Initiatives for a Stable Supply of Electricity and Reduced CO₂ Emissions

Since the founding of J-POWER in 1952, we worked to resolve the nationwide power shortages in postwar Japan by developing large-scale hydropower locations. After the experience of two oil shocks in the 1970s, we moved forward with construction of large-scale coal-fired power stations fueled using imported coal, which has abundant reserves. As a result, the J-POWER Group has a well-balanced composition of facilities with hydropower electric power facilities, which are CO₂-free power sources, and coal-fired power generation facilities, which provide outstanding economy and stability of supply, produce about the same amount of power.

Since the year 2000, we have also been pressing forward vigorously with development of wind power and other types of renewable energy. Going forward, the J-POWER Group will continue further development of hydropower, wind power, and geothermal power which are CO₂-free power sources. At the same time, we will move ahead with coal-fired power generation with lower CO₂ emissions. We take these measures to move toward a balance between providing a stable supply of electricity and reducing CO₂ emissions.

From the 1950s
Development of Large-scale Hydroelectric Power Stations

Up to this point, we built large-scale dams and hydroelectric power stations such as those as Sakuma, Tagokura, Okutadami, and Miboro. This approach both contributed to the effective utilization of water resources and the stable supply of electric power and, as a method of CO₂-free power generation, has also been contributing to global warming countermeasures.

Since then we have continued developing new hydroelectric power stations while taking steps for shared existence and shared prosperity with local environments. At present we own hydroelectric power facilities at 60 locations in Japan (the second-largest share in the country).

1975 Onikobe Geothermal Power Station Enters Operation

We built this power station within the class 1 special district of a quasi-national park, taking steady measures to maintain the scenic appearance of the grounds as well as to preserve the surrounding natural environment.

From the 1980s
Measures for Thermal Power using Imported Coal

Matsushima Thermal Power Station was the first power plant in Japan to use imported coal. J-POWER plans to develop thermal power using imported coal continued to be realized, and Takehara Thermal Power Station Unit No. 3, Ishikawa Coal Thermal Power Station, and Matsuura Thermal Power Station appeared in succession. Over the period of a half-century, we made every effort to reduce the environmental impact of these facilities by increasing efficiency and taking environmental protection measures while contributing to the stable supply of electric power.
Reduced CO₂ Emissions

From the 2000s Development of Wind Power Stations

The J-POWER Group was an early participant in the wind power business. We started in 2000 with the Tomamae Wind Farm, in Tomamae-cho, Hokkaido, and have been going ahead with development of wind power stations ever since. As of March 2016, our wind power facilities number 229 units in 20 wind farms around Japan, giving us the second largest share in the country.

J-POWER Share of Output from Japan’s Wind Power Facilities (as of the end of March 2016)

Source: Compiled from Japan Wind Power Association and other information materials

13%

Coal-Fired Power Initiatives

Promoting reduction of carbon emissions

The J-POWER Group is making every effort to maintain high thermal efficiency at our coal-fired power stations by conducting appropriate operations and maintenance and upgrading facilities. We have also been promoting the mixed combustion of biomass fuel such as sewage sludge and wooden biomass as a way to further the reduction of carbon emissions at existing coal-fired power stations. At older power stations where thermal efficiency is lower, we are pursuing possibilities for replacement of existing facilities and construction of new power plants. We are implementing measures for the reduction of carbon emissions from coal-fired power stations by introducing coal-fired power at the world’s highest levels of efficiency.

Development of technology for reduction of carbon emissions

The J-POWER Group is making a practical reality of coal-fired power at the world’s highest levels of efficiency. We will conduct further research and development, however, to achieve still greater reduction of carbon emissions from coal-fired power. Specifically, we will implement development and trials of oxygen-blown integrated coal gasification combined-cycle power generation as next-generation technology, and will pursue research and development of CO₂ separation and capture technology.

Renewable Energy Initiatives

Renewable energy is not only a precious domestic source of energy. It is also a form of CO₂-free power generation, and as such has value as a power source in terms of global warming countermeasures, as well. The J-POWER Group is making full use of the know-how and technology developed over many years to promote the expanded use of hydroelectric, wind, geothermal, and other sources of renewable energy.

Ohma Nuclear Power Plant Initiatives

For the island country of Japan, with its limited natural resources, nuclear power is an essential and indispensable energy source from the perspective of providing a stable supply of energy. It is also an effective power source in terms of dealing with the problem of global warming. J-POWER will steadily take safety countermeasures and implement measures to build power plants that earn the trust of local and regional communities.
Hydroelectric power

The J-POWER Group has 60 locations throughout Japan with a total output of 8.57 GW, the second-largest share of hydroelectric power facilities in the country. J-POWER’s Group hydroelectric power facilities are able to respond rapidly to changes in electricity demand and have high output per power station. For these reasons, they make significant contributions to electricity supplies in various regions around Japan as peak power supplies that can respond to daily and seasonal peak demand periods. In addition, hydroelectric power is a valuable, entirely domestic energy source and accounts for the J-POWER Group’s largest renewable energy generation facilities, comprising 14% of Japan’s total renewable energy capacity. As a result, hydroelectric power is a core presence for ensuring stable electricity supplies and reducing CO$_2$ emissions.

**VOICE**

*Facility Maintenance and Management and Consideration for the River Environment*

Kouchi Power Administration Office operates three power plants on the Naharigawa River water system, and the Civil Engineering Section carries out maintenance and management of the civil engineering facilities involved in generating power. Among other things, this involves handling facilities that have been in operation for 50 years and, in this rainy region that has average annual rainfall of approximately 4,000 mm, it faces the major issues of safely carrying out dam discharges in times of flooding and measures against turbidity following flooding. We also act to obtain the understanding of local residents as we implement measures to maintain and improve the river environment. These measures include restoring dam sediment to the rivers and improving sweetfish spawning grounds.

For the future, the entire Group will act as one in the effort to earn the trust of local residents as we engage in facility maintenance and management to provide for stable operation while also implementing measures that take the river environment into consideration.

**VOICE**

*Continuing Use of Power Generation Facilities*

The Electric Power Group of East Regional Headquarters engages in a variety of different operations necessary for the maintenance and management of hydroelectric power stations. One of the important operations we perform is formulating long-term plans for maintaining the various component equipment of the hydroelectric power stations and for upgrading facilities. Fifty or more years have passed since many of the J-POWER hydroelectric power stations entered operation, and in order to keep the aging facilities ready for continuing effective use, we formulate plans in cooperation with related companies to see that maintenance and facility upgrades are carried out at the appropriate times.
The J-POWER Group implements measures on a daily basis to increase the reliability and efficiency of its existing hydroelectric power facilities. To use hydroelectric resources, a CO₂-free, renewable energy source, we are actively developing small and medium-sized hydroelectric power stations, one of the policies set forth in Fourth Energy Basic Plan, and taking measures to increase generating capacity including installing new facilities and replacing facilities at existing dams to enhance use of facilities and resources.

### Stable Operation of Hydroelectric power Facilities

The J-POWER Group operates 60 hydroelectric power stations located throughout Japan and monitors and controls each power station under a 24-hour system with three regional control centers located in Hokkaido, Saitama Prefecture, and Aichi Prefecture. At each power station, we conduct daily inspections to detect any abnormalities in facilities early and prevent accidents before they can occur so that J-POWER can provide stable power to the entire country. If a facility abnormality occurs, maintenance personnel immediately go to the site and work to restore the facility at the earliest possible time and use their knowledge to investigate and implement measures to prevent recurrence. To raise facility reliability even further, we will continue to undertake facility maintenance measures suitably adapted to accidents and environmental needs while working to maintain harmony with local communities.

### Measures for New Hydroelectric power Facilities

The J-POWER Group is pursuing various measures to enhance the reliability and efficiency of existing hydroelectric power facilities. One such measure is the complete overhaul of principal electrical equipment at hydroelectric power stations that are becoming obsolescent. The complete overhaul of Akiba No. 2 Power Station that has been underway since 2015 was completed in May 2016. By using the latest analysis and design technology, we increased the power output by 400 kW. Overhauls are scheduled for Akiba No. 1 Power Station starting in 2016, and Ashoro Power Station starting in 2019.

Hydroelectric power is a valuable, wholly domestic energy source for Japan, which is resource-poor, and to maximize the use of this valuable resource, the J-POWER Group is actively developing small and medium-sized hydroelectric power stations that utilize unused water resources. Construction of Konokidani Power Station was started in October 2014, utilizing an unused drop from the Konokidani water intake of the existing Kuzuyu Dam reservoir. A dam is being constructed near the intake and a water turbine generator will generate a maximum of 199 kW. Construction is scheduled to be completed during the 2016 fiscal year. Since this is a region that experiences considerable snowfall, the highest priority is being placed on safety during the work.

Through measures such as these, the J-POWER Group is working to maximize hydroelectric power and the efficient use of water resources in order to ensure the stable supply of electric power.
Thermal Power

The J-POWER Group has nine locations throughout Japan with a total output of 8.55 GW, the largest share of coal-fired power generation facilities in the country. The J-POWER Group also has 310 MW of gas-fired thermal power.

The J-POWER Group’s coal-fired power generating facilities maintain high use rates as economical and stable base power supplies. To achieve this, appropriate maintenance of generating facilities is reliably conducted and we make efforts to limit declines in thermal efficiency in conjunction with aging and the occurrence of problems with facilities and to maintain and enhance facility reliability.

Stable Operation of Coal-Fired Power Station

In order to provide for the stable operation of its coal-fired power stations, the J-POWER Group is involved in the entire value chain for coal, including procurement, transport, and receiving. We are acting globally to build a system that enables the stable procurement of coal.

Stable Transport of Coal

The J-POWER Group uses approximately 22 million tons of coal per year. Transporting this coal to the various power stations requires 200 or more ship voyages per year. We will introduce dedicated vessels* and so on for this purpose as part of our measures to provide stability in the transport of coal.

Coal Mine Project in Australia

The J-POWER Group began its participation in the Blair Athol Coal Mine, in the state of Queensland, in 1982. We have been investing in coal mining interests since that time, and as of the end of fiscal 2015, we own coal mining interests in the states of Queensland and New South Wales, Australia. For the future, we will be scrutinizing trends in coal supply-and-demand balance and among competing companies for stable procurement of the coal as we examine new, cost-competitive projects, and as we pursue participation in new coal mine projects.

Management of Coal at Power Stations

On-site at the power stations, the coal that has been received needs to be managed according to its particular characteristics. In order to control coal temperatures in the coal yard, we use infrared cameras and install water sprinkler systems in addition to enacting 24-hour systems of control.

Voice

Weather is the Natural Enemy

As the person in charge of fuel for a coal-fired power station, I work mainly on coal receiving and delivery operations. The coal that makes its way to us across the oceans from foreign countries is first received at outdoor coal yard on the power station grounds. After that we send it on to the power station main building for combustion. In my private life, I’m the kind of person who leaves home without looking at the weather report and gets rained on. In my work, however, I am constantly paying attention to the state of the weather. If there is a heavy rain, the piles of coal may collapse and make it difficult to transfer the coal. If there are strong winds, then there can be delays in unloading the coal. Also, in early summer there is the monsoon, followed by the typhoon season, while in winter the coal storage piles have to be watched for rising temperatures, so there is no time throughout the year when we can let down our guard. Matsuura Thermal Power Station has outdoor coal yard facilities so it is a power plant that is particularly susceptible to the influence of weather. Weather is difficult to predict, and in its fickleness the weather can go on the rampage, so this is the greatest natural enemy for the person in charge of fuel. We will continue our struggle with the weather as we go forward and make our contribution to the stable supply of electric power.
Creating Steam
Coal stored in the coal yard is finely ground into a powder by a coal pulverizer. The powdered coal is combusted by burners and water is heated in a boiler to generate high-temperature, high-pressure steam.

Generating Electricity
The high-temperature, high-pressure steam spins a turbine. The high-speed turbine generates electricity by spinning a generator.

Effective Use of Ash
The coal ash produced from burning coal is effectively used as a raw material in cement and other applications (see p. 40).

I am involved in operation (third shift) of Tachibanawan Thermal Power Station as an operator of outdoor environmental equipment. Operators work in the power station operating center using large 100-inch screens to track the status of every device, monitor it, and operate it. Since we use a mouse to operate the equipment, we rigorously implement “pointing and calling” during operation as a measure to prevent operating error. When we change the configuration of instruments and other such equipment, we do cross-checking with two or more personnel. We make every effort to reduce human error as close to zero as possible. The operators also consider it important to have the awareness and the mindset of acting for the stable operation of the plant. When we conduct on-site patrols in this frame of mind, we are able to detect small problems early on, and we can prevent trouble before it happens. Going forward, all of us in the Group will work as one to address the various issues that come up and make every effort for the stable operation of the plant.

“Pointing and Calling” is the Basis for Operation

Jpec Co., Ltd.
Tachibanawan Company
Operating Group
Takahisa Masuda
Clean Coal Technology Contributes to Global Reduction of Carbon Emissions

The Long-Term Energy Supply-Demand Outlook formulated by the national government in July 2015 sets the goal of establishing a power source composition that balances renewable energy, nuclear power, coal-fired power and other such sources of power by the year 2030. Of these sources, coal-fired power is slated to account for one-fourth of the power source composition (approximately 26% of the volume of power generated). The stated policy is to continue using coal while achieving a balance with reduction of environmental impact.

Meanwhile, the electricity utilities as a whole are being required to achieve CO₂ reduction targets and further increase thermal power plant efficiency in accordance with the amended Energy Conservation Act with a view to meeting the greenhouse gas reduction objectives for 2030 determined by the government.

For our part, the J-POWER Group intends to take measures to reduce the carbon emissions from coal-fired power generation. We are doing this by the new construction of highly efficient coal-fired power stations that adapt the world’s highest levels of technology, as introduced in this report, by the replacement of existing plants, and by the development of next-generation clean coal technology.

As the leading company in coal-fired power, we will also take the clean coal technology that we have cultivated in Japan and deploy it in countries around the world where the demand for electric power is anticipated to grow in the future. In this way we will contribute to global economic growth and CO₂ reduction, thereby realizing the J-POWER philosophy of “Harmonizing energy supply with the environment” both in Japan and in the world at large.
Coal-Fired Power and J-POWER’s Role

In Japan, a country poor in natural resources, it is necessary to employ a balanced mix of various different energy sources, including coal.

Coal is more economical than oil or natural gas, which are also fossil fuels. There are also abundant reserves of coal distributed widely around the world. These are outstanding factors in terms of energy security. Coal is consequently used as the main fuel for power generation that supports the stable supply of electricity in countries everywhere. In Japan, too, coal has a very high utilization rate as a baseload power source for generating electricity, while coal-fired power generation accounts for 40% or more of electric power supplied worldwide. According to the national government’s Long-Term Energy Supply-Demand Outlook, coal-fired power is supposed to make up 26% of the volume of power generated in Japan in the year 2030.

However, coal is high in CO₂ emissions per volume of power generated relative to other fossil fuels, which means that it is necessary to work on lessening its environmental impact as we go on using it. The J-POWER Group is working toward the further development and introduction of still higher efficiency coal-fired power generation as a way of reducing CO₂ emissions. We are also pressing forward with research and development of further low-carbon technologies.

For the purpose of economic growth in the newly emerging countries, as well, where electric power demand is expected to rise in the future, the use of economically advantageous coal-fired power will be essential for the time being. The J-POWER Group will proceed with implementation of measures for CO₂ reduction on a global scale by disseminating the higher-efficiency coal-fired power generation technology (clean coal technology) that we have been cultivating in Japan.

Approximately 50% of the world’s current CO₂ emissions come from China, India, and the United States. It has been estimated that if all the coal-fired power stations in those countries were to be given the power generating efficiency of the Isogo Thermal Power Station, which is at the world’s highest level as shown in the below figure, then the CO₂ reduction impact would be approximately 1.51 billion tons, which is equal to or greater than the total annual emissions of Japan.

Cycle of CO₂ reduction on a global scale by means of higher-efficiency coal-fired power technology

Within Japan, promote development, demonstration, and commercialization of clean coal technology. Disseminate results overseas by technology transfer and cut global CO₂.

- Use construction of new coal-fired power stations in Japan and replacement of existing plants to cut CO₂ emissions in Japan. Also actively promote development, demonstration, and commercialization of new clean coal technology.
- Establish and disseminate the most up-to-date clean coal technology
- Transfer Japan’s most up-to-date clean coal technology to developing countries, mainly in the Asia region, and disseminate it to promote reduction of energy consumption and of CO₂ emissions.
- Actively apply the most up-to-date clean coal technology

1. Develop further clean coal technology
2. Curb coal consumption and cut CO₂ emissions
3. Business returns, credit transfers, etc.
4. Establish and disseminate the most up-to-date clean coal technology
5. Actively apply the most up-to-date clean coal technology

Source: Compiled from Ecofys International Comparison of Fossil Power Efficiency and CO₂ Intensity Update 2015

Comparison of thermal efficiency of coal-fired power around the world
(at generation point, LHV*)

* See note on p. 15.

Source: IEA World Energy Outlook 2015

Ratio of coal-fired generation in total power generation (2013)

Source: IEA World Energy Outlook 2015

Trends in Fuel Prices

Source: Ministry of Finance trade statistics
Promoting Reduction of Carbon Emissions by Coal-Fired Power

Even since the J-POWER Group started operating Matsushima Thermal Power Station using imported coal, a first in Japan, in 1981, we have developed a number of large-scale thermal power stations using imported coal while improving power generation efficiency and reducing carbon emissions by enhancing steam conditions and increasing station size. Going forward, we will aim for further efficiency improvements by means of the introduction of high-efficiency power generation technology and the development of technology.

**History of improvements in generating efficiency of J-POWER Group coal-fired power stations (at generation point, LHV*)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Power Station</th>
<th>Efficiency (%)</th>
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<tbody>
<tr>
<td>1965</td>
<td>Takasago</td>
<td>36</td>
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<tr>
<td>1970</td>
<td>Takasago</td>
<td>38</td>
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<tr>
<td>1975</td>
<td>Takehara Unit No. 1</td>
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<tr>
<td>1980</td>
<td>Takehara Unit No. 2</td>
<td>40</td>
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<td>1990</td>
<td>Matsuura Unit No. 1</td>
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<td>1995</td>
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<td>44</td>
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<tr>
<td>2000</td>
<td>Isogo New Unit No. 1</td>
<td>44</td>
</tr>
<tr>
<td>2005</td>
<td>Isogo New Unit No. 2</td>
<td>46</td>
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<tr>
<td>2010</td>
<td>Tachibanawan No. 2</td>
<td>46</td>
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</tbody>
</table>

* At the generation point, the power generation efficiency calculated by using the amount of electric power at the point of generation (amount of electric power at the time of generation by the generator).

**Maintenance High-Efficiency Operation**

The J-POWER Group’s coal-fired power stations play an important role as economical and stable baseload power supplies. Thermal efficiency declines as generating facilities age. Operating management and facility updates make it possible to continue operating with high levels of thermal efficiency. One example of this is Takasago Thermal Power Station, which even now, maintains nearly the same power generation efficiency more than 40 years after it began operating.

**Replacement Plans and Promotion of New Power Plant Construction**

The replacement of aging power stations leads to higher power generation efficiency and environmental preservation through the introduction of the latest technologies. Isogo Thermal Power Station, which underwent replacement, now has the latest ultra-supercritical (USC) generating technologies and boasts power generation efficiency at the world’s highest levels. Sulfur oxide, nitrogen oxide, soot and dust have been reduced to levels far below those of thermal power stations in other leading developed countries, becoming the world’s cleanest coal-fired power station. (see p. 16)

The J-POWER Group is implementing replacement of existing facilities, following work on Isogo Thermal Power Station with work on Takehara Thermal Power Station. At Takasago Thermal Power Station, we are carry out the procedure for an environmental impact evaluation in preparation for replacement work.

We will also engage in construction of new coal-fired power stations, introducing high-efficiency power generation technology and making use of operations and maintenance methods cultivated in Japan, to contribute to the reduction of carbon emissions from coal-fired power generation. At present, we are undertaking two joint projects with other companies, and the plans for Kashima Thermal Power Plant Unit No. 2 and Nishiokinoyama Power Plant (provisional name) are undergoing the procedure for environmental impact assessment. (see p. 43.)

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**Promoting Reduction of Carbon Emissions by Coal-Fired Power**

1. Use of supercritical (SC) generation
2. Use of ultra-supercritical (USC) generation
3. Increased thermal efficiency through improvement of steam conditions

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Source: Compiled by J-POWER with reference to Federation of Electric Power Companies of Japan information materials
Takehara Thermal Power Station Replacement Plan:
Pursuing the World’s Highest Levels as USC Technology

The J-POWER Group is carrying out a plan to replace Takehara Thermal Power Station Units No. 1 (250 MW) and No. 2 (350 MW), which went into operation some 40 years ago, with a New Unit No. 1 (600 MW). The environmental assessment procedures have been completed, and construction began in March 2014, with operations scheduled to begin in 2020.

By introducing the latest power generation technologies and environmental pollution control equipment, we will create a coal-fired power station with the world’s highest-level ultra-supercritical (USC) technologies.

World’s Most Efficient Power Generation Technologies

The new Unit No. 1 at Takehara Thermal Power Station will produce steam conditions at the world’s highest level and will be one of Japan’s most efficient power stations. Raising power generation efficiency will reduce the consumption of coal, the station’s energy source, making it possible to curtail CO₂ emissions and substantially reduce carbon.

Clean Environmental Technology at the World’s Highest Level

The new Unit No. 1 at Takehara Thermal Power Station has been upgraded with state-of-the-art flue-gas denitrification system, flue-gas desulfurization, and electrostatic precipitator. This gives it the capability to greatly reduce emissions of nitrogen oxides (NOx), sulfur oxides (SOx), and soot and dust. Isogo Thermal Power Station, which is already equipped with similar equipment, boasts emissions that are extremely low compared to other thermal power plants in Europe, the U.S., and Japan.

Comparison of Power Generation Efficiency after Replacement (at generation point, LHV*)

* See note on p. 15.

International Comparison of SOx and NOx Emissions Intensity for Thermal Generation


Japan: Materials published by The Federation of Electric Power Companies of Japan (10 electric power companies and J-POWER)

Figures for Isogo and J-POWER are formulated from results for 2015
Research and Development of Next-Generation Low-Carbon Technologies:

For the Sake of the Earth’s Future

The J-POWER Group is pursuing cutting-edge clean coal technologies and employing USC power generation at the world’s highest levels, and by conducting further research and development, we are promoting additional reductions in carbon from coal-fired power. We are committed to continuing active research and development in Japan and overseas on next-generation, higher-efficiency coal-fired power generation that can reduce CO₂ emissions through even higher power generation efficiency, CCS to capture and store CO₂ produced by power generation so it is not released into the atmosphere, and other technologies.

Thermal Efficiency Improvement by Technical Development (At transmission point; upper row is HHV*, lower row is LHV*)  * See note on p. 15.

### Higher-Efficiency Coal-Fired Power Generation Technologies

The higher-efficiency coal-fired power generation technologies on which the J-POWER Group is conducting R&D include integrated coal gasification combined-cycle (IGCC) power generation, which combines conversion of coal into a flammable gas for combustion in a gas turbine with a steam turbine that uses the waste heat; integrated coal gasification fuel cell (IGFC) combined-cycle power generation, which adds triple-combined-cycle generation to fuel cell power generation using IGCC; and advanced ultra-supercritical power generation, which improves USC steam conditions even further. With regard to IGCC, which has the closest affinity with CO₂ separation and recovery, trial operations at a pilot plant facility were conducted for more than 10 years starting in 2002 under the EAGLE Project in collaboration with the New Energy and Industrial Technology Development Organization (NEDO) (the project ended in June 2014). The knowledge and results obtained from the project will be used, and the technology is entering the testing phase under the Osaki CoolGen Project.

### CO₂ Capture and Storage (CCS) Technology

CO₂ capture and storage (CCS) separates and collects CO₂ produced from the combustion of coal and other fossil fuels without releasing it into the atmosphere and transports the CO₂ for storage deep in the earth. R&D on CCS is being conducted around the world as a promising technology for achieving substantial reductions in CO₂ emissions.

At this time, there are issues of lower power generation efficiency during the separation and collection phase as well as securing suitable sites and creating infrastructure and legal systems in the transport and storage phases, and as a result, CCS is not in practical use anywhere in the world. The J-POWER Group is making preparations for a separation and collection technology demonstration as a part of the Osaki CoolGen Project based on the results from the EAGLE Project.

J-POWER participated in the Callide Oxyfuel Combustion Project, a joint Japanese-Australian public and private sector initiative. As part of this project, oxyfuel combustion tests and CO₂ storage tests were conducted at the Callide A Coal-Fired Power Station, and in light of those tests, we will go on taking steps to accumulate further technology and knowledge.

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### CCS Concept

- **Injection from offshore facility**
- **Separation/Capture**
- **Transport**
- **Injection**
- **Injection from offshore facility**
- **Ship**
- **Cap rock (impermeable layer)**
- **Offshore aquifer**

The EAGLE Project tested a physical collection method and a chemical collection method for separating and collecting CO₂, and information was gained on the properties of each.
Osaki CoolGen Project: Seeking IGCC at the World’s Highest Levels

In order to curtail CO₂ emissions from coal-fired power generation beyond what is possible with current clean coal technologies, the Energy Basic Plan expresses expectations for development and application of next-generation, higher-efficiency coal-fired power generation technologies such as IGCC as well as research and development in the pursuit of application of CCS technologies. The J-POWER Group is conducting the Osaki CoolGen Project in collaboration with Chugoku Electric Power Co., Inc. to test these advanced clean coal technologies. For the project, an oxygen-blown IGCC trial power station with output of 166 MW is being built at the Chugoku Electric Power Osaki Power Station, and tests will be conducted in three phases.

Osaki CoolGen Project Schedule

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J-POWER and Chugoku Electric Power established Osaki CoolGen Corporation in 2009 to carry out the project. The “CoolGen” name is derived from the Cool Gen Plan proposed to carry out the Japanese government’s Cool Earth-Innovative Energy Technology Program and was created from “cool” and “generation.” At present we are running operational trials of equipment to prepare for the start of the first phase of testing in the 2016 fiscal year. We also started on the second phase CO₂ separation and capture type IGCC demonstration in April 2016, and we will move steadily forward on the project with a view to starting trials during the 2019 fiscal year.
Initiatives for a Stable Supply of Electricity and Reduced CO₂ Emissions

[Report] The Ohma Nuclear Power Plant

Business Operations That Fulfill Social Responsibility

Renewable Energy

We are actively taking measures concerning renewable energy under the Energy Basic Plan, which positions renewable energy as a promising domestic energy source that contributes to ensuring energy security. The J-POWER Group’s renewable energy initiatives are diverse and include contributing to stable electricity supplies through existing hydroelectric power, wind power, and geothermal power stations, for which we have the second-highest shares among each type of domestic generation facilities; developing new power sources such as wind and geothermal power; and conducting research and development on offshore wind power. Renewable energy is a CO₂-free energy source that does not produce greenhouse gases such as CO₂ at the time of generation. The J-POWER Group is moving forward with the Ohma Nuclear Power Plant plan and expanding the use of renewable energy with the aim of increasing CO₂-free energy sources.

Wind Power

The J-POWER Group made an early entry into the wind power business with the start of operation of the Tomamae Winvilla Wind Farm in December 2000. We currently have 21 wind farms, total number of 241 units, with a total generating capacity of approximately 430 MW located nationwide (as of June 2016).

We are conducting our business by making full use of the technology and know-how we have cultivated to date in carrying out construction, operation, and maintenance of the hydroelectric and thermal power stations located in every region of Japan as well as of transmission lines. The strengths of our business are in using integrated implementation systems that cover everything from wind surveys to planning, construction, operation, and maintenance. In future, we will continue promoting the new development of wind power stations while also making every effort for safe operation and increased operating rates in those wind power stations that are in operation.

There are high expectations for offshore wind power in Japan, which is surrounded by seas on all four sides. J-POWER is conducting a demonstration project relating to offshore wind power in waters off Kitakyushu City in Fukuoka Prefecture (outsourced and joint research for NEDO*) and consistently conducting research, deepening our technical knowledge regarding offshore wind power generation.

* The New Energy and Industrial Technology Development Organization

At wind power stations, we periodically shut down the turbines to perform inspections and repairs from the perspective of preventive maintenance. If inspections and repairs are performed on a windy day, not only do we lose power generating opportunities but the work is dangerous, so we plan inspections and repairs for periods when the winds tend to be weak. On workdays we monitor wind conditions and coordinate processes such as turbine shutdown times and the number of units to be worked on so we can maximize power generation by the wind.

A large turbine with individual generating capacity of 2.4 MW, a first for J-POWER, was installed at the Kaminokuni Wind Farm, which went online in 2014. Responding to a breakdown required us to make repairs in locations where we had no experience, but the maintenance workers combined their knowledge to complete the repairs.

Now, two years after the start of operations, the turbine is steadily generating power. I will continue the daily process of repeated trial and error to acquire worksite knowledge and enhance my maintenance skills so that the wind farm, which has established deep local ties, can continue operating long into the future.

VOICE

Working to Enhance Maintenance Skills at Wind Power Stations

J-Wind Service Co., Ltd.
Manager, Kaminokuni Office
Koji Mima

Kaminokuni Wind Farm (Hokkaido)
Assembling a wind turbine (in the winter)
Geothermal Power

Geothermal power is a CO₂-free power source that emits almost no CO₂ at the time of generation and is also a renewable energy source capable of providing a stable supply of electricity throughout the year without being affected by weather. For these reasons, there are high expectations for the future development of geothermal power.

The J-POWER Group joined with Mitsubishi Materials Corporation and Mitsubishi Gas Chemical Company, Inc. to establish Yuzawa Geothermal Power Corp. with the aim of building the Wasabizawa Geothermal Power Stations in Yuzawa City, Akita Prefecture in April 2010. Construction is currently under way with commercial operations scheduled to begin in May 2019. We are also addressing the age-related deterioration of facilities at the existing Onikobe Geothermal Power Station in Osaki City, Miyagi Prefecture (output: 15 MW) by planning facility updates (23 MW-class output) within the same grounds.

Promoting the Biomass Mixed Combustion

Wooden biomass and sewage sludge are carbon neutral biomass that absorb and release equal amounts of CO₂ over their life cycles, but in Japan, much of these resources remains unused.

The J-POWER Group is reducing the carbon emissions of coal-fired power stations by utilizing unused biomass for mixed combustion at power stations.

Status of biomass mixed combustion initiatives

<table>
<thead>
<tr>
<th>Biomass resources</th>
<th>Wood</th>
<th>Sewage sludge</th>
<th>Carbonization of ordinary waste for use as fuel</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Chips</td>
<td>Pellets</td>
<td>Low-temperature carbon fuel</td>
</tr>
<tr>
<td>Examples of biomass fuels</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Characteristics of biomass fuels</td>
<td>Scrap construction timber is chipped and used. Comprise 50 to 70% of the calorific value of coal.</td>
<td>Forest offcut is dried, ground, and formed into pellets. They have about 70% of the calorific value of coal.</td>
<td>Sewage sludge is carbonized at a lower temperature than the incineration temperature used in conventional processing in order to manufacture fuel that produces less NO₂, a greenhouse gas, than conventional processing. The fuel produces little odor and has 50-70% of the calorific value of coal.</td>
</tr>
<tr>
<td>Sites for the production of biomass fuel</td>
<td>Nagasaki City, Nagasaki Prefecture</td>
<td>Kitayachi City, Miyazaki Prefecture</td>
<td>(1) Hiratsuka City, Hiratsuka Prefecture* (2) Kumanotsu City, Kumanotsu Prefecture* (3) Osaka City, Osaka Prefecture*</td>
</tr>
<tr>
<td>Mixed combustion in coal-fired power stations</td>
<td>Matsuura Thermal Power Station</td>
<td>Matsuura Thermal Power Station</td>
<td>(1) Takasago Thermal Power Station (2) Matsuura Thermal Power Station (3) Takasago Thermal Power Station</td>
</tr>
<tr>
<td></td>
<td>Matsuura Thermal Power Station</td>
<td>Matsuura Thermal Power Station</td>
<td>Under consideration</td>
</tr>
</tbody>
</table>

Conceptual diagram of the biomass fuel business (using the solidified sewage sludge fuel production business as an example)

<table>
<thead>
<tr>
<th>Sewage treatment plant</th>
<th>Low-Temperature Carbonization</th>
<th>Fuel Conversion Facility</th>
<th>Carbonized Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dehydrated Sludge</td>
<td></td>
<td>Promotion of the use of sewage sludge as a resource</td>
<td>Reduction of greenhouse gases</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Valuable Commodity</td>
</tr>
</tbody>
</table>

Coal-fired power station

- Reduction of greenhouse gases
Power Transmission, Substation, and Communications Facilities

J-POWER’s transmission facilities do more than just send electricity to where there is demand within each power utility’s business area. They also utilize extra-high-voltage AC and DC transmission lines to link Honshu with Hokkaido, Shikoku, and Kyushu, interconnecting the electrical grids of different regions. The Sakuma Frequency Converter Station, which enables the transmission of electricity between the different frequencies of eastern and western Japan, and the Hokkaido-Honshu Electric Power Interconnection Facility, which links Honshu with Hokkaido via DC transmission lines, support power interchange over wide areas of Japan and contribute to reducing needed spare electric power and maintaining frequencies.

J-POWER has also constructed a nationwide high-reliability information and telecommunications network that uses microwave radio circuits, optical lines, and other communications lines operated by the Group to operate the electric power grid and conduct centralized, remote control of unmanned hydroelectric power stations and dams. These facilities are installed in various environments including mountainous regions and urban areas and are exposed to extreme weather conditions including wind, snow, lightning, and seawater. Consequently, we conduct daily patrols and regular inspections to discover irregularities at an early stage and prevent facility accidents before they can occur.

**VOICE** Providing for a Stable Supply of Electricity by Extensive Construction of Power Transmission Facilities

At this location, we manage Hokkaido-Honshu HVDC Interconnection Line, which is the only inter-area connection line linking Honshu and Hokkaido. Since Hokkaido-Honshu HVDC interconnection Line has been in operation for approximately 40 years, and since the line passes through coastal areas, some spares have seen deterioration of the wire so that construction for wire replacement is necessary. This involves construction over a wide area and by a wide range of people, which requires drafting plans with an awareness of scheduling, requesting landowner cooperation, going through authorization procedures, and so on. The result of obtaining the understanding and cooperation of the people concerned without delays is that construction can proceed according to plan, and we contribute to the stable supply of power.

**VOICE** Maintaining and continuing stable operation of the Hokkaido-Honshu Electric Power Interconnection Facility and related facilities

This Substation Group was newly established as part of the separation of power generation and transmission. We do maintenance on the transmission facilities at the Hakodate AC/DC Converter Station, and carry out outage coordination and other such dispatching services on the Hokkaido-Honshu Electric Power Interconnection Facility and Tokachi Trunk Line. In order to maintain and continue the stable supply of electric power, it is also necessary to respond rapidly and flexibly to changes in the environment or other conditions, and for that, teamwork is essential. We make a regular practice of caring for the communication with members and other concerned people and we make every effort toward the stable operation of the Hokkaido-Honshu Electric Power Interconnection Facility.

**VOICE** Securing propagation paths in demanding environments

J-POWER’s wireless and optical communication circuits are indispensable facilities for the maintenance and operation of power generation plants, substations, and transmission lines. The maintenance area covered by this group extends from mountainous areas to urban areas. In mountainous areas it is mature trees and in urban areas it is high-rise buildings and other such structures that may block wireless propagation paths. Therefore we trim trees, conduct studies at high-rise building construction locations, and so on in our efforts to secure propagation paths. In doing so, we show care for the surrounding environment and do our work in ways that will minimize the impact as much as possible.
Overseas Business

The J-POWER Group’s corporate philosophy calls on us to “play our part for the sustainable development of Japan and the rest of the world.” Taking this as our basic approach, and leveraging the accomplishments and know-how we have acquired through a half-century of overseas operations, we are engaging in international consulting projects, which involve technical cooperation to develop power sources and protect the environment, and in overseas power generation projects, which involve our participation in businesses through the investment of capital and technology.

Overseas Business Initiatives

The purpose of the J-POWER Group’s overseas consulting business is to provide cooperation on electric power generation technology to emerging countries and so contribute to the international community. Since implementing our first project in 1962, we have been involved in 355 projects in 64 countries (as of the end of March 2016). In the overseas power generation business, we have 36 electric power generation facilities in six countries and regions with a total output of 20.47 GW. Our owned share of this output amounts to 7.50 GW (as of the end of March 2016). We are implementing numerous projects in Thailand in particular. With U-Thai Power Station No. 2 system initiation of operation in December 2015, the J-POWER’s owned share of Thailand’s electric power supply came to approximately 10%. In Indonesia, we are building a power plant (1.00 GW × 2) with ultra super critical (USC) power generation technology, which has a low environmental impact.

The J-POWER Group will aim to use the clean coal technology we have in Japan to simultaneously achieve a contribution to growth primarily in Asia and to reduction of environmental burden.

Importance of Quality and Safety Management

J-POWER has been engaging in overseas consulting business in various different countries over a half-century so far. In executing these projects in other countries, it is imperative not only that we conduct quality management of the equipment, but also that we pay the greatest attention to safety management during construction. However, Japanese approaches do not necessarily work in other countries, and there are even some countries where, as a matter of the national character, no interest whatsoever is shown in worker safety. Under circumstances like these, the engineers working on a site carry out their assigned duties in ways that implicitly exercise leadership so that the importance of quality management and safety management become thoroughly familiar on the local scene. We consider it the mission of our engineers to make the J-POWER spirit a pervasive presence in those other countries.

Project Development & Engineering Office, International Business Development Department
Kazuyuki Yamada