



**International
Standard**

ISO 6338-2

**Calculations of greenhouse gas
(GHG) emissions throughout the
liquefied natural gas (LNG) chain —**

**Part 2:
Natural gas production and
transport to LNG plant**

*Calcul des émissions de gaz à effet de serre (GES) dans la chaîne
gaz naturel liquéfié (GNL) —*

Partie 2: Production du gaz naturel et transport à l'usine GNL

**First edition
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 document 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.

Introduction

Natural gas will play a key role in the energy transition (e.g. by replacing coal to produce electricity) and the use of liquefied natural gas (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 utilized.

There is no standardized 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 are inconsistent in their results or not easily applicable.

The ISO 6338 series covers each part of the LNG chain and enables a consistent GHG inventory.

The KPIs and related requirements to access to key international initiatives, agreements and reporting/accounting standards on climate ambitions and zero carbon emission strategies are given in ISO 6338-1:2024, Annex B.

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 is not possible to make like-for-like comparisons, or define a certification scheme, for one block only.

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Calculations of greenhouse gas (GHG) emissions throughout the liquefied natural gas (LNG) chain —

Part 2: Natural gas production and transport to LNG plant

1 Scope

This document provides a method to calculate the greenhouse gas (GHG) emissions during natural gas production (onshore or offshore), gas processing and gas transport to liquefied natural gas (LNG) liquefaction plant.

NOTE It can be applied to other gases as biogas or non-traditional types of natural gas.

This document covers all facilities associated with producing natural gas, including:

- drilling (exploration, appraisal, and development) and production wells;
- gas gathering network and boosting stations (if any);
- gas processing facilities (if any), transport gas pipelines with compression stations (if any) up to inlet valve of LNG liquefaction plant.

This document covers facilities associated with producing other products (such as, but not limited to, domestic gas, condensate, Liquefied Petroleum Gas (LPG), sulphur, power export) to the extent required to allocate GHG emissions to each product.

This document covers the upstream facilities “under operation”, including emissions associated with commissioning, initial start-up and restarts after maintenance or upset. This document does not cover the exploration, construction and decommissioning phases or the losses from vegetation coverage.

This document covers all GHG emissions associated with production, process and transport of natural gas to the LNG liquefaction plant. These emissions spread across scope 1, scope 2 and scope 3 of the responsible organization, as defined in ISO 6338-1. All emissions sources are covered including flaring, combustion, cold vents, process vents, fugitive leaks and emissions associated with imported energy. Gases covered include CO₂, CH₄, N₂O and fluorinated gases.

This document does not cover compensation.

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.

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 6338-1, *Calculations of greenhouse gas (GHG) emissions throughout the liquefied natural gas (LNG) chain — Part 1: General*

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*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 14064-1 and ISO 6338-1 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/>

4 Principles

The principles given in ISO 6338-1 shall be followed.

5 GHG inventory boundaries

The GHG report for an onshore or offshore plant for the production, processing and conditioning of natural gases (NG) to be used as LNG shall cover all facilities which are associated to produce LNG. The list in [Table 1](#) is not exhaustive.

Table 1 — List of facilities within the scope of this document

NG production, processing and conditioning plant facility	In scope	Out of scope
Natural gas production wells	X	
Natural gas gathering system	X	
Slugcatchers and condensate removal facilities	X	
Sour gases removal units	X	
Mercury removal units	X	
Dehydration and water removal units	X	
Any other natural gas conditioning units	X	
Natural gas stabilization units	X	
Dew point adjustment units	X	
Quality adjustment and metering units	X	
Natural gas compression	X	
Natural gas pipeline transportation to liquefaction plant and any other logistics	X	
Oil and gas separation	X	
LPG extraction upstream of liquefaction	X	
Non-fossil gas production	X	
Condensate treatment and stabilization facilities		X
Sour water facilities		X
Condensate fractioning facilities		X
Facilities for LPG or gasoline		X
Liquefaction		X (ISO 6338)
All facilities downstream liquefaction		X

The organization having financial and/or operational control over the facilities 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 General

The following steps shall be performed to quantify the GHG emissions associated with gas supply to an LNG facility:

- develop a flow diagram of the complete upstream system, from the gas reservoir, or other source of natural gas (such as bio-methane, e-methane);
- for each production or processing step in this system, identify the complete inventory of GHG sources;
- for each production or processing step that has multiple commercial products, allocate the total GHG associated with that step to the products, including the gas supply to the LNG facility.

6.2 Defining the upstream system

6.2.1 General

The first step to quantify upstream emissions is to develop a flow diagram of the gas supply system upstream of the LNG facility. 6.2.2 to 6.2.5 show some typical arrangements.

6.2.2 Gas production feeding LNG liquefaction directly

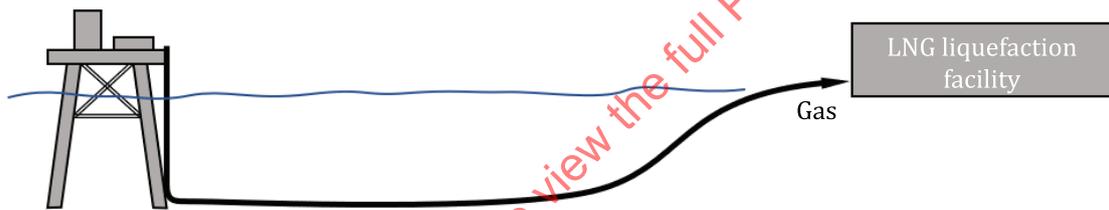


Figure 1 — Gas production feeding LNG liquefaction directly

In the arrangement shown in Figure 1, all the produced hydrocarbons are fed to the LNG liquefaction facility, hence all the GHG emissions associated with the upstream system are carried forward in the feed gas to the liquefaction plant.

6.2.3 Oil production with associated gas feeding LNG liquefaction

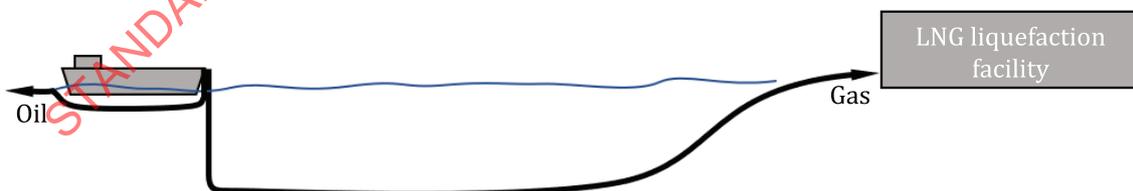


Figure 2 — Oil production with associated gas feeding LNG liquefaction

In the arrangement shown in Figure 2, the total GHG emissions associated with the upstream facilities shall be allocated to the oil product and gas feed to the LNG liquefaction facility. 6.6 provides more information on allocation.

6.2.4 LNG liquefaction fed from gas grid

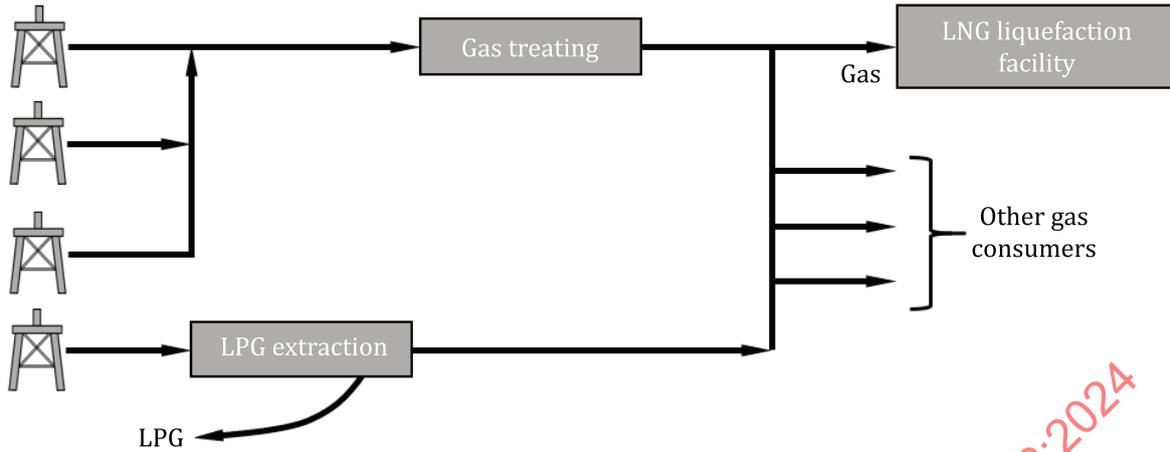


Figure 3 — LNG liquefaction fed from gas grid

Figure 3 shows a more complex arrangement. Many LNG liquefaction facilities are fed from a gas grid. The grid may have multiple gas supplies, multiple different extraction and processing facilities and multiple customers. Furthermore, over time, the producers, processors, and other gas consumers may be variable.

The following steps shall be performed to analyse a complex system such as the example in Figure 3:

- draw a flow diagram of the upstream system, tracing back to the origin of all the gas supplies that can arrive in the liquefaction plant feed;
- obtain operating data for the network, including flow rates and compositions; in case of varying flowrates at producers and consumers, the average of the previous 12 months' data may be used as representative;
- obtain GHG emissions data for all processing in the supply network, which may include compression, gas treating to remove contaminants, extraction processes to remove other commercial products such as LPG or condensate, flaring, venting and fugitives;
- for processing steps where another commercial product is extracted, such as the LPG extraction unit in Figure 3, an allocation calculation is required to allocate the correct proportion of the GHG emissions to the gas feed to the liquefaction plant.

The result of the analysis described above is a quantity of GHG emissions assigned to the LNG plant feed gas, generally based on the “average” operating performance of the gas grid over the previous 12 months.

6.2.5 LNG liquefaction supplied with non-fossil feed



Figure 4 — LNG liquefaction supplied with non-fossil feed

In case of non-fossil gas supply shown in Figure 4, such as biogas or synthetic methane from low carbon hydrogen and recycled carbon dioxide, the gas supply shall be analysed to identify any GHG associated with feed gas supply.

NOTE 1 The GHG associated with the feed to the liquefaction facilities can be negative in this situation, in case of carbon dioxide or methane capture.

NOTE 2 These types of gas are often associated with a certificate.

NOTE 3 When liquefaction is part of the upgrading process for biogas, the quantification of GHG is typically addressed by certificates.

6.3 Identification of GHG sources and quantification approach

6.3.1 General

The general approach is given in ISO 6338-1. Emissions estimation guidance for LNG value chain can be found in the API *Consistent Methodology for Estimating Greenhouse Gas Emissions from Liquefied Natural Gas (LNG) Operations (2015)*^[24].

6.3.2 Emissions from fuel combustion

The quantification approaches for emissions from fuel combustion are described in [Table 2](#).

Table 2 — Emissions from fuel combustion

Source	Examples	Quantification approach
Gas turbine drivers	Primary gas compression drivers, power generation drivers, other refrigeration drivers (e.g. fractionation), CO ₂ sequestration compressor drivers	Typically, primary data are recorded to enable GHG quantification. As a minimum, fuel gas consumption and composition shall be measured (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 are recorded to enable GHG quantification for major fuel consumers (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 may be used on operating duty and efficiency.
Incinerators	Acid gas vent incinerator, thermal oxidizers, catalytic oxidizers, waste disposal	As above.
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.		

6.3.3 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

Source	Examples	Quantification approach
Atmospheric waste disposal from treating units	Acid gas vent, sulphur plant tail gas	Typically, primary data are 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 shall be measured.
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 are recorded for significant venting events, such as pipeline blowdown. The primary data may be calculated 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 are recorded to enable GHG quantification from flaring contributing >5 % of the site's total GHG emissions. The primary data may be calculated for smaller individual sources.
Nitrogen vents from NRU	Nitrogen vents from nitrogen rejection units can contain methane, and are generally routed to atmosphere	If primary data are not available, a calculated allowance using licensor composition data may be used.
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.		

6.3.4 Fugitive emissions

The quantification approaches for fugitive emissions are described given in [Table 4](#).

Table 4 — Fugitive emissions

Source	Examples	Quantification approach
Permeation	Emissions through porous materials	Can be calculated with emissions factors for different materials.
Gas leaks	Leaks from pipes and fittings, rotating equipment seals, storage tank seals	Typically done via calculation using equipment count and standard leakage factors. Measured leakage data from atmospheric monitoring may be used to adjust the leakage factors applied.

6.3.5 Emissions associated with imported energy, utilities, and consumables

Emissions associated with imports require data from the exporter. Contractual relationship with the exporter should include a requirement to provide emissions data. In the absence of reliable GHG data for imports, the calculation shall account for the complete supply chain for the imported commodity. The cut-off criteria for reporting shall be defined in accordance with ISO 14044.

The quantification approaches for emissions associated with imported energy, utilities and consumables are described in [Table 5](#).