

Innovation / Technological Development

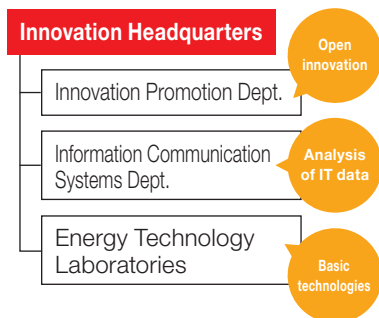
To address the challenge of creating new value beyond conventional frameworks, the Daigas Group will further commit to innovation, including open innovation and digital technologies, with the aim of ensuring optimized solutions for customers and fostering next-generation innovation.

Promotion of Innovation

Set up the Innovation Headquarters

- Set up the Innovation Headquarters with the aim of creating new values through business reforms
- Set up the Innovation Promotion Department and integrally promote companywide innovation activities

Challenge of creating new value



Advance Open Innovation

- Collaborate with diverse corporate partners not only in the field of technology but also in the service field
- Strengthen Silicon Valley-based activities
- Collaborate with start-up companies at home and abroad

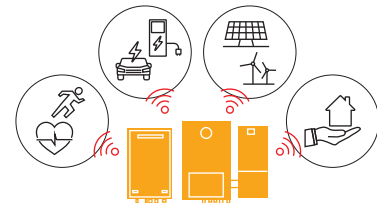
Co-create New Businesses



Promote digitization Exploration of technology

- More convenient lifestyle services and business solutions utilizing IoT and AI
- New electric power business utilizing distributed energy sources and ICT
- High-level infrastructure operations with digitalization
- Innovative technology development such as fuel cells

Equipment and energy bringing lifestyle reforms



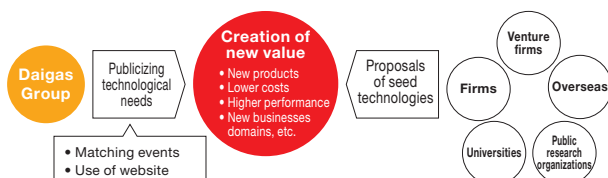
Business reforms in preparation for a paradigm change

Products and services that go beyond customer expectations

Achieving drastic business reforms

Open Innovation Developments

By fusing proprietary and outside technologies, Daigas Group is developing open innovation, aiming to speed up the pace of technological development while improving functionality and cutting costs. In the fiscal year ended March 31, 2010, we began publicizing technological needs. We have sponsored technology exhibitions, formed alliances with other companies, attended technology-matching conventions and developed alliances with universities.



Investment in US Venture Fund

In April 2018, we invested in a venture investment fund operated by WiL LLC, a venture capital company headquartered in Silicon Valley. Through this investment, we aim to invest in and form alliances with start-up companies mainly in Japan and the United States to accelerate the pace of innovation-oriented activities, including the creation of convenient daily services and business solutions using the IoT, AI and other digital technologies, as well as ensuring high infrastructure operational standards.

Examples of Major Initiatives

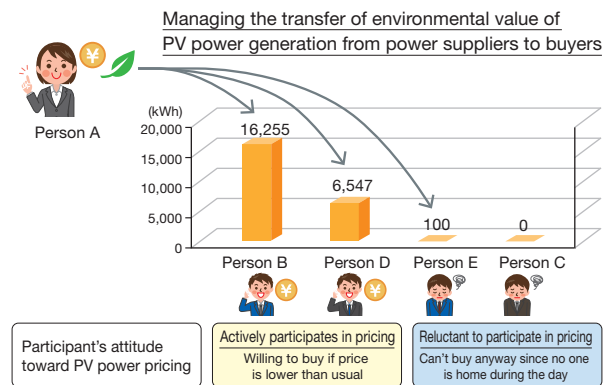
■ “TORCH”: A Program for New Business Creation for Young Employees

We are promoting a program in which young, willing employees share ideas and create new businesses. The program name, “TORCH,” stands for both the flame of gas and the passion of young employees. For the creation of ideas, our young employees use the “Foresight Creation” methodology of Osaka Gas Research Institute of Behavior Observation. Project management is entrusted to Loftwork Inc., which has a reputation for supporting the creation of new businesses within a company. In the fiscal year ended March 31, 2019, 26 employees from our Group companies participated in the program. These employees were divided into seven teams and spent about two months considering business ideas. The ideas were presented to all employees in a contest format. Business ideas that are highly evaluated in the contest are considered in more detail and will aim for commercialization while conducting actual test marketing. While aiming to create new businesses that are not confined to existing business frameworks, participants will apply the knowledge gained through the program to their current operations, building a culture of innovation throughout the company.



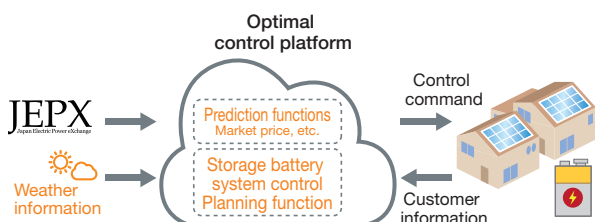
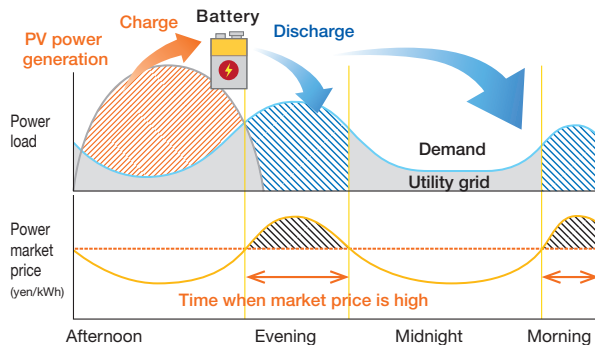
■ Demonstration of Individual Power Transaction by Residents

Using the actual living environment of NEXT21, the experimental housing site owned by Osaka Gas, we are conducting demonstration tests of power transactions between individuals using blockchain technology. Through liberal pricing by residents, we aim to create services that answer to our customer's emerging needs. This includes enabling our customers to select and trade highly environmentally friendly power such as solar power generation and ENE-FARM.



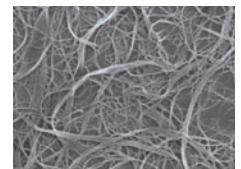
■ Joint Demonstration Project with Virtual Power Plant (VPP) Platform Startup Company in the USA

With Growing Energy Labs, Inc., we are jointly conducting a control demonstration of storage battery for the optimization of PV self-consumption and demand and supply adjustment of the power system by predicting power market prices and photovoltaic (PV) power output. We aim to provide a variety of values to our customers through the advanced use of a distributed power generation system.



■ Development of Fluorene Cellulose[®] as a Fiber for Strengthening Resin

Osaka Gas developed fluorene cellulose, a cellulose fiber with uniform dispersion, by reacting the cellulose fiber surface with a fluorene derivative. Fluorene cellulose does not mix easily with water but mixes easily with resin. Fluorene cellulose is a resin fiber material with low environmental impact and has strong potential for use in home appliances and as a structural material in automobiles.

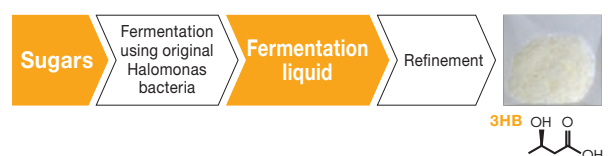


Electron microscope image of fluorene cellulose

■ Successful Production of Ketone Bodies, Known for Their Use in Diets

Osaka Gas has developed a method for manufacturing ketone bodies, (R)-3-hydroxybutyric acid (3HB), using bioprocess (fermentation) technology cultivated over many years in collaboration with the National Institute of Advanced Industrial Science and Technology. Recent years have seen rising interest in ketone bodies for their effectiveness in dieting and improving athletic performance. Osaka Gas has succeeded for the first time in effectively generating and isolating 3HB using bioprocesses. We anticipate new applications for their use in the future in health foods, supplements, and cosmetics.

Fermentative production of (R)-3-hydroxybutyric acid (3HB), ethyl (R)-3-hydroxybutyrate (3HB ethyl)



Weather Simulation Technology by an Energy Company

The energy business is closely related to weather conditions. The demand for electricity and gas depends on the temperature and the amount of solar power generation is affected by the amount of sunlight. Under such business circumstances, we have traditionally made effective use of weather information in our business operations. For example, weather information has been applied to predict sales of gas fan heaters, in providing

data to natural gas-fired power plants whose output changes with atmospheric temperature and pressure, and in examining construction sites for wind power plants.

In the fiscal year ended March 31, 2019, we obtained a weather forecast service permit in order to provide new services to our customers with businesses that are likely to be significantly influenced by weather conditions.

Interview with Project Leader

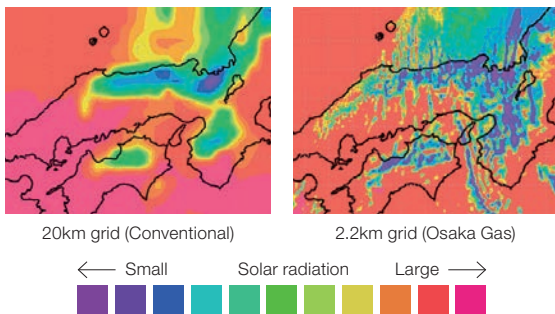
Q1. Why did you focus on weather simulation?

About ten years ago, the need was not yet apparent but since the energy business is closely related to the weather, we felt that there will come a time when it will become an important factor in business development. So, we thought that if we could forecast weather conditions such as wind, solar radiation, and rain based on fluid simulation technology that we had cultivated for 30 years, it would become a new fundamental technology.

Q2. What are the advantages of our weather simulation technology?

It carries out simulations in finely divided grids, focusing on our supply area, while also combining AI technology to enable highly accurate, pinpoint predictions.

Example of solar radiation prediction [W/m²]



Note: If the simulation is performed with a fineness of approximately 1/9 (2.2km grid) of the conventional grid size, it is possible to predict more detailed weather changes (clouds, solar radiation, etc.)

Q3. What is in store for the future?

In recent years, as the movement to predict renewable energy in advance has become active primarily in Europe, there has been also an increased momentum in Japan to predict the amount of generated renewable energy, such as wind and solar power. We would like to advance our technological development in order to contribute to such fields. In the future, we will strive to provide paid services to customers who need weather forecasts. These customers include those in the retail and service industries where the number of customers and sales vary depending on temperature and weather, as well as those in the agricultural industry, where weather affects harvests.



Intellectual Property Strategy

The Daigas Gas Group positions intellectual property rights as an important management resource. At the same time, the Group takes proactive steps to secure and utilize intellectual property rights in concert with its business and technology development strategies.

Strategically Acquiring Intellectual Property Rights

We acquire patents on a steady basis by focusing on invention and discovery that is closely related to specific development sites, incorporating judgments on patentability from external authorities after filing. Through patent analysis and mapping, we are able to build a thorough and complete network of patents, which is an important motif. In the fiscal year ended March 31, 2019, 360 patents were filed, totaling 3,286 held by the Daigas Group,

including patents for upstream gas production, distribution and supply, and downstream gas appliances and material technologies. The intellectual property rights that we possess are used for business and are actively licensed to other companies. In addition, we are careful to acquire trademarks for services and products we offer and protect company brands. As of March 31, 2019, the Daigas Group holds 1,068 trademarks.

■ Establishing a New Method of Evaluating Rice for Sake Brewing

In the process of studying how the state of water absorption by rice affects rice cooking, we established an evaluation technology to visualize and quantify the state of water absorption. Since 2016, we began evaluating liquor rice (rice for sake brewery, or sake rice) with the Fushimi Sake Brewers Association. We have verified the consistency of the technology with conventional methods of evaluating the state of water absorption by rice visually and by weight, and correlations with

various data from the brewery site. As a result of a two-year joint verification, we were able to confirm that this evaluation technology is also effective in evaluating rice for sake breweries and corresponded with the sense of those at brewery sites. In the future, we will aim to support our customers' production and use this method in various fields, while further expanding its scope of application, including other foods.

Interview with Project Leader

Q1. What are the advantages of this technology?

With this technology, we are able to quantify and visualize the progress of rice soaking in water, a process called "shinseki." This soaking process is extremely important in sake brewing. The optimal soaking time is not constant and changes with the quality and variety of rice each year.

Q2. What are some of the breakthroughs of this technology?

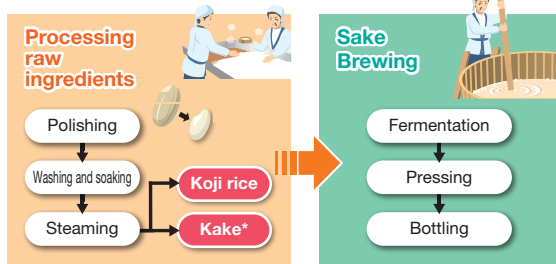
Sake rice for ginjo sake and daiginjo sake is polished to a size of less than 50% of brown rice, so it absorbs water quickly, leading to cracks during absorption. For these reasons, we developed technology that captures the expansion of rice during water absorption three-dimensionally, as well as new image recognition technology using AI, making it possible to accurately capture changes occurring each second.

Q3. What is in store for the future?

We'd like to promote this rice evaluation technology throughout Japan. In addition to rice evaluation technology, we are researching and developing various food evaluation technologies (rice, vegetables, meats, etc.). We would like to offer these technologies as one of our wide range of solution proposals and create new services that help our customers with product quality improvement, manufacturing process management, and product development.



Process of Sake Brewing

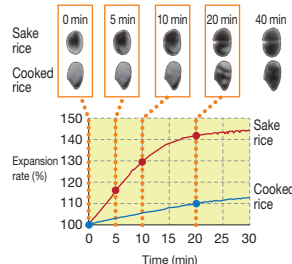


* Sake rice used for fermentation starter and fermentation mash, except for koji making

Conventional Method
Check water absorption visually and by weight



Our Method
Evaluating the state of water absorption using image recognition in real time



■ Strengthening Intellectual Property throughout the Group

We employ a variety of educational and instructional tools to further improve Daigas Group employees' understanding of intellectual property rights. For example, instructors from both inside and outside the Company conduct training sessions based on both goals and employee career level. We also publish an email magazine and distribute the latest news articles on relevant topics.

The Daigas Group's Patent Portfolio by Business Type (number)

