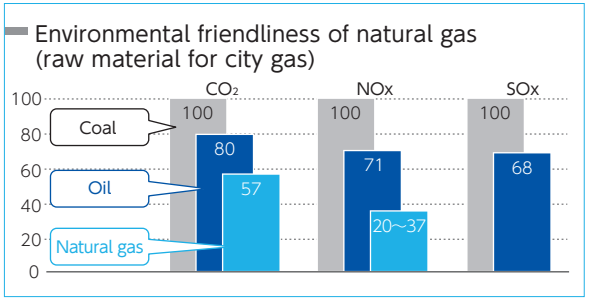
Initiatives for Carbon Neutrality

①Reductions of carbon and decarbonization at customer locations

Switching fuel types for thermal demand

To achieve carbon neutrality, we will advance the conversion to city gas, one of the established low-carbonization technologies at the grassroots level. The Chubu region is a prominent industrial hub, particularly in the high-temperature heat sector, where there is potential for the low-carbonization of fossil fuels. Natural gas, the raw material for city gas, has the lowest CO_2 emissions among fossil fuels, and by transitioning from coal, oil, and other fuels, it contributes to the low-carbonization of heat demand.



Sources:Regarding CO_2: Report of Research into Demonstration of Atmospheric Impact Assessment Technology for Assessment of Thermal Power Plants (March 1990), The Institute of Applied Energy; Regarding NOx and SOx: Natural Gas Prospects to 2020 (1986), IEA

Energy conservation and advanced utilization of energy

We contribute to regional and customer-location energy conservation and decarbonization through the promotion of high-efficiency gas air conditioning, cogeneration, district cooling and heating, and the like. In addition to traditional energy conservation and advanced utilization of energy, we also actively promote new initiatives such as carbon recycling and hydrogen utilization, providing comprehensive support for achieving low-carbon and decarbonized environments at customer locations.

GHP XAIR III gas heat-pump air conditioner

The ultra-high-efficiency GHP XAIR II gas engine heat pump maintains low power consumption of less than 1/10 of EHP (electric heat pump) building multiple packaged air conditioning systems, while achieving further energy savings and improved functionality, addressing such needs as *achieving energy conservation and power savings* and climate change adaptation.

スマート＆超高効率 ヒートポンプ
GHP XAIR III
GHPエグゼアIII

Advancement of heat management through high-density thermal storage technology

We are promoting the practical application of thermal storage material of our own proprietary development that is aimed at effectively utilizing unused waste heat and other sources. The thermal storage material developed by Toho Gas has a heat storage capacity of about ten times that of hot water, and over twice that of existing latent heat storage materials that are mainly composed of paraffin. This material is being implemented in Toho Gas research institute facilities as well as in practical applications such as camping and disaster prevention supplies, and food preservation. We are further working on expanding its application scope, including for water heating, air conditioning, on-vehicle applications, industrial applications, and in agriculture.

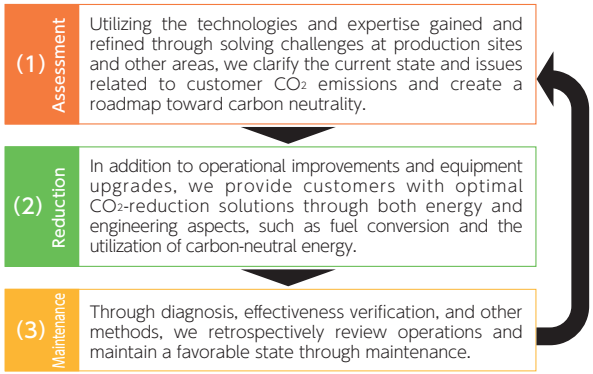
CNxP business

We are carrying out CNxP Business operations, which support achievement of carbon neutrality by customers through such means as visualizing data, assisting in formulating execution plans, and adopting renewable energy sources and high-efficiency equipment.

CNxP

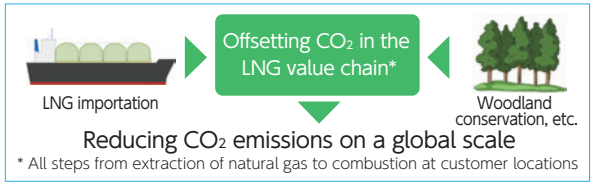
The CNxP Business is a service where the energy **P**rofessionals that Toho Gas Group comprises provide support from consulting to engineering as a one-stop **P**ackage, working together with customers as **P**artners aiming for carbon neutrality.

Leveraging our strength in offering integrated energy and engineering solutions, we contribute to achieving carbon neutrality by cycling through the steps of (1) assessment, (2) reduction, and (3) maintenance.



Carbon-neutral LNG

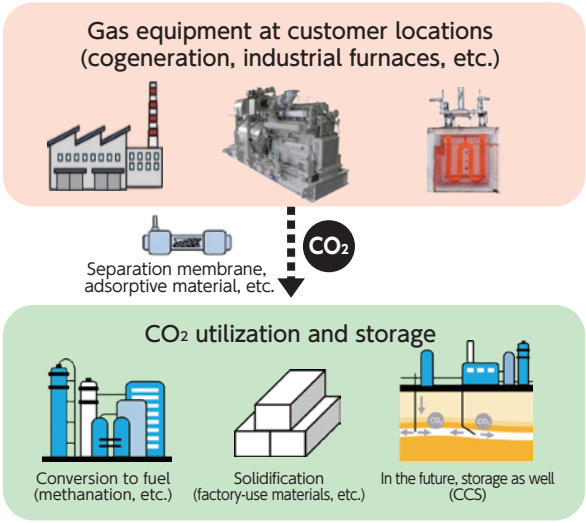
Toho Gas introduced carbon-neutral LNG in April 2021 and began supplying it in August 2021. As a means of carbon neutrality for city gas that can be implemented from the grassroots level, we have received diverse industrial customer demands for it, and the amounts handled are expanding. To ensure transparency and reliability, the operation status of carbon neutral LNG undergoes verification by third-party institutions. We will continue to investigate and consider projects that lead to agile procurement and credit creation, contributing to customer CO_2 reductions.



② Carbon recycling

Toho Gas was quick to focus on developing CO_2 separation and capture technology. In the future, we will further enhance our technological capabilities from the perspective of CO_2 utilization (conversion to fuel and solidification) and storage.

As a grassroots-level low-carbonization method, we aim to establish a supply chain for carbon recycling, where CO_2 is separated and captured at customer locations for utilization. Alongside the development of CO_2 separation and capture technologies, we are conducting studies to achieve actual CO_2 utilization. We are also exploring challenges such as direct atmospheric capture and expanding utilization applications.



Achieving higher-performance, lower-cost separation and capture

Within the Toho Gas Technical Research Institute, we have established a demonstration facility composed of membrane separation and physical adsorption methods. We are conducting performance evaluations of CO_2 concentration, capture volume, energy consumption, and the like, and working toward achieving higher performance and lower costs.

CO_2 separation and capture demonstration facility
(membrane separation methods, physical adsorption method, etc.)

- Exploration of new materials (membranes and adsorbents) that yield high CO_2 concentrations and large capture volumes, with installation in the demonstration facility for evaluation and enhancement
- Optimization using simulation technology

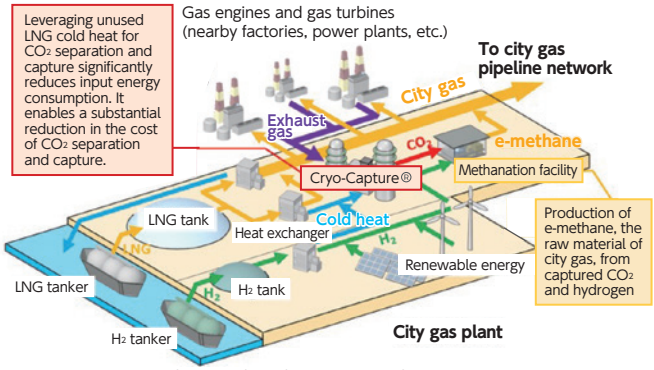
Technical development for the future

As a technology for cost-effective CO_2 capture using unused cold heat from LNG, we are devoting effort to technical development of Cryo-Capture® to capture exhaust gases from large-scale factories and the like in coastal areas as well as to technical development of Cryo-DAC® with the aim of capturing CO_2 from the atmosphere in the future.

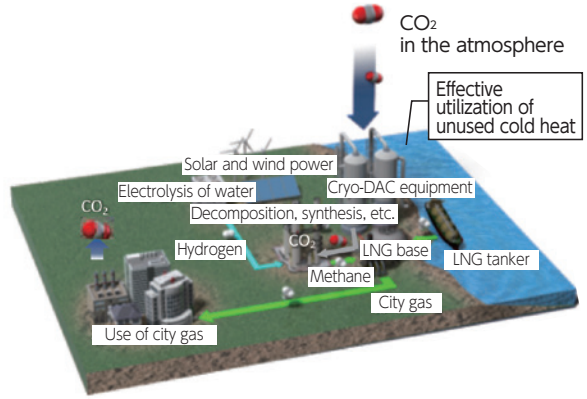
Conventional technology	System driven by heat (high-cost CO_2 capture)
Innovative technology	System driven by unused LNG cold heat (enables reduction of CO_2 recovery costs)

For CO_2 separation and capture targeted at large-scale facilities in coastal areas, we are collaborating with Nagoya University as part of the New Energy and Industrial Technology Development Organization's (NEDO) Green Innovation Fund project to commercialize the technology. In the demonstration phase (FY2028 to 2030), we plan to use CO_2 captured by Cryo-Capture® at an LNG base for the production of e-methane.

The separation and capture of CO_2 from the atmosphere are being pursued through a NEDO "moonshot"-type research and development project, involving collaborative research between academia and industry.



Artist's concept of societal implementation of Cryo-Capture®



Artist's concept of societal implementation of Cryo-DAC®

Initiatives for CO_2 separation and capture ▶ P.77

Initiatives for Carbon Neutrality

③Decarbonization of gas itself

Toho Gas is positioning methanation as the core of our gas decarbonization efforts, aiming to achieve practical application of methanation technology and the like, and the widespread adoption of clean e-methane through this. Through a broad array of alliances, we are working on demonstrations and solutions to challenges, including improving efficiency and reducing costs.

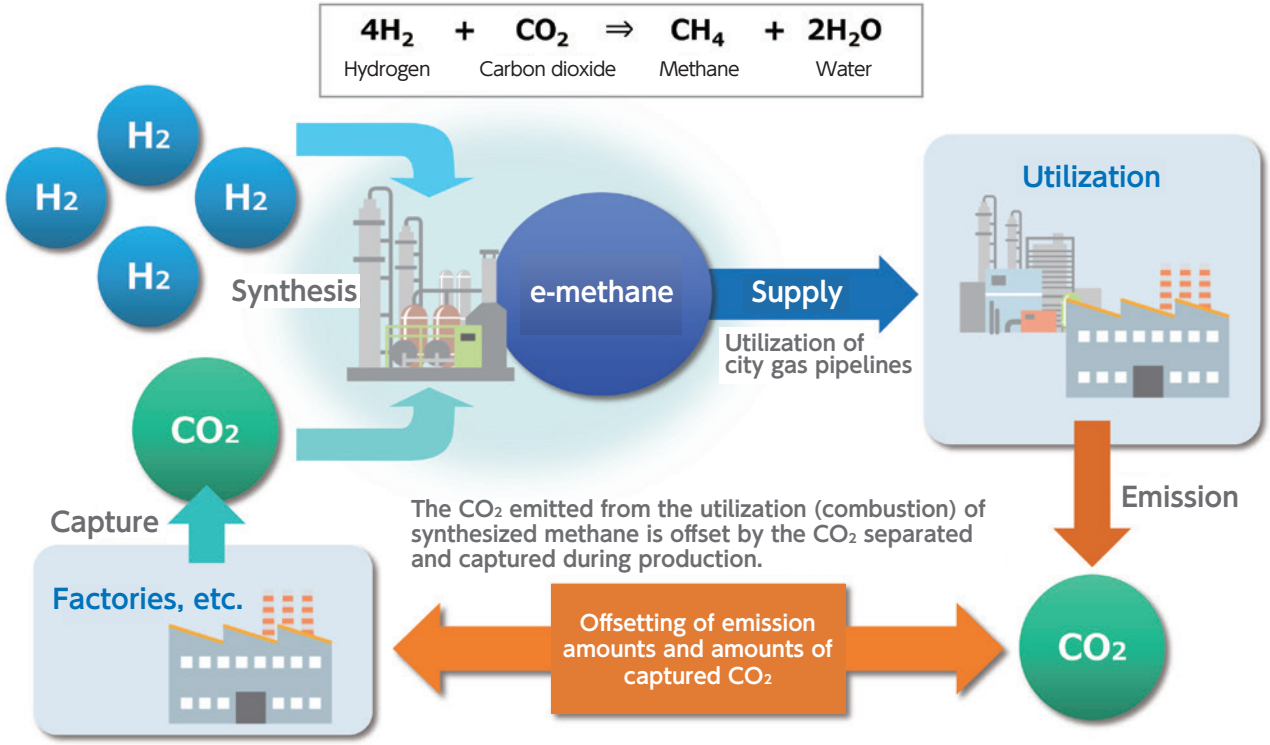
Toward the societal implementation of e-methane by 2030, we are conducting business feasibility studies for e-methane production both domestically and internationally.

Benefits of e-methane

Methanation is a technology that synthesizes methane (e-methane) by reacting hydrogen and CO_2, and is expected to be a potential means for the future decarbonization of gas itself.

E-methane produced from captured CO_2 and hydrogen is a decarbonized fuel, and when used in the same way as hydrogen or ammonia, does not contribute to increased atmospheric CO_2.

e-methane (イーメタン)



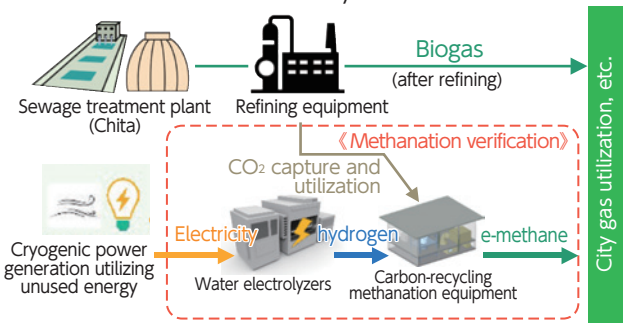
The utilization of e-methane can also effectively leverage existing city gas infrastructure and consumer devices. As it facilitates efficient energy transportation, it contributes to reducing societal costs and sustaining customer convenience.

Methanation verification utilizing CO_2 from biogas

We have initiated methanation demonstration in collaboration with the city of Chita, Aichi Prefecture, and are working on identifying and addressing challenges on both technical and regulatory fronts.

In this initiative, we carry out methanation using CO_2 derived from biogas generated through sewage sludge treatment at the Chita City Nambu Purification Center, along with hydrogen produced from cryogenic power generation. The resulting product, e-methane, is intended to be used as a raw material for city gas, in a move intended to contribute to the effective utilization of local resources. This endeavor aims to establish a domestic first by utilizing methanation-synthesized e-methane as a raw material for city gas. Looking ahead, through large-scale societal implementation of methanation facilities, we aspire to achieve the decarbonization of gas itself.

Overview of methanation demonstration in collaboration with the city of Chita

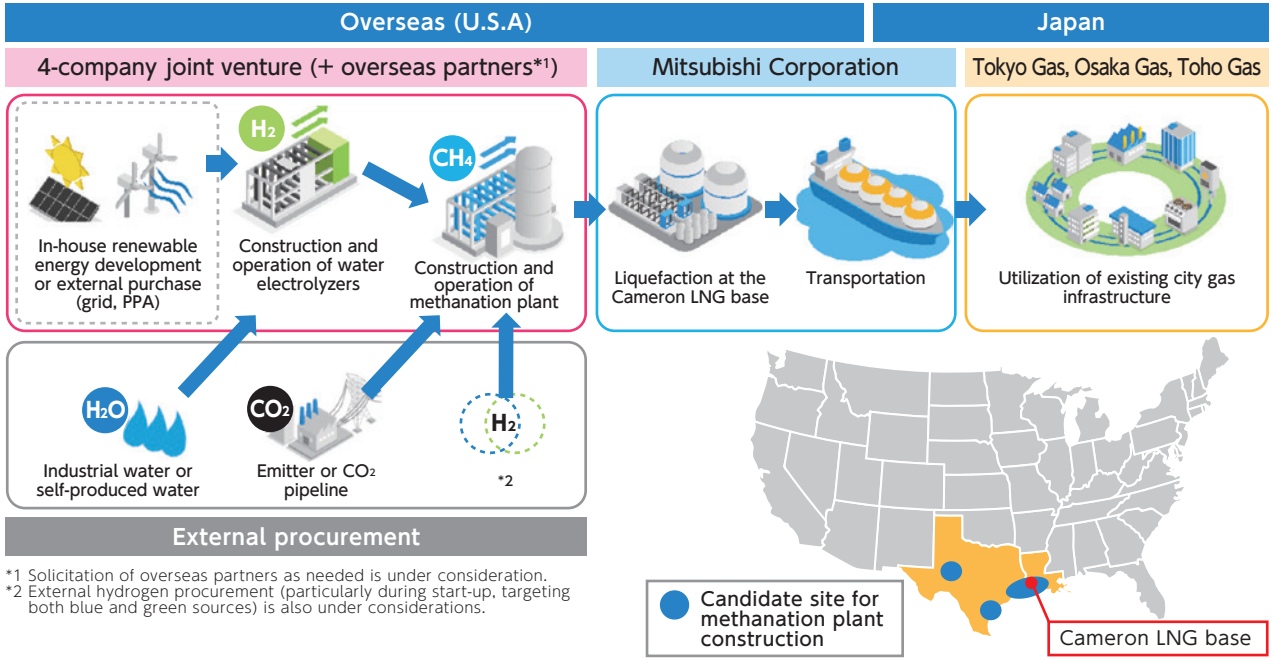


Feasibility study for the implementation of e-methane using an LNG base in the U.S.A.

We are advancing a feasibility study for e-methane production near an overseas LNG shipping facility.

In preparation for the start of implementation of e-methane in 2030, we, along with Mitsubishi Corporation, Tokyo Gas, and Osaka Gas, are conducting a feasibility study for e-methane production in North America. This collaborative effort aims to utilize the existing LNG supply chain of the Cameron LNG facility, LNG vessels, receiving terminals, and the like to liquefy and transport e-methane, as well as to achieve the goal of adopting 1% e-methane in Japan by 2030. Detailed discussions have been initiated to achieve this target.

With respect to the adoption and dissemination of e-methane produced overseas, ensuring origin certification to differentiate it from natural gas between Japan and the production countries, calculation of the CO_2 emission count during e-methane utilization, and securing investment visibility for e-methane production and utilization are crucial. To advance these regulatory and environmental arrangements, discussions with stakeholders in the U.S. and Japan are also planned.



*1 Solicitation of overseas partners as needed is under consideration.
*2 External hydrogen procurement (particularly during start-up, targeting both blue and green sources) is also under considerations.

Investigations oriented toward building a value chain for hydrogen, e-methane, etc.

In collaboration with Toyota Tsusho Corporation and Total Energies, we are conducting a feasibility study on the business potential of building a value chain for hydrogen, e-methane, and other components to introduce these elements into Japan.

By combining the expertise of Toho Gas in the LNG value chain, the knowledge of Toyota Tsusho Corporation in decarbonized fuel business, and Total Energies's global fuel supply portfolio, Toho Gas is conducting business feasibility studies in Australia and other locations for creating an optimal value chain.

TotalEnergies　豊田通商株式会社　東邦ガス

Discussion of methanation regional collaboration in the Chubu area

In collaboration with Aisin Corporation and Denso Corporation, we are exploring regional circulation models for CO_2.

With the goal of early achievement of a carbon-neutralization method for heat demand, we are investigating a model case where CO_2 emitted from inland factories is captured, transported to city gas production facilities, and subjected to methanation. This model envisions the circulation of CO_2 within domestic and regional areas.

Initiatives for Carbon Neutrality

④Use of hydrogen

Expanding mobility needs

In the Chubu region, the utilization of hydrogen for mobility purposes is advancing, and to support the proliferation of fuel cell vehicles, Toho Gas is working on establishing hydrogen stations. For industrial and transportation vehicles, as well as others, we will leverage cross-industry frameworks to effectively utilize the hydrogen infrastructure as we expand the range of vehicle models and applications.

Establishment of hydrogen stations (5 locations in operation)

Toyota Hoei Hydrogen Station

Building a hydrogen supply chain

We are constructing a hydrogen production plant at Chita Midorihama Works (Chita, Aichi Prefecture) that uses natural gas as a raw material. By 2024, we aim to complete the construction of a plant with a hydrogen production capacity of 1.7 tonnes per day and begin hydrogen supply.

We are considering distribution to demand sites using trailers, carriers, and the like, as well as exploring pipeline supply through local networks. Through the establishment of the hydrogen supply chain, we aim to drive the expansion of hydrogen adoption in the Chubu region.

Furthermore, Toho Gas is advancing alliances with other companies possessing knowledge and expertise in the transportation, supply, and consumption of hydrogen. This is aimed at establishing a foundation for the widespread adoption and expansion of hydrogen, and in the future, we also aim to position Chita Midorihama Works as a receiving hub for imported hydrogen.

Building a hydrogen supply chain

・Collaboration with other companies possessing knowledge and expertise to advance initiatives at various stages in response to the hydrogen utilization needs of the local region

Manufacturing

・Launch of construction of a plant with a manufacturing capacity of 1.7 tonnes per day* at Chita Midorihama Works, with hydrogen supply scheduled to commence by 2024

* A capacity of 1.7 tonnes can fill approximately 340 fuel cell vehicles.

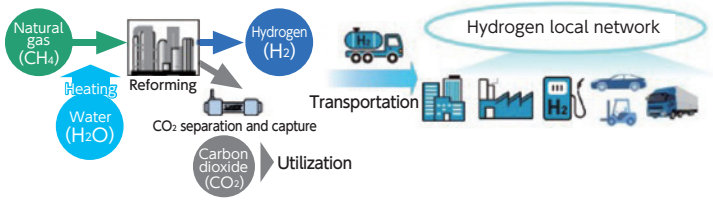
Transportation and supply

・Consideration of transportation using trailers and carriers in collaboration with other companiesence by 2024
・Advancing studies for hydrogen pipeline supply (local network) at Minato AQULS

Consumption

・Promoting the technical development and demonstration of hydrogen combustion and co-combustion technologies to expand applications in the thermal sector and beyond
-Promotion of hydrogen and city gas dual-use burners
-Investigation of the challenges and other matters in hydrogen co-combustion in conventional gas engines
・Contribution to the proliferation of mobility, including hydrogen stations, fuel cell vehicles, and industrial vehicles

Hydrogen supply change (future image)



Expansion of hydrogen combustion testing services

Hydrogen combustion Test Field (within the Technical Research Institute)

・Leveraging expertise and technology in fuel conversion and burner development to support the identification of challenges and solutions for hydrogen utilization using customers' burners and furnaces
・Construction of a dedicated test site in March 2023 to accommodate larger furnaces

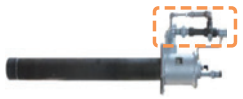
Development of hydrogen combustion technology

To bring about a hydrogen society, Toho Gas is pressing ahead with development of hydrogen combustion technology for industrial burners and cogeneration systems, and has initiated demonstration tests and other activities.

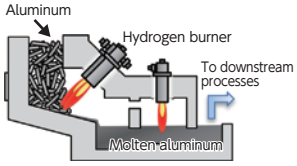
Hydrogen combustion

Initiation of joint demonstration experiments on hydrogen combustion technology targeting Aisin Corporation's industrial furnace burners

NOx emission control technical



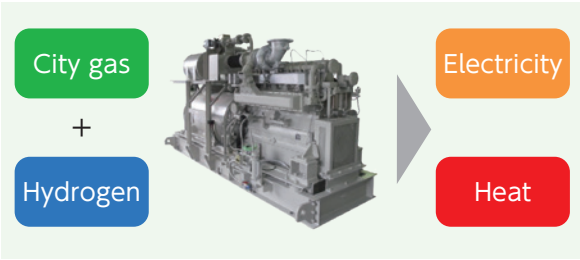
Hydrogen combustion technology using single-end radiant tube burners



Initiation of hydrogenation demonstrations, including aluminum melting furnaces

Hydrogen co-combustion cogeneration

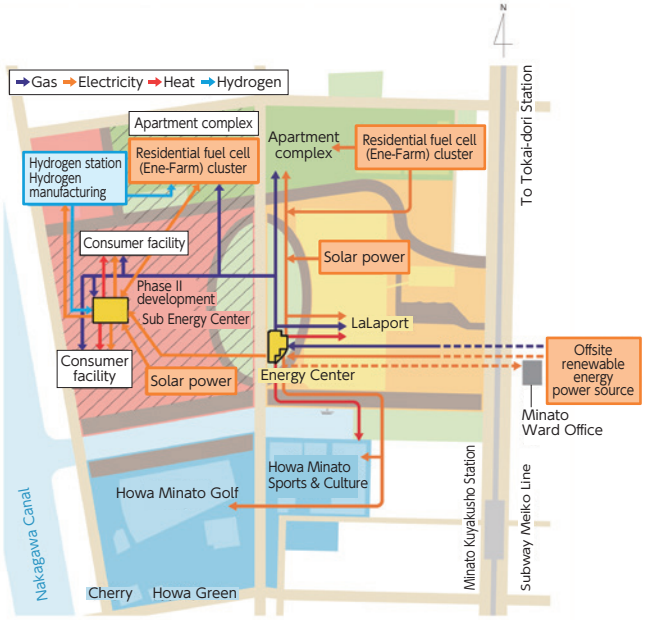
For the first time in Japan, Toho Gas successfully engaged in test operation of city gas and hydrogen combustion using gas engine cogeneration units, making use of rated power generation output and achieving a hydrogen mixing rate of 35% (by volume).



Implementation of hydrogen technology at Minato AQULS

In the Minato AQULS Phase II development now under discussion, hydrogen is positioned as a new energy source.

Hydrogen utilization is anticipated to begin from hydrogen stations in inland areas, and plans are progressing to manufacture hydrogen at a hydrogen station within Minato AQULS. The produced hydrogen will be supplied to fuel cell vehicles and the like. Hydrogen pipelines will also be laid from the station to supply hydrogen-using equipment such as cogeneration facilities and fuel cells.



Minato AQULS energy supply diagram

Minato AQULS Initiatives ▶ P.46

⑤Electricity

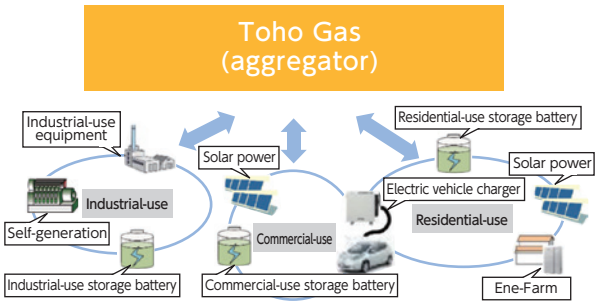
Reductions of carbon and decarbonization at customer locations

Along with promoting the adoption of diverse distributed energy resources, including solar power generation, energy storage batteries, and electric vehicles, Toho Gas aims to provide services that integrate and control these resources using digital technology, enabling the mutual exchange of electricity and environmental value. This approach seeks to provide services that both create customer benefits and achieve efficient energy utilization.

Initiatives toward VPP commercialization

A virtual power plant (VPP) is a system that uses IoT to remotely and integrally control devices such as customer-owned storage batteries, operating them like a single power plant. This concept involves operators called aggregators, which act as control centers to manage the supply-demand balance of electricity.

Toho Gas initiated discussions for VPP commercialization in FY2019. Currently, we are establishing VPP systems primarily focusing on the equipment of commercial and industrial customers. Serving as an aggregator, we engage in demand response aligned with the supply-demand situation to contribute to maintaining the balance of electricity supply and demand.

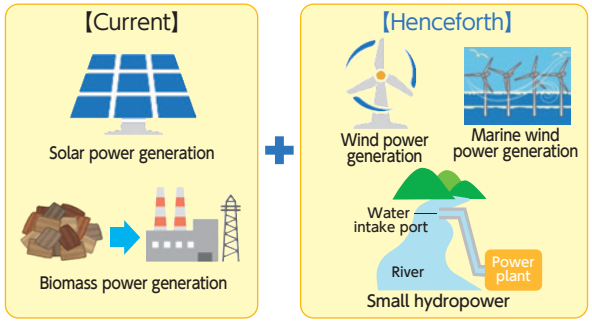


Decarbonization of power sources

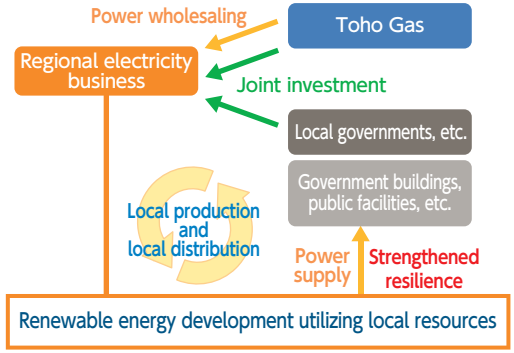
To decarbonize Toho Gas's own power sources, we are devoting effort to developing and procuring renewable energy sources, and to their diversification.

In collaboration with local governments, we work towards utilizing potential renewable resources within the region through initiatives such as regional new power suppliers, contributing to addressing local issues including localized energy production and consumption, as well as enhancing resilience.

Diversification of types of power sources



Power Source Development Contributing to Local Production and Local Distribution



Initiatives for regional new power ▶ P.45