TOKYO GAS GROUP

Compass2030 and Activities toward decarbonized society

TOKYO GAS CO.,LTD.
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Executive Vice President

Outline

Ⅰ. Compass2030

Ⅱ. Activities toward decarbonized society

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Ⅱ. Activities toward decarbonized society

2 Environmental awareness and our future goals

- The Tokyo Gas Group, while maintaining S+3E* as the bedrock of its business activities, **recognizes changes in the market environment as a major opportunity for growth** in the lead-up to 2030.

Our goal will be a **business group which continues to create value together with our customers, business partners and society as a whole** while **becoming a leader in the future energy systems**.

Noteworthy changes in the market environment

(1) Decarbonization
- Increased desire for decarbonization on the part of the general public worldwide
- Increase in the number of companies participating in the RE100 initiative, etc.

(2) Digitalization (rapid technical innovation)
- Changes in how people purchase and communicate in their daily lives
- Changes in the efficiency of work processes and work styles in business

(3) Diversification of customer
- Change from “things” to “experiences” and “value” in consumption behavior
- Increase in the number of “prosumers”** due to increased decentralization

(4) Deregulation in Energy Market
- Increased competition between energy providers
- Changes in industry structure that transcend industrial sectors (market entry by companies in different industries such as telecommunications, railways, IT and so on)

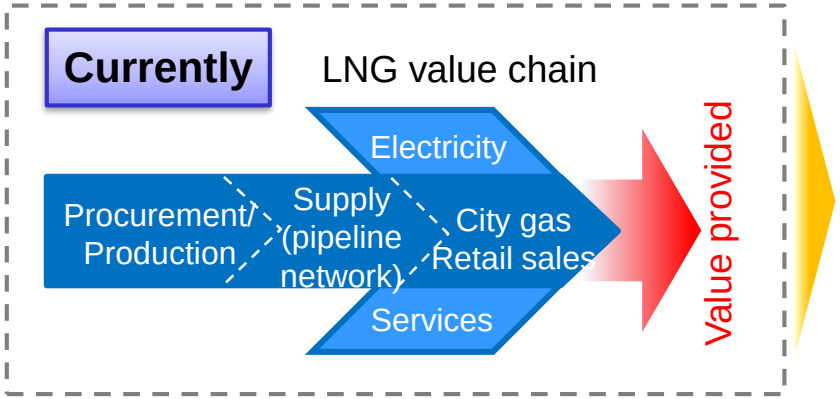
S+3E: The “Golden Rules” for Energy

Certain achievement of the energy mix*** leading up to 2030
Natural gas — with its outstanding stability, environment-friendliness and economic viability — will become even more important in the global energy market.

* S+3E: Safety + Energy security, Economic efficiency and Environment
** Prosumer: Consumers who engage in production activities (for example, consumers who own power generation equipment and sell the power they generate)
*** Energy mix: Policy objectives for energy supply and demand in FY 2030 as indicated in the Strategic Energy Plan of Japan

3 Three Challenges

- In addition to providing value in retail sales of city gas, the Tokyo Gas Group, working with its customers, business partners and society as a whole, will **create and provide various types of value** in **each function of the LNG value chain**.

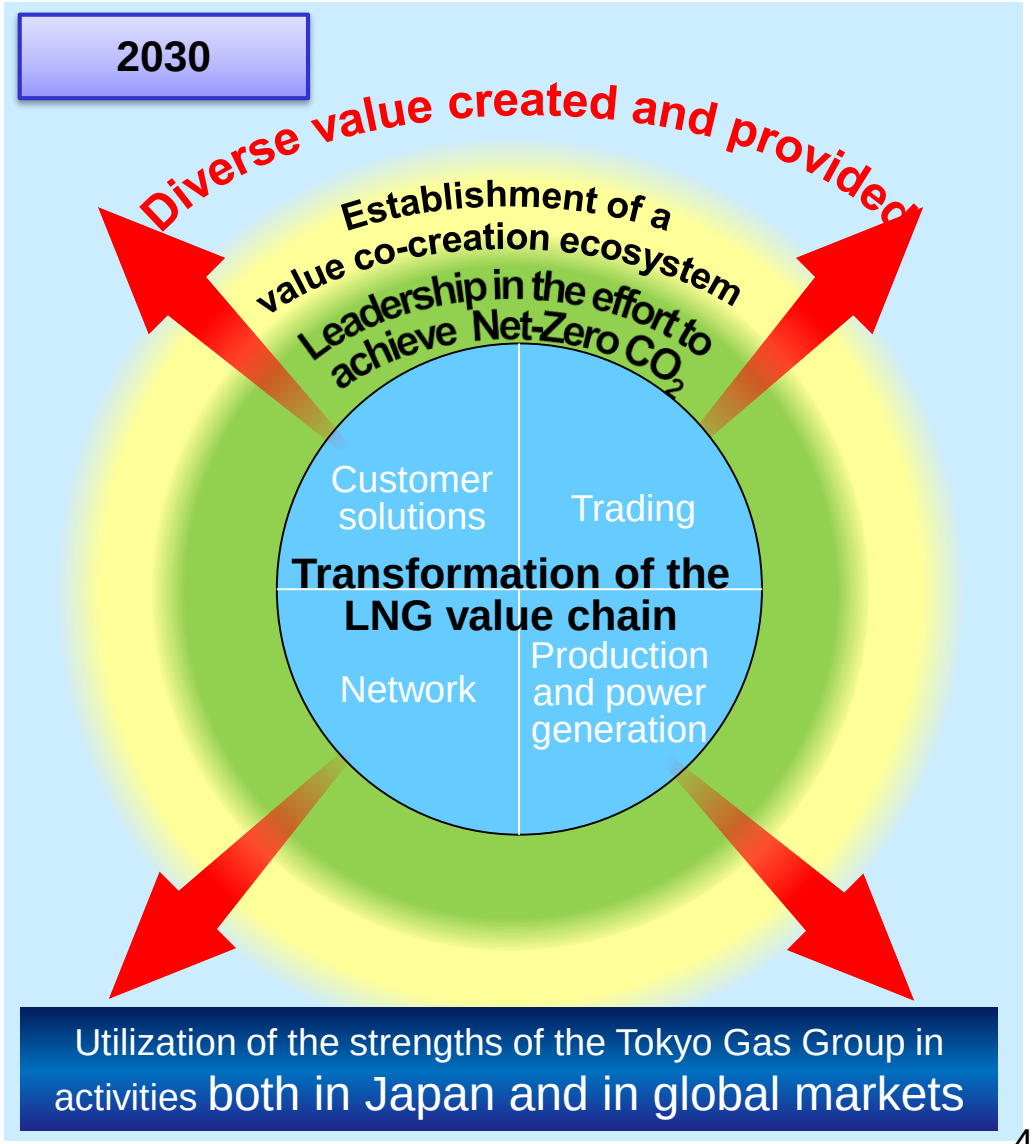


Three Challenges

1: Leadership in the effort to achieve Net-Zero CO_2

2: Establishment of a value co-creation ecosystem

3: Transformation of the LNG value chain



4 Challenge 1: Leadership in the effort to achieve Net-Zero CO_2

- In its overall business activities, the Tokyo Gas Group will **work to achieve Net-Zero CO_2 emissions** including customer emissions and **lead the transition to a decarbonized society**.
- We will use **technologies and expertise for the effective use of natural gas** to promote decarbonization in the electricity and heat sectors as well as for CO_2 capture technologies.
- We will **contribute to reduce carbon emissions on the scale of 10 million tons** by 2030 (which exceeds Japan's target ratio*) and lead the way to reducing CO_2 emissions on a global scale.

<Efforts to achieve Net-Zero CO_2 in the Tokyo Gas Group's style>

Efforts domestically and internationally

– 2030 → **– around 2050**

Emissions reductions not only in the Tokyo metropolitan area but on a global scale

1: Zero emissions

- Expanded use of renewable power sources
- Development of decarbonization technologies for gaseous energy

→ **Decarbonization in the electricity and heat sectors**

2: Zero emissions achieved through offsetting

- **Effective use of natural gas** (reduced energy consumption through efficient use of natural gas, coordination with the fluctuating output of renewable energy sources)
- **Use of CCUS**** technologies (capture of emitted CO_2)
- Incorporation of **successful reduction efforts overseas**

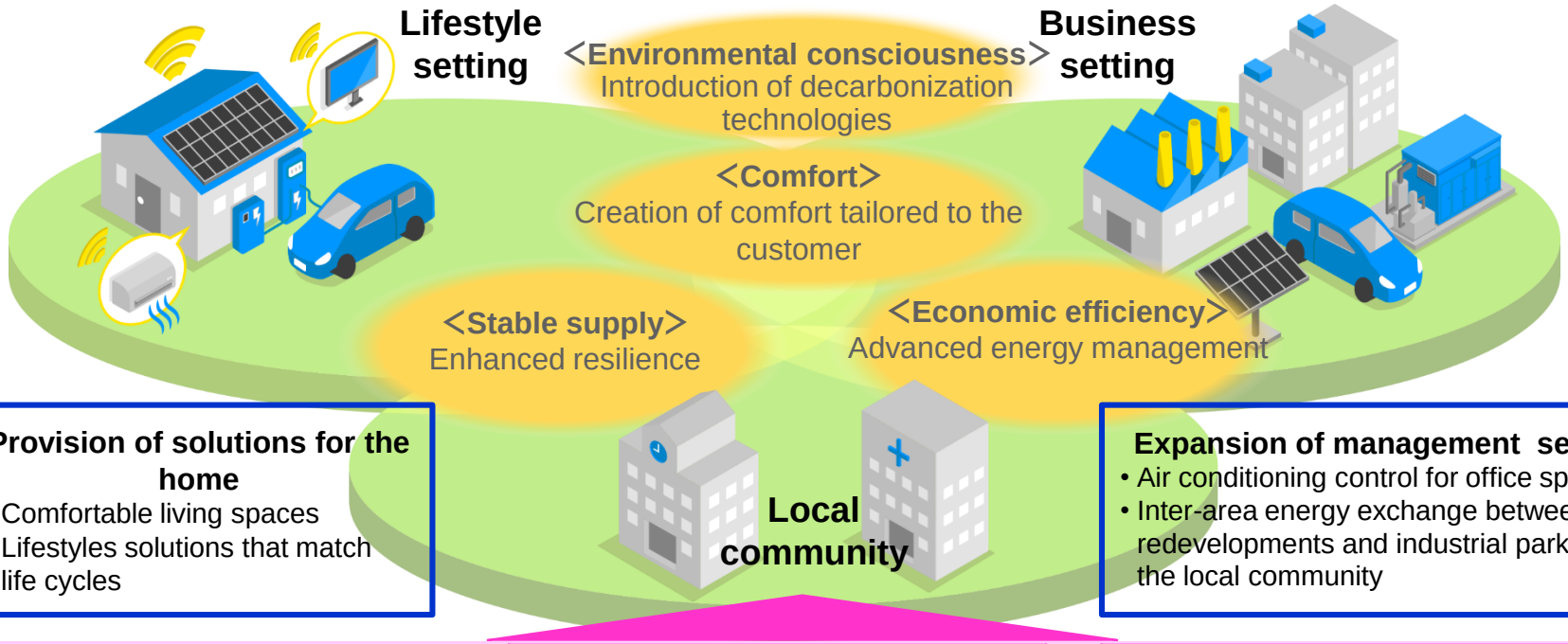
The combination of these activities will lead to Net-Zero CO_2

* Japan's reduction target ratio: The greenhouse gas reduction target in the Intended Nationally Determined Contribution submitted to the United Nations (26% reduction in FY 2030 as compared to FY 2013).

** CCUS: Carbon Capture, Utilization, and Storage

4 Challenge 2: Establishment of a value co-creation ecosystem

- We will establish a **value co-creation ecosystem*** that creates value together with customers, the local community, local governments, and business partners that include companies in different industries and venture firms.
- We will **flexibly combine the diverse products, technologies and services** in the ecosystem to provide **a variety of solutions that resolve various issues** in areas ranging from individual lifestyles to the local community.



Provision of solutions for the home
- Comfortable living spaces
- Lifestyles solutions that match life cycles

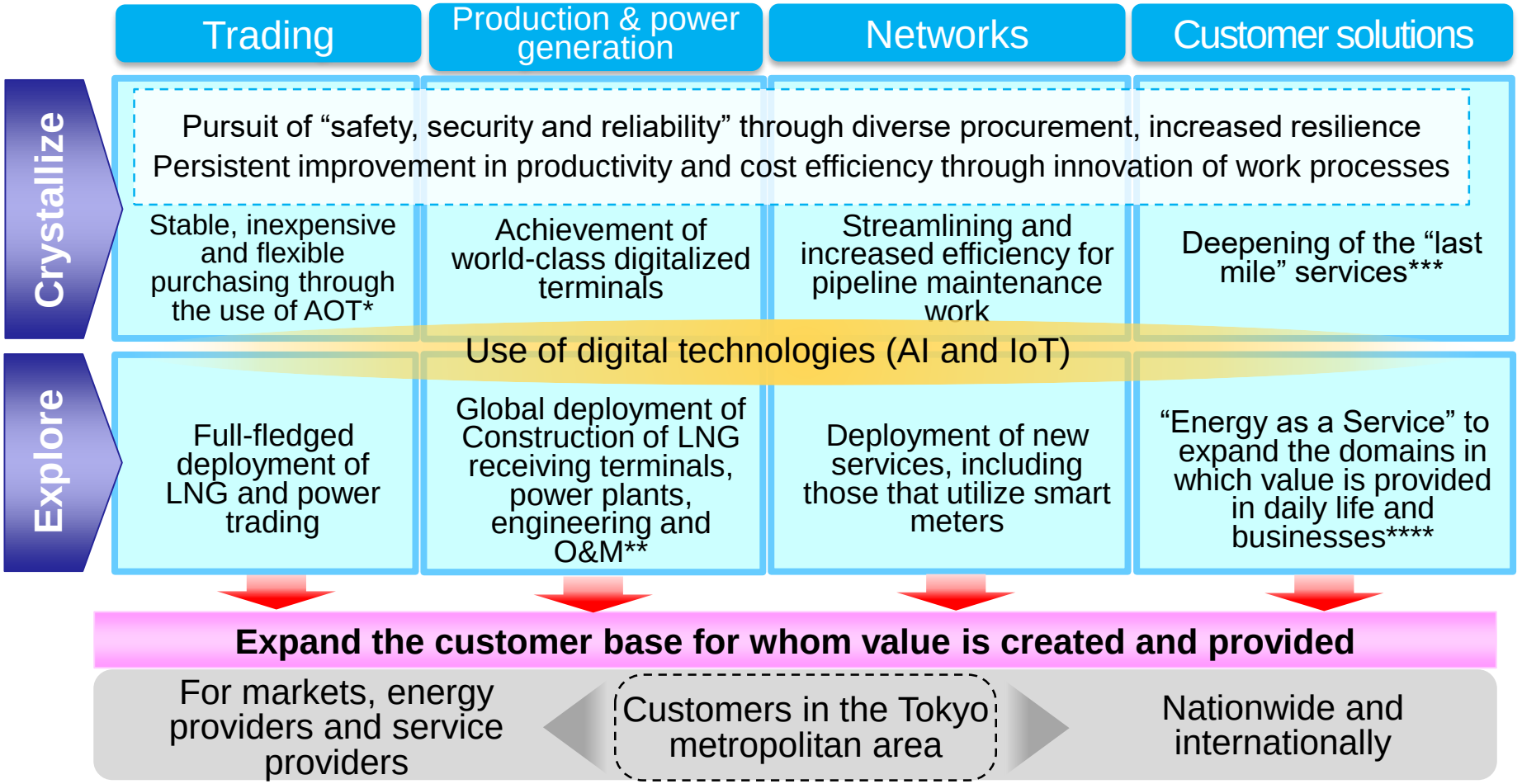
Expansion of management service
- Air conditioning control for office spaces
- Inter-area energy exchange between redevelopments and industrial parks and the local community

Customer participation	Strengths of the Tokyo Gas Group	Business partner participation
• Volume of energy use and equipment operation • Data on spaces and living environments • Excess energy from prosumers • Life cycle and lifestyle preferences	• Data and connections with customers (primarily through Tokyo Gas Lifeval) • Provision of gas, electricity and solutions • Equipment/appliances, construction and maintenance	• Energy technologies (IoT equipment, storage batteries) • Digital technologies (blockchain) • Data analysis (AI) • Connections with individual company customers

* Ecosystem: Business environment in which many companies combine their technologies, expertise and knowledge in their specific areas of strength in order to create new value.

4 Challenge 3: Transformation of the LNG value chain

- We will create and provide the various types of value from trading, production and power generation, networks, and customer solutions.
- We will **Crystallize** the business expertise accumulated up to now and **Explore** new domains in order to expand the customers base for whom value is created and provided, and maximize each of the functions of the LNG value chain.



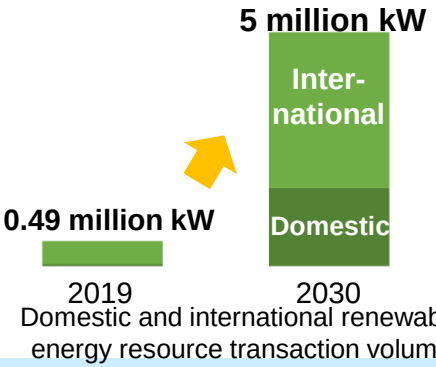
* AOT: Asset Optimization & Trading (use of digital technology for optimal linkage of LNG transactions, LNG vessels and receiving terminals)
** O&M: Operation & maintenance
*** Last mile: Site operations that require human intermediation in the final process of the value chain.
**** Energy as a Service: Sale not of energy alone but of a menu of services combining energy, equipment, control technologies and maintenance, etc.

5 Action 1: Coordination of renewable energies and natural gas

- We will accelerate the efforts to acquire renewable power sources both in Japan and global markets, and actively use of decentralized resources such as PV*, storage batteries and EV** to develop businesses that **combine large-scale power sources and decentralized power sources**.
- We will **combine renewable energies with clean natural gas that offers excellent control** to achieve a stable and inexpensive supply of energy.

Acquisition of renewable power sources

• Expand renewable power source transaction volumes both at home and abroad



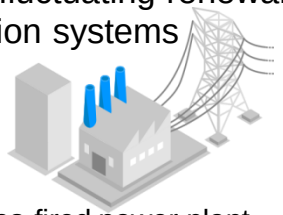
Domestic and international renewable energy resource transaction volume

New businesses utilizing decentralized resources

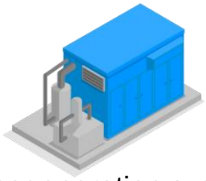
• Promote new businesses utilizing PV, storage batteries, EV etc. as well as VPP***

Stable supply through the combination of renewable energies and natural gas using digital technology

• Adjustment of fluctuating renewable energy output using gas-fired power generation and gas cogeneration systems



Gas-fired power plant



Gas cogeneration systems

ENE-FARM

Effective use of natural gas

* PV: Photovoltaic power ** EV: Electric vehicles

*** VPP: Virtual power plant. A mechanism that uses IoT to manage and control decentralized power sources, batteries, etc. as if they were a single power plant.

5 Action 2: Decarbonization technology innovations

- **We will promote innovations in essential core technologies that contribute to decarbonization** in the period leading up to 2030.
- After 2030, we will promote **hydrogen production and direct use** that make use of both domestic and global **renewable power sources** and the introduction and use of **methanation technology*, etc. to meet the demand for heat**. In addition, **these means will be combined and utilized** for achieving Net-Zero CO_2 through IoT, AI.

Roadmap to Net-Zero CO_2

Development of essential core technologies using open-innovation

Hydrogen production technology

CO_2 separation and capture technologies

High-efficiency fuel-cell technology

× Partner companies, universities and research institutions

Degree of contribution to Net-Zero CO_2 Achievement

To Net-Zero CO_2

Combination and use of various means

- **Introduction and use of hydrogen, methanation technology etc.**
- **Introduction of ultra-high efficiency fuel cells**
- **Introduction and use of CCUS**
- **Optimal use and control of renewable power sources**
- **Advanced use of natural gas**

Current 2030 2050

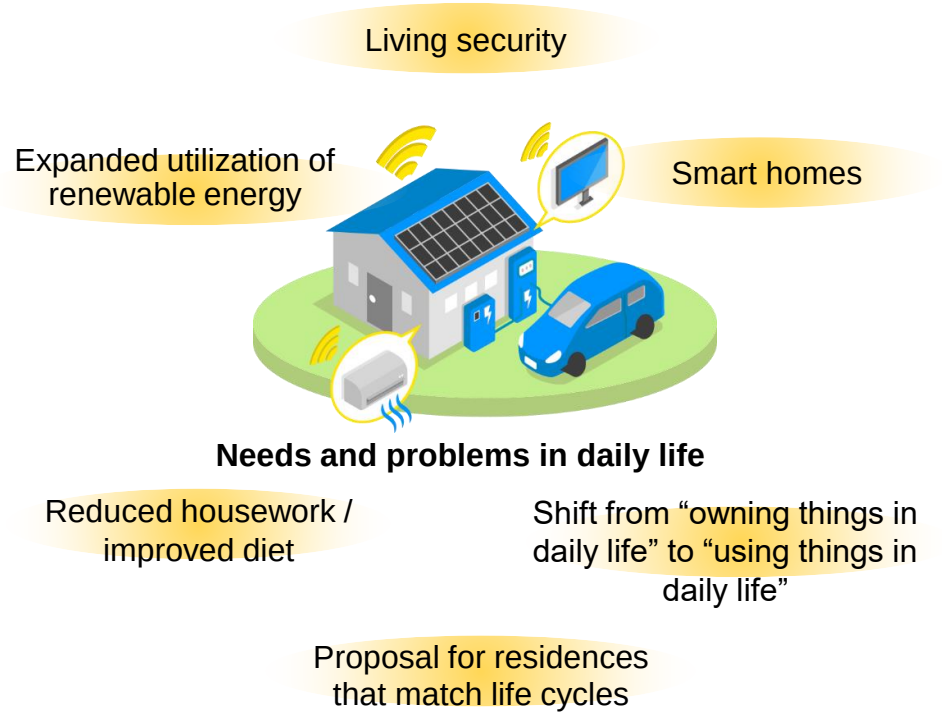
* Methanation technology: Producing carbon neutral methane by combining hydrogen and CO_2

5 Action 3: Resolving problems in daily life and businesses

- We will confront problems in daily life and businesses and provide various solutions, beginning with “Energy as a Service.” Efforts **to create and provide new solutions, including the establishment of new companies**, will be accelerated.
- **A digital infrastructure for value co-creation will be established** and advanced digital marketing will be employed. In addition, we will expand the number of business partners, the amount of data used, and products and technologies to enable a **broader range of solutions to be created and provided**.

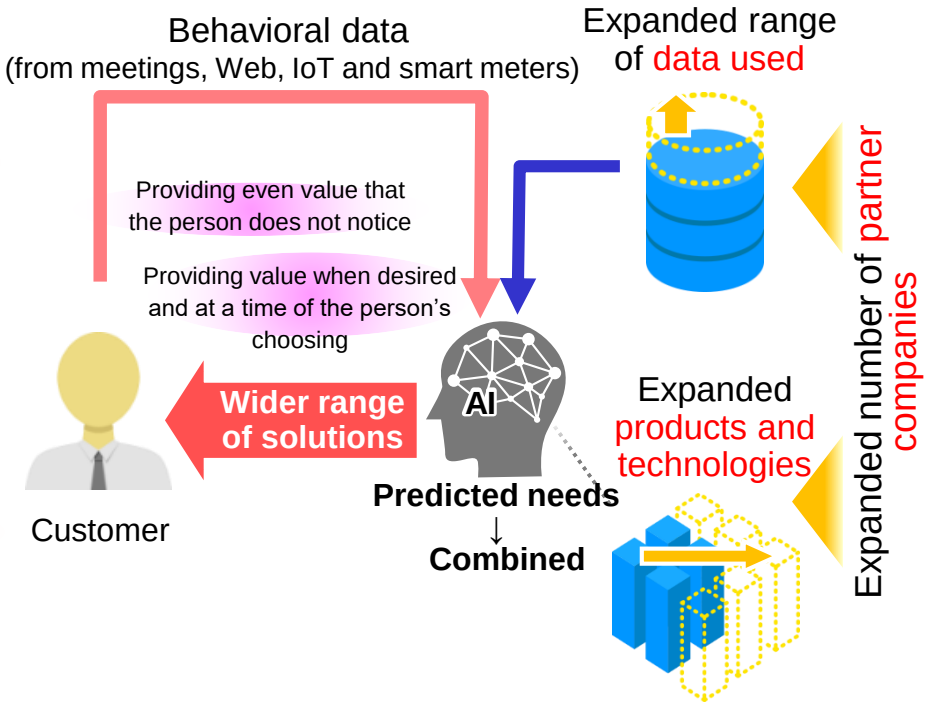
Resolving various customer needs and problems

- Accelerate the creation of new solutions including the establishment of new companies



Instantly offering wide-ranging values tailored to customers

- Establishment of a digital infrastructure for value co-creation



5 Action 4: Enhanced resilience functions through the use of natural gas

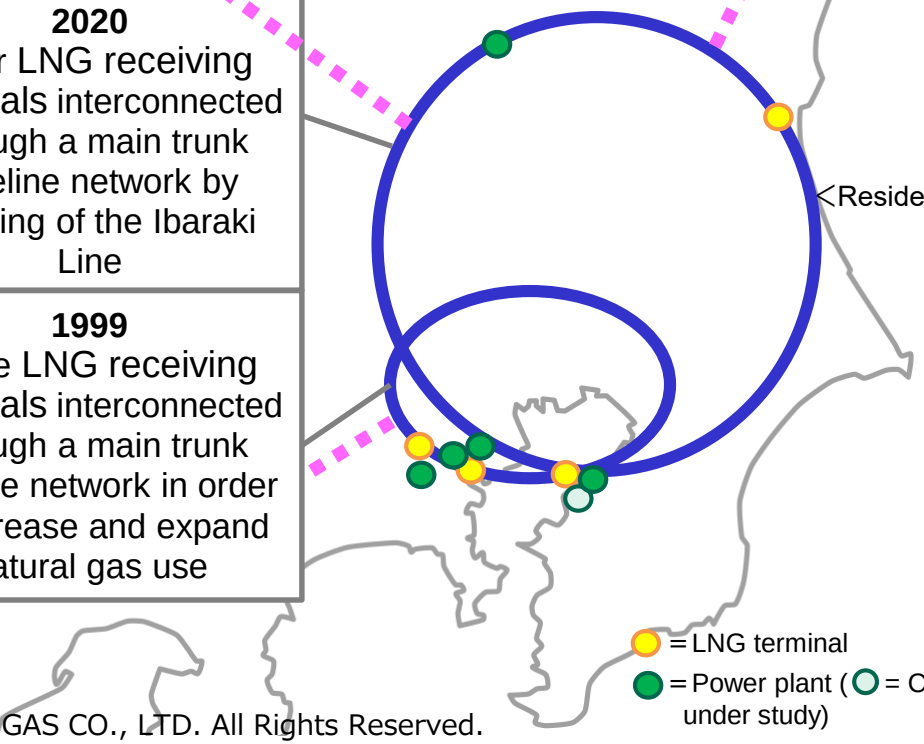
- The opening of the Ibaraki Line in 2020 will create our second circular trunk pipeline network. The Tokyo Gas Group, through stronger cooperation with local governments and infrastructure companies, will work to **strengthen the resilience of the natural gas infrastructure** towards 2030 **in the Tokyo metropolitan area** that is the political, economic and industrial center of Japan.
- By expanding decentralized energy systems, we will promote **disaster-resilient lifestyles and urban design** that can continue to supply energy even in the event of an emergency.

Enhanced resilience of natural gas infrastructure

In the period leading up to 2030
Cooperation with local governments and infrastructure companies (interconnected pipeline, etc.)

2020
Four LNG receiving terminals interconnected through a main trunk pipeline network by opening of the Ibaraki Line

1999
Three LNG receiving terminals interconnected through a main trunk pipeline network in order to increase and expand natural gas use



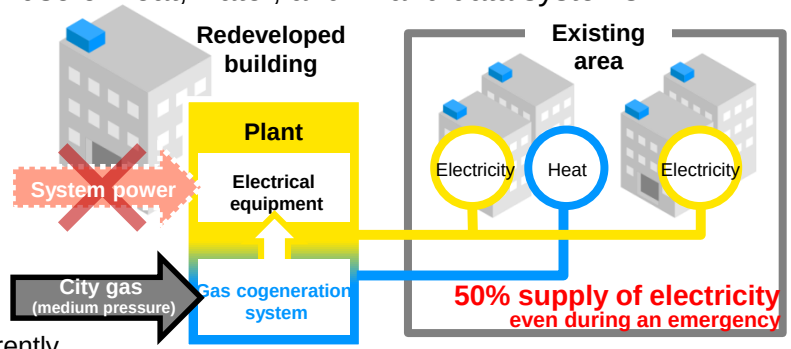
Disaster-resilient lifestyles and urban design

- Enhanced disaster preparedness functions for homes and businesses through the expansion of decentralized energy systems

<Residential fuel cell (“ENE-FARM”)>


<Gas cogeneration system>

- Urban design that not only provides electricity in the event of an emergency but also ensures the stable use of heat, water, and IT and data systems



<Nihonbashi Smart Energy Project>

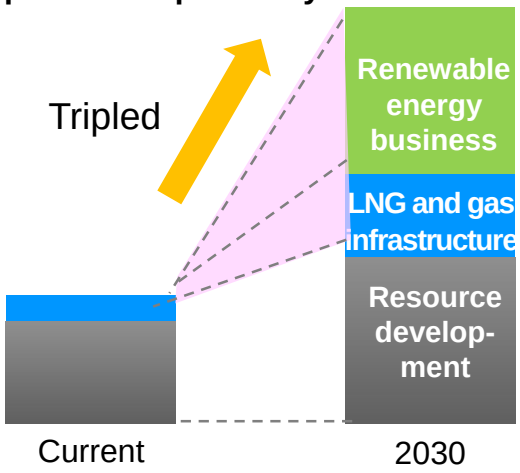
5 Action 5: Overseas expansion

- The Tokyo Gas Group will strive to achieve Net-Zero CO_2 on a global scale through business development, considering the energy market environment in each country.
- We will work to **triple overseas profits through business operations** that utilize the Group's strengths in the LNG value chain.
- In addition to resource development, we will diversify operations our activities **gas & power supply and the renewable energy business**.

Utilization of LNG value chain functions Expansion into renewable energy business

- Expand operations at an accelerated pace by means of growth engine type investment* that utilizes our expertise cultivated through project investments.
- Promote shale gas and other resource development that creates the Group's earnings base, and expand into renewable energy business, gas & power supply and LNG terminal business.

Expansion of profits by overseas investment

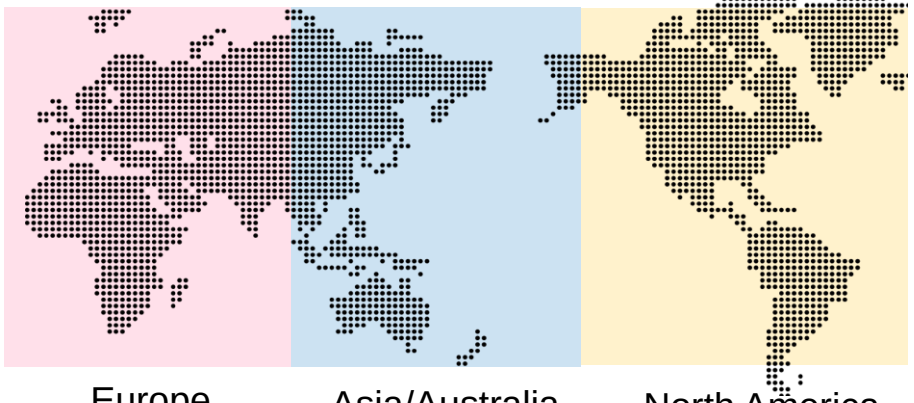


Wind power generation (Mexico)

Photovoltaic power generation (Mexico)

Expansion of LNG trading

- Work with business partners mutually taking advantage of individual strengths and regional differences, etc. to develop full-fledged trading in expanding LNG markets.
- Optimally combine LNG trading, owned LNG vessels and receiving terminals, using digital technologies as well.
- Increase LNG added value through transport and operation.



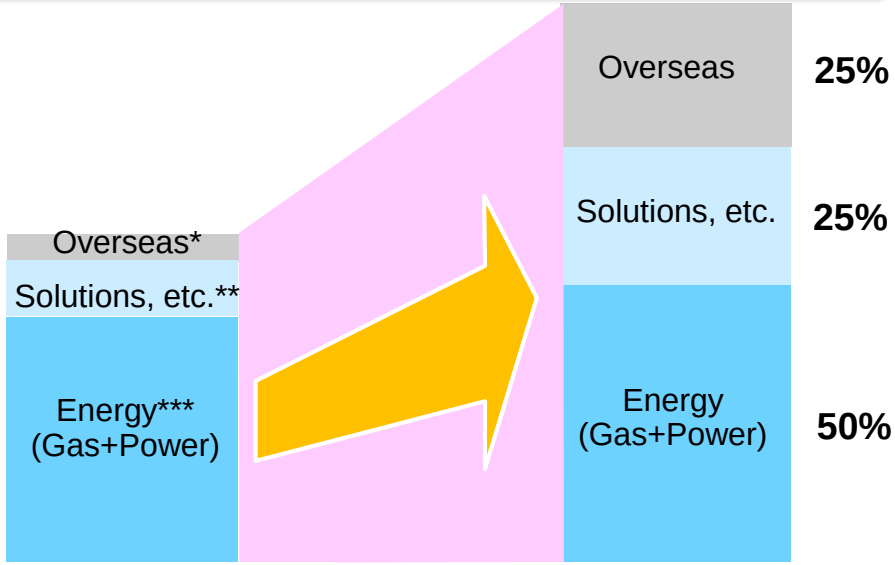
Use in each LNG value chain function
Provided to customers both at home and abroad (Southeast Asia, etc.)
Expansion of trading scale to 5 million tons

* Growth engine type investment: Activities to grow operating companies by investing them and taking part in their management.

6 Management guidelines and key figures for achieving growth

- In the first half of the 2020s, we will concentrate primarily on making operations more cost-effective in accordance with the transformation of the LNG value chain, in order to expand energy (gas + power) profits.
- Throughout the second half of the 2020s, we will work to increase profits from services and overseas projects in which we have invested, and actively use means such as M&A to achieve growth.
- We will work to increase the overall profit level to approximately **JPY 200 billion** by 2030, while maintaining profitability and fiscal health and judging the results of activities based on key figures. We will meet shareholder expectations through the increase in enterprise value.

Company portfolio in 2030: Profit level



* Overseas: All overseas businesses
** Solutions, etc.: Ongoing service agreements, engineering, real estate etc.
*** Energy: Domestic gas and power business

Key figures

Challenge 1: Leadership in the effort to achieve Net-Zero CO_2

CO_2 reduction contribution	-10 million tons
Renewable power source transaction volume (domestic and international, including purchasing)	5 million kW

Challenge 2: Establishment of a value co-creation ecosystem

No. of customer accounts****	20 million

Challenge 3: Transformation of the LNG value chain

Natural gas transaction volume*****	20 million tons

**** Total no. of gas, power and service agreements (domestically and internationally)
***** LNG equivalent including overseas business and trading

Outline

Ⅰ. Compass2030

Ⅱ. Activities toward decarbonized society

Three Challenges

1: Leadership in the effort to achieve Net-Zero CO_2

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Five Actions

① Coordination of renewable energies and natural gas
- Smart energy network

② Decarbonization technology innovations
- Carbon neutral LNG
- Hydrogen station
- High-efficiency fuel cell
- CCUS
- Hydrogen, Methanation

③ Resolving problems in daily life and businesses

④ Enhanced resilience functions through the use of natural gas

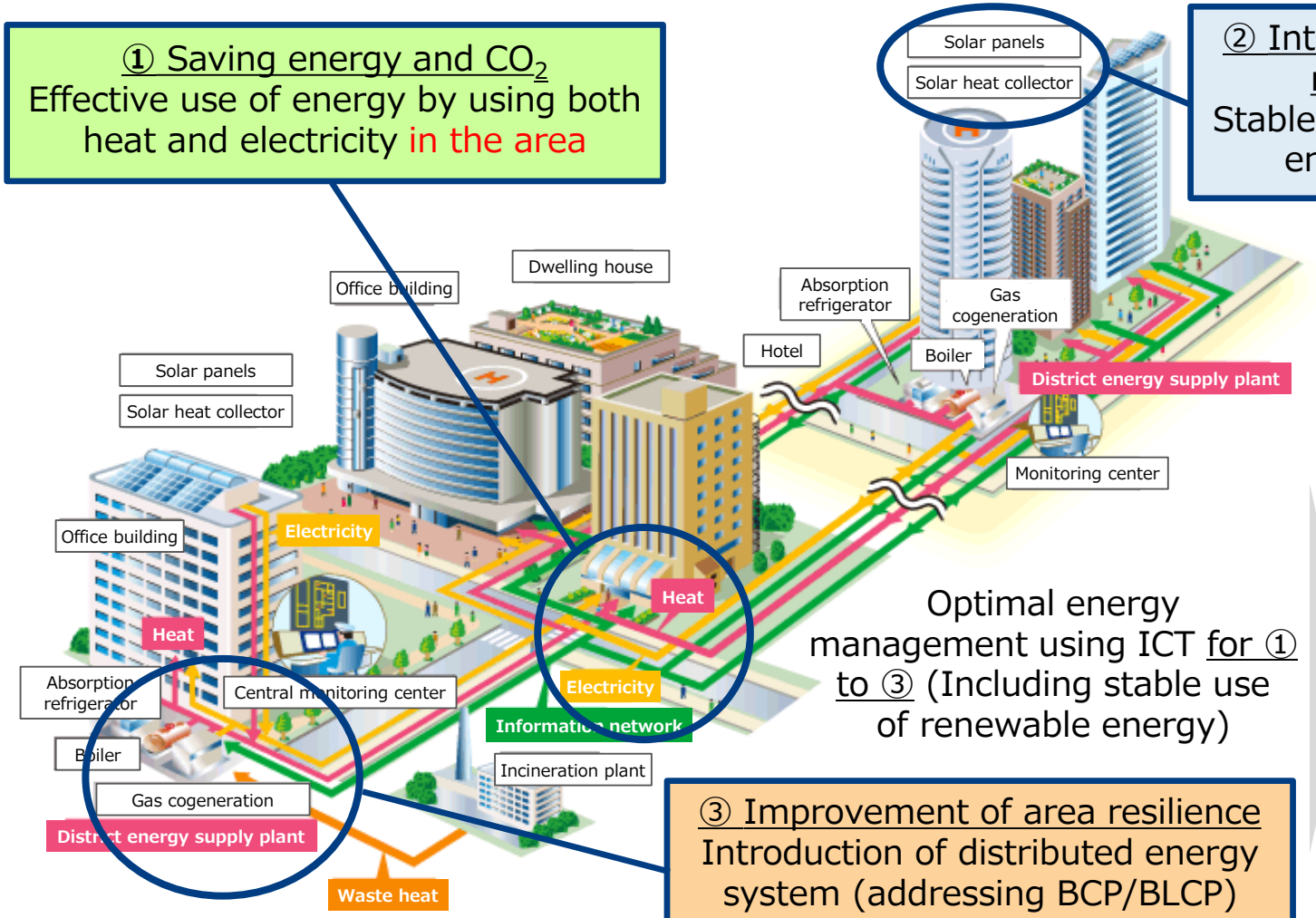
⑤ Overseas expansion

Coordination of renewable energies and natural gas: smart energy network

- Through the construction of smart energy using cogeneration (CGS), we will contribute to the creation of attractive towns that can save energy and CO_2, and continue to supply electricity and heat in the event of a disaster (S+3E).

① Saving energy and CO_2
Effective use of energy by using both heat and electricity in the area

② Introduction promotion of renewable energy
Stable use utilizing renewable energy, CGS and ICT



Optimal energy management using ICT for ① to ③ (Including stable use of renewable energy)

④ Revitalization of local economy

③ Improvement of area resilience
Introduction of distributed energy system (addressing BCP/BLCP)

Note: Implementation examples of "City center type" regional revitalization

Tamachi smart energy network

I block

Ⅱ-2 block

Main equipment

Gas engine CGS	【Ⅰblock】 370kW×2 【Ⅱ-2 block】 1,000kW×5	**Solar heat collector**	【Ⅰblock】 288m² 【Ⅱblock】 82m² under construction
Fuel cell	【Ⅰblock】 105kW×1	**Solar panels**	【Ⅰblock】 73kW customer ownership

Note: In addition to the above, use renewable energy and unused energy from wind and underground tunnel water

Based on the city planning vision of Minato city, promote public-private partnerships to create a low-carbon disaster-resistant town. Optimal operation realized by supply and demand coordination control.
[Supply energy: electricity, hot water, cold water]

Toyosu smart energy network

Main equipment

Gas engine CGS	6,970W×1	**Generation using gas pressure difference**	Generation: approx. 650kW Cold: approx. 200RT
		Solar panels	2,000kW class customer ownership

Based on the "Toyosu Green Eco Island Concept" in Koto city, we contribute to the development of a low-carbon, self-reliant and safe town utilizing large CGS, unused energy, etc. The thermal/electrical network will be gradually expanded according to the progress of town development (planned).
[Supply energy: electricity, steam, cold water]

Decarbonization measures: Carbon neutral LNG

- Carbon neutral LNG is an LNG that is regarded as generating no CO_2 on a global scale by burning natural gas by offsetting the CO_2 generated in the process from mining to combustion of natural gas with CO_2 credits.
- We purchased first carbon neutral LNG from shell as Japanese LNG buyer and began providing it to customers.

Tokyo Gas purchases carbon neutral LNG … Press release (Jan. 18, 2019)

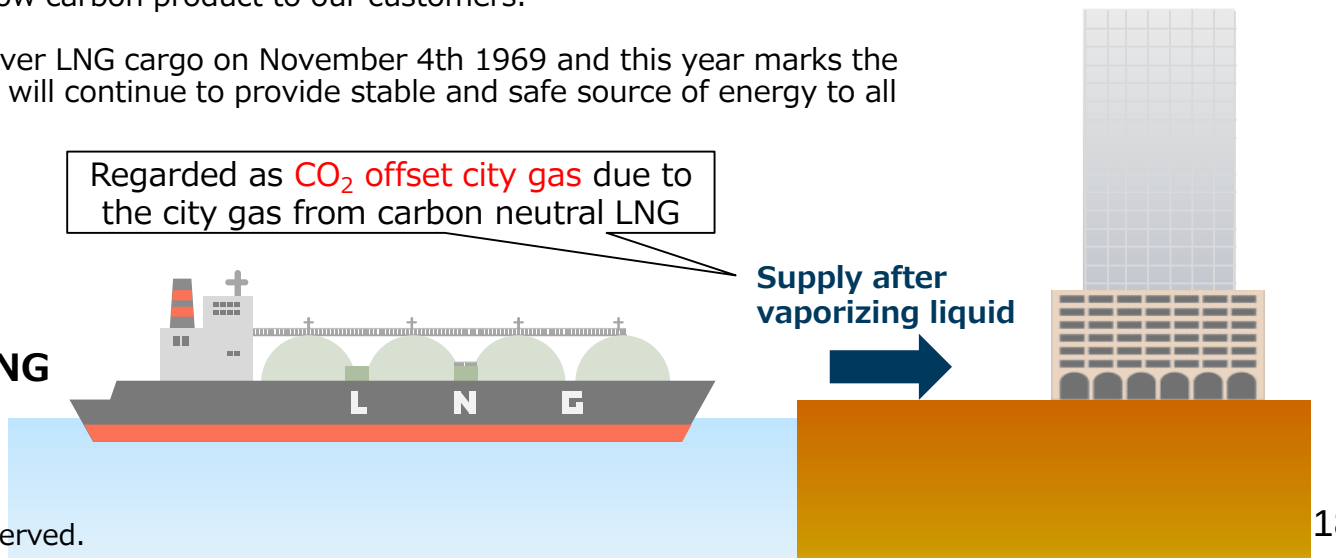
Tokyo Gas Co., Ltd. (President: Takashi Uchida; "Tokyo Gas") and Shell Eastern Trading (Pte) Ltd. have been engaging in joint discussions and as a result, for the first time in Japan, Tokyo Gas has decided to receive the supply of carbon neutral liquefied natural gas (LNG).

Under this Master Agreement, with regard to this supply of carbon neutral LNG, Shell 's carbon credits will be used to compensate the full carbon dioxide (CO_2) emissions generated – from exploring for and producing the natural gas to use by the final consumer.
The carbon credits are purchased by Shell from a global portfolio of nature-based projects, and each carbon credit is subject to a third-party verification process.

By receiving the supply of carbon neutral LNG, Tokyo Gas will reinforce its effort toward low carbon society as well as providing a new low carbon product to our customers.

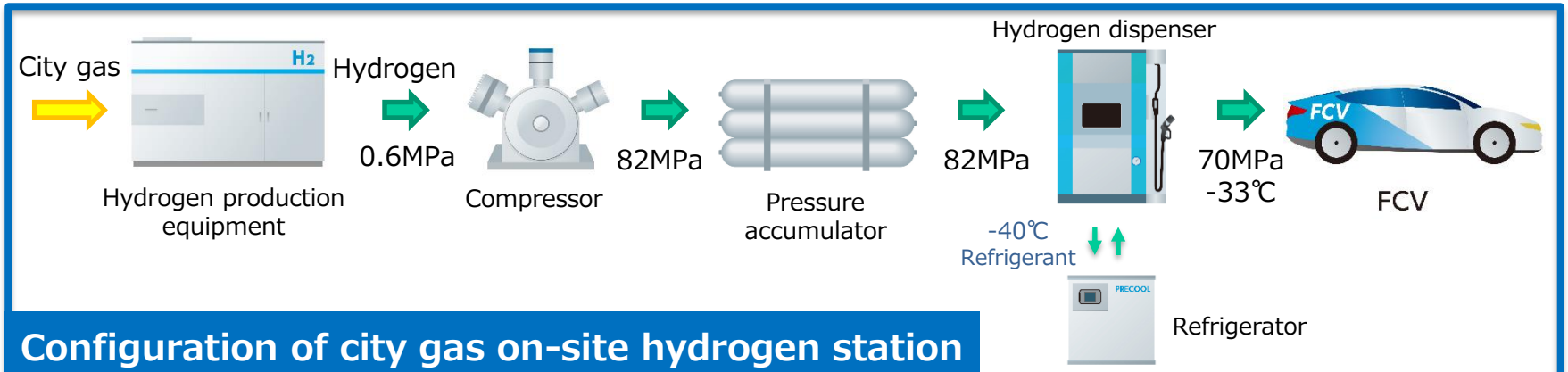
Tokyo Gas received Japan's first-ever LNG cargo on November 4th 1969 and this year marks the 50th anniversary. Tokyo Gas Group will continue to provide stable and safe source of energy to all our customers.

Example: Marunouchi Building



Decarbonization measures: Hydrogen station

- Tokyo Gas is contributing to the diffusion and expansion of fuel cell vehicles (FCV) through the construction and operation of hydrogen stations, utilizing the technology for producing hydrogen from city gas.



Configuration of city gas on-site hydrogen station

Nerima Hydrogen Sta.

- Opened in Dec. 2014 (first in Kanto)
- Medium scale (300m³/h)
- Off-site

Senju Hydrogen Sta.

- Opened in Jan. 2016
- Small scale (100m³/h)
- Off-site

Urawa Hydrogen Sta.

- Opened in Feb. 2016
- Medium scale (300m³/h)
- Off-site

Toyosu Hydrogen Sta.

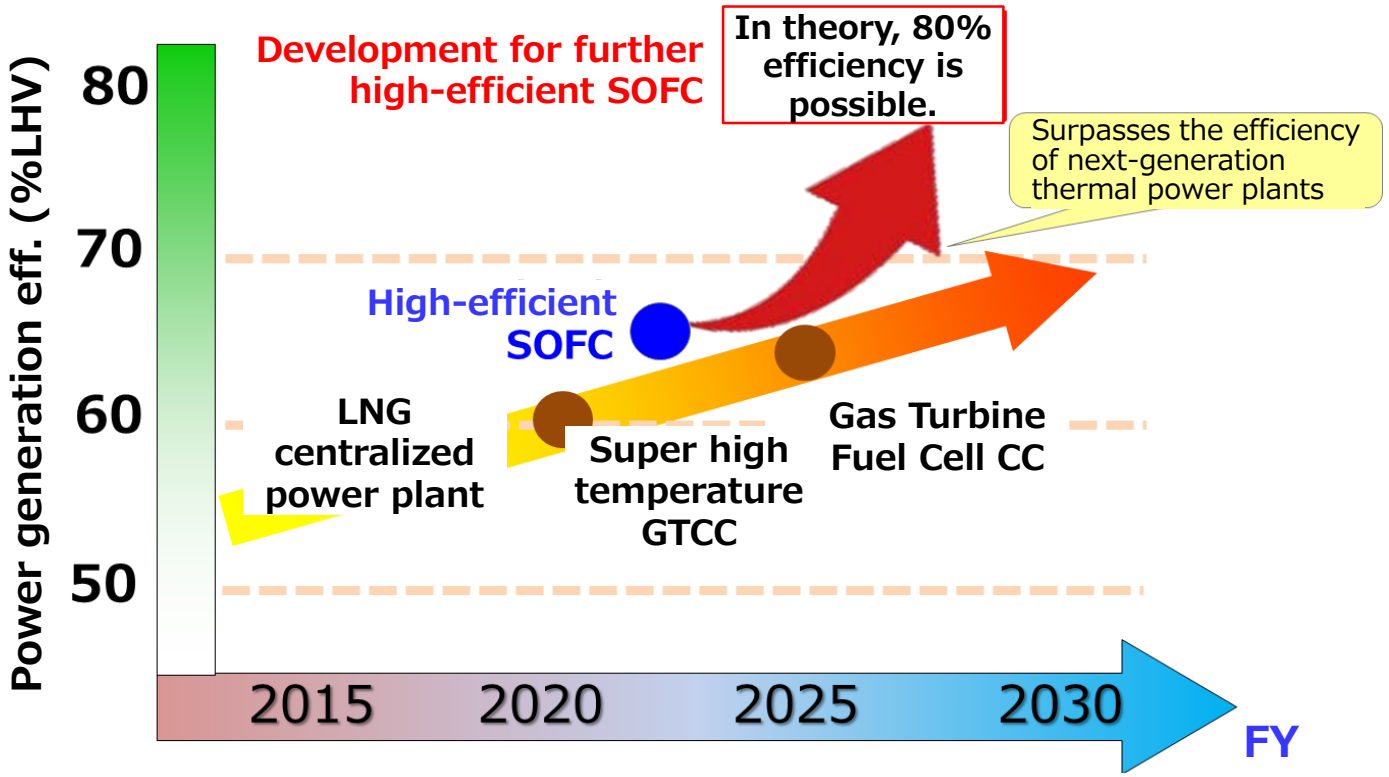
- Opened in Jan. 2020
- Large scale (also for bus)
- Off-site
- Supply carbon neutral hydrogen through carbon neutral LNG

Also for Fuel Cell Bus

Decarbonization measures: Ultra-high efficient fuel cell

- The power generation efficiency of gas cogeneration system (CGS) has improved dramatically. In recent years, the efficiency has been approaching 50%, which is comparable to large-scale thermal power on demand end basis.
- We are developing a distributed power generation, small fuel cells, that achieves high power generation efficiency, which surpasses the efficiency of next-generation thermal power plants.

<Roadmap for increasing the efficiency of fuel cells>

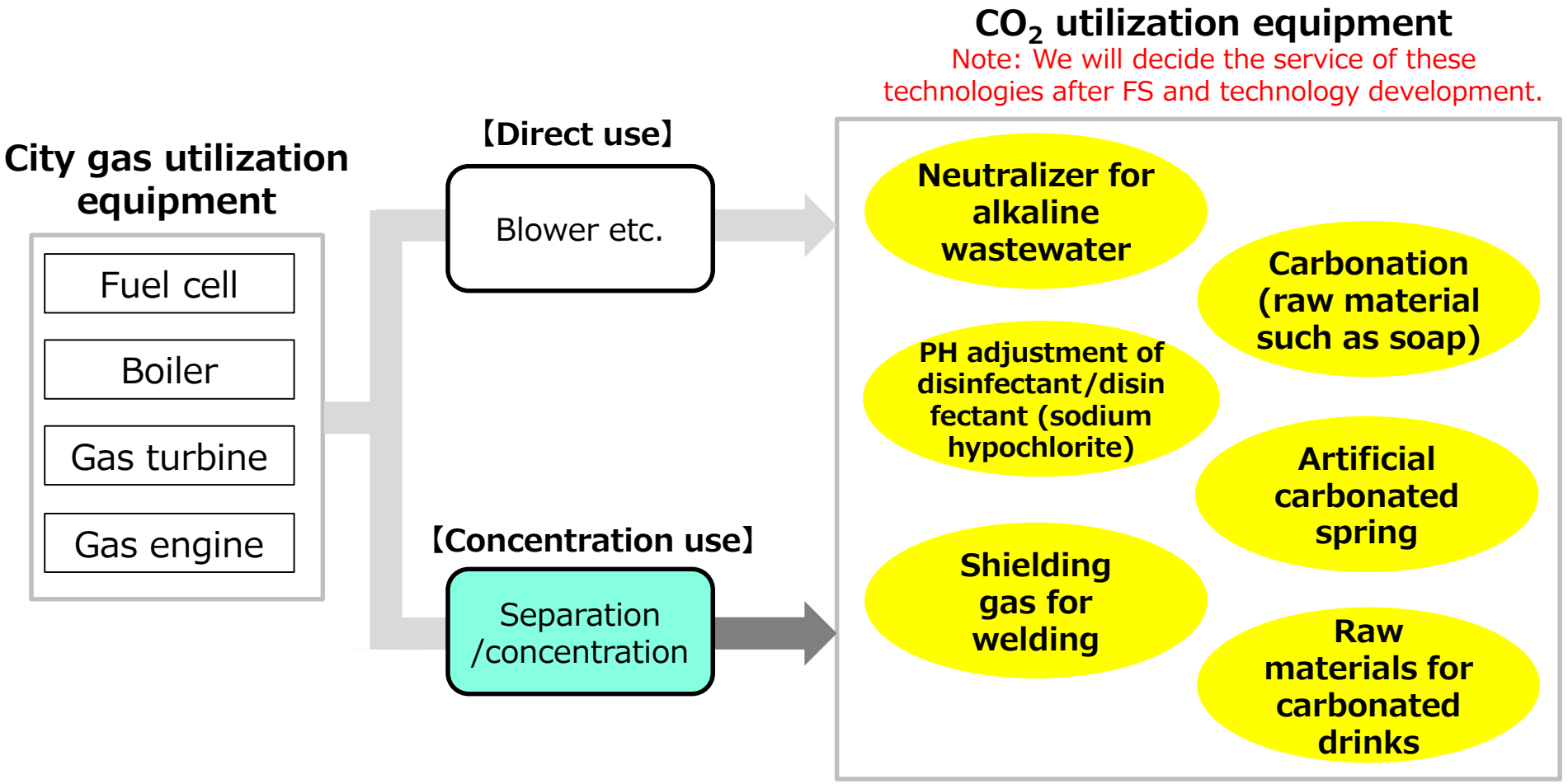


Based on “Technology roadmap for next-generation thermal power generation.”
Assumed transmission loss is 5%.

Prototype of high-efficient SOFC

Decarbonization measures: CCUS

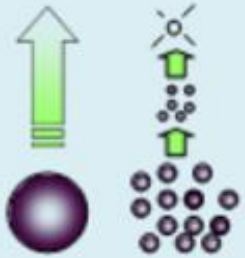
- CCUS is an abbreviation for Carbon dioxide Capture, Utilization and Storage.
- In order to realize technology to capture CO_2 emitted from city gas equipment at customer and use it as a resource (dry ice, concrete products, carbonates, etc.), we have developed a system to efficiently capture CO_2 and to effectively use of captured CO_2.



Note: CO_2 storage technology using microbubbles

- In order to realize Carbon Capture Storage (CCS) efficiently, we are working with RITE to commercialize a technology to convert CO_2 into microbubbles and store more CO_2.
- This technology makes it possible to store CO_2 in large quantities and efficiently, leading to a reduction in CCS costs. In addition, it is expected to be applied to Enhanced Oil Recovery (EOR), which increases oil production by injecting CO_2 into the underground to increase the fluidity of oil in the reservoir.

Microbubbles technology



Bubbles diameter from 1 μm to 100 μm

- Low ascent speed
- Large surface area and internal pressure

⇩

Increases injection volume and dissolves quickly

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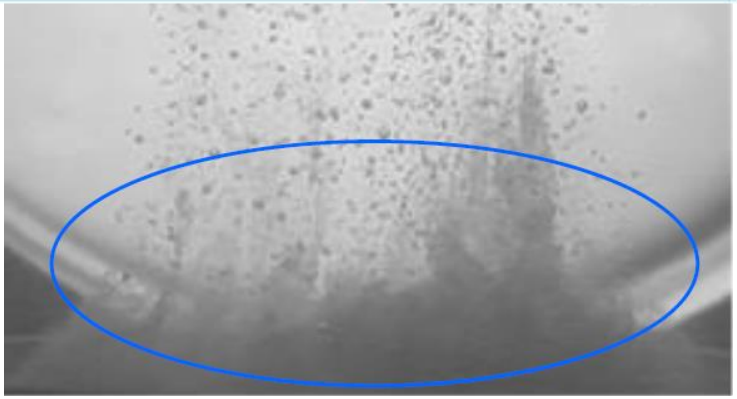
Large-scale CO_2 injection storage at low cost

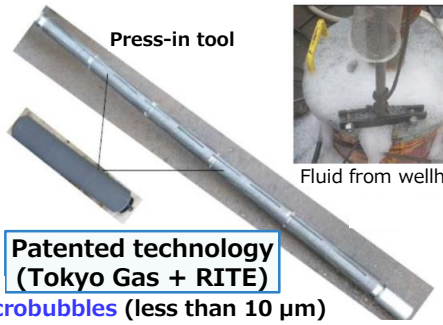


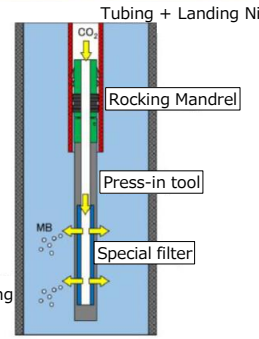
For realizing microbubbles

Tool production

- Installation type: Retrievable system
- Installation location: Tubing tip
- Installation method: Slick line
- Shape: Slit on outer cylinder, multiple connection possible

- **Improvement of sweep efficiency by microbubbles injection**
- **Applicable to EOR as well as CCS**



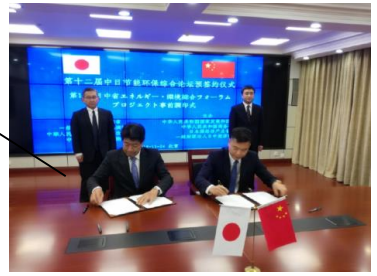


Ref: CCS Technical Workshop 2019

License agreement with Junlun Petroleum for patented technology (co-owned with RITE)

Takashi Honjo, Senior Managing Director of RITE

The 12th Japan-China Energy Conservation and Environment Forum in Nov., 2018

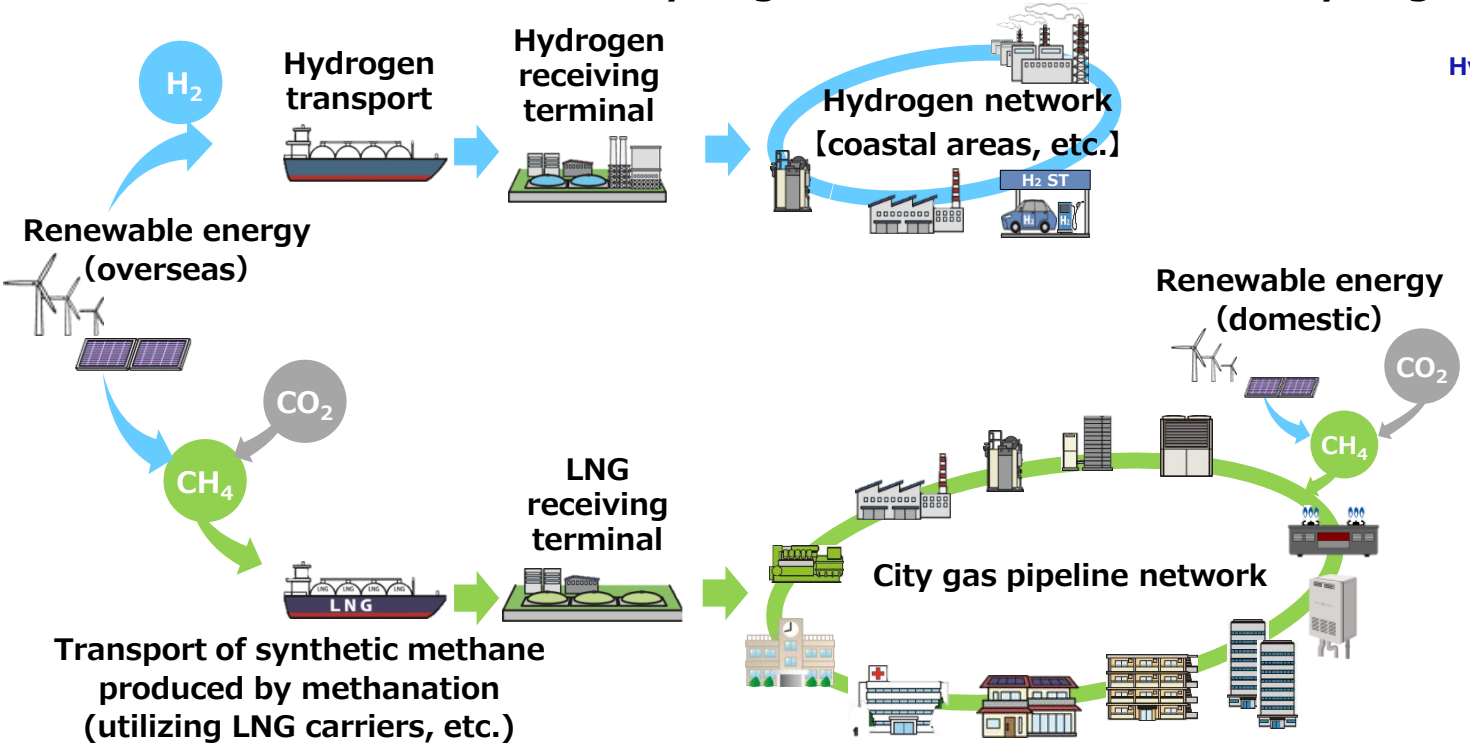


Ref: RITE press release

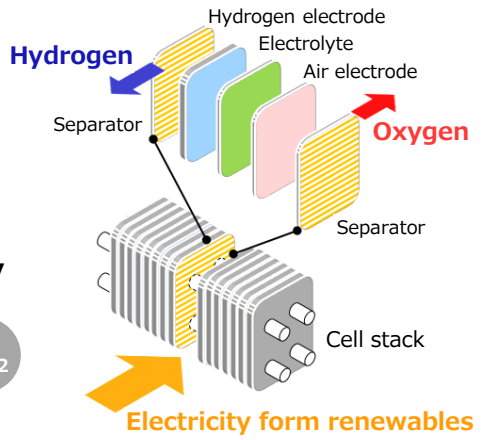
Decarbonization measures: Hydrogen, Methanation

- Methanation is a technology for synthesizing methane. In order to generate carbon free methane, methane is synthesized with CO_2 free hydrogen from renewable energy and recovered CO_2.
  $4H_2 + CO_2 \rightarrow CH_4 + 2H_2O$
- Methanation technology can effectively utilize existing city gas infrastructure such as pipelines and LNG receiving terminals (manufacturing sites), and gas systems and gas consuming equipment such as cogeneration, hot water supply, and air conditioning.
  Methanation technology is attracting attention as a decarbonization option for gaseous energy.
- We are working on the development of new hydrogen production technology to reduce the cost of hydrogen as a raw material for the practical use of methanation.

【 Overview of utilization of hydrogen and methanation 】



【Hydrogen production cell stack】



Closing remarks

- We, the Tokyo Gas Group, are taking on new challenges.
- We believe that the expected role of natural gas, which is a pillar of our business, will further expand based on given its stability, environmental friendliness, economic efficiency, and compatibility with unstable renewable energy. We will continue to provide the value of natural gas to our customers.
- However, at the same time, as a leading company dealing with natural gas, one of the fossil fuels, we believe that it is our duty to seriously address climate change. We combine natural gas with new technologies, including renewable energy, to provide solutions for living, cities and the planet.