Aiming to raise the generating efficiency of coal-fired thermal power and achieve low-carbon emissions, J-POWER is developing clean coal technologies that are the keys to creating next-generation, coal-fired thermal power generation facilities.

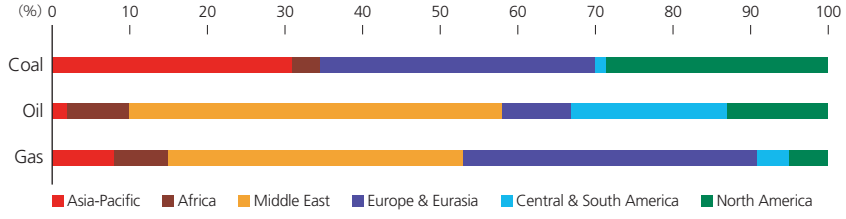
Coal Is a Major Energy Source for Electric Power Generation

Compared to oil and natural gas reserves, coal deposits are abundant and dispersed broadly in many countries throughout the world. In terms of supply, it is the stablest and most-economical of all fossil fuels. Many countries around the world rely on coal as a primary power generation fuel source. On a worldwide basis, coal is the most-prevalent source of energy, accounting for roughly 40% of all electric power generated, including countries with high energy consumption. For example, China uses coal for approximately 80% of the power it generates, while in the United States the ratio is a little less than 50%.

Going forward, the number of coal-fired thermal power plants is projected to grow further. It is believed that coal-fired thermal power generation will continue to be a crucially important energy source for meeting ever-increasing worldwide demand.

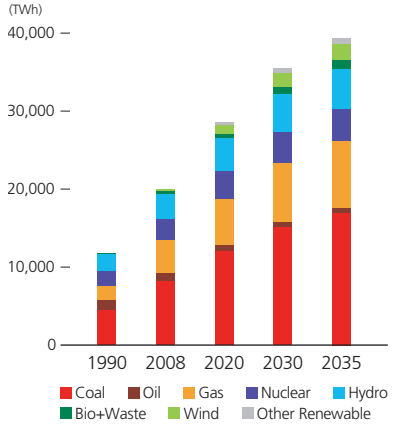
At the same time, the combustion of coal and other fossil fuels generates CO_2, a greenhouse gas, and CO_2 from coal-fired thermal power plants accounts for roughly 30% of the world's energy-derived CO_2 emissions. Because rising demand for energy in such emerging countries as China and India is projected to increase those countries' coal use by a substantial margin, reducing CO_2 emissions from coal-fired thermal power generation has become an international issue.

Geographical Distribution of Resource Reserve



Source: Compiled from *BP Statistical Review of World Energy 2012*

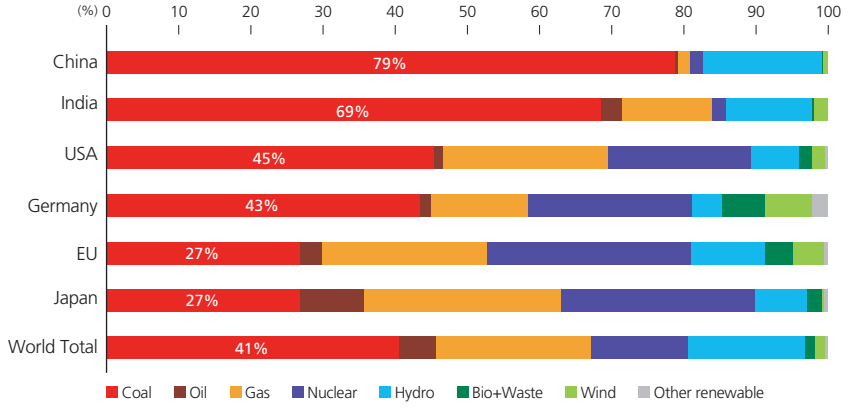
Estimated Global Power Generation Output by Power Source



Source: Compiled from current policies scenario* in *IEA World Energy Outlook 2011*

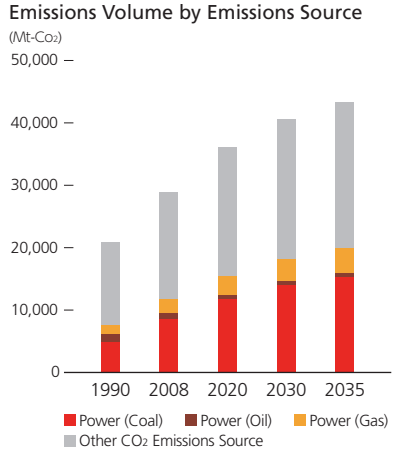
* A scenario that takes into account measures officially adopted as at mid-2011

Breakdown of Power Generation Volume by Power Source for Each Country/Region (2009)



Source: Compiled from *IEA World Energy Outlook 2011*, except for Germany, which is based on *IEA Electricity Information 2011*.

Estimated Global Energy-Derived CO_2 Emissions Volume by Emissions Source



Source: Compiled from current policies scenario in *IEA World Energy Outlook 2011*

Spreading J-POWER's Cutting-Edge Technologies throughout the World

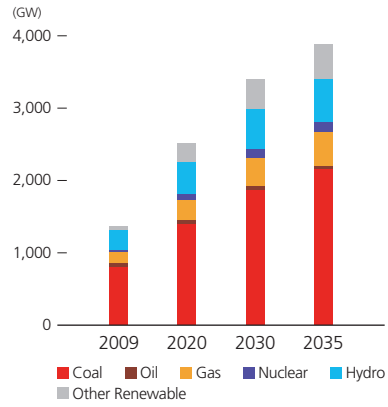
One effective way to reduce CO_2 emissions from coal-fired thermal power plants is by increasing generation efficiency. Were power generation made more efficient, this alone would bring down fuel costs and curb CO_2 emissions. Japanese coal-fired thermal power plants utilize the ultra-supercritical (USC) method, which raises steam turbine pressures and temperatures to extremely high levels, enabling them to realize a level of generating efficiency higher than at plants in Europe, the United States, and Asia. Active in developing these cutting-edge technologies under its own initiative and having championed their application, J-POWER is achieving the highest levels of efficient energy use.

J-POWER leverages Japan's accumulated expertise and technologies, while the widespread conversion to highly efficient coal-fired thermal power stations throughout the world holds major significance for the reduction of worldwide CO_2 emissions and the conservation of energy resources.

If Japan's best-performing coal-fired thermal power technologies were to be used globally at all newly built and existing coal-fired thermal power plants, it is estimated that, in 2030, the world's annual CO_2 emissions would be reduced by 1.87 billion tons. This is an amount that far exceeds Japan's annual CO_2 emission volume, which was 1.19 billion tons in fiscal 2010.

Power demand is steadily increasing particularly elsewhere in Asia, and coal-fired thermal power generation is expected to play an ongoing major role in power supply. Both the amount of electricity generated at and the facility capacity of Asian coal-fired thermal power plants are projected to have doubled the current levels by 2030. As the coal-fired thermal power plants in other Asian countries are also of the conventional, comparatively less efficient subcritical type, a full-fledged switch to high-efficiency plants is under way. J-POWER is thus targeting contributions toward the simultaneous achievement of Asian growth and reduced environmental impact by means of Japanese clean coal technologies.

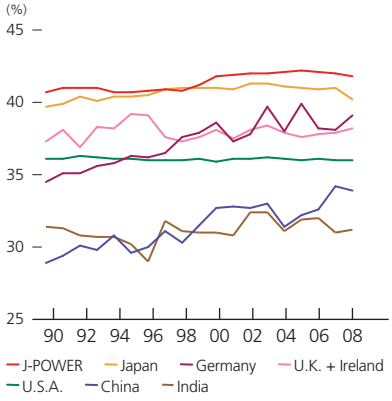
Estimated Asian Power Plant Capacity by Power Source



Source: Compiled from current policies scenario in *IEA World Energy Outlook 2011*

Trends in Average Thermal Efficiency of the World's Coal-Fired Thermal Power Plants

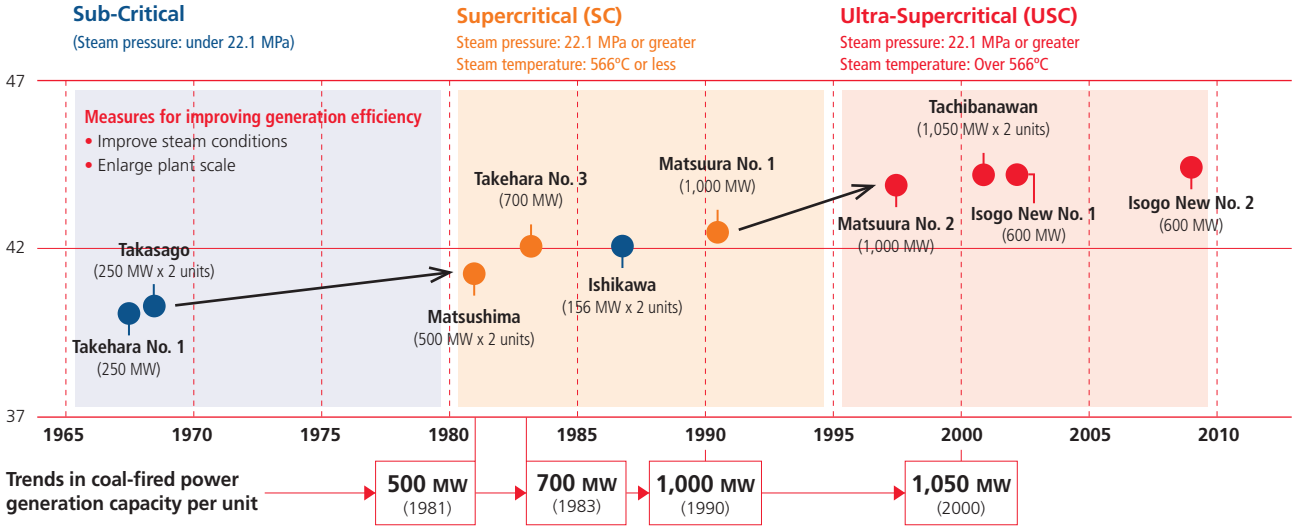
Gross efficiency (LHV)



Source: *Ecofys International Comparison of Fossil Power Efficiency and CO_2 Intensity 2011*

Generation Efficiency of J-POWER Coal-Fired Thermal Power Plants

Designed Thermal Efficiency (%, gross efficiency, LHV basis)



Isogo Thermal Power Plant
(before replacement work)

Isogo Thermal Power Plant
(after replacement work)

Takehara Thermal Power Plant
(Hiroshima Prefecture)

Case 1 Replacing Older Thermal Power Plants with Cutting-Edge Facilities

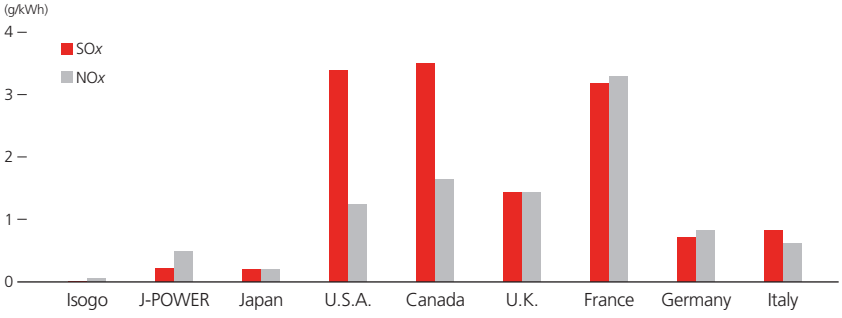
Replacing the Isogo Thermal Power Plant

In 1996, a project was launched to replace the two original 265 MW units at the Isogo Thermal Power Plant with state-of-the-art, coal-fired thermal facilities. The project was a means of complying with a City of Yokohama environmental improvement plan, improving the stability and reliability of power supply, and addressing problems associated with aging facilities. The New No. 1 (600 MW) went online in April 2002, followed by the New No. 2 (600 MW) in July 2009.

As the Isogo Thermal Power Plant is located in a major city, a pollution prevention agreement—the first of its kind in Japan—was signed with the City of Yokohama; focus was placed on environmental measures from early on, measures that included installing flue-gas desulfurizers. Replacing the first unit at the Isogo Thermal Power Plant brought together J-POWER's clean coal technologies and introduced USC, the highest standard for coal-fired thermal power with a main steam turbine pressure of 25 MPa, a steam temperature of 600°C, and a reheat steam temperature of 610°C. J-POWER also worked on significant improvements in thermal efficiency that were realized with New No. 2, which boasts a reheat steam temperature of 620°C, 10°C higher than No. 1. The Isogo Thermal Power Plant reduces sulfur oxide (SO*x*) and nitrogen oxide (NO*x*) emissions per unit of electricity generated to extremely small values compared with thermal power plants in other major industrial countries thanks to the installation of the latest environmental equipment. Isogo represents the highest standard of clean, coal-fired thermal power plant from the standpoints of both generation efficiency and environmental impact.

To maintain power supply capabilities during the Isogo Thermal Power Plant replacement project, an unprecedented "build, scrap, and build" approach was employed, which involved a number of innovations. The New No. 1 was constructed on a narrow site covering approximately 12 hectares while the original power facilities were still in operation. When the New No. 1 went online, the old facilities were shut down and removed, and the New No. 2 was built in their place.

International Comparison of SO*x* and NO*x* Emissions per Unit of Thermal Power Generation



Sources:
Overseas (2005 results) Emissions: *OECD Environmental Data Compendium 2006/2007*
Amount of power generated: *IEA Energy Balances of OECD Countries, 2008 Edition*
Japan (2010 results) Materials published by The Federation of Electric Power Companies of Japan
Figures for Isogo and J-POWER derived from results for 2011

Takehara Thermal Power Plant New No. 1 (Facility Replacement) Project

Following on from the Isogo Thermal Power Plant, J-POWER is already moving ahead with replacement plans at the Takehara Thermal Power Plant in Hiroshima Prefecture, where unit Nos. 1–3, which have a total output of 1,300 MW, are currently in operation. As more than 45 years have already elapsed since the 250 MW No. 1 commenced operations in July 1967, and more than 38 years have passed since the 350 MW No. 2 came online in June 1974, it is becoming necessary to address the problems associated with these aging facilities. The plan is to replace Nos. 1 and 2 with a New No. 1 capable of producing 600 MW. From the perspective of responding proactively to the issue of global warming, introducing the new state-of-the-art facility will reduce the environmental impact of SO*x* and NO*x*, significantly improve energy utilization and be a step closer to a low-carbon society. The Company is completing environmental assessment procedures; the plans call for the New No. 1 to come online in 2020.

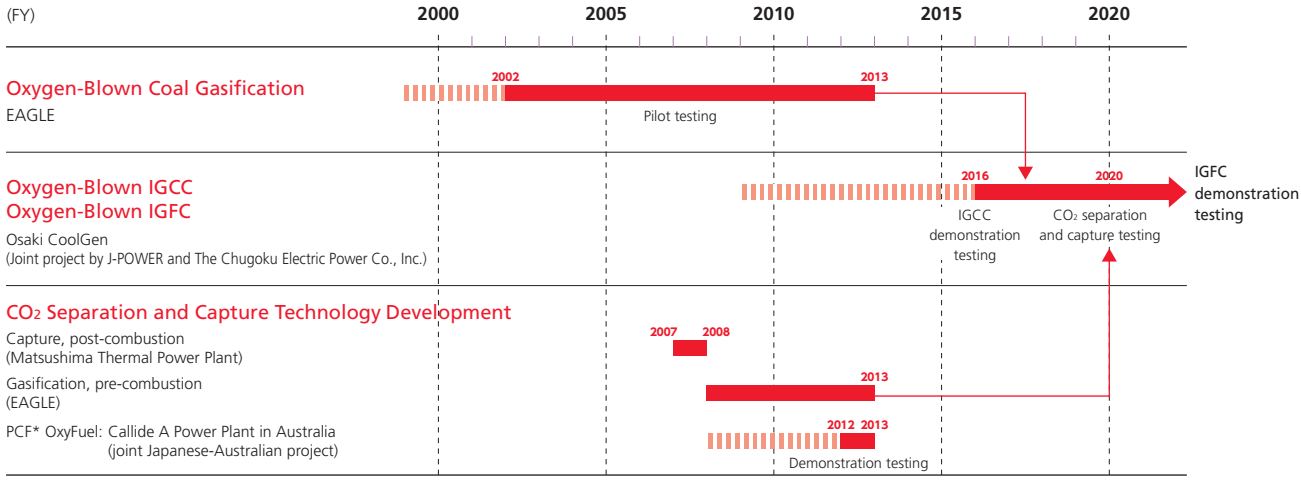
Aiming to Realize Zero Emissions

Aiming to further increase coal-fired power generation efficiency and realize low-carbon performance, J-POWER is engaged in the development of a variety of next-generation technologies and is making advances in the combined combustion utilization of biomass fuels.

With regard to integrated coal gasification combined cycle (IGCC)*1 systems, J-POWER is planning to build a 170 MW demonstration plant jointly with Chugoku Electric Power Co., Inc. at a site in Osaki, Hiroshima Prefecture, drawing on the result with the EAGLE*2 development program carried out at the Wakamatsu Research Institute. Furthermore, in continuing to develop integrated coal gasification fuel cell combined cycle (IGFC)*3 systems, the Company is aiming to dramatically increase generating efficiency and substantially reduce CO_2 emissions. At the present time, J-POWER is also making progress with the development of advanced ultra-supercritical (A-USC)*4 technologies that will further enhance the already high efficiency of cutting-edge USC*5 technology.

Ultimately, we will strive to realize innovative, zero-emission, coal-fired thermal power by combining IGCC and IGFC systems with CO_2 capture and storage (CCS) technologies deep in the ground.

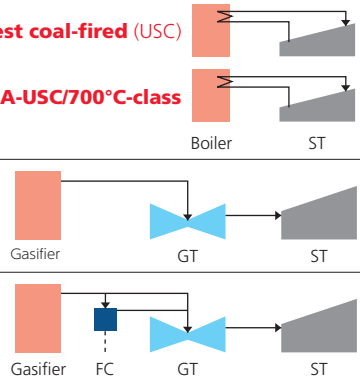
New Technology Development Schedule for Coal-Fired Thermal Power Generation at J-POWER



*PCF: Pulverized coal-fired

Coal-Fired Power Technology for the Next Generation

		Gross efficiency (LHV):	CO_2 reduction: (compared with latest coal-fired)
Pulverized coal-fired (USC)	**Latest coal-fired** (USC)	43%	
	A-USC/700°C-class	48%	Approx. 11%
Integrated coal gasification combined cycle (1,500°C-class)		48~50%	Approx. 11%~15%
Integrated coal gasification fuel cell combined cycle		58% or more	Approx. 25% or more



*1 Integrated Coal Gasification Combined Cycle (IGCC)
An integrated power generation system with a twin-turbine configuration; the gas produced from burning coal is used as fuel to drive a gas turbine, the exhaust gases from which are used in a steam turbine

*2 EAGLE
An oxygen-blown coal gasification project being conducted at the Wakamatsu Research Institute. The acronym is taken from Coal Energy Application for Gas, Liquid, & Electricity.

*3 Integrated Coal Gasification Fuel Cell Combined Cycle (IGFC)
A coal-fired power generation highly efficient system combining fuel cells with gas and steam turbines in a triply integrated power generation configuration

*4 Advanced Ultra-Supercritical (A-USC)
Raises thermal efficiency achievable with USC technology by utilizing a steam temperature of 700°C or higher

*5 Ultra-Supercritical (USC)
Current cutting-edge technology for raising the efficiency of pulverized coal-fired thermal power. Utilizes a steam pressure of 24.1 MPa or greater with a steam temperature of over 566°C

EAGLE Pilot Test Facility
(Fukuoka Prefecture)

Planned layout of Osaki CoolGen test facility
(Hiroshima Prefecture)

Case 2 Developing the Next Generation of Coal-Fired Thermal Power Technologies

Large-Scale Demonstration Test of Oxygen-Blown IGCC Technology

EAGLE Project

Since fiscal 2002, the Research & Department Dept. at J-POWER's Wakamatsu Research Institute in Fukuoka Prefecture has been heavily involved in the EAGLE project pilot programs with a view to using coal efficiently and reducing CO_2 emissions to zero. The aims of the EAGLE project are to develop an oxygen-blown gasifier to verify the oxygen-blown IGCC system and to establish the technology to separate and capture CO_2 from the gases generated during the coal gasification process.

Through the EAGLE project, J-POWER has achieved the world's highest cold gas efficiency, verified coal gasifiers that enable the highly efficient gasification of a wide range of coal types—from low-grade coal (sub-bituminous coal and lignite) to high-grade coal (bituminous coal) used in the production of thermal power from pulverized coal—and established oxygen-blown coal gasification technologies. Because they generate a gas mainly composed of CO and H_2, a special characteristic of oxygen-blown coal gasification technologies is that they facilitate CO_2 separation and capture. As a result, J-POWER is working to establish techniques that will separate and capture the CO_2 from gasification more efficiently.

Osaki CoolGen Project

Leveraging the expertise and accomplishments obtained with the EAGLE project, J-POWER and the Chugoku Electric Power Co., Inc. established a joint venture, Osaki CoolGen Corporation, in 2009 to carry out large-scale Osaki CoolGen demonstration tests designed to bring about the commercialization of IGCC and CO_2 separation and capture technologies. The project plan calls for the commencement of construction of a 170 MW oxygen-blown IGCC demonstration plant (with a coal processing capacity of 1,100 tons per day) in fiscal 2012. From fiscal 2016, demonstration tests will investigate the plant's reliability, economic efficiency, and ease of operation as a system. From 2020, we plan to commence tests and verify the applicability of the most recent CO_2 separation and capture technology. Based on these tests, we will set out to further increase efficiency with the IGFC system, which combines fuel cells with the oxygen-blown IGCC system. The aim of these technological developments is to bring to fruition the CoolGen Project* that was put before a national commission.

* Advocated at the Ministry of Economy, Trade and Industry's Advisory Committee for Natural Resources and Energy in June 2009, the national CoolGen Project is a plan for experimental research aimed at realizing "zero-emission, coal-fired thermal power generation" through a combination of IGCC, IGFC, and CCS technologies.

Development of CO_2 Separation and Capture Technology

Several countries are making progress with CCS surveys and trial projects. The CCS process involves separating and capturing CO_2 given off by large-scale emission sources and storing it permanently underground. Of the three distinct elements comprising CCS—CO_2 separation and capture, transport, and storage—J-POWER has from a user's perspective focused primarily on the former because those technologies must be designed for use at power plants and because CO_2 separation and capture is the most cost-intensive component of the entire CCS process. Technologies for separating and capturing CO_2 from the gas produced by oxygen-blown coal gasification are believed to hold the most potential for future application. We demonstrated the effectiveness of a chemical absorption method associated with those technologies during one of the EAGLE pilot programs and since 2010 have been conducting tests of the physical absorption method in a project that is scheduled to end in fiscal 2013.

J-POWER is also actively working to develop CO_2 separation and capture technologies for combustion exhaust from pulverized coal-fired thermal power, currently the most-common method of power generation from coal. In collaboration with Mitsubishi Heavy Industries, Ltd., we conducted pilot trials using the chemical absorption method from 2007 to 2008 at our Matsushima Thermal Power Plant, in Nagasaki Prefecture. Additionally, we are a participant in the Callide Oxyfuel Project using the oxyfuel method, which is being carried out at the Callide A Power Plant in Queensland, Australia. Scheduled to conduct demonstration operations from 2012 to 2013, this joint Japanese-Australian project will be the first in the world to test an integrated CCS and underground storage system using the oxyfuel method at an existing power plant.