The 437th Forum on Research Work (25 December 2020)

Outlook of Renewable Energy Market in Japan and the World in 2021

Institute of Energy Economics, Japan

Yasushi Ninomiya, Senior Researcher

New and Renewable Energy Group, Electric Power Industry & New and Renewable Energy Unit

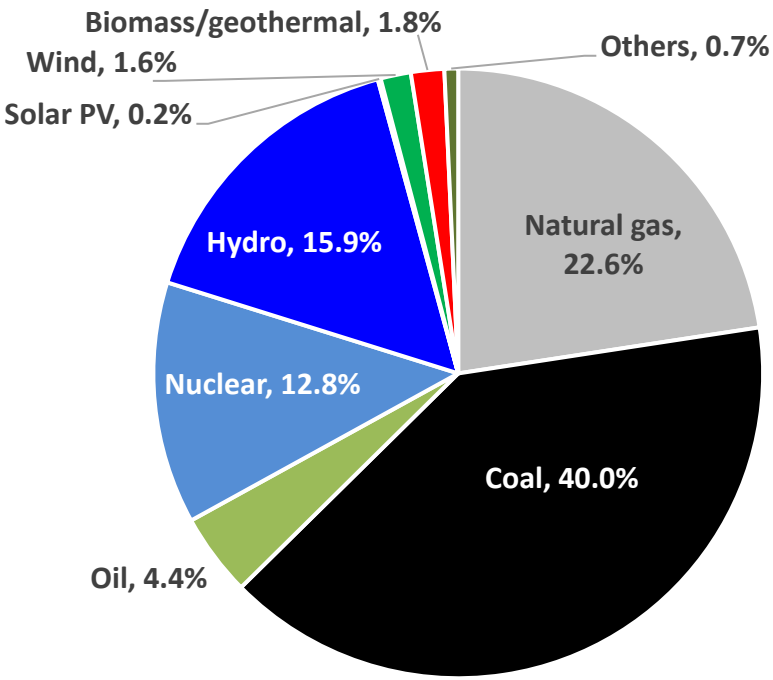
Key Points of the Report

- ✓ The drop in economic activity caused by COVID-19 pandemic saw 2020 global power generation decline over 2019. Although thermal power generation from sources such as coal has declined significantly throughout the year, renewable energy power generation is expected to grow at a pace of approximately 5% year-over-year. As a result, renewable energy as a proportion of global energy power generation, which was 26% in 2019 (including 16% hydropower), is expected to grow to approximately 28.0–28.5% in 2020 and 29% in 2021.
- ✓ Growth in renewable energy power generation capacity continues in 2020, putting increasing downward pressure on coal-fired thermal power in especially the U.S. and Europe. This is likely to see renewable energy as a proportion of total power generation continue to grow beyond 2021, when economies stage a recovery from COVID-19.
- ✓ Renewable energy capacity increased significantly in particularly China, the U.S., and Europe beginning in the second half of 2020. Consequently, the 2020 annual renewable energy growth is expected to match or exceed the 2019 level (190 GW), the highest level recorded. 2020 will set a new record for annual renewable energy growth, which will then be outpaced in 2021. Due to renewable energy support programs, the U.S. and China are racing to build renewable energy facilities. Projects in the countries that had seen delays in 2020 will begin operations, which could see annual renewable energy growth over 200 GW and a new record.
- ✓ In Japan, generation capacity for all renewable energy, excluding large-hydro above 30 MW will grow at a rate of 6 GW/year for FY 2020-2021 as a result of a slowdown in residential and commercial solar PV deployment resulting from COVID-19. Total generation capacity will reach 87 GW by the end of FY 2021, bringing FY 2021 renewable energy power generation as defined above to 166 TWh. If large-hydro >30 MW is included, renewable energy as a proportion of all energy power generation will reach 20.4% (8.0% hydro, 12.4% non-hydro) for FY 2021. As renewable power generation capacity is also expected to continue rising beyond FY 2021, the current energy mix plan by 2030 (renewable energy becoming 22–24% of total power generation) could actually be reached in the first half of 2020.
- ✓ Japan's renewable energy policy to date has focused only on electricity. However, achieving Japan's 2050 carbon-neutral target will require eliminating the majority of the country's current energy-originated CO_2 emissions. Policy interest is rising not only for electricity, which satisfies only a mere 28% of final energy demand, but also for fossil fuels, which satisfy the remaining 72%, with a particular focus on heat utilization in industry sector and decarbonization in transportation sector. Along with the decarbonization of fossil fuels, further renewable energy usage is also expected to draw attention in these sectors.

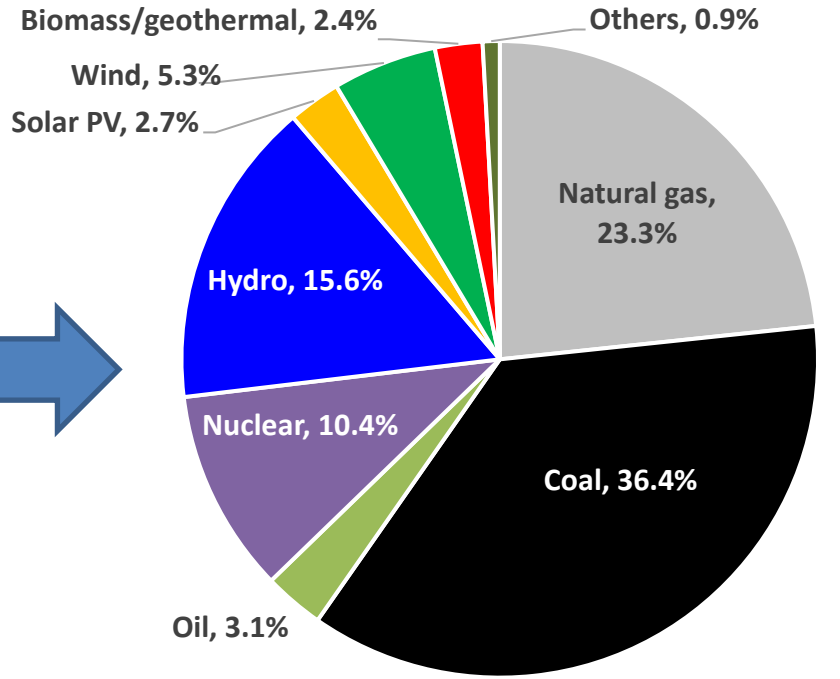
Renewables as a proportion of total global power generation to reach 28% in 2020 and 29% in 2021

- 2020 global power generation dropped by several percent over 2019, and coal, oil, natural gas, and nuclear energy out put decreased across the board. On the other hand, solar PV, wind, and other renewable grew roughly 5% year-over-year
  - The renewables share is forecast to increase about 2% from 26% (2019) to 28.0–28.5% (2020)
  - Even after electricity demand recovers in 2021, a trend towards less coal and more solar and wind power usage will persist, with renewable energy as a proportion of global power generation expected to grow to 29% in 2021 (In contrast, the coal-fired power share will fall to about 33%).
  - Renewable energy as a proportion of global power generation is expected to increase by 8–9% over the 10 years from 2010.

2010 global power generation (21,570 TWh)
(Renewables share 19.5%)



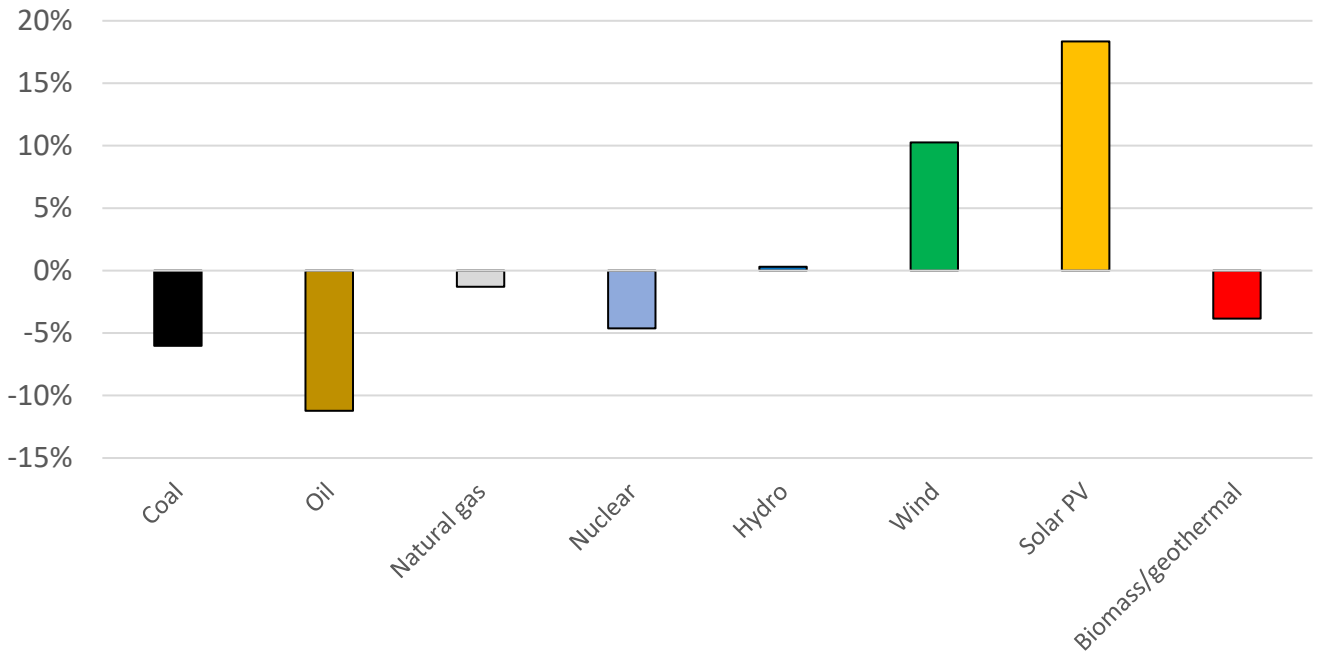
2019 global power generation (27,005 TWh)
(Renewables share 26.0%)



Source: Prepared by IEEJ based on data from the *BP Statistical Review of World Energy*, June 2020

A contrast between declining coal and rising solar PV/wind in 2020

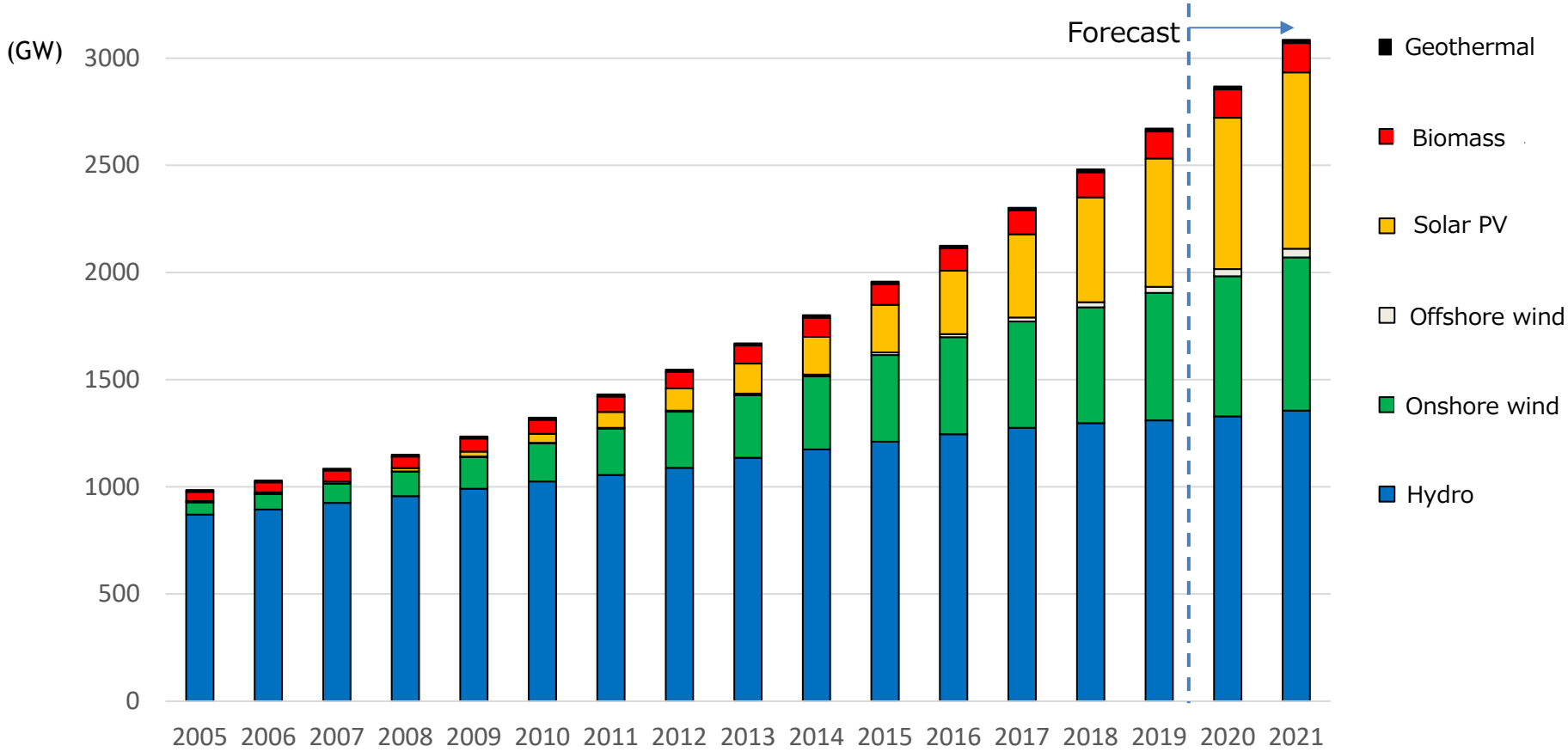
- In the OECD countries plus China, India, and Brazil, the change by energy sources (see graph below) seen in the energy power generation from January to August, 2019 to the same period in 2020 shows a marked contrast between declining coal-fired power and rising wind and solar PV.
  - The increase in renewable energy is for the reasons that include the start of operations in 2020 at renewable energy power generation plants that saw a significant boost in capacity in 2019 due to previous investment, many countries' adoption of incentives to spur greater renewable energy usage, including priority dispatch policies and mandates for purchasing power under FIT schemes, and the fact that marginal generation costs for renewable energy (other than biomass) are close to zero, making it competitive for the wholesale electricity markets in the U.S. and Europe, which buy and sell based on the merit order.
  - Growth in renewable energy power generation capacity continues in 2020, putting increasing downward pressure on coal-fired thermal power in especially the U.S. and Europe. This is likely to see the trend towards more renewable energy and less coal-fired power become systemic in 2021, even if electricity demand recovers.



Source: Prepared by IEEJ based on data from the IEA's *Monthly OECD Electricity Statistics: Data up to August 2020*

Cumulative global renewable power capacity (2005-2021)

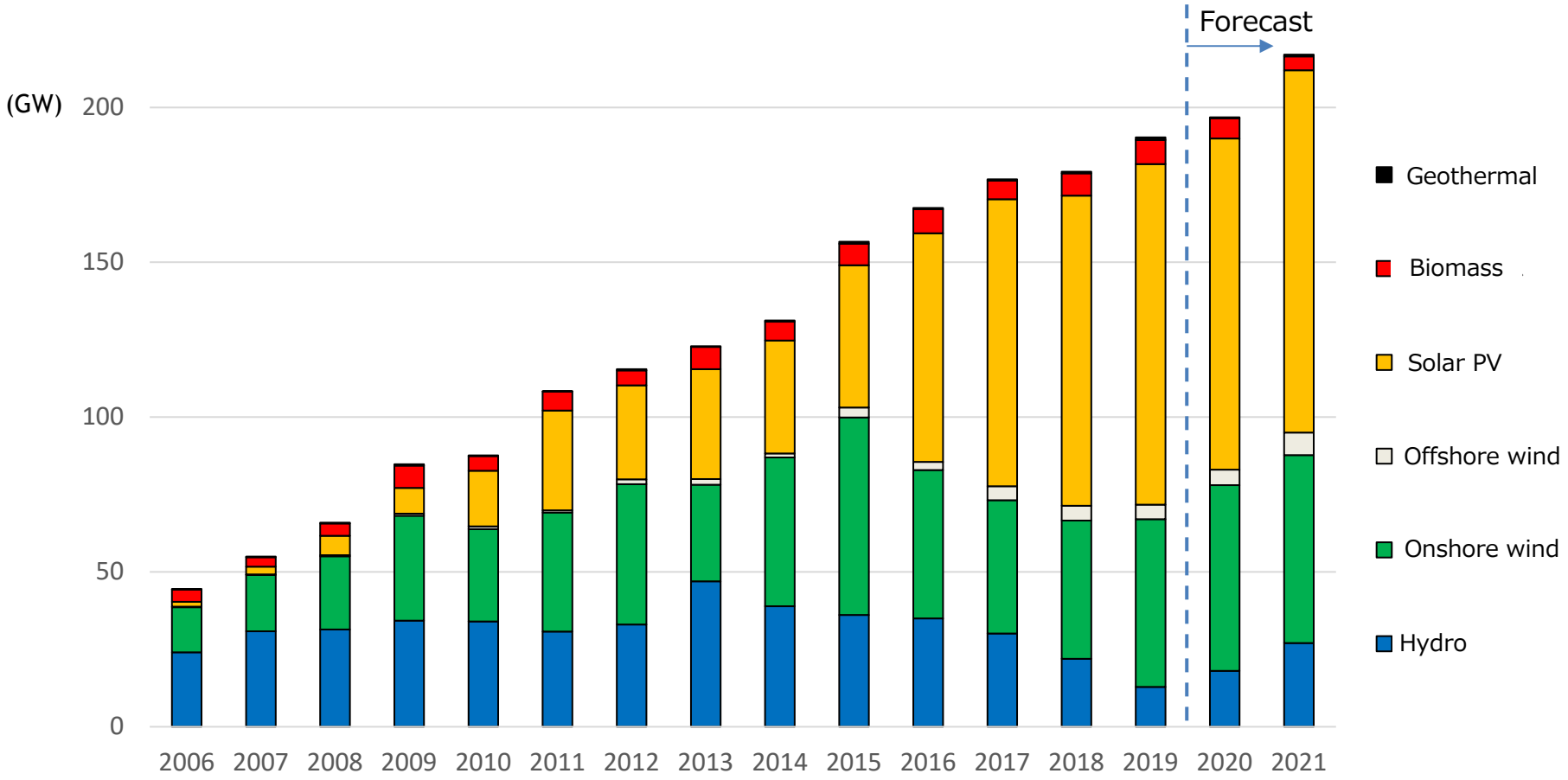
- Renewable power capacity continues to grow in 2020 despite the COVID-19 pandemic, on track to reach 2,900 GW by the end of 2020 and 3,100 GW by the end of 2021 (hydro: 1,350 GW, non-hydro: 1,750 GW)
  - Although the rate of increase was initially expected to slow from 8% to 6% annually as a result of COVID-19, the rate is forecast to be close to 8% for 2021 due to a rapid recovery in the second half of 2020
  - Within the 3,100 GW in 2021, China, the EU, and the U.S. will account for 30%, 17% and 12%, respectively, and Japan about 4%



Source: Prepared based on data from IRENA's *Renewable Electricity Capacity and Generation Statistics, IEA Renewables 2020* and other sources

Global annual addtion of renewable power capacity (2006-2021)

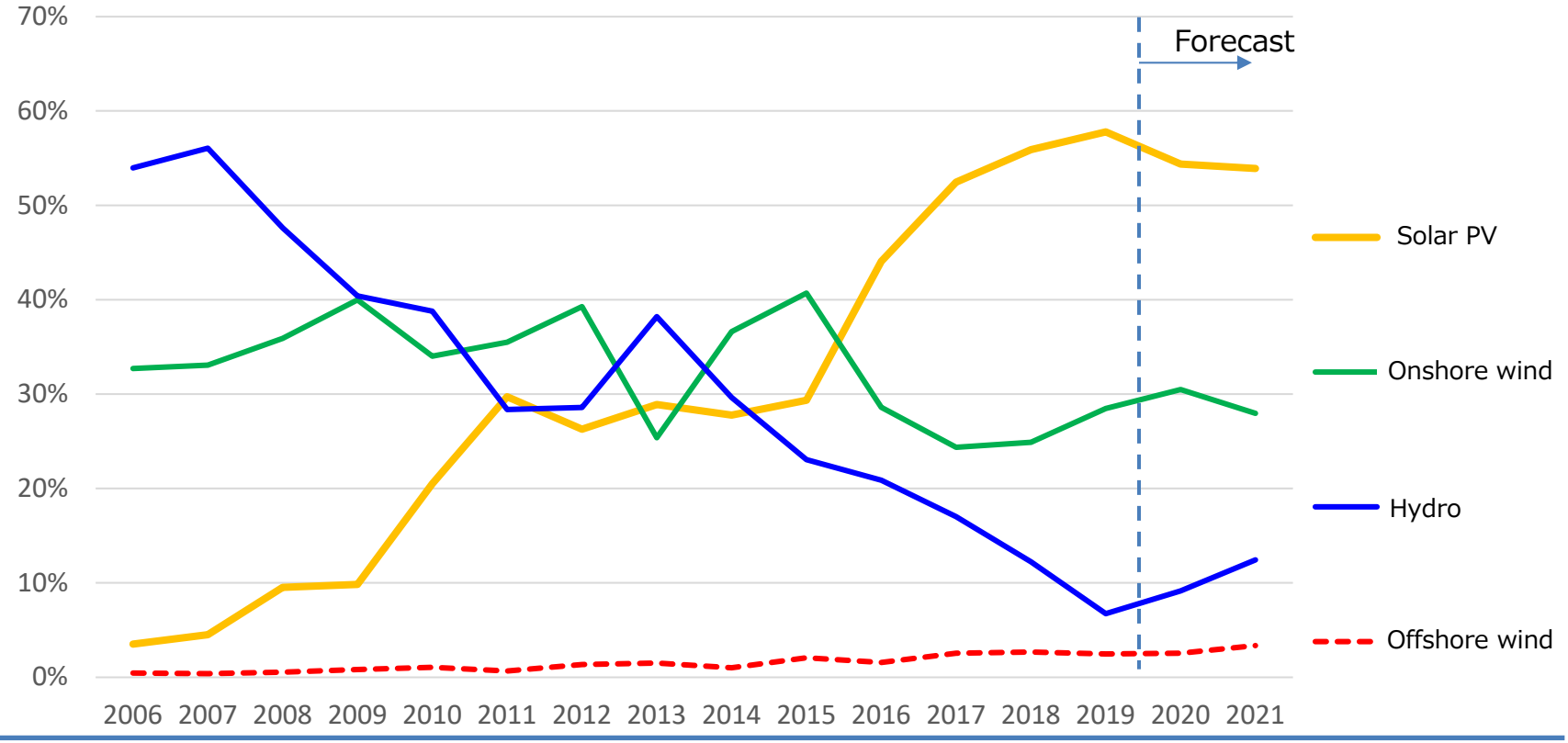
- Renewable capacity increased significantly in particularly China, the U.S., and Europe beginning in the second half of 2020. Consequently, 2020 annual renewable energy power generation capacity is expected to match or exceed the 2019 level (190 GW), the highest level recorded.
  - A steady stream of renewable power businesses that had seen delays due to COVID-19 will begin operations in 2021, which could see annual renewable energy growth over 200 GW and a new record



Source: Prepared based on data from IRENA's *Renewable Electricity Capacity and Generation Statistics, IEA Renewables 2020* and other sources

Share of global annual addition of renewable power capacity by resources (2006-2021)

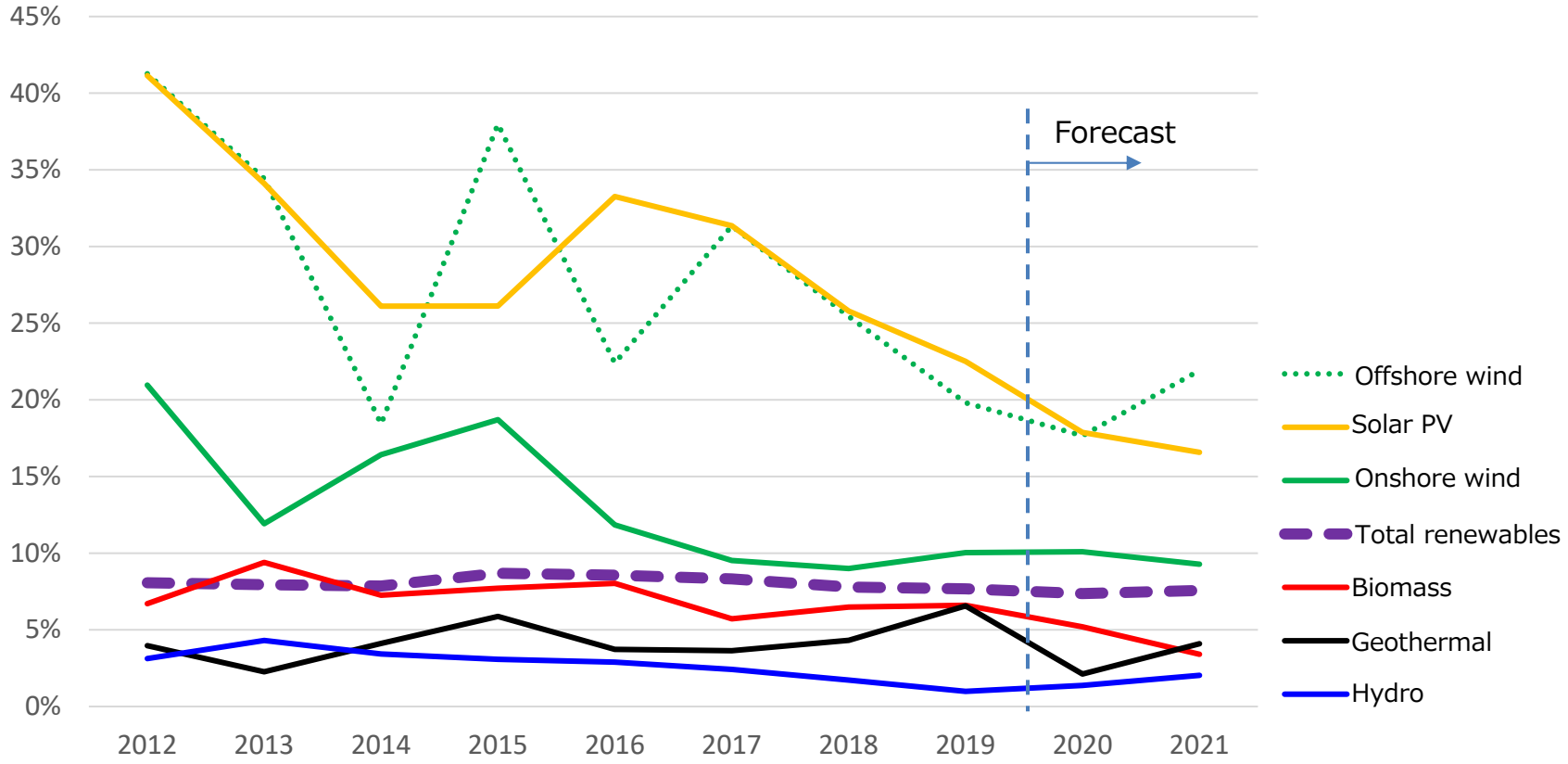
- Even amid the COVID-19 pandemic, solar PV and onshore wind together comprise more than 80% of the total capacity increase, continuing the same basic structure
  - However, the share of power for residential use and distributed power for mid-size self-consumption as a proportion of total solar power generation, which had risen to just under 50% in 2018–2019, dropped about 30% in 2020–2021. Conversely, the share increased for large-scale solar power generation intended for sale to the grid – reversing a trend away from “selling to the grid” towards “self-consumption”
  - Offshore wind power is trending gradually upwards albeit still with low absolute volume
  - The increase in hydropower is a temporary phenomenon prompted by the start of large-scale projects in places such as China and Laos



Source: Prepared based on data from IRENA's *Renewable Electricity Capacity and Generation Statistics, IEA Renewables 2020* and other sources

Global annual rates of increase in renewable power capacity (2012-2021)

- Total renewable energy power generation capacity is forecast to see a stable 8%/year increase for 2020–2021
  - COVID-19 had almost no impact on the rate of increase for global renewable power capacity
  - Offshore wind power and solar power fared particularly well, increasing between 15% and 20%

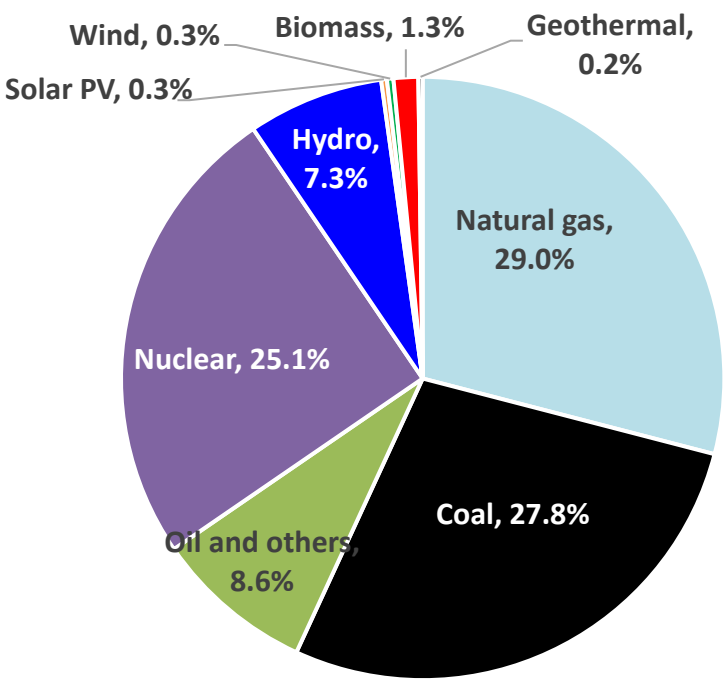


Source: Prepared based on data from IRENA's *Renewable Electricity Capacity and Generation Statistics, IEA Renewables 2020* and other sources

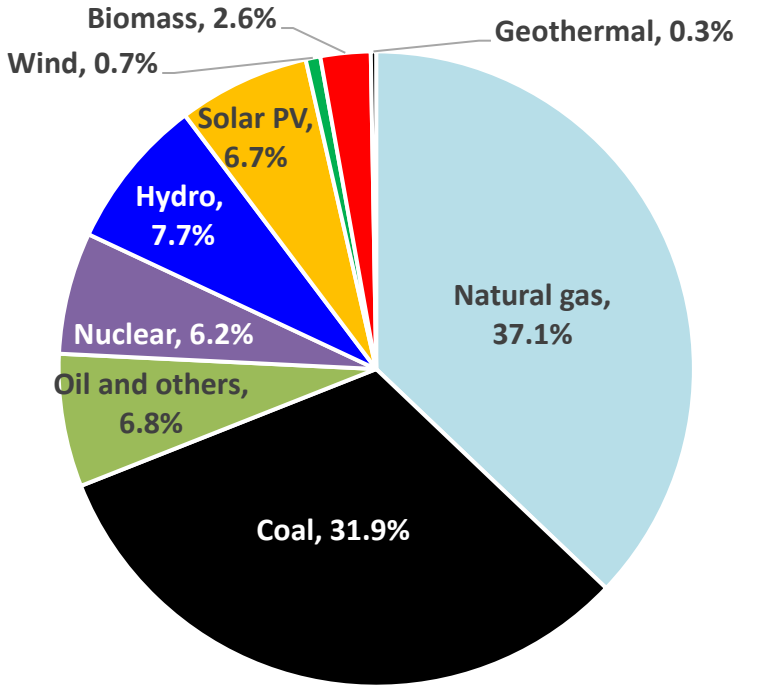
Renewable energy accounted for 18.0% of total power generation in Japan in FY 2019

- Renewable energy accounted for 18.0% of total power generation of 1,028 TWh in Japan in FY 2019, up 1.1% from the 16.9% of FY 2018 of 1,051 TWh
  - Solar increased by 0.7%, while biomass rose by 0.4%; other renewables were flat
  - The renewables share increased 8.5% over the nine years from FY 2010 (9.5%) to FY 2019 (18.0%)

FY 2010 power generation in Japan (1,150 TWh)
(Renewables share 9.5%)



FY 2019 power generation in Japan (1,028 TWh)
(Renewables share 18.0%)

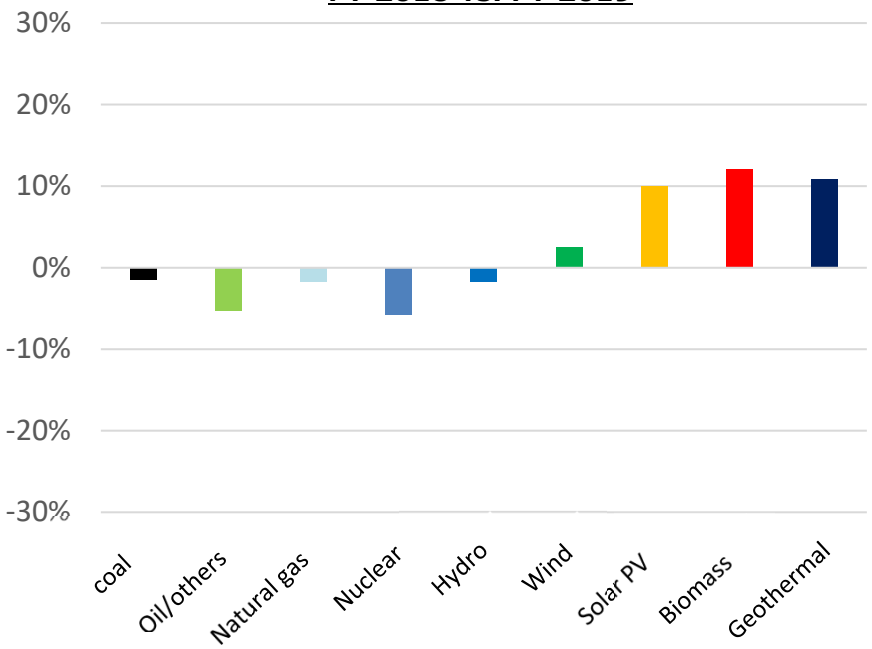


Source: Prepared based on data from the *General Energy Statistics of Japan 2020*

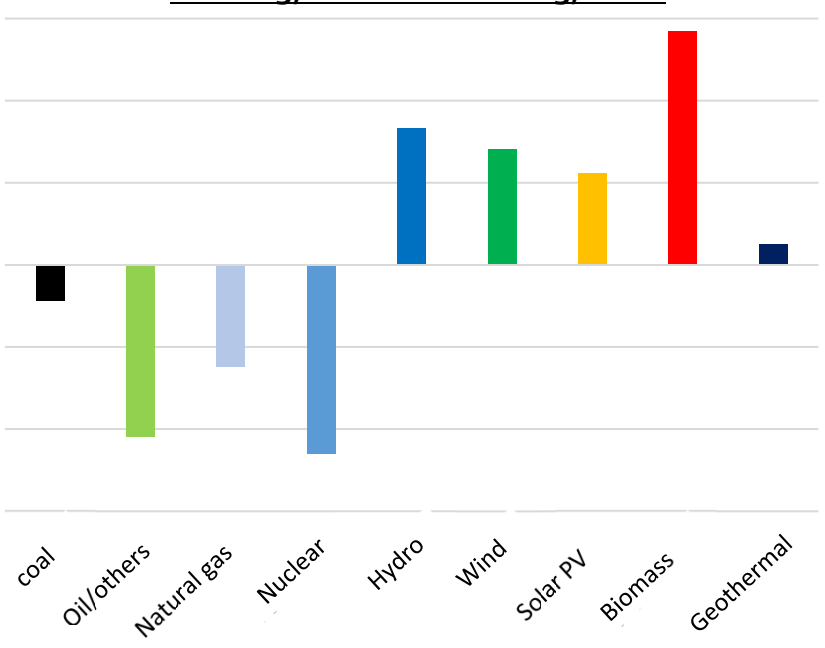
Japan's energy mix: A clear increase in renewables in 2020

- The FY 2018 to FY 2019 change in power generation in the left-hand chart by resource shows slight declining of fossil fuels contrasted with rising renewables particularly solar, biomass and geothermal
  - The increase in geothermal power is a temporary phenomenon owing to starting operations at a large-scale 46 MW facility in May 2019, the first facility of its size to operate over the past 23 years
- Changes in power generation by resources in the right-hand chart between January-August 2019 and 2020 show an increasingly clear picture of declining fossil-fuels and rising renewables, a phenomenon identical to the global trend towards rising renewables amid the COVID-19 pandemic
  - Forecasts call for renewables to comprise just under 20% of total power generation in FY 2020

Changes in the power generation by resources: FY 2018 vs. FY 2019



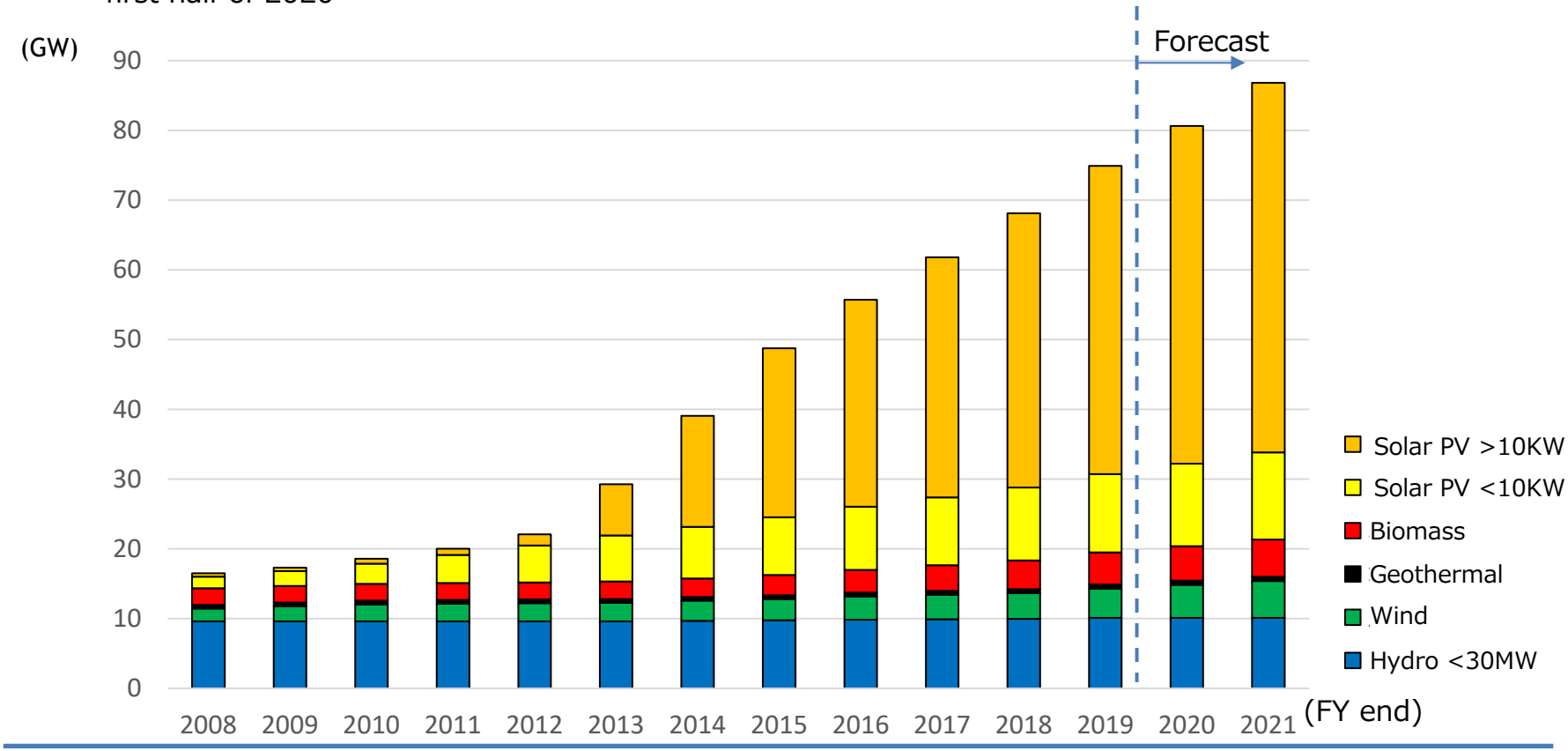
Changes in the power generation by resources: Jan-Aug, 2019 vs. Jan-Aug, 2020



Source: Prepared based on data from the *Comprehensive Energy Statistics of Japan 2020* and *IEA Monthly OECD Electricity Statistics: Data up to August 2020*

Cumulative renewable power generation capacity in Japan (FY 2008-2021) (excl. 30 MW< large hydro)

- Growing at a rate of 10%/year between FY2017-2019, renewables will slow to 8%/year in FY2020–2021
  - Cumulative renewable capacity is expected to reach 87 GW* and power generation to reach 166 TWh** by the end of FY 2021
  - If large hydro>30MW is included, renewables will comprise 20.4% of total power generation in FY2021 (8.0% hydro, 12.4% non-hydro)
  - As renewable capacity is also expected to continue rising beyond FY2021, the current energy mix plan by 2030 (renewable energy becoming 22–24% of total power generation) could actually be reached in the first half of 2020

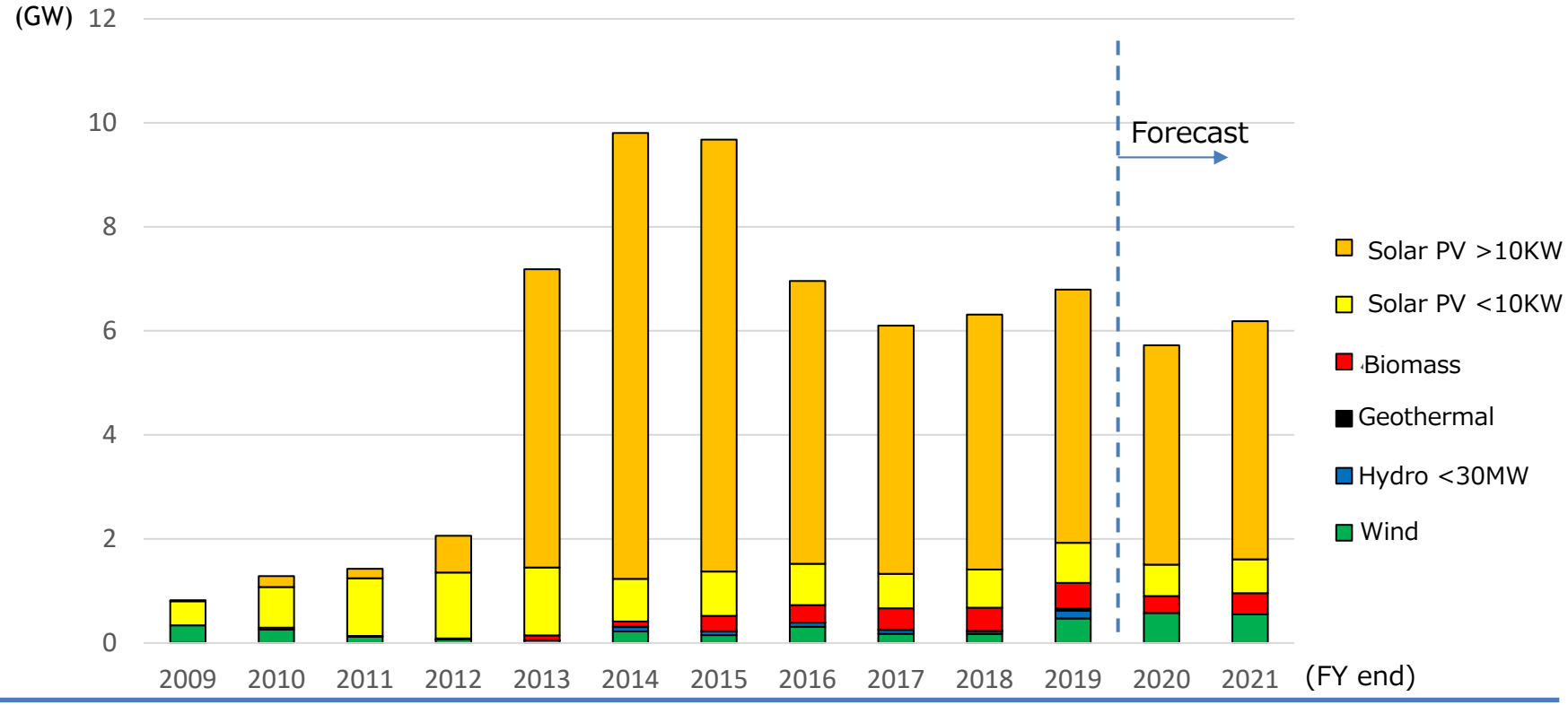


*Solar PV is measured in AC capacity
**Includes self-consumption by rooftop solar PV and others

Source: Estimates from the Institute of Energy Economics, Japan

Annual addition of renewable power capacity in Japan (FY 2009-2021) (excl. 30 MW< larger hydro)

- As construction of new plants to generate solar power for residential and commercial use has slumped due to COVID-19, the increase in solar power generated in 2020 amounted to only just under 6 GW; however, 2021 should see a rebound to over 6 GW*
  - This is due to the expectation of a last-minute rush to begin operations at currently “idle” large-scale solar PV before generous FIT pricing expires, and of an increase in commercial solar PV ahead of policy changes from FIT to FIP scheduled in 2022
  - As numerous onshore wind projects approved for FIT are set to begin operations, implying that markets will gradually shift away from an “overconcentration” on solar PV

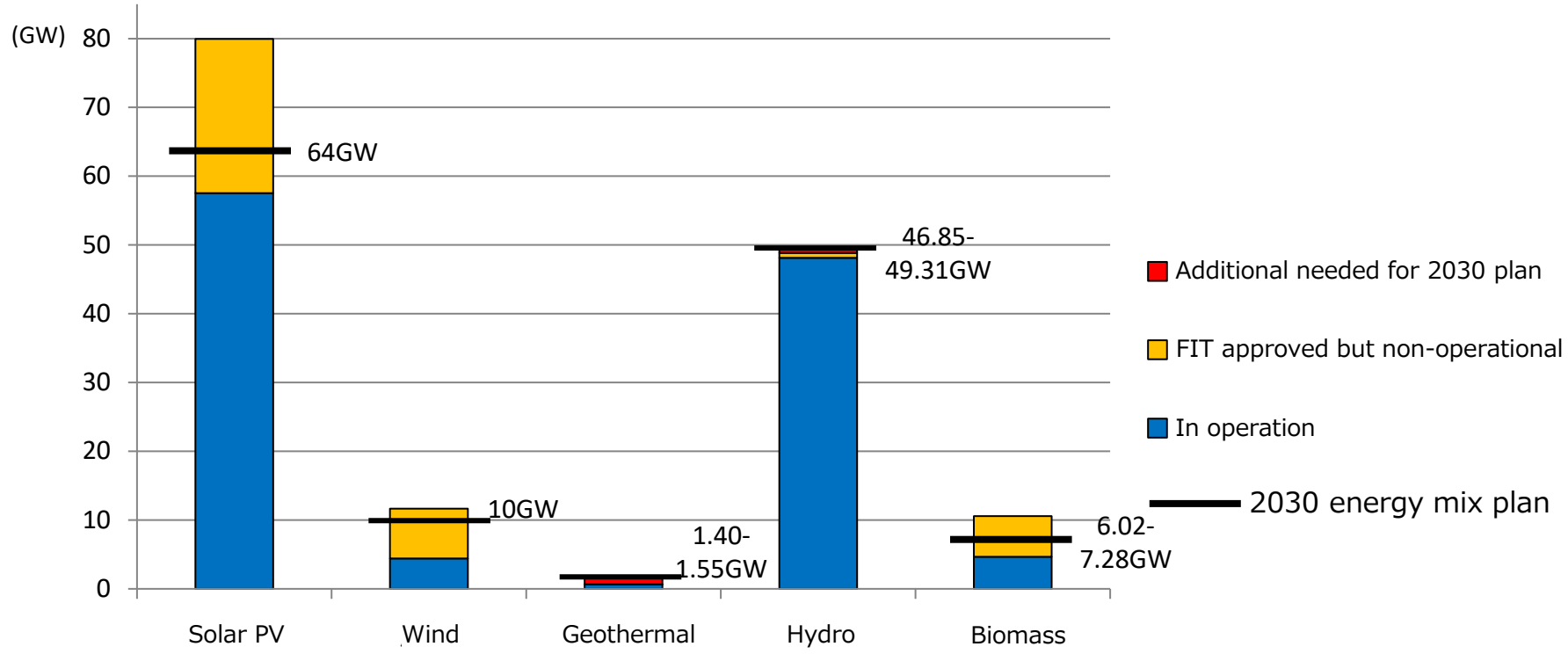


*Solar PV is measured in AC capacity

Source: Estimates from the Institute of Energy Economics, Japan

Cumulative renewable capacity compared to 2030 energy mix plan in Japan (as of June 2020, incl. 30 MW< larger hydro)

- Solar PV is expected to reach 65 GW by the end of FY2021, exceeding the 2030 plan of 64 GW*
  - FIT-approved onshorewind projects have increased significantly exceeding the 2030 plan of 10 GW if combined with currently operating plants; FIT-approved projects are expeced launch at around 0.5 GW/year, which should see offshore wind projects also begin to rise in FT2021
  - The picture is similar for biomass: FIT-approved projects and facilities in operation will together significantly exceed the 2030 plan, with annual growth of around 0.4 GW/year
  - Overall, renewable capacity is rising towards the 2030 energy mix plan
  - If the 93 GW of capacity that has received FIT approval as of June 2020 goes into operation, consumers will have paid JPY 60 trillion to date; this is equivalent to about a JPY 3.40/kWh rise in electricity prices which is slightly higher than the current FIT surcharge of JPY 2.98/kWh for FY2020



*Solar PV is measured in AC capacity Source: Prepared based on data from the the Agency of Natural Resources and Energy

Impact of the COVID-19 Pandemic on Renewables in 2020

- Although many predicted that there would be a clear slowdown in renewable capacity growth due to supply chain disruptions and lockdowns caused by the COVID-19 pandemic, capacity actually rapidly expanded in the second half of 2020 along with the economic recovery.
- Renewable plants construction increased particularly in China, the U.S., and Europe. The 2020 annual capacity increase was forecast to match or exceed the 2019 level (190 GW), the highest level recorded. Surpassing 2019 would make a new record for annual renewable capacity increases.
- Among all types of energy produced in 2020 amid the COVID-19 pandemic, renewables were the only category for which supply increased; this indicates the strength of renewable power business in the face of the pandemic. A global trend towards combining green investment with policies to rescue economies from the pandemic is creating a virtuous cycle that is seeing investors become increasingly interested in renewables.
- 2020 also saw Japan, the U.S., Europe, China, and South Korea make political commitments to more quickly reduce carbon and achieve carbon neutrality, while further efforts were made by key players in private industry worldwide to reduce carbon. These factors eliminated some of the uncertainty concerning the long-term investment environment for renewables.
- The economic turmoil and subsequent recovery in 2020 brought about by the COVID-19 pandemic brought the world to a fork in the road concerning the future of energy, presenting us with the choice of whether to decarbonize or to return to burning fossil fuels. Now that we are clearly on the path decarbonization, there will be opportunities to expand renewables.

Japan's 2050 carbon-neutral commitment: Increase in renewables to the maximum extent

- Japan will "dedicate itself to increase energy efficiency and increase renewables to the maximum extent" (General policy speech given by Prime Minister Suga on 26 October 2020)
- Achieving carbon neutrality will require increasing renewables to the maximum extent
  - No specific roadmap to achieving its objectives has been established; some indications that renewables will comprise 50–60% of total generation capacity by 2050
  - Offshore wind power will bring in 10 GW by 2030 and 35–45 GW by 2040 which could comprise 11–12% of the renewables share

- Support measures through the tax system
  - Taxpayers are given the option of applying a 5–10% tax credit for investments in or 50% special depreciation for costs of acquisition of wind power generation equipment which is a temporary measure through 2024
  - Deduction limit for tax losses carried forward will be raised to 100% of taxable income on the condition that funds are used for decarbonization activities with a maximum carry-over periods of 5 years
- Promotion of R&D into renewable-related technologies
  - Establishment of a JPY 2 trillion fund under NEDO to support decarbonization R&D, which includes renewable-related technologies
- Relaxation of the current regulations to promote further deployment of renewables
  - Conversion of farmland into space for renewable power plants; relaxation of exclusive permissions and of regulations for installation of various facilities
  - Establishment of a specific task force to review the current regulations impeding renewables adoption
- Review of rules for operating transmission and distribution power systems
  - Allocation of power line capacity, strengthening and line duplication in inter-region power grids
  - A focus on achieving the 2050 carbon-neutral commitment will be incorporated into Cross-regional Network Development Plan (so-called "Master Plan")
    - (From January 2021) non-farm connections apply to nationwide trunk transmission power systems that no longer have enough capacity and to apply those connections also to local grid
    - Change in the current curtailment rule due to congestion of transmission line: Regardless of non-farm connection or not, fossil fuel plants is restricted firtst before non-fossil plants such as renewables

Massive increase in offshore wind: 10 GW by 2030 and 30–45 GW by 2040

- Since the Act of Promoting Utilization of Sea Areas in Development of Power Generation Facilities Using Maritime Renewable Energy Resources went into effect in April 2019, a number of offshore wind projects have been developed in prospective areas nationwide

- Offshore wind capacity targets are set at 10GW by 2030, 30–45 GW by 2040; almost 2,800 times the current 0.016 GW, a massive increase

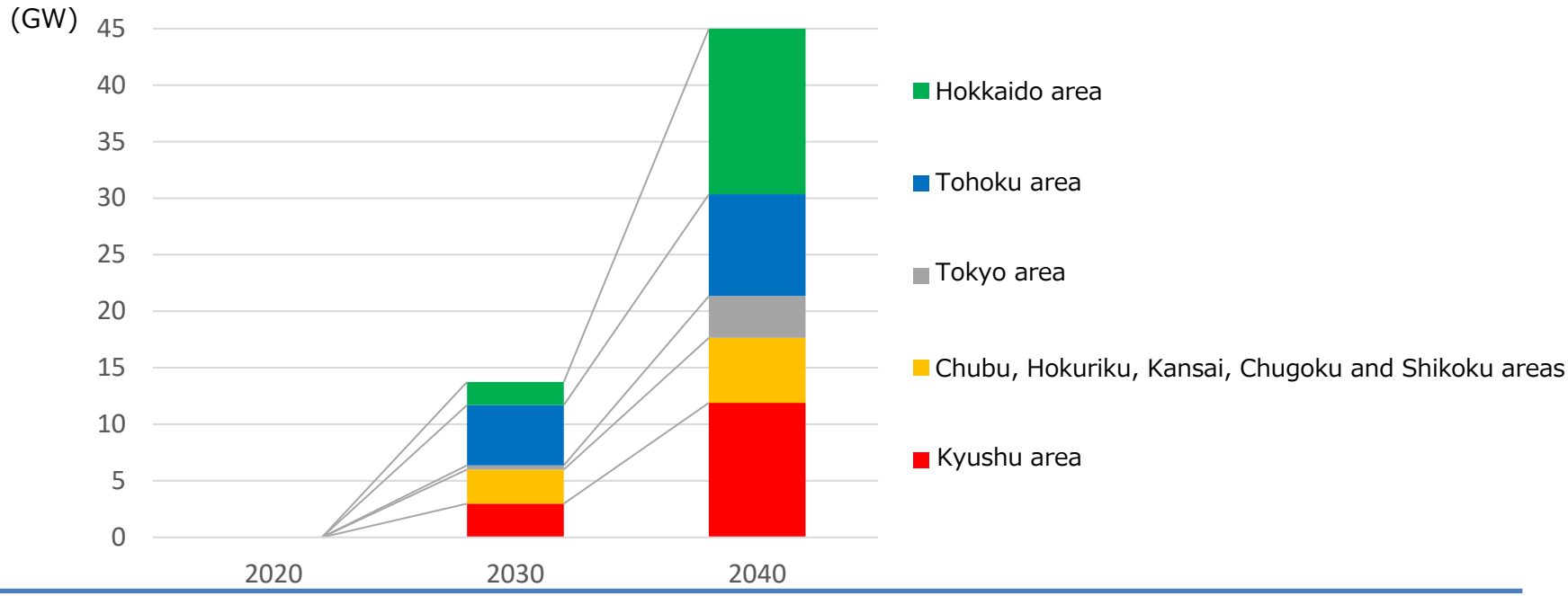
- Main challenges: costs, create domestic supply chains and expansion/strengthen of power grid
  - Target generation cost is JPY 8–9/kWh for fixed-foundation type by 2030, compared to the current FIT price is JPY 36/kWh
  - Japan needs a competitive domestic supply chain as it currently relies on other countries for almost all materials and equipment needed to build offshore wind facilities; could Japanese corporations exercise their strengths to this end?
  - Power lines must be expanded/strengthened that connect Hokkaido, Tohoku, and other areas favorable for wind power generation to Tokyo and other areas of demand (also consider HVDC power transmission)

- Many other countries are also setting targets for or are predicting significant increases in offshore wind capacity over the next 10 years
  - EU: Targeting 60 GW by 2030, 300 GW by 2050 (25x the current 12 GW)
  - China: Forecasting 59 GW by 2030 (Almost 10x the current 6 GW)
  - South Korea: Targeting 12 GW by 2030 (100x the current 0.12 GW)
  - Taiwan: Targeting 5.5 GW by 2025 and 15.5 GW by 2035 (120x the current 0.13 GW)
  - U.S.: Forecasting 22.6 GW by 2030 (780x the current 0.029 GW)

Three main pillars presented in “Offshore Wind Industry Vision” (published in 15 December 2020)

1. Creating an attractive domestic offshore wind power market
   - Designating continuously 1GW/year projects throughout next 10 years, achieving 10GW by 2030 and 30–45GW by 2040
   - Government-led push-style project creation scheme under the new law for offshore wind development
   - Actualize and announce, by next spring, the first draft of “master plan” for grid expansion/strengthen to achive the offshore wind targets, and consider HVDC transmission
   - Harbor infrastructure development: Construction to strengthen soil bearing capacity as necessary to install and maintain large wind turbines at 4 sites in Japan
2. Promoting investment and raising up domestic supply chain
   - Domestic procurement and cost reduction goal for industry: Achieve domestic production ratio of 60% by 2040
   - Cost reduction: target set at JPY 8–9/kWh by 2030–2035 for fixed-foundation type
3. Developing next-generation technology and enhancement of international cooperation aiming at Asian market

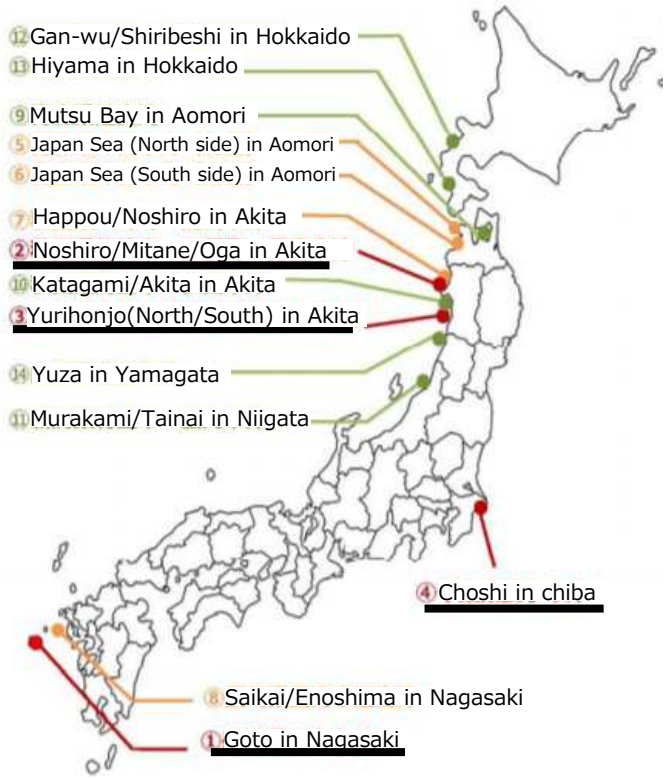
Offshore wind capacity developemnt by area in Japan (max. targets for 2030 and 2040)



Source: Prepared based on the Offshore Wind Industry Vision (first draft) (15 December 2020)

Designate for 4 zones as offshore wind promotion areas where tenders to select business operators begin in FY 2021

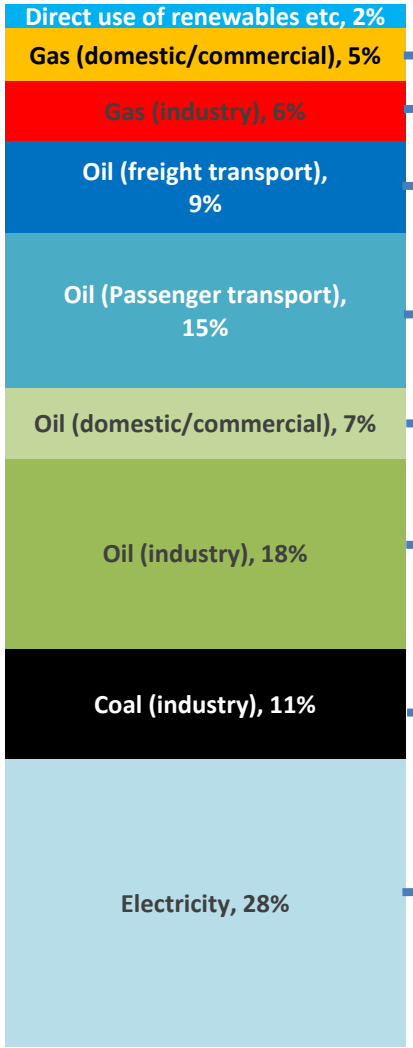
- 4 zones of Goto in Nagasaki Prefecture (21 MW, floating); offshore Noshiro in Akita Prefecture (415 MW, fixed-foundation), offshore Yurihonjo in Akita Prefecture (730 MW, fixed-foundation), and offshore Choshi in Chiba Prefecture (557 MW, fixed-foundation) are officially designated as promotion areas under the law
  - A series of tenders to select offshore wind operators in the designated 4 zones will be in place in 2021
  - Subsequently FIT approval with long-term concession over 30 years will be granted to the selegted operators
  - Preparations are also under way to designate 10 more sites in Hokkaido, Tohoku and Kyushu areas
  - After 2021, Japan is highly likely to rapidly grow into a market that well exceeds 650 MW of current FIT-approved capacity



Source: Partial revisions made to secretariat documents for the first Meeting of the Council for Government-Industry Dialogue for Offshore Wind in Japan

Renewables in heat/transportation sectors are future challenges under the 2050 carbon-neutral commitment

FY2018 final energy demand in Japan



Achieving Japan's 2050 carbon-neutral commitment will require eliminating most of the country's current energy-related CO_2 emissions. Going forward, attention will focus not only on electricity, which accounts for a mere 28% of final energy consumption, but also fossil fuels, which satisfy the remaining 72%.

12% of total: Demand for oil products and gas for heat use in domestic/commercial sectors
○ Applicable renewables: Renewable electricity + heat pumps, renewable hydrogen + fuel cells, biofuel, and renewable hydrogen-originated synthetic fuel
○ Challenges: Reducing the cost of renewable hydrogen/biofuels; establishing methods for supplying large quantities, handling huge amount of existing equipments

24% of total: Demand for oil products for transport use (passenger/freight)
○ Applicable renewables: Renewable electricity + EVs, renewable hydrogen + FCVs, biofuel, and renewable hydrogen-originated synthetic fuel
○ Challenges: Reducing the cost of batteries, fuel cells, renewable-hydrogen, and biofuel, establishing methods for supplying large quantities, develop supply infrastructure such as EV and hydrogen vehicle charging stations

35% of total: Demand for coal, oil products and gas for industrial heat use (production processes, boilers, industrial furnaces, etc.)
○ Applicable renewables: Renewable electricity + production process electricity; biofuels; renewable hydrogen combustion; renewable hydrogen-originated synthetic fuel; and direct usage of heat from biomass combustion, geothermal heat, and solar heat
○ Challenges: No renewable technologies have been developed to satisfy current some of industrial heat demand; it is uncertain whether it will be economically feasible to supply large amounts of energy even if the technologies exist; there are numerous production processes for which electricity cannot be used effectively; switching to renewables is the most challenging endeavour

Japan's renewable energy policy so far has exclusively focused on electricity

28% of total: Demand for electricity for industrial, domestic, commercial and transport use
○ Applicable renewables: Solar, wind, hydro, biomass, geothermal, tidal, and wave power
○ The only area of renewable usage making progress. Forecast to comprise 22–24% of the energy mix in 2030, and future policy revisions could put more focus on increasing the renewables share
○ Challenges: Reduce generation costs; overcome VRE integration into grid; ensure system flexibility; determine the optimal programs for promoting further usage (transitioning from FIT to FIP etc); develop business environments for renewables without public financial support in the long-term; and develop domestic industry for renewable power generation facilities

Source: Prepared based on data from the *Handbook of Japan's & World Energy & Economic Statistics 2020*

Contact: report@tky.ieej.or.jp