

Technological Development of the Osaka Gas Group

Our R&D Policy

The Osaka Gas Group views R&D as the most effective means to differentiate itself from others and to strengthen its competitive edge. For this reason, the Group strategically invests in fields such as energy and the environment, with a strong focus on developing and commercializing new technologies.

Cogeneration System Initiative

■ Residential Solid Oxide Fuel Cells*¹ (SOFCs)



SOFCs

From 2004, the Company and Kyocera Corporation have been co-developing residential fuel-cell cogeneration systems using SOFCs. This system achieves a high power generation efficiency of 45%*², which makes itself more marketable for households with

smaller heat demand. Also, with its compact design downsized from the previous model, the unit will be made available for installation in multi-unit dwellings.

In March 2009, the co-development framework was joined by Toyota Motor Corporation and Aisin Seiki Co., Ltd. In cooperation with the alliance partners, Osaka Gas has started verification testing of the cogeneration system 2010 model with 41 units installed in detached homes in its service area. These trials are part of the demonstration study Osaka Gas participates in under the auspices of the New Energy and Industrial Technology Development Organization (NEDO). The parties have been accelerating development by integrating the technologies and expertise of each company, towards the completion of the study by 2015.

*1 SOFC stands for Solid Oxide Fuel Cell, a type of fuel cell that uses ceramics as an electrolyte, with a higher power generation efficiency (45%) in a smaller package than already commercialized PEFCs (Polymer Electrolyte Fuel Cells). In SOFCs, oxygen is ionized and traverses the electrolyte as oxygen ions, and then chemically reacts with hydrogen to generate electricity. Another major feature of SOFCs is utilization of carbon monoxide besides hydrogen.

*2 On a Lower Heating Value (LHV) basis. LHV represents the amount of power generated when a fuel gas undergoes complete combustion, less the latent heat of vaporization of water.

■ Smart Energy Houses

The Group is involved in the development of “smart energy houses,” which provide comfortable, environmentally friendly living. The houses feature information technology and a combination of three types of batteries—residential fuel cells, solar cells and rechargeable batteries—to smartly and efficiently produce, store and utilize electricity and heat. To accelerate development and eventual commercialization, we initiated verification testing in February 2011 with two new residences we constructed: one for technical assessment and the other to be used as an experimental dwelling.

[Refer to page 22-23 for further details.](#)

■ Smart Energy Networks

A “smart energy network” is a next-generation energy system that optimizes the energy supply and demand balance by combining gas cogeneration systems, photovoltaic units and other devices and managing heat and electricity produced by and shared among consumers. Osaka Gas is currently testing a smart energy network with an energy community created in the Kansai region with the cooperation of nine customers.

[Refer to page 23 for further details.](#)

Technological Development for a Low-Carbon Society

■ Energy Conservation at Office Buildings Using Behavior Observation Methods

The Company not only introduced energy-efficient equipment but incorporated behavior observation methods in the architectural process of renovating the Hokubu Office Building (Takatsuki City, Osaka).

In order to identify which behaviors hindered energy efficiency, behavior analysis was conducted following behavior observation, interviews and questionnaires with tenants and visitors. The results highlighted that the main obstacles were caused by the difference in how people of various work-styles sensed temperature and gender-derived behavioral divergence, as well as apathy of tenants toward energy conservation. In response to these findings, we plan to install a room sensor system to control air conditioning based on each tenant's behavior and preference, as well as an assistance system for energy conservation that provides useful tips to the residents. In addition, by installing energy-efficient equipment like photovoltaic units and gas heat pumps with generator capability, we hope to reduce CO₂ emissions by approximately 25%.



Hokubu Office Green Gas Building

■ ECOMICELL

ECOMICELL is a water additive developed by the Company that minimizes the loss of hydraulic pressure within pipes and thus reduces the power consumption of chilled/hot water pumps for air conditioning systems in buildings. The addition of this liquid to chilled/hot water circulating in air conditioning systems reduces the piping pressure loss inside pipes, and thus improves the flow of chilled/hot water. It reduces power consumption of pumps by around 30% and lowers CO₂ emissions by around 3% in an average building. ECOMICELL is an effective energy conservation measure requiring no construction work, having been introduced to 92 existing buildings as of March 31, 2011.

ECOMICELL has received numerous commendations in recognition of its ability to drastically reduce CO₂ emissions. Notably, ECOMICELL won the Minister of the Environment Award for the Prevention of Global Warming in the fiscal year ended March 31, 2008.

■ Hydrogen Station Demonstration Project

Hydrogen achieves high generation efficiency and overall efficiency when used to fuel the electrochemical reaction in fuel cells for extracting electrical power. Since all that is left after the chemical reaction is water, it is said to be the ultimate clean energy source.

The Osaka Gas Group set up Japan's first hydrogen filling station on its premises in the fiscal year ended March 31, 2002. From the fiscal year ending March 31, 2012, Osaka Gas will participate in the Area Hydrogen Supply Infrastructure Technology and Social Demonstration Project implemented by the New Energy and Industrial Technology Development Organization (NEDO) as a member of The Research Association of Hydrogen Supply/Utilization Technology (HySUT). Through this project, Osaka Gas will demonstrate the use of technologies for fuel cell vehicles and hydrogen supply infrastructure. Measures include supplying hydrogen to fuel cell vehicles via the Osaka Hydrogen Station, which was renovated and reopened on the premises of the Company's Torishima Office. Also planned is the CO₂ separation from hydrogen production units. Through these



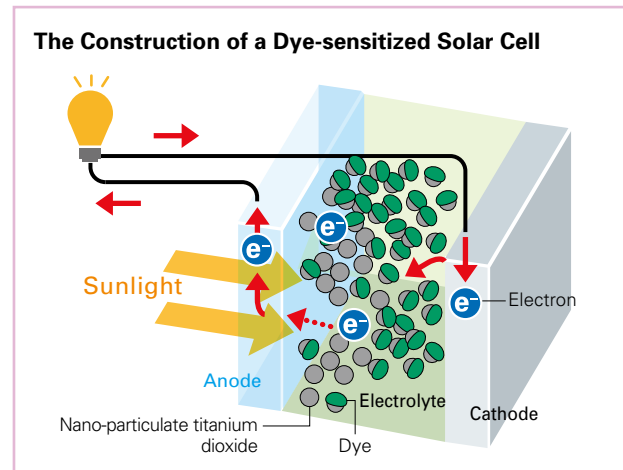
Osaka Hydrogen Station (on Torishima Office premises)

measures, Osaka Gas will investigate the user-friendliness, commercial feasibility, social acceptance and other parameters of hydrogen technologies.

■ Dye-Sensitized Solar Cells

Osaka Gas is developing dye-sensitized solar cells, a technology gathering significant attention as a low-cost successor to silicon solar cells.

To achieve commercialization of dye-sensitized solar cells we need to improve the energy conversion efficiency at which light is converted to electricity and increase the life span of the cells. Osaka Gas uses a proprietary nano-material technology to develop cells with the primary focus on making high-performance titania electrodes. In the fiscal year ended March 31, 2011, the Company achieved a conversion efficiency of 10.4%, the highest level in Japan.



■ Coal Mine Methane (CMM) Enrichment Technology

In our quest to contribute to the fight against global warming, we have developed equipment to enrich coal extraction-associated low-concentration methane which is otherwise released into the atmosphere. The concentrated gas can be used to fuel cogeneration and boilers. We have succeeded in a verification test using pilot equipment at the Fuxin Coal Mine (Liaoning Province, China).* Since the fiscal year ended March 31, 2010, we have been working to further improve performance and reduce costs, aiming for early launch into the market. The equipment leverages the Company's materials technology, which enables selective adsorption of methane from a mixed gas composed of air and methane.

* New Energy and Industrial Technology Development Organization (NEDO) Collaborative Research Project for fiscal years ended March 31, 2008 and 2009.

Technology Development that Contributes to Environmental Conservation

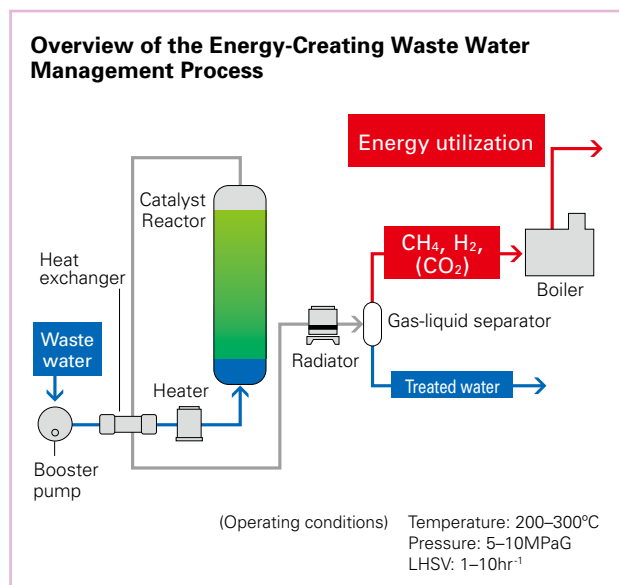
Energy-Creating Wastewater Treatment Process

Wastewater and high-concentration toxic drainage produced by conductor plants, chemical factories and other industrial facilities are processed by burning fuel oil and other fuels. This method is problematic, however, due to large amounts of CO₂ emissions and substantial processing costs.

Osaka Gas has developed a method for rapidly decomposing and processing organic matter in wastewater by passing the wastewater through a specially processed nickel catalyst at high temperatures and high pressure. The process creates a flammable gas primarily composed of methane that can be recycled within factories as fuel for boilers and other applications. The result is a roughly 110% reduction* in CO₂ emissions and an approximately 40% reduction in wastewater processing costs compared to processing via combustion.

We began pilot plant testing in August 2010, the first such round of testing in Japan, with a view toward commercialization.

* Including CO₂ emissions reductions by the produced gas.



High-Efficiency Methane Fermentation Technology (Methasolution®) that Utilizes Sludge and Raw Garbage

The Company has developed a highly efficient biogas technology for turning waste into methane, which can then be used as a renewable energy source. The Company has employed its own unique resin reforming technology and ultra-high temperature solubilizing technology (Methasolution®) to decompose and ferment “whole” garbage and plastic bags used to hold garbage in a short period of time.

Technology for Stable Gas Supply, Safety and Peace of Mind

Osaka Gas works every day to drive technological innovation to ensure the safe and reliable use of gas by its customers. One factor limiting the installation of gas sensors is the need for AC power outlets. To remove this constraint, we are developing an ultra energy-efficient methane sensor with around 1/2000 of the power consumption of conventional devices and that does not require an AC power outlet. This is one way we are working to enhance the safety and reliability of gas at the consumption stage. Looking ahead, the Company will continue to develop technologies with the aim of enhancing safety and ensuring a stable supply of gas.

Open Innovation

In recent years, the Company has pursued a policy of “Open Innovation” in an effort to speed up and increase the efficiency of R&D by leveraging external technologies. “Open Innovation” is a policy to disclose the key technological challenges that we face to external entities such as major corporations, small-to-medium-sized companies, venture businesses, government-affiliated organizations, universities and international research institutes to accelerate technological development in cooperation with external entities. By linking with external resources, we seek to develop technologies that will contribute to the realization of a low-carbon society and support the expansion of our business fields.

In the fiscal year ended March 31, 2011, “Open Innovation” activities became well entrenched throughout the Osaka Gas Group. The Group held technology matching conferences, formed new industry-academia partnerships, and searched for overseas technologies in many different areas. Through these measures, the Company worked to incorporate numerous external technologies, which helped to accelerate technological development and create new products.

Intellectual Property Activities of the Osaka Gas Group

Basic Policies on Intellectual Property Activities

Osaka Gas has established the following three basic policies on intellectual property activities and is actively engaged in carrying them out to ensure that intellectual property rights are appropriately acquired for technological achievements and effectively utilized.

Reinforcing intellectual property rights acquisition in important areas

We are promoting an intellectual property strategy that complements our business and R&D strategies and working to reinforce acquisition of intellectual property rights capable of helping to strengthen business operations in areas of strategic management importance for the Group now or in the future, including residential energy systems.

Promoting effective utilization of intellectual property

We transparently provide information on intellectual property rights we have acquired and actively utilize them in Osaka Gas Group business operations. We also actively license rights to other companies so that the patents we hold are effectively utilized.

Strengthening intellectual property throughout the Group

Basic training is held throughout the Osaka Gas Group on acquiring and utilizing intellectual property rights and on practical expertise to raise the related capabilities of the Group. We also conduct activities to mitigate risks associated with intellectual property.

Intellectual Property Activities

Reinforcing intellectual property rights acquisition in important areas

The Group has been developing strong rights coverage centered on technologies of strategic importance to business and R&D and placing priority on filing applications for their patents. To that end, we have employed various methods including patent portfolio management. In particular, we are strategically filing patent applications in technologies related to cogeneration systems for households such as fuel cells.

In the fiscal year ended March 31, 2011, the Osaka Gas Group submitted 431 patent applications.

Promoting effective utilization of intellectual property

Patents held by the Osaka Gas Group totaled 2,461 as of March 31, 2011, an increase of 221 from March 31, 2010.

The Company owns patents in LNG tank technologies and non-excavation pipeline excavation methods applied in the production, distribution and supply business domains, in cogeneration systems and gas air conditioners applied in the commercial and industrial energy domain, and in fuel cells and mist saunas applied in the residential energy business domain.

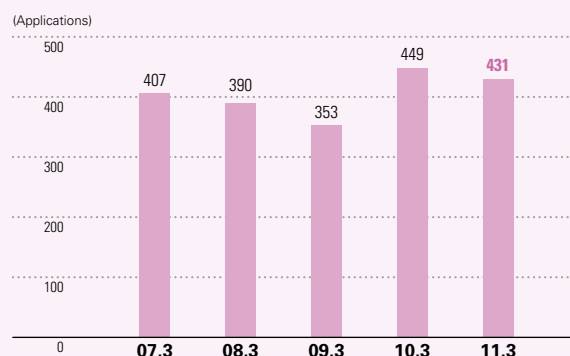
Osaka Gas also owns patents on fine materials and other advanced materials technologies, as well as on data communications and electric power technologies applied broadly throughout the Group's businesses.

Separately, the Group actively licenses patents to other companies to ensure that the patents the Group owns are utilized effectively.

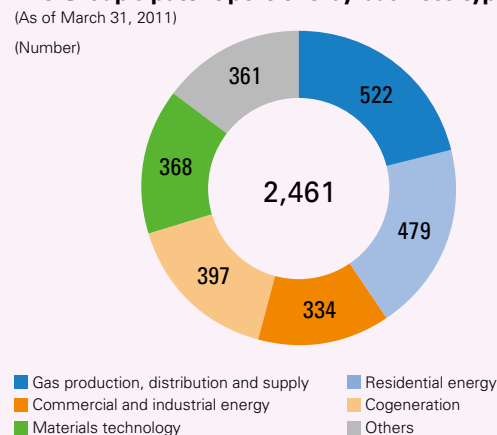
Strengthening intellectual property throughout the Group

We conduct training and awareness-raising activities so as to equip Osaka Gas Group employees with the fundamentals for filing a patent application and using intellectual property. These varied activities include training sessions run by instructors from inside and outside the Company for different objectives and employee ranks, and publication of an email magazine that includes intellectual property news and administrative reminders.

Patent applications by the Group



The Group's patent portfolio by business type



On the other hand, we make every effort to ensure that we do not infringe on the intellectual property rights of others and to prevent others from infringing on the intellectual property rights of the Osaka Gas Group. Efforts are actively made on a Group-wide basis to reduce exposure to intellectual property risk. Measures include performing a full inspection of the Group's trademarks and sharing a patent investigation system throughout the Group.