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ENERGY AND ENVIRONMENT
JAPANESE ELECTRIC UTILITY INDUSTRY IN THE WORLD
2010–2011

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ENERGY AND ENVIRONMENT

JAPANESE ELECTRIC UTILITY INDUSTRY IN THE WORLD

2010–2011

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Foreword

Pollution problems first became a social concern in Japan in the 1960s with the development of heavy chemical industries adjacent to urban centers. As countermeasures to these problems, governmental and private organizations took steps to develop anti-pollution measures in their respective fields. Thanks to these measures, pollution problems have been largely overcome, and today Japan boasts some of the world's most advanced anti-pollution policies. The electric power industry gave special priority to the specific environmental concerns of each region. In establishing integrated operations from generation to distribution, careful consideration was given to the characteristics of industries closely related to each region, and the most effective measures within equipment and operation were implemented at any given time. The industry has not only upheld the regulations and standards set by national and municipal governments, but has worked to develop and promote even more stringent anti-pollution measures, and has achieved the highest level in the world.

In establishing power supply systems, the industry gives equal consideration to environmental concerns, supply stability and economic efficiency. When determining the location of a power-generating plant, pertinent environmental impact studies are conducted beforehand, taking into consideration the possible effect on local residents and surrounding land and marine ecosystems. The utmost efforts are made to preserve the natural environment around the plant through tree planting, landscaping and other activities. In addition, the effective use, recycling, management, disposal and reduction of waste materials are actively promoted.

The resolution of global environmental problems requires a combination of international efforts and activities strongly rooted in each individual community. Hence efforts by the electric power industry must include, in addition to domestic measures, international cooperative efforts such as the transfer of technologies that facilitate efficient energy use and environmental preservation to other developing countries, and the promotion of activities for the reduction of energy and resource consumption and environmental protection. We will implement the above-mentioned activities not only with our industry, but also with our clients and local communities in order to extend these to our society.

This brochure provides information on the activities of Japan's electric power companies which are directed at the reduction of energy and resource consumption, environmental preservation and the problem of global warming. We hope to contribute to the better public understanding of the electric power industry's activities and attitude toward environmental protection.

Overview of Japan's Electric Power Industry

a.Composition of Japan's Electric Power Industry

There are 4 business types in the Japanese electric power industry, which are general electricity business, wholesale electricity business, specified electricity business, and specified-scale electricity business.

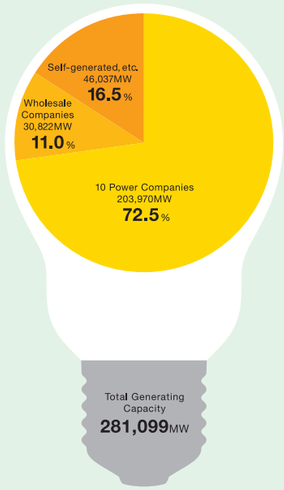
The general electricity utility consists of 10 power companies representing the regions of Hokkaido, Tohoku, Tokyo, Chubu, Hokuriku, Kansai, Chugoku, Shikoku, Kyushu, and Okinawa. They produce, transmit and supply electric power. There are 2 companies, the Electric Power Development Co., Ltd. and Japan Atomic Power Company, which comprise the wholesale electricity utility, selling power generated at their facilities to the power companies. In addition, there are 5 specified electricity utilities which supply power to meet the demand at a specified service point, and also there are 35 specified scale utilities that retail power to the "specified-scale demand" via the general electricity utility's power grid.

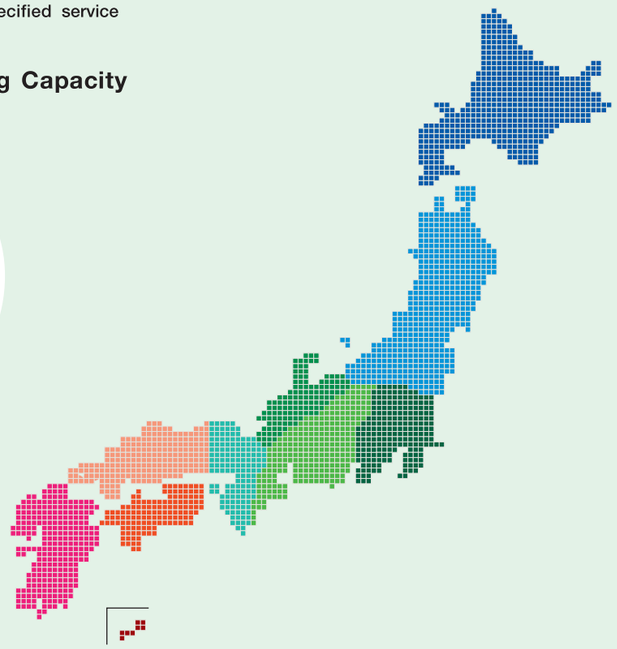
"Specified-scale demand" was newly established due to the partial liberalization of the power retail market in March 2000. Originally, it targeted the extra high voltage users, but the target expanded to include a part of the high voltage (500kW or more) users in April 2004 and to all high voltage users in April 2005.

*The number of utilities is as of the end of March 2010.

Japan's Power Generating Capacity

(as of end of fiscal 2009)





Outline of 10 Major Electric Utilities in Japan Fiscal 2009

Source: Japan Electric Utilities Handbook

	Capital (billions of yen)	Maximum Electricity Demand (MW)	Power Sold (x 1-million kWh)	Sales (billions of yen)	Employees	Power Generating Capacity (MW)				
						Hydro	Thermal	Nuclear	Wind	Total
Hokkaido Electric Power Co.	114	5,686	31,451	526	5,631	1,232	4,115	2,070	—	7,418
Tohoku Electric Power Co.	251	14,516	78,992	1,497	12,639	2,422	10,853	3,274	—	16,550
Tokyo Electric Power Co.	676	54,496	280,167	4,733	38,117	8,987	38,192	17,308	1	64,487
Chubu Electric Power Co.	431	24,327	122,849	2,050	16,600	5,219	23,904	3,504	6	32,632
Hokuriku Electric Power Co.	118	5,159	27,175	459	4,716	1,817	4,400	1,746	—	7,963
The Kansai Electric Power Co.	489	28,178	141,605	2,294	22,143	8,196	16,357	9,768	—	34,321
The Chugoku Electric Power Co.	186	10,714	57,911	951	9,871	2,905	7,801	1,280	—	11,986
Shikoku Electric Power Co.	146	5,422	27,496	488	6,003	1,141	3,501	2,022	1	6,665
Kyushu Electric Power Co.	237	16,653	83,392	1,312	12,543	2,979	11,785	5,258	3	20,025
Total-9 companies	2,648	157,790	851,038	14,310	128,263	34,898	120,908	46,230	10	202,046
The Okinawa Electric Power Co.	8	1,543	7,478	152	1,554	—	1,924	—	—	1,924
Total-10 companies	2,656	159,128	858,516	14,461	129,817	34,898	122,832	46,230	10	203,970

b.Comparison of Electric Power Generation with Other Countries

Due to electricity's convenience, its consumption continues to increase steadily. Power sources are being continually developed and combined, resulting in the wide variety of combinations now in use in different countries. The figure on the right shows a comparison of the composition of electric power generation in major countries in 1980 and 2008 as based on information from OECD Energy Balances.

Steady Increase in Power Generation

A comparison of electric power production in 1980 and 2008 shows an average increase of approximately 101% in the total power produced in the seven major countries. This reconfirms that electric power consumption has been increasing due to the improvement and the maintenance of the production level and the living standards in all countries. At the same time, due to factors such as energy security, limited resources and the increasing concern with environmental problems, dependence on oil in the major countries has declined over the past 25 years. This decline has been particularly evident in Italy, France and Japan. In contrast, the use of natural gas as a primary energy source is increasing.

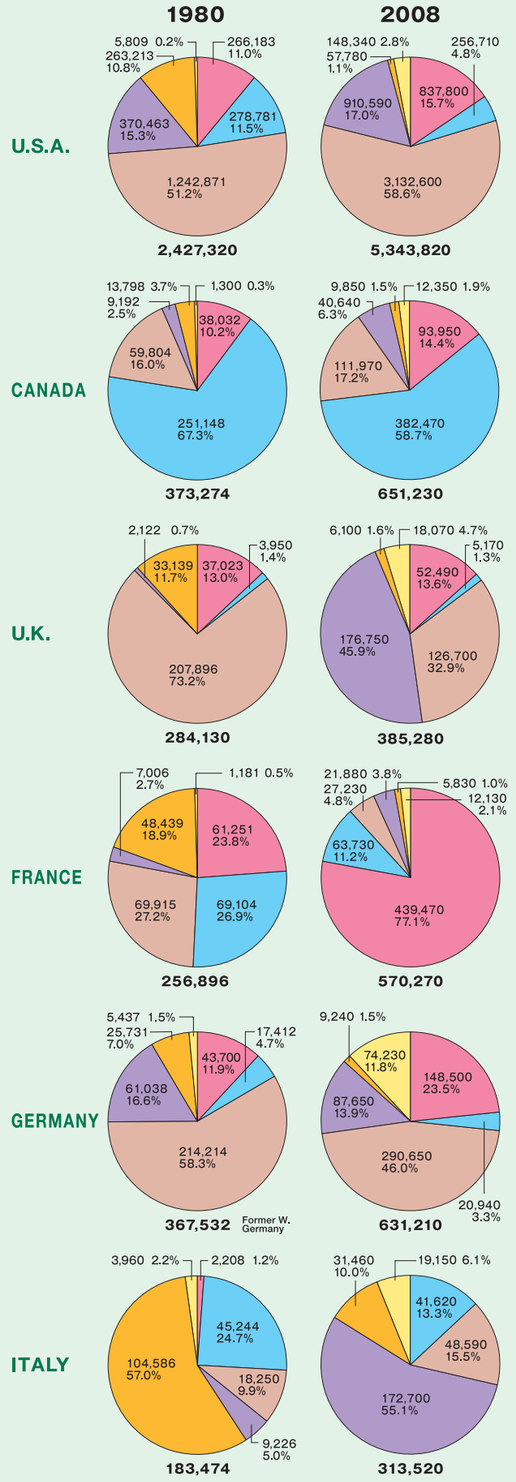
Electric Power Generation by Energy Source in Different Countries

(Including Privately Generated Power and CHP Plant)

Oil Gas Coal Hydroelectric Nuclear Others

Source: OECD ENERGY BALANCES OF OECD COUNTRIES

Unit: Million kWh

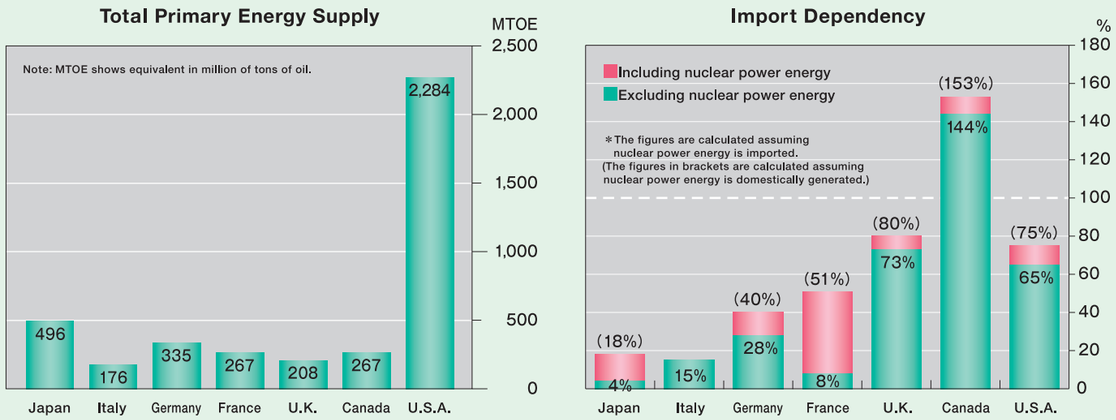


A Balanced Electric Power Composition

Japan relies on imports for 96% of its primary energy requirements. Given this situation, electric power development which depends on a particular energy source presents security and other problems. The best solution for Japan is to select an optimal combination of the three energy group sourses of hydro, nuclear and fossil fuel including oil, coal and LNG.

Primary Energy Supply and Import Dependency for Major Countries 2008

Source: OECD ENERGY BALANCES OF OECD COUNTRIES



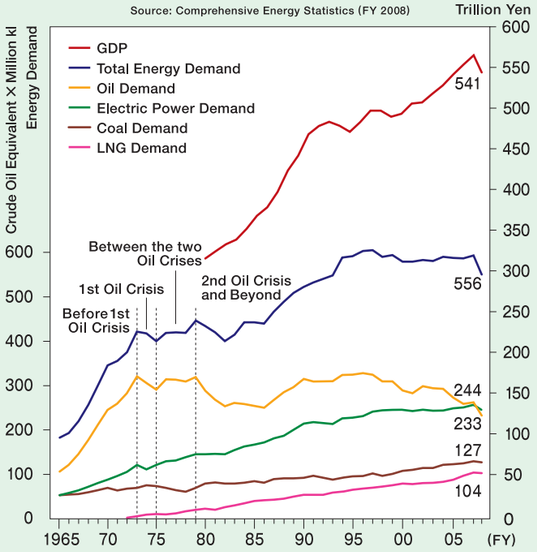
c.Energy Consumption in Japan

Changes in Demand

Japan's energy demand peaked at 443 million kl (crude oil equivalent) in 1979, but thereafter, with the oil crisis stimulating increased energy conservation, it declined annually until 1982. Demand rose again in 1983, but the rate of growth was relatively low in comparison to past trends. This was mainly due to factors such as the shift from high energy consumption industries to low energy consumption industries in the manufacturing sector and the progress achieved in energy conservation programs. However, despite the marked decrease in dependency on oil, overall demand for electric power has continued to rise steadily along with the increased use of electrical appliances such as computers.

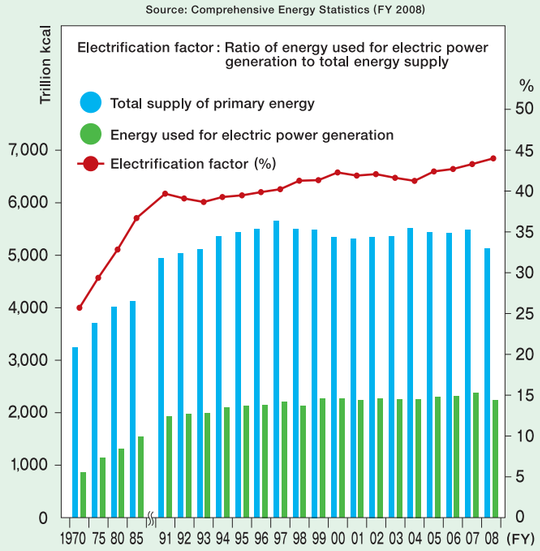
Changes in Energy Demand and GDP

Source: Comprehensive Energy Statistics (FY 2008)



Trend of Japan's Electrification

Source: Comprehensive Energy Statistics (FY 2008)



Dealing with Global Environmental Issues

There is currently considerable worldwide interest and concern in environmental issues such as global warming, acid rain, desertification, and the destruction of the ozone layer. It is essential that we seek an accurate understanding of these problems and act in an concerted effort, both as individuals and as members of society. Environmental problems are closely linked to the way we utilize energy for economic activities and in our daily lives. Energy demand tends to increase yearly in proportion to economic and social development, and as our contemporary imformation-oriented society develops toward a higher level of sophistication and our lifestyles become increasingly centered on amenities, the demand for electricity can be expected to rise further. The electric utility industry is fully committed to global environmental issues in all its activities, including power supply, transmission and distribution. Recognizing our responsibility to pass on economic and social progress to future generations, we pursue a policy of socioeconomic development combined with active measures to protect the environment and conserve our irreplaceable natural resources. Efforts undertaken by the industry to deal with global warming, a problem closely related to the electric utility industry as part of the energy sector, are presented below.

Finding a Solution to Global Warming

CO_2 emissions, a principal cause of global warming, are a major challenge for the electric utility industry. Accordingly, the Federation of Electric Power Companies has set up several types of committees, including the "Investigative Committee on Global Warming," to conduct research and study of various approaches. A comprehensive approach is required in order to control CO_2 emission levels. Steps to cut CO_2 emissions are mainly based on two sections as shown in the figure below: the supply and demand sides. The electric utility industry comprehensively considers a stable energy supply, economic security and environmental conservation (3Es), and seeks to achieve a well-balanced combination of energy sources through the appropriate introduction of nuclear power and LNG power generation systems, based on a proper assessment of these power sources in terms of supply stability. At the same time, efforts are being made to upgrade thermal efficiency in power plants and reduce energy losses in power transmission and distribution systems. The electric utility industry will continue to actively work on the CO_2 issue by focusing on the following activities.

a. Expanding use of non-fossil energy sources
b. Improving efficiency of electric power equipment
c. Energy conservation

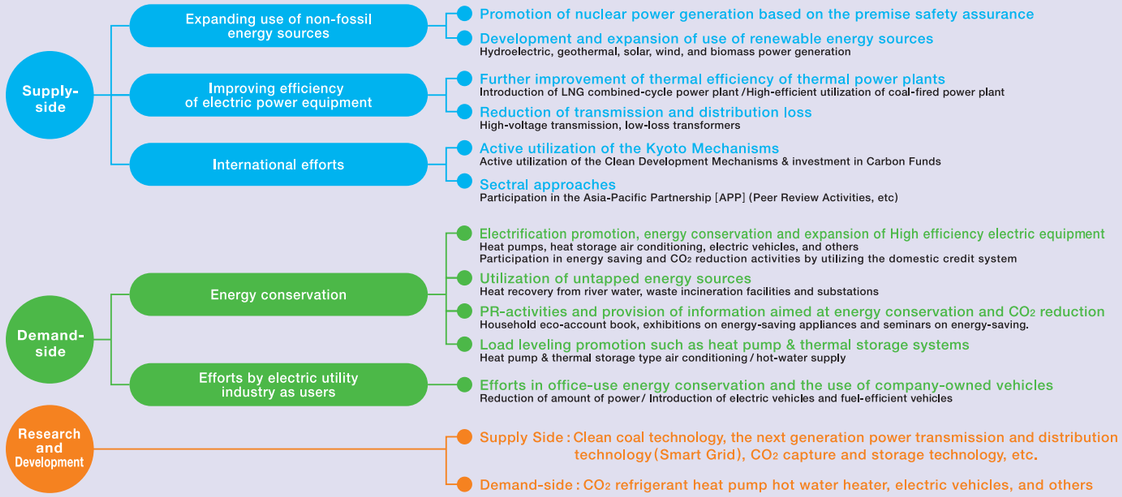
CO_2 emission levels in the electric utility industry have risen by 1.9 times since the Oil Crisis in the 1970s, while power demand has increased by 3.3 times since then. As a result, CO_2 emission intenslty (end use electricity) were 0.351 kg-CO_2/kWh in fiscal 2009 (after Kyoto Mechanism credit is reflected). Resolving to continue to lower CO_2 emissions, the electric utility industry has set a target to reduce CO_2 emission intensity (end use electricity), although electricity demand will continue to increase. As part of its efforts, the industry formulated the "Environmental Action Plan by the Japanese Electric Utility Industry" in November 1996, and completed its 13th review in September 2010.

(Refer to P.37 to P.40 for details.)

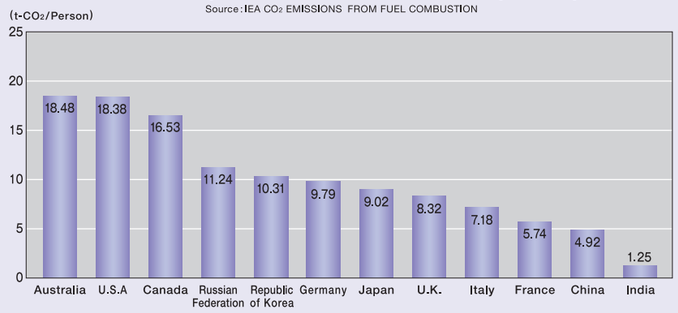
CO_2 emissions suppression target of the electric utility industry

From fiscal 2008 to fiscal 2012, we aim to further reduce CO_2 emissions intensity (emissions per unit of user end electricity) by an average of approximately 20% from the fiscal 1990 level, to about 0.34 kg-CO_2/kWh.

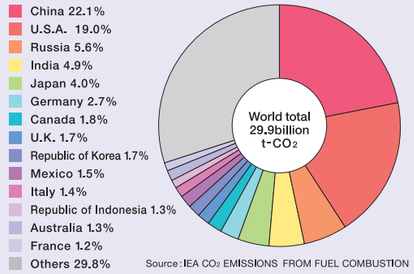
CO_2 Emissions Suppression Measures



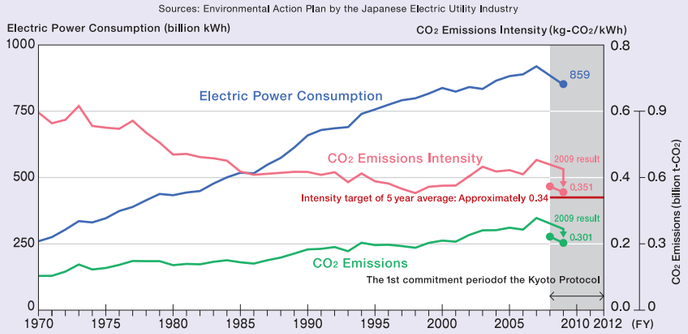
International Comparison of CO_2 Emissions per Capita 2008



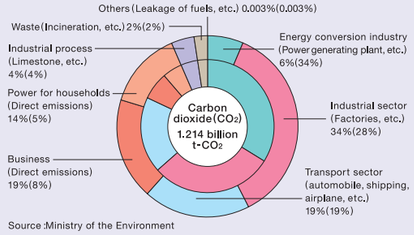
International Comparison of CO_2 emissions 2008



Trends in CO_2 Emissions by the Electric Utility Industry



CO_2 Emission Levels by Sector in Japan 2008



Source : Ministry of the Environment

The outside circle shows CO_2 emission levels due to electric power generation assigned to respective final demand sectors in accordance with their electricity consumption. The figures in the inside circle are ratios of direct emissions (figures in parentheses).

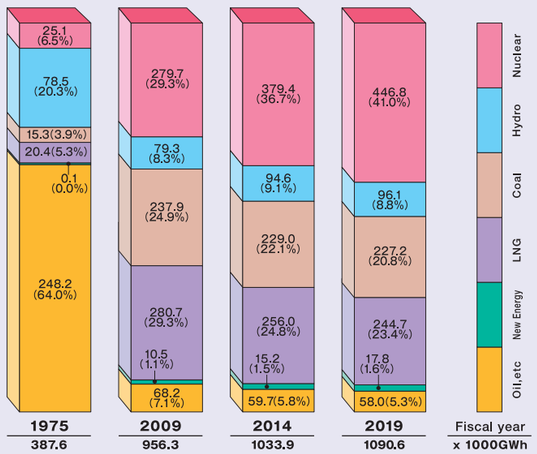
Note : Respective shares might not necessarily total 100% due to rounding differences. Percentages above indicate the ratio to total CO_2 emissions, respectively. Other sectors includes statistical error and power consumption accompanied by the use of lubricating oils etc.

a. Promoting a Stable and Well-Balanced Combination of Power Sources

The three types of power generation systems—hydroelectric, thermal and nuclear—have different operational characteristics and economic efficiency. To counter the environmental threat of global warming and ensure stable and efficient power supply, a well-balanced combination of electric power sources is essential without excessive dependence on one particular form of energy. To that end, the industry stresses the combined use of different power sources including hydroelectric, thermal (oil, coal and LNG) and nuclear at optimally balanced percentages. Active efforts are also necessary to develop and use natural power sources such as geothermal, solar and wind power along with biomass as a renewable energy source with the aim of achieving greater diversification in power generation sources.

Composition of Electric Power Production

for the Ten EPCs, EPDC and Others Source: The Federation of Electric Power Companies



Genkai Nuclear Power Station, Kyushu Electric Power Co.

Shin-Nagoya Thermal Power Station (LNG), Chubu Electric Power Co.

No.2 Numasawa Hydro electric Power Station, Tohoku Electric Power Co.

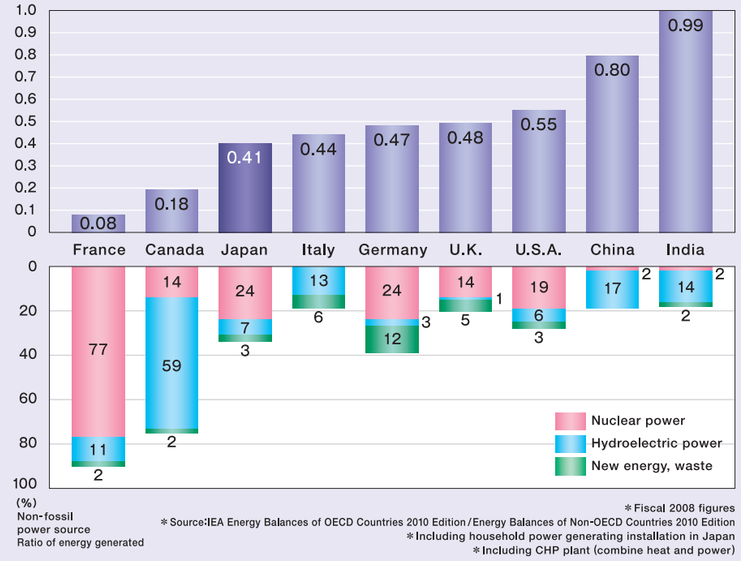
Tsuruga Thermal Power Station (coal), Hokuriku Electric Power Co.

Promotion of Developing Nuclear Power

Nuclear power is one of the most important power sources currently in use in Japan. Located in Ibaraki Prefecture, Japan's first commercial nuclear power plant started operation in 1966. As of September 2010, 54 plants with a total output capacity of 48,847MW are in operation throughout Japan. As a core energy resource, nuclear power has played an important role in recent years, accounting for roughly 30% of the total power generated. Japan is a country with few domestic natural resources, and with the anticipated continued increase in the demand for electricity, nuclear power is expected to continue playing a vital role as a quasi-domestic energy source. The most important alternative to oil, nuclear power offers excellent supply stability and economic efficiency. Nuclear power does not produce CO_2, hence its use contributes to the prevention of global warming. For these reasons, nuclear power will continue to serve as the core energy source for power generation in Japan.

Comparison of CO_2 Emissions intensity (power generating end) in Major Countries 2008

Preliminary Calculation by the Federation of Electric Power Companies



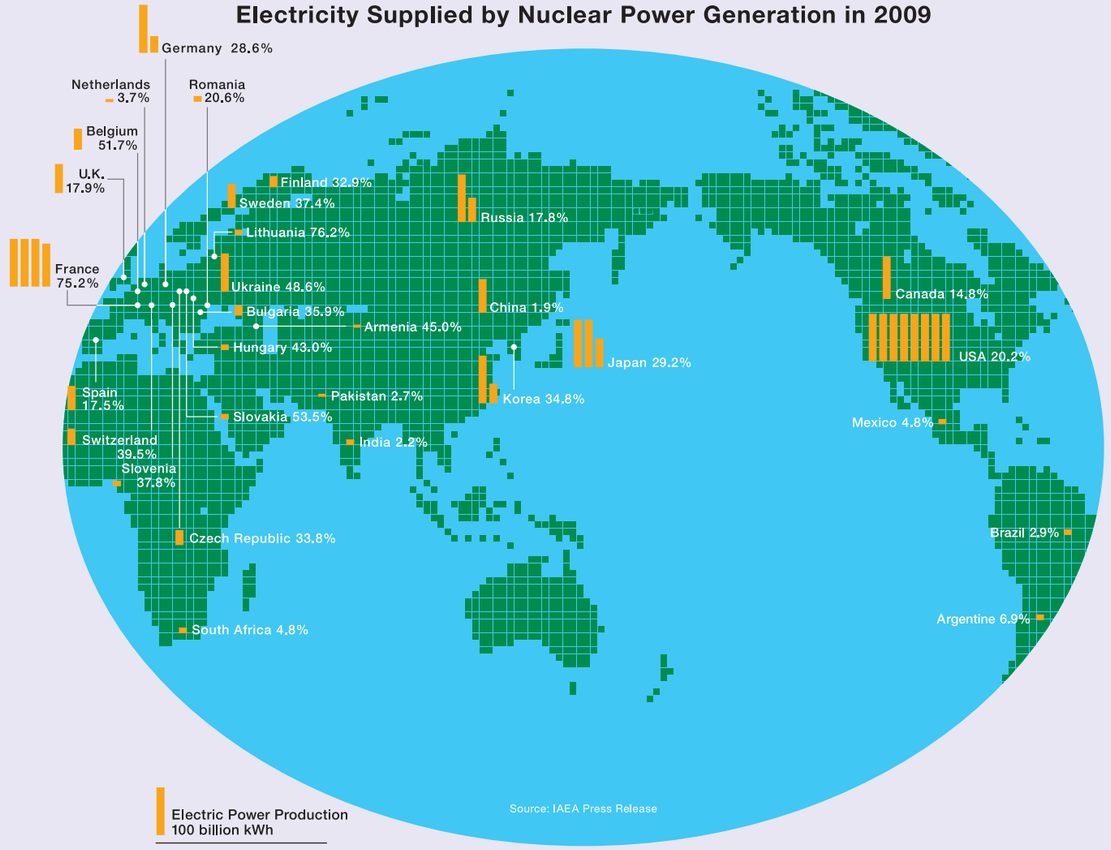
＊Fiscal 2008 figures

＊Source : IEA Energy Balances of OECD Countries 2010 Edition / Energy Balances of Non-OECD Countries 2010 Edition

＊Including household power generating installation in Japan

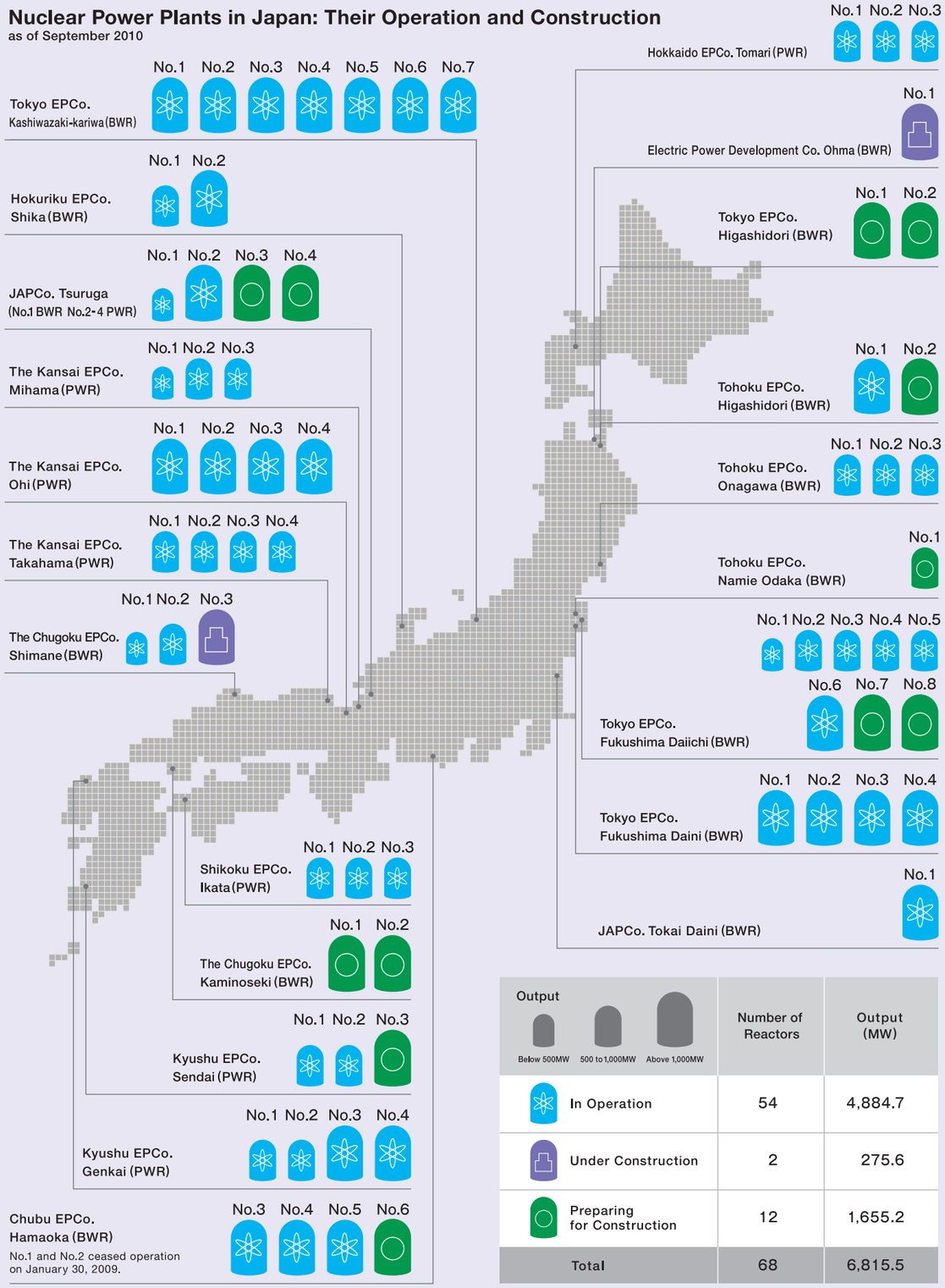
＊Including CHP plant (combine heat and power)

Electricity Supplied by Nuclear Power Generation in 2009



Nuclear Power Plants in Japan: Their Operation and Construction

as of September 2010



Output (Below 500MW / 500 to 1,000MW / Above 1,000MW)	Number of Reactors	Output (MW)
In Operation	54	4,884.7
Under Construction	2	275.6
Preparing for Construction	12	1,655.2
Total	68	6,815.5

Development and Expansion of Use of Renewable Energy Sources

Based on global environmental issues, electric power companies are putting effort into research and development and promoting the introduction of natural energy power systems including solar, geothermal, and wind power. Renewable energy development is conducted by the establishment of wind and solar power generation facilities by electric power companies and also by mixing woodchip biomass and sewage-derived fuel in coal-fired power plants. Due to the various conditions in Japan, there is high expectation for solar power generation among the renewable energy systems; however, installation costs are a major obstacle. Therefore, the electric utility industry will take an initiative in introducing mega solar power generation in order to prove the influence of large-scale solar power generation on the transmission network and begin price reductions. To realize this idea, the entire electric utility industry will carry out construction of mega solar power stations with capacities of around 140,000 kW in about 30 locations by 2020. Electric power companies will promote this expansion by purchasing excess electricity generated by environment-friendly natural energy such as wind and solar power, which do not use fossil fuels. Also, the “Green Power Fund System,” which is a system which has customers who agree to natural energy expansion contribute a certain amount of money, was implemented in October 2000. Furthermore, the government started a new solar power generated electricity purchasing system in November 2009. The electric utility industry will cooperate with this system in order to expand solar power generation.

Matsuyama Photovoltaic Power Generation Station, Shikoku Electric Power Co.

Miyako Photovoltaic Power Verification Research System, The Okinawa Electric Power Co.

Yanaizu-Nishiyama Geothermal Power Station, Tohoku Electric Power Co.

Noma-misaki Wind Park Power Station, Kyushu Electric Power Co.

	Features	Present Conditions
Photovoltaic Power Generation	Photovoltaic power generation provides a clean, universally available source of energy. Power generation is carried out using solar cells which produce electricity when exposed to sunlight. It has many drawbacks, such as cost, decline in electrical output at night or during bad weather, and a low energy density which necessitates the use of a large surface area to generate power on a large scale.	Corroborative research and trial operations are being conducted using generators with outputs of several kilowatts. As of the end of fiscal 2009, units totalling 6,168kW of output had been installed.
Geothermal Power Generation	Japan, one of the world’s most volcanically active regions, is blessed with plentiful geothermal resources. Great expectations are being placed on the development of geothermal energy as a valuable domestic energy source that provides clean energy without the SOx and NOx emissions which accompany the use of fossil fuels.	There are twelve locations in operation as part of the electrical power industry, producing 499,600kW of power. (End of fiscal 2009)
Wind Power Generation	Wind power is harnessed by using the energy of the wind to turn a windmill, which in turn powers a generator. Its drawbacks include low energy density and the influence of variable wind conditions, but it has the benefit of using an inexhaustible natural source of energy.	Corroborative testing and operation with an output in the order of several hundred kilowatts is being carried out on isolated islands and in windy areas. Installation of 15,444kW capacity was achieved by the end of fiscal 2009.

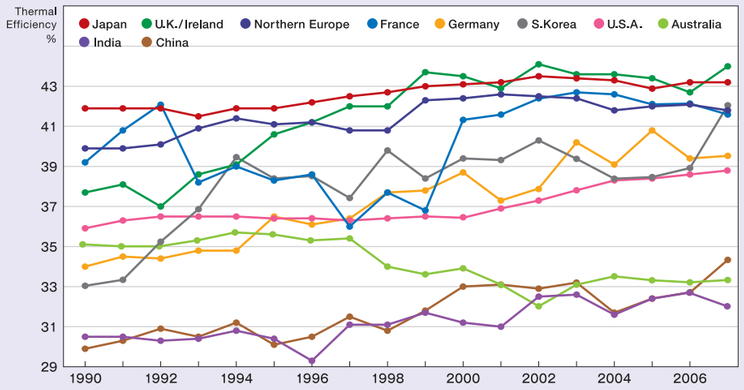
b.Improved Efficiency of Power Facilities

Improved thermal efficiency in thermal power stations and reduced power loss during transmission and distribution are closely related to energy conservation and CO_2 emissions suppression. Operating within limitations caused by the fact that Japan has no significant natural resources of its own, the electric utility industry has constantly made efforts to ensure the efficient utilization of energy sources. These include the construction of large-scale power generation facilities with higher thermal efficiency from improved steam conditions (temperature and pressure). Thermal efficiency and transmission/distribution loss factor in Japan are currently among the best in the world.

Kawasaki Thermal Power Station, Tokyo Electric Power Co.

Comparison of thermal power plant efficiency in Japan with other countries

Sources: International Comparison of Fossil Power Efficiency and CO_2 Intensity, 2010 (ECOFYS)



*Thermal efficiency is the gross generating efficiency based on the weighted averages of efficiencies for coal, petroleum and gas (lower heating value standard).

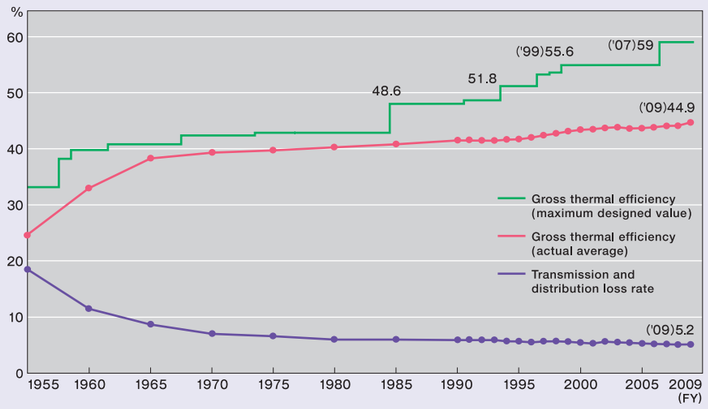
*Comparisons are made after converting Japanese data (higher heating value standard) to lower heating value standard, which is generally used overseas.The figures based on lower heating value are around 5-10% higher than the figures based on higher heating value.

*Private power generation facilities, etc. not covered.

*Figure is based on fiscal year for Japan

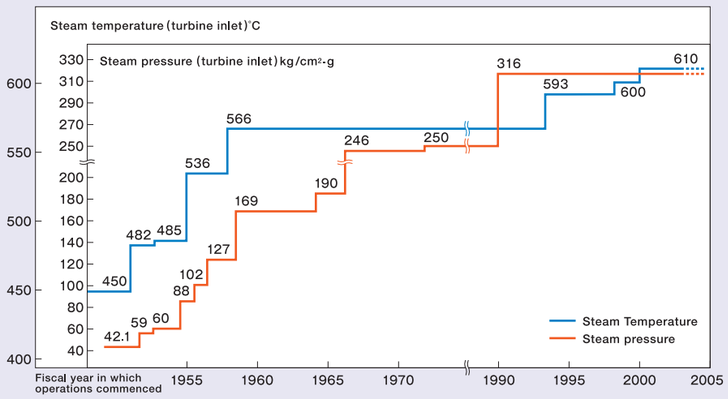
Improvements in Thermal Efficiency (Lower Heating Value) and Transmission/Distribution Loss factor in Thermal Power Generation Facilities

Source: Japan Electric Utilities Handbook, etc.



*Lower heating value standard is estimated based on the higher heating value standard using the conversion factor of explanation of the comprehensive energy statistics (2007).

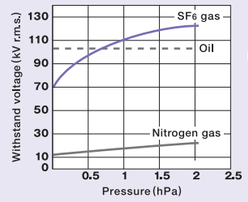
Improvements in Steam Temperature and Pressure in Thermal Power Generation Facilities



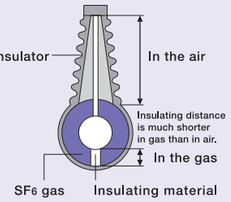
c.For the Use of Sulfur Hexafluoride (SF_6)

SF_6 gas, a compound of fluorine and sulfur, features excellent insulation, arc-extinguishing capabilities and stability, as well as being safe for human beings. In the electric utility industry, SF_6 is often used for gas circuit breakers (GCB) and gas-insulated switch gear (GIS). Equipment can be configured in a compact package and because of its high level of safety and compatibility with the environment, its application has become vital in Japan to ensure stable power supplies. On the other hand, SF_6 has been said to have a high global warming potential. At the Third Conference of Parties to the UN framework Convention on Climate Change held in Kyoto in 1997, it was listed as a gas to be restricted under the Kyoto Protocol. Because an effective insulating gas that substitutes for SF_6 has not been found and the electric utility industry will have to continue to use SF_6 in the future, the industry has set voluntary targets for emissions from these devices at the time of inspection (about 3%) and at their retirement (about 1%) from the viewpoint of promoting the recycling and the restricting of emissions of SF_6 as much as possible. These commitments were formulated in the “Voluntary Action Plan on SF_6 Emission Restrictions in the Electric Utility Industry” in April 1998, and corresponding measures were taken later.

Excellent Insulation

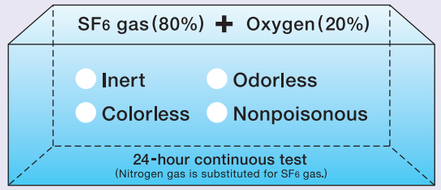


Comparison of dielectric strength

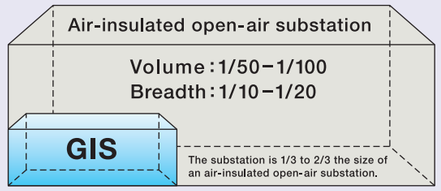


Insulating distance

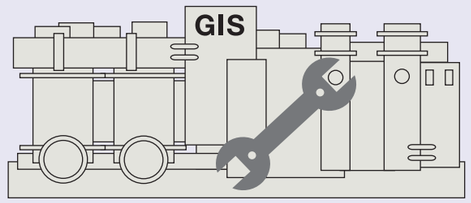
Safe and Stable Gas



Environmentally Harmonious without Requiring a Large Space



Rationalized Maintenance Operations



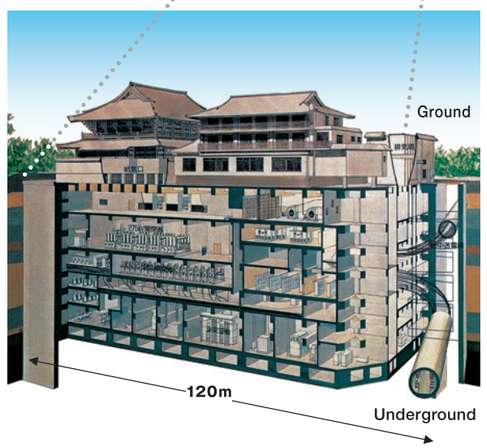
Comparison of Both Substation Types

An air-insulated-type open-air substation

Kitakumagaya-Substation, Tokyo Electric Power Co. (275kV, 900MVA)

A gas-insulated-type underground substation

Takanawa-Substation, Tokyo Electric Power Co. (275kV, 1080MVA)



Efforts toward Environmental Protection and Harmony

When establishing thermal, nuclear and other power-generating facilities, comprehensive environmental impact studies are carried out to assess air and water quality, noise, vibration, organisms and the possible effects on the surrounding environment. Information obtained is submitted to national and municipal authorities for approval, and conveyed to the residents of the area for their understanding. Since Japan relies on imports for almost all fuels and utilizes seawater as a coolant in condensers, thermal and nuclear power stations in Japan are located along the coast. The seawater is used to cool steam generated in the station, and is consequently warmer when released back into the ocean. In light of this fact, when designing condensers and cooling water pumping stations, measures to minimize the effect of the thermal effluent on the surrounding marine environment, such as the reduction of difference in temperature between inflowing and outflowing water and the control of flow speeds, are implemented in accordance with the local conditions. Even after a power station has commenced operations, continuing efforts are made to ensure that the assessments made in the environmental impact studies are fully observed. In comparison with other countries, Japan's electric power industry follows extremely stringent environmental qual-ity and emission level standards. In addition, through agreements with municipal authorities, regional emission levels are often much lower than nationally prescribed standards. To highlight the industry's commitment to environmental protection, the following examples focus on atmospheric and water quality conservation measures, efforts to control wastes, anti-noise and anti-vibration measures, greening programs and environmental assessment procedures.

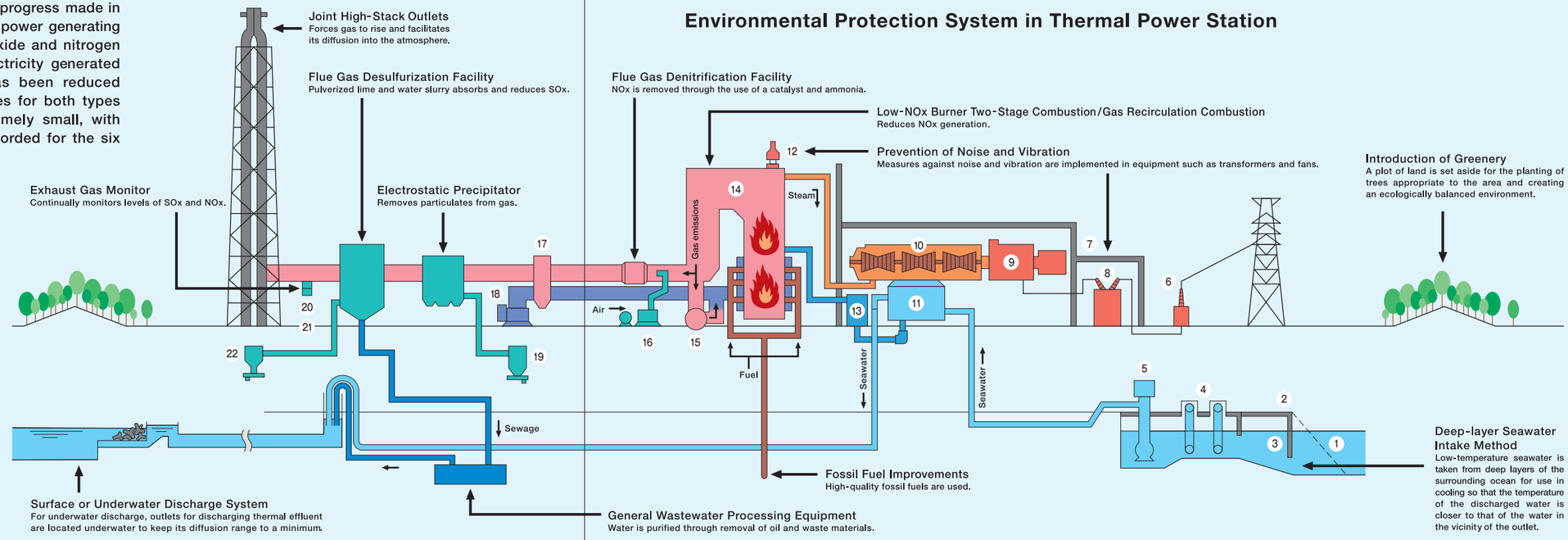
Yanai Thermal Power Station (LNG), The Chugoku Co.

Coastal Power Station

(1) Protection of the Atmosphere a.Reduction of SOx and NOx Emissions

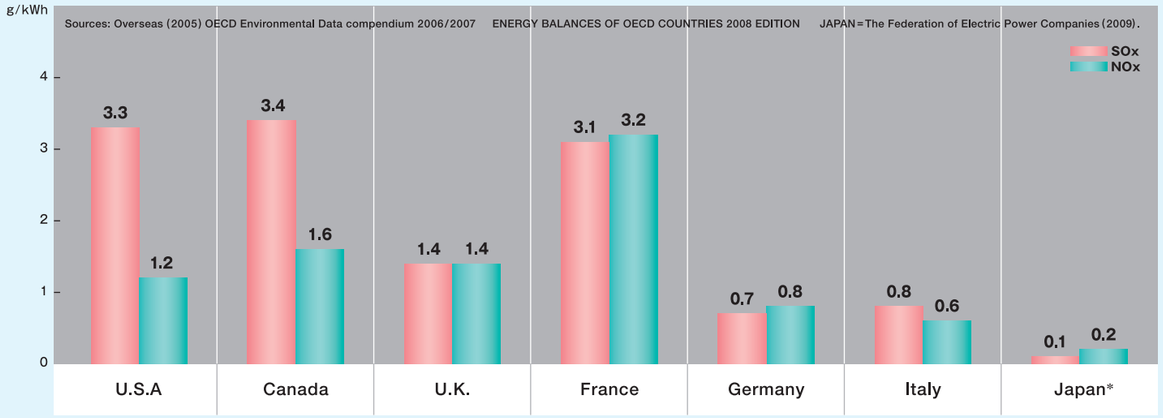
From the mid-1970s, through progress made in improving fossil-fuel quality and power generating facilities, the volume of sulfur oxide and nitrogen oxide emissions per unit of electricity generated by thermal power in Japan has been reduced drastically. At present, the values for both types of noxious emissions are extremely small, with figures much lower than the recorded for the six leading OECD countries.

Environmental Protection System in Thermal Power Station



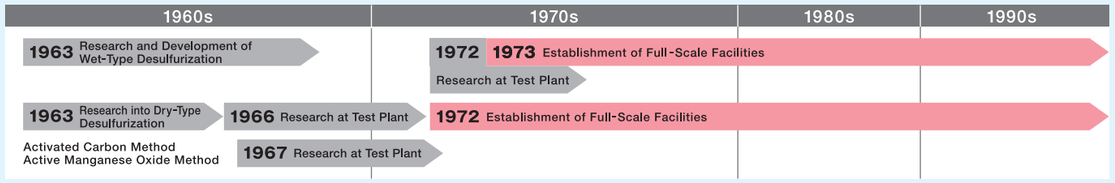
1	Net to Keep Out Jellyfish	12	Safety Valve Muffler
2	Curtain Wall	13	Feed Water Pump
3	Intake	14	Boiler
4	Screen	15	Gas Mixing Fan
5	Cooling Water Pump	16	Ammonia Injector
6	Switching Device	17	Air Preheater
7	Soundproofing Wall	18	Forced Draft Fan
8	Main Transformer	19	Ash Treatment Equipment
9	Generator	20	NOx Continuous Measurement Facility
10	Steam Turbine	21	SOx Continuous Measurement Facility
11	Condenser	22	Manufacturing Facility

SOx and NOx Emissions per Unit of Electricity Generated by Thermal Power in Each Country

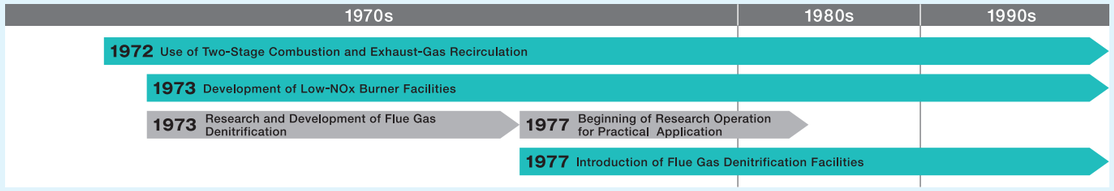


*(10 electric power companies and Electric Power Development CO.,LTD)

Operation of SOx Treatment Facilities



Operation of NOx Treatment Facilities



b.Keep the Air Clean

The industry actively promotes a “Keep the Air Clean” policy with regard to fuel, equipment and operating procedures. Emissions of air pollutants such as sulfur oxides, nitrogen oxides and particulates are reduced through an appropriate combination of these three countermeasures.

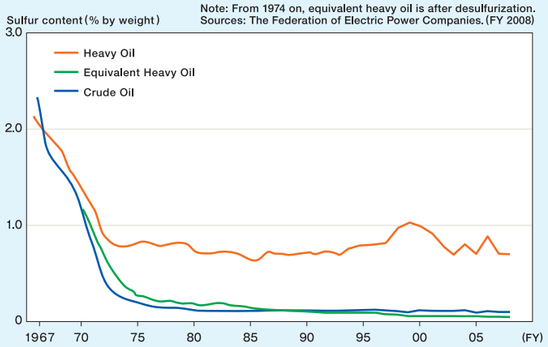
1. Fuel

Continuous reduction of SOx, NOx and particulate emissions is being achieved through the use of high-quality fuels such as heavy/crude oil and coal grates with low sulfur and nitrogen and LNG that contains no sulfur or particulates.

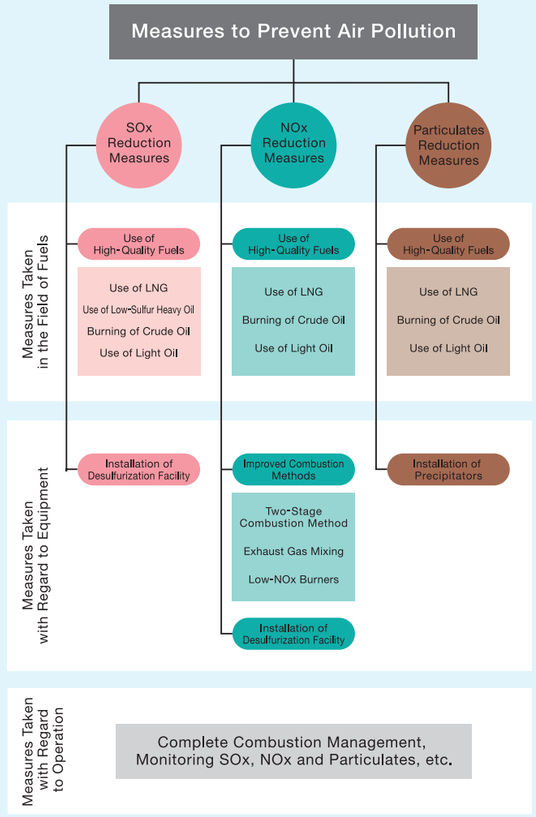
Shin ooita Thermal Power Station(LNG), Kyushu Electric Power Co.

Changes in Sulfur content of Fuels

Note: From 1974 on, equivalent heavy oil is after desulfurization.
Sources: The Federation of Electric Power Companies.(FY 2008)



Outline of Measures to Prevent Air Pollution



2. Equipment

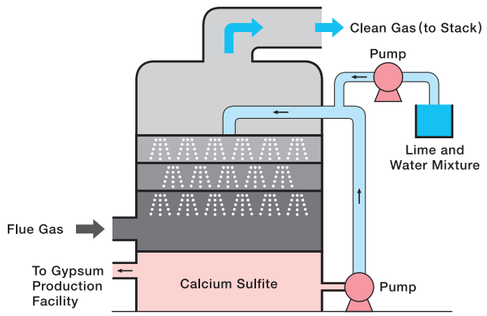
In addition to the above-mentioned measures, the following measures are taken with regard to equipment.

SOx

Sulfur oxides can be removed through the installation of desulfurization facilities using the wet-type lime-gypsum process. In recent years, high-efficiency flue gas desulfurization facilities capable of removing over 90% of SOx have been installed in Japan.

Flue Gas Desulfurization Facility
Reihoku Thermal Power Station (Coal), Kyushu Electric Power Co.

Configuration of Desulfurization Facility



The limestone is powdered and mixed with water. When this is blown as a mist into the flue gas, the sulfur oxides within the exhaust gas react with the lime to form calcium sulfite. This is combined with oxygen, reacting to form gypsum.

NOx

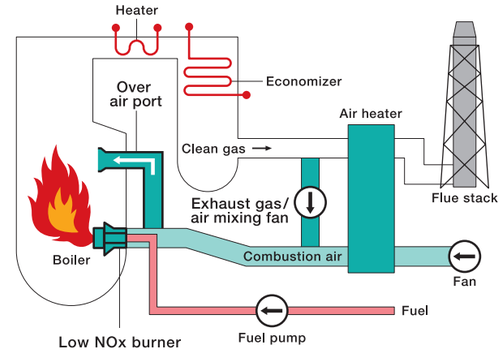
NOx can be controlled and reduced through improved combustion methods and the use of flue gas denitrification facilities. A combination of these methods and facilities is used in Japan. High-efficiency flue gas denitrification facilities capable of removing approximately 90% of NOx produced are operating in the latest combined-cycle LNG thermal power plants located near major urban centers.

- **Mixing of exhaust gases with air**
  In this method, part of the exhaust gases from the boiler are mixed with air for combustion.
- **Two-stage combustion**
  In this method, the air volume required for complete combustion of fuel is supplied in two stages: at the burner inlet and at the burner top (over air port).
- **Low-NOx burner**
  This method improves the way in which fuel is atomized and air is supplied.

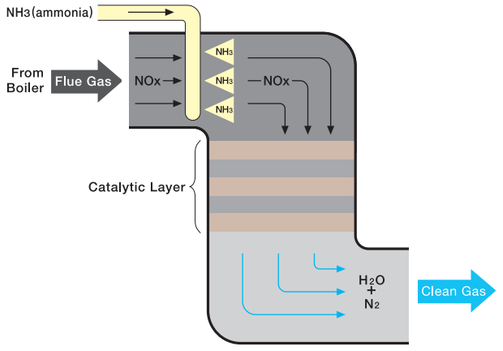
All of the above techniques result in a reduced combustion temperature and are therefore capable of controlling the generation of nitrogen oxides (NOx).

Flue Gas Denitrification Facility
Tomatoatsuma Power Station No.4, Hokkaido Electric Power Co., Inc. (coal)

NOx Emission Control Measures Based on Improvements in Combustion Efficiency



Configuration of Flue Gas Denitrification Facility



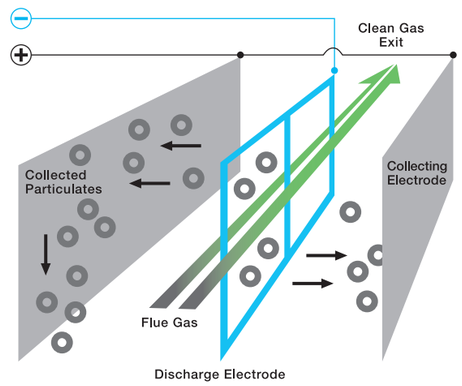
When ammonia is added to the flue gas, which includes NOx, and passed through the catalytic layer, the catalyst causes the NOx to separate into nitrogen and water.

Particulates

In order to reduce particulates, which include unburned carbon in heavy/crude oil combustion and fly ash in coal combustion, power producers in Japan have installed high-efficiency electrostatic precipitators which remove over 80% of particulates in almost all heavy/crude oil combustion and over 99% of particulates in coal combustion.

Electrostatic Precipitator
Saijo Thermal Power Station (Coal, petroleum), Shikoku Electric Power Co.

Configuration of Electrostatic Precipitator



The electrostatic precipitator uses a voltage differential between two electrodes to extract and collect particulates.

(2) Conservation of Water Quality

a.Warm Discharged Water

A thermal power station discharges approximately 40-45m^3/s per 1 million kW of warm discharged water. Combined-cycle power generation, employing a combination of gas and steam turbine, offers higher efficiency and produces only about 60% of the aforementioned quantity of warm discharged water. A nuclear power plant, with its different steam conditions, generates about 50% more discharged water, which rapidly cools down and takes on the same temperature as the surrounding seawater when it mixes with the currents and the tidal flow, and also when heat is dissipated into the atmosphere.

1. Warm Discharged Water Using Deep-Layer Seawater for Cooling

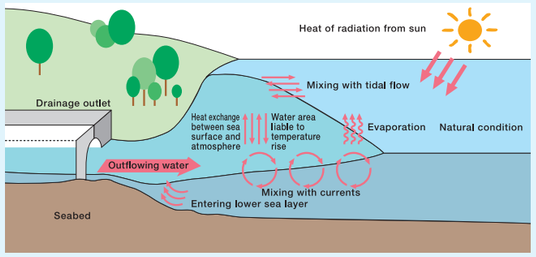
In the past condensers for cooling water in thermal and nuclear power stations were designed for a temperature rise of 8-10℃, but from the mid-1970's they have been designed for a temperature rise of 7℃ or lower. A system now in use pumps up water from the deep layers of the sea to be used as cooling water in the power plant, and discharged after cooling so that the temperature difference between the discharged water and the seawater around the discharge aperture is minimized. This means that the warm discharged water from the power station is discharged into the surface layer of the sea to make use of the large surface area for more efficient heat dissipation into the atmosphere and seawater. In some cases, the discharged water is discharged into the middle layer of the sea to achieve a more rapid cooling process. The warm effluent cools down quickly as it mixes with the currents and is swept away into the surrounding seawater.

2. Effect of Warm Discharged Water on Marine Environment

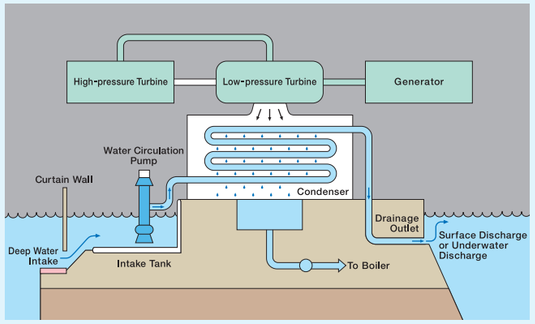
Long-term monitoring studies have been conducted at thermal and nuclear power stations for a predetermined period to assess the effect of warm discharged water on the marine environment. The results have shown that while marine life is subject to certain natural variations, especially seasonal changes, there are no particularly noteworthy changes on a yearly basis. Scientific field studies and experiments at power stations in various parts of Japan have been conducted independently by the Marine Bio-Environment Research Institute, an organization under the joint jurisdiction of the Ministry of Agriculture, Forestry and Fisheries, the Ministry of Environment, and the Ministry of Economy, Trade and Industry. The results of the institute's studies have likewise confirmed that warm discharged water has no measurable effect on the marine environment.

3. System for Effective Utilization of Warm Discharged Water

Heat contained in warm discharged water from power stations can be effectively used in a variety of fields to suit specific conditions in the surrounding area. For example, a fish-breeding center or a research institute for seeds and saplings can be set up in the vicinity of a power station. These can make beneficial use of warm discharged water from the power station. A public amenity center, an agricultural crop cultivation station, or an angling/fishing pond could also benefit from the warm discharged water supply offered by a power station.



Flow of Warm Discharged Water



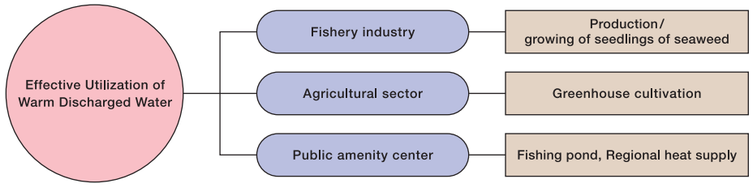
Cooling Water System at Thermal Power Station

Marine life study in the vicinity of the project site.

Ornamental plants grown in greenhouse
Takahama Power Station, The Kansai Electric Power Co.

Fish breeding center in Fukushima Prefecture, Using warm discharged water from the No.1 Fukushima Power Station, Tokyo Electric Power Co.

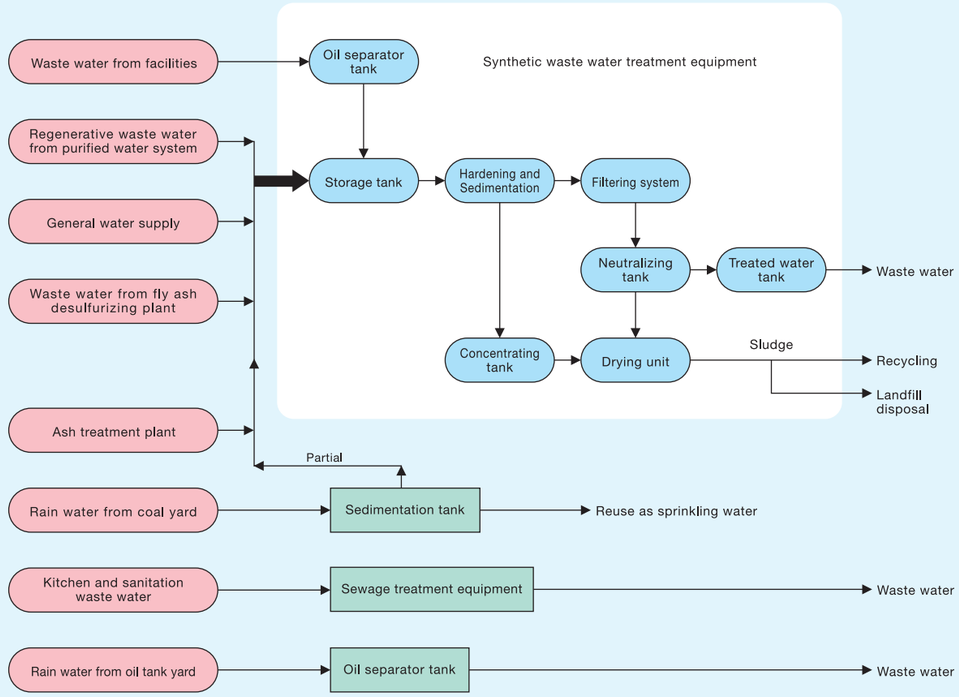
System for Warm Discharged Water Utilization



b.Dealing with Waste Water in Thermal Power Station Complexes

Rain water, waste water related to sanitation and other types of waste water resulting from the operation of thermal power plants are treated in a neutralizing, coagulation and sedimentation system, an oil separator and other systems. Waste water is discharged into the sea only after it has been fully treated.

Waste Water Flow Chart

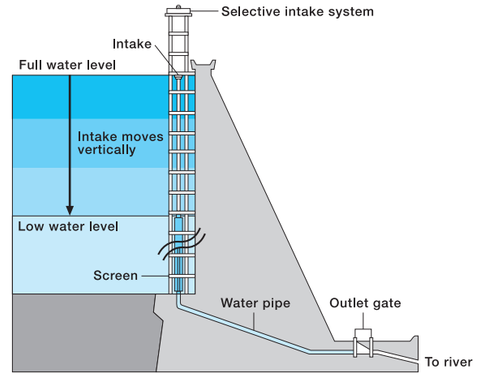


c.Water Quality Control at Hydro Power Station

The selective intake system has been commonly installed at recently constructed hydro power station. The system, which enables adjustment of the depth at which water is withdrawn from a reservoir, aims at preventing low-temperature or turbid water of the reservoir from being discharged downstream.

Sabigawa Dam using selective intake system Tokyo Electric Power Co.

Selective Intake System of a Hydro Power Station

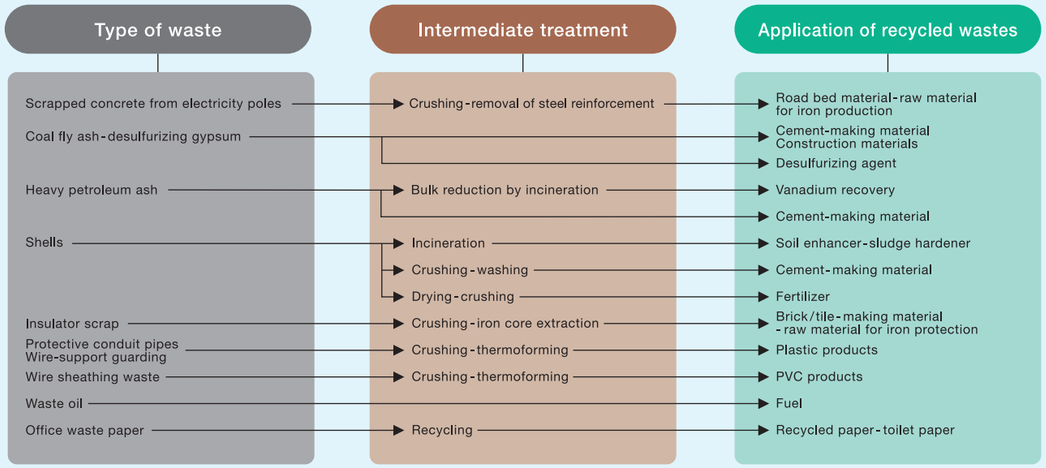


(3) Promotion of a Recycling-based Society

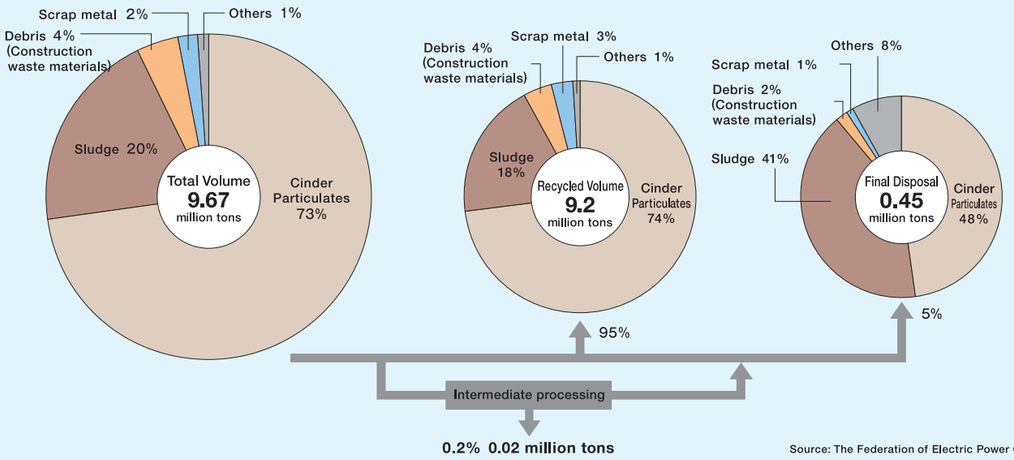
a.Recycling and Reuse of Wastes

Major waste materials include coal ash from thermal plants, debris (construction waste materials) related to power distribution works, such as scrapped concrete electricity poles, scrap metal including electric wires, and desulfurizing gypsum, an important by-product produced in thermal power stations. Every possible effort is made by the industry to efficiently reuse waste products as resources in other industrial sectors. Approximately 97% of all coal ash, which is produced in large volume, is used for cement production, civil engineering works or as a landfill material, whereas all of the desulfurizing gypsum is used in the cement and construction industries. Through research and development, the industry will work to expand the areas in which coal ash in particular can be effectively used. The recycling of used office paper is also being vigorously promoted. A system has been established in which office buildings in a given area, especially in urban areas, cooperate as a single unit sharing know-how on used-paper separation and collection and using fixed, common collection days. This system is beneficial in terms of both volume collected and collection/transport costs. The electric utility industry is undertaking the task of further promoting effective use of resources, including conventional waste recycling and the establishment of nuclear fuel cycles, targeting to form a "recycling-based society." As the voluntary objective, we aim to *make efforts to realize a 95% waste recycling rate in fiscal 2010.* Since the formation of "Environmental Action Plan by the Japanese Electric Utility Industry" in November 1996, we have followed-up every year through the 13th review in September 2010. (Refer to page 40 for details.)

Recycling and Reuse of Wastes



Waste Materials from Electric Utility Industry Fiscal 2009



Source: The Federation of Electric Power Companies.

b.Recycling of Construction Wastes

Efforts are made by the electric utility industry to recycle waste materials generated in construction work, including concrete blocks, asphalt/concrete slabs, wood, and excavated soil.

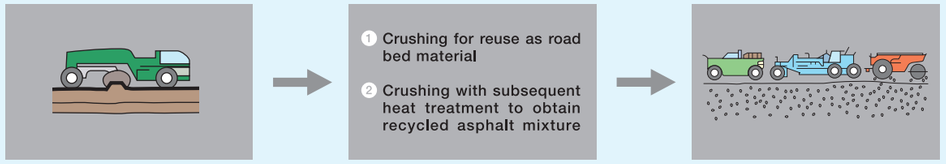
Concrete Blocks

Concrete blocks or lumps from structural demolition work

Concrete blocks are crushed to a size of 0-40mm dia.

Used for laying temporary road bed to support heavy machinery

Asphalt/Concrete Slabs and Blocks



Removal of asphalt surface

① Crushing for reuse as road bed material
② Crushing with subsequent heat treatment to obtain recycled asphalt mixture

Transportation to recycling facility

Road surfacing with recycled asphalt mixture

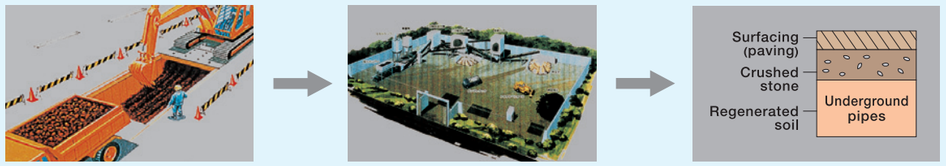
Wood

Cutting of tree branches

Converting wood to chips

Use as fertilizer or mulch

Recycling of Excavated Soil (Currently Under Study)



Trench excavation work

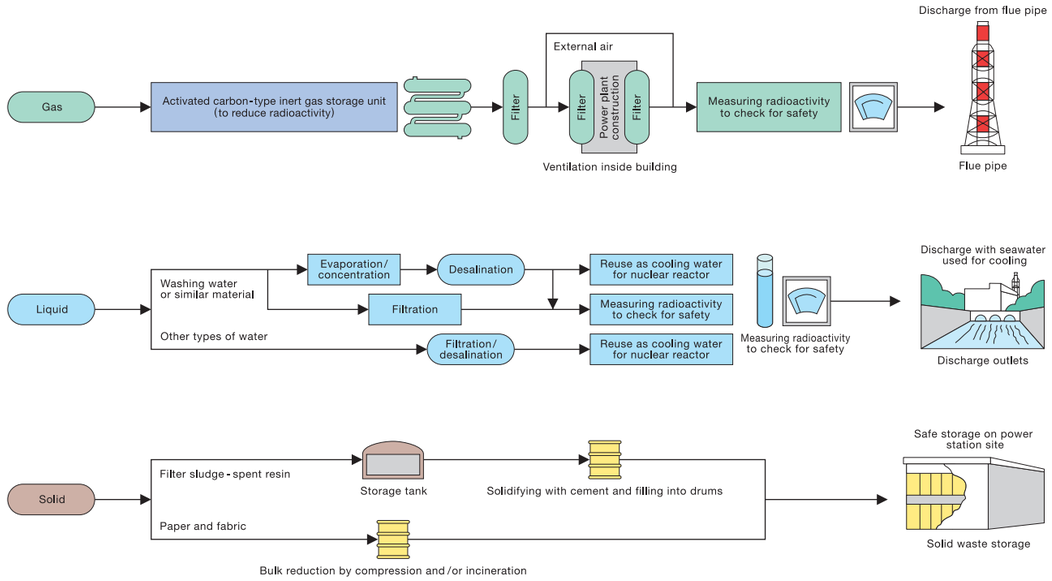
Recycling plant for excavated soil

Refilling of excavated trench

c. Treatment of Radioactive Wastes

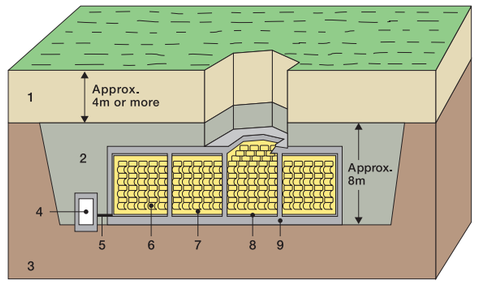
Because wastes from nuclear power stations contain radioactive materials, they fall under a different category than ordinary industrial wastes, as “radioactive wastes,” and are subject to very stringent control under current government regulations. Radioactive wastes are graded low-level or high-level, depending on radioactive concentration levels. Whether low-level or high-level, all radioactive wastes require disposal methods that do not affect the environment.

Disposal of Radioactive Wastes



Example of Buried Low-Level Radioactive Waste

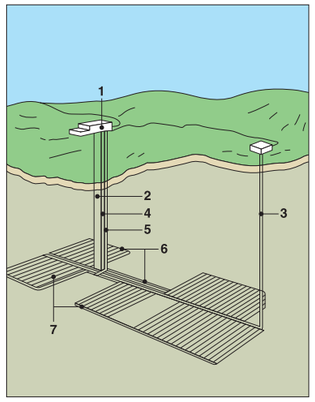
1. Top soil
2. Covering with bentonite-mixed soil
3. Rock bed
4. Inspection corridor
5. Waste water pipe
6. Drum
7. Cement-based filler
8. Porous concrete layer
9. Steel-reinforced concrete pit



Note: Bentonite is virtually impermeable to water.

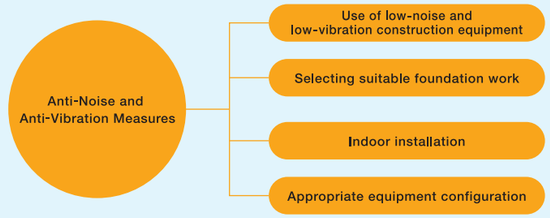
Concept of Underground Disposal of High-Level Radioactive Wastes

1. Ground reception facility
2. Vertical shaft for canister delivery
3. Vertical shaft for ventilation
4. Vertical shaft for human and material access
5. Vertical shaft for emergency access
6. Main tunnel
7. Disposal tunnel



(4) Reduction of Noise and Vibration

Noise and vibration in power stations and substations are reduced by installing generators and transformers indoors as much as possible, by selecting low-noise and low-vibration equipment, and by installing sound absorbers and sound barriers. To cut down noise and vibration further, the equipment is installed on reinforced foundations, and at a maximum distance from neighboring residential areas. Starting from the design stage, measures against noise and vibration are also considered in the construction of buildings. Low-noise and low-vibration construction machines and methods are selected, and a noise barrier is erected during construction.

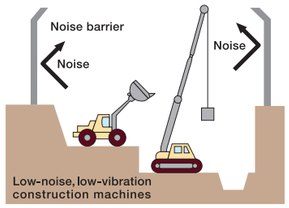


Safety valve silencer

Soundproofing wall

Principal Measures in Construction Work

- Measurement of noise and vibration levels
- Use of low-noise and low-vibration machines
- Erection of noise barrier
- Carefully planned time slot for construction work (voluntary refraining from nighttime work in residential areas)



(5) Greening and Environmental Considerations

The scenic aspects of the surrounding natural environment are taken into consideration in power plant construction projects with provisions for the planting of trees and greenery. Specifically, as measures to preserve scenery, the industry gives consideration in its designs to the shape of on-site buildings, their layout and color schemes, and also keeps land alteration and tree clearing to an absolute minimum. Green belts are created around the facilities, on the outer perimeter of the site, and along the main roads, and greenery projects are otherwise actively conducted using trees and shrubs suited to the location. More than 20% of a new power plant site is set aside for green areas. When recreational facilities such as tennis courts and baseball grounds are added to this, the total area accounts for more than 25% of the plant site. Green belts around power plant facilities are home to a rich variety of wildlife such as wild birds, insects and small animals. Both the green areas and recreational facilities are open to local residents, thus helping build closer relations with the community.

Nanko Thermal Power Station (LNG), The Kansai Electric Power Co.

Power Plants and Their Surrounding Environments

Yanai Power Station (LNG), The Chugoku Electric Power Co.

A Power Plant Surrounded by Rich Foliage

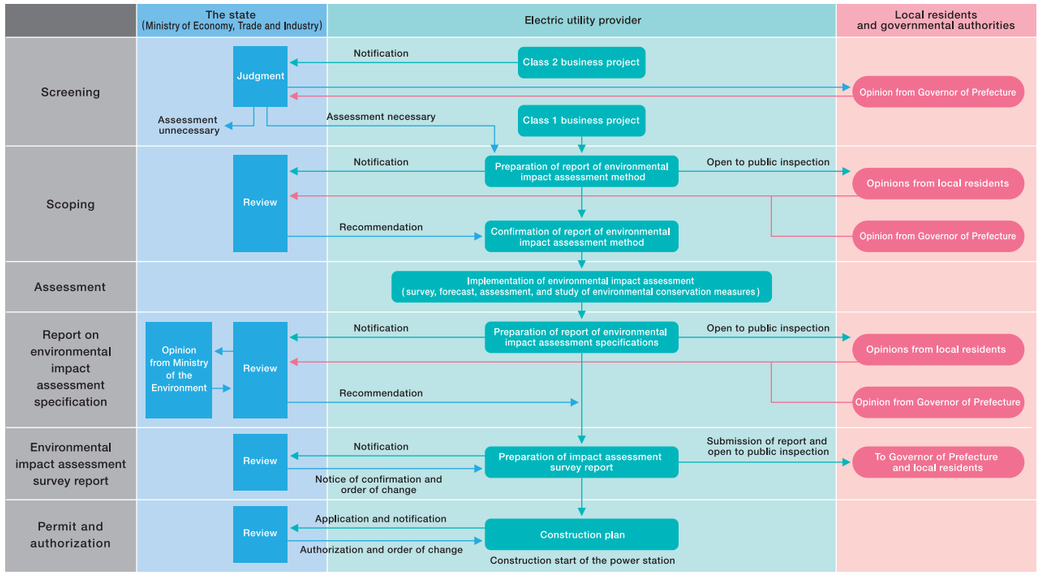
Niigata Thermal Power Station (Petroleum, LNG), Tohoku Electric Power Co.

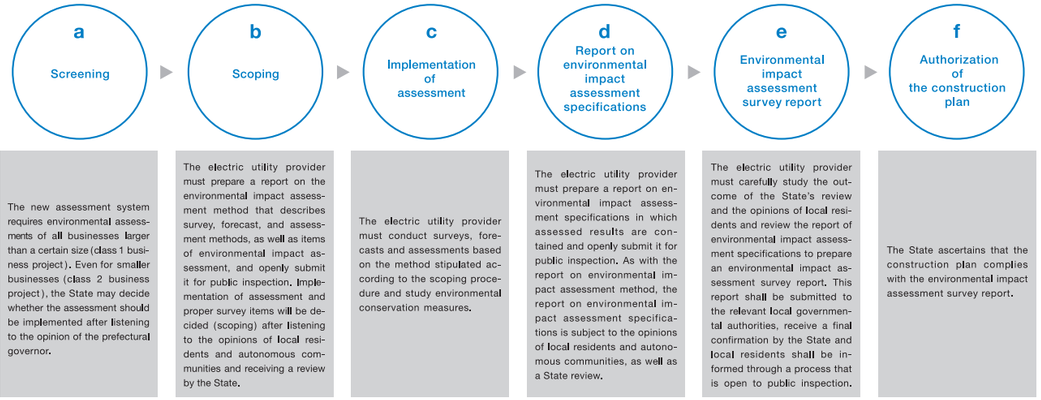
Yokohama Thermal Power Station (LNG), Tokyo Electric Power Co.

(6) Environmental Impact Assessment

The Ministry of International Trade and Industry's July 1977 directive, "Enforcement of Environmental Impact Assessment and Environmental Review for the Construction of Power Plants" provided a clearly defined framework of rules and regulations on environmental impact assessments, based on experience accumulated from about 130 cases. The Cabinet's August 1984 directive, "Implementation of the Environmental Impact Assessment Law" similarly provided a guideline for the industry's activities other than power generation plant operation, such as land reclamation. Following the Basic Environment Law implemented in November 1993, legislation on environmental impact assessments were studied, and the Environmental Impact Assessment Law was legislated in June 1997 and then fully enforced in June 1999. At the same time as this Environmental Impact Assessment Law was introduced, the Electric Utility Law was modified to stipulate specific procedures for impact assessment relating to power stations, such as a review by the Ministry of International Trade and Industry. The new assessment system under these two relevant laws—the Environmental Impact Assessment Law and the Electric Utility Law—requires that the opinions of local residents and governmental authorities be solicited earlier in the process (screen-ing and scoping procedures) than was previously the case.

Flow Chart of Environmental Impact Assessment (For a thermal power station)





Business Projects Subject to Environmental Impact Assessment
(for a power station)

	Hydroelectric power stations	Thermal power stations	Geothermal power stations	Nuclear power stations
Class 1 business project	30 thousand kW or above	150 thousand kW or above	10 thousand kW or above	For all scales
Class 2 business project	22.5 to 30 thousand kW	112.5 to 150 thousand kW	7.5 to 10 thousand kW	——

Air quality survey

Public meeting to explain environmental assessment to local residents

Environmental Elements for Environmental Impact Assessment
(Example of a thermal power station)

Maintenance of good conditions of the environment's natural constituents	Aerial environment (air quality, noise, vibration)
	Water environment (water quality, surface soil quality, water flow orientation, flow velocity)
	Topography, geological survey
Preservation of bio-diversity and systematic preservation of natural environment	Animals
	Plants
	Ecology
Securing good places for contact between people and nature	Natural scenery
	Places for contacts with the nature
Load on environment	Waste etc.
	Gases with global warming effect

(7) Approaches to Biodiversity

a.Biodiversity Related Situation in Japan

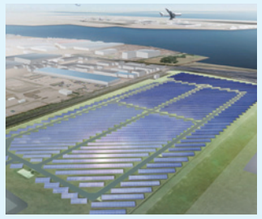
Biodiversity (ecosystem diversity, species diversity, genetic diversity) on the earth provides various natural benefits (ecosystem services), which are vital to human activities, and is the basis of the existence of human beings. However, biodiversity is realized by a complicated balance, and human activities have an impact on this balance regardless of being intentional or not. In Japan, the National Biodiversity Strategy of Japan was crafted based on the Convention on Biological Diversity adopted by the UN Conference on the Environment and Development UNCED (Rio Summit) in 1992, and the Basic Act on Biological Diversity was established in 2008 to establish basic standards for the measures and policies concerning biodiversity conservation and sustainable use. In October 2010, COP10 (10th Conference of the Parties to the Convention on Biological Diversity) was held in Nagoya City in Aichi Prefecture.

b. Approaches to Biodiversity by the Electric Utility Industry

The electric utility industry has been blessed with various natural benefits through our business activities including installation and operation of power equipment and waste disposal. On the other hand, we are concerned about the influence of our business activities on CO_2-generated global warming and the impact on biodiversity at global and regional levels by land alteration in association with installation of facilities. Therefore, we take the environment into consideration on a global basis through our activities by promoting nuclear power and renewable energy to create a low carbon society. We also actively deal with environmental preservation at regional levels through activities such as environmental assessments, as well as contributive activities to societies such as forestry preservation and environmental educational activities. The electric utility industry has always endeavored to minimize its impact on biodiversity and to make sustainable use of the benefits from biodiversity. In order to clearly specify the direction of these activities, we established and announced the "Biodiversity Action Guidelines by the Japanese Electric Utility Industry" in April 2010. We will strive for sustainable business activities based on these guidelines while appreciating the gifts of nature.

Consideration of Environmental Impact on a Global Scale

The electric utility industry is promoting the "best mix of power sources" that is a well-balanced combination of nuclear power, thermal power, and hydroelectric power to confront the issue of global warming while maintaining stable and economical power supply. The impact on global warming of CO_2 generated by burning fossil fuels in power generation is considerd; therefore, we are striving to promote nuclear power generation, develop and promote wide spread use of renew able energy, and improve thermal efficiency in thermal power generation so as to reduce CO_2 emission intensity helping to realize a lowcarbon society.



Mega Solar Power Generation

Consideration for Biodiversity at Regional Levels

When newly building or adding on to power plants, we try to understand and analyze the impact on the environment (air, water quality, seawater temperature, plants and animals, etc.) in advance and implement environmental conservation measures that meet the characteristics of the region. Furthermore, after starting operation of a power plant, we monitor the surrounding environment and evaluate the comprehensive environmental impact to confirm that there are no problems.

Water Quality Investigation in the Vicinity of the Power Plant

Social Action Programs including Forest Preservation Activities

The power plants promote afforestation considering the local ecosystem and also provide local people with opportunities to become acquainted with nature by opening their grounds to the public. Each power plant has been making social contributions to community-based forest preservation in cooperation with concerned organizations and local individuals.

Tree planting for local afforestation

(8) Control of Chemical Substances

Since 1997, the electric utility industry has worked to determine the actual status of emissions and transfers of chemical substances released from power stations even before the enforcement of the Law Concerning Reporting etc. of Releases to the Environment of Specific Chemical Substances and Promoting Improvements in Their Management (PRTR Law) through its autonomous surveys on the target chemical substances, which have gradually increased in number. In April 2002, the notification system began operation in accordance with the PRTR Law. Each power company now precisely records and reports released and transferred quantities of the targeted chemical substances under the Law for every business establishment. The emissions and transfers of chemical substances for fiscal 2009 are shown in the table below. In addition, as demonstrated by the reexamination of Class I Designated Chemical Substances in association with a partial amendment of the PRTR (Pollutant Release and Transfer Register) law in November 2008, the industry will continue to endeavor for appropriate control and maximum reduction of emissions of these chemical substances.

Total Release and Transfer of Chemical Substance (Results for fiscal 2009)

Chemical codes	Chemical	Volume released to the environment (kg/year)				Volume transferred (kg/year)		Application, etc.
		Air	Water	Soil	Landfill	Sewage	Others	
16	2-Amino ethanol	0	0	0	0	0	10,000	Feed water-processing agent
26	Asbestos	0	0	0	0	0	180,000	insulating material, sealing material etc.
30	Bisphenol A type epoxy resin	470	0	0	0	0	0	Used in painting
40	Ethylbenzene	55,000	0	0	0	0	4.5	Used in painting
43	Ethylene glycol	8,400	0	0	0	0	0	Heat-source water for heat supply
63	Xylene	150,000	0	0	0	0	17,000	Used in painting, power-generation fuel
85	Chlorodifluoromethane (HCFC-22)	3,300	0	0	0	0	0	Air conditioning refrigerant
121	Dichlorodifluoromethane (CFC-12)	220	0	0	0	0	0	Air conditioning refrigerant
124	2,2-dichlo-1,1,1 Trifluoroethane (HCFC-123)	2,200	0	0	0	0	0	Air conditioning refrigerant
144	Dichloropentafluoropropane (HCFC-225)	7,400	0	0	0	0	0	To launder clothing
177	Styrene	23,000	0	0	0	0	0	Used in painting, Plastic fixation agent
179	Dioxins	2.0	0.049	0	0	0	18	Waste incinerators
227	Toluene	22,000	0	0	0	0	9,200	Used in painting, power-generation fuel
253	Hydrazine	11	2,500	0	0	0	4,100	Feed water-processing agent
299	Benzene	200	0	0	0	0	3,200	Power-generation fuel, Painting
304	Boron and Boron compound	130	0	0	0	0	0	Coolant water-processing agent
353	Tris phosphate (dimethyl phenyl)	0	0	0	0	0	24,000	Turbine control oil

* Chemical codes represent the number assigned to each chemical under the PRTR Law. * Volume transferred is the amount transferred from the plant for processing as waste, etc.
* Units in this table for release and transfer volumes for dioxin substances are measured as [kg/year→mg-TEQ/year].
* Figures for dioxin substances represent sum totals that include release and transfer volumes from those establishments designated in the Law Concerning Special Measures against Dioxins. Figures for all other substances represent sum totals that include release and transfer volumes from each establishment that handles at least one ton of the Type I chemical substances specified in the PRTR Law or at least half a ton of the special Type I chemical substances specified by this law.
* It has been confirmed that the volume of dioxin released or transferred is within the emission limits stipulated in the Law Concerning Special Measures against Dioxins.

Efforts toward Technical Development

Japan's electric utility industry has a long-standing commitment to technical development in a wide range of fields with a view to achieving greater efficiency in the use of energy and natural resources and the protection of the environment. This commitment is directed at the areas shown in the diagram.

Outline of Research and Development

Advanced use of energy resource and diversified, highly efficient power supply	Integrated coal gasification combined cycle (IGCC) power generation, CO_2 capture, storage and fixation technology
Establishment of the next generation power grid technology and system stabilization technology	Superconductive power equipment, next generation power transmission and distribution network (Smart Grid), etc.
Promotion of end-use energy saving and electrification by improving convenience	Heat pump, thermal storage technology, electric vehicles, etc.

(1) High-efficiency Power Generation Technology

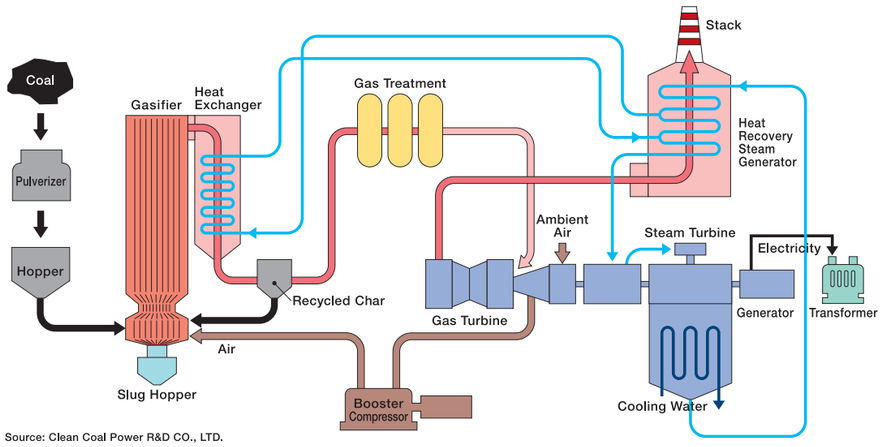
a. Integrated Coal Gasification Combined Cycle (IGCC) Power Generation

The IGCC process leads to efficient power generation using coal-gasified fuel, in which a gas turbine and a steam turbine are combined. This process extends utilizable coal types with an estimated transmission end of 48-50%, which is higher than that of conventional powdered-coal-fired systems, and is expected to be the next generation coal-fired technology. Therefore, trial IGCC power generation and related research were conducted from 1986 to 1996 with the participation of the major power companies at a pilot plant to demonstrate the economic and technological viability of basic IGCC system technology. Clean Coal Power R&D CO., LTD., was established in 2001 by nine power companies, Electric Power Development Co., Ltd. and the Central Research Institute of Electric Utility Industry, and operation tests toward the practical use have been implemented since September 2007. A 5000 hour endurance test was achived on June 2010, and further operational characteristics, durability, and economic efficiency are to be verified in the future.

Full View of IGCC Verification Research

Source: Clean Coal Power R&D CO., LTD.

Structure of Integrated Coal Gasification Combined Cycle Power Generation System

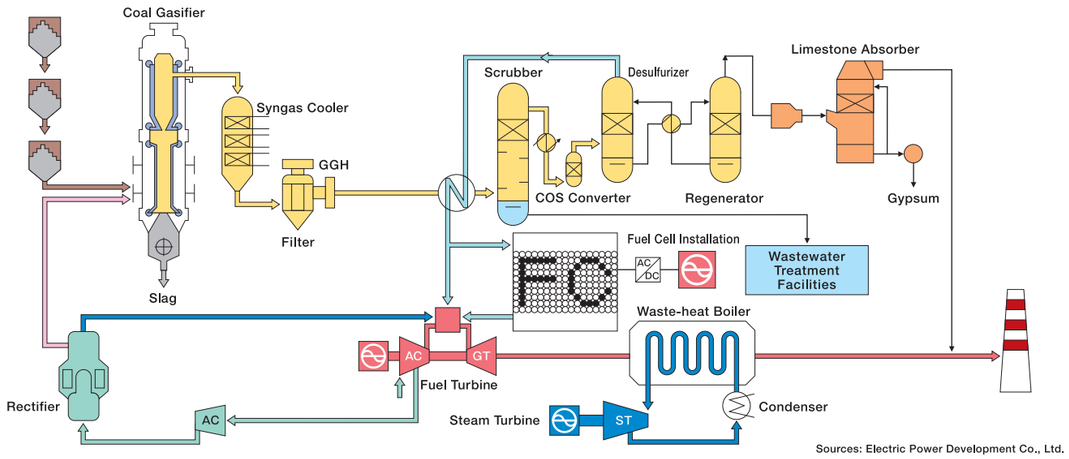


Source: Clean Coal Power R&D CO., LTD.

b. Integrated Coal Gasification Fuel Cell Combined Cycle (IGFC)

The plant for integrated coal gasification fuel cell combined-cycle consists of a gasifier, gas turbine, stream turbine, etc. The efficiency of power generation using an integrated coal gasification fuel cell combined-cycle exceeds 53%. R&D efforts for this system are under way.

Structure of Integrated Coal Gasification Fuel Cell Combined Cycle Generation system

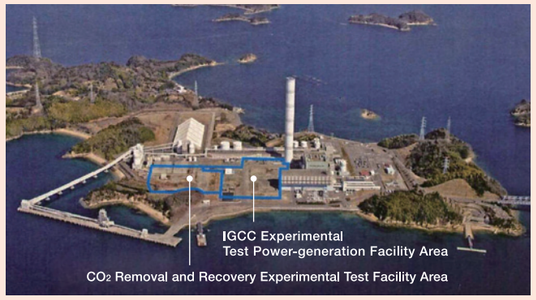


Sources: Electric Power Development Co., Ltd.

Large-scale Experimental Test of Oxygen Blown Coal Gasification Technology

Chugoku Electric Power Co., Inc. and Electric Power Development Co., Ltd. jointly established a new company, Osaki Coolgen Co., Ltd., in July 2009 to promote a large-scale experimental test of "oxygen blown Integrated coal Gasification Combined Cycle (oxygen blown IGCC) technology" and "CO_2 removal and recovery technology." In the future, they will build a large-scale 170,000kW class experimental test facility using the oxygen blown integrated coal gasification combined cycle technology to verify reliability, economic efficiency, and operational ability of the oxygen blown IGCC system followed by verification by application tests using the latest CO_2 removal and recovery technology. Furthermore, they are proceeding with the project aiming at the possibility of "Integrated coal Gasification Fuel Cell combined cycle (IGFC)" which could obtain higher efficiency by being combined with large-scale fuel cells in the future.

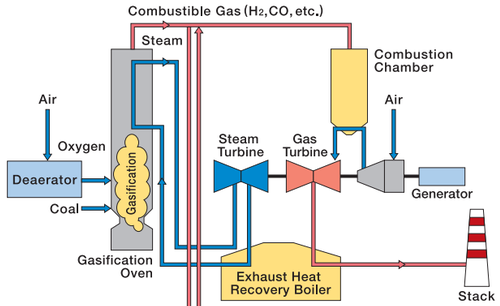
Experimental Test Facility Site Plan

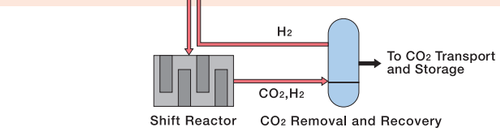


Outline of the Experimental Test System

Integrated Coal Gasification Combined Cycle (IGCC)

Coal is converted to combustible gas (H_2,CO, etc.)
by gasification and used as gas turbine fuel.
Steam is generated by gas turbine exhaust heat and gasification oven heat.





Shift Reaction: Moisture vapor is added to CO and CO is converted to CO_2 and H_2 by catalyzed reaction.
CO_2 Removal and Recovery: CO in the combustible gas is converted to CO_2 and H_2 by shift reaction to remove and recover CO_2.

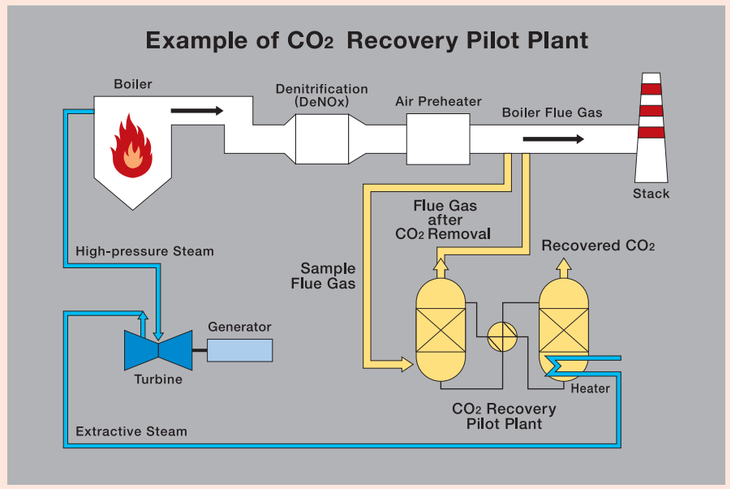
CO_2 Removal and Recovery Technology

c. Environmental Conservation Technology
CO_2 Capture, Storage and Fixation Technology

Japan's electric utility industry is pressing forward with research and development work on the removal, separation, sequestration and fixation of carbon dioxide contained in flue gases from fossil-fuel power plants. In 1990, the Kansai Electric Power Co., was the first electric company to start a study of CO_2 separation and capture. They built a pilot plant at Nanko Power Plant in Osaka City the following year to work on research and development of CO_2 capturing and absorbing solution with the world's highest efficiency. Based on this research, 10 electric companies and Electric Power Development Co., Ltd. invested and participated in "Japan CCS Research Co., Ltd." established in May 2008, and conduct research projects toward a grand-scale verification test with collaboration between Japanese electric companies and the Electric Power Development Co., Ltd.

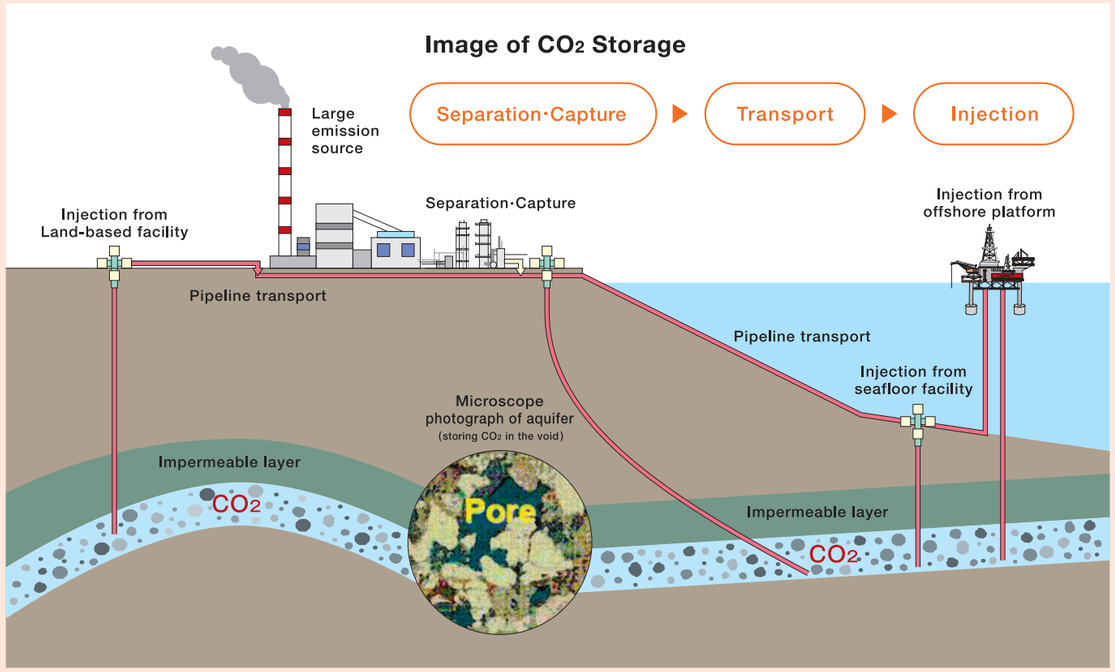
Flue Gas CO_2 Recovery Pilot Plant
Nanko Thermal Power Station, The Kansai Electric Power Co.

Example of CO_2 Recovery Pilot Plant



Flue Gas Decarburization System Flow Chart
Nanko Thermal Power Station, The Kansai Electric Power Co.

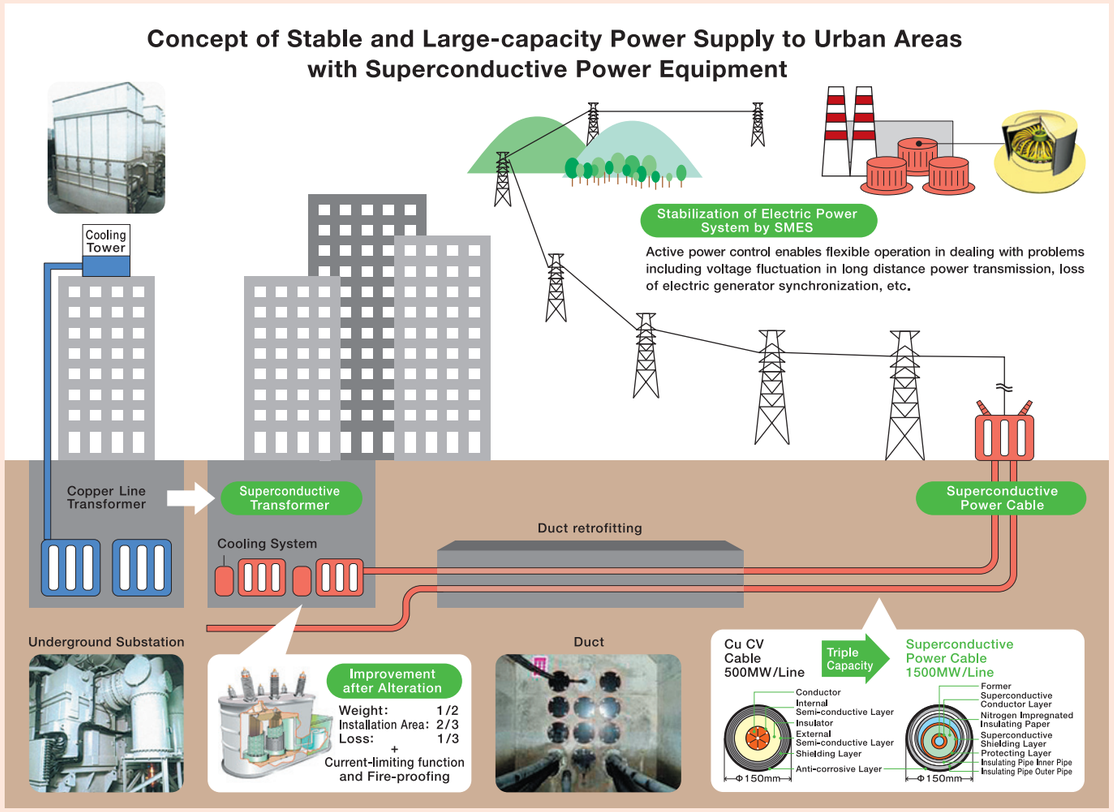
Image of CO_2 Storage



(2) Energy Conservation a.Superconductive Power Equipment

Power equipment that uses superconductivity which makes electric resistance zero is environment-friendly technology. It contributes to energy saving due to limited loss and it minimizes use of underground space due to compact equipment. Technology development of such superconductive power equipment is being promoted.

Concept of Stable and Large-capacity Power Supply to Urban Areas with Superconductive Power Equipment



Sources : International Superconductivity Technology Center (ISTEC)

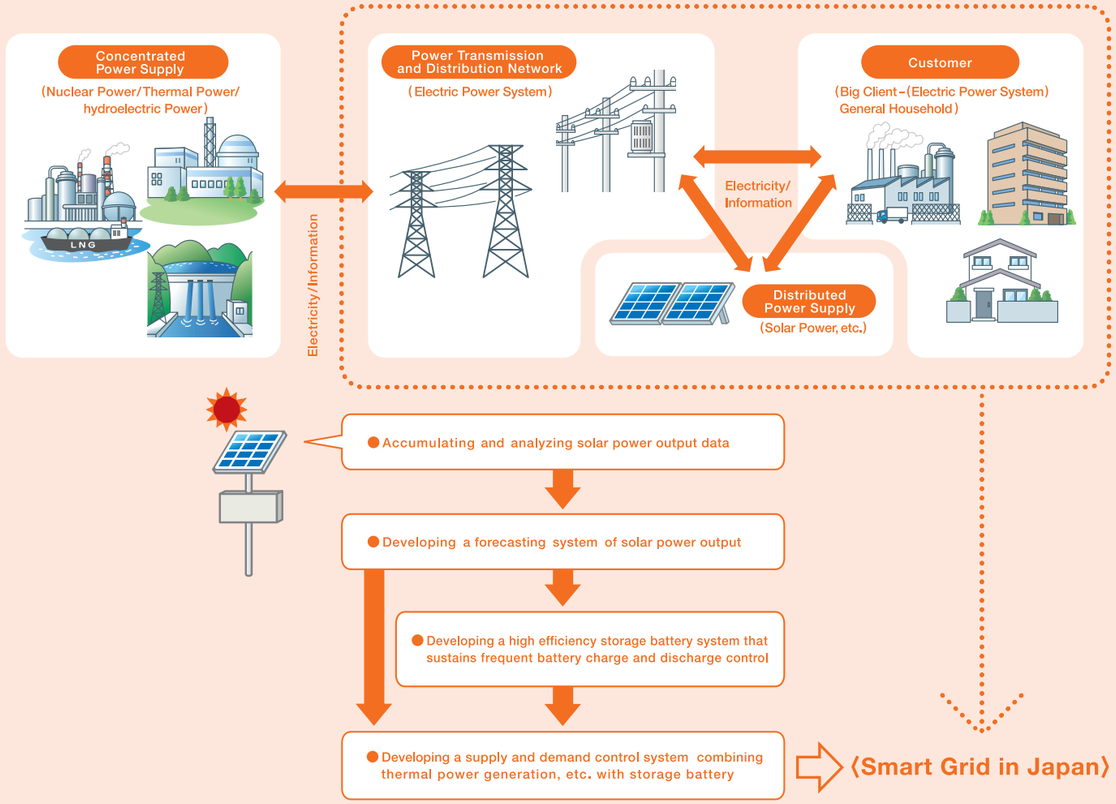
Features of Superconductive Power Equipment being Developed

	Stabilization of Electric Power System by SMES	Superconductive Power Cable	Superconductive Transformer
Summary	Electric power storage system that applies the permanent current to a Superconductive coil to store electromagnetic energy which can be extracted when necessary.	Alternative device to present power cable	Alternative device to present power transformer
Feature	Compared to a storage battery, it can handle, admit and release considerable energy instantaneously. Energy storage efficiency is high as well.	Superconductive power cables can reduce power transmission loss between a half and a third compared to the existing power cables that are used for underground power transmission facilities in urban areas.	Superconductive transformers can reduce loss to a sixth in the same way as the power cables. Furthermore, it is compact compared to existing transformers, so it can reduce the burden on the environment which is generated in association with the construction of substation spaces which are often installed underground in urban areas.
Current situation	There are study results of instantaneous voltage drop compensating devices and load fluctuation compensating devices. At the moment, technology of practical use of 2GJ class SMES for system stability of long distance power transmission is being promoted.	Verification tests of power cables using Bi (bismuth) wire rods are being planned. Also technology of Y (yttrium) wire rode that can transmit larger capacity of power than Bi is being developed.	Technology of practical use of the distribution transformer is being developed. Also technology for a current-limiting function that uses superconductivity to control excessive current running through electric power systems is being developed.

b.Electric Power Quality Maintenance and Improvement Technology: The Next Generation Power Transmission and Distribution Network (Smart Grid)

Efficient expansion of renewable energy usage typified by solar power is expected in order to control CO_2 emissions which are regarded as the major cause of global warning. The power companies have started a study of the next generation power transmission and distribution network (Smart Grid) to establish a new power supply system. The Smart Grid which the power companies aim to realize is a high quality, efficient, and reliable electric power supply system. It combines information technology (IT) with an integrated operation of the current concentrated power source, such as nuclear power, thermal power, and hydraulic power, and the transmission grid to integrate and utilize distributed renewable energy power sources including solar power generation. We are actively promoting research and development to establish this “Japanese Style Smart Grid.”

Basic Concept of Smart-Grid in Japan



Japanese Style Smart Grid

In the US, due to its vastness and scattered consumption regions, there are issues, such as a long distance, high cost, and huge loss to transmit electric power between the power plant and the consumer. Also, investment into power transmission sectors remains stagnant. To overcome such issues, the Smart Grid started in the US to aim to establish an electric power supply system using Mega Solar on the supply side and controlling users’ electricity usage in local areas. In Japan, land area is small, major consumption areas are aligned in a row, and electricity transmission and distribution facilities are integrally organized and operated. Also, development of electric power sources is being promoted, and stable power supply is maintained at the top level in the world. However, from the aspect of realizing a low-carbon society and controlling CO_2 emission, the introduction of natural energy including solar power on a massive scale is desired. Particularly in Japan, unlike Europe and the USA, introduction of solar power generation to residential housing on a massive scale in several hundred locations is a national goal. Due to such differences in the power supply system structure and introduction method of natural energy, differences occur in approaches for realizing the Smart Grid. As the Japanese electric utility industry, we intend to develop a “Japanese Style Smart Grid” in the sense that it will be designed specifically to fit the unique needs of Japan.

Efforts toward Energy Saving

a.R&D and Promotion of High-Efficiency and Load-Leveling Equipment and Appliances

Japan's power companies have aggressively worked to develop and encourage the use of energy-efficient electric appliances and systems to achieve further energy conservation and load leveling in power demand. One result of such efforts is the development of a heat pump water heater using a CO_2 refrigerant through joint research with manufacturers and others. This hot water supply system uses a naturally existing form of energy, the heat of the air, to heat water. CO_2 refrigerant / heat pump water heaters advance energy conservation in the water heating area, and as such their use is expected to grow at an increasingrate. Power companies will continue to develop and promote high efficiency and load-leveling equipment and appliances.

Hot-Water Supply System (EcoCute) with CO_2 Refrigerant Heat Pump

EcoCute runs on naturally existing heat energy in the air instead of burning fossil fuels, as with conventional hot-water supply systems. Instead of a combustion system, EcoCute uses a high efficiency heat pump such as those found on appliances like air conditioners. With its high energy efficiency (it has a APF※1 of more than 3), EcoCute consumes only one-third the heat energy required to heat water. This means it can reduce CO_2 emissions by about 50% compared to a combustion-based supply system. In addition, its use of naturally existing CO_2 as the refrigerant (the substance that conducts the heat energy), means less damage to the ozone layer as compared to CFC refrigerants and very little contribution to global warming, as well as excellent heating properties. The cumulative number of EcoCute systems introduced to market as of the end of fiscal 2009 had reached 2.25 million units. That calculates out to approx. 1,600,000 t-CO_2※2 emissions suppressed.

※1 Annual Performance factor of hot water supply APF = Heat quantity for hot water supply used for 1 year / Power consumption required for 1 year

※2 Provisional calculation with coefficient after the Kyoto Mechanism credit is reflected based on the law to promote global warming countermeasures

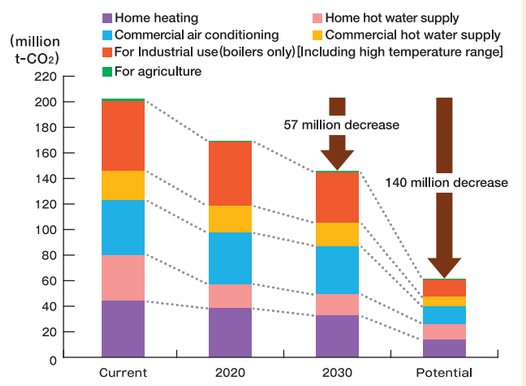
Possibility for CO_2 reduction through heat pump use

If heat pump system usage spreads, CO_2 emissions will be suppressed by up to a maximum of 100 million t-CO_2 in air conditioning and hot water supplies in the civilian sector (homes and businesses) and 30 million t-CO_2 in the industrial sector. Furthermore, the suppression potential will reach 140 million t-CO_2 by adding 10 million t-CO_2 of high-temperature range heat pump for industrial use that is being introduced into market.

Calculations by The Heat Pump & Thermal Storage Technology Center of Japan, Japan Electro-Heat Center, Mitsubishi Research Institute,Inc

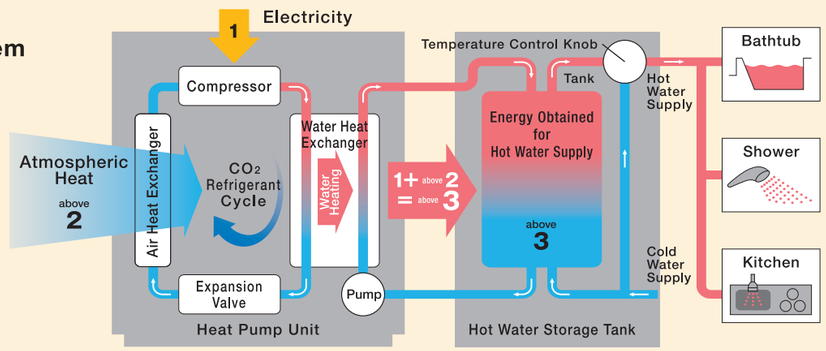
Prospect of CO_2 reduction effect of heat pumps/thermal storage system

(Including industrial high temperature and agriculture)



● A reduction of 140 million t-CO_2, approximately 10% of Japan's CO_2 current emissions of approximately 1.21 billion t-CO_2 is possible.

Diagram of Hot Water Supply System (EcoCute)



Electric Vehicles

Electric vehicles are very environment-friendly: they produce considerably less CO_2 emissions than (the same size) gasoline vehicles. Utilizing the recent performance advances in lithium-ion batteries, automobile manufacturers have developed new models aiming for expanded market acceptance. In fiscal 2009, next-generation electric vehicles with greatly improved performance were introduced into the market. The electric utility industry is engaged in driving verification tests, the development of quick chargers, and standardization in and outside of Japan, while promoting own use of electric vehicles and plug-in hybrid vehicles as business cars.

Characteristics of electric vehicles

- CO_2 emissions is low※.
  (Approximately 30% compared to gasoline vehicles.)
- Total efficiency※ is high.
  (Primary energy input per 1km drive is approximately 30% that of gasoline vehicles.)
- Fuel cost is low.
  (Approximately 30% or less of that of gasoline vehicles.)
- Improvement of city environment
  (No gas emission, noise reduction, etc.)

※CO_2 emissions and total efficiency are evaluated through energy production, supply, and consumption

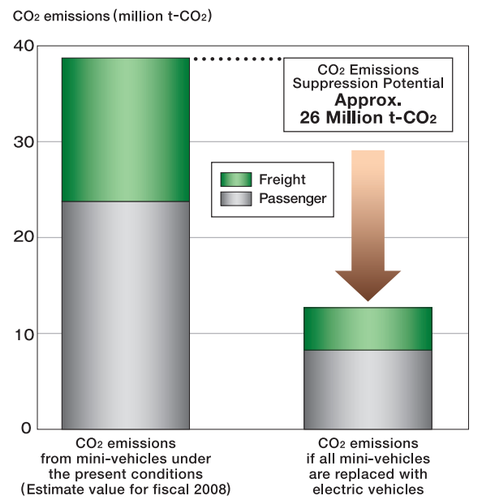
Fuji Heavy Industries Ltd., Plug in Stela

Electric vehicles and quick charger

Mitsubishi Motors Corporation, i MiEV

Trial Calculation of CO_2 Emissions Suppression by Electric Vehicles (Mini-vehicles)

CO_2 emissions from all vehicles in fiscal 2008 was approximately 205 million t-CO_2. If next-generation automobiles, such as electric vehicles and plug-in-hybrid vehicles become more popular, further CO_2 emissions reduction can be expected. If all mini-vehicles in Japan are replaced with electric vehicles, CO_2 emissions are expected to be reduced by approximately 26 million t-CO_2 per year, which is equivalent to approximately 2% of CO_2 emissions in Japan.



Trial calculations were made assuming that electric vehicles (electricity consumption: 8 km/kWh) are substituted for mini-vehicles (fuel consumption: 19.2 km/ℓ) The Federation of Electric Power Companies of Japan made a trial calculation using energy consumption values in the "Automobile Transport Statistical Annual Report for Fiscal 2008" by the Ministry of Land, Infrastructure and Transport

b. Promoting the Operation of Regional Heat Supply Services Using Untapped Energy

Various forms of untapped energy, such as exhaust heat emitted from buildings, factories, substations or sanitation plants and energy from temperature differences of the sea, river or sewage are recovered as effective thermal energy through heat pumps, and can be utilized for regional heat supply. Such regional heat supply services operations can make a significant contribution to reducing the use of fossil fuels and the emission of sulfur oxides (SOx), nitrogen oxides (NOx) and another greenhouse gas, CO_2. Electric power companies in Japan are strongly advocating and promoting the introduction of regional heat supply as it can help achieve more efficient energy use and better power demand loadleveling in combination with heat storage systems.

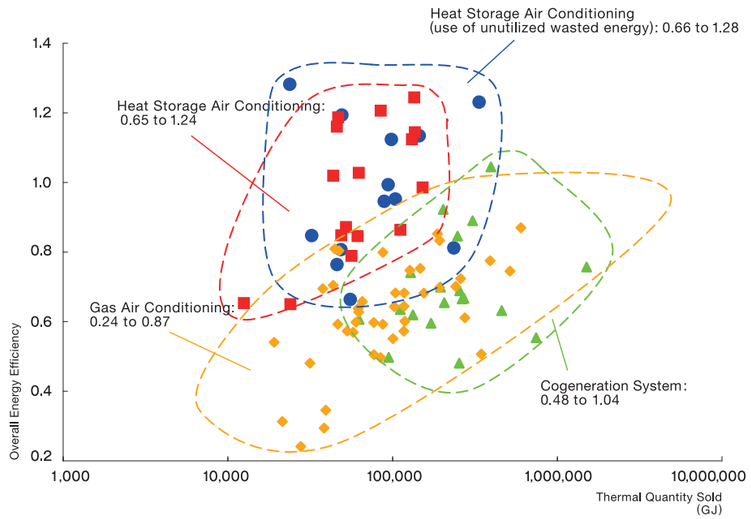
Conceptual Illustration of Regional Heat Supply Service Using Urban Waste Heat

Utility Service Center Plant

Regional heat supply serviceusing river water
(Hakozaki area)

Overall Energy Efficiency of Local Area Air Conditioning Services

* Points Investigated: Areas where both heating media—cold water and hot water (including steam and hot water supply)—are supplied mainly to commercial and business facilities.
* Sources: The Japan Heart Service Utilities Handbook (2009)
* Converted into electricity at 9,760 kJ/kWh and city gas at 45.0 MJ/m³.
* Overall Energy Efficiency = Thermal Quantity Sold / Primary Energy Input



c. Promoting Load-leveling in Power Demand

Electricity usage is subject to considerable variations according to the season and the time of day. Reducing these demand fluctuations, or load-leveling, helps raise the efficiency of existing power-generating facilities and reduce the necessity of constructing new power stations, thus contributing to energy conservation and environmental protection. In particular, load leveling is strongly recommended as a governmental policy in the Kyoto Protocol Target Attainment Plan because load leveling has a significant effect on CO_2 emission reduction. In practice, the industry's specific load-leveling measures are as follows:

① Extended use of regenerative systems

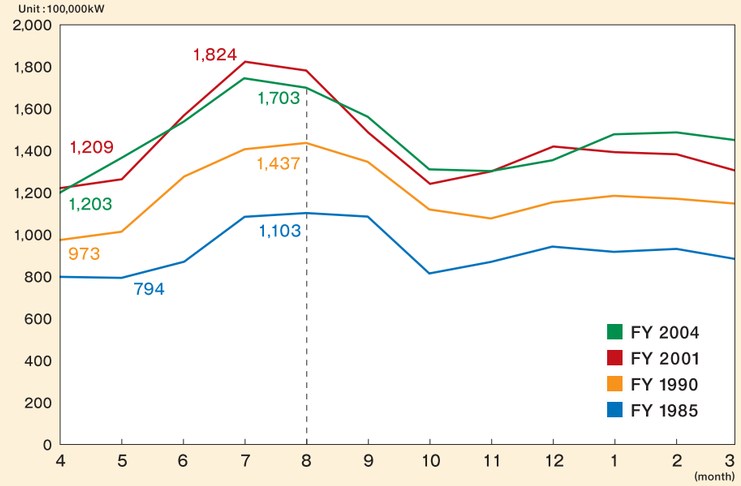
Regenerative systems contribute to load-leveling by storing heat at night when the electricity load is lower and using cold/warm thermal heat stored in a thermal storage tank during the day. A highly efficient heat pump adopted as a heat source unit ensures considerable energy conservation effects due to the release of higher heat quantity than input energy, the rated operation that makes the most of thermal heat stored at night during the day and the improved efficiency while regenerating heat using the cool outdoor air at night.

② Load-leveling with electricity rate systems

Electricity rates are structured to offer consumers options based on the season or a time band, nighttime usage and the regeneration adjustments contract. The electric utility industry uses these electricity rate menus as an indirect means to level power demand.

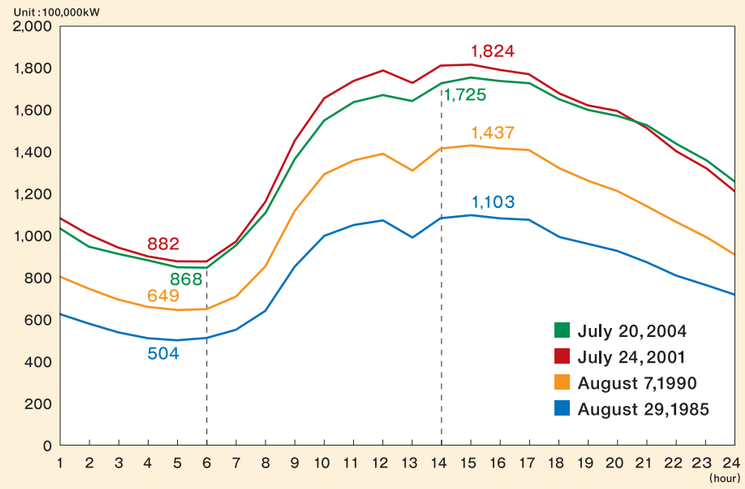
Monthly Electric Power Consumption

(Annual Load Curve) Ten companies combined



Variations in Daily Electric Power Consumption

(Daily Load Curve) Ten companies combined



Environmental Communication

a. Environmental and Energy Education Support

To contribute to local communities, electric power companies have conducted various education support activities to serve as the catalyst for enabling children who will be responsible for the next generation to think of, understand, and voluntarily act on the future energy and environment. To be more specific, we implement educational support that can be useful for energy and environmental education by offering environmental and energy courses, providing educational materials for finding assignments or research study, and offering an opportunity of hands-on study including electric power facility tours and science events.

b. Cooperation with Community

The electric utility industry is cooperating with NPOs, government, schools and local people to encourage afforestation and forest management activities in various locations.

Examples of forest preservation, planting, and efforts on nature

- "TEPCO nature school" at Oze and natural area at power station
- "Invitation to the Forest": forest activity with participation by the public in company-owned forests
- 1 million tree plantings (Kyushu Homeland Forestation Program)
- Environmental tree plantings program (approx. 100 hectares)
- Forest restoration of "Zanpa Shiosai no Mori"
- Presenting seedlings to customers (schools, etc.) for planting
- Participation in afforestation volunteer programs
- Management of company-owned forests for water source cultivation
- Contribution to the forest fund and establishment of guidelines for forest conservation

TEPCO Pair Watching nature observation event at Chiba Thermal Power Station, Tokyo Electric Power Co.

c. PR activities and provision of information aimed at energy conservation and CO_2 reduction

The electric utility industry is also actively rolling out initiatives that contribute to the promotion of energy conservation and CO_2 reduction by customers. Activities include providing information that helps customers conserve energy and reduce CO_2 and proposing measures through diagnosing their energy usage. In particular the "Household Eco-Account Book" is promoted by the entire electric utility industry, as a method known as "visualization." As for expanding the use of the Household Eco-Account Book, each electric power company is reaching out to customers through sales offices, web pages and notices of electricity consumption, so as to attract active participation by customers. Through these kinds of activities, we hope to raise national consciousness for the mitigation of global warming.

Website of the Kansai Electric Power Co.
http://www.kepco.co.jp/kankyou/csr/communication/kakeibo.html

International Cooperation

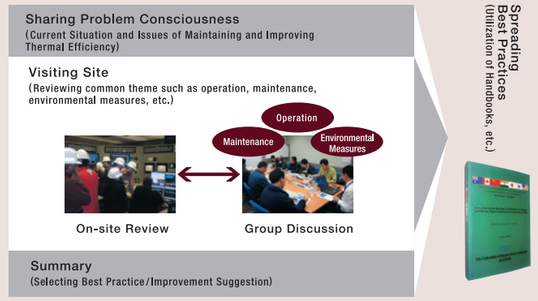
One of the policies of Japan's electric utility industry is to continuously develop new measures and technologies to improve environmental protection and reduce energy consumption, both independently and in cooperation with manufacturers and related industries. As a matter of policy, the industry offers technical assistance and support to overseas electric utility industries, specifically in the form of educational programs for foreign trainees, the dispatch of technological specialists overseas, and a regular exchange of information and technology with other electric power industries around the globe. To meet the worldwide need for stable energy supply and environmental conservation, in recent years there has been an increased global request for technological cooperation on environmental measures for coal-fired thermal power plant as well as on nuclear power. Responding to this call for greater global cooperation, intensive exchange programs with engineers from overseas have been conducted by the electric utility industry. With the exceptional, efficient energy conversion technologies and the environmental preservation technologies that the industry already has accumulated, and the expected results of ongoing research and development, the industry hopes to make major contributions toward energy conservation and environmental protection in both advanced and developing countries. The industry considers it especially necessary to tackle the issue of global warming through international cooperation. We will actively create opportunities for cooperation with various countries so as to promote technical developments effective to the reduction of fossil-fuel consumption. We will also strongly promote technology transfers that are applicable to the conditions in each country with sufficient attention to local cultural backgrounds and conservation of the environment of developing countries.

a. Participating in the Asia-Pacific Partnership (APP) on clean development and climate

The Asia-Pacific Partnership on Clean Development and Climate, also known as APP, is a regional partnership by public and private sectors among the United States, Australia, China, India, South Korea, and Japan formally established at a meeting of Ministers in Sydney, Australia in January 2006. Its goal is to appropriately deal with environmental pollution, stable supply of energy, climate change, and other problems arising with the increasing energy demand in the Asia-Pacific region. (Canada joined in as an official member at the 2nd ministerial meeting held in October 2007.) In the "Power Generation and Transmission Task Force" which is one of the task forces that the Federation of Electric Power Companies of Japan participates in, the peer review activity for "Best Practice for Power Generation" targeting maintaining and improving thermal efficiency of the existing coal thermal power plants, was selected as the flagship project for its effectiveness in the reduction of CO_2. Until now, 5 peer review activities have been implemented including the 1st peer review at the Takasago Thermal Power Station of Electric Power Development Co.,Ltd in April 2007. Through the peer review activities, it is expected that best practices in the operation and maintenance of the coal-fired power plants would be shared and improved among participants and such knowledge would be deployed to thermal power plants in participant countries so that their thermal efficiency would be maintained or improved.

Results of Peer Review Activities

	Host Country	The Number of Participants	Summary
1st (2007.4)	Japan	52	Actively exchanged opinions and shared experience on operation management, turbine maintenance, and boiler's water quality management.
2nd (2008.2)	India	75	Officially adopted the "Green Handbook, Implementation Procedure, Check Sheet, and Evaluation Sheet" made and proposed by Japan.
3rd (2008.4)	U.S.A	81	Confirmed that thermal efficiency improvement by 1 to 1.5% would be feasible. (Equivalent to potential 90,000 t-CO_2 reduction annually)
4th (2008.6)	Australia	49	Confirmed that thermal efficiency improvement by 0.5% would be feasible. (Equivalent to potential 24,000 t-CO_2 reduction annually)
5th (2009.7)	S.Korea	100	Confirmed that thermal efficiency improvement by 0.6% would be feasible. (Equivalent to potential 58,000 t-CO_2 reduction annually)



b. Activities in International Electricity Partnership (IEP)

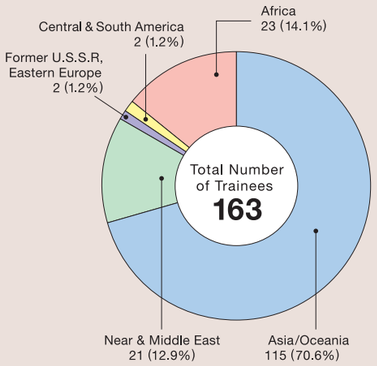
The International Electricity Partnership (IEP) was established by the electricity associations of Europe, USA, Australia, Canada and Japan in October 2008. It is the objective of the IEP to exchange views and opinions to identify common interests within the electricity sector including making a technology roadmap for the power sector. In December 2009, a workshop was held during the 15th Conference of the Parties to the United Nations Framework Convention on Climate Change (COP15), in which the IEP's "Roadmap for a Low-Carbon Power Sector by 2050" was announced. This technology roadmap not only indicates the vision of technology spread in developed countries but also can be used as a guideline for or assistance to developing countries. The Japanese electric utility industry continues to engage in the joint research and development of such technologies with the government and to promote adoption of such technologies in cooperation with other electric utilities in the world in order to contribute to the delivery of a low-carbon and energy-saving society.

c. Accepting trainees from developing countries and dispatching professional engineers to provide technical assistance

We have actively implemented international exchanges and technical assistance through electric companies and the Japan Electric Power Information Center. We continuously accepted trainees from various countries and dispatched professional engineers in fiscal 2009.

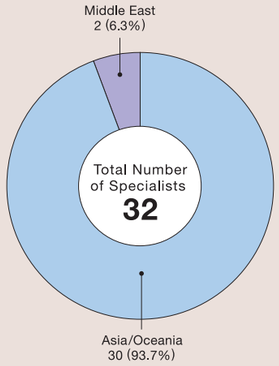
Trainees from Developing Countries through the Japan Electric Power Information Center (FY 2009)

Source: Japan Electric Power Information Center



Japanese Specialists Sent to Developing Countries through the Japan Electric Power Information Center (FY 2009)

Source: Japan Electric Power Information Center



d. Involvement in CO_2 Reduction Activities through International Cooperation

The Kyoto Mechanisms* are expected as measures because of their contribution to preventing global warming and their cost effectiveness in reducing CO_2 emissions. The industry is conducting feasibility studies and projects overseas that help reduce greenhouse gasses including biomass power generation, thermal efficiency improvement projects and afforestation projects. Such projects are targets of the Joint Implementation and Clean Development Mechanisms stipulated in the Kyoto Protocol. The industry also provides investment to such entities as the World Bank's Carbon Fund and the Japan Greenhouse Gas Reduction Fund (JGRF) in which Japan's industries participate, and is otherwise involved in projects to prevent global warming. The industry also actively transfers technology to developing nations by instruction for energy-saving technologies and seminars on improving and managing thermal efficiency though projects to prevent global warming and afforestation. Global warming prevention activities will continue in the future on a global scale.

* Refers to emissions trading (ET), joint implementation (JI) and the clean development mechanism (CDM) stipulated in the Kyoto Protocol.

Overseas greenhouse gass reduction/ absorption projects by the Japanese Electric Utility Industry

Environmental Action Plan of the Electric Utility Industry

Measures to Mitigate Climate Change/ CO_2 Emissions Suppression Initiatives

[CO_2 Emissions Suppression Targets]

The electric utility industry sets CO_2 emissions suppression targets using CO_2 emissions per kWh of electric power consumed by power industry customers (this is known as the user-end CO_2 emissions intensity). The industry has declared that, "from fiscal 2008 to fiscal 2012 we aim to reduce CO_2 emissions intensity by an average of approximately 20% from the fiscal 1990 level, to about 0.34kg-CO_2/kWh."

[Result of CO_2 Emissions Intensity]

CO_2 emissions at the user's end was 0.351kg-CO_2/kWh in fiscal 2009, which was a decrease by 0.022kg-CO_2/kWh compared to fiscal 2008. This was influenced by the following facts: the nuclear power plant utilization ratio increased to 65.7% by a partial operation restart of the TEPCO Kashiwazaki Kariwa Nuclear Power Plant after its shutdown due to the Niigata Prefecture Chuetsu Offshore Earthquake in 2007, and the ratio of nuclear power and hydroelectric power generation increased among overall power generated due to the decrease of electric demand by the rapid economic recession. Also, approximately 52 million t-CO_2 of Kyoto Mechanism credit that had been transferred to the national control account free of cost were reflected in CO_2 emissions intensity. As a result, CO_2 emission intensity decreased by 0.061kg-CO_2/kWh, compared to that before credit was reflected.

[CO_2 Emissions Suppression Measures]

The CO_2 emission control measures by the electric utility industry are mainly divided into two as shown below. One is supply-side low-carbon energy (reduction of CO_2 emission basic unit), and the other is making demand-side energy utilization more efficient (promoting energy saving per industry, transportation, business, and households as well as highly efficient electric equipment).

Decarbonization of energy at supply-side (lowering of CO_2 emissions intensity)

- Expanding use of non-fossil energy sources
  - Promotion of nuclear power generation based on the premise of safety assurance
  - Development and expansion of the use of renewable energy
- Improving efficiency of electric power equipment
  - Further improvement of thermal efficiency of thermal power plants
  - Reduction of transmission and distribution loss
- International efforts
  - Active utilization of Kyoto Mechanisms, etc.
  - Sectoral approaches

Improvement of energy usage efficiency at demand-side

- Energy conservation
  - Energy conservation and expansion of high energy conservation efficiency electric equipment
  - PR-activities and provision of information aimed at energy conservation and CO_2 reduction
- Efforts by electric utility industry as users
  - Efforts in office-use energy conservation
  - Efforts in using company-owned vehicles

Research and Development

Clean Coal Technology, next generation power transmission and distribution technology (Smart Grid), CO_2 capture/storage (CCS) technology, technologies for efficient use of electricity (EcoCute, electric vehicle)

Expanding use of non-fossil energy sources

○ Promotion of nuclear power on the precondition of ensuring safety

Nuclear power is of great importance because CO_2 is not emitted when generating electricity. It stands to play a central role in future initiatives in Japan to counter global warming. Along with working to restore the public's trust in nuclear power, the industry will continue to make the promotion of nuclear power a top management priority. In cooperation with the government, the industry will devote maximum effort to locating sites for nuclear power plants, raising the capacity factor, establishing the nuclear fuel cycle, and strengthening back-end measures, all while putting safety above all else and eliciting the understanding of local communities and the general public. Also, we will strive to further improve nuclear power station credibility based on the "Guidelines for seismic design evaluation of nuclear power reactor facilities" which was revised in 2006, and the seismic safety at Kashiwazaki-Kariwa Nuclear Power Station, which was affected by Niigata Prefecture Chuetsu Offshore Earthquake in 2007. On the basis of safety, we will contribute to improve utilized capacity by such means as conditionbased maintenance, which has been already implemented in other countries, online maintenance, flexible operating cycles, power uprating and upgrading inspection technology and safety evaluation technology.

○ Development and expansion of the use of renewable energy sources

The electric utility industry is obligated by the RPS Law* to use electricity including new energy, so we will continue to put all our efforts into meeting our obligations. We conduct co-combustion of wood biomass, etc. at coal-fired power plants. Also, as an entire electric utility industry, we decided to develop mega solar power generation and plan to build 140,000 kW mega solar generation facilities in about 30 locations nationwide by 2020. We have cooperated with "Green Power Fund" and "Green Power Certificates System" and purchased surplus electricity generated by wind power and solar power generation systems to expand and promote the use of renewable energy. The new purchase system of solar power generated started in November 2009, and we will cooperate with this system to promote solar power generation. There are still problems to be solved in wind and solar power generation, such as low energy density and high power generation cost. In order to introduce a large volume of solar power generation, etc, which is easily influenced by the climate, cutting-edge control systems that combine existing power plants and storage batteries, etc. (sophisticated Smart Grid in Japan) need to be established. We will work together with the government for future technological developments.

* "Special measures law related to use of new energy by electric utility industry"

Power Equipment Efficiency Improvement

○ Further improvement of thermal efficiency of thermal power plants

Improvement of thermal efficiency of thermal power plants directly contributes to CO_2 emission intensity reduction. The electric utility industry is pursuing such improvements such as by introducing and expanding the use of highly efficient equipment, including LNG combined cycle generation, when replacing highly aged thermal power facilities or installing a new equipment. The cutting-edge LNG combined cycle power generation technology that was introduced in 2007 has achieved a high thermal efficiency of 59%, the highest level in the world (lower heating value standard). We will strive for further thermal efficiency improvements. As coal is an excellent fossil fuel in terms of energy security and economical efficiency, it is crucial for a stable energy supply. We have been conducting technology development of the Integrated Coal Gasification Combined Cycle (IGCC) for effective utilization of coal as part of our efforts to improve efficiency.

International Efforts

Realizing that the Kyoto Mechanism helps efforts to combat global warming on a global basis and is also important as a domestic supplementary measure, we will continue to utilize Kyoto Mechanism credits. The contribution in CO_2 reduction through efforts such as the Kyoto Mechanism is affected by the approval of the United Nations and host countries. However, it is forecasted to be around 260 million t-CO_2 by 2012. The industry will also continue to promote projects that utilize such efforts as the Kyoto Mechanism and afforestation, and will utilize suppressed CO_2 emissions in achieving its targets. As for sectoral approaches, CO_2 emissions by the 7 countries: the United States, Australia, China, India, South Korea, Japan, and Canada, which participated in Asia-Pacific Partnership on Clean Development and Climate (APP), exceeds 50% of the total world emissions. Therefore, striving to reduce the emissions of these 7 countries is of great significance. To be more precise, through peer reviews we work on expanding the use of our operation and maintenance technology at a worldclass level to coal-fired power plants with low thermal efficiency in order to maintain and improve thermal efficiency. Moreover, we established the International Electricity Partnership (IEP) with electricity industry associations of Europe, USA, Canada, and Australia. In December 2009, we announced the technology roadmap by IEP, "Roadmap for a Low-Carbon Power Sector by 2050" during the session of COP15, Conference of the Parties to the UNFCCC (United Nations Framework Convention on Climate Change).

Energy conservation

○ Energy conservation and expansion of high energy conservation efficiency electric equipment

The electric utility industry will promote electrification and diffusion of highly efficient electric equipment, such as the heat pump, an advanced technology in our country, so as to contribute to energy use efficiency in industry, transportation, business, and household sectors. In particular, we will make efforts to expand the use of CO_2 refrigerant heat pump type electricity water heating supply machines (EcoCute), which can greatly reduce CO_2 compared to conventional water heaters, through joint efforts of the public and private sectors.

○ PR-activities and provision of information aimed at energy conservation and CO_2 reduction

The electric utility industry also plans to actively roll out initiatives which contribute to the promotion of energy conservation by customers. These include providing information that helps customers conserve energy and proposing measures through diagnosing their energy usage. Especially, the "Household Eco-Account book" is promoted by the entire industry. Use of the Household Eco-Account book is actively promoted as part of our "visualization" initiative.

Efforts by the electric utility industry as users

Since fiscal 2000, the electric utility industry has been implementing measures to reduce consumption of electricity for companies and of fuel for its own transport. Each company has set targets, and is making efforts to suppress CO_2 emissions. In addition, electric vehicles and plug-in hybrid vehicles have environmental advantages due to great suppression of CO_2 emissions compared to gasoline-powered vehicles. The government is making all efforts to expand the use of those vehicles. As the electric utility industry, we target to introduce about 10,000 electric vehicles (including plug-in hybrid vehicles) for corporate use by fiscal 2020 to contribute toward achieving full-scale commercialization of environmentally-efficient electric vehicles.

Research and Development

In response to the issues of global warming, the industry believes that we need to proceed with our technology research and development both in supply and demand sides from medium-andlong-term viewpoints. In particular, we will actively collaborate with the government in researching and developing technologies such as high-efficiency power generation technology, technology that is conducible for customers' energy conservation, capture and storage of CO_2 in the gas emitted by the thermal power plants, nuclear technologies, system stabilization technology, etc.

[Future Efforts and Issues]

The targets found in the electric industry's environmental action plans were set based on supply and demand forecasts and nuclear power development plans from that time (1996) and assumed full-scale efforts. Due to undecided operation plans for the Kashiwazaki-Kariwa Nuclear Plant of Tokyo Electric Power, Co. inc, which had been out of service due to the effect of the Niigata Prefecture Chuetsu Offshore Earthquake in 2007, it is difficult to envision its influence on CO_2 emissions until 2012 at the moment. Measures of the action plans include improvement of capacity factor for nuclear facilities through various ingenious efforts, development and popularization of energy-saving facilities and utilizing Kyoto Mechanism by participation in CO_2 reduction projects. Going forward, the electric utility industry will continue to commit its full efforts to achieve its target by steadily implementing existing measures and by strengthening the following initiatives in order to further improve effectiveness.

- ◆ **Promotion of nuclear power generation based on the premise of safety assurance**
- ◆ **Further improvement of the thermal efficiency of thermal power generation**
- ◆ **Development and expansion of the use of renewable energy sources**
- ◆ **Active utilization of the Kyoto Mechanisms, etc.**

Response to the Problem of Global Warming from a Long-term Perspective

The 15th Conference of the Parties to the United Nations Framework Convention on Climate Change (COP15) was held in December 2009 to discuss the framework of "post Kyoto Protocol." At the COP15, the Copenhagen Accord was taken note of and includes submissions of emissions targets by developed countries, mitigation actions to be taken by developing countries, funding commitments to developing countries, etc. Electricity is indispensable for sustainable development of societies and economies, and provides effective energy for taking environmental measures. Therefore, the electric utility industry has set the reduction of CO_2 emissions as the most important means of approaching global environmental issues, and we have realized the most efficient CO_2 emissions per generated output (CO_2 emissions intensity) in the world. We will maximize our efforts to achieve stable energy supply, environmental conservation, and economic efficiency (3Es) simultaneously.

① Efforts up to fiscal 2020

We have a supply plan based on the actual demands to fulfill the responsibility of stable supply, which is the biggest mission for the electric utility industry. We will proceed with business operations based on the supply plan announced at the end of March 2009, targeting 0.33 kg-CO_2/kWh of CO_2 emissions intensity in total of 10 electric companies in fiscal 2020 by realizing maximum nuclear energy development and high-efficiency combined cycle power generation. Specifically, we will strive for the following on the supply side: ①Realizing 50% of non-fossil energy rate using mainly nuclear power by fiscal 2020 ②With renewable energy, efforts for mega solar power generation and cooperation for the new solar power purchase system ③Realizing highly-efficient use of fossil fuel (introduction of the world's highest efficiency combined cycle power generation and development of coal gasification combined power). On the demand side, we will pursue the promotion of electrification through introduction and expansion of the use of "EcoCute," a heat pump that uses CO_2 as a refrigerant, to realize a low carbon society with our customers. Internationally, we will make efforts to improve the ability of engineers engaged in power plant operation and maintenance and also to maintain and improve facility performances in the developing countries through APP (Asia Pacific Partnership) activities and diagnosing coal-fired thermal facilities so that we will be able to actively support a low carbon society in developing countries by transferring and providing Japanese electric power technology.

② Efforts up to fiscal 2050

The electric utility industry regards the promotion of electrification as the key to realizing a low carbon society. Therefore, we will step up maximum efforts to realize further low carbon system power and a power shift of energy supply-demand structure on a long-term basis for 2050 in order to contribute toward realizing a low carbon society with drastic CO_2 reductions.

Establishing a Recycling-based Society

Measures for waste reduction and recycling

Waste Recycling Rate Target

As power supply and demand grow, so does the amount of waste generated. The industry forecasts its total volume of waste will expand to 10.1 million tons in fiscal 2010, about twice as much as that in fiscal 1990. Seeking to reduce the amount of waste finally disposed of and to realize a society based on a recycling economy, the industry has been working on a target of reaching a waste-recycling rate of 95% by fiscal 2010.

Waste Recycling Achievements

Waste generated by the industry amounted to 9.67 million tons in fiscal 2009, a decrease of 1.05 million tons from the fiscal 2008 level. This is because the amount of power generated from coal-fired power stations decreased. On the other hand, the recycled volume in fiscal 2009 was 9.22 million tons, which is a decrease by 1.17 million tons from fiscal 2008. The result is that a recycling rate of 95% was achieved in fiscal 2009, and we have continued achieving our high target recycling rate of 95% since 2008. By category of waste, coal ash was the most voluminous at 7.02 million tons, of which 6.8 million tons was recycled, primarily as a raw material for cement, an admixture for concrete, or material for land reclamation. Renewed resources are produced from nearly all of the total scrap metal and the construction waste material generated, and every possible effort is made to produce renewed resources from other waste products as well. All gypsum, which is a byproduct of the desulfurization process, is used to produce renewed resources such as gypsum boards and as an ingredient for cement.

The Three Rs and Future Efforts

● Coal Ash: Recycling of coal ash remains an important issue, thus we are working on the development of applications and a technology to handle large volumes of coal ash in a stable manner. ● Desulfurized gypsum: We will maintain 100% re-utilization. ● Other wastes: Actively implement 3Rs

Recycling by the Nuclear Industry

In Japan, where more than 80% of its primary energy comes from offshore supplies, the nuclear fuel cycle, which recycles uranium and plutonium recovered from spent fuels, is an ideal system. The cycle brings out the properties of nuclear power production by securing stable energy sources while complementing a recycling economy. A chemical reprocessing plant for spent fuels is under construction in Aomori Prefecture to establish the nuclear fuel cycle, and the plant is scheduled to start operation in 2012. Due to the current energy policy in Japan which dictates that there should be no surplus plutonium, the industry is promoting its "Plu-thermal" plan. This technology enables the plutonium recovered from spent fuel to be used as MOX fuel (Mixed Oxide Fuel-pellets of uranium mixed with plutonium) in existing light water reactors. We are aiming for introducing plu-thermal to 16 to 18 nuclear reactors nationwide by fiscal 2015. This policy is based on Japan's national principle of not storing surplus plutonium. In the future, the use in fast breeder reactors, on which R&D efforts are in progress, would be most effective, and its practical application should dramatically improve the utilization of uranium resources.

Management of Chemical Substances

The electric utility industry has carried out PRTR Law (Pollutant Release and Transfer Register) studies since 1997, even before the relevant laws were enacted, in an effort to precisely monitor release and transfer volumes at power generators and other facilities as the amount of special chemical substances gradually increases. A system for reporting emission volumes and other factors was introduced in April 2002 and was based on the PRTR Law. Under this system, electric utility companies gather information on the release and transfer volumes for specific chemical substances at each of their facilities and report their findings to the national government. In the future, the industry will endeavor to appropriately control and maximally reduce emissions of these chemical substances.

Approaches to Biodiversity

The electric utility industry has been endowed with various natural benefits which are created by biodiversity through our business activities. However, we are concerned about global warming by CO_2 emissions and the impact on biodiversity at global and regional levels by land alteration in association with installation of facilities. Therefore, we take the environment into consideration on a global basis through our activities of building a recycle-based society by promoting nuclear power and renewable energy. We also actively nurture biodiversity at the regional level by taking environmental preservation measures according to the environment assessment. We will drive sustainable business activities based on these guidelines while appreciating the gifts of nature.

Promotion of Environmental Management

The Japanese power companies have established in-house environmental management systems by establishing an environment department, and their involvement in efforts to protect the environment has been disclosed through CSR reports and websites. As for environmental management systems, each power company actively and voluntarily commits to various measures based on its own policies, such as the reinforcement of an internal environmental management system in compliance with the requirements of the ISO 14000 series of international promotion of environment management and the acquisition of the ISO 14001 certification for its representative business establishment.

Environmental Considerations in Overseas Projects

The electric utility industry has long trained personnel in environmental fields by accepting trainees from developing countries and providing technical assistance by dispatching specialists from Japan. With regard to participation in projects overseas and technology collaborations, the industry has conducted initiatives in consideration of local environmental issues and global-scale environmental preservation. These include biomass power generation, afforestation and measures to reduce the environmental impact of thermal power plants. The electric utility industry plans to continue to aggressively promote these kinds of initiatives that give adequate consideration to the environment.

Conclusion

As shown in this brochure, the energy conservation
and environmental preservation efforts
by Japan's electric utility industry are contributing toward
the solution of environmental problems such as global warming and acid rain.
The leading role of the government
and international cooperation system are indispensable
in scientific elucidation of its mechanisms,
the search for new sources of energy,
and the establishment of appropriate countermeasures to environmental problems
on the issue of global warming.
The industry expects appropriate response by the government
and international organizations,
and will cooperate positively at the private level for the preservation of the environment.