Tokyo Gas Group
Carbon Neutrality Roadmap 2050

A detailed roadmap for realizing a carbon-neutral society

Mar. 22, 2024

TOKYO GAS GROUP

Carbon Neutrality Roadmap 2050 — Contents

Note: This Roadmap includes forecasts based on assumptions about economic rationality that take into account progress in technological development, policy and institutional trends, and other factors. Going forward, the Tokyo Gas Group will review the Roadmap as needed in the light of changes in its business environment while working to realize a carbon-neutral society. In line with the TCFD recommendations, the Group will also continue to assess and disclose the impacts of climate change on the Group's business activities as well as the measures taken to address those impacts, and will take action on climate change based on the content of the Roadmap.

1. Basic Policy for Achieving Carbon Neutrality

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Key points

- The Tokyo Gas Group declared that it would take on the challenge of achieving Net-Zero CO_2 emissions in its management vision Compass 2030 (2019), and announced the policy of responsibly leading the transition to Net-Zero CO_2 in Compass Action (2021).
- We have now formulated a detailed roadmap for achieving carbon neutrality in 2050 through efforts that **from 2030 onward will continue to build upon the responsible transition**.
- **Guided by the basic policy outlined below, we will work together with customers and society as a whole to bring forth a carbon-neutral society.**

Now

Compass 2030: Responsible Transition

Making sophisticated use of natural gas and decarbonizing gas & electricity

Ahead

Advancing innovation in 2030 and beyond

The environment is changing: Greater public-private investment in green transformation (GX) will lead innovation to real-world deployment

Basic Policy for Achieving Carbon Neutrality

We will lead a seamless transition to a carbon-neutral society by taking three approaches that build upon the responsible transition to Net-Zero CO_2

Approaches

The perspective of the best mix:
Decarbonize both gas and electricity

In addition to making sophisticated use of natural gas, decarbonize **both gas and electricity**

+

The perspective of demand/supply sides:
Partner with customers

Advance decarbonization on **both the demand side and the supply side**

+

The perspective of real-world innovation deployment:
Optimize social benefits*1

Pursue real-world deployment that **flexibly adapts to S+3E*2 needs, while maintaining different choices**

Aim

60% reduction of CO_2 emissions*3
+ 2040: 50% carbon neutrality in domestic gas/electricity supply

2050: Net-Zero CO_2

*1 This also includes provision of value beyond energy, such as cost improvements, stronger resilience, and greater comfort. *2 S+3E is Japan's core energy policy to simultaneously achieve stable supply, economic efficiency, and environmental suitability on the overarching premise of maintaining safety. *3 Greenhouse gas emissions of the entire supply chain (including upstream) associated with our supply of energy (gas & electricity) to domestic users, in CO_2 equivalents. The reduction rate is indicated as a comparison to the FY2022 and it aligns maintaining consistency with the level of reduction if progress continues thereafter, in accordance with the NDC's objective of achieving a 46% reduction by FY2030 (vs FY2013).

3. Three Approaches for Realizing the Basic Policy

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Key points

- While shifting to clean energy across the LNG supply chain, we will work to decarbonize gas mainly by adopting e-methane, and electricity mainly by expanding the use of renewables.
- We will work together with customers to achieve optimal use of energy by expanding the deployment of distributed resources and making effective use of them.
- We will pursue real-world deployment of innovation that flexibly adapts to S+3E needs, while maintaining different choices.

Challenges

The perspective of the best mix

- **Decarbonizing gas and electricity supplied to customers while ensuring stable supply**
- **Decarbonizing heating**, which accounts for 60% of the civil & industrial sectors' energy consumption

The perspective of demand/supply sides

- **Promoting use of renewable energy and distributed systems/equipment** at customer sites
- Providing optimal solutions to customers (decarbonization, optimization, resilience)

The perspective of real-world innovation deployment

- **At present, it is not clear what technologies will be adopted and expanded**
- **Real-world deployment of decarbonization approaches tailored to each area's characteristics**

Approaches

Decarbonize both gas and electricity

- ✓ Thoroughly reduce GHG[*1] emissions across the LNG supply chain (shift to clean energy)
- ✓ Adopt e-methane, biomass, etc.
- ✓ Expand renewable power source transaction volume
- ✓ Achieve net-zero CO_2 emissions from gas-fired power plants (e-methane, hydrogen, CCS[*2], etc.)

Partner with customers

- ✓ Expand models for introducing distributed systems/equipment at customer sites (PPAs[*3] and other models, EF[*4], PV, storage batteries)
- ✓ Expand our distributed resources (grid storage batteries, storage batteries at renewable energy power plants, etc.)
- ✓ Optimize energy use by combining our assets with customer resources
- ✓ Utilize hydrogen at customer sites and expand carbon recycling solutions

Optimize social benefits

- ✓ Pursue decarbonization by expanding use of e-methane, developing innovative technologies, and utilizing existing facilities
- ✓ Realize hydrogen utilization tailored to each area's characteristics
  1. Onsite hydrogen production through renewable energy water electrolysis and methane pyrolysis (turquoise hydrogen[*5]), 2. Utilize in areas around power plants
- ✓ Expand highly reliable methods of offsetting (tree planting, BECCS[*6], DACCS[*7], etc.)

*1 Greenhouse gases *2 Carbon capture and storage *3 Power purchase agreements; here, this refers to agreements such as onsite PPAs in which customers use electricity produced by generation facilities installed at their sites, and offsite PPAs in which electricity is supplied to the customers from generation facilities installed away from their sites *4 ENE-FARM (residential fuel cells) *5 Hydrogen produced through pyrolysis of methane in city gas; this process breaks down methane into hydrogen and solid carbon and hence does not emit CO_2 *6 Bioenergy with carbon capture and storage *7 Direct air capture with carbon storage

3. Carbon Neutrality Roadmap 2050

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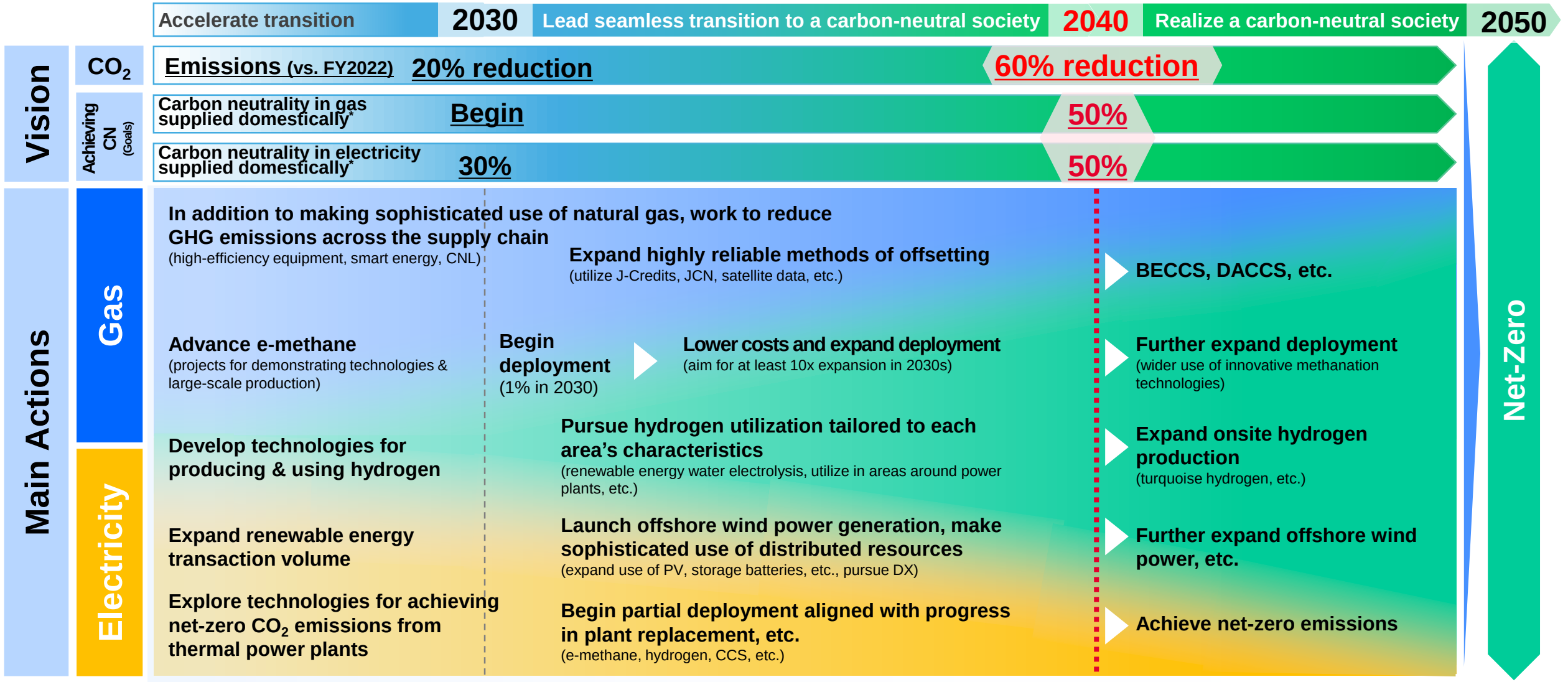
Key points

・In the 2020s, we are laying the groundwork for decarbonizing gas and electricity while pursuing further efforts for making **sophisticated use of natural gas**. **In the 2030s, we will deploy decarbonization technologies in the real world and expand them**. We will seek to achieve **a 60% reduction in CO_2 emissions and 50% carbon neutrality in both gas and electricity by 2040**. Subsequently, we will further increase those improvements to achieve carbon neutrality by 2050.



* Through a process of revisions, the Roadmap will be evolved into a comprehensive plan covering both Japan and overseas.

Reference: Tokyo Gas Group's Vision for a Carbon-neutral Society

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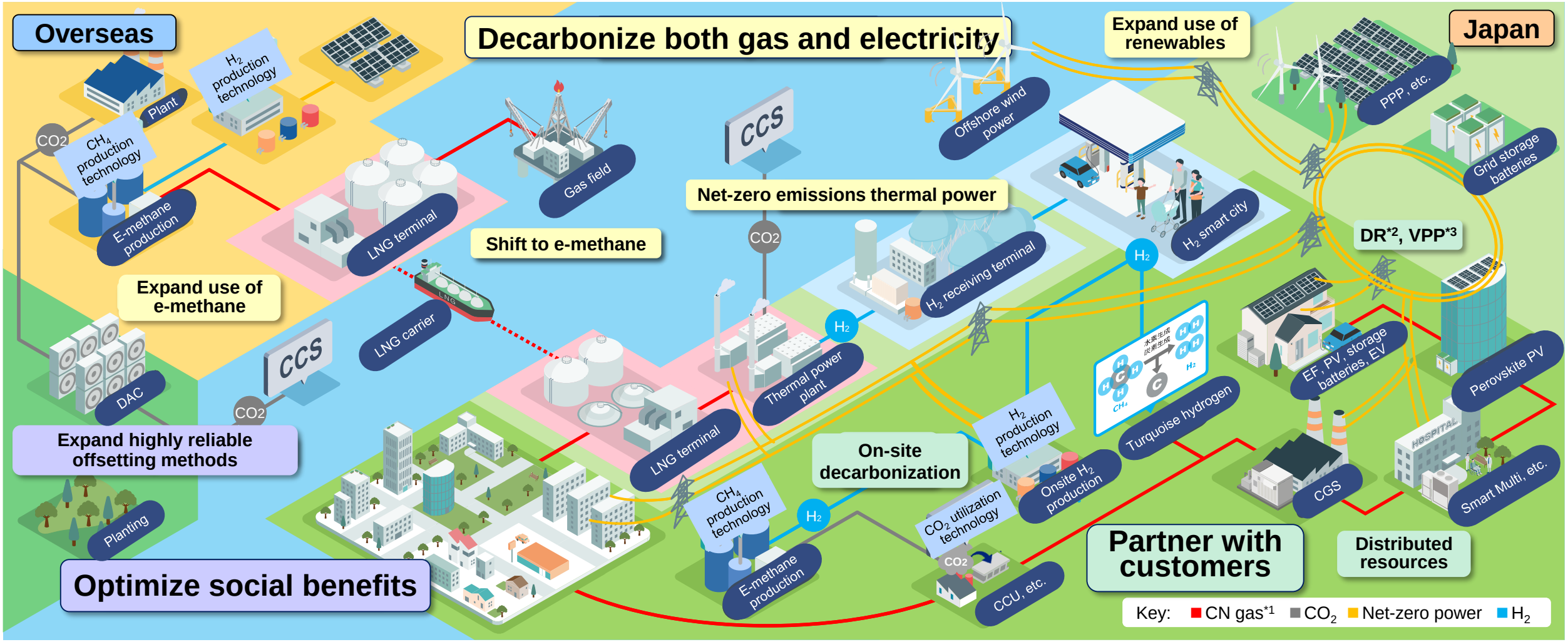
Key points

- Value for society: **Realize optimal decarbonization in terms of S+3E**. Also **optimize social value**, including by utilizing existing facilities.
- Value for customers: Realize **the best mix of solutions suited to customer needs, in terms of electricity/gas and demand side/supply side**.

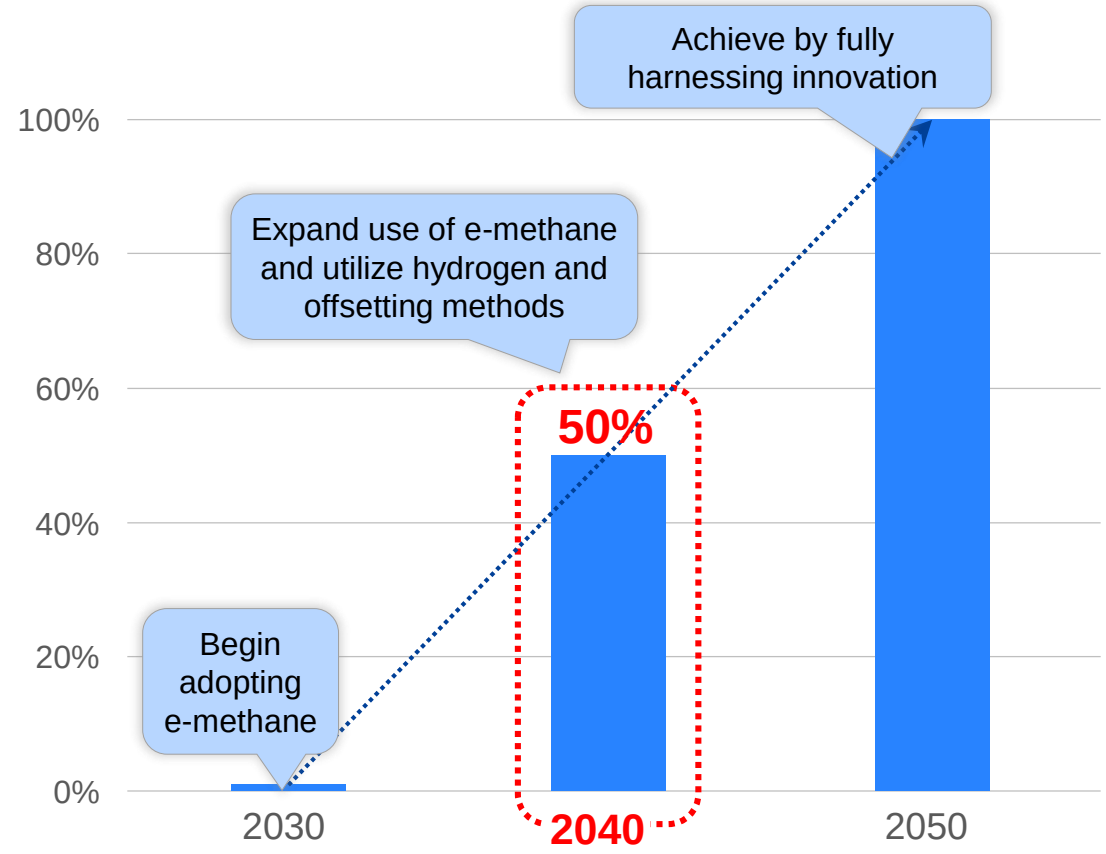


*1 CN gas: Carbon-neutral gas; term for city gas made carbon neutral through use of e-methane, biogas, carbon-offset LNG, etc. *2 Demand response: Scheme that supports stable supply by leveling electricity demand/supply through customer efforts to conserve energy *3 Virtual power plant: System for managing/controlling energy resources not directly connected to the grid in a way that provides functions similar to a power plant

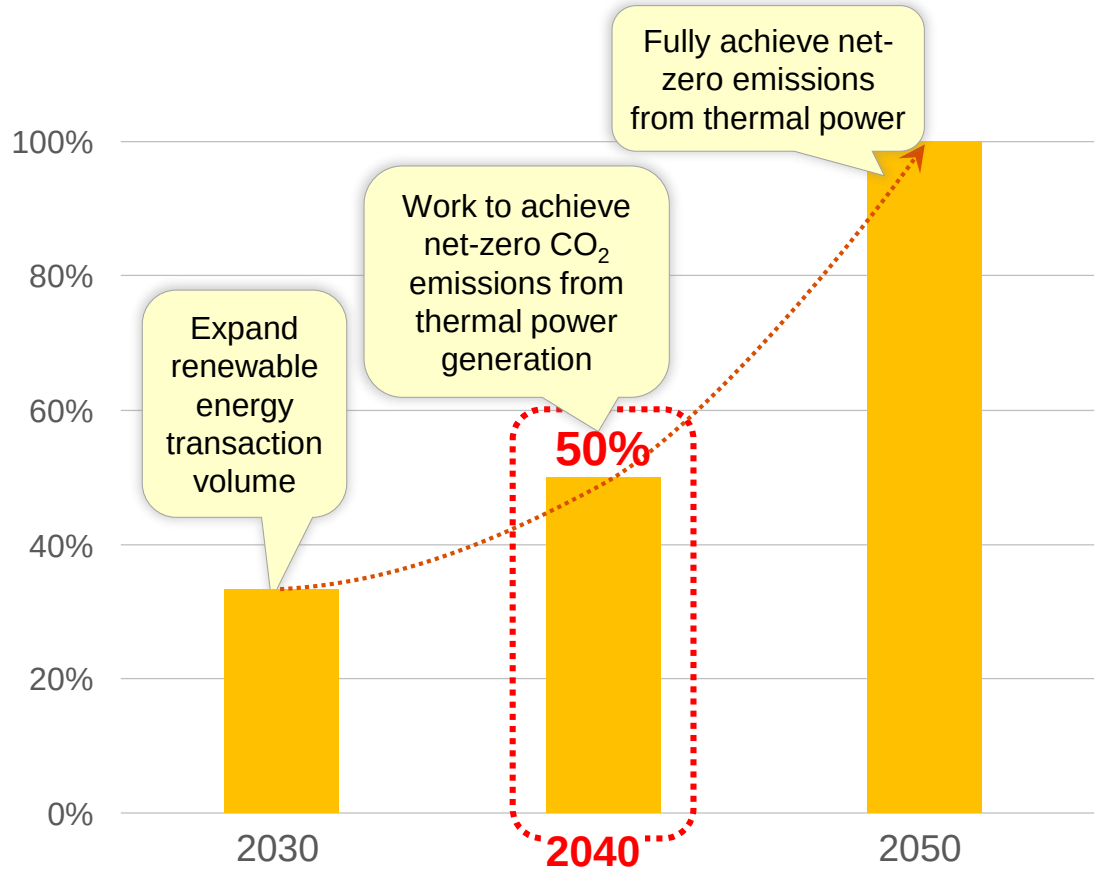
4-1. Path for Decarbonizing Energy Supply (Goals)

Key points

- Gas: We will seek to achieve **50% carbon neutrality by 2040** through sophisticated use of natural gas, reduction of GHG emissions across the supply chain, and, from 2030 onward, expanded use of e-methane. We will also fully harness innovation in DACCS/BECCS, turquoise hydrogen, etc.
- Electricity: We will seek to achieve **50% carbon neutrality by 2040** through expanded use of renewables and, from 2030 onward, efforts such as switching to hydrogen as fuel for thermal power plants. We will **completely achieve net-zero CO_2 emissions from thermal power generation in the 2040s**, and to further increase carbon neutrality.



Tokyo Gas Group's carbon neutrality goals* for gas supplied domestically



Tokyo Gas Group's carbon neutrality goals* for electricity supplied domestically

* Percentage of energy supplied to customers that is deemed to have net-zero emissions or utilizes highly reliable offsetting methods.
The figures are forecasts based on assumptions about economic rationality that take into account progress in technological development, policy and institutional trends, and other factors; going forward, these will be reviewed as needed in the light of changes in the business environment.

4-2. Path for Reducing CO_2 Emissions (Domestic Energy Supply)

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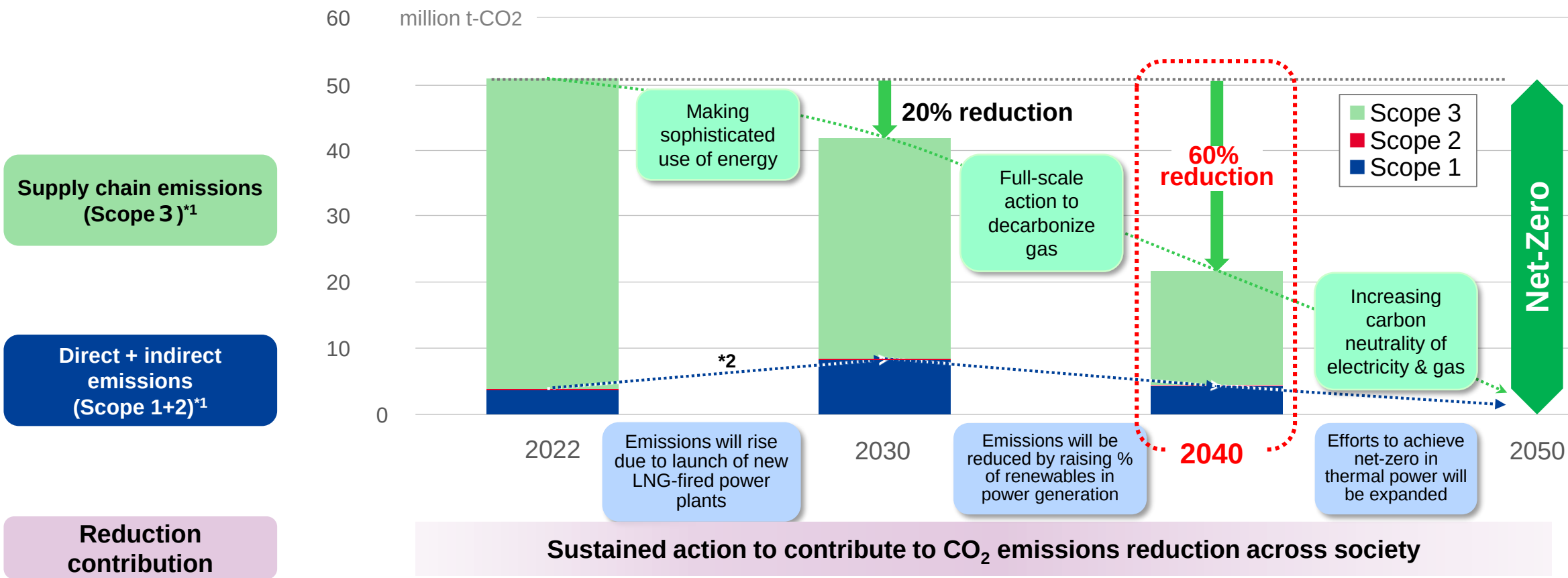
Key points

- Direct and indirect emissions (Scope 1+2): While the **launch of new thermal power plants will lead to a rise in emissions**, we will **expand our renewable energy transaction volume and pursue efforts to achieve net-zero emissions in step with the replacement of thermal power plants, which will go into full swing in the 2040s**, with the aim of achieving net-zero CO_2 emissions by 2050.
- Supply chain emissions (Scope 3): In addition to working together with customers to further promote energy conservation and make sophisticated use of energy, we will **begin full-scale efforts from the 2030s onward to decarbonize the energy we supply**.
- Other actions: We will also continue working to reduce CO_2 emissions of society as a whole and thus contribute to the achievement of Japan's reduction goal.



*1 Greenhouse gas emissions of the entire supply chain (including upstream) associated with our supply of energy (gas & electricity) to domestic customers, in CO_2 equivalents

*2 We will work to reduce CO_2 emissions of society as a whole by pursuing a shift to low-carbon natural gas and making sophisticated use of this resource. This will include the opening of new high-efficiency thermal power plants, which will temporarily increase Tokyo Gas Group's CO_2 emissions (for details, see "Decreasing by Increasing" on our website (in Japanese; https://www.tokyo-gas.co.jp/sustainability/pdf/gx-league.pdf)).

5-1. Concrete Actions for Achieving Carbon Neutrality: GHG Emissions Reduction & Offsetting

Thoroughly reduce GHG emissions across supply chain

Why

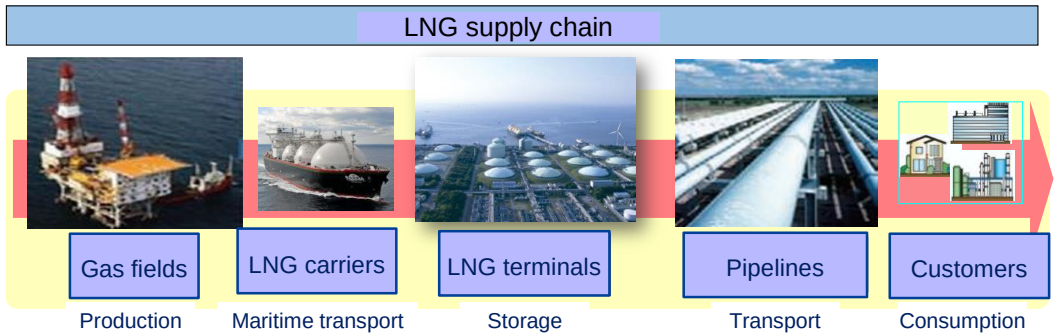
- As we fully exploit natural gas & LNG, it is vital that we reduce GHG emissions across the entire supply chain

Our actions

- Thorough methane leak detection at LNG terminals and pipelines through daily patrols and other inspections/actions
- Acquired shale gas operator in US as a subsidiary (TG Natural Resources) and stepped up methane leak countermeasures (replacement of equipment with models less prone to leaking, ground/aerial detection & repair of leaks, etc.), achieving large improvement in methane intensity (0.1% or lower in 2022, compared with regulatory cap of 0.2%)
- Working with LNG producers to improve visibility of upstream leaks and countermeasures

Our strengths

- Equipment operation/maintenance expertise related to methane leak reduction at terminals and pipelines
- Track record of our innovative actions as an upstream operator



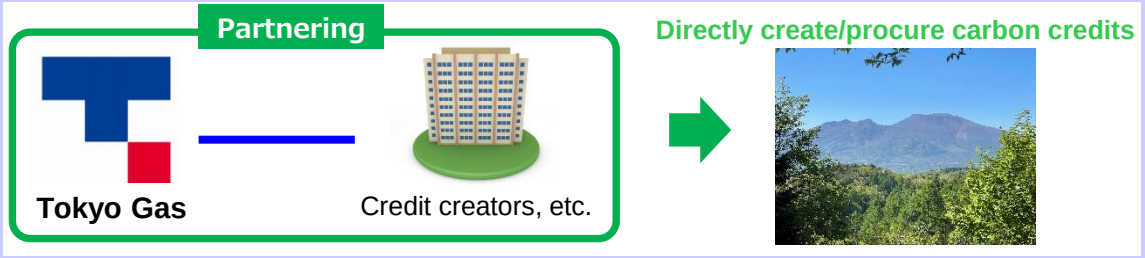
Directly create/provide highly reliable carbon credits

Why

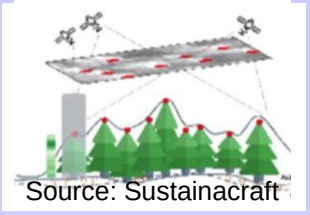
- Key approaches for decarbonizing heating include not only energy conservation, reduction of CO_2 emissions, and use of e-methane, but also offsetting through highly reliable carbon credits and other means

Our actions

- Carried out joint demonstration testing in the Philippines with Kubota and Creattura on technology for reducing methane emissions from rice paddies. Participating in the first private JCM (Joint Crediting Mechanism, bilateral offset crediting) project in agriculture in the ASEAN region.
- Formed a strategic partnership with Vertree, a company with many insights on carbon credit creation, to jointly develop nature-based credit creation projects (tree planting, etc.) to enable stable procurement of highly reliable credits.



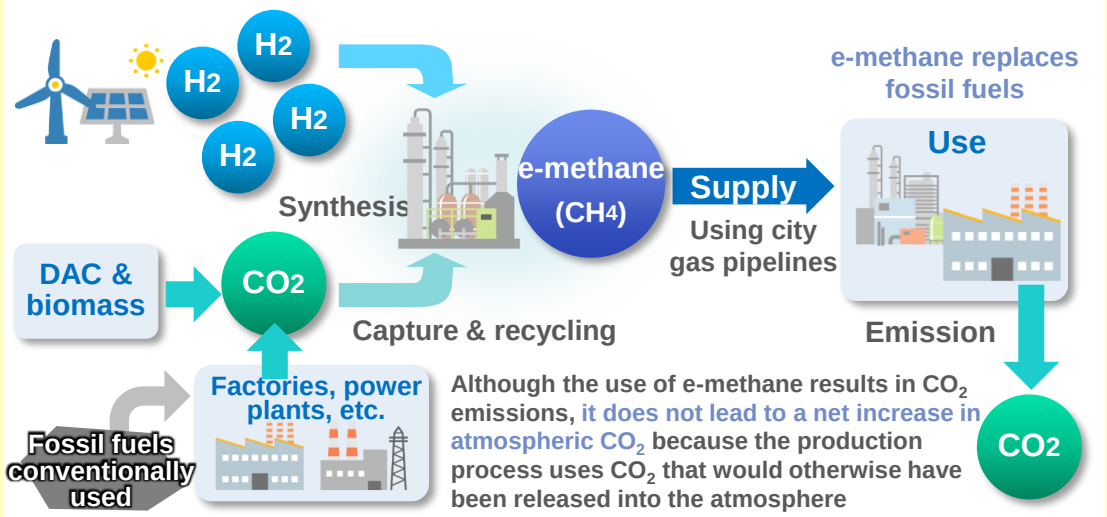
- Efforts to ensure the reliability of carbon credits through partnership with Sustainacraft, a company with sophisticated project evaluation technology and insights, and technology for analyzing forest growth, etc. using satellite-based remote sensing



Our strengths

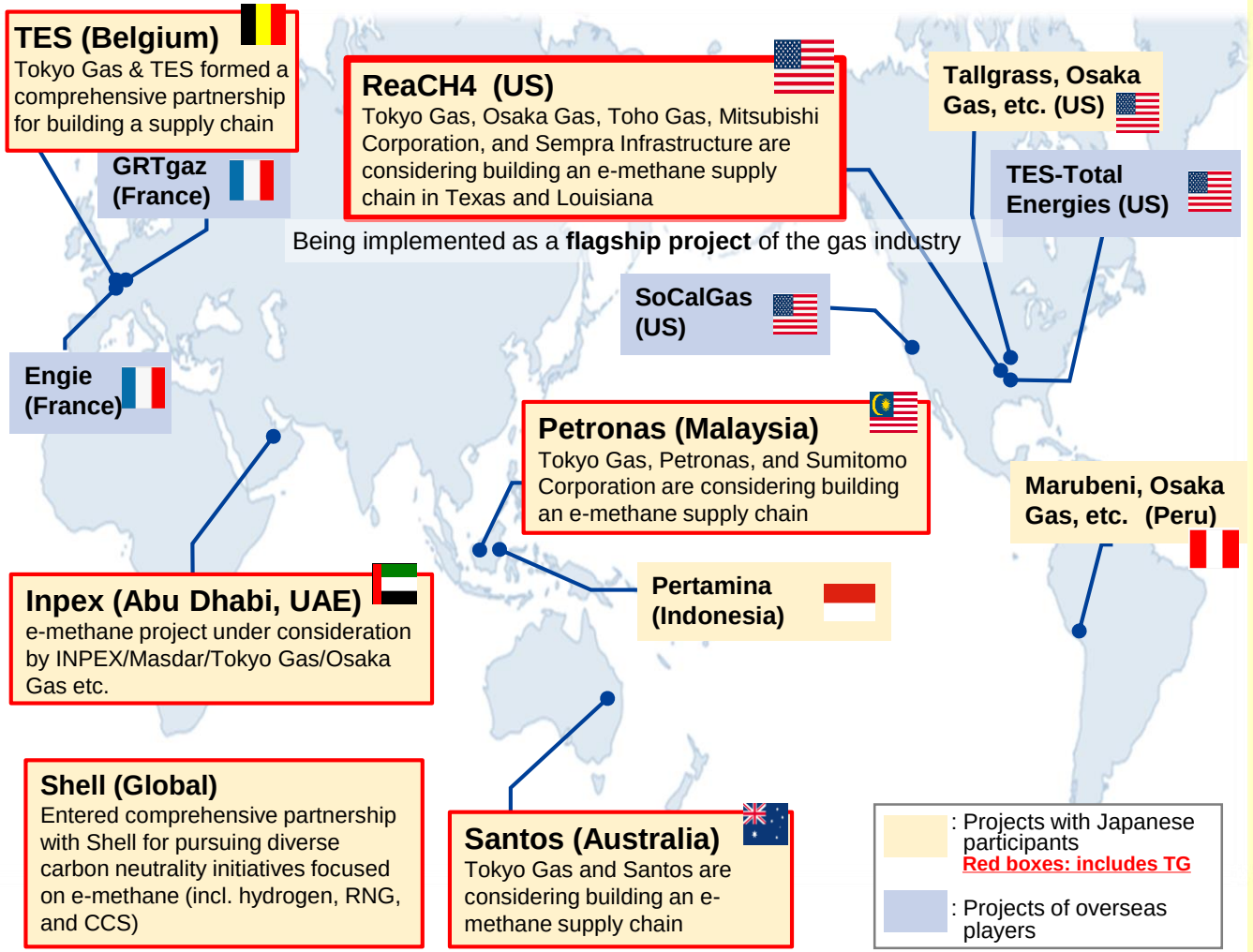
- Ability to stably procure highly reliable carbon credits using our capabilities in assessing credit quality in the light of international standards and in utilizing digital technologies
- Early accumulation of insights on credit creation, including not only avoidance/reduction credits (forest conservation, etc.), but also JCM, J-Credits, removal/absorption credits (DACCS), etc.

Establishing a Carbon Recycling System



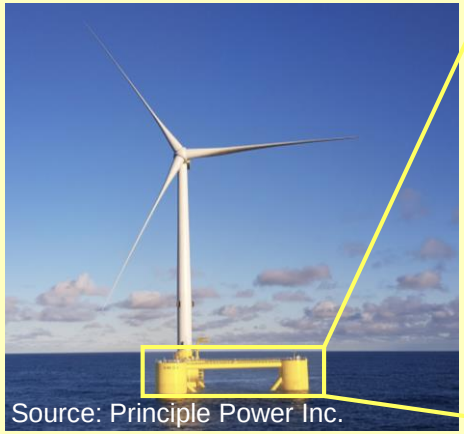
Why	• It is important to promote the use of e-methane, which can be supplied using existing infrastructure, as a means of decarbonizing heat demand, which accounts for 60% of energy consumption
Our actions	• Participation in US-Japan consortium seeking to launch world's largest carbon recycling system in North America in 2030 • Implementation of projects with global players, including in Southeast Asia, Australia, and Middle East • Active involvement in rule-making (e.g., participation in e-NG*1 Coalition)
Our strengths	• Utilization of technologies and expertise amassed through hydrogen and fuel cell development • Ongoing demonstration of domestic e-methane production at our research center • Carrying out world-leading project for developing innovative methanation technology that greatly improves efficiency through effective use of heat

Projects studying e-methane opportunities*2



*1 Another term for e-methane *2 Information is based on corporate press releases

Pursuing innovation in floating offshore wind power



Why

- Given Japan's lack of shallow waters, floating offshore wind power offers strong potential with its ability to be installed in deep waters
- Mass production through continuous manufacture and installation is an essential step for reducing costs

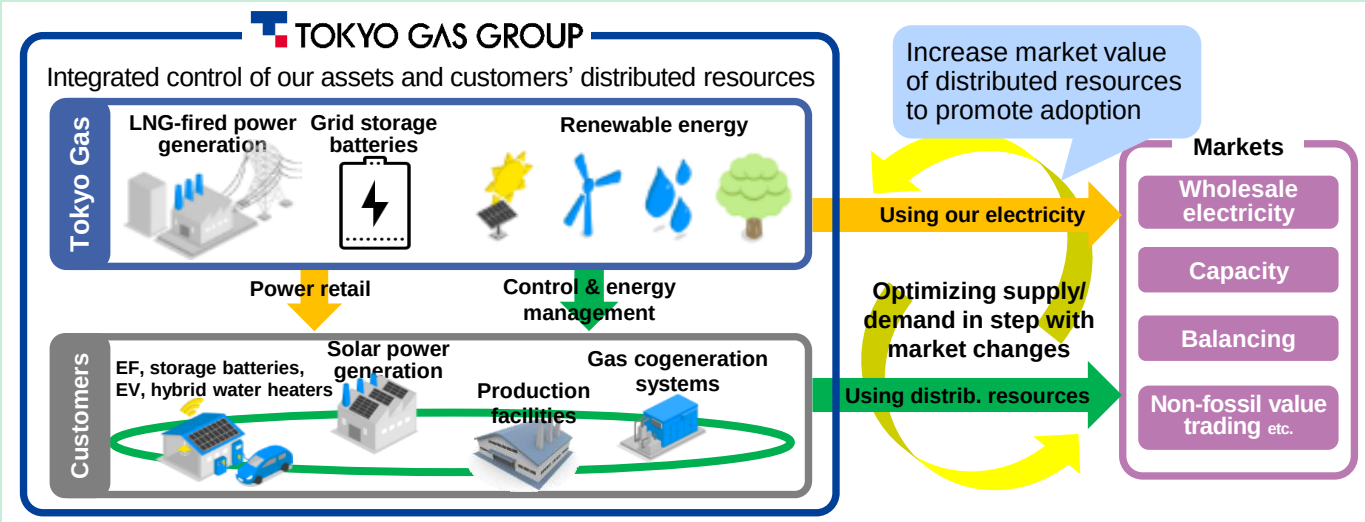
Our actions

- Utilization of floating platform technology of Principle Power, Inc. (PPI)*1 toward development of Japan's first large-scale offshore wind farm
- Specific aim is to establish technologies for realizing continuous manufacture and installation of floating wind turbine platforms suited to Japan's climate and marine conditions
- Participation in technology consortium for laying the foundation in areas of collaboration, with the aim that operators can work together to try to establish offshore wind power at an early stage

Our strengths

- Invested in PPI, which possesses one of few floating platform technologies in service at floating wind farms in Europe (2020)
- Completed demonstration (construction of mockup, etc.) of mass production method not dependent on shipbuilding docks, using the Green Innovation Fund*2 (2022-2023)

Collaborating with customers toward a carbon-neutral society (utilizing distributed resources)



Why

- In addition to pursuing supply side actions such as customer decarbonization and resilience strengthening, we need to coordinate these with the demand side

Our actions

- Increasing the market value of distributed resources through demand/supply side initiatives and platform development
  Supply side: Increased the sophistication and scale of LNG/electricity trading
  Demand side: Deployed distributed resources such as CGS, EF & renewables
  Platform: Adopted Octopus Energy's KrakenFlex (KF)

Our strengths

- Ability to utilize the flexibility of our assets to respond to market fluctuations across the entire value chain
- Large number of customer accounts
- Ability to optimize operation of distributed energy systems, including expanding balancing capacity through connection and control of diverse customer resources, since KF can swiftly and flexibly adapt to environmental changes, thanks to its track record as a widely used solution

*1 A startup that develops and owns WindFloat technology, a floating platform system for offshore wind power *2 Japanese government fund supporting projects for realizing carbon neutrality

5-4. Concrete Actions for Achieving Carbon Neutrality: Net-zero Thermal Power & Hydrogen Utilization

Advancing net-zero efforts for large-scale thermal power generation

Artist's drawing of Chiba-Sodegaura Power (CSP) when completed

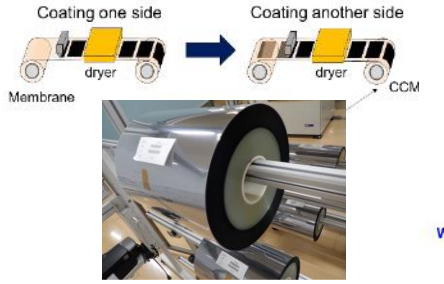
Why	• There is a growing call to achieve net-zero in thermal power, which plays a key role in supplying electricity and provides balancing capacity for renewable power. • It is necessary to pursue decarbonization while also maintaining stable energy supply.
Our actions	• Made investment decision on in CSP, which will contribute to stable supply of electricity (state-of-the-art gas turbine combined cycle power plants) • Considering possibilities for using hydrogen, e-methane, CCS, etc.
Our strengths	• We have already adopted power generation equipment at CSP that supports hydrogen co-firing. • We can apply insights on stable supply, safety, etc. gained through our operation of LNG terminals and thermal power plants.

Promoting the use of hydrogen

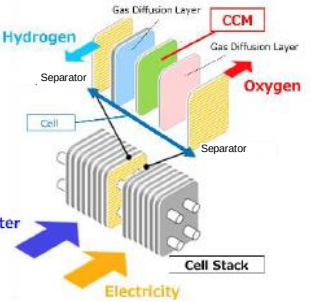
Source: Tokyo Metropolitan Government, "Redevelopment of Olympic/Paralympic Village"

Why	• Hydrogen is attracting attention as a candidate for next-gen carbon-neutral energy. • Areas along ports are particularly seen as promising locations for launching hydrogen energy use
Our actions	• Japan's first hydrogen supply project under the Gas Business Act (Harumi Flag) • Development of industrial hydrogen burners for specific temperature ranges and purposes • Hydrogen station operation, ENE-FARM developments
Our strengths	• Insights on hydrogen safety gained through Harumi Flag project based on its characteristics • Application of insights from city gas burner development to hydrogen combustion

Innovation for realizing a hydrogen-powered society



Catalyst coating technology for roll-to-roll production (CCMs for water electrolysis)



Cell stack composition

Why	• Launches of many green hydrogen production projects around the world are driving demand for water electrolysis systems. • Development of systems that minimize the use of costly rare metals.
Our actions	• Co-developed water electrolysis cell stack for low-cost green hydrogen production with SCREEN • Co-developed a novel low-cost catalyst that doesn't use rare metals with a startup in the US
Our strengths	• Hydrogen production technologies amassed through development of fuel cells, etc. • Established technology for mass production of CCMs (catalyst-coated membranes) for water electrolysis

Reference: Progress of Efforts for Achieving Carbon Neutrality (past 12 months)

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Decarbonize both gas and electricity ▶ Pursue decarbonization of gas AND electricity, not just one

e-methane	✓ Participation of Sempra Infrastructure to the Detailed Study regarding the Introduction of e-methane to Japan Utilizing Cameron LNG Terminal (Aug. 30, 2023) ✓ MoU signed with TES on comprehensive partnership on e-methane (Nov. 7, 2023) ✓ Commencement of the Joint Feasibility Study with Santos for Production and Export of e-methane in Australia (Nov. 21,2023) ✓ Establishment of e-NG Coalition, international alliance for e-methane (Mar. 19, 2024) ✓ Establishment of a Local Subsidiary to Develop e-Methane Business in the U.S. (Mar. 19, 2024) ✓ First introduction of foreign-produced biomethane (RNG) to Japan (Mar. 22, 2024)
Sophisticated use	✓ Acquisition of Shares in Rockcliff Energy II LLC and Change in Subsidiaries* (Dec. 16, 2023) ✓ Establishment of Subsidiaries and Acquisition of Interest in Gas M&T Company in North America* (Feb. 6, 2024)
Renewable energy	✓ Launch of commercial operation of mega solar power plant in Ichikai Town, Tochigi Prefecture; Tokyo Gas involved from design to construction (July 31, 2023) ✓ Tokyo Gas Investment in the Octopus Energy Offshore Wind Fund (Nov. 17, 2023) ✓ Completion of Aktina Solar Power Plant in the USA* (Jan. 24, 2024) ✓ Completion of study on mass production method supporting low-cost production and installation of floating offshore wind turbine platforms (Jan. 26, 2024) ✓ Agreement signed with James Fisher and Sons for collaboration in O&M services for offshore wind farms in Japan (Feb. 27, 2024)
Zero-Emissions thermal power	✓ Investment Decision-Making Concerning the LNG-fired Thermal Power Generation Business in Anticipation of the Realization of Carbon Neutrality (July 21, 2023)

Partner with Customers ▶ Work with customers to solve challenges, instead of focusing on supply side only

Distributed resource utilization	✓ Newly Established Green Energy Frontier Co., Ltd. to Begin Operation: Energy Supplier will Contribute to Decarbonization Drive at Narita International Airport (Feb. 20, 2023) ✓ Launch of joint demonstration project for storage batteries installed at renewable energy power plants, utilizing the FIP scheme (Mar. 27, 2023) ✓ Kiyohara Industrial Park smart energy project receives Minister of Economy, Trade and Industry Prize of 31st Grand Prize for the Global Environment Award (Apr. 22, 2023) ✓ Adoption of Octopus Energy's Kraken and Kraken Flex platforms brings greater improvements to CX and to the value of distributed energy resources (Oct. 12, 2023) ✓ Establishment of Subsidiaries in the United States and the Acquisition of a 174MW Battery Energy Storage System (BESS) Project* (Dec. 22, 2023)
Hydrogen utilization & carbon recycling	✓ Establishment of Mass Production Technology for Catalyst-coated Membranes (CCMs) for Water Electrolysis toward Low-cost Green Hydrogen Production (Mar. 15, 2023) ✓ Started selling hydrogen produced by AEM water electrolyzer at hydrogen refueling station (July 13, 2023) ✓ Launch of Demonstration Experiment for CO_2 Capture from Waste-to-Energy Plant Flue Gas for Use in Methanation (July 28, 2023)

Optimize Social Benefits ▶ Pursue real-world deployment that flexibly adapts to S+3E needs, while maintaining different choices

e-methane	✓ Tokyo Gas and H2U Technologies Enter Joint Agreement to Develop Low Cost Electrolyzers (Mar. 9, 2023)
Hydrogen utilization	✓ World's first! Development of hydrogen-only burner for use at asphalt plants (drying & heating processes) (Mar. 23, 2023) ✓ Japan's first! Development of hydrogen burner with built-in device for recovering waste heat from aluminum manufacturing, etc. (July 5, 2023)
Offsetting methods	✓ Investment in and collaboration with Global Thermostat, US-based company with innovative DAC technology (Jan. 19, 2023) ✓ Joint demonstration of method of reducing methane emissions from paddy fields in the Philippines (Feb. 28, 2024) ✓ Signing of MoU on joint feasibility study on DACCS (Mar. 14, 2024) ✓ Joint study with Kawasaki Kisen on liquefied CO_2 marine transportation toward achieving CCS (Mar. 15, 2024) ✓ Launch of collaboration with Sustainacraft for refining evaluation and selection process for nature-based credit creation projects (Mar. 15, 2024) ✓ Formation of strategic partnership toward joint development of nature-based credit creation projects (Mar. 19, 2024)

*Examples of overseas efforts

Reference: Business Growth through Carbon Neutrality Initiatives

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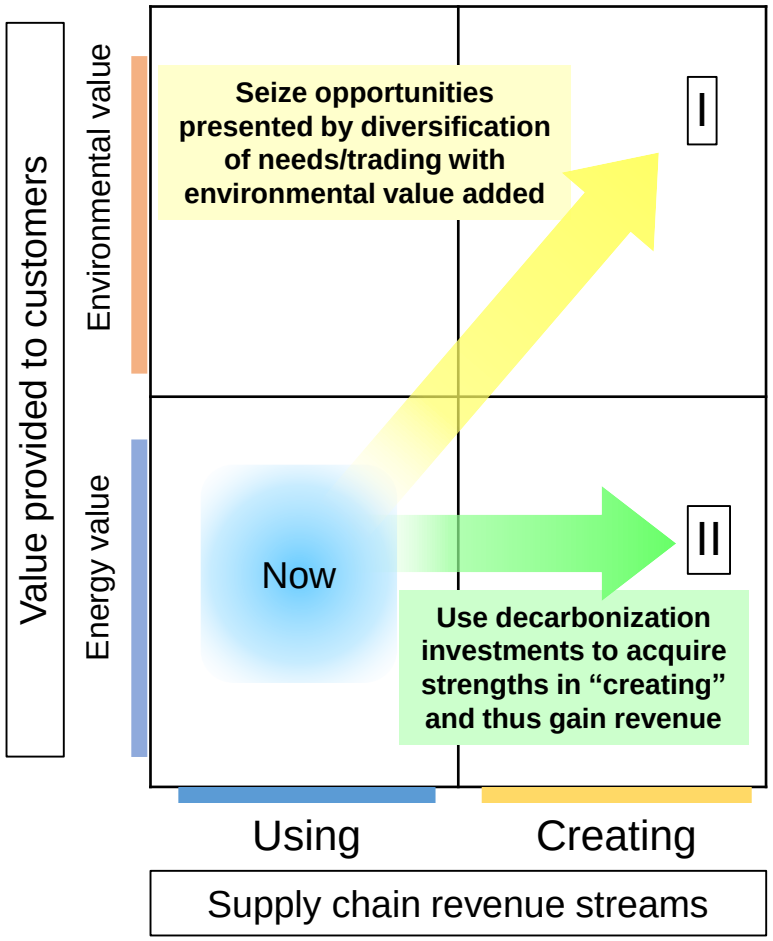
Two directions for business growth



Concept

I

As GX advances, trading in [energy + environmental value] is becoming more diverse and transaction volume is growing*1

Operate IGNITURE*2 as a provider of the best solutions for customer needs

II

Acquire new strengths in production technologies through investments in decarbonization

Gain revenue from the business of "creating" as well

(maximizing value added in the supply chain)

Examples of concrete actions

I. **Built digital trading platform**, and combine our supply capacity and balancing capacity with storage batteries and other customer needs/distributed resources to **provide solutions** that maximize value such as decarbonization and resilience

I. And, II. **Directly create and procure carbon credits**, use digital technologies in efforts that increase reliability, and provide **diverse carbon offset products** tailored to customer needs

II. **Develop innovative technologies** that significantly improve e-methane production efficiency and thus **reduce manufacturing costs**, and use our insights on supply chain building to contribute to other operators' supply businesses in Japan and abroad

II. Engage in asset management*3 of equipment for wind power and other renewables, acquire O&M technologies, **scale up offshore wind power facilities, shrink costs**, and utilize data to build up a business in **efficient O&M**

II. **Establish technologies for mass production of key components of water electrolyzers** that help to lower the cost of green hydrogen; use it for production of e-methane raw material and on-site hydrogen production, and consider turning it into a global business

*1 Increase in not only conventional trading in energy (gas, electricity, etc.). but also trading involving environmental value
*2 Our solutions business brand; leverages GX and DX to provide three forms of value: decarbonization, optimization, and resilience
*3 Efficient management and operation of equipment and other assets

Standing by every person and

dedicating ourselves to the society,

we shall be the energy that weaves the future.

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