Possibilities and Pathways to Decarbonize LNG: The Roles and Challenges of e-methane

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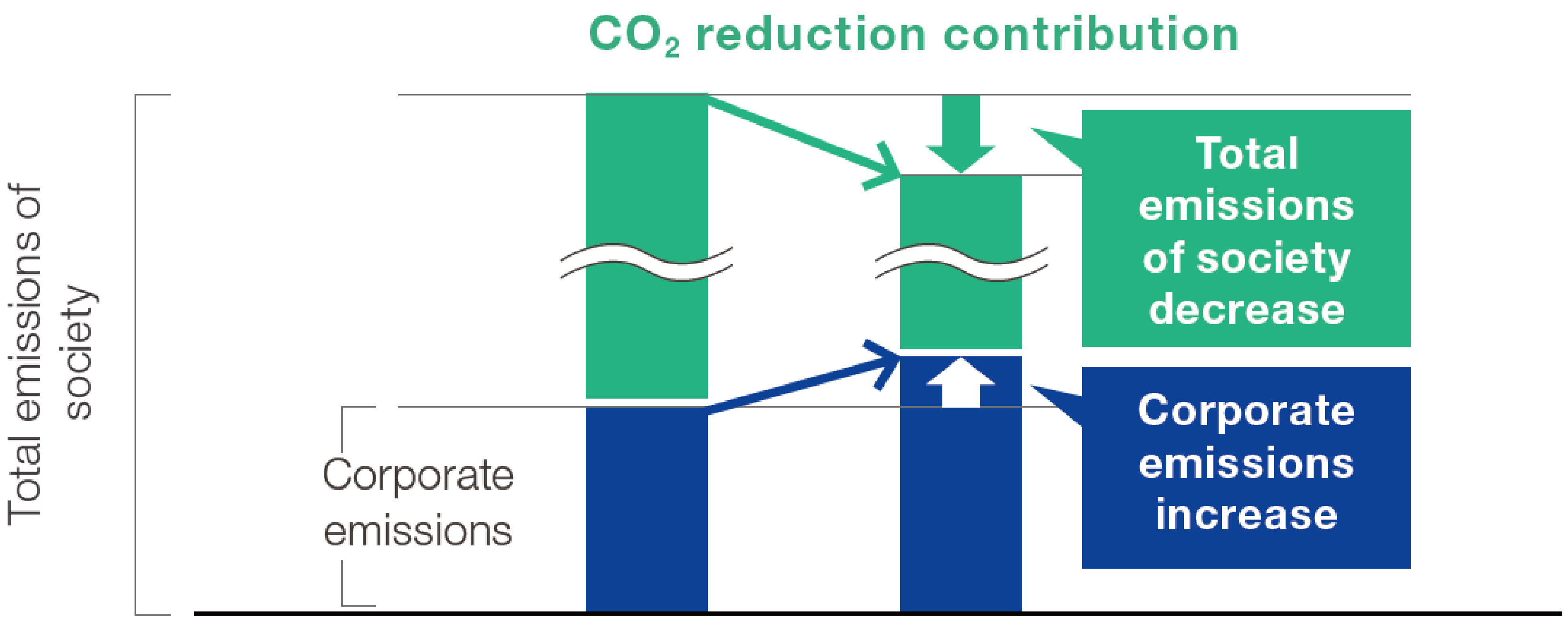
Natural Gas Still Needed

- Towards decarbonization;
  - ✓ Firstly, from coal/oil to natural gas.
  - ✓ Then, from natural gas to biomethane/e-methane, which can avoid the stranded assets of natural gas supply chain including LNG.

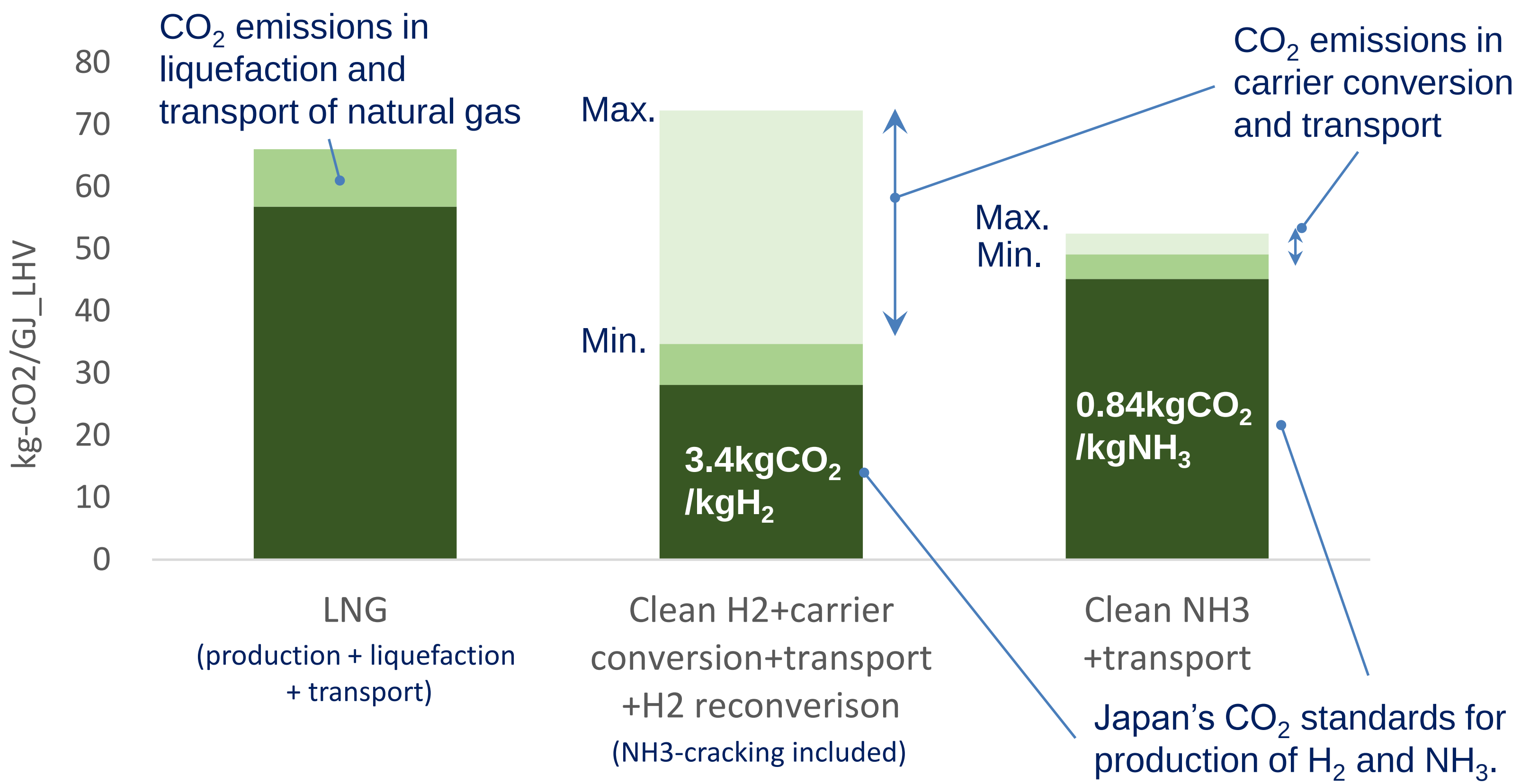


Source: "Tokyo Gas Group Integrated Report 2023"

Carbon Footprint: LNG vs. Early Stage H_2 Carriers

- Carbon footprint of H_2 supply chain varies largely, depending on the H_2 carrier and the energy used in the process.

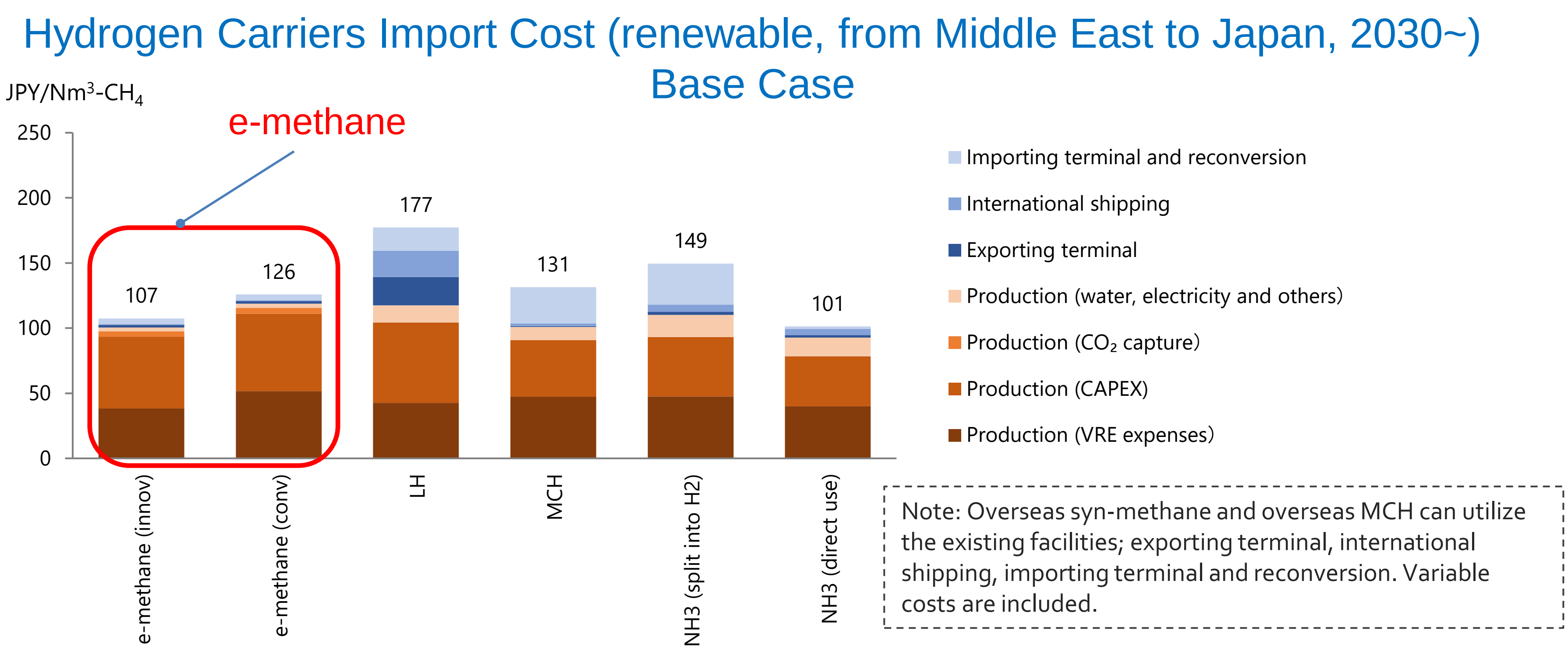
CO_2 Intensity (production + carrier conversion + transport)



Source: LNG is from JGA (https://www.gas.or.jp/tokucho/). H_2 and NH_3 are from "STUDY ON THE ECONOMICS OF THE GREEN HYDROGEN INTERNATIONAL SUPPLY CHAIN", IEEJ, 2021.

Future e-methane Supply Cost

- Supply cost of overseas e-methane (syn-methane) is the second lowest following overseas NH_3 (direct use). ➔ Seaborne transport, loading/unloading and storage are mature.
- VRE expense and CAPEX of methanation including electrolysis account for the large part of the cost, which should be squeezed.



Note: Overseas syn-methane and overseas MCH can utilize the existing facilities; exporting terminal, international shipping, importing terminal and reconversion. Variable costs are included.

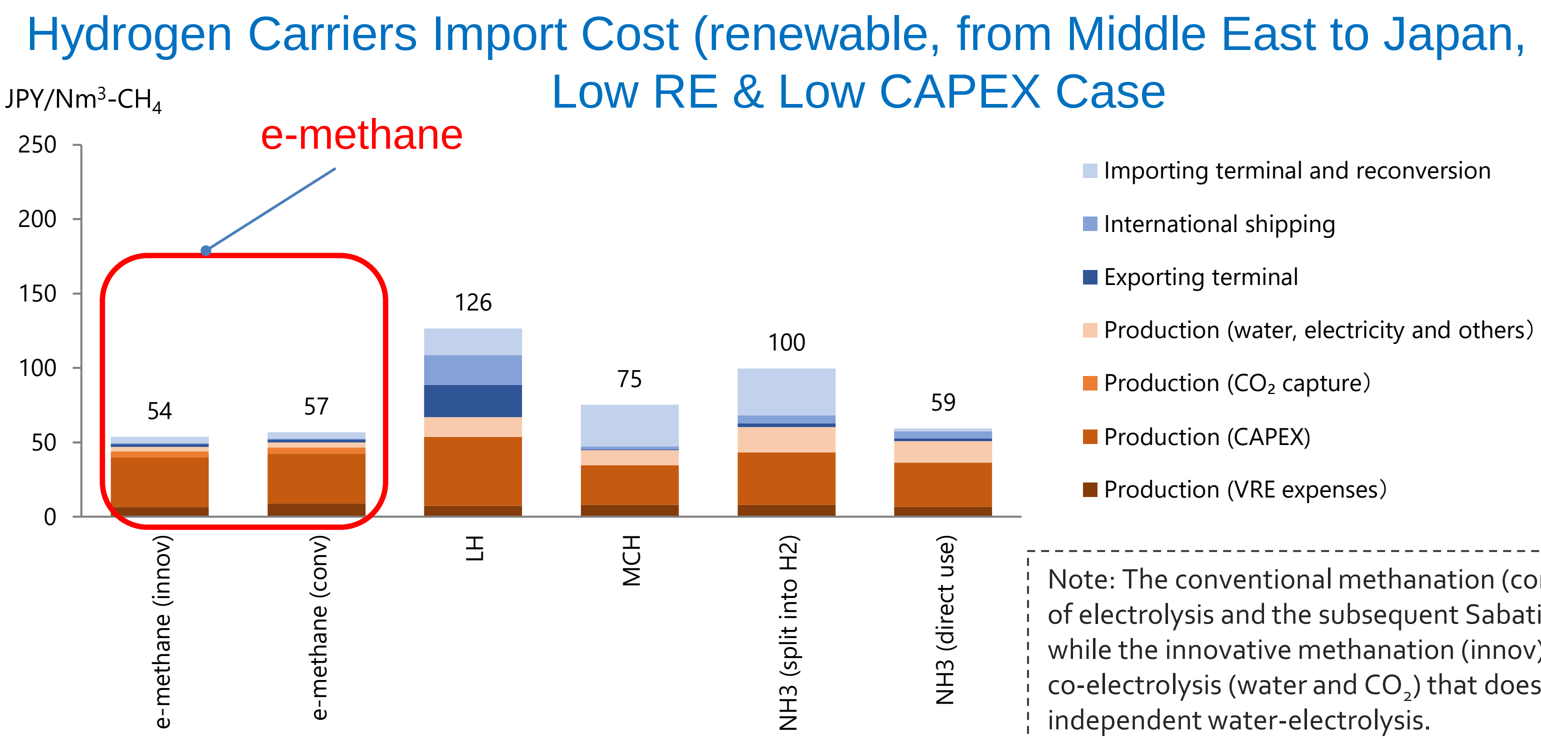
JPY 100/Nm^3-CH_4 = JPY 3,000/MMBtu

LCOE of VRE = 2.5 cent/kWh

Source: Council for Promotion of Methanation (METI), The 9th meeting, 22 November 2022

Lower renewables and synthesis CAPEX are indispensable

- If lower renewable can be procured and process CAPEX is squeezed, e-methane cost would be JPY 50~60/Nm3-CH_4 (=JPY 1,500~1,800/MMBtu)



Note: The conventional methanation (conv) is composed of electrolysis and the subsequent Sabatier methanation, while the innovative methanation (innov) is composed of co-electrolysis (water and CO_2) that does not need independent water-electrolysis.

JPY 100/Nm3-CH_4 = JPY 3,000/MMBtu

LCOE of VRE = 0.4 cent/kWh

Source: Council for Promotion of Methanation (METI), The 9th meeting, 22 November 2022

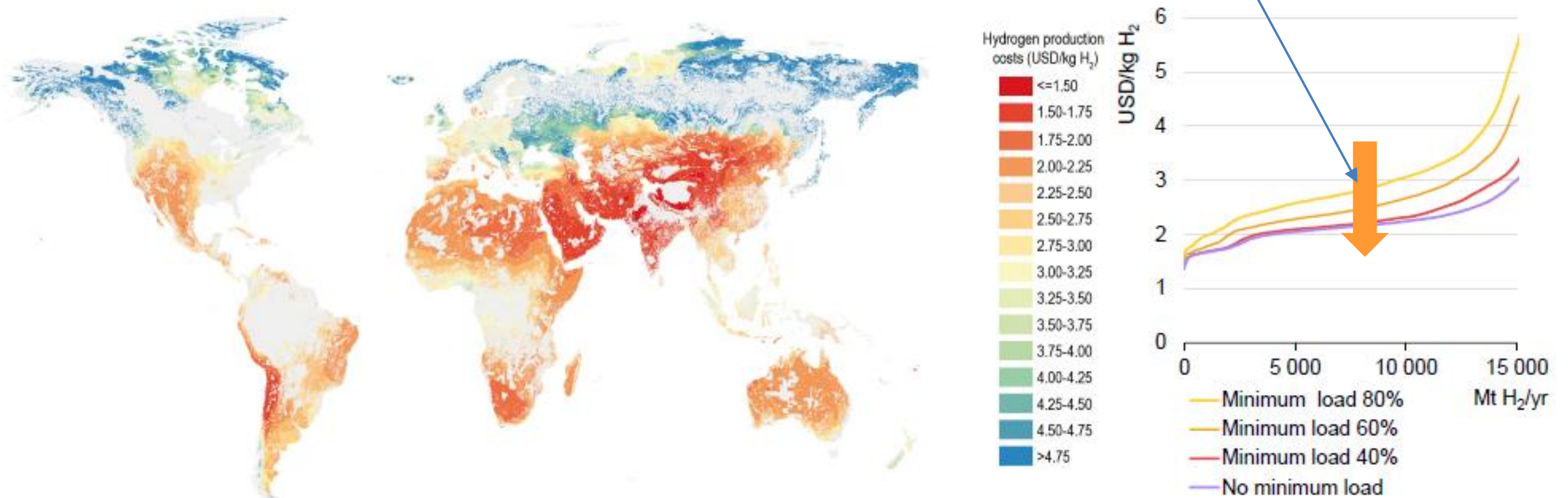
VRE & Technology Development of Methanation

- Identification of the renewable-rich region
- In addition, How to improve the tolerance of methanation process to variability of renewables is another key issue. ➔ How to minimize energy storage capacity (battery, hydrogen tank, etc.)

Process with higher tolerance to variability is able to reduce hydrogen production cost

Hydrogen production costs from hybrid solar PV and wind systems for a minimum load of 40%, 2030 (left map)

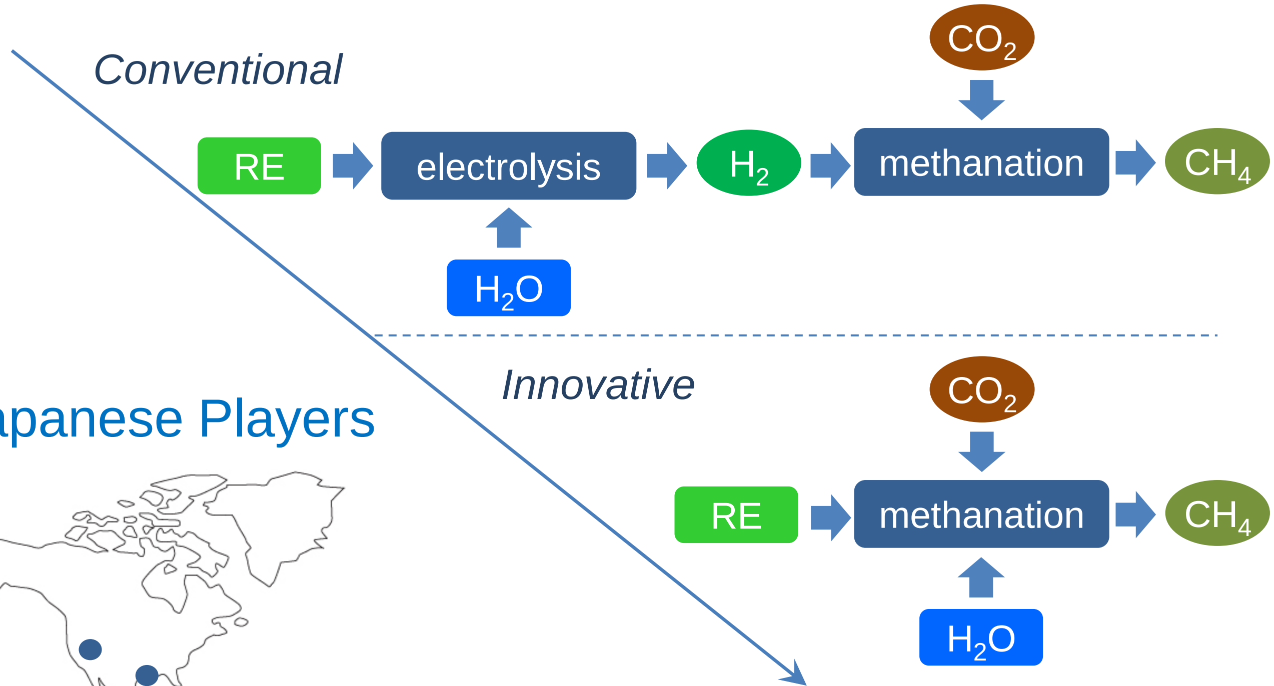
Global supply cost curves for different minimum load factors (right figure)



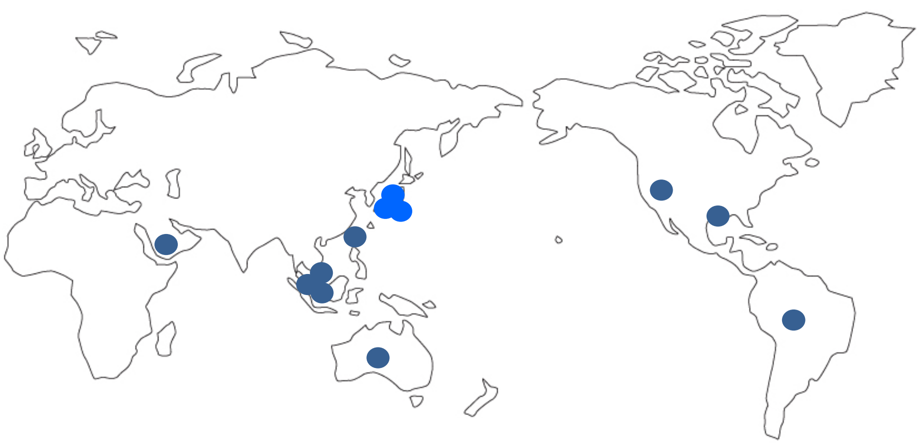
Source: "Global Hydrogen Review 2022", IEA

Japan’s Activities in e-methane

Methanation Process: from conventional to Innovative



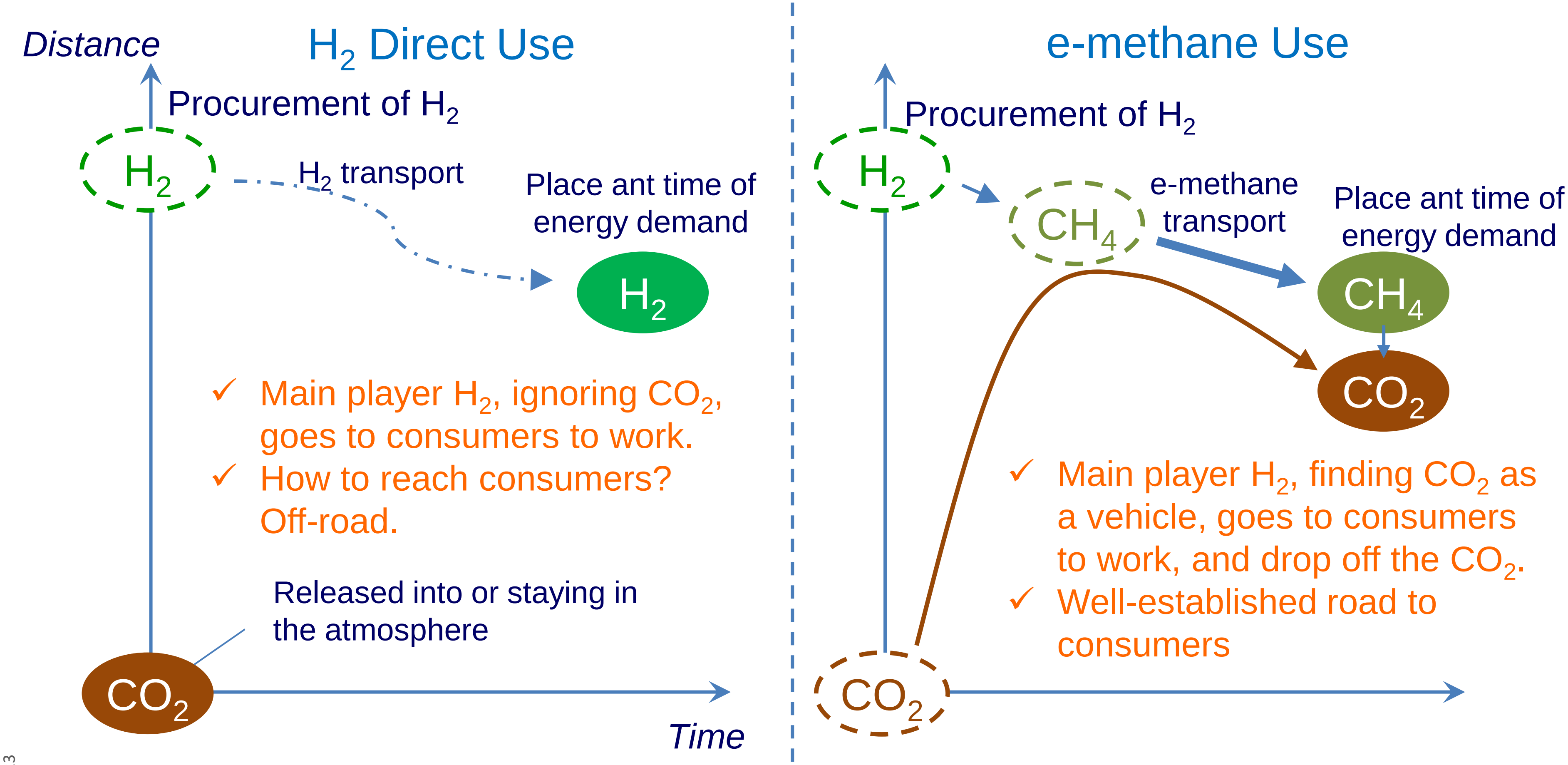
e-methane Projects by Japanese Players



- ✓ Feasibility studies are being carried out.

Revisiting the Mechanism of e-methane

- Mechanism : e-methane = CCU + RE_H_2
- CO_2 reduction impact : e-methane = RE_H_2
- e-methane is one of the hydrogen carriers. e-methane is H_2 transformed to CH_4.



Source: Shibata, Y, "Economics and Roles of e-gas towards City Gas Decarbonization", 43rd IAEE INTERNATIONAL CONFERENCE, August, 2022

CO_2 emission reduction should be attributed to e-methane users

Q: Who contributes to the CO_2 emission reduction from e-methane?

A1: All for CO_2 emitter/provider

NO

- Unrealistic, as there is no incentive for e-methane users.
- This may cause lock-in of fossil fuel use in CO_2 provider, in spite of the fact that there is no CO_2 emission reduction from CCU in e-methane production.

A2: Shared between CO_2 emitter/provider and e-methane user

NO

- This may cause lock-in of fossil fuel use in CO_2 provider, in spite of the fact that there is no CO_2 emission reduction from CCU in e-methane. production
- No theoretical grounds for allocation.

A3: All for e-methane user

YES

- H_2 is the main player and CO_2 is mere a supporting player in e-methane (e-methane = H_2)
- The logic that users of H_2 (= users of e-methane) contribute to CO_2 emission reduction is rational.

Source: Shibata, Y, "Economics and Roles of e-gas towards City Gas Decarbonization", 43rd IAEE INTERNATIONAL CONFERENCE, August, 2022

Strategy for CO_2 Procurement for e-methane

- Using CO_2 from fossil for e-methane production does not matter. However, fossil-CO_2 emitters should reduce their CO_2 emission in the transitional phase toward decarbonization.
- Then, e-methane producers relying on fossil-CO_2 faces difficulty in stable CO_2 procurement.
- Then, e-methane producers will be “nomad” looking for CO_2.
- Eventually, it is wise for e-methane producers to possess their own clean CO_2 emitting facilities such as biomass power plants or DAC (Direct Air Capture) plants. Biomass power plants can provide electricity, which brings economic benefit.

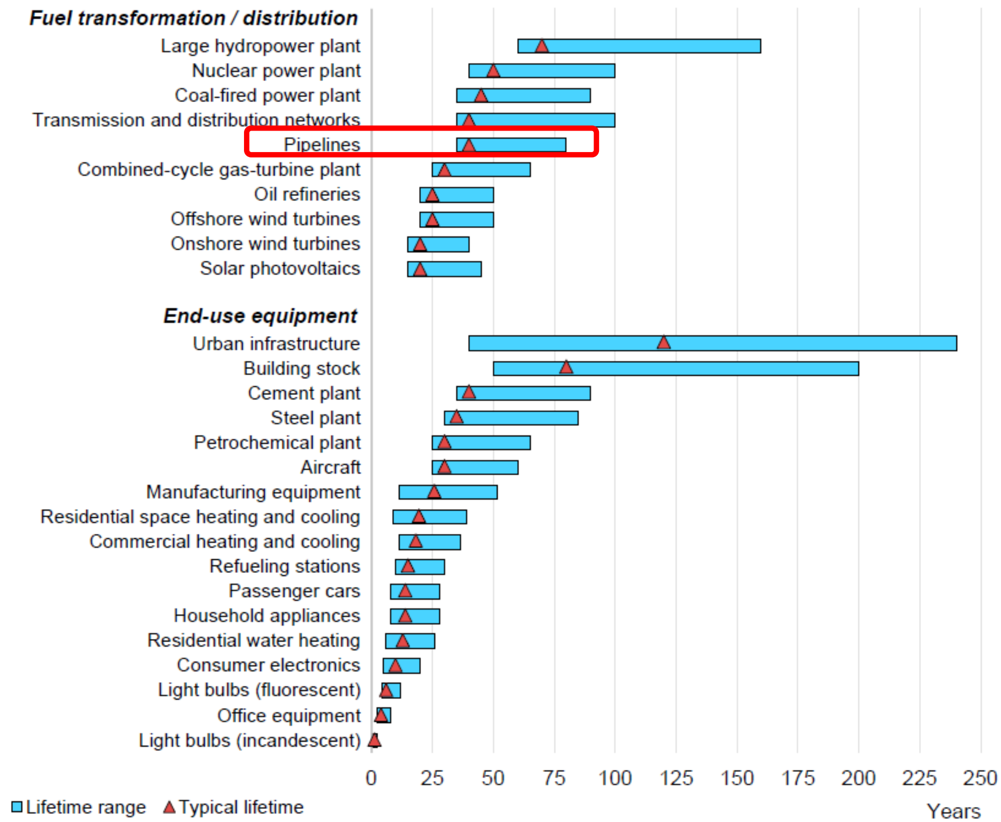
Hydrogen or e-methane: Infrastructure

- e-methane/e-fuel is option to deliver and use hydrogen cost-effectively through the existing infrastructure.
  ➡Avoiding stranded assets

- If "advantage through existing infrastructure" > "cost of CO_2 capture and synthetic methane/fuel production", then e-methane/e-fuel. Otherwise, hydrogen.

Lifetime of energy-related infrastructure

Figure 1.12 Typical lifetimes for key energy sector assets



Source: Energy Technology Perspectives 2020, IEA

Summary

- Natural gas is transitional energy that contributes to reduce GHG.
- The assets of infrastructure of natural gas/LNG that are existing and that will be invested in the transitional phase should no be stranded.
- e-methane will be one of the options to avoid the stranded assets of natural gas/LNG supply chain while decarbonizing natural gas.
- The cost down of e-methane synthesis and securing low-cost renewables are crucial. Investment to renewables is indispensable.
- CO_2 emission should be totally attributed to CO_2 emitters, not to e-methane users.
- Discussions on how the gas network should be in the longer term, e-methane or hydrogen, are required.

Thank you.

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