Alternative fuel toward carbon neutrality using IHI's standard methanation

21th, June 2023

IHI Corporation
Resources, Energy & Environment Business Area

Introduction of IHI

About IHI (Consolidated)

Year of establishment : 1853
Capital : 107.1 billion yen
Net sales : 1,352.9 billion yen
Employees : 28,801 (as of March 2022)

Branches/Sales offices in Japan : 16
Overseas offices : 14
Affiliated company : 201 (as of May 2023)

【IHI Group Vision】

- Contribute to the development of society through technology
- Human resources are our single most valuable asset

Resources, Energy & Environment

Main products :
Carbon Solutions, Gas Turbine/Diesel Engines/Gas Engines, LNG Receiving Terminal, Storage Tank, etc.

Social Infrastructure & Offshore Facilities

Main products :
Bridges, Watergates, Shields, Concrete Construction Materials, Offshore Structure, Environment Monitoring

Industrial Systems & General-Purpose Machinery

Main products :
Compressors, Separators, Cryogenic Product, Turbochargers for Vehicles, Parking System

Aero Engines, Space & Defense

Main products :
Aero Engines, Air Traffic Control, Rocket System and Space Exploration

Trends of Japanese government①:
Carbon recycling technology roadmap (revised in July 2021)

Carbon recycling:
Considering Carbon dioxide (CO_2) as source for Carbon, then utilize and recycle it as Carbon compounds such as ①Chemicals ②Fuel ③Mineral and Concrete

CO_2 usage

Phase 1

- **Started research, technology development, and demonstration**
- **Focus on technologies for manufacturing valuable products**

Chemicals
Further reduction of CO_2 emissions

Fuel
Cost reduction

Mineral and Concrete
Cost reduction

Phase 2

- **Cost reduction**
- **Focus on manufacturing technology for multi-purpose products with high demand**

Widespread from 2030
・Chemicals
Polycarbonate etc.
・Fuel
Biofuel etc.
・Mineral
Concrete products, Cement

Phase 3

- **Further cost reduction**

Consumption will increase from 2030
・Chemicals : Polycarbonate etc.
・Fuel : Biofuel etc.
・Mineral : Concrete products, Cement

Widespread from 2040
・Chemicals
Multi-purpose products(Olefin, BTX etc.)
・Fuel
Gas, Liquid(Methane, Synthetic fuel)
・Mineral
Concrete products, Cement

CCS technology — **Cost reduction** — **Less than 1/4 of the current level**

2023 — **2030** — **2040~**

Source : METI

Alternative fuels towards to Carbon neutrality in 2050

Technical Development Required for a use

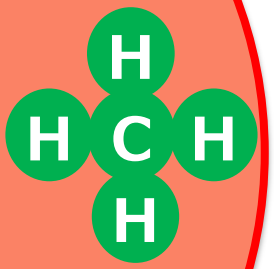
Ammonia

Hydrogen

Carbon Neutral

Can be used now

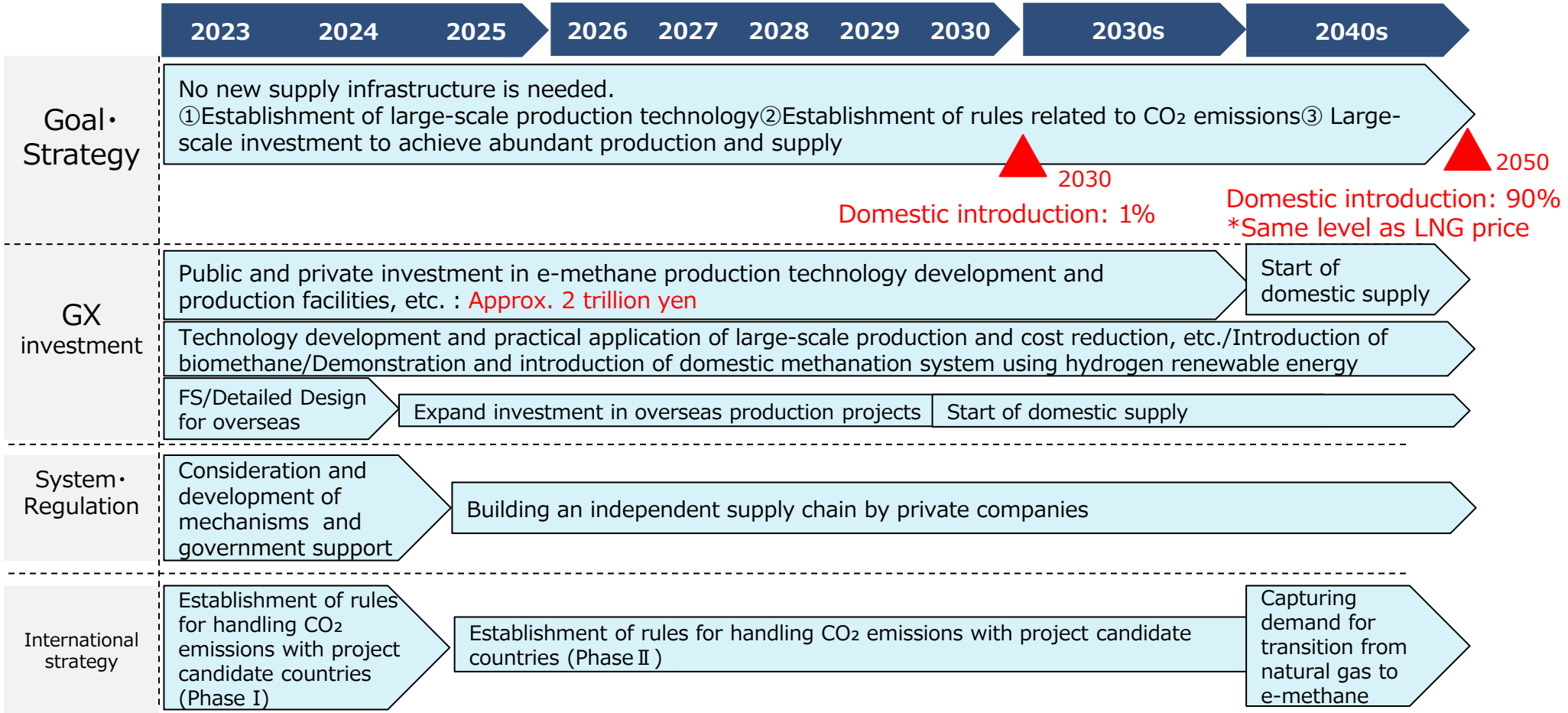
e-methane



e-methane

Trends of Japanese government② : Basic Policy for Realization of GX(announced on February 10, 2023)

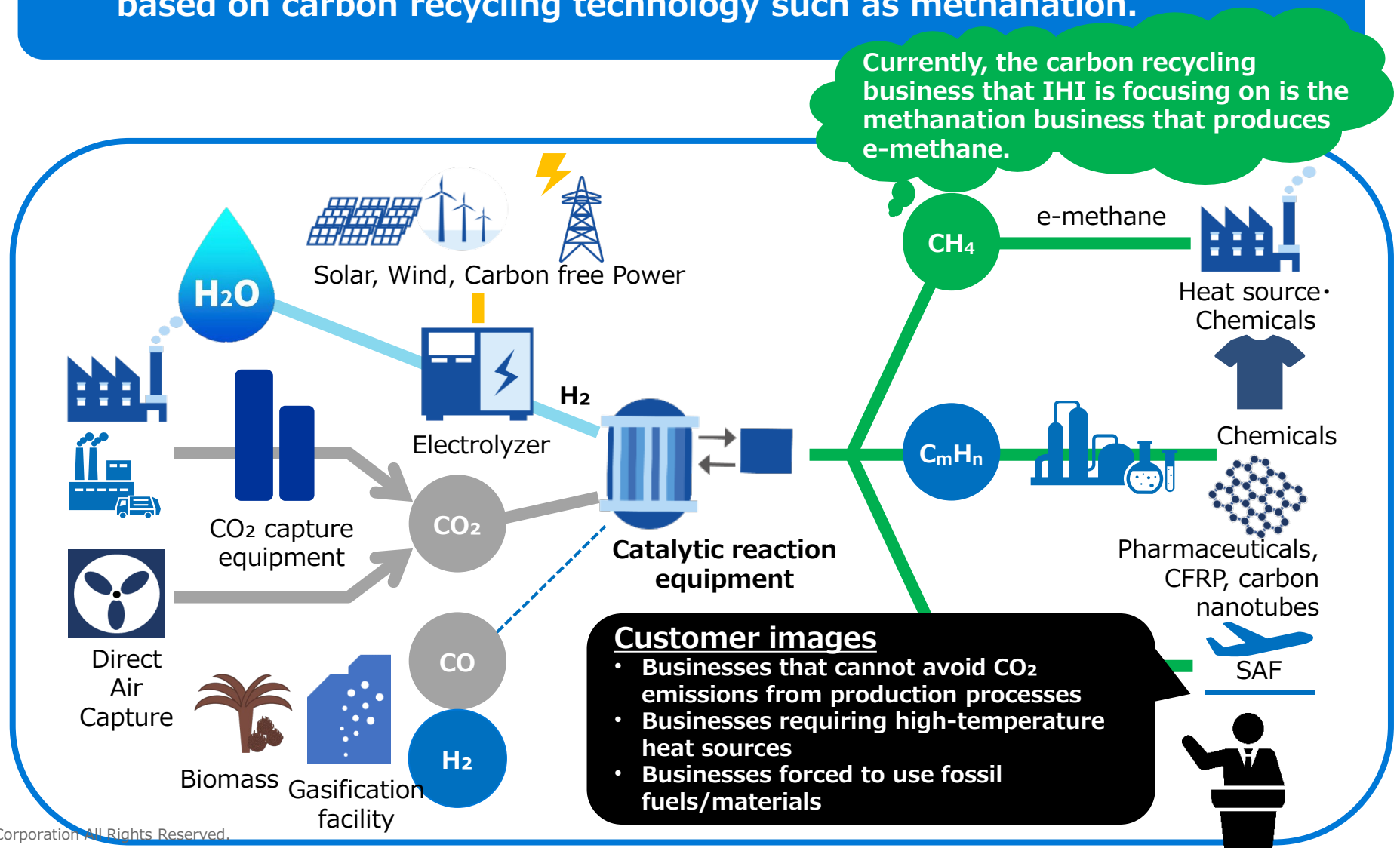
To promote the use of fuels that contribute to decarbonization, Japan will work on technological development, demonstration, and capital investment over the next 10 years, as well as on the development of regulations and systems, and coordination for the establishment of international rules.



Source : METI

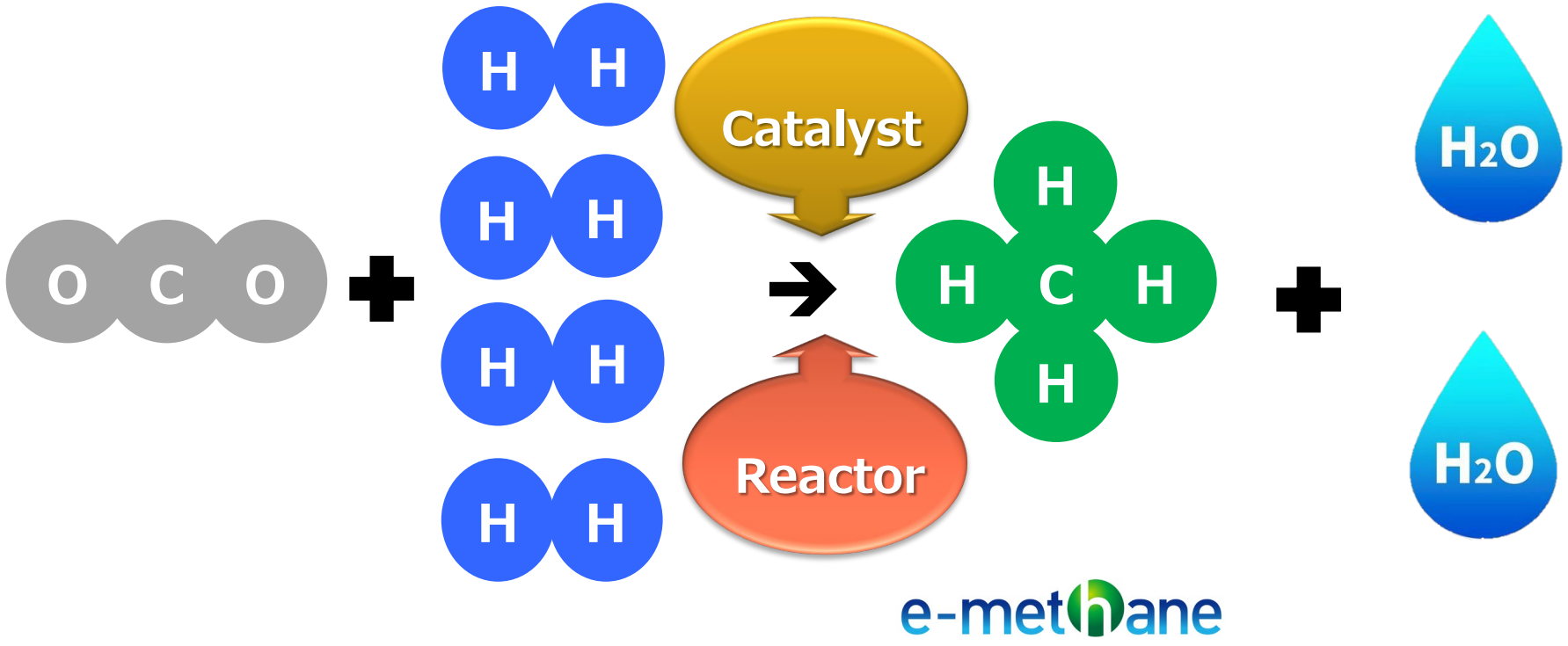
IHI Group's solution towards to Carbon neutral

As one of the decarbonization solutions, we aim to provide solutions based on carbon recycling technology such as methanation.



What is Methanation

- Technology to produce Methane by synthesizing CO_2 and H_2.
- The synthesis methane is called e-methane.
- Catalyst and Reactor is required to produce e-methane.



CO_2 $4H_2$ CH_4 $2H_2O$

Establishment of e-methane Value Chain

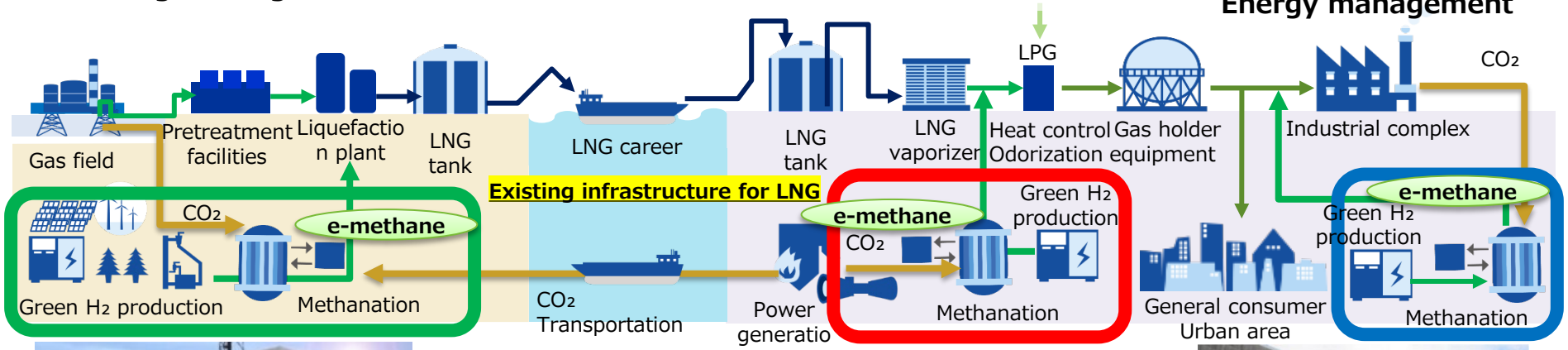
IHI is contributing to establish e-methane value chain through our various knowledge

Engineering

LNG career

LNG tank/terminal

Green H₂ production
Energy management



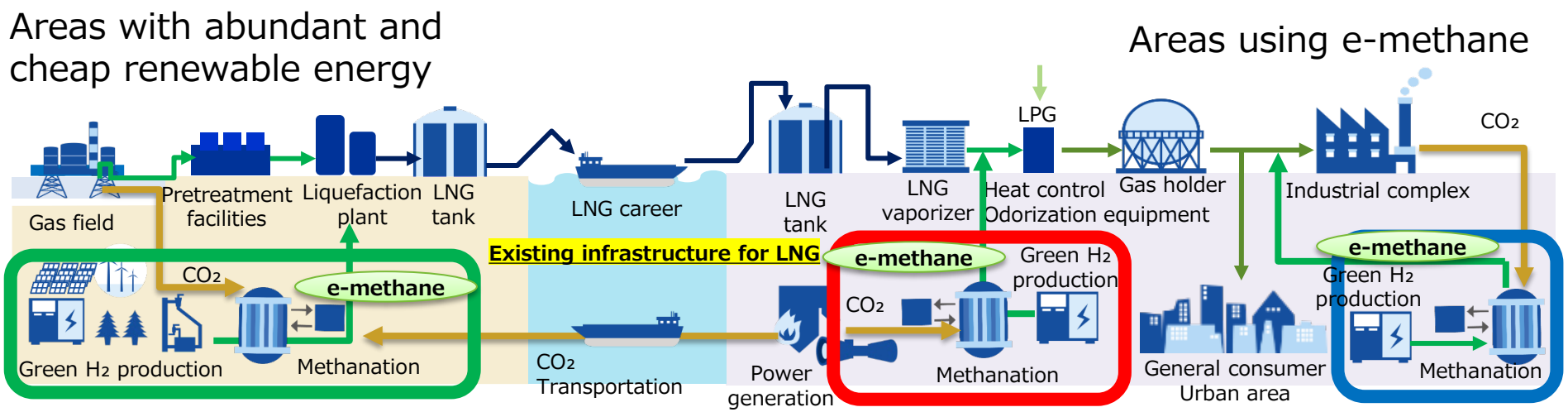
Energy storage system

Carbon capture system

Methanation System

Large-scale reactor (Shell & Tube)
maximum capacity: 275kt/y (EO)

Social implementation of Methanation in Japan



Case 1 : Export

Project development by Japanese gas company towards the following goals

2030 : 1% of city gas injected through e-methane pipelines
2050 : 90% of city gas injected through e-methane pipelines

The plant consists of renewable energy power generation equipment, hydrogen production equipment, CO_2 recovery equipment, methanation equipment, etc.

Case 2 : Import

Collection of CO_2 at LNG terminals
⇒ e-methane production hub

Case 3 : On-site

Production of e-methane at sites with CO_2
⇒ self-consumption/input e-methane into the pipelines of city gas & LNG

ex)
Steel & Cement industry
・JFE Steel :
Replacing coke with e-methane
・Taiheiyo Cement :
Utilizing CO_2 derived from Cement production

Expected CO_2 reduction amount
2030 : 800,000 tons
2050 : 72.3 million tons

In addition, CO_2 reduction amounts in Cases 2 and 3 will be added from the latter half of the 2020s.

Scale up of Methanation Process

Sales start in October 2022

①SIGC*
②Toho-Gas
③Taiheiyo Cement

*SIGC: Soma IHI Green Energy Center

Methane production volume (Nm^3/h)

Lab scale ~0.05 (~2018)
Bench ~1.2 (2019)
Demo ~12 (2020)

JFE Steel 500Nm^3/h

Mid-scale ~500Nm^3/h
Case 2
Case 3

2022~2025

Started considering of a large-scale methanation plant for overseas

Large-scale ~10,000Nm^3/h
Case 1

2030

No.	CH^4 Volume	Purpose	Site	Remarks
1	0.05Nm3/h	Development of catalyst Study of parameter characteristics	$ISCE^2$ @Singapore	Completed
2	1.2Nm3/h	Scale-up Catalyst/reactor performance validation	IHI Yokohama R&D Center	Completed
3	12.5Nm3/h	Scale-up Catalyst/reactor performance validation System operation properties check	Soma IHI Green energy Center (SIGC)	Completed

$ISCE^2$: Institute of Sustainability for Chemicals, Energy and Environment, a national research institute in Singapore.
SIGC : IHI-owned renewable energy research and demonstration center with solar panels, water electrolyzers and so on.

Standard Methanation Unit (12.5Nm^3/h)

Image

- Sales start in October 2022
- Commercialized for demonstration of many companies aiming for carbon neutrality
- Standard design realizing
  ①small package ② cost reduction ③ short delivery
- Natural gas facilities can be used

Utilization for Community Bus

Bus operation using e-methane as fuel

- Started supplying and operating e-methane to community buses as a means of transportation for citizens. This is the first use of e-methane for mobility in Japan.
- The filling equipment used in CNG vehicles can be reused.
  No need to develop new filling equipment for e-methane supply.

Standard Methanation Unit

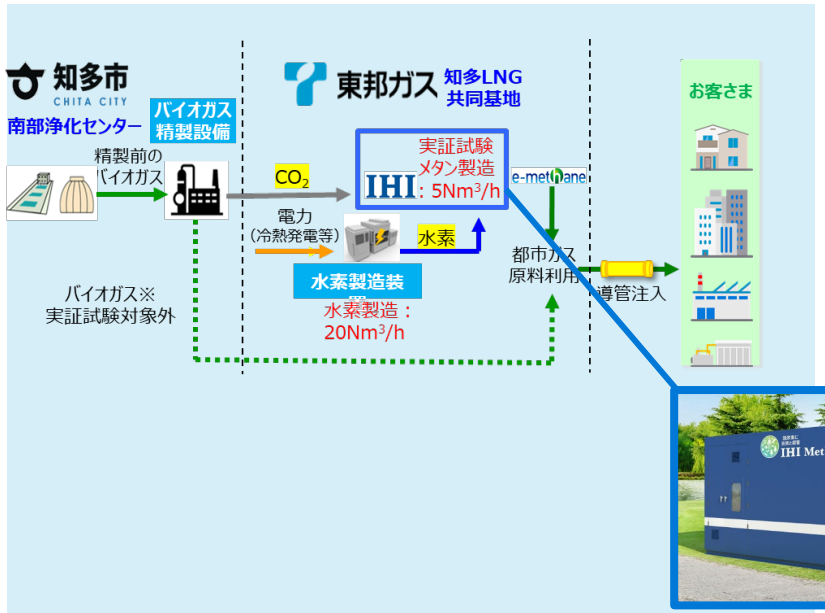
Community bus

Putting e-methane in the bus

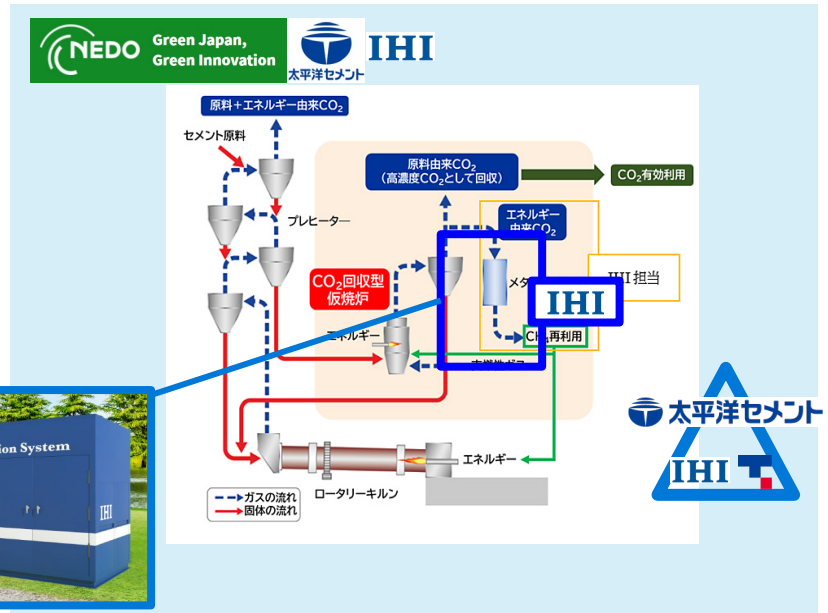
Examples of using Standard Methanation Unit (12.5Nm3/h)

◆ **It has been decided that the standard methanation unit will be used in various methanation demonstration projects.**

- Toho-Gas : Utilizing CO_2 derived from biogas
- Taiheiyo Cement : Utilizing CO_2 derived from Cement production



Methanation using CO_2 derived from biogas (Injection to Gas grid)



Methanation using CO_2 from the cement manufacturing process (On site)

Mid-scale Demonstration Project (500Nm3/h)

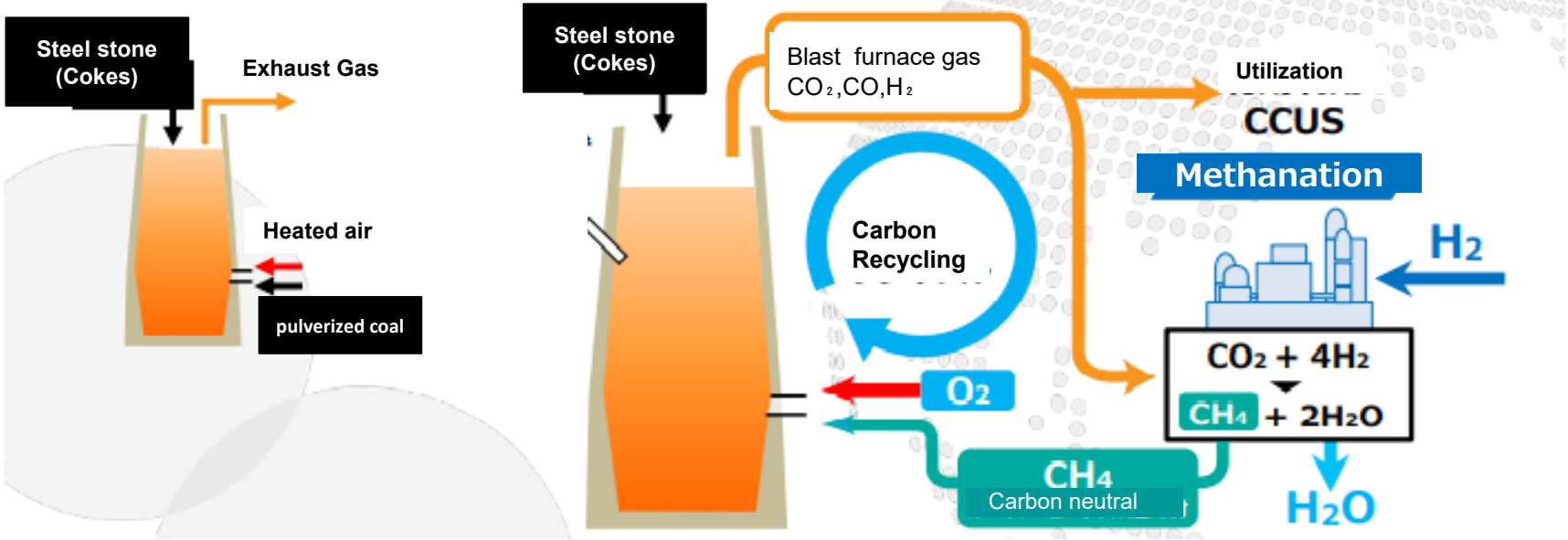
JFE Steel Corporation

- Demonstration of technology to reduce CO_2 emissions by 50% compared to conventional in the blast furnace process in the steel industry.
- Realize carbon recycling by replacing coke with synthetic methane as the reducing agent in the blast furnace.
- The operation will be started in April 2025

NEDO Green Japan, Green Innovation　JFE　IHI

Existing Blast Furnaces → Carbon recycling blast furnace

Replacing coke with e-methane.



Conclusion

- Japan declared that it aims to achieve carbon neutrality by 2050 and sets goals to start injecting more than 1% of e-methane into city gas by 2030 and expand it to 90% by 2050
- IHI has pledged to make its complete value chain carbon-neutral by 2050.
- IHI started sales of Standard Methanation Unit (12.5Nm3/h) for the demonstration of many companies aiming for carbon neutrality
- Mid-scale Demonstration Project (500Nm3/h) started and IHI finished basic design. IHI continue research and development for further scale-up.

IHI provides the best possible solution towards realization of carbon-neutral society.

Thank you for your kind attention.

IHI

Realize your dreams