e-methane

For IEA Webinar
E-methane: a new gas for a net-zero future?

THE JAPAN GAS ASSOCIATION

Developing e-methane value chain for carbon neutral city gas supply in Japan

September 5th, 2024

Ryota KUZUKI, Ph.D.
Division Head, Int'l Certification & Standards Harmonization

Contents

e-methane

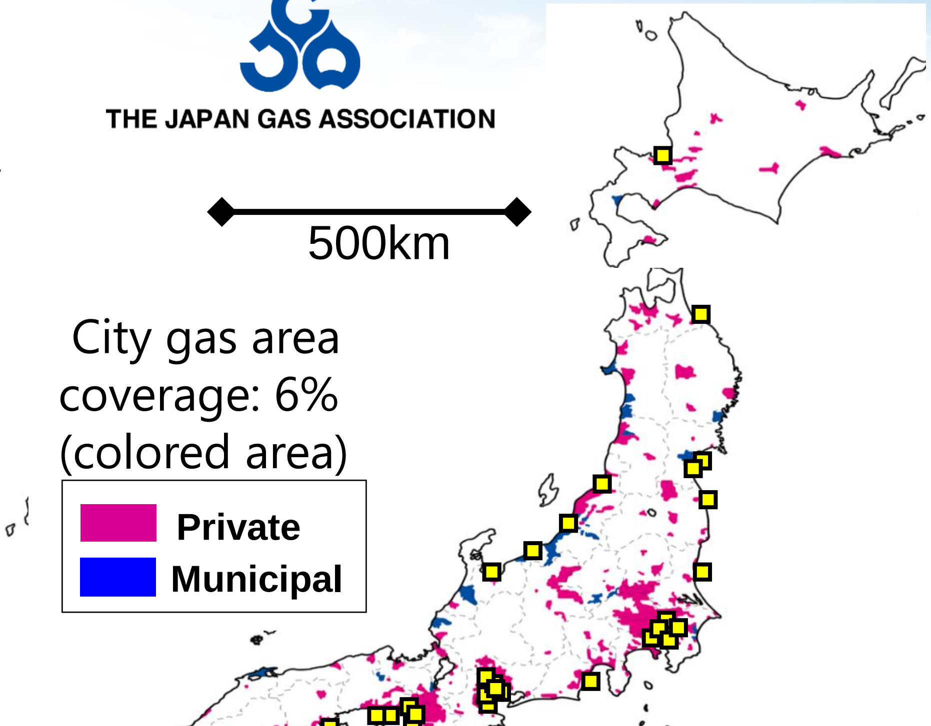
About JGA and Current Japan’s City Gas Industry

- **The Japan Gas Association (JGA) is a non-profit organization established in 1947, consisting of about 200 companies.**
- **Our members cover about 27 million customers, or about half of the total number of households in Japan, total volume of annual gas supply is about 40 billion m^3, total pipeline length is over 260 thousand km.**
- **Japan’s city gas industry was the "first mover" in the world to introduce and commercialize LNG for city gas supply in 1969. Now, there are 37 LNG terminals.**

LNG tanker
In 1969

Photos:
Tokyo Gas

THE JAPAN GAS ASSOCIATION



About 50 years have passed since the introduction of LNG

In October 2020, the Japanese government announced its goal of becoming carbon neutral (net zero carbon emissions) by 2050. In April 2021, it also set a new target of reducing GHG emissions in 2030 by 46% from 2013.

Prime Minister Y.Suga announced national target in 2050 in October,2020

Japan’s city gas industry is now facing a new challenge to meet the target.

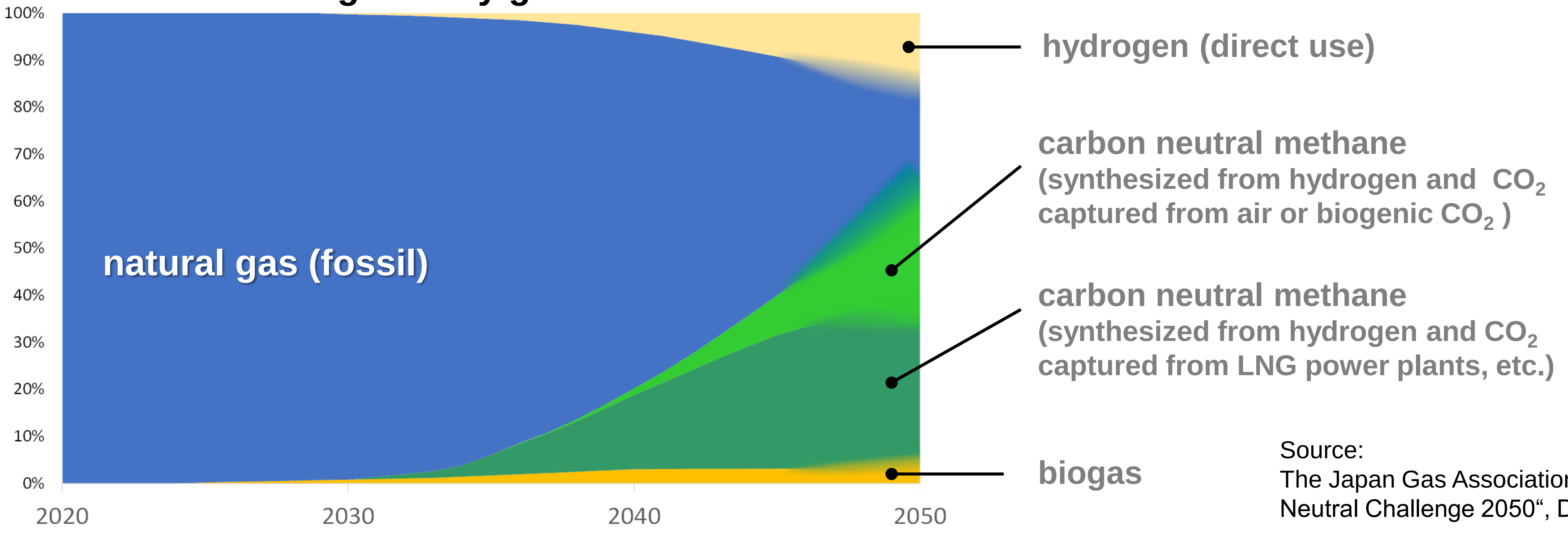
JGA's "Carbon Neutral Challenge 2050 Action Plan" and a role of e-methane

- In June 2021, JGA formulated and announced "Carbon Neutral Challenge 2050 Action Plan".
- This vision includes the goals for 2030-2050 of the city gas industry, consistent with the Japan's current Basic Energy Plan.

2030 Establish a value chain including overseas imports of e-methane, with 1% e-methane in city gas supply

2050 Achieving carbon neutral city gas supply by e-methane as main feedstock, and rest of the share will be covered by direct use of hydrogen, biogas and other means

Transition image of city gas feedstock share

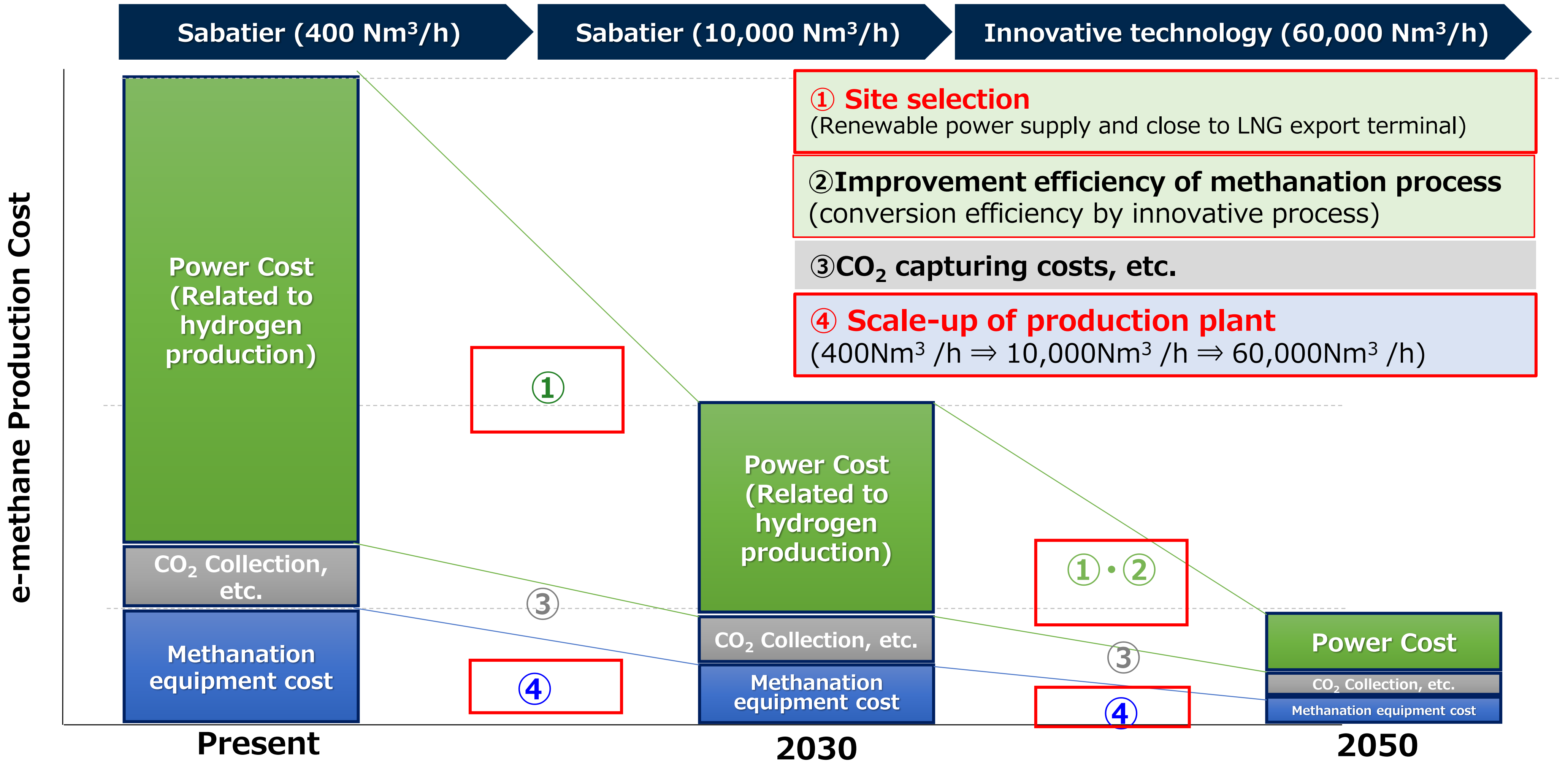


Source:
The Japan Gas Association, "Carbon Neutral Challenge 2050", December 2020

Contents

Image of production cost structure and critical factors for cost reduction

- The cost structure of e-methane is estimated to be much dependent on hydrogen production.
- Procurement of stable and inexpensive renewable power is the key. Production site selection is the most important.
- Followed by technological factors such as large-scale production and advanced higher efficient process.



Various efforts by leading Japanese companies

Japanese major gas companies are leading field tests. Various efforts are now underway to scale-up production, demonstrations, and feasibility studies of international projects.

As of Aug. 2024

Large scale (1000-100000 Nm^3/h)

Project site	Business entities, partners	Capacity	Feedstocks	Schedule
Cameron	Mitsubishi Corporation Tokyo Gas, Osaka Gas, Toho Gas, Sempra Infrastructures Partners LP	130,000 ton-CH_4/y	Green H_2, recycled CO_2, etc.	FY2023 FS FY2025 FID FY2030- Start production
Midwest	Osaka Gas, Tallgrass, Green Plains	Max 200,000 ton-CH_4/y	Blue H_2, biogenic CO_2	
FSs in other potential regions (Australia, Middle East, South-East Asia, South America, etc.) for commercial production plants				

ENEOS, OSAKA GAS (Daigas Group)
- Joint study on large-scale domestic production of e-methane
- Study on production scale : 10,000 Nm³/h (or 250,000 ordinary households) in Osaka port area.

Middle scale (100 – 1000 Nm^3/h)

TOKYO GAS
- In May 2024, start studying domestic e-methane production at Oji Paper's Mill in Tomakomai City, Hookaido.
- Start of demonstration of e-methane production by 2030 , expand to several thousand Nm^3/h beyond 2030

INPEX, OSAKA GAS (Daigas Group)
- Main construction of the methanation test plant started in Nagaoka City in October 2023.
- Approximately 400Nm^3/h production and injection into gas pipelines will start from FY2025.

JFE, IHI: JFE Steel and IHI signed contract in Dec 2022 to build 500Nm^3/h e-methane production plant by FY2024.

Hitz (Hitachi Zosen): Hitachi Zosen tested 125Nm^3/h e-methane production in 2022 with Odawara municipal government

Small scale (- 100 Nm^3/h)

SAIBU GAS HOLDINGS, KITAGAS, HIROGAS, IHI
- Joint e-methane production demonstration with Hokkaido Gas / Hiroshima Gas / Nihon Gas, etc.
- 12.5 Nm³/h of e-methane to be produced at Kitakyushu LNG terminal by the end of FY2025.

TOKYO GAS: 2022- 12.5Nm^3/h production; 2023- CO_2 from incineration plant

OSAKA GAS (Daigas Group): 2022- 5 Nm^3/h biomethanation in Konohana area

TOHO GAS: 2024- 5Nm^3/h in Chita with municipal government

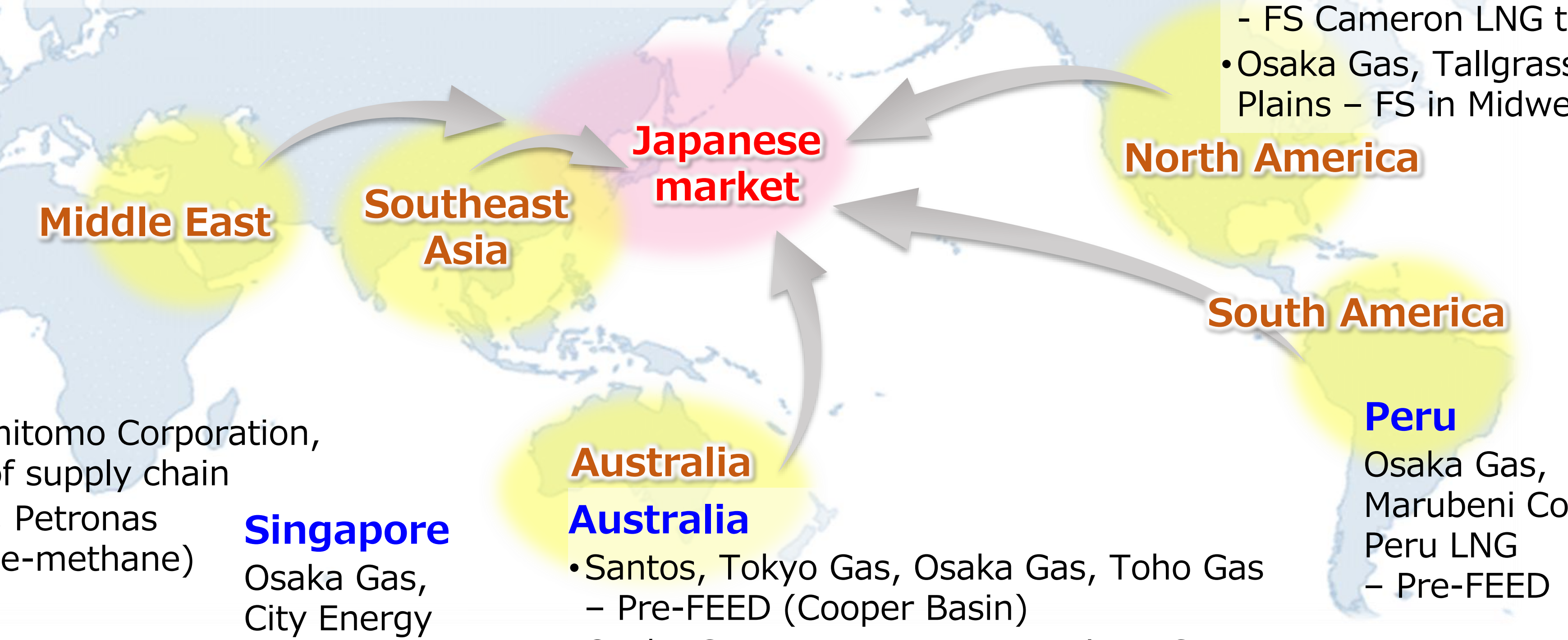
Feasibility studes to develop competitive supply chains for e-methane

- **Variety of FSs for larger scale production are undergoing in the areas where plenty of renewable electricity supply would be expected, which is the most critical factor for the production costs.**
- **In addition, the areas close to existing LNG terminals are expected to contribute to much competitive supply chain.**

- **TES** eNG Coalition (incl. Tokyo, Osaka, Toho)
- **Shell,** Tokyo Gas, Osaka Gas – supply chains study
- **ENGIE**, Osaka Gas – MOU for Asian market
- **Total Energies**, Toho Gas, Toyota Tsusho Corp - FS

UAE
INPEX, Masdar,
Tokyo Gas, Osaka Gas
– FS in UAE

Oman
Hitachi Zosen,
Oman LNG
– MOU (demonstration)



United States
- Mitsubishi Corporation, Tokyo Gas, Osaka Gas, Toho Gas, Sempra Infrastructures Partners - FS Cameron LNG terminal
- Osaka Gas, Tallgrass Green Plains – FS in Midwest

Malaysia
- Tokyo Gas, Sumitomo Corporation, Petronas – FS of supply chain
- Osaka Gas, IHI, Petronas – FS (biogenic e-methane)

Indonesia
IHI, Pertamnia
– FS near existing LNG plants

Singapore
Osaka Gas,
City Energy
– FS

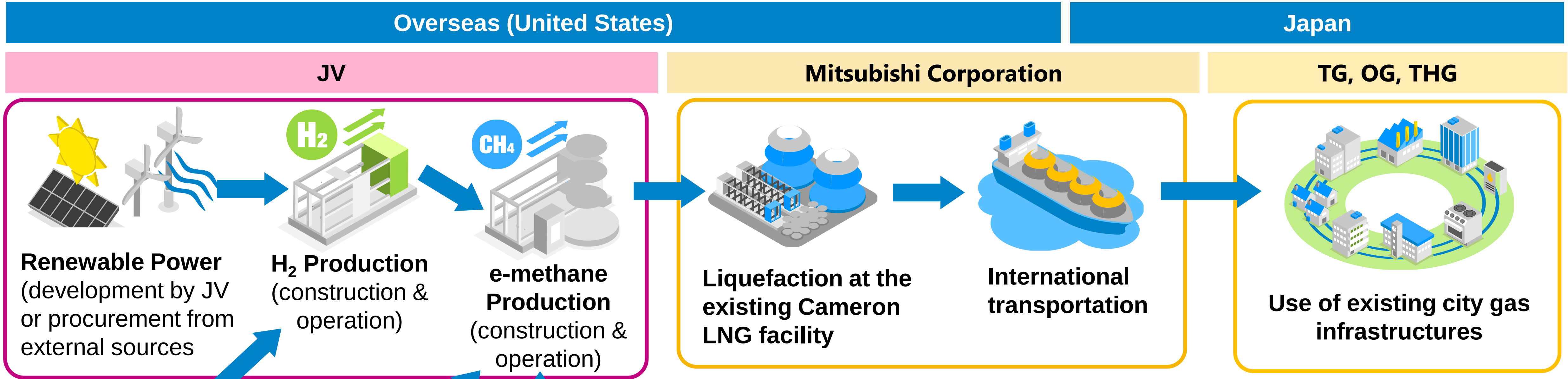
Australia
- Santos, Tokyo Gas, Osaka Gas, Toho Gas – Pre-FEED (Cooper Basin)
- Osaka Gas, INPEX, Nagoya Univ. -FS

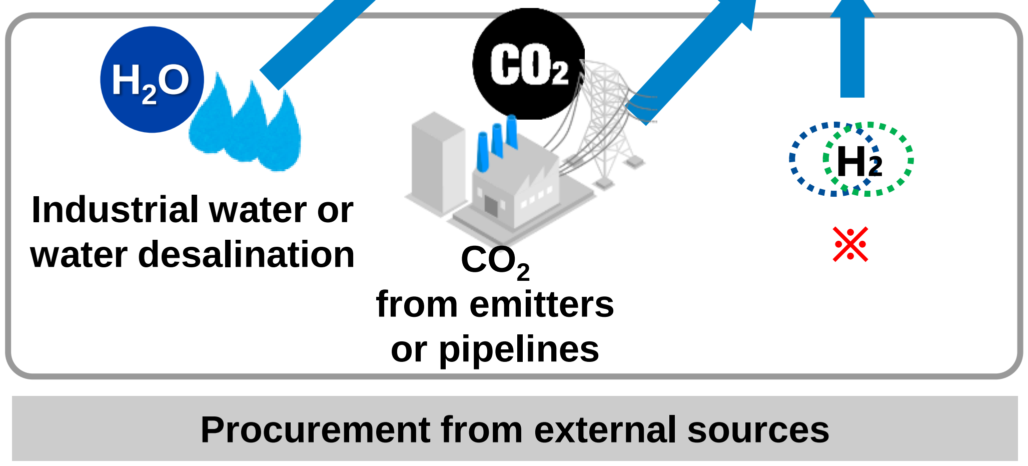
Peru
Osaka Gas,
Marubeni Corporation,
Peru LNG
– Pre-FEED

Sources: JGA, JOGMEC

FS Example : e-methane import from the Cameron LNG Terminal in US

- For examples, Cameron LNG terminal's facilities as well as those of the LNG supply chain are expected to be fully used.
- To contribute to the target of meeting 1% of the gas demand of TG, OG, THG in 2030, FID in 2025 is needed.





※H2 procurement from external sources to be assessed (both blue & green H2 in initial production period)

Sources:
Mitsubishi Corporation, Tokyo Gas, Osaka Gas, Toho Gas Collaborate to Produce e-methane in the US and Transport It to Japan, Utilizing Cameron LNG in Louisiana (Joint Press Release), November 29, 2022, etc.

Tokyo Gas	80 million Nm³-CH4/y
Osaka Gas	60 million Nm³-CH4/y
Toho Gas	40 million Nm³-CH4/y
Total	**180 million Nm³-CH4/y in 2030** ≒130,000 ton-CH_4/y (1% of the total demand of the above three gas companies)

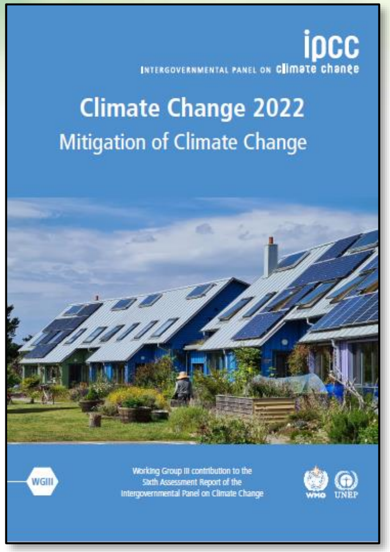
Innovative technologies challenged for efficiency improvement

- **Major gas companies are challenging innovative technologies to improve production efficiency for cost reduction supported by "Green Innovation Funding Program" by the government.**
- **There are SOEC and hybrid processes that include Sabatier reaction, featured by direct use of water without hydrogen production process. Target efficiency is excess 70 to 90%, commercialization is expected in the 2040s.**

	Existing Technology	**Innovative Technology**		
	Reference	**Osaka Gas**	**Tokyo Gas**	
Process	**Sabatier Reaction (Conventional)**	**SOEC**	**Water Electrolysis**	**PEM**
Conceptual image		**Renewable power** 	**Renewable power** 	**Renewable power** 
Feedstock (molecule)	Hydrogen and CO_2	Water and CO_2	Water and CO_2	Water and CO_2
Reaction formula	$4H_2+CO_2 \rightarrow CH_4+2H_2O$	$3H_2O+CO_2 \rightarrow CO+3H_2+2CO_2$ $CO+3H_2 \rightarrow CH_4+H_2O$	$CO_2+4H_2O \rightarrow CH_4+2H_2O+2O_2$	$CO_2+4H_2O \rightarrow CH_4+2H_2O+2O_2$
Reaction method	Chemical Reaction	Electrochemical Reaction	Electrochemical Reaction	Electrochemical Reaction
Temperature	up to 500℃	up to 800℃ (high temperature)	up to 220℃ (low temperature)	up to 80℃ (low temperature)
Merit	Existing technology	- No need to procure hydrogen - High efficiency by use of effective use of waste heat	- No need to procure hydrogen - High efficiency by use of effective use of waste heat	- No need to procure hydrogen - One-step methane synthesis - Low temperature process
Efficiency (targeted)	55-60%	**85-90% (Future Target)**	**Over 80% (Future Target)**	**Over 70% (Future Target)**
Challenges	- Improvement of overall efficiency - Management of thermal reactions	- Cell development for high temperature thermal electrolysis - Catalyst durability etc.	- Cell development for water electrolysis - Catalyst durability etc.	- Durability of methane synthesis catalysts

Contents

G7 and IPCC, support e-fuels and e-methane, contribute GHG emission reduction as RCFs



IPCC 6th Assessment Report Mitigation of Climate Change 2022.4 Chapter 6.4.4.1（P.656）

Power to fuels (PtX) (see also Section 6.4.3.1).
The process of using electricity to generate a gaseous fuel, such as hydrogen or ammonia, is termed power-to-gas (PtG/P2G) (IEA 2020h). When injected into the existing gas infrastructure (Section 6.4.5), it has the added benefit of decarbonising gas (Brandon et al. 2015). Electricity can be used to generate hydrogen, which is then converted back into electricity using combined-cycle gas turbines that have been converted to run on hydrogen. For greater compatibility with existing gas systems and appliances, the hydrogen can be combined with captured carbon dioxide to form methane and other synthetic fuels (Thema et al. 2019),

https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_FullReport.pdf

G7 Climate, Energy and Environment Ministers' Communiqué

Sapporo, April 16, 2023

We, the G7 Ministers of Climate, Energy and the Environment, met on 15th - 16th April 2023 in Sapporo.

I. Climate, Energy, and Environment Joint Section

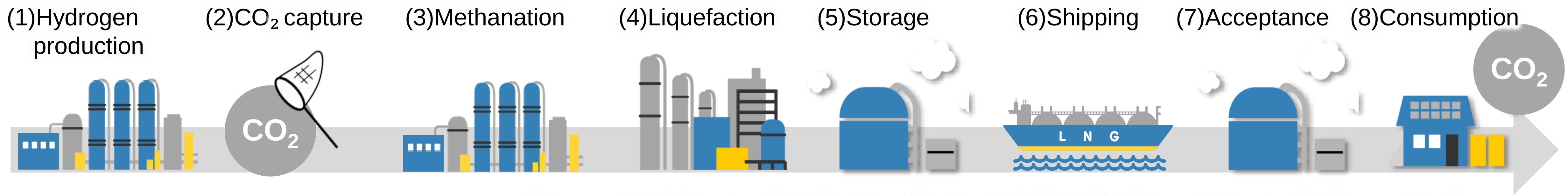
G7 Climate Energy and Environment Ministers Communiqué 2023 2023.4 （P.26）

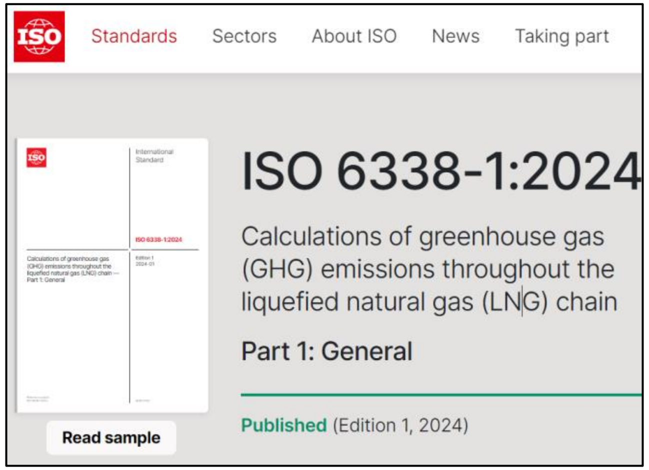
68. Carbon Management:
….Utilization(CCU)/carbon recycling technologies, including recycled carbon fuels and gas (RCFs) such as e-fuels and e-methane, also can reduce emissions with existing infrastructure from industrial sources that cannot be avoided otherwise by displacing fossil-derived commodities and by using CO_2.

https://www.meti.go.jp/english/press/2023/0417_002.html

Challenge to develop/harmonize internationally authorized rules : ISO

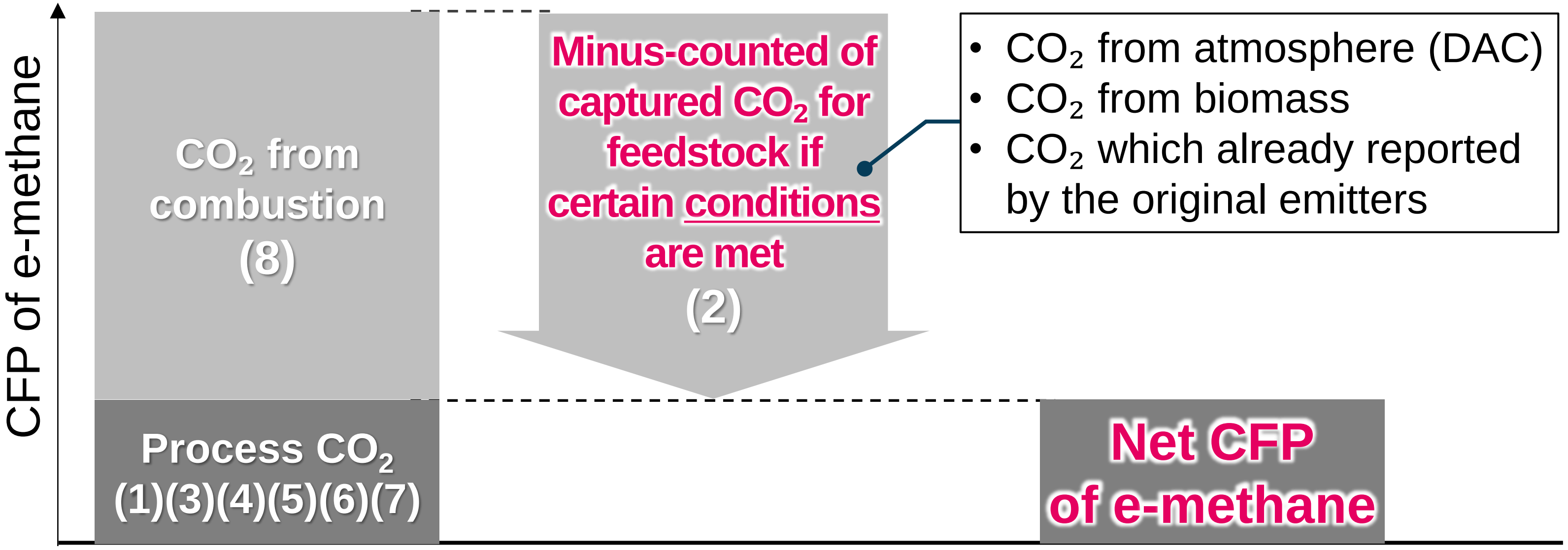
- **ISO 6338-1, published in January, 2024, includes calculation formula which JGA proposed for carbon footprint (CFP) (carbon intensity (CI)) of e-methane in accordance with ISO14067, well known standard of CFP calculation.**
- **The core concept is that if the CO_2 feedstock (captured carbon) meets certain conditions, it should be minus-counted to calculate CFP in the entire boundary.**





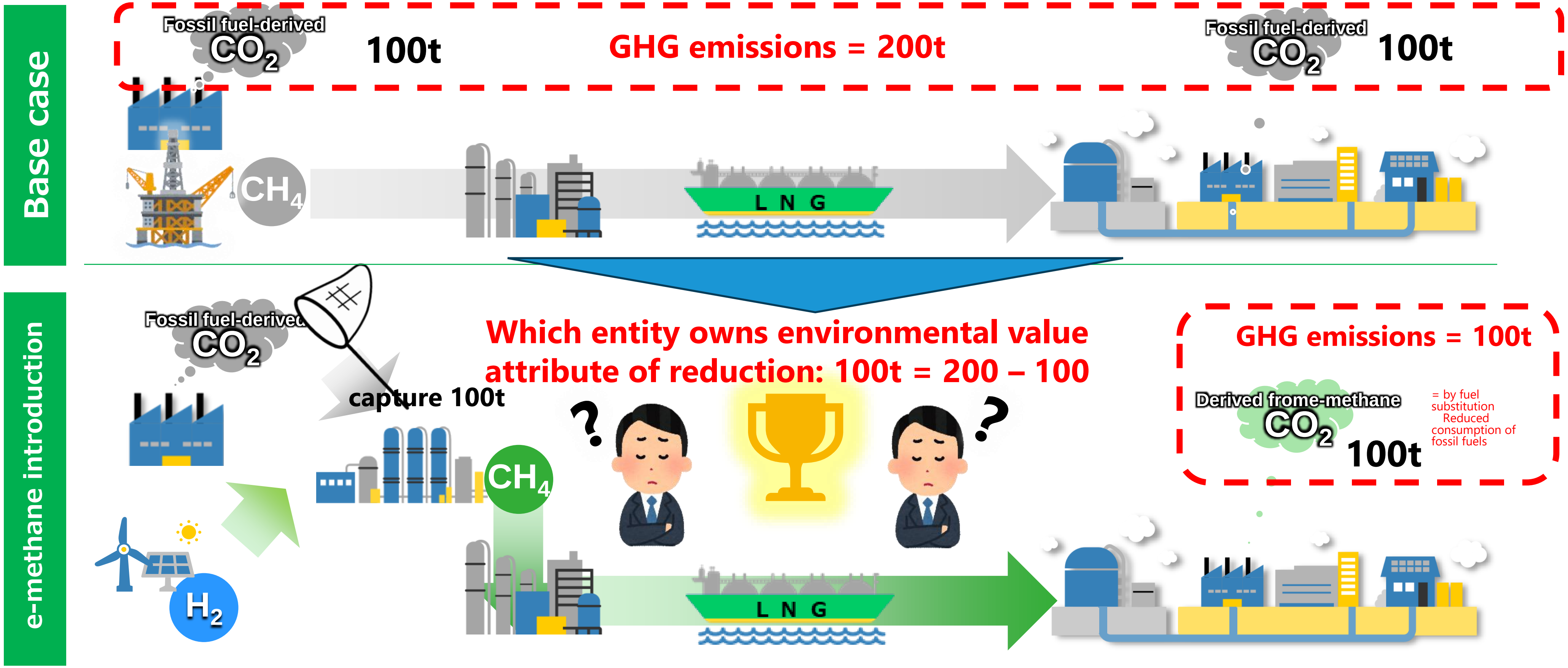
Source: ISO Website
https://www.iso.org/standard/87114.html

Concept of Annex C : Carbon footprint (CFP) of e-methane (Informative)



Needs for rules of GHG accounting and environmental value attributes of RCFs

- Common problem for RCFs is… to which entity is the environmental value created by displacing fossil fuels with lower carbon intensity fuels attributed, those who captured CO_2 or those who use the RCFs.
- In principle, the environmental value should be attributed to the entity who paid for the value. However, commonly accepted GHG accounting rules for RCFs have not yet been developed.



Recent bilateral meetings' documents referring avoidance of CO_2 double counting

- In the recent bilateral meetings at the summit-level and energy ministry representatives' level between Japan and the United States, they welcomed the progress of ongoing projects including e-methane.
- Outcome documents of both mentioned recognition of the private-sector's agreement to avoid CO_2 double-counting.

(Summit level) FACT SHEET: Japan Official Visit with State Dinner to the United States, April 10, 2024

President Joe Biden, United States
Prime Minister Mr. Fumio Kishida, Japan

(Excerpt of the Fact Sheet)

Carbon Management:
We welcome the progress of ongoing projects in carbon capture, utilization, and storage, as well as carbon recycling, between U.S. and Japanese companies.
On e-methane, Japanese companies have signed Letters of Intent (LOIs) with U.S. companies to avoid CO_2 double counting.

THE WHITE HOUSE

MENU

APRIL 10, 2024

FACT SHEET: Japan Official Visit with State Dinner to the United States

BRIEFING ROOM › STATEMENTS AND RELEASES

Today, President Biden welcomed Prime Minister Kishida of Japan for an Official Visit with State Dinner to celebrate the deep and historic ties between our two countries. This visit also reflects the upward trajectory of the U.S.-Japan Alliance as it evolves into a global partnership that promotes a shared vision of progress and prosperity for the future. The two leaders' ambitious efforts span the depth and breadth of the Alliance to include cooperation on defense and security; space; advanced technology and economic cooperation; diplomacy and development; and people-to-people ties.

This bilaterally coordinated fact sheet provides an overview of political understandings that were affirmed or reaffirmed during the Official Visit with State Dinner, as well as plans for further cooperative activities between the United States and Japan.

Click here

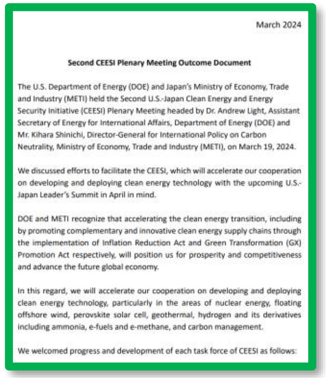
Second U.S.-Japan Clean Energy and Energy Security Initiative (CEESI) Plenary Meeting Outcome Document March 19, 2024.

Dr. Andrew Light, Assistant Secretary of Energy for International Affairs, DOE, United States

Mr. Kihara Shinichi, Director-General for International Policy on Carbon Neutrality, METI

(Excerpt of the Outcome Document)

CCUS/CR(including e-methane):
We welcome the progress of ongoing projects in CCUS/ carbon recycling between U.S. and Japanese companies including e-methane and e-fuels.
For e-methane, Japanese companies have signed Letters of Intent (LOIs) with U.S. companies to avoid CO_2 double counting.



March 2024

Second CEESI Plenary Meeting Outcome Document

The U.S. Department of Energy (DOE) and Japan's Ministry of Economy, Trade and Industry (METI) held the Second U.S.-Japan Clean Energy and Energy Security Initiative (CEESI) Plenary Meeting headed by Dr. Andrew Light, Assistant Secretary of Energy for International Affairs, Department of Energy (DOE) and Mr. Kihara Shinichi, Director-General for International Policy on Carbon Neutrality, Ministry of Economy, Trade and Industry (METI), on March 19, 2024.

We discussed efforts to facilitate the CEESI, which will accelerate our cooperation on developing and deploying clean energy technology with the upcoming U.S.-Japan Leader's Summit in April in mind.

DOE and METI recognize that accelerating the clean energy transition, including by promoting complementary and innovative clean energy supply chains through the implementation of Inflation Reduction Act and Green Transformation (GX) Promotion Act respectively, will position us for prosperity and competitiveness and advance the future global economy.

In this regard, we will accelerate our cooperation on developing and deploying clean energy technology, particularly in the areas of nuclear energy, floating offshore wind, perovskite solar cell, geothermal, hydrogen and its derivatives including ammonia, e-fuels and e-methane, and carbon management.

We welcomed progress and development of each task force of CEESI as follows:

Click here

Challenge to develop/harmonize international GHG accounting rules

- **Major international GHG accounting rules do not have methods for RCFs including e-methane.**
- **Revisions are expected in IPCC Inventory Guideline and GHG Protocol's Corporate Standards.**
- **JGA is trying to involve in the revision process through advocacy activities and making efforts to develop international standard that can serve as one of the references for the revision process.**

IPCC: The TFI will hold an Expert Meeting on CDR Technologies, CCUS and provide a Methodology Report on these by the end of 2027.

GREENHOUSE GAS PROTOCOL: Revisions of the standards and guidance by 2026

Advocacy activities

- The public and private sectors are collaborating for effective involvement
- 18 organizations submitted a joint proposal to the GHGP secretariat

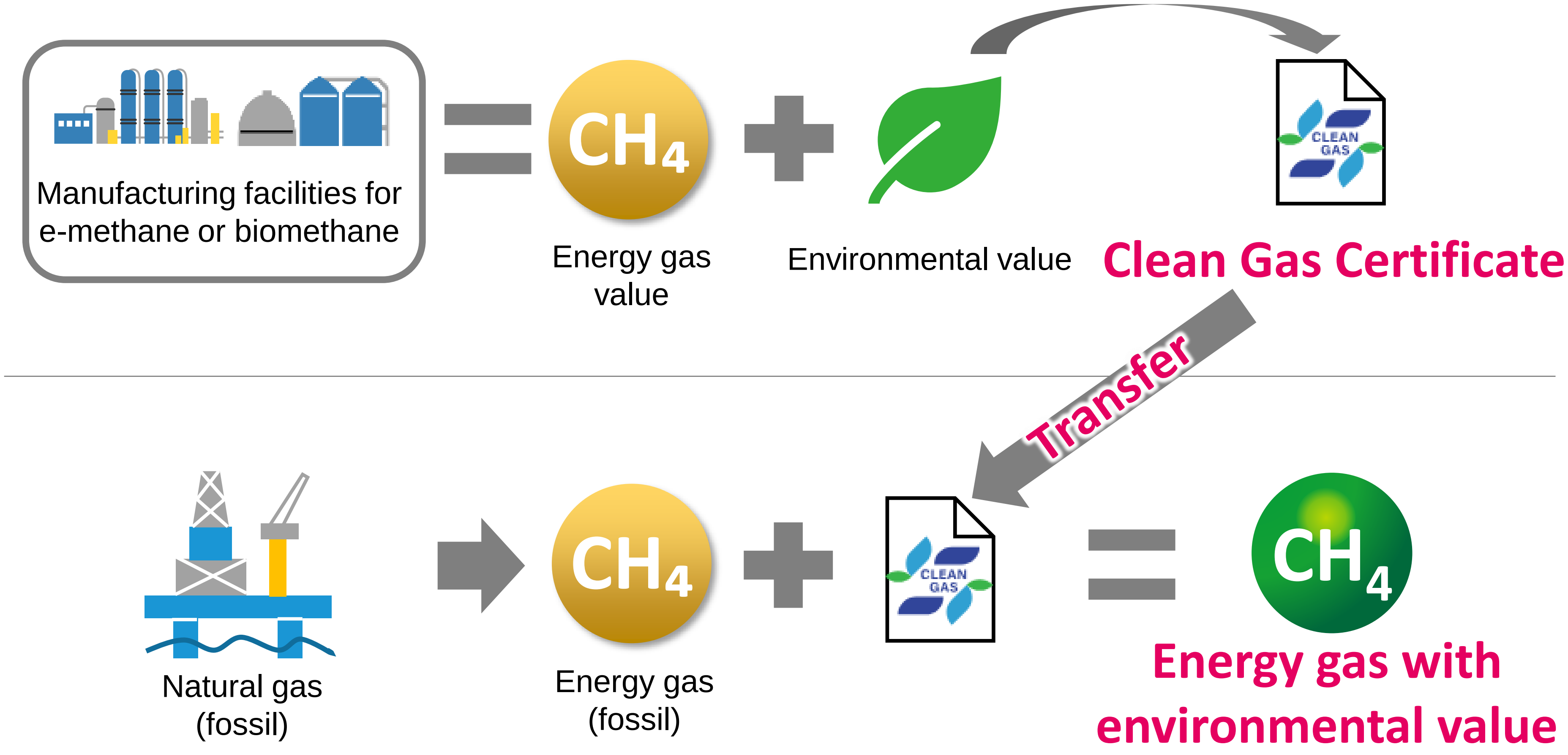
Efforts for developing internationally applicable accounting rules

- Method of **calculating carbon footprint of e-methane**, which has become effective as an international standard (ISO 6338-1)
- Launch of "**Clean Gas Certificate**" scheme for transferring environmental value attribute of e-methane

Contents

Launch of "Clean Gas Certificate" for e-methane and biomethane

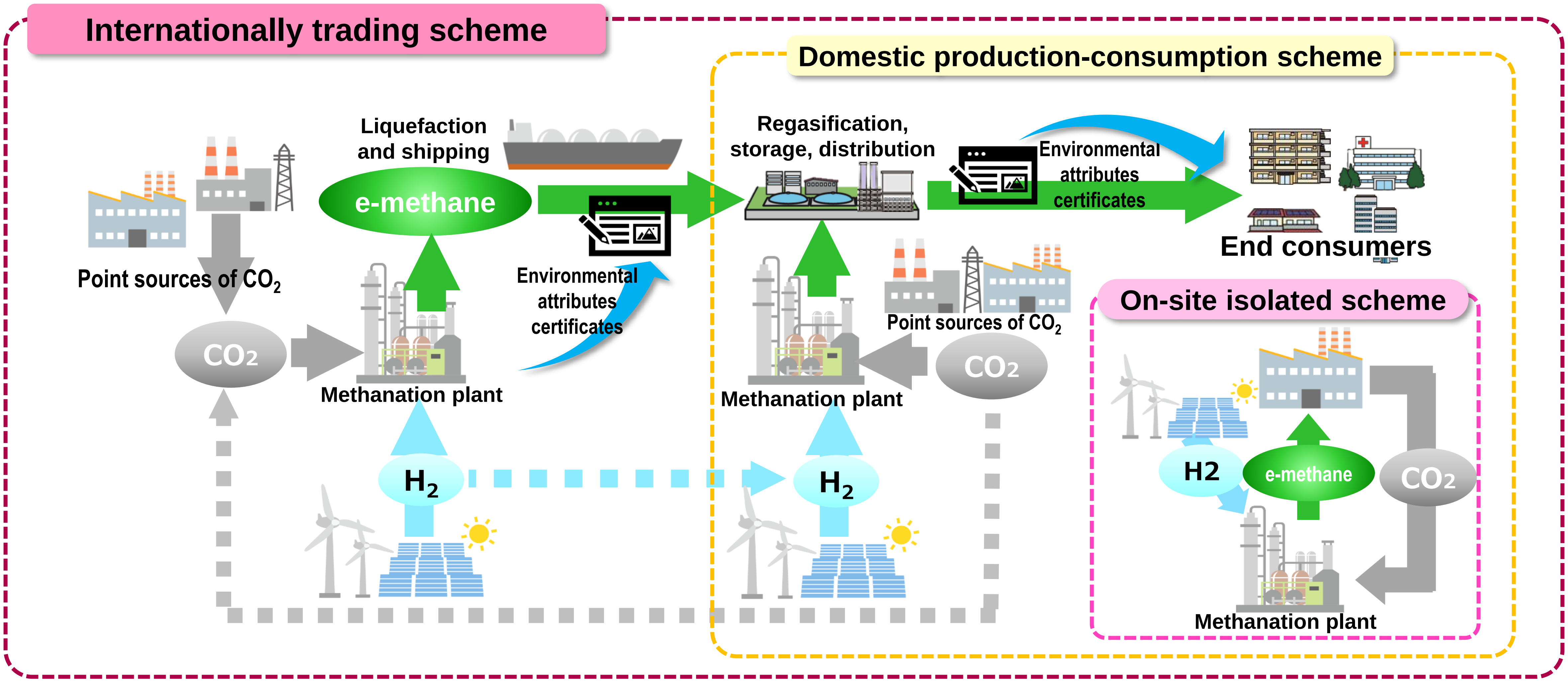
- **JGA and gas-related organizations have developed a scheme of certifying and transferring the environmental value attributes of e-methane and biomethane produced in Japan.**
- **Aiming the scheme to be applied to cross-border traded e-methane and biomethane.**



Source: Clean Gas Certificate Website (only in Japanese)
https://www.clean-gas-certificate.com/

Image of value chain of e-methane with internationally applicable certification schemes

Harmonizing the internationally applicable environmental value attributes certifying measures for RCFs such as e-methane, traded across borders, is one of the most important issues to be resolved to accelerate project decision making.



Requirement for CO_2 feedstocks to avoid double-counting

- **Some certification systems have requirement for CO_2 feedstocks to produce synthetic fuels including e-methane.**
- **As well as ISO 6338-1:2024, variety of CO_2 feedstock are recognized to be eligible. Showing evidences is required.**

ISO 6338-1:2024 Annex C January,2024

Minus-counted CO_2 feedstock for calculating carbon footprint (CFP) of e-methane

- CO_2 acquired **from DAC** technology or **from bio-origin**; or
- **CO_2 emission already reported by the original emitters**.

EU RED Ⅱ Delegated Act June,2023

Eligible CO_2 sources for RFNBOs/RCFs

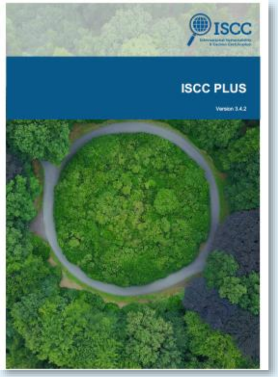
- **CO_2 emitted from activities listed under Directive 2003/87/EC** (limited to max.2041)
- **CO_2 captured from the air**
- Production or **combustion pf biofuels**
- **Combustion of RFNBOs and RCFs**
- **Naturally released CO_2** from a geothermal source

ISCC PLUS Ver 3.4.2 March, 2024

CO_2 from the following sources can be used

- **Biogenic CO_2** which originates from biomass
- **Atmospheric CO_2** from direct air capture
- **Post-industrial (fossil) CO_2 captured from industrial processes**, which use fossil sources to deliberately produce electricity, heat, or materials (e.g., cement, iron and steel, petrochemical industry)

Additionally, during the audit, **it must be verified that the CO_2 was not deliberately produced for use in the above-mentioned production processes**.



Clean Gas Certificate April, 2024

- The CO_2 feedstock must be that **which does not increase CO_2 in the atmosphere by combustion.**
- It is **required to show the evidence** regarding the CO_2 feedstock supply process (including the measured amount of CO_2).

Conclusions

Challenges of the Japan's city gas industry and the value of e-methane

- Japan's city gas industry is focusing on e-methane to realize carbon neutral city gas supply by 2050.
- E-methane's value of drop-in fuel for existing infrastructure and equipment can reduce transition cost.
- Japanese leading city gas companies are working on projects to develop international e-methane value chain.

Expected international GHG accounting rules for RCFs such as e-methane

- RCFs produced from captured CO_2 have value that does not increase atmospheric CO_2.
  ISO has established an international standard for calculating CFP of e-methane.
- The document agreed between the governments of Japan and the U.S. mentions an agreement between the private sector to avoid double counting of CO_2. It is expected that additional rules regarding RCFs will be included in the GHG Protocol guidelines and others as well.

Launch of "Clean Gas Certificate" to transfer the environmental value of e-methane

- The "Clean Gas Certificate" scheme has been established and started as a voluntary certification system.
- Through the experience of various cases, it will expand its scope to compliance scheme and for those produced abroad.

Thank you very much.