429th Forum on Research Works 26 July 2018

Outlook on Global Renewable Energy Market

The Institute of Energy Economics, Japan

Yasushi Ninomiya, Senior Researcher
New and Renewable Energy Group
Electric Power Industry & New and Renewable Energy Unit

Summary

- ✓ The world's capacity of renewable energies including hydropower is expected to increase from 2,200 GW at the end of 2017 to over 2,600 GW at the end of 2019. The increase is expected to be 150 GW/year in 2018-2019, slightly lower than the preceding two years of 2016 and 2017, which saw consecutive record-highs. Asia including China and India accounts for approximately 50% of the increase while Europe and the U.S. account for approximately 30%. In 2017, renewables generated 24.5% of global electricity generation, specifically 16.0% of hydropower and 8.4% non-hydropower.

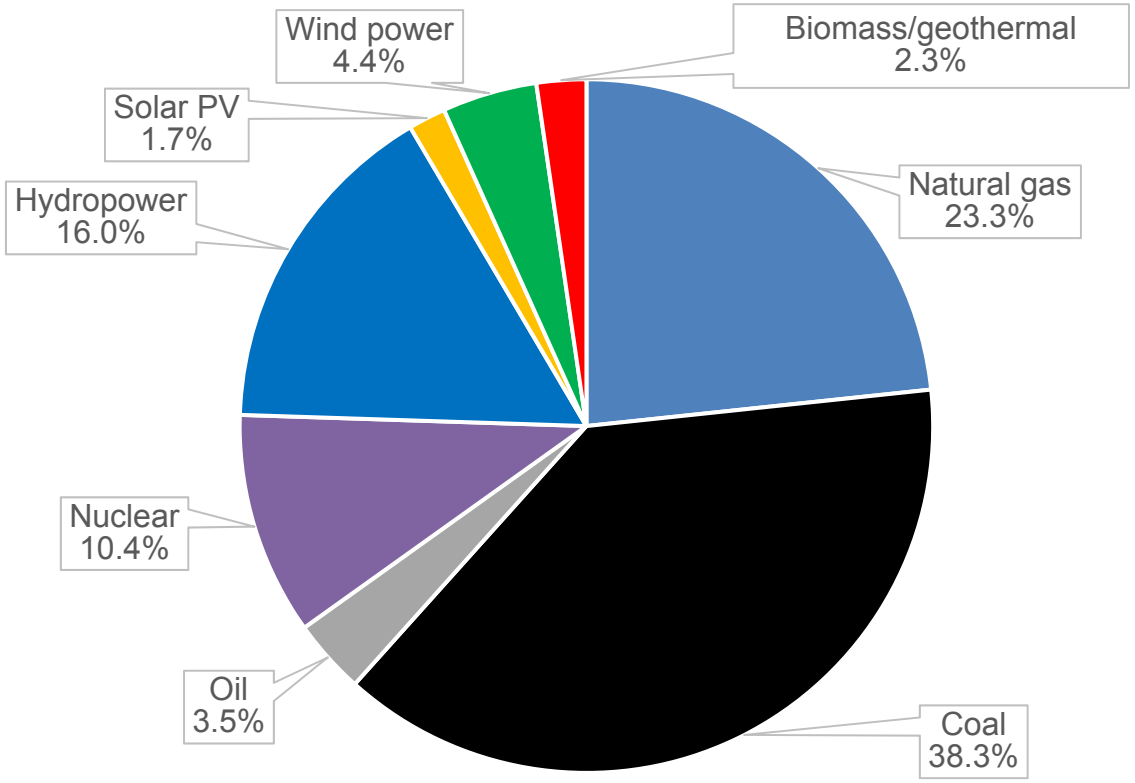
- ✓ The 5th Strategic Energy Plan approved by the Cabinet in July 2018 made a clear reference for the first time to "aiming to make renewables a key power source" as the long-term direction. To reduce costs and control the public burden, efforts will be urged to reduce reliance on the FIT scheme by, for example, using more auction and promoting self-consumption. To overcome the other major challenge of network constraints, "Japanese Connect & Manage" will be implemented to improve the efficiency of existing transmission facilities.

- ✓ Generating capacities of solar PV, wind and biomass in Japan, when combined with their already operating capacities and FIT certified capacity, have almost reached the 2030 Energy Mix target. In particular, solar PV has far exceeded the 2030 target; biomass is projected to meet the 2030 target even after excluding the capacity which may be abandoned due to constraint on fuel procurement. On the other hand, the FIT surcharge is expected to exceed 50 trillion yen in total over the next 20 years, and so reducing the public burden is another challenge that must be addressed.

World's Power Production by Source (2017)

- Of the world's 2017 power production of 25,369 TWh*, renewables accounted for 24.5%.
  - Hydropower 16.0%, Non-hydropower renewables 8.4% in which solar PV 1.7%, wind 4.4% and biomass/geothermal 2.3%)
  - An increase of 0.7% from the renewables' 2016 figure of 23.8%

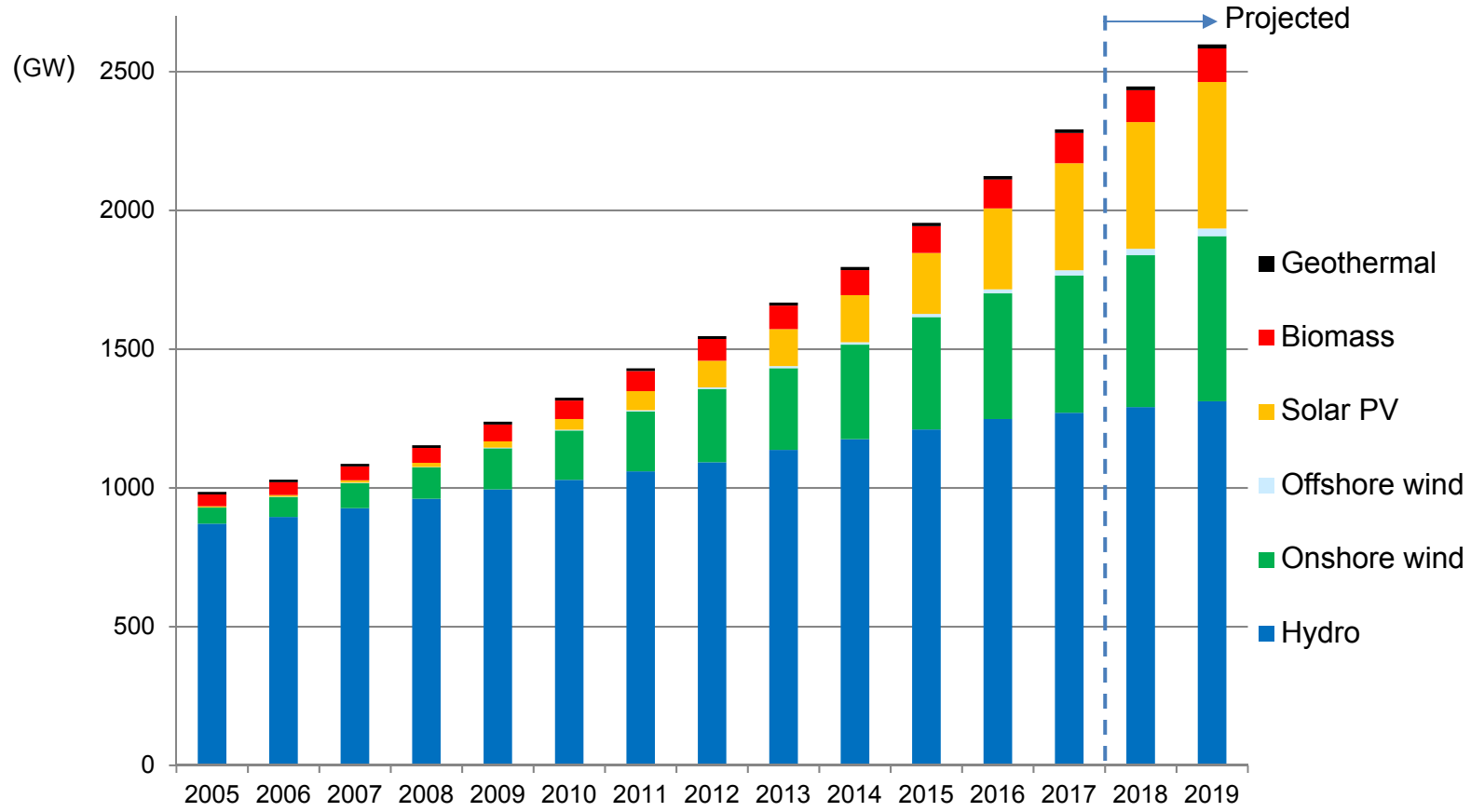
* Excluding 182.6 TWh of statistical errors etc.



Source: based on *BP Statistical Review of World Energy June 2018*

World's Installed Renewable Energy Capacity (Cumulative) (2005-2019)

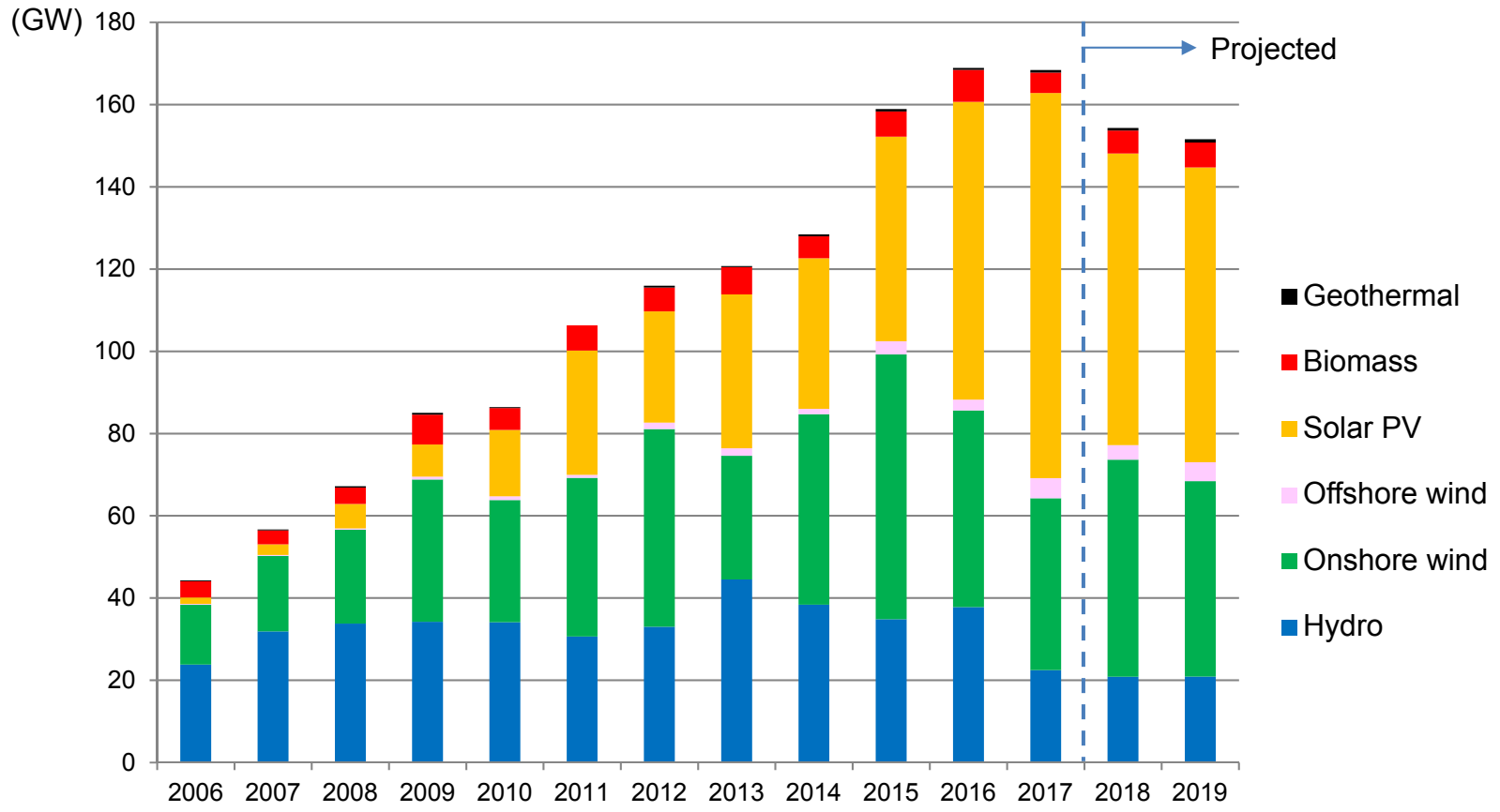
- Reached 2,290 GW at the end of 2017and projected to reach 2,600 GW by the end of 2019.
  - Non-hydropower renewables are expected to double in 5 years of 2014-2019.
  - The total installed capacity of renewables is the largest, exceeding coal (approx. 2,100 GW), gas (approx. 1,700 GW), and nuclear (approx. 400 GW).



Source: based on *IRENA Renewable Electricity Capacity and Generation Statistics, IEA Renewables 2017* and others.

World's Installed Renewable Energy Capacity (Annual Growth) (2005-2019)

- The growth of installed capacity was a record-high of 170 GW p.a. for 2016-2017; a similar but slightly lesser increase in installed capacity is expected to continue in 2018-2019.
  - Solar PV and wind accounting for the bulk of growth has strengthened in recent years; they are expected to account for 80% or more of the growth in 2018-2019.
  - In particular, due to its rapidly declining cost, solar PV is maintaining its growth momentum.

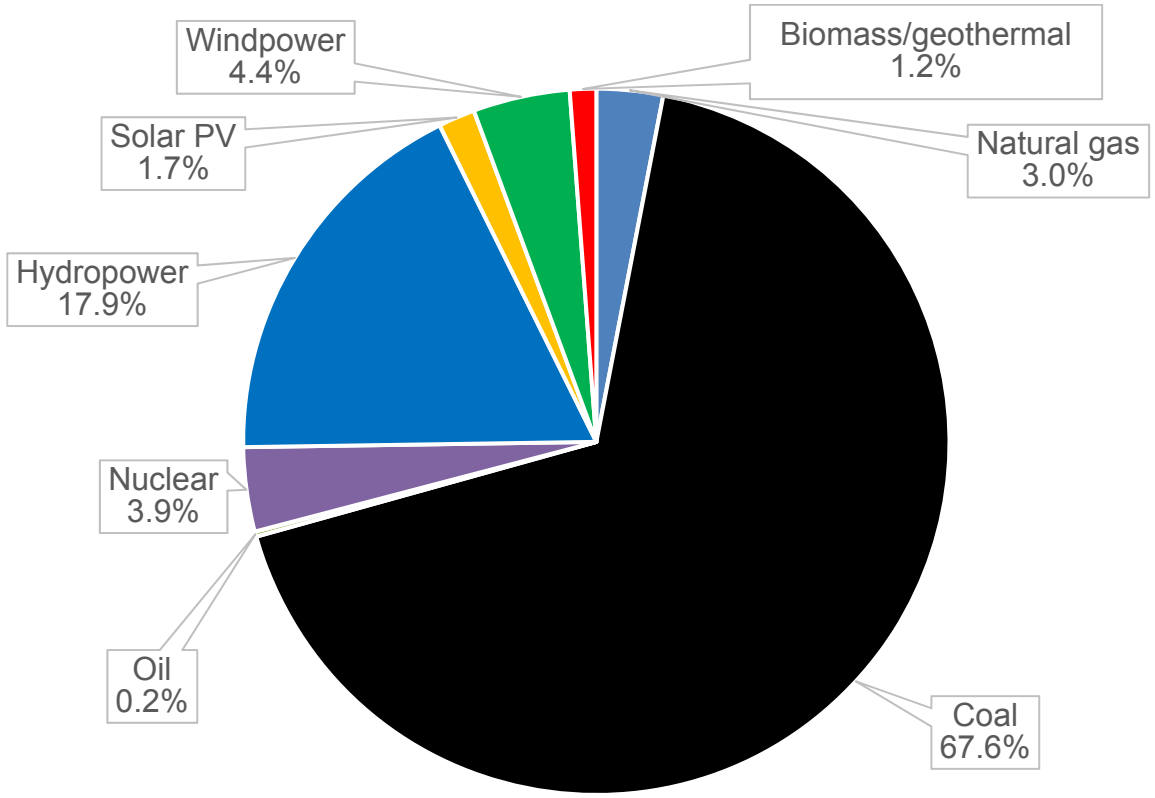


Source: based on *IRENA Renewable Electricity Capacity and Generation Statistics, IEA Renewables 2017* and others.

China's Power Production by Source (Percentage) (2017)

- Of China‘s 2017 power production of 6,448 TWh*, renewables accounted for 25.2%.
  - Hydropower 17.9%, non-hydropower renewables 7.3% in which solar PV 1.7%, wind 4.4% and biomass/geothermal 1.2%
  - An increase of 0.3% from the renewables' 2016 figure of 24.9% (hydropower: down 1% from 18.9% to 17.9%, solar PV: up 0.7% from 1.0% to 1.7%, wind: up 0.5% from 3.9% to 4.4%)

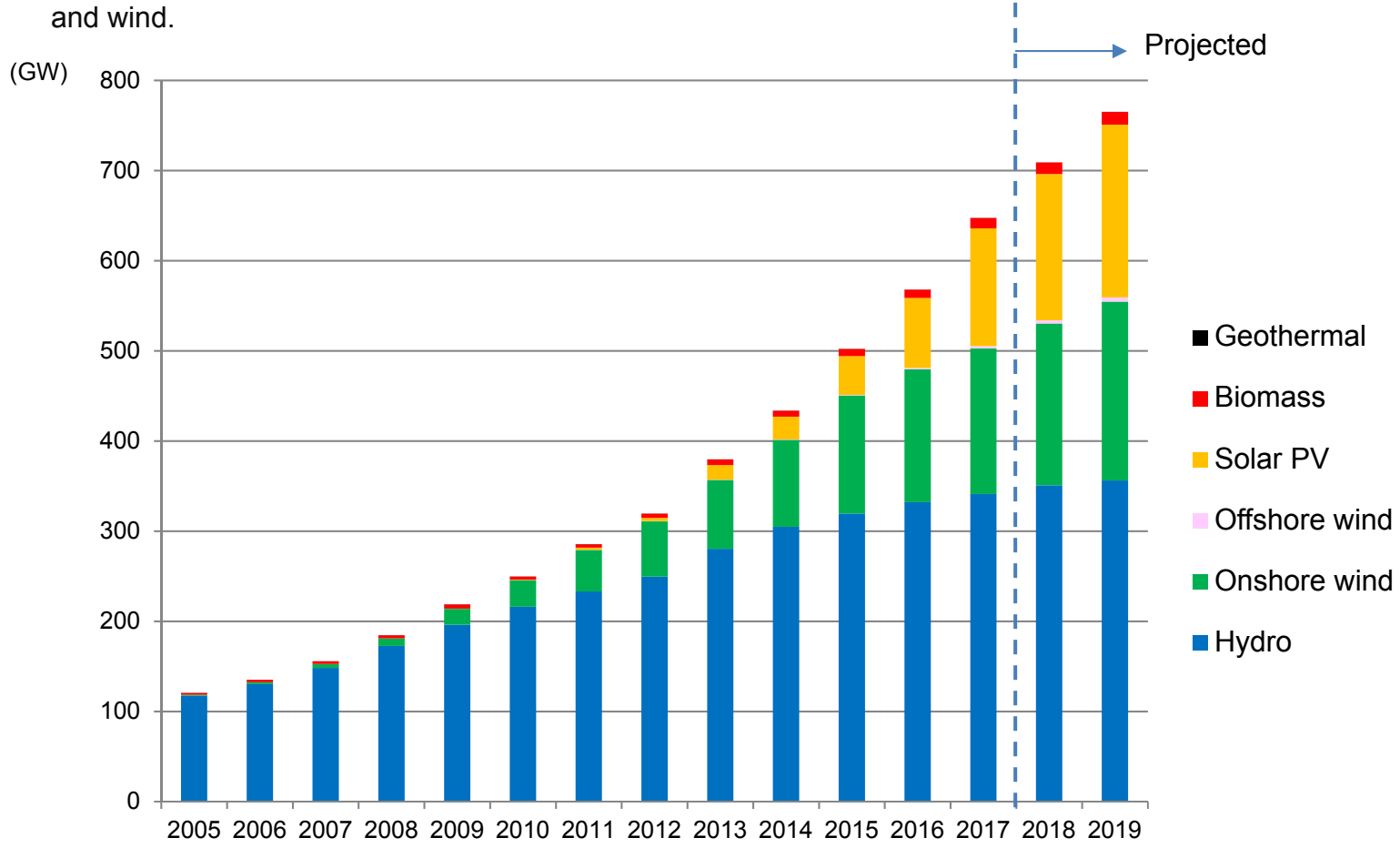
* Excluding 47.4 TWh, statistical errors, etc.



Source: based on *BP Statistical Review of World Energy June 2018*

China's Installed Renewable Energy Capacity (Cumulative) (2005-2019)

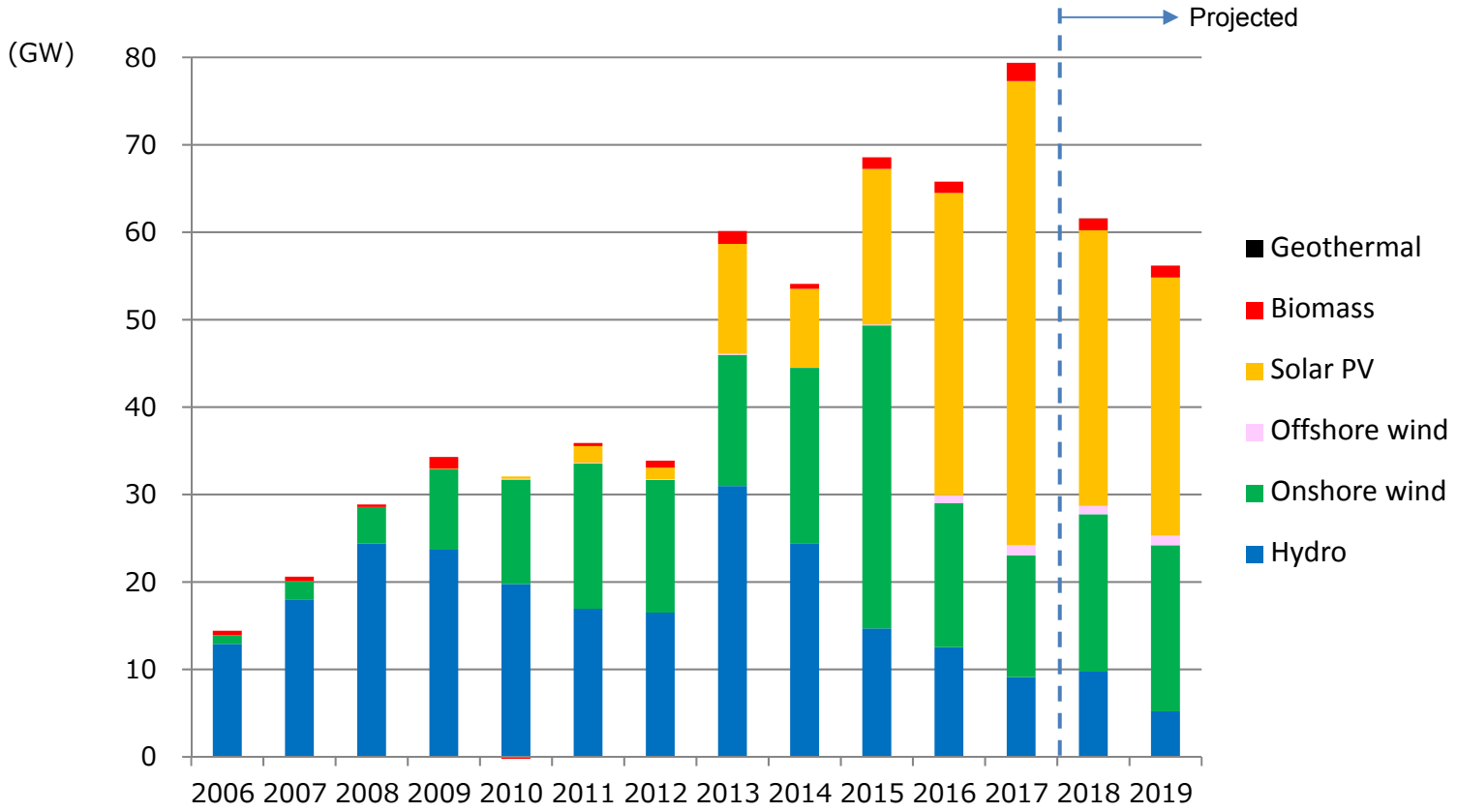
- Likely to reach 770 GW by the end of 2018; one-third of the world's RES capacity is in China.
  - Installed renewables capacity excluding hydropower will be 410 GW in 2019, more than double the 180 GW in 2015.
  - Hydropower is expected to remain almost the same after 2018; the increase will mainly be accounted for by solar PV and wind.



Source: based on *IRENA Renewable Electricity Capacity and Generation Statistics, IEA Renewables 2017* and others.

China's Installed Renewable Energy Capacity (Annual Growth) (2005-2019)

- Growth of solar PV has been accelerating: 18GW in 2015 to 53GW in 2017; however, the growth in 2018 is expected to be around 30GW due to the changes in the government policy.
  - Far larger-than-expected growth of solar PV in 2016-17 squeezed the financial resources for the FIT scheme.
  - With the effect likely continuing into 2019, annual growth in that year is expected to settle at around 30 GW.

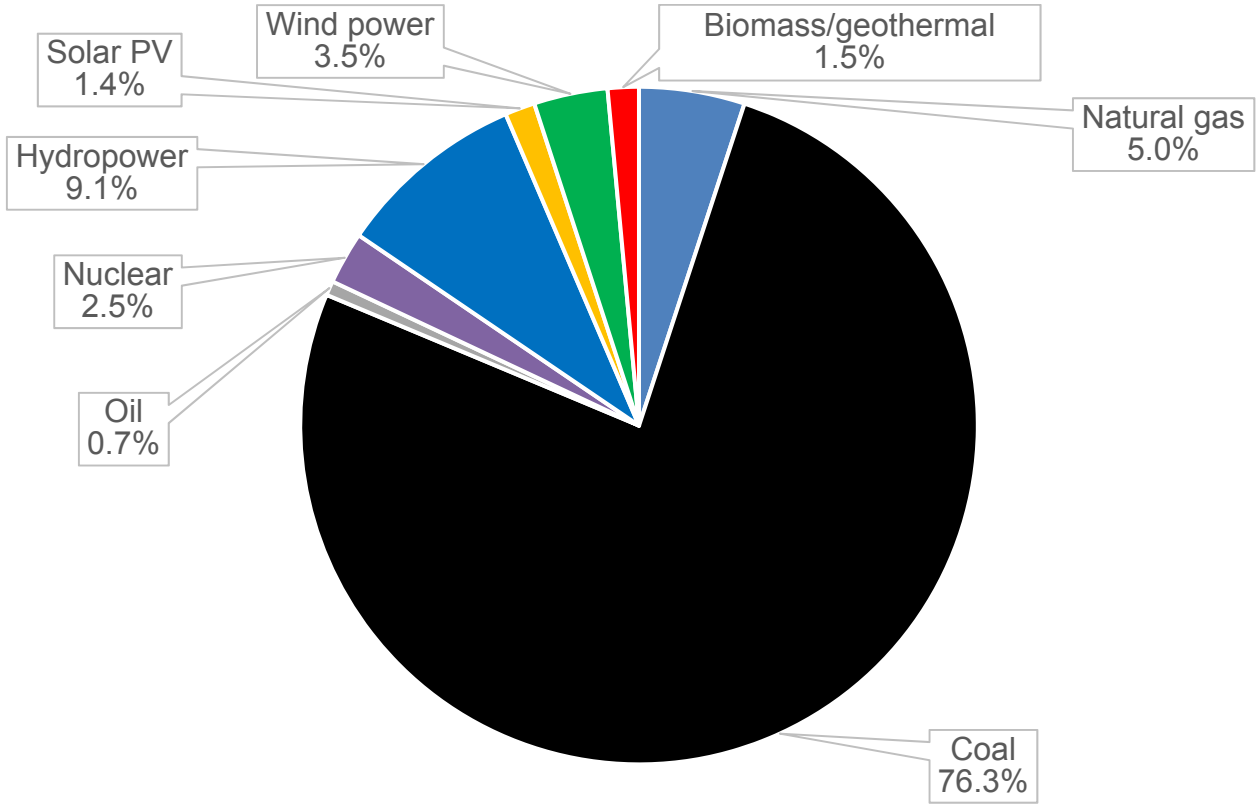


Source: based on *IRENA Renewable Electricity Capacity and Generation Statistics, IEA Renewables 2017* and others.

India's Power Production by Source (2017)

- Of India's 2017 power production of 1,497 TWh*, renewables accounted for 15.5%.
  - Hydropower 9.1% and non-hydropower renewables 6.4% in which solar PV1.4%, wind3.5% and biomass/geothermal1.5%
  - Renewables incl. hydropower increased from 14.7% in 2016 to 15.5% in 2017

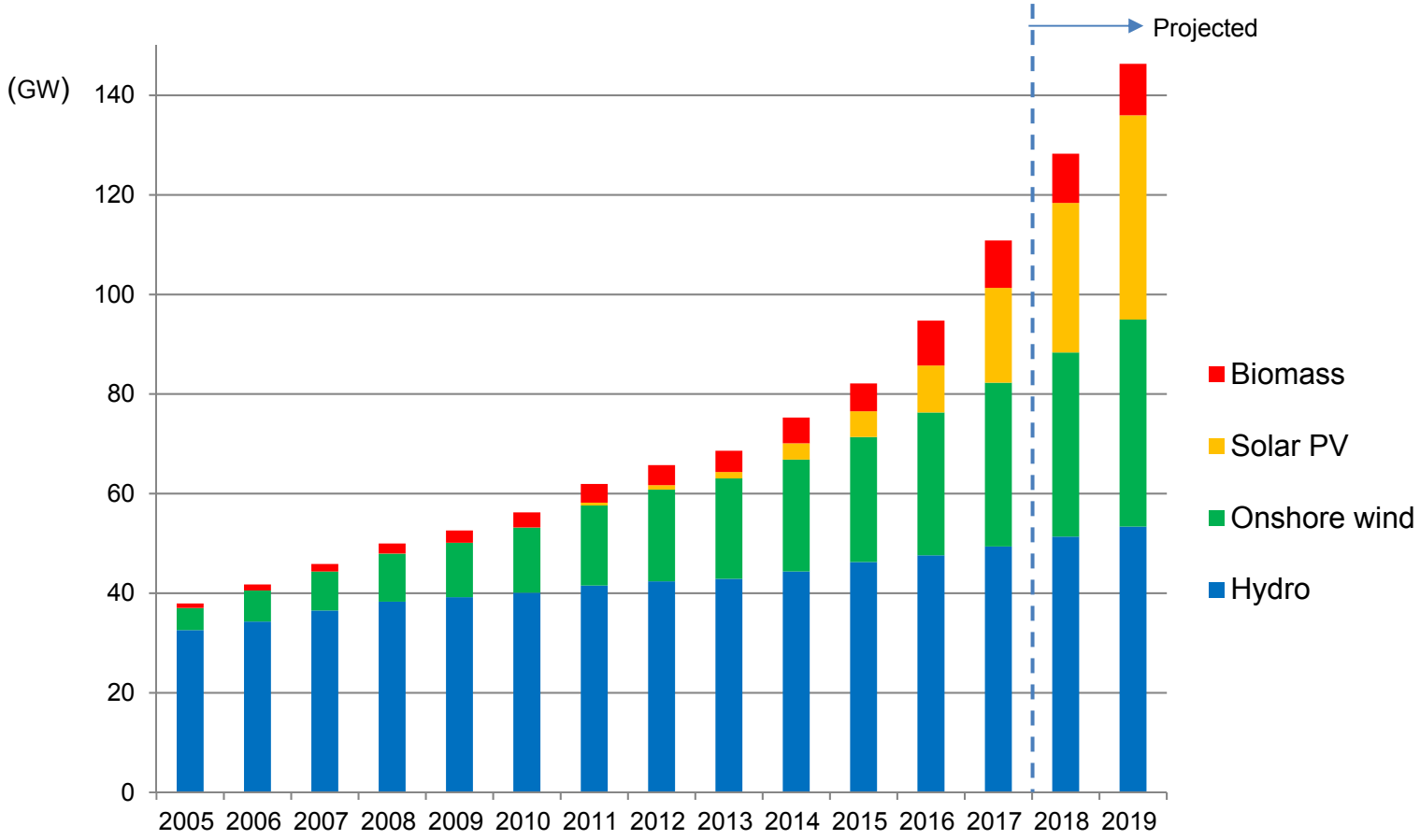
* Excluding 0.3 TWh, statistical errors, etc.



Source: based on *BP Statistical Review of World Energy June 2018*

India's Installed Renewable Energy Capacity (Cumulative) (2005-2019)

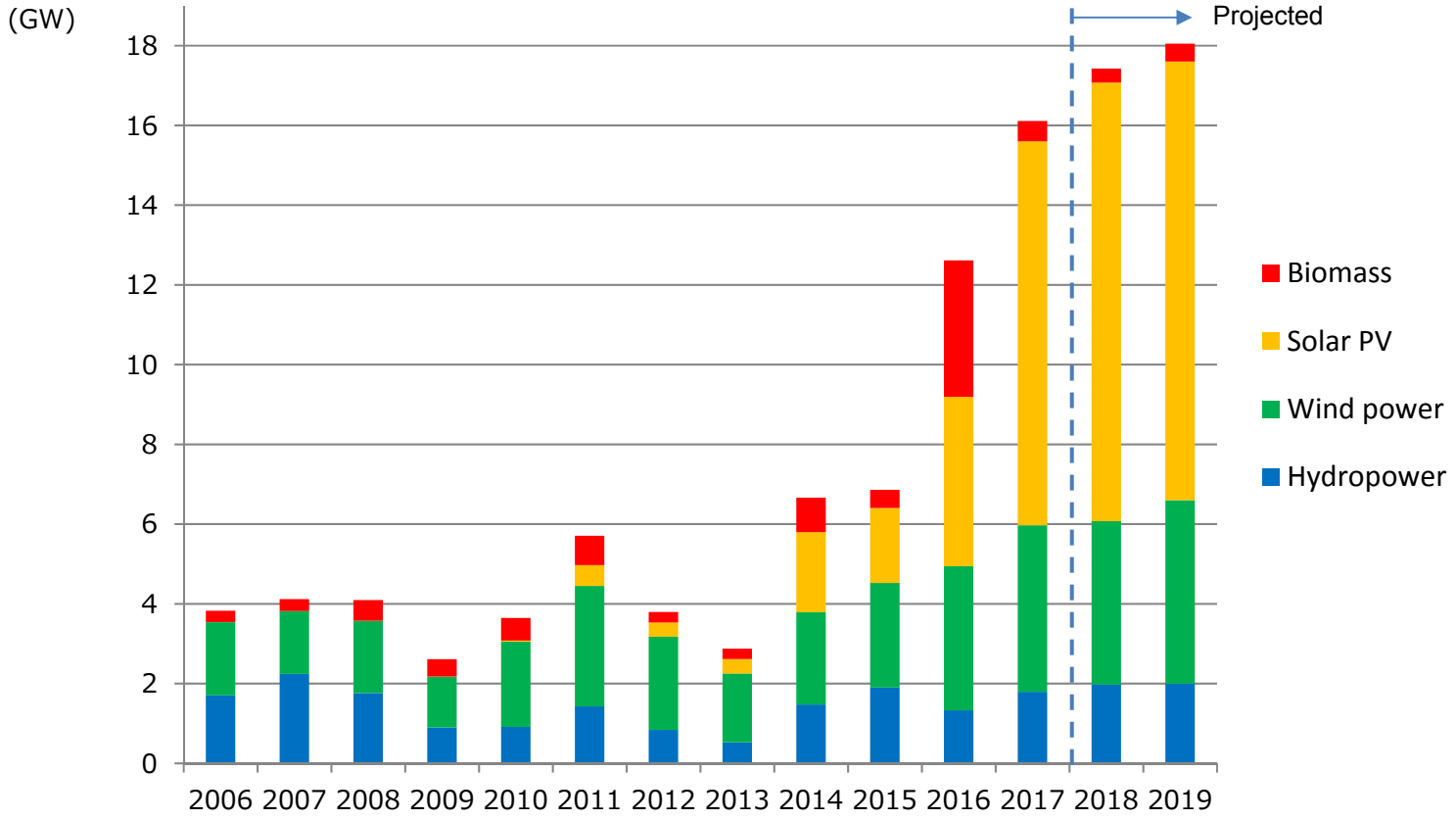
- Growth of installed renewables capacity has been accelerating since 2015; it is expected to double in five years from 75GW in 2014 to 146GW in 2019.
  - Non-hydro power renewables are expected to triple in five years from 31GW in 2014 to 93GW in 2019.
  - With the 2022 target of 100GW, solar PV is expected to reach around 40GW by 2019.



Source: based on *IRENA Renewable Electricity Capacity and Generation Statistics, IEA Renewables 2017* and others.

India's Installed Renewable Energy Capacity (Annual Growth) (2005-2019)

- Installed solar PV capacity grew from 2GW in 2015 to 10GW in 2017, marking a sharp five-fold increase, and is expected to grow at least 10GW p.a. over the next a few years.
  - To reach the 2022 target of 100 GW, solar PV needs to be installed 15 GW p.a. or more in 2018 and beyond.
  - India may become the world's second largest solar PV market after China, outpacing the U.S.

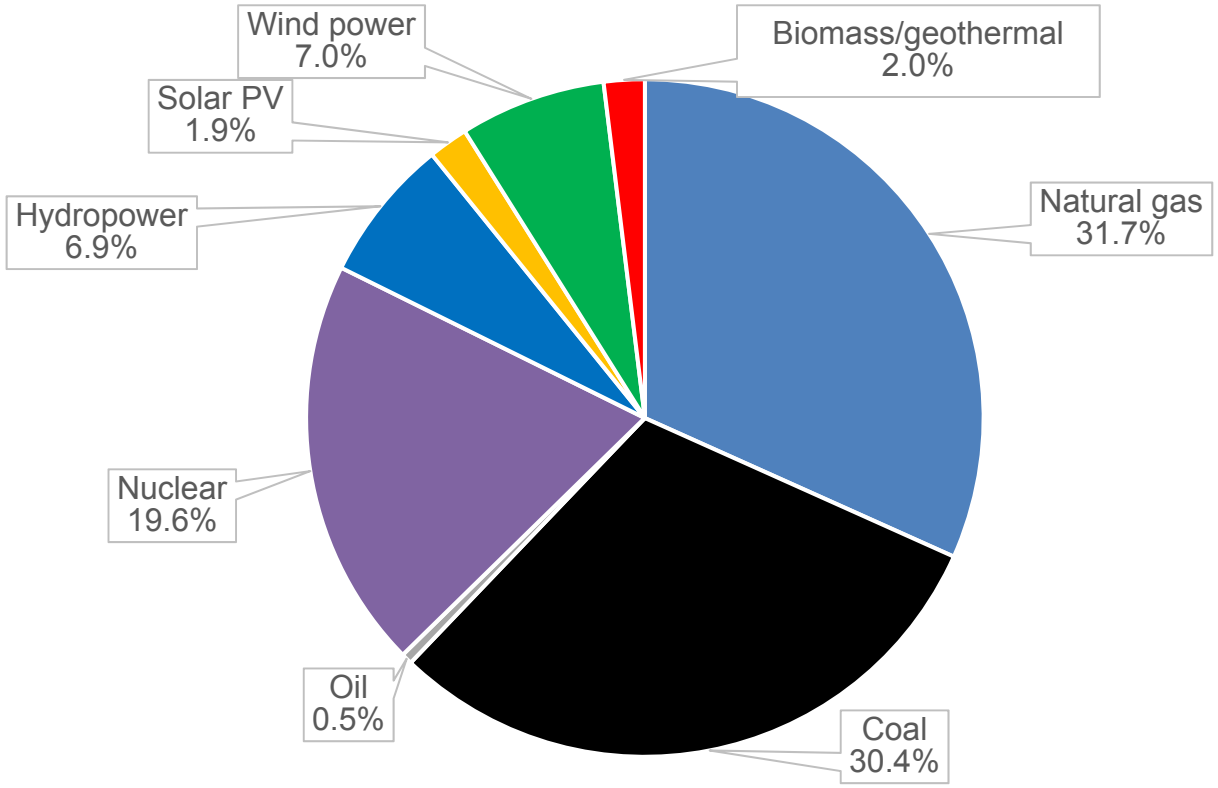


Source: based on *IRENA Renewable Electricity Capacity and Generation Statistics, IEA Renewables 2017* and others.

U.S. Power Production by Source (2017)

- Of U.S. 2017 power production of 4,268 TWh*, renewables accounted for 17.8%.
  - Hydropower 6.9% and non-hydro power renewables 10.9% in which solar PV1.9%, wind 7.0% and biomass/geothermal 2.0%
  - An increase of 2.2% from the renewables' 2016 figure of 15.6% incl. hydropower.

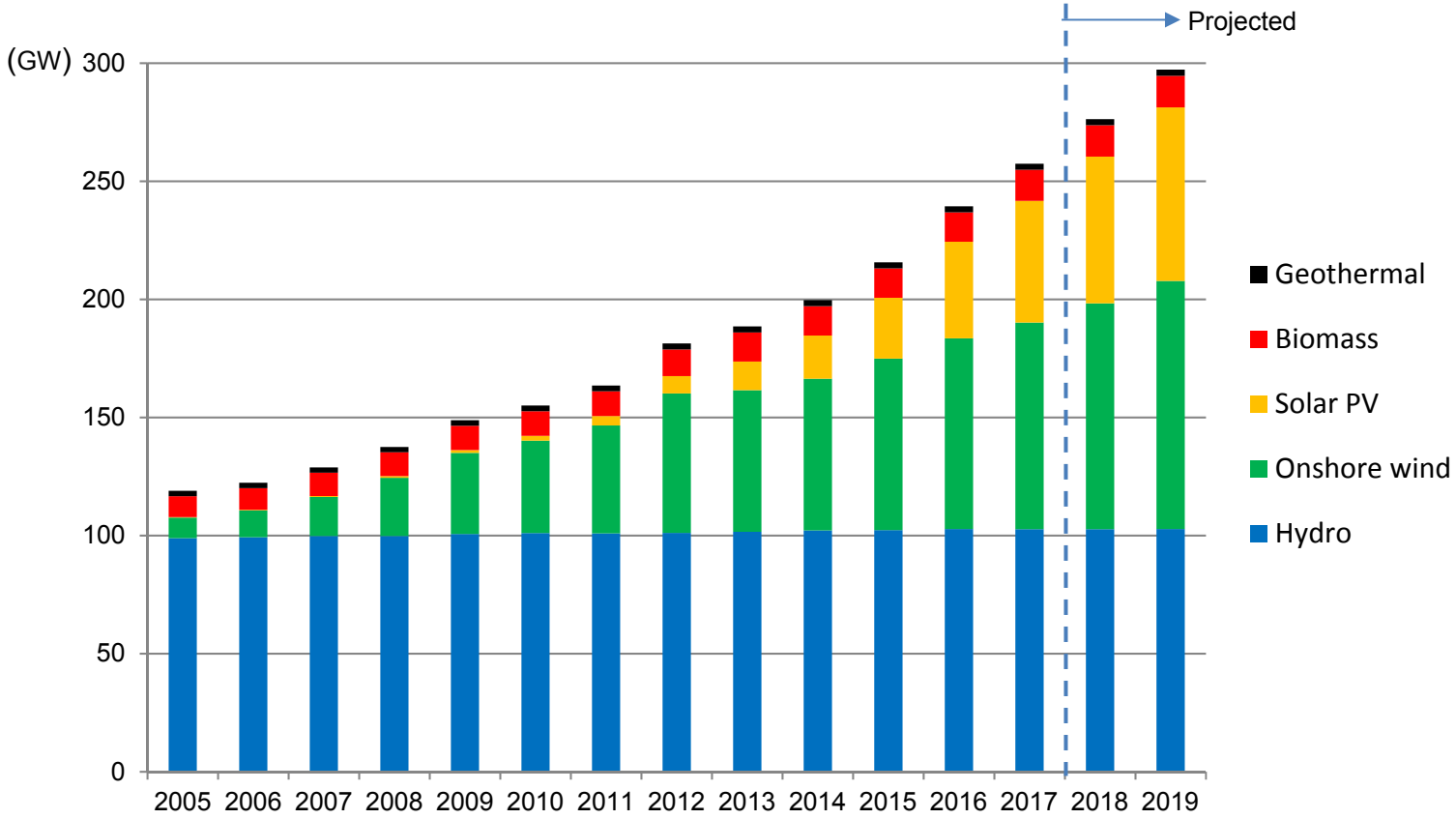
* Excluding 13.6 TWh, statistical errors, etc.



Source: based on *BP Statistical Review of World Energy June 2018*

U.S. Installed Renewable Energy Capacity (Cumulative) (2005-2019)

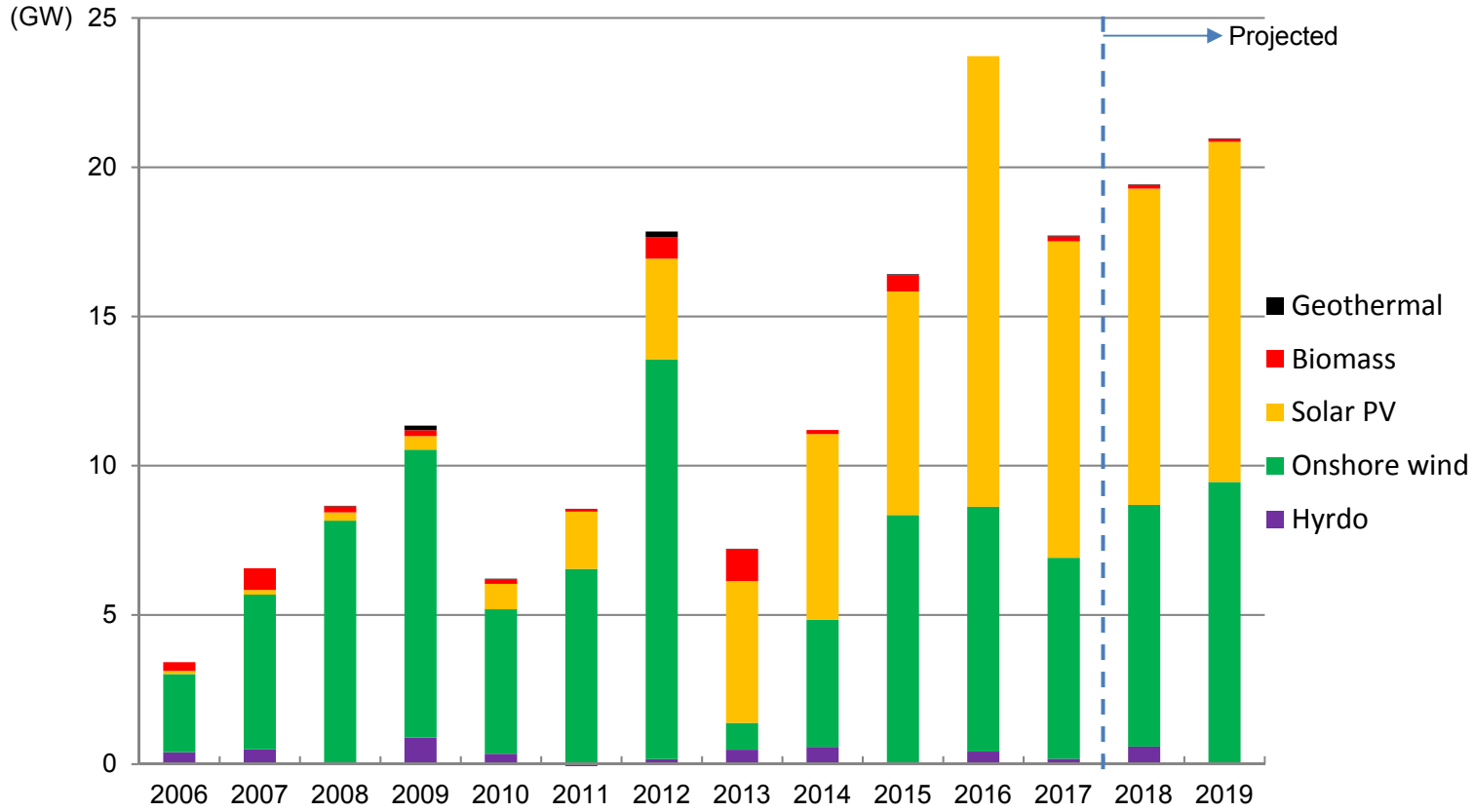
- Solar PV and wind are expected to continue to grow even under the Trump Administration.
  - The capacity, which exceeded 250 GW at the end of 2017, is likely to grow in 2018, approaching 300 GW in 2019.
  - Solar PV and wind are likely to increase mainly driven by the market thanks to their cost competitiveness



Source: based on *IRENA Renewable Electricity Capacity and Generation Statistics, IEA Renewables 2017, various IEA PVPS TCP reports* and others.

U.S. Installed Renewable Energy Capacity (Annual Growth) (2005-2019)

- The U.S. introduced 18GW of renewable capacity in 2017, the first year of the Trump Administration, marking the second largest along with 2012 after the record of 2016.
  - The upward trend in renewables is expected to continue in 2018-2019 due to declining solar PV costs and last-minute introduction before the phasing-out of PTC and ITC.
  - There are many uncertainties including the Trump Administration's imposition of the safeguard measures against solar PV module imports and the impact of the tax reforms.

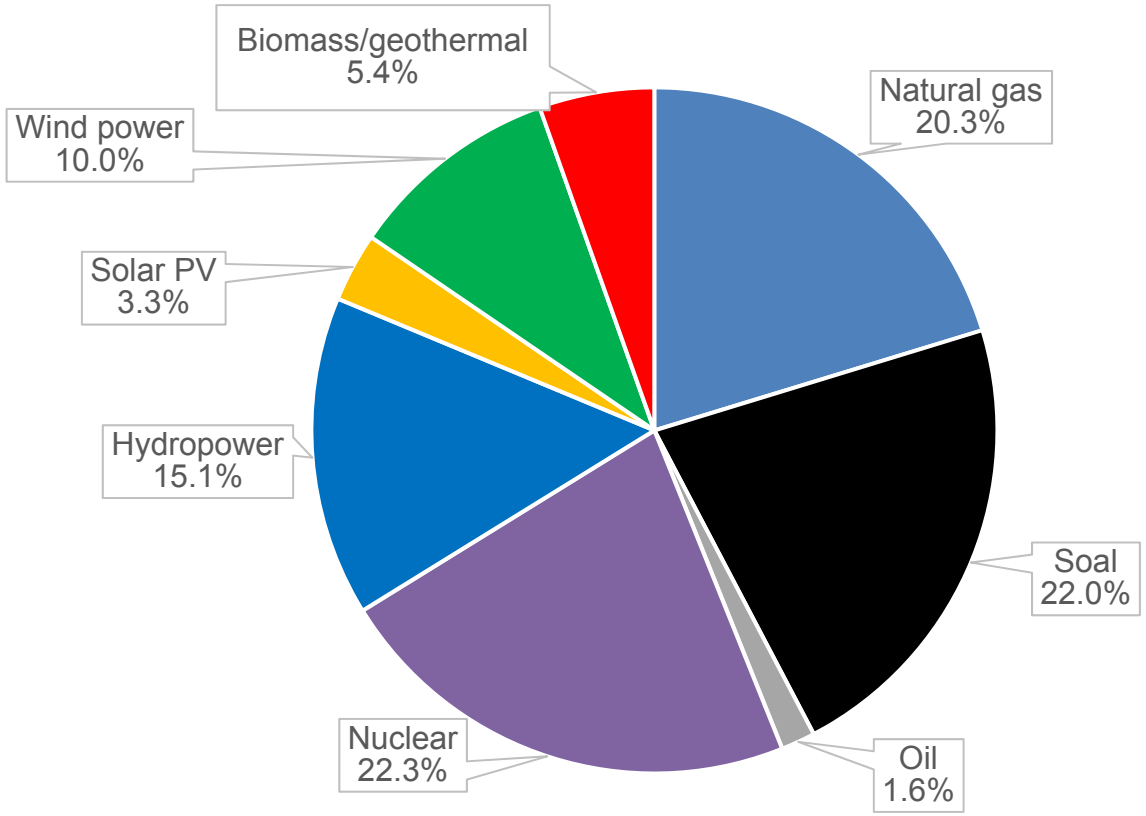


Source: based on *IRENA Renewable Electricity Capacity and Generation Statistics, IEA Renewables 2017, various IEA PVPS TCP reports* and others.

Europe's Power Production by Source (2017)

- Of Europe's 2017 power production of 3,819 TWh*, renewables accounted for 33.8%.
  - Hydropower 15.1% and non-hydro renewables 18.7% in which solar PV3.3%, wind 10.0%, biomass/geothermal 5.4%
  - A decrease of 0.2% from the renewables' 2016 figure of 34.0% caused by a reduction of hydropower from 17.1% in 2016 to 15.1% in 2017 due to record drought; Conversely, non-hydropower renewables increased from 16.9% in 2016 to 18.7% in 2017.

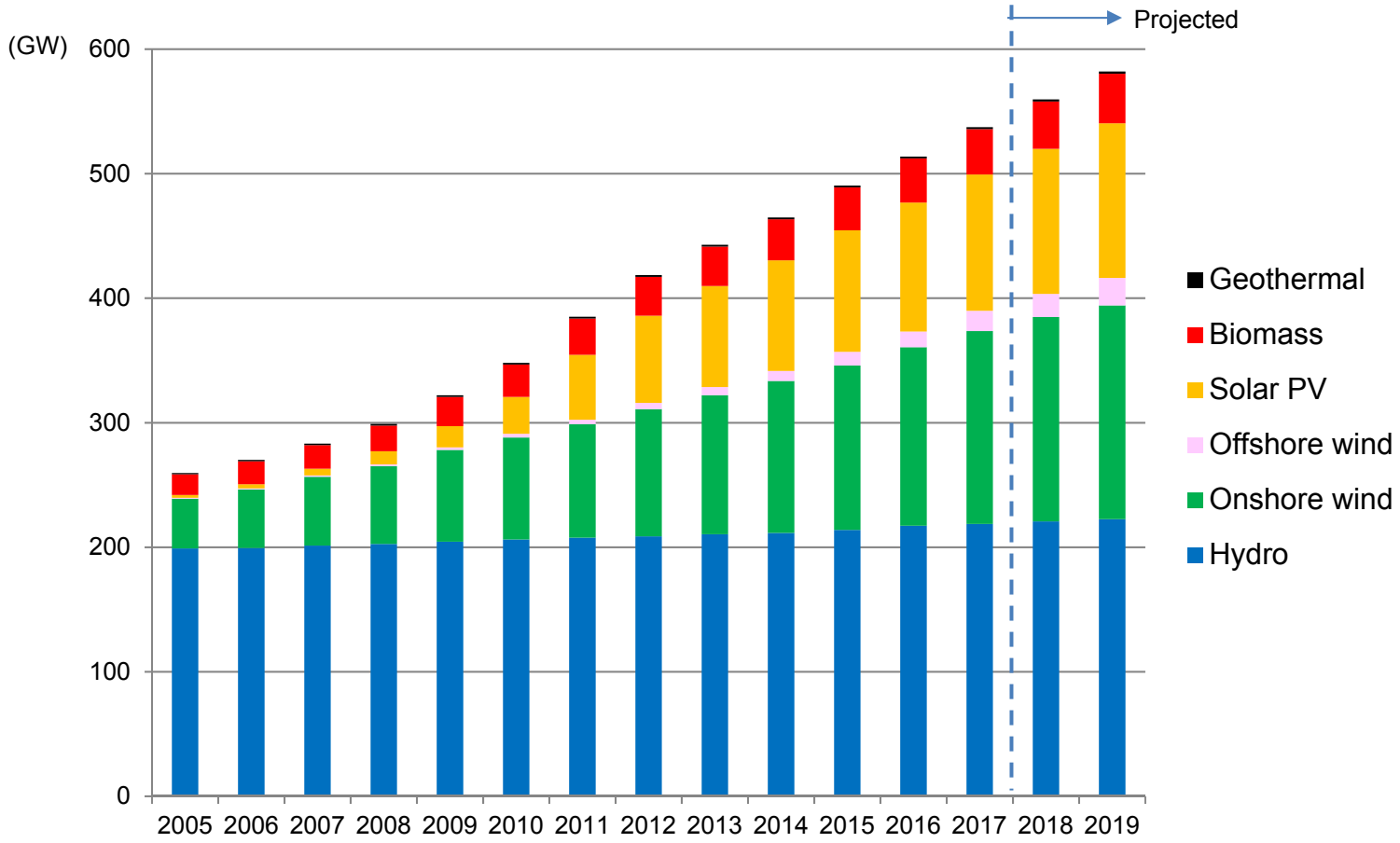
* Excluding 81.9 TWh, statistical errors, etc.



Source: based on *BP Statistical Review of World Energy June 2018*

Europe's Installed Renewable Energy Capacity (Cumulative) (2005-2019)

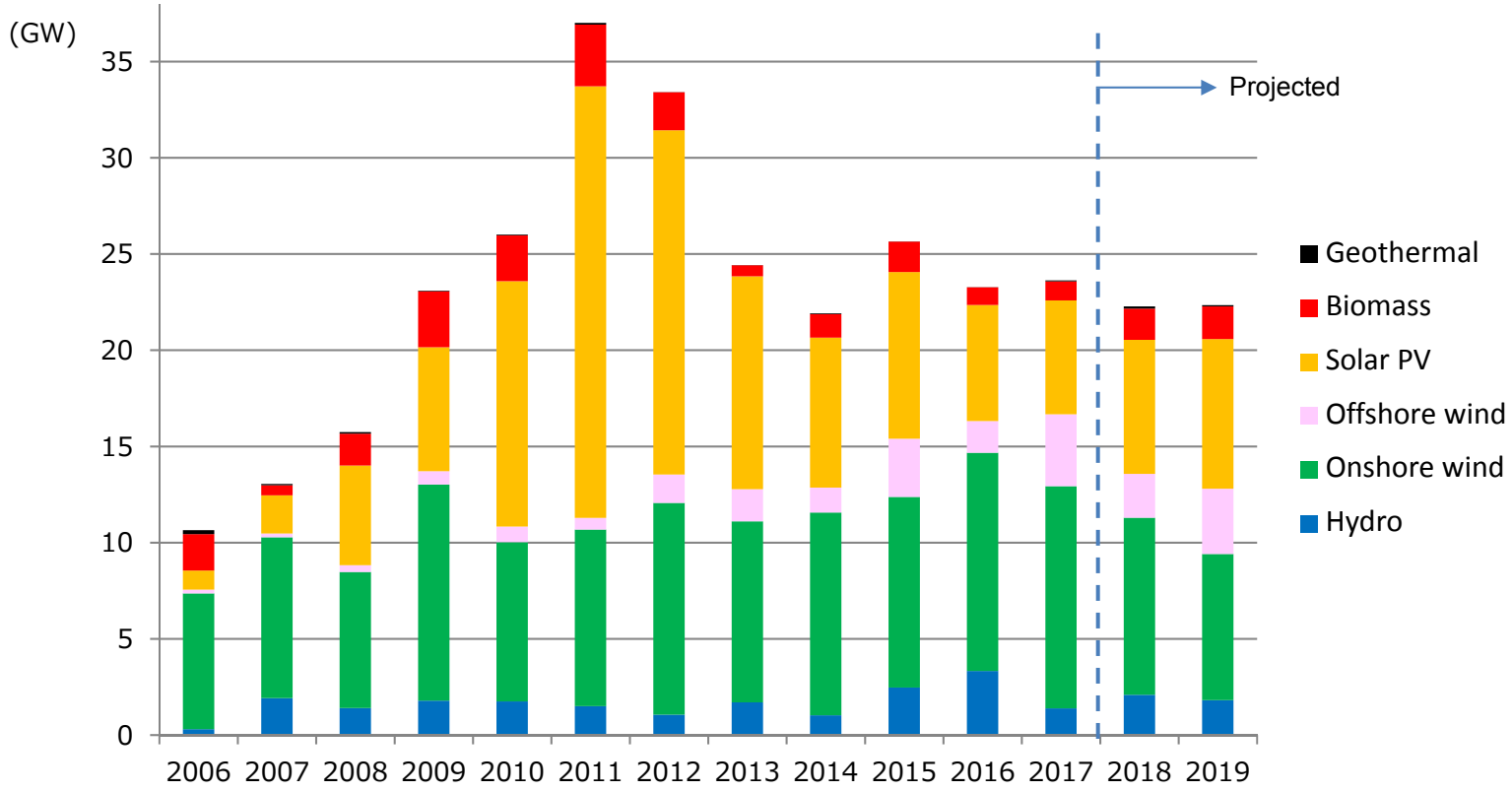
- A stable increase is expected, reaching 580 GW by the end of 2019.
  - In spite of the small portion in absolute level, offshore wind has steadily increasing; expected to double from 10 GW in 2015 to 22 GW in 2019.



Source: based on *IRENA Renewable Electricity Capacity and Generation Statistics, IEA Renewables 2017* and others.

Europe's Installed Renewable Energy Capacity (Annual Growth) (2005-2019)

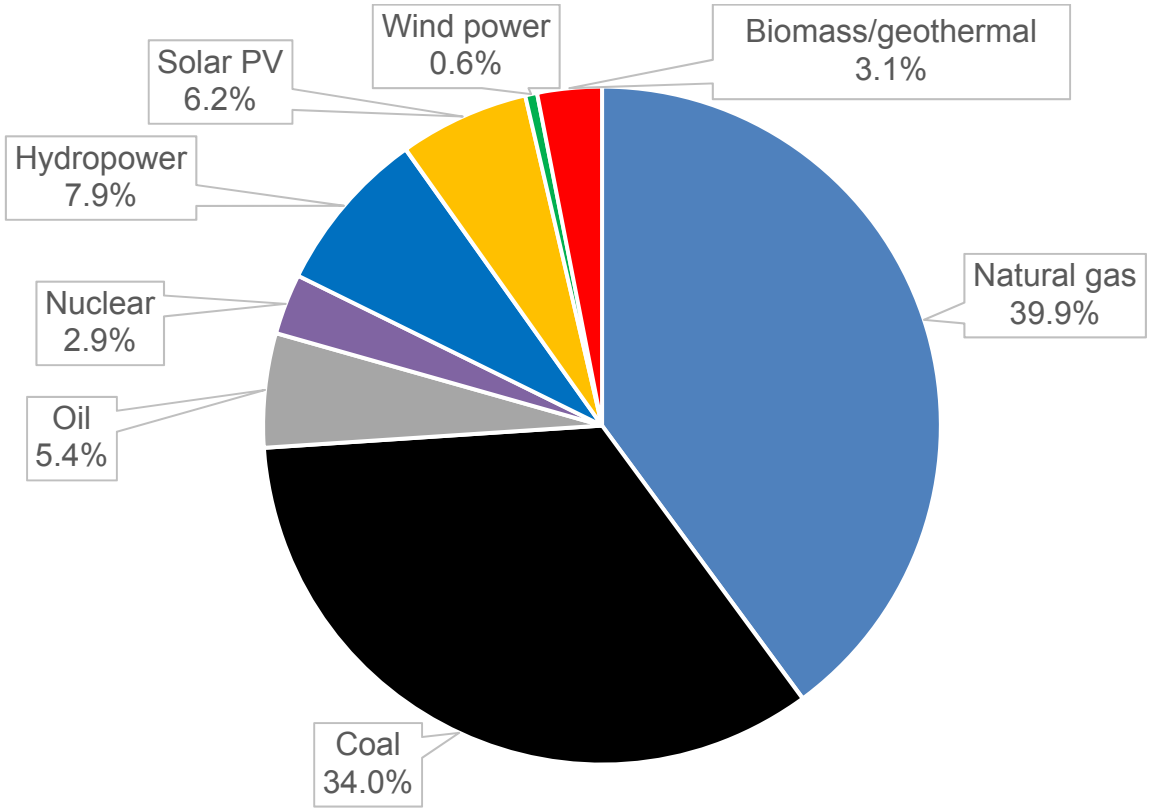
- After having experienced “solar PV bubble” in 2011-12, Europe is now seeing a stable increase of 20-25 GW p.a.
  - Due to rapidly declining costs, solar PV has hit bottom and signs of revitalisation can be seen.
  - Offshore wind is growing more rapidly (20% p.a.) than onshore wind (around 5% p.a.).



Source: based on *IRENA Renewable Electricity Capacity and Generation Statistics, IEA Renewables 2017* and others.

Japan's Power Production by Source (2017)

- Of Japan's 2017 power production of 1,006 TWh*, renewables accounted for 17.8%.
  - Hydropower 7.9% and non-hydropower renewables 9.9% in which solar PV 6.2%, wind 0.6% and biomass/geothermal 3.1%
  - An increase of 1.3% from the renewables' 2016 figure of 16.5% (solar PV: up 1.3% from 4.9% to 6.2%)

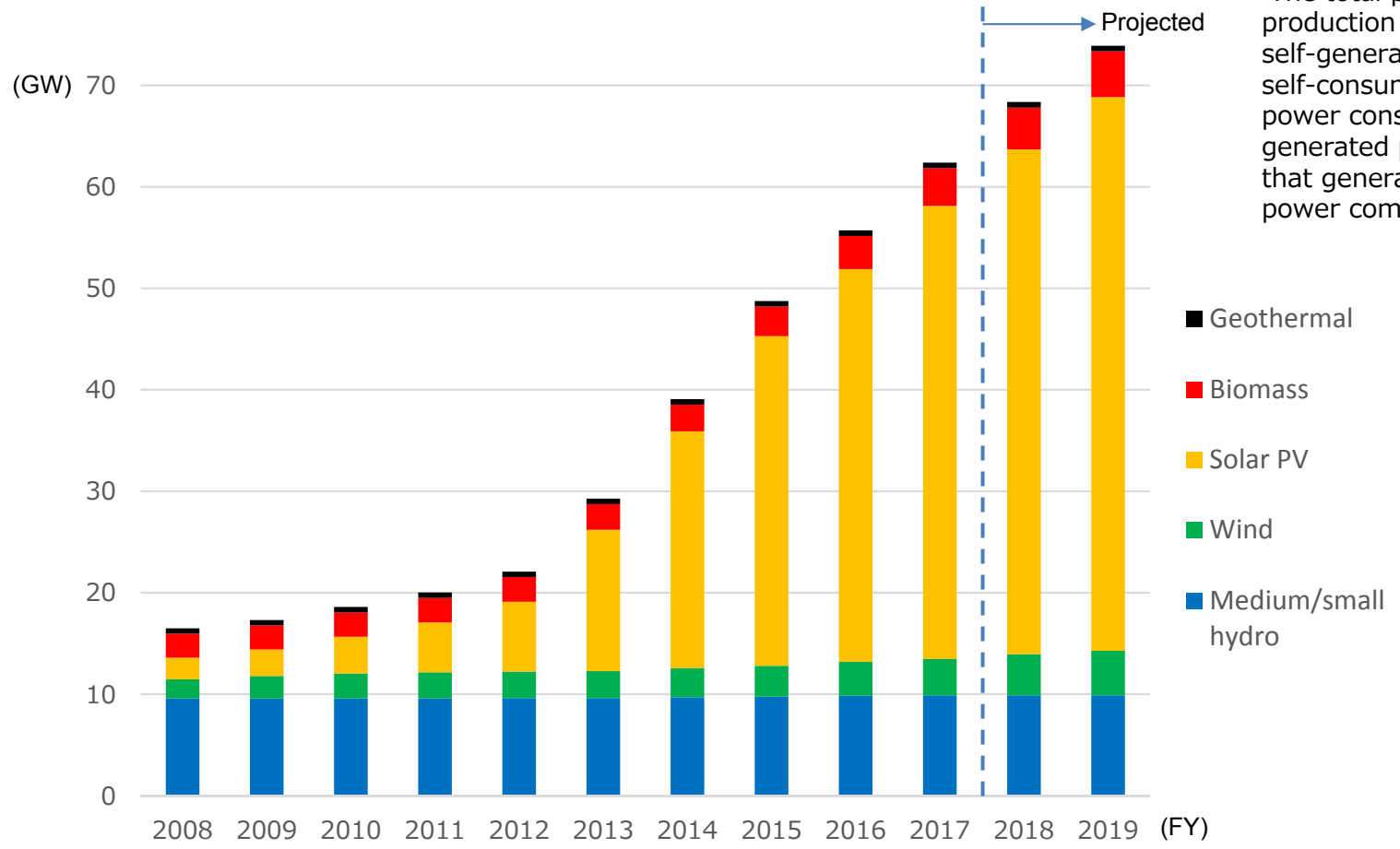


* Excluding 14.1 TWh, statistical errors, etc. Note that the figure refers to the power generated by power companies only, and does not include self consumption/auxiliary power consumption of self-generated power.

Source: based on *BP Statistical Review of World Energy June 2018*

Japan's Installed Renewable Energy Capacity (Cumulative) (2008-2019)(excluding large hydropower of over 30 MW)

- Renewables capacity is expected to reach 68 GW by the end of FY2018 and 74 GW by the end of FY2019.
  - Annual production is expected to reach 135.1 TWh, accounting for13% of total power production*.
  - If large hydropower plants (over 30 MW) are included, the percentage becomes 17%.

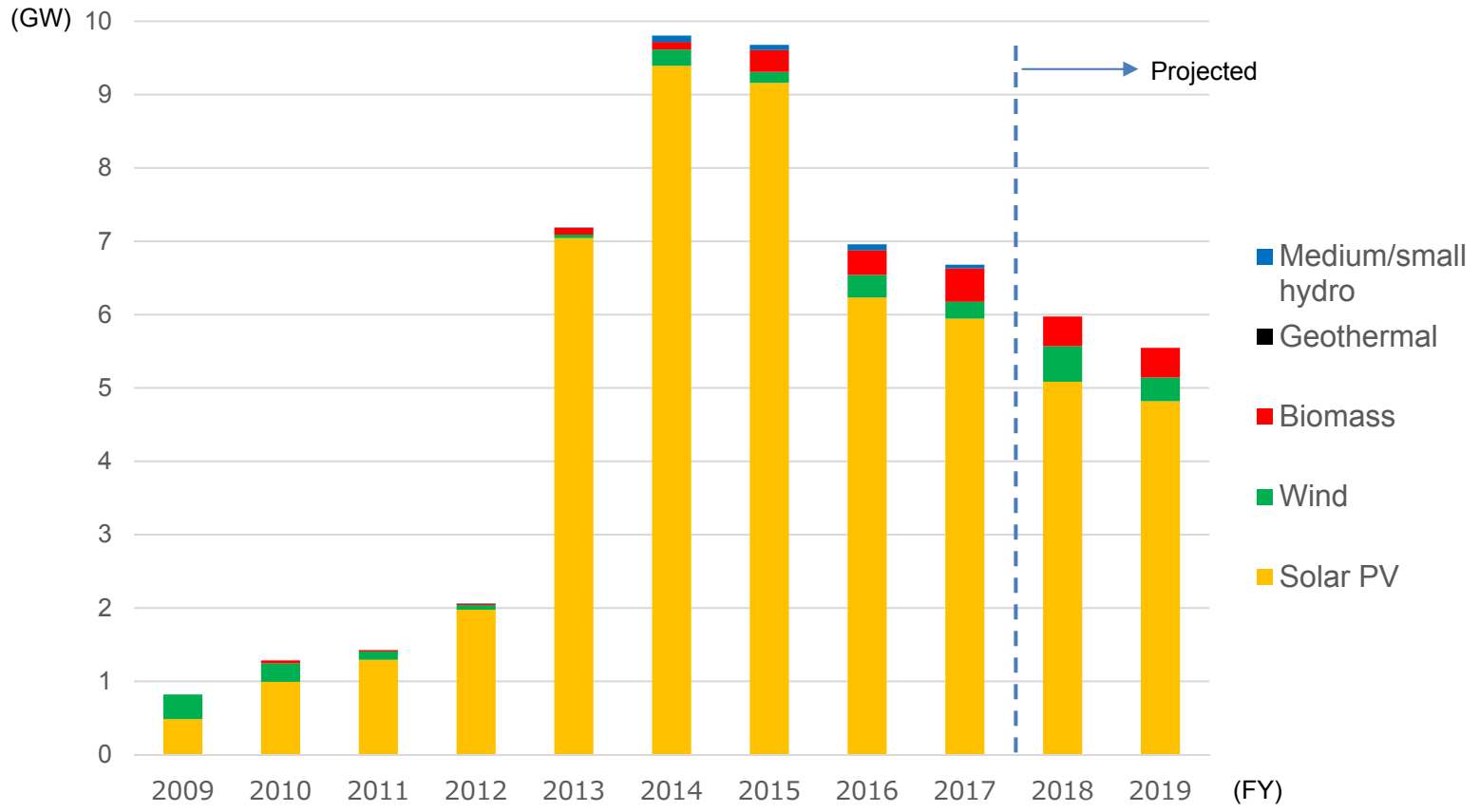


* The total power production here includes self-generated power for self-consumption/auxiliary power consumption of self-generated power as well as that generated by the power companies.

Source: Estimation by Institute of Energy Economics Japan

Japan's Installed Renewable Energy Capacity (Annual Growth) (2009-2019)(excluding large hydropower of over 30MW)

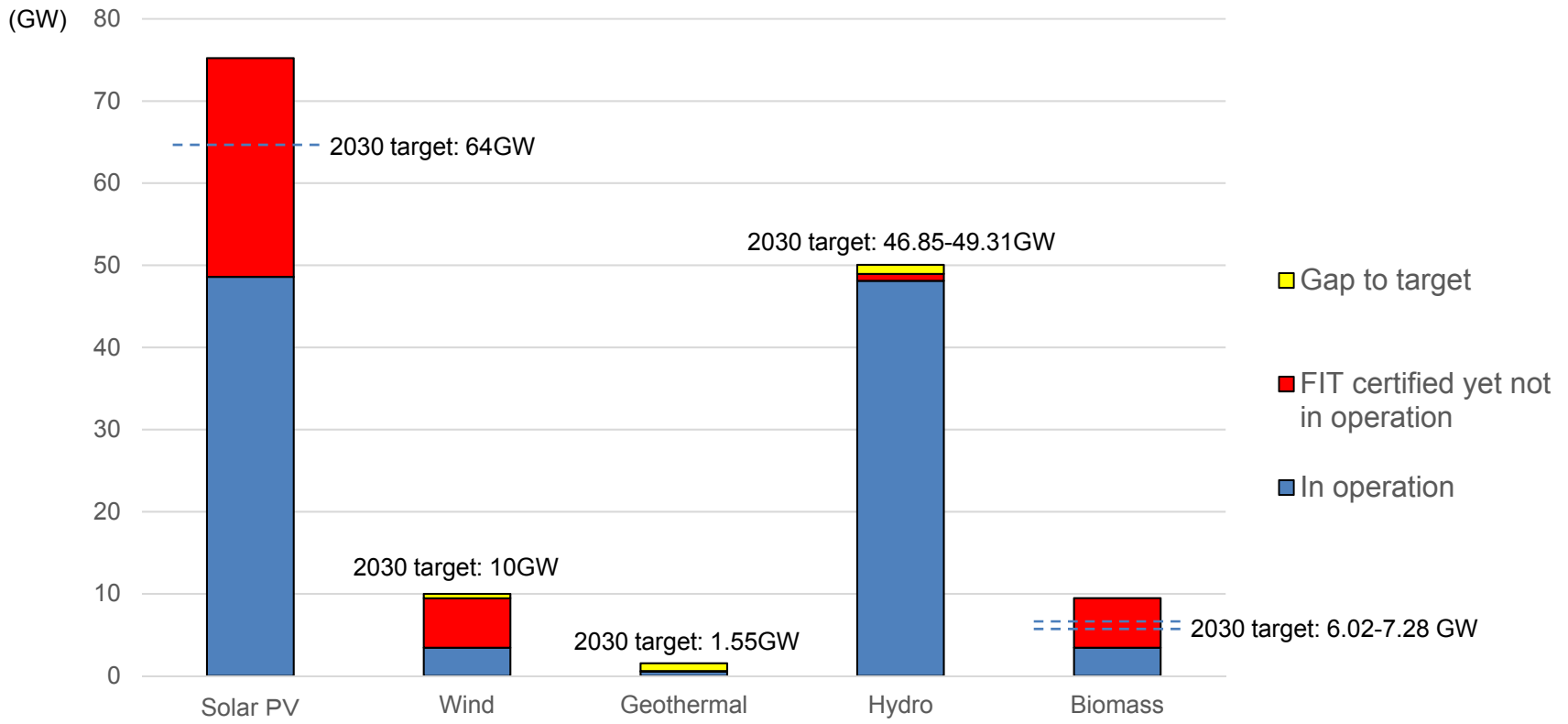
- Annual growth of solar PV, which peaked in 2014-2015, has been shrinking in subsequent years, but is expected to increase by around 5 GW p.a. for 2018-2019.
  - Solar PV is likely to continue to account for approx.80% of the growth in renewables in total over the period.



Source: Estimation by Institute of Energy Economics Japan

Current Renewables situation with respect to Japan's 2030 Energy Mix

- Combining the operating capacity and FIT certified capacity, it has nearly reached the capacity target level assumed in the 2030 Energy Mix.
  - Solar PV has far exceeded the 2030 target level; biomass has reached the 2030 level even after excluding the capacity which may be abandoned due to constraint on fuel procurement. .
  - If they are allowed to connect to the grid without a large burden, the 2030 target for 22-24% share of renewables in the total generated power may be achieved by around the mid-2020s.



Source: based on *Renewable Electricity Capacity and Generation Statistics* by IRENA, various publications by METI and others.

Japan's 5th Strategic Energy Plan (Approved by the Cabinet on 3 July 2018)

- For the first time, clear reference to "aiming to make renewables a key power source" as the long-term direction.
  - However, the target percentage of renewables in the 2030 Energy Mix remains at 22-24%.

- Challenge #1 for making renewables a key power source: to reduce the cost and control the public burden
  - Use of auction and effective change in FIT price as the cost decease
    - Aiming at 2030 targets of 7 JPY/kWh for utility scale solar PV and 8-9 JPY/kWh for onshore wind
  - Promote to independent from the FIT scheme
    - Shifting rooftop solar PV from "selling electricity" to "self-consumption"; directing utility scale solar PV, wind and geothermal to the direct marketing

- Challenge #2 for making renewables a key power source: to overcome grid constraints and secure grid flexibility
  - Early implementation of "Japanese Connect & Manage," which utilises the existing capacity of existing grid
  - Conversion to next-generation transmission and distribution network in view of major flow from renewables
  - Securing grid flexibility: use of thermal power plants + renewables' own adjustment margin and interconnections among wider areas for the time being; in the long term, decarbonisation will be promoted by using margins from next-generation technology such as VPP, V2G, batteries, and P2G
  - Flexible attitude towards reverse power flow in order to respond flexibly by accepting power flow from batteries to the grid

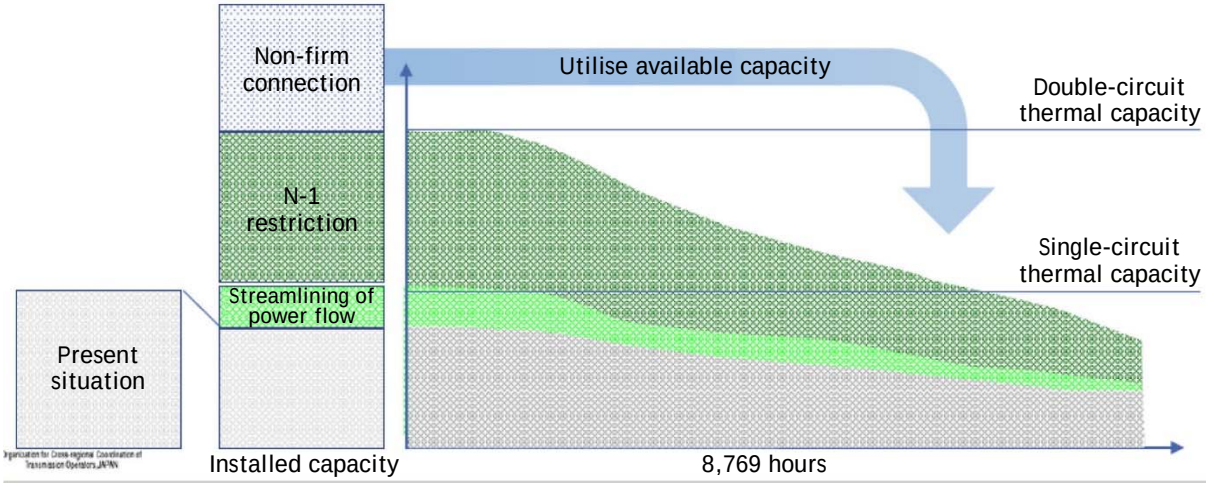
Japan's measures to reduce renewable generation cost: Shift from FIT to auction

- Solar PV more than 2 MW has been subject to auction since 2017.
  - In the first auction held in November 2017, the total of successful bids for the maximum of 500 MW was only 144 MW, of which just 41 MW was followed by second deposits. The lowest auction price was 17.2 JPN/kWh in contrast to the FIT price of 21 yen/kWh.
- With the auction rules revised in view of the results of the first auction, subsequent auctions for solar PV more than 2 MW are scheduled to be held twice in FY2018
  - 2nd solar PV auction in Aug. 2018: for 250 MW
  - 3rd solar PV auction in Dec. 2018: for 250 MW or if the total tendered capacity falls short of 250 MW in the 2nd auction, then the 3rd auction will be held for that capacity
- Following solar PV, biomass will be subjected to auction as listed below from FY2019
  - General woody biomass of more than 10 MW
    - 1st auction in Dec. 2018: for 180 MW
  - All liquid fuel biomass (primarily palm oil)
    - 1st auction in Dec. 2018: for 20 MW
- As to bottom-mounted offshore wind turbines, along with the start of application of the general sea area occupancy rule, those to which the rule is applicable will be shifted to auction
  - 3.76 GW worth is already undergoing environmental impact assessments.
  - Floating offshore and onshore wind will not shift to auction immediately, remaining within the FIT framework for the time being.

To Overcome the Network Constraints: “Japanese Connect & Manage”

- "Japanese Connect & Manage," which increases connections by using the existing transmission lines, will be put forward.
  - Streamlining the assumed power flow
    - Conventionally assumed power flow (assuming that all sources operate at full power) → power flow to be assumed based on operational status closer to reality (assessing operation probabilities of power sources and naturally fluctuating renewables' output)
  - N-1 restriction (instantaneous power restriction at the time of N-1 failure)
    - Connections during normal periods are encouraged by accepting them on condition that, at the time of a single failure in the grid, the connection is automatically severed without compensation.
  - Non-firm connection (connection with conditional restriction during congested period)
    - New connections are accepted on condition that the connection may be severed without compensation not only at the time of a system failure but also during congested periods.
    - Since power producers are required to present business plans that have incorporated the risk of output control during congested periods, information on grid congestion needs to be disclosed.

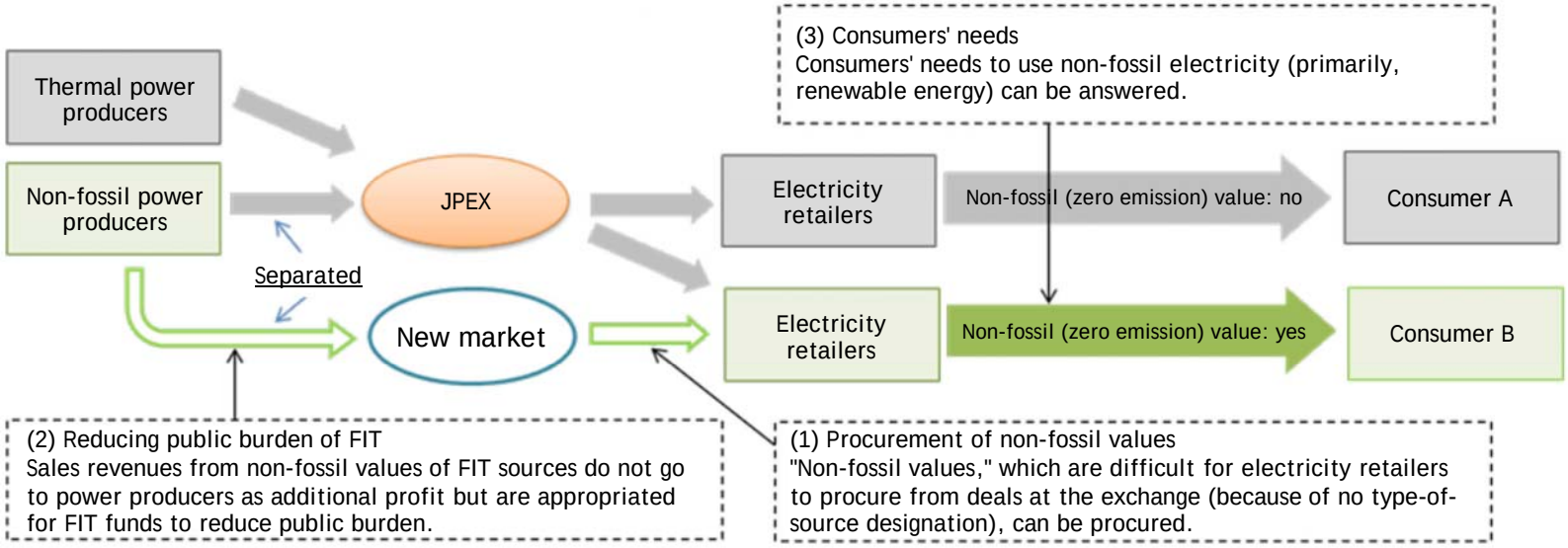
Image of Power flow according to Japanese Connect & Manage



Source: *Examination of "Japanese Connect & Manage" at Wide-Area Institutions*, distributed at the 2nd meeting of the Subcommittee on the Mass Introduction of Renewable Energy and the Next-Generation Electricity Network

Establishing “Non-Fossil Value Trading Market”

- A market where the non-fossil value of non-fossil electricity such as FIT electricity is separated and certified to be sold by the Government.
  - Virtual "non-fossil value per kWh," a concept newly created by the Government and completely different from the power trading
- Eligible buyers are electricity retailers.
  - Electricity retailers who sell electricity (for example, electricity generated by a coal-fired plant) with purchased non-fossil certification at the same amount are regarded as selling non-fossil electricity i.e. their CO_2 emission factor is considered to be zero; In fact, electricity retailers are required to have the non-fossil percentage of their 2030 sales at 44% or more.
  - Sales of non-fossil securities will be appropriated for FIT funds → to reduce the public burden with appropriations
- In May 2018, the first tender was held at Japan Electric Power Exchange (JPEX).
  - Of the non-fossil securities worth approx. 50 TWh generated from Apr. to Dec. 2017, only approx. 5,150 MWh were bid for.
  - Twenty-six firms participated in the auction; contract prices were 1.3-4 yen/kWh (weighted average of 1.3 JPY/kWh); and sales revenues were about 6.7 million JPY.
  - Since 1.3 JPY/kWh ≈ 2,600 JPY/tCO_2, some felt that the deal was relatively expensive compared to similar systems (for example, 1,700 JPY/tCO_2 by J-Credit Scheme).



Source: *Non-Fossil Value Market*, distributed at the 15th meeting of the System Study Working Group in the Electricity and Gas Basic Policy Subcommittee , held on Nov. 28, 2017.

New Law for Offshore Wind Power: the Important First Step towards Promoting Japan's Offshore Wind Power

- In May 2018, a bill for the new law for offshore wind was approved by the Cabinet, which lays the framework for balancing the interests of long-term occupiers of general sea areas for the purpose of offshore wind business and the vested interests of antecedents.
  - The bill prescribes a framework for balancing interests between the zone designation for sea area utilization for offshore wind business in the general sea area and the antecedent use.
  - The bill prescribes necessary procedures to select business operators through public offering and to effect long-term occupancy while reducing supply prices.
    - To promote business projects by enhancing the ability to assess their medium/long-term feasibility
    - Regarding port areas, the 2016 revision of the Port and Harbor Act instituted a system for securing long-term occupancy of sea areas; however, systems intended for vast general sea areas have not been discussed yet.

- The bill would be an important first step towards promoting Japan's offshore wind
  - Applicable projects prescribed in the bill are those with FIT purchase price → to be shifted to auction system (fixed-bottom wind turbines only)
  - Predicting that the bill will be passed, projects worth 3.76 GW are already undergoing environmental assessments.
  - European offshore wind companies such as Danish Ørsted (formerly Dong Energy) and MHI Vestas, Norwegian Equinor (formerly Statoil), and German E-on are showing interest in entering the Japanese market.

- However, the deliberations were not completed and the bill was abandoned; creating negative impact on Japan's offshore wind.

Contact :report@tky.ieej.or.jp