

2020



History of Japan's Electric Utility Industry

Electricity was first used in Japan on March 25, 1878 at the Institute of Technology in Toranomon, Tokyo when an arc lamp was switched on in commemoration of the opening of the Central Telegraph Office. In those days, electricity was still unfamiliar and uncommon not only in Japan but also in Europe and the United States. In 1886, Tokyo Electric Lighting, a private company, commenced operations as the nation's first electric power company, and began supplying electricity to the public in the following year.

In the early days, use of electricity grew primarily for lighting because of its safety and cleanness, and gradually found broader applications as a power source to replace the steam engine. By 1896, the number of electric utilities established throughout the nation reached a total of 33. The early 20th century marked the establishment of long-distance transmission technology. As larger thermal and hydro-power plants were introduced, generation costs fell and electricity came into wider use throughout the country. Consequently, electricity became an indispensable energy source for peoples' lives and industry.

In the years that followed, the electricity utility business grew in tandem with the modernization of Japan and development of its industry. At the same time, the electric utility industry experienced a major restructuring that led to the dissolution of 700 electric utilities, which merged to create five major electric utilities after the First World War. During the Second World War, the electric utility industry was completely state-controlled and utilities were integrated into Nihon Hatsusoden Co. (a nationwide power generating and transmitting state-owned company) and nine distribution companies.

After the end of World War II in 1945, supply and demand for electricity remained very tight in Japan. A series of intense discussions were held on restructuring

the electric utility industry as one of the measures for democratizing the economy. As a result, nine regional privately owned and managed General Electricity Utilities— Hokkaido, Tohoku, Tokyo, Chubu, Hokuriku, Kansai, Chugoku, Shikoku and Kyushu Electric Power Companies — were established in 1951 and assumed the responsibility of supplying electricity to each region.

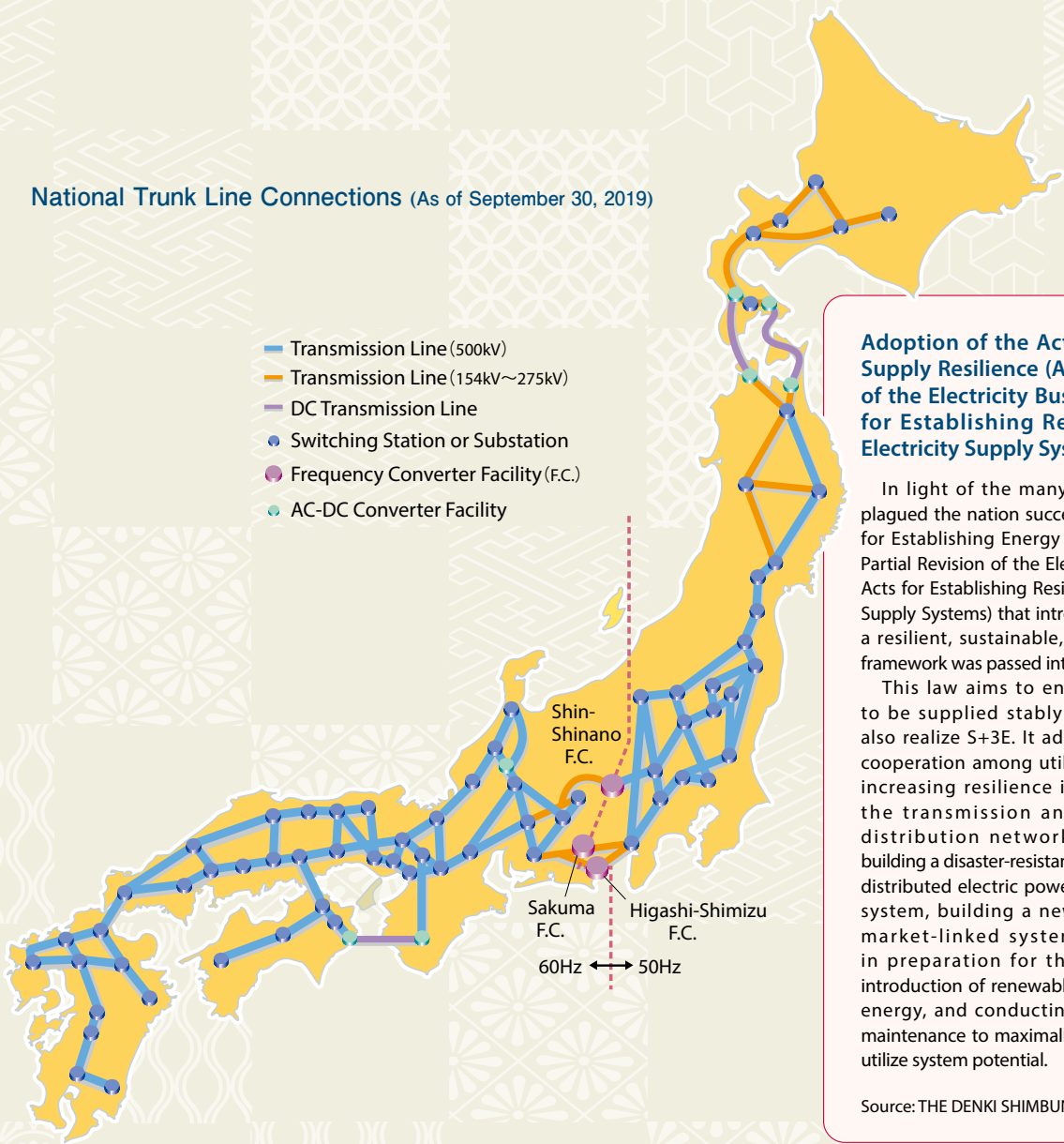
The Okinawa Electric Power Co. was established with the return of Okinawa to Japan in 1972.

At the end of the 20th century, a trend toward deregulation and competition took hold throughout society, and the electric utility industry started to be liberalized. In December 1995, organizations such as independent power producers (IPP) were allowed to provide electricity wholesale services, and in March 2000, electricity retail supply for extra-high voltage users (demand exceeding 2MW) was liberalized. The scope of retail liberalization was then expanded in April 2004 to users of more than 500kW, and subsequently in April 2005 to users of more than 50kW. Thus, a Japanese model of liberalization based on fair competition and transparency, while maintaining the vertical integration of generation, transmission and distribution to ensure a stable supply of electricity, was established.

With the Fukushima Daiichi Nuclear Power Station accident and subsequent tight demand and supply brought about by the Great East Japan Earthquake in March 2011 as a turning point, a policy to implement three-phase reforms of the electric power system was adopted in 2013.

In 2015, the Organization for Cross-regional Coordination of Transmission Operators, JAPAN (OCCO) was established in the first phase of reform, in 2016, new entry into the electricity retail market was fully liberalized in the second phase, and in 2020, the transmission / distribution sector was legally unbundled in the third phase.

National Trunk Line Connections (As of September 30, 2019)



Adoption of the Act for Establishing Energy Supply Resilience (Act on the Partial Revision of the Electricity Business Act and Other Acts for Establishing Resilient and Sustainable Electricity Supply Systems)

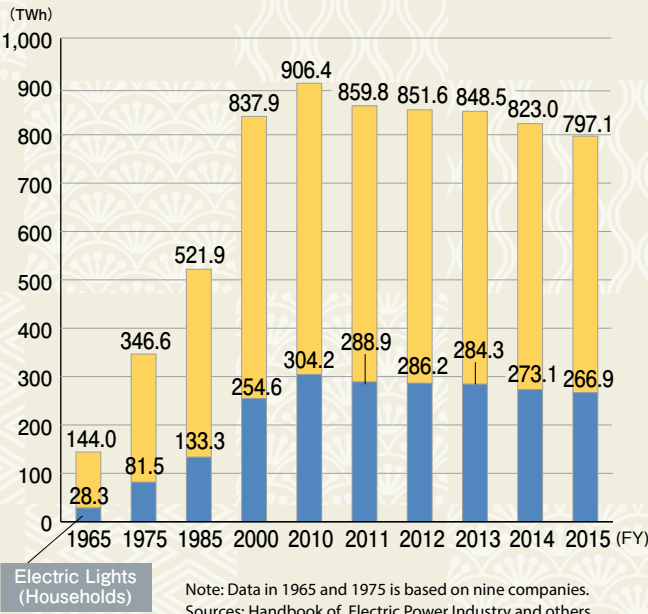
In light of the many natural disasters that have plagued the nation successively in recent years, the Act for Establishing Energy Supply Resilience (Act on the Partial Revision of the Electricity Business Act and Other Acts for Establishing Resilient and Sustainable Electricity Supply Systems) that introduces system reform to secure a resilient, sustainable, and stable electricity supply framework was passed into law in June 2020.

This law aims to ensure electricity will be able to be supplied stably now and in the future and also realize S+3E. It addresses the strengthening of cooperation among utilities during times of disaster, increasing resilience in the transmission and distribution network, building a disaster-resistant distributed electric power system, building a new market-linked system in preparation for the introduction of renewable energy, and conducting maintenance to maximally utilize system potential.



Source: THE DENKI SHIMBUN

Power Demand for Ten Companies



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Note: Nine Companies include Hokkaido, Tohoku, Tokyo, Chubu, Hokuriku, Kansai, Chugoku, Shikoku and Kyushu. Ten Companies include the above Nine Companies plus Okinawa.

Japan's Energy Supply Situation

Resource-poor Japan is dependent on imports for more than 90% of its energy. 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 about 40% of Japan's primary energy supply, and more than 80% 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. To ensure Japan's stable electricity supply, it is crucial to establish an optimal combination of power sources that can concurrently deliver energy security, economic efficiency, and environmental conservation, while making safety the top priority.

For the future, it is important for Japan's energy mix to continue to include a certain level of nuclear energy premised on ensuring safety, while maximizing the use of renewable energy and using a reasonable proportion of thermal power considering the stability of fuel supply.

The "5th Strategic Energy Plan" revised by the government in July 2018 also states that nuclear power is an important base load power source that can, strictly premised on safety, contribute to the stability of the supply and demand structure of energy.

Development of 2030 Energy Mix

After the Great East Japan Earthquake, almost all nuclear power stations have been halted and thermal power generation accounts for most of the energy mix. As a result, Japan's energy self-sufficiency ratio has dropped from 20.2% at the time before the Earthquake to 6.4% in FY2014 and fuel costs have nearly doubled from 3.6 trillion yen to 7.2 trillion yen in the same time period. The increase in thermal power generation has also increased CO₂ emissions.

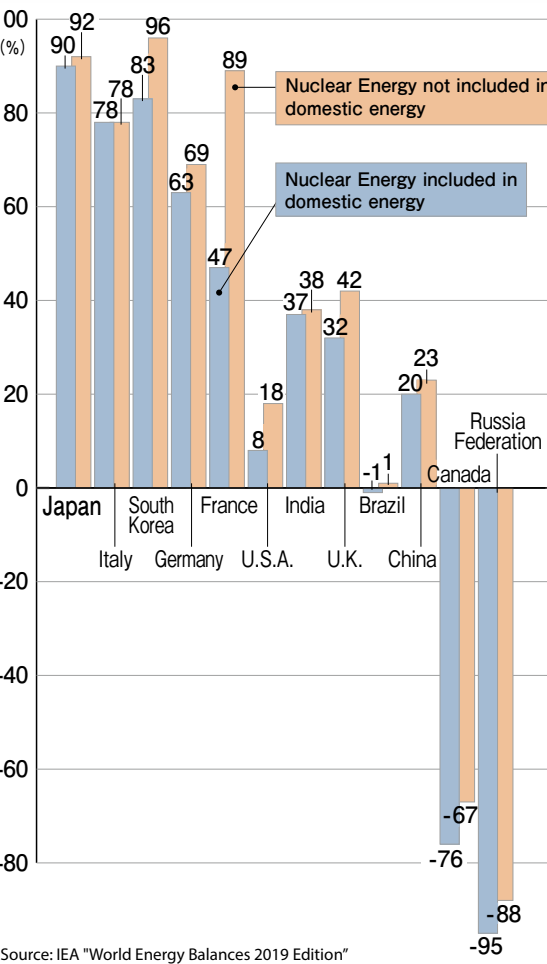
In July 2015, reflecting these observations, the Government decided the "Energy Mix" of FY2030 with the basic objectives of raising the nation's energy self-sufficiency ratio higher than that even before the earthquake, lowering

the electricity cost from the current level, and setting a CO₂ emission reduction target comparable to those of western nations.

The Energy Mix proposes, in addition to a firm commitment to reduce overall energy consumption, that nuclear should account for 22-20%, thermal power for 56% (27% LNG, 26% coal, and 3% oil), and renewable energy for 22-24%.

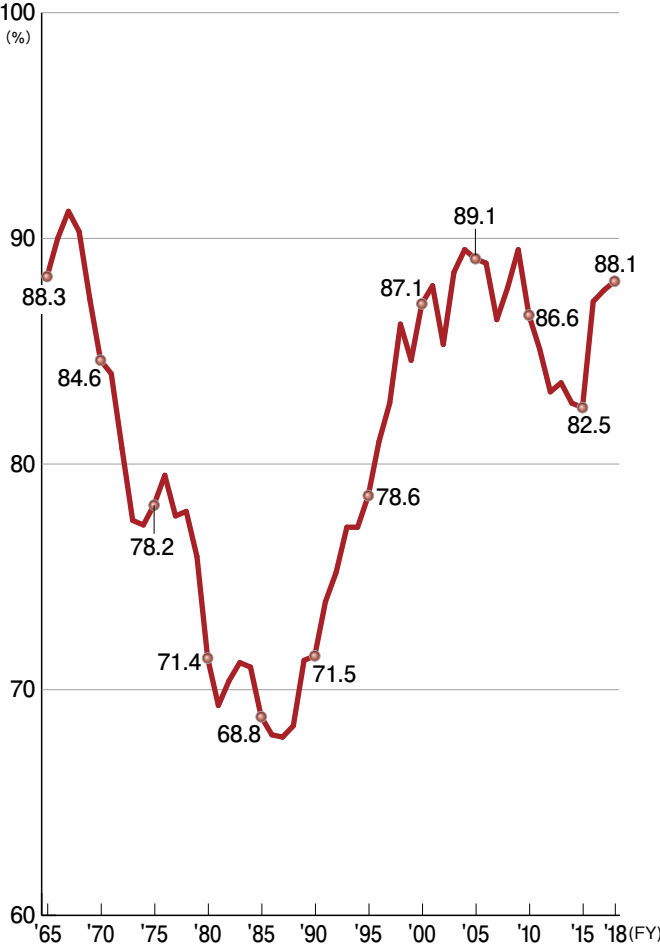
In view of the Energy Mix decided by the Government, the electric power companies will strive to achieve energy security, economic efficiency, and environmental conservation, while putting top priority on safety.

Dependence on Imported Energy Sources by Major Countries (2017)



Source: IEA "World Energy Balances 2019 Edition"

Japan's Reliance on Middle East Crude Oil of Total Imports



Source: Petroleum Association of Japan

Three Viewpoints Concerning Development of the Energy Mix

Securing safety
Major premise

Energy self-sufficiency rate:

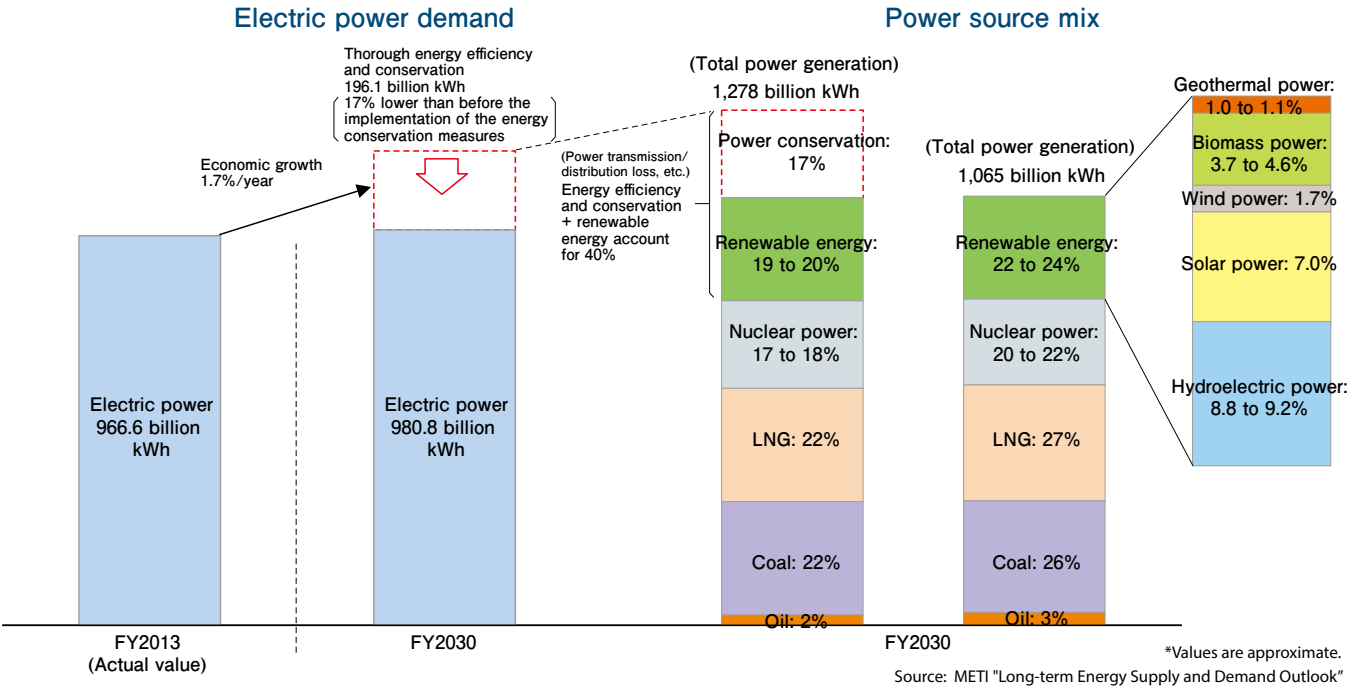
Only 12% at 2018 → Target: About 24%, surpassing the pre-earthquake level of about 20%

Electricity cost:

Electricity rates have risen since the earthquake. The surcharge for purchasing renewable energy in FY2020 is 2.4 trillion yen. → Target: Bring it down from the present level

Greenhouse gas emissions:

Due to NPP shutdowns and the increase of thermal power generation, the CO₂ emissions (from energy sources) in FY2013 were the worst ever. → Target: 26% decrease compared to FY2013



Electric Power Companies' Commitment to Safety Measures at Nuclear Power Plants

The Great East Japan Earthquake on March 11, 2011 led to a nuclear accident at the Fukushima Daiichi Nuclear Power Station, resulting in the release of radioactive materials into the environment.

Determined to avoid a repeat of this accident, the electric power companies have been taking both tangible and intangible measures since immediately after the accident, starting with emergency safety measures including the installation of additional emergency power source vehicles and fire engines, as well as upgrading procedure manuals and conducting drills.

Even after implementing the emergency safety measures, the electric power companies are making further efforts to improve safety, including installing air-cooled emergency power generators, filtered ventilation systems and earthquake-isolated emergency response centers.

To enable these efforts to be constantly and objectively evaluated, the Japan Nuclear Safety Institute(JANSI), which evaluates the safety improvement activities of electric power companies and gives them technical advice, and the Nuclear Risk Research Center(NRRC), which uses Probabilistic Risk Assessment(PRA) and proposes solutions based on R&D, were established. The electric power companies take to heart

the evaluations and recommendations and are striving to achieve the highest safety level in the world.

In July 2018, so that these autonomous and continuous initiative of the nuclear industry become established practices, a new organization, the Atomic Energy Association (ATENA), was established to effectively utilize the knowledge and resources of the entire nuclear industry, formulate effective measures while engaging in a continuing dialogue with regulators and others, and encourage nuclear operators to incorporate these measures in their plant operations. The electric power companies will work to reliably incorporate the safety measures decided by ATENA in their safety improvement initiatives to continuously reduce risk and recover the trust of society.

Also, in July 2013, the new regulatory requirements set forth by the Nuclear Regulation Authority (NRA) were put into effect. As of February 2021, electric power companies have applied for a review of conformance with the new regulatory requirements for 27 units out of their 16 power stations. Sixteen units have passed the review and nine of them have restarted commercial operation.

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Establishment of an Emergency Response Force (ERF) at Hamaoka Nuclear Power Station

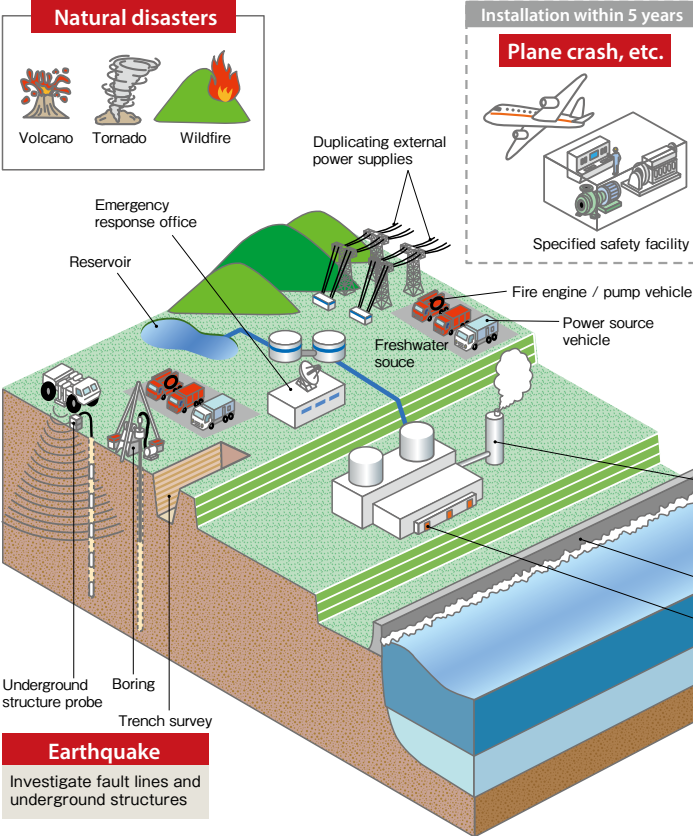
Strengthening on-site response capabilities is as important as having better equipment. Chubu Electric Power established its Emergency Response Force (ERF), a specialized team that will arrive at the scene of an accident first and engage in initial response, at Hamaoka Nuclear Power Station in July 2014. Chubu EPCO is increasing the number of personnel in ERF to have them be stationed on site at all hours of the day, every day of the week.



Power connection training at night



Emergency Response Force (ERF)



Fair Competition and Transparency

The electric power market in Japan has been progressively liberalized to ensure competitive neutrality on the basis of a stable power supply by the former ten General Electricity Utilities, which consistently handle all functions from power generation to distribution.

In 1995, a law was revised to enable IPPs to participate in the electricity wholesale market in addition to conventional general electrical utilities. Then, in March 2000, use of the transmission/distribution network owned by the electric power companies was liberalized, and the retail market was partially liberalized to allow power producers and suppliers (PPSs) to sell electricity to extra-high voltage users requiring more than 2MW. The scope of liberalization was then expanded in April 2004 to users requiring more than 500kW, and subsequently in April 2005 to users requiring more than 50kW. Then, in April 2016, all users including individual households and retail stores were included in the scope of this liberalization so that everyone is free to choose an electric power company and price menu. Electric power companies have responded to this trend of liberalization by increasing their business efficiency while lowering electricity prices and offering a variety of pricing plans.

With the three goals of ensuring supply stability, suppressing electricity rates to the maximum extent possible, and expanding the options for consumers and the business opportunities for operators, the government is planning to advance the reforms in three phases through the three key measures of enhancing nationwide grid operation, full

deregulation of the electricity retail and generation sectors, and further ensuring neutrality in the transmission / distribution sector through the legal unbundling while thoroughly inspecting each phase to solve any issues and taking necessary measures based on the results of the inspections.

As practitioners, the electric power companies would like to continue taking an active role in the deliberation so the markets will be organized to secure the stable supply of electricity, including the market transactions that are already active, and so that the electric power system reform will truly bring benefits to the customers.

Column

Overview of the Electricity System Reform

The following revisions to the Electricity Business Act related to the reforms of the electric power system were passed into law in November 2013.

Phase 1: Enforced in April 2015

- (1) Establishment of the "Organization for Cross-regional Coordination of Transmission Operators, JAPAN" (Enhancement of nationwide grid operation)

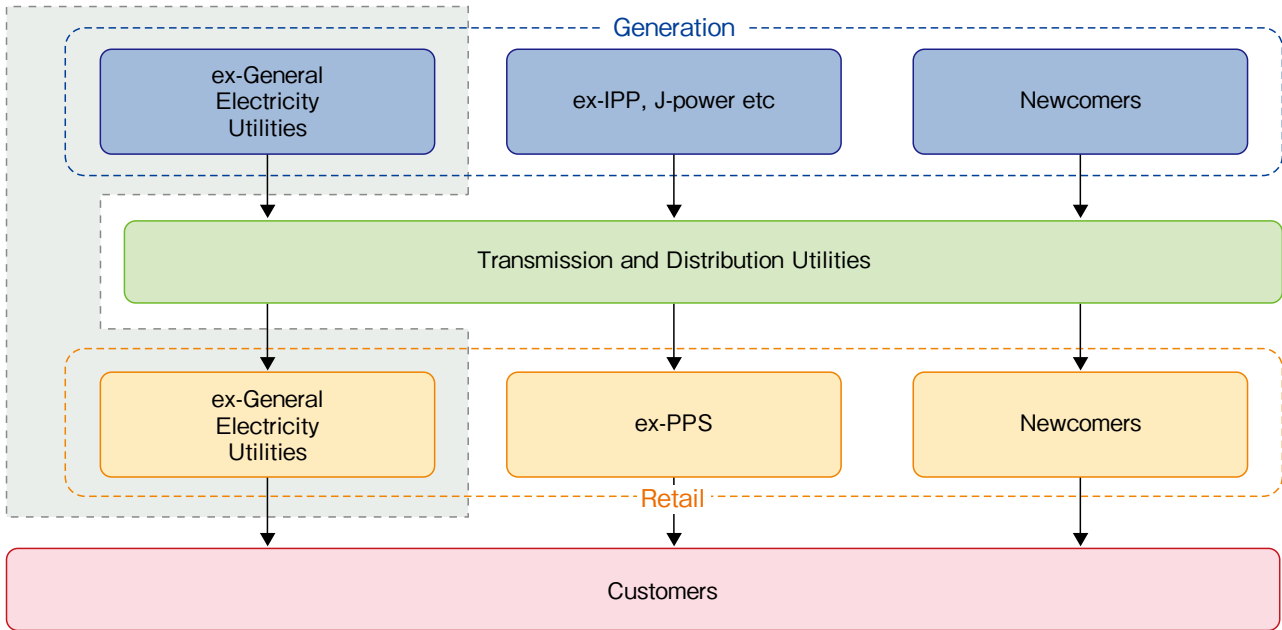
Phase 2: Enforced in April 2016

- (2) Full liberalization of entry to electricity retail business
- Abolishment of wholesale regulations

Phase 3: Enforced in April 2020

- (3) Implementation of the legal unbundling of the electricity transmission and distribution department (for ensuring further neutrality)
- (4) Abolishment of the retail price regulations

The New Electricity Supply System (from April 2020)



Optimal Combination of Power Sources

Electric power companies in resource-poor Japan are committed to developing an optimal combination of power sources including hydro, thermal and nuclear power in order to provide electricity, which is essential for modern living, in a stable manner at the lowest prices.

As electricity is nearly impossible to store in large quantities, electric power companies generate electricity by combining various power sources, considering optimal operational and economic performance, to ensure that fluctuating demand, such as during the daytime in the height of summer, can always be met.

Hydroelectric Power

Hydroelectric power has been one of the few self-sufficient energy resources in resource-poor Japan for more than 100 years. Hydroelectric power is an excellent source in terms of stable supply and generation cost over the long term. Though it used to compare unfavorably with thermal power for some time, hydroelectric power saw a renaissance following the oil crisis.

Although the steady development of hydroelectric power plants is desired, Japan has used nearly all potential sites for constructing large-scale hydroelectric facilities, and so recent developments have been on a smaller scale. As the gap in demand between daytime and nighttime continues to widen, electric power companies also has developed pumped-storage power generation plants to meet peak demand. As a result, the share of pumped-storage generation facilities of the total hydroelectric power capacity in Japan has grown year-by-year.

Thermal Power

Initially, coal was the dominant fuel for thermal power generation in Japan, but it later lost that place to oil. Today, a diverse range of fuels including coal, oil, and LNG are used for the important generating role that thermal power plants play. In particular, electric power companies are promoting the introduction of LNG fired plants in response to global environmental concerns, as they emit less CO₂ and other pollutants.

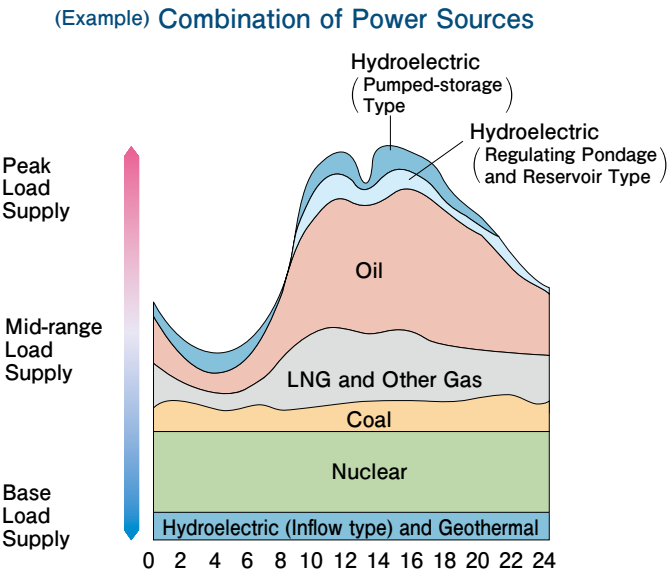
To enhance thermal efficiency further, combined-cycle power plants with both gas and steam turbines have been installed. As a result, gross thermal efficiency (maximum designed value) has exceeded 60%. In the future, we will continue to research and develop new technologies in order to increase thermal efficiency as well as the use of integrated coal gasification combined cycle (IGCC) power generation.

Nuclear Power

Japan's first commercial nuclear power plant started operation in Ibaraki Prefecture in 1966. The electric utility industry believes that nuclear power generation will retain an important position in the optimal combination of power sources from the viewpoint of assuring energy security and mitigating global warming.

Electric utilities are firmly committed to implementing extensive voluntary safety measures by adopting best practice from both Japan and overseas, while also complying with the new regulatory requirements following the accident at the Fukushima-daiichi Nuclear Power Station.

We will also continue to publish the latest information to contribute to the safety of nuclear power generation throughout the world.



Hydroelectric and nuclear power provides base load supply, while coal and LNG are major power sources for mid-range load supply. Oil-fired and pumped-storage hydroelectric power respond to peak demand fluctuation and contribute to the consistent, stable supply of electricity.



Okumino Hydroelectric Power Station (Pumped-storage)



Takami Hydroelectric Power Station



Kawasaki Thermal Power Station (LNG Combined-cycle)



Yoshinoura Thermal Power Station (LNG-fired)



Ohi Nuclear Power Station (PWR)



Ohma Nuclear Power Station (ABWR, Under Construction)

Japan's Nuclear Fuel Cycle

The nuclear fuel cycle is a series of processes consisting of reprocessing spent fuel that has been used at nuclear power plants and recovering and recycling plutonium and residual uranium as nuclear fuel.

Japan has chosen a closed nuclear fuel cycle policy since the dawn of its nuclear power generation development. Having few resources, Japan decided to recycle spent nuclear fuel domestically in order to establish nuclear power as a homegrown energy source. The benefits of a closed nuclear fuel cycle for Japan are significant: it conserves uranium resources; and it reduces the volume of high-level radioactive waste that must be disposed of.

Reprocessing is a chemical process that recovers plutonium and reusable uranium from spent fuel and separates radioactive wastes into more manageable forms. Once recovered, the plutonium is ready to be re-introduced into the nuclear power plants in the form known as uranium-plutonium mixed oxide (MOX) fuel. Under the policy of possessing no plutonium reserves without specified purposes, Japan's electric power companies have sincerely committed to a plan to utilize recovered plutonium – in the form of MOX fuel – as soon as possible.

In the past, Japan has relied on countries such as the U.K. and France to reprocess most of the spent fuel it produced. However, to place Japan's domestic nuclear fuel cycle on a firmer footing, Japan Nuclear Fuel Limited (JNFL) is preparing for completion of construction of a reprocessing plant at a site in Rokkasho-mura in the northern prefecture of Aomori. JNFL's spent fuel reprocessing plant passed the Nuclear Regulation Authority's conformance review in July 2020 and the plant is scheduled to be completed in the first half of FY2022.

In addition, JNFL engages in uranium enrichment, temporary storage of vitrified waste, and disposal of low-level radioactive waste. It has also working on constructing a MOX fuel fabrication plant which also passed the Nuclear Regulation Authority's conformance review in December 2020 and the plant is scheduled to be completed in first half of FY2024.

Electric utilities regard nuclear power as an important power source for Japan from viewpoints such as assuring energy security and mitigating global warming. We will make the utmost effort to establish the nuclear fuel cycle on the premise of securing thorough safety.

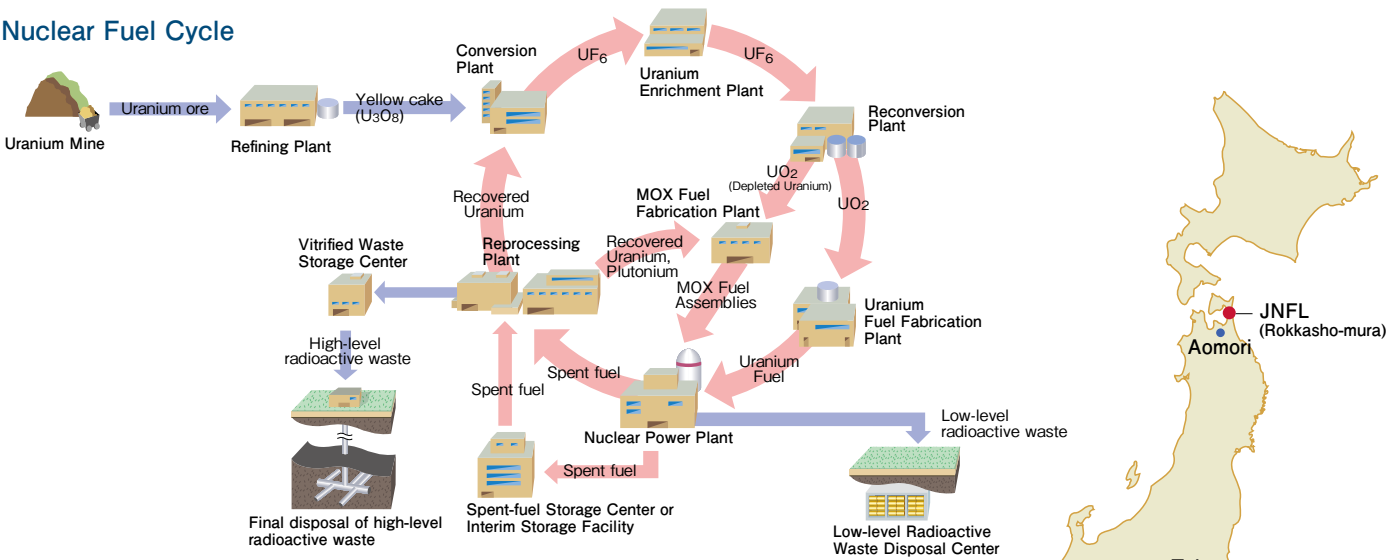
Outline of JNFL's Nuclear Fuel Cycle Facilities (as of December 16, 2020)

Facility	Reprocessing Plant	MOX fuel fabrication plant	Vitrified waste storage center	Uranium enrichment plant	Low-level radioactive waste disposal center
Site	Iiyasakatai, Rokkasho, Kamikita-gun, Aomori Prefecture			Ooishitai, Rokkasho, Kamikita-gun, Aomori Prefecture	
Capacity	Maximum capacity: 800 ton-U/year Storage capacity for spent fuel: 3,000 ton-U	Maximum capacity: 130 ton-HM/year (*)	Storage capacity for wastes returned from overseas plants: 2,880 canisters of vitrified waste	Design capacity 1,500 ton-SWU/year (*)	Planned to be expanded to 600,000m³ (equivalent to 3 million of waste drums)
Current Status	Under construction	Under construction	Cumulative number of received canisters: 1,830	In operation using the new centrifuge	Cumulative number of received drums: about 321,354
Schedule	Start of construction: 1993 Completion of construction: The first half of FY2022 (planned)	Start of construction: 2010 Completion of construction: The first half of FY2024 (planned)	Start of construction: 1992 Start of storage: 1995	Start of construction: 1988 Start of operation: 1992	Start of construction: 1990 Start of operation: 1992

(*) "ton-HM" stands for "tons of heavy metal" which indicates the weight of plutonium and uranium metallic content in MOX. "SWU" stands for "Separative Work Unit" which is a measure of the work expended during an enrichment process of uranium

Sources: JNFL's website and others

Nuclear Fuel Cycle



The Peaceful Use of Nuclear Energy

Japan's electric power companies are fully committed to implementing the closed nuclear fuel cycle and plutonium utilization consistent with all domestic laws and international nonproliferation standards. Since 1955, the domestic laws of Japan require that all nuclear activities, including commercial activities, be conducted only for peaceful purposes. Also, since 1968, Japan has embraced the "Three Non-Nuclear Principles," which state that Japan will not possess, produce, or permit the entry of nuclear weapons into its territory.

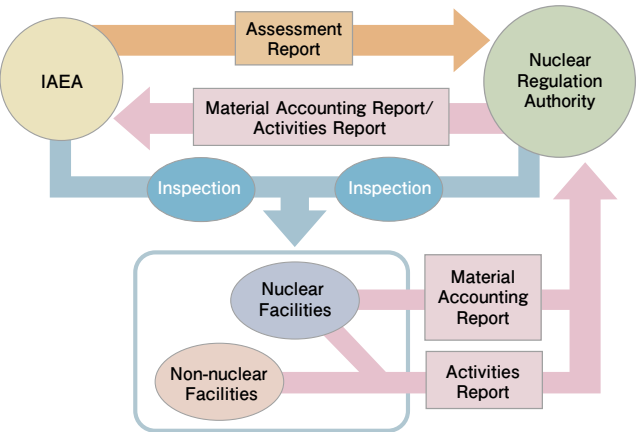
In addition, in 1976, the Government of Japan ratified the Nuclear Non-Proliferation Treaty (NPT) and thereby obligated itself to a national policy not to produce or acquire nuclear weapons. In order to ensure the application of more extensive safeguards, Japan signed the IAEA Additional Protocol in 1998, which allows the IAEA to carry out a range of additional inspection measures. In accordance with national laws, Japan's electric power companies submit reports on material accounting and safeguards activities to the Minister of Education, Culture, Sports, Science and Technology, and accept joint inspections by the IAEA and Japanese regulatory authorities to check the reports.

The results of each of these Japanese initiatives were reflected in the IAEA's conclusion in June 2004, which stated that all the nuclear materials in Japan are protected under IAEA safeguards and are not being diverted to the manufacture of nuclear weapons. As a result, more effective and efficient IAEA safeguards known as integrated safeguards came into effect in Japan in September 2004.

Furthermore, the 5th Strategic Energy Plan states the following concerning the handling of plutonium. Japan will maintain the policy of possessing no plutonium reserves without specified purposes and using it only for peaceful purposes, while steadily advancing the use of plutonium in order to reduce the plutonium stockpile while contributing to nuclear non-proliferation and gaining the understanding of the international community. To make these efforts effective, Japan will manage and use plutonium appropriately by further promoting pluthermal* while paying due consideration to the balance of plutonium collected and utilized, and promote R&D of fast reactors through international cooperation with the United States and France.

* the use of plutonium - uranium mixed oxide fuel at nuclear power plants

The Safeguards Program



Column

On the Start of the Literature Survey on the Final Disposal of High-Level Radioactive Waste

Literature surveys were started in Suttso-cho and Kamoenai-mura, Hokkaido in November 2020, beginning the final disposal site selection process for high-level radioactive waste.

There are three stages to the high-level radioactive waste site selection process, the "literature survey", which involves desk research into areas that are not well-suited to being disposal sites, the "preliminary investigation", which involves drilling to analyze the characteristics of the geographical layers, and the "detailed investigation", where a facility for investigation will be built underground to investigate the ground layers in detail.

The local community's opinion will be consulted at each stage of the investigation and the law requires that the investigation be stopped with if they are opposed.

Status of MOX Fuel Utilization

The electric power industry in Japan intends to introduce MOX fuel in 16 to 18 nuclear reactors in the future. The New Pluthermal Program published in December 2020 aims to introduce MOX fuel in at least 12 reactors by FY2030.

So far 27 units have applied for a review of conformance with the new regulatory requirements, out of which 9 units have received permission to introduce MOX fuel and have gained the understanding of the local municipalities. 4 units have restarted operation using MOX fuel thus far. The electric power companies recognize the importance of improving the transparency of the MOX fuel project. Based on the outlook of individual companies toward restarting nuclear power plants and considering the schedule and other details of the plan to start up the reprocessing plant, we compiled and announced the Plutonium Utilization Plan.

"International Roundtable on Final Disposal of High-Level Radioactive Waste"

The Energy Ministers' Meeting (G20 Ministerial Meeting on Energy Transitions and Global Environment for Sustainable Growth) was held in Karuizawa, Nagano in June 2019. The energy ministers reached an agreement on establishing the "International Roundtable on Final Disposal of High-Level Radioactive Waste" for the first time in order to realize the final disposal of high-level radioactive waste which is a common concern for all countries that make use of nuclear power generation.

A report was published in August 2020 following this Roundtable which addressed the central government's role in geological disposal, dialogue with stakeholders, the decision-making process, and international cooperation in technological development.

Measures by the Electric Utility Industry to Suppress CO₂ Emissions

Regarding global warming measures, the “Paris Agreement” was adopted in December 2015 at the 21st Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (COP21), and it entered into force in November 2016, building a framework that all countries and regions of the world participate for global warming measures.

In COP 24, held in December 2018, countries adopted a “rulebook” to implement the 2015 Paris Agreement starting in 2020. This set in motion an international framework for tackling climate change spanning all countries including major greenhouse emitting countries.

In July 2015, the Japanese Government announced its “Intended Nationally Determined Contributions (INDC)”, with the objective of reducing greenhouse gas emissions in 2030 by 26% from 2013 levels. In May 2016, in accordance with INDC, the plan for Global Warming Countermeasures was adopted.

Then, in June 2019, the cabinet adopted a “Long-term Strategy under the Paris Agreement” which outlined an ambitious vision to realize a “decarbonized society” that is carbon neutral. In October 2020, the government declared its intention to realize carbon neutral, reducing greenhouse gas emissions to net zero, by 2050.

Emissions of carbon dioxide (CO₂), a major cause of global warming, are closely related to energy utilization in economic activities and daily life, and so the reduction of

CO₂ emissions is a major challenge for the industry.

The electric power companies are trying to reduce CO₂ emissions mainly through attaining the optimal energy mix, seeking to simultaneously achieve Energy security, Economic efficiency and Environmental conservation, under the major premises of Safety (S+3Es).

In July 2015, 35 electricity utility companies jointly constructed a voluntary framework for a low carbon society and prepared an “Action Plan for a Low-Carbon Society” that laid out specific efforts to be made. In February 2016, “the Electric Power Council for a Low-Carbon Society (ELCS)” was founded to facilitate efforts toward this goal (a membership of 62 companies as of February 2021).

According to the Action Plan, an end-user CO₂ emission factor of about 0.37kg- CO₂/kWh will be targeted in light of the Government’s 2030 energy supply and demand outlook. Moreover, as the maximum reduction potential, a reduction of about 11 million t- CO₂ will be expected by using economically achievable best available technologies(BATs) in light of the construction of new thermal power plants, etc.

The member companies will make efforts towards a low carbon society by utilizing nuclear power generation premised on ensuring safety or renewable energy, raising the efficiency of thermal power plants and optimizing their appropriate maintenance and control, and promoting energy-conservation or CO₂ reduction services on both the supply and demand sides.

Decarbonization of Energy on the Supply-side

Promoting nuclear power generation while assuring safety, and improving the thermal efficiency of thermal power plants further

Nuclear power emits no carbon dioxide (CO₂) in the process of power generation, and even considering CO₂ emissions over the entire life cycle of various energy sources, those from nuclear power are lower than those from thermal power, and are even lower than those from solar or wind power. However, because of the extended shutdown of nuclear power plants following the Great East Japan Earthquake, and subsequent increase in thermal power generation, the CO₂ emission factor has remained higher than that before the earthquake.

Considering that nuclear power generation will continuously play a key role in combating global warming, the industry is committed to making the utmost effort to improve the safety of nuclear power generation and to restore the trust of citizens.

The electric power companies are also striving to maintain and improve the efficiency of thermal power plants through the introduction of highly efficient plants of the latest design or through appropriate operation and maintenance of the existing plants using digital technologies.

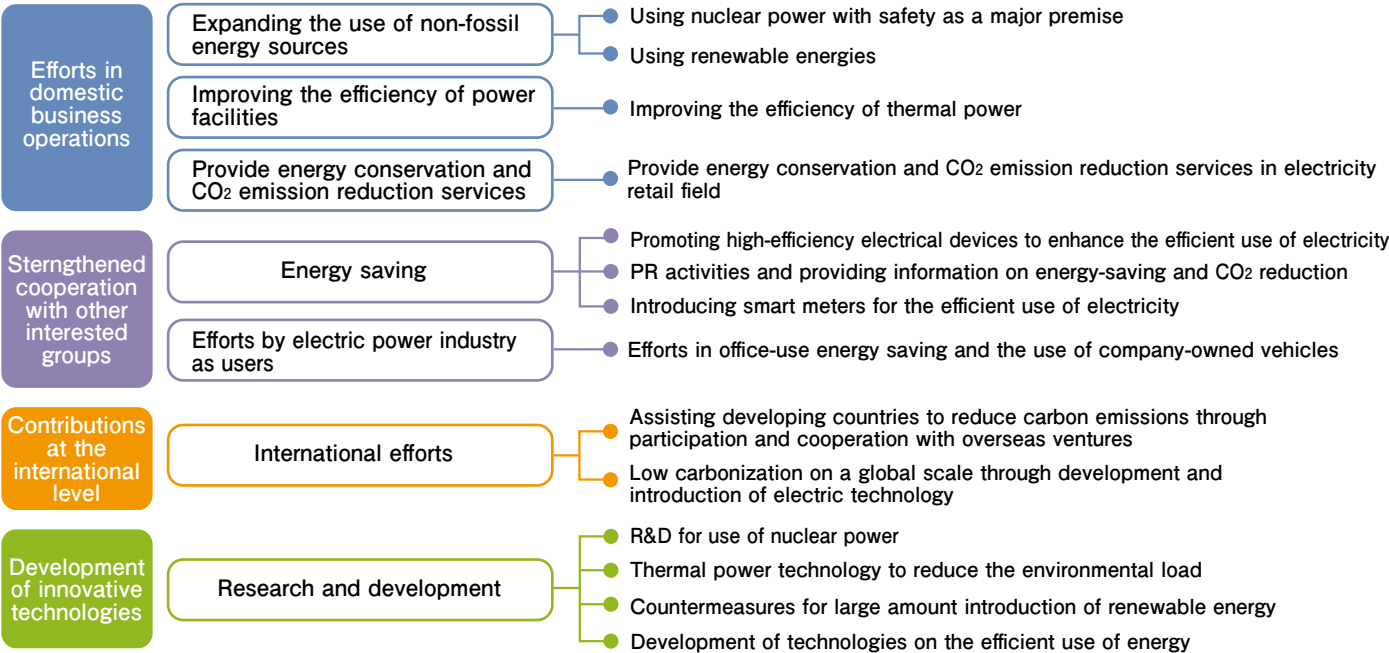
Currently operating state-of -the-art gas turbine combined cycle power plants have achieved the world’s highest level of 62% (LHV) in thermal efficiency by, for example, raising the combustion temperature at the gas turbines. (JERA’s Nishi-Nagoya Thermal Power Station Unit 7-1 has achieved the

world’s highest thermal efficiency of 63.08% (LHV) (as of March 2018))

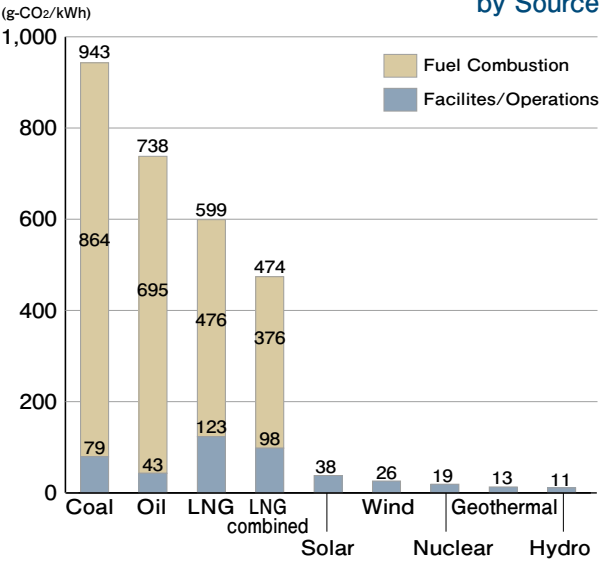
As to the conventional coal-fired power plants, the adoption of enhanced steam conditions (temperature and pressure) is being promoted to improve thermal efficiency. Presently, ultra-supercritical (USC) thermal power generation with the main steam temperature of 600°C is commercially available. Moreover, research and development of Integrated coal Gasification Combined Cycle (IGCC) has been conducted, in which gasified coal is used in combination with gas turbines and steam turbines to generate electricity. Joban Joint Power’s Nakoso Power Station Unit 10 started operation as Japan’s first commercial IGCC plant in June 2013. Low carbonization initiatives continue to progress steadily—a large scale IGCC plant is being constructed and preparation for a demonstration project of Integrated Coal Gasification Fuel Cell Combined Cycle (IGFC) that combined fuel batteries with IGCC is underway in Osakikamijima of Hiroshima Prefecture.

Coal-fired thermal power, as a cost-effective power source, serves a central role in base load power. Government discussions on phasing out inefficient coal-fired thermal power need to consider the viewpoint of S+3E including the perspectives of stable supply and the impact on the regional economy.

International efforts- Assisting developing countries to reduce carbon emissions through participation and cooperation with overseas ventures

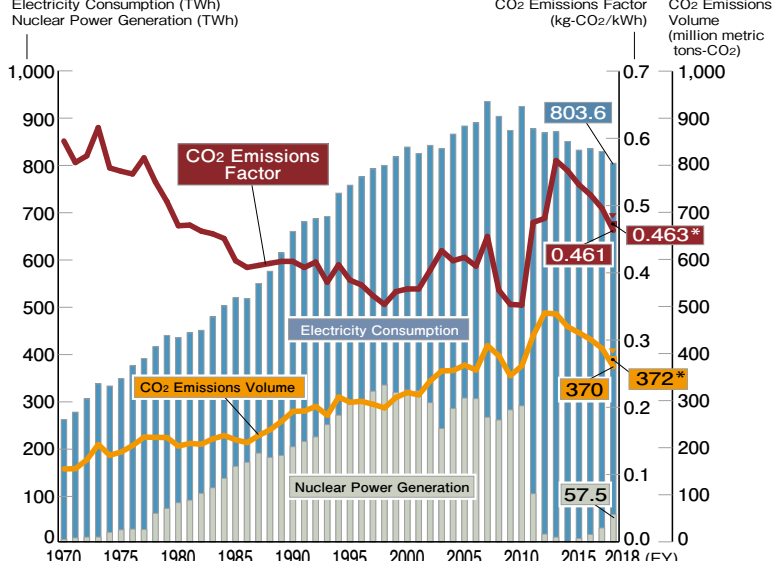


CO₂ Emissions Intensity over the Entire Lifecycle by Source



Note: (1) Based on total CO₂ emissions from all energy consumed in energy extraction, transportation, refining, plant operation and maintenance, etc. in addition to burning of the fuel.
(2) The figure of nuclear power generation is calculated including the reprocessing of spent fuel, use of MOX fuel, and the disposal of high-level radioactive waste.
Source: Report of the Central Research Institute of Electric Power Industry, etc.

Historical Trends in CO₂ Emissions from Power Generation



Note: Data up until 2007 is reported by FEPC.
Data from 2007 to 2014 is reported by FEPC and some PPSs.
Data from 2014 onward is reported by ELCS.
Up until 2014, the figures for nuclear power generation are on a gross-output basis as reported by FEPC, whereas the figures from 2015 onward are on a net-output basis as reported by ELCS.
The figures with an asterisk are adjusted values taking into account CO₂ credits and other adjustments.

Decarbonization of Energy on the Supply-side

Development and expansion of the use of renewable energy sources

The feed-in tariff system for renewable energy began in July 2012, whereupon the electric power companies are obliged to buy such electricity at a fixed price for a certain period. The cost of purchasing this electricity is finally borne by customers in the form of a surcharge, which in principle is proportional to the amount of electricity consumed.

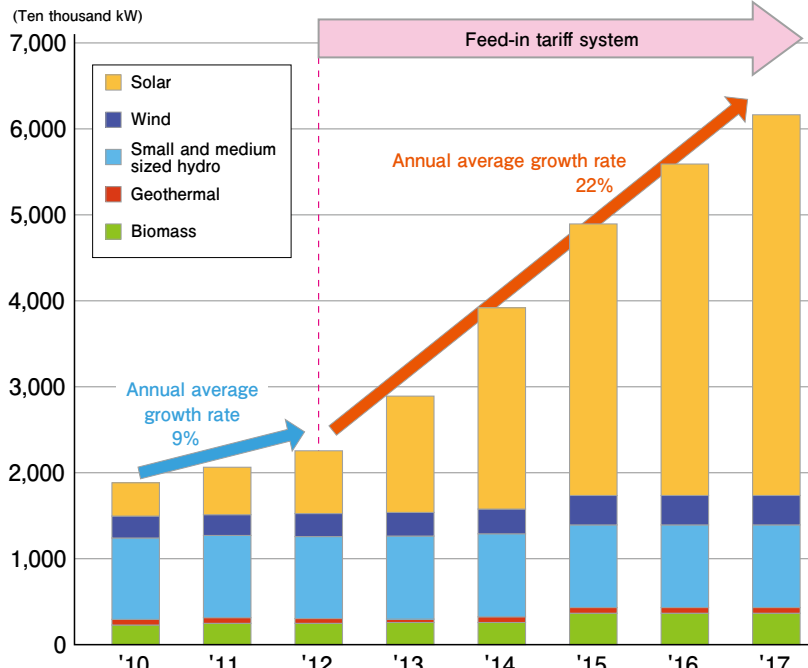
The Revised FIT Act was enacted in April 2017, making changes to the FIT system including creating a new authorization system, revising the method of setting purchase prices, and revising businesses obliged to purchase FIT electricity, under the policy of “maximizing the amount of renewable energy to be introduced while suppressing the burden on the public”.

However, renewable energy such as solar power has problems involving efficiency, cost of power generation and stability of output. R&D on the latest power system control technologies for combining existing power plants and storage batteries will be actively conducted to help stabilize the system, when introducing large amounts of wind and photovoltaic power, which are susceptible to the weather. Electric utilities will keep striving to develop and improve renewable energy sources.

In March 2017, the Organization for Cross-regional Coordination of Transmission Operators, JAPAN (OCCTO) significantly shifted the approach taken toward electricity

network operation and facility configuration by presenting a direction where “maximum use would be made of existing electricity networks to comprehensively minimize long-term electricity source and distribution costs while continuing to meet electric source connection needs through expanded adoption of renewable energies and other measures”. Given this new policy, discussions are being held on measures on flexibly utilizing existing transmission lines’ capacity to enable connection under certain conditions. Measures that have been approved in discussion will be implemented sequentially. In June 2020, the Act for Establishing Energy Supply Resilience (Act on the Partial Revision of the Electricity Business Act and Other Acts for Establishing Resilient and Sustainable Electricity Supply Systems) was passed into law. Starting in FY2022, the FIP system (electricity is bought back at a premium on the market price) will be introduced, in addition to the existing FIT system. Renewable energy operators will be engaging in market transactions under the FIP system which is expected to encourage generating behavior that reflects market price fluctuations. The FIP system will be adopted for “competitive power sources” such as utility photovoltaic power and wind power, while FIT system will continue to be used for “regional vitalization power sources” such as small-scale photovoltaic power and biomass.

Introduction amount of Generating Capacity (Renewable energy)*



* Excludes large-scale hydroelectric power generation
Source: METI



Mikuni Solar Power Station



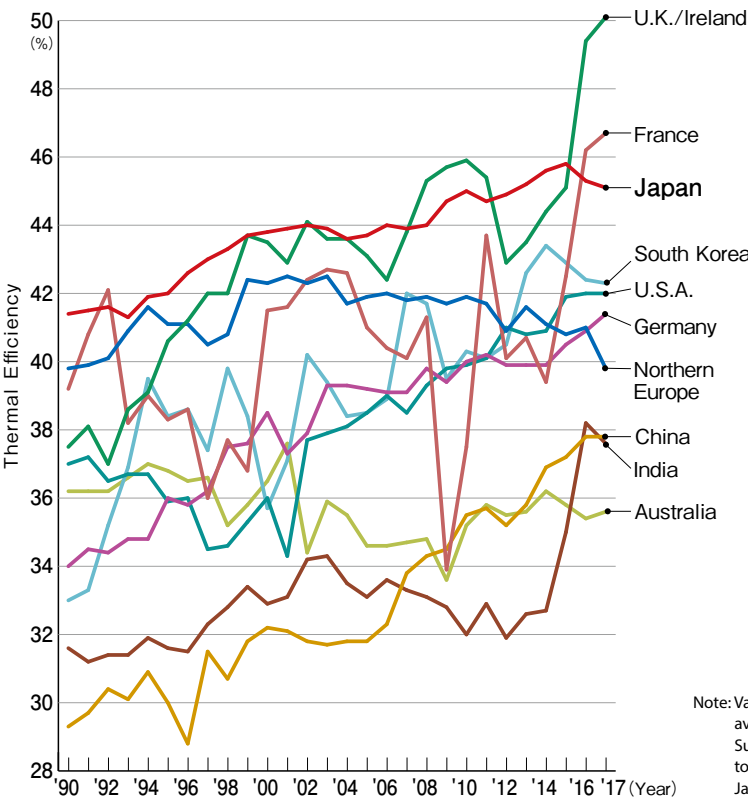
Wind Power

Sharing Japan's Top-level Power Generation Technologies with the World

Japan has achieved the world's top-level in energy efficiency by introducing various technologies for higher energy efficiency to thermal power plants. Based on this achievement, the electric utility industry in Japan has been making efforts to establish a mechanism for sharing such advanced technologies with electric power industries in other countries.

With high-efficiency plants to be introduced and the improvement of operation and maintenance technologies, coal-fired plants' CO₂ reduction potential in OECD countries and developing countries in Asia in FY 2030 is estimated to be a maximum of 900 million t- CO₂/year. The electric utility industry of Japan will contribute to the reduction of global CO₂ emissions with Japan's expertise and advanced technologies.

Comparison of Thermal Power Plant Efficiency in Japan and Other Countries



Note: Values listed for heat efficiency are gross thermal efficiency values; a weighted average of the heat efficiency of coal, oil, and gas (lower heating value standard). Subject facilities are those of operators whose main business is selling electricity to third parties. Japan's values are fiscal year values.

Source: ECOFYS "INTERNATIONAL COMPARISON OF FOSSIL POWER EFFICIENCY AND CO₂ INTENSITY (2019)"

Column

Promotion of Electrification for a Decarbonized Society

The Green Growth Strategy Towards 2050 Carbon Neutrality announced by the central government on December 25, 2020 takes the decarbonization of the electricity sector as one of its fundamental premises and indicates a policy of maximally using renewable energy, using thermal power along with carbon dioxide capture, pursuing hydrogen generation as an option, and using nuclear power as much as possible as an established decarbonized technology.

The Strategy states that “Sectors other than the electricity sector” such as industrial, transport, office, and household sectors, “will center around electrification” and aims to have all sales of new passenger vehicles be electrically-driven vehicles by the mid-2030s. In the residences and buildings, Japan will pursue a life cycle carbon minus (LCCM) approach and build net zero energy house and buildings (ZEH/ZEB), while also remodeling existing houses to be more energy efficient and increasing the scale of photovoltaic power generation as much as possible.

According to the Strategy, “electricity demand in 2050 may increase by 30 to 50% as a result of the electrification of the industrial, transport, and household sectors.”

In order to realize a decarbonized society, there will need to be drastic reform in the way energy is used and drastic and structural reform of our lifestyles to change the structure of our society to a decarbonized structure. Discussions looking forward to 2050 will need to start immediately and measures implemented in a timely manner.

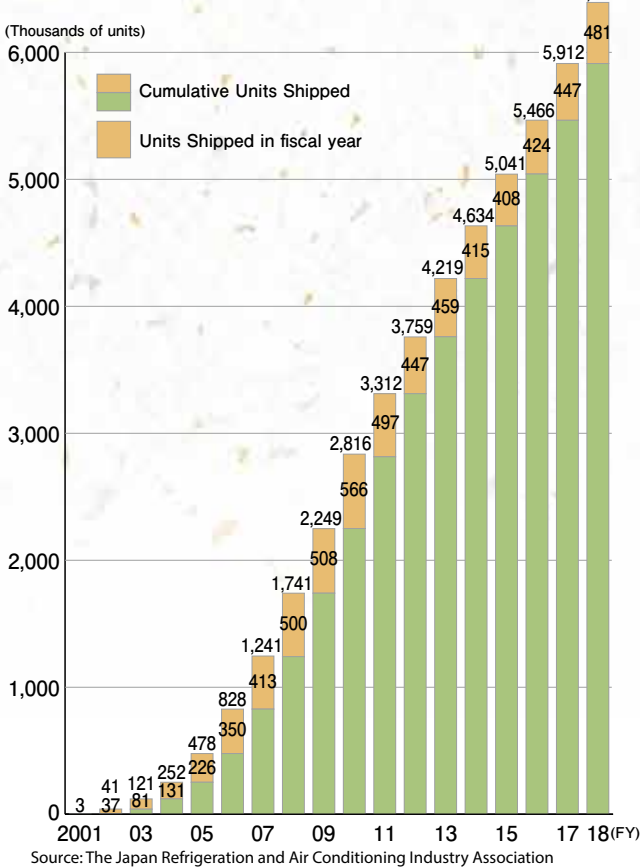
Demand-side Efforts for CO2 Reduction

Along with working to promote further use of hot water supply systems (EcoCute) with CO2 refrigerant heat pumps, which significantly reduce CO2 emissions compared to conventional water heaters, the industry is actively working to promote more widespread use of high-efficiency commercial air conditioners and other appliances that utilize heat pump technology.

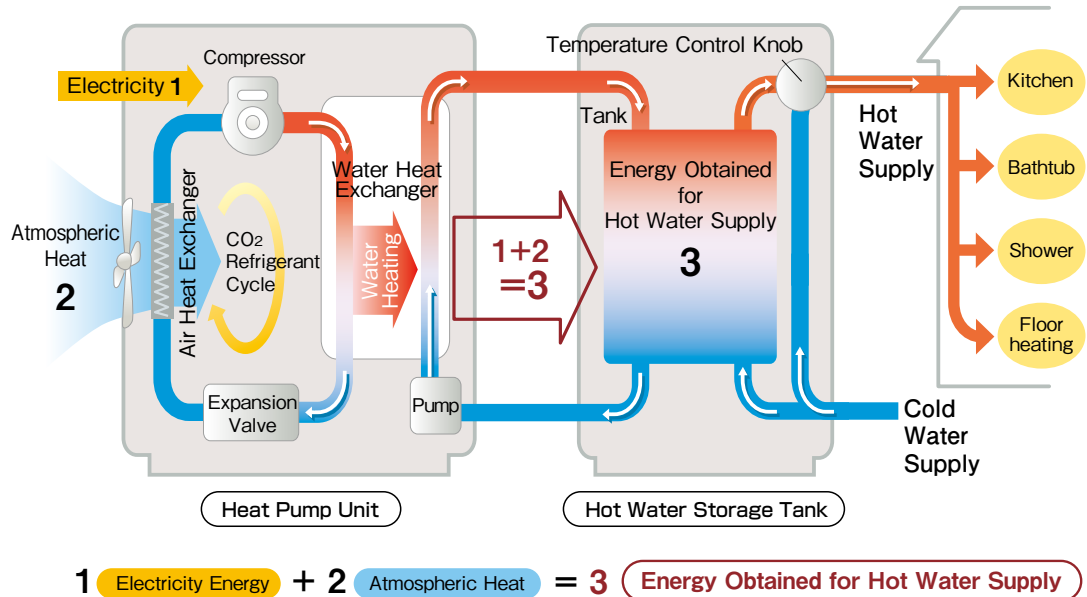
EcoCute heats water by transferring the thermal energy in air, which is freely available, to water by means of refrigerants. With a single unit of electric energy for heat pump operation and two units of thermal energy from air, it produces three units of thermal energy.

If the heat demand for the consumer division (households and commercial divisions) and industrial division currently being fulfilled through boilers can be met with heat pumps, CO2 emissions in 2030 are estimated to be reduced by 21.74 million t-CO2/year compared to 2015 levels.

Trends in EcoCute Unites Shipped



EcoCute Hot Water Supply Structure: CO2 Refrigerant Heat Pump Hot Water Heater



EcoCute Heat Pump Unit (left) and Hot Water Storage Tank

Strengthening International Communication and Cooperation

Japan's electric power companies remain active on a worldwide basis. In order to cope with global warming and to ensure the safety of nuclear power generation, international cooperation is indispensable. Each of the electric power companies in Japan has individual agreements with overseas utilities in order to facilitate exchanges on a wide range of information such as power generation, customer relations, distribution and quality

control. The industry's top executives actively participate in international meetings such as the International Electricity Summit and the World Association of Nuclear Operators (WANO) to exchange views, while we also accept trainees from overseas. We import most of our fuel such as oil and coal from overseas countries and also keep our doors open to foreign companies for the purchase of equipment such as generators.

Overseas Offices

Please feel free to contact your nearest office.

WASHINGTON, D.C.

The Federation of Electric Power Companies of Japan, Washington Office

The Federation's Washington Office was established in January 1994. Its principal objectives are to study U.S. energy policies and to exchange information with U.S. energy opinion leaders in order to promote a greater understanding of the Japanese electric power industry.

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Established in 2008

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Tel: (02)014-2520 Fax: (02)014-2521
Established in 2016

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18th Floor Summitmas I Jl Jend Sudirman Kav 61-62 Jakarta 12190 INDONESIA
Tel: (021)2751-0048 Fax: (021)2751-0047
Established in 2016

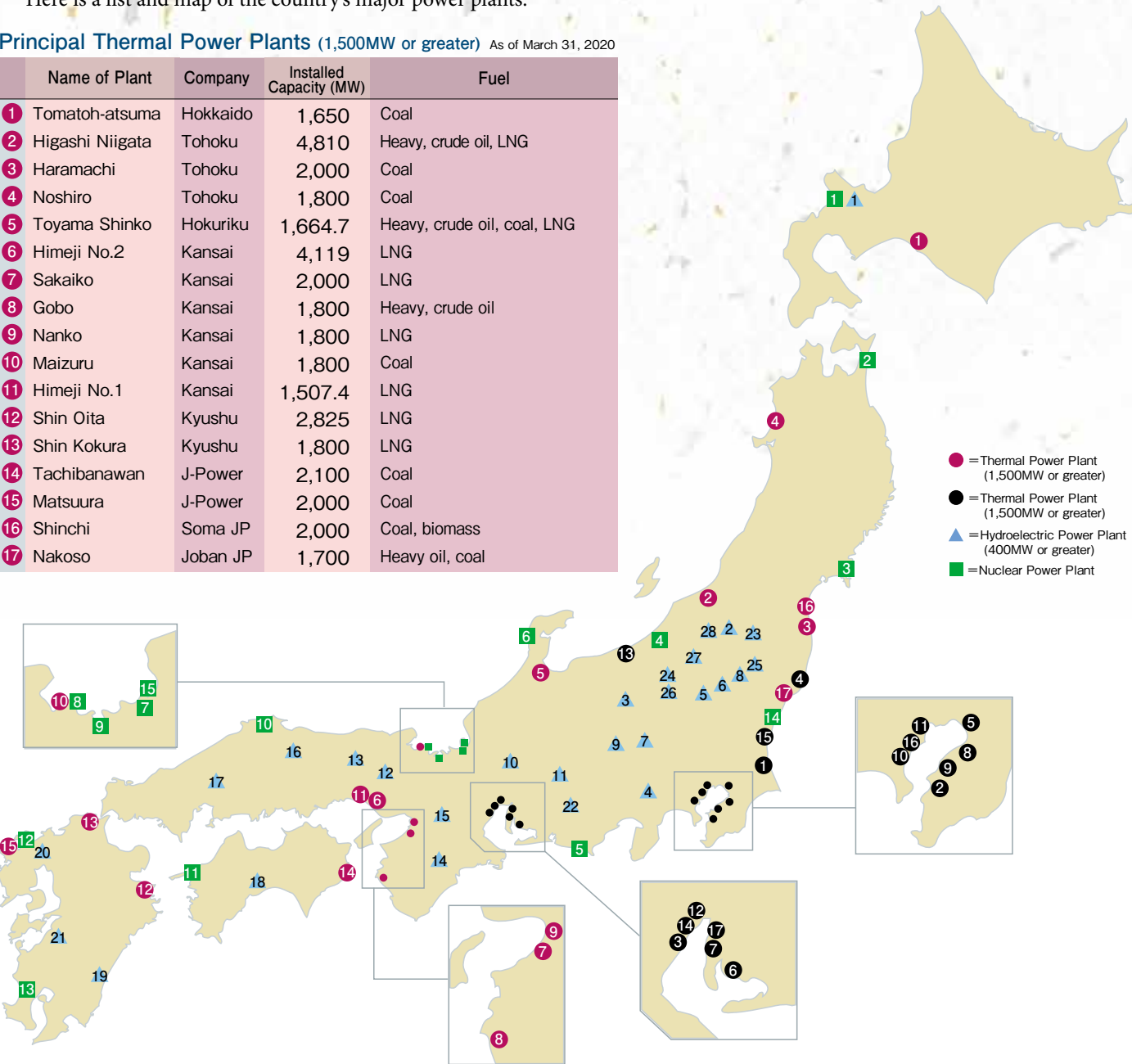


Major Power Plants

Here is a list and map of the country's major power plants:

Principal Thermal Power Plants (1,500MW or greater) As of March 31, 2020

	Name of Plant	Company	Installed Capacity (MW)	Fuel
1	Tomatoh-atsuma	Hokkaido	1,650	Coal
2	Higashi Niigata	Tohoku	4,810	Heavy, crude oil, LNG
3	Haramachi	Tohoku	2,000	Coal
4	Noshiro	Tohoku	1,800	Coal
5	Toyama Shinko	Hokuriku	1,664.7	Heavy, crude oil, coal, LNG
6	Himeji No.2	Kansai	4,119	LNG
7	Sakaiko	Kansai	2,000	LNG
8	Gobo	Kansai	1,800	Heavy, crude oil
9	Nanko	Kansai	1,800	LNG
10	Maizuru	Kansai	1,800	Coal
11	Himeji No.1	Kansai	1,507.4	LNG
12	Shin Oita	Kyushu	2,825	LNG
13	Shin Kokura	Kyushu	1,800	LNG
14	Tachibanawan	J-Power	2,100	Coal
15	Matsuura	J-Power	2,000	Coal
16	Shinchi	Soma JP	2,000	Coal, biomass
17	Nakoso	Joban JP	1,700	Heavy oil, coal



(Reference) JERA's Principal Thermal Power Plants * (1,500MW or greater) As of March 31, 2020

	Name of Plant	Installed Capacity (MW)	Fuel		Name of Plant	Installed Capacity (MW)	Fuel
1	Kashima	5,660	Heavy, crude oil, city gas	10	Yokohama	3,541	Heavy, crude oil, LNG
2	Futtsu	5,160	LNG	11	Kawasaki	3,420	LNG
3	Kawagoe	4,800	LNG	12	Shin Nagoya	3,058	LNG
4	Hirono	4,400	Heavy, crude oil, coal	13	Joetsu	2,380	LNG
5	Chiba	4,380	LNG	14	Nishi Nagoya	2,376.4	LNG
6	Hekinan	4,100	Coal	15	Hitachinaka	2,000	Coal, biomass
7	Chita	3,966	LNG	16	Higashi Ohgishima	2,000	LNG
8	Anegasaki	3,600	LNG, LPG	17	Chita Daini	1,708	LNG
9	Sodegaura	3,600	LNG				

* JERA: Related company of TEPCO HD and Chubu Electric Power,not FEPC member.

Nuclear Power Plants

● In Operation As of March 31, 2020					
	Name of Plant	Unit Number	Company	Installed Capacity (MW)	Type of Reactor
1	Tomari	1	Hokkaido	579	PWR
		2		579	PWR
		3		912	PWR
2	Higashidori	1	Tohoku	1,100	BWR
3	Onagawa	2	Tohoku	825	BWR
		3		825	BWR
4	Kashiwazaki Kariwa	1	Tokyo	1,100	BWR
		2		1,100	BWR
		3		1,100	BWR
		4		1,100	BWR
		5		1,100	BWR
		6		1,356	ABWR
		7		1,356	ABWR
5	Hamaoka	3	Chubu	1,100	BWR
		4		1,137	BWR
		5		1,380	ABWR
6	Shika	1	Hokuriku	540	BWR
		2		1,206	ABWR
7	Mihama	3	Kansai	826	PWR
8	Takahama	1	Kansai	826	PWR
		2		826	PWR
		3		870	PWR
		4		870	PWR
9	Ohi	3	Kansai	1,180	PWR
		4		1,180	PWR
10	Shimane	2	Chugoku	820	BWR
11	Ikata	3	Shikoku	890	PWR
12	Genkai	3	Kyushu	1,180	PWR
		4		1,180	PWR
13	Sendai	1	Kyushu	890	PWR
		2		890	PWR
14	Tokai No.2		Japan Atomic Power Co.	1,100	BWR
15	Tsuruga	2	Japan Atomic Power Co.	1,160	PWR
Total		33 Units		33,083MW	

● Under Construction (Estimated start)					
	Higashidori	1	Tokyo	1,385	ABWR U.D
	Shimane	3	Chugoku	1,373	ABWR U.D
	Ohma		J-Power	1,383	ABWR U.D
Total		3 Units		4,141MW	

● Preparing for Construction				(Estimated start)	
Higashidori	2	Tohoku	1,385	ABWR	U.D
Higashidori	2	Tokyo	1,385	ABWR	U.D
Hamaoka	6	Chubu	1,400 Class	ABWR	U.D
Kaminoseki	1	Chugoku	1,373	ABWR	U.D
	2		1,373	ABWR	U.D
Sendai	3	Kyushu	1,590	APWR	U.D
Tsuruga	3	Japan Atomic Power Co.	1,538	APWR	U.D
	4		1,538	APWR	U.D
Total	8 Units		11,582MW		

● Others			
Name of Plant	Company	Installed Capacity (MW)	Type of Reactor
Fugen	Japan Atomic Energy Agency	165	ATR(Prototype) End of Operation
Monju	Japan Atomic Energy Agency	280	FBR(Prototype) End of Operation

Principal Hydroelectric Power Plants (400MW or greater)

As of March 31, 2020			
	Name of Plant	Company	Installed Capacity (MW)
1	Kyogoku	Hokkaido	400
2	Dai-ni Numazawa	Tohoku	460
3	Shin Takasegawa	Tokyo	1,280
4	Kazunogawa	Tokyo	1,200
5	Tanbara	Tokyo	1,200
6	Imaichi	Tokyo	1,050
7	Kannagawa	Tokyo	940
8	Shiobara	Tokyo	900
9	Azumi	Tokyo	623
10	Okumino	Chubu	1,500
11	Okuyahagi No.2	Chubu	780
12	Okutataragi	Kansai	1,932
13	Okawachi	Kansai	1,280
14	Okuyoshino	Kansai	1,206
15	Kisenyama	Kansai	466
16	Matanogawa	Chugoku	1,200
17	Nabara	Chugoku	620
18	Hongawa	Shikoku	615
19	Omarugawa	Kyushu	1,200
20	Tenzan	Kyushu	600
21	Ohira	Kyushu	500
22	Shintoyone	J-Power	1,125
23	Shimogo	J-Power	1,000
24	Okukiyotsu	J-Power	1,000
25	Numappara	J-Power	675
26	Okukiyotsu No.2	J-Power	600
27	Okutadami	J-Power	560
28	Tagokura	J-Power	400

● End of Operation (End)					
	Onagawa	1	Tohoku	524	BWR 2018.12
	Fukushima Daiichi	1	Tokyo	460	BWR 2012.4
		2		784	BWR 2012.4
		3		784	BWR 2012.4
		4		784	BWR 2012.4
		5		784	BWR 2014.1
	Fukushima Daini	6		1,100	BWR 2014.1
		1	Tokyo	1,100	BWR 2019.9
		2		1,100	BWR 2019.9
		3		1,100	BWR 2019.9
		4		1,100	BWR 2019.9
	Hamaoka	1	Chubu	540	BWR 2009.1
		2		840	BWR 2009.1
	Mihama	1	Kansai	340	PWR 2015.4
		2		500	PWR 2015.4
	Ohi	1	Kansai	1,175	PWR 2018.3
		2		1,175	PWR 2018.3
	Shimane	1	Chugoku	460	BWR 2015.4
		2		566	PWR 2016.5
	Ikata	1	Shikoku	566	PWR 2018.5
		2		559	PWR 2015.4
	Genkai	1	Kyushu	559	PWR 2019.4
		2		559	PWR 2019.4
	Tokai		Japan Atomic Power Co.	166	GCR 1998.3
	Tsuruga	1	Japan Atomic Power Co.	357	BWR 2015.4
Total		24 Units		17,423MW	

Note: PWR=Pressurized Water Reactor, BWR=Boiling Water Reactor, APWR=Advanced Pressurized Water Reactor, ABWR=Advanced Boiling Water Reactor, GCR=Gas Cooled Reactor, ATR=Advanced Thermal Reactor, FBR=Fast Breeder Reactor

The Federation of Electric Power Companies

Close cooperation among electric utilities is essential to effectively supply Japan's electricity. 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.

Board of Directors



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Kazuhiro Ikebe



Vice Chairman
Yutaka Kanai



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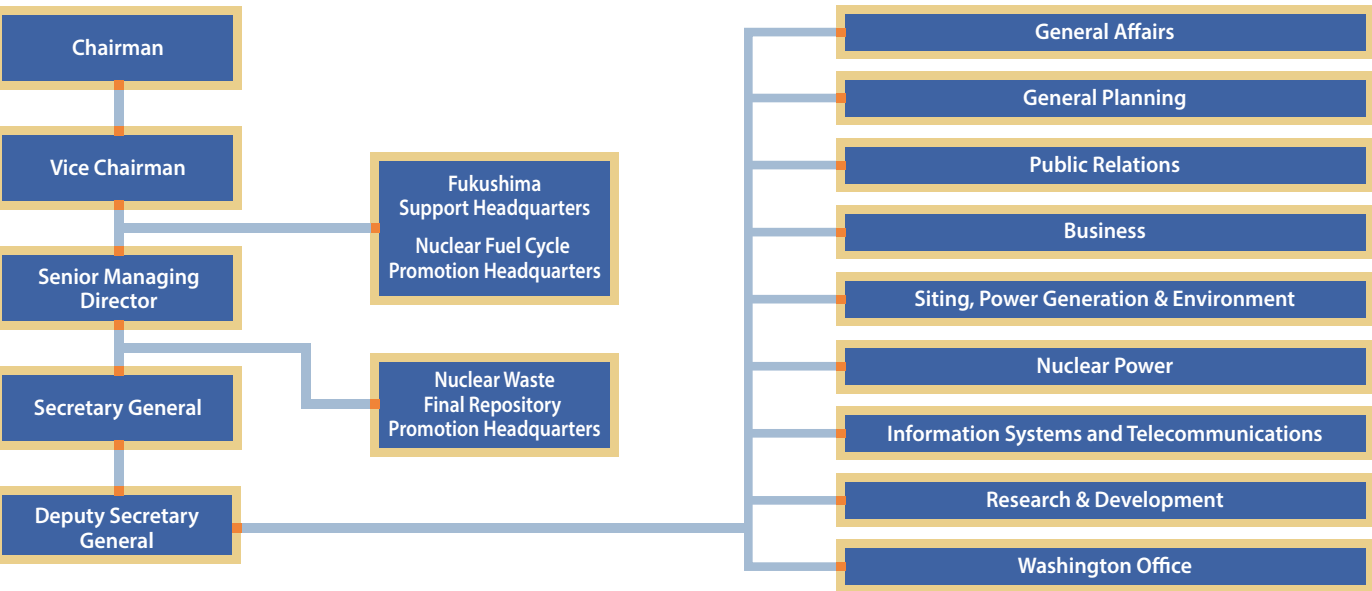


Director
Deputy Secretary General
Yoshihiro Tomioka



Director
Deputy Secretary General
Osamu Okamura

Organization of FEPC



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The Japan Atomic Power Company (JAPC)
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Japan Nuclear Fuel Limited (JNFL)
4-108 Aza Okitsuke, Oaza Obuchi, Rokkasho, Kamikita-gun, Aomori Prefecture 039-3212, Japan
Tel: (0175) 71-2000 URL <https://www.jnfl.co.jp>

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Atomic Energy Association (ATENA)
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