OVERVIEW

In 2017, Japan’s total installed wind power capacity reached 3,399 MW, including 64.6 MW of offshore capacity. The annual net capacity increase was 169 MW. Total wind-generated electricity during 2017 was about 5.8 TWh, which corresponded to 0.64% of the national electricity demand (906.2 TWh).

Although the environmental impact assessment (EIA) review process has been streamlined, new wind farm projects (with an additional capacity of 16 GW) are still undergoing the EIA review process. Some projects are proceeding in port and ocean areas, where Japan has considerable potential for offshore wind farms.

MARKET DEVELOPMENT

National Targets & Policies Supporting Development

Following publication of The Fourth Strategic Energy Plan, the Ministry of Economy, Trade and Industry (METI) issued the Long-Term Energy Supply and Demand Outlook, which included an estimate for the power source mix in 2030 [1]. The projected share of wind energy in Japan’s 2030 power source mix is 1.7%, or 10 GW of capacity, including 0.82 GW of offshore wind power. However, according to a Japan Wind Power Association (JWPA) report, wind energy capacity will probably exceed this share by the early 2020s.

Japan adopted a feed-in-tariff (FIT) scheme to support the development of renewable energies, including wind power, in July 2012. The country’s former incentive programs were investment subsidies and renewable portfolio standards. The FIT will last 20 years for wind power, including small wind and offshore wind power.

The tariff is reassessed every year, based on Japan’s latest market situation. METI drafted a modified tariff for wind and solar power in 2016. With these modifications, the FIT for land-based wind would be reduced 1 JPY/kWh (0.007 EUR/kWh; 0.009 USD/kWh) every fiscal year, from 21 JPY/kWh (0.165 EUR/kWh; 0.19 USD/kWh) in FY 2017 to 19 JPY/kWh (0.14 EUR/kWh; 0.17 USD/kWh) in FY 2019. The tariff for offshore wind would maintain a constant rate of 36 JPY/kWh (0.27 EUR/kWh; 0.32 USD/kWh). METI also drafted a new tariff for repowering wind power, which is 3 JPY/kWh (0.021 EUR/kWh; 0.027 USD/kWh) lower than the tariff for large wind power.

Progress & Operational Details

Japan installed 169 MW of new wind power capacity in 2017. The net increase is approximately 12% smaller than that recorded in 2016, when 195 MW were installed. Cumulative wind power capacity reached 3,399 MW across 2,225 turbines at the end of the year (Figure 1). Electrical energy output from wind-based sources during 2017 totaled approximately 5.8 TWh—0.64% of the national electricity demand.

Japan’s operational offshore wind power capacity reached 64.6 MW in 2017. The Fukushima FORWARD project started operation in March 2017 with one 5-MW wind turbine built on an advanced spar-type floater (manufactured by Japan Marine United Corporation).

Although the 2012 environmental impact assessment (EIA) law continues to impact wind farm projects, the wind energy sector has begun to show signs of recovery. The EIA Law requires developers of wind power plants with more than 10 MW of capacity to conduct an EIA for each project—a process that can take about four years.

<table>
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<th>Table 1. Key Statistics 2017, Japan</th>
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<td>Total (net) installed wind power capacity</td>
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Matters Affecting Growth & Work to Remove Barriers

METI amended the FIT act in 2017 enabling FITs to be approved in the middle of the EIA process, two to three years prior to a project’s construction. This should significantly improve predictions of wind power profitability.

A mismatch between wind resource locations and electricity demand in Japan is causing grid connection problems. The country’s northern areas (Hokkaido and Tohoku) have most of wind resources, but their population is small and their grid infrastructure does not have enough capacity to integrate a large number of generators.

Hokkaido Electric Power Company requires wind power developers with more than 20,000 W to stabilize output fluctuation by installing batteries or taking similar measures. In October 2016, Tohoku Electric Power Company announced that it would not accept requests for new grid connection in the northern three prefectures (Aomori, Iwate, and Akita).

Tohoku Electric Power Company also developed a grid enhancement plan to enable 2.8 GW of additional transmission capacity. Several wind farm operators agreed to share the construction costs, and construction work was put out to tender. When the bidding process closed in April 2017, approximately 344 proposals were submitted; the aggregated capacity totaled 15.45 GW—six times larger than the planned capacity—including 4.46 GW for land-based wind power and 7.86 GW for offshore wind power.
National R,D&D Priorities & Budget
METI and the New Energy and Industrial Technology Development Organization (NEDO) administer the main national R&D programs in Japan. Many of these programs focus on lowering the LCOE of offshore wind. NEDO Research and Development of Offshore Wind Power Generation Technologies (FY 2008-2022) has worked on the following:

Research on Next-Generation Floating Offshore Wind Power Generation System (FY 2014-2022): To reduce the costs associated with floating offshore wind turbine system, an empirical study has been conducted to determine the potential for floating offshore wind power capacity at water depths of 50–100 m. Construction for the floater started in 2017 at Hitachi Zosen and the system will be installed in Kitakyushu offshore (Figure 2).

NEDO also started developing new element technologies for a floating offshore wind turbine system, aiming to lower the cost of energy by 20 JPY/kWh (0.15 EUR/kWh; 0.18 USD/kWh) after 2030. For this project, NEDO has developed a conceptual design for a new integrated light-weight wind turbine-tower-floater structure, as well as other activities that aim to reduce the cost of the system.

Offshore Wind Resource Map (FY 2015-2017): NEDO developed a 500-m grid resolution offshore wind resource database for areas within 20 km of the Japanese coastline. The database, which utilizes the Weather Research and Forecasting Model, became accessible to the public in March 2017. The target accuracy for the simulations is an annual bias of less than ±5% for the wind speed at a hub height of 80 m.

In addition to coastal winds, researchers also collected data on open-ocean winds using satellite observations. Social and environmental information data associated with offshore wind development, such as significant wave heights, fishing rights, shipping routes, water depth, and seabed properties, are collected and stored in the database.

In FY2017, NEDO modified the Resource Map based on requests from developers. Researchers improved the accuracy of coastal shapes near high potential offshore wind areas and added information that would improve site selection for offshore wind projects (ship passages, restrictive areas by aviation, self-defense forces facilities etc.).

Low Cost Construction (FY2017): NEDO conducted feasibility studies on low cost construction methods for offshore wind. Four groups studied new engineering and foundation construction, while one group studied a new vessel for construction operations. NEDO also referred to the methods used in the Joint Industry Program when considering evaluation methods for low-cost construction.

Another national R&D program by METI and NEDO focuses on further reducing the cost of wind energy and improving capacity factor. This program, NEDO Advanced Practical Research and Development of Wind Power Generation (2013-2020), involves the following: R&D of Smart Maintenance Technologies (FY 2013-2017): As wind turbine maintenance treatments change from “break down maintenance” to “preventive maintenance,” NEDO has developed technology development to analyze data from wind turbine CMS (Condition Monitoring Systems), estimate the lifetime of each component, and reduce downtime when preparing to exchange components.

R&D of Performance Evaluation of Lightning Detection Device for Wind Turbine (FY 2016-2017): To reduce wind turbine issues caused by lightning strikes and downtime, NEDO evaluated the performance of several lightning detection systems and established integrated evaluation techniques.

Through the Floating Offshore Wind Farm Demonstration Project (Fukushima FORWARD PJ, FY 2011 to FY 2016), METI initiated the world’s leading offshore wind demonstration. For this project, METI installed several offshore wind turbines with various types of floaters in the Pacific Ocean, more than 20 km offshore of the Fukushima prefecture.

In the first phase of the project, METI installed a Hitachi 2-MW downwind turbine with a four-column, semisubmersible floater and a 66-kV floating offshore electrical substation with a measurement platform; this turbine began operations in 2013. In 2015, an MHI 7-MW wind turbine with a three-column, semisubmersible floater was anchored to the demonstration site and began operation. In 2016, a Hitachi 5-MW downwind turbine with an advanced spar type floater (manufactured by the Japan Marine United Corporation) was installed (Figure 3). This turbine began operations in March 2017.
**Collaborative Research**

In 2017, Japan joined IEA Wind TCP Task 26, Cost of Wind Energy. Japanese organizations Kyushu University and Wind Energy Institute of Tokyo (WEIT) proposed the formation of new Task on downwind turbine technologies, and the ExCo approved it as Task 40 in 2017. Japan currently participates in:

- Task 11 Base Technology Information Exchange
- Task 25 Design and Operation of Power Systems with Large Amounts of Wind Power
- Task 26 Cost of Wind Energy
- Task 27 Small Wind Turbines in High Turbulence Sites
- Task 28 Social Acceptance of Wind Energy Projects
- Task 30 Offshore Code Comparison Collaboration, Continued, with Correlation (OC5)
- Task 31 WAKEBENCH: Benchmarking of Wind Farm Flow Models
- Task 32 Lidar Systems for Wind Energy Deployment
- Task 40 Downwind Turbine Technologies

Japan also participates in many maintenance teams, project teams, and working groups in IEC TC 88.

**IMPACT OF WIND ENERGY**

**Environmental Impact**

In 2017, wind-generated electricity contributed to a reduction of about 2.8 million tons of CO₂ equivalent, amounting to 0.2% of Japan’s total CO₂ emissions. Japan aims to reduce greenhouse gas (GHG) emissions by 26% from their FY 2013 levels by FY 2030. Wind energy will contribute somewhat to reaching this target, but its impact will be limited.

**Economic Benefits & Industry Development**

Japan’s wind energy industry has a limited impact on the domestic economy. Hitachi is the only domestic wind turbine manufacturer; however, some Japanese manufacturers produce essential wind turbine components and export their products to foreign companies. Local governments are hopeful that the wind power industry will have a positive impact on the local economy and create jobs, especially in construction and O&M sectors.

In 2016, Hitachi developed a 5.2-MW downwind turbine, the HTW5.2-136, which is a large-rotor diameter version of a previous model, the HTW5.0-126. By increasing the rotor diameter to 136 meters and increasing the wind-swept area on the rotor by 15%, the new turbine has made it possible to increase output in regions whose annual average wind speeds are below 7.5 m/s.

Hitachi intends to market the HTW5.2-136 to regions with relatively low wind speed along the coast of Honshu, the main island of Japan. Hitachi also plans to market another turbine, the HTW5.2-127, for areas with stronger winds. These areas include the coasts of Hokkaido, the northern part of the Tohoku region in Honshu, and southern Kyushu. Hitachi has optimized the setup and control programs of the HTW5.2-127, increasing its rated power over that of the previous model.

**NEXT TERM**

Several new wind farm projects are still in the process of completing their EIAs. These projects are expected to begin operation within four years, adding more than 16 GW to Japan’s total capacity. Other planned projects still require approval for grid connection, so their operation dates remain uncertain. On the other hand, a total of 2 GW in offshore wind projects are currently under consideration. In March 2018, the Cabinet approved a draft for new rules covering general ocean areas. If these rules go into effect, they will be a positive factor for expanding offshore wind deployment in Japan.

**References**

- Opening photo: 2-MW downwind turbines, manufactured by Hitachi and installed within the Hinode Forest (Source: Eco Power Co., Ltd.)

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