

## Wind Turbine Supply Chain and Components Industries in Japan

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### **Abstract:**

Japanese wind turbine industrial societies have started collecting and reporting production statistics regarding wind turbines(WTGs) and their components made by Japanese companies since 2010. The statistics data from fiscal year (from April to next Mar.) 2009 to FY2014 are available now.

The research results revealed that Japan has produced 104 billion JPY(0.91 bil.€, 1.03 bil.\$) of WTGs and their components at 69 factories by 64 domestic companies and has created 3,537 jobs in FY 2014. The breakdowns are; WTGs production 28 bil.JPY(27%), Yaw&Brake 30 bil.JPY(29%), Bearing 117 bil.JPY(16%), Substation 14 bil,JPY(13%), Generator 10 bil.JPY(10%). Japanese Mechanical industries are well trained by Automobile industry, so they have strong competitiveness worldwide.

50.6 bil.JPY(49%) of products were exported abroad in FY2014. The export rate at WTGs were very high from FY2009 to FY2012 and very low at FY2013 & FY2014. And additionally, 6.9 bil. JPY of products were made at overseas and 28.7 bil. JPY of components & materials were purchased from abroad in FY2014.

The total domestic production(104 bil.JPY) decreased to about 40% from 251 bil.JPY in FY2009, but rebounded to about double from 54 bil.JPY in FY2013. The reduction mainly caused by the shrunk of Mitsubishi Heavy Industries(MHI)'s WTG business.

7GW of wind power projects are in the pipeline in Japan at Apr. 2016., So Japanese wind industry will grow up according to the domestic market growing up in future.

**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 and reporting production statistics regarding wind turbines and their

main components made by Japanese companies since 2010. This research is supported by Japanese Ministry of Economy, Trade and Industry (METI).

## 2. Approach

### 2.1 Research Committee Organization

“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. The committee organization in FY2014 is shown in Table 1 and Fig.1. 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 board members and committee members are re-selected each year. The members include the manufactures of wind turbines, blades, generators, power converters, bearings, towers and so on. The officers of Japanese Ministry of Economy, Trade and Industry (METI) have joined as observer.

Table 1 Research Committee Organization in FY2014

Chairman	Prof. Takao Maeda, Mie University, JWEA	
Secretary	JSIM and JWPA	
Board Members; 8	WTG Manufacturers; 2	Mitsubishi Heavy Industries, Ltd. (MHI) Hitachi Co. Ltd.
	Components & Material Manufacturers; 3	Fuji Electric Co. (Electric devices) NTN (Bearing) ISHIBASHI (Gearbox)
	Industrial Associations; 3	The Japan Society of Industrial Machinery Manufacturers (JSIM) The Japan Electrical Manufacturers’ Association (JEMA), The Japan Wind Power Association (JWPA)
Committee Members; 10	Small WTG; 1	Zephyr Corporation
	Components & Material Manufacturers; 6	Yasukawa Electric Co. (Generator & Electric devices) Meidensha Co. (Generators & Electric devices) Jtekt (Bearing) NSK (Bearings) Sumitomo Heavy Industries, Ltd. (Gearbox & Yaw devices) GH Craft (Blade)
	Industrial Societies; 3	The Japan Bearing Industry Association (JBIA) The Shipbuilders’ Association of Japan (SAJ) Japan Fluid Power Association (JFPA)



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Fig.1 Japanese Companies relating WTG supply Chain

## 2.2 Research Methods

At first, we classify the wind turbine industry into the 17 categories (now increased to 31 now) as wind turbines themselves, their main components and associated facilities. Then, we nominated more than 400 Japanese companies which may make wind turbine components now or in future. These works have been conducted by committee core members and the committee secretary JSIM and JEMA. There are 3 large WTG manufacturers, Mitsubishi Heavy Industries Ltd.(MHI), Hitachi Co. (formerly Fuji Heavy Industries Ltd., FHI) and Japan Steel Works Co.(JSW) in Japan (Table 2, Fig.2.). We have made interview with them about their supplier chains.

Table 2 WTGs line up made in Japan

Manufacturer	Wind turbine	Rated output	Type
MHI	MWT92/2.4	2.4 MW	
	MWT62/1.0	1.0 MW	
Hitachi	HTW5.0-126	5.0 MW	Downwind
	HTW2.0-86	2.0 MW	Downwind
JSW	J100-2.0	2.0 MW	Gearless PMSG



Fig.2 WTGs made in Japan

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 FY2009 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. (We sent to 243 companies and got 115 answers in FY2014.) 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 individual 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 data. We repeat above procedure every year since 2010. We have already published 6 annual reports for FY2009 to FY2014. You can purchase these reports (paper book/PDF) written in Japanese from JSIM.

### 3. Japanese Wind Turbine Industry in FY2014.

Japan has produced 104 bil.JPY(0.91 bil.€, 1.03 bil.\$) of WTGs and their components at 69 factories by 64 domestic companies and has created 3,537 jobs in FY 2014. Its breakdowns are shown in Fig.3. Japanese Mechanical industries are well trained by Automobile industry, so they have strong competitiveness worldwide.

50.6 bil.JPY(49%) of products were exported abroad in FY2014. (The export rate at WTGs were very high from FY2009 to FY2012 and very low at FY2013 & FY2014.) And additionally, 6.9 bil.JPY of products were made at overseas and 28.7 bil.JPY of components & materials were purchased from abroad in FY2014.

Factory location and Employer distribution are shown in Fig.4. There are two Industry accumulations. One is capital Tokyo and another one is Nagoya. The latter is close to Toyota city where Toyota Motors base factories locate. The supply chain for WTG industry is duplicated to the supply chain for automobiles.

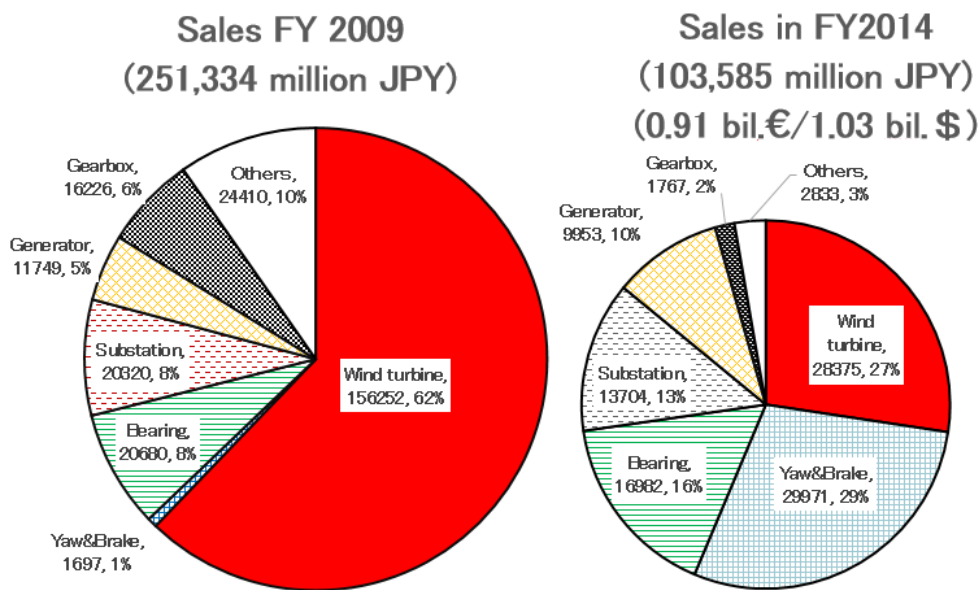


Fig.3 Breakdown of total domestic production in Japan FY2009 & FY2014

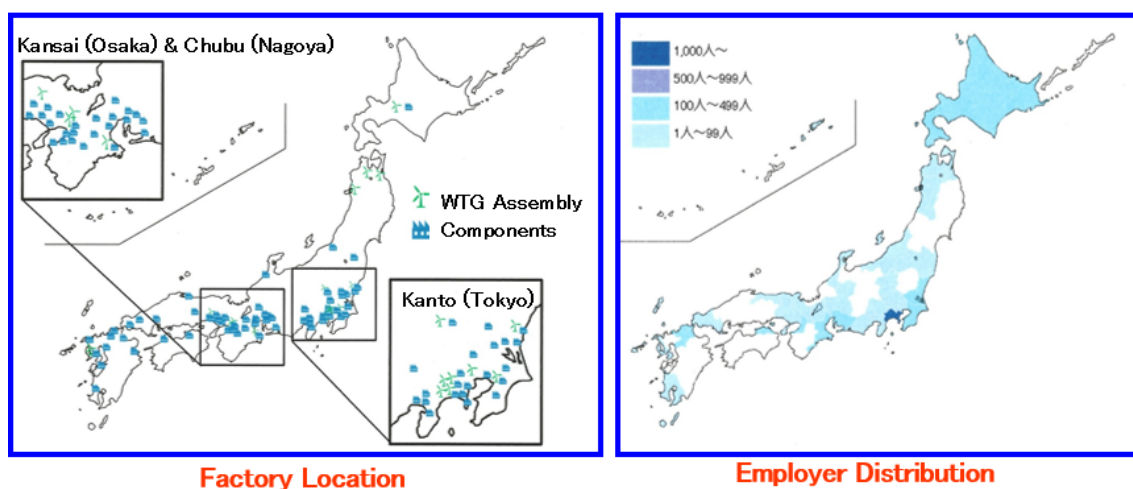


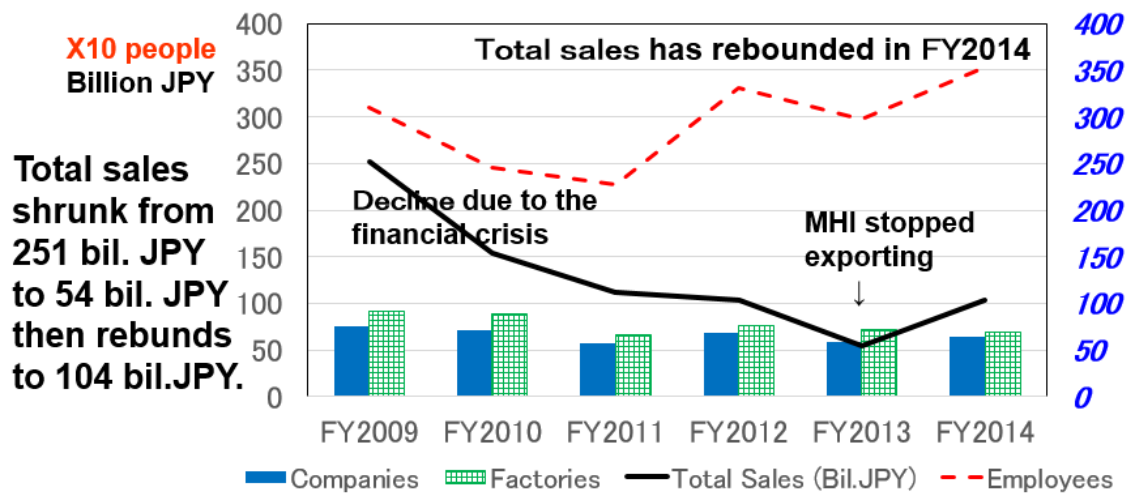
Fig.4 Factory location and Employer distribution in Japan

#### 4. Japanese Wind Turbine Industry trends from FY2009 to FY2014.

##### 4.1 Total production

The total domestic production decreased about one fifth, from 251 bil.JPY in FY2009 to 54 bil.JPY in FY2013, and rebounded to about double to 104 bil.JPY in FY2014 (Fig.5). Most of sales in FY2009 was WTGs export to US market by Mitsubishi Heavy Industries(MHI) (Fig.3). Unfortunately, US WTG market has shrunk due to financial crisis since 2009. Then, MHI shrunk its WTG business.

By the expansion of components suppliers' sales and rebound of Japanese domestic wind power market, the total production has turned to increase from FY2014.



	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014
Total Sales (Bil.JPY)	251.334	153.995	111.781	103.966	54.222	103.585
Employees	3097	2460	2279	3313	2969	3537
Companies	75	72	57	68	59	64
Factories	92	89	67	76	72	69

Fig.5 The trend of total production

#### 4.2 Breakdown of each Components production

WTGs had 62% share in FY2009, but it decreased to 27% in FY2014 (Fig.3, Fig.6).

Yaw & Brake and Main Bearings have major share since FY2013.

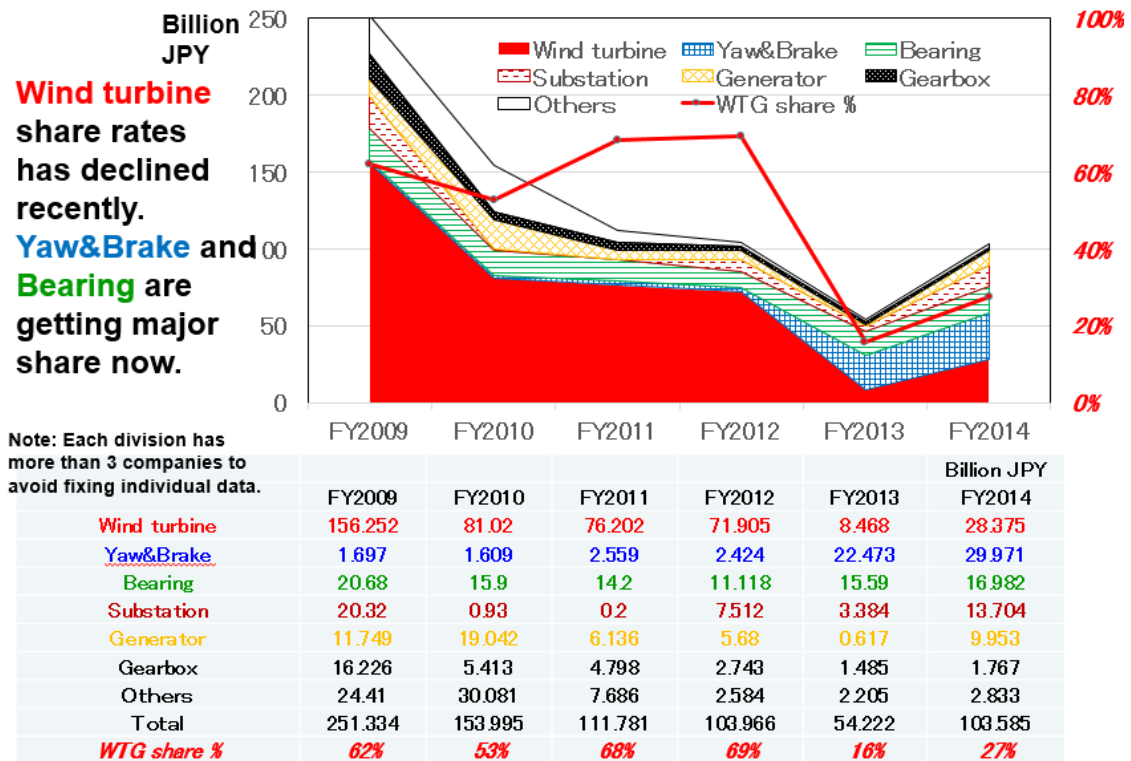


Fig.6 The trend of each components' total production

### 4.3 Breakdown of export and domestic use

Exports rate moved from 65% in FY2009 to 86% in FY2011, then dropped to 49% in FY2014 (Fig.7). Most of WTGs are exported from FY2009 to FY2012. As for components, most of them are exported.

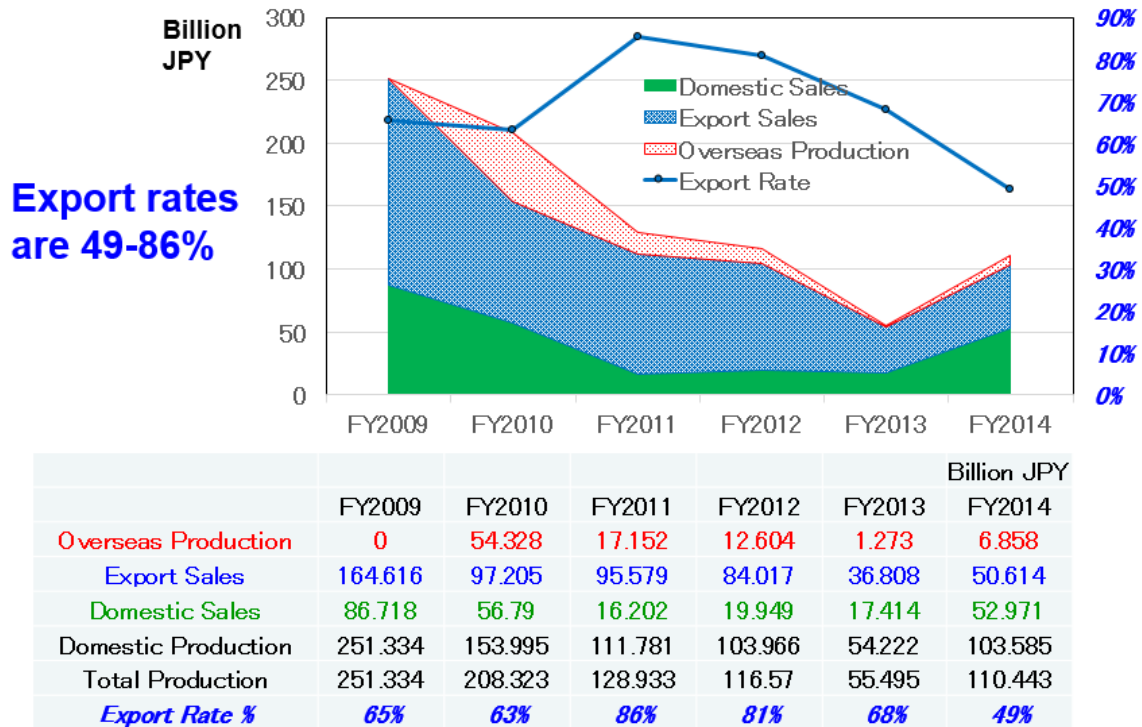


Fig.7 The trend of export and domestic use



#### 4.4 WTG production

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 16 companies manufacturing wind turbines at 14 factories in Japan and 412 employees are working directory for wind turbine manufacturing in FY2014. 4 companies are manufacturing “large WTG”. The total sales in FY2014 is 28.4 bil.JPY. “Large WTG”’s production is 27.4 bil.JPY (97%). 1.7 bil.JPY (6%) of WTGs are exported to abroad. 21.8 bil.JPY (77% of sales) is used for purchasing components and materials. 12.0 bil.JPY (55% of purchasing) is purchased from abroad (foreign suppliers) in FY2014.

The total domestic production decreased from 156 bil.JPY in FY2009 to 8.5 bil.JPY in FY2013, and rebounded to 28.4 bil.JPY in FY2014 (Fig.8). MHI has almost stooped its new WTG production since FY2013.

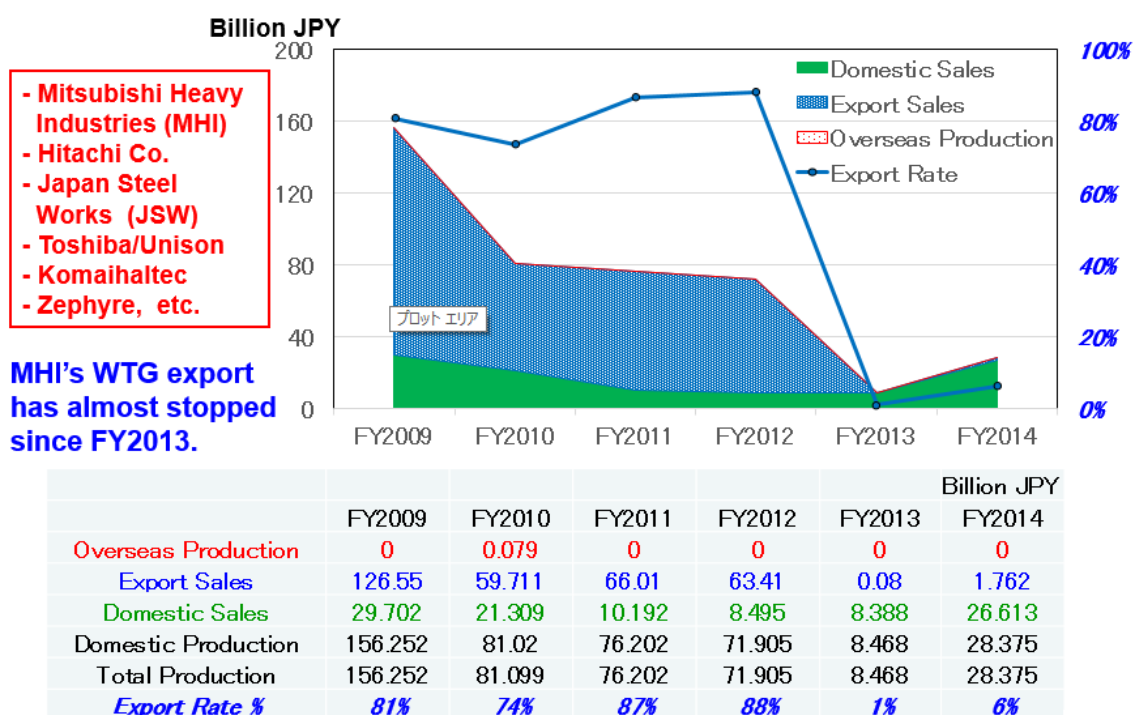
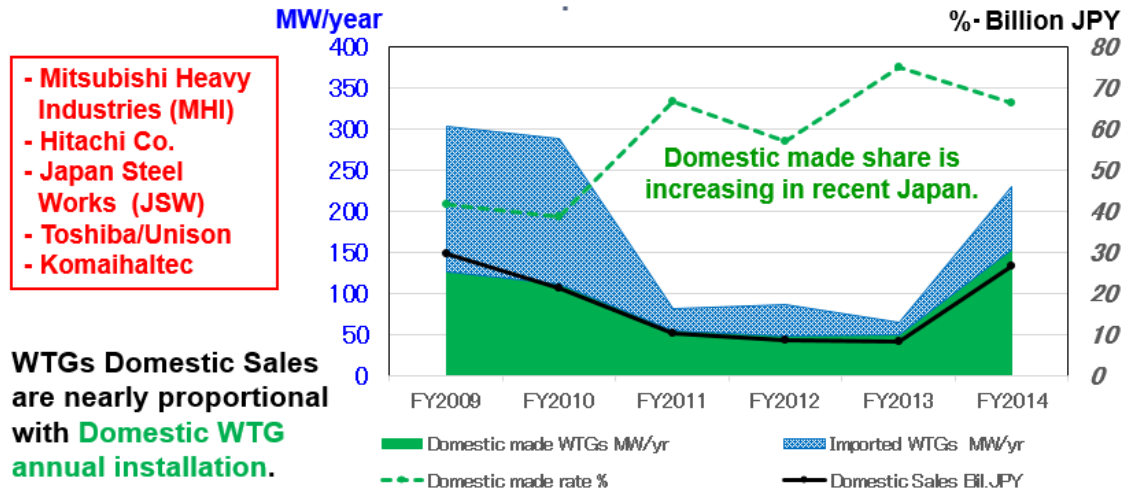


Fig.8 The trend of WTG production

The other manufactures, Hitachi and JSW, are mainly dedicated to domestic market (Fig.9).



	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014
Annual Installation in Japan MW/yr	303.535	289.28	81.023	85.61	65.15	229.455
Imported WTGs MW/yr	177.355	177.77	27.033	36.91	16.217	76.955
Domestic made WTGs MW/yr	126.18	111.51	53.99	48.7	48.933	152.5
<b>Domestic made share %</b>	<b>42 %</b>	<b>39 %</b>	<b>67 %</b>	<b>57 %</b>	<b>75 %</b>	<b>66 %</b>
<b>Domestic Sales Bil.JPY</b>	<b>29.702</b>	<b>21.309</b>	<b>10.192</b>	<b>8.495</b>	<b>8.388</b>	<b>26.613</b>

Fig.9 The Trend of Domestic WTG production and Annual installation in Japan

#### 4.5 Yaw&Brake production

There are few but competitive manufacturers for Yaw&Brake production in Japan. Their total sales are around 22 to 30 bil.JPY annually. Most of the production are exported (Fig.10).

The collected data for FY2009 – FY2012 are incorrect because of some lack of data.

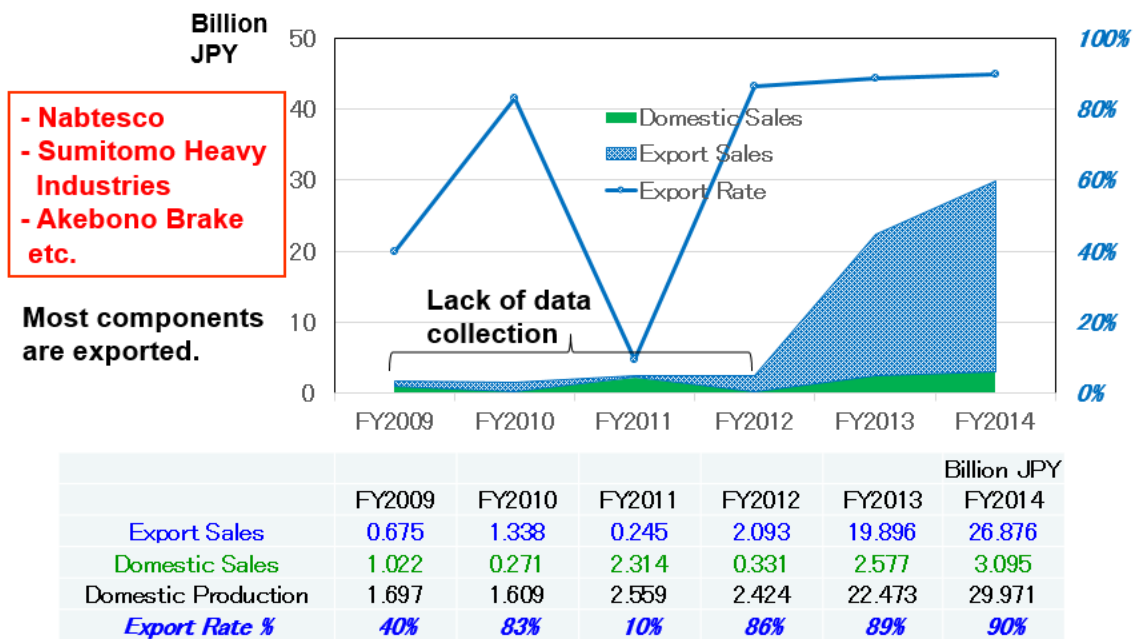


Fig.10 The Trend of Yaw&Brake production

#### 4.6 Main Bearing production

There are three competitive manufacturers (NSK, Jtekt, NTN) for large main bearing production in Japan. (Yaw and blade pitch bearings are categorized for “Yaw&Brake”, etc. at our research.) Their total sales are around 11 to 21 bil.JPY annually. Most of the production are exported (Fig.11).

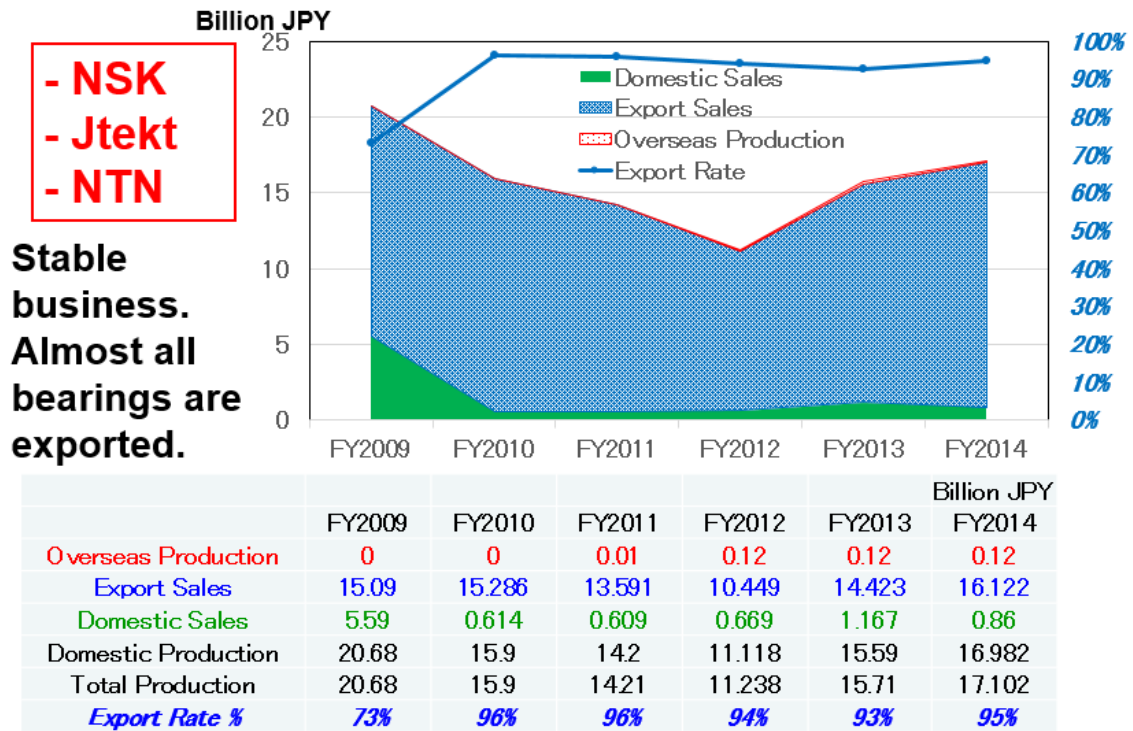


Fig.11 The Trend of large Main Bearing production

#### 4.7 Generator production

Generator business is not stable compared with Yaw&Brake and Bearing. One some companies got a large order from WTG manufactures, the sales reached to 29 bil.JPY (in FY2010), but, when they lost new order, the sales shrunk to almost zero (Fig.12).

Hitachi mainly produces induction type generators. Yasukawa (including its Finish subsidiary “The Switch”) mainly produces PMSG. There are strong permanent magnet suppliers in Japan. It will promote Japanese Generator industries in future.

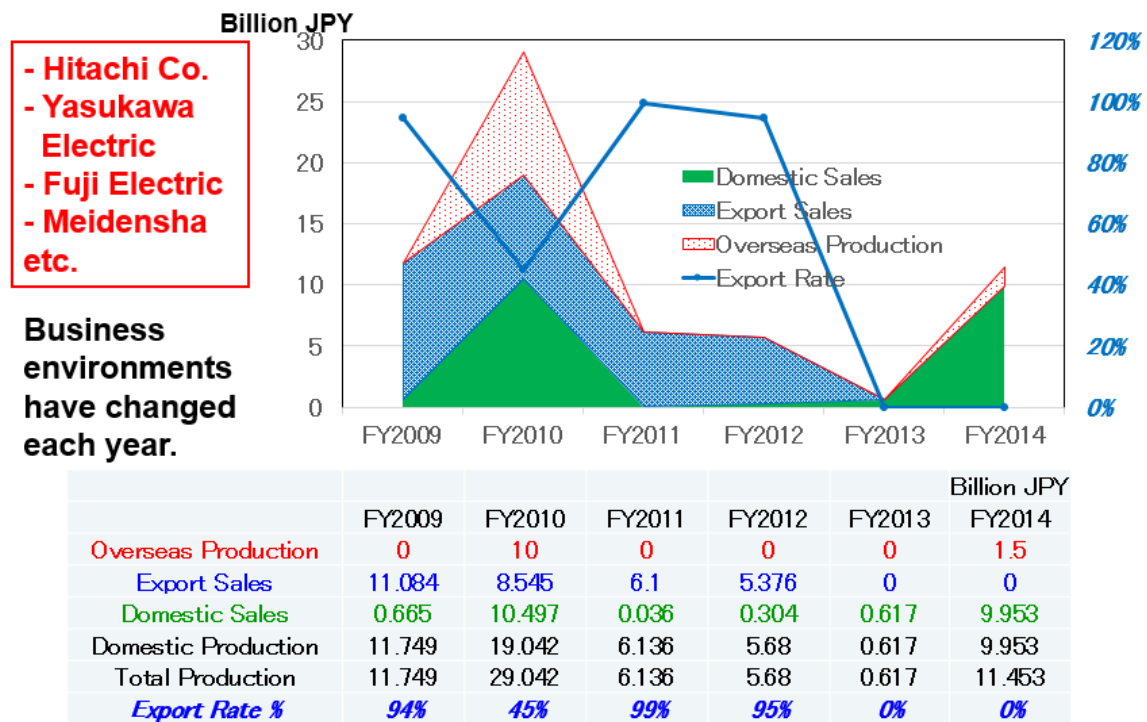


Fig.12 The Trend of Generator production

## **5. 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. Almost 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.

3,119 MW, 2,102 WTGs had been installed in Japan at Mar. 2016. They supplied 0.5% of the total power supply in Japan. New installation was 171 MW in FY2015. The attractive feed-in-tariff (FIT) 22JPY/kWh was introduced in July 2012, on the other hand, a strict environmental impact assessment (EIA, which needs 4,5 years to pass through) has applied for all wind farms with capacity of over 10 MW since Oct.2012. This EIA has frozen new installation for several years. There are about 7GW of new projects are in the pipeline of EIA process now. They may start installation within 5 years. This big domestic market will promote Japanese WTG industries in future.

## **7. Conclusion**

The annual production of WTGs & their Components is 104 bil.JPY (0.91 bil.€/1.03 bil. \$) in FY2014. It decreased from 251 bil.JPY in FY2009, but rebounded from FY2013. 64 companies have 69 factories and hire 3,537 people for WTG industries in Japan.

Breakdown of 104 bil. JPY in FY2014 : Wind turbine(WTG) 27%/28 bil.JPY, Yaw&Brake 29%/30 bil.JPY, Bearing 16%/17 bil.JPY, Substation 13%/14 bil.JPY, Generator 10%/10 bil.JPY. Japanese Mechanical industries are well trained by Automobile industry, so they have strong competitiveness worldwide.

WTG production has shrunk from 156 bil.JPY in FY2009 to 28 bil.JPY in FY2014, because MHI has stopped new production recently. Export rate is very low now at WTGs, on the contrary, most of WTG components made in Japan are exported.

Japanese WTG components manufacturers intend to expand their business by M&A. Yasukawa merged Finish The Switch and Toray bought Zoltek, for example. Therefore, oversea production by consolidated subsidiaries shall increase in future.

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