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Outlook for Renewable Energy Market

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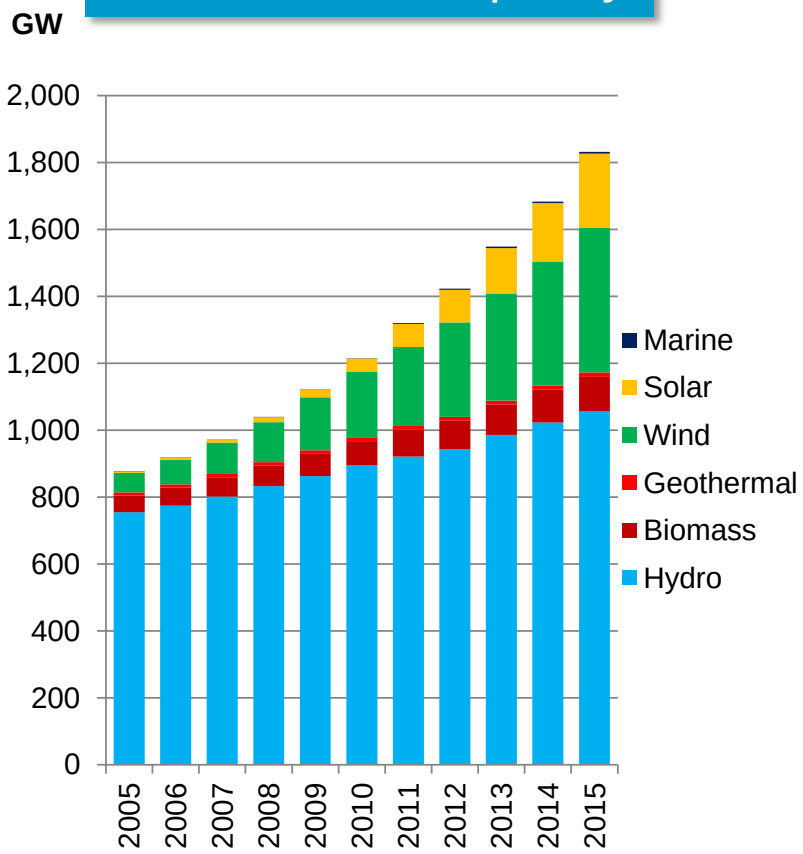
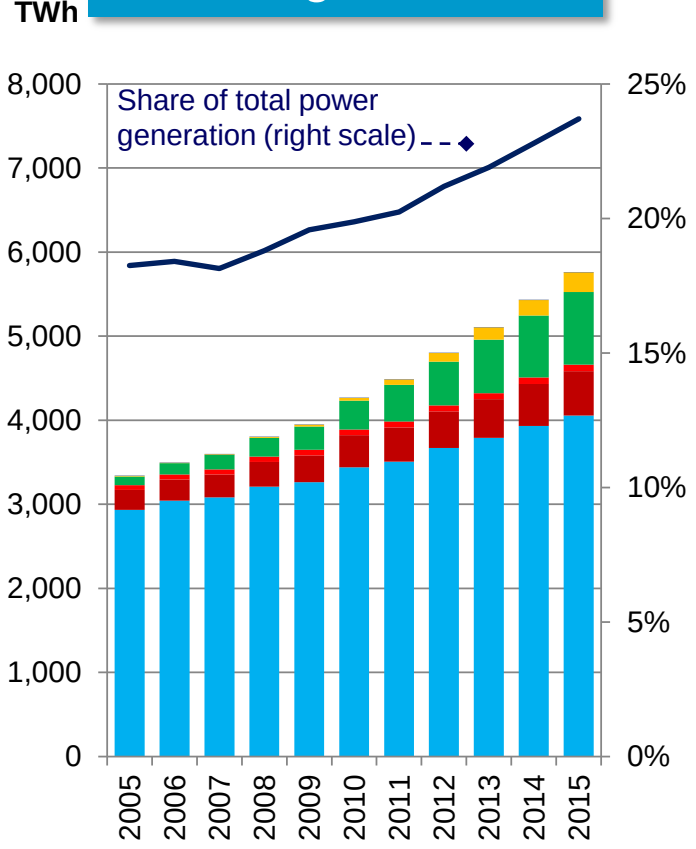
World Renewable Energy Expansion

- Renewable energy power generation capacity exceeded 1,800 GW in 2015. Renewable power generation accounted for 24% of total power generation (the share includes 17 percentage points for hydro, 4 points for wind and 1 point for solar energy).

Accumulated capacity



Power generation

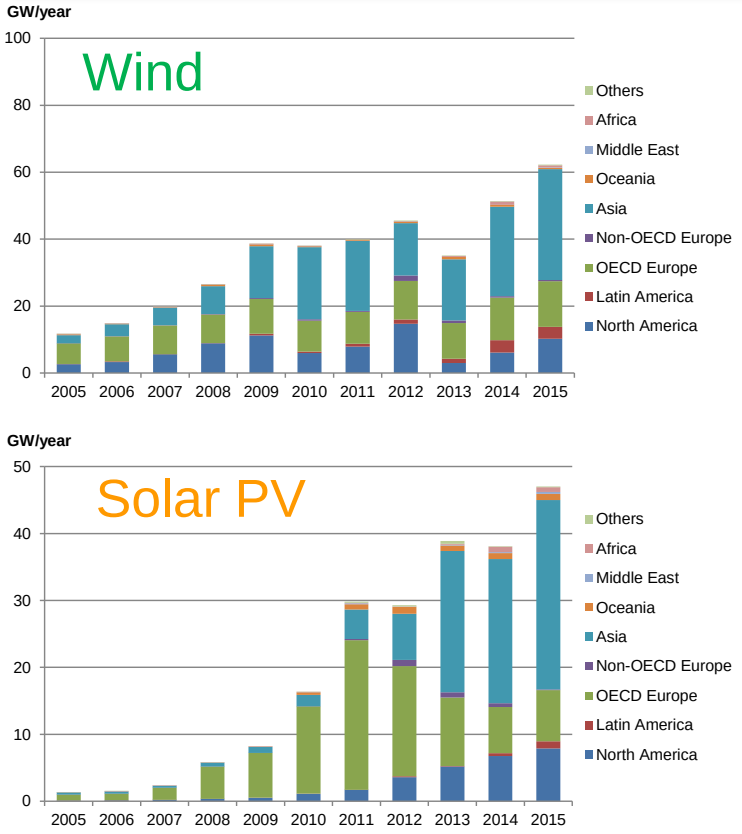


Source: Estimated from IEA, IRENA, REN21
Note: Including large-scale hydro power generation, excluding pumped-storage power generation

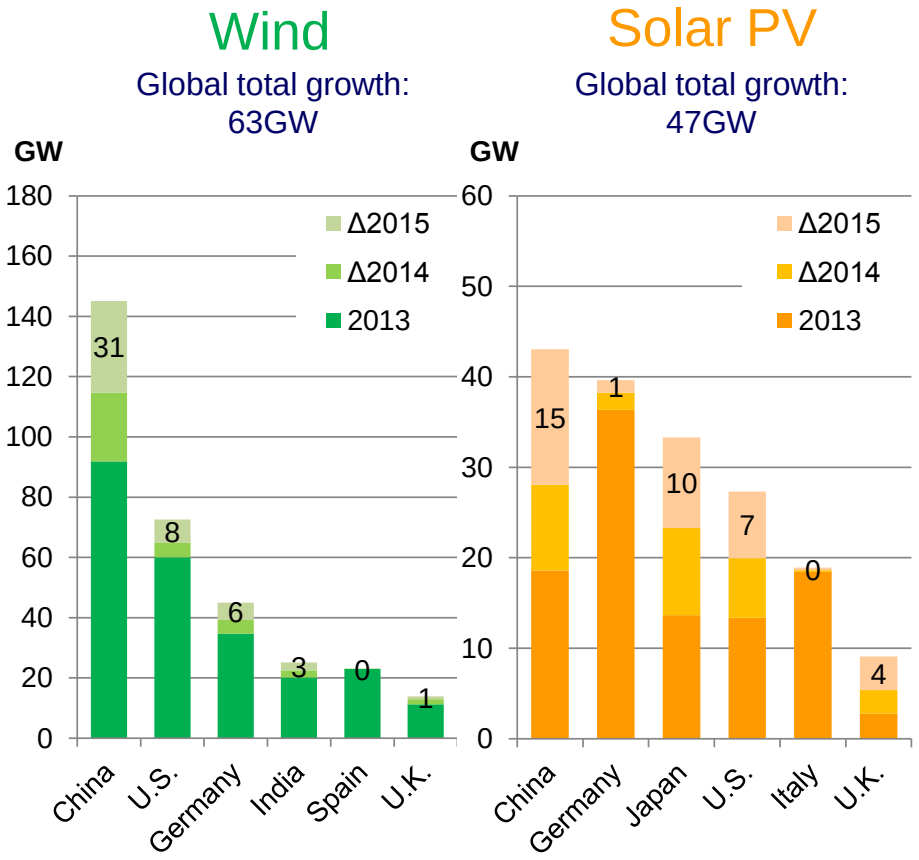
Wind and Solar PV Expansion by Region

- The market is shifting from Europe to Asia and North America. China is accelerating wind and solar PV expansion, being followed by the United States.
- The expansion is decelerating in Europe going ahead with institutional reform.

Capacity expansion by region



Accumulated capacity in major countries

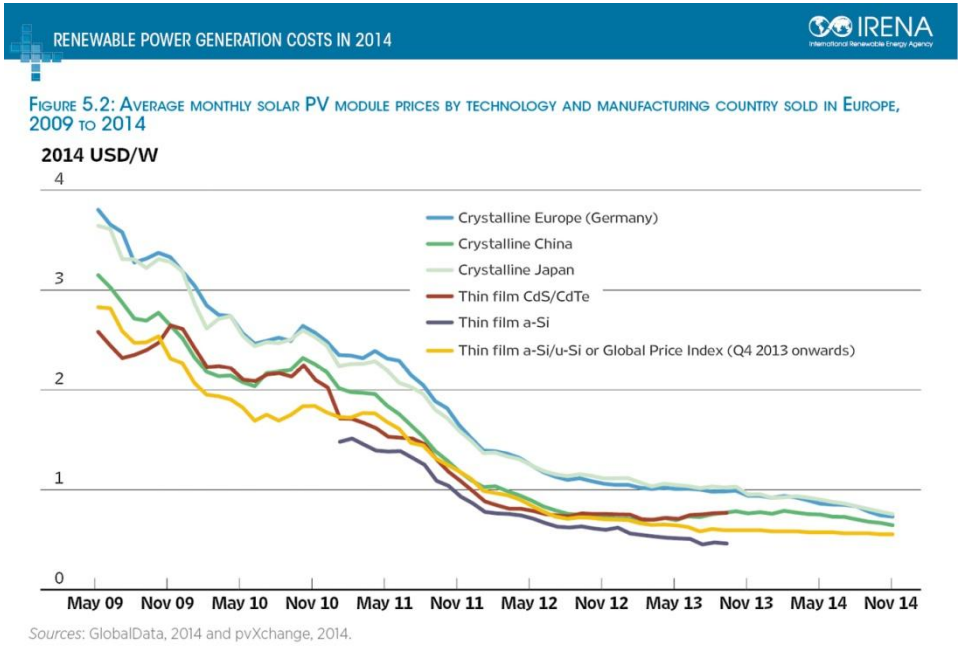


Source: Estimated from IRENA, REN21

Solar PV Price Fall and Intensifying Competition

- Solar PV prices have fallen rapidly in the past five years.
- In recent years, bid prices slipped below US10 ¢/kWh for many deals.
- Solar PV expansion is intensifying in developing countries.

PV module cost trend



Source: IRENA

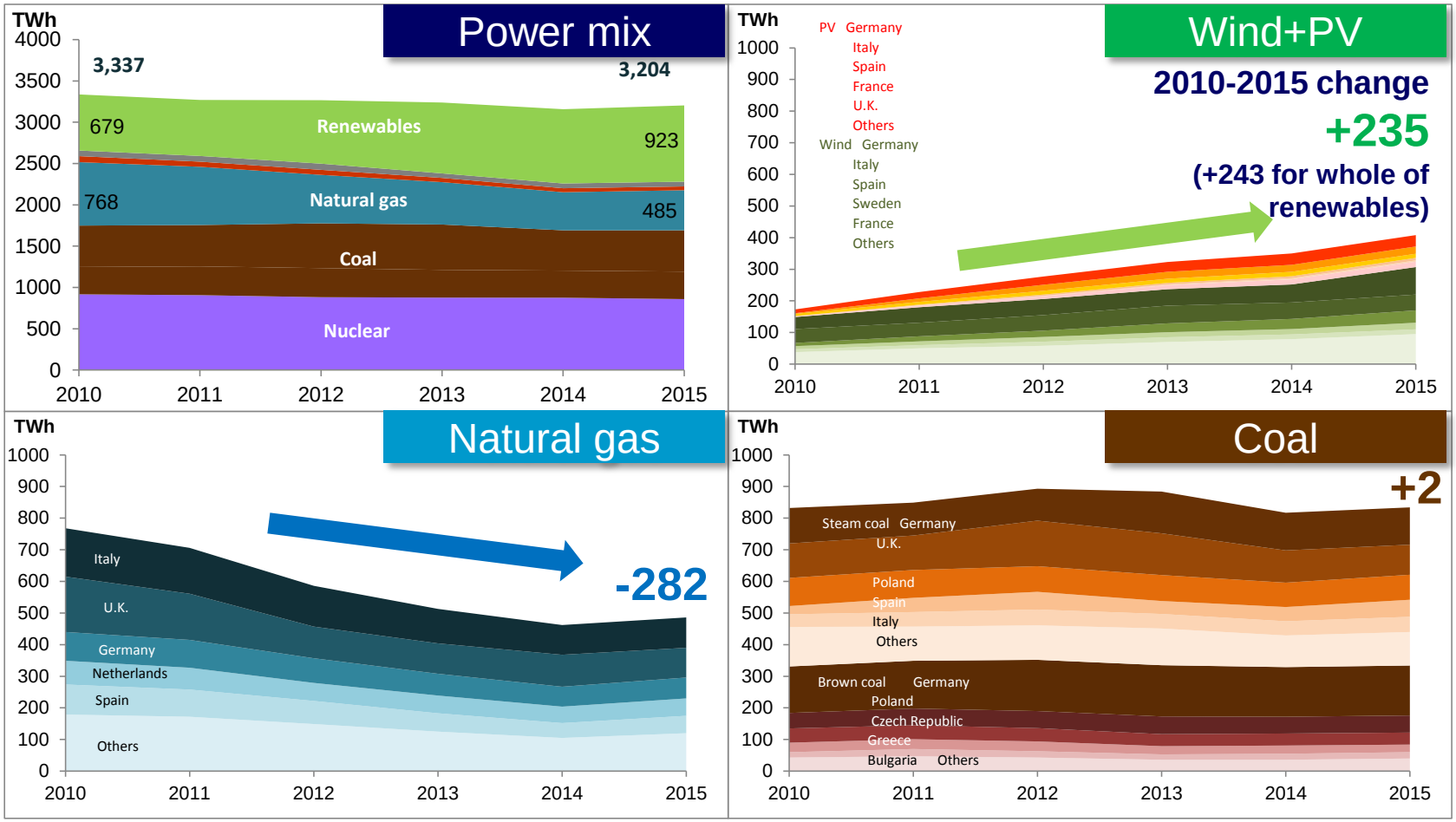
Recent bid prices for solar PV

Country/region	Month	Bid price (US ¢/kWh)
Dubai	January 2015	5.84
India	July 2015	7.95
India	July 2015	8.27
Nevada	July 2015	3.87
Texas	August 2015	4.00
India	November 2015	7.29
Mexico	March 2016	3.60
Dubai	May 2016	2.99

Source: Prepared from media reports
Note: Megasolar projects. Attention must be paid to U.S. projects that may include auxiliary facilities.

EU Power Mix Changes

- Renewables' share of the power mix in the EU stood at 29% (including 13% for wind and solar PV) in 2015.
- Renewable power generation growth (+243 TWh) led to a fall in natural gas power generation (-201 TWh).



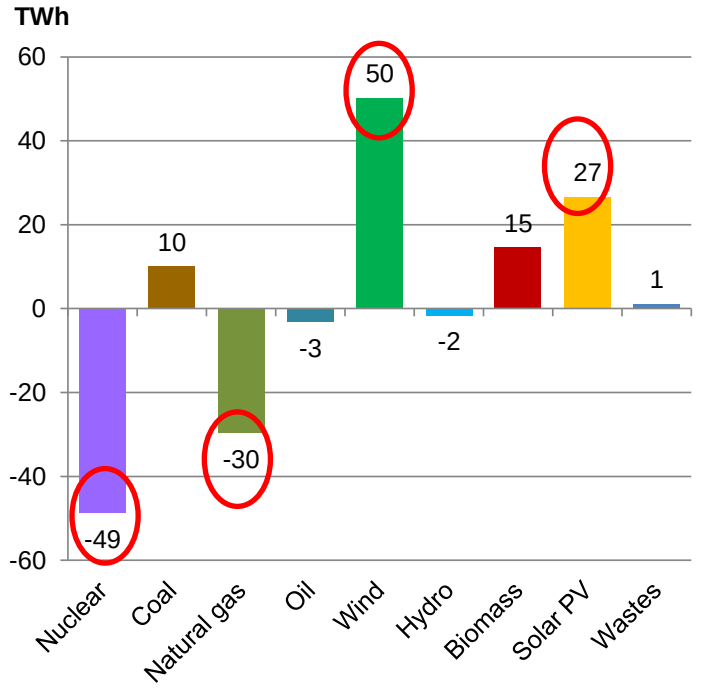
Source: Energy Transition in the Power Sector in Europe: State of Affairs in 2015, Agora, energiewende

Electricity source shift: Germany, U.K.

Germany

- Renewables' share of the power mix stood at 30.1% (19% for wind and solar PV) in 2015 (their share of total power consumption stood at 32.6%).
- In the past five years, wind and solar PV power generation expanded substantially, with natural gas power generation falling substantially.

Changes by electricity source (2010⇒2015)

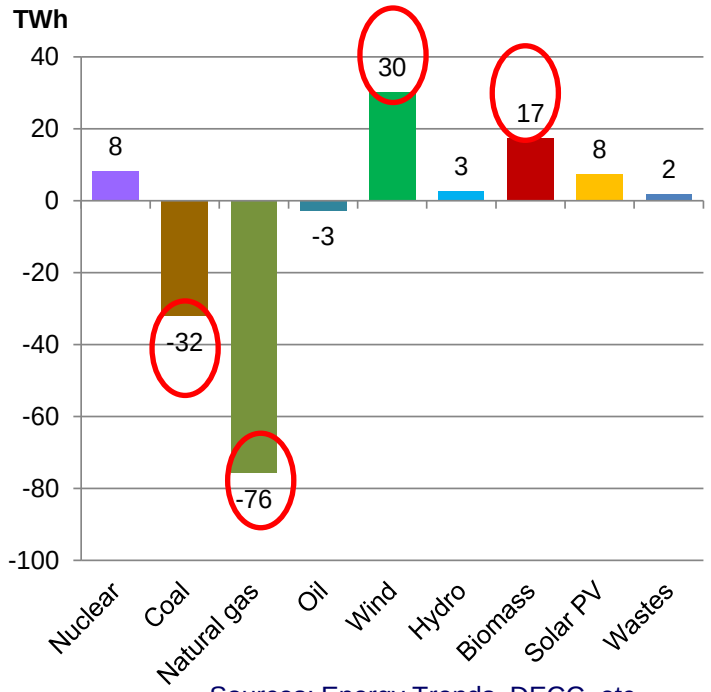


Sources: AGEB, etc.

U.K.

- Renewables' share of the power mix stood at 25.7% (14% for wind and solar PV) in 2015.
- While power demand declined, wind and biomass power generation increased substantially in the past five years, with natural gas and coal power generation decreasing substantially.

Changes by electricity source (2010⇒2015)

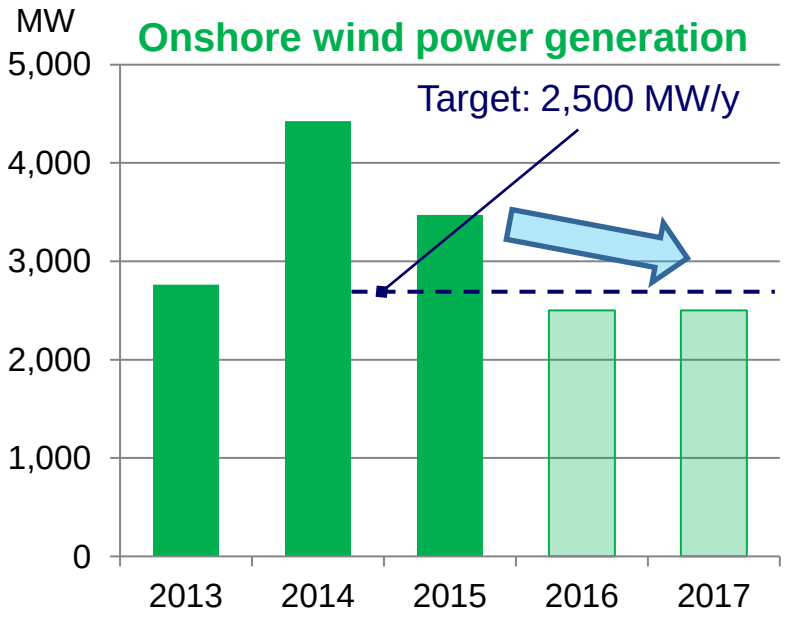


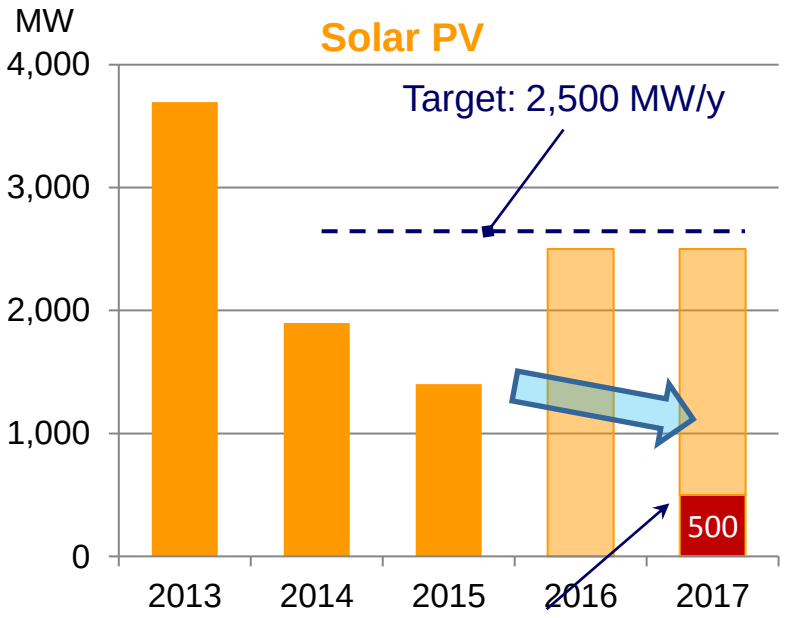
Sources: Energy Trends, DECC, etc.

Short-term Outlook：Germany

- Renewable energy expansion decelerated due to the compulsory implementation of the market premium system, the establishment of annual expansion targets, a shift to a bidding system, and surcharges on private power generation for private consumption.

Capacity growth





However, offshore wind power generation capacity is expected to grow by an average 600 MW per year.

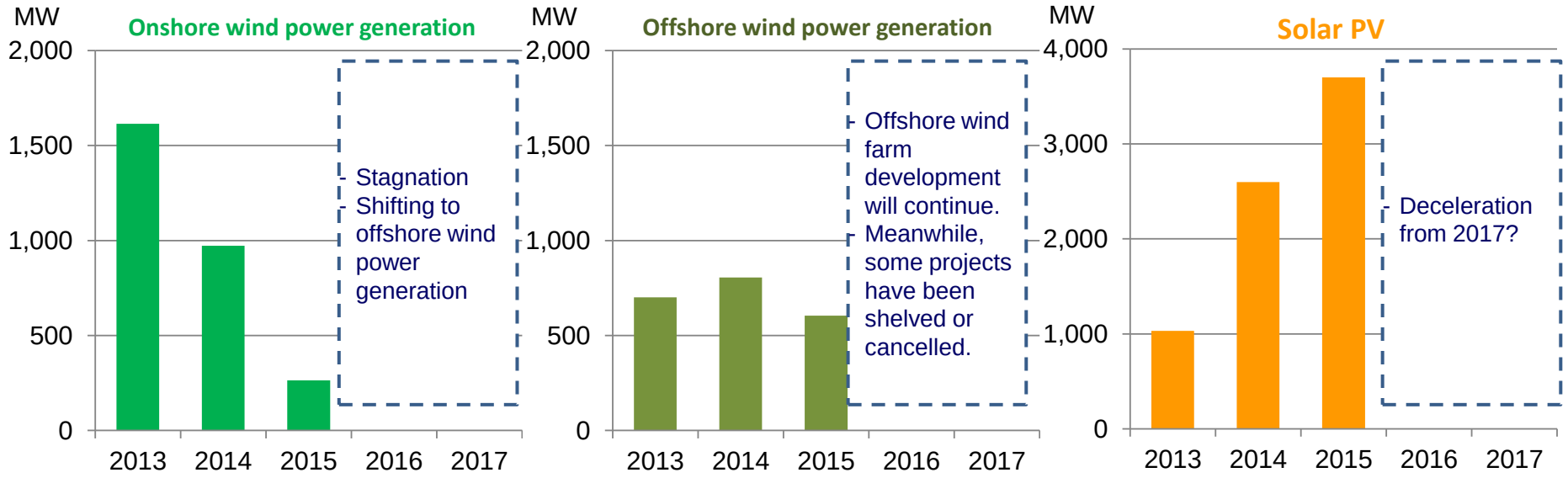
Bidding quota (equipment with capacity at 1 MW or more)

- 500 MW for 2015, 400 MW for 2016, 300 MW for 2017
- Operation will start in two years after bidding.

Short-term Outlook: U.K.

- From 2014, annual solar PV capacity growth in the United Kingdom exceeded that in Germany, becoming the largest in Europe. Given projects with construction going on, would growth in 2016 be similar to that in 2015?
- Renewable generation capacity growth may decelerate on the launch of the CfD (Contract for Difference) (5 MW or more） in 2015, a subsequent end to the RO (Renewables Obligation), the substantial reduction of feed-in tariffs, etc.

Capacity growth

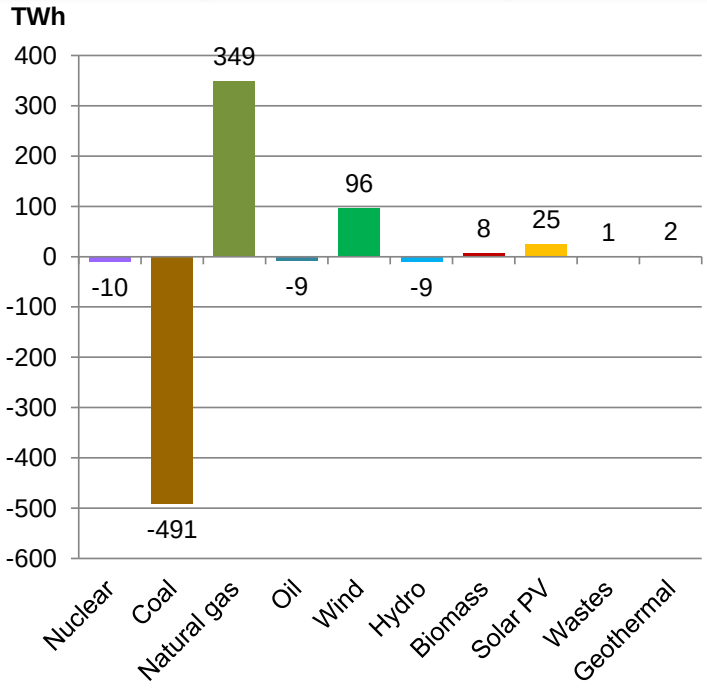


U.S.

- Renewables' share of the power mix stood at 13.4% (5% for wind and solar PV) in 2015.
- Wind and solar PV generation have posted rapid growth, which was still slower than natural gas generation capacity growth or coal generation capacity shrinkage.

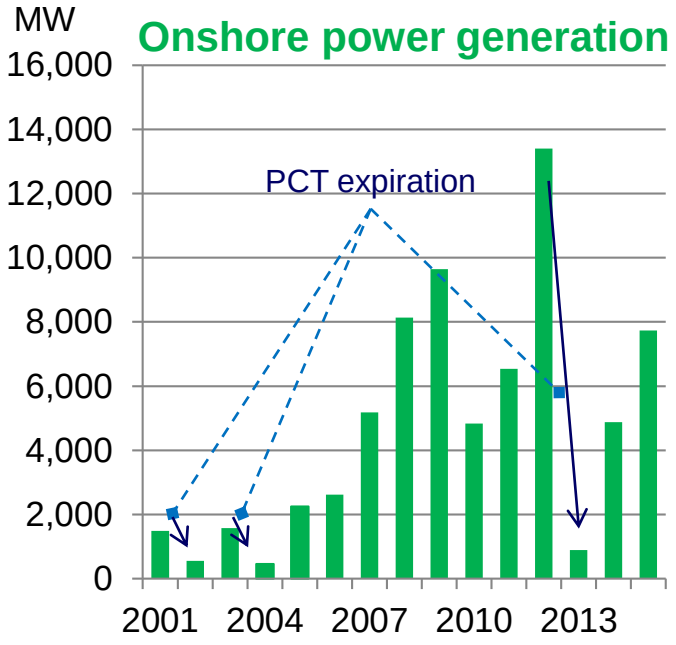
- In the past, wind power generation capacity growth rapidly decelerated as the PTC (Renewable Electricity Production Tax Credit) policy expired.
- Future PTC and ITC (Business Energy Investment Tax Credit) trends will hold the key to capacity growth.

Changes by power source (2010⇒2015)



Source: EIA, DOE

New onshore wind power generation capacity



Summary of World Trends

Developed countries

- After driving renewable energy expansion, major European countries, though expected to expand renewable energy further over a long term, are exploring how best to reduce the burden on consumers and integrate renewable energy into the electricity market to break away from the FIT system.
- Amid the institutional reform, renewable energy expansion will decelerate over a short term.

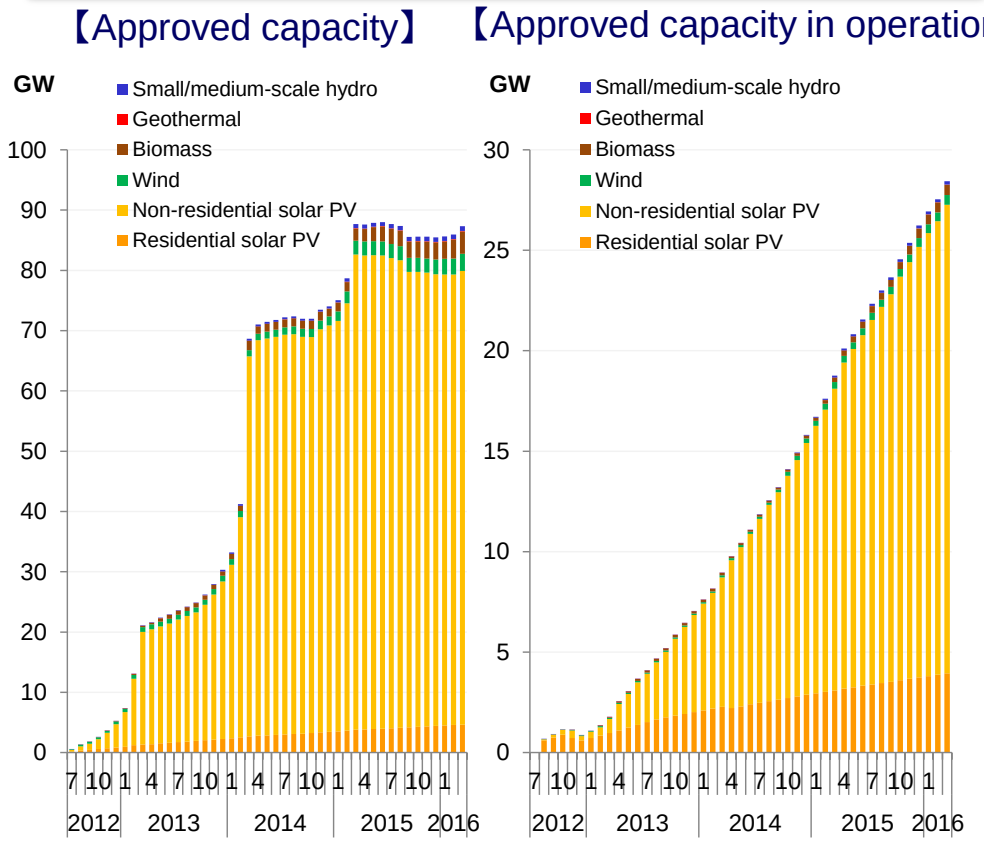
Developing countries

- Solar PV is expanding in developing countries as well thanks to cost cuts and competitive bidding. The elimination of subsidies for traditional energy sources also supports renewable energy expansion.
- However, developing countries are required to address a great number of challenges including grid stabilization, the rising burden on consumers under the FIT system and an industrial shakeout under excessive competition.

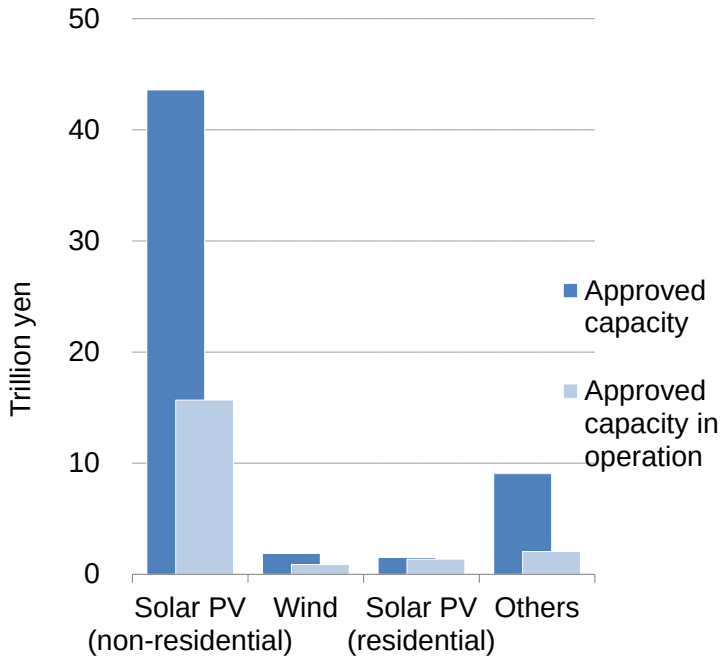
FIT Capacity and Burden on Consumers in Japan

- Operating capacity approved under the FIT system totaled 28 GW at the end of March 2016. Total approved capacity remained unchanged in the past year.
- If all capacity approved under the FIT system (87 GW at the end of March 2016) is in operation, cumulative surcharges over 20 years may total 56 trillion yen (or 3.2 yen/kWh).

Authorization and operation of FIT-eligible Capacity



Cumulative FIT surcharges



Japan's FIT System Revision

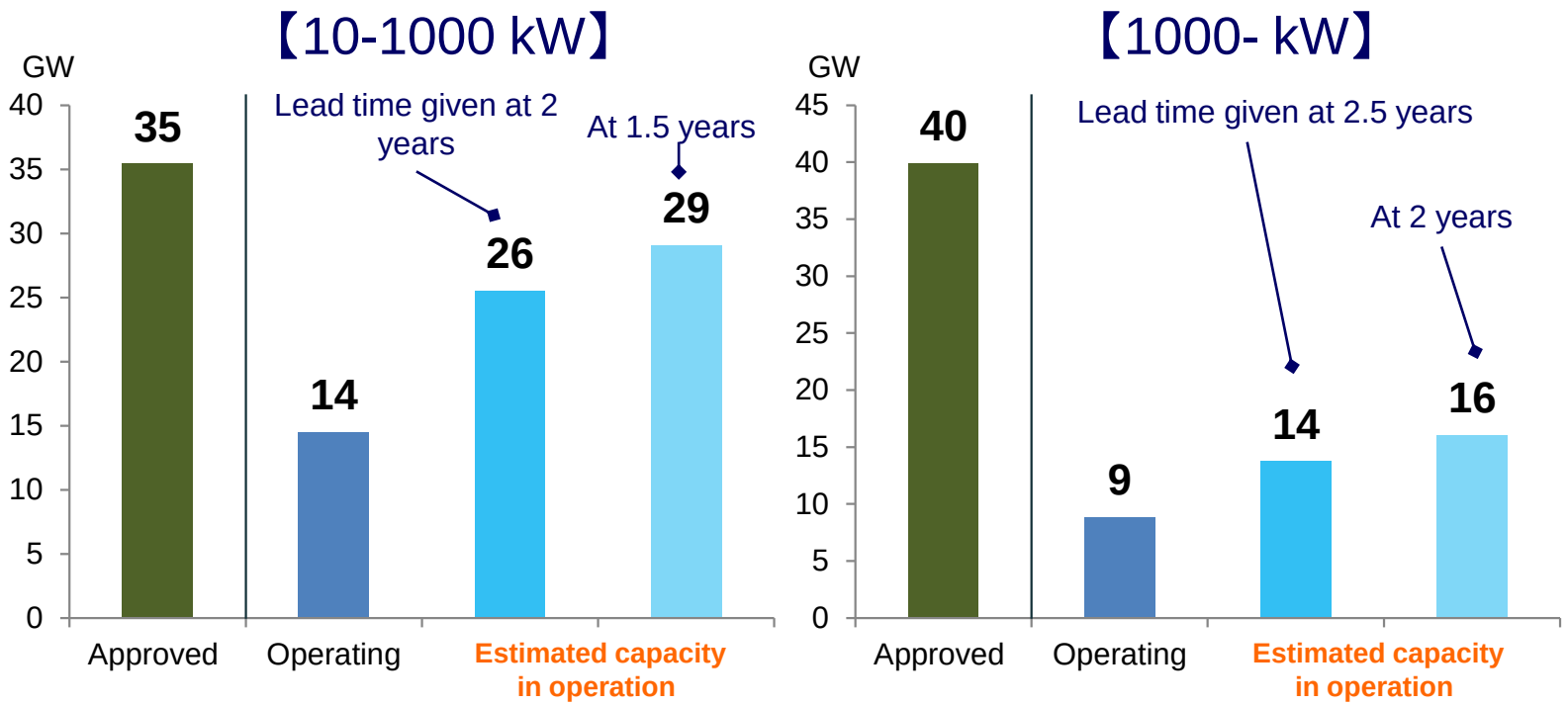
- A bill to revise the Act on Special Measures Concerning Procurement of Electricity from Sources of Renewable Energy by Electricity Utilities (FIT Act) was enacted at the Diet on May 25 and promulgated on June 3.
- The act revised the FIT Act that brought about various challenges while contributing much to expanding renewable energy.
- Before the revised FIT Act takes effect on April 1, 2017, the Subcommittee for Reforming Systems Related to Introduction of Renewable Energy and the New and Renewable Energy Subcommittee have started deliberations to build specific systems within the current fiscal year.

- Creating a new approval system with consideration given to non-operating approved.
- Introducing a mechanism to secure the appropriate implementation of projects
- Cost-efficient renewable energy introduction
- Expanding electricity sources with long lead time
- Taking advantage of the electricity system reform to expand renewable energy

Non-operating Approved Capacity (non-residential solar PV)

- Operating capacity accounts for 23 GW of 75 GW in total approved non-residential solar PV capacity (at the end of March 2016). Non-operating approved capacity stood at 52 GW.
- Given the average lead time, 39 to 45 GW should have been in operation. Some 20-30% of approved capacity may represent projects that have been left untouched.

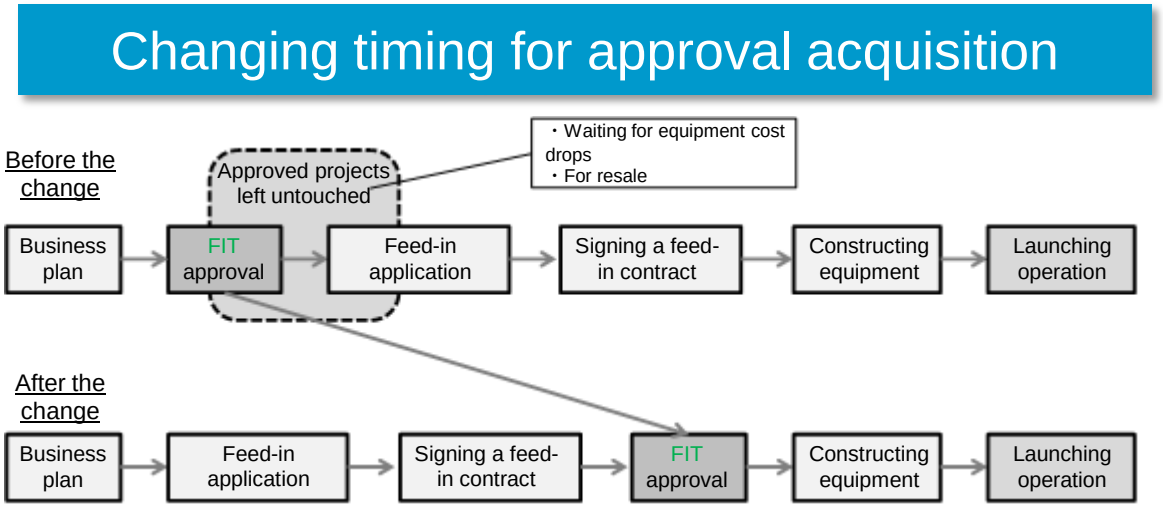
Operating approved non-residential solar PV capacity at March-end 2016



System Design under Revised FIT Act: Eliminating Non-operating approved capacity

- The cancellation of approvals has already been done since the summer of 2014.
- The revised FIT Act will enhance the cancellation:
  - Existing approvals: Approvals will lose effect unless relevant feed-in contracts are signed by April 2017.

    ➔ As nine months are required for signing feed-in contracts, feed-in applications increased rapidly toward June 30, 2016.
  - New approvals: The timing for an approval will be changed to come after a relevant feed-in contract is signed. A procurement price may be fixed upon the approval.
  - Preventing non-operating approved capacity: Plans to set deadlines between the approval acquisition and the operation launch (3 years for commercial solar PV and one year for residential solar PV), discount feed-in tariffs and shorten FIT periods are under consideration.

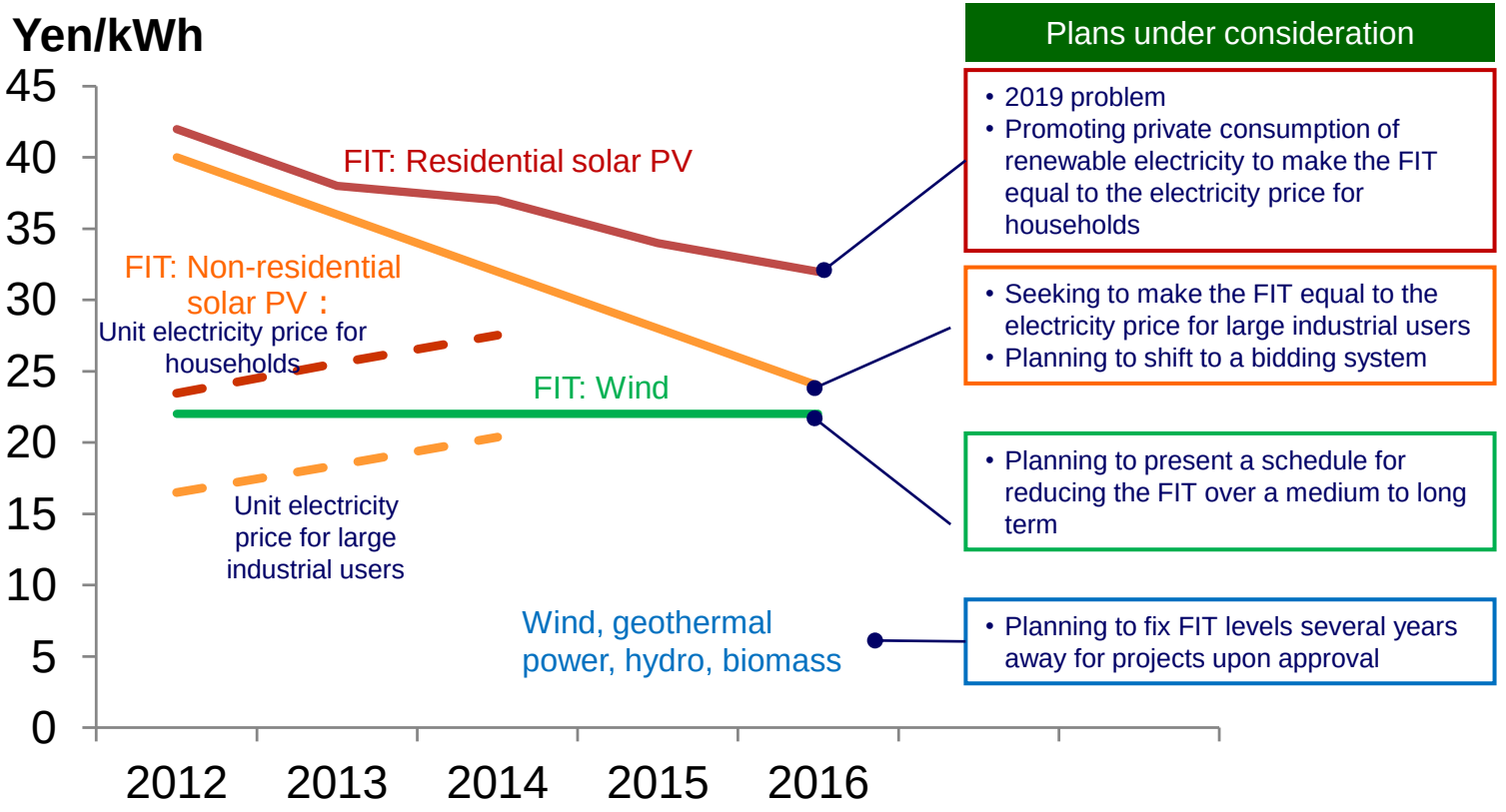


Source: Document for the 5th meeting of the Subcommittee for Reforming Systems Related to Introduction of Renewable Energy, prepared by the Ministry of Economy, Trade and Industry

System Design under Revised FIT Act: How to Set Feed-in Tariffs

- The FIT surcharge will rise from 0.22 yen/kWh in 2012 to 2.25 yen/kWh in 2016. Japanese feed-in tariffs for solar PV and wind power generation double those in major European countries. It is pointed out that the high FITs prevent efforts to reduce equipment costs.

Image of System Design for Reducing Feed-in Tariff



System Design under Revised FIT Act: Bidding System

- Major European countries have taken advantage of bidding systems to cut costs.
- A bidding system in Japan is planned to begin with large solar PV projects. The system could be used for wind farm projects as well.
- Conceivable challenges
  - How to set project sizes, maximum bid prices, etc.
  - Project concentration in optimum locations (with good solar radiation or wind conditions)
  - Excessive competition could lead to an increase in foreign bidders and the stagnation of new investment

U.K. bidding results

(Unit: p/kWh)		2015 /2016	2016 /2017	2017 /2018	2018 /2019
Standard price*	Solar PV	12.00	11.50	11.00	10.00
	Onshore wind farm	9.50	9.50	9.00	9.00
Bid price		5.00	7.92	8.00	8.25

Source：DECC
Note: The year is for launching operation.
*: Subject to bidding is the strike price in the CfD. The Strike Price standard is fixed on a technology-by-technology basis. Solar PV and onshore wind power generation projects are subjected to the same conditions for bidding.

German bidding results

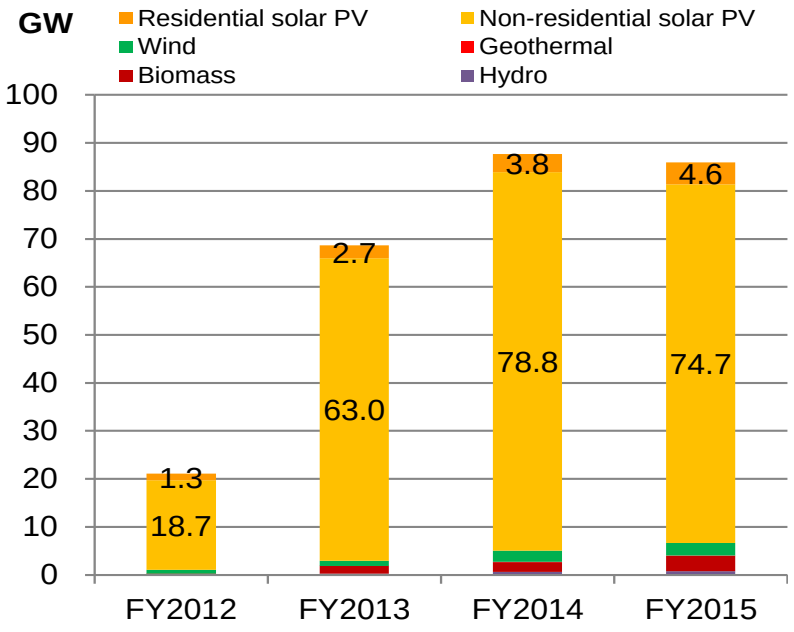
(Unit: €c/kWh)		#1 2015/4	#2 2015/8	#3 2015/12
Solar PV	FIT	9.02	8.93	
	Bid price	9.17	8.49	8.00

Note: Subject to bidding is a standard price for the FIP (Feed-in Premium) system .
Year: The year is for bidding, with operation planned to start in two years.

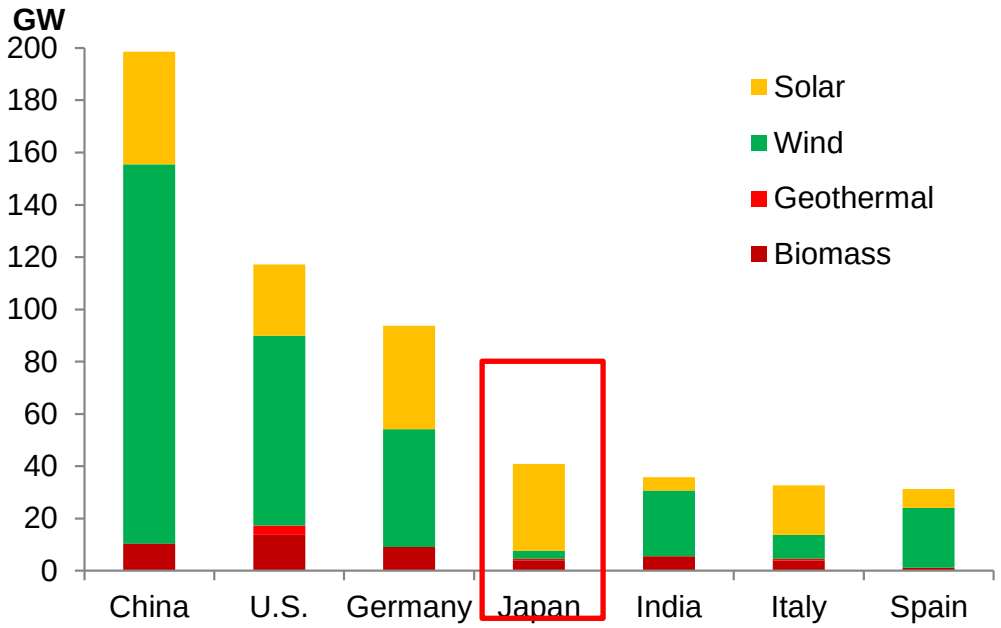
Correcting Imbalance in Renewable Energy Expansion

- Japan features heavier concentration in large-scale solar PV among renewables than other countries.
- Measures for other renewables under consideration include setting FITs for the next several years, promoting technology development, and accelerating environmental assessment and negotiations with local communities for other renewables.

Japan's cumulative approved capacity



Comparing renewable generation capacity breakdowns



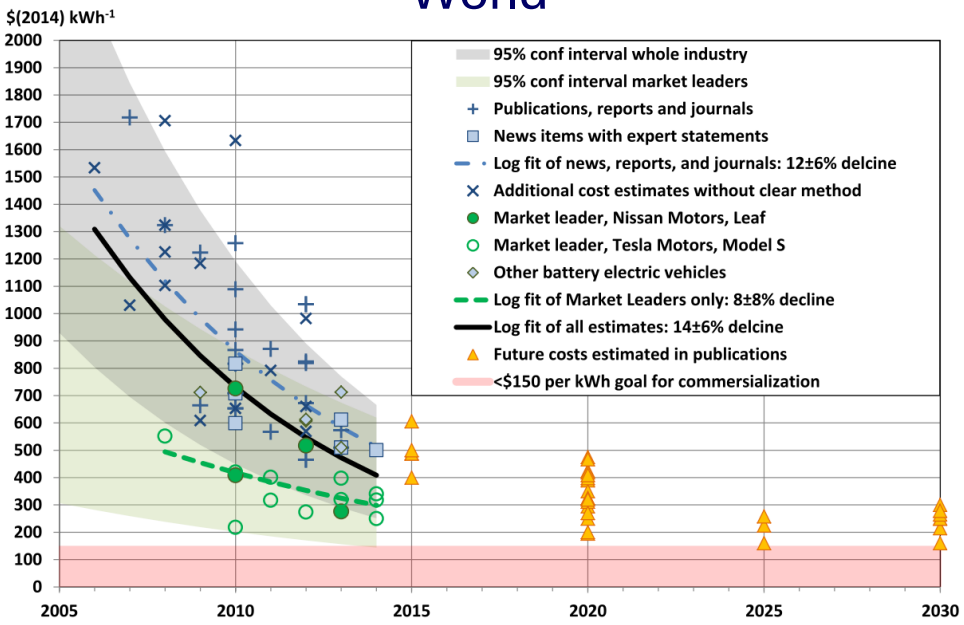
Source: Estimated from IRENA, REN21

Topic: Storage Battery Trends

- In March 2016, one of the world's largest NaS sodium-sulfur batteries (with capacity at 300 MWh) started operation (on the grid side) in Buzen, Kyushu.
- Prices of lithium-ion batteries for electric vehicles have declined rapidly. Storage batteries on the demand side are expected to help stabilize the grid.

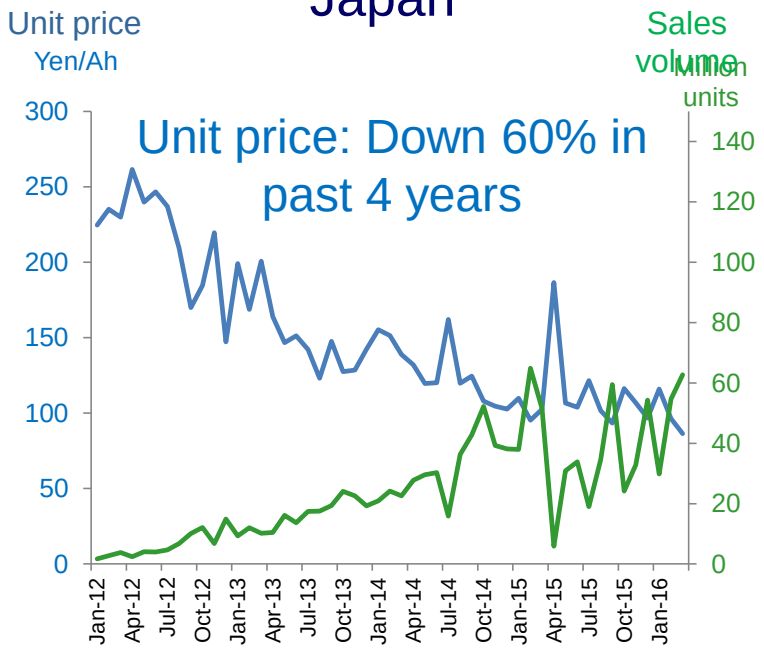
Lithium-ion battery (for vehicles) price trends

World



Source: Björn Nykvist and Måns Nilsson, "Rapidly falling costs of battery packs for electric vehicles," 2015

Japan

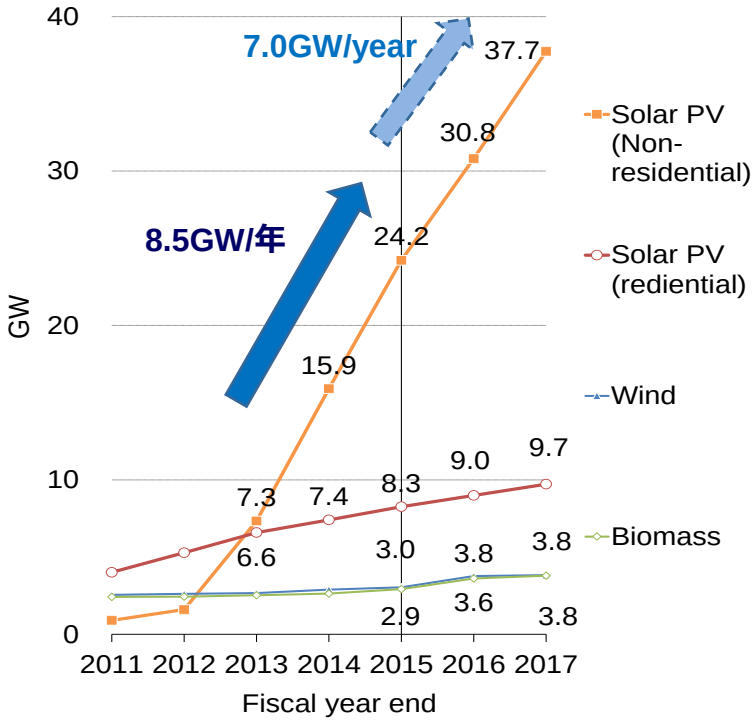


Source: Estimated from machinery production statistics

Renewable Power Generation Capacity Outlook

- Renewable power generation capacity at the end of FY2017 is projected at 65 GW (including 38GW for non-residential solar PV), accounting for more than 10% of total power generation.
- Additional capacity approvals for renewables other than solar PV will be required to meet the best energy mix for 2030.

Renewable power generation capacity



Capacity required to meet the best energy mix for 2030

(GW)	Additional capacity required to be in operation by 2030	Non-operating approved capacity (at March-end 2016)
Solar PV	31.5	52.7
Wind	7.0	2.4
Biomass	3.1～4.4	3.2
Geothermal	0.8～0.9	0.1
Small/medium-scale hydro	1.2～1.9	0.6

Summary of Renewable Energy Trends in Japan and Challenges

Short-term outlook

- Approved capacity is expected to decline under traditional measures and the enhancement of measures against non-operating approved capacity under the revised FIT Act.
- In line with the decline, Japan's renewable energy expansion will decelerate over a short term.

Challenges

- How to design a bidding system and a schedule for reducing FITs holds the key to maintaining an appropriate pace for renewable energy expansion.
- Japan features a greater imbalance among renewables than other countries and is required to enhance wind and geothermal power generation.

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