide a basis for comparison, emission intensities of existing international LNG facilities are also included. Emission intensities are based on how much CO_2e is emitted per amount of LNG produced and, hence, are a measure of the emission efficiency of a facility. Therefore, this assessment compares the estimated Project GHG emission intensity with the existing global LNG industry profile and the profile of newly approved and proposed international LNG facilities.

These allow for the comparison of the best achievable LNG technologies (approved at the time of each facility construction) currently in operation.

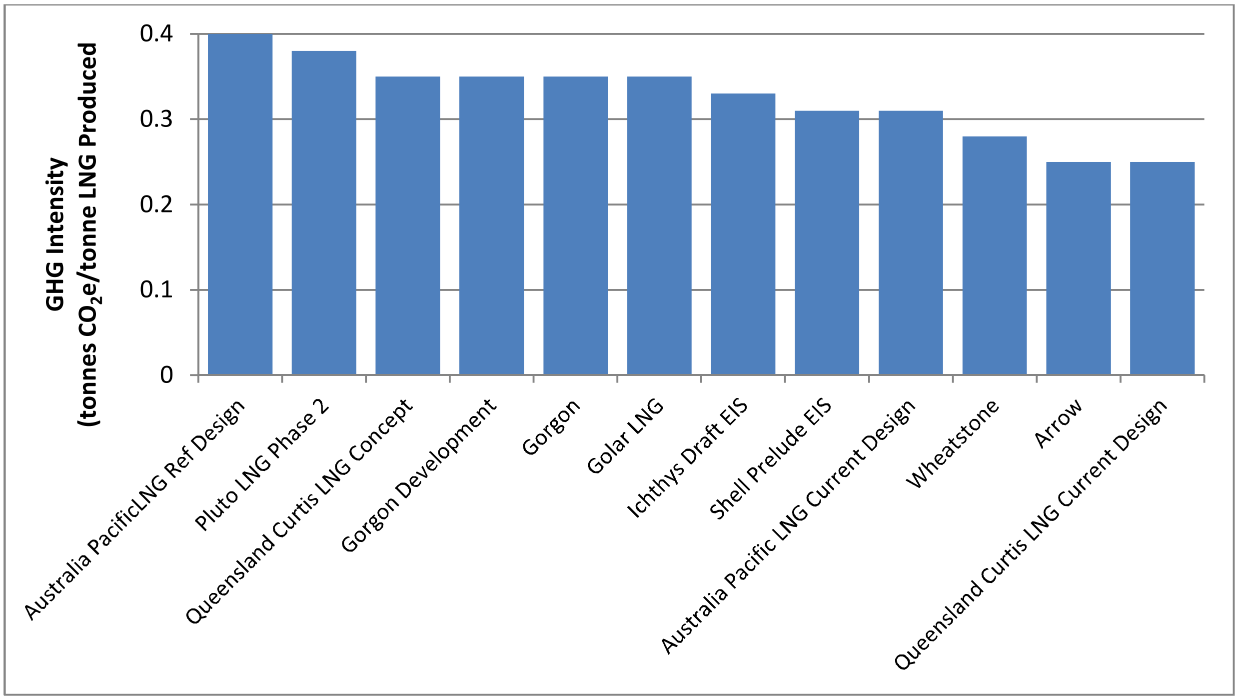
The GHG emission intensities of a number of international LNG facilities, which are either already in operation or currently under construction, are shown in Figure 5.3-1. Comparison of the GHG intensity of one project to another is not straightforward. The data presented in Figure 5.3-1 are from a range of sources (i.e., environmental assessments, regulatory submissions, public announcements). For this reason, it is important to recognize that the methods used to calculate GHG emissions (and the accuracy of the data) for each facility are not standardized, but these are the best publicly disclosed data available to date. In addition, each of these projects relies on engineering designs unique to the project, its location, feed gas composition, processing technology and more. Hence, caution is required when directly comparing the individual emission intensities. With this understanding, the data show that the average GHG intensity of the projects shown in Figure 5.3-1 is approximately 0.35 tonne CO_2e/tonne LNG. The average for the top quartile (lowest three emission intensities) is 0.25 tonne CO_2e/tonne LNG and the best-in-class facility is Snohvit LNG at 0.22 tonne CO_2e/tonne LNG.



Source: LNG Canada

Figure 5.3-1: Comparison of Global LNG Facilities GHG Intensity

Another industry profile analysis (with similar data and methodology limitations to those outlined above) presented similar emission intensities (Stantec Consulting Ltd. 2014b). This analysis compared 12 proposed LNG export facilities worldwide and concluded that the average emission intensity for these proposed projects is 0.33 tonne CO_2e/tonne LNG. It identified the Queensland Curtis LNG Project (current design), with an emission intensity of 0.25 tonne CO_2e/tonne LNG, as currently the lowest emission-intensity project. The comparison presents a coarse understanding of the industry norms.



Source: Stantec Consulting Ltd. (2014b) (reformatted)

Figure 5.3-2: Comparison of GHG Intensity of Newly Approved and Proposed LNG Projects

As mentioned above, the LNG industry in BC is in its infancy. However, Shell Global Solutions Inc. (2014) evaluated the BC LNG industry performance based on publicly available information for the most advanced BC LNG development proposals. Bearing in mind the uncertainty surrounding the level of data availability and the preliminary stage of the project designs, the study concluded that the emission intensity of the different BC LNG facilities may range from 0.09 to 0.28 tonne CO_2e/tonne of LNG. The most representative case is estimated to be at 0.20 tonne CO_2e/tonne LNG, which is lower than the previously mentioned global average of 0.25 tonne CO_2e/tonne LNG (Shell Global Solutions Inc. 2014).

Another approach to providing an industry profile is to assess a well-to-wire perspective as completed by Shell Global Solutions Inc. (2014). This study evaluated how a generic LNG sector in BC compares to other global energy supply pathways to China on a well-to-wire GHG emission intensity basis. Global energy supply pathways include the BC natural gas sector, other LNG sources, as well as coal suppliers. All of these suppliers (US Gulf Coast LNG, Western and Eastern Australia LNG, coal from Australia and coal produced domestically in China) are assumed to be providing power production in China, since China represents the largest and fastest growing Asian natural gas market. The well-to-wire study for the energy pathways included upstream activities (gas production, pipeline transport), the LNG process (LNG liquefaction) and downstream activities (shipping, LNG re-gasification, gas distribution and combustion for electricity generation).

The comparison showed that all LNG pathways, no matter the source, have a lower GHG emission intensity than coal based power generation. Specifically, a BC LNG development would be 51% less than the well-to-wire emission intensity of a coal fired power plant in China using Chinese domestic coal combined with subcritical technology for combustion of the coal (1995 technology). BC LNG well-to-wire emission intensity would also be roughly 43% less than the emission intensity of a new coal fired power plant using Australian coal and supercritical technology for combustion of the coal. Power generation using western Australian LNG showed the lowest well-to-wire GHG intensity, which is mainly related to applied carbon capture and storage as well as substantial formation gas pressure, which drives the gas to the facility without the need of any additional pipeline compression energy to transport the gas (Shell Global Solutions Inc. 2014).

The study also showed that fuel combustion for electricity generation at the end stage amounts for the largest share of the emission intensity across the energy supply pathways. Natural gas supply (upstream) activities (natural gas production and transport to the LNG facility) are usually the second largest contributor towards life cycle assessments, followed by the liquefaction process itself (Shell Global Solutions Inc. 2014). Comparing LNG-based energy to other energy sources that could be displaced by LNG, as done in the well-to-wire study, is helpful when providing an industry background and putting it into a GHG emissions context. The result of the well-to-wire study is that, when compared with coal, LNG as an energy source could lead to a decrease in GHG emissions.

5.3.4 Project Interactions

Table 4.4–1 (Section 4) identifies potential interactions of concern between Project activities and each of the selected VCs that are assessed. The potential effects identified in Section 5.3.2.4 that may result in an adverse effect as a result of interactions with Project activities are ranked in Table 5.3-5.

A conservative approach is taken in assigning a Rank of 1, whereby interactions with a meaningful degree of uncertainty are assigned a Rank 2 so that a detailed effects assessment is conducted.

Table 5.3-5: Potential Project Effects on GHG Management

Project Activities and Physical Works	Potential Effect
	GHG Emissions
Facility Activities and Works	
Construction	
Site preparation (clearing, grubbing, grading, levelling, and set-up of temporary facilities)	2
Onshore construction (installation of LNG facility, utilities, ancillary support facilities, access roads, and includes hydrotesting)	2
Dredging (includes disposal)	2
Marine terminal construction (modifications to existing wharf, installation of sheet piling, material offloading and laydown areas, transfer piping and electrical installations)	2
Vehicle and rail traffic (road use, vehicle traffic)	2
Commissioning and start-up	2
Operation	
LNG production (including natural gas treatment, condensate extraction, storage, and transfer), storage and loading	2
Vehicle and rail traffic (haul road upgrades, road use, vehicle traffic)	2
Decommissioning	
Dismantling of land-based and marine infrastructure	1
Remediation and reclamation of the site	1
Shipping Activities	
Construction	
Shipping equipment and materials	2
Operation	
LNG shipping	2
Decommissioning	
Shipping equipment and materials	1

KEY:

0 = No interaction.

1 = Potential adverse effect requiring mitigation, but further consideration determines that any residual adverse effects will be eliminated or reduced to negligible levels by existing codified practices, proven effective mitigation measures, or BMPs.

2= Interaction may occur and the resulting effect may exceed negligible or acceptable levels without implementation of Project-specific mitigation. Further assessment is warranted.

NOTE: Only activities with an interaction of 1 or 2 for at least one effect are shown.

5.3.4.1 Justification of Interaction Rankings

Some activities will result in such negligible amounts of GHGs that the effect on the overall GHG levels will be undetectable. These include waste management activities and LNG loading operations. Potential LNG loading boil off gas emissions are captured and returned to the LNG facility for reuse.

GHG emissions during decommissioning activities will be generated primarily from combustion of fuels from road traffic, and operation of onsite equipment. Although it is not possible to accurately estimate the volume of GHG emissions that will be generated during the decommissioning phase, emissions are expected to be temporary, intermittent, transient and substantially lower than those associated with construction and operation. LNG Canada will comply with applicable laws and submit a formal Decommissioning Environmental Management Program before decommissioning and reclamation commence. These interactions are ranked as 1 and are not significant. They are not addressed further in the assessment.

Site preparation, onshore construction, vehicle traffic, dredging and marine construction and shipping activities will be the primary sources of GHG emissions during construction. During operation, land-based and marine-based emission sources will include combustion of fuel by the compressor drivers and acid gas incinerators, with lesser amounts from flares and LNG carriers. Operation activities will be the largest contributors of GHG emissions during the Project lifetime. Direct emissions (also known as scope 1) and indirect emissions originating from BC Hydro electricity are included in the assessment.

5.3.5 Assessment of Residual Effects from the LNG Facility and Shipping

5.3.5.1 Analytical Methods

5.3.5.1.1 Analytical Assessment Techniques

The method used to quantify Project GHG emissions is based on accounting and reporting principles of the WRI GHG Protocol (WRI 2004) and adheres to the final AIR (BC EAO 2014). The WRI protocol is an internationally accepted accounting and reporting standard for quantifying and reporting GHG emissions. Relevance, completeness, consistency, transparency, and accuracy are the guiding principles of this protocol and have been adapted to this assessment. Scope 1 emissions, as defined by the WRI protocol, are the main focus of this assessment as outlined in the AIR. These include all direct GHG emissions generated by Project activities and physical works such as combustion, fugitive and vented sources from the Project. Fugitive emissions are unintentional releases and differ from venting emissions, which are usually voluntary releases of un-combusted gas (BC OGC 2013). Vented methane emissions are generally associated with LNG facility maintenance activities or are produced when emergencies require a rapid reduction of system pressure. These vented emissions will not be released to the atmosphere but will be captured and sent to the flare.

Details of calculations for equipment usage, such as emission factors, power ratings, fuel consumption, and estimated operating times, are based on specifications from the manufacturers, default data or Project information and experience with similar projects. The emission inventories are estimates based on best available information at the time of Application submission.

A breakdown of the construction and operation activities included in the GHG assessment and the respective methods used for calculating the emissions are listed in Table 5.3-6 and Table 5.3-7; see the Greenhouse Gas Management TDR (Stantec Consulting Ltd. 2014a) for a more detailed description.

Table 5.3-6: Methods for Calculating Construction GHG Emissions

Project Activity or Physical Work	Method
Land clearing	Deforestation emission factors for BC by region from the Ministry of Forests, Lands and Natural Resources Operations office (Dymond 2013) are applied to the estimated area of land cleared.
Site preparation Instrumental, mechanical and electrical installation	CO_2 emission factors from the EPA Nonroad 2008a model (US EPA 2009) and CH_4 and N_2O emission factors from the Environment Canada NIR (EC 2014) are used in conjunction with a list of representative construction equipment and estimated operation hours by LNG Canada.
Marine terminal construction (including dredging) Shipping activities	Emission estimates from marine terminal construction equipment follow the same approach as site preparation estimates. Emissions from vessels used during construction of the facility and terminal are calculated following the methods in *Preparing Mobile Source Port-Related Emission Inventories* final report prepared for the United States Environmental Protection Agency (ICF Consulting 2009).
On road transportation	Emission factors from the Canadian version of the US EPA Mobile6 model (US EPA 2004) are used in conjunction with assumptions of estimated movements and distances of on road vehicles provided by LNG Canada.

Table 5.3-7: Methods for Calculating Operation GHG Emissions

Project Activity or Physical Work	Method
Natural gas fuelled turbines Acid gas incinerators	Methods and emissions factors from the Western Climate Initiative (WCI) *Final Essential Requirements of Mandatory Reporting document* (WCI 2011) as well as Canadian Association of Petroleum Producers (CAPP 2003) methods are used to calculate stationary combustion emissions based on fuel consumption. Expected carbon content values are used to adjust WCI emission factors for the Project.
Flares	Pilot burner emissions are calculated following WCI methodology. Maintenance flaring emissions are estimated following a default factor based on experience from LNG Canada.
Fugitive sources	Fugitive emissions are calculated using WCI (2011) and CAPP (2003) methods and an estimated equipment count for the Project by LNG Canada.
Shipping activities	Emissions from LNG carriers and tug boats are calculated following the methods in *Preparing Mobile Source Port-Related Emission Inventories* final report prepared for the United States Environmental Protection Agency (ICF Consulting 2009).

5.3.5.1.2 Assumptions and the Conservative Approach

The conservative assumptions and approach applied to each of the Project activities and physical works are summarized below and described in more detail in the Greenhouse Gas Management TDR (Stantec Consulting Ltd. 2014a). Assumptions are applied to the full build-out scenario, which includes the construction and operation of four liquefaction trains and two berths at the marine terminal.

Construction

Construction emissions are conservatively estimated for the full build-out scenario to include all phases until all four trains and two berths at the marine terminal are constructed. Main activities during construction will include delivery of materials; dredging; modifications to the existing RTA wharf 'B' including pile, and superstructure installation; installation of the water intake and outfall pipes; on-land clearing and site preparation; establishment of electrical supply; establishment of rail marshalling yard and laydown areas; construction of storage tanks; onsite concrete production; and vehicle and vessel traffic. The primary source of GHG emissions during construction will be related to operation of vehicles, vessels, and heavy equipment used during these activities as well as land clearing related emissions. Assumptions related to each type of activity are listed below:

Land Clearing

- Site preparation will require removal of trees, other vegetation, and top soil. It is conservatively assumed that the vegetated area is consistently forested at the density recognized by the emission factors. Clearing of this area, as well as subsequent decay, will emit GHGs. Merchantable timber will be salvaged and available timber will be offered to local communities (Mitigation 5.2-3). The burning of biomass will be avoided, where practicable (Mitigation 5.3-5).
- Emission factors for the Skeena ecoregion (Dymond 2013) are applied to the vegetated area. It is conservatively assumed that the entire vegetated area is subject to 19 years of decay after the initial year of disturbance. This approach follows the international IPCC *Guidelines for National GHG Inventories* and the *Good Practice Guidance for Land Use, Land-Use Change and Forestry* (IPCC 2006, 2003). This approach has been chosen to be consistent with the annual BC GHG inventory report, which follows the same IPCC guidance. For simplicity reasons, it is also assumed that emissions from decay over 19 years are all accounted for in the construction phase and, therefore, are not included in the operation phase.

Site Preparation; Instrumental, Mechanical and Electrical Installation; and Marine Terminal Construction

- Construction emissions are based on construction activities necessary for building Phase 1 (two trains). To estimate emissions for the full build-out scenario (four trains), it has been assumed that subsequent phases will emit the same volume of emissions as Phase 1.
- Construction of the marine terminal will include emissions from dredging.

Shipping Activities

- Emission estimates for shipping activities include emissions generated by vessels at port during delivery of construction materials, as well as during the shipping along the marine access route. For construction, a total of 200 construction vessels and 500 barges are assumed. Emission estimates include emissions from assisting tugs.
- Within inland waters, vessels are assumed to run on marine oil gas; tugs are assumed to run on diesel. This is conservative because burning these fuels leads to higher emissions than using potentially cleaner energy sources.
- Each vessel is assumed to travel between the Kitimat Harbour Terminal and the pilot boarding location at or near Triple Island at 12 knots per hour (22.2 km/h). Actual speeds may vary, particularly in sensitive coastal areas.
- All vessels used during construction (tugs and vessels) are assumed to be Canadian registered and are, hence, domestic marine activities and included in the construction total.

On Road Transportation

- Road transportation includes LNG Canada related bus movements transporting workers from the airport to the workforce accommodation centre(s) and from the accommodation centre(s) to the LNG facility and back. It also includes small vehicle usage on site (e.g., pickup, SUV, car, van).

Operation

The Project will consist of natural gas receiving and treatment facilities, natural gas liquefaction facilities, and product storage and loading and infrastructure facilities. Main activities during the operation phase will include LNG treatment, production and loading onto the LNG carriers. The majority of emissions will occur at combustion sources, such as the acid gas incinerators and gas turbine-driven compressors. Shipping, as well as flaring activities, will also release emissions, albeit on a smaller scale than the turbines and incinerators related to LNG production. Components, such as compressor seals, valves, and piping connectors throughout the system, may be small sources of fugitive emissions. Fugitive emissions are unintentional releases and differ from venting emissions, which are usually a voluntary release of un-combusted gas (BC OGC 2013). LNG Canada has a no venting policy, except where required for safe operations; these emissions are captured and flared and not vented to the atmosphere. Therefore, releases of GHGs from venting are not expected on a regular basis and are not included in this assessment. The Project will also include two emergency diesel generators and one diesel firewater pump. This equipment will only be used for short periods and in emergencies and thus is not included in the GHG emissions estimates.

Assumptions related to each type of activity are listed below:

Natural Gas Fuelled Turbines/Acid gas incinerators

- The full build-out scenario includes four liquefaction trains each with two aero-derivative gas turbines and one incinerator. The Project will receive approximately 4.2 billion standard cubic feet per day (Bcf/d) of natural gas and produce approximately 26 mtpa of LNG. The CO_2 mole percent of the feed gas is set to 0.8%, which is based on a three-year average of the two closest natural gas receipt points with available data (Saddle Hill and Pipestone).
- It is assumed that each of the eight turbines will operate at a maximum load of 93.4 MW.
- Based on a 30-year average of past experiences, LNG Canada assumes the facility will operate 24 hours per day, 344.5 days per year at full production (accounting for turnarounds).

Flares

- Flaring estimates are conservatively based on emissions of continuously operating pilot burners and the emissions associated with maintenance activities approximately every few years.
- Pilot burner emissions are conservatively assumed to be the same for all five flare stacks (warm, cold, operational, storage and loading, spare flare).
- Flaring does not occur continuously. Flaring emissions from larger maintenance activities occur approximately every few years, but have been based on a conservative default percentage of the annual LNG production in order to get an annual average for flaring volumes. This default percentage is based on experience from LNG Canada and converts total production to CO_2 emissions flared.

Fugitive Sources

- A conservative equipment count by LNG Canada is used to estimate the fugitive emissions according to WCI (2011) and CAPP (2003) method.
- LNG Canada will implement a program to control fugitive emissions. For this assessment, fugitive emissions are conservatively estimated assuming that there are no fixes or leak prevention activities taken.

Shipping Activities

- Size of LNG carriers may vary throughout the year. For this assessment, the GHG estimates are conservatively based on a maximum of 350 LNG carrier visits per year, involving the largest carriers that the two berths can accommodate (345 m length).

- Each LNG carrier is assumed to travel between the Kitimat Harbour Terminal and the pilot boarding location at or near Triple Island under the escort of one tug boat. For this assessment, the average speed along the entire marine access route is assumed to be 12 knots per hour (22.2 km/h). The use of 12 knots per hour for the largest LNG carriers yields conservative emission rates after engine load, combustion efficiency and travel time are incorporated. Actual speeds may vary, particularly in sensitive coastal areas.
- Each LNG carrier is assumed to be assisted by three tugs during harbour maneuvering and by one tug continuously during loading at the port.
- Within inland waters, LNG carriers are assumed to run on marine oil gas; tugs are assumed to run on diesel and will not use shore power. This is conservative because burning these fuels leads to higher emissions than using potentially cleaner energy sources.
- All LNG carriers during operation are assumed internationally registered and are hence excluded from the GHG emissions total. Tug boats are assumed to be Canadian registered and are domestic marine. Emissions related to domestic marine are included in the operation GHG emissions total.

5.3.5.2 Assessment of GHG Emissions

5.3.5.2.1 Description of Project Effect Mechanisms for GHG Emissions

During construction, GHG emissions will be generated primarily from land clearing and the combustion of fuel in vehicles and heavy equipment as well as marine activities. During operation, the primary emission sources will include the operation of stationary combustion sources, such as the compressors driven directly by gas turbines and the acid gas incinerators. To a smaller extent, shipping, flaring, and fugitive emissions will contribute to the total GHG emissions released during operation.

The direct drive turbines in the liquefaction trains will use natural gas to power the refrigeration compressors. Electric helper motors may be used to increase the production capacity of the turbines without increasing fuel demand. In addition to that, the LNG facility and the marine terminal will require electrical power for the supporting facilities and infrastructure. It is estimated that approximately 120 MW of electrical power will be required for Phase 1. Power demand will increase to approximately 235 MW at full build-out. The Project will rely on electricity from BC Hydro to meet that required auxiliary electricity demand. The GHG releases associated with electricity use are not attributable to the Project under the *Greenhouse Gas Reduction (Cap and Trade) Act* (GGRCTA) (Government of BC 2008a) as these emissions are reported by the entity generating the electricity – BC Hydro. This approach is taken in order to avoid double counting of emissions since BC Hydro is accounting for these emissions already. Following provincial and federal GHG reporting requirements BC Hydro is reporting on these GHG emissions annually.

5.3.5.2.2 Mitigation for Greenhouse Gas Emissions

There are different opportunities to reduce GHG emissions from various sources of an LNG project. Best GHG management options considered by LNG Canada include development of a GHG Management Plan, consideration of best achievable technology (BAT) in Project design and implementation of best industry practice to reduce Project GHG emissions (Mitigation 5.3-14).

GHG Management Plan

LNG Canada will adhere to the requirements for GHG management described in the LNG Canada Health, Safety, Security and Environment & Social Performance (HSSE&SP) Control Framework Environment Manual that includes the development and implementation of a GHG Management Plan for the Project (Shell 2013). This plan will include the GHG regulatory environment, GHG efficiency factors relevant for Project design, guidance on how to meet the LNG Canada HSSE&SP control framework requirements, and BATs. The GHG Management Plan will also be adapted to meet CEA Agency guidance where possible, and include items such as policy updates, emission source categories, effectiveness of mitigations, and activity specifications (i.e., frequency of monitoring and reviewing), as well as the data management system.

LNG Canada will continue to monitor the GHG regulatory and political environment.

Best Achievable Technologies

LNG Canada completed a detailed internal analysis to identify the best solutions using criteria such as effect on schedule, capital and operating costs, operational reliability, expected equipment utilization rates, effect on GHG emissions, and fuel efficiency. This analysis involved identifying potential technologies, eliminating those not technically feasible, ranking those that were reliable and economically viable based on the GHG emission reduction potential, and then choosing the BAT.

LNG Canada evaluated various operating scenarios, each leading to different LNG production capacities, LNG to ship rundown rates, and CO_2 emission intensities. The scenarios evaluated economic performance as well as CO_2 emissions. Upstream activities or construction emissions are not included in the analysis. The scenarios included different combinations of best available technology turbine drivers (aero-derivative open cycle or the Frame 7EA) and power generation. Power generation options included partial or full power import from the BC Hydro grid, import from a separate gas-fired combined cycle power plant, or self-power generation by the Project (Shell 2013).

LNG Canada evaluated the feasibility of an all-electric scenario, where all the power is provided from the BC Hydro grid. This scenario was not selected because of risks and uncertainties related to cost, reliability of power supply, and schedule for completion of the additional infrastructure (Shell 2013).

The analysis resulted in the selection of the scenario that includes a mixed refrigerant and a pre-cool mixed refrigerant compressor driven by highly efficient aero-derivative gas turbines (two LMS100 strings per train, operating in an open cycle) with waste heat recovery and auxiliary power import from the BC Hydro grid for LNG facility auxiliary power needs.

The selected BAT scenario is predicted to achieve an emission intensity of 0.15 tonne CO_2/tonne LNG produced, which is the lowest GHG intensity of all LNG facilities in the world due to its efficient aero-derivative turbine technology, combined with the selected dual-mixed refrigerant technology, waste heat integration and use of the BC Hydro grid for auxiliary power. In general, the Project also benefits from efficient liquefaction processes due to its location in colder average ambient temperature and its access to cold cooling water from Kitimat River (Shell 2013).

Sequestration of CO_2 was not considered to be feasible because the amount of CO_2 that could be most easily captured (i.e., CO_2 vent gas) is expected to be low, and the distance and cost of transporting this CO_2 to a suitable sequestration zone is high (Shell 2013).

Design Considerations and Mitigation

LNG Canada is planning the following Project design considerations and GHG management measures for GHG emissions associated with the Project:

The following are construction mitigation measures:

- Implement industry best practice for mobile construction equipment (i.e., regular maintenance, speed restrictions, correct sizing of equipment, modernizing of fleet, reduce idling, driver behaviour, etc.) (Mitigation 5.3-1)
- Use existing roads as main access points to the LNG facility to limit area of new disturbance, where practicable (Mitigation 5.3-2)
- Use buses, where feasible, instead of personal transportation at the facility and workforce accommodation centre(s) to reduce traffic emissions (Mitigation 5.3-3)
- Footprint for LNG facility and temporary construction facilities will be sized to allow safe and efficient construction. Existing cleared areas will be utilized, where practicable, to limit area of new disturbance (Mitigation 5.3-4), and
- Avoid burning of biomass where practicable (Mitigation 5.3-5).

The following are operation mitigation measures:

- Use efficient aero-derivative gas turbine technology to drive the refrigeration compressors in the liquefaction process (Mitigation 5.3-6)
- Use BC Hydro power for LNG facility auxiliary electricity supply (Mitigation 5.3-7)

- Operate combustion sources at optimal efficiency settings to reduce fuel consumption (Mitigation 5.3-8)
- Adhere to existing flaring and venting reduction guidelines. Minimize flaring or venting, except as required to maintain safe operations and LNG train start up (Mitigation 5.3-9)
- Conduct preventative maintenance of facility and equipment as per schedule in the maintenance management system (Mitigation 5.3-10)
- Reuse heat recovered from gas turbine exhausts to reduce fuel consumption in other processes (Mitigation 5.3-11)
- Recover boil-off gas during storage and loading processes, and re-inject the recovered gas into the fuel/feed gas system. (Mitigation 5.3-12)
- Implement a fugitive emissions survey program with the aim to measure, control and manage fugitive emissions (Mitigation 5.3-13), and
- Develop and adhere to a GHG Management Plan that would incorporate Best Achievable Technology (BAT) in current project design and implement best industry practice to manage Project GHG emissions (Mitigation 5.3-14).

5.3.5.2.3 Characterization of GHG Emissions

Construction

Assuming full build-out, an estimated 255,742 tonnes CO_2e will be released into the atmosphere during the construction phase. All shipping activities during construction are conservatively assumed to be executed by domestic registered vessels. Hence, their emissions are included in the construction total, following the approach taken in the NIR (EC 2014). Table 5.3-8 summarizes GHG emissions from the Project construction sources.

Table 5.3-8: Estimated GHG Emissions during Construction

Source	GHG Emissions (tonnes)			Total	
	CO_2	CH_4	N_2O	Tonnes CO_2e	Percent (%)
Land clearing	-	-	-	166,137	65
Site preparation	20,190	1.12	8.20	22,661	8.9
Instrumental, mechanical and electrical installation (Phase 1)	7,695	0.43	3.13	8,637	3.4
Instrumental, mechanical and electrical installation (subsequent phases)	7,695	0.43	3.13	8,637	3.4
Marine terminal construction (Phase 1)	5,054	0.50	0.94	5,347	2.1
Marine terminal construction (subsequent phases)	5,054	0.50	0.94	5,347	2.1

Source	GHG Emissions (tonnes)			Total	
	CO_2	CH_4	N_2O	Tonnes CO_2e	Percent (%)
Shipping activities – Domestic marine	22,779	0.42	1.12	23,123	9.0
On road transportation	15,810	0.18	0.13	15,854	6.2
Total GHG emissions from construction	**84,276**	**3.57**	**17.58**	**255,742**	**100**

NOTE:
Aggregated totals may not equal disaggregated values in this table due to rounding.

With the exception of land clearing emissions and shipping activities, construction emissions are not included in provincial, national, or global emission inventories. However, because land clearing and shipping make up the majority of construction emissions (74%), construction emissions are compared to jurisdictional inventories. If construction emissions are assumed to be evenly distributed over the minimum number of construction years (five years), the emissions will be approximately 51,148 tonnes CO_2e/year. This assumption also suggests that emissions from subsequent phases of construction will also be completed within the first five years of construction; this is a conservative assumption. Annual construction emissions will increase provincial, national and global inventories by 0.085%, 0.007% and 0.0001%, respectively (see Table 5.3-4 for baseline emission totals). The geographic extent of construction GHG emissions is global. The duration is long term because most GHGs will require 100 years or more to chemically breakdown in the atmosphere. Given current technology, the residual effects on global GHG levels from construction is irreversible within the century after ceasing construction emissions, but reversible after chemically breaking down in the atmosphere. Emissions during the construction phase will originate from transient activities that will occur on multiple occasions, but over a short period of time (only during the construction phase). The context for the GHG emission assessment is disturbed because the atmosphere has been previously disturbed by human activity. The likelihood that a residual effect will occur is high during construction because there is high confidence that GHGs will be released during construction.

Operation

At full build-out (four trains) and operating at a maximum capacity of approximately 26 mtpa of LNG production, operation will release approximately 4.0 million tonnes CO_2e per year into the atmosphere from the combustion of fossil fuels, flaring, domestic shipping activities and fugitive sources. International shipping emissions are excluded from the total. Table 5.3-9 summarizes GHG emissions from the Project sources.

Table 5.3-9: Estimated GHG Emissions during Operation

Source	Emission Rate (tonnes/year)				Percent of Total Operation Emissions (%)
	CO_2	CH_4	N_2O	CO_2e	
8 Gas Turbines	3,054,358	63	56	3,072,570	77.6
4 Incinerators	704,917	345	208	775,636	19.6
2 Flare Derricks (5 flare sources)	78,810	5.2	1.5	79,398	2.0
Fugitive sources	0.89	1,002	-	25,056	0.6
Shipping activities - Domestic marine	5,008	0.65	0.15	5,067	0.13
Shipping activities – International marine	83,396	0.59	4.8	84,827	-
Total GHG emissions from Project operation, excluding international marine emissions	**3,843,094**	**1,415**	**266**	**3,957,728**	**100**
Facility GHG intensity (based on 26 mtpa LNG production and including domestic marine) = 0.15 tonne CO_2e/tonne LNG					

NOTE:
Aggregated totals may not equal disaggregated values in this table due to rounding.

The majority of GHG emissions attributable to LNG production will be from combustion in the gas turbines and the acid gas incinerators; 97.2% will originate from operation of the four trains (eight gas turbines and four incinerators). Flaring emissions will represent the second largest emission source, accounting for 2% of the total annual emissions during operations. Flaring includes emissions from the continuous pilot burners as well as maintenance flaring. Although maintenance flaring does not occur continuously, , annual emissions are conservatively estimated based on uniform distribution of production over the operational life. Fugitive emissions and emissions from domestic marine activates will be less than 1%.

LNG facility operations (excluding international shipping activities, but including domestic shipping, flaring and fugitive emissions) will reach an emission intensity of approximately 0.15 tonne CO_2e/tonne LNG during the operational life, based on an average CO_2 content of 0.8 mol% of the feed gas. The emission intensity is well below both the top quartile benchmark for existing global LNG facilities and newly approved and proposed global LNG facilities. At 0.15 tonne CO_2e/tonne LNG, the Project is well positioned to be one of the most efficient LNG facilities in the world.

Annual operation GHG emissions of about 4 million tonnes CO_2e will increase the 2012 national (699 million tonnes CO_2e per year) and BC GHG reported emission total (60.1 million tonnes CO_2e per year) by 0.57% and 6.6%, respectively (see Table 5.3-10). Based on the latest available data, total global emissions were 43,967 million tonnes CO_2e in 2010 (WRI 2013). During operation, annual Project GHG emissions will increase total global emissions by 0.009%.

Table 5.3-10: Comparison of Estimated GHG Emission during Operation with Baseline Conditions

	Units	BC	Canada
2012 GHG Baseline Data	million tonnes CO_2e/year	Total: 60.1	Total: 699
Project GHG Operation Estimates at Full Build-Out		4.0	
2020 Reduction Targets		43 (33% below 2007 total)	610 (17% below 2005 total)
Increase to 2012 GHG Baseline Data	**Percent**	**Total: 6.6**	**Total: 0.57**

NOTE:
The BC and Canada totals are from the NIR (EC 2014).
The Project GHG operation estimates are based on sources of emissions operating at full load throughout the operation phase.

The magnitude of the Project GHG emissions will be high, based on the criteria outlined in Table 5.3-3. The geographic extent of operation emissions is global. The duration is long term because GHGs will require 100 years or more to chemically breakdown in the atmosphere. Given current technology, the effects of GHG emissions from operation are irreversible within the century after operations cease, but reversible after chemically breaking down in the atmosphere. Emissions during the operation phase will originate from continuous activities over the lifetime of the Project. The context is disturbed because the atmosphere into which the emissions will be released from the Project has been previously disturbed by human activity. The likelihood that a residual effect will occur during operation is high because there is high confidence that GHGs will be released during operation.

5.3.5.3 Determination of Significance for GHG Emissions

Annual operation GHG emissions for the Project at full build out (4 trains) will produce about 4.0 million tonnes CO_2e/year. Although this represents a large increase in terms of provincial GHG emissions, these estimates are based on sources of emissions operating at full load throughout the operation phase. The load factor will likely be lower and GHG emissions are expected to be less than the estimated emissions shown in Table 5.3-10 during normal operation. Further, because the Project is proposed to be built over several phases, actual emissions may not reach estimates, if future technology advancements in GHG emission reductions become economically available.

Residual effects of GHGs from the Project have been established to have a global geographic extent and, therefore, the significance of the residual effects can be determined in the global context (Table 5.3-11). It is acknowledged that GHG emissions from anthropogenic sources are extremely likely altering the global climate (IPCC 2013). Furthermore, based on CEA Agency (2003) guidance, which states that "[…] unlike most project-related environmental effects, the contribution of an individual project to climate change cannot be measured", it is recognized that it is not possible to measure how the individual contribution of the Project's GHG emissions to global GHG concentrations will affect climate change.

Based on the estimated total GHG emissions during construction (255,742 tonnes CO_2e), annual emission rates will be approximately 51,148 tonnes CO_2e/year and, therefore, effects associated with Project construction have a low magnitude, following CEA Agency guidance (2003). During operation, the Project will emit approximately 4.0 million tonnes CO_2e/year; therefore, the magnitude is high.

In light of BC's current legislated GHG reduction target of reducing the annual emissions by 33% below 2007 levels by 2020 and by 80% by 2050 and the national reduction target of reducing Canada-wide GHG emissions by 17% from 2005 levels by 2020 (presented in Table 5.3-10), the increase in emissions from the Project and other projects with similar emission profiles (greater than 1 million tonnes CO_2e/year) will challenge BC’s commitment to the 2020 target of 43 million tonnes/year. To date, clear guidance on how Canada and BC will address this issue has not been communicated. LNG Canada will continue to work closely with applicable jurisdictions.

Considering these magnitudes and following CEA Agency guidance (2003) on ranking GHG emission intensities, the Project is ranked as a high emitter. Therefore, a detailed GHG Management Plan must be prepared by LNG Canada. The GHG Management Plan will be prepared upon Project approval and will be similar to the current GHG and Energy Plan of LNG Canada. Some components of the GHG Management Plan will also be applicable to the GHG reporting requirements.

The required GHG Management Plan will address compliance with relevant GHG emissions management and reporting legislations, as well as Project mitigation measures. It will also cover inspection and maintenance requirements, as well as adaptive management approaches that are directed towards GHG mitigation strategies in light of new information from monitoring or changing regulatory requirements. The GHG Management Plan will show that LNG Canada will seek to manage GHG emissions throughout Project operation by selecting innovative technology in final Project design and implementing best GHG and other operations-related management practices as new technologies emerge.

The Project is expected to reach an emission intensity of 0.15 tonne CO_2e/tonne of LNG produced (including domestic shipping activities), which is low compared with other global LNG facilities. Based on the industry profile presented in Section 5.3.3.3, the emission intensity of the Project will be the lowest of currently proposed or operating LNG facilities around the world.

Project GHG emissions during operation will represent a 0.009% increase in total global GHG emissions relative to 2010 levels. This contribution will cause a small material change to global GHG levels. In this context, the residual effects of the Project-alone case on GHG emissions are assessed as not significant.

5.3.6 Summary of Project Residual Effects

A summary of the residual effects of the Project on GHGs is provided in Table 5.3-11.

Table 5.3-11: Summary of Project Residual Effects: Greenhouse Gas Management

Project Phase	Mitigation Measures	Residual Effects Rating Criteria						Likelihood of Residual Effects	Significance	Prediction Confidence	Follow-up and Monitoring
		Magnitude	Geographic Extent	Duration	Frequency	Reversibility	Context				
Facility Works and Activities											
Greenhouse Gas Emissions											
Construction	Mitigation 5.3-1 Mitigation 5.3-2 Mitigation 5.3-3 Mitigation 5.3-4 Mitigation 5.3-5	L	G	ST	MI	I	D	H	N	H	No follow-up programs are proposed for GHG management.
Operation	Mitigation 5.3-6 Mitigation 5.3-7 Mitigation 5.3-8 Mitigation 5.3-9 Mitigation 5.3-10 Mitigation 5.3-11 Mitigation 5.3-12 Mitigation 5.3-13 Mitigation 5.3-14	H	G	LT	C	I	D	H	N	H	No follow-up programs are proposed for GHG management.

KEY

MAGNITUDE:

L = Low—negligible change in provincial, national, and global GHG emissions

M = Medium—although measurable, based on CEA Agency guidance (2003), professional judgment and the industry profile, relatively small changes are expected in provincial, national, and global GHG emissions

H = High—based on CEA Agency guidance (2003), professional judgment, and the industry profile, a notable change in provincial and national emissions, while change to global emissions will still be small

GEOGRAPHIC EXTENT:

P = Provincial—residual effect is within the provincial extent

N = National—residual effect is within the national extent

G = Global—residual effect is within the global extent

DURATION:

ST = Short term—residual effect restricted to construction phase only

MT = Medium term—residual effect extends through lifetime of the Project

LT = Long term—residual effect extends through the lifetime of the Project and beyond decommissioning

FREQUENCY:

S = Single event—residual effect occurs only once

MI = Multiple event—residual effect occurs sporadically at irregular intervals throughout construction, operation or decommissioning phases

MR = Multiple regular event—occurs on a regular basis and at regular intervals throughout

C = Continuous—residual effect occurs continuously throughout the life of the Project

REVERSIBILITY:

R = Reversible—will recover after Project closure and reclamation

I = Irreversible—permanent

CONTEXT:

U = Undisturbed—atmosphere relatively or not affected by human activity (anthropogenic sources)

D = Disturbed—atmosphere has been previously disturbed by human activity (anthropogenic sources)

LIKELIHOOD OF RESIDUAL EFFECT:

Based on professional judgment

L = Low likelihood that there will be a residual effect

M = Moderate likelihood that there will be a residual effect

H = High likelihood that there will be a residual effect

SIGNIFICANCE:

N = Not Significant

S = Significant

PREDICTION CONFIDENCE:

Based on scientific information and statistical analysis, professional judgment and effectiveness of mitigation, and assumptions made.

L = Low level of confidence

M = Moderate level of confidence

H = High level of confidence

5.3.7 Assessment of Cumulative Effects

Scientific consensus has been established that it is very likely that GHG emissions from anthropogenic sources are altering the global climate and that the effects will be widespread (IPCC 2013). As concentrations of GHGs in the atmosphere increase, there has been corresponding warming of the atmosphere, oceans, and related systems. Current global concentrations of GHG are at unprecedented high levels compared to the last 800,000 years, with consequences to climate systems (IPCC 2013); thus, it is recognized that there is already a serious cumulative effect of global GHGs levels on climate change.

GHG emissions generated from the Project will contribute to global atmospheric GHG concentrations. However, because cumulative GHG emissions are acting at a global scale it is not possible to single out the potential cumulative effects of this Project in combination with other regional projects and activities, as identified in the Project and Activities Inclusion List (Section 4). In accordance with Section 4.5 of the AIR (BC EAO 2014), the cumulative effects assessment relies on a comparison of estimated Project GHG emissions to recent provincial, national and global emission inventories.

Project GHG emissions will increase provincial and national levels by 6.6% and 0.57% respectively. The contribution will be small in the global context (0.009%). Since the Project-related releases of GHGs are acting cumulatively with other global sources of GHG on an already serious effect, the Project contribution to GHG emissions is assessed as significant.

As mentioned in the industry profile, LNG Canada is designed to achieve a low emission intensity when compared to other currently available data and it is their goal to reach best-in-class performance.

At a global scale, there is a possibility that LNG will facilitate the displacement of higher carbon fuels (such as oil and coal) for energy generation. Replacement or displacement of higher carbon fuels with natural gas in power plants can potentially reduce GHG emissions globally. The most recent IPCC report on mitigation of climate change also states that GHG emissions from the energy sector could be substantially reduced if coal-fired power plants are replaced with natural gas power plants. The report also states that natural gas power plants could act as a bridge technology and that natural gas could hence play an important role as a transition fuel (IPCC 2014).

The Project is in line with LNG Canada’s goal to supply affordable and cleaner burning LNG to Asia that could help transition away from higher GHG fuels such as coal. LNG can also contribute to reductions in the use of more carbon intensive fossil fuels by providing a reliable base load of peaking fuel or to supplement peak power for renewable energy such as wind and solar power. LNG Canada also recognizes, at the corporate and project level, the need to mitigate excess anthropogenic GHG emissions to prevent a level of global warming considered to be unacceptable by international scientific authorities, and towards this end engages in a wide variety of approaches to reducing its corporate GHG footprint.

5.3.8 Prediction Confidence and Risk

The emission estimates for this Project is high and conservative because the published emission factors and manufacturer specifications used in this Project consider the carbon content of the various emission sources and fuel types. Furthermore, the certainty relative to the effectiveness of the mitigation measures is high because the majority of the measures reduce the source of GHG emissions (i.e., fuel consumption or natural gas emissions). Professional judgment from prior experience supports the conclusion that design considerations, management strategies and mitigation measures included in this Project serve to reduce GHG emissions.

5.3.9 Follow-up Program and Compliance Monitoring

No follow-up programs are proposed for GHG management. Annual compliance reporting, potential mitigation and GHG management options will be continually reviewed as technology advances and government regulation evolves. Compliance monitoring to be implemented through EMPs is described in Section 12 and Section 21 (Table 21.3–1).

5.3.9.1 Reporting Requirements

This Project will adhere to the annual reporting requirements of both the BC *Reporting Regulation—Greenhouse Gas Reduction (Cap and Trade) Act* and EC's *GHG Reporting Regulation*. Because Project GHG emissions will exceed 50,000 tonnes CO_2e per year, LNG Canada will report total facility operation emissions to the MOE and will also have the emissions verified by an accredited third party by March 31 each year. Reports will also be submitted to EC by June 1 each year.

5.3.9.2 Detailed Management Plan

A detailed GHG Management Plan will be prepared as described in Section 5.3.5.2.2 and Section 12.

5.3.9.3 Fugitive Emission Management Program

LNG Canada will implement a fugitive emissions survey program with the aim to measure and manage fugitive emissions.

5.3.9.4 BC Carbon Tax

Most GHG emissions from this Project will originate from the combustion of fossil fuels, of which LNG Canada will be required to pay BC carbon taxes. LNG Canada will continue to optimize its energy use in accordance with the BC Carbon Tax requirements and its GHG Management Plan.

5.3.9.5 Research and Development

LNG Canada will continue to evaluate opportunities to reduce GHG emissions from its operations. Potential activities and developments will be documented in the GHG Management Plan.

5.3.10 Summary of Mitigation Measures

LNG Canada will manage GHG emissions from the Project through implementation of the following mitigation measures:

The following are construction mitigation measures:

- Implement industry best practice for mobile construction equipment (i.e., regular maintenance, speed restrictions, correct sizing of equipment, modernizing of fleet, reduce idling, driver behaviour, etc.) (Mitigation 5.3-1)
- Use existing roads as main access points to the LNG facility to limit area of new disturbance, where practicable (Mitigation 5.3-2)
- Use buses, where feasible, instead of personal transportation at the facility and workforce accommodation centre(s) to reduce traffic emissions (Mitigation 5.3-3)
- Footprint for LNG facility and temporary construction facilities will be sized to allow safe and efficient construction. Existing cleared areas will be utilized, where practical, to limit area of new disturbance. (Mitigation 5.3-4), and
- Avoid burning of biomass where practicable (Mitigation 5.3-5)

The following are operation mitigation measures:

- Use efficient aero-derivative gas turbine technology to drive the refrigeration compressors in the liquefaction process (Mitigation 5.3-6)
- Use BC Hydro power for LNG facility auxiliary electricity supply (Mitigation 5.3-7)
- Operate combustion sources at optimal efficiency settings to reduce fuel consumption (Mitigation 5.3-8)
- Adhere to existing flaring and venting reduction guidelines. Minimize flaring or venting, except as required to maintain safe operations and LNG train start up (Mitigation 5.3-9)
- Conduct preventative maintenance of facility and equipment as per schedule in the maintenance management system (Mitigation 5.3-10)
- Recover boil-off gas during storage and loading processes, and re-inject the recovered gas into the fuel/feed gas system. (Mitigation 5.3-11)
- Recover boil off gas during storage and loading processes, and re-inject the recovered gas into the fuel/feed gas system (Mitigation 5.3-12)

- Implement a fugitive emissions survey program with the aim to measure, control and manage fugitive emissions (Mitigation 5.3-13), and
- Develop and adhere to a GHG Management Plan that would consider Best Achievable Technology (BAT) in current project design and implement best industry practice to manage Project GHG emissions (Mitigation 5.3-14).

5.3.11 Conclusion

Project-related GHG emissions are estimated for both the construction and operation phases compared to provincial, national, and global emission levels.

Key findings of the assessment include:

- Construction GHG emissions are estimated to amount to 255,742 tonnes CO_2e over the entire construction period to reach the full build-out of four trains. If the minimum construction period (5 years) is assumed this amounts to 51,148 tonnes CO_2e per year.
- Based on the 2012 provincial and national GHG baselines reported in the latest NIR (EC 2014), the Project construction emissions will increase total provincial emissions by 0.085% and total national emissions by 0.007%.
- Based on 2010 estimates from WRI (2013), the construction emissions will increase the total global GHG emissions by 0.0001%.
- Operation GHG emissions are estimated to be 4.0 million tonnes CO_2e per year. This total includes domestic, but excludes international shipping activities.
- Based on the 2012 provincial and national GHG baselines (EC 2014), the Project operation emissions will increase total provincial emissions by 6.6% and total national emissions by 0.57%.
- Based on 2010 estimates from WRI (2013), the Project operation emissions will increase the total global GHG emissions by 0.009%.
- Based on a production capacity at full build-out of 26 mtpa and a 0.8mol% CO_2 content of the feed gas, the Project will result in an emission intensity of 0.15 tonne CO_2e/tonne of LNG produced, including domestic shipping activities.
- International shipping will amount to approximately 84,827 tonnes CO_2e/year.

There is a consensus within the scientific community that global GHG emissions are contributing to climate change, but that the effect is due to a multitude of emissions sources, rather than an individual activity or project (IPCC 2013, CEA Agency 2003). Project GHG emissions during operation will represent a 0.009% increase in total global GHG emissions relative to 2010 levels. Estimated in this context, residual effects from the Project-alone on GHG emissions increases will be small in the global context (0.009%) and, therefore, are assessed as not significant.

The contribution of Project GHG emissions during operation will be high compared to 2012 provincial totals (6.6%) and notable compared to 2012 national totals (0.57%). Therefore, as per CEA Agency (2003) guidance, the Project will complete a detailed GHG Management Plan upon Project approval.

When considering the global cumulative environment effects, it is recognized that there is currently a serious adverse effect of cumulative global releases of GHGs on climate change. Project GHG emissions will contribute to these serious cumulative effects, although the contribution will not be substantive in a global context (0.009%) even at full build-out. At a global scale, there is the possibility that LNG will displace higher carbon fuels (coal and oil) for electricity generation, which would contribute to a reduction in GHG emissions globally. However, the Project contribution to GHG emissions is assessed as significant. LNG Canada has incorporated BATs and best industry practice and will have a GHG emission intensity of 0.15 tonne CO_2e/tonne LNG, which will be the lowest intensity when compared to existing global LNG facilities and new LNG facilities recently approved.

The Project will be designed and operated to comply with federal GHG emission programs and policies in BC, which includes the participation in the BC Carbon Tax system. The majority of emissions from the Project will originate from the combustion of fuel, for which the Project will pay carbon taxes. Mitigation of GHG emissions will be realized by direct management and encouragement through participation in the BC Carbon Tax system.

Best management practices for land clearing and BATs for stationary combustion equipment as well as flaring reduction strategies and a no venting policy will be implemented to reduce GHG emissions, where possible. These practices will be documented in detail within the Project GHG Management Plan that will be prepared upon Project approval. LNG Canada recognizes that the GHG Management Plan may evolve with future changes in technology, best practices and regulatory requirements, and that it will need to be responsive to new information gained through monitoring activities.