

Wind Turbine Supply Chain and Components Industries in Japan

Takao Maeda, Mie University, Tsu, Japan

Yoshinori Ueda, The Japan Wind Energy Association (JWEA), Tokyo, Japan

Takamoto Manabu, The Japan Wind Power Association (JWPA), Tokyo, Japan

Katsuhiko Shono, The Japan Society of Industrial Machinery Manufacturers (JSIM), Tokyo, Japan

Takatoshi Maysushita, The Japan Electrical Manufacturers' Association (JEMA), Tokyo, Japan

Abstract:

Japanese wind turbine industrial societies have started collecting production statistics regarding wind turbines and their components made by Japanese companies since 2010. The research results revealed that Japan has produced 112 billion JPY of wind turbines and their components by 57 domestic companies and has created 2,300 jobs in FY 2011. 96 billion JPY of products which were about 86% of total production were exported abroad, because of the small domestic market. 17 billion JPY of products were made at overseas. More than 51 billion JPY of components were purchased from abroad.

Japanese wind turbine manufactures had minor market share in the world. On the other hand, manufacturers of bearings and generators were more competitive and had significant market share in the world. This is not strange, because Japan is well known as its "High-Technology" at precise machinery and electronics.

4GW of wind power projects are in the pipeline in Japan at Jan. 2013. They are waiting for the Environmental Impact Assessment which needs 3 to 4 years. Japanese wind industry will grow up when their domestic wind power market jumps up after 2016.

Keywords: Industrial Statistics, Non-EU markets

1. Introduction

Japanese government has decided to grow up domestic renewable industries including wind power, after the Fukushima nuclear accident on 11 Mar. 2011. The wind turbines are consisted by thousands of various components, such as blades, shafts, gears, bearings, generators, power converters, etc. Therefore, wind turbine industry has positive effects for machinery and electric industries and it is expected to create a lot of jobs.

Japanese wind turbine industrial societies (JSIM, JEMA, JWPA and JWEA) have started collecting production statistics regarding wind turbines and their main components made by Japanese companies since 2010. This research was supported by Japanese Ministry of Economy, Trade and Industry (METI).

2. Approach

"Japanese Wind Turbine Industrial Production Statistics Study Committee" has been

created by several core members in the Japanese wind turbine industrial societies (JSIM, JEMA, JWPA and JWEA) in June 2010. 7 industrial societies (wind power, machinery, electric, bearing, fluid power, etc.) and 17 companies (Mitsubishi Heavy Industries Ltd., Fuji Heavy Industries Ltd., Japan Steel Works Co., NTN, Fuji Electric Co., Yasukawa Electric Co., etc.) have joined as the committee core members and more 30 companies have cooperated as the discussion members. These members include the manufactures of wind turbines, blades, generators, power converters, bearings, towers and so on. Prof. Takao Maeda in Mie University became the chairman, and the Japan Society of Industrial Machinery Manufacturers (JSIM) and the Japan Electrical Manufacturers' Association (JEMA) took secretary work. The officers of Japanese Ministry of Economy, Trade and Industry (METI) have joined as observer.

At first, we classify the wind turbine industry into the 17 categories as wind turbines themselves, their main components and associated facilities. Then, we nominated more than 400 Japanese companies which make wind turbine components now or in future. These works have been conducted by committee core members and the committee secretary organized by JSIM and JEMA. We have made interview with main players of Japanese wind turbine industry, like Mitsubishi Heavy Industries Ltd., Hitachi Co. (formerly Fuji Heavy Industries Ltd.) and Japan Steel Works Co., about their supplier chains. We have finished above preparation and we made concrete industrial research questionnaire sheet by Sep. 2010.

The committee secretaries have sent the questionnaire sheets regarding production statistics of 2009 fiscal year to the nominated 400 companies in Oct. 2010 with the name of Japanese METI. We could get answers from about 150 companies by Dec. 2010. The committee secretaries have made basic tables and charts from answers. Then, the secretaries have re-arranged the categorization that each category includes more than 3 companies so as not to detect each company's sales data directly. These data were presented to the committee and discussed by the committee members for several times during Dec. 2010 to Jan. 2011. The production statistics and the analyzed results were summarized as the annual report in Japanese. This report was reviewed and finalized by the committee in Feb. 2011. Then, the final report was published from the JSIM in Mar. 2011. Therefore, our statistic are published about 1 year later from actual production. We repeat above procedure every year since 2010. We have already published three annual reports for the production for FY2009, FY2010 and FY2011. The report for FY2012 is under the finishing work and it will be published in April 2014. These reports written in Japanese can be purchased from JSIM.

3. Industrial Statistics regarding Japanese Wind Turbine Industry for FY2011.

The research results for FY2011 are as follows.

3.1 Wind Turbines

We classify it to 4 categories by rated output, "Micro WTG" as "Lesser than 1kW", "Small WTG" as "from 1kW to 50kW", "Medium WTG" as "from 50kW to 1MW" and "Large WTG" as "More than 1MW". There are 18 companies manufacturing wind turbines in Japan and 1200 employee are working directory for wind turbine manufacturing. 4 companies are manufacturing "large WTG". The total sales in 2011 fiscal year are 76 billion JPY. "Large WTG" has more than 99% of the sales. 66 billion JPY (87% of total sales) of wind turbines are exported to abroad. 51 billion JPY (68% of total sales) is used for purchasing components and materials. 25 billion JPY (49% of purchasing) is purchased from domestic Japanese suppliers.

3.2 Generators

There are 7 companies and 6 factories producing generators and 271 employee are working directory for this production. The total sales in 2011 fiscal year are 6.1 billion JPY. Almost all generators are exported. 3.7 billion JPY (60%) of generator sales is used for purchasing equipment and materials. 3.1 billion JPY (85% of purchasing) is purchased from domestic Japanese suppliers. Hitachi Co. and Yasukawa Electric Co. intend to get large share in the world market. They have enough ability based on the fossil power generation business.

3.3 Controllers

There are 11 companies and 9 factories producing controllers and 346 employee are working directory for this production. The total sales in 2011 fiscal year are 1.6 billion JPY. 66% of controllers are exported. 0.36 billion JPY (22%) of controller sales is used for purchasing equipment and materials. 0.25 billion JPY (69% of purchasing) is purchased from domestic Japanese suppliers.

3.4 Main Bearings

There are 3 companies and 5 factories producing wind turbine main bearings and 800 employee are working directory for this production. The total sales in 2011 fiscal year are 14.2 billion JPY. 13.6 billion JPY (96%) of bearings are exported. 1.65 billion JPY (12%) of bearing sales is used for purchasing equipment and materials. Almost all of them are purchased from domestic Japanese suppliers. JTEKT, NSK and NTN are very competitive in this business, because they have enough and long experience from automobile business.

3.5 Gearboxes

There are 3 companies and 5 factories producing gearboxes and 215 employee are working directory for this production. The total sales in 2011 fiscal year are 4.8 billion JPY. 3.9 billion JPY (81%) of gearboxes are exported. 1.83 billion JPY (38%) of gearbox

sales is used for purchasing equipment and materials. 0.95 billion JPY (52% of purchasing) is purchased from domestic Japanese suppliers. Japanese manufacturers are very good at precise machinery. Their products are trustworthy.

3.6 Blades and nacelle FRP cover

There are 4 companies and 5 factories producing wind turbine blades and 343 employees are working directly in Japan for this production. The total sales in 2011 fiscal year are 0.04 billion JPY for domestic production and 15.5 billion JPY for abroad production by Japanese companies. Blade manufacturing is labor-intensive industry. Therefore, it is very difficult to keep profitability in Japan where the labor cost is very high.

3.7 Towers and auxiliaries

There are 11 companies and 5 factories producing towers and their auxiliaries and 235 employees are working directly for this production. The total sales in 2011 fiscal year are 1.14 billion JPY for domestic production and 1.5 billion JPY for abroad production by Japanese companies. Tower manufacturing is also labor-intensive industry. Therefore, it is very difficult to keep profitability in Japan where the labor cost is very high.

4. Resent Wind Power Development in Japan

The trade balance of Japan became a deficit up to 11.5 trillion JPY in 2013. This deficit is worst in the past and it has kept since 2011. All 48 nuclear power plants in Japan have been shut down for safety investigation against earthquake, and Japan is spending extra 3 trillion JPY a year for additional fossil fuel import. This situation is not sustainable for Japan, both environment and economy. It is clear that mass-introduction of renewable energies is the right solution.

2,661MW of wind capacity had been installed in Japan at the end of 2013. They supplied 0.5% of the total power supply in Japan. New installation was 50MW in 2013 which is the smallest since 2003. (And 2.1MW has been decommissioned, therefore net increase was about 47MW in 2013.) Only two wind farms have started operation in 2013(Fig1, Fig2). Almost half of new installation (24.4MW) was offshore wind power. FIT price for wind has been kept same 22JPY/kWh because of the small installation increase and FIT price for offshore wind is to be fixed by coming March.

The feed-in-tariff (FIT) was introduced in July 2012, on the other hand, a strict environmental impact assessment (EIA) has applied for all wind farms with capacity of over 10MW since Oct.2012. This EIA has frozen new installation for several years. As of Jan. 2014, 5 wind power projects with 174MW have finished EIA procedure, and 88 projects with 3.963MW are in the pipeline. It is about 1.5 times larger than all wind turbines operating Japan now. It is expected that Japanese wind power market is

bottoming out in 2013. New installation in 2014 and 2015 will become 200MW and 300MW. And it will grow rapidly after 2016, when most of projects clear EIA procedures. The Japan Wind Power Association (JWPA) is preparing a new long-term road map by May, revising the current target of 50GW of wind by 2050 upward considerably. This road map should address the effective use of the feed-in-tariff (FIT), resolution of the grid-access issue, the need for drastic energy-market deregulation and the expansion of offshore wind, to name a few of the most urgent matters.

5. Resent Wind Power Industry in Japan

Three Japanese wind turbine manufacturers keep more than 60% domestic market share for several years. They are developing new wind turbines as shown in Table 1.

Table 1: New wind turbines developed by Japanese manufacturers

| Company | Wind turbine | Rated output | Start operation | Type |
|---------|--------------|--------------|-----------------|-------------------------|
| MHI | MWT167/7.0 | 7.0MW | 2014 | Digital hydraulic drive |
| Hitachi | HTW5.0-126 | 5.0MW | 2014 | Downwind |
| | HTW2.0-86 | 2.0MW | 2014 | Downwind |
| JSW | J100-2.7 | 2.7MW | 2013 | Gearless PMSG |

Because of the shrink of domestic market, Japanese companies intend to expand their business worldwide by merging or collaborating with foreign companies.

Mitsubishi Heavy Industries, Ltd. and Vestas establish a new JV company for offshore wind business in April 2014, aiming to get major share against Siemens.

Toray has acquired Zoltek, which produces carbon fiber for wind turbine blades of Vestas and Gamesa, by \$610 million. Mr. Sadayuki Sakakibara, who is the former chairman of Toray, is to become the president of Japanese Federation of Economic Organizations (“Keidanren”) after April 2014. It might bring the change at Japanese business societies in favor for the renewable energies.

Yasukawa Electric Co. has made cooperation with Finnish wind-power technology specialist The Switch. The combination of Yasukawa’s high voltage technology and The Switch’s wind power experience enable to produce compact generators for bigger wind turbines.

And, many Japanese trade companies, such as Marubeni, Mitsubishi and Sumitomo, have started investing for European offshore wind power business.

6. Resent Offshore Wind Power Development in Japan

Japanese government has large interest in offshore wind power development, because

Japan is surrounded by seas and has world 6th largest EEZ. Various type offshore wind turbines have started in operation after 2013 as shown in Table2 and Fig1,2. They could withstand against large typhoons and it proved Japanese high technology and craftsmanship. These offshore wind projects enable us to compare the advantages and disadvantages each other. Then, we can learn much experience in short time.

Table2: Recent Offshore Wind Power developed in Japan

| Location | Start | Developer | Wind turbine | Foundation / Floater |
|---|--------------|------------------------|-------------------------|---------------------------------------|
| Kamisu, Ibaraki Pref. | Feb. 2013 | Wind Power Group | Hitachi 2MW x 8units | Monopile foundation |
| Choshi, Chiba Pref. | Mar. 2013 | NEDO / TEPCO | MHI 2.4MW | Gravity foundation |
| Hibikinada/Kitakyu -syu, Fukuoka Pref. | Aug. 2013 | NEDO / J Power | JSW 2MW | Jacket & Gravity hybrid foundation |
| Akita Port Akita Pref. | Feb. 2015 | Eurus Energy | Siemens 3MW | Dolphin foundation |
| Kabashima (Fukue) /Goto,Nagasaki Pref. | Oct. 2013 | MOE / Toda Co. | Hitachi 2MW | Spar type floater made by Toda Co. |
| Fukushima, Fukushima Pref. | Nov. 2013 | METI / Marubeni Co. | Hitachi 2MW | Semi-sub type floater made by MES |
| Fukushima, Fukushima Pref. | Mar. 2016 | METI / Marubeni Co. | Mitsubishi 7MW | Semi-sub type floater made by MHI |



Fig1. GOTO FOWT floating offshore wind turbine demonstration project,
Hitachi 2MW on the spar type floater, Courtesy of MOE



Fig2. FukushimaFORWARD floating offshore wind farm demonstration project,
Hitachi 2MW & MHI 7MW on the semi-sub type floater, Courtesy of METI

Japan has large wind power potential at offshore. The FIT price for offshore wind power (fixed type) will be decided by Mar. 2014. JWPA points out to Japanese government that European countries generally offer from 1.5 to 2 times higher tariff than the onshore level. Several groups are planning to develop offshore wind power, and 4 offshore wind power projects with 254MW are under the EIA procedure at Jan. 2014. It includes 14MW of two floating wind turbines at FukushimaFORWARD project.

On the other hand, large scale offshore wind power developments require a huge investment for harbors, SEP ships, undersea cables, etc.. Unfortunately, Japan is not ready for them now. We have to wait for a couple of years, until Japanese government settles the new ambitious long-term energy vision.

Offshore wind power development in Japan shall be limited to the shallow near port area using 2-3MW class wind turbines on the monopile or gravity foundations for coming several years.

7. Conclusion

There are 57 companies in charge of manufacturing wind turbines and their

components. About 2,300 people are directly working for wind turbine industry in Japan among the total employee of these companies are 510 thousand people. The total sales of wind turbines and their components made in Japan is 112 billion JPY for 2011 fiscal year. 96 billion JPY are exported to foreign countries. Most of them are large wind turbines exported to the U.S.A. 28 billion JPY are used for importing components and materials from abroad, this is about 25% of total sales. The oversea production of Japanese companies is 17 billion JPY. Sales of general-purpose products, such as power converters (inverter, converter, trans, etc.) cannot be caught by our research. Their manufacturers don't categorize and gather their sales data for "wind turbine use", therefore, they cannot answer our questionnaire sheet sufficiently. We suspect sales and employee to increase if general-purpose products are included.

Japanese wind turbine manufacturers have small share in the world. On the other hand, Japanese component supplier have more large market share in the world at large bearings, generators and gearboxes, because Japanese companies are very good at precise machinery and high technology electric equipment.

The sales of Japanese wind turbine industries are decreasing for this 3 years due to the world depression after the "Lehman Shock". The total sales are 251 billion JPY in 2009 fiscal year, 154 billion JPY (-39%) in 2010 fiscal year and 112 billion JPY (-27%) in 2011 fiscal year. It will increase when Japanese domestic market grows up by Feed in Tariff introduced in July 2012. For the domestic market forecast, about 50% of companies answered "It will expand clearly" and about 30% of companies answered "It will expand somewhat". About 80% of Japanese companies have positive forecast for future Japanese domestic market.

The Japanese government has chosen renewable energy industry as the "Strategic growth areas". We want to contribute to achieve this political target by giving sufficient information in our research results.

References

- [1] Research report of Wind Turbines & their Components Industry in Japan, by the Japan Society of Industrial Machinery Manufacturers (JSIM), published in Apr. 2016, Mar. 2015, May 2014, May 2013, April 2012, Mar. 2011 (in Japanese)
- [2] Japanese Wind Turbine Industry, Research Result of Production Statistics, Yoshinori Ueda, atal, GRE2014, Jul. 2014