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Method to calculate GHG emissions at LNG plant

Méthode pour calculer les émissions de GES dans les usines GNL

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 67, *Oil and gas industries including lower carbon energy*, Subcommittee SC 9, *Production, transport and storage facilities for cryogenic liquefied gases*.

~~A list of all parts in the ISO 6338 series can be found on the ISO website.~~

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

Natural gas will play a key role in the energy transition (e.g. by replacing coal to produce electricity) and the use of LNG to transport natural gas is expected to increase. The process of liquefying natural gas is energy-intensive. Gas producers are increasingly accountable for their greenhouse gas (GHG) emissions and the ambition to reduce them. Furthermore, there is an emerging marketing demand for GHG data to enable commercial mechanisms such as offsetting to be utilisedutilized.

There is no standardisedstandardized and auditable methodology to calculate the carbon footprint of the whole LNG chain (including but not limited to the well, upstream treatment, transportation, liquefaction, shipping, regasification and end user distribution). Various standards indicate possible approaches but these are not consistent in their results or easily applicable.

The intention is to develop documents for each part of the LNG chain and to start with liquefaction. Attention should be paid to activities that can occur in different parts (e.g. gas treatment and distribution upstream of the liquefaction plant).

NOTE It will not be possible to make like-for-like comparisons, or define a certification scheme, for one block only.

Method to calculate GHG emissions at LNG plant

1 Scope

This document provides a method to calculate the GHG emissions from an LNG liquefaction plant, onshore or offshore.

The frame of this document ranges from the inlet flange of the LNG plant's inlet facilities up to and including the offloading arms to truck, ship or railcar loading. The upstream supply of gas up to the inlet flange of the inlet facilities and the distribution of LNG downstream of the loading arms are only covered in general terms.

This document covers:

— all facilities associated with producing LNG, including reception facilities, condensate unit (where applicable), pre-treatment units (including but not limited to acid gas removal, dehydration, mercury removal, heavies removal), LPG extraction and fractionation (where applicable), liquefaction, LNG storage and loading, Boil-Off-Gas handling, flare and disposal systems, imported electricity or on-site power generation and other plant utilities and infrastructure (e.g. marine and transportation facilities).

— natural gas liquefaction facilities associated with producing other products (e.g. domestic gas, condensate, LPG, sulphur, power export) to the extent required to allocate GHG emissions to the different products.

— all GHG emissions associated with producing LNG. These emissions spread across scope 1, scope 2 and scope 3 of the responsible organization. Scope 1, 2 and 3 are defined in this document. All emissions sources are covered including flaring, combustion, cold vents, process vents, fugitive leaks and emissions associated with imported energy.

The LNG plant is considered "under operation", including emissions associated with initial start-up, maintenance, turnaround and restarts after maintenance or upset. The construction, commissioning, extension and decommissioning phases are excluded from this document but ~~may~~can be assessed separately.

The emissions resulting from boil-off gas management during loading of the ship or any export vehicle are covered by this document. The emissions from a ship at berth, e.g. mast venting are not covered by this document.

This document describes the allocation of GHG emissions to LNG and other hydrocarbon products where other products are produced (e.g. LPG, domestic gas, condensates, sulphur~~...)~~, etc.).

This document defines preferred units of measurement and necessary conversions.

This document also recommends instrumentation and estimations methods to monitor and report GHG emissions. Some emissions are measured, and some are estimated.

This document is applicable to the LNG industry.

Applications include the provision of method to calculate GHG emissions through a ~~standardised~~standardized and auditable method, a means to determine their carbon footprint.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 14044, *Environmental management — Life cycle assessment — Requirements and guidelines*

ISO 14064-1, *Greenhouse gases — Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals*

API *Consistent Methodology for Estimating Greenhouse Gas Emissions from Liquefied Natural Gas (LNG) Operations*

3 Terms and definitions

For the purposes of this document, the terms and definitions ~~from~~given in ISO 14064-1 ~~apply. In addition,~~ and the following ~~terms and definitions~~ apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
facility
single installation, set of installations or production processes (stationary or mobile), which can be defined within a single geographical boundary, organizational unit or production process

[SOURCE: ISO 14064-1:2018, 3.4.1]

3.2
global warming potential
GWP
ratio of the time-integrated radiative forcing (warming effect) from the instantaneous release of 1 kg of the GHG relative to that from the release of 1 kg of CO2

3.3
greenhouse gas
GHG
gaseous constituent of the atmosphere, both natural and anthropogenic, that absorbs and emits radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere and clouds

Note 1 to entry: For a list of GHGs, see the 6th Intergovernmental Panel on Climate Change (IPCC) Assessment Report.

Note 2 to entry: Water vapour and ozone are anthropogenic as well as natural GHGs, but are not included as recognized GHGs due to difficulties, in most cases, in isolating the human-induced component of global warming attributable to their presence in the atmosphere.

[SOURCE: ISO 14064-1:2018, 3.1.1]

3.4
organizational boundary
grouping of activities or facilities in which an organization exercises operational or financial control or has an equity share

[SOURCE: ISO 14064-1:2018, 3.4.7]

3.5
reporting boundary
grouping of greenhouse gas (GHG) emission or GHG removals reported from within the organizational boundary, as well as those significant indirect emissions that are a consequence of the organization's operations and activities

[SOURCE: ISO 14064-1:2018, 3.4.8]

3.6
scope 1
direct greenhouse gas emissions
direct GHG emissions
~~scope 1~~
emissions coming from sources that are owned or controlled by the facility

Note 1 to entry: This can be the emissions that are directly created by product fabrication or synthesis, for example, combustion fumes from a refinery.

3.7
scope 2
indirect greenhouse gas emissions from purchased and consumed energy
indirect GHG emissions from purchased and consumed energy
~~scope 2~~
emissions from the generation of imported electricity, steam, and heating/cooling consumed by the facillity

Note 1 to entry: These emissions physically occur at the facility where electricity, steam and cooling or heating are generated but as a user of the energy, the consuming party is still responsible for the greenhouse gas emissions that are being created.

3.8
scope 3
other indirect greenhouse gas emissions
other indirect GHG emissions
~~scope 3~~
emissions from sources that are not owned and not directly controlled by the facility

Note 1 to entry: However, they are related to the company's activities. This is usually considered to be the supply chain of the company, so emissions caused by vendors within the supply chain, outsourced activities, and employee travel and commute. In many industries, other indirect GHG emissions account for the biggest amount of GHG emissions. This is due to the fact that in today's economy, many tasks are outsourced and few companies own the entire value chain of their products.

3.9

quality assurance
QA
planned system of review procedures conducted by personnel not directly involved in the inventory compilation/development process

3.10
quality control
QC
planned system of review procedures conducted by personnel not directly involved in the inventory compilation/development process

4 Principles

4.1 General

The application of the following principles is fundamental to guarantee that GHG calculations are a true and fair account.

4.2 Relevance

Use data, methods, criteria, and assumptions that are appropriate for the intended use of reported information. The quantification and reporting of GHG emissions shall include only information that users~~—~~ — both internal and external to the plant — need for their decision-making. This information shall thus fit the intended purpose of the GHG project and meet the expectations or requirements of its users. Data, methods, criteria, and assumptions that are misleading or that do not conform to this document are not relevant and shall not be included.

4.3 Completeness

Consider all relevant information that ~~might~~can affect the accounting and quantification of GHG reductions, and complete all requirements. All relevant information shall be included in the quantification of GHG emissions. A GHG monitoring plan shall also specify how all data relevant to quantifying GHG reductions will be collected.

4.4 Consistency

Use data, methods, criteria, and assumptions that allow meaningful and valid comparisons. The credible quantification of GHG emissions requires that methods and procedures are always in the same manner, that the same criteria and assumptions are used to evaluate significance and relevance, and that any data collected and reported will be compatible enough to allow meaningful comparisons over time.

4.5 Transparency

Provide clear and sufficient information for reviewers to assess the credibility and reliability of GHG emissions claims. Transparency is critical for quantifying and reporting GHG reductions, particularly given the flexibility and policy-relevance of many GHG accounting. GHG information shall be compiled, analysed, and documented clearly and coherently so that reviewers ~~might~~can evaluate its credibility. Information relating to the GHG assessment boundary, the estimation of baseline emissions shall be sufficient to enable reviewers to understand how all conclusions were reached.

4.6 Accuracy

Uncertainties with respect to GHG measurements, estimates, or calculations shall be reduced as much as is practical, and measurement and estimation methods shall avoid bias. Acceptable levels of uncertainty will depend on the objectives for implementing a GHG project and the intended use of quantified GHG reductions. Where accuracy is sacrificed, data and estimates used to quantify GHG reductions shall be conservative.

4.7 Conservativeness

Where data and assumptions are uncertain and where the cost of measures to reduce uncertainty is not worth the increase in accuracy, make best endeavours to use the most probable data, with an analysis of the impact of likely uncertainty margins.

5 GHG inventory boundaries

The reporting boundaries of the GHG report for an onshore or offshore LNG liquefaction plant shall cover all facilities which are associated with the production of LNG. Table 1 provides examples of LNG plant facilities.

Table 1 — List of LNG plant facilities [1]

LNG Plant Facility	In scope of the report	Out of scope of the report	
Natural Gas Production		X	
Shipping / Pipeline Transport		X	
Inlet gas Receiving Facilities	X		
Condensate Unit (where applicable)	X		
Pre-treatment Units (e.g. acid gas removal, dehydration, mercury removal, heavies removal, others)	X		
LPG Extraction and Fractionation (where applicable)	X		
Liquefaction Unit	X		
LNG Storage and Loading	X		
Flare and Disposal Systems	X		
Carbon Capturing Unit	X		
Utilities Supply (on-site power generation)	X		
Utilities Supply (imported)	X		
Plant Utilities and Infrastructure (e.g. plant piping and marine facilities)	X		
Regasification		X	

The organization having financial and/or operational control over the LNG liquefaction plant shall report all GHG emissions and removals within the reporting boundaries at least on an annual average basis.

6 Quantification of GHG emissions

6.1 Identification of GHG sources and quantification approach

6.1.1 General

The main emission sources to consider derive from fuel combustion, flaring, releases to atmosphere (including fugitive emissions) and emissions associated with imported energy or consumables. Tables 2 to 5 give an initial checklist of emission sources to consider, and an overview of typical quantification methods suitable for different emission sources.

The chosen method of quantification per emissions source will differ from one LNG facility to another. Different plants will have access to a varying number of flow meters, composition analysis equipment and level meters available.

Operators shall develop a GHG quantification plan to map out how all emission sources can best be identified in the facility, with a preference to obtain primary data for all major emission sources. The measurement plan shall also include an assessment of data accuracy and impact on the total GHG emissions calculation. This assessment will then allow the operator to assess if there is a need to further improve the amount or accuracy of instruments available for the total assessment. Guidance on this assessment is detailed in ISO 14064-1:2018, Annex C.

A list of activity data shall be defined based on reliability as primary and secondary data:

— Primary data: quantified value of a process or an activity obtained from a direct measurement or a calculation based on direct measurements

— Secondary data: data obtained from sources other than primary data

There is always a preference to use primary data. Only in the absence of primary data, secondary data may be used, that could include estimated quantities and industry average emission factors.

Typically, primary data is recorded to enable GHG quantification contributing >5 % of the site's total GHG emissions. For smaller individual sources a calculated approach is acceptable.

The following subclauses describe sources to consider and typical quantification approach for the main emissions sources.

6.1.2 Emissions from fuel combustion

The quantification approaches for emissions from fuel combustion are described in Table 2.

Table 2 — Emissions from fuel combustion at LNG liquefaction facilities

Source	Examples	Quantification approach
Gas turbine drivers	Primary liquefaction drivers, power generation drivers, other refrigeration drivers (e.g. fractionation), CO_2 sequestration compressor drivers	Typically, primary data is recorded to enable GHG quantification. As a minimum, fuel gas consumption and composition are required. (Noting that fuel composition at an LNG plant can vary widely depending on operating mode)
Diesel drivers	Firewater pumps, power generation, boiler feed water pumps	Operator may report typical annual diesel consumption and include resulting annual emissions as a nominal allowance in the GHG calculation
Boilers	Steam for turbine drivers, steam for process heating	Typically, primary data is recorded to enable GHG quantification for major fuel consumers

Source	Examples	Quantification approach
		(contributing >5 % of the total GHG emissions.) As a minimum, fuel gas consumption and composition shall be measured
Fired heaters	Regeneration gas heater, heating medium heater, direct fired reboilers	If fuel measurements are available, operator should record total fuel gas consumption and composition. If direct fuel measurements are not available, a calculation based on operating duty and efficiency is acceptable
Incinerators	Acid gas vent incinerator, thermal ~~oxidisers~~oxidizers, catalytic ~~oxidisers~~oxidizers, waste disposal	As above
~~NOTE:~~ Unburned hydrocarbons shall be taken into account in all sections. If fuel measurements are available, operator should record total fuel gas consumption combined with combustion efficiency data for the fired equipment used. Ideally, combustion efficiency should be validated with measured emission data.		

6.1.3 Emissions from flaring and venting

The quantification approaches for emissions from flaring and venting are described in Table 3.

Table 3 — Emissions from flaring and venting at LNG liquefaction facilities

Source	Examples	Quantification approach
Atmospheric waste disposal from treating units	Acid gas vent, sulphur plant tail gas	Typically, primary data is recorded to enable GHG quantification from venting contributing >5 % of the site's total GHG emissions. For smaller individual sources a calculated approach based on heat and material balance data is acceptable. As a minimum, fuel gas consumption and composition are required
Atmospheric venting of unburned hydrocarbon	Feed gas pipeline blowdown, storage tank venting and pressure protection, loading arm blowdown, compressor blowdown, flare operation with failed ignition	Typically, primary data is recorded for significant venting events, such as pipeline blowdown. A calculated approach is acceptable for venting events contributing <5 % of total annual emissions
Flares	Process plant pressure protection, depressuring, storage tank pressure protection, boil-off gas management, refrigerant composition management, purge gas and pilots	Typically, primary data is recorded to enable GHG quantification from flaring contributing >5 % of the site's total GHG emissions. For smaller individual sources a calculated approach is acceptable.
Nitrogen vents from NRU	Nitrogen vents from nitrogen rejection units can contain methane, and are generally routed to atmosphere	If primary data not available, a calculated allowance using licensor composition data may be used.
~~NOTE:~~ Unburned hydrocarbons shall be taken into account in all sections. Operator should record total flare gas, combined with combustion efficiency data for the flare tip used. Ideally, combustion efficiency should be validated with measured emission data.		

6.1.4 Fugitive emissions

The quantification approaches for fugitive emissions are described in Table 4.

Table 4 — Fugitive emissions at LNG liquefaction facilities