Environmental Action Plan by the Japanese Electric Utility Industry

September 2013

The Federation of Electric Power Companies of Japan (FEPC)

Contents

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Introduction

The twelve electric power-related companies[1] (ten general electric utility companies which comprise the Federation of Electric Power Companies (FEPC) and two wholesale suppliers), compiled and published the Environmental Action Plan by the Japanese Electric Utility Industry in November 1996. This paper outlined the twelve companies' policies and plans for addressing global warming, creating a recycling-oriented society and managing chemical substances. This action plan has been reviewed every year since fiscal 1998 to confirm the status of implementation and the progress made, with this review being the sixteenth.

As this year is the final year of our CO_2 emissions reduction target (fiscal 2008 – 2012), this follow-up summarizes the efforts made over this period, as well as the status of implementation in 2012.

Regarding the global warming countermeasures beyond 2013, the electric utility companies will participate in the Keidanren's Action Plan for Achieving a Low-Carbon Society, designate it as the new "Environmental Action Plan by the Japanese Electric Utility Industry", and continue their efforts on both the supply and demand sides of electricity to achieve a low-carbon society.

1) The twelve electric power related companies include ten members of the Federation of Electric Power Companies (Hokkaido Electric Power Co., Tohoku Electric Power Co., Tokyo Electric Power Co., Chubu Electric Power Co., Hokuriku Electric Power Co., Kansai Electric Power Co., Chugoku Electric Power Co., Shikoku Electric Power Co., Kyushu Electric Power Co. and Okinawa Electric Power Co.) as well as Electric Power Development Co. and Japan Atomic Power Co.

1 Global Warming Countermeasures

(1) Basic Policy for Global Warming Issue

<Simultaneous Pursuit of Environmental and Economic Integrity>

Continuous efforts must be made to address global warming by taking advantage of technical innovation and ingenuity under the basic concept that "environmental conservation and economic growth should be achieved simultaneously" in order to reduce greenhouse gases on a global level.

<Simultaneous Achievement of 3Es on the Basic Premise of S>

The electric utility industry is making great efforts to achieve the Environmental Action Plan and realize a low-carbon society through pursuing an optimal energy mix based on simultaneous achievement of the S + 3Es: energy security, economic stability and environmental conservation, while placing top priority on safety.

<Realizing a Low-carbon Society>

Based on the fundamental goal of "ensuring a stable supply of high-quality and inexpensive electricity", we promote the following activities on both the supply and demand sides in order to realize a low-carbon society. (1) Low-carbonization of supply energy and (2) Efficiency improvement of customers' energy usage by expanding use of highly efficient equipment.

❍Activities to deliver low-carbon energy on the supply-side

We strive to improve the share of non-fossil energy sources, and also work hard to use fossil fuels more efficiently by raising the thermal efficiency of thermal power generation (through the use of nuclear power premised on safety, and renewable energies).

❍Activities to enhance efficiency of energy use by customers

We endeavor to promote energy conservation and CO_2 emissions reduction by expanding use of highly efficient electric equipment through our proposals and consultations to customers in industry, transportation, building, and household sector. We will also lead in the development of innovative next-generation technologies that help to reduce CO_2 emissions and conserve energy use.

(2) CO_2 Emissions Suppression Target and CO_2 Emissions

(i) CO_2 Emissions Suppression Target

The electric utility industry has set CO_2 emissions suppression target, as measured in kg-CO_2 per kWh of energy used by customers (this is also known as CO_2 emissions intensity) as below.

> During 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%, about 0.34 kg-CO_2/kWh, from the fiscal 1990 level.

<Concept behind goal setting>

The amount of CO_2 emissions accompanied by the use of electricity can be calculated by multiplying electric power consumption by the CO_2 emissions intensity. Of these factors, electric power consumption can increase or decrease due to factors beyond the control of the electric power companies such as the weather and the circumstances surrounding using electricity. For this reason, the electric utility industry adopts targets of emissions intensity reduction that can reflect their own efforts.

These targets were set based on the supply and demand outlook and the nuclear development plans of the time (1996), assuming that maximum efforts will be made. Furthermore, in 2006, it was decided to collaborate with the Keidanren and stretch the target year from 2010 alone to the entire 1st Commitment Period of the Kyoto Protocol (2008–2012).

(ii) CO_2 Emissions for the Five Years from Fiscal 2008 to 2012

Electric power consumption was 852 billion kWh in fiscal 2012, while CO_2 emissions* totaled 415 million t-CO_2 and user-end CO_2 emissions intensity* was 0.487 kg-CO_2/kWh. As a result, the average user-end CO_2 emissions intensity* for the five years was 0.406 kg-CO_2/kWh.

* CO_2 emission intensity and CO_2 emissions reflect the credit[2] in the way stipulated in the "Law Concerning the Promotion of Measures to Cope with Global Warming." The figures for 2012 and the five-year average may improve slightly when the additional credits currently outstanding due to the delay in review by the UN have been incorporated (to be announced when they are fixed).

Item \ Fiscal Year	1990	2008	2009	2010	2011	2012	Five-year average (2008–2012)
Electric power consumption*1 (billion kWh)	659	889	859	906	860	852	—
CO_2 emissions*2 (million t-CO_2)	275	332 [395]*3	301 [353]*3	317 [374]*3	409 [439]*3	415 [486]*3	—
CO_2 emissions intensity user end electricity*4 (kg-CO_2/kWh)	0.417	0.373 [0.444]*3	0.351 [0.412]*3	0.350 [0.413]*3	0.476 [0.510]*3	0.487 [0.571]*3	0.406 [0.469]*3

*1 Electric power consumption includes power purchased from cooperative thermal power plants, IPPs (independent power producers), and household generators and then sold.
*2 CO_2 emissions include CO_2 emissions that are emitted at the time of generation of electric power purchased from cooperative thermal power plants, IPPs (independent power producers), and household generators. They also include CO_2 emissions equivalent to electric power transmitted and received in wholesale electric power trading, and CO_2 emissions reflecting carbon credits according to the stipulated methods.
*3 Figures in the brackets [ ] are the CO_2 emissions and CO_2 emission intensity not reflecting carbon credits. These figures are provided as a reference.
*4 User-end CO_2 emissions intensity (credits incorporated) = CO_2 emissions (credits incorporated) / electricity consumption
CO_2 emissions were derived in the way stipulated by the "Calculation and Official Announcement of Real and Adjusted Emissions Factor by Each Electric Utility" (revised on March 29, 2013), which newly includes the adjustment methods related to the surplus solar electricity purchasing system[3] and the FIT system for renewable energies[4].

2) It refers to the credits generated by the International Emissions Trading (ET), Joint Implementation (JI), and Clean Development Mechanism (CDM)that were set in the Kyoto Protocol and the credits generated in the domestic credit system.

3) In this system the power company purchases surplus electricity generated by the customer's solar power generation facility under the conditions set by the national government. The cost required for purchasing electricity is born by all electricity users depending on the power consumption as the "Solar Power Generation Promoting Surcharge." The system started on November 1, 2009.

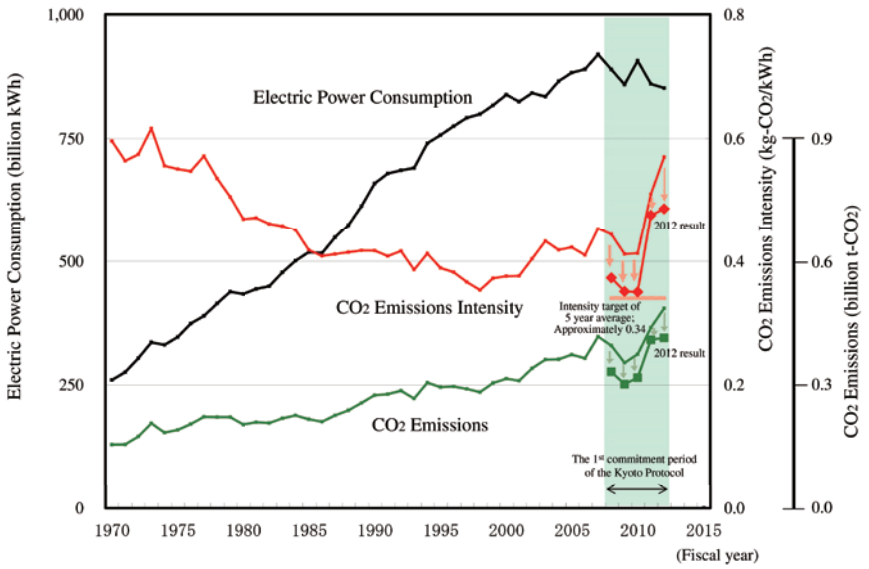
4) A system launched on July 1, 2012 in which the electric utilities are obliged to purchase, for a certain period at a certain price, electricity generated using renewable energy sources such as solar energy.

Reference

Trends in CO_2 emissions, etc. by the electric utility industry

Since the oil crisis of the 1970s, power consumption in Japan has increased by a factor of approximately 3.3, but CO_2 emissions have increased only 2.7-fold. This improvement is largely attributed to the efforts by both the supply and demand sides, which are low carbonization by the suppliers and improved efficiency use by the users. CO_2 emissions per kWh (CO_2 emissions intensity) have decreased by about 18%.

CO_2 emissions and CO_2 emissions intensity by the electric utility industry

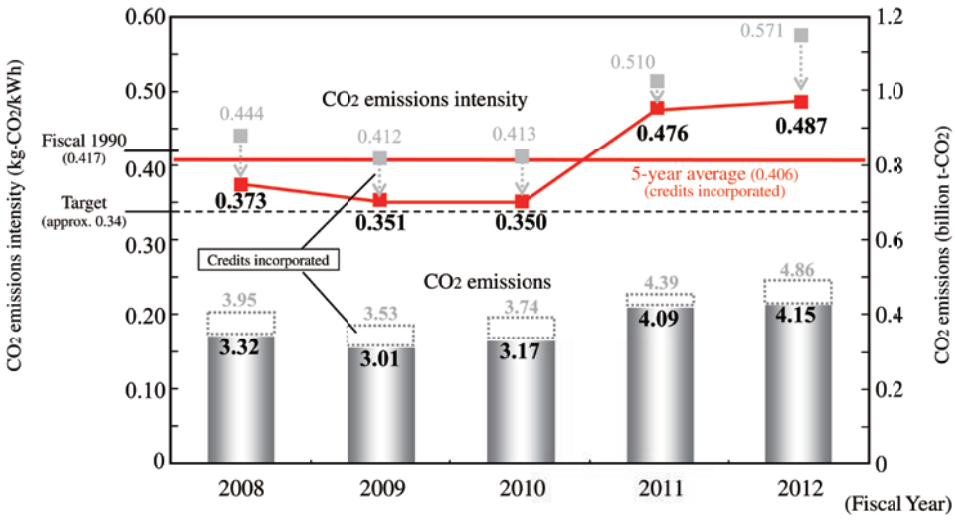


* The marker indicates user-end CO_2 emissions intensity after reflecting credits and CO_2 emissions after reflecting credits. The electric utility industry targets an approximately 20% reduction (to approx. 0.34 kg-CO_2 /kWh) over the average of five-year period between fiscal 2008 and fiscal 2012, compared to fiscal 1990.

(3) Analysis and Evaluation of CO_2 Emissions

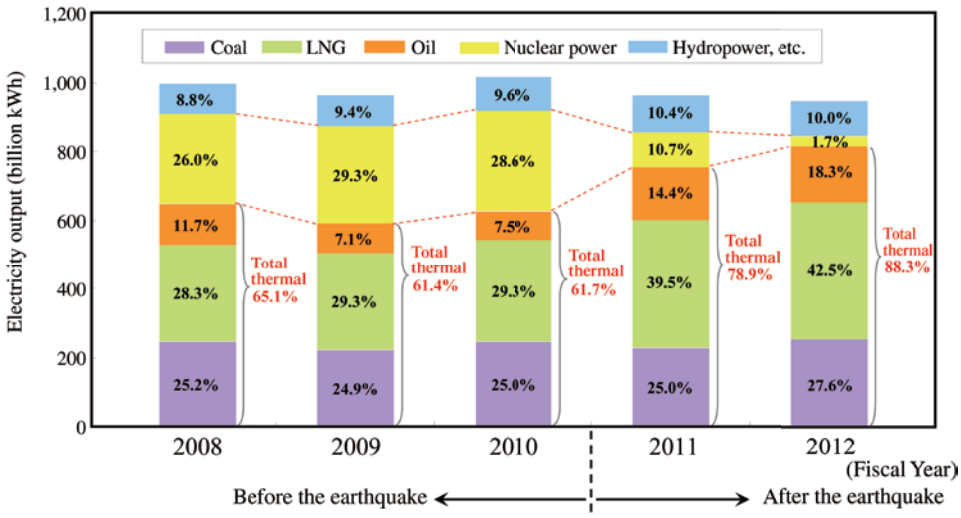
In order to achieve the CO_2 emissions suppression target, the electric utility industry has constantly made utmost efforts, including using nuclear power, developing and promoting renewable energies, and improving the thermal efficiency of thermal power plants, as well as using the Kyoto Mechanism. However, due to the long-term shutdown of nuclear power plants after the Great East Japan Earthquake in March 2011, the 5-year average of user-end emissions intensity between 2008 and 2012 (credits incorporated) reached no further than 0.406 kg-CO_2/kWh (down 2.6% from 1990 levels).

Trend of CO_2 emissions and CO_2 emissions intensity



This is due to the drop in the proportion of nuclear power generation, which is recognized as a major countermeasure against global warming, from 30% before the earthquake disaster to 10% or less, and the increase in thermal power generation to 80 to 90% from approximately 60%.

Proportion of power sources in the generation mix



Proportion of power generation by energy source

FY / Items	Before the earthquake disaster			After the earthquake disaster	
	2008	2009	2010	2011	2012
Nuclear (billion kWh) [Capacity factor (%)]	258.1 [60.0]	279.7 [65.7]	288.2 [67.3]	101.8 [23.7]	15.9 [3.9]
Hydropower, etc. (billion kWh)	87.5	89.8	97.3	99.6	94.2
Thermal (billion kWh)	645.9	586.9	620.9	753.6	830.7
Total (billion kWh)	991.5	956.5	1,006.4	955.0	940.8

Despite not reaching the CO_2 emissions suppression target of 0.34 kg-CO_2/kWh (20% lower than fiscal 1990 levels), the efforts to reduce CO_2 were continued even during the prolonged shutdown of the nuclear power plants after the disaster. Furthermore, the use of the Kyoto Mechanism credits surpassed the 5-year target set before the earthquake disaster, reaching approximately 270 million t-CO_2.

We recognize that our intensive efforts have contributed to achieving the national target for Kyoto Protocol.

Reference

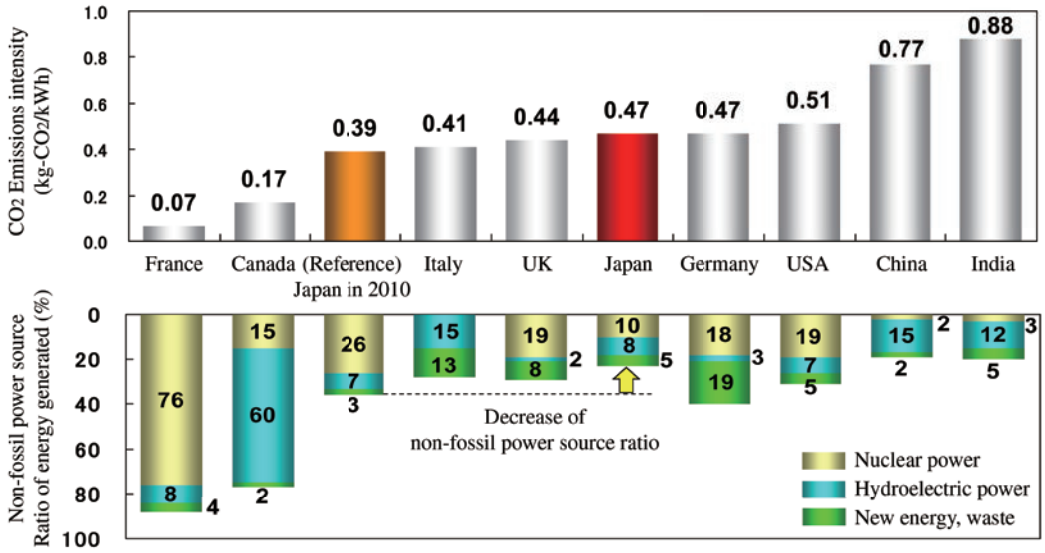
Country-to-country comparison of CO_2 emissions intensity (gross)

CO_2 emissions intensity in Japan is low in comparison with major European and North American countries, although not as low as France (which has a high ratio of nuclear power generation) and Canada (a high ratio of hydroelectric power generation).

Thus, it can be said that the electric utility industry of Japan has sought to implement the optimal combination of energy low carbonization by the suppliers and the efficiency improvement on the user side.

However, in 2011, CO_2 emissions intensity increased by approximately 20% compared to before the earthquake disaster due to the long-term shutdown of nuclear power plants which caused the ratio of non-fossil fuels to drop.

Country-by-country comparison of CO_2 emissions intensity (gross) provisional calculation by FEPC



* Fiscal 2011 figures
* Including household power generating installation in Japan
* Including CHP plant (combine heat and power)
* Source: IEA Energy Balances of OECD Countries 2013 Edition/
Energy Balances of Non-OECD Countries 2013 Edition

(4) Measures to Suppress Greenhouse Gas Emissions Other than CO_2

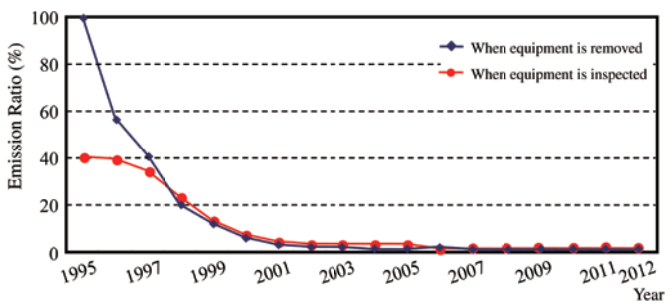
The combined effect on the climate of five greenhouse gases other than CO_2 emitted by the electric utility industry is about 1/380 of that of CO_2. The industry has been putting great effort into suppressing emissions of these gases through the measures following.

(i) Sulfur hexafluoride (SF_6)

SF_6 is a gas with superior insulation and arc suppressing properties that is safe to humans and is stable. The electric utility industry uses SF_6 for gas blast circuit breakers and gas-insulated switches. The gas is essential for a stable electric power supply in Japan with its small land mass, as SF_6 allows equipment to be constructed compactly. It is effective in land use, and effective to reduce noise, and safe. While SF_6 has been indicated to be a gas with higher greenhouse effect properties. it is necessary for us to continue using it as no effective alternate gas is known at this stage.

Although the electric utility industry must continue to use SF_6, we adopted "the Voluntary Action Plan of the Japanese Electric Utility Industry to Reduce SF_6 Emissions" in April 1998, which takes into account suppression of SF_6 emissions and recycling. Under this plan, the industry suppressed emissions in 2005 to 3% of SF_6 contained when devices are inspected, and to 1% when they are disposed of. In the 2012 results, targets have been met during mechanical inspections and disposal. The industry aims to continue to meet its targets by continuing its efforts in this area.

Transition of SF_6 Emission



(ii) Hydrofluorocarbon (HFC)

HFC is principally used as a refrigerant for air-conditioning equipment. The industry foresees a continuing shift from CFCs, whose use is restricted by law, to HFC substitutes. The industry will make the utmost effort to prevent leakage during device installation and repair and to recover and recycle the gas.

(iii) Perfluorocarbon (PFC)

Liquid PFC is used as a refrigerant and an insulating medium for certain types of transformers. Since it is used in liquid form, it is easy to recover and recycle, and there is no fear of leakage to the environment, either during normal operation or upon disposal.

(iv) Nitrous oxide (N_2O)

N_2O emissions occur at thermal power plants due to the combustion of fuels. N_2O emissions by the electric power industry account for about 3% of total N_2O emissions in Japan. The industry is striving to reduce its emissions, primarily by improving thermal efficiency.

(v) Methane (CH_4)

The concentration of CH_4 in flue gases emitted as unburned combustible content in the burning of fuel at thermal power plants is less than the concentration in the atmosphere, meaning emissions are essentially zero.

(5) Promotion of the Action Plan for Achieving a Low-Carbon Society

So far, the electric utility industry has focused on reducing global warming CO_2 emissions as the key to tackling global warming.

Beyond 2013, the companies will participate in the Action Plan for Achieving a Low-Carbon Society announced by the Keidanren in January 2013, and will continue to actively address global warming. These efforts, with a basic purpose of pursuing the optimal energy mix, will be made on both the supply and demand sides of electricity, from a perspective of simultaneous achievement of the S + 3Es: energy security, economic stability and environmental conservation, while placing top priority on safety, in order to achieve a low-carbon society.

The Action Plan for Achieving a Low-Carbon Society by the Japanese electric utility industry is based on four pillars: efforts in the domestic business activities, strengthening the collaboration between the supply and demand sides including customers, promoting international contributions, and developing innovative technologies.

Efforts in domestic business activities

Expanding the use of non-fossil energy sources

- **Using nuclear power with safety as a major premise**
- **Using renewable energies**
  - Using hydropower, geothermal, solar and wind power, and biomass
  - Studies for dealing with the output fluctuation of renewable energies and for expanding their introduction

Improving the efficiency of power facilities

- **Improving the efficiency of thermal power**
  - In developing thermal power, adopting the highest level of technology suitable for the size of the plant
  - Appropriately maintaining and controlling the thermal efficiency of existing plants

Strengthening the collaboration between the supply and demand sides including customers

Energy conservation

- **Promoting high-efficiency electrical devices to enhance the efficient use of electricity**
  - Heat pumps (EcoCute, etc.), TES air-conditioning systems
- **PR activities and providing information on energy-saving and CO_2 reduction**
  - Environmental housekeeping books, exhibitions on energy-saving appliances, seminars on energy saving
- **Introducing smart meters for the efficient use of electricity**

Efforts by electric utility industry as users

- **Efforts in office-use energy conservation and the use of company-owned vehicles**
  - Reduction of amount of power consumption
  - Introduction of electric vehicles and fuel-efficient vehicles

Promoting international contributions

International efforts

- **Assisting developing countries to reduce carbon through international partnership (GSEP) activities**
  - Transfer and granting of Japanese electricity technologies through coal thermal facility diagnosis and CO_2 emissions reduction activities
- **Reducing carbon in all parts of society through international efforts**
  - Developing and introducing advanced and feasible electricity technologies through international efforts such as the "International Electricity Partnership"

Developing innovative technologies

Research and development

Supply side

- **Clean coal technology, CCS, next-generation power transmission and distribution technology**

Customer side

- **Ultra-high-efficiency heat pump, EV-related technologies**

i) Efforts in Domestic Business Activities

a. Using nuclear power with safety as a major premise

The electric utility industry believes that nuclear power generation, because of the stable fuel supply it provides, will continue to be an important energy source to ensure a stable energy supply in Japan, which has an energy independence rate of only 4%. Nuclear power will remain very important in mitigating global warming since it does not emit CO_2 in the process of power generation, giving it a central role in Japan's efforts to counter global warming.

So far, the electric utility companies have taken extensive safety measures based on the lessons and new knowledge gained in the Fukushima Daiichi nuclear power plant accident, and are now taking the necessary steps to have the plants reviewed for compliance with the new safety requirements implemented by the Nuclear Regulation Authority in July this year.

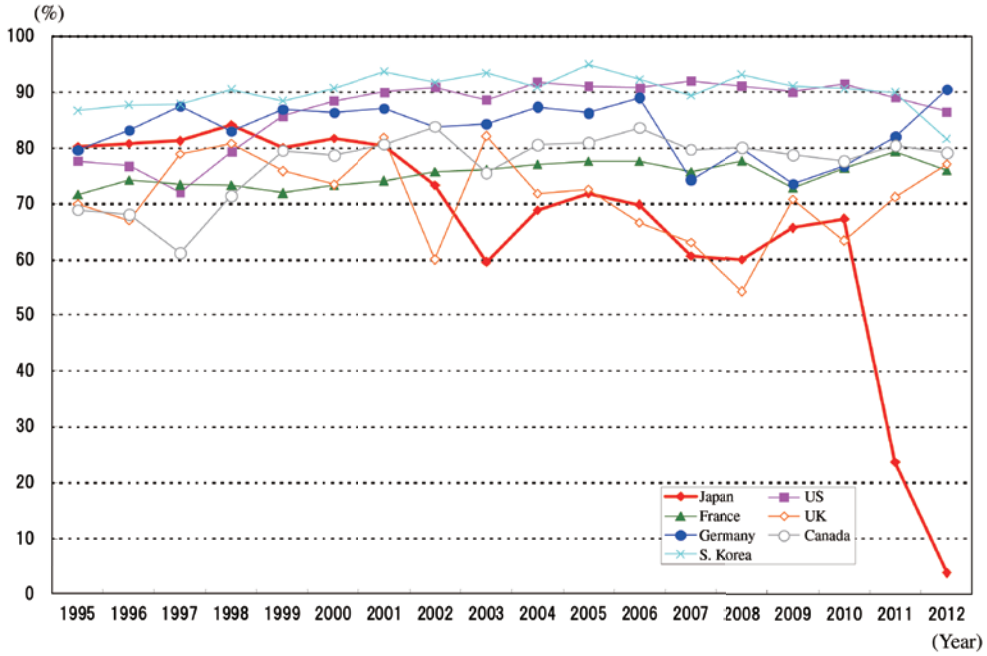
The companies will make utmost efforts for the safe and stable operation of the nuclear plants that have been proven to be safe once they are restarted with the understanding of the plant-hosting communities and the general public.

The power companies will continue to work to ensure nuclear safety, including further improving safety and reliability, while fully meeting the new regulatory requirements.

Reference

Comparison of nuclear facility capacity factor transition among countries

Transition of Nuclear Facility Capacity Factor



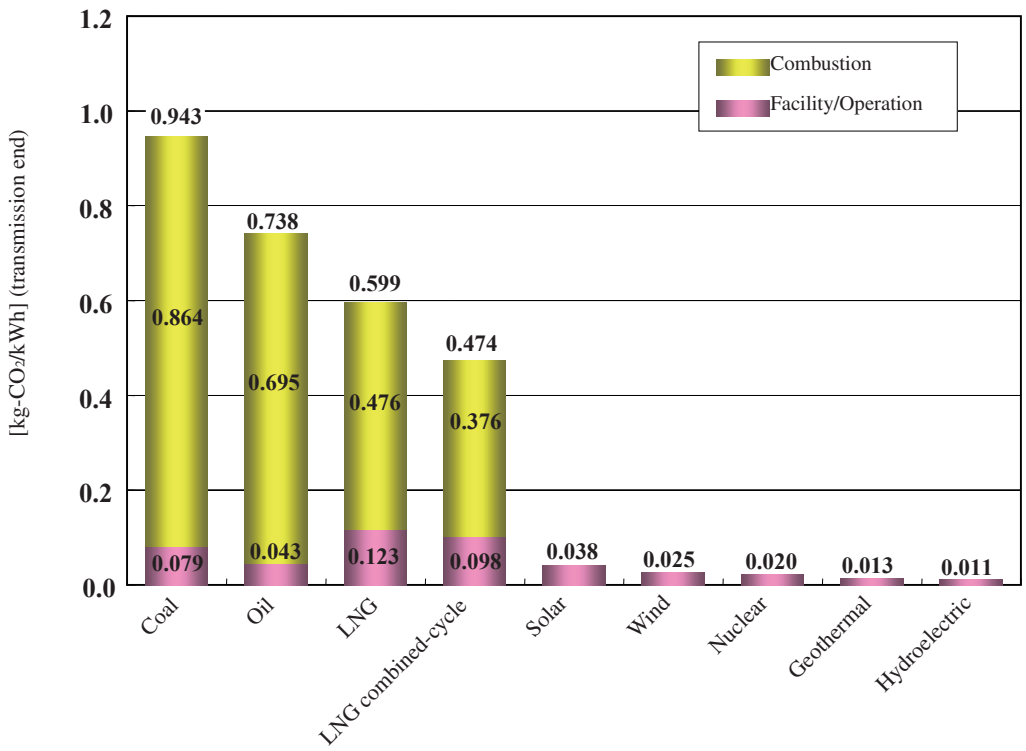
Source: Annual Report of Nuclear Power Plant Operation Management, etc.
* Transition of Japan shows utilization ratio per fiscal year
* Starting 1982, France has introduced load following operation that reduces output depending on power demands, so capacity factor is relatively low.

Other countries are moving from time-planned maintenance methods where machinery is disassembled and inspected at regular intervals to condition-based maintenance methods in which machinery operation data is monitored to find signs of trouble before disassembly and inspection. Also, on-line maintenance in which backup machinery is maintained during operations has been introduced, and operation cycles of 18 to 24 months of continuous operations are being flexibly employed. Increasing rated output for existing nuclear power plants is also being actively promoted. The result of achieving such intensive use has been high levels with capacity factors of 81.6% in S. Korea and 86.5% in the USA (2012 figures).

Reference

Comparison of lifecycle CO_2 emissions intensity for Japan's energy sources

Comparison of lifecycle CO_2 emissions intensity for Japan's energy sources



* Note (1): Based on total CO_2 emissions from all energy consumed in energy extraction, plant construction, transportation, refining, plant operation and maintenance, etc. in addition to burning of the fuel.
* Note (2): Data for nuclear power: 1) includes spent fuel reprocessing in Japan (under development), MOX fuel use in thermal reactors (assuming recycling once) and disposal of high level radioactive waste, and 2) is based on the capacity-weighted average of CO_2 emissions intensities of existing BWR and PWR plants in Japan, which are 19 g-CO_2/kWh and 21 g-CO_2/kWh respectively.

Source: Report of the Central Research Institute of Electric Power Industry in Japan

Reference

CO_2 emissions suppression effect of nuclear power generation

The CO_2 emissions suppression effect of one nuclear power plant (1000 MW) is approximately 5 million t-CO_2 higher than that of oil-fired thermal power per year (at a nuclear plant capacity factor of 85%). This difference is equal to the annual emissions of 1.4 million general households.

This is why the stable operation of nuclear power, which does not emit CO_2 when generating power, is important for fighting global warming.

Reference

Achieving the Highest Level of Safety in the World

Determined to avoid a repetition of the Fukushima Daiichi accident, the electric power companies have been taking emergency safety measures since immediately after the accident, including installing additional emergency power supplies, and strengthening measures for cooling and water-proofing, to ensure that core damage is prevented even if all three functions (station power supply, cooling by sea water, and spent fuel pool cooling function) are lost due to a tsunami exceeding the design basis.

Furthermore, the power companies have voluntarily taken additional measures to raise safety at their own initiative without waiting for the new safety requirements to come into effect. These include measures reflecting the technical knowledge learned from the Fukushima Daiichi accident, including preventing containment vessel failures with filtered ventilation systems and preventing hydrogen explosion of hydrogen processing facilities, and measures for responding to external events, such as strengthening the design basis and preparing for severe accidents postulating earthquakes, tsunami and terrorist attacks.

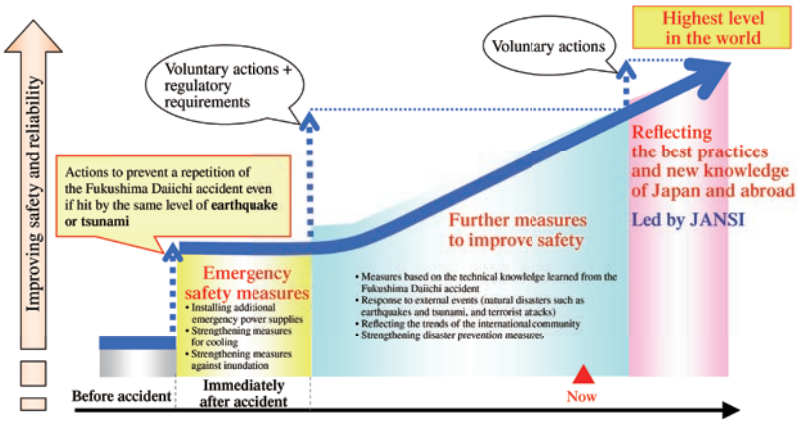
Furthermore, disaster prevention measures are being strengthened by reflecting the best practices and the latest knowledge of foreign countries and by establishing the nuclear emergency support organization.

To drive such efforts by the power companies, the Japan Nuclear Safety Institute (JANSI) was established to achieve the highest level of safety in the world.

The Contents of the New Safety Regulatory Requirements and the Compliance Efforts of the Power Companies

Items			New safety regulatory requirements	Efforts by power companies (examples)
Response to the Fukushima Daiichi accident	Emergency safety measures (instructed by the former NISA)		- Installing additional emergency power supplies - Strengthening measures for cooling - Strengthening measures against inundation	- Installing power-supply trucks and portable power supplies - Installing fire engines and portable fire pumps - Fitting watertight doors to power supply and cooling equipment rooms
	Reflecting technological knowledge	Additional measures to improve safety	- Preventing core damage - Preventing containment vessel failure - Preventing hydrogen explosion	- Strengthening external power supplies and DC power supplies - Installing filtered ventilation systems - Installing emergency response centers (proactive voluntary actions)
Response to external events	Earthquakes, tsunami		- Evaluating design basis earthquakes and tsunami - Severe accident countermeasures	- Reviewing the reference earthquake as needed by investigating active faults and subsurface structures, and strengthening seismic resistance - Evaluating the height of tsunami; installing tidal embankments and water-tight doors
	Other natural disasters		- Volcano and tornado countermeasures	- Setting a reference natural disaster, and taking necessary measures
	Terrorist attacks, etc.		- Measures against intentional airplane strikes	- Establishing a designated severe accident response center - Preparing a major damage alleviation guideline (proactive voluntary action)
Reflecting the measures taken in other countries			- Strengthening fire prevention measures - Measures against intentional airplane strikes (also appears above)	- Evaluating the impact of fire and taking necessary measures - Establishing a designated severe accident response center (also appears above) - Preparing a major damage alleviation guideline (also appears above)
Strengthening disaster prevention measures			- Strengthening nuclear disaster countermeasures	- Reviewing disaster preparedness and improving disaster prevention infrastructure nationwide to end the accident quickly and ensure the safety of residents - Strengthening disaster countermeasures such as preparing hubs and support organizations
Reflecting the best practices and the latest knowledge of Japan and abroad				- Establishment of a new organization (JANSI) (voluntary action)

Efforts for Improving the Safety of Nuclear Power



b. Utilization of renewable energies

The electric power companies have developed and expanded the use of renewable energies such as hydropower, geothermal, solar and wind power, and biomass by themselves, while purchasing solar and wind electricity from customers. The companies will continue to utilize renewable energies through the measures outlined below.

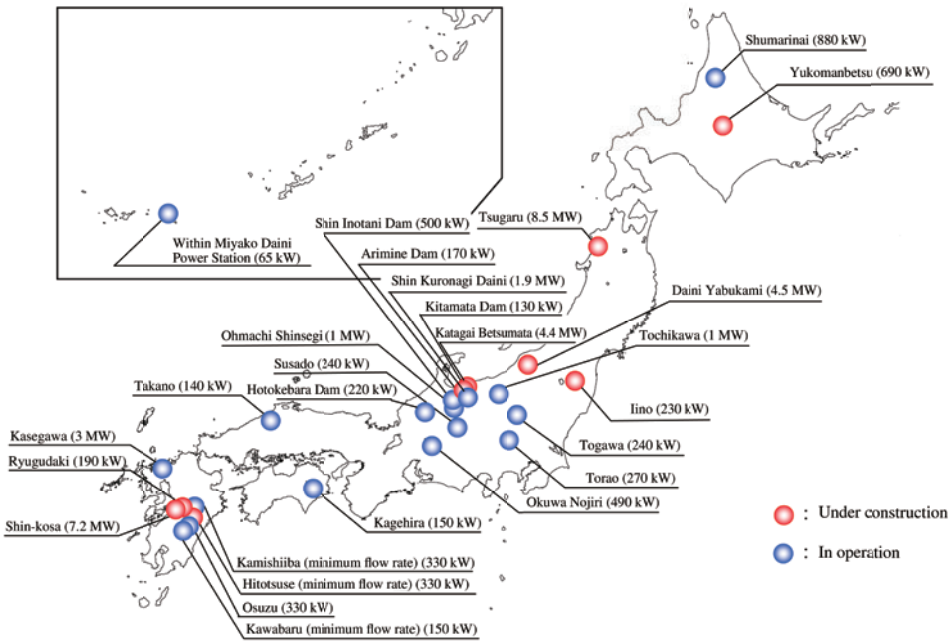
<Main efforts by electric power companies>

• Development of the hydroelectric power generation

As Japan has few domestic energy sources, hydroelectric power generation is valuable. Currently, there are 1,242 hydroelectric power stations in operation throughout the country. Generation capacity has reached approximately 44 GW in total with 67 billion kWh produced during the 2012 fiscal year.

Recently, the companies are working actively on developing low-head hydropower stations which make use of unused energy such as the minimum flow rate of a river and on improving the output of power generators when repairing old power stations. Low-head hydropower plants have been launched since 2008 at 18 locations, producing 11,000kW of electricity.

Status of Low-Head Hydropower Stations (as of the end of August 2013)



• **Utilization of geothermal power generation**

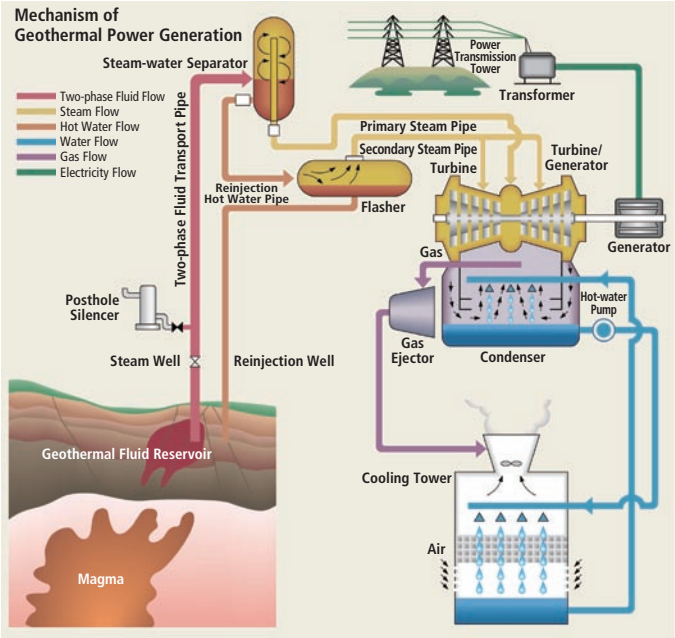
Currently, geothermal power plants are located mainly in Tohoku and Kyushu regions. Total energy output in 12 locations nationwide is approximately 500 MW. In fiscal 2012, approximately 2.5 billion kWh was generated.

Reference

Mechanism of Geothermal Power Generation (Example: Hacchobara Power Plant of Kyushu Electric Power Co., Inc.)

Geothermal power generation produces electricity by rotating a turbine directly with the steam taken from deep within the earth. The earth serves as the boiler. The so called "geothermal zone", a volcanically active area, is full of volcanoes, natural fumaroles, solfataras, spas, or altered rocks, with the magma reaching about 1,000°C at a comparatively shallow level of several km in depth.

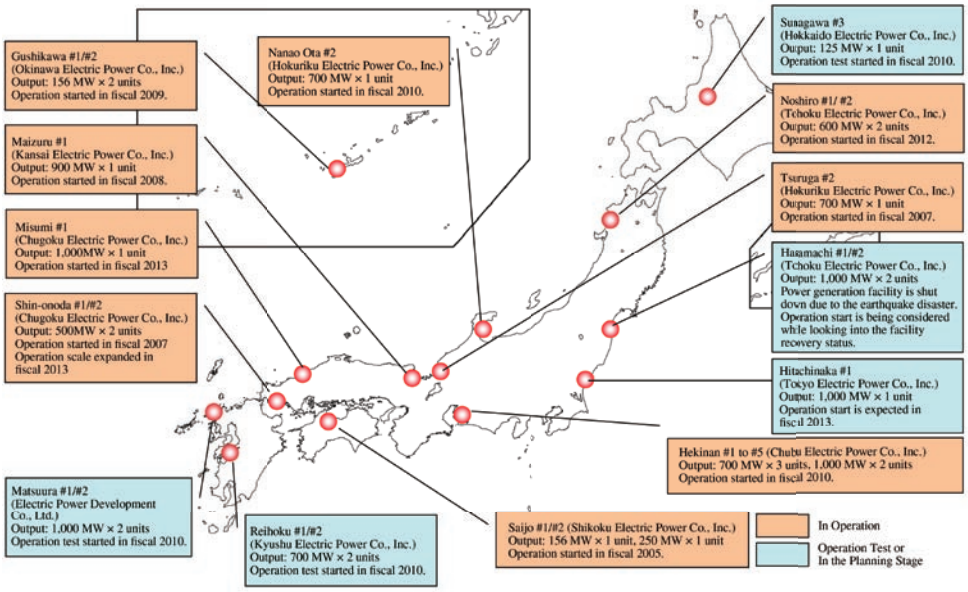
The magma heats the meteoric water infiltrating into the groundwater forming a geothermal fluid reservoir. The underground heat at such a place is utilized as a direct energy source.



• Using Woody Biomass Fuel at Existing Coal-Fired Power Plants

As part of their efforts to use renewable energies, the electric power companies are burning woody biomass fuel at their coal-fired power plants. In fiscal 2012, 264,000 tons of woody biomass were burned, producing approximately 380 million kWh of electricity.

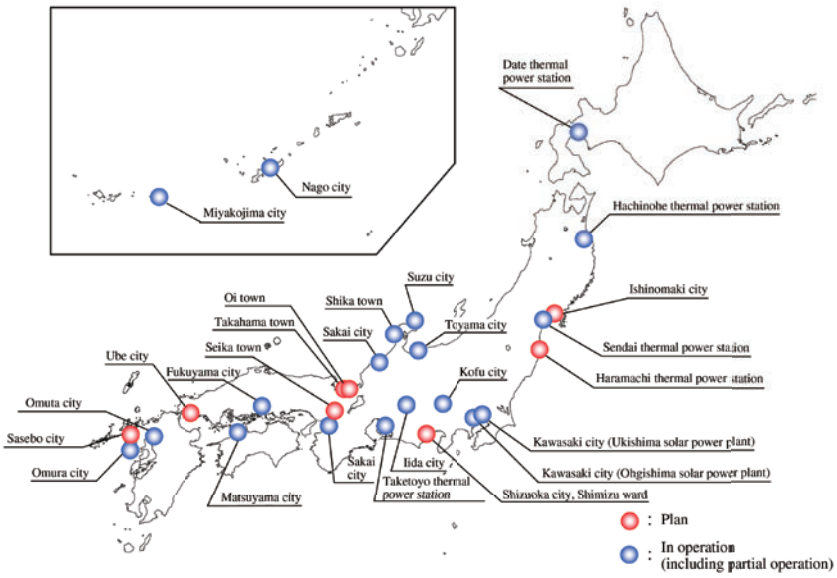
■ Current and Planned Burning of Woody Biomass in Coal-Fired Thermal Power Plants (Main Locations)



• Introduction of Mega Solar

In September 2008, we announced the introduction plan of mega solar power plants of approximately 140 MW in about 30 locations nationwide by fiscal 2020. Annual electric energy (approximately 150 million kWh) generated by 140 MW mega solar power plants is equivalent to power consumption by approximately 40 thousand households. As of the end of August 2013, commercial operations totaling approximately 80 MW have started in 19 locations. Approximately 86 GWh of electricity was generated in fiscal 2012.

■ Status of Mega Solar Power Generation (as of the end of August 2013)



• **Countermeasures for stabilization of power system**

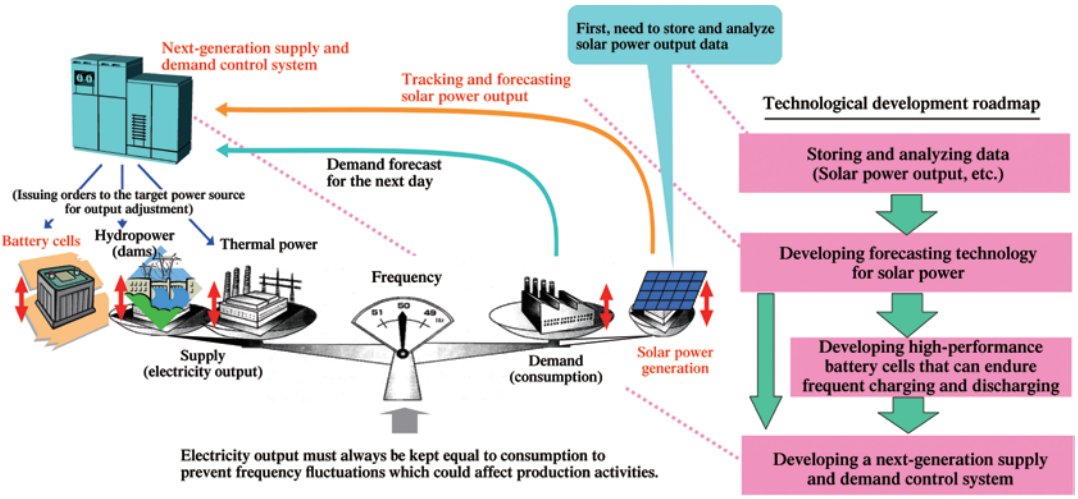
Since solar and wind power generation depend on local weather conditions, there is a great fluctuation in their output. In order to connect the mass of such generations into the grid, measures must be taken to stabilize the power system. The electric utility industry actively copes with development and introduction of a new network control system.

Reference

Output Fluctuations of Solar and Wind Power Generation

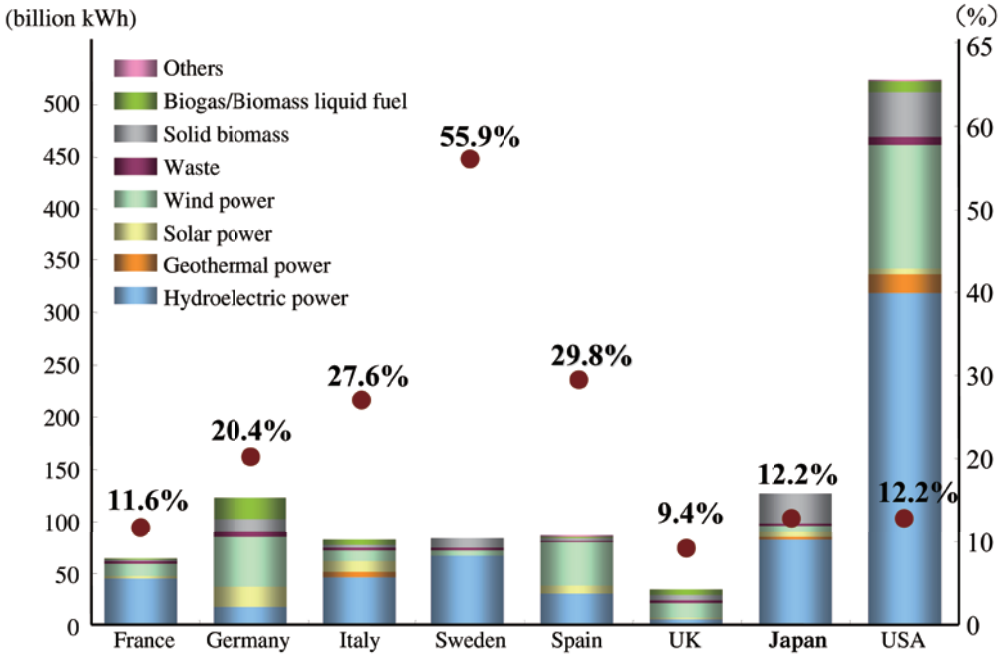
Since solar and wind power generation depend on local weather conditions, the time of day, and the season, there are great fluctuations in their output. Measures must be taken to deal with output fluctuations in order to supply electricity with stable voltage and frequency. The fluctuations are currently adjusted using thermal and hydropower. However, as there could be a shortage of adjustment power in the future if large quantities of solar and wind power are introduced, a new system for controlling the supply and demand will be developed and introduced.

Outline of next-generation supply and demand control system



Reference

Comparison of renewable energy generated output between countries (pumped hydropower is excluded)



Left scale shows generated output. Right scale shows the ratio of renewable energy source among generated output.
* Fiscal 2011 figures
* Source: IEA, Energy Balances of OECD Countries 2013 Edition

c. Improving the Efficiency of Thermal Power Plants

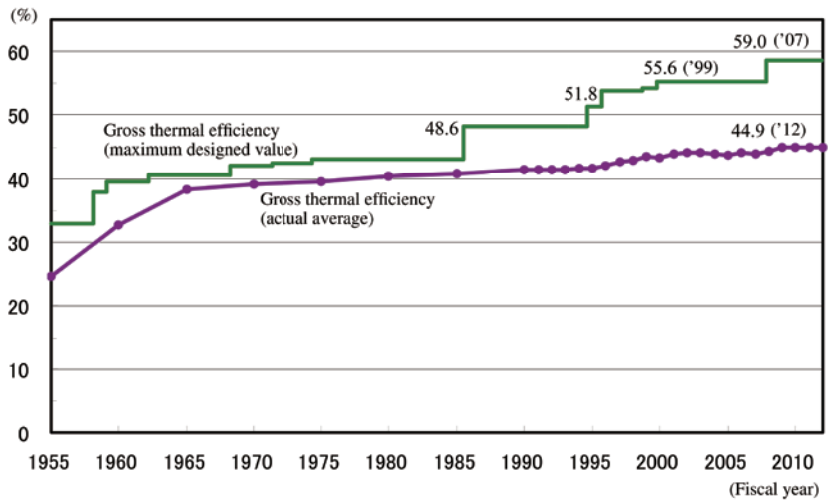
The electric utility industry has endeavored to improve the efficiency of thermal power plants by introducing high-efficiency facilities when replacing old thermal power plants and by constructing new plants. Improving the thermal efficiency of thermal power directly helps to decrease CO_2 emissions intensity. As for the state-of-the-art LNG combined-cycle power plant that has been introduced, a thermal efficiency of 59%, the highest level in the world (lower heating value standard), was achieved by raising the combustion temperature.

A balanced ratio of energy sources (coal, LNG, and oil) needs to be developed and used in a manner which considers supply stability, the economy, and environmental impacts of each fuel. Of those sources, coal is cheaper and its supply is more stable compared to other fuels, making it an excellent fossil fuel in terms of energy security and economic efficiency. To effectively use coal which offers these advantages, we are working on improving the steam conditions (temperature and pressure) of existing coal-fired thermal power plants to improve their thermal efficiency, and currently, 600ºC ultra-super-critical (USC) power generation technology is being introduced. In addition to improving efficiency, we are expanding the types of coal that can be used by developing and adopting the technology for 1,200ºC integrated coal gasification combined-cycle (IGCC) power generation capable of using coal with a low ash melting point, which conventional coal-fired plants cannot use.

As the thermal efficiency of a power generation plant drops without proper maintenance, these plants, in which new technologies have been introduced, will be maintained appropriately to keep their thermal efficiency as high as possible.

We will continue to further improve the efficiency of thermal power by planning and constructing LNG combined cycle plants with a thermal efficiency of above 60% (lower heat value standard) and by conducting demonstration experiments of yet another type of IGCC technology currently being developed.

Trends in Thermal Efficiency (Lower Heating Value Standard)



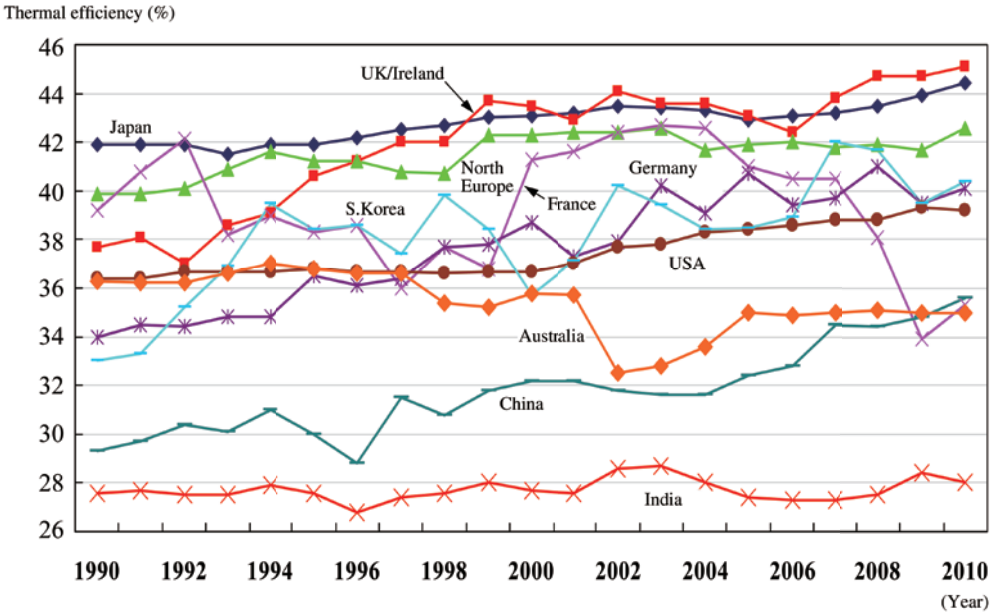
Source: Japan Electric Utilities Handbook, etc.
Lower heating value is estimated based on the higher heating value using the conversion factor of explanation of the comprehensive energy statistics (2010).

Reference

Country-by-country comparison of thermal efficiency

Japan's electric utilities work to maintain thermal efficiency through thermal efficiency management and efforts including increasing the combustion temperatures of gas turbines used in LNG combined-cycle power generation and raising the temperature and pressure of the steam in boiler and turbines. As a result, the thermal efficiency of Japan's thermal power plants is at the highest level in the world.

Comparison of thermal power plant efficiency in Japan with other countries



* 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

Sources: INTERNATIONAL COMPARISON OF FOSSIL POWER EFFICIENCY AND CO_2 INTENSITY, 2013 (Ecofys)

ii) Strengthening the Collaboration between the Supply and Demand Sides including Customers

a. Expansion of High-Efficiency Electric Equipment for Using Electricity Efficiently

The electric utility industry promotes widespread adoption of highly efficient electric equipment, such as heat pumps, so as to contribute to efficient energy usage.

In particular, we strive to expand the use of "CO_2 refrigerant electric heat pump hot water heater (EcoCute)", which can greatly reduce CO_2 emissions compared to conventional water heaters. We will also be actively involved in promoting the spread of "high-efficienct office air conditioners applied heat pump technology".

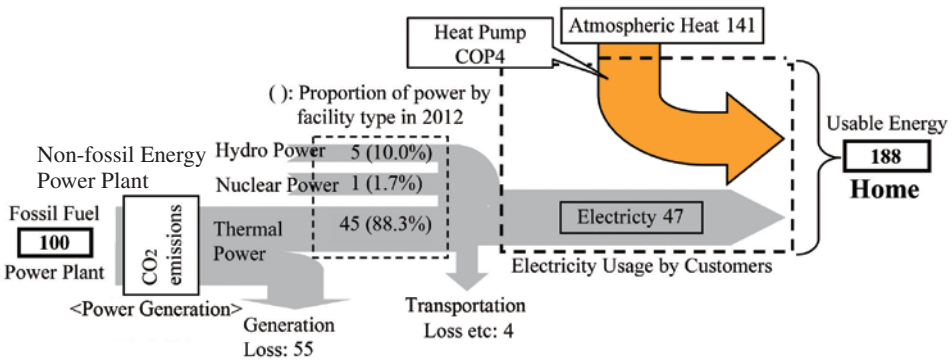
Reference

Efficient electric usage by customers

Perspectives and evaluations that follow the flow of energy from power plants to customer usage are effective in supporting the more efficient use of electrical energy. Given this perspective, increased use of high-efficiency energy-saving devices is an important measure for users of electricity.

For example, 189 units of energy can be used with 100 units of fossil fuel and non-fossil energy by utilizing unused energy from atmospheric heat and other sources with a heat pump of COP 4.0[5]. (Sample provisional calculation)

Electricity: From the Power Plant to the Home



5) $COP = \frac{\text{Cooling or Heating Capacity (kW)}}{\text{Heat Pump Power Consumption (kW)}}$

COP = (Coefficient of Performance)

Reference

EcoCute Hot Water Supply System: CO_2 Refrigerant Electric Heat Pump Hot Water Heater

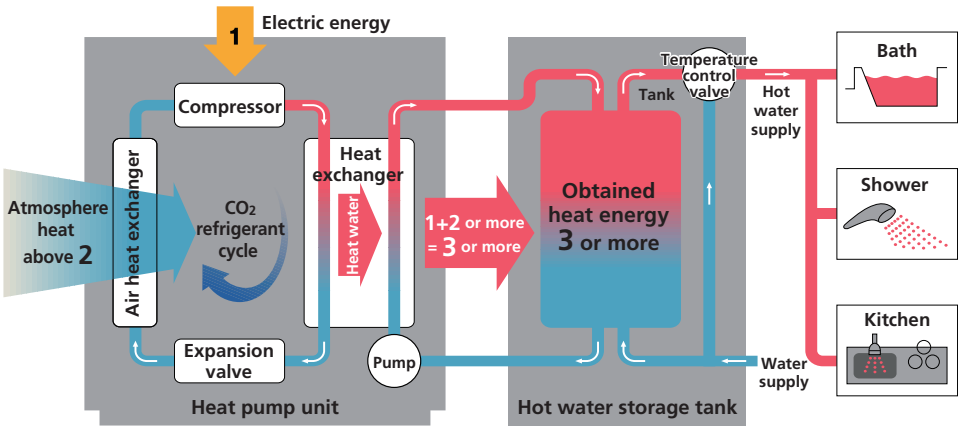
It is essential to take countermeasures against global climate change. Hot water supply accounts for about 30% of energy consumption, and reducing CO_2 and saving energy of hot water supply is very effective as a countermeasure. EcoCute is a hot water supply system that uses CO_2 refrigerant heat pump, and effect of its CO_2 emissions reduction and energy saving are significant. As one of major countermeasures against global climate change in the civilian sector, the public and private sectors are making efforts to expand the use of EcoCute.

EcoCute is a hot water supply system that uses a CO_2 refrigerant heat pump to effectively gather heat from the air and use it as energy to heat water. Compared to hydro fluorocarbon refrigerants, CO_2 refrigerant heat pumps have superior heat exchange property, so their usage in hot water heaters is expanding. The EcoCute's annual performance factor of hot water supply and hot retention (JIS)[6] that considers how hot water is used annually is 3 or greater (the maximum efficient model JIS is 3.5, as of the end of April 2013), so it is extremely effective at conserving energy. CO_2 emissions are also reduced compared to conventional combustion-based hot water heaters.

6) Annual Performance factor of hot water supply and hot retention (JIS) $= \dfrac{\text{Heat quantity for hot water supply and bath hot water retention used for 1 year}}{\text{Power consumption required for 1 year}}$

* Changed to JIS in February 2011

1 (Electricity energy) + above 2 (Atmospheric heat) = above 3 (Energy obtained for hot water supply)



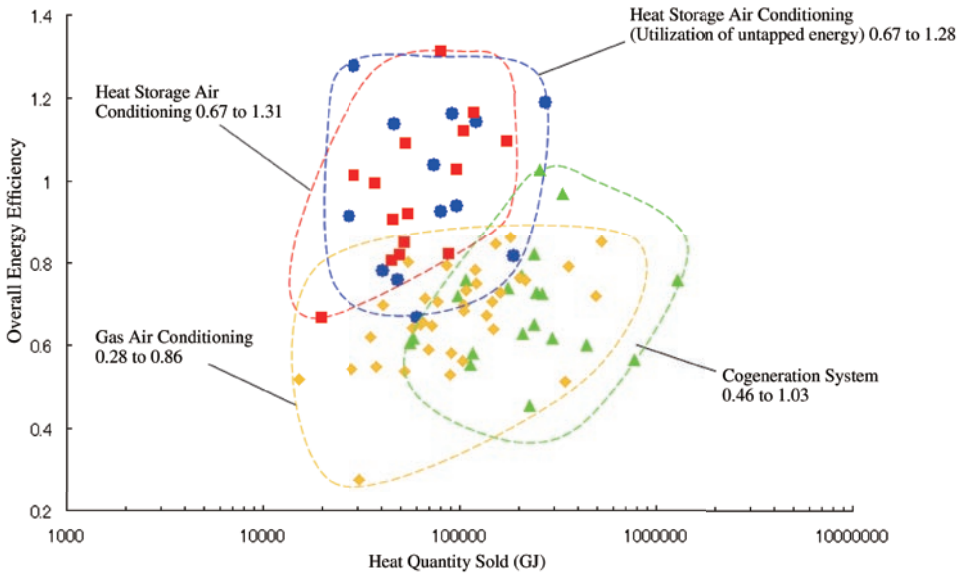
Reference

Utilization of untapped energy sources

Renewable energy sources and untapped energy sources, such as atmospheric heat, exhaust heat from buildings, factories, and substations, or temperature differential energy held by ocean water, river water, and sewage water is collected through the heat pump as effective thermal energy and can be utilized for district heat and cooling. Such district heating and cooling systems reduce fossil fuel use and CO_2 emissions.

Being combined with a heat storage system, the district heating and cooling system contribute to further improve efficiency of energy use and leveling load, therefore introduction of the system is promoted in various locations.

Gross Energy Efficiency of Air Conditioning System for Local Area



* 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. (including sale of heat procured by purchasing exhaust heat from other parties)
* Sources: The Japan Heat Service Utilities Handbook (2011) (calculated from FY2010 result)
* Converted into electricity at 9,760 kJ/kWh and city gas at 45.0 MJ/m³.
* Overall Energy Efficiency = Heat Quantity Sold/Primary Energy Input

b. 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, and promoting use of the "Household Eco-Account Book".

Reference

Initiatives providing information to employees and customers on energy conservation and CO_2 emission reduction

- Presenting energy conservation information to customers via a website, such as energy-saving level check and money saving tips for using and selecting home electronics
- Introducing seasonal energy-saving ideas for the household by passing out calendars and household bookkeeping ledgers with tips on saving energy
- Holding exhibitions of energy-saving appliances and seminars on energy conservation
- Visiting customers' houses and measuring ampere consumption of electronic devices, as well as providing contract/energy-saving advice
- Environmental education for employees through Environmental Trainer System and e-Learning

Reference

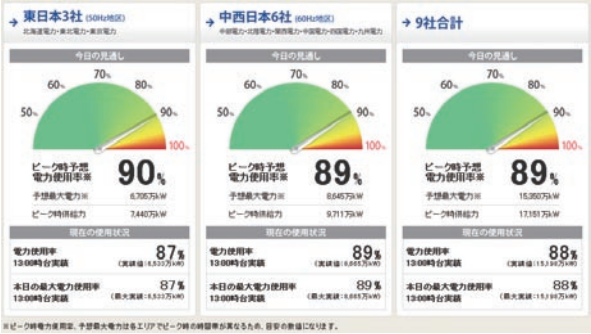
Asking Our Customers to Save Power

As the prospects for restarting the nuclear power stations remain unclear, the supply and demand situation of electricity remains tight. We are taking all possible measures to secure additional supply capacity and to improve the supply and demand situation, such as encouraging customers to shift the peak consumption times and save energy by offering a tariff discount to customers who agree to have their power cut off when an electricity shortage is imminent.

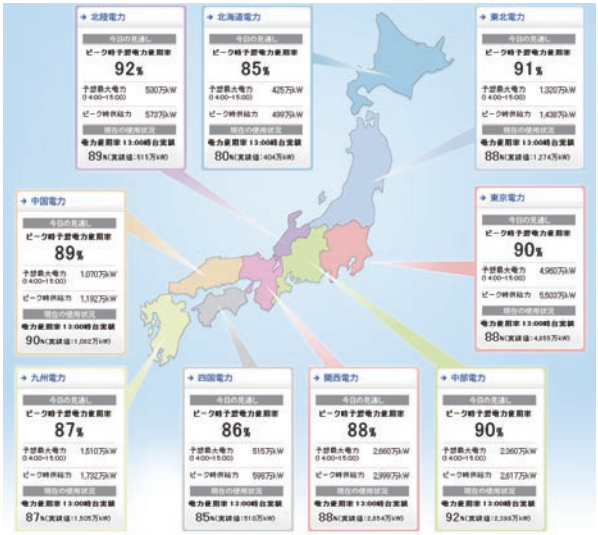
As one of the activities, we provide our customers with detailed information on power consumption by "Denki-yoho (Electricity Forecast)", which visualizes the status of electricity consumption.

"Denki-yoho (Electricity Forecast)" (Example: Website of Federation of Electric Power Companies)

We provide the information to customers via web sites so that they can view the estimated maximum electricity demand and supply capacity at the peak time and thus gain a better understanding of daily electricity usage. We ask customers to understand the need for conservation and to cooperate in these efforts.



Figures show the ratios of power demands against power supply capabilities.
Green Zone: Usage rate of less than 90%
Yellow Zone: Usage rate between 90% and 95%
Red Zone: Usage rate of 95% or more



Figures show ratios of power demands against power supply capabilities at 9 electric companies.
Upper: Usage rate forecast at the peak time
Lower: Current usage rate

c. Introduction of Smart Meters for Promoting Efficient Use of Electricity

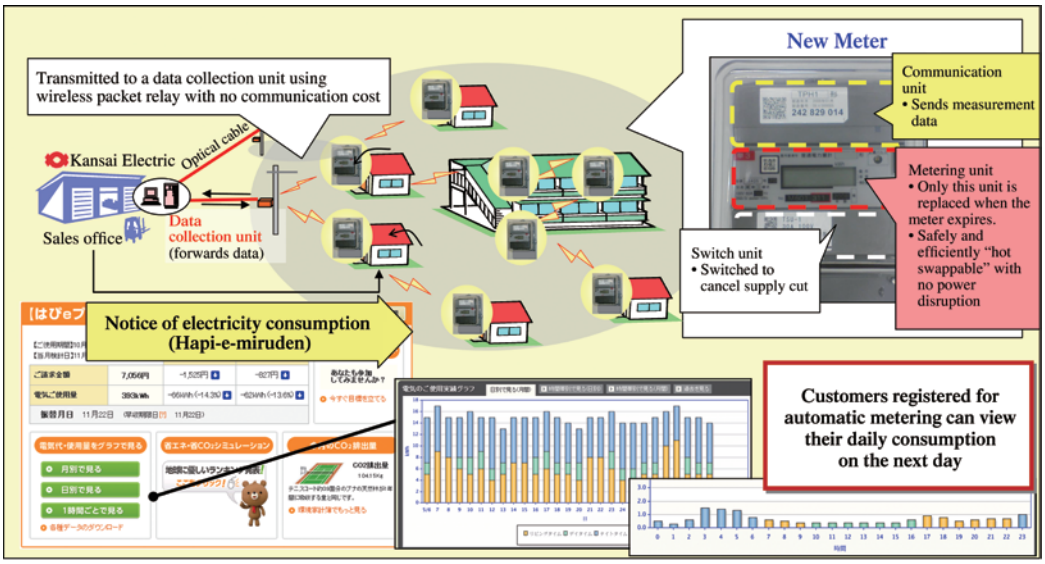
We will strive to achieve the government's target of "Smart meters used for 80% of total demand within 5 years (by 2016)", in order to level peak demand and realize efficient electricity usage.

Reference

Introducing Smart Meters (Kansai Electric's "New Metering System")

The new metering system allows metering-related tasks and opening and closing of the meter to be performed remotely via an optical fiber network covering the entire area, by integrating telecommunications functions in the electricity meters in the homes. The system can measure the electricity consumption of a household every 30 minutes, and the data can be used for sophisticated purposes such as improving the efficiency and safety of on-site work and the speed of recovery from a power cut, improving energy consulting, and streamlining the configuration of facilities by analyzing the electricity consumption pattern of customers.

System Overview



d. Efforts by Electric Utility Industry as One of Users

Since fiscal 2000, the electric utility industry has been implementing measures to reduce its companies' consumption of electricity (classified as commercial sector) and of fuel for its own transport (classified as transport sector). Each company has set targets, and is making efforts to suppress CO_2 emissions.

<Efforts in office-use energy conservation>

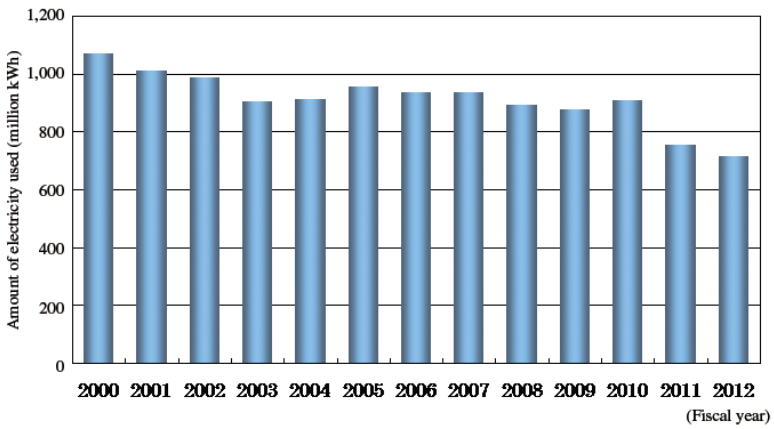
Total electricity used in company offices such as head offices, branches, and sales offices for fiscal 2012 was 710 million kWh (equivalent to 350,000 t-CO_2 emissions) in the whole electric utility industry. That means approximately 350 million kWh (approximately 35%) have been reduced from the result of fiscal 2000 level. CO_2 emissions have been reduced by approximately 50,000 t-CO_2. We will make further reductions going forward.

Major efforts

Major targets (specific targets are set by each company)
❖ Reduction in electricity usage ❖ Reduction in the amount of copy & printer paper purchased and used ❖ Reduction in water usage ❖ Establishing an environmental management system in each company's facilities, and setting targets for each workplace

Details of specific efforts
❖ Efficient operation of air conditioning (thorough temperature control, reducing usage time, etc.) ❖ Turning off lights at lunch and after hours, less use of lighting; reducing usage of elevators by promoting stairway use ❖ Switching office appliances and lighting equipment to energy-conserving models, and turning off power supply when not needed. ❖ Energy management in company-owned buildings ❖ Introduction of ice thermal storage system air conditioning ❖ Introduction of highly efficient water heaters for commercial use ❖ Introduction of solar power generation equipment ❖ Restriction of flow by tightening water valves ❖ Application of shielding films to windowpanes

Trends in amount of electricity used in offices



<Efforts in the use of company-owned vehicles>

Total consumption of fuel (gasoline, diesel) for company-owned vehicles in fiscal 2012 was 25,000 kℓ (equivalent to 58,000 t-CO_2 emissions) in the whole electric utility industry. That means approximately 6,900 kℓ (approximately 22%) have been reduced from the results of fiscal 2000. This is a reduction of about 16,300 t-CO_2 in terms of CO_2 emissions.

In addition, electric vehicles and plug-in hybrid vehicles have environmental advantages because CO_2 emissions are reduced compared to those of internal combustion vehicles. The government is making every effort to expand the use of these vehicles. The electric utility industry aims to introduce about 10,000 electric vehicles (including plug-in hybrid vehicles) into its fleet for commercial use by fiscal 2020 to contribute toward achieving full-scale commercialization of environmentally-efficient electric vehicles. We introduced approximately 130 electric vehicles (including plug-in hybrid vehicles) in fiscal 2012.

Major Efforts

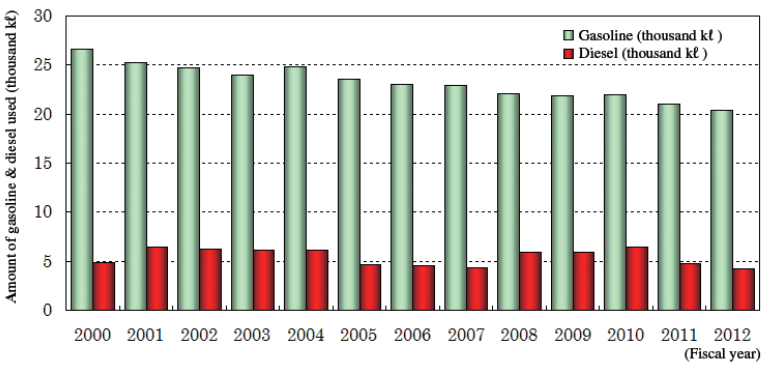
Main Targets (specific targets are set by each company)

- Introduction of electric vehicles for commercial use
- Reduction in the amount of fuel used by vehicles
- Improvement in the rate of introduction of low emission vehicles

Details of Specific Efforts

- Initiative introduction of electric vehicles (Approximately 1,600 vehicles have been introduced in the electric utility industry)
- Introduction of low emission & high-efficient vehicles such as electric vehicles and vehicles using clean energy
- Implementing a day when use of private cars is discouraged
- Enforcing Eco-drive (Keeping correct tire pressure, turning engine off when idling)
- Efficient vehicle use (confirming route beforehand, implementation of carpools)
- Making distribution more efficient through joint delivery amongst all group companies, resulting in 20% reduction in the number of trucks
- Cooperation with verification business of practical use of bio-ethanol 3% mixed fuel (E3)

Trends in the amount of fuel used by using company-owned vehicles



Reference

Efforts in forest utilization and management

The electric utility industry is cooperating with afforestation and forest management activities in various locations including management of company-owned forests, water conservation forests, and greenery at power plants.

<Examples of forest preservation and planting efforts>

- "Invitation to the Forest" forest activity with participation by the public utilizing company-owned forests
- Kyushu Homeland Forestation Program
- Zanpa Shiosai no Mori forest restoration
- Presenting seedlings to customers (schools, etc.) for planting
- Participation in afforestation volunteer programs
- Management of company-owned forests for water source cultivation
- Setting of forest preservation policies
- Use of printing paper for environmental reports, etc., which contributes to Effective utilization of wood thinned from forests and "satoyama" reforestation
- Forest management and preservation in Oze-Tokura Mountain Forest (16,000 hectares)
- Tree planting in Hokkaido's Abira Enemo Forest
- Distributing seeds of creeping plants, morning glory, bitter gourd, and gourd (Green Curtain Campaign)

<Examples of using domestic materials>

- Use of wood thinned from forests in environmental reports and paper fans
- Utilization of driftwood (construction material and gardening materials, etc.)

iii) Promoting International Contributions

a. Assisting Developing Countries to Reduce Carbon through International Partnership (GSEP) Activities

The Global Superior Energy Performance Partnership was established in July 2010 as a successor to the Asia-Pacific Partnership on Clean Development and Climate (APP). [7)]

Through the GSEP's activities such as coal thermal facility diagnosis and CO_2 emissions reduction activities, Japan plans to transfer and grant electricity technologies to developing countries to reduce their carbon emissions. According to the Energy White Paper 2008, Japan's technologies have the potential to reduce carbon dioxide by 130 million t-CO_2 if applied to the coal-fired thermal power plants of the US, China and India.

7) The Asia-Pacific Partnership on Clean Development and Climate (APP) was a regional partnership of public and private sectors among the United States, Australia, China, India, South Korea, and Japan formally established in January 2006. APP aimed to tackle environmental pollution, energy security, and climate change issues while meeting increasing energy demand in the Asia-Pacific region. (Canada officially joined in October 2007.)

b. Reducing Carbon throughout Society through International Efforts

The International Electricity Partnership (IEP) was established by the electricity associations of Europe, USA, Australia, Canada and Japan in October 2008. The IEP's mission is to exchange opinions to identify common interests within the electricity sector including making a technology roadmap for the power sector.

Through international efforts such as the IEP, we aim to reduce carbon throughout society by developing advanced and feasible electricity technologies.

Reference

Peer Review Activities by the GSEP

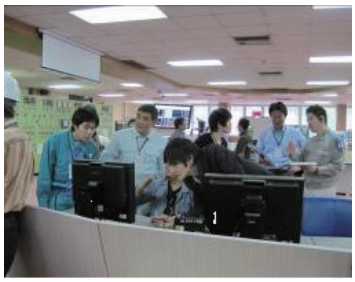
In January 2013, the first workshop (WS) was held in Jakarta, Indonesia to share the best practices in electricity generation, distribution and demand management technologies. Forty-seven participants from Japan, the US, China, Europe and Indonesia joined the meeting for a seminar on electricity generation, distribution and demand management technologies, as well as a quick peer review at a coal-fired thermal power plant (Suralaya Thermal Power Plant), and actively exchanged views on operation and maintenance (O&M).

Overview of Suralaya Thermal Power Station

- Four 400 MW units
  (Start of commercial operation: Unit 1: 1984, Unit 2: 1985, Unit 3: 1988, Unit 4: 1989)
- Three 600 MW units (Start of commercial operation: Unit 5: 1996, Units 6 & 7: 1997)

Result of the review

- Confirmed an efficiency reduction of about 2% based on the amount of fuel and the output (64,000 tons of fuel saved annually, reducing CO_2 by 150,000 tons)
- Identified a reduction of equipment performance based on plant operation data
- Commented on the need for regular calibration of measuring instruments and regular inspection for minor drain leakage



iv) Developing Innovative Technologies

In response to the issue of global climate change, the industry recognizes the necessity of promoting research and development of technologies in the areas of supply, demand and environmental preservation for the mid- to long-term perspective, with consideration of preserving the environment.

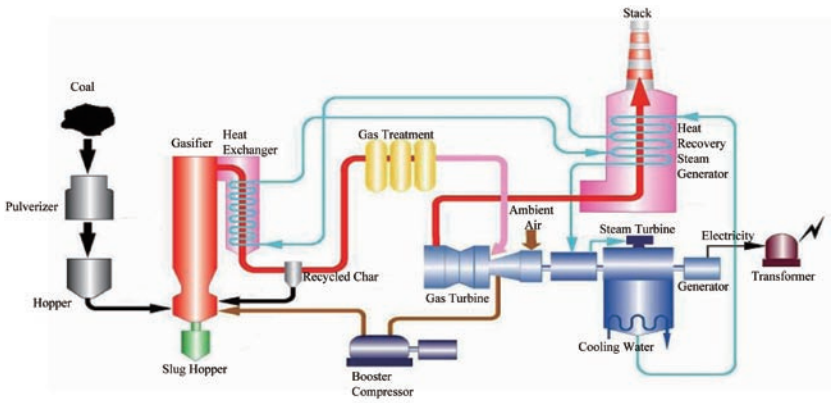
Specifically, we are collaborating with the government on R&D of technologies for high-efficiency power generation, energy conservation for customers, CO_2 capture and storage in the exhaust gas from thermal power plants, nuclear power generation, and power grid stabilization.

<Examples of efforts in technology development to solve the global climate change>

■ Clean coal technology

From the perspective of energy security and environmental conservation, it is necessary to develop clean coal technology for highly efficient use of coal, which offers excellent supply stability and economical performance. Integrated coal gasification combined-cycle power generation (IGCC), which is an example of the next-generation technology for high-efficiency coal-fired power generation, is a system that gasifies coal in order to burn it in a gas turbine which is integrated with a steam turbine. It is expected to deliver a power generation efficiency of approximately 48 to 50% (net thermal efficiency, higher heating value standard), which is higher than that of conventional coal-fired power generation. We will further improve the efficiency of the technology based on the results achieved so far from research and development.

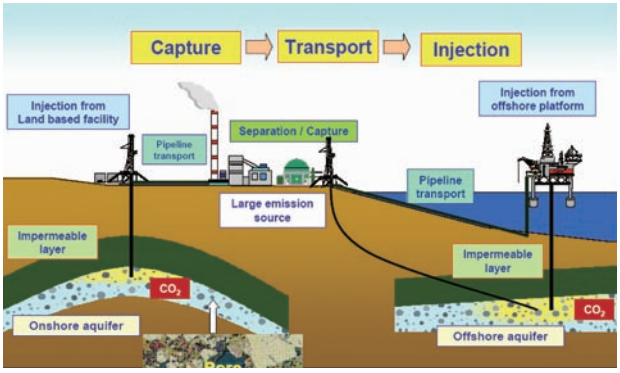
Integrated coal gasification combined-cycle power generation (IGCC)



■ CO_2 capture and storage technology (CCS)

CCS technology is recognized as an effective and innovative technology to reduce the emissions of CO_2, which is regarded as the primary countermeasures of the global warming in and outside Japan, but numerous tasks lie ahead before CCS technology may be put to practical use. Therefore, we will actively cooperate in the large scale verification tests initiated by the government so as to overcome latent challenges. We also promote the development of CCS related technologies.

Image of CO_2 capture and storage

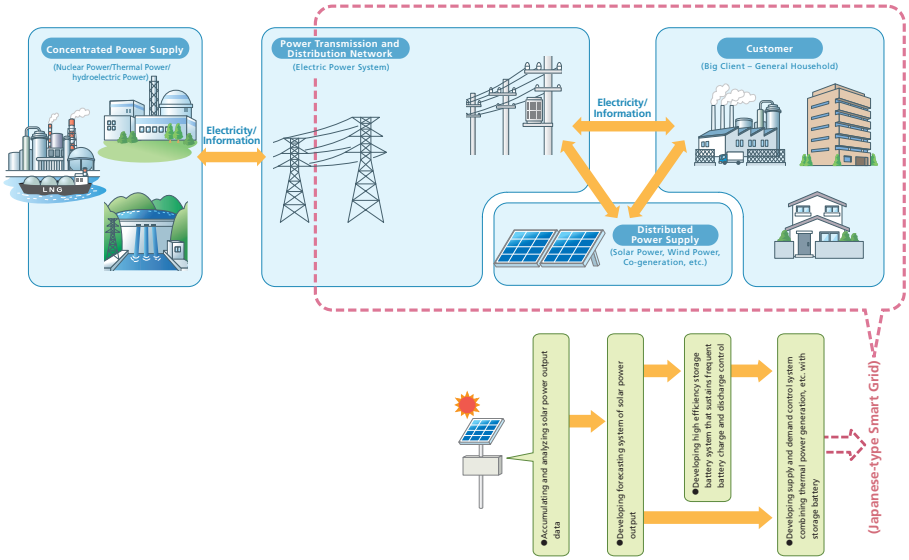


Sources: Research Institute of Innovative Technology for the Earth

■ Next-generation electric power transmission and distribution technology (Japanese-type Smart Grid[8])

With the high adoption goal for renewable energy sources such as solar power and wind power by the government for realization of a low-carbon society, the electric utility industry is advancing government-subsidized research on evaluating the effect of the large-scale expansion of photovoltaic generation into the power system and verification of measures for stabilizing the power system using a battery storage system.

Basic Concept of Japanese-type Smart Grid



8) The smart grid is a high-quality, effective, and reliable power supply system. The smart grid will integrate the current concentrated nuclear, thermal, and hydroelectric power supplies, transmission system, information communication technology (ICT) and the distributed power supplies using renewable energy such as solar power generation.

■ Technology for efficient electricity usage

Regarding the "CO_2 refrigerant heat pump water heater (EcoCute)," further technological development on high-efficiency will be pursued to achieve better environmental conservation, greater energy conservation and CO_2 emissions mitigation. We also promote high-efficiency and downsizing products developed by other heat pump technologies and thermal/electrical storage technology. In addition, through the government smart meter verification project, etc., energy management in the average household will allow us to work toward energy saving and load leveling without sacrificing comfort.

■ Technology for more convenient use of electricity

Electric vehicles are very environment-friendly: they produce 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 tests, the development of quick chargers, and its standardization in and outside of Japan, and is also introducing electric vehicles and plug-in hybrid vehicles for use in the company fleets.

Reference

Electric vehicles

<Characteristics of electric vehicles>

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

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

Mitsubishi Motors Corporation, i MiEV

Electric vehicles and quick charger

v) CO_2 Reduction Target for 2020

With a realistic national energy policy yet to be formulated, and with no clear prospects for restarting the nuclear power stations, it is difficult for the electric power companies to set numerical targets.

The companies will begin to consider specific targets when a realistic energy policy is established and the prospects for restarting the nuclear power plants materialize, and will then be able to present a business outlook for the supply and operation of electricity.

Reference

Action Plan for Achieving a Low-Carbon Society

		Details of the Plan
1. Reduction targets for 2020 for domestic corporate activities	Target level	With a realistic national energy policy yet to be formulated, and with no clear prospects for restarting the nuclear power stations, it is difficult for the electric power companies to set numerical targets, so they will continue to consider the targets and how they should be set. Regarding the fight against global warming, the electric utility industry will continue its efforts to reduce CO_2 emissions by pursuing an optimum energy mix based on the "S+3E's policy", which means simultaneously achieving safety, which is a major premise, and energy security, environmental conservation and economic efficiency.
	Basis of the target	❍ Utilizing nuclear power with safety as a major premise • Implementing thorough safety measures in nuclear power stations based on the lessons and knowledge learned from the Fukushima Daiichi accident • Making utmost efforts for safe and stable operation of the nuclear plants that have been proven to be safe once they are restarted ❍ Utilizing renewable energies • Utilizing hydropower, geothermal, solar and wind power, and biomass • Advancing the research and development of technologies for controlling the output fluctuations of renewable energies - Considering ways of controlling the output fluctuation of solar power - Considering expanded introduction of wind power using the inter-region connection networks ❍ Improving the efficiency of thermal power • In developing thermal power, adopting the highest level of technology suitable for the size of the plant • Appropriately maintaining and controlling the thermal efficiency of existing plants
2. Strengthening the collaboration between the supply and demand sides including customers (reduction by 2020 through the promotion of low-carbon products and services)		❍ Reducing the CO_2 emissions of customers by improving the efficiency of their electricity consumption through the use of high-efficiency electric appliances, and through energy saving and CO_2 reduction activities ❍ Introducing smart meters to improve the efficiency of electricity consumption by customers
3. Promoting international contributions (reduction by 2020 outside of Japan by promoting energy conservation technologies)		❍ Transferring and granting Japanese electricity technologies by means of coal thermal facility diagnosis and CO_2 emissions reduction activities through GSEP, to assist developing countries ❍ Reducing carbon throughout society by developing and introducing advanced and feasible electricity technologies through international efforts such as the International Electricity Partnership (Reference) Japan's technologies have the potential to reduce carbon dioxide by 130 million t-CO_2 if applied to the coal-fired thermal power plants of the US, China and India.
4. Developing innovative technologies		❍ Developing technologies in the areas of supply, demand and environmental preservation (clean coal technology, next-generation transmission and distribution technology, CCS, ultra-super-high-efficiency heat pumps, EVs)

2 Establishing a Recycling-based Society

Today, Japan is promoting the 3Rs of "reduce, reuse, recycle" to form a recycling-oriented society with less burden on the environment. In 2013, "The Fundamental Plan for Establishing a Sound Material-Cycle Society"[9], which is the basis for Japan's waste & recycling policies, was reviewed. There is an urgent need to create a recycling-based society both domestically and internationally aiming at reducing the consumption of natural resources and reducing the environmental load by focusing on a sustainable society and integrating activities for a low-carbon and natural symbiotic society, while ensuring environmental preservation, safety and reassurance.

In light of this situation, the electric utility industry has been voluntarily working toward the achievement of such a recycling-based society. It is promoting more effective use of resources by recycling waste products and other materials[10] and by establishing nuclear fuel cycles.

We will consider the appropriate treatment and disposal of radioactive waste generated at the Fukushima Daiichi Nuclear Power Plant of Tokyo Electric Power Co., Inc. as the result of the Great East Japan Earthquake.

9) The Fundamental Plan for Establishing a Sound Material-Cycle Society was established based on the Fundamental Law for Establishing A Sound Material-Cycle Society to comprehensively and systematically promote measures related to the formation of a sound material-cycle society.

10) Waste products and other materials include those defined as industrial waste (defined under Waste Management and Public Cleaning Law, including certain products of value) and those generated secondarily through production activities (byproducts).
Radioactive waste is not included in the definition of waste products. It is handled in a separate, more appropriate manner.

(1) Measures for Waste Reduction and Recycling

Waste produced by the electric utility industry includes coal ash from thermal power plants, construction waste materials such as discarded concrete poles from power distribution works, and scrap metal such as electric cable. There are also by products, an example of which is gypsum produced by thermal power generation facilities. Total volume of waste generated has been increasing as the total amount of power generated is rising with the growth in electricity demand.

The amount of such waste is increasing with the expansion of power demand and has almost doubled the level produced in fiscal 1990.

The electric utility industry considers the reduction of waste volume ultimately disposed of as an important issue in responding to the increase in waste volumes and is increasing efforts of waste reduction and recycling.

(i) Waste Recycling Rate Targets

The electric utility industry has been working on waste reduction with an initial target of keeping the final disposal amount less than fiscal 1990 levels (2.4 million tons). But, with the promotion of 3Rs activities, we reduced the target to 2.0 million tons, and then to 1.5 million tons.

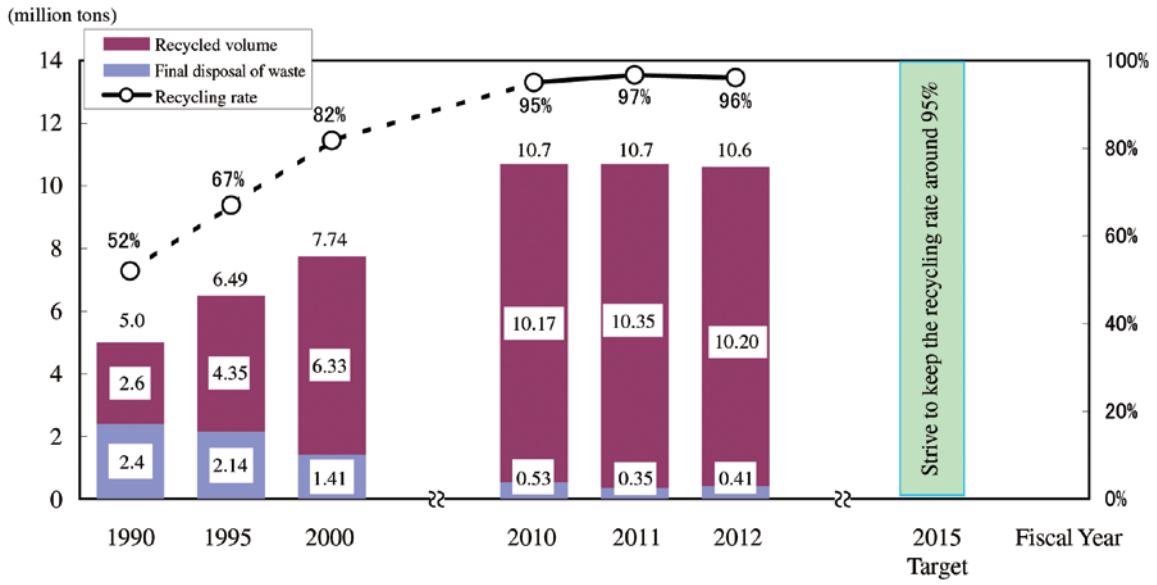
Also, since fiscal 2005 we have targeted at 90% recycling rate[11] as an index which is not significantly influenced by fluctuations in electricity demand. Then in fiscal 2006, having revised the target value to 5 points higher, we explored to achieve our waste recycling rate for fiscal 2010 at around 95%.

We have revised our target fiscal year as shown below beginning fiscal 2011 so that we can continue to maintain our high recycling rate.

11) Recycling Rate = Recycling Amount ÷ figures for the volume generated × 100

Through fiscal 2015, we aim to maintain our waste recycling rate at around 95%.

Waste recycling rate targets for the electric utility industry



* The place of disposal after final disposal (disposal in landfills) is utilized as land for power generation facility expansions or other industrial land uses. Some of the coal ash used there is counted as recycled as land development material according to government interpretation.
* Figures less than 10,000 tons of generated volume, recycled volume, and final disposal of waste are rounded.

(ii) Fiscal 2012 Waste Recycling Results

Waste generated by the industry amounted to 10.6 million tons in fiscal 2012, 90,000 tons less than the amount in fiscal 2011. The recycled volume decreased by 150,000 tons from fiscal 2011 to 10.2 million tons.

As a result, we achieved a recycling rate of 96% in fiscal 2012, thus continuously achieving our ambitious target of "a waste recycling rate target of around 95%."

Coal ash makes up the greatest part of the waste, accounting 7.72 million tons in fiscal 2012. Of that 7.45 million tons were recycled, mainly as a material for cement and an admixture for concrete, or as land development material.

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. Nearly all gypsum, which is a byproduct of the desulfurization process, is used as a material to produce gypsum boards, or as an ingredient for cement.

Trends in reutilizing major types of waste and byproducts

(10,000 tons)

Type			Fiscal 1990	Fiscal 2010	Fiscal 2011	Fiscal 2012
Waste	Combustion residue, dust and soot (Coal ash)	Volume generated	347	796	783	722
		Recycled volume (Recycling rate)	137 (39%)	759 (95%)	762 (97%)	745 (97%)
	Construction waste material	Volume generated	40	40	40	39
		Recycled volume (Recycling rate)	21 (53%)	39 (97%)	39 (97%)	37 (97%)
	Scrap metal	Volume generated	14	23	30	20
		Recycled volume (Recycling rate)	13 (93%)	23 (99%)	30 (99%)	20 (99%)
Byproducts	Gypsum from esulfurization process	Volume generated	85	176	181	194
		Recycled volume (Recycling rate)	85 (100%)	176 (100%)	181 (100%)	193 (99%)

* Waste includes products of value.
* Figures for construction waste material and scrap metal in fiscal 1990 are estimates.
* Recycling rates are calculated on an actual volume basis. (Figures for the volume generated and recycled volume are rounded to the nearest 10,000 tons.)

(iii) Future Efforts to Promote 3Rs (reduce, reuse, recycle)

The electric utility industry continues to work on the following issues in order to form a recycling-based society.

● Coal ash:

Recycling of coal ash is still an important issue. Therefore we are working to develop applications and technologies which enable us to recycle coal ash in a stable manner.

● Gypsum from desulfurization process:

We will promote recycling of all waste.

● Other wastes:

Actively precede efforts for 3Rs.

Examples of reduction

- The industry is working on maintaining and improving thermal efficiency in thermal power plants to reduce generation of coal ash and other waste products.
- New reusable steel containers were developed and introduced which are to replace wooden crates for the transport of switchboards in order to reduce wooden frame waste.

Examples of reuse

- Some part of a thermal insulator attached to exhaust ducts of gas turbines, etc. is reused.
- Drums (wooden, plastic) for power line packing are reused.
- Power maters that have exceeded their product life are remanufactured and reused once receiving certification.

Examples of recycling

Major type of waste or byproduct		Major recycling applications
Combustion residue, dust and soot	Coal ash	Raw material for cement, fertilizer, construction materials (soil enhancement and sand replacement)
	Heavy oil ash Crude oil ash	Vanadium recovery and combustion enhancement
Sludge		Raw material for cement
Construction waste material		Structural material for new construction, roadbed material and recycled asphalt
Scrap metal		Recycled distribution lines and ingredient for metal products
Scrap glass and scrap ceramics		Tile and block material, structural material for new construction and roadbed material
Waste plastic		Raw material for plastic
Gypsum from desulfurization process (byproduct)		Gypsum board material and raw material for cement

* Examples of 3Rs (reduce, reuse, recycle) appear in the following sections.

(iv) Increased Utilization of Reused and Recycled Products

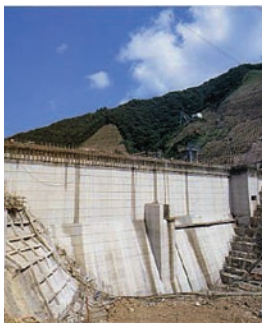
We recognize that the use of environmentally friendly products in addition to going forth with 3Rs for waste products and recycling resources is critical to forming a recycling-based society. The electric utility industry has been actively working to promote green purchasing and to expand the use of reused and recycled products.

Specific examples of recycling (partial)

Coal ash (Fly ash)

Coal ash from coal-fired thermal power plants
(Photo: Fly ash. Fly ash is collected by electric dust catchers, making fine round particles.)

Use as admixture for concrete



Fly ash is used in dam constructions, because when fly ash is mixed, uncracked concrete with increased strength and water-tightness is produced.

Use as a material for concrete spray

Replacing some of the material used in sprayed concrete for tunnel construction with fly ash reduces spattering when spraying, achieving conservation of materials and less dust, thus improving the work environment.

Use as concrete secondary products

Use as a material for concrete secondary products. Mixing fly ash into cement not only reduces consumption of cement but also gains superior characteristics of concrete products such as increased strength. (Photo: Wave-dissipating blocks.)

In fiscal 2010, the electric power industry, in conjunction with local governments and related organizations won the Minister of Land, Infrastructure, Transport and Tourism's Prize for 3Rs Promotion for the programs to use concrete mixed with fly ash as a standard material in public works projects.

Coal ash from coal-fired thermal power plants
(Fly ash)

Use as substitute for gravel

Coal ash mixed with cement, water and additives is agglomerated and recycled as a substitute for gravel used in construction works.

Use as fertilizer

We develop and distribute a potassium silicate fertilizer that uses coal ash as its main ingredient

Use as a substitute for sea sand and as an environment restoration material

Coal ash is granulated by a granulator and sold as a substitute for sea sand.
This product is used in public works for purifying the sludge from rivers and marshlands to improve the bottom sediment.

Coal Ash (Clinker Ash)

Coal ash from coal-fired power plants
(Photo: Clinker ash. Clinker ash is pulverized from the lumps of ash that fall to the bottom of boilers.)

Use as water-retentive blocks

Water-retentive block which contain recycled coal ash (clinker ash) is utilized for road paving when to develop a comfortable city because the water-retentive property can mitigate increase in temperature on road surface and the water-absorbing property can prevent rainfall to form puddles.

Scrap metal

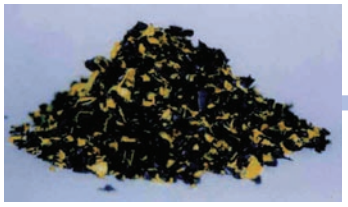
Old and replaced copper and aluminum power lines are cut up, crushed, and separated by material.

Recycle as metal materials
(Photo: Recycled power lines)

Waste plastic (Branch Line Guard)

[Received the 2004 Reduce, Reuse, Recycle Promotion Council President Award]

Old and replaced polyethylene branch line guards.



Plastic covers are separated by material, crushed, cleaned, and recycled as raw material (repelleted).

Recycle as raw material for plastic
(Photo: Support wire guard.)

Waste plastic (Plastic Under-bracing)

[Received the 2007 Encouragement Prize for Resources Recycling Technology/System]
[Received the 2009 Reduce, Reuse, Recycle Promotion Council President Award]

Condition of installation of the insulation cover

Removed plastic waste

Removed plastic waste

Condition of installation of the instrument casing

Plastic under-bracing

The waste plastics are recycled into "plastic under-bracing" to be used as foundation protection material for power distribution poles, replacing old concrete ones.

Gypsum

Gypsum extracted from thermal power plant fuel gas desulfurization equipment (byproduct)
(To extract sulfur oxides in exhaust fuel gas, lime and sulfur oxide are made to react, and Sox is removed in the form of gypsum.)

Recycled as a material for gypsum board or cement
(Photo: Gypsum board)

Waste concrete pillars

[Received the 2009 Reduce, Reuse, Recycle Promotion Council President Award]

Discarded concrete poles from power distribution works are cut and pulverized to be recycled as foundation materials for civil engineering and construction works.

We work on usage reduction of natural aggregate by using waste concrete poles as aggregate to make recycled concrete poles.

Waste insulators

Waste insulators are used as exterior products such as garden pebbles after crush and edgeless process.

Others

Mussels and other shellfish attached to power plant cooling water intake and discharge channels

Shellfish undergo interim processing such as composting or incinerating.

Reuse after interim processing as fertilizer, soil improvement material, cement raw material, etc.
(Photo: fertilizer)

Reference

Specific example of reducing

Steel containers for the transportation of switchboard

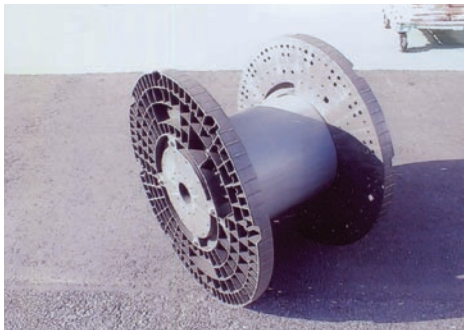
[Received the 2008 Reduce, Reuse, Recycle Promotion Council President Award]

New reusable steel containers were developed to replace wooden crating materials for the transport of switchboard to reduce wooden frame waste.

Reference

Specific examples of reuse (partial)

Drums used for power distribution lines



Drums used to reel distribution lines have been changed in material from wood to lightweight resin and have become reusable.

(2) Recycling by the Nuclear Industry

(i) Establishment of the Nuclear Fuel Cycle as Part of the Recycling-based Society

The nuclear fuel cycle makes it possible to recycle uranium and plutonium recovered from spent fuel. For Japan, which depends on imports for about 96% of its energy use, this could be a very effective way of enlarging resource usage efficiency and reducing waste. The nuclear fuel cycle would enhance the stable supply of nuclear power and is also consistent with the concept of a recycling-based society.

As for plutonium collected from a spent fuel reprocessing plant that is currently under construction in Aomori Prefecture, due to Japan's international commitment which dictates that there should be no surplus plutonium, we will promote 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 lightwater reactors. The fast-breeder reactors currently under development will enable uranium fuel to be recycled repeatedly, which would dramatically extend the life of the uranium reserves.

(ii) Effective Utilization of Recyclable Resources from Nuclear Power Facilities

Among scrap generated by decommissioning or operation of nuclear facilities, some materials that have extremely low density of radioactive substances and low impact on human health are generated. It is important from the standpoint of forming a recycling-based society in our country to conduct appropriate recycling or disposal by separating from radioactive wastes. The Nuclear Reactor Regulation Law, which allows handling "materials that cannot be treated as radioactive waste" (hereinafter, referred to as clearance object) equally to general valuable resource or waste after strict confirmation by the government, was revised in 2005.

This clearance system was applied in 2006 for the first time, and the recycling of clearance objects generated by decommissioning construction started at Tokai Power Station of the Japan Atomic Power Company.

By applying the clearance system, the electric utility industry keeps working to actively make use of scrap metal and wasteconcrete from nuclear facilities as recyclable resources that have been confirmed by authorities to be cleared substances in line with the revised law.

Cleared objects are processed or disposed at a facility that understands the clearance objects are from the nuclear facility until this system is broadly recognized in the society, and we will take an initiative in promoting recycling at the companies concerned.

Bench and shield are made by processing and treating clearance objects generated from the Japan Atomic Power Company Tokai Power Station decommissioning.

Installed to PR facilities of nuclear power plants.
(Used for legs)

Used for the radiation shield at nuclear power facilities.

3 Management of Chemical Substances

(1) Volume of Chemical Substance Release

The electric utility industry has carried out PRTR studies since 1997, even before the law, "Act on Confirmation, etc. of Release Amounts of Specific Chemical Substances in the Environment and Promotion of Improvements to the Management Thereof" was enacted, in an effort to precisely monitor the release and transfer volumes of chemical substances at power stations and other facilities, gradually increasing the sort of special chemical substances to be studied.

A system for reporting emission volumes and other factors based on the law (PRTR system) was introduced in April 2002. 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.

Release and transfer volumes for fiscal 2012 are shown in the next table.

The majority of emissions into the environment is emitted into the air from painting and fuel combustion, while the majority of transported waste consists of waste processed to remove asbestos.

Total release and transfer of chemical substances (Results for fiscal 2012)

Chemical codes	Chemical	Volume released to the environment (kg/year)				Volume transferred (kg/year)		Applications, etc.
		Air	Water	Soil	Landfill	Sewer	Other	
20	2-Amino ethanol	0	0	0	0	0	3,700	Feed water-processing agent
33	Asbestos	0	0	0	0	0	73,000	Insulating material, sealing material
37	4,4'-Isopropylidenediphenol	5,600	0	0	0	0	0	Mechanical joint grouting material
53	Ethylbenzene	51,000	0	0	0	0	1,300	Used in paints, power-generation fuel
71	Ferric chloride	0	0	0	0	0	0	Waste water processing agent
80	Xylene	100,000	0	0	0	0	1,500	Used in paints, power-generation fuel
104	Chlorodifluoromethane (HCFC-22)	4,600	0	0	0	0	0	Freezer refrigerant, air conditioning refrigerator
161	Dichlorodifluoromethane (CFC-12)	340	0	0	0	0	0	Freezer refrigerant
164	2,2-dichloro-1,1,1-Trifluoroethane (HCFC-123)	230	0	0	0	0	4,800	Freezer refrigerant
185	Dichloropentafluoropropane (HCFC-225)	6,500	0	0	0	0	0	Dry cleaning agent
240	Styrene	36,000	0	0	0	0	1,400	Used in paints
243	Dioxins	2.4	0.0058	0	0	0	0.65	Waste incinerators, PCB treatment facility
288	Trichlorofluoromethane (CFC-11)	0	0	0	0	0	0	Freezer refrigerant
296	1,2,4- Trimethylbenzene	360	0	0	0	0	0	Used in paints, power-generation fuel
300	Toluene	95,000	36	0	0	0	1,400	Used in paints, power-generation fuel
333	Hydrazine	13	810	0	0	1.2	0	Feed water processing agent
355	Bis (2-ethylhexyl) phthalate	20	0	0	0	0	0	Sealing material
382	Bromotrifluoromethane (Halon-1301)	0	0	0	0	0	0	Extinguishing media
384	1-bromopropane	50,000	0	0	0	0	0	Agent used to determine completion of metal processing parts
392	n-Hexane	36,000	0	0	0	0	0	Used in paints, power-generation fuel
400	Benzene	7,100	0	0	0	0	1,300	Used in paints, power-generation fuel
405	Boron compounds	11	2,600	0	0	0	9,400	Nuclear reactor reaction control agent, sludge treatment
406	Polychlorinated biphenyl	0	0	0	0	0	28,000	Insulating oil
438	Methylnaphthalene	17,000	0	0	0	0	890	Power-generation fuel, supplemental boiler fuel
448	Methylenebis (4,1-phenylene) diisocyanate	2,700	0	0	0	0	0	Sealing material

* 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.

(2) Efforts to Reduce Chemical Substance Release

The electric utility industry continues to make efforts stated as follows to properly manage chemical substances and reduce emissions.

- By complying with management documentations such as control manuals, the industry performs proper control on substances regulated by law, such as those found in boiler feed water processing agents, and it endeavors to reduce the amount used by improving operating methods.
- The industry is taking appropriate steps to reduce emissions of ozone-depleting chemicals used as refrigerants, cleaners, etc. These steps include reducing the amount used through proper usage, leakage prevention, recovery and recycling and replacement with alternatives.
- Efforts are also being made to reduce emissions of regulated chemical substances from the painting of machinery, piping and other materials by reducing painting frequency,

shifting to paints with lower proportions of such substances and other measures.

- The industry thoroughly controls the combustion waste incinerators to minimize the amount of dioxins emitted from them. Dioxin emissions have also been reduced by reusing waste in order to limit the use of incinerators or to shut them down as much as possible.
- New use of asbestos is prohibited by law. We are working to identify the status of use of asbestos, and are going forward with appropriate processing and systematic removal.
- The chemicals emitted from burning fuel in boilers in thermal power generation are minimized by maintaining and improving the thermal efficiency of thermal power stations to reduce the amount of fuel combustion

4 Activities for Biodiversity

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 strive to consider the environmental impact on a global scale and create a low carbon society by utilizing nuclear power generation subject to secure safety and promoting renewable energy. We also give back to the community with local environmental conservation activities, forest 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 blessings 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 drive for sustainable business activities based on these guidelines while appreciating the blessings of nature.

5 Promotion of Environmental Management

The electric utility companies have established environmental departments and set up in-house environmental management systems respectively. They have reported on their environmental protection efforts through CSR reports and websites.

According to its own policy, each electric utility company has voluntarily and actively worked to improve in-house environmental management systems in line with the international standards of the ISO14000 series, and to earn ISO14001 certification at their representative sites. The industry has also paid close attention to other societal trends.

These efforts will continue in the future to ensure that we place even less impact on the environment.

6 Environmental Considerations in Overseas Projects

The electric utility industry has implemented capacity development programs for developing countries in the environmental field such as invitation of trainees from those countries and dispatch of Japanese experts as technical instructors. With regard to participation and technical supports in overseas projects, the industry has conducted activities in consideration of regional environmental issues and global-scale environmental preservation. These include biomass power generation, reforestation and measures to reduce environmental load of thermal power plants.

The electric utility industry plans to continue to aggressively promote these types of initiatives that provide adequate consideration to the environment.

The Federation of Electric Power Companies

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