経済産業省
Ministry of Economy, Trade and Industry

# Energy White Paper 2021 (Summary)

**June 2021**

**Agency for Natural Resources and Energy**

# Energy White Paper 2021

- The Energy White Paper is an annual report based on the Basic Act on Energy Policy (statutory white paper). The 2021 version is the 18th publication since its first release.
- The White Paper has been historically comprised of 3 parts, namely Part 1: Analysis based on the current energy situation, Part 2: Data on energy trends at home and abroad, and Part 3: Measures taken. The composition of the 2021 version is as follows:

## ■Composition of 2021 version

### Part 1 Current Energy Situation and Key Measures

**Chapter 1** Progress of reconstruction of Fukushima

1. Efforts made to cope with the accident at Fukushima Daiichi Nuclear Power Station
2. Support for victims of the accident
3. Fukushima plan for a new energy society
4. Nuclear damage compensation

**Chapter 2 Efforts and challenges toward carbon neutrality by 2050**

1. Changing energy situation (affected by finance and COVID-19, etc.)
2. International trends toward decarbonization
3. Efforts to address challenges toward carbon neutrality by 2050 in Japan

**Chapter 3** Changing energy security

1. Energy security for fossil fuels
2. Structural changes in energy security
3. Assessment of energy security based on the structural changes

### Part 2 Energy Trends

**Chapter 1** Domestic energy trends

1. Energy supply and demand
2. Energy consumption by sector
3. Primary energy
4. Secondary energy

**Chapter 2** International energy trends

1. Energy supply and demand
2. Primary energy
3. Secondary energy
4. Comparison of energy costs by country

### Part 3 Measures Taken in FY2020 concerning Energy Supply and Demand

**Chap.1** Comprehensive measures to secure a stable supply of energy

**Chap.2** Smarter and more flexible consumption activities toward realizing a society of enhanced energy efficiency

**Chap.3** Renewable energy to be a main source of electricity

**Chap.4** Nuclear policy deployment

**Chap.5** Environment in which fossil fuels can be utilized efficiently and stably

**Chap.6** Supply structure reform with cross-market transactions

**Chap.7** Resilience of domestic energy supply networks

**Chap.8** Resilience of energy systems and structural reform toward new types of secondary energy such as hydrogen

**Chap.9** Comprehensive international cooperation on energy

**Chap.10** Strategic technological development

**Chap.11** Enhancing public awareness on energy by close communication

# (Reference) Changes of Topics in Part 1 of White Paper

- Part 1, analyzing the latest trends, characterizes each year's White Paper.

| Part 1 | Chapter 1 | Chapter 2 | Chapter 3 |
|---|---|---|---|
| **2021** | **Progress of the Reconstruction of Fukushima** | **Efforts and challenges toward carbon neutrality by 2050**<br>1. Changing energy situation (affected by finance and COVID-19, etc.)<br>2. International trends<br>3. Efforts and challenges toward carbon neutrality by 2050, and promotion of innovation | **Changing energy security**<br>1. Energy security for fossil fuels<br>2. Structural changes in energy security<br>3. Assessment of energy security based on the structural changes |
| 2020 | Progress of the reconstruction of Fukushima | Resilience of energy systems based on risks associated with disasters and geopolitics | Measures to cope with the effectuation of the Paris Agreement |
| 2019 | Reconstruction of Fukushima | Global warming countermeasures and energy policy based on the Paris Agreement (long-term strategy) | Recent disaster response and efforts toward the enhancement of energy resilience |
| 2018 | Historical evolution of the energy situation in Japan since the Meiji Restoration | Progress of the reconstruction of Fukushima | Energy situation at home and abroad and varying challenges (Basic Energy Plan/Discussion Meeting) |
| 2017 | Progress of the Reconstruction of Fukushima | New development of energy policies (JOG, FIT, Retail market liberalization) | Energy system reform and enhancement of competitiveness of the energy industry |
| 2016 | Energy security in the era of cheap crude oil prices | Response to the accident at Fukushima and formulation of nuclear policy based on the lessons learned | Energy Policy reform based on the Paris Agreement (energy mix) |

# Chapter 1 Progress of the Reconstruction of Fukushima

**The Reconstruction of Fukushima from the nuclear disaster**
**--The starting point for promoting energy policies--**

- March 2021 marked the tenth year after the accident at TEPCO's Fukushima Daiichi NPS. Although reconstruction of Fukushima is progressing gradually, there are a number of challenges left unsolved. We must be firmly determined not to cause such a disastrous incident again. We pledge to continue an all-out effort toward decommissioning of the NPS and reconstruction of Fukushima.

## Decommissioning of NPS (On-site)

- Damaged reactors are maintained under low temperature with on-site radiation levels reduced substantially.
  ※ In 96% of the NPS area, wearing protective clothing is not mandatory.
- Work for decommissioning progressing steadily

1. Contaminated water and treated water management:

・Contaminated water generation reduced substantially thanks to frozen soil walls and other measures.

※ 540㎥/day (May 2014) ⇒ 140㎥/day (during 2020)

・Basic policy on ALPS-treated water disposal formulated (Apr. 2021)

2.Spent fuel removal from the pool in Units ¾ completed.

3. Fuel debris retrieval: investigation of the inside of the reactor progressed.

## Reconstruction of Fukushima (off-site)

- Evacuation orders lifted for all areas except "restricted areas"
  ※ Number of evacuees under evacuation orders
  81,000 (August 2013)⇒ 22,000 (April 2020)
- Creating an environment for re-inhabitation
  ※ The JR Joban Line resumed full operation (march 2020). Roadside service areas developed, etc.
- Business environment reinvigorated with industrial locations gradually increased
  ※ 398 corporate locations in 15 municipalities creating 4,610 jobs (December 2020)
- Industrial bases opened to create clusters of new industries
  ※ Fukushima Robot Test Field (Fully operational in March 2020)
  ※ Fukushima Hydrogen Energy Research Field (opened in March 2020)

## Remaining Challenges

○ Measures to reputational damage, disposal of ALPS-treated water

○ Spent fuel removal from the pool

※ To be completed at all Units by 2031

○ Fuel debris retrieval

○ Handling of "restricted areas"

※ Maintenance of the Specified Reconstruction and Revitalization Bases (6 municipalities), lifting of evacuation orders therein

※ Examining possibility of lifting evacuation orders in areas other than above

○ In addition to re-inhabitation, moving and settling in those areas to be encouraged. Consumption from outside to be increased through interaction of people.

○ Further implementation of the Fukushima Innovation Coast Framework.

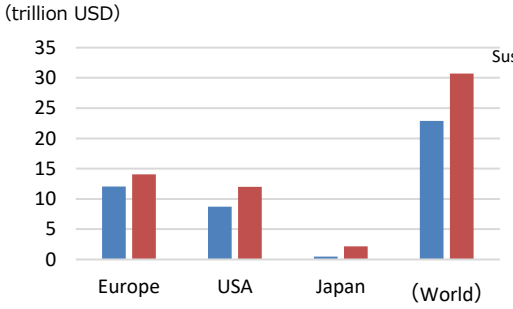
# Part 2 Efforts and challenges toward carbon neutrality by 2050

## Changing Energy Situation—decarbonization by the private sector, and COVID-19

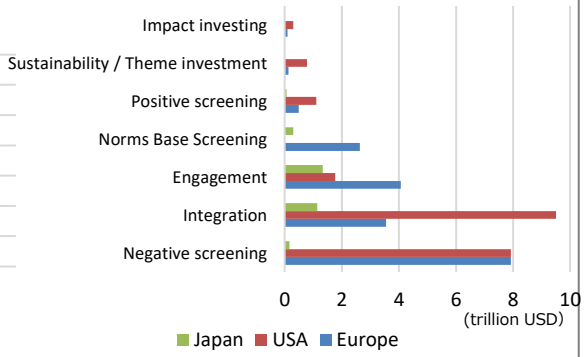
- An increasing number of countries including Japan are declaring carbon neutrality. **Efforts are being accelerated in the private sector toward decarbonization.** In the financial sector, **ESG investment is increasing with investment strategies diversified.** In the non-financial sector, an increasing number of companies are **voluntarily declaring decarbonization** such as RE100.There are some **cases in which companies in supply chains are requested to move toward decarbonization** (meeting targets by **making use of credits**). **Competitiveness of industrial locations depends on the accessibility to decarbonize energy (i.e. competition between countries as well as between urban areas and remote areas.)**
- COVID-19 not only causes changes in short-term demand, but also **could bring about long-lasting trends such as less physical movement of people due to increasing remote activities online.**

### ESG Investment increasing, encouraging decarbonization

<ESG assets held by region>



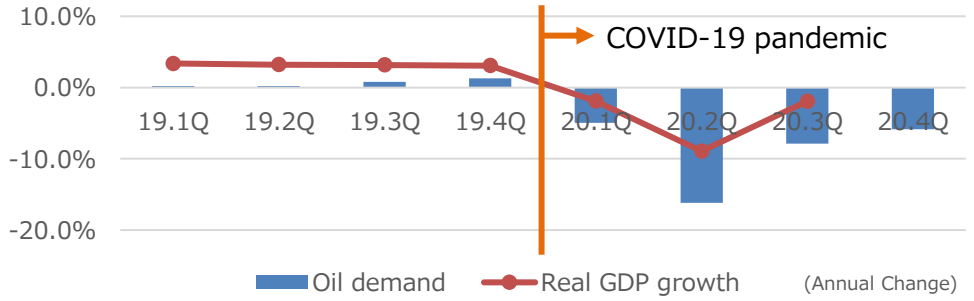

<ESG investment by strategy>




Source: Created by METI based on Global Sustainable Investment Review

### World oil demand plummeted due to the economic downturn, and has yet to return to the previous levels

<World oil demand and GDP>



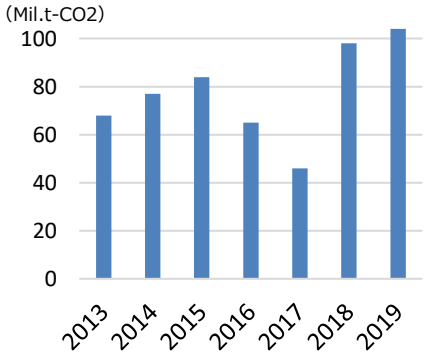

Source: Created by METI based on IEA, Oil Market Report, IMF, World Economic Outlook

### Procurement based on decarbonization

| | | |
|---|---|---|
| Overseas | Apple | Achieve carbon neutrality by 2030 in the whole supply chain |
| | Microsoft | Zero carbon by 2030 on its own, asking for reduction plans from suppliers |
| Japan | Sekisui House | Achieve carbon neutrality by 2050 in the whole supply chain |
| | NTT Data | 60% reduction from 2016 level by 2030 asking suppliers for 55% reduction |

Source: Created by METI based on press releases, etc.

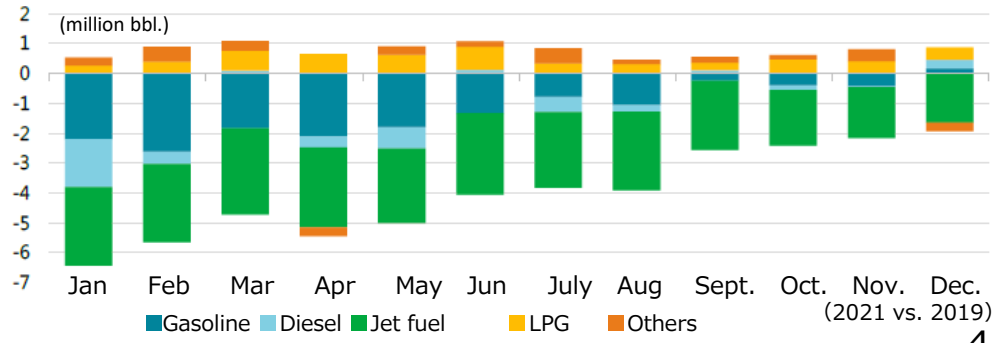
### Private credit trading increasing worldwide




Source: State of the Voluntary Carbon Markets 2020

### Demand for jet fuel decreasing due to online meetings, etc.

<World demand for oil products: 2021 (estimate) vs. 2019>



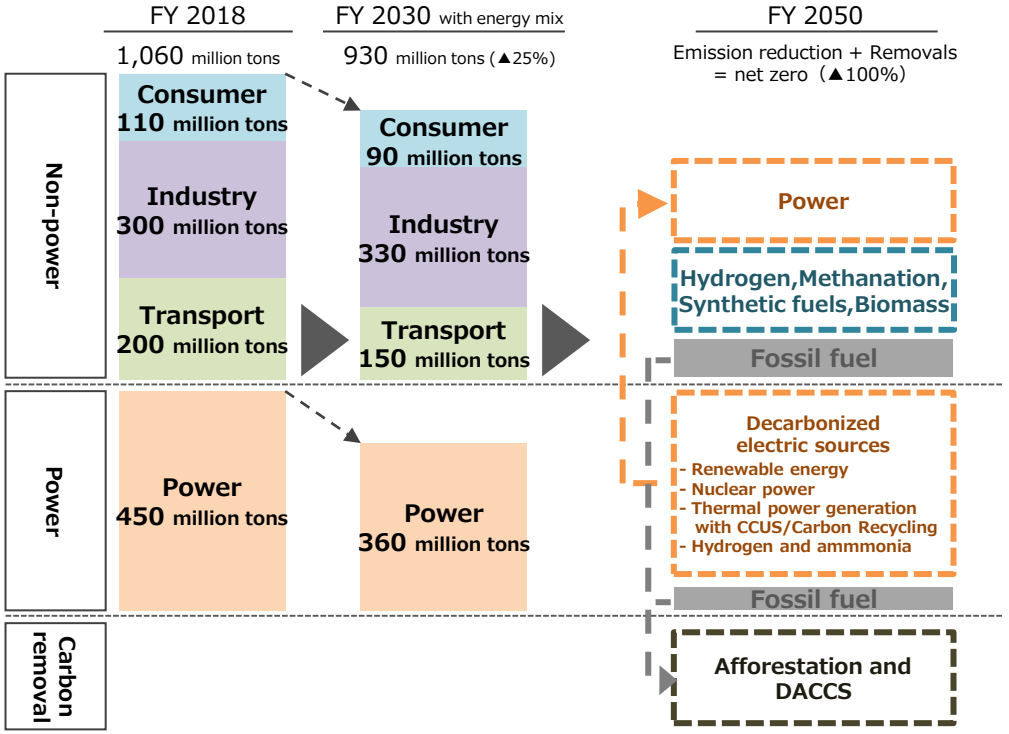

Source: IEA, Oil Market Report

# Path to carbon neutrality toward 2050

- In October, 2020, Prime Minister Suga declared Japan's intention to aim for **carbon neutrality by 2050** (*). In order to achieve a carbon neutral society, **the power sector should expand non-fossil power sources**. Additionally, **the non-power sector (industry/consumer/transport) should pursue decarbonizetion through electrification of energy, hydrogenation of unelectrified heat, capture and use of remaining CO2 (methanation, synthetic fuels etc.)**
- **Other countries have declared carbon neutrality one after another (126 countries and 1 area.)** However, **no country has committed to a single path**. They examine **various possibilities based of multiple "scenarios"**.

*In April, 2021, Prime Minister Suga declared that Japan aims to reduce greenhouse gas emissions by 46% in FY2030 compared with FY2013 levels, and that it will continue making strenuous efforts toward a more ambitious goal of 50% reduction. The declaration was made at the Global Warming Prevention Headquarters and the Leaders Summit on Climate.

## Transition to carbon neutrality




Source: Strategic Policy Com. under Advisory Com. for Natural Resources and Energy 11/17/20

## Declarations by Japan and other countries

| | Japan | EU | UK | USA | China |
|---|---|---|---|---|---|
| 2020 | | | | Back to Paris Agreement in January 2021 | |
| 2030 | 46% reduction from FY2013 levels toward higher goal of 50% declared by the PM at Global Warming Prevention HQ and Leaders Summit on Climate | At least 55% reduction from 1990 (NDC) | At least 68% reduction from 1990 (NDC) | 50-52% reduction from 2005 (NDC) | CO2 emissions to start to decrease by 2030 (speech at UN) |
| 2040 | | | | | |
| 2050 | **Carbon Neutral** (expressed at the Diet) | **Carbon Neutral** (long term strategy) | **Carbon Neutral** (legislated) | **Carbon Neutral** (pledge by the President) | |
| 2060 | | | | | **Carbon Neutral** (speech at UN) |

Source: Created by METI

# Part 2 Efforts and challenges toward carbon neutrality by 2050

## Japan's Industrial and technological strengths toward carbon neutrality by 2050

- **The "Green Growth Strategy through Achieving Carbon Neutrality in 2050"** published in December, 2020 analyzed **patent-related competitiveness in 14 industrial fields by country, quantifying the number of patents obtained for past 10 years as well as patent attention and exclusivity, etc.**
- Japan's competitiveness in intellectual property ranks **1st in 4 fields, i.e. hydrogen, automobile/storage batteries, semiconductors/information and communication, food/agriculture forestry and fisheries. In other 7 fields, it ranks 2nd or 3rd.** Support measures are necessary for those industries to maintain competitiveness in the social implementation stage.
- **"Carbon Recycling" that uses CO2 as a resource is one of the promising fields where Japan can utilize its manufacturing strength.**

### International comparison of patent-related competitiveness

| | Energy-related industry | | | | Transport/manufacturing industries | | | | | | | Households/Offices | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Offshore wind | Fuel ammonia | Hydrogen | Nuclear | Mobility/ batteries | Semicon./ info | Shipping | Logistics/ Infrastructure | Food/Agri. | Aircraft | Carbon Recycling | Housing/ Next gen. solar power | Resource circulation | Lifestyle |
| 1st | China | USA | **Japan** | USA | **Japan** | **Japan** | Korea | China | **Japan** | USA | China | China | China | China |
| 2nd | **Japan** | China | China | China | China | USA | China | USA | USA | France | USA | **Japan** | USA | USA |
| 3rd | USA | **Japan** | USA | UK | USA | China | **Japan** | ROK | ROK | China | **Japan** | USA | ROK | **Japan** |
| 4th | Germany | Germany | ROK | **Japan** | ROK | ROK | USA | **Japan** | China | **Japan** | ROK | ROK | **Japan** | France |
| 5th | ROK | UK | Germany | ROK | Germany | Taiwan | Germany | Germany | France | UK | France | Germany | France | Germany |

*Comparison of patent asset indices in aggregate from 2010 to 2019 by country and field
Total patent asset is an index calculated by quotations, views, exclusivity, remaining years, etc.

Source: Astamuse Company "Analysis of Japan's competitiveness in decarbonization-related technologies concerning Energy White Paper 2020"

### Corporate patent competitiveness in Carbon Recycling

| Rank | Company | Country | Patent comp |
|---|---|---|---|
| 1 | ExxonMobile | USA | 268,278 |
| 2 | Mitsubishi H.I. | Japan | 240,381 |
| 3 | Chinese Acad. of Science | China | 151,949 |
| 4 | Air Liquide | France | 141,046 |
| 5 | Toshiba | Japan | 124,863 |

Source: Same as above

Mostly **bio fuels and CCS**. For **artificial photosynthesis**, for example, Japanese companies are dominant in higher ranks.

| Rank | Company | Patent comp |
|---|---|---|
| 1 | ARPCem* | 9,563 |
| 2 | Fuji Film | 9,311 |
| 3 | University of Tokyo | 7,529 |
| 4 | Shin-Etsu Chemical | 6,663 |
| 5 | Tokyo Uni of Science | 5,099 |

Expanding into materials such as artificial photosynthesis as well as in manufacturing fields

**CO2 absorption concrete**

**Poly carbonate**

*Technical research cooperative by Mitsubishi Chemical, Fuji Film, INPEX, Fine Ceramics Center, Mitsui Chemical and TOTO

Source: Same as above

# Part 2 Efforts and challenges toward carbon neutrality by 2050

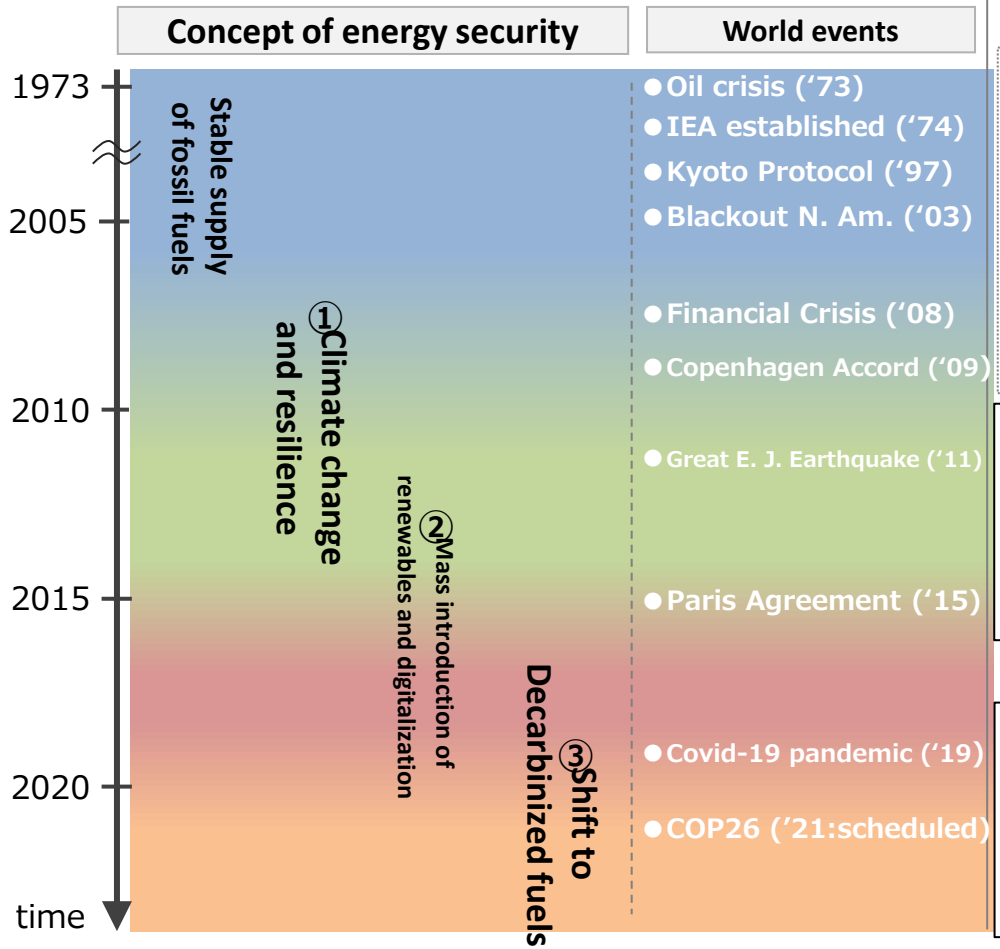
## (Reference)Outline of analysis of international comparison in terms of patent competitiveness by field

| | Field/Industry | Outline of analysis |
|---|---|---|
| 1 | Offshore wind power | ✓ China ranks 1st far ahead of Japan and USA with a large number of patent applications. Furthermore, it is highly rated in terms of IP with high patent attention and exclusivity. |
| 2 | Fuel ammonia | ✓ USA ranks 1st with ExxonMobil boasting outstanding competitiveness in IP.<br>✓ China ranks 2nd. It surpasses USA in the no. of applications, mostly filed by universities/research inst. |
| 3 | Hydrogen | ✓ Japan ranks 1st with there major car makers leading in patents related to fuel cell vehicles.<br>✓ Car manufacturers in other countries are also dominant in this field. |
| 4 | Nuclear | ✓ US and Chinese companies boast a large number of applications with high patent attention and exclusivity. These two countries are far ahead of others in this field. |
| 5 | Automobile/Storage batteries | ✓ Japan ranks 1st with there major car makers leading in this field. Car manufacturers in other countries are also dominant in this field followed by battery makers and material makers. |
| 6 | Semiconductors/Information and communication | ✓ Japan ranks 1st in this field led by power semiconductors.<br>✓ USA, despite the smaller number of applications, is highly competitive in IP with high patent attention and exclusivity. |
| 7 | Shipping | ✓ ROK is highly competitive in IP with Korean companies dominating top 3 positions. |
| 8 | Logistics/People flow/Civil engineering infrastructure | ✓ Companies involved in land transportation (automobile/heavy electric) and logistics hold higher ranks. China boasts a large number of applications with high attention and exclusivity. |
| 9 | Food/Agriculture, forestry and fisheries | ✓ Patents in relation to stock raising and related equipment for GHG absorption are analyzed. Japan ranks 1st with its farm machinery makers dominating in terms of energy efficiency. |
| 10 | Aircraft | ✓ USA ranks 1st followed by France. Boeing and Airbus are superior. |
| 11 | Carbon Recycling | ✓ Most patents are related to bio fuels and CCS. Artificial photosynthesis and CO2 absorption concrete follow, but the number of applications still low. Japan is highly competitive in these two fields. |
| 12 | Houses/buildings, Next-generation solar power generation | ✓ Patents for solar power generation are dominant. China boasts a large number of applications as well as attention and exclusivity. Japanese photovoltaic companies are still competitive. |
| 13 | Resource circulation-related | ✓ Garbage/sludge related patents are analyzed. China ranks 1st with a large number of patent applications, most of which are filed by universities and research institutes. |
| 14 | Lifestyle-related | ✓ Patents related to behavior change, sharing and climate change forecast are analyzed. China ranks 1st with a large number of patent applications. |

# Changes in the focus of energy security

- Past Energy White Papers conduct a quantitative analysis of energy security. Japan's current energy security as a whole is not showing a substantial change from 2015. However, **figures for a stable supply of electricity have shown an improvement due to reduced time of power stoppages**.
- On the other hand, **energy security is now focusing on different factors in line with active introduction of climate change countermeasures and mass introduction of renewable energy.** These factors should be taken into account when assessing energy security.

## Changes in the focus of energy security (IEA)

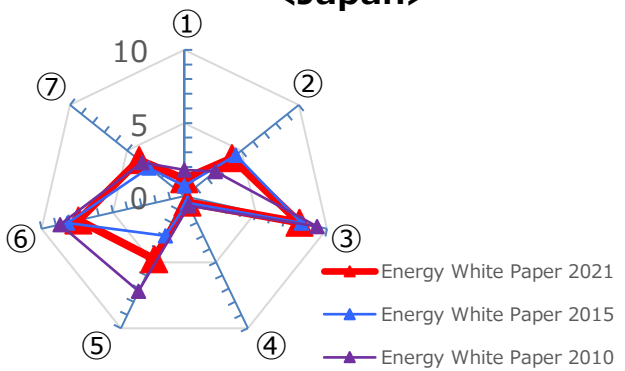



## Indices to assess energy security in White Paper

### Conventional indices

① Primary Energy self-sufficiency ratio
② Diversification of supply sources
③ Diversification of energy sources
④ Reduction of choke point risks (e.g. dependency on the Middle East)
⑤ Stable supply of electricity (stoppages)
⑥ Energy consumption per unit of GDP
⑦ Ability to cope with interrupted supply of fossil fuels (oil stockpiles)

<Japan>




<Concept of conventional indices for quantitative assessment>

- The focus was placed on a **stable supply of fossil fuels**, which represented a major part of energy sources.
- As Japan is prone to natural disasters, **ability to cope with emergencies and resilience to disruptions were highly evaluated**.

Assessment targets expanded

- Changes in circumstances such as climate change countermeasures and mass introduction of renewables
- As **IEA advocates the importance of power system flexibility and cybersecurity measures, corresponding indices are to be added**.

# Japan's quantitative assessment

- In addition to energy self sufficiency ratio and a stable supply of fossil fuels, storage capacity of electricity and cybersecurity in electric power supply are assessed quantitatively.
- Japan's storage capacity of electricity is highly assessed at the moment thanks to the current large pump-back functionality to reservoir for hydro plants. In the future, the expansion of storage capacity of electricity will become essential to create flexibility that enables mass-introduction of renewable energy.

**Indices used in past Energy White Papers**

- ①Primary energy self-sufficiency ratio
- ②Diversification of supply sources
- ③Diversification of energy sources
- ④Reduction of choke point risks (dependency on the Middle East, etc.)
- ⑤Stable supply of electricity (power stoppages)
- ⑥Energy consumption per unit of GDP
- ⑦Ability to cope with interrupted supply of fossil fuels (oil stockpiles)

**Newly added indices**

- ⑧Electricity storage capability (storage capacity including pump-back functionality)/diversification of procurement of storage batteries and related materials)
- ⑨Cybersecurity in electric power supply

## How Japan is rated in respective categories

- In light of energy procurement, ①Energy self-sufficiency ratio and ④Reduction of choke point risks are insufficient. On the other hand, ②Diversification of supply sources and ③Diversification of energy sources are highly rated.
- Japan's ratings are similar to those of the ROK which has geographic characteristics in common.

- Regarding ⑤Stable supply of electricity (power stoppages), Japan is compared favorably with other countries despite frequent natural disasters.
- Regarding ⑥Energy efficiency, Japan is highly rated despite concentration of industries.
- Regarding ⑦Oil stockpiles, based on the number of days endurable without supply from the largest importing area, Japan is rated on average due to high dependence oh the Middle East albeit high stockpiles.

- The following factors are mainly taken into account. ⑧Electricity storage capability (storage capacity, procurement of storage batteries) for mass-introduction of renewables and ⑨Cybersecurity for electronic control systems
- ⑧Electricity storage capability is highly rated thanks to pump-back functionality. However, procurement of storage batteries and materials is rated insufficient due to low diversification of supply sources. Overall rating is high.
- ⑨Cybersecurity is rated high as major necessary measures have been in place.

## Comparison with other countries (latest results)