JAPAN'S ENERGY 2018

10 questions for understanding the current energy situation

1 How much energy can Japan supply independently?

2 How are electric power rates changing?

3 How much greenhouse gases are being emitted?

4 Is the reconstruction of Fukushima in progress?

5 What is the government's energy policy?

6 Are programs being implemented for improving energy efficiency?

7 Is the introduction of renewable energy in progress?

8 Is nuclear power generation necessary?

9 Will hydrogen energy and power storage technologies come into general use?

10 2018 Energy Topics

経済産業省
資源エネルギー庁
Ministry of Economy, Trade and Industry
Agency for Natural Resources and Energy

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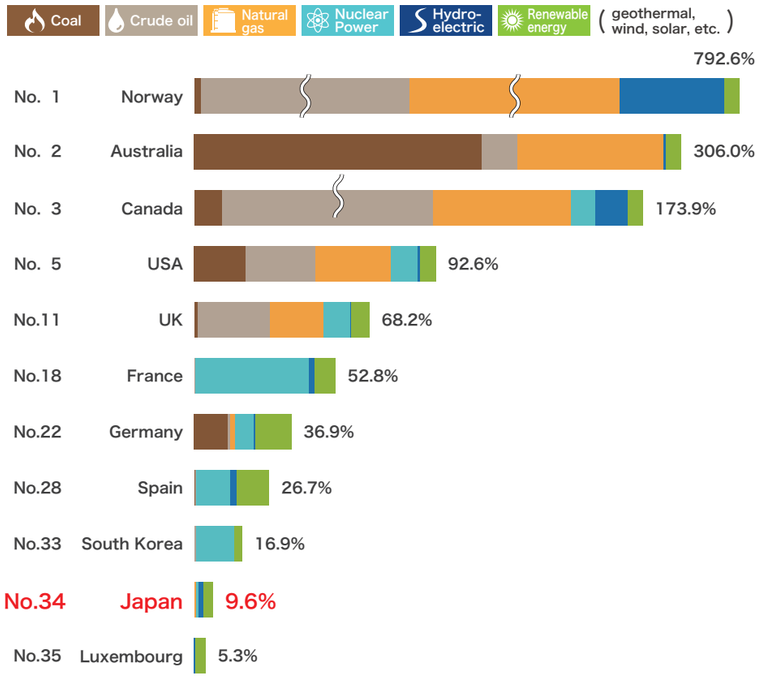
1. How much energy can Japan supply independently?

Decline in the Energy Self-Sufficiency Ratio

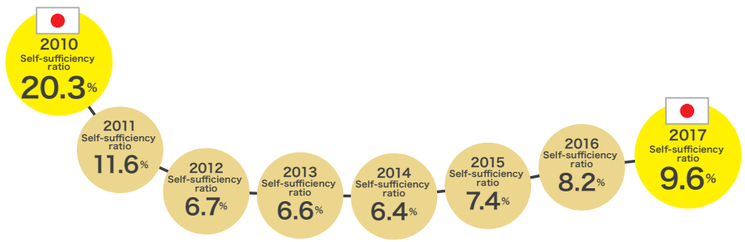
Q How much energy can Japan supply independently from domestic resources?

A Japan has always been a country that lacks resources such as oil and natural gas.
The energy self-sufficiency ratio of Japan in 2017 was 9.6%, which is a low level when compared with other OECD countries.

Comparison of Primary Energy Self-Sufficiency Ratios of Major Countries (2017)



Japan energy self-sufficiency ratio



A low energy self-sufficiency ratio results in dependence on other countries for resources. This makes a country susceptible to the effects of international situations, raising concerns over the stability of the energy supply.

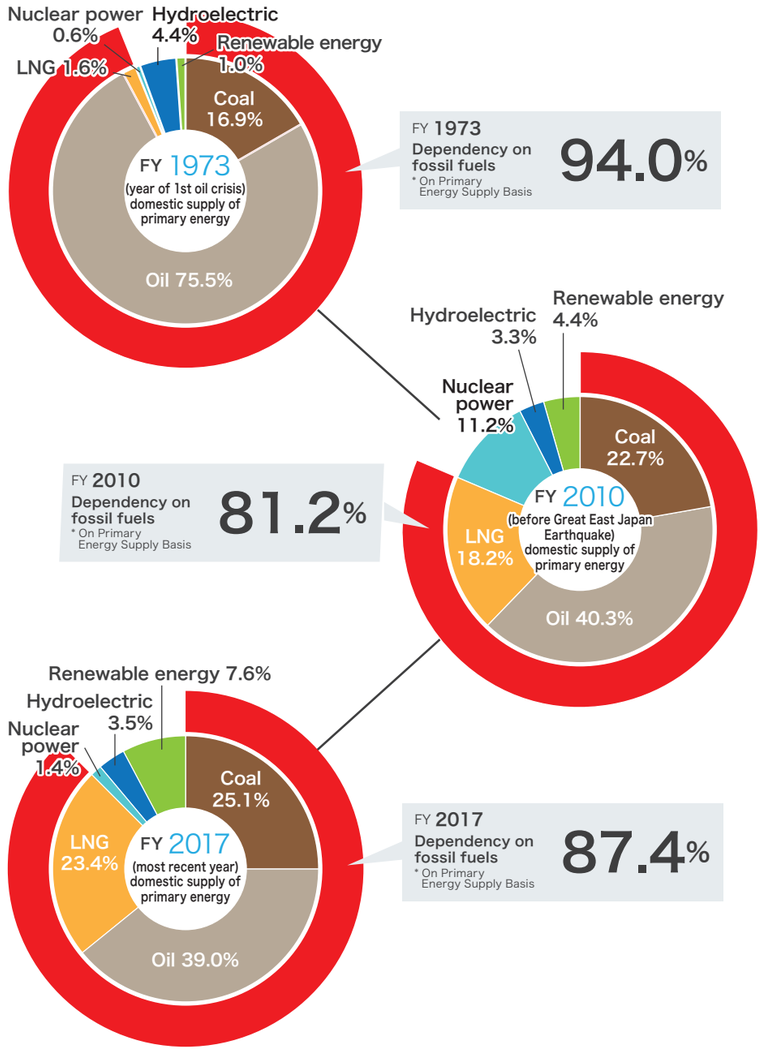
Energy self-sufficiency ratio: In primary energies required for life and economic activity, the ratio that can be secured within one's own country.

Source: 2017 estimates in IEA "World Energy Balances 2018". For Japan only, the FY 2017 figures from "Comprehensive energy statistics of Japan".
* The ranks in the table are those of the 35 OECD member countries in 2017.

Q What resources does Japan depend on?

A Japan is largely dependent on fossil fuels such as oil, coal and natural gas (LNG) imported from overseas. Before the Great East Japan Earthquake, Japan was dependent on supply for 81.2% of its fossil fuels demands (primary energy supply basis). This dependence rose to 87.4% in FY 2017 as a result of power generation using thermal power plants resulting from the shutdown of nuclear power plants.

Trends in Composition of Primary Energy Supply of Japan



Source: Comprehensive energy statistics.
* The total amount expressed in % may not be 100% due to rounding.
* Renewable energy here includes unused energy such as biomass and excludes hydroelectric power.

Securing Resources

Q What countries does Japan import resources from?

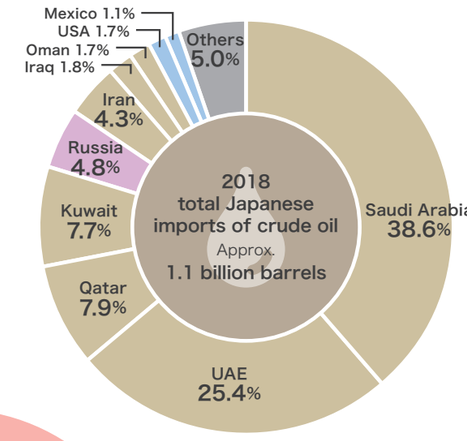
A Japan depends on the Middle East for around 86% of its crude oil imports. For natural gas and coal as well, Japan relies almost entirely on overseas imports from regions such as Australia, Russia, Asia-Oceania and the Middle East.

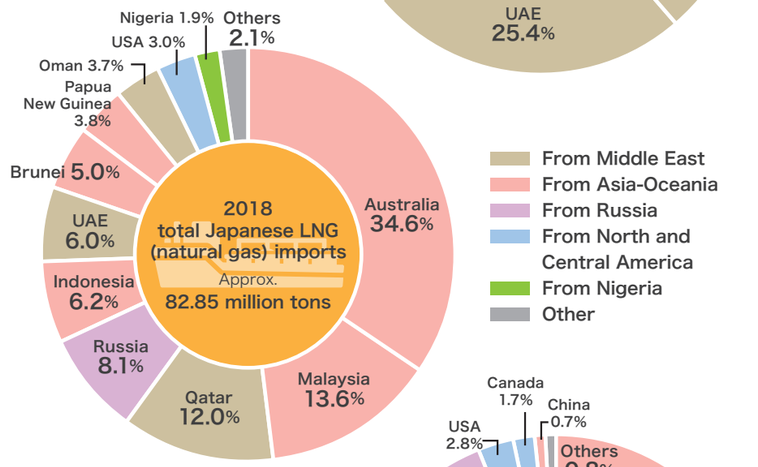
Sources of Japanese fossil fuel imports (2018)

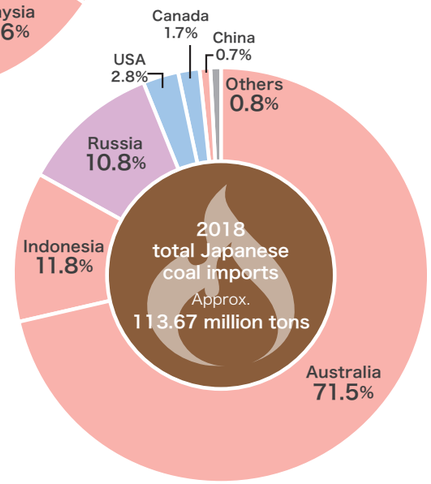
Dependence on imported fossil fuels

Coal	99.7%
LNG (natural gas)	97.5%
Crude oil	99.3%

Source: Comprehensive energy statistics







In order to secure a stable supply of resources, Japan is endeavoring to strengthen relations with oil-producing countries in the Middle East that are its main sources of crude oil. It is also diversifying its supply sources, working for further acquisition of resource rights and interests, and pursuing more active LNG transactions.

Source: Trade statistics

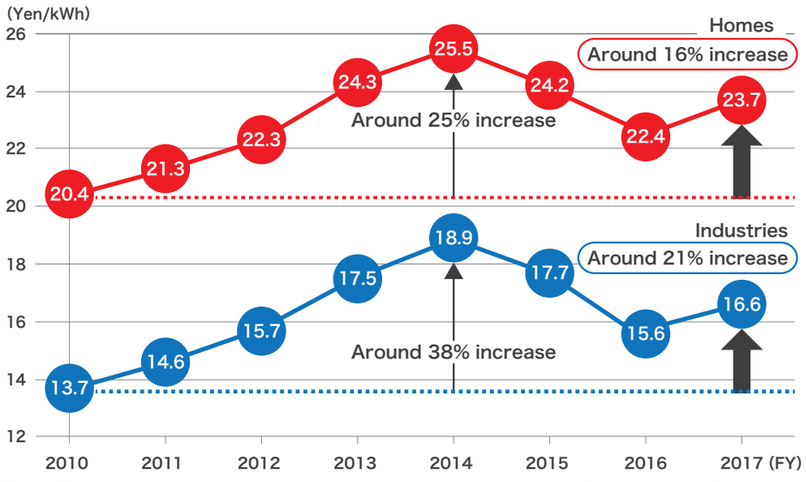
2. How are electric power rates changing?

Changes in electricity rates

Q How are electric power rates changing?

A Electricity rates were increased multiple times after the Great East Japan Earthquake. The rates then began trending downward since FY 2014 due to factors such as the subsequent decline in crude oil prices. However, they have recently begun to rise again.

Changes in average electricity rates



Source: Created based on monthly reports of generated and received electric power, and financial materials of each electric power company.

Compared with FY 2010 before the Great East Japan Earthquake, in FY 2014 electricity rates for homes increased by around 25%, and rates for industries increased by around 38%. Although rates had been declining since FY 2014, they have recently begun to rise again. Compared with the rates before the Great East Japan Earthquake, electricity rates have increased by around 16% for homes, and around 21% for industries.

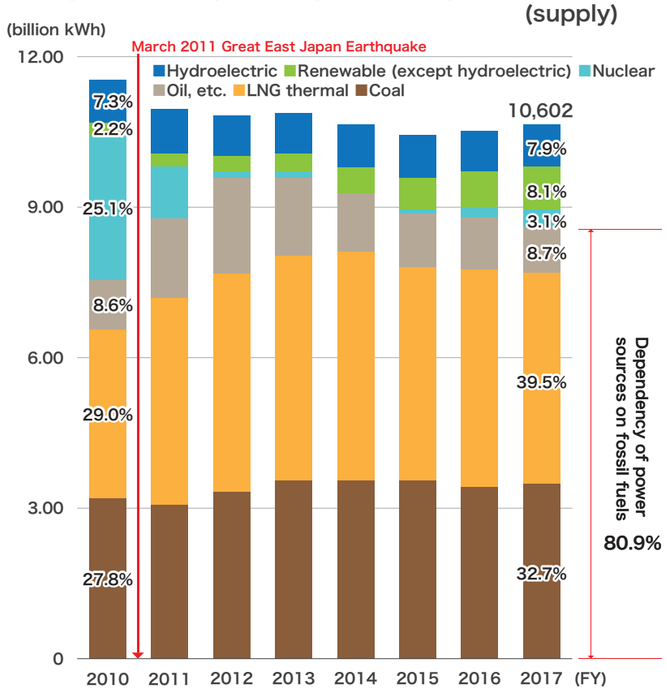
Changes in Electricity Rates

Electricity rates in Japan increased repeatedly after the 2011 Great East Japan Earthquake as a result of growing oil thermal power generation and LNG thermal power generation to make up for the shutdown of nuclear power plants. In addition, because crude oil prices and oil-linked gas prices during this period were high, comparing the rates before the earthquake in FY 2010 and those in FY 2014, the electricity rates for homes and industries rose significantly by 25% and 38% respectively. Thereafter oil prices fell as a result of the shale revolution in the United States and electricity rates began to decrease. However oil prices began to rise again from FY 2016 and at the same time the renewable energy surcharge rates also increased. As a result, electricity rates began rising again in FY 2017.

According to IEA long-term forecasts, energy demand in emerging nations will continue to grow for some time, and oil prices are expected to exceed 100 USD per barrel in 2030 - 2040.

Aiming to increase the energy self-sufficiency ratio and create a composition of power sources that is resistant to changes in international oil prices, the government of Japan is working to stabilize electricity rates by promoting competition between business operators through the full liberalization of the electricity retail market that was started in FY 2016, by restarting nuclear power generation with safety as the top priority, and by lowering the cost of renewable energy.

Changes in the Japan composition of power sources (supply)

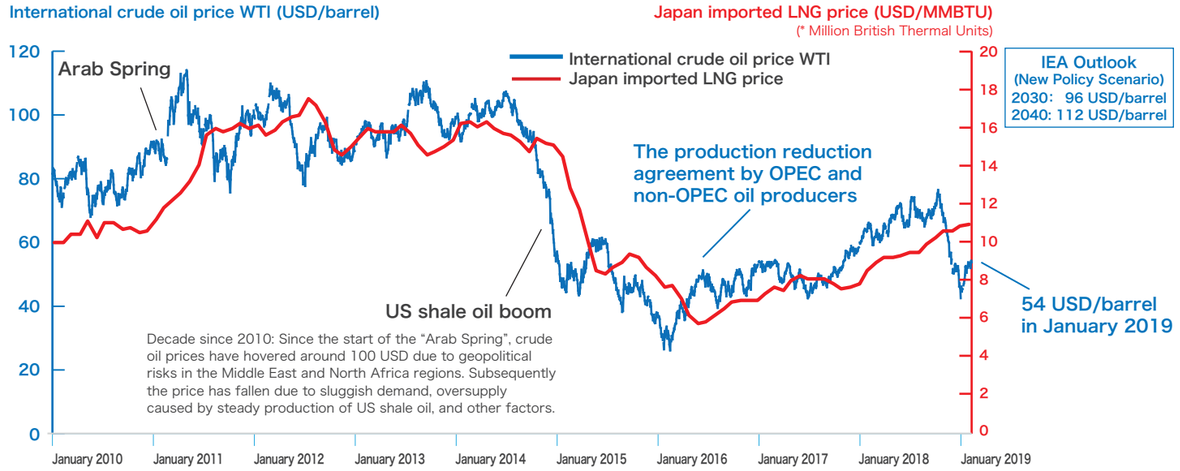


Source: Agency for Natural Resources and Energy "Comprehensive energy statistics"

Factors causing changes in electricity rates ①: Fuel prices

According to the new policy scenario and other forecasts of the International Energy Agency (IEA), the price of crude oil is expected to be 96 USD/barrel in 2030 and 112 USD/barrel in 2040. This will make an impact on electricity rates and energy costs.

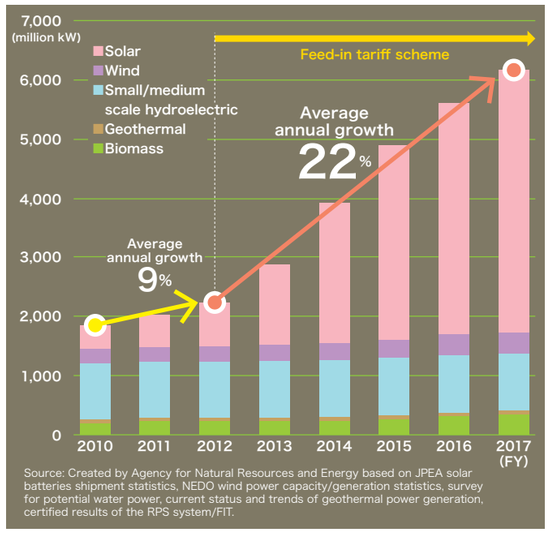
The Situation in the Past Where the Crude Oil Price Fell and the Current Situation



Source: Created based on NYMEX announced figures and IEA World Energy Outlook 2018.

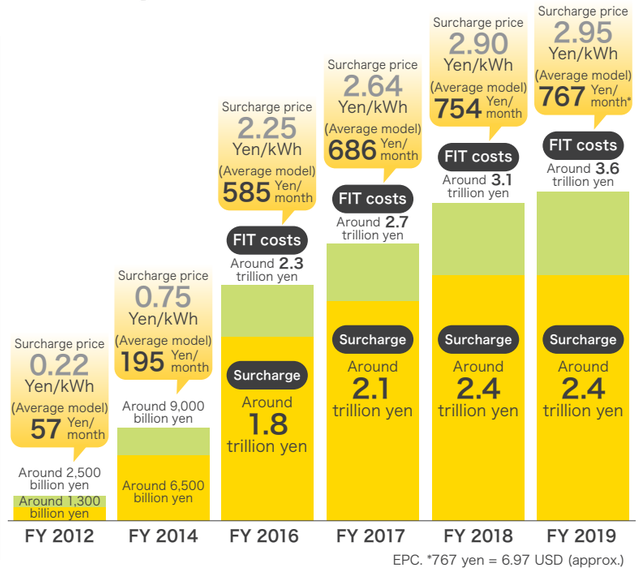
Factors causing changes in electricity rates ②: Renewable energy cost

Changes in installed capacity resulting from renewable energy and other factors
(Excluding large scale hydroelectric power)



Source: Created by Agency for Natural Resources and Energy based on JPEA solar batteries shipment statistics, NEDO wind power capacity/generation statistics, survey for potential water power, current status and trends of geothermal power generation, certified results of the RPS system/FIT.

Trends in Surcharge after Introducing the FIT



EPC. *767 yen = 6.97 USD (approx.)

Thanks to the introduction of the Feed-In Tariff scheme (FIT) in 2012, the installed capacity of renewable energy systems is growing rapidly. However the purchase costs have reached 3.6 trillion yen (approximately 33 billion USD) and cost of the surcharge based on the standard model (260kWh/month) has risen to 767 yen/month. In order to maximize the introduction of renewable energy while also reducing the burden on the people, it will be necessary to expand cost-efficient introduction. For this purpose, we will proceed with setting long-term price targets for the FIT system, utilize a "top runners approach" to reducing solar and wind power prices to meet those targets, use a competitive bidding system, and develop technologies for reducing cost.

Feed-In Tariff Scheme (FIT): This is a system in which the electricity generated by renewable energy is purchased by electric power companies at a fixed rate for a certain period of time. The purchase costs are collected by means of a surcharge that is paid by electricity users.

Average model: Monthly power usage 260 kWh model that is posted on the websites of the Tokyo EPC and Kansai EPC.

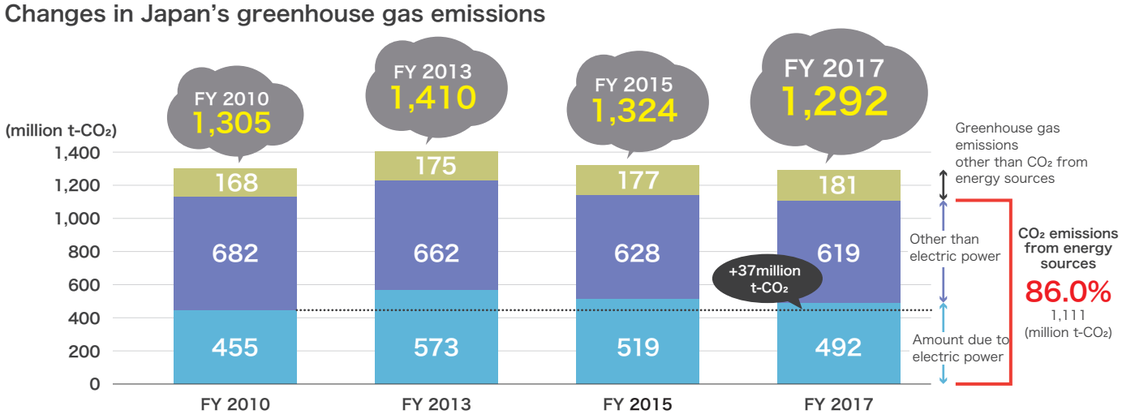
3. How much greenhouse gases are being emitted?

An increase in the amount of CO_2 emissions

Q How much greenhouse gases are emitted in Japan?

A Since the Great East Japan Earthquake, the amount of greenhouse gas emissions in Japan has been increasing, reaching a historical peak of 1.4 billion tons in FY 2013.
The level started to decline after FY 2013, and in FY 2017 emissions of greenhouse gases have dropped to below the level of FY 2010 before the Great East Japan Earthquake.
We must continue making efforts with the standards that are comparable to other countries' reduction targets.

Changes in Japan's greenhouse gas emissions

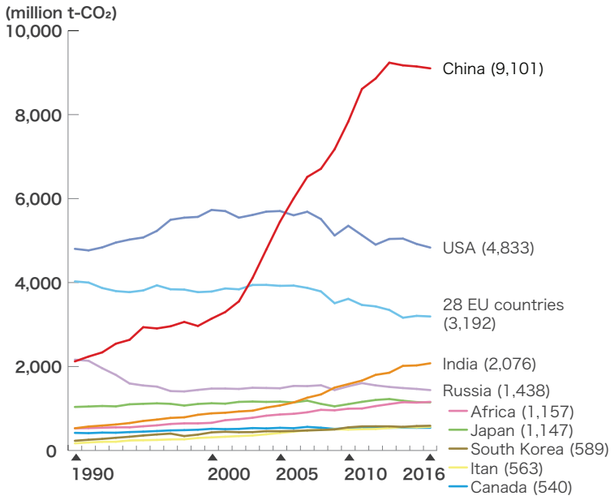


Source: Comprehensive energy statistics, environmental action plans (FEPC), and calculation results of the amount of greenhouse gas emissions in Japan (Ministry of the Environment).

FY 2017 greenhouse gas emissions
National Institute for Environmental Studies: http://www.nies.go.jp/whatsnew/20190416/20190416.html

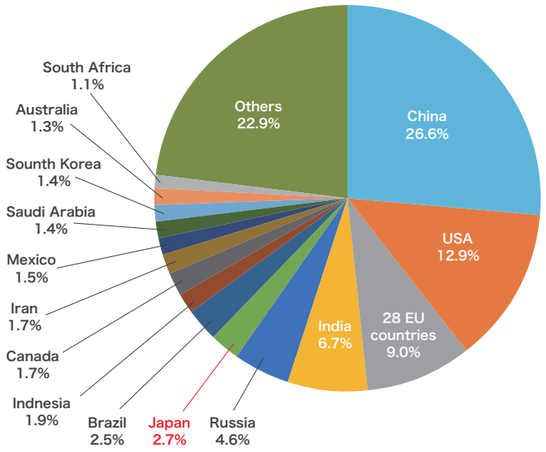
Changes in greenhouse gas emissions from global energy sources (1990 - 2016)

Global greenhouse gas emissions from energy sources in 2016 were 32.1 billion tons of CO2. Although emissions in North America and the EU are declining, they are growing in China, India, and Africa. Japan is the only country with declining emissions in the growing Asia region.



Source: CO_2 Emissions from Fuel Combustion 2018 Highlights (IEA)
Top 10 countries and regions in terms of greenhouse gas emissions from energy sources, figures in parentheses are 2016 emissions (million tons)
* Greenhouse gas emissions from non-energy sources are not included.

Share of greenhouse gas emissions produced by each country (2018)



Units: Converted to million tons CO_2
Source: IEA CO_2 EMISSIONS FROM FUEL COMBUSTION (2018 Edition)
2015 Greenhouse-gas emissions (2018Edition).pdf

Global warming countermeasures: Paris Agreement, COP negotiations

November 2015: Adoption of the Paris Agreement (COP21)
The target is set to keep a global temperature rise well below 2°C above pre-industrial levels and pursue efforts to limit the temperature increase even further to 1.5°C.

All countries including developed and developing countries must submit targets for reducing greenhouse gas emissions.

November 2016: Paris Agreement takes effect.

December 2018: Decision of Paris Agreement implementation rules (COP24 Katowice, Poland)
The rules necessary to fully implement the Paris Agreement beginning from 2020 were adopted.

All countries are to take action including reporting their emissions and submitting reduction targets under the same rules.

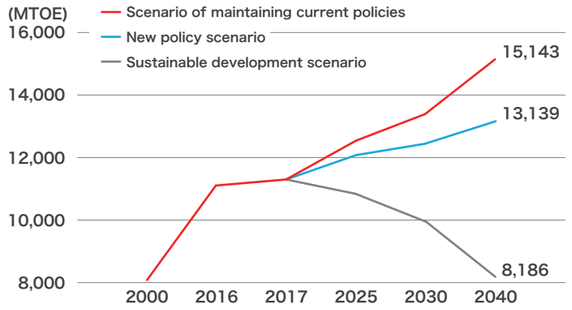
Japan 2030 target: 26% reduction from FY 2013 level

Country	Comparison to 1990	Comparison to 2005	Comparison to 2013
Japan	▲18.0%	▲25.4%	Reduction target ▲26.0% (by 2030)
USA	▲14～16%	Reduction target ▲26～28% (by 2025)	▲18～21%
EU	Reduction target ▲40% (by 2030)	▲35%	▲24%
China	・Reduce greenhouse gas **emissions by 60 - 65% per unit of GDP by 2030 compared with 2005 levels.** ・Reach peak greenhouse gas emissions in or around 2030.		
South Korea	・Reduce emissions by 37% by 2030 compared to expected 2030 levels with no measures taken.		

Japan reduction targets are in comparison to the 2013 level. USA targets are in comparison to the 2005 level. EU targets are in comparison to the 1990 level. When the targets are all converted to 2013 values for comparison, you can see that the target for Japan is high.

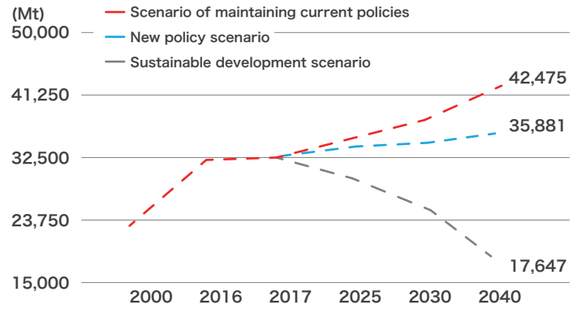
Source: Comparison of pledges from major countries (targets for reduction of greenhouse gas emissions)(Ministry of Economy, Trade and Industry created)

Forecast for fossil fuel (coal, oil, gas) demand



Source: IEA World Energy Outlook 2018
Note: 2000 and 2016 figures are actual. 2017 figure is an estimate.

CO_2 emissions forecast



Source: IEA World Energy Outlook 2018
Note: 2000 and 2016 figures are actual. 2017 figure is an estimate.

As the consumption of fossil fuels has a large impact on the planet, it is important to change energy sources and shift away from carbon.

Notes: Scenario of maintaining current policies = If no changes are made to current policies
New policy scenario = If the currently announced policy targets are achieved
Sustainable development scenario = If the shift to clean energy is accelerated, ensuring universal access, preventing climate change, and achieving a clean atmosphere

4. Is the reconstruction of Fukushima in progress?

Decommissioning of Fukushima Daiichi Nuclear Power Station

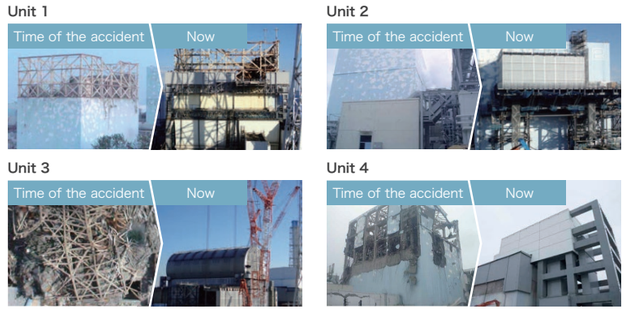
Q How is the progress of decommissioning & the management of the contaminated water at Fukushima Daiichi Nuclear Power Station?

A Although it is an unprecedented challenge, continuous measures are being implemented safely and steadily based on the “Mid-and-Long-Term Roadmap.”

Decommissioning

Stable conditions are being kept at all reactors, and rubble removal, decontamination, and other measures are carried out aimed at removing the fuel from the spent fuel pool. Internal investigation of the containment vessel are conducted toward retrieval of the fuel debris (fuel that melted and resolidified). Based on the investigation results, the method of retrieval will be determined and retrieval will start in 2021.

(Current conditions of each reactor)

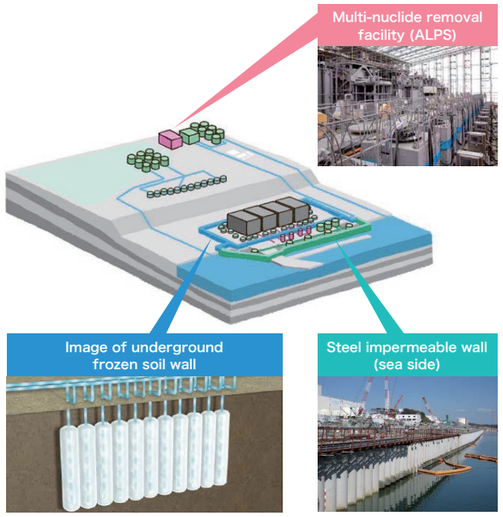


Photographed from top of building (at time of the accident)

Previous investigations have identified the containment vessels, such as distribution of fuel debris.
In February 2019 during an investigation of Unit 2, deposits thought to be fuel debris were successfully grasped and lifted up.

Contaminated Water Management

Amount of contaminated water generated at Fukushima Daiichi Nuclear Power Station has reduced to one third by multi-layered countermeasures (frozen-soil wall, etc.), compared to it before measures were taken.
Contaminated water from the Fukushima Daiichi Nuclear Power Station is processed by multiple treatment facilities to remove as much of the radioactive substances as possible before the water is stored in the tanks. The quality of water of the surrounding sea areas has also greatly improved.



March 2011 (immediately after the accident)	Radioactive material concentration in surrounding ocean areas of the Fukushima Daiichi Nuclear Power Station	March 2019 (nearly 8 years after the accident)
About 10000 Bq/L		Less than 0.6 Bq/L

Handling of the water stored in the tanks

At present, the water in the tanks has been treated by multiple treatment facilities which reduced the concentration of radioactive substances to around 1/1,000,000 of the original value. Because this water contains tritium, which cannot be removed by purification facilities, and other nuclides. The handling of the water is the problem. Consultations are being conducted, including societal perspectives such as the reputational damage.
For a simple explanation of the basics and the latest information related to the contaminated water management, please visit our website.

Related Article

ALPS-Treated Water Stored at the TEPCO Fukushima Daiichi Nuclear Power Station
JEF: Japan Economic Foundation
Reference: https://www.jef.or.jp/journal/pdf/225th_Special_Article_01.pdf

Use this QR code to view the article. (English)

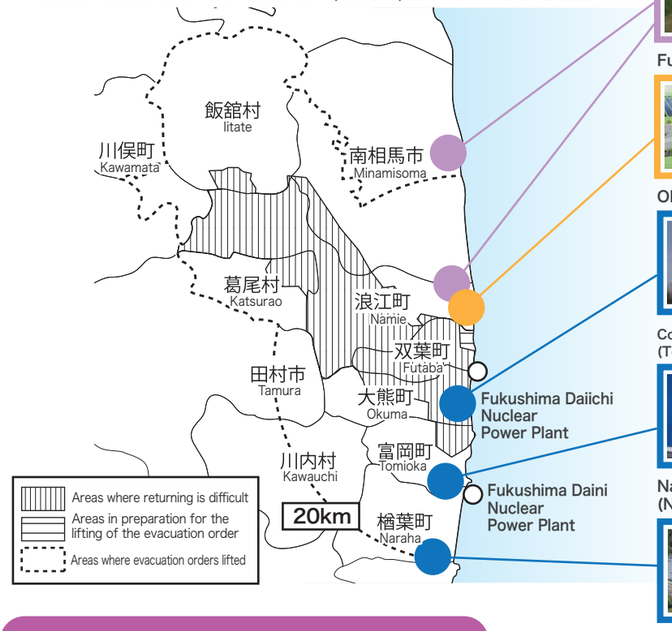
Toward Reconstruction of Fukushima

Q How is the progress of the reconstruction of Fukushima?

A By spring 2017, all “restricted residence areas” and “areas in preparation for lifting of the evacuation order” had been lifted except for Okuma Town and Futaba Town. Efforts to construct bases for reconstruction are also being made in designated “difficult-to-return” areas. In addition, we are working for regional revitalization of Fukushima in a number of ways, such as by accelerating decontamination and the construction of infrastructure and daily living services, by creating new technologies and industries, and by promoting industrial clusters.

Fukushima Innovation Coast Framework :

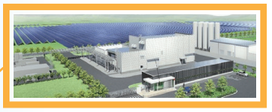
We are working for constructing a new industrial infrastructure to revitalize industries in the Hama-dori (coastal) area and other areas.



Fukushima Robot Test Field (Minamisoma City, Namie Town)

Has constructed robot testing fields for development and demonstration of robots, and an international facility for collaboration by industry, academia, and government (partially opened in July 2018).

Fukushima Hydrogen Energy Research Field (Namie Town)



Conducting demonstration projects for large-scale production of hydrogen from renewable energy using the world's largest 10,000 kW class water electrolyzer.

Okuma Analysis and Research Center (Okuma Town)

Conducting analysis of low- and medium-dose radioactive rubble and fuel debris.

Collaborative Laboratories for Advanced Decommissioning Science (Tomioka Town)

Universities, research institutes, and companies within and outside Japan have gathered in Fukushima and are conducting research related to decommissioning nuclear reactors and other subjects.

Naraha Center for Remote Control Technology Development (Naraha Town)

Conducting investigations of reactor containment vessels, development and demonstration tests of repair robots, and training for workers using virtual reality systems.

The Fukushima Plan for a New Energy Society :

We are creating a model for a “future energy society” and promoting the “Fukushima Model” to the world.

Expanding the introduction of renewable energy

- Reinforcement of transmission lines for new wind farms in the Abukuma and Futaba areas

Development of a model for realizing a “Hydrogen Society”

- Demonstration project for large-scale hydrogen production using renewable energy (10,000 kW demonstration project - the largest in the world)
- Demonstration project for next-generation hydrogen transport and storage technologies (To be utilized during the 2020 Tokyo Olympics and Paralympics)

Creation of Smart Communities

- Support for construction of Smart Communities in some Fukushima regions including Shinchi Town, Soma City, Namie Town, Naraha Town and Katsurao Village

Food safety in Fukushima Prefecture

- Agricultural, forestry, and fishery products are subject to thorough monitoring inspections before shipping, and the results of these and other inspections are made public.
- Unlike the period immediately after the earthquake, almost no products exceed the standard limit (100 Bq/kg) in recent years.
- There have been zero incidents of rice exceeding the standard since 2015 crop, and zero incidents of seafood exceeding the standard since April 2015.
- If food exceeding the standard is found, the necessary steps are taken to prevent it from reaching the market.

Status of monitoring inspections for agricultural, forestry and fishery products
(April 1, 2017 - February 28, 2018)
* Aug. 22, 2017 - Feb. 28, 2018 for brown rice only

Classification	Number of inspections	Number exceeding standard	Percentage exceeding standard
Brown rice (produced in 2017)	Approx. 9.89 million	0	0.00%
Livestock products	3,814	0	0.00%
Cultivated plants/mushrooms	1,066	0	0.00%
Marine seafood	7,680	0	0.00%
Fish from inland fisheries	68	0	0.00%
Vegetables/fruits*	2,830	0	0.00%
Edible wild plants/mushrooms	836	1	0.12%
Fish in rivers and lakes	677	8	1.18%

None exceeding standard
- Safe product shipments
- Continuing investigations aimed at ending restrictions

When an item exceeding the standard is detected, shipment is restricted from the entire area where the item was produced.

* Fruits excludes chestnuts from certain areas.

Argentina, Turkey, and Brazil have lifted their import restrictions, while import restrictions have been relaxed in China and the USA.

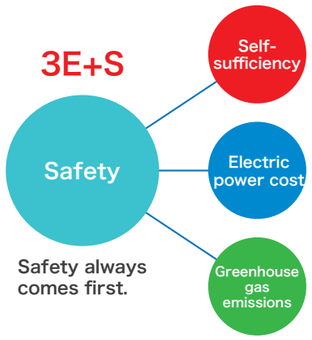
Source: Created by Reconstruction Agency based on Progress of Fukushima Recovery (Ver. 22) and the “Newly released in Fukushima” homepage.

5. What is the government's energy policy?

Basic Policies

Q What are the basic energy policies?

A Keeping in mind that Safety always comes first, programs are being carried out in order to simultaneously achieve improvement of Energy Security, Economic Efficiency, and Environment Suitability. (3E+S)
It is essential to create a multi-layer energy supply structure where each power source delivers its maximum strength and complements the weaknesses of the others.



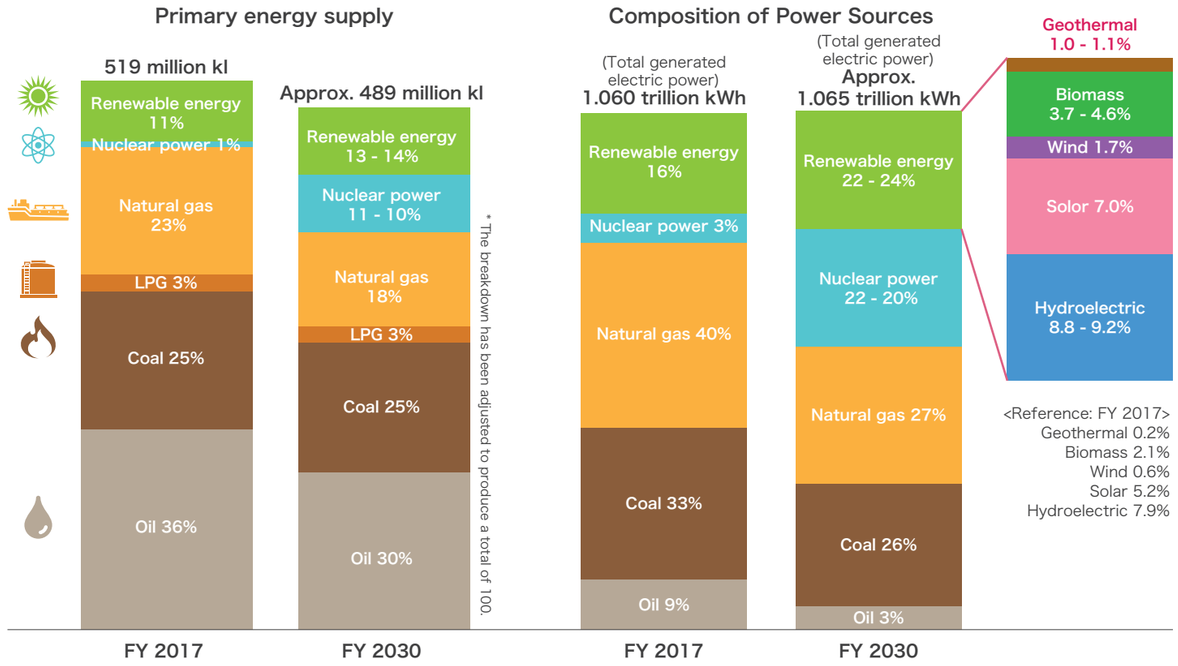
Energy Security
Exceed the level from beforethe Great East Japan Earthquake (approx. 20%).
Approx. 25% (currently 9.6%)

Economic Efficiency
Reduce costs from their current level.
(FY 2013 9.7 trillion yen ⇒ FY 2030 9.5 trillion yen)
* When formulating the energy mix

Environment
Achieve targets for reduction in greenhouse gases that are comparable to Western countries.
(26% reduction from FY 2013 levels by FY 2030)

Q What will the future composition of power sources look like?

A The figure below shows the ideal energy supply and demand structure for the future (FY 2030) that will be realized by policies aimed at achieving 3E+S based on the basic energy policies.

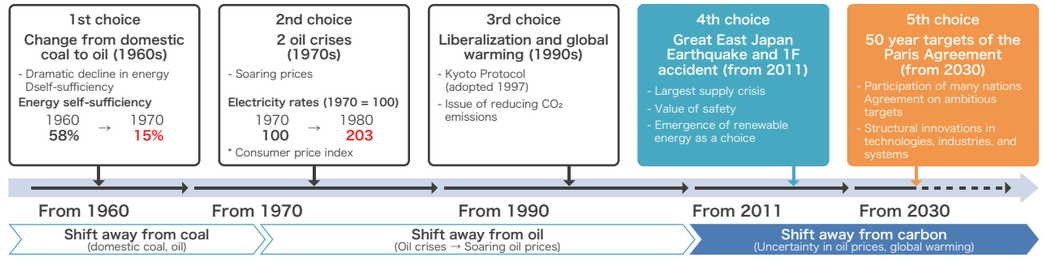


Q What does "decarbonization" mean?

A The policy is to reduce carbon emissions.
It will change the energy supply structure of Japan that is highly dependent on fossil fuels, and also help reduce greenhouse gas emissions.

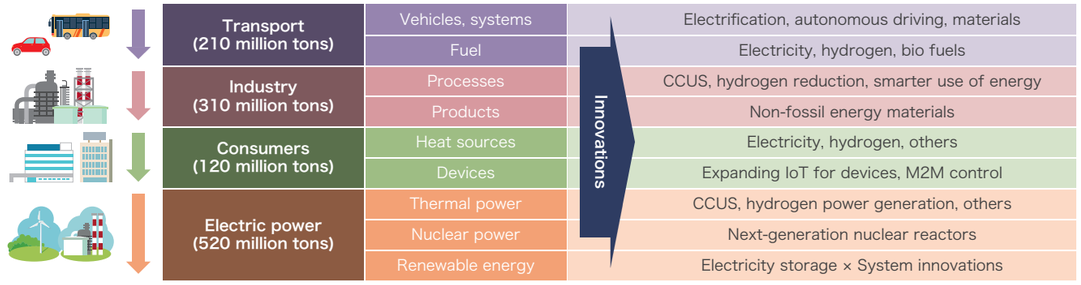
Flow of energy choice

Japan achieved economic growth through past policy choices to reduce dependence on coal and oil. The country is making steady progress towards achieving the target energy mix in 2030, and a carbon-free energy supply has become visible as a possible direction for 2050.



Innovations aimed at achieving zero carbon

Innovations are the key to the decarbonization challenge that we are looking at for 2050. For this purpose, it is important to pursue all options including renewable energy, nuclear power, hydrogen, storage batteries, and CCUS.

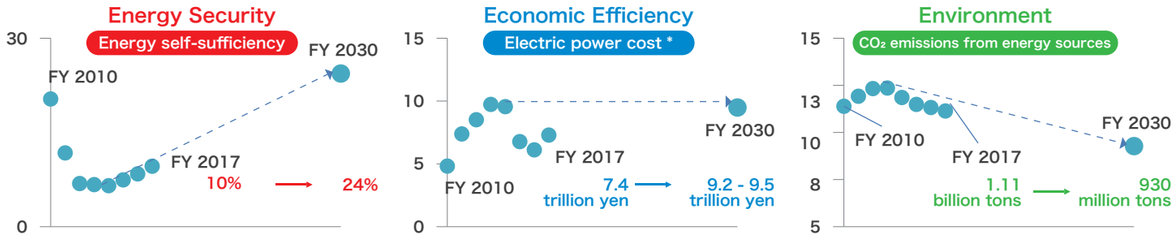


* Figures in parentheses are 2015 emissions
* CCUS: Carbon dioxide Capture, Utilization and Storage

Source: Created by the Agency for Natural Resources and Energy.

Column: Progress towards achieving the 2030 energy mix

Although steady progress is being made towards achieving the 2030 energy mix, we are still only halfway there.



* Electricity costs are unstable as a result of changing fuel prices and an increase in FIT purchase costs.

Source: Created by the Agency for Natural Resources and Energy based on comprehensive energy statistics (FY 2017 figures) and other information.

6. Are programs being implemented for improving energy efficiency?

Energy efficiency

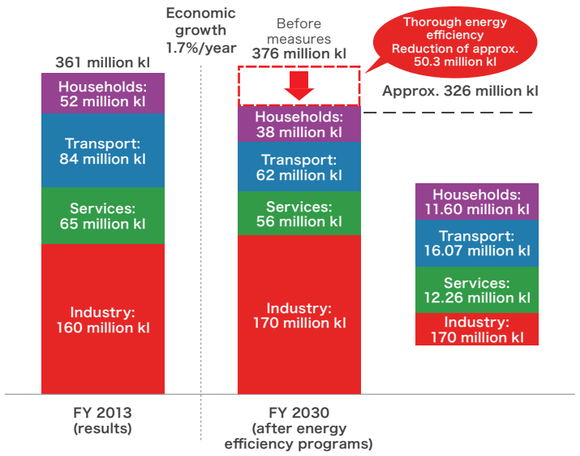
Q Why is improving energy efficiency necessary?

A It is necessary in view of effective use of limited resources. In addition, measures to improve energy efficiency can reduce CO_2 emissions, and can lead to a solution to the problem of global warming. Continuing efforts for improving energy efficiency measures is essential.

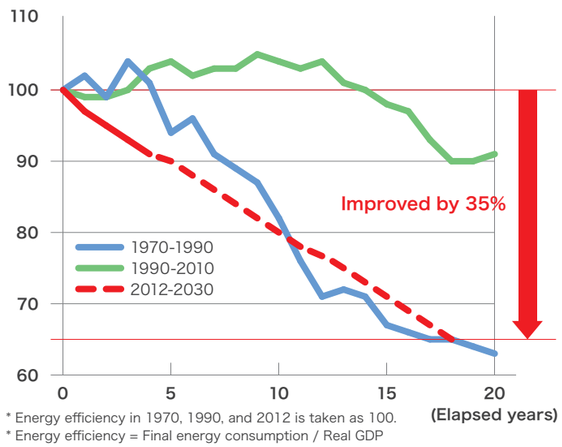
Q To what extent have measures to improve energy efficiency in Japan progressed?

A Japan is a nation with excellent energy efficiency and advanced measures for energy efficiency improvements. However from 1990 to 2010, improvements of energy efficiency stalled. Further measures to improve energy efficiency will need to be implemented in the future.

Final energy demand in the energy mix



Improvement of Energy Consumption Efficiency



* Energy efficiency in 1970, 1990, and 2012 is taken as 100.
* Energy efficiency = Final energy consumption / Real GDP

Progress of improving energy efficiency

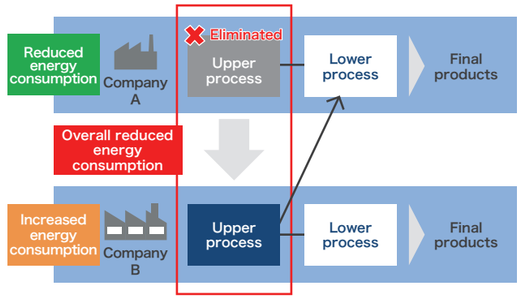
Main measures to improve energy efficiency			FY 2016	FY 2030
All	LED	Adoption rate	Industry: Approx. 41% (450,000 kl) Services: Approx. 39% (880,000 kl) Households: Approx. 43% (860,000 kl)	All sectors 100% (5.38 million kl)
Industry	Top Runner Motors (Widespread use in pumps, fans, etc.)	Units in use	Approx. 1.66 million units (90,000 kl)	Approx. 31.2 million (5.38 million kl) Expected to replace half of all units in use (66 million units).
Services	Buildings	Rate of compliance with energy efficiency standards (Floor size basis)	Large scale: Approx. 97% Medium scale: Approx. 94% Small scale: Approx. 69% (440,000 kl)	Allmost 100% (3.32 million kl)
Households	High efficiency hot water systems	Units in use	Approx. 13.01 million (520,000 kl)	Approx. 46.3 million (2.69 million kl) Expected to increase to around 90% of the total (51.2 million households).
Transport	EV/PHV, FCV, and other next-generation automobiles	Percentage of new vehicle sales	Approx. 36% (part of 720,000 kl)	50 - 70% (part of 9.39 million kl) It is expected that EV/PHV will account for up to 20 - 30% of new vehicle sales (16% of all vehicles) while FCV will account for up to 3% (1% of all vehicles).

Further improvement of energy efficiency in the industrial sector

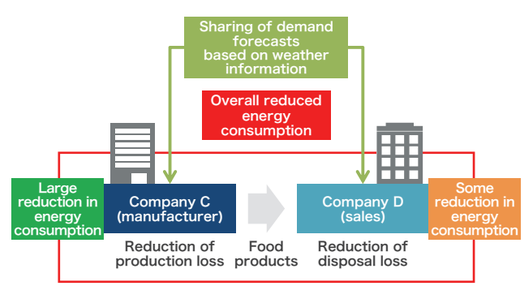
Proposed energy efficiency improvements through business collaboration

The pace of improvements will be accelerated not only through the steps taken by individual companies but also through new measures for improving energy efficiency conducted in cooperation by multiple companies.

Case 1: Concentration of production facilities of multiple companies in the same industry



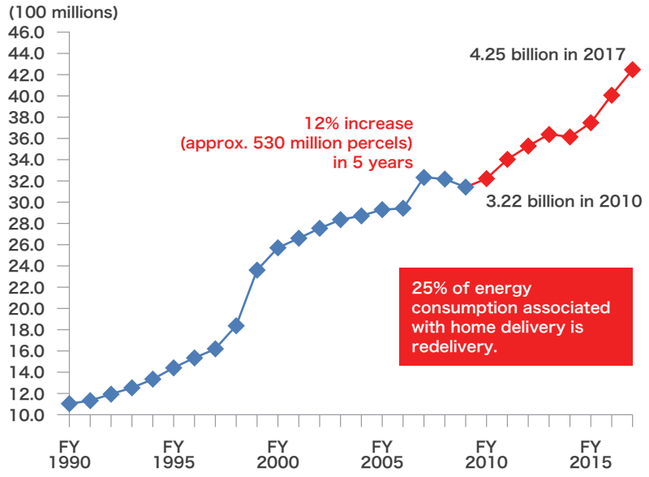
Case 2: Optimization through supply chain alliance



Further improvement of energy efficiency in the transport sector (cargo transportation)

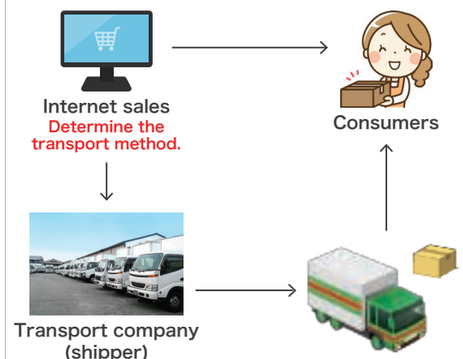
As trucks are more difficult to electrify than passenger vehicles, improving the efficiency of logistics in cargo transportation is essential. Actions are needed to be taken against concerns of growing energy consumption resulting from the increase in small shipments and repeated deliveries in the rapidly expanding ecommerce market (which has grown 1.8 times for the past 5 years).

Changes in home deliveries



Source: Ministry of Land, Infrastructure, Transport and Tourism "FY 2015 Investigation of the Numbers of Parcel Deliveries"
Note: From FY 2007, the numbers include the quantity handled by Japan Post.

The internet retailers which determine the methods of transport are subject to the Act on the Rational Use of Energy, and they are also implementing measures for improving energy efficiency.



The Act on the Rational Use of Energy

Lacking in fossil fuels, Japan has worked on improving energy efficiency and has achieved top class results on a worldwide scale. The Act on the Rational Use of Energy was revised in June 2018, and improving energy efficiency methods that are adapted to the changing times will be used to achieve further improvements in energy efficiency.

Reference: https://www.enecho.meti.go.jp/about/special/tokushu/ondankashoene/shoenehoukaisei.html

Use this QR code to view the article. (Japanese only)

7. Is the introduction of renewable energy in progress?

Introduction of Renewable Energy

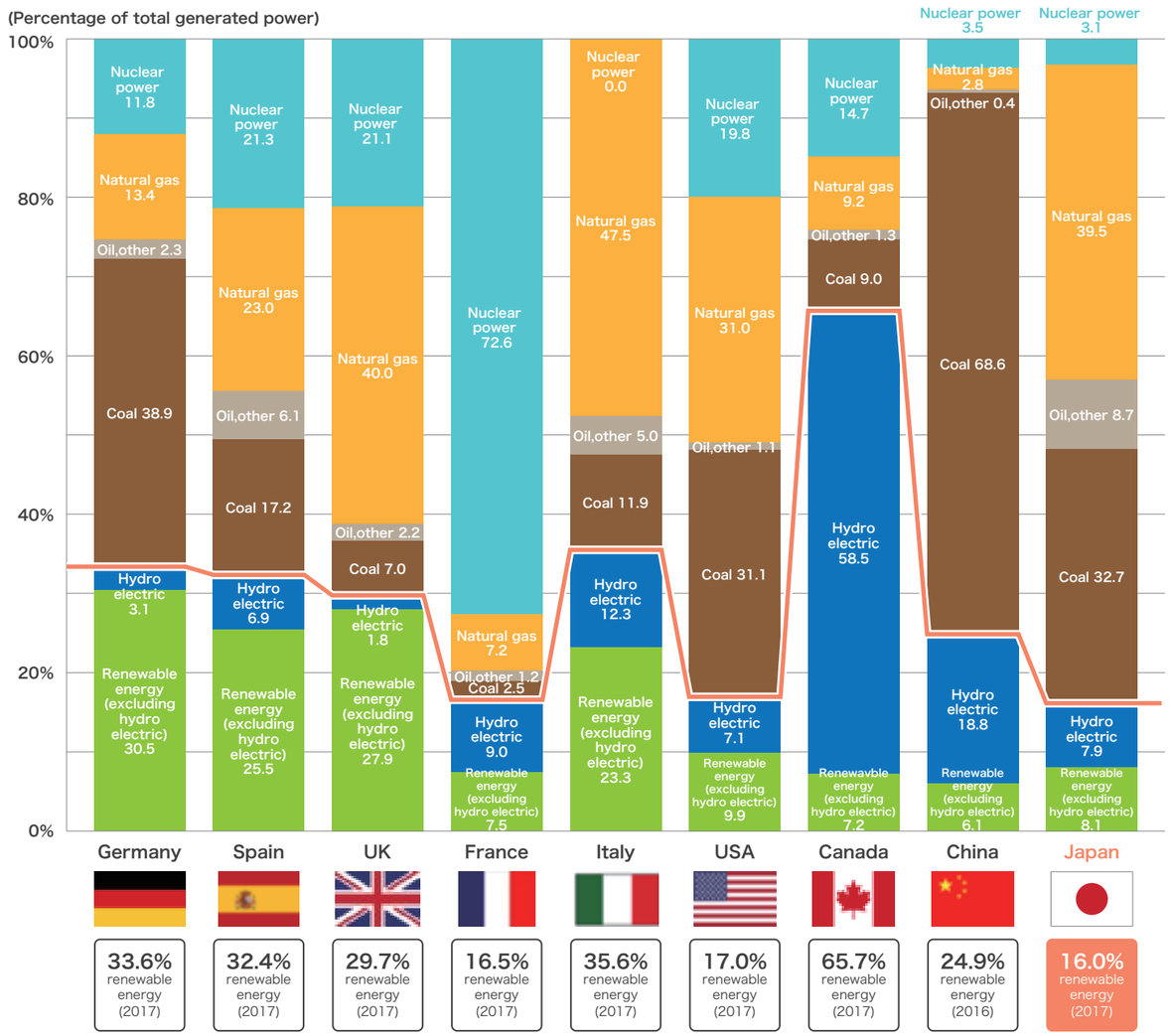
Q Why does renewable energy need to be introduced?

A Renewable energy is an important source of energy for Japan as it generates energy without emitting CO_2 and contributes to energy self-sufficiency.

Q Is the introduction of renewable energy in progress in Japan?

A As of 2017, the percentage of electrical power generated by renewable energy in Japan is 16.0% (8.1% if hydroelectric power is excluded). This is low compared to other major countries, and further expansion is needed.

Comparison of the Renewable Energy Ratio of Total Generated Electric Power

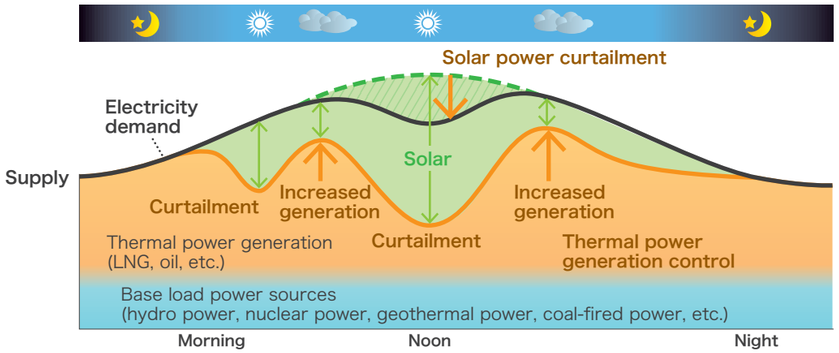


Source: Investigation by the Agency for Natural Resources and Energy

Q Is it possible to supply electricity only from renewable sources?

A The amount of electricity generated by renewable energy varies significantly depending on the weather or season, which makes power supply unstable. Flexible power sources such as thermal power need to be prepared as a backup.
There are also a number of remaining issues, such as securing batteries and other means of energy storage, and determining how to transform power network that can integrate a large amount of electricity generated by renewable sources.

Image of supply/demand situation on the lowest demand day (such as a sunny day in May)

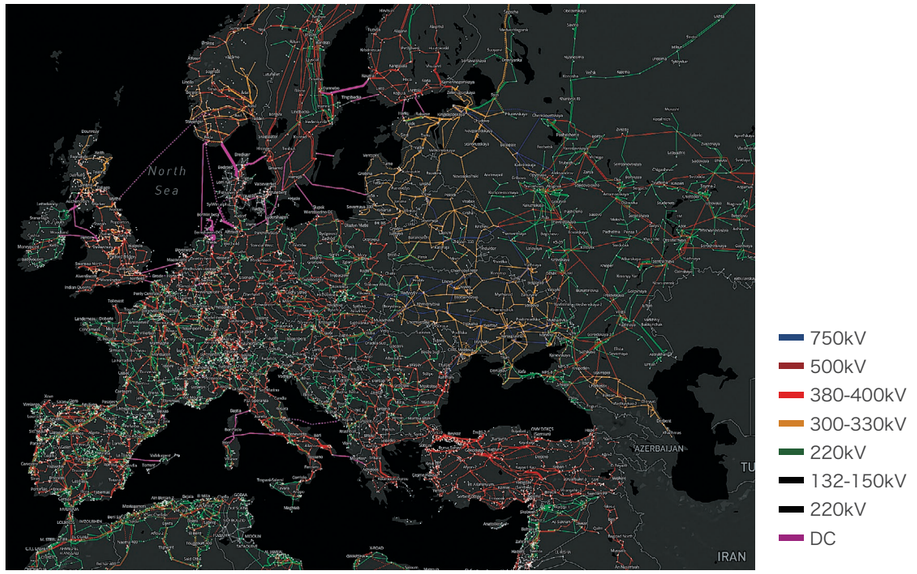


In order that consumers can use electricity in a stable manner, a balance between generation (supply) and consumption (demand) is needed on the same level. To this end, flexible power sources such as thermal power are used to adjust the fluctuation of renewable energy.

Column: Energy network in Europe

For example, Germany is connected by cross-border electricity interconnections to around 10 nearby countries including Poland, Czech Republic, Austria, Switzerland, France, The Netherlands, Denmark, and Sweden. When renewable electricity surplus occurs in one area, it is exported to other countries. When electricity is insufficient in one area, it is imported from other countries. Transmission network among countries are highly developed in Europe and it is possible to maintain a balance between supply and demand as a whole.

European grid map (from ENTSO-E)



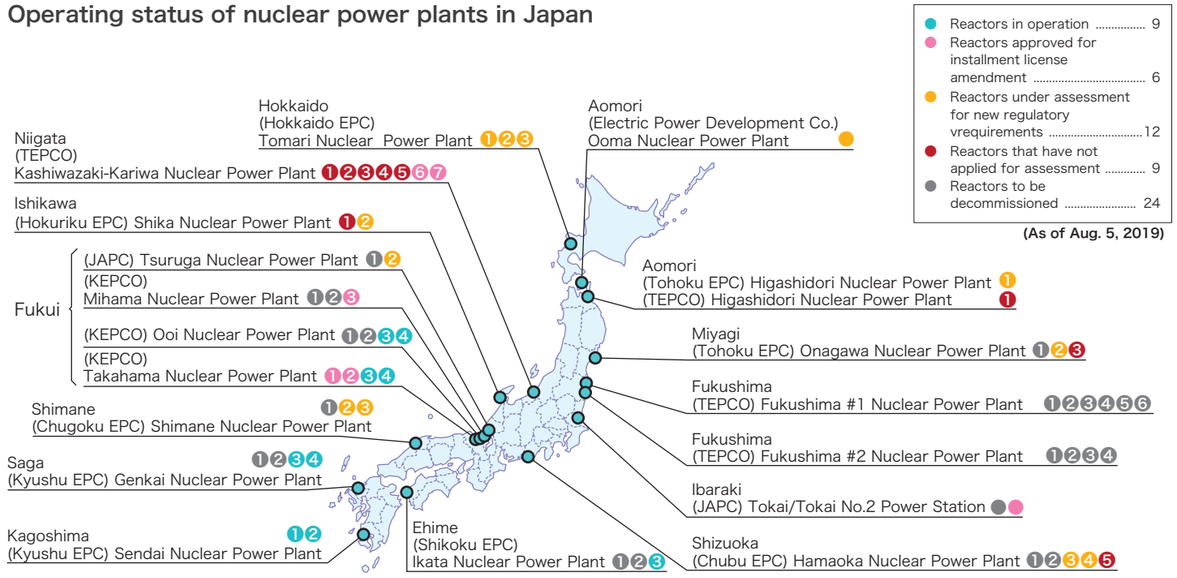
https://www.entsoe.eu/map/Pages/default.aspx

Regarding Nuclear Power Plants

Q Is nuclear power generation necessary?

A For a country that lacks natural resources, nuclear power generation is essential in order to achieve the following 3 objectives: ① securing a stable supply of power, ② reducing electric power costs, ③ reducing CO_2 emissions. In order for nuclear power plants are restarted, conformance with new regulatory requirements that prioritize safety is required.

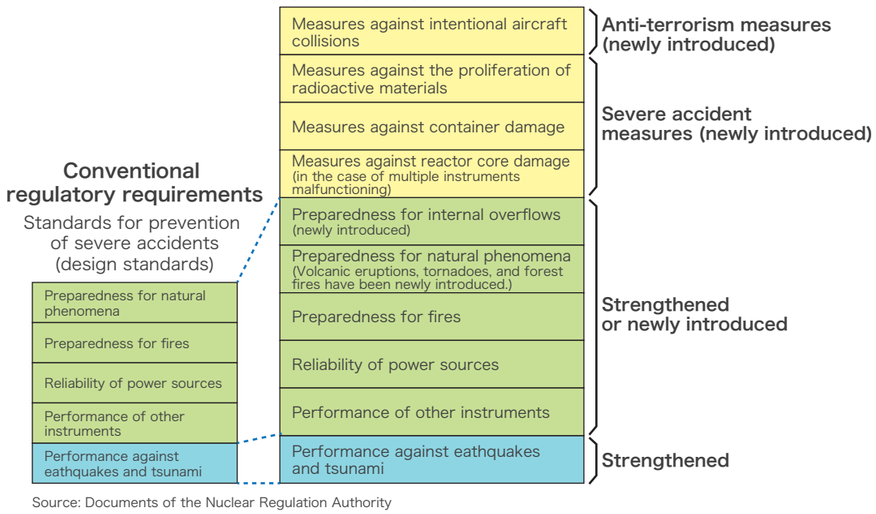
Operating status of nuclear power plants in Japan



Response to the new regulatory requirements for higher safety

The Nuclear Regulation Authority requires that before a nuclear power plant is restarted, it must conform to its new regulatory requirements. Measures to prevent accidents are being reinforced and preparation for emergencies enhanced as well.

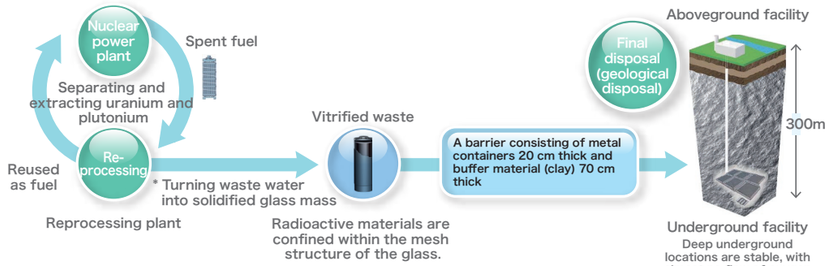
New regulatory requirements (July 2013)

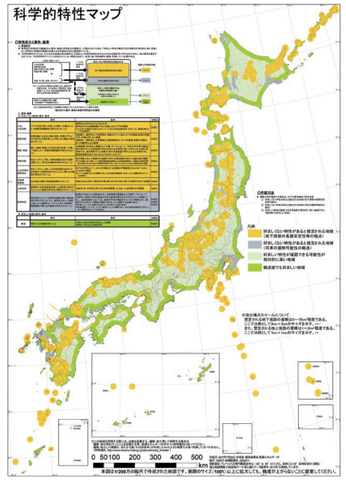


Source: Documents of the Nuclear Regulation Authority

Treatment and disposal of spent fuel

Spent nuclear fuel that is produced by the operation of a nuclear power plant is recycled and reused as fuel. Raw glass material is melted into the remaining waste water to create a solidified glass mass known as “vitrified waste”. This mass is disposed by burying and isolating it deep underground (geological disposal).





Scientific characteristics map

To provide a better understanding of the mechanism of geological disposal and the geological environment of Japan, we published the "Scientific Characteristics Map" in July 2017 which shows the scientific characteristics of each region of Japan.

Reference:
https://www.enecho.meti.go.jp/category/electricity_and_gas/nuclear/rw/kagakutekitokuseimap/

Use this QR code to view the article. (Japanese only)

Current state of spent fuel: Towards completion of a nuclear fuel cycle

The spent fuel that is produced by power plants in Japan will be reprocessed at Rokkasho reprocessing plants to create MOX fuel which can be reused for power generation. The Rokkasho reprocessing plants are required to conform to the new regulatory requirements for nuclear power facilities, and are now under construction, with completion planned for the first half of FY 2021.

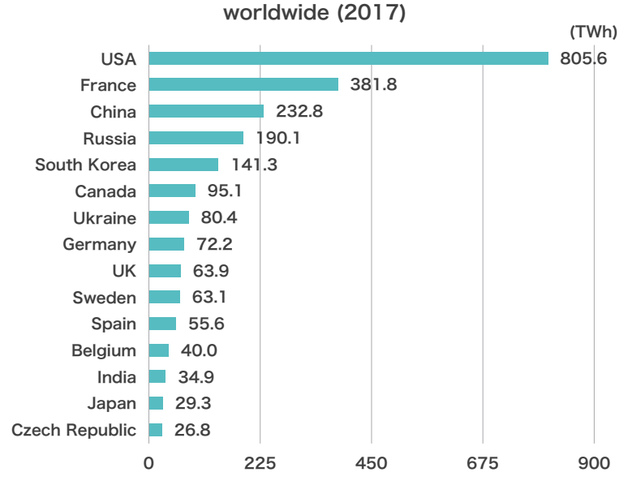
Reference: https://www.enecho.meti.go.jp/about/special/johoteikyo/shiyozuminenryo.html

Use this QR code to view the article. (Japanese only)

Column: Global trends in nuclear power

Based on the nuclear power generation results shown below, the leading countries are the United States, France, China, Russia, and Korea. The nuclear power generation capacity of plants under construction shows that China is constructing a large number of plants.

Power generation capacity of nuclear power plants worldwide (2017)



Power generation capacity of nuclear power plants under construction (at the end of 2017)

Source: IAEA Energy, Electricity and Nuclear Power Estimates for the Period up to 2050
IEA Tracking Clean Energy Progress

9. Will hydrogen energy and power storage technologies come into general use?

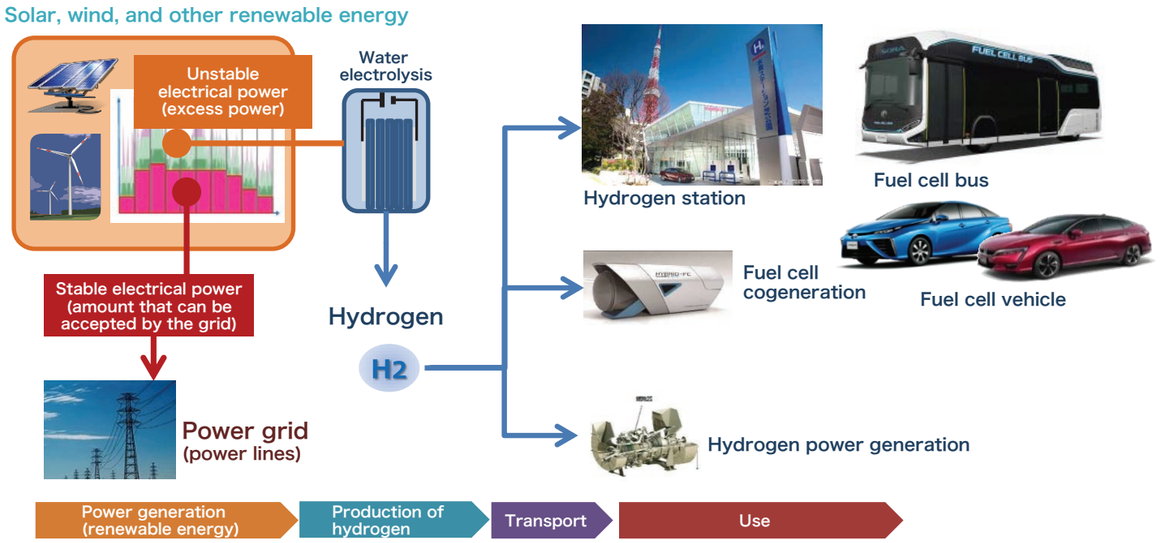
Hydrogen energy

Q Will the use of hydrogen energy become widespread in the future?

A In the future, hydrogen energy is expected to be used for a wide range of purposes and to play a central role of a future source of energy replacing oil and other energy sources.

A hydrogen based society using clean energy - Power to Gas

Expanding the use of renewable energy with fluctuating output such as solar and wind power will require technologies for storage of excess power. For this purpose, power-to-gas technologies which store energy as hydrogen are receiving attention both in Japan and overseas.



Fukushima Hydrogen Energy Research Field

2020
Demonstration project for large-scale hydrogen production using renewable energy - aiming for use during the Tokyo Olympics
(Namie Town, Fukushima Prefecture)

Large-scale network for maritime hydrogen transport

2020
Japan-Australia and Japan-Brunei Hydrogen Energy Supply Chain Project Demonstration

Hydrogen power generation demonstration test

2018
The world's first city district to achieve 100% hydrogen supply of heat and power entirely by hydrogen
(NEDO)

Fukushima Hydrogen Energy Research Field

One of the projects aimed at the conversion to a hydrogen supply structure is the Fukushima Hydrogen Energy Research Field that is underway in Namie Town, Fukushima Prefecture. The goal is not only to utilize the hydrogen that is produced in Namie Town within Fukushima Prefecture, but also to utilize it in Tokyo during the Tokyo 2020 Olympic and Paralympic Games.

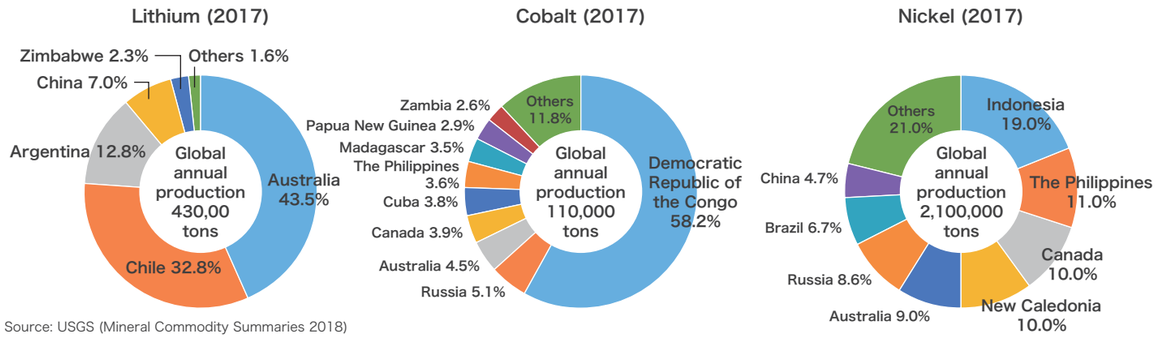
Reference: https://www.enecho.meti.go.jp/about/special/johoteikyo/fukushimasuiso.html

Use this QR code to view the article. (Japanese only)

Mineral resources

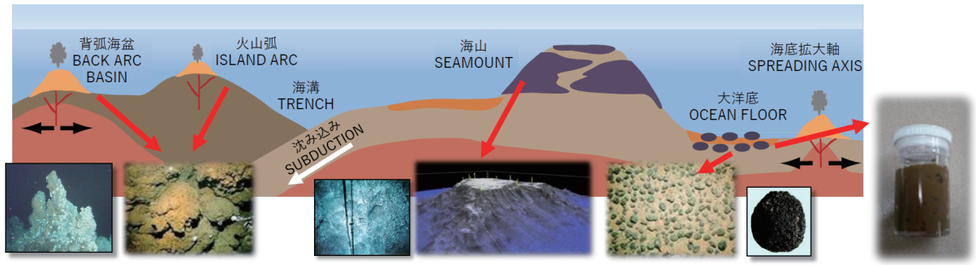
Q Have there been advances in research and development of domestic resources?

A An electric vehicle (EV) requires a large amount of mineral resources. Of particular importance are the minerals known as "rare earth metals". The lithium-ion battery that accounts for 1/3 of the vehicle price contains rare earth metals such as lithium, cobalt, nickel, and graphite. Japan relies on imports for nearly 100% of its mineral resources demands.



Source: USGS (Mineral Commodity Summaries 2018)

Japan has the world's 6th largest Territorial Sea / Exclusive Economic Zone (EEZ). This ocean area includes 4 marine mineral resource areas each containing different metals. Suitable technologies are being developed according to the depth and distribution of each resource.



	Submarine hydrothermal mineral deposit	Cobalt-rich crust	Manganese nodules	Mud containing rare earth metals
Features	Precipitated metal components of hot water that is ejected from hydrothermal vents on the sea floor	A crust of ferromanganese oxides ranging in thickness from several cm to several decimeters covering the slopes and peaks of undersea mountains	Ellipses of ferromanganese oxides with diameters of 2 - 15 cm scattered on the sea floor	Broadly distributed in clay sediments underneath the sea floor.
Sea areas where located	Okinawa, Izu, Ogasawara (EEZ)	Minamitori Island, others (EEZ, international waters)	Pacific Ocean (international waters)	Minamitori Island sea area (EEZ)
Metals contained	Copper, lead, zinc, others (including gold and silver)	Cobalt, nickel, copper, platinum, manganese, others	Copper, nickel, cobalt, manganese, others	Includes rare earth metals
Depth for development	700 m - 2,000 m	800 m - 2,400 m	4,000 m - 6,000 m	5,000 m - 6,000 m

Learn about the mineral resources that support industries around the world.

Rare earth metals and other mineral resources have become important resources that support industries all over the world. You may recall that they have frequently been hot topics, such as "rare earth metals" and "urban mines" - a term that describes scrapped home electronics and mobile phones that contain mineral resources. Here we will introduce some mineral resources that play a variety of roles in places out of sight.

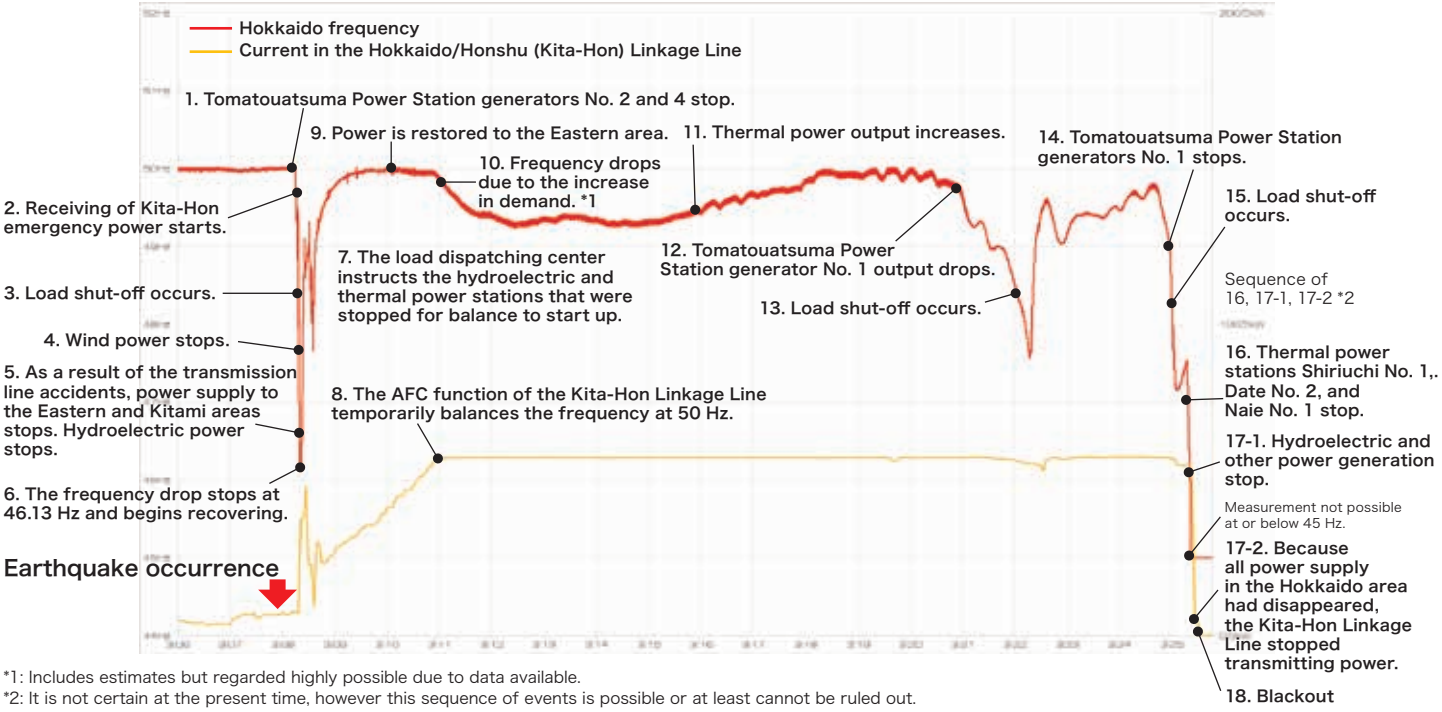
Reference: https://www.enecho.meti.go.jp/about/special/tokushu/anzenhosho/koubutsusigen.html#header

Use this QR code to view the article. (Japanese only)

10. 2018 energy topics

Hokkaido earthquake and blackout - 18 minutes from earthquake to blackout

An earthquake with a maximum seismic intensity of 7 struck Hokkaido at 3:07 on the morning of September 6, 2018. As a result of this earthquake, at 3:25 the entire Hokkaido area suffered large-scale blackout, an incident that Japan has never experienced. The blackout resulted from a combination of factors, including stoppage of the No. 1, 2, and 4 generators at the Tomatouatsuma Power Station, and multiple hydroelectric power generators that were taken offline by power transmission line accidents which affected 4 lines on 3 routes.

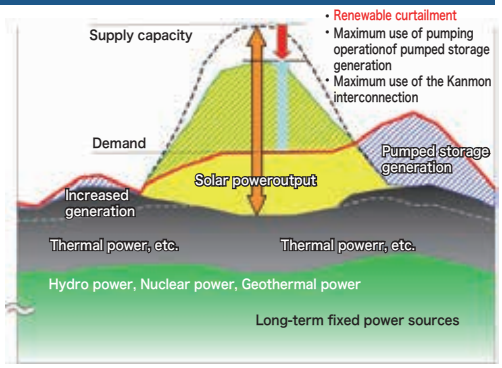


*1: Includes estimates but regarded highly possible due to data available.
*2: It is not certain at the present time, however this sequence of events is possible or at least cannot be ruled out.
Source: Created by the Agency for Natural Resources and Energy from the final report of the Verification Committee for the 2018 Hokkaido Eastern Iburi Earthquake.
Reference: https://www.occto.or.jp/iinkai/hokkaido_kensho/hokkaidokensho_saishuhoukoku.html

Renewable energy output restriction in mainland Kyushu

In order to maintain a balance between supply and demand and prevent widespread blackouts, when power supply exceeds demand, several measures are taken based on the priority dispatch rule which is determined by laws and regulations. At first, thermal power is curtailed, and pumping operation of pumped storage generation and electric transmission to other areas through interconnections are maximized. If an electrical surplus still remains, renewable electricity such as solar and wind is curtailed. In Kyushu, where solar PV was rapidly introduced, renewable curtailment occurred in October 2018 for the first time in mainland Japan. Solar and wind power generation tends to fluctuate depending on natural conditions, but renewable curtailment serves as a safety valve adjusting electric output when surplus occurs, which enable more renewable energy to be integrated into the power grid with security.

Source: based on Kyushu Electric Power Co.,Inc
(http://www.kyuden.co.jp/power_usages/pdf/common/seigyo.pdf?dt=20190517000000)



Accidents involving solar cell power generation equipment

As a result of the torrential rains that struck western Japan and typhoons in 2018, solar panels were blown away, immersed in water, or dislodged. Windmills were also knocked over, and other accidents occurred that brought concerns about the safety of renewable energy to the forefront. Together with measures aimed at reducing the cost of renewable energy, efforts will be made to ensure safety, to promote cooperation with local communities, and to work out measures for disposal of solar panel waste so that renewable energy can be used as a stable power supply source over the long-term.

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