Actions for Climate Change

Principle and Outline

In response to the growing social need for measures against global warming, the Daigas Group aims to become carbon neutral by 2050 by decarbonizing the raw materials of city gas through methanation* using hydrogen and CO_2 produced powered by renewable energy and by making power sources carbon neutral through the introduction of renewable energy, in addition to the conventional efforts to expand the use of natural gas.

*A technology for synthesizing methane, which is the main component of city gas, from hydrogen and CO_2

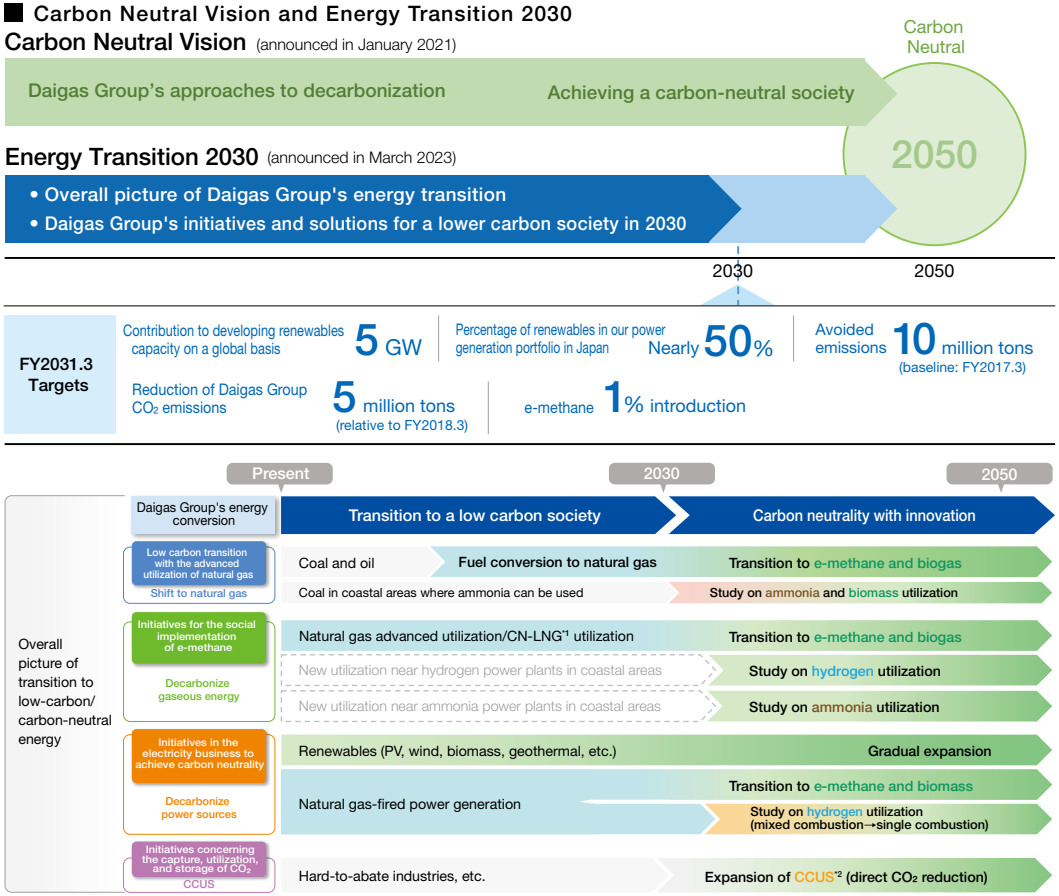
Carbon Neutral Vision

In response to the further increase in social demands for global warming countermeasures, the Daigas Group aims to become carbon neutral by 2050. We plan to reach the goal through decarbonization of our gas and electricity by introducing methanation* to generate gas with renewable energy and hydrogen and by increasing the share of renewables in its power generation portfolio, in addition to continuing efforts to expand the use of natural gas to date.

Energy Transition 2030 (ET2030)

Under Energy Transition 2030 (ET2030), the Daigas Group outlines the overall picture of its transition to low-carbon and carbon-neutral energy. In order to achieve carbon neutrality, a steady transition to low-carbon energy is crucial, as a great deal of time and social cost will be required for technological innovation and the building of new supply chains. It is also important to choose optimal energies and supply methods to suit the customer's energy use characteristics, such as the balance of electricity and heat use and their location. Focusing on the transition to low-carbon energy by 2030 through a shift from coal and oil to natural gas, and the seamless transition to carbon-neutral energy with the introduction of "e-methane" and biogas in the future, we will continue to pursue the decarbonization of power sources in ways that meet customer needs. This will include the use of hydrogen and ammonia, the decarbonisation of power sources, such as renewable energy generation and zero-emission thermal power plants.

Carbon Neutral Vision and Energy Transition 2030

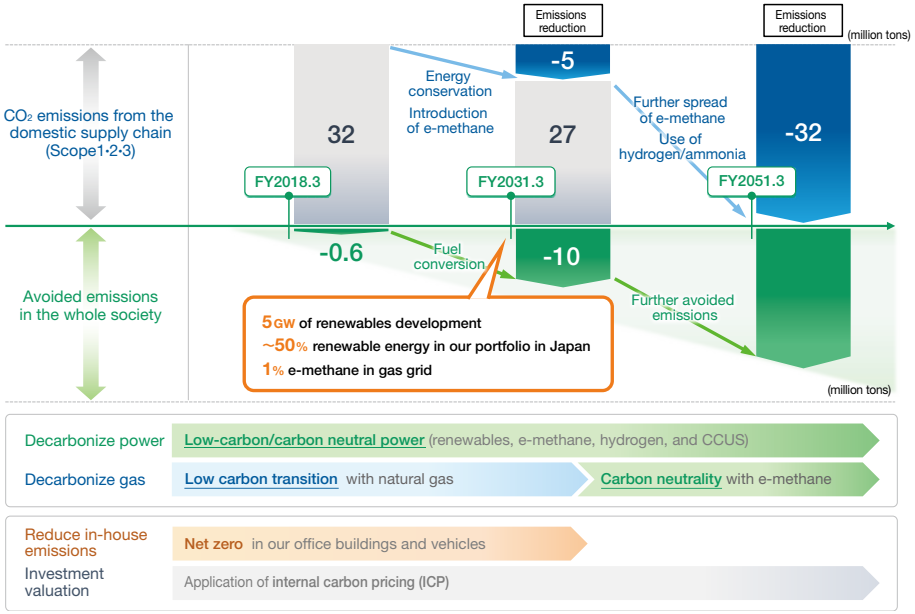


*1 CN-LNG: Carbon Neutral LNG, which is considered to produce no CO_2 on a global basis when greenhouse gases emitted in the supply chain from natural gas production to combustion are offset by CO_2 absorbed and reduced in a separate process from the value chain.

*2 CCUS: Carbon dioxide Capture, Utilization and Storage

Daigas Group's CO_2 Emissions Reduction Roadmap

In Energy Transition 2030, we have declared targets for 2030 and 2050 regarding CO_2 emissions in our domestic supply chain and avoided emissions in the whole society, and presented a CO_2 emissions reduction roadmap. Through such measures as the 1% introduction of e-methane into existing infrastructure, we will aim to reduce the CO_2 emissions of the Daigas Group's supply chain in Japan by 5 million tons, and 10 million tons of avoided emissions in society as a whole in FY2031.3 through the Group's activities. After the introduction of "e-methane" in FY2031.3, we will pursue decarbonization through its wider use.

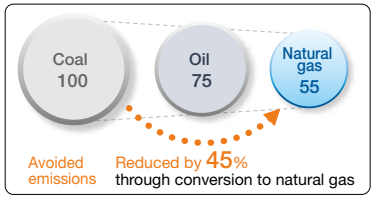


Approach to Avoided Emissions in Society

The following sums up our approach to avoided emissions in society. For example, we can reduce approximately 45% of CO_2 emissions with the switch from coal to natural gas. However, if we have supplied the natural gas, our gas sales volumes increase, which means an increase in Scope 3 CO_2 emissions according to the GHG Protocol*1 that is commonly used by companies to calculate their CO_2 emissions. For this reason, in the transition phase until 2030, our CO_2 emissions will increase by promoting fuel conversion from oil and coal to natural gas. On the other hand, by switching to natural gas, CO_2 emissions per the same calorific value will be reduced, which means that we can contribute to CO_2 emissions reduction in the whole society. However, under the current GHG Protocol, there is no way of evaluating the CO_2 reduction effect on society as a whole through contributions to other parties.

To steadily promote the transition to low-carbon/decarbonization together with our many customers, we believe that it is important to understand our progress with an indicator that shows the effect of CO_2 emissions reduction in the whole society (avoided emissions) and to obtain the understanding of our stakeholders.

CO_2 emissions per same calorific value*2



What is "avoided emissions"?

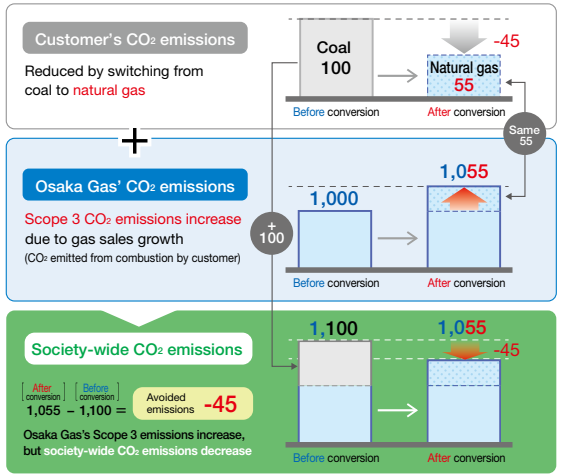
Quantified CO_2 emissions reduction through products and services provided to others

Calculated based on the "Guidelines for Quantifying GHG emission reductions of goods or services through Global Value Chain" (Ministry of Economy, Trade and Industry, March 2018)

Indicator of society-wide avoided emissions through contribution to other companies' emissions reduction

*1 International standard for calculating and reporting GHG emissions
*2 Prepared based on the "Ordinance Concerning Calculation of GHG Emissions from Business Activities of Specified Emitters" issued by METI and the Ministry of the Environment

Avoided emissions calculation example



Daigas Group's Avoided Emissions

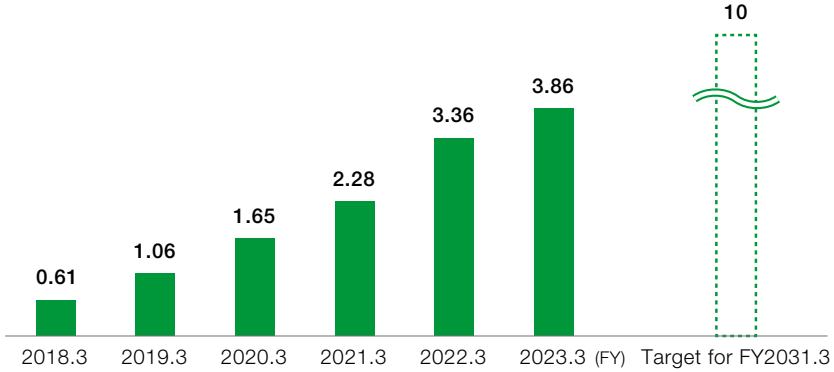
The Daigas Group is working to introduce various low-carbon or decarbonized systems both domestically and internationally at our customers' sites and in our own business activities. The avoided CO_2 emission is calculated for such systems that contribute to the reduction of CO_2 emissions in society as a whole.

The Osaka Gas Group contributed to a 3.86-million-ton CO_2 emissions reduction, as revealed by the results of calculations of the effect of reducing CO_2 emissions in FY2023.3 (FY2023.3 results) achieved by using the systems listed below that the Daigas Group has introduced since FY2018.3 at customer sites and in its own business activities.

The results were calculated using the stock-based approach, based on the "Guidelines for Quantifying GHG Emission Reductions of Goods or Services through Global Value Chain" (published by the Ministry of Economy, Trade and Industry in March 2018), assuming the calculation method and baseline concept shown in the table below.

The calculation results were validated by a third-party review by Bureau Veritas Japan Co., Ltd.

Avoided emissions results (million t)



Calculation method

Area of reduction	Low-carbon/ carbon-neutral system	Reduction effect calculation method	Baseline concept
Reduction of CO_2 emissions from business activities	Renewable energy sources  Wind farm  Solar power plant  Biomass power plant etc.	Amount of electricity generated or procured × Average electricity emission factor of thermal power*	Substitution for thermal power generation
	High-efficiency thermal power generation  High-efficiency thermal power plant	Amount of electricity generated × Difference in CO_2 emission factor between high-efficiency and existing thermal power	Comparison with emission factor of existing thermal power generation
	Cryogenic power generation facilities using cold heat generated in the manufacturing process of city gas	Amount of electricity generated × Average electricity emission factor of thermal power	Substitution for thermal power generation

Area of reduction	Low-carbon/ carbon-neutral system	Reduction effect calculation method	Baseline concept
Reduction of CO_2 emissions at customer sites	High-efficiency distributed system   Household fuel cell system / Cogeneration system	Household fuel cell system: Number of installed units × Reduction per unit	Substitution for conventional water heaters (boilers) and purchased electricity
		Cogeneration system: Installed capacity × Reduction per unit capacity	
	Expanded and advanced use of natural gas   Fuel conversion / High-efficiency water heater	Fuel conversion: Amount developed × Difference in CO_2 emission factor	Emissions comparison with other fuels
		Gas-powered air conditioning: Capacity sold × Reduction per unit capacity	Substitution for conventional air conditioners
	  Gas-powered air conditioning	High-efficiency water heater: Number of installed units × Reduction per unit	Substitution for conventional water heaters
	Proposals for energy saving (Solar power generation systems/ Conversion to LED lighting)	Amount of electricity generated or saved × Average electricity emission factor of thermal power*	Substitution for thermal power generation

*Calculated using the average electricity emission factor of thermal power given in the Plan for Global Warming Countermeasures (approved by the Cabinet on October 22, 2021): 0.65 kg-CO_2/kWh (FY2014.3)

Efforts to achieve net zero emissions regarding the Group's CO_2 emissions (environmental impact throughout the Daigas Group value chain)

The Daigas Group calculated the amount of greenhouse gas (GHG) emissions from companies that constitute the Daigas Group's value chain network, based on the GHG Protocol, an international emission accounting standard. The methodology of the calculation and its results have been certified by an independent organization to verify their reliability and accuracy.

Combined GHG emissions by the Daigas Group and value chain companies, measured by CO_2, totaled about 25.98 million tons in FY2023.3. The sum breaks down into about 4.73 million tons, or about 18%, for GHG emitted through business activities by the Daigas Group (Scope 1 and Scope 2), and about 21.25 million tons, or about 82%, emitted by others in our value chain (Scope 3). GHG emissions from city gas and LNG combustion on the customer side amounted to 16.54 million tons in the reporting year in terms of CO_2, accounting for about 64% of the total. GHG emissions through electricity generation, as measured in terms of CO_2 in the year, amounted to 3.89 million tons, accounting for about 15% of the total emissions, which represented the majority of GHG emissions from the Group's own business activities. As a way of reducing GHG emissions from power generation, the Group will continue to actively introduce highly advanced energy-efficient power generation facilities and use renewable energy sources.

GHG emissions from material and fuel procurement totaled 4.61 million tons, as measured in terms of CO_2 in the year, accounting for about 18% of the total emissions. The procurement of energy sources, especially LNG, accounted for over 70% of that amount. Under these circumstances, we will continue our efforts to improve fuel efficiency regarding the operation of LNG tankers in collaboration with resource suppliers.

Reduction of CO_2 emissions from the Group's own business activities— Facilitating the development of renewable energy sources

The Daigas Group aims to raise by FY2031.3 the percentage of renewables in its power portfolio in Japan to about 50% and renewables development contribution on a global basis to 5 GW. To achieve these targets, it is engaged in renewable energy businesses such as wind, solar, and biomass.

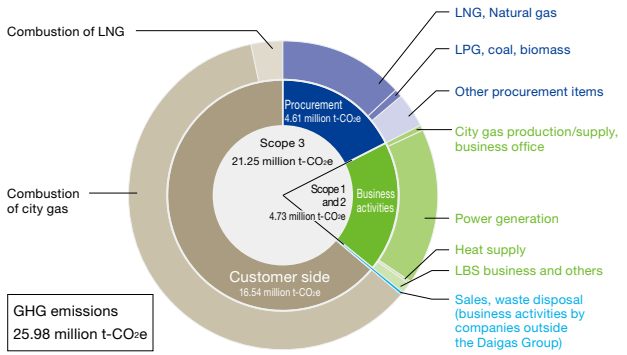
In FY2023.3, the percentage of renewables in our power portfolio was 13.0%, and renewable power development contribution was approximately 2.11 GW.

Domestically, we participated in a biomass power generation project in Gobo City, Wakayama Prefecture, and a solar power generation project in three locations in Japan, including Oita City, Oita Prefecture. In January 2023, the Noheji Mutsu Bay Wind Farm in Noheji-cho, Kamikita District, Aomori Prefecture, began commercial operation.

Overseas, Osaka Gas has concluded an agreement with Oriden LLC in the United States regarding the joint development of a solar power plant in the United States and with Summit Ridge Energy, LLC, an operator of distributed solar power generation business in Maine, U.S., to jointly implement the same business in Illinois, U.S.

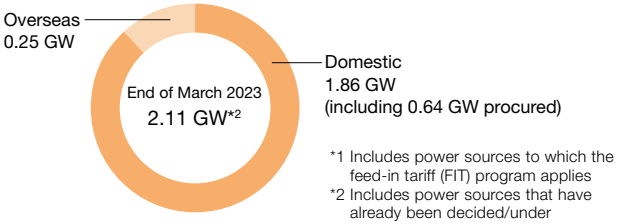
GHG emissions from the value chain (FY2023.3 results)

Please see P.34 for detailed data.



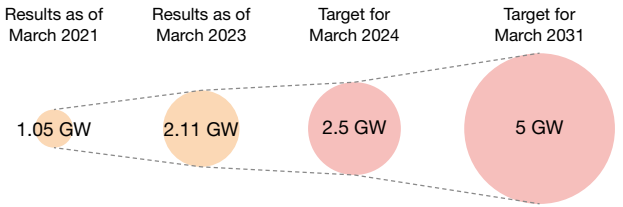
Companies subject to the calculation of GHG emissions:
63 companies in total, including Osaka Gas Co., Ltd. and 62 companies among 154 consolidated subsidiaries are subject to calculation of GHG emissions. Those housed in office buildings as tenants and whose environmental data are difficult to grasp and whose environmental effects are minimal are not subject to such calculation. Also excluded from the calculation are overseas companies, except two companies.

Contribution to developing renewables capacity on a global basis*1 (FY2023.3)



*1 Includes power sources to which the feed-in tariff (FIT) program applies
*2 Includes power sources that have already been decided/under construction

Contribution to developing renewables capacity on a global basis: Targets and results



CO_2 Reduction Initiatives at Customers and in the Value Chain

The Daigas Group believes that it is important to reduce not only GHG emissions from its own business activities but also CO_2 emissions at customers' sites. We are seeking to assist customers in reducing their CO_2 emissions by popularizing the use of natural gas and developing and proposing highly energy-efficient equipment. We are also cooperating with our business partners and affiliated companies to reduce CO_2 emissions from logistics.

Efforts to reduce CO_2 emissions in LNG transportation

In 2022, Osaka Gas began chartering the low-fuel-consumption LNG carrier Grace Freesia to achieve even greater energy savings when transporting LNG, an essential material for city gas. The new type of LNG carrier is equipped with a dual-fuel low-speed diesel engine and a reliquefaction device that effectively utilizes surplus boil-off gas to further reduce fuel consumption, CO_2 emissions, and transport costs.

Low fuel consumption LNG carrier chartered

Reducing CO_2 emissions in logistics

In Japan, the number of trucks accounts for less than 20% of the overall number of automotive vehicles, yet CO_2 emissions in the logistics sector are as high as about 35%. Large trucks generate particularly high emissions, so the introduction of natural gas-powered large trucks can have a significant effect on reducing CO_2 emissions. According to a road verification report by the Organization for the Promotion of Low Emission Vehicles (LEVO), large natural gas trucks have 12.9% lower CO_2 emissions than large diesel trucks. Osaka Gas is working to expand the use of large natural-gas trucks for long-distance transport between cities, and small and medium-sized natural-gas trucks for transport within municipalities.

We have also transported LNG using LNG tanker trucks fueled by compressed natural gas (CNG). These LNG tanker trucks can help reduce CO_2 emissions by about 7%, compared with diesel-fueled tanker trucks.

Japan's first commercial LNG station was opened in Osaka City in June 2018, allowing the start of transport using large LNG trucks. LNG features high-efficiency fuel storage, which lets trucks run for over 1,000 kilometers without refueling for further reductions in CO_2 emissions.

LNG tanker truck fueled by CNG

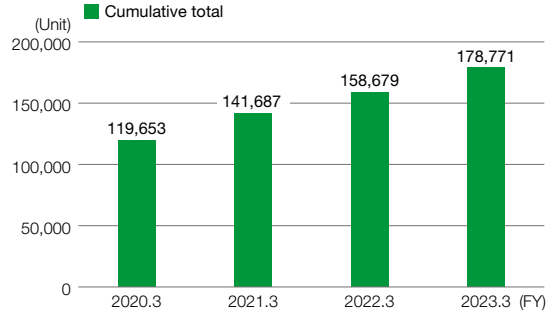
Approaches at customer sites

To help realize a low-carbon society, Osaka Gas is striving to sell and disseminate two types of fuel-cell systems that generates electricity through chemical reactions between the hydrogen extracted from city gas and oxygen in the air. Those are polymer electrolyte fuel cells (PEFC) and solid oxide fuel cells (SOFC) sold as "Ene-Farm" and "Ene-Farm type S," respectively as co-generation systems for household use that help conserve energy and reduce CO_2 emissions. These are high-efficiency energy systems that make effective use of the heat generated alongside electricity to supply hot water.

In FY2020, Osaka Gas developed a new product of ENE-FARM Type S*1 in collaboration with Aisin Seiki Co., Ltd., Kyocera Corporation, Noritz Corporation, Purpose Co., Ltd., and Rinnai Corporation. The new product was launched in April 2020. This product attains the highest power generation efficiency in the world*2 of 55%.*3 Installation has been improved by significantly downsizing the main unit. A convenient switch, which has been added to the remote controller, works with a special smartphone app, enhancing the product's IoT function.

The cumulative sales total of the fuel cell systems, Ene-Farm and Ene-Farm type S, reached 180,000 units*4 on May 11, 2023. These units have helped reduce CO_2 emissions by about 330,000 t-CO_2*5 annually, which is equivalent to the planting of about 23.95 million sugi cedar trees.*6

Cumulative sales total of the fuel cell systems



*1 ENE-FARM Type S is an environmentally friendly energy system that generates power through a chemical reaction between hydrogen, which is extracted from clean natural gas, and oxygen in the air. The generated power can be used at home, and hot water generated in the power generation process can also be used effectively. In development, we utilized some of the results obtained from the project commissioned by the New Energy and Industrial Technology Development Organization (NEDO).
*2 The highest power generation efficiency in the world in terms of fuel cells for household use whose rated output is 1 kW or less (based on a survey conducted by Osaka Gas as of the end of January 2020).
*3 Power generation efficiency when rated power generation is continued for at least three hours (e.g. under the surplus electricity purchase system). In the cases other than the above, the rated power generation efficiency is 54% (overall efficiency: 87%). The power generation efficiency for LP gas is 53% (overall efficiency: 85%). The values were calculated based on the Lower Heating Value (LHV).
*4 Based on orders received by Osaka Gas
*5 Our estimated value when a "gas water heater and heating unit," which is the conventional system, is replaced by "ENE-FARM" or "ENE-FARM Type S" (in the case of a family of four who lives in a single-family detached home)
[Conventional system] A gas water heater/heating unit, gas hot water floor heating system (living/dining room), gas hot water bathroom heater/dryer equipped with a mist sauna function, gas stove, electric air conditioner
[ENE-FARM/ENE-FARM Type S] ENE-FARM/ENE-FARM Type S, gas hot water floor heating system (living/dining room), gas hot water bathroom heater/dryer equipped with a mist sauna function, gas stove, electric air conditioner
[CO_2 emissions coefficient] Gas: 2.29 kg-CO_2/m^3 (our data), electricity: 0.65 kg-CO_2/kWh (source: mean coefficient of thermal power sources of FY2014.3 in the Plan for Global Warming Countermeasures [approved by the Cabinet in October 2021])
*6 Unit CO_2 absorption of one sugi cedar tree = 13.9 kg-CO_2/year (on the supposition of a 50-year-old sugi cedar tree with a diameter of 26 cm and a height of 22 m; source: 1997 White Paper on Forestry)

About Green Power Fuel Corporation

In March 2019, Osaka Gas established Green Power Fuel Corporation (hereinafter, "GPF"), a joint venture company that procures and sells domestically grown woody biomass for biomass power plants, in cooperation with Seishin Shinrin Shigen Co., Ltd. and Nippon Paper Lumber Co., Ltd. The Daigas Group already operates or plans to operate seven biomass plants in Japan, including participating in operating the Matsusaka Woody Biomass Power Plant, which is fueled 100% by locally available biomass. In cooperation with Seishin Shinrin Shigen, which has abundant knowledge about forestry, and Nippon Paper Lumber, which has a long track record in dealing in domestically grown woody biomass, GPF procures and transports unused wood from woodlands in Japan as power generation fuel to ensure stable, long-term biomass supply for several biomass power plants owned or under development by the Daigas Group.

On December 17, 2021, Green Power Fuel Corporation signed a cooperation agreement with Shiso City, Hyogo Prefecture, on the utilization of fast growing trees*1 for fuel applications, aiming for local production and consumption of biomass fuels and sustainable growth of domestic forestry. GPF decided to start a demonstration project that aims to build a stable supply system of biomass fuels using fast growing trees, in cooperation with Shiso City, which has abundant forest resources (land suitable for project operationalization). The company focuses on fast growing trees, which are expected to have shorter growth and logging cycles than those of general tree species, from the viewpoint of further increasing its biomass procurement volume and reducing cost. As the first step of this project, the company plans to examine the growth of fast growing trees and evaluate their usefulness as biomass fuels through trial planting in the forests and on abandoned cultivated land owned by Shiso City. Through this demonstration project, GPF will work to build a sustainable business model for domestic forestry by utilizing fast growing trees as fuels. In addition, by utilizing the output of this project, the company will try to realize the independent operation*2 of biomass power plants after the purchase period under the FIT scheme expires.

*1 A general term for trees that grow faster than the commonly planted tree species. Some representative species include Chinaberry and Chinese Fir.

*2 Under the feed-in tariff (FIT) scheme, renewable electricity is purchased at fixed prices for 20 years at maximum. After this period, the generated electricity must be sold at market prices. For this reason, GPF aims to substantially reduce mainly transportation costs by using domestically produced fuels, thereby realizing sustainable fuel costs.

Participated in the "Keidanren Carbon Neutrality Action Plan" (formerly titled "Commitment to a Low Carbon Society")

Recognizing that global warming is a global long-term issue to be solved, the Japan Business Federation (Keidanren) formulated a plan titled "Keidanren's Commitment to a Low Carbon Society" in 2013 (revised in 2017), presenting a vision common to the Japanese industries of leveraging their technological prowess to play a central role in achieving the target of reducing global GHG emissions by half by 2050. This plan envisions that each member industry should work to reduce CO_2 emissions from business activities and people's lives in Japan by introducing the best available technologies (BAT) to the maximum and that aspiring initiatives to stop global warming should be actively encouraged abroad. The plan also sets targets for strategically developing innovative technologies that will help achieve a breakthrough for the reduction of CO_2 emissions by half by 2050.

Among the industrial organizations participating in this plan, the Japan Gas Association and the Electric Power Council for a Low Carbon Society have established their own action plans to achieve a low-carbon society in the city gas industry and the electricity industry, respectively. Osaka Gas, a member of both organizations, participates in those plans for both industries and promotes initiatives to address global warming (climate change).

In June 2021, this plan was renewed as the "Keidanren Carbon Neutrality Action Plan." From now on, we will formulate a plan to achieve carbon neutrality by 2050 and promote initiatives to serve that purpose.

Joint investment in a forestry fund formed by the Sumitomo Forestry Group —A Fund in the order of USD 415 million to contribute to the realization of a decarbonized society—

In July 2023, Osaka Gas, together with nine Japanese companies, announced a joint investment in a forestry fund formed by the Sumitomo Forestry Group.

The size of this fund is approximately USD 415 million, and the investment period is planned for 15 years. By 2027, the pooled capital will have been invested in the acquisition and management of 130 thousand hectares (more than 320 thousand acres) of forest, primarily in North America. Through this fund, we will increase the CO_2 absorption capacity of forests, generating approximately one million tons of additional CO_2 absorption capacity each year, and contribute to the realization of a decarbonized society by creating high-quality carbon credits and rewards. The value of forests as natural capital will also be enhanced, such as by maintaining biodiversity and conserving water resources. The fund will deliver global climate benefits by supporting responsible forest management at an area and financial scale beyond that which individual companies could achieve on their own.

■ Structure of forestry fund