

Carbon Neutral Challenge 2050 Action Plan (Full version)

10 June 2021
The Japan Gas Association

1-1. Carbon Neutral Challenge

- In November 2020, the Japan Gas Association (JGA) declared that the gas industry would take on the challenge of "carbon neutralizing gas in 2050," and expressed its determination to realize a decarbonized society.
- Looking ahead to 2050, in the transition period, the gas industry will make efforts by combining the following three various approaches in a complex manner, which will lead to the realization of a decarbonized society.
(1) Thorough shift to natural gas / advanced use of natural gas (2) Decarbonization of gas itself
(3) Initiatives such as CCU / CCS and overseas contribution
- Aiming to realize carbon neutralization of gas as an industry that supplies next-generation thermal energy (next-generation thermal energy industry *) by utilizing multiple means for decarbonization such as direct use of methanation and hydrogen.

* One of the "14 priority areas where growth is expected" in the "Green Growth Strategy for 2050 Carbon Neutral (Draft)"

Scenario for carbon neutralization of gas

Greenhouse
gas
emissions

Efforts during the transition period

1. Thorough shift to natural gas and advanced use of natural gas (demand side)

Fuel conversion from oil and coal, widespread use of cogeneration and fuel cells, higher efficiency of equipment, etc.

2. Decarbonization of the gas itself (supply side)

Decarbonization of the gas itself for innovation on the supply side such as methanation and hydrogen utilization

3. CCU / CCS and overseas contribution, etc.

CCU / CCS, overseas expansion of innovative gas appliances and engineering capabilities developed in Japan, utilization of carbon-neutral LNG, etc.

Decarbonized
society

Carbon
neutralization
of gas

Government target

now

2030

1

2050

1-2. What the gas industry is aiming for

- Deepened discussions through the "Study Group on the Ideal Gas Business for 2050" held as a METI study group, and set targets for 2050 and 2030 as a milestone.

2030

Achieving carbon neutralization rate of 5% or more for gas
Practical application of methane
(injection of carbon neutral methane into city gas pipeline 1% or more)

2050

Aiming to **realize carbon neutralization of gas**
by multiple means

*Efforts to solve major issues such as increasing the capacity of methanation equipment and stable and inexpensive hydrogen procurement.

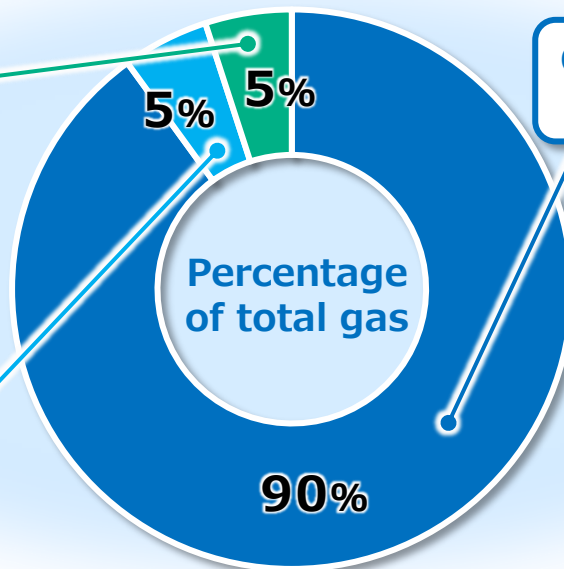
*Although there are many uncertainties, we will take on the challenge of realizing it by making full use of various measures that contribute to decarbonization.

Our view toward the realization of carbon neutralization of gas in 2050

Biogas
Other decarbonization
measures

- CCU/CCS
- Carbon neutral LNG(CNL)^{*1}
- Overseas contribution, DACCS^{*2},
Tree planting

Direct use of
hydrogen



Carbon neutral methane
(CN methane^{*3})

* 1. LNG that offsets GHG generated in the process from natural gas mining to combustion by CO2 reduction by supporting reforestation.

* 2. Direct Air Carbon Capture with Storage (CO2 direct capture and storage technology)

* 3. Decarbonized hydrogen and CO2 synthesized methane

● The figures in the graph are an example of the goals to be achieved when innovation progresses smoothly.

● Assuming that hydrogen, CO2, etc. are economically and physically accessible in conjunction with policies, etc.

2. Action Plan -3 Actions~

Action 1

**Contribution to
achieving NDC*
in 2030**

*NDC:Nationally Determined Contribution

Action 2

**Challenge to
implement
methanation**

Action 3

**Challenge to
direct hydrogen
supply**

CONTRIBUTION TO ACHIEVING NDC IN 2030

POINT

- **In the transition period** until the practical application of decarbonization technology, **it is important to reduce the CO2 emissions of society as a whole by promoting the spread of natural gas.**
- **Natural gas conversion from other fossil fuels such as large-scale industrial users** who have immediate effect and contribute to CO2 reduction toward achieving NDC (Japan's greenhouse gas reduction target: -46% * compared to FY2013) in 2030 Promote advanced utilization **by converting fuel to CO2 and expanding the spread of distributed energy systems (cogeneration, fuel cells, etc.).** At the same time, we will accelerate the promotion of the spread of **carbon-neutral LNG**, whose introduction is expanding, and **CCU**, which is under consideration for social implementation, **across the country.** By expanding the use of gas, we will contribute to **strengthening resilience and stabilizing the supply and demand of electricity.**
- In the transition period, these efforts will reduce cumulative CO2 and, in the future, replace the gas itself with decarbonized carbon-neutral methane **to achieve carbon-neutralization of the gas.**

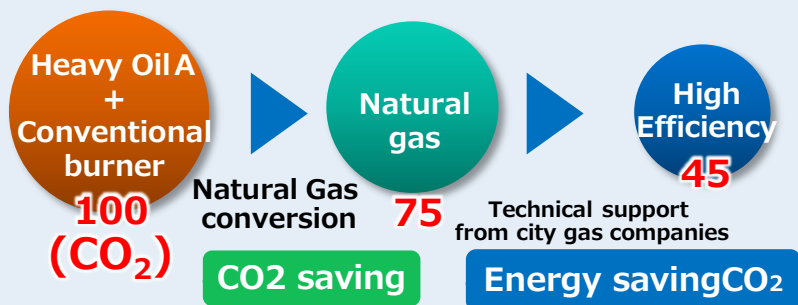
* Prime Minister's remarks at the government's Global Warming Countermeasures Promotion Headquarters Meeting and Climate Summit (held on April 22, 2021)

[Action 1] Contribution to achieving NDC in 2030

(Natural gas conversion: Industrial field, Marine transportation field)

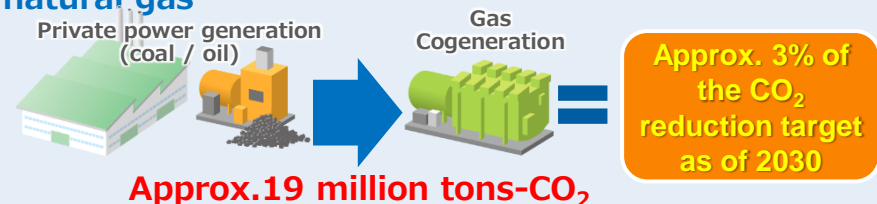
- **Fuel conversion and advanced utilization from other fossil fuels to natural gas in the industrial field is expected to reduce CO₂ reliably and on a large scale**, while large-scale conversion costs and running costs are expected to rise. In addition, we are accelerating the conversion by seeking support for the introduction of subsidies.
- CO₂ reduction **in the marine transportation field** can be expected to have a significant effect, and in recent years, major gas companies have also participated **in bunkering to LNG carriers, mainly in urban areas**. **Gas companies are actively involved in expanding the maintenance area for future base development.**

Promotion of natural gas conversion



In addition to natural gas conversion, energy measurement, burner development, etc. Implementing technical support and promote advanced use of natural gas

CO₂ reduction potential by converting coal / oil to natural gas



* When all fossil fuels such as coal that can be converted in Japan are shifted to natural gas.

* Calculated only for applications that can be gasified with natural gas by referring to the detailed table of Government Statistics 2018

Cases of natural gas conversion

Industrial sector (Asahi Kasei)

Before fuel conversion	Coal	Coal-fired power generation
New facilities	Gas turbine cogeneration	Natural gas-fired power generation scheduled to start operation in 2022
	Power : 37,000kW Steam : 140t/h	
LNG receiving facilities	LNG tank : 6,500kL Coastal vessel receiving equipment, LNG vaporizer, gas conduit, etc.	

Newly Established

Annual reduction of approximately 160,000 tons-CO₂ (equivalent to 5% of Asahi Kasei's total annual CO₂ emissions)

Bunkering bases are being developed mainly in the harbor area of the metropolitan area

Kitakyushu Port

In May 2019, Saibu Gas, Kyushu Electric Power, Chugoku Electric Power, and Nippon Yusen conducted the first LNG bunkering at Kitakyushu Port as a demonstration project.



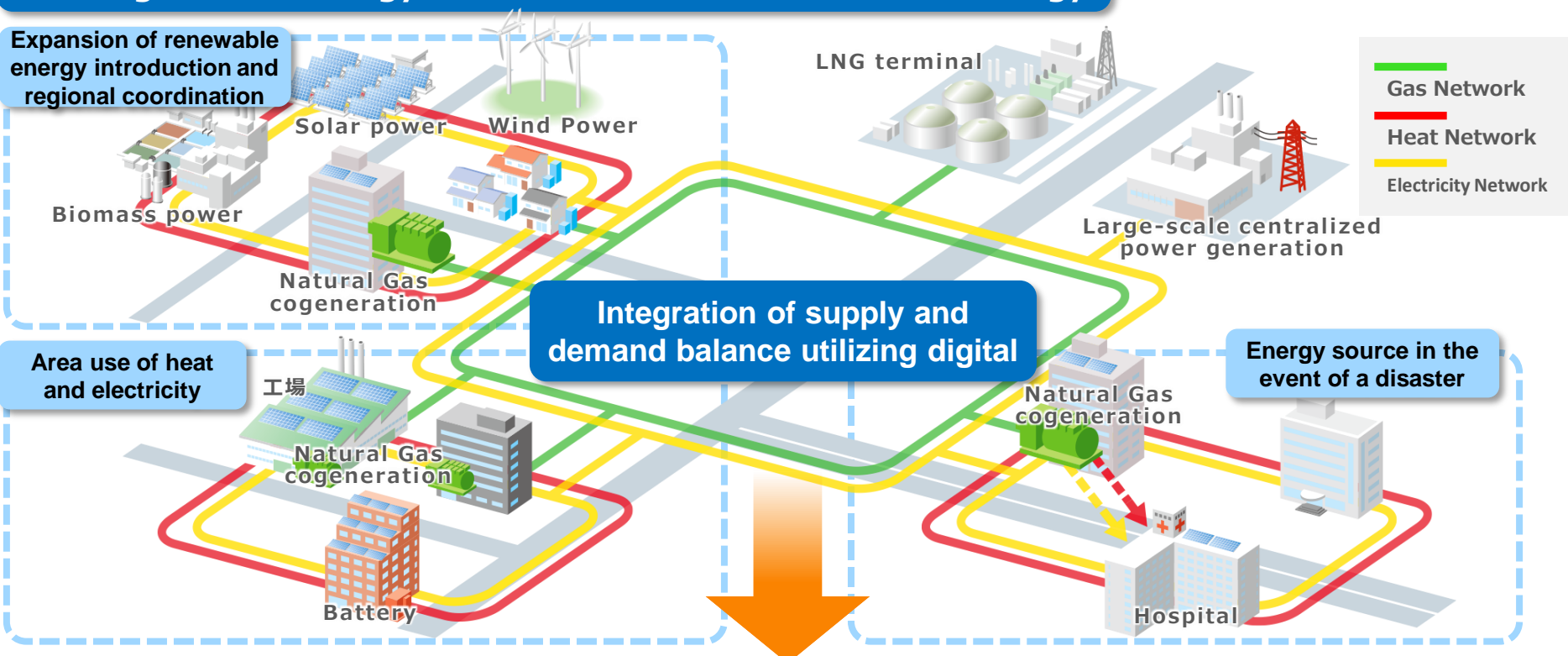
(Source: Saibu Gas Co. Website)

[Action 1] Contribution to achieving NDC in 2030

(Distributed energy system)

- Contributing to **significant energy savings and resilience** through the widespread use of "Distributed energy systems" such as cogeneration and fuel cells.
- **Promoting further low-carbonization and decarbonization** while strengthening regional resilience by **local gas companies who are familiar with the characteristics of the region**, working together with local governments and companies to expand the introduction of renewable energy and build a **smart energy network** through advanced management **utilizing digital technology**.

Building a smart energy network that utilizes distributed energy



In the future, we will promote the conversion to CN methane through methane, etc. to decarbonize the region

[Action 1] Contribution to achieving NDC in 2030

(Carbon Neutral LNG, CCU / CCS)

- **Carbon-neutral LNG (CNL)** has been introduced by gas companies, with Tokyo Gas announcing the introduction decision for the first time in Japan in June 2019, followed by Hokkaido Gas, Osaka Gas, and Toho Gas. In the future, **we will work on creating a mechanism for further expansion of introduction, such as responding to institutional issues.**
- Regarding **CCU**, we are considering technological development such as **CO2 separation and capture** through collaboration with industries such as the steel industry and chemical industry, centered on major gas companies, and **socially mountable schemes for chemical raw materials and concrete applications will be discussed.**

Expanded introduction of carbon-neutral LNG

CNL introduction cases

- Tokyo Gas announced Japan's first CNL introduction decision (June 2019)
- Tokyo Gas established CNL buyers' alliance (15 customers)
- Hokkaido Gas, Osaka Gas, Toho Gas announced introduction of CNL

Future JGA Initiatives

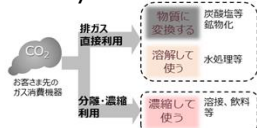
Working on creating a mechanism for further expansion of introduction in collaboration with gas companies

Promotion of the spread of CCU / CCS

CCU (Reuse)

Technology development for practical use of CCU business

⇒Promote technological development and service development that collects and utilizes CO2 emitted by customers (Tokyo Gas)



CCS (Storage)

Participation in government-led projects and EOR projects

⇒Efforts to demonstrate microbubble technology, etc. that converts CO2 into fine bubbles and efficiently stores them underground (Tokyo Gas)



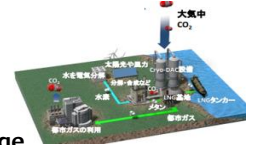
※ EOR: Enhanced Oil Recovery

CCU/CCS (Separation, Recovery)

Technology development to reduce CO2 separation and capture costs

⇒R&D of direct CO2 capture in the atmosphere using cold heat(Cryo-DAC) implemented by Tokyo Gas.

* Joint research with NEDO



Cryo-DAC image



Source : <https://carbon-neutral-lng.jp/> (processed by JGA)

Action 2

CHALLENGE TO IMPLEMENT METHANATION

POINT

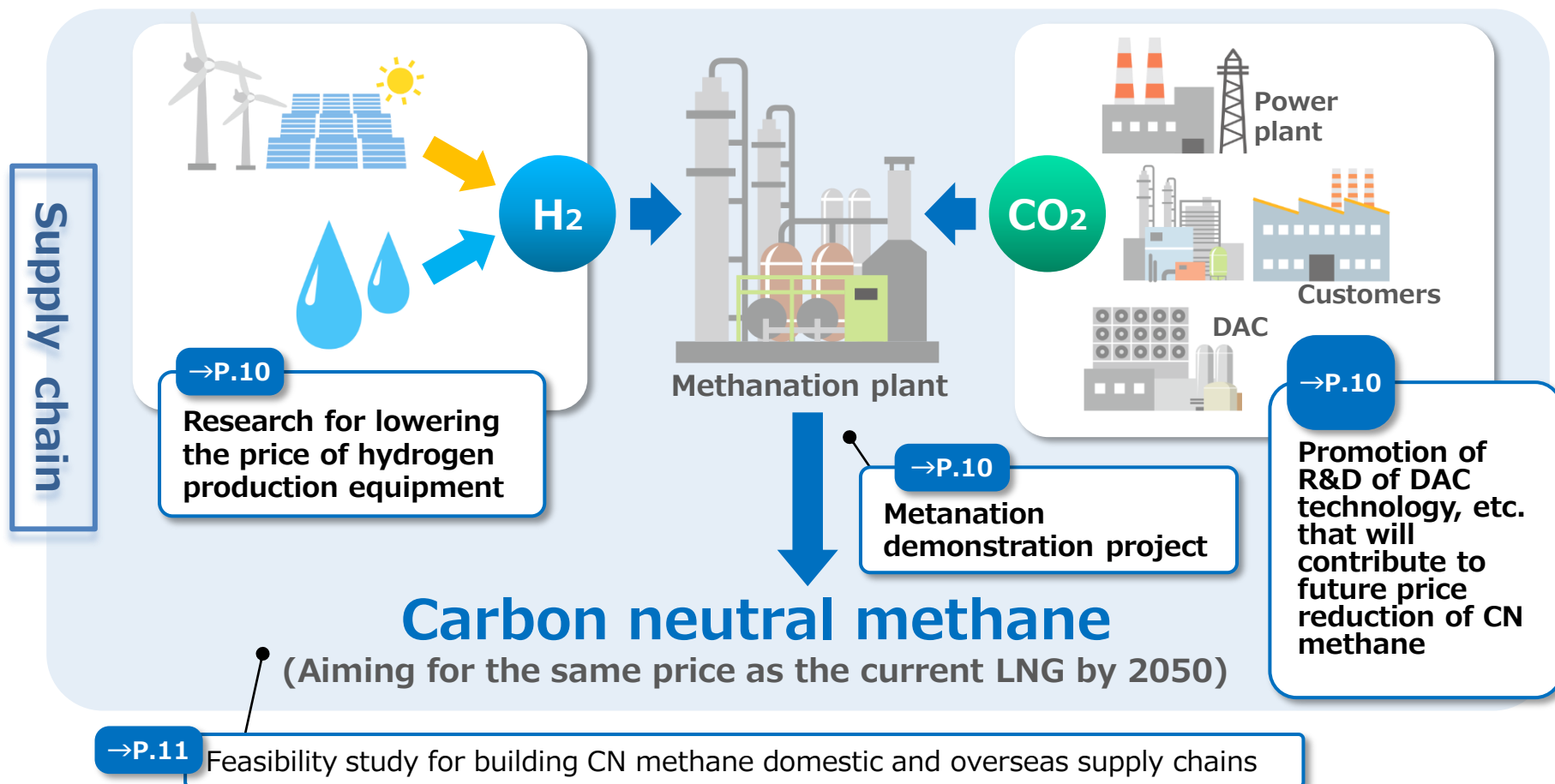
- Methane synthesized by **methanation can effectively utilize existing infrastructure and existing equipment such as city gas pipelines, can reduce social costs, and has great potential** as an efficient decarbonization means.
- **Sabatier reaction formula that succeeded in demonstrating a small-scale plant * 1**
Scale-up of methanation / Pilot plant demonstration led by each gas company, etc., paving the way for urban gas conduit injection and commercialization.
- In addition, we will promote the development of **cost reduction technology for hydrogen production, research and development and scale-up of the innovative technology SOEC type * 2** methane, and by collaborating with other industries within the industry, a large amount of CN methane will be produced in the future. **Aim to reduce the price and realize commercialization.**

*1Technology to generate CH₄ (methane synthesis) by reacting H₂ and CO₂ via a catalyst

*2Technology to generate CH₄ (methane synthesis) by electrolyzing (co-electrolyzing) both CO₂ and H₂O at the same time

Image of efforts to reduce methanation costs

- Japanese gas industry aim **to achieve the same price as the current LNG in 2050** for carbon-neutral methane produced from decarbonized hydrogen and CO₂.
- In order to reduce prices, it is necessary **to reduce costs and develop technologies for hydrogen production, CO₂ capture and methanation**, and Japanese gas industry will proceed with efforts to realize them.



[Action 2] Challenge to implement methanation (CN methane production demonstration, innovative R&D)

- Promoting upsizing and demonstration of manufacturing plants for commercialization of CN methane. At the same time, Japanese gas industry is developing technology to reduce hydrogen production costs. As a precedent example, in the NEDO project, INPEX and Hitachi Zosen are developing and demonstrating the technology of a small CN methane manufacturing plant (8Nm³ / h).
- Osaka Gas has succeeded in basic research on the SOEC-type methanation, which has higher conversion efficiency than the Sabatier reaction formula, which is a conventional technology. In the future, Japanese gas industry will promote research and development as a practical technology with the support of the government.
- For stable and inexpensive procurement of CO₂, Japanese gas industry is promoting innovative research and development such as CO₂ capture emitted by industrial users and DAC (Direct Air Capture) technology, which is a CO₂ capture technology in the atmosphere.

Price reduction by demonstration of CN methane production and upsizing

Demonstration proposal at the Osaka / Kansai Expo 2025

Osaka Gas is proposing a methanation demonstration to produce CN methane from biogas generated from swill at the venue and hydrogen derived from renewable energy for the Expo 2025.

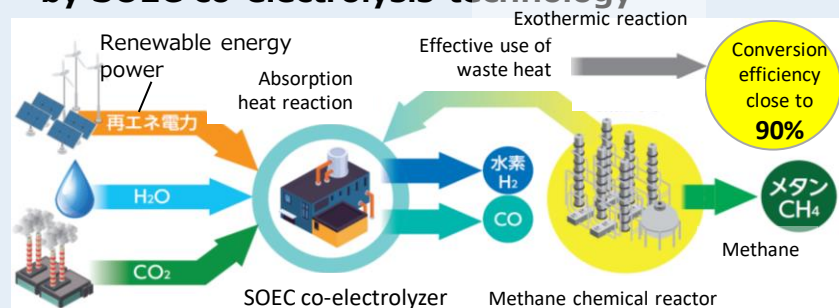
Technology development to reduce hydrogen production costs

Tokyo Gas is working on the technological development of electrolytic equipment for inexpensive and large-scale hydrogen production by utilizing the technology and know-how cultivated in the world's first commercialization of fuel cells and the development of hydrogen production equipment.



Innovative R & D to reduce future costs

■ High efficiency of methanation by SOEC co-electrolysis technology



■ Promotion of R&D of CO₂ capture method and DAC technology

research content	details
CO ₂ capture method	R & D of CO ₂ capture method for CO ₂ generated from gas consumption of large consumers near the methanation equipment and CO ₂ generated from nearby steel factories, power plants, and chemical factories
DAC	DAC element technology development

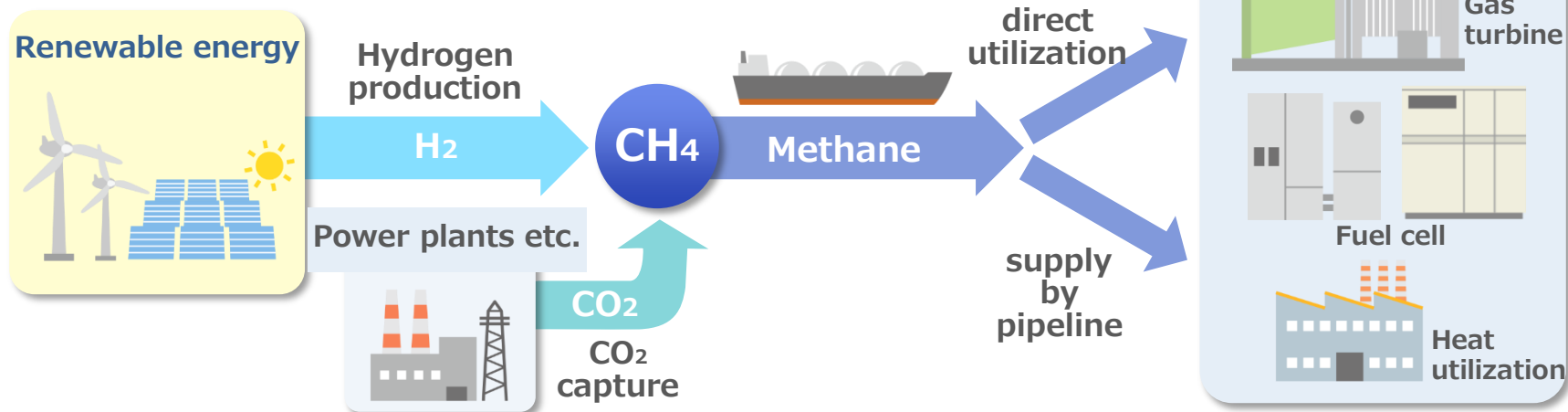
[Action 2] Challenge to implement methanation

(Building domestic and overseas supply chains)

- For the production and commercialization of CN methane, it is necessary to secure a large amount of low-priced hydrogen, CO₂, and renewable energy, and to establish a stable supply system for these. In order to solve this problem, Japanese gas industry will conduct **feasibility studies with manufacturing in Japan or overseas.**
- To build a supply chain, Japanese gas industry will proceed with studies **in collaboration with various industries** such as trading industry and engineering industry.

Supply chain of hydrogen carriers containing CN methane

(manufacturing-transportation-utilization)



Issues to be considered

manufacture

- Procurement of inexpensive renewable energy
- Inexpensive hydrogen production and development of methanation plant

transportation

- Combined use of CN methane and natural gas in existing infrastructure such as liquefaction bases, LNG carriers, receiving terminals, and pipelines

utilization

- Establishment of carbon neutral system for CO₂ emissions during gas utilization

- Preparation / examination for reducing calorific value, etc.

Action 3

CHALLENGE TO DIRECT HYDROGEN SUPPLY

POINT

- **New hydrogen pipelines will be constructed** in suitable locations centered on coasts. **Aiming to supply hydrogen directly through local hydrogen network.**
- Regarding hydrogen, while considering trends such as the interim report of the National Hydrogen and Fuel Cell Strategy Council, with a view to **collaborating with various alliance partners** on issues in terms of manufacturing, import, supply, utilization, etc.

[Action 3] Challenge to direct hydrogen supply

- Gas companies promote efforts for direct hydrogen supply **in cooperation with local governments**, etc., and **form a large-scale local network for direct hydrogen supply in the region.**
- Issues for making up hydrogen supply chain include **(1) hydrogen production**, **(2) hydrogen marine transportation**, **(3) hydrogen tank**, **(4) hydrogen conduit supply**, **(5) consumer equipment development**, and **(6) other security aspects.**
The gas industry will focus on (1), and (4) to (6).

Examination for hydrogen supply chain

Direct hydrogen supply for HARUMI FLAG* (Tokyo Gas Co.)

Hydrogen pipeline will be installed in HARUMI FLAG to supply hydrogen to pure hydrogen fuel cells installed in each block.

* Scheduled to be completed as a new house after utilizing the

Tokyo 2020 Olympic and Paralympic Olympic Village.



(Source: Tokyo Metropolitan Government)

Formulation of new energy society realization concept (Jobankyodo Gas Co.)

Independently formulated the "New Energy Society Realization Concept" that includes the construction of hydrogen pipelines and the development of industrial parks as a measure to create hydrogen demand.

Organizing and examining issues for direct hydrogen supply

(1) Hydrogen production

→ Action2

(2) Hydrogen sea transport

(3) Hydrogen tank

(4) Hydrogen pipeline supply

To be considered by the national hydrogen and fuel cell strategy council, etc.

- Selection of suitable site for local hydrogen network construction
- Safety evaluation associated with hydrogen pipeline construction

(5) Consumer equipment development

- R&D support for hydrogen gas appliances

(6) Other security aspects, etc.

- Safety verification in direct hydrogen supply

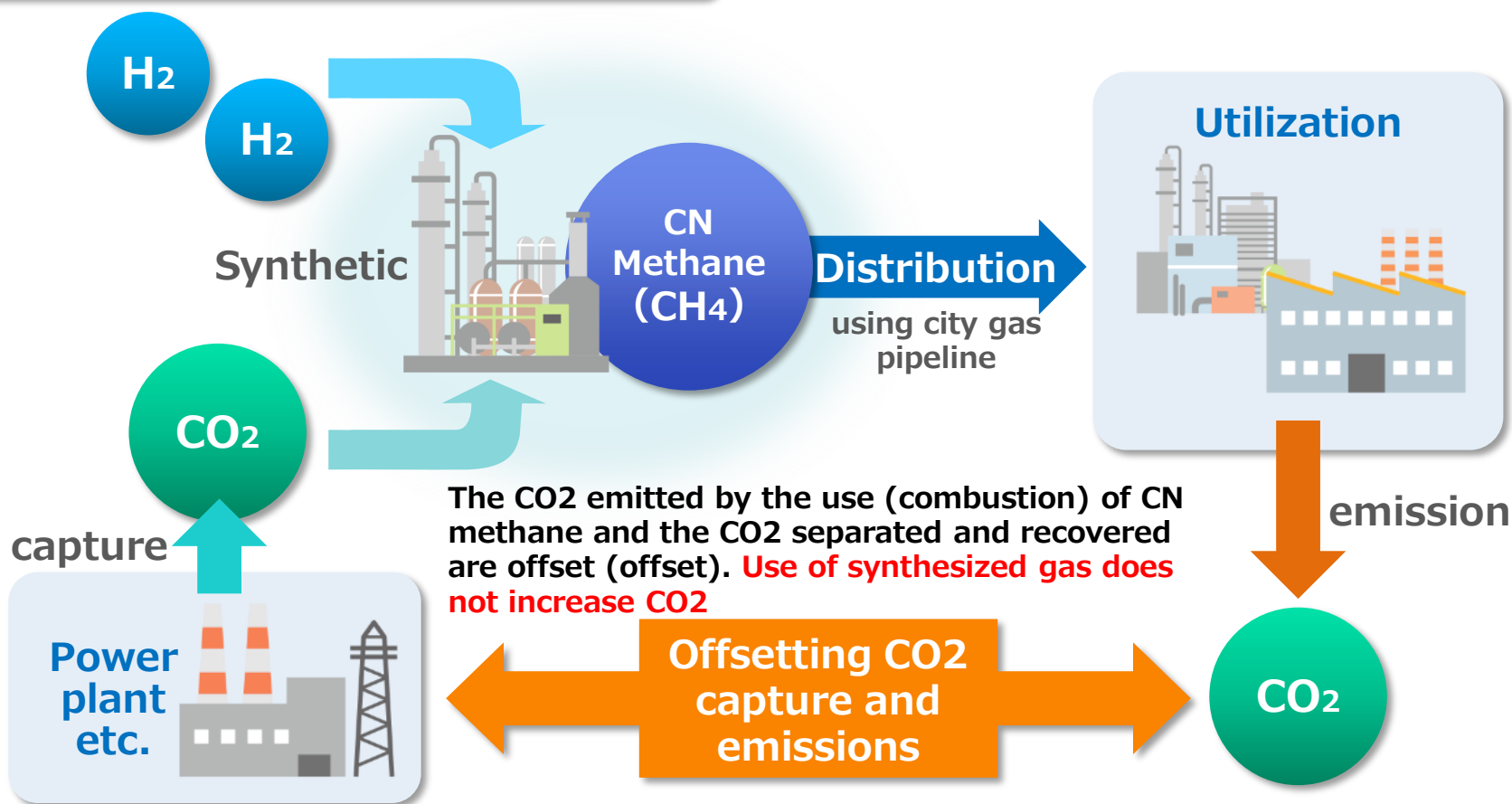
3. Action plan-Roadmap for realization

	Starts from now	start now~2030	start after 2030	2030	2040	2050	
[Action 1] Contribution to achieving NDC in 2030	Promotion of natural gas conversion		Natural gas conversion from coal / oil		Conversion of natural gas as a raw material for city gas to CN methane		
	Expansion of LNG bunkering	Bunkering base maintenance		Expansion of infrastructure development			
	Widespread use of distributed energy systems		Widespread use of distributed energy systems				
	Expanded introduction of carbon-neutral LNG		Expanded introduction of CNL(Carbon Neutral Methane)				
	Promotion of CCU / CCS	CCU initiatives at customers		Expansion of CCU introduction			
		CCS technology development / examination of suitable sites		Business scale expansion		Full-scale expansion	
	Promotion of biogas spread	On-site utilization of biogas		Expansion of utilization scale			
		Overseas biogas business		Expansion of overseas business			
	Overseas contribution	Contribution to CO2 reduction overseas, etc.		Business scale expansion			
R & D of water electrolyzer			Demonstration by pilot plant	Realization and expansion of cost reduction		Commercial expansion	
[Action 2] Challenge to implement methanation	CN methane production demonstration and upsizing	Research for improving catalyst durability		Improving durability			
	Innovative technology development	SOEC Metanation Technology Development		Larger scale & lower cost		Expansion of introduction	
		DAC element technology development		Demonstration			
	Establishing domestic & overseas supply chains	FS / Suitable site survey	Commercial scale demonstration		Start of transportation from overseas to Japan & expand introduction		Domestic & overseas supply chain construction
Efforts to improve the system							
[Action 3] Challenge to direct hydrogen supply	Establishing a hydrogen supply chain	Construction of local hydrogen network, selection of suitable site		Gradual introduction expansion			
		Examination for building a supply chain	Demonstration				
	Expansion of direct use of hydrogen	Hydrogen combustion equipment development		Expanding the use of hydrogen			
		Safety evaluation associated with hydrogen pipeline laying					

4. Initiatives for institutional issues

- In order to realize carbon neutrality in 2050 through the spread and expansion of CN methane produced by methanation and CNL utilizing credits, the social significance of various efforts is appropriate in Japan's laws and systems. Japanese gas industry will request the government to make efforts to improve the system so that it will be evaluated by the government.

CO2 emission reduction effect by methanation



5. Promotion system

- The "Carbon Neutral Committee" will be newly established within the Japan Gas Association as an organization to promote carbon neutrality in the gas industry.
- The committee consists of seven regional chairs, headed by the chair of the regional chairs' meeting.
- Japanese gas industry is also working with the public and private sectors to promote efforts toward the realization of carbon neutrality.

Gas companies

Carbon Neutral Committee

Role

- Specific examination for execution of action plan
- Exchange of opinions on the progress of the action plan and exchange of information between businesses regarding carbon neutralization efforts
- External transmission of various initiatives in the action plan

Committee System

Chair

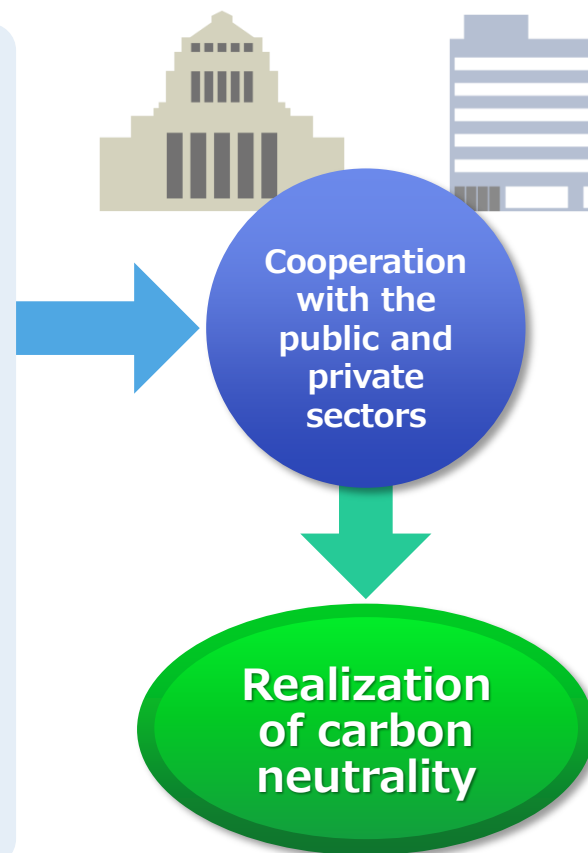
Chair of the 7 Regional Chairs' Meeting*1
(President of Tokyo Gas)

Members

7 Regional Chairs*2

※1. Regional Chairs' Meeting : A meeting body where the heads of seven regional committees nationwide gather

※2. Regional Chairs : Presidents of following 7 companies: Hokkaido Gas, Tobu Gas, Tokyo Gas, Toho Gas, Osaka Gas, Hiroshima Gas, Saibu Gas





END

[Reference] Image of gas supply in 2050 (published in November 2020)

- Japanese gas industry will contribute to the realization of a carbon-free society in 2050 by properly using carbon neutral methane (CN methane) that can utilize the existing gas infrastructure and direct use of hydrogen in the right place, and optimizing the entire energy including renewable energy.

(1) Coastal areas

Construction of hydrogen pipeline network starting from overseas imported hydrogen, CN methane production at home and abroad, domestic import

(2) Urbanized areas

Inexpensive decarbonization of CN methane by utilizing existing gas equipment

(3) Rural Areas

Use CN methane and hydrogen properly. Local production for local consumption within each conduit network to revitalize the region.

