Recommended guideline
for
Greenhouse gas and Carbon intensity accounting framework for LNG/Hydrogen/Ammonia project
(JOGMEC GHG/CI guideline)

Executive Summary

Version 1

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Preface, background, and purpose

JOGMEC hereby presents a guideline (hereinafter "Guideline") to enable the calculation of greenhouse gas emissions (GHG) and carbon intensity (CI) according to the actual operation mode by comparing and examining several international standards related to GHG emissions. This is one of JOGMEC's actions to support the implementation of liquified natural gas (LNG), ammonia, and hydrogen projects by Japanese business entities. Important to note is that this guideline has been established according to current international standards and does NOT propose a new methodology. The content of this Guideline includes 1) appropriately setting the system boundaries to enhance the transparency and comparability with other guidelines, 2) recommends using primary data (measurement, operation data, equipment-specific emission factor) for major GHG emission sources to calculate the GHG emission that reflects the actual operation mode, and 3) provides a transparent GHG emissions approach to reflect the environmental value of the product / energy source.

＜Steps for calculating CI＞

- Step 1: Identify the process and flow for each stage of the product lifecycle
- Step 2: Prepare data to calculate GHG emissions and CI for each identified process/flow
- Step 3: Identify byproducts and determine the GHG allocation method
- Step 4: Determine the GHG emission calculation method for the product
- Step 5: Calculate the carbon footprint (CFP) of the product
- Step 6: Calculate the CI of the product, and compile in report
- Step 7: Report the CI (if necessary, after third-party verification)

Chapter 1
Coverage of Guideline and data handling

This chapter outlines the boundaries of the Guideline for calculating the GHG emissions of the targeted products (LNG, hydrogen, and ammonia). As previously noted, the guideline is not meant to propose a new methodology; however, it does define the system boundaries and central premise behind the system flow, and method for reporting the calculation results.

1. System boundaries

Basic philosophy

This guideline sets the boundary from the feedstock production until the export point of the final product (Well to Gate). GHG emissions related to the process after the export point (e.g., storage, transportation, supply, and final consumption) are not considered.

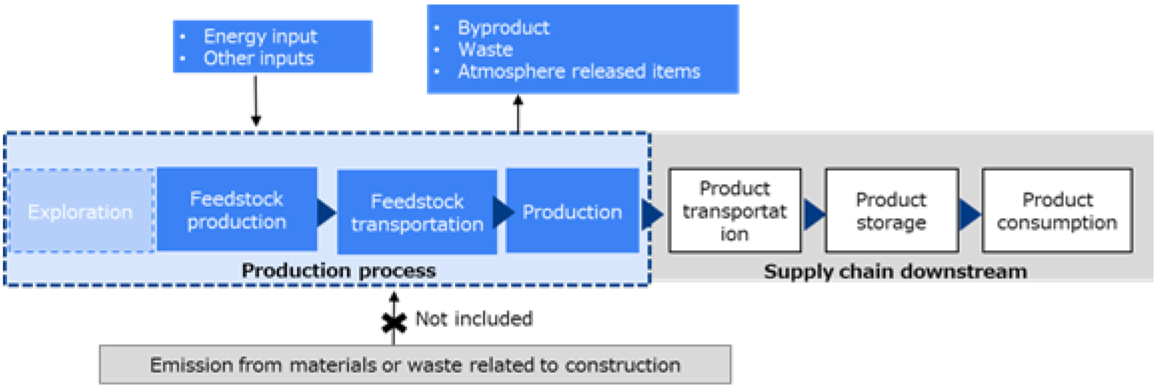

Fig 1:System boundaries and process

The amount of energy input, waste, and atmospheric emissions should be identified for each process. If there is doubt when comparing the input and output data, additional data may be necessary to verify the fairness. The collected data included the following:

- Energy input, and other input (if any)
- All byproducts
- Waste products, direct atmospheric emission

Cut-off criteria

The cut-off criteria refer to the material/energy flow and GHG emissions not included in the CFP calculation. The guideline recommends not using cut-off criteria and suggests the use of alternate data to calculate GHG emissions. Simultaneously, it refers to the England carbon footprint standard (PAS2050) if a cutoff needs to be set.

Allocation

If several products are produced during the process of each boundary, GHG emissions must be allocated between the main product and byproduct. The guideline refers to the ISO14044 to break down the process or expand the system boundary as a means to avoid allocation.

2. Calculation data

Data aggregation and quality

For each process inside the boundary, input data (energy input and consumption) and output data (waste products and atmospheric emissions) needs to be collected. High-quality data will help ensure assure the accuracy of GHG emissions and reduce uncertainty and bias. Where applicable, using primary data is recommended to ensure high-quality data.

Chapter 2
GHG emission calculation

This chapter explains the GHG emission calculation method for the targeted products.

１. GHG of interest

The Guideline focuses on the following as “GHG”

- Carbon dioxide（CO_2）
- Methane（CH_4）
- Nitrous oxide（N_2O）
- Hydrofluorocarbons（HFC）
- Perfluorocarbons（PFC）
- Sulfur hexafluoride（SF_6）
- Nitrogen trifluoride（NF_3）

２. GHG emission source

GHG emission categories and the main source of emission are listed in Table 1.

Table 1: Main emission sources for each emission category

Priority for data gathering	
Primary data (direct)	Direct measurement, flow measurement, and gas sampling
Primary data (indirect)	Engineering assumption and fuel composition modelled under a process-specific condition.
Secondary data (direct)	De-facto value according to the process. Includes values that are derived from LCA models, where specific primary data is used as an input.
Secondary data (indirect)	Standardized emission factors, values that are derived from LCA models, where specific primary data is NOT used as an input.

3. Calculation of GHG emission

Typical GHG calculation methods include the following:

Table 2: GHG calculation methodology and its features

Categorization	Calculation methodology	Carbon dioxide (CO_2)	Methane (CH_4) Nitrous Oxide (N_2O)
Primary data	Project specific emission factor	• CO_2 emission relies on the fuel type rather than specific equipment • Emission factors provided by manufacture is based on combustion equipment, fuel, air-fuel ratio	• Emission relies heavily on specific equipment
	Engineering calculation with operation data	• Can be applied to various emission sources, but relies on the methodology and assumptions • May need specific data	• May need specific data
	Emission factor derived from activity factor (actual measurement data and/or operation data)	• Accuracy is comparable to that of the engineering calculation	• Emission factor that reflects the actual operation mode
	Direct measurement	• Accuracy is comparable to that of engineering calculation	• High accuracy • Requires intense cost and time
Secondary data	Conventional emission factor	• Based on average carbon content of each fuel • Fuel composition is derived from fuel type	• Emission relies heavily on specific equipment • Uncertainty does not have much effect on the overall emission

Source: API, 2021: Compendium of Greenhouse Gas Emissions Methodologies for the Oil and Natural Gas Industry, USA, 138 pp. (Table 4-1), partially amended

To calculate GHG emissions, many guidelines adopt the secondary data method by multiplying the general emission factor and the activity factor rather than using direct measurement data. However, this method may not accurately reflect the actual operation mode of a plant. Thus, the Guideline recommends using primary data, especially for major emission sources. The GHG emissions amount can be calculated using the following equation for both direct and indirect emissions:

$$GHG\ emission[t\text{-}CO_2eq] = Activity\ factor \times GHG\ emission\ factor \times coefficient \times GWP$$

- Activity factor: Activity data for a certain period. Primary data are recommended, although the assumed value may be used.

- <u>GHG emission factor:</u> GHG emission data per unit of activity unit. The emission factor should be determined based on the direct measurement data (gas sampling) or a value specific to the target fuel or equipment.
- <u>Coefficient:</u> Additional factors for GHG emission calculation, such as unit conversion, emission factor adjustment, and heating value adjustment.
- <u>GWP (Global Warming Potential):</u> GWPs for major GHG are described in Chapter 2 (1).

3. Methane leakage

Methane is known to contribute to climate change and there are global movements for the reduction of methane emissions. LNG or methane-derived hydrogen and ammonia projects have usually introduced measurements to reduce fugitive methane; however, there are cases where methane is released into the atmosphere. Thus, an appropriate management system is increasingly important to ensure that methane leakage is not excluded from the GHG emission calculation. Methane measurement methods can be categorized as “bottom-up” and “top-down”, which will be discussed in this section.

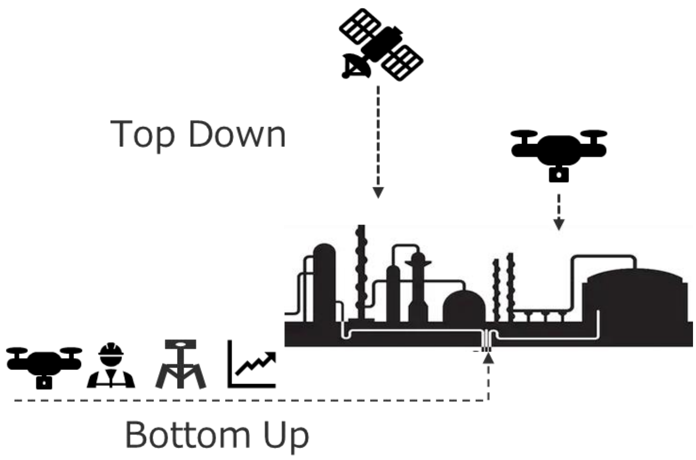

Fig 3: Illustration of methane measurement

4. Production process flow

This section describes the typical block flow used to produce LNG, hydrogen, and ammonia. The process and flow should be adjusted according to the target plant when applying the Guideline.

5. Selection of GHG emission calculation methodology

The Guideline recommends using primary data for major emission sources so that the GHG emissions related to the product reflect the actual operation mode. Even when primary data are obtained, an appropriate calculation methodology should be selected according to the emission source or target gas. This section presents examples of the GHG emission calculation methodology for each emission source and target gas (especially carbon dioxide, methane, and nitrous oxide).

Chapter 3
Calculation of product Carbon Intensity (CI)

This chapter explains the calculation method of the product CI that should be reported through this Guideline, along with the basic ideas for carbon dioxide capture, utilization, and storage (CCUS) and carbon crediting.

１.CI calculation

The Guideline calculates the product CI according to the CFP calculation method to enable multiple stakeholders to compare the product CI for different lifecycle stages. The calculation is done using the following equation:

$$Product\ CI\ (Carbon\ Intensity) = \frac{Product\ GHG\ emission - emission\ deduction}{Product\ energy\ content\ or\ weight}$$

- Product GHG emission:
  "feedstock production", "feedstock transportation", and "production process" should be separately calculated.
- Emission deduction:
  Refer to Chapter 3.2 ” Emission deduction”
- Product energy content:
  Unit: MJ. Heating value should be unified to lower heating value (LHV)
- Product weight:
  Unit: metric ton

２. Emission deduction

As a countermeasure against global warming, the environmental value of products such as LNG, hydrogen, and ammonia need to be appropriately determined. To ensure this, a GHG emission calculation and reporting method that reflects the actual operating mode is essential. This section describes the basic concept of CCUS and carbon credits.

Carbon dioxide Capture and Storage（CCS）

When carbon dioxide is captured and stored within the boundary, it can be subtracted from the product CI value, given that the deduction calculation methodology is appropriate. In addition, refer to JOGMEC's guideline, which illustrates the calculation method for carbon storage amounts for CCS projects.

Carbon dioxide Capture and Utilization（CCU）

If carbon dioxide is captured and utilized in a product, it can be subtracted from the product CI value, given that the deduction calculation methodology is appropriate. For example, if carbon dioxide is used to produce a carbon-recycled product, it needs to be assured that the product can become an alternative to natural gas-based products, or that the fixed carbon dioxide will not be rereleased into the atmosphere after a short period.

Carbon credit

The credibility of applying carbon credits to the product CI is still under discussion. In contrast, there are existing crediting mechanisms established by governments where credits are awarded under an appropriate methodology and management system that increases the credibility of credits for emission deduction.

Appendix: Table of contents of GHG/CI guideline