経済産業省

# FY2018 Annual Report on Energy (Energy White Paper 2019)

**June 2019**

**Agency for Natural Resources and Energy**

# FY 2018 Annual Report on Energy (Energy White Paper 2019)

- The Energy White Paper is an annual report based on the Basic Act on Energy Policy. It has been published annually since June 2004.
- Based on studies to review the Basic Energy Plan, information on issues, especially the current state of affairs inside and outside Japan, was carefully collected and analyzed.

## ○ FY 2018 Annual Report on Energy (Energy White Paper 2019) Outline

### **Part 1 Current Energy Situation and Key Measures** (Topics)

**Chapter 1 Progress in the recovery of Fukushima**

1. Approach to the Fukushima Daiichi Nuclear Power Station accident
2. Support for nuclear victims
3. The Fukushima Plan for a New Energy Society
4. Nuclear Damage Compensation
5. TEPCO Reform

**Chapter 2 Global warming countermeasures and energy policy based on the Paris Agreement**

1. Trends on Global Warming Countermeasures (Effectuation of the Paris Agreement, etc.)
2. Greenhouse gas reduction targets in various countries and recent progress
3. Energy situation in each country viewed by data

**Chapter 3 Efforts to cope with recent disasters and enhance resilience**

1. Summary of major disasters that occurred in 2018
2. Emergency inspection of critical infrastructure and its countermeasure package

### **Part 2 Energy Trends** (Data)

### **Part 3 Measures Taken in FY2018 concerning Energy Supply and Demand** (Measures)

* Article 11 of the Basic Act on Energy Policy: The Government is required to submit to the Diet an annual report outlining measures taken in the previous fiscal year concerning energy supply and demand.

# [Reference] Energy White Papers in Recent Years Concerning Topics in Part I

| | Chapter 1 | Chapter 2 | Chapter 3 |
|---|---|---|---|
| FY2017 Annual Report on Energy (Energy White Paper 2018) <Cabinet decision on June 7, 2018> | **Japan's history of energy after the Meiji Restoration**<br>• History of changes in Japan's situation and energy choices from the Meiji Restoration to the Great East Japan Earthquake | **Progress in Fukusima's Reconstruction**<br>• Efforts towards the decommissioning of reactor units 1-4 at TEPCO's Fukushima Daiichi Nuclear Power Station<br>• Amendments to the roadmap toward the decommissioning (fuel debris retrieval etc.)<br>• Measures taken in evacuation order areas | **Changes in energy situation inside and outside Japan**<br>• Progress and challenges toward 2030 energy mix<br>• Changes of energy situation and challenges toward 2050 (Measures against global warming being taken in major countries, the current status of energy security in Japan, energy technology and the possibilities of Japanese companies, etc.) |
| FY2016 Annual Report on Energy (Energy White Paper 2017) <Cabinet decision on June 2, 2017> | **Progress in Fukusima's Reconstruction**<br>• Efforts towards the Decommissioning of TEPCO's Fukushima Daiichi Nuclear Power Station Units 1-4<br>• Basic Policy for Accelerating Fukushima's Reconstruction from the Nuclear Disaster<br>Revisions of the Act on Special Measures for the Reconstruction and Revitalization of Fukushima and the Act on Nuclear Damage Compensation and Decommissioning Facilitation Corporation, etc. | **New Direction of Energy Policy**<br>• Enhancement of energy security (e.g. revision of the JOGMEC Act)<br>• Energy conservation policy and new energy policy that strike a balance between environmental restrictions and growth (e.g. enforcement of the revised FIT Act)<br>• Response to problems related to the public interest under invigoration of competition and liberalization on energy supply (e.g. thorough pursuit of the electricity system reform) | **Energy System Reform in Japan and Abroad and Trends in the Energy Industry**<br>• Changes in the business environment surrounding overseas energy industries (changes in the market and systems, etc.)<br>• Trends in the response of overseas energy industries to changes in the business environment (example cases in the United States and Europe)<br>• Trends in the Japanese energy industry |
| FY2015 Annual Report on Energy (Energy White Paper 2016) <Cabinet decision on May 17, 2016> | **Contributions to energy security in the era of low crude oil prices**<br>• Recent crude oil prices and forecast<br>• Need for investment in upstream development and measures<br>• Responses to oil price fluctuation risks (LNG)<br>• Reduction of dependence on crude oil on the demand side (energy conservation) | **Responses to the Great East Japan Earthquake and the Accident at Tokyo Electric Power Company's (TEPCO) Fukushima Daiichi Nuclear Power Station and the Nuclear Energy Policy Based on the Lessons thereof**<br>• Efforts towards the Decommissioning<br>• Support for nuclear disaster victims and the New Energy-Oriented Society Scheme<br>• New nuclear power policy | **Changes in energy policy based on the Paris Agreement**<br>• Influence of the Paris Agreement<br>• Innovative Energy Strategy<br>• New mechanism in the electricity sector |
| FY 2014 Annual Report on Energy (Energy White Paper 2015) <Cabinet decision on July 14, 2015> | **The Shale Revolution and changes in the global energy situation**<br>• Changes brought about by the Shale Revolution<br>• Impact on and changes in energy security<br>• Future changes in the global energy situation | **Responses to the Great East Japan Earthquake and the Accident at TEPCO's Fukushima Daiichi Nuclear Power Station**<br>• Activities related to decommissioning, support for accident victims, compensation and regulation | **Dealing with energy costs**<br>• Changes in energy and electricity prices<br>• Impact on households and industries<br>• Measures to deal with energy costs |

# Chapter 1 Progress in the recovery of Fukushima

# Current status of efforts for reconstruction and revitalization of Fukushima

| | 2011 (just after accident) | 2017 (6 yrs after) | 2019 (8 yrs after) | Future |
|---|---|---|---|---|
| **Off-site** | Tomioka **app.25mSv/yr** (●Kobama)<br>Naraha **app.16mSv/yr** (●Kamishigeoka)<br>Tamura **app7mSv/yr** (●vic. Kasuga Shrine) ※estimate assuming constant | Physical Attenuation + Weathering Effect + Decontamination<br>**app.0.5mSv/yr**<br>**app.1.1mSv/yr**<br>**app.1.6mSv/yr** ※estimate assuming constant | **Measures for Returning**<br>・Promotion of Fukushima Innovation Coast Framework<br>・Industrial revitalization in Hamadori<br>・Reconstruction of business/livelihood<br>・Clearing reputational damage for agricultural/marine products<br>・To Improve the environment of the Specified Reconstruction and Revitalization Bases | Reconstruction |
| | **Evacuation orders lifted for all habitation restricted and preparation areas except Okuma/Futaba Towns by Apr. 2017** | | | |
| **Contaminated Water** | **app. 10,000Bq/L**<br>※Concentration of radioactive materials in the sea around the site | **reduced below 1/10,000 by management of contaminated water**<br>Management of Contaminated water<br>Decontamination/paving, Frozen-soil wall, impermeable wall (sea-side)<br>Contaminated water, Reactor building, sea | **As low as almost undetectable (app. 0.6Bq/L or less)** | Sustainable Measures |
| **Decommi-ssioning** | **Mid-and-Long Term Roadmap (1st Edition)** (Dec. 2011)<br>**International Research Institute for Nuclear Decommissioning (IRID) established** (Aug.2013)<br>**Nuclear Damage Compensation and Decommissioning Facilitation Cooperation (NDF) established** (Aug. 2014) | **Continuing action toward decommissioning: Policy for retrieval of fuel debris determined** (Sept. 2017) | **Internal investigation of the containment vessel of Unit 2 was conducted toward retrieval of fuel debris** (Jan. 2018)<br>**Contacted to deposit during internal investigation of Unit 2** (Feb. 2019)<br>**Started removal of fuel from Unit 3** (Apr. 2019) | Realization of Decommissioning |

# The latest approach to reconstruction and revitalization of Fukushima

## On-site

### ✓ Preventive and multi-layered measures against contaminated water progressed

- According to the assessment of experts, the water blocking effect of the frozen soil wall was clearly recognized, and the water level management system, together with the function of sub-drain etc., was established to control the groundwater stably so that it could be kept away from the building (March 2018).
- The amount of contaminated water generated has decreased from approximately 540 tons per day (May 2014) before the countermeasures to approximately 180 tons per day (April 2018-February 2019).

### ✓ Progress towards fuel removal

- Unit 1 began removal of rubble from operating floor on the top of the reactor building in January 2018.
- At Unit 2, the opening for access to the inside of the operating floor was installed in February 2018 prior to the dismantling of top of the building, and the inside of the operating floor is under investigation.
- At Unit 3, the dome roof was installed in February 2018, and fuel removal started in April 2019.

### ✓ Internal investigation for fuel debris retrieval

- At Unit 2, the internal investigation of the reactor containment vessel was conducted in January 2018, and the deposits that were thought to be fuel debris were confirmed. In February 2019, it was confirmed that the investigation equipment could be brought into contact with the deposit thought to be fuel debris, and the pebble like deposit could be grasped and lifted up.

### ✓ Progress confirmation by International Organization (IAEA)

- In November 2018, the fourth peer review mission by the International Atomic Energy Agency (IAEA) Expert Team was conducted.
- "The transition from emergency to steady state has been achieved at the Fukushima Daiichi Nuclear Power Station, and it has been evaluated that there have been many improvements since the previous review (February 2015)".

### ✓ Working environment improved

- From June 2018, ordinary working clothes is used in about 96% of on-site area.

## Off-site

### ✓ Lifting of evacuation order, development, of specific revival reproduction base

- By May 2018, the Specified Reconstruction and Revitalization Base area plan was approved for all six municipalities that have been promoting development. Aim for the lifting of evacuation orders approximately five years later.
- In April 2019, the evacuation order was lifted in some areas of Okuma Town (That was the first time that the evacuation order was lifted at the local town where Fukushima Daiichi Nuclear Power Station locates).

### ✓ Fukushima robot test field partial opening

- "Communication tower" opened in July 2018, and "test plant" opened in February 2019 (to be fully opened in 2020)
- The field is being used by the public and private sectors, including the research and development project of the Cabinet Office.

### ✓ Development of living environment advances

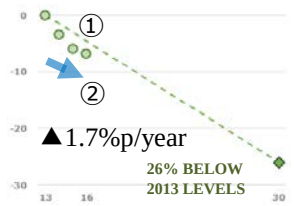
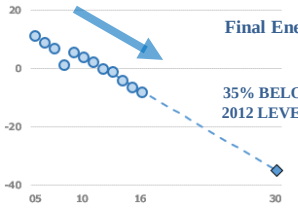
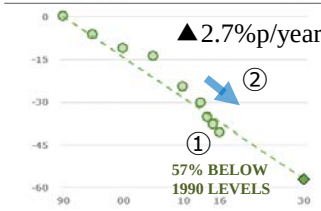
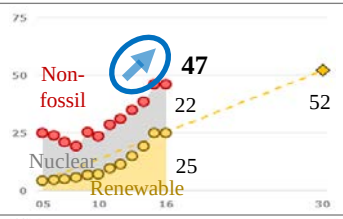
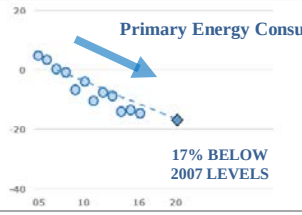
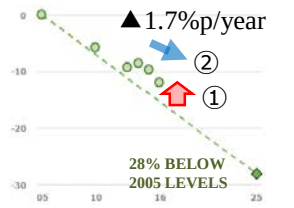
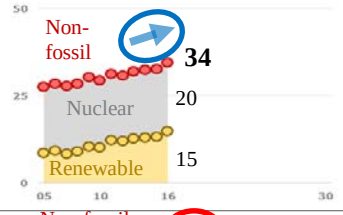
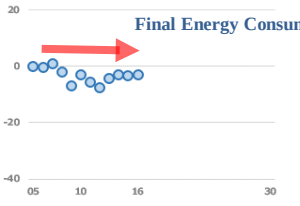
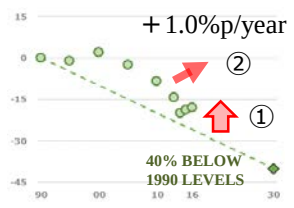
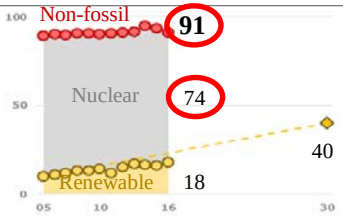
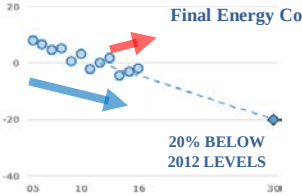
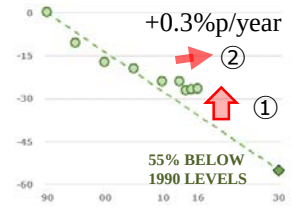
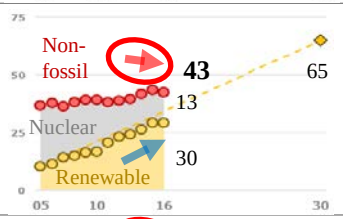
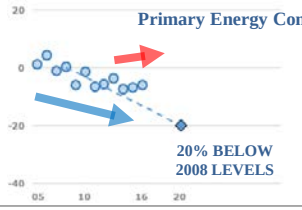
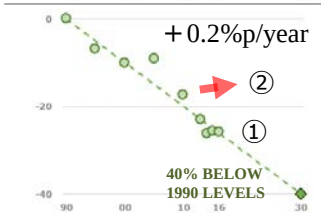
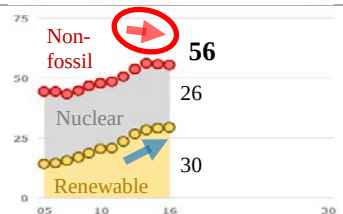
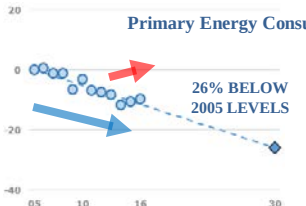
- From April 2018, elementary and junior high schools are established and resumed, and schools are resumed in all municipalities where evacuation instructions have been lifted.
- Development of environment for return progresses, such as opening of secondary emergency medical care facilities and opening of fire department.

### ✓ Construction of a hydrogen refueling hydrogen proof base starts

- In Namie Town, with the world's largest water electrolyzer, demonstration of hydrogen production from renewable energy
- Construction of "Fukushima Hydrogen Energy Research Field" started in July 2018

# Chapter 2 Global warming countermeasures and energy policy based on the Paris Agreement

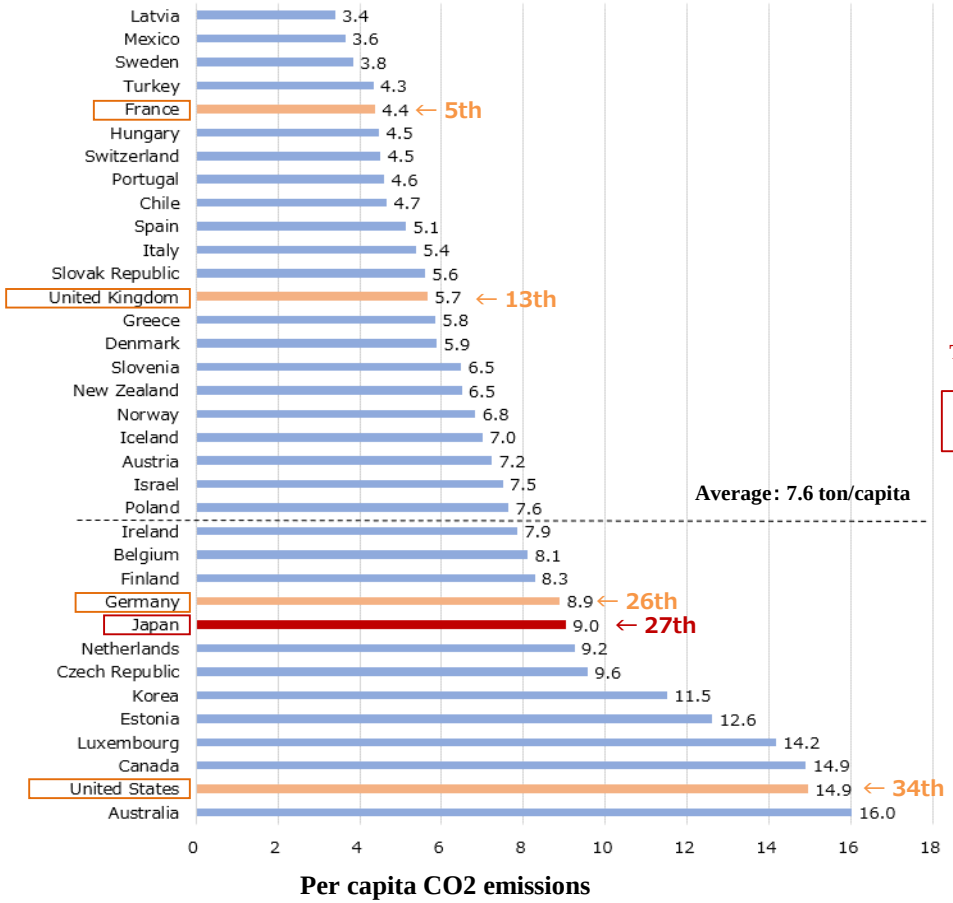
# Progress of GHG reduction in major countries ～JP and UK progress towards the goal. FR and DE stagnated at present.
## Balanced efforts such as non-fossil power supply, gas conversion, energy saving etc. are important.～

| FY2016 | Medium-term goals and progress on GHG reduction | Factor 1: Non-fossil power ratio (Renewable, Nuclear) | Factor 2: Energy consumption reduction |
|---|---|---|---|
| **JP**<br>1.1 billion ton-$CO_2$<br>0.9 billion ton-$CO_2$/capita |  <br>①Same level as target line<br>②The latest trend is reduction (Last 3 years average, same below) |  <br>✓ Non-fossil is low but increasing<br>・Renewable energy and Nuclear power gradually increases |  <br>✓ Reduction |
| **UK**<br>0.4 billion ton-$CO_2$<br>0.57 billion ton-$CO_2$/capita |  <br>①Same level as target line<br>②The latest trend is reduction |  <br>✓ Non-fossil is increasing<br>・Renewable energy increases and Nuclear power maintains.<br>✓ Convert coal to gas |  <br>✓ Reduction |
| **US**<br>4.8 billion ton-$CO_2$<br>1.49 billion ton-$CO_2$/capita |  <br>①Run above target line<br>②The latest trend is reduction |  <br>✓ Non-fossil is increasing<br>・Renewable energy increases and Nuclear power maintains.<br>✓ Convert coal to gas |  <br>✓ Flat |
| **FR**<br>0.3 billion ton-$CO_2$<br>0.44 billion ton-$CO_2$/capita |  <br>①Run above target line<br>②The latest trend is flat |  <br>✓ Non-fossil is already high (It is difficult to pull it up further)<br>・Nuclear accounts for 70%.<br>※In energy-derived CO2, "non-electricity" such as transport and home accounts for 90% |  <br>✓ Past：Reduction<br>✓ Latest：Flat |
| **DE**<br>0.7 billion ton-$CO_2$<br>0.89 billion ton-$CO_2$/capita |  <br>①Run above target line<br>②The latest trend is flat |  <br>✓ Non-fossil is flat<br>・Renewable energy increases but Nuclear power decreases.<br>・Coal accounts for 40%. |  <br>✓ Past：Reduction<br>✓ Latest：Flat |
| **EU**<br>3.1 billion ton-$CO_2$<br>0.64 billion ton-$CO_2$/capita |  <br>①Same level as target line<br>②The latest trend is flat |  <br>✓ Non-fossil is flat<br>・Renewable energy increases but Nuclear power decreases. |  <br>✓ Past：Reduction<br>✓ Latest：Flat |

# Per capita CO2 emissions in each country and factor decomposition (2016)

- Japan's energy-induced CO2 emissions are **9 tons per capita** annually, **27th among OECD 35 countries**.
- Looking at the causes of emissions, Japan has **strengths on the demand side** but **weaknesses on the supply side**. **4th out of 5 major countries**.
- It is important for Japan **to strengthen CO2 emission reduction on the supply side**.

Per capita CO2 emissions （OECD 35 countries※1）

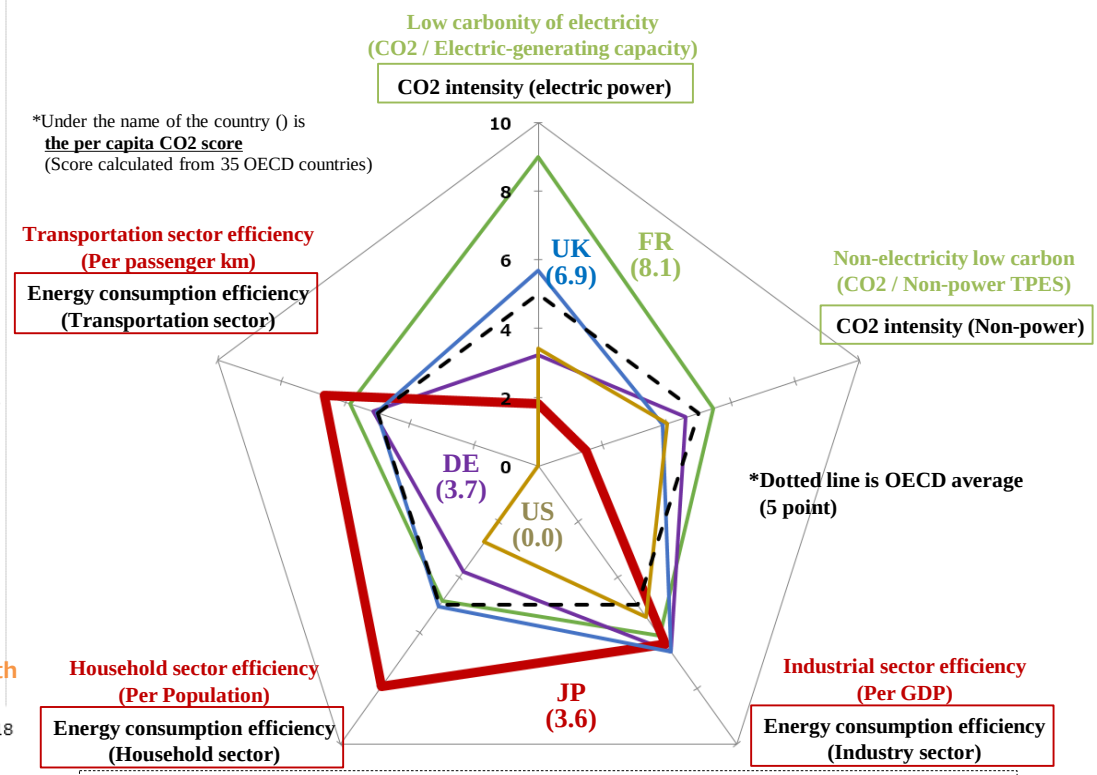



※1: Lithuania is not included because it became a member in 2018

Source：IEA CO2 Emissions from Fuel Combustion, World Energy Balances, OECD stat

Factorization of CO2 emissions in major countries （JP・UK・US・FR・DE）

$$\frac{CO_2}{Population} = \underbrace{\frac{CO_2}{Energy\ consumption}}_{\text{Low carbonity of energy}} \times \underbrace{\sum_{sector}\left(\frac{Energy\ consumption}{Activity\ amount\ (GDP,etc)}\right)}_{\text{Energy consumption efficiency}} \times \frac{Activity\ amount}{Population}$$




**How to calculate the score**
Deviation values are calculated in the OECD 35 countries and normalized so that deviation value 35 is 0 and deviation value 65 is 10
（10 for deviation value 65 or more, 0 for 35 or less）

# Challenges of renewable energy becoming the main electric power source

**Renewable energy as main power source**

| Problem / Direction of energy plan | Main initiatives taken so far | Future direction |
|---|---|---|
| **Power generation cost**<br>• Twice as much as in Europe<br>• Previous national burden annual amount 2 trillion yen / year Renewable energy + 5%（10%→15%）<br>→ Japan needs + 9% (15% → 24%) for 1 trillion yen / year from now on<br>**Acceleration of cost reduction and independence from FIT** | **To cope with uncommissioned projects**<br>• Solar power projects that have not reached the operation preparation stage by a certain time **are to be awarded reduced prices.**<br>• **In addition, measures to secure early operation start**<br>**To move forward price targets and expand the scope of auction**<br>• Target of solar power for business to be **7 yen 2025**<br>• Auction scope of solar for business to be revised 「2,000 kW or more」⇒「**500 kW or more**」 | **①Promote development of power sources using renewable energy**<br>**⇒ Incentives according to individual power supply characteristics**<br>・For renewable energy with rapid cost reduction (solar, wind, large-scale biomass), consideration will be conducted for the ideal measures for integration into the market while promoting cost reduction acceleration.<br>・For local symbiosis renewable energy (geothermal, small/medium-scale hydro, local biomass), consideration will be conducted for the ideal way of development promotion not limited to FIT |
| **Business environment**<br>• Environment to support long-term stable power generation is immature<br>• Location restrictions on offshore wind power etc.<br>**Securing long-term stable business operations** | **Establishment of information liaison meeting aiming at regional symbiosis**<br>• **Sharing of advanced cases such as ordinance enactment among local governments**<br>**Formulation of rules concerning the use of general sea area through the Sea Area Utilization Law for Renewable Energy**<br>• **Toward the expansion of offshore wind power, formulation of rules for long-term occupancy of sea area together with competitive tender** | **②Strengthen business discipline**<br>**⇒ Reinforcement of responsibility system towards long-term stable power supply**<br>・Strengthen enforcement of Electric Business Act in coordination with Act on FIT<br>・Cases of innovative local governments including ordinance enactment to be shared with other local governments<br>・Discussion on disposal cost securing method from a professional point of view (toward external funding in principle with internal funding as some exceptions) |

**Construction of next-generation power network supporting mass introduction of renewable energy**

| | | |
|---|---|---|
| **Grid constraints**<br>• Inconsistency between existing grid and renewable energy location potential<br>• Structural decline in grid demand | **Further utilization of the "unused capacity" of existing grids**<br>• **Implement tentatively the plan to release capacity for emergency**<br>(**Expect additional** capacity of about **40.4 GW**) | **③Improvements of renewable energy business environment**<br>**⇒ Support maximum renewable energy introduction**<br>・Further consideration to **overcome location restrictions**<br>＝Implementation of the Sea Area Utilization Law, etc.<br>・Further consideration to overcome **grid constraints**<br>＝Realization of Japanese version "Connect & Manage"<br>＋Securing necessary investment in the grid system including the review of consignment etc. |
| **Flexibility**<br>• Expanded introduction of variable renewable energy<br>**Steady implementation of action plans** | **NW cost reform in the age of mass introduction of renewable energy**<br>• Mechanism to promote thorough reduction of NW costs<br>• Study for improvements of system environment toward the transition to the next-generation NW | |

# Land area and amount of renewable energy introduced (2016)

- **In Japan, the introduction of renewable energy per unit area is at a high level.**
- On the other hand, it is difficult to increase the renewable energy ratio because the power demand is large.

| | Group① (Similar size as Japan) | | | | Group② (Similar size as Kyushu) | | |
|---|---|---|---|---|---|---|---|
| | **Germany** | **Norway** | **Japan** | **California** | **Albania** | **Kyushu** | **Denmark** |
| **Land area** | 350 thousand km² | 370 thousand km² | 380 thousand km² | 420 thousand km² | 30 thousand km2 | 40 thousand km2 | 40 thousand km2 |
| **Renewable energy generation** | 190 billion kWh<br>Wind: 80<br>Biomass: 50<br>Solar: 40 | 145 billion kWh<br>Hydro: 143<br>Wind: 2 | 160 billion kWh<br>Hydro: 80<br>Solar: 500<br>Biomass: 20 | 80 billion kWh<br>Hydro: 30<br>Solar: 20<br>Wind: 10 | 8 billion kWh<br>Hydro: 8 | 17 billion kWh<br>Solar: 8<br>Hydro: 5<br>Biomass: 3 | 18 billion kWh<br>Wind: 13<br>Biomass: 5<br>Solar: 1 |
| **Renewable energy per unit land area** | 540 thousand kWh/km²<br>Wind: 220<br>Biomass: 150<br>Solar: 110 | 400 thousand kWh/km²<br>Hydro: 390<br>Wind: 10 | 410 thousand kWh/km²<br>Hydro: 210<br>Solar: 130<br>Biomass: 40 | 190 thousand kWh/km²<br>Hydro: 70<br>Solar: 40<br>Wind: 30 | 280 thousand kWh/km²<br>Hydro: 280 | 400 thousand kWh/km²<br>Solar: 180<br>Hydro: 130<br>Biomass: 70 | 440 thousand kWh/km²<br>Wind: 300<br>Biomass: 120<br>Solar: 20 |
| **Demand scale** (Net import and export) ※The demand is the total power generation | 640 billion kWh<br>(Net import and export 50 billion kWh) | 150 billion kWh<br>(Net import and export 20 billion kWh) | 1,050 billion kWh<br>(Net import and export 0) | 200 billion kWh<br>(Net import and export 70 billion kWh) | 8 billion kWh<br>(Net import and export 0.04 billion kWh) | 109 billion kWh<br>(Net import and export 14 billion kWh) | 31 billion kWh<br>(Net import and export 5 billion kWh) |
| **Renewable energy ratio** | 29%<br>Wind: 12%<br>Biomass: 8%<br>Solar: 6% | 98%<br>Hydro: 96%<br>Wind: 1% | 15%<br>Hydro: 8%<br>Solar: 5%<br>Biomass: 2% | 40%<br>Hydro: 15%<br>Solar: 10%<br>Wind: 7% | 100%<br>Hydro: 100% | 15%<br>Solar: 7%<br>Hydro: 5%<br>Biomass: 3% | 60%<br>Wind: 42%<br>Biomass: 16%<br>Solar: 2% |
| | If recalculated using the total demand of Japan | | | | If recalculated using the total demand of Kyushu | | |
| | 18% | 14% | 15% | 7% | 7% | 15% | 17% |

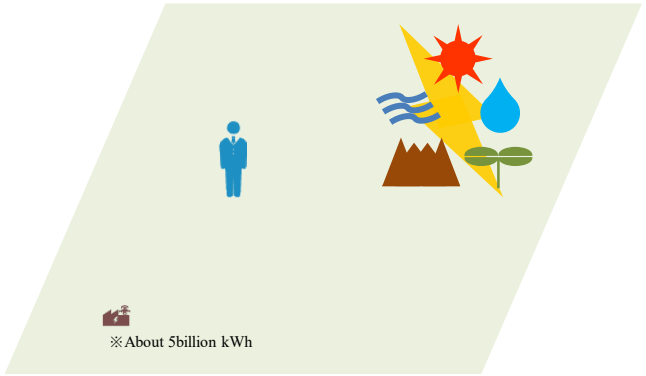
Source: Based on various data by IEA, EIA, World Bank and statistics by the Ministry of Internal Affairs and Communications, etc. ※Figures of renewable energy power generation, demand and import/export have been rounded off to the nearest.

# Relationship between electricity demand and renewable energy ratio

- The greater the population, the greater the demand for electricity.
- The greater the demand for electricity, the more difficult it is to raise the renewable energy ratio.

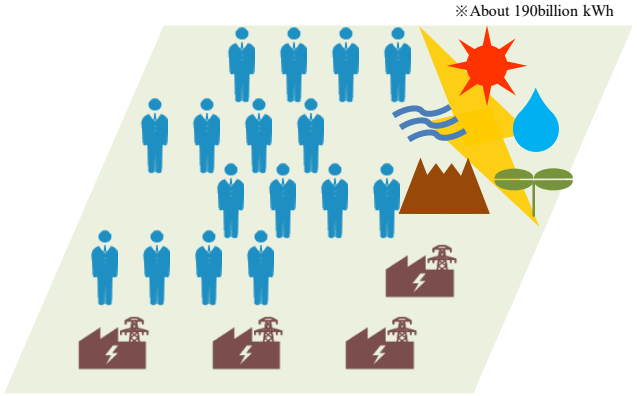
## Norway

Renewable energy ratio ：98%
Country area ：370thousand km²
△Renewable energy ratio 1 %：1.5billion kWh



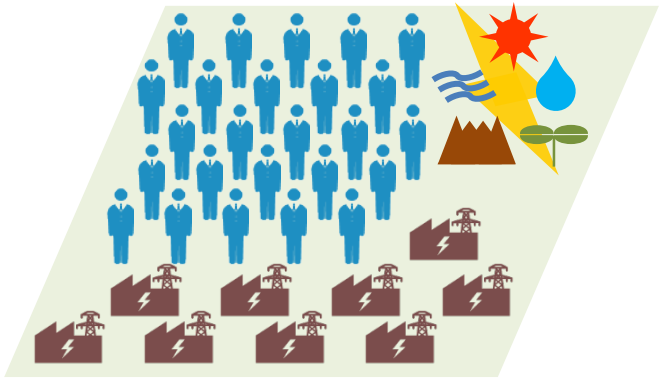

## Germany

Renewable energy ratio ：29%
Country area ：350thousand km²
△Renewable energy ratio 1 %：64billion kWh




## Japan

Renewable energy ratio ：15%
Country area ：380thousand km²
△Renewable energy ratio 1 %：105billion kWh



About 5 million people

Renewable energy generation
About 150billion kWh

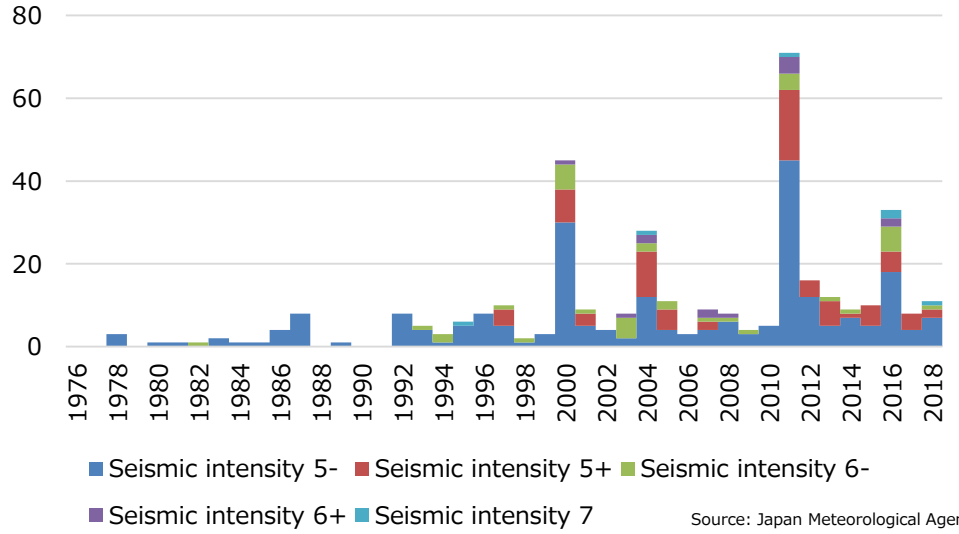
Required energy other than renewable energy
About 100billion kWh

# Chapter 3　Efforts to cope with recent disasters and enhance resilience

# Recent Natural Disasters

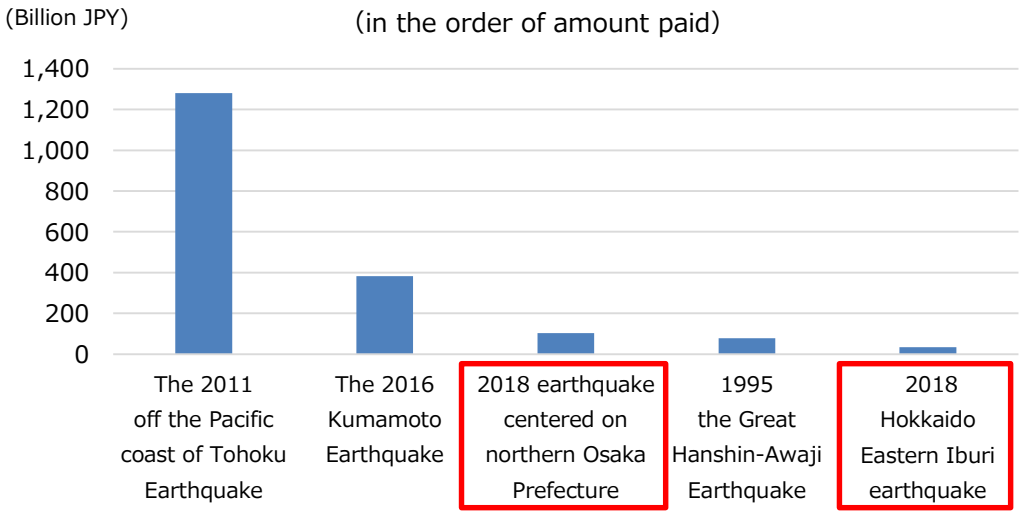
- Since 2000, **number of earthquakes with seismic intensity 5+ has increased** with **tendency of increasing precipitation**
- **2018 in particular saw large scale disasters** and suffered significant damage from earthquakes and wind/flood

(Count) Occurrence of earthquakes with seismic intensity 5



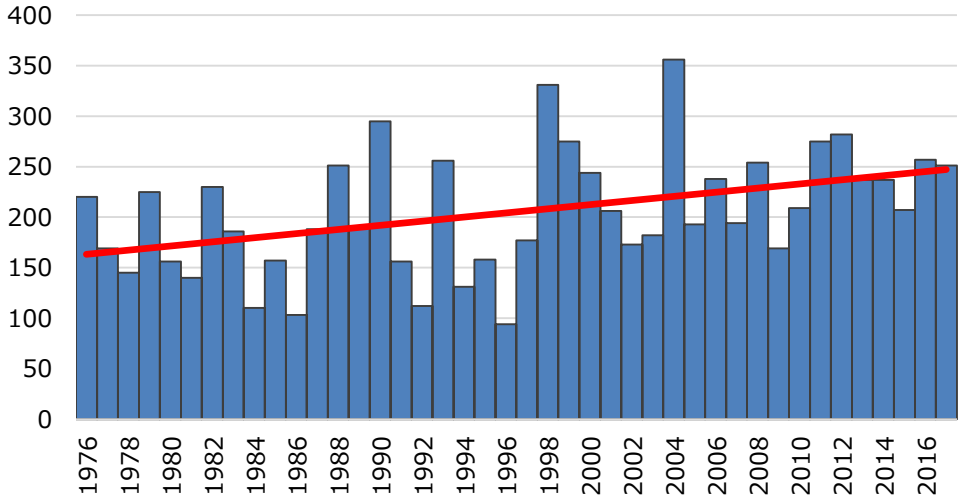

Source: Japan Meteorological Agency

List of earthquake insurance claims due to earthquakes (in the order of amount paid)



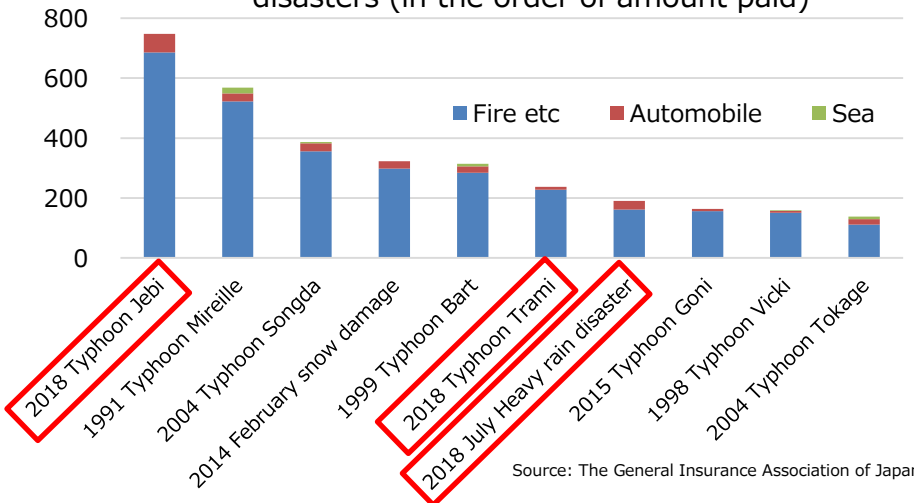

Source: The General Insurance Association of Japan

(Count) Annual occurrence of hourly precipitation 50mm+




Source: Japan Meteorological Agency

(Billion JPY) List of insurance claims due to wind and water disasters (in the order of amount paid)




Source: The General Insurance Association of Japan

# Efforts to cope with major disasters during 2018

## Snow

**Feb.**
**Heavy snowfall Fukui**
Heaviest since 1981
(140cm+)

- **1500 vehicles stuck** for several days on National Highway #8
- 22 service stations including major ones **"ended up with nil stocks"**

## Earthquake

**Jun.**
**Earthquake N. Osaka**
Earthquake with seismic intensity 6-
occurred in North Ward of Osaka City

- In Osaka/Hyogo Prefectures. **power failure at about 170,000 houses**
- Immediately after earthquake, **supply of town gas to about 112,000 houses stopped**

**Sept.**
**Earthquake E. Iburi, Hokkaido**
Blackout all over Hokkaido

- After earthquake, **blackout affected 2.95 million houses** in whole Hokkaido area
- Despite gradual restart of power stations, r**equest for power saving** made due to critical S/D situation

## Wind/Flood

**July**
**Torrential rains W. Japan**
Downpour due to typhoon 7 and other causes

- **Power failure at max 80,000 houses** mainly in Chugoku and Shikoku areas
- To prevent heatstroke, 541 air conditioning units installed. Staff of 352 sent from 4 power companies.

**Sept. Typhoon #21**
Large scale blackout mainly in Kansai district

- **Power failure at 2.4 million houses** mainly in Kansai and Chubu areas
- **More than 1,000 utility poles went down**, which required a long time for restoration

**Sept. Typhoon #24**
Power cuts throughout country

- It passed through the Japanese archipelago, causing **power cuts at 1.8m houses** throughout the country, mainly in Chubu area
- It took **about one week for restoration** in Chubu Electric Power Company's service area

## Inspection of Electricity infrastructure

**Hokkaido** : **Review/verification made including actual operational modifications** in case complete shutdown of Tomatoatsuma P.S.

**E. Japan/W. Japan** : Areas are connected by robust linkage lines for integration to minimize relative effects of missing power sources, **"blackout is not foreseen" should all the largest power sources be shut down**

**Okinawa** : **"Blackout is not foreseen" if proper operational measures are taken**

## Inspection of gas infrastructure

Confirmed that **main production facilities and high-pressure/mid-pressure pipes fully conform to anti-earthquake design guidelines**

Confirmed that independent power generating equipment **installed at 95%** of the LNG receiving terminals with the remaining 5% backed up by other terminals

Quick dispatch of staff for immediate assistance implemented. **5100 staff were sent 5 days after** earthquake N. Osaka

## Inspection of fuel infrastructure

**263 "local base service stations"** in Japan have their own power generators (as at end Jan.) ※to be increased up to 8,000 by the end of 2019

**22 oil refineries have their own generators for emergency with reinforcement being in progress. About 60% of oil depots have their own generators of emergency**

Social cost

Infrastructure investment + Restoration cost

**It is important to minimize these** in total