Introduction of JOGMEC's Recommended Guideline for Greenhouse Gas and Carbon Intensity Accounting framework for LNG/Hydrogen/Ammonia Projects (JOGMEC CI Guideline) Ver. 2

Japan Organization for Metals and Energy Security

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1. Background

- Expansion of hydrogen, fuel ammonia, and synthetic fuels (e-fuel, e-methane) are expected to be introduced to achieve carbon neutrality by 2050.

- JOGMEC, as an organization responsible for stable energy supply for Japan, is promoting technical and business support for LNG, hydrogen, and ammonia projects with their lower greenhouse gas (GHG) emissions.

- From the viewpoint of climate change mitigation, it is important to consider the amount of GHG emitted in the production process of LNG, hydrogen, ammonia, and synthetic fuels (feedstock production, liquefaction, reforming, etc.). From the perspective of clean resource procurement, it will become even more important in future resource development to calculate GHG emissions and visualize their environmental value in terms of carbon intensity (CI) based on these emissions.

- Australia, the United States, and other countries are studying mechanisms to certify GHG emissions during production, while in Europe, efforts are ongoing to set CI thresholds for defining clean resources. However, the calculated value of GHG emissions varies depending on the selected calculation method. Even if existing international standards are invoked, the calculation values vary because of differences in the system boundary settings and calculation methods, such as whether to calculate using general emission factors as secondary data or emission factors based on actual measurements and operation data as primary data. Therefore, the search for a consistent and highly transparent calculation method is in progress.

- Based on the above social situation, to support the promotion of LNG, hydrogen, ammonia, and synthetic fuel businesses by Japanese operators, JOGMEC has compared and verified multiple existing international standards and formulated recommendation guidelines for GHG and CI calculations. This guideline is in harmony with existing international standards and does not define any new calculation methods.

- First edition (Ver.1), published in May 2022, has been updated and the second edition (this document) has now been developed and published. Major changes from the Ver.1 are described on slides 4, 5, and 6

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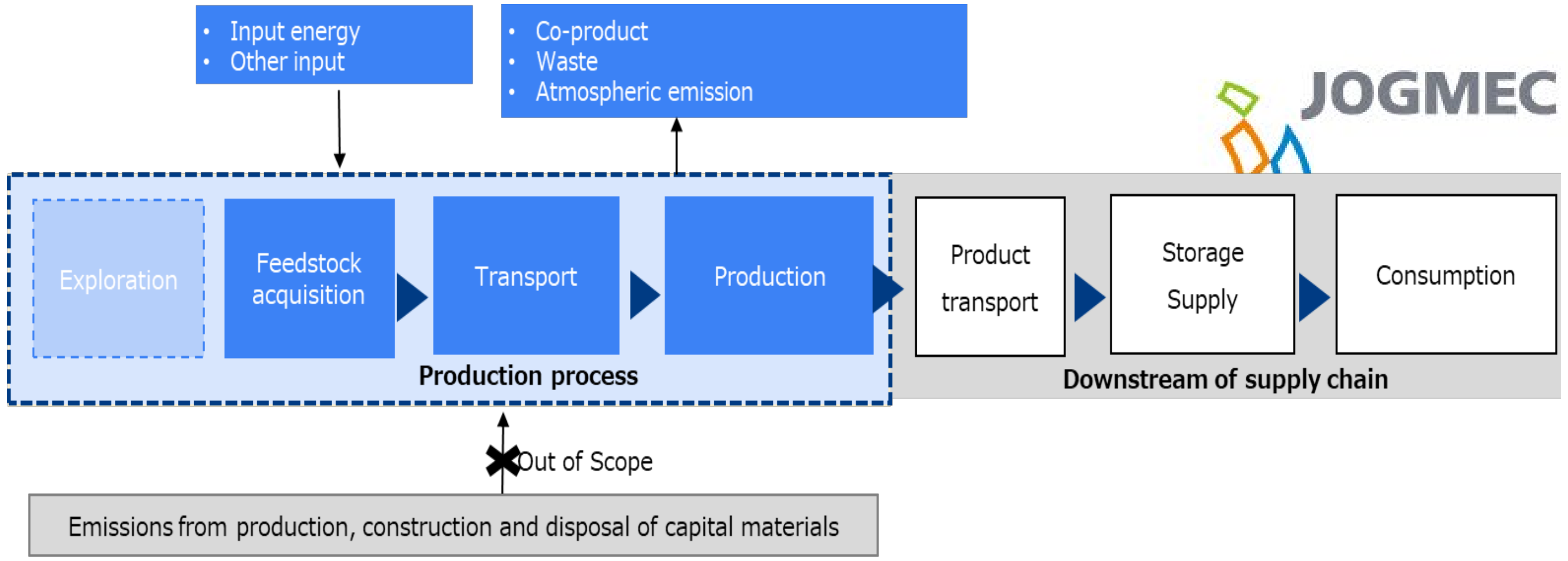
➢ This guideline is in harmony with existing international standards and does not define any new calculation methods; however, it has the following features:

① Various conditions, such as system boundaries, are clearly and appropriately set to enhance transparency and comparability with other guidelines and standards.

② For the major GHG emission sources and types of GHGs that significantly impact calculation results, use of primary data (actual measurements, operating data, business-specific emission factors, etc.) is recommended in the calculation of GHG emissions that could reflect actual business conditions

③ The guideline suggests a highly transparent method for calculating GHG emissions and CI containing methane (CH4), which can also accurately reflect the environmental value of energy resources.

3. Feature - *Overview of Ver.1*



➢ Based on international discussion

- We have organized internationally harmonized calculation methods by referring to ISO, IPHE and national and regional systems and discussions.

➢ Importance of using primary data at major emission sources

- Organize the idea of each emission source and primary & secondary data
- Use of primary data provides a more accurate representation of actual project emissions.
- Recommend using primary data for major emission sources for practical use.

➢ Methane Emissions Management

- To establish monitoring and management methods using CH4 measurement technology
- To calculate GHG emissions after showing that there are no unidentified and unaccounted methane leaks.

Classification of methods by data	Calculation method	CO2	Methane Nitrous oxide
Method using primary data	Calculations using specific emission factors on a project	• Emission factor values recommended by manufacturers are based on type of combustion equipment, air and fuel ratio and fuel type	• Emissions strongly depend on equipment characteristics
	Engineering calculations using operating data	• Able to be applied to many sources but depends on methodologies and assumptions used • Sometimes detailed data is required	• Sometimes detailed data is required
	Calculated using activity data such as emission factors from actual measurement data and operating data	• Calculation accuracy is considered to be less different from engineering calculation	• It is possible to calculate an emission factor that matches the actual situation
	Calculation of emissions using measured data (Actual measurements for all target emission sources and for all periods)	• Calculation accuracy is considered to be less different from engineering calculation • Generally impractical given the huge number of sources of emissions in product manufacturing plants	• Calculation accuracy is high, but it takes a lot of cost and time
Method using secondary data	Calculations using general emission factors	• Based on average carbon content of various fuels • Fuel composition is determined by fuel type	• Emissions depend on equipment type • Uncertainty contributes less to overall emissions calculations

4. Feature - *Identification of major sources of GHG emissions (addition to Ver.1)*

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➢ Background for the addition

- Prioritizing use of project-specific primary data to improve data quality

➢ Identification of major emission sources at LNG and ammonia plants

- .Based on JOGMEC ‘s technical verification projects and surveys, we have organized the following as major emission sources:

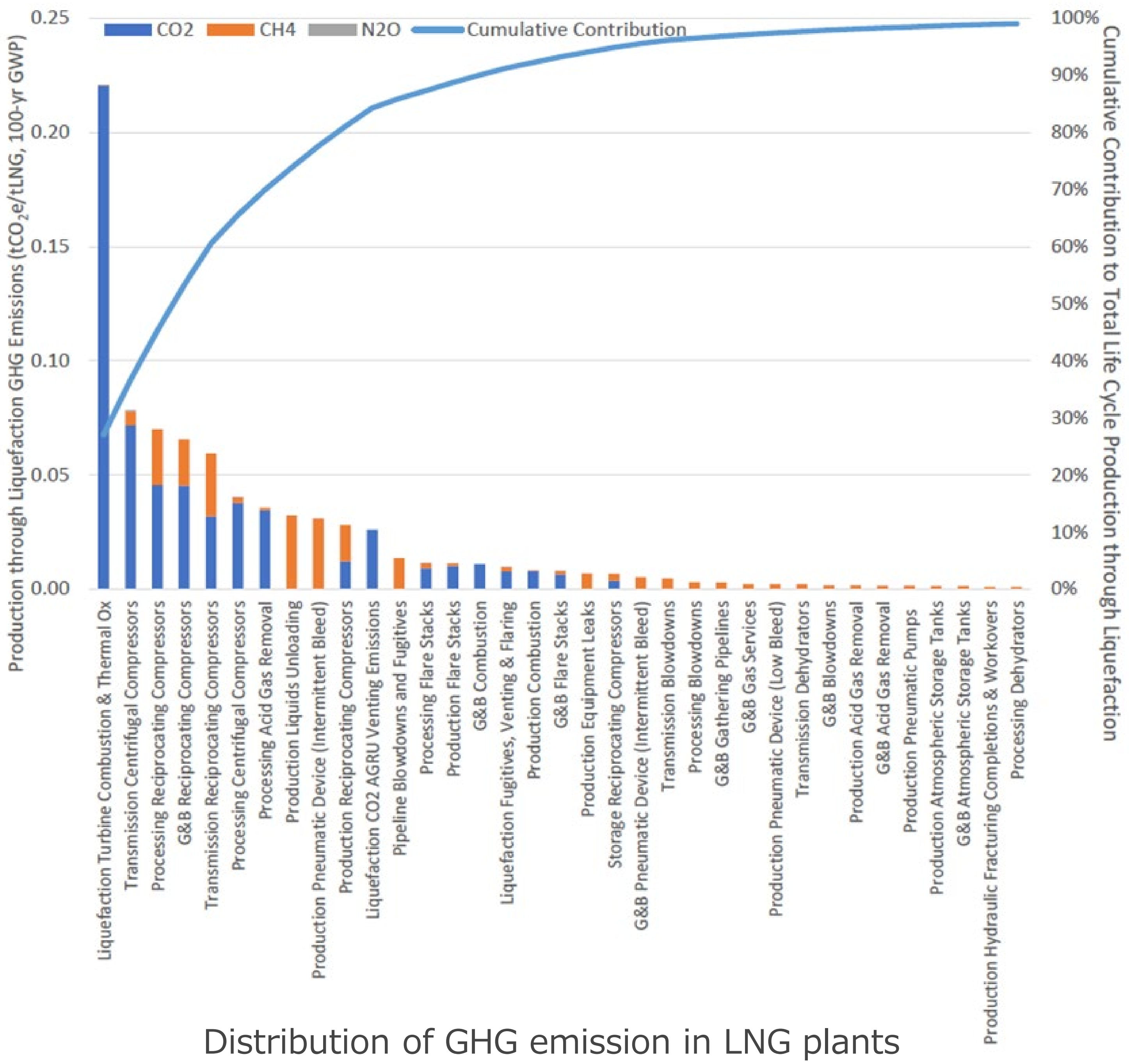
LNG plant

- Emissions from refrigerant compressor drivers and internal engines for power generation
- Vent to atmosphere from an acid gas removal unit

Ammonia production plant

- Vent to atmosphere from acid gas removal unit
- Emissions from a primary reformer
- Emissions from boilers
- Emissions from internal combustion engines for power generation

These major emission sources account for approximately 80% of total emissions



Distribution of GHG emission in LNG plants
Source: Paper written by Cheniere

・The premise of this guideline is to measure all emissions.
・It may be acceptable to use primary data for major emission sources that account for more than 80% to improve data quality, while using secondary data for the remaining 20% in order to reduce the burden on project operators.

5. Feature - *Hydrogen from water electrolysis (addition to Ver.1)*

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➢ Background for the addition

- Since ①hydrogen production from renewable energy sources is a trend and ②hydrogen is one of the raw materials for e-methane, in addition to hydrogen production by steam reforming of natural gas (mainly methane), hydrogen derived from water electrolysis is added to the scope of this guideline.

➢ GHG emissions calculation method based on IPHE

- GHG emissions should consider not only electrolysis but also electricity, heat, and steam used in pretreatment and downstream processes.
- Indirect emissions from the production of electricity, heat, and steam supplied from outside the system boundary are also included in GHG emissions.
- If electricity from renewable resources is produced and used within the system boundary, GHG emissions from electricity use can be considered zero.

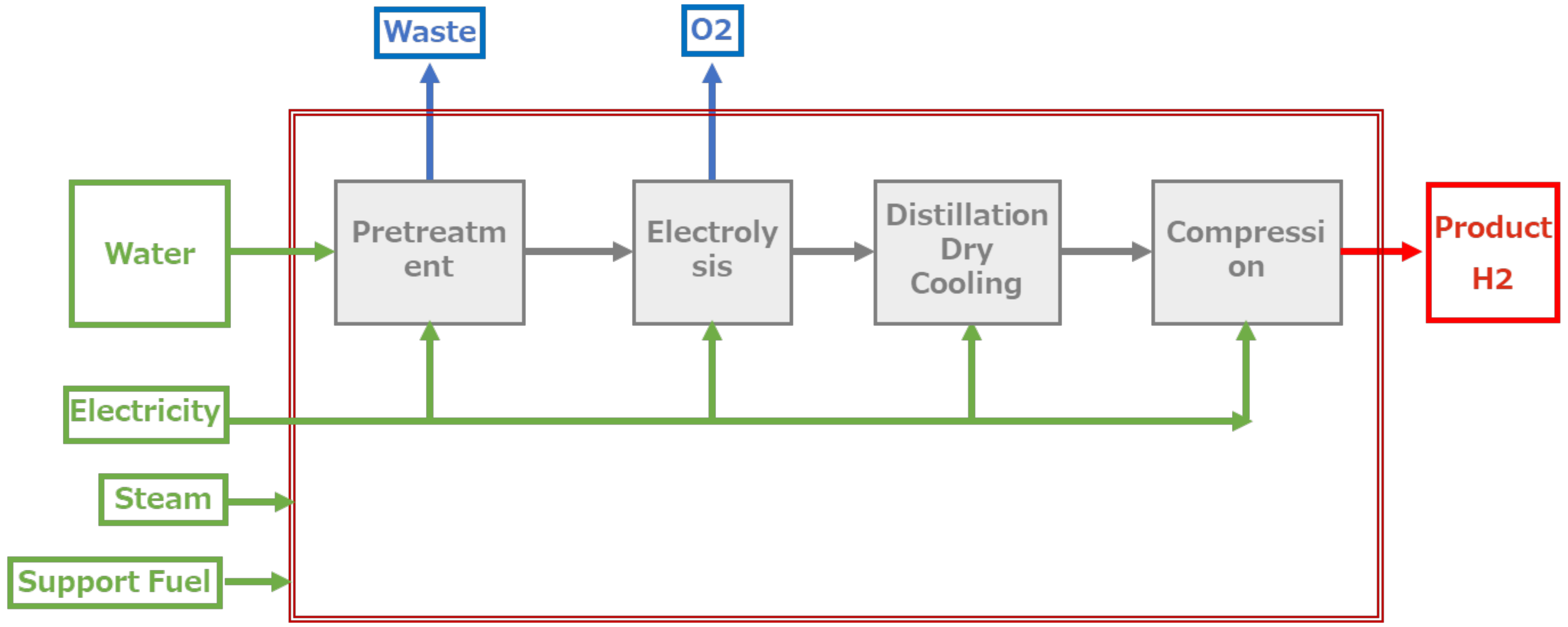

Figure. Block flow diagram of water electrolysis

Process	Major emission source	Other emission sources (*1)
Pretreatment	Impurity removal equipment	-
Electrolysis Distillation, Dry, Cooling, Compression	Each equipment	External equipment which supplies electricity, heat or steam. Equipment which produces electricity, heat and steam by fuel combustion within the system boundaries.

(*1) when applicable

6. Feature - *CI calculation for E-methane (addition to Ver.1)*

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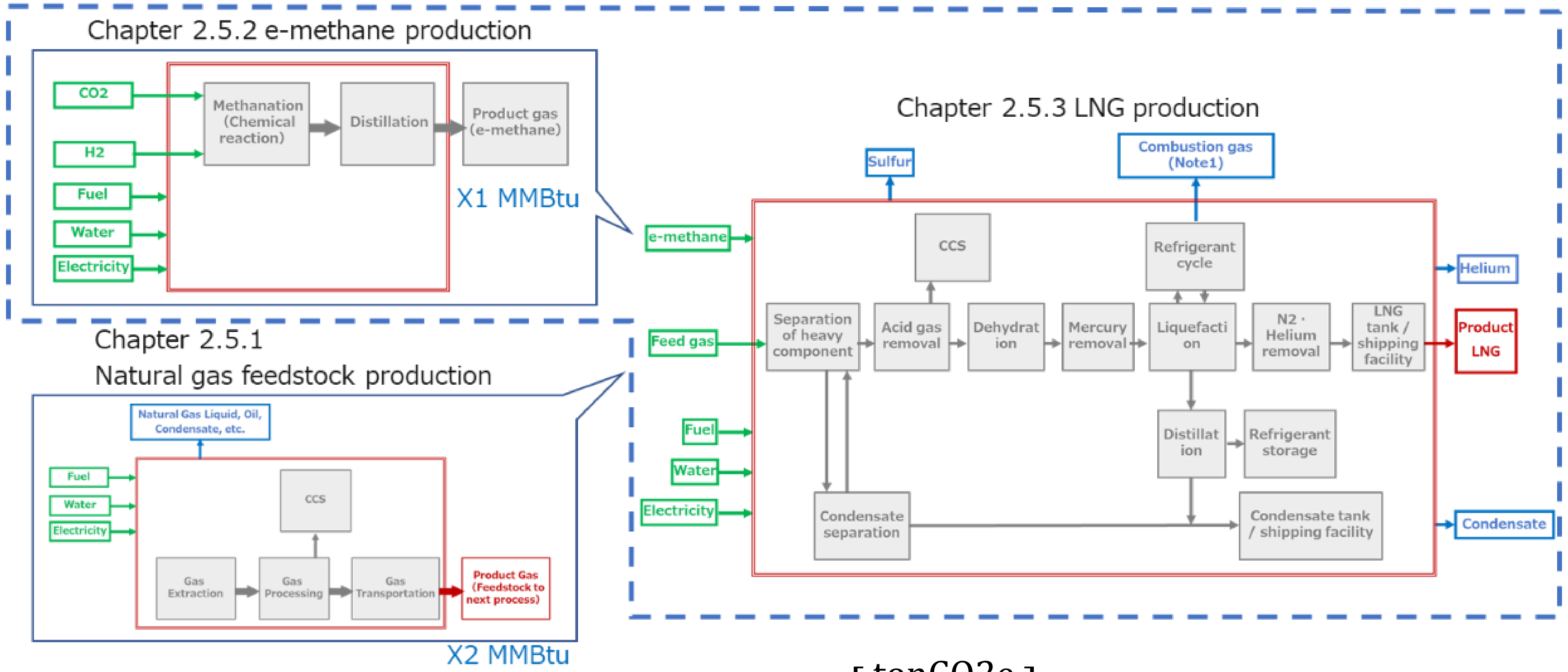
➢ Background for the addition

- e-methane is produced through a synthesis reaction with hydrogen and captured CO2, and it is one of the synthetic fuels used as energy. e-methane is expected to make effective use of existing LNG and natural gas infrastructure, such as city gas pipelines and LNG carriers.
- IPCC Sixth Assessment Report (AR6) also mentions "power to fuels", indicating that e-methane has a high affinity with existing gas systems.

➢ CI calculation method for e-methane

- In the case of DAC (Direct Air Capture) or biomass technology, in which CO2 is captured from the atmosphere, GHG emissions from e-methane combustion are considered zero since the concentration of CO2 in the atmosphere does not change.
- Including notes on GHG emissions associated with the capture and transportation of feedstock CO2 and the handling of GHG emissions associated with the production and transportation of raw material hydrogen, etc.
- Providing calculation examples for mixing e-methane in LNG production.



$$CI_{\mathrm{LNG(e-methane\ derived)}}\left[\frac{\mathrm{tonCO2e}}{\mathrm{MMBtu}}\right] = \frac{\begin{array}{c}\text{GHG emissions of e} - \text{methane process [tonCO2e]} \\ +\text{GHG emissions of LNG production process } \times \alpha \text{ [tonCO2e]}\end{array}}{\text{Product LNG(e} - \text{methane derived) energy content [MMBtu]}}$$

$$(\alpha = \frac{x_1}{x_1 + x_2})$$

(Reference)

	CCS guideline	CO_2-EOR guideline	CI Guideline
Published May 2022	（Ver.1）		（Ver.1）
Public consultation started March 2023 Published June 2023		（Ver.1）	（Ver.2）