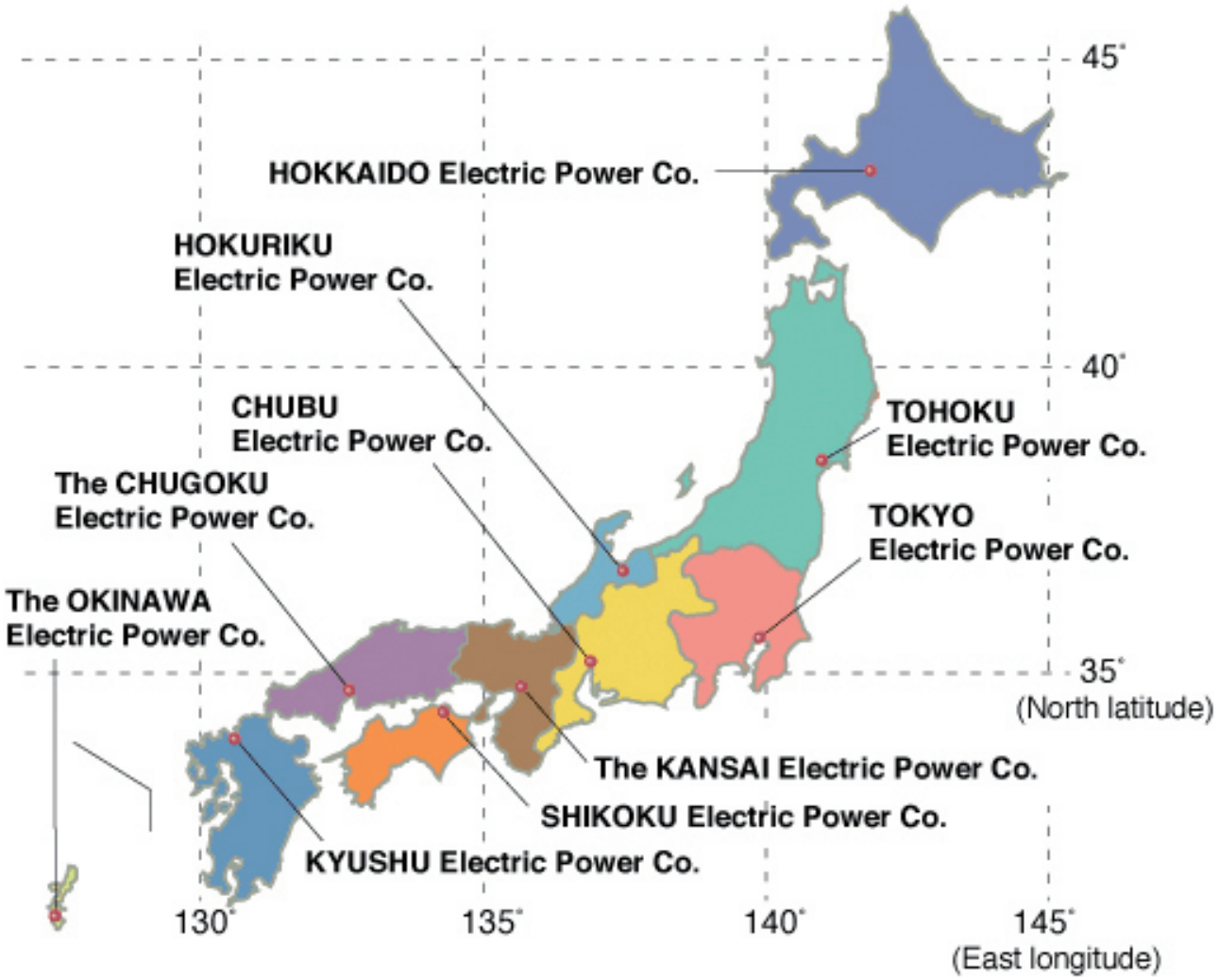
Addressing to Climate Change
Issue Brief

The Federation of Electric Power Companies of Japan (FEPC)
November 2015

About Us

- Electricity supply in Japan is carried out by privately-owned independent regional electric power companies and close cooperation among these companies is essential for efficient operations. In 1952, the nine electric power companies established the Federation of Electric Power Companies (FEPC) to promote smooth operations within the industry.
- Since then, FEPC has played an important role as a base for close communication between the electric power companies and as a forum for exchanging views to create the electric power industry of the future. Moreover, FEPC undertakes various activities to ensure stable operations of the electric power industry, with an awareness of its role in the energy industry of Japan.
- With the return of Okinawa to Japan in 1972, the Okinawa Electric Power Company rejoined Japan's electric power industry, becoming an FEPC member in March 2000.

The Ten Electric Power Companies by Service Area



Basic Approaches to Climate Change

■ Voluntary Approaches

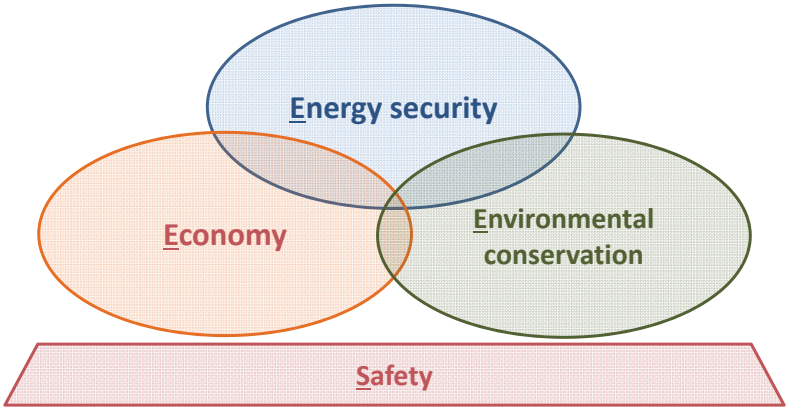
➢ Industries institute voluntary approaches because services providers are in the best position to understand the actual state of each business. This enables the establishment and execution of effective measures and the achievement of cost-performance taking account of technical trends and other management elements.

■ Simultaneous Achievement of 3Es on the Basic Premise of S (S+3Es)

➢ Resource-poor Japan is dependent on imports for 95% of its primary energy supply; even if nuclear energy is included in domestic energy, dependency is still at 94%.

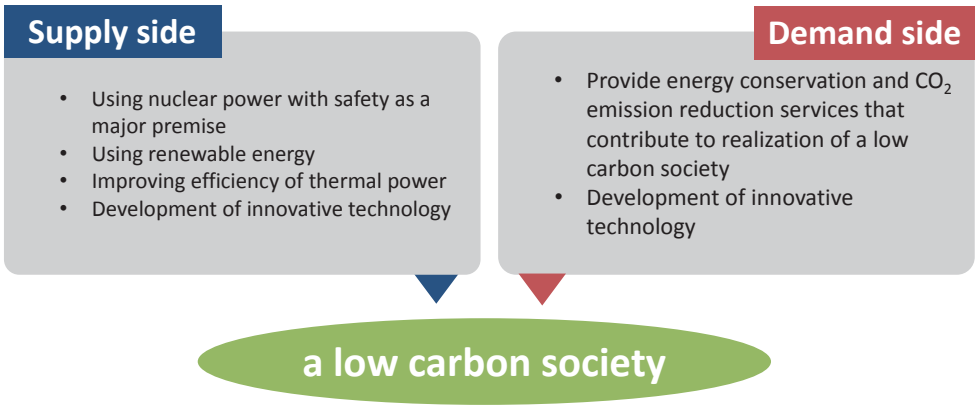
➢ Thus, Japan's energy supply structure is extremely vulnerable. Following the two oil crises in the 1970s, Japan has diversified its energy sources through increased use of nuclear energy, natural gas and coal, as well as the promotion of energy efficiency and conservation. Despite these improvements, oil still accounts for approximately 40% of Japan's primary energy supply, and nearly 90% of imported oil comes from the politically unstable Middle East. Moreover, although Japan has one of the highest proportions of electricity demand in total energy demand at over 40%, prospects for importing electricity from neighboring countries are very poor because Japan is an island nation. In addition, there is an urgent need for global warming countermeasures such as reduction of carbon dioxide emissions from the use of energy.

➢ As such, given conditions in Japan, providing the best mix of power sources able to achieve energy security, economy and environmental conservation (3Es) at the same time, all premised on safety (S), is extremely important for the supply of electricity.



■ Supply- and demand-side efforts

➢ Promoting both supply- and demand-side efforts towards the realization of a low carbon society.

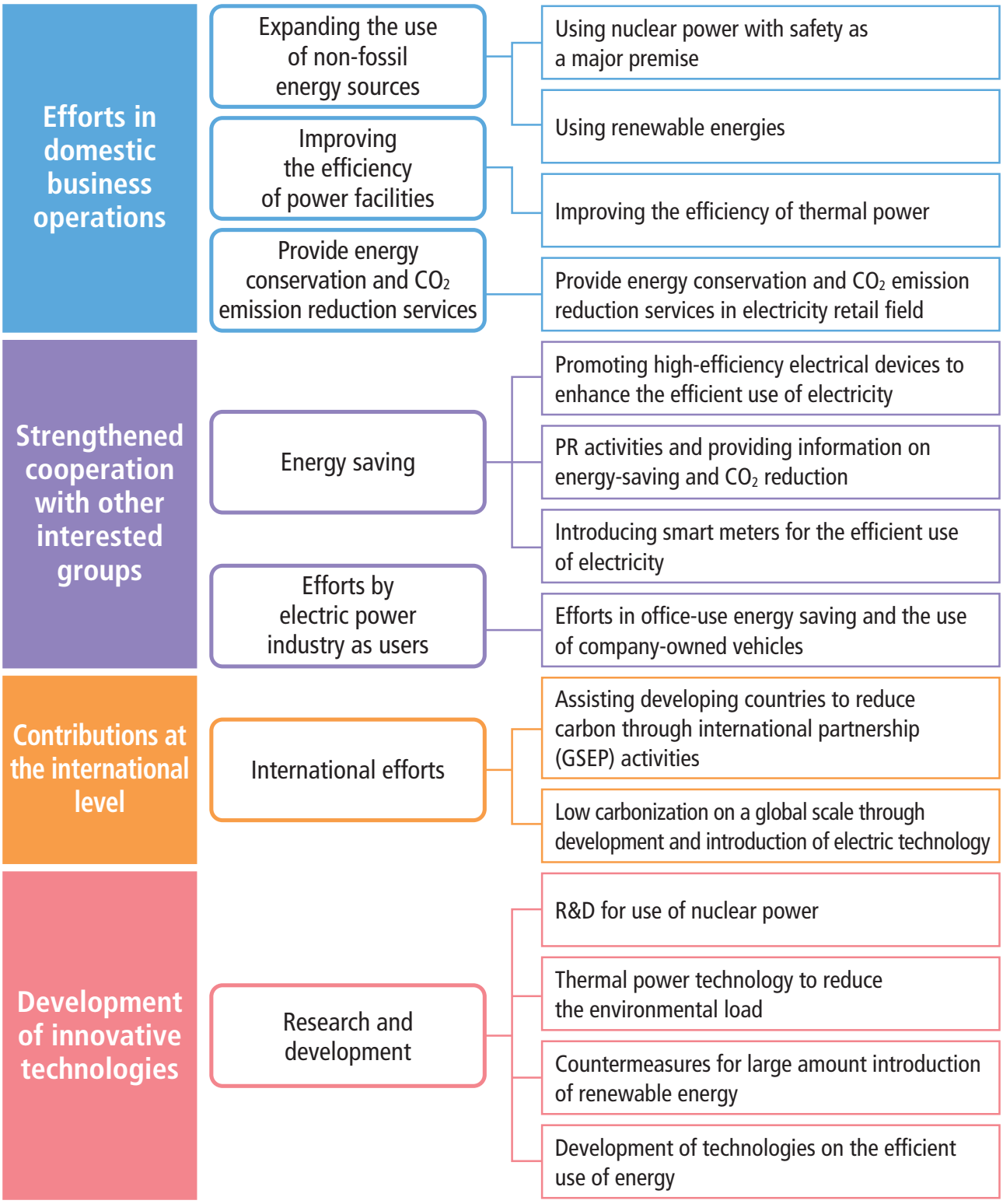


Promotion of the Action Plan for Achieving a Low Carbon Society

■ Action Plan for a Low Carbon Society of Electric Power Industry

➢ The 10 member companies of the Federation of Electric Power Companies, together with the Electric Power Development Co., Ltd., the Japan Atomic Power Company and 23 Power Producers and Suppliers (PPSs) collaborating on a volunteer basis, established the Action Plan for a Low Carbon Society of Electric Power Industry and is taking the leading role in addressing climate change.

■ Overview of the Action Plan for a Low Carbon Society of Electric Power Industry



Efforts in domestic business operations

■ CO_2 emission reduction targets for 2020

➢ We will continue to strive for the realization of a low carbon society by promoting various initiatives to reduce carbon dioxide (CO_2) emission at both the demand and supply sides of electricity in light of an optimal combination of power sources, which fit together with simultaneous achievement of Energy Security, Economic Efficiency and Environmental Conservation, under the major premise of Safety (S+3Es).

➢ We estimate that CO_2 emissions can be reduced by a maximum of approximately 7 Mt-CO_2 by utilizing the economically achievable best available technologies (BATs) in accordance with the capacity of plants when building new thermal power plants.

Reference: CO_2 reduction targets for 2030

➢ We set a nationwide emission factor target at approximately 0.37kg-CO_2/kWh (end user).

➢ We estimate that CO_2 emissions can be reduced by a maximum of approximately 11 Mt-CO_2 by utilizing the economically achievable best available technologies (BATs) in accordance with the capacity of plants when building new thermal power plants.

■ CO_2 emission reductions achieved by adopting BATs in FY 2014

➢ Results from 12 electric power-related companies and PPS companies. (Includes results of PPS companies only in this section for this fiscal year.)

❍ CO_2 reduction achieved by adopting BATs at thermal power plants

- Annual CO_2 reductions achieved by introducing highly efficient thermal power plants that began operations from FY 2013*1: approximately 3.8 Mt-CO_2/year
- Primary electric power plants that began operations from FY 2013

Date	Name of facility
December 2013	Unit No. 6, Hirono Thermal Power Plant, Tokyo Electric Power
December 2013	Unit No. 2, Hitachinaka Thermal Power Plant, Tokyo Electric Power
May 2014	Unit 2-2, Joetsu Thermal Power Plant, Chubu Electric Power
July 2014–March 2015	New units 4 to 6, Himeji No. 2 Thermal Power Plant, Kansai Electric Power

❍ CO_2 reductions achieved with improved thermal efficiency at thermal power plants

- Annual CO_2 reductions achieved by renovating thermal power plants from FY 2013*2: approximately 0.4 Mt-CO_2/year
- Primary initiatives since FY 2013

Date	Name of facility	Initiatives
July 2013	Unit No. 1, Tsuruga Thermal Power Plant, Hokuriku Electric Power	Replacement of high-and-intermediate pressure turbine (improved efficiency type)
September 2014	Unit No. 3, Kawagoe Thermal Power Plant, Chubu Electric	Replacement of gas turbine
March 2015	Unit No. 1, Yanai Thermal Power Plant, Chugoku Electric Power	Replacement of gas turbine

❍ Total reduction: approximately 4.2 Mt-CO_2/year

*1: Comparison on the assumption that the high-efficiency thermal power plants that began operating from FY 2013 operate at an efficiency equivalent to the previous plants.

*2: Comparison to a case in which measures to improve efficiency are not taken from FY 2013.

Efforts in domestic business operations

Reference

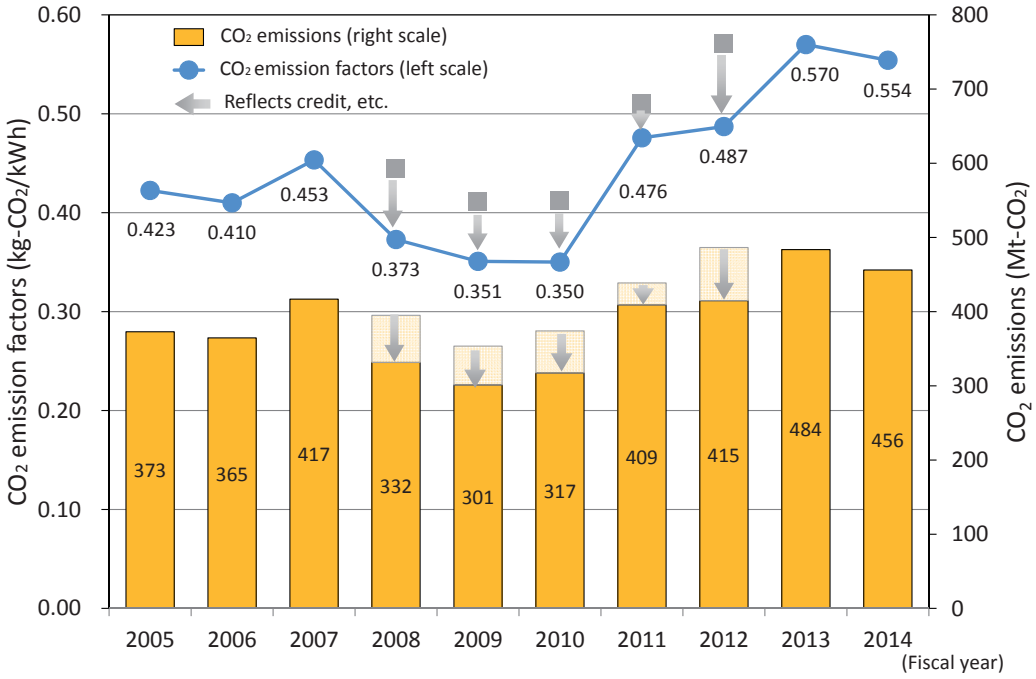
CO_2 emissions in FY 2014

	FY 2014	FY 2013 (Reference)
Electric power consumption (TWh)	823	849
CO_2 emissions (Mt-CO_2)	456	484
CO_2 emission factors user end electricity (kg-CO_2/kWh)	0.554	0.570

Note: CO_2 emissions and emission factors reflected the Feed-in Tariff, etc.

Reference

Trend in CO_2 emissions and emission factors

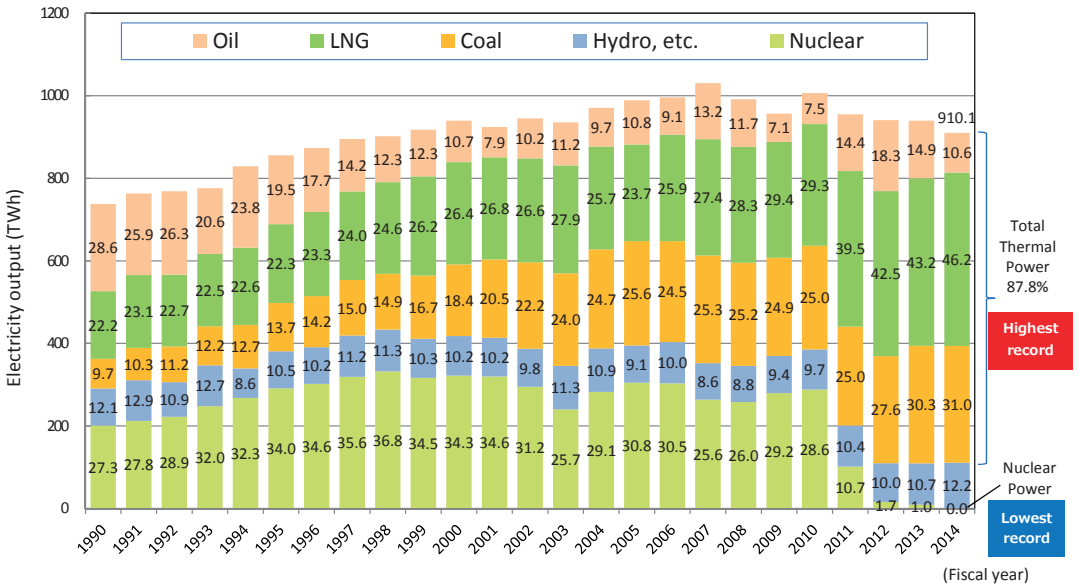


Note: CO_2 emissions and emission factors in FY 2008–2014 reflected the Kyoto Mechanism credits and the Feed-in Tariff, etc.

Reference

Trend in power generation volume by source

- Because Japan relies on imported energy resources for most of its power, there is a pursuit for a good balance of sources rather than depending on only one.
- The structure changed greatly after the long-term suspension of nuclear power triggered by the Great East Japan Earthquake.



Note 1: Total of 10 electric power companies, including power purchased from other companies. Oil includes LPG and other gasses.
Note 2: Figures within the graph represent the composition ratio (%), which may not add up to 100% due to rounding.

Reference

Analysis and evaluation of CO_2 emissions in FY 2014

- Nuclear power plant usage rates fell further in FY 2014 from FY 2013 rates as a result of the long-term suspension of nuclear power plants following the Great East Japan Earthquake, reaching 0% for the first time since nuclear power plants began operating for commercial purposes. <1>
- At the same time, renewable energy is being introduced, <2> and as a percentage of non-fossil fuel energy, it is about the same as in the previous fiscal year. <1+2>
- Thermal power plants began operating as a primary alternative energy source to nuclear power to ensure energy capacity after the earthquake. The amount of thermal power generated as a percentage of total power generated has been unchanged since FY 2012 (past maximum level). <3>
- Cutting edge, highly efficient thermal power is being introduced, raising thermal efficiency for thermal power overall. <4>

CO_2 emission factor in FY 2014: 0.554kg-CO_2/kWh
Decrease of 2.8% over FY 2013 (0.016kg-CO_2/kWh)

Comparison with previous fiscal year

		FY 2013		FY 2014	Increase or Decrease
	Nuclear power [TWh] Utilization factor [%]	9.3 (1.0%) 2.3%	1	0 (0%) 0%	-9.3 -2.3%
	Hydroelectric power and others [TWh]	100.4 (10.7%)	2	111.3 (12.2%)	+10.9
Total non-fossil fuel [TWh]		109.7 (11.7%)	1+2	111.3 (12.2%)	+1.6
Total thermal power [TWh]		830 (88.3%)	3	798.7 (87.8%)	-31.3
Thermal efficiency (LHV*) [%]		45.3%	4	46.1%	+0.8%
Total [TWh]		939.7		910.1	-29.6

*LHV: lower heating value
Note: Parentheses indicate percentage of total power generation

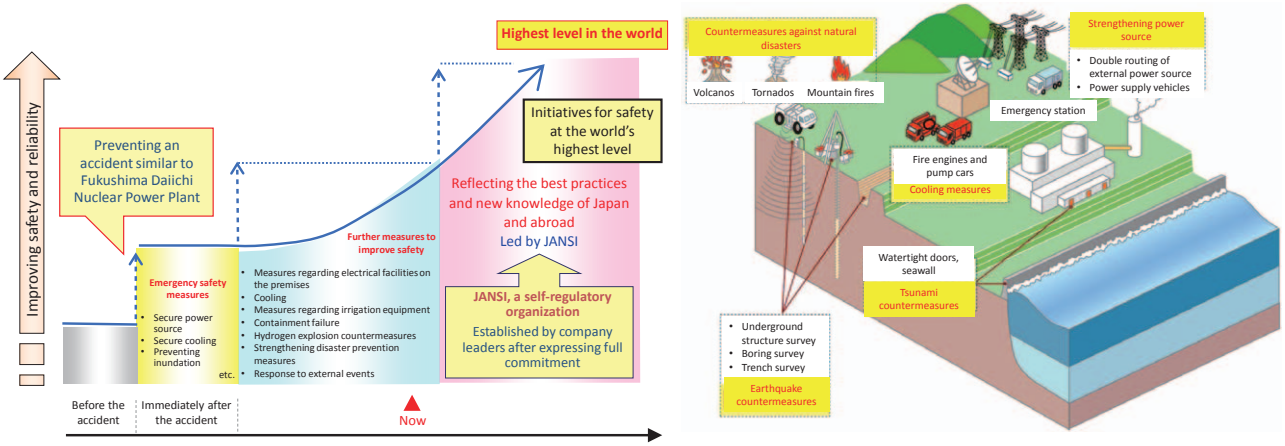
Efforts in domestic business operations

■ Using nuclear power with safety as a major premise

➢ We will take extensive safety measures based on the lessons and knowledge acquired from the accident at the Fukushima Daiichi Nuclear Power Station. We will go beyond the regulatory standards and take independent and ongoing steps to improve safety.

➢ We will provide careful explanations to gain the general public's understanding including the local community where nuclear power plants are located. Once the individual plant's safety has been confirmed and the plant operations are restarted, we will strive to safely and stably operate the plant.

■ Initiatives for the improved safety of nuclear power

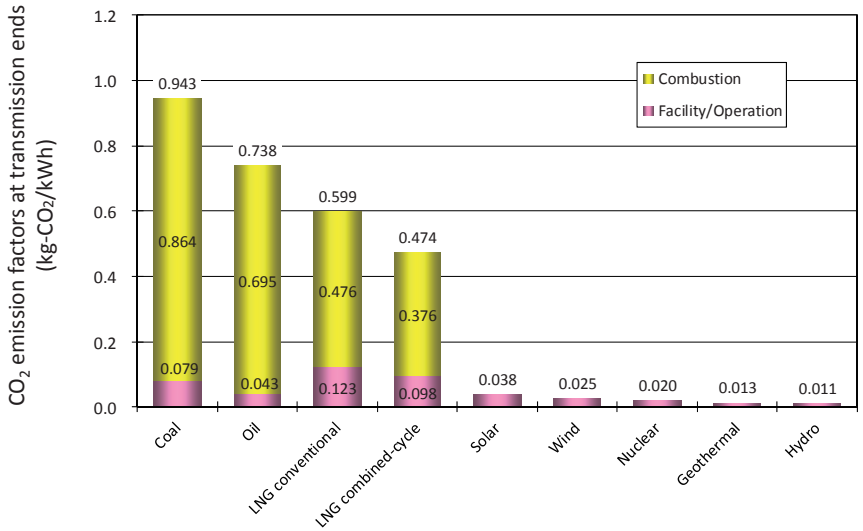


■ Effects of CO_2 emission reduction by nuclear power

➢ Estimated in accordance with total power source averages, the reduced CO_2 emissions for nuclear energy (per 1 GW) amount to approximately 3.1 Mt-CO_2 per year.

■ Comparison of lifecycle CO_2 emissions factor in Japan by energy sources

➢ Nuclear power has high energy density and excellent supply stability. Because it does not emit CO_2 during power generation, using nuclear power under the premise of safety plays an important role in measures against climate change.



Source: Report by Central Research Institute of Electric Power Industry

Efforts in domestic business operations

■ Using renewable energy

➢ Electric utilities develop hydro, geothermal, solar PV*, wind, and biomass power generation.

➢ We develop and popularizing renewable energy, connecting power from solar PV and wind power generation facilities to the power grid based on feed-in tariffs.

➢ Because the weather particularly causes great output fluctuation in solar PV and wind power generation, a number of measures are necessary for mass connection to the power grid. As a solution, efforts are also underway towards the development and installation of a new type of systems control.

* PV: photovoltaic

■ Effects of CO_2 emission reduction by renewable energy for FY 2014 (estimate)

Type of energy	Power generation volume (actual) (TWh/year)	Annual effects of CO_2 emission reduction (Mt-CO_2/year)
Hydro (excludes PSPP*)	65	Approx. 34
Geothermal	2.4	Approx. 1.2
Biomass	0.37	Approx. 0.4
Solar PV	0.089	Approx. 0.05
Wind	0.034	Approx. 0.02

*PSPP: pumped storage power plant

➢ For renewable energy, it is important to maintain maximum use while considering technical and location potential, and decisively reducing costs through technical innovation.

Advantages	Disadvantages
• Domestically produced energy • No worry of depletion • Low environmental impact and other	• High cost • Output fluctuation • Siting problems (huge amount of land, limited locations) and other

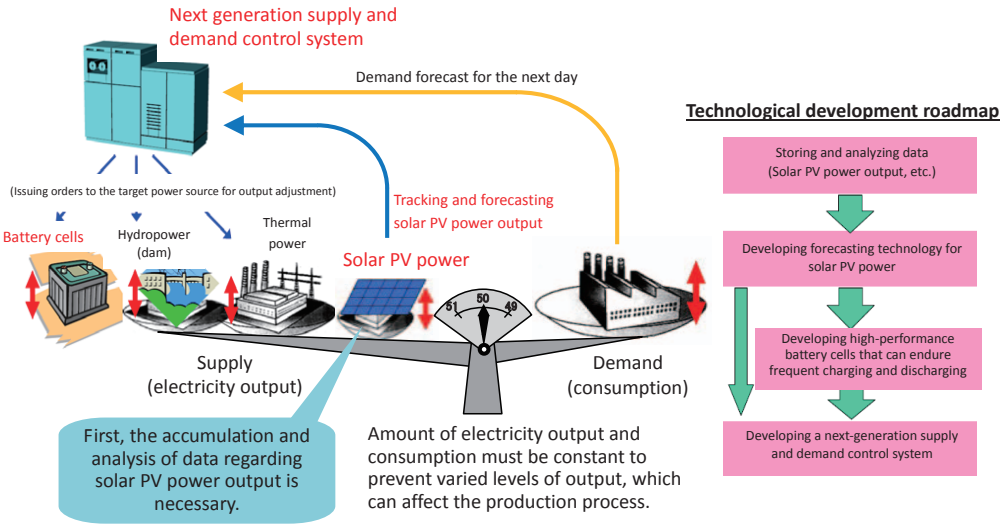
Efforts in domestic business operations

■ Countermeasures for output fluctuation of solar PV and wind generation

➢ The weather impacts output fluctuation in solar PV and wind power generation. Output variation measures are needed in order to supply power with stable voltage and frequency.

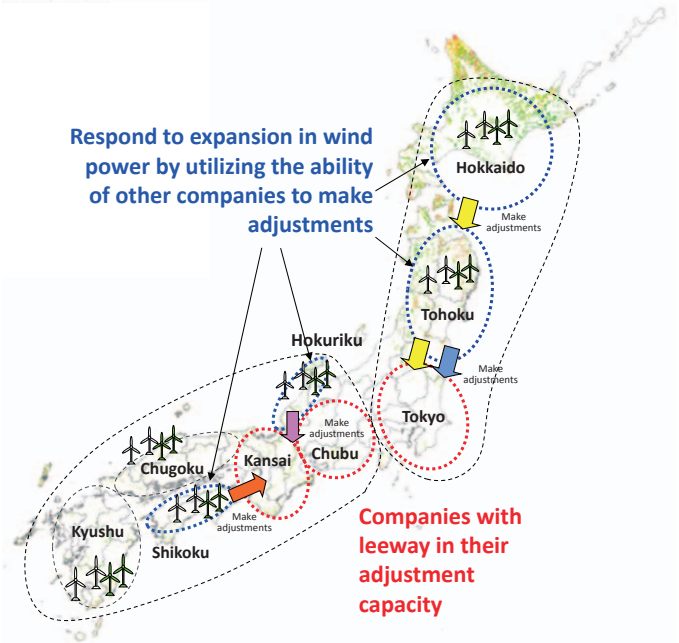
■ Development of next-generation supply and demand control systems

➢ We will reflect the results of output projections at solar PV power plants and others in power generation plans, and research and develop next-generation supply/demand control systems that combine existing power generators and storage batteries to optimize supply/demand and frequency control in actual operations.



■ Initiatives aimed at expanding the adoption of wind power generation through the use of interregional transmission lines

➢ If the ability to make adjustments addressing fluctuations in the output of wind power generation in a particular area is inadequate, we are considering expanding the adoption of wind power generation by using interregional transmission lines and the adjustment capacity of areas with relatively substantial system capacity.



Efforts in domestic business operations

■ Higher efficiency thermal power generation

➢ Introduce high-efficiency facilities when aged thermal power plants are replaced and new facility is adopted
⇒ In FY 2014, a total of approximately 4.8 GW in cutting-edge high-efficiency thermal plants were introduced.

➢ Appropriate maintenance of existing facility
⇒ Thermal efficiency of thermal power plants was 46.1% in FY 2014 (LHV: lower heating value), up 0.8% over FY 2013 (45.3%).

■ Implementation of the economically achievable best available technologies (BATs)

➢ While taking into account a variety of factors in a comprehensive manner, we will implement BATs in accordance with the capacity of the plants

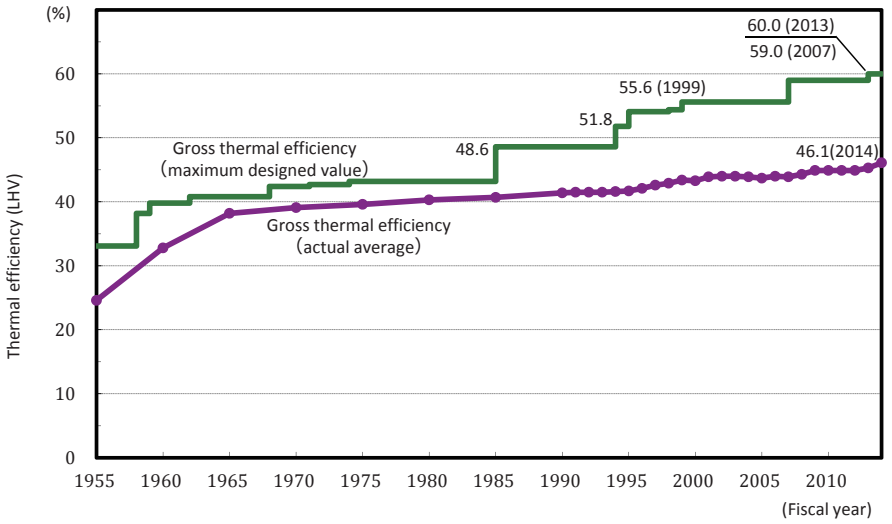
❍ Implementation of LNG combined cycle generation
- Achieved roughly 60% (LHV) of the world's highest standard of thermal efficiency. (2014, FY-end) Going forward, we will work to plan and construct a combined cycle power generation of the world's highest standards with thermal efficiency of higher than 60%.

❍ Implementation of high-efficiency equipment such as ultra-super-critical thermal power generation
- For better thermal efficiency, we are improving steam conditions (temperature, pressure) and have now installed a state-of-the-art 600°C-class ultra super critical (USC) coal-fired power generation.
- In conjunction with high efficiency, we plan to expand the use of coal types by developing and installing a 1200°C-class integrated coal gasification combined cycle (IGCC) that can use coal with a low-ash melting point that is difficult to use in conventional coal-fired power generation.

■ Trends in thermal efficiency of thermal power generation

➢ In addition to the introduction of high-efficiency thermal power plants, even amidst aging of the plants due to increased firing after the Great East Japan Earthquake, rigorous operational management maintained the thermal efficiency of thermal power.

■ Trends in thermal efficiency of thermal power plants

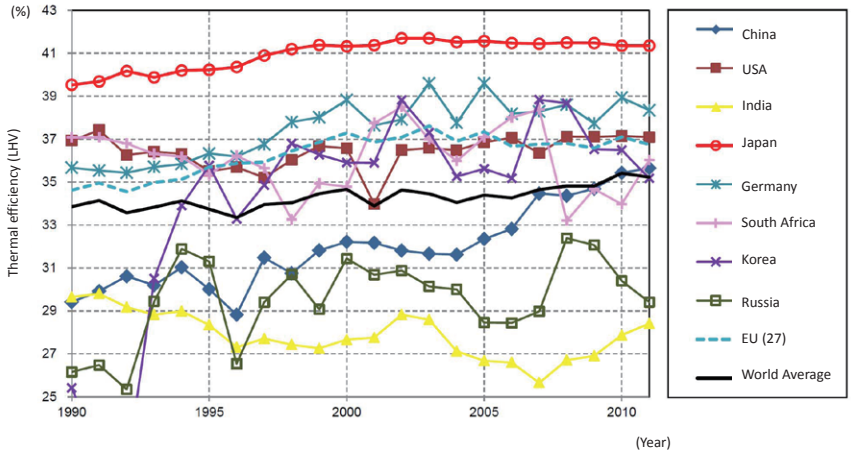


Source: Japan Electric Utilities Handbook, etc.
* LHV (lower heating value) is estimated based on the HHV (higher heating value) using the conversion factor of explanation of the comprehensive energy statistics (2010 revised edition).

Reference

International comparison of thermal efficiency of coal-fired thermal power plants

To date, coal-fired power in Japan has stably maintained the world's highest level of efficiency

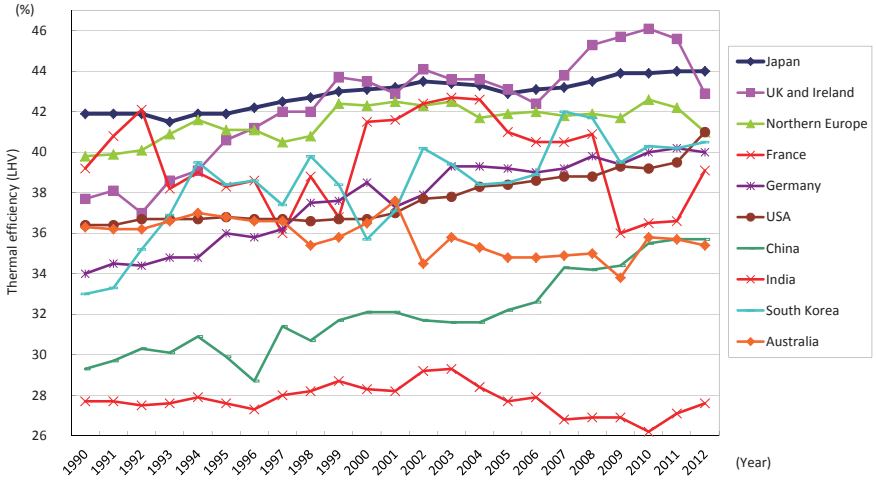


Source: Report "Comprehensive Evaluation of Voluntary Action Plan compiled by study group" (April 2014)
* Gross thermal efficiency (LHV based). Includes private power generation and CHP (Combined Heat and Power). Excludes peat power. (calculated from IEA statistics)

Reference

International comparison of thermal efficiency of thermal power plants

Thermal efficiency of thermal power generation in Japan, through the installment of highly efficient equipment and commitment to appropriate operation and maintenance, stably continues to maintain the world's highest standards.

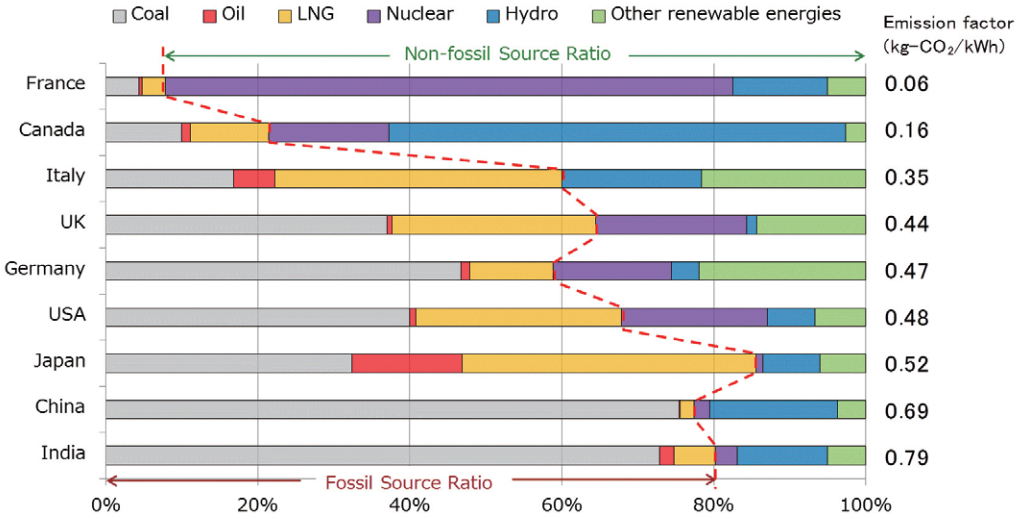


Sources: INTERNATIONAL COMPARISON OF FOSSIL POWER EFFICIENCY AND CO_2 INTENSITY, 2015 (Ecofys)
* Thermal efficiency is the gross generating efficiency based on the weighted averages of efficiencies for coal, oil and gas (LHV based).
* Comparisons are made after converting Japanese data (higher heating 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.

Efforts in domestic business operations

Reference

Power source configuration and CO_2 emission factors of major countries and regions



* Figures from 2013
* Japanese figures include private power generating equipment
* Figures include CHP plants (thermoelectric supply)
* FEPC calculations based on IEA, Energy Balances of OECD Countries 2015 Edition/Energy Balances of Non-OECD Countries 2015 Edition

■ Provide energy conservation and CO_2 emission reduction services that contribute to realize a low carbon society

➢ Based on customers' needs in a low carbon society, we will make an effort to provide energy conservation and CO_2 emission reduction services in power retailing.

❍ Specific initiatives

- Use web sites to provide customers with information on energy conservation, such as "Checkpoints for Energy Conservation" and "How to Use and Select Home Appliances"
- Distribute calendars and household account books containing energy-saving ideas, and introduce customers to energy-saving ideas for the home tailored to each season
- Hold exhibits with energy-saving proposals and seminars on energy conservation, and provide education on environmental energy
- Visit customers to measure the current of electric equipment and give advice on contracts and conservation
- Provide environmental education to employees through environmental trainer programs and e-learning

Strengthened cooperation with other interested groups

■ Popularization of high-efficiency equipment for efficient use of energy

➢ Reducing CO_2 emissions and conserving energy through "hot water" in the home is extremely effective against climate change, as it makes up roughly 30% of energy consumed in the residential sector.

➢ "Eco Cute," a heat pump hot water heater using CO_2 as the refrigerant, has advanced energy conservation and CO_2 emission reduction features. We are working together in a collaboration between the private sector and the government to popularize this hot water heater as a key measure in countering climate change in the civil sector.

➢ We will actively promote the use of heat pump technology for higher efficiency of air conditioners for commercial use and other equipment.

Reference

Effect of wider use of heat pumps in reducing greenhouse gases

➢ According to the Report on the Effect of Wider Use of Heat Pumps in Reducing Greenhouse Gases (August 2015), issued by the Heat Pump & Thermal Storage Technology Center of Japan, greenhouse gases (converted to CO_2) could be reduced by 48.3 Mt-CO_2/year by FY 2030 (compared to FY 2012) if the boilers used to provide heat in the civil sector (households and business sector) and industrial sector were replaced by heat pump equipment.

■ Installation of smart meters

➢ From the viewpoint of controlling peak hours from the customer's side and using electricity more efficiently, we commit to the government goal of installing smart meters in all homes and all factories by the early 2020s.

■ Plans to adopt smart meter

Figures in table are plans in low-pressure sector (as of July 2015)

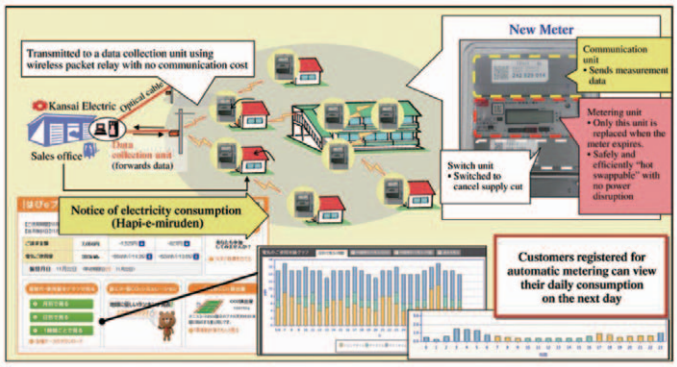
	Hokkaido	Tohoku	Tokyo	Chubu	Hokuriku	Kansai	Chugoku	Shikoku	Kyushu	Okinawa
Start of full-scale adoption	Started	Started	Started	Started	Started	Started	April 2016	Started	April 2016	April 2016
Adoption complete	End of FY 2023	End of FY 2023	End of FY 2020	End of FY 2022	End of FY 2023	End of FY 2022	End of FY 2023	End of FY 2023	End of FY 2023	End of FY 2024

Reference

Smart meter scheme example

➢ 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



Contributions at the international level

■ Assisting developing countries to reduce carbon through international partnership (GSEP) activities

➢ Electric utilities participated in GSEP,*1 a public/private partnership cooperation

*1: Global Superior Energy Performance Partnership

➢ In October 2014, the Third GSEP Workshop was held with the aim of sharing best practices for power generation, transmission and distribution and demand management technology in Mongolia. At the Ulaanbaatar Thermal Power Plant No.4 (coal) that we visited, Japan's electronic power companies in particular checked equipment and analyzed operations data, and presented proposals for improvements to operations and maintenance (peer review).

➢ We will continue to contribute to the reduction of CO_2 emissions on a global scale through the activities of GSEP in the action plan for achieving a low carbon society.*2

*2: In July 2015, the Fourth GSEP Workshop was held in Turkey. Similarly, Japanese electric power companies took a central role in carrying out peer reviews of coal-fired thermal power plants.

Ulaanbaatar
Thermal Power Plant No.4

Confirmation of condition
of equipment on site

Discussions

➢ Results of diagnosis (reference)

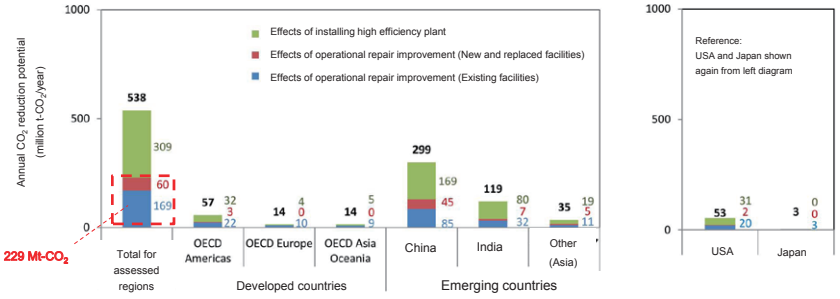
- ❍ It was confirmed that repair and operation systems have been developed using Japan and other countries as a reference.
- ❍ Japan recommended that inspection rounds be augmented and that remaining life diagnosis be improved, and the participants agreed that these proposals would help to reduce start-up losses resulting from unplanned stoppages and would maintain and improve thermal efficiency.

Reference

CO_2 emission reduction potential through operation and maintenance (O&M)

Potential for reductions (total for all regions) through O&M in key countries is estimated to be 229 Mt-CO_2 in 2020.

CO_2 reductions when taking countermeasures (compared to base case, 2020)



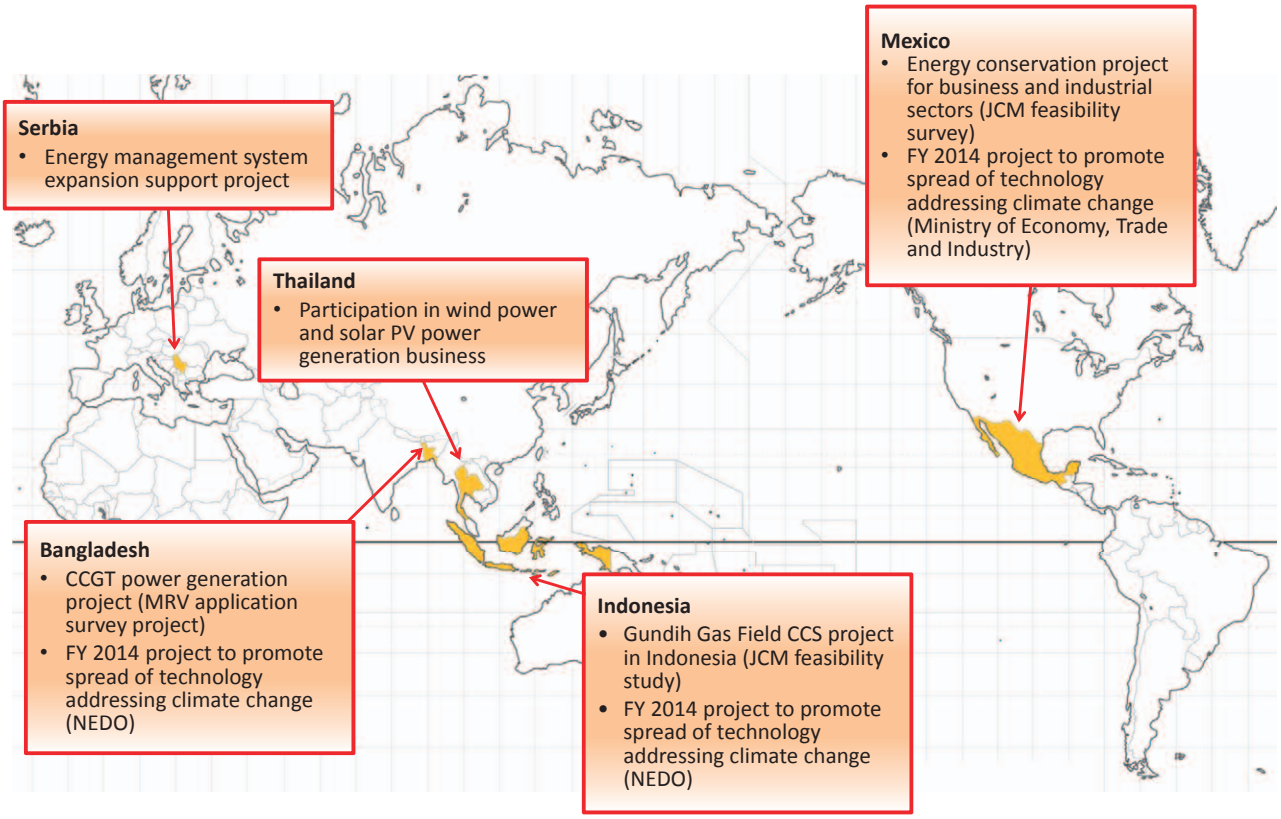
Source: Research Institute of Innovative Technology for the Earth (RITE) "Evaluation of coal-fired CO_2 reduction potential for major countries: effects of operational repair and new establishment (August 2014)"

* Studied measures: Assuming the installation of immediate USC and power generation efficiency equipment equivalent to a 1500°C-class IGCC in 2030

Contributions at the international level

■ Other low carbon assistance through overseas activities

➢ In order to contribute to the reduction of CO_2 and the conservation of energy overseas, we provide overseas projects and consulting, making use of accumulated experience, know-how and high technology accumulated through domestic business activities.



Note: Only projects selected in FY 2014 are listed here.

Development of innovative technologies

<table>
<tr><td rowspan="3">Supply side</td><td>R&D for use of nuclear power
➢ Japanese and foreign cutting-edge technology and knowledge will be rapidly incorporated, every effort made to ensure safety at nuclear power plants and the world's highest level of safety pursued. In addition, measures to demolish the Fukushima Daiichi Nuclear Power Station will be taken safely and promptly. Through these means, the public's trust will be restored and a stable supply of electric power can be ensured.</td></tr>
<tr><td>Thermal power technology to reduce the environmental load
➢ In terms of ensuring energy security and preserving the environment, coal, which is advantageous for its stable supply and affordability, will be used efficiently and technology to reduce the environmental load will be developed.
<Example of thermal power technology that reduces environmental load>
Integrated gasification combined cycle (IGCC), CO_2 capture and storage (CCS) technology</td></tr>
<tr><td>Countermeasures for large amount introduction of renewable energy
➢ Research and development will be pursued with government cooperation, such as examining the negative impact on the overall power network from the large-scale adoption of solar PV power and measures to stabilize the system utilizing storage cells.</td></tr>
<tr><td>Demand side</td><td>Development of technologies on the efficient use of energy
➢ Technology for efficient electricity usage
• Regarding the EcoCute CO_2 refrigerant heat pump water heater developed to date, we will develop technologies for higher efficiency in order to further promote environmental protection through energy conservation and CO_2 emission reduction.
• For other heat pump technology, thermal storage, and storage utilization technologies, we will also make efforts in higher efficiency and downsizing.
➢ Technologies that contribute to improved convenience for customers
• Compared with gasoline run vehicles, electric vehicles can reduce CO_2 emissions and are highly environmental. The electric utility industry too is making efforts in improving convenience through test runs, developing chargers, and standardizing rapid chargers for use in Japan and abroad. Meanwhile, it is promoting the use of electric vehicles and plug-in hybrid cars for its commercial vehicles.</td></tr>
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The Federation of Electric Power Companies of Japan

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