JAPAN'S ENERGY 2020

10 questions for understanding the current energy situation

1. Energy Security
   - How much energy can Japan supply independently?

2. Economic Efficiency
   - How are electric power rates changing?

3. Environment
   - What is carbon neutrality?
   - What steps are being taken to ensure a stable energy supply and safety?

4. Safety
   - What is the government’s basic energy policy?

5. 3E+S
   - What innovations is Japan working on to achieve decarbonization?

6. Innovation
   - Is Japan advancing the introduction of renewable energy?

7. Renewable Energy
   - Is Japan advancing the reconstruction of Fukushima?

8. Reconstruction of Fukushima
   - Is nuclear power generation necessary?

9. Nuclear Power
   - How much energy efficiency has Japan achieved?
1. Energy Security

Changes in Energy Self-Sufficiency Ratio

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

A In 2018, Japan’s self-sufficiency ratio was 11.8%—lower than other OECD countries.

Comparisons of primary energy self-sufficiency ratios among major nations (2018)

<table>
<thead>
<tr>
<th>No.</th>
<th>Country</th>
<th>Self-sufficiency ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Norway</td>
<td>70.0%</td>
</tr>
<tr>
<td>2</td>
<td>Australia</td>
<td>320.0%</td>
</tr>
<tr>
<td>3</td>
<td>Canada</td>
<td>175.8%</td>
</tr>
<tr>
<td>4</td>
<td>USA</td>
<td>97.7%</td>
</tr>
<tr>
<td>5</td>
<td>UK</td>
<td>70.4%</td>
</tr>
<tr>
<td>6</td>
<td>France</td>
<td>55.1%</td>
</tr>
<tr>
<td>7</td>
<td>Germany</td>
<td>37.4%</td>
</tr>
<tr>
<td>8</td>
<td>Spain</td>
<td>27.4%</td>
</tr>
<tr>
<td>9</td>
<td>South Korea</td>
<td>16.0%</td>
</tr>
<tr>
<td>10</td>
<td>Japan</td>
<td>11.8%</td>
</tr>
<tr>
<td>11</td>
<td>Luxembourg</td>
<td>5.3%</td>
</tr>
</tbody>
</table>

Source: Estimates for 2018 from IEA “World Energy Balances 2019”, except for data for Japan, which are confirmed values of FY 2018, derived from “Comprehensive energy statistics of Japan”, Agency for Natural Resources and Energy. * The ranks in the table are those of the 35 OECD member countries.

Energy self-sufficiency ratio in Japan

Primary energy sources: Primary forms of energy, including oil, natural gas, coal, nuclear power, solar power, and wind power.

Energy self-sufficiency rate: The percentage of the primary energy resources required for people’s daily life and economic activities which can be produced or acquired in their own country.

Q What sources of energy does Japan depend on?

A Japan is largely dependent on oil, coal, natural gas (LNG), and other fossil fuels imported from outside Japan. Following the Great East Japan Earthquake, the degree of dependence on fossil fuels increased to 85.5% in FY 2018 in Japan.

Trends in the mix of the primary energy supply in Japan


* Renewable energy here, including geothermal power, wind power, and solar power, but not hydroelectric power, includes unused energy.
Q: What countries does Japan import fossil fuels from?

A: Japan depends on the Middle East for around 88% of its crude oil imports. For LNG and coal, although dependence on the Middle East is low, Japan still relies on imports from Asia and other overseas sources.

Sources of Japanese fossil fuel imports (2019)

Source: "Trade statistics of Japan", Ministry of Finance (The degree of dependence on sources outside Japan is derived from "Comprehensive energy statistics of Japan").

Efforts to secure the stable supply of resources: Japan is strengthening its relationships with the Middle East countries that are its main sources of crude oil. Aiming to increase the amount of LNG in the market, which is low compared to crude oil, Japan is also diversifying its supply sources, and working for further acquisition of resource rights and interests.

Q: What kinds of mineral resources are used?

A: As an example, the lithium-ion batteries that are used in electric vehicles require rare metals such as lithium, cobalt, and nickel. Japan depends almost 100% on imports for its mineral resources.

Global annual production of important rare metals

Source: USGS “Mineral Commodity Summaries 2020”

Efforts to secure the stable supply of mineral resources: The government has developed the Act for Establishing Energy Supply Resilience, which permits the revision of the JOGMEC Act. It enhances support for risk capital, i.e. funding and debt guarantee, to the mining development business (upstream) and refining business (midstream) in order to secure a stable supply of mineral resources.

JOGMEC Act: This is the Act on the Japan Oil, Gas and Metals National Corporation, which stipulates the scope of business for the JOGMEC.
2. Economic Efficiency

Changes in Electric Power Rates

Q How are electric power rates changing?

A Electric power rates have been rising since the Great East Japan Earthquake. The rates declined from FY 2014 to 2016 as a result of falling oil prices, but they are rising again.

Changes in average electric power rates

![Graph showing changes in electric power rates from 2010 to 2019(FY)]

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

Crude oil CIF price: Transaction price consisting of the import price plus related costs, such as transport cost and insurance cost.

Factor 1: Fuel prices

Fuel prices have an effect on electric power rates and energy cost.

The past decline in crude oil prices and the current situation

![Diagram showing decline in crude oil prices with labels for factors affecting the decline, such as Arab Spring and US shale oil boom]
Factor 2: Cost of renewable energy

Thanks to the introduction of the Feed-In Tariff scheme (FIT) in 2012, the installed capacity of renewable energy systems is growing rapidly. On the other hand, the purchase costs have reached 3.8 trillion yen (approximately 36 billion USD), and the cost of the surcharge to ordinary households based on the average model (260 kWh/month) has risen to 774 yen/month. We are working to expand the introduction of renewable energy sources in a cost-efficient way in order to maximize the use of renewable energy while suppressing the financial burden on the people.

Changes in the installed capacity of renewable energy (excluding large-scale hydroelectric power)

<table>
<thead>
<tr>
<th>Year</th>
<th>Solar</th>
<th>Wind</th>
<th>Hydroelectric</th>
<th>Biomass</th>
<th>Geothermal</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>50</td>
<td>100</td>
<td>200</td>
<td>150</td>
<td>50</td>
</tr>
<tr>
<td>2015</td>
<td>150</td>
<td>300</td>
<td>450</td>
<td>200</td>
<td>100</td>
</tr>
</tbody>
</table>

Average annual growth: 8%

Changes in surcharges following the introduction of the FIT scheme

- Surcharge price: 2.90 Yen/kWh (Average model: 754 Yen/month)
- Surcharge price: 2.95 Yen/kWh (Average model: 767 Yen/month)
- Surcharge price: 2.98 Yen/kWh (Average model: 774 Yen/month)

International comparison of electric power rates

The electric power rates in Japan were in a higher level for both home and industrial uses than other countries, but increasing burdens on the electric power companies overseas due to taxation and policies of promoting the introduction of renewable energy has reduced the gap in the rates between Japan and other countries.

We will have to continue efforts aimed at improving the efficiency of the electric power business and reducing electric power rates. On the other hand, we should be thoughtful of our country’s specific conditions, meaning our issues related to resource supply. We should consider that most fuels and raw materials are largely dependent on imports from outside Japan, and thus it is absolutely necessary for us to secure a stable supply of resources.

International comparison of electric power rates (2018)

<table>
<thead>
<tr>
<th>Country</th>
<th>Home use</th>
<th>Industrial use</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(Total tax)</td>
<td>Before-tax price</td>
</tr>
<tr>
<td>Japan</td>
<td>23.3</td>
<td>28.7</td>
</tr>
<tr>
<td>USA</td>
<td>12.9</td>
<td>15.8</td>
</tr>
<tr>
<td>UK</td>
<td>12.8</td>
<td>14.0</td>
</tr>
<tr>
<td>France</td>
<td>16.3</td>
<td>14.6</td>
</tr>
<tr>
<td>Germany</td>
<td>19.6</td>
<td>14.4</td>
</tr>
<tr>
<td>Italy</td>
<td>23.1</td>
<td>17.9</td>
</tr>
<tr>
<td></td>
<td>23.1</td>
<td>14.6</td>
</tr>
<tr>
<td></td>
<td>20.0</td>
<td>12.0</td>
</tr>
<tr>
<td></td>
<td>(19.0)</td>
<td>(7.1)</td>
</tr>
<tr>
<td></td>
<td>(12.9)</td>
<td>(6.1)</td>
</tr>
<tr>
<td></td>
<td>(23.3)</td>
<td>(17.9)</td>
</tr>
</tbody>
</table>

Source: Created based IAE “Energy Prices and Taxes 1st Quarter 2019”.

Note 1: The details of tax and before-tax prices are not known for the United States.

Note 2: The rates in Japan, France, and Germany are the amounts for the second quarter. The rates in England are for the third quarter for industrial use and the fourth quarter for home use.
3. Environment

Global Warming Countermeasures: Carbon Neutrality

Q What is carbon neutrality?

A It refers to achieving net zero greenhouse gas emissions.
- “Greenhouse gas” covers not only CO₂ but all gases with a “greenhouse effect,” including methane.
- “Net zero gas emissions” means balancing gas emissions with gas offsets obtained through removing such gases from the atmosphere, causing the total gases emitted to be equal to zero (net zero, or substantially zero).

Greenhouse gas emissions in Japan (FY 2018)

<table>
<thead>
<tr>
<th>Gas</th>
<th>Emissions (billion tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO</td>
<td>0.02</td>
</tr>
<tr>
<td>CH₄</td>
<td>0.03</td>
</tr>
<tr>
<td>CO₂ from emissions other than energy sources</td>
<td>0.08</td>
</tr>
<tr>
<td>Total emissions</td>
<td>1.24 billion tons</td>
</tr>
</tbody>
</table>

Rate of CO₂ from energy sources 85%

The amounts for greenhouse gases other than CO₂ are converted to CO₂ equivalents.

Simplified diagram for net zero emissions of greenhouse gases

Countries that have agreed with the principle of carbon neutrality

123 countries including Japan and one area

Transition to carbon neutrality

<table>
<thead>
<tr>
<th>Year</th>
<th>Emissions offset by absorbed amount equal to net zero tons (minus 100%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY 2018</td>
<td>Emissions not related to electric power generation</td>
</tr>
<tr>
<td>1,060 million tons</td>
<td>Consumer 110 million tons</td>
</tr>
<tr>
<td>Industry 300 million tons</td>
<td>Transport 200 million tons</td>
</tr>
<tr>
<td>FY 2030 with energy mix</td>
<td>930 million tons (minus 25%)</td>
</tr>
<tr>
<td>450 million tons</td>
<td>Electric power generation</td>
</tr>
<tr>
<td>800 million tons</td>
<td>Electric power generation</td>
</tr>
<tr>
<td>360 million tons</td>
<td>Electric power generation</td>
</tr>
<tr>
<td>FY 2050</td>
<td>0GGTFU</td>
</tr>
<tr>
<td>0GGTFU</td>
<td>0GGTFU</td>
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<tr>
<td>0GGTFU</td>
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<td>0GGTFU</td>
<td>0GGTFU</td>
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</tbody>
</table>

The Special Report on Global Warming of 1.5°C from the Intergovernmental Panel on Climate Change (IPCC) showed that we would have to achieve carbon neutrality by around 2050 to accomplish our goal of limiting the post-industrial-revolution rise in temperature to within 1.5 °C.

In order to accomplish this challenge of 1.5 °C, 123 countries including Japan and one area as of October 28, 2020 have pledged to achieve carbon neutrality by 2050.
Q  How much greenhouse gas is being emitted in Japan?
A  The amount of greenhouse gas emissions in Japan increased after the Great East Japan Earthquake. However, in FY 2018, emissions dropped to 1.24 billion tons. Japan must continue efforts toward reducing emissions.

Changes in Japan’s greenhouse gas emissions

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1,305</td>
<td>1,410</td>
<td>1,361</td>
<td>1,322</td>
<td>1,305</td>
<td>1,291</td>
<td>1,240</td>
<td></td>
<td></td>
</tr>
<tr>
<td>168</td>
<td>175</td>
<td>176</td>
<td>176</td>
<td>178</td>
<td>181</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>682</td>
<td>663</td>
<td>644</td>
<td>629</td>
<td>618</td>
<td>617</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Greenhouse gas emissions other than CO₂ from energy sources
- 85.4% Other than electric power
- 1,059 (million t-CO₂) Amount due to electric power

Source: Created based on the “Comprehensive energy statistics” and “Calculation results for the amount of greenhouse gas emissions in Japan”, published by the Ministry of the Environment.

Greenhouse gases: There are 6 main gases: carbon dioxide, methane, dinitrogen oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.

Column - Outlook for global CO₂ emissions

Japan generates the fifth-most CO₂ emissions in the world. Most of CO₂ emissions are from energy sources. The CO₂ emissions from energy sources have been decreasing in developed countries, but they have not decreased as a global total. Since CO₂ emissions from energy sources are caused by the use of fossil fuels, Japan is committed to developing innovations such as high-efficiency and low carbon technology and Carbon Recycling in order to contribute to the reduction of global CO₂ emissions.

Changes in global CO₂ emissions

Global CO₂ emissions(2017)

Source: Created based on IEA “Energy related CO₂ emissions 1990-2019”

Note: “Developed countries” refers to Australia, Canada, China, European Union countries, Iceland, Israel, Japan, the ROK, Mexico, Norway, New Zealand, Switzerland, Turkey, and the United States.

How do we measure the amount of CO₂ emissions? “Developed vs Developing countries”

Although CO₂ emissions are said to be “reducing in developed countries, but increasing in developing countries”, we should not be concerned too much about changes in emissions of respective countries and conflicts between the two groups of countries, but rather should keep an eye on how much we have been able to reduce global CO₂ emissions.

https://www.enecho.meti.go.jp/about/special/johoteikyo/co2_sokutei.html
4. Safety

Ensuring safety

Q What steps are being taken to ensure a stable supply of energy and safety in the face of intensifying natural disasters?

A In June, 2020, a Cabinet decision was made to enact the Act of Enhancing Energy Supply Resilience, and a partial revision of the Electricity Business Act was made. They will help to enhance collaborations in case of natural disasters, enhance resilience of the electricity transmission/distribution networks, and build disaster-resilient, distributed power systems.

Damage to the fuel and electric power infrastructure caused by typhoons and torrential rains

Collapsed wind turbine in Awaji City, Hyogo Prefecture (Due to a typhoon in August 2018)

Damaged floating solar power plant in Ichihara City, Chiba Prefecture (Due to a typhoon in September 2019)

Collapsed power transmission tower in Kimitsu City, Chiba Prefecture (Due to a typhoon in September 2019)

Flooded refinery facilities (Due to a typhoon in October 2019)

Submerged tank lorries (Due to torrential rain in July 2020)

Damage caused by tsunamis

Fukushima Daiichi Nuclear Power Station, which suffered a steam explosion due the effects of tsunamis following the Great East Japan Earthquake (March 2011)

Act for Enhancing Energy Supply Resilience

The Act for Enhancing Energy Supply Resilience is formally named “the Act of Partial Revision of the Electricity Business Act and Other Acts for Establishing Resilient and Sustainable Electricity Supply Systems”. As stated in the name (“the Electricity Business Act and Other Acts”), this act contains partial revisions not only for the act governing the electricity business, which is called “the Electricity Business Act,” but also for “the Act on Special Measures Concerning Procurement of Electricity from Renewable Energy Sources by Electricity Utilities” (“the Act on Renewable Energy Special Measures”) and “the Act on the Japan Oil, Gas and Metals National Corporation” (“JOGMEC Act”).

Legislative measures to improve power system resilience

This article highlights the objectives of the revisions and presents salient points of each related Act.
- The “Act for Establishing Energy Supply Resilience” aims to establish resilient and sustainable electricity supply systems
- Three challenges facing Japan’s power system infrastructure

Effort 1: Enhancing the resilience of electric power infrastructure

In the context of potential risks where large-scale disasters, such as massive typhoons or earthquakes directly beneath the Tokyo Metropolitan Area are possible, as well as increasing demands for decarbonization, it is essential to drastically enhance the resilience of the electric power networks in Japan. There is also a high demand to make the transition to next-generation networks suitable for the introduction of large volumes of renewable energy. We will strive to duplicate the nationwide networks to enhance the backup structure for those systems and ensure the resilience of the power infrastructure.

Status of enhancing cross-regional interconnection lines

- Between Hokkaido and Tohoku:
  - Duplication of lines (2019)
  - Increase by 0.3 million kW (2028)
  - Further increase to be considered
- Between Tohoku and Tokyo:
  - Duplication of lines (2027)
- Between Tokyo and Chubu:
  - Triplcation of lines (2020)
  - Transmission capacity to be increased 2.5 times as much as the current capacity (2028)

Projects for which enhancement policies have already been determined
Potential projects for which future measures are expected (examples)

Resilience: means sturdiness, recuperative power or elasticity.
Cross-regional interconnection lines: power transmission lines, frequency converters and AC/DC converters that connect different control areas, allowing the exchange of power across area borders.

Effort 2: Conforming to new regulatory requirements for higher levels of safety

When nuclear power plants are restarted, the Nuclear Regulation Authority will require them to conform to new regulatory requirements, which demand stricter accident-prevention measures than the former requirements. The power plants are also required to prepare provisions for contingencies and anti-terrorism measures.

Conventional regulatory requirements

Standards for prevention of severe accidents (design standards)
- Preparedness for natural phenomena
- Preparedness for fires
- Reliability of power sources
- Performance of other instruments
- Performance against earthquakes and tsunami

New regulatory requirements (July 2013)

- Measures against intentional aircraft collisions
- Measures against the proliferation of radioactive materials
- Measures against container damage
- Measures against reactor core damage (in the case of multiple instruments malfunctioning)
- Preparedness for internal overflows (newly introduced)
- Preparedness for natural phenomena (volcanic eruptions, tornadoes, and forest fires have been newly introduced)
- Preparedness for fires
- Reliability of power sources
- Performance of other instruments
- Performance against earthquakes and tsunamis

Anti-terrorism measures (newly introduced)

Severe accident measures (newly introduced)

Example measures against severe accidents

In preparation for a serious incident in which vapor in the containment vessel must be discharged into the atmosphere to reduce the pressure in the containment vessel, the nuclear power plants must maintain systems that are capable of limiting the volume of discharge of radioactive substances to less than 1/1,000 and of preventing hydrogen explosion.

Typical new requirements demanding stricter measures

Earthquakes: The reference value for seismic vibration has been revised from 580 Gal to 1,000 Gal. Tsunamis: Based on the previous experience of earthquake disasters, potential tsunami height is estimated to be 23.1 m and the required height of tide embankments has been revised from 14.8 m to 29 m.

Source: TEPCO website

Source: Documents of the Nuclear Regulation Authority.
5. **3E+S**

**Basic Policy**

**Q** What is the government’s basic energy policy?

**A** With the underlying premise that Safety is always the primary concern, we are making efforts to simultaneously achieve improvement of Energy Security (self-sufficiency rate), Economic Efficiency, and Environment (3E+S).

Japan is a country with limited natural resources. There is no one source of energy that is superior in every way. Therefore, it is essential to create a multi-layered energy supply structure where each energy resource is exploited fully for its best performance and compensates for disadvantages of other resources.

- **Energy Security** (Self-sufficiency rate)
  - Exceed the level from before the Great East Japan Earthquake (around 20%).
  - Approximately 25% in FY 2030 (currently 11.8%)

- **Economic Efficiency** (Electricity cost)
  - Reduce costs from their current level.
  - (9.7 trillion yen in FY 2013) ⇒ 9.2 to 9.5 trillion yen in FY 2030
  - *When formulating the energy mix*

- **Environment** (Greenhouse gas emissions)
  - 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 primary energy supply and the structure of power sources in the future be?

**A** The figure below shows the ideal energy supply and demand structure (energy mix) for FY 2030 that will be realized by measures based on the government’s basic energy policy.

### Primary Energy Supply

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>FY 2018</th>
<th>FY 2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renewable</td>
<td>12%</td>
<td>13 to 14%</td>
</tr>
<tr>
<td>Nuclear</td>
<td>3%</td>
<td>1 to 10%</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>23%</td>
<td>18%</td>
</tr>
<tr>
<td>LPG</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td>Coal</td>
<td>25%</td>
<td>25%</td>
</tr>
<tr>
<td>Oil</td>
<td>35%</td>
<td>30%</td>
</tr>
</tbody>
</table>

### Mix of Power Sources

<table>
<thead>
<tr>
<th>Power Source</th>
<th>FY 2018</th>
<th>FY 2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renewable Energy</td>
<td>17%</td>
<td>22 to 24%</td>
</tr>
<tr>
<td>Nuclear Energy</td>
<td>3%</td>
<td>6%</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>38%</td>
<td>22 to 24%</td>
</tr>
<tr>
<td>Coal</td>
<td>32%</td>
<td>26%</td>
</tr>
<tr>
<td>Oil</td>
<td>7%</td>
<td>3%</td>
</tr>
</tbody>
</table>

<Reference: FY 2018>
- Geothermal 0.2%
- Biomass 2.2%
- Wind 0.7%
- Solar 6.0%
- Hydro electric 7.7%

*The sum of the values shown may not be 100% in some cases for a reason of round values.*
Current Progress of Energy Mix

**Energy Security**
Changes in energy self-efficiency rates

**Economic Efficiency**
Changes in electric power costs (fuel + FIT)

**Environment**
Changes in the amount of CO₂ emissions from energy sources

Source: Created by the Agency for Natural Resources and Energy based on the "Comprehensive energy statistics (Confirmed values of FY 2018)"

COVID-19 crisis and stable energy supply

Q
What impacts did the COVID-19 crisis have on the demand and supply of energy?

A
The International Energy Agency (IEA) estimated that the world GDP of 2020, primary energy supply rates, and CO₂ emissions would be significantly less than in the previous year.

Percent change due to the COVID-19 crisis and the past crises from the previous year (global)

Status and challenges on the demand side

1. Efforts towards the improvement of efficiency in the use of energy and the total optimization on the basis of new daily life, lifestyle, and business activities
2. Support and promotion of energy transition (e.g. electrification, expanded use of hydrogen)
   - AI, IoT, digitization...

Status and challenges on the supply side

3. Stable procurement of resources and fuels
   - Fossil resources, Mineral resources
4. Creation of an environment in which the investment for innovation is made in a systematic manner
5. Further use of decarbonized energy
6. Further enhancement of energy resilience

Source: Created from the materials of the 31st Comprehensive Resources and Energy Study Group Basic Policy Subcommittee
6. Innovation

Japan’s Up-and-Coming Innovations

What innovations is Japan working on to achieve decarbonization?

For example, production of CO₂-free hydrogen from renewable energy sources, wide-ranging use of hydrogen in fuel cell vehicles and other equipment, and Carbon Recycling are promising.

Efforts for creating a hydrogen-based society

We are promoting the use of hydrogen in a wide variety of fields, including fuel cell vehicles and household fuel cells, in addition to the construction of supply chains aimed at enabling large-scale hydrogen supply and international trade in hydrogen.

Carbon Recycling (reuse of CO₂)

This is a technology used for capturing CO₂, and utilizing it as a raw material resource in concrete, plastics or others thereby controlling CO₂ emissions into the atmosphere.

Hydrogen Energy Update: A promising image of a “hydrogen-based society” is emerging.

The government of Japan and various private enterprises are using all efforts to carry out demonstration projects with a view to realizing a “hydrogen-based society” ahead of other countries. Let’s see how hydrogen energy is being utilized now in 2020.

Q How far has the innovation progressed in Japan?

A The government formulated the Environment Innovation Strategy in January 2020 to define 39 subjects on the following five top priority technology sets for the cost targets, technology roadmap, implementation systems, etc.

1. **Non-fossil energy**
   - **Renewable energy**
     - PV · Hydro · Wind · Geothermal · Solar thermal · Underground heat and unused heat · Biomass · Ocean energy
   - **Fossil fuels**
     - Coal · Oil · Natural gas · Methane hydrate
   - **Nuclear power**

2. **Energy networks**
   - **Electricity**
     - Electricity · Heat
   - **Secondary energy**
   - **Ultimate energy consumption**
     - Agriculture, forestry and fisheries 2)

3. **Hydrogen**
   - **CO₂**
     - CO₂ storage
     - Hydrogen import
     - Oversea sites
     - CCS
     - DAC
     - Air
     - H₂
     - CO₂

4. **Carbon Recycling and CCUS** 1)

5. **Zero-emission agriculture, forestry and fisheries**

**Practical use of various technologies can reduce CO₂ emissions**

- **Flexible, lightweight, high-efficiency photovoltaic generation**
- **Building an integrated supply chain from production through transport & storage to utilization of hydrogen**
- **Developing a technology for the reduction of iron ore with hydrogen**
- **Separating and collecting CO₂ from emissions from thermal power plants or other facilities and recycling it into construction materials**
- **Developing technologies to capture CO₂ from the atmosphere and solidify it**
- **Developing next-generation electrified aircraft, etc. and required technologies to realize such aircraft**
- **Developing technologies to sustain and expand CO₂ absorption in forests and oceans**

**Source:** Overview of “Environment Innovation Strategy” determined by the Council for Integrated Innovation Strategy on January 21, 2020

**Note:** For the reduction and absorption quantities, the total world values are estimated by NEDO.

**Innovations currently in progress in the nuclear power sector**

One of the innovative nuclear technologies is so-called small modular reactors. Besides use for power generation, nuclear technologies have been actively studied for the production of hydrogen, use with thermal energy, energy resources in remote locations, and for medical/industrial use.

https://www.enecho.meti.go.jp/about/special/johoteikyo/smr_01.html
7. Renewable Energy

Introduction of Renewable Energy

Q: Is Japan advancing the introduction of renewable energy?

A: The percentage of renewable energy power in Japan was 18% in FY 2019. Japan ranks 6th in the world in terms of renewable energy generation capacity, and 3rd in the world for solar power generation.

Comparison of percentages of renewable energy in total power generation in major nations

(Percentage of total generated power)

<table>
<thead>
<tr>
<th>Country</th>
<th>Nuclear power</th>
<th>Natural gas</th>
<th>Coal</th>
<th>Hydro electricity</th>
<th>Renewable energy</th>
<th>Total renewable energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>10.9%</td>
<td>31.3%</td>
<td>37.5%</td>
<td>15.5%</td>
<td>0.0%</td>
<td>100%</td>
</tr>
<tr>
<td>UK</td>
<td>19.7%</td>
<td>33.5%</td>
<td>39.7%</td>
<td>1.1%</td>
<td>0.0%</td>
<td>100%</td>
</tr>
<tr>
<td>Spain</td>
<td>18.0%</td>
<td>21.3%</td>
<td>14.2%</td>
<td>16.9%</td>
<td>0.0%</td>
<td>100%</td>
</tr>
<tr>
<td>Italy</td>
<td>22.8%</td>
<td>44.6%</td>
<td>10.7%</td>
<td>16.9%</td>
<td>0.0%</td>
<td>100%</td>
</tr>
<tr>
<td>France</td>
<td>28.7%</td>
<td>34.3%</td>
<td>28.7%</td>
<td>16.7%</td>
<td>0.0%</td>
<td>100%</td>
</tr>
<tr>
<td>USA</td>
<td>34.0%</td>
<td>30.0%</td>
<td>25.5%</td>
<td>6.7%</td>
<td>0.0%</td>
<td>100%</td>
</tr>
<tr>
<td>Canada</td>
<td>37.7%</td>
<td>36.3%</td>
<td>28.7%</td>
<td>6.7%</td>
<td>0.0%</td>
<td>100%</td>
</tr>
<tr>
<td>China</td>
<td>31.9%</td>
<td>31.8%</td>
<td>32.5%</td>
<td>2.8%</td>
<td>0.0%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Source: IEA database, investigation by the Agency for Natural Resources and Energy

Renewable energy power generation capacity among major nations (Results for 2018)

<table>
<thead>
<tr>
<th>Country</th>
<th>Biomass (GW)</th>
<th>Geothermal (GW)</th>
<th>Hydro (GW)</th>
<th>Wind (GW)</th>
<th>Solar (GW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>730</td>
<td>134</td>
<td>126</td>
<td>123</td>
<td>114</td>
</tr>
<tr>
<td>USA</td>
<td>280</td>
<td>57</td>
<td>53</td>
<td>53</td>
<td>100</td>
</tr>
<tr>
<td>Brazil</td>
<td>100</td>
<td>57</td>
<td>53</td>
<td>53</td>
<td>100</td>
</tr>
<tr>
<td>Germany</td>
<td>114</td>
<td>57</td>
<td>53</td>
<td>53</td>
<td>100</td>
</tr>
<tr>
<td>India</td>
<td>100</td>
<td>57</td>
<td>53</td>
<td>53</td>
<td>100</td>
</tr>
</tbody>
</table>

Solar power generation capacity among major nations (Results for 2018)

<table>
<thead>
<tr>
<th>Country</th>
<th>Biogas (GW)</th>
<th>Geothermal (GW)</th>
<th>Hydro (GW)</th>
<th>Wind (GW)</th>
<th>Solar (GW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>175</td>
<td>62</td>
<td>56</td>
<td>45</td>
<td>28</td>
</tr>
<tr>
<td>USA</td>
<td>200</td>
<td>62</td>
<td>56</td>
<td>45</td>
<td>28</td>
</tr>
<tr>
<td>Japan</td>
<td>200</td>
<td>62</td>
<td>56</td>
<td>45</td>
<td>28</td>
</tr>
<tr>
<td>Germany</td>
<td>200</td>
<td>62</td>
<td>56</td>
<td>45</td>
<td>28</td>
</tr>
<tr>
<td>India</td>
<td>200</td>
<td>62</td>
<td>56</td>
<td>45</td>
<td>28</td>
</tr>
</tbody>
</table>

Source: Created by the Agency for Natural Resources and Energy based on the IEA “Renewables 2019”
Is it possible to meet all demands of electric power only with renewable energy?

The amount of electricity generated by renewable energy varies significantly depending on the weather and season. In order to ensure a stable supply, it is necessary to secure a method of energy storage to complement renewable energy in combination with flexible output power sources, such as thermal power generation and storage batteries.

Supply/demand situation on the lowest demand day (such as a sunny day in May)

The power generation (supply) should be balanced with the consumption (demand) at all times to ensure stable access to electric power. To this end, power sources with variable output such as thermal power generation are used to compensate for fluctuations in the output of renewable energy generation.

What are the policies being implemented by the government to make renewable energy a major power source?

The government is adopting a support scheme to be linked to the electric power market as in Europe for renewable energy sources which are expected to become competitive in the future, such as large-scale photovoltaic and wind power.

FIT and FIP schemes

It has been decided that renewable energy sources which are expected to become competitive should be subject to the FIP scheme to be linked to the electric power market as in Europe. We are expanding the introduction of such renewable energy resources in a cost-efficient manner in order to achieve both the maximum introduction of renewable energy and the suppression of the burden on consumers.

* The Calculation Committee for Procurement Price, etc. will deliberate on target renewable energy for a possible support scheme and the timing of such support, considering the conditions of renewable energy introduced, etc., and the Minister of Economy, Trade and Industry will make a decision based on the results of committee deliberations.

FIT scheme: The prices are fixed, and the revenues are constant whenever power is generated.

FIP scheme: The subsidy (premium) remains constant for a pre-determined period with the revenues linked to market prices.

Market trends for lithium-ion electricity storage systems in Japan

The number of systems shipped in Japan exceeded 110 thousand in FY2019. Out of them, 90% are for home use, and an increase is expected in the rate of self-consumption of the surplus power from solar power generation.

Electrified vehicles become lifelines in disasters!

How to use xEVs as emergency power sources.

The Ministry of Economy, Trade and Industry published the “Manual for Promoting Use of Electrified Vehicles in Disaster Situations” in collaboration with the Ministry of Land, Infrastructure, Transport and Tourism. Try using the reference manual to check the proper procedures for using an electrified vehicle to supply electricity.

https://www.enecho.meti.go.jp/about/special/johoteikyo/xev_saiga.html
8. Reconstruction of Fukushima

Decommissioning and Contaminated Water Management of Fukushima Daiichi Nuclear Power Station

Q Are decomposition and contaminated water management in Fukushima Daiichi Nuclear Power Station progressing?

A Although decommissioning and contaminated water management are unprecedented challenges, measures are being implemented safely and steadily based on the “Mid-and-Long-Term Roadmap”.

Decommissioning

All reactors are kept in stable conditions, and rubble removal, decontamination, and other measures are being carried out toward fuel removal from the spent fuel pools. Investigations of inside of the containment vessels and the development of special equipment for fuel debris retrieval (melted and re-solidified fuel) are being advanced in preparation for fuel debris retrieval. Based on the investigation results, trial retrieval will start at Unit 2 as soon as preparations are in place and the scale of retrieval will be gradually expanded.

Contaminated water management

The amount of contaminated water generated per day at the Fukushima Daiichi Nuclear Power Station has been reduced to around one-third of the initial amount through multi-layered countermeasures (such as frozen-soil walls). Contaminated water is treated using multiple purification facilities that remove as many of the radioactive materials as possible before the water is stored in tanks. The water quality in the surrounding sea areas has also been greatly improved.

Efforts of decommissioning and contaminated water management at Fukushima Daiichi Nuclear Power Station

Decommissioning and contaminated water management is explained on the websites.

- The challenge of retrieving “fuel debris”
- Fight against contaminated water
- First priority is given to safety and security

Measures related to contaminated water in Fukushima

https://www.enecho.meti.go.jp/about/special/keyword/?k=廃炉
Reconstruction of Fukushima

Q Is Japan advancing the reconstruction of Fukushima?

A The government has lifted evacuation orders for all areas except for “Areas where returning is difficult”. The JR Joban line resumed full operation from March 14, 2020. Efforts are being made toward constructing the Specified Reconstruction and Revitalization Base in “the areas where returning is difficult”. Efforts are also underway for restoring Fukushima communities through accelerating decontamination and construction of infrastructure/living environment services, rebuilding livelihoods, creating new industries, and promoting industrial clusters.

Fukushima Innovation Coast Framework

This project aims to create new industrial bases for economic recovery in the Hama-dori (coastal) area and other areas.

The Fukushima plan for a new energy society

The prefecture is creating a model for a future New Energy Society and promoting the “Fukushima Model” to the world.

Expanding the introduction of renewable energy
- Reinforcement of transmission lines for 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 (Introduction of a 10,000 kW water electrolysis system - the largest in the world)
- Demonstration project for 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 produced in Fukushima are tested for safety before shipment. Any items exceeding the radiation standards are restricted from shipment at each city, town, or village level. Therefore, such items will not be distributed to the market.

Status of monitoring inspections for agricultural, forestry and fishery products


<table>
<thead>
<tr>
<th>Classification</th>
<th>Number of inspections</th>
<th>Number exceeding standard</th>
<th>Percentage exceeding standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brown rice (produced in 2020)</td>
<td>1220</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>Vegetables/fruits</td>
<td>1,743</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>Livestock products</td>
<td>442</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>Cultivated plants/mushrooms</td>
<td>1,689</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>Marine seafood</td>
<td>14</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>Fish from inland fisheries</td>
<td>458</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>Edible wild plants/mushrooms</td>
<td>459</td>
<td>4</td>
<td>3.50%</td>
</tr>
</tbody>
</table>

All rice produced and shipped in all areas of Fukushima were inspected for safety. Since no products exceeding the radiation standards have been found since 2015, all rice harvested in 2020 in Fukushima, except for 12 areas of cities, towns, and villages covered by the evacuation order, is now subject to less restrictive monitoring, while the rice harvested in 12 areas covered by the evacuation order are still strictly inspected on a ‘every-lot basis’ for safety.

Source: Created based on “Progress of Fukushima Recovery (Ver. 29)”
9. Nuclear Power

Operational Status of Nuclear Power Plants

Is nuclear power generation necessary?

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

Operating status of nuclear power plants in Japan

<table>
<thead>
<tr>
<th>Region</th>
<th>Plant Name</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Niigata (TEPCO)</td>
<td>Tomari Nuclear Power Plant</td>
<td>Online</td>
</tr>
<tr>
<td>Ishikawa</td>
<td>(Hokuriku EPC) Shika Nuclear Power Plant</td>
<td>Online</td>
</tr>
<tr>
<td>(JAPC) Tsuruga</td>
<td>Nuclear Power Plant</td>
<td>Online</td>
</tr>
<tr>
<td>(KEPCO) Mihama</td>
<td>Nuclear Power Plant</td>
<td>Online</td>
</tr>
<tr>
<td>(KEPCO) Ooi</td>
<td>Nuclear Power Plant</td>
<td>Online</td>
</tr>
<tr>
<td>(KEPCO) Takahama</td>
<td>Nuclear Power Plant</td>
<td>Online</td>
</tr>
<tr>
<td>Fukushima</td>
<td>(Tohoku EPC) Higashidori Nuclear Power Plant</td>
<td>Online</td>
</tr>
<tr>
<td>(Tohoku EPC)</td>
<td>Onagawa Nuclear Power Plant</td>
<td>Online</td>
</tr>
<tr>
<td>Shimane (Chugoku EPC) Shimane Nuclear Power Plant</td>
<td>Online</td>
<td></td>
</tr>
<tr>
<td>Saga (Kyushu EPC)</td>
<td>Genkai Nuclear Power Plant</td>
<td>Online</td>
</tr>
<tr>
<td>Kagoshima (Kyushu EPC) Sendai Nuclear Power Plant</td>
<td>Online</td>
<td></td>
</tr>
<tr>
<td>Ehime (Shikoku EPC) Ikata Nuclear Power Plant</td>
<td>Online</td>
<td></td>
</tr>
</tbody>
</table>

Aomori (Electric Power Development Co.) Ooma Nuclear Power Plant

(As of December 8, 2020)

Nuclear Fuel Cycle and Geological Disposal

Japan is advancing technologies for the "nuclear fuel cycle", in which spent fuel from nuclear reactors is reprocessed, the recovered uranium and plutonium are reused, and the volume of waste is reduced.

Three advantages of the nuclear fuel cycle

- Reduces the amount of radioactive waste.
- Shortens the time until hazard of radioactive waste declines to the same degree as natural uranium.
- Allows effective use of resources.

When spent fuel is disposed of directly: The waste remains hazardous for approximately 100,000 years.

When it is solidified into a vitrified waste: The volume is reduced to around 1/4 and the waste remains hazardous for only approximately 6,000 years (around 1/12 of the original period).

Remaining waste is melted into the raw glass material to create a vitrified waste, which is buried deep underground to eliminate any possibility of exposure (geological disposal).
To promote a better understanding of the mechanism of geological disposal and the geological environment of Japan, the "Nationwide Map of Scientific Features" was published in July 2017.

Classification of area into 4 colors based on scientific features

- Orange: Areas close to a volcano, active fault, etc.
- Silver: Areas with underground mineral resources
- Green: Areas assumed to be favorable
- Dark green: Areas assumed to be preferable also from the viewpoint of safe waste transportation

* Even in the green areas, step-by-step investigations need to be conducted to confirm precisely whether or not a particular location satisfies the required conditions for geological disposal.


Since the Nationwide Map of Scientific Features was published, public dialogue sessions with local people have been held throughout Japan. Building on these past efforts, dialogues will continue to be held across Japan to aim to conduct literature research in as many areas as possible.

No radioactive substances will be brought into the target area during the research period which is expected to be approximately 20 years.

Column: Global trends in nuclear power generation

From the viewpoint of the total output results of nuclear power generation, the leading countries are, in order, the United States, France, China, Russia, and South Korea. However, for the generation capacity of nuclear power plants under construction, China will be the leader as it is constructing an extremely large number of plants.

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>China</td>
</tr>
<tr>
<td>France</td>
<td>UAE</td>
</tr>
<tr>
<td>China</td>
<td>South Korea</td>
</tr>
<tr>
<td>Russia</td>
<td>India</td>
</tr>
<tr>
<td>South Korea</td>
<td>Russia</td>
</tr>
<tr>
<td>Canada</td>
<td>UK</td>
</tr>
<tr>
<td>Ukraine</td>
<td>USA</td>
</tr>
<tr>
<td>Germany</td>
<td>Belarus</td>
</tr>
<tr>
<td>Japan</td>
<td>Bangladesh</td>
</tr>
<tr>
<td>Sweden</td>
<td>Ukraine</td>
</tr>
<tr>
<td>Spain</td>
<td>Pakistan</td>
</tr>
<tr>
<td>UK</td>
<td>France</td>
</tr>
<tr>
<td>Belgium</td>
<td>Finland</td>
</tr>
<tr>
<td>India</td>
<td>Brazil</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>Turkey</td>
</tr>
<tr>
<td>Switzerland</td>
<td>Iran</td>
</tr>
<tr>
<td>Finland</td>
<td>Slovakia</td>
</tr>
</tbody>
</table>

Source: IAEA Energy, Electricity and Nuclear Power Estimates for the Period up to 2050 REFERENCE DATA SERIES No. 1 2020 Edition
10. Energy Efficiency

How much energy efficiency has Japan accomplished?

Japan is continuing efforts to increase energy efficiency. Improvements in energy efficiency are essential in order to achieve the projected demand and supply in FY2030 with the currently planned energy mix.

New energy efficiency indicator for devices

The evaluation metric based on a score of one to five that was used to date has been changed to a 41-point scale in increments of 0.1 (1.0 to 5.0) to allow for greater detail and differentiation. The new metric has been utilized for electric refrigerators, electric freezers, electric toilet seats, and lighting devices since November 2020, and the new rating system is now being used in retail outlets. The new metric will also be applied to air conditioners and TV sets in and after 2021.

A typical (new) unified label for energy efficiency (an electric refrigerator)

1. Multistage evaluation score
   These scores represent the comparative energy efficient performance of the product in the market on a 41-point scale in 0.1 unit increments from 5.0 to 1.0 in the order of quality (multistage evaluation). The star is based on the multistage evaluation score.

2. Energy efficiency label
   This label shows energy efficiency, achievement level based on the standard, efficiency of energy consumption, and target fiscal year.

3. Estimated annual electric rates
   The estimated annual electric rates are indicated to facilitate understanding of the energy consumption efficiency (i.e. annual electricity consumption).

You can access the new energy efficiency label on this site: Information site for energy efficient products

On this site, you can view the energy efficient performance for each device and download the label for printing. This site contains information on how to select and use an energy efficient device for reference in purchasing a home electric or gas appliance. We are distributing the "Brochure of Energy Efficient Performance in PDF format" covering more than 4,000 products.

Contact: Research and Public Relations Office, General Policy Division, Director-General, Secretariat, Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry
1-3-1 Kasumigaseki, Chiyoda-ku, Tokyo 100-8931
TEL: +81-(0)3-3501-1511 (main) https://www.eenecho.meti.go.jp/
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