

**Reorganizing Manufacturing Capabilities:  
Globalization and East Asian electrical companies**

Shigehiro NISHIMURA

*Kansai University*

**1. Introduction**

This paper explores the actual conditions of, competition in, and competitive advantages of East Asia's electrical equipment industry. The electrical equipment industry comprises the manufacturing and installation of turbines, generators, motors, transformers, switchgears, and so on. These products are supplied to the electrical grid as pieces of social infrastructure or to manufacturing industries as power systems.

The competitive advantages of an industry should be assessed from two perspectives: manufacturing and distribution. In the analysis of electrical equipment industry, one should attempt to answer questions like where the electrical products were produced, how manufacturing capabilities (or technologies) were developed, and how those capabilities were diffused and summed up. While it is important to clarify who produces electrical equipment, analyses of regional competitive advantages should focus both on individual companies and on the regional scale. Second, an analysis of an industry also needs to clarify the distribution or marketing aspects. Customers of heavy electrical equipment vary from

state-owned electric power companies and private power companies to large-scale manufacturers and factories that require isolated power systems. Furthermore, power companies devote more attention to the small-scale, decentralized network grid than to the large-scale, centralized grid. Competitive advantages depend not only on manufacturing capabilities or technologies but also on the organization for marketing electrical equipment. However, this paper focuses on the former aspect—manufacturing—and clarifies the development of the East Asian electrical equipment industry.

Two features of the electrical equipment industry are that the global market for its goods has existed since the late 19<sup>th</sup> century and that related technologies have been traded internationally. Global suppliers of electrical equipment include American companies such as General Electric and Westinghouse, whose atomic power department is now under Toshiba, while some other divisions are now part of Siemens; European companies such as Siemens, Alstom, and Brown Boveri, the latter of which became part of ASEA and then Alstom Power; and Japanese companies such as Mitsubishi Heavy Industries and Mitsubishi Electric, Toshiba, Hitachi, and Fuji Electric. Although there has been some reorganization of international alliances and cooperative relationships between major companies, electrical equipment manufacturing has traditionally been shouldered for the most part by a big global enterprise with a history that is a century or more long. Therefore, we can say that one of the features of the industry is its internationalism. On the other hand, the electrical equipment industry exhibits characteristics of regionalism. With the exception of “socialist” countries, steam turbine generators, for example, have been exclusively produced in the United States, several European countries, and Japan. As the electrical equipment industry is an essential industry, the national industrial policies introduced

between WWII and the 1990s had a significant impact on the entire industry.<sup>1</sup>

However, from the 1990s onward, the electrical equipment industry underwent global reorganization and experienced changes in its long-term industrial structure. Gas turbines now represent a hot issue because new electrical grid systems involving wind power and photovoltaic power need gas turbines for system operations, but steam turbines have been core components of electric power systems for a long time. This paper examines the dynamics of the industry by focusing on steam turbines, investigating the dynamics of the East Asian industry from the perspective of steam turbines and addressing the questions of how the East Asian electrical equipment industry developed under the industry's global reorganization.

## **2. Electrical equipment industry: An overview**

While big businesses in the electrical equipment industry operated globally since early on, the markets for electrical products were comparatively domestic. Because large-sized steam turbines, generators, and a series of electrical products were critical components of national electric power grids, governments procured electrical equipment from national manufacturers and protected their domestic markets, while the American market remained relatively open.<sup>2</sup> However, in the 1990s, the privatization and liberalization of the electric power business changed domestic markets, opening them to international procurement and

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<sup>1</sup> Barbara Epstein, *The Politics of Trade in Heavy Electrical Equipment*. Doctoral thesis submitted to the Graduate Faculty of Political and Social Science of the New School for Social Research, New York, 1970. (University Microfilms); A. J. Surry and J. H. Chesshire, *The World Market for Electric Power Equipment: Rationalisation and Technical Change*. Sussex: The Science Policy Research Unit, University of Sussex, 1972.

<sup>2</sup> Jules Backman, *The Economics of the Electrical Machinery Industry*. New York: New York University Press, 1962.

creating conditions for the emergence of independent power producers.<sup>3</sup> An even more influential factor was the rapid expansion of emerging markets such as China and India. Today, more than half of the world's demand for electrical equipment comes from China, followed by India. These changes in the electric power market brought about a reorganization of the electrical equipment industry.

First, the industry's dynamics need to be reviewed from the perspective of the development of the world market. **Figure 1** shows the trends in exports and imports of steam turbines. While exports and imports were stabilized at approximately US\$3 billion during the 1990s, the values of both exports and imports soared from 2004 onward and reached approximately US\$8 billion in 2010. Japan, the United States, and European countries such as Germany and France have been the main exporters of steam turbines for many years. Among them, the exports of Japan, the United States, and Germany were approximately US\$0.4 billion each. In 2010, Japan's exports increased to \$1.8 billion, Germany's exports increased to \$1.1 billion, and those of the United States increased to \$0.7 billion, although the increase in US exports was slower than the increase in exports of the other two countries (**Figure 2**).

In East Asia, China's exports skyrocketed during the first decade of the 21<sup>st</sup> century. While the value of China's exports of steam turbines was US\$62 million in 2004, its exports jumped by more than 20 times to reach US\$1.3 billion in 2010 (**Figure 3**). From the viewpoint of world export statistics, the globalization of the steam turbine market was caused by an expansion of China's exports and growth in exports from the traditional exporters, Japan and Germany. In all, East Asia was one of the central areas of globalization

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<sup>3</sup> Miki Kishida, "1990 nendai no juden sijo ni okeru gurobaruka to nihon juden sangyo" [Globalization of the world heavy electrical market and the Japanese heavy electrical industry in 1990's], *Kagoshima kenritsu tandai kiyo* [Bulletin of Kagoshima Prefectural College] 53 (2002): 59-78.

of the electrical products industry. East Asia's competitive advantage in the industry is evidenced by its increased export share within the world market. Therefore, the change in East Asia's industrial structure should be assessed from the standpoint of Japan and China.

### **3. Dynamics in East Asia trade**

#### **3-1. Japan as an exporter**

Japan's trade balance of steam turbines has largely been an excess of exports over imports ever since the early days. **Figure 4** shows the exports, imports, and trade balance of steam turbines from 1998 to 2012. As the volume of exports increased, the surplus expanded during this period. The monetary value of Japan's exports for the latest three years from 2010 to 2012 was 428,875 million yen compared to imports of 39,112 million yen; the surplus was thus 389,763 million yen.

The main destinations of steam turbine exports, which increased beginning in 2004, have been Asian countries; the growth rate of exports to the Asian region was also the highest (**Figure 5**). An average of approximately 62.8% of steam turbine and steam turbine-related item exports was to Asian countries from 2004 to 2012.

Analyzing Japan's exports of steam turbines by item provides a more concrete image of the industry dynamics. Exports of steam turbines are largely divided into those of steam turbines as finished products and those of steam turbine parts. Although the growth period from 2004 onward saw increases in exports of both finished steam turbines and parts, exports of parts increased more rapidly than those of finished products. During the three years from 2010 to 2012, exports of parts accounted for 65.3% of the total steam turbine

exports.

Furthermore, each steam turbine category can be reviewed as follows (**Table 1**). The export volumes for large-sized steam turbines having an output capacity exceeding 40MW except for marine propulsion (HS code 8406.81) were stable with some fluctuations from 1998 to 2012; the main destination of items in this category was North America. The export volumes for medium- and small-sized steam turbines having an output capacity not exceeding 40MW and except for marine propulsion (HS code 8406.82) increased continuously after 2004. Approximately 75.7% of the volume was exported to the Asian region from 2004 to 2012. Within the Asian region, exports increased to China and India from 2004 on and to Thailand after 2010, while the export volume to China and India appeared to fall slightly in the three years since 2010. In addition, exports to South Korea occupied a substantial portion of the total exports in this category; the export volume to China and India is thus not dominant. Exports of steam turbine parts increased rapidly after 2004. Of these, exports to the Asian region increased more rapidly than those to other destinations. From 2004 to 2012, Asian countries accounted for 58.6% of the volume of exports in this category. When exports of steam turbine parts are analyzed by the country, it is clear that exports to China increased from 2004 above all. Such an analysis also shows that although the export volume to China decreased after 2010, exports to India and Indonesia increased rapidly instead (**Figure 6**).

These trade statistics indicate that the rapid increase of Japan's steam turbine exports after 2004 was caused by the expansion of exports of medium- and small-sized turbines and turbine parts to the Asian region, especially China. Exports of steam turbine parts to China were particularly distinctive. On the other hand, it is important to note that the export volumes in these two categories to China decreased after 2010.

### **3-2. China as an importer and exporter**

From the 1990s onward, demand for power-generating equipment in China was tremendous due to the country's rapid economic growth. Japanese electrical equipment companies thus aggressively exported steam turbines and steam turbine parts to the Chinese market. Beginning in 2007, on the other hand, China expanded its exports of steam turbines and became one of the world's leading producers and exporters, followed by Japan.

China's balance of trade of steam turbines was in the red through 2007. However, as Chinese exports soared, the balance went into the black; since 2008, China has been an exporter of steam turbines and related items (**Figure 7**). On the other hand, from the mid-2000s onward, imports continued to rise while the growth rate of imports was lower than that of exports. Therefore, the changes in China's trade position within the world trade market should be closely examined from the perspectives of both imports and exports.

Imports of steam turbine-related items increased from around 2004. While imports of medium- and small-sized steam turbines (HS 8406.82) increased after 2010, parts represented the most dominant portion of imports from 2004 to 2012 (**Figure 8**). For the three years since 2010, the value of imported steam turbine parts was approximately US\$1,555 million, whereas the value of imported finished products imported was US\$605 million.

The origins of China's imports of steam turbines and steam turbine parts should be reviewed by category. **Table 2** shows the countries from which items have come, import volumes, and the ratios of the countries from 2001 to 2012 by category. In the category of

large-sized steam turbines, the majority of imports come from Russia (approximately 53%), followed by Japan (19%), from 2001 to 2003. From 2004 onward, Japan, Germany, and the United States have been the dominant exporters to China. In the category of medium- and small-sized steam turbines, Germany, the United States, and Japan have been the chief exporters, competing with each other in the Chinese market from 2001 to 2009. Germany established the strongest competitive edge and maintained an approximately 50% share of this category. During the period from 2010 to 2012, however, imports from the Czech Republic occupied 56% of the total volume.<sup>4</sup> In the category of parts, which accounted for the largest volume of steam turbine-related item imports, the major exporters to China were Japan, China, and South Korea from 2001 to 2012. Japan occupied more than 40% of the share from 2004 onward, a much higher level than those commanded by other exporters.

China's exports of steam turbines are detailed in **Table 3**. The data shows that the export volume for parts was overwhelmingly larger than that of other categories, as is the case for imports. For the three years since 2010, the value of steam turbine part exports from China was US\$3,366 million, whereas that of finished steam turbines was US\$883 million, or 20.8%. In the category of large-sized and medium- and small-sized steam turbines, the destinations of exports were mainly India and Indonesia, followed by Turkey, Pakistan, Thailand, and so on. The proportion occupied by India and Indonesia was so large that it is clear that Chinese steam turbine manufacturers target these newly emerging markets more than they target domestic markets. In the category of parts, India and Indonesia were the major destinations, while Japan was also a substantial export market for Chinese manufacturers. One of the reasons for this could be that Japanese companies

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<sup>4</sup> It could be assumed that steam turbines made in Czech Republic by Siemens were exported to China.



procured steam turbine parts from Chinese companies.

These trade statistics on China highlight two points to be considered. First, although China imported finished steam turbines from Japan, Germany, and the United States, it accelerated its part imports rather than finished item imports. Secondly, China expanded its exports of both finished items and parts to Asian regions, especially India and Indonesia. This development, which occurred at the beginning of the 21st century, represents a tectonic shift in the realm of steam turbine manufacturing in East Asia.

#### **4. Reorganizing manufacturing capability**

To comprehend East Asia's competitive advantage, it is important to consider the regional development of the electrical equipment industry and the manner in which companies' competitive advantages have been reorganized in East Asia. The most important things are that from the 2000s onward, Chinese companies have joined Japanese companies as powerful players in the steam turbine industry, and that the manufacturing capabilities for steam turbines, which require advanced technology and precision work of the highest order, have spread to China and India. This section examines major manufacturers' strategies and the expansion of producing regions in East Asia.

Japanese electrical equipment companies introduced advanced foreign technologies far before the World War II and continued doing so after the war. The technological capacities of Japanese companies to manufacture electrical equipment reached the global level by the 1980s.<sup>5</sup> In 1989 Mitsubishi Heavy Industries had changed the license

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<sup>5</sup> Shin Hasegawa, "Judenki kogyo no hatten to hatsuden setushi kyokyu nouryoku no keisei: sengo hukko kara 1980 nen dai made o chusin ni" [The formation of the ability to supply generation plants in postwar Japan], *Aoyama keiei ronshu* [Aoyama journal of business 41, no. 1 (2006) 28.

agreement with Westinghouse from a subordinate agreement to an equal cross-licensing agreement<sup>6</sup>, as Mitsubishi originally developed the ultra supercritical (USC) type steam turbine. During a decade from the 1990s, Japanese manufacturers revised their licensing agreements with the US companies.<sup>7</sup> Throughout the trajectory of introducing and absorbing technology, Japanese companies accumulated and maintained manufacturing capabilities for steam turbines in specific regions. Hitachi Limited has manufactured steam turbines in Hitachi City for long periods; Toshiba manufactures at the Keihin Complex; Mitsubishi Heavy Industries operates at the Nagasaki Dockyard Factory and Takasago Factory (mainly gas turbines), and Fuji Electric manufactures at the Kawasaki Factory. These companies have continued to manufacture turbines at their respective sites for long periods in order to maintain and improve production techniques and technological skills. Furthermore, these companies research and develop new technologies for efficient steam turbines at their respective R&D centers in Japan.

Nevertheless, Japanese electrical companies have entered the expanding Chinese market through technological tie-ups with Chinese steam turbine manufacturers. In 1991, Hitachi Limited joined forces with Dongfang Electric Corporation to produce a steam turbine for thermal power plants in China. This alliance was to some extent necessitated by global competition over China's huge market. At that time, Harbin Power Equipment Company, a major electrical equipment manufacturer, teamed up with Westinghouse Electric Corporation of the United States, whereas Shanghai Electric Group, another major manufacturer, tied up with Siemens of Germany. It is said that if Hitachi had not allied

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<sup>6</sup> Akito, Yamamoto, et. al., "Mitsubishi Juko ni okeru turbine seizo gijutu no keisei katei" [Processes of forming turbine manufacturing technologies at Mitsubishi Heavy Industries] in Tetsuro Nakaoka ed., *Sengo Nihon no Gijutu Keisei: Moho ka sozo ka* [Formation of Technology in Japan after the World War II: Imitation or Creation?], Tokyo: Nihon Keizai Hyoron-sha, 2002, pp. 174-5.

<sup>7</sup> Hearing from Prof. Shozo Kaneko, Tokyo University, 31st Jan. 2014.

itself with Dongfang Electric, it may have gotten off to a very slow start in China's emerging market. However, Hitachi successfully entered the Chinese market through the alliance and obtained orders of more than 100 billion yen by 2008. In addition, Hitachi and Dongfang Electric jointly expanded their thermal power plant business outside China. Since 2009, the two companies have jointly received orders for steam turbines from Libya and produced and delivered eight steam turbines having an output capacity of 350 MW.<sup>8</sup>

Mitsubishi Heavy Industries (MHI) came to an agreement with Harbin Turbine Company Limited for providing Harbin with the main components of supercritical pressure-type steam turbines in June 2007.<sup>9</sup> Under the contract, MHI was to provide high- and medium-pressure turbine blades, rotors, and other important parts. In December of the next year, MHI received an order from Harbin Turbine Company for 12 sets of main components for 600-MW supercritical pressure-type steam turbines. These components were assembled with other parts and accessories at Harbin and then delivered to Chinese power companies.<sup>10</sup>

Furthermore, in January 2013, MHI announced that it had set up Mitsubishi Heavy Industries Jieneng (Qingdao) Steam Turbine Company, a joint venture with Qingdao Jieneng Steam Turbine Group. The aim of this joint venture is to design and sell medium- and small-sized turbines and marine turbines. MHI provides manufacturing licenses with Qingdao Jieneng Steam Turbine Group and sells turbines made by the Group through this joint venture.<sup>11</sup>

On the other hand, Chinese electrical equipment companies accumulate capabilities for manufacturing steam turbines backed by the rapidly expanding domestic market and

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<sup>8</sup> *Nikkei Business Online*. 25 June 2008.

<sup>9</sup> MHI, News release, No. 4017. 23 July 2002.

<sup>10</sup> News release No. 4187, 19 December 2003.

<sup>11</sup> News release No. 5306, 15 January 2013.

technological introduction from foreign companies. It is said that the three big electrical equipment manufacturers in China are the Shanghai Electric Group, Dongfang Electric Corporation, and Harbin Electric Group. Dongfang Steam Turbine Works (DFSTW), established in 1966, is the leader company. In 2007, DFSTW held more than 7,000 employees, produced steam turbines for thermal and atomic power plants, and occupied more than 20% of the domestic market. DFSTW formed technological tie-ups not only with Hitachi, as described above, but also with General Electric Company of America, Alstom of France, and Toshiba and Mitsubishi Heavy Industries to enhance its manufacturing capabilities.<sup>12</sup> Shanghai Turbine, the largest company in China, has a technological tie-up with Siemens, whereas Harbin Turbine Company is allied with Mitsubishi Heavy Industry, as described above. These Chinese companies not only supply electrical equipment to Chinese electric power companies and industrial enterprises but also export to foreign markets.

In the latter half of the first decade of the 21<sup>st</sup> century, Japanese electrical equipment companies began establishing manufacturing facilities in India. Toshiba, Hitachi, and MHI ventured into India and built factories with local partners. In 2008, Toshiba established the Toshiba JSW Turbine and Generator Private Limited as a joint venture with a local company and installed a manufacturing facility for supercritical pressure-type steam turbines that range from 600 to 1,000 MW (this factory was completed in 2012).<sup>13</sup> Toshiba regards its Indian facility as one of its global manufacturing sites for steam turbines and steam turbine generators for thermal power plants, second only to its Keihin complex in Yokohama, Japan. The East Asian electrical equipment market will be developed through

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<sup>12</sup> Tsusan siryo shuppan kai [Trade and industry materials publishers], *Chugoku no kikai sangyo 2009* [Chinese machinery industry 2009]. Tokyo: Tsusan siryo shuppan kai (2009) 305-6.

<sup>13</sup> Toshiba, Press release. 12 May 2012.

expansion into the major Asian region.

In 2010, Hitachi Limited and BGR Energy System established BGR Turbines Company Private Limited as a joint enterprise to conduct steam turbine business. In 2013, this joint venture received two sets of 800-MW supercritical pressure-type steam turbines for the Indian national power company.<sup>14</sup>

MHI also formed a joint venture called L&H-MHI Turbine Generators Private Limited with Indian company Larsen & Toubro Limited in 2007. This joint company began operation in 2010 to produce and sell steam turbines and generators in the Indian market with a workforce of more than 1,000 employees. Establishment of local manufacturing was required by the Indian government's industrial development policy. MHI received turbines through this joint company and then exported some components to the company. In this manner, MHI expanded both local production and exports from Japan.<sup>15</sup>

## **5. Conclusion**

From the 2000s onward, in particular, the most distinctive feature of the East Asian electrical equipment industry was that, in the case of steam turbines, manufacturing capabilities that had not moved or diffused for nearly 100 years rapidly spread to China and India. While the Japanese electrical equipment industry had introduced advanced technology from the United States, Germany, the United Kingdom, and other European countries, Japan had been the sole manufacturer of steam turbines in the East Asian region, except for "socialist" countries. However, in order to compete with global producers over rapidly growing markets and to keep their competitive advantages in the region, Japanese

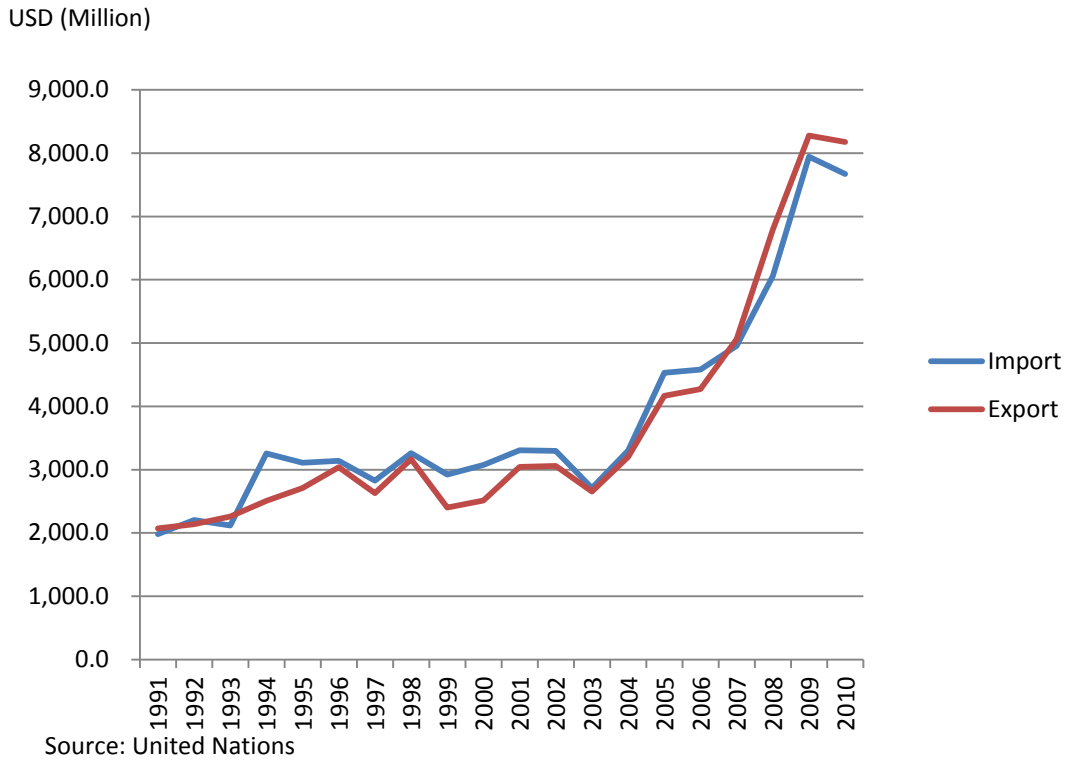
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<sup>14</sup> Hitachi, Press release, 23 January 2013

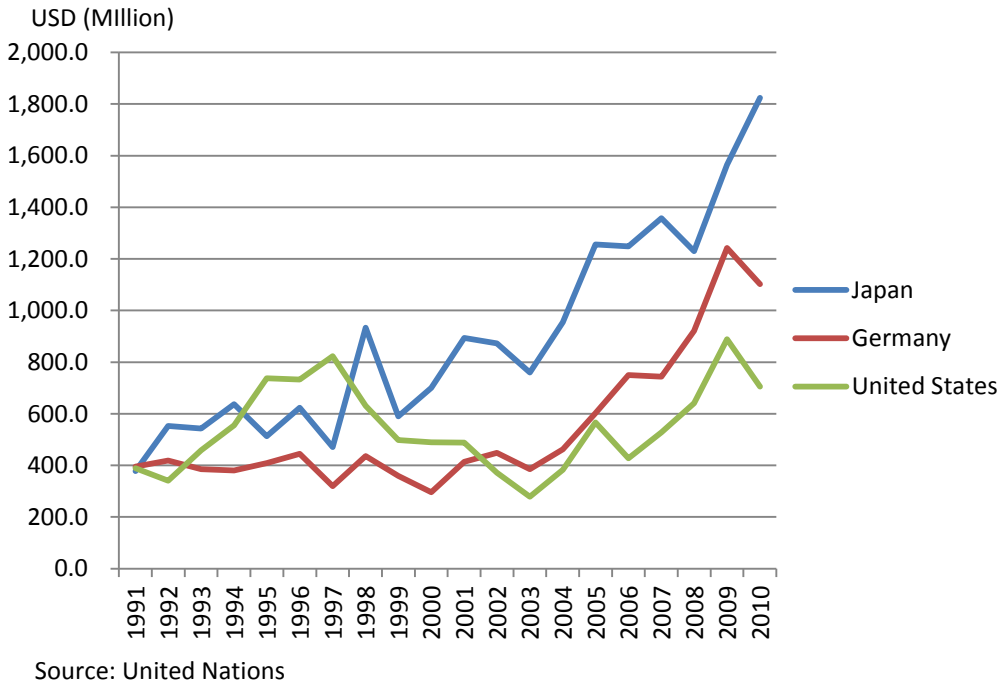
<sup>15</sup> JBIC report, December 2012; MHI, news release, 11 January 2011, 2 February 2012.

companies were forced to enter into local manufacturing. They provided technology and licenses to leading Chinese companies to produce highly advanced products there and formed joint manufacturing facilities. Japanese companies also had to begin and expand local manufacturing in India, as well. Through these processes, Japanese companies have expanded their manufacturing capabilities for steam turbines to China and India while retaining their domestic manufacturing, research, and development capabilities. A new industrial structure in which leading companies organize manufacturing capabilities as the competitive advantage of the region and compete with global giants has appeared.

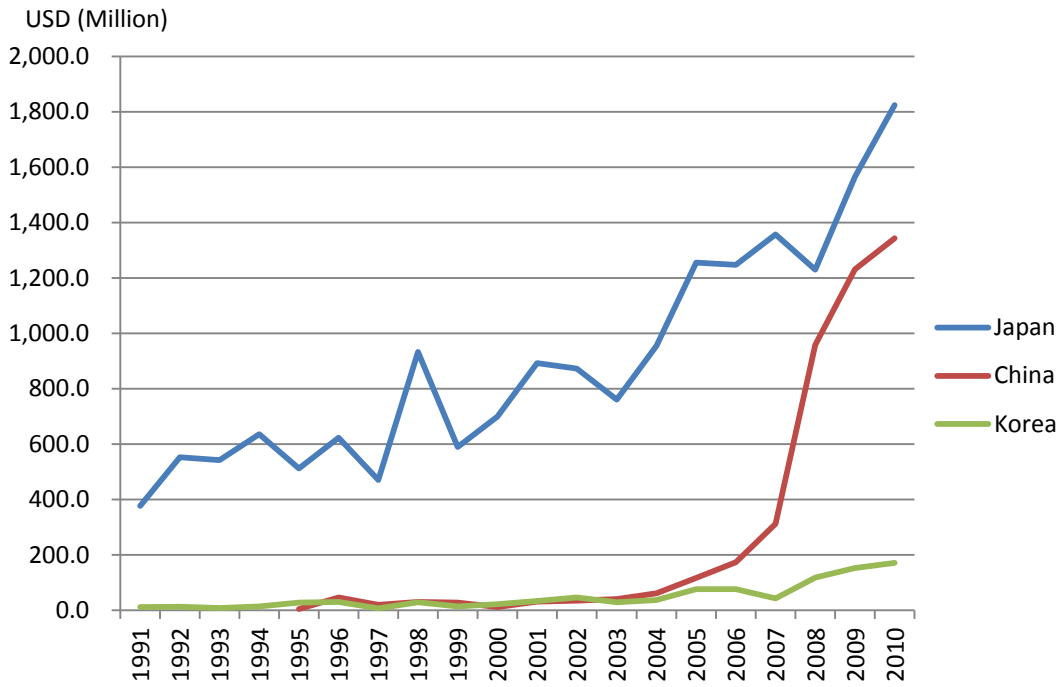
**Fig. 1 World trade of steam turbines**



**Fig. 2 Export of steam turbines by 3 countries**

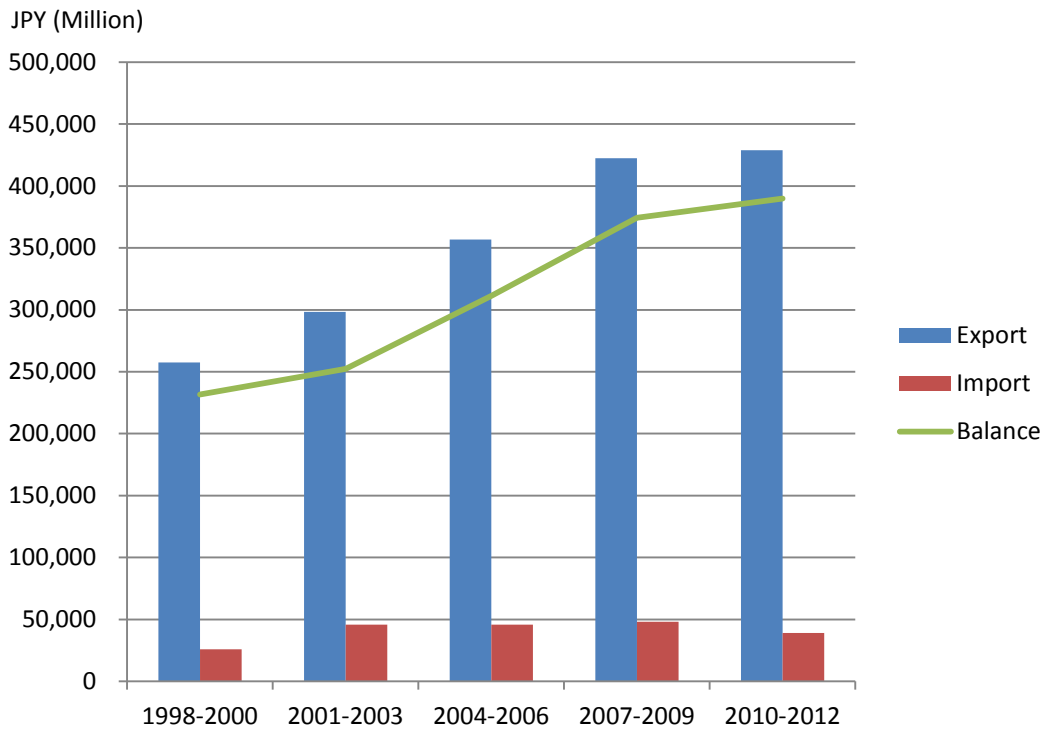


**Fig. 3 Export of steam turbines by East Asia**



Source: United Nations

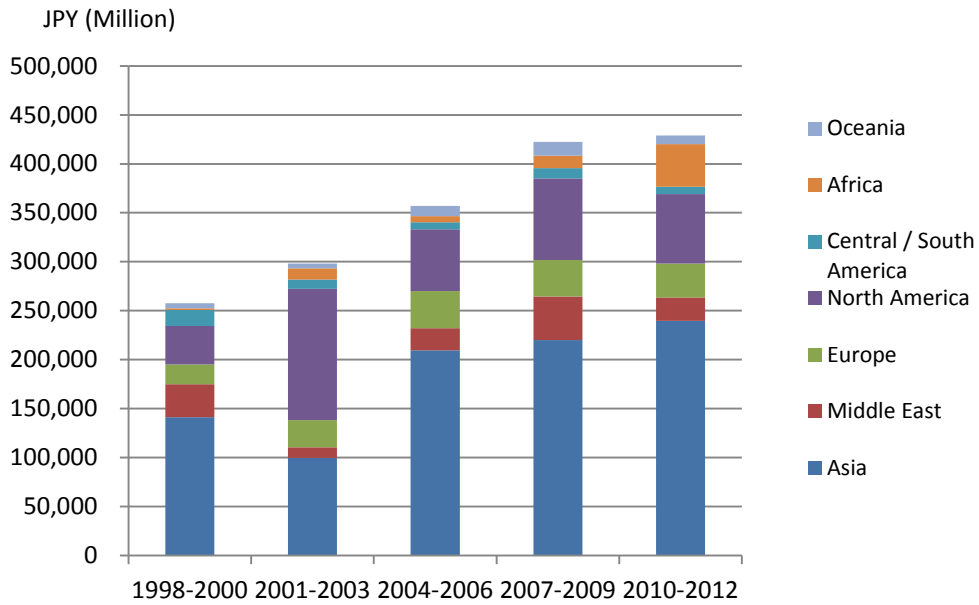
**Fig. 4 Japan's trade balance of steam turbine**



Source: Trade Statistics of Japan

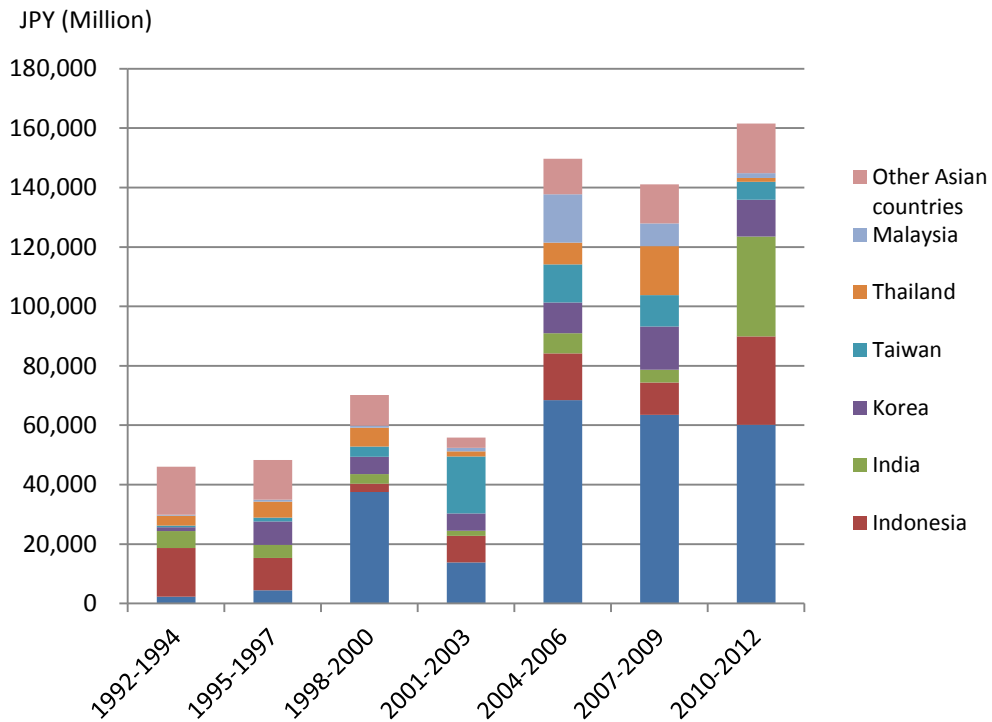


**Fig. 5 Destination of steam turbines (HS 8406.00)**



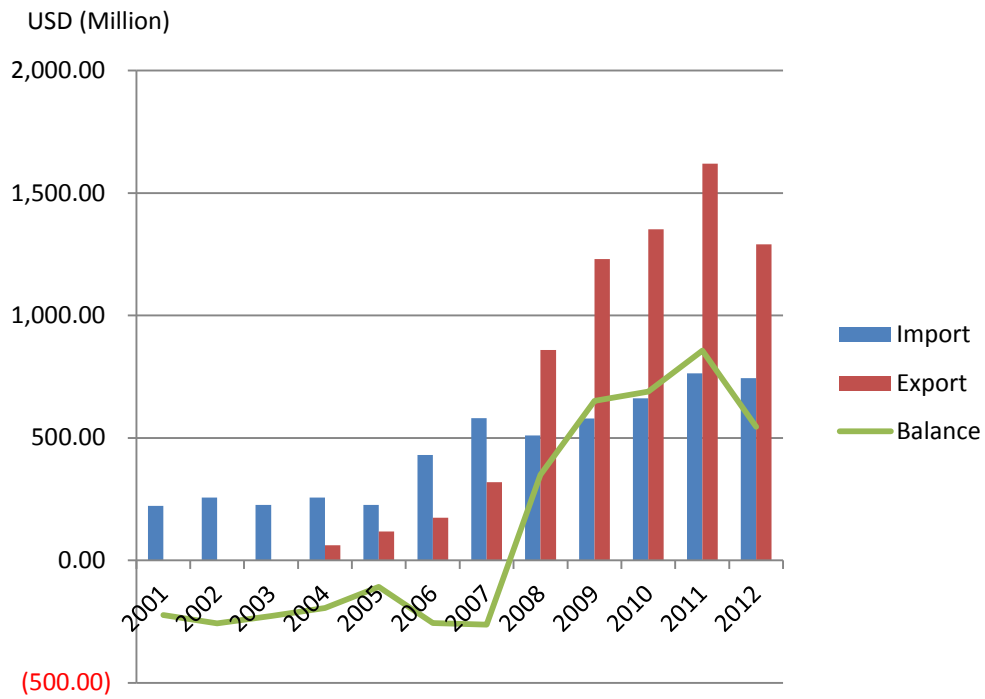
Source: Trade Statistics of Japan

**Fig. 6 Destination of steam turbine parts (HS 8406.90)**



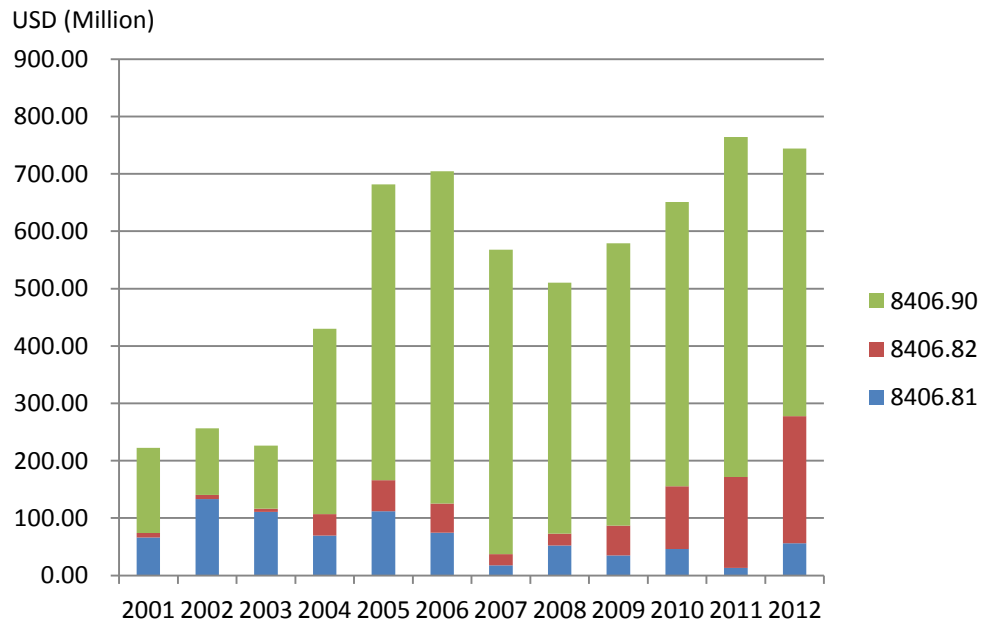
Source: Trade Statistics of Japan

**Fig. 7 China's balance of trade of stern turbines**



Source: China Customs

**Fig. 8 China's Imports of steam turbine, by category**



Source: China Customs

Table 1: Exports of steam turbines from Japan/destinations

	1998-2000		2001-2003		2004-2006		2007-2009		2010-2012	
	JPY (million)	%	JPY (million)	%	JPY (million)	%	JPY (million)	%	JPY (million)	%
<b>HS 8406.81</b> : Steam turbines and other vapor turbines, an output exceeding 40MW, except for marine propulsion										
Asia	49,707	61.5	22,800	21.7	24,030	33.6	31,131	29.7	31,188	36.6
Middle East	390	0.5	2,510	2.4	2,073	2.9	11,823	11.3	1,316	1.5
Europe	4,987	6.2	2,912	2.8	7,485	10.5	14,435	13.8	9,459	11.1
North America	15,969	19.8	65,534	62.5	32,373	45.2	37,306	35.6	30,150	35.4
Central/South America	5,497	6.8	2,908	2.8	2,046	2.9	1,652	1.6	778	0.9
Africa	223	0.3	6,189	5.9	2,722	3.8	1,418	1.4	8,512	10.0
Oceania	4,060	5.0	2,003	1.9	878	1.2	6,925	6.6	3,839	4.5
Total	80,834	100.0	104,857	100.0	71,607	100.0	104,691	100.0	85,241	100.0
<b>HS 8406.82</b> : Steam turbines and other vapor turbines, an output NOT exceeding 40MW, except for marine propulsion										
Asia	21,310	66.5	21,180	60.0	36,021	78.9	47,777	74.9	47,087	74.1
Middle East	2,097	6.5	842	2.4	2,928	6.4	4,297	6.7	5,812	9.1
Europe	2,196	6.9	1,825	5.2	2,175	4.8	1,998	3.1	1,589	2.5
North America	3,053	9.5	6,272	17.8	2,005	4.4	4,803	7.5	1,071	1.7
Central/South America	2,598	8.1	3,617	10.3	1,248	2.7	2,937	4.6	3,176	5.0
Africa	584	1.8	1,538	4.4	376	0.8	1,944	3.0	4,218	6.6
Oceania	201	0.6	11	0.0	903	2.0	1	0.0	574	0.9
Total	32,039	100.0	35,284	100.0	45,654	100.0	63,758	100.0	63,527	100.0
<b>HS 8406.90</b> : Parts of steam turbines and other vapor turbines										
Asia	70,136	48.5	55,813	35.3	149,693	62.5	141,048	55.5	161,537	57.7
Middle East	31,407	21.7	7,400	4.7	17,412	7.3	28,448	11.2	16,614	5.9
Europe	12,857	8.9	22,901	14.5	28,301	11.8	20,667	8.1	23,437	8.4
North America	20,388	14.1	62,423	39.5	28,818	12.0	41,555	16.4	39,895	14.2
Central/South America	8,173	5.6	2,922	1.8	3,776	1.6	5,824	2.3	3,467	1.2
Africa	813	0.6	3,610	2.3	2,982	1.2	9,369	3.7	30,785	11.0
Oceania	955	0.7	3,010	1.9	8,643	3.6	7,098	2.8	4,371	1.6
Total	144,728	100.0	158,078	100.0	239,624	100.0	254,008	100.0	280,107	100.0

Source: Trade Statistics of Japan

Table 2: China's imports of steam turbines/supplier countries

2001-2003			2004-2006			2007-2009			2010-2012						
	USD(million)	%		USD(million)	%		USD(million)	%		USD(million)	%				
<b>HS 8406.81</b> : Steam turbines and other vapor turbines, an output exceeding 40MW, except for marine propulsion															
1	Russia	164.19	52.96	1	Japan	152.17	59.47	1	Japan	43.47	41.36	1	Germany	77.27	66.59
2	Japan	58.05	18.73	2	Germany	67.60	26.42	2	Germany	43.28	41.17	2	United States	23.91	20.60
3	United Kingdom	40.23	12.98	3	United States	25.34	9.90	3	United Kingdom	11.41	10.85	3	Japan	14.86	12.81
4	Germany	27.54	8.89	4	Italy	3.47	1.36	4	United States	6.96	6.62				
5	France	13.35	4.31	5	Czech Republic	3.11	1.22								
6	Czech Republic	5.43	1.75	6	United Kingdom	2.68	1.05								
7	United States	1.08	0.35	7	Switzerland	1.04	0.40								
8	Hong Kong	0.14	0.04	8	France	0.45	0.17								
9	Singapore	0.00	0.00	9	Hong Kong	0.01	0.00								
	Total	310.00	100.00		Total	255.86	100.00		Total	105.12	100.00		Total	116.04	100.00
<b>HS 8406.82</b> : Steam turbines and other vapor turbines, an output NOT exceeding 40MW, except for marine propulsion															
1	Germany	10.55	50.81	1	Germany	69.78	48.78	1	Germany	46.31	50.63	1	Czech Republic	272.96	55.84
2	United States	5.85	28.15	2	Japan	56.20	39.29	2	Japan	22.32	24.39	2	Germany	133.16	27.24
3	Japan	3.59	17.27	3	United States	6.28	4.39	3	United States	14.02	15.33	3	United States	42.02	8.60
4	Italy	2.38	11.46	4	Czech Republic	5.70	3.98	4	Switzerland	7.82	8.55	4	Japan	22.17	4.54
5	France	0.02	0.11	5	Italy	3.33	2.33	5	France	0.97	1.06	5	Switzerland	12.12	2.48
				6	India	0.81	0.57	6	Italy	0.04	0.04	6	Italy	4.95	1.01
				7	Brazil	0.52	0.37					7	Canada	0.77	0.16
				8	France	0.42	0.29					8	France	0.63	0.13
				9	Taiwan	0.02	0.01								
	Total	22.39	107.80		Total	143.05	100.00		Total	91.48	100.00		Total	488.79	100.00
<b>HS 8406.90</b> : Parts of steam turbines and other vapor turbines															
1	Germany	140.86	37.62	1	Japan	583.17	41.14	1	Japan	686.17	46.99	1	Japan	629.20	40.48
2	Japan	90.94	24.29	2	Germany	272.83	19.25	2	Germany	242.30	16.59	2	France	419.65	27.00
3	United States	55.94	14.94	3	South Korea	160.77	11.34	3	South Korea	119.29	8.17	3	Germany	253.41	16.30
4	France	30.16	8.05	4	United States	149.05	10.52	4	France	101.39	6.94	4	South Korea	61.44	3.95
5	Russia	23.22	6.20	5	Italy	52.60	3.71	5	Italy	79.47	5.44	5	Italy	53.21	3.42
6	South Korea	13.40	3.58	6	Czech Republic	47.14	3.33	6	Switzerland	43.49	2.98	6	Switzerland	33.07	2.13
7	Italy	5.05	1.35	7	Austria	39.33	2.77	7	United Kingdom	37.92	2.60	7	United States	24.44	1.57
8	United Kingdom	4.68	1.25	8	United Kingdom	27.96	1.97	8	United States	34.26	2.35	8	United Kingdom	12.84	0.83
9	China	1.62	0.43	9	France	16.78	1.18	9	Russia	33.56	2.30	9	Austria	12.38	0.80
10	Hungary	1.57	0.42	10	Netherlands	14.91	1.05	10	Netherlands	26.95	1.85	10	Poland	9.83	0.63
	others	6.95	1.86		others	52.94	3.73		others	55.61	3.81		others	45.04	2.90
	Total	374.40	100.00		Total	1,417.46	100.00		Total	1,460.39	100.00		Total	1,554.50	100.00

Source: China Customs

Table 3: China's exports of steam turbines/destinations

2004-2006			2007-2009			2010-2012					
	USD(million)	%		USD(million)	%		USD(million)	%			
<b>HS 8406.81 : Steam turbines and other vapor turbines, an output exceeding 40MW, except for marine propulsion</b>											
1	India	8.46	23.85	1	India	219.67	70.00	1	India	184.62	35.83
2	Indonesia	7.90	22.26	2	Indonesia	40.11	12.78	2	Indonesia	152.32	29.56
3	Turkey	7.24	20.40	3	Vietnam	21.57	6.87	3	Turkey	45.34	8.80
4	Bangladesh	4.66	13.12	4	Turkey	21.50	6.85	4	Brazil	42.44	8.24
5	Yemen	3.50	9.86	5	Sudan	8.30	2.65	5	Belarus	40.19	7.80
6	Iran	2.64	7.45	6	Brazil	2.68	0.85	6	Jordan	13.60	2.64
7	Pakistan	1.09	3.07					7	Pakistan	12.16	2.36
								8	Malaysia	6.59	1.28
								9	Djibouti	5.60	1.09
								10	Germany	5.32	1.03
								Others	7.06	1.37	
Total	35.50	100.00	Total	313.83	100.00	Total	515.24	100.00			
<b>HS 8406.82 : Steam turbines and other vapor turbines, an output NOT exceeding 40MW, except for marine propulsion</b>											
1	India	57.23	45.14	1	India	142.24	43.73	1	India	105.70	28.73
2	Indonesia	31.69	24.99	2	Indonesia	65.71	20.20	2	Indonesia	66.52	18.08
3	Pakistan	9.04	7.13	3	Thailand	30.29	9.31	3	Thailand	38.05	10.34
4	Thailand	8.76	6.90	4	Pakistan	19.22	5.91	4	Venezuela	33.93	9.22
5	Sudan	8.08	6.37	5	Syria	11.84	3.64	5	Turkey	28.58	7.77
6	Guyana	4.87	3.84	6	Turkey	11.56	3.56	6	Vietnam	28.50	7.74
7	Algeria	3.30	2.60	7	United States	9.32	2.86	7	Pakistan	19.14	5.20
8	Malaysia	1.58	1.25	8	Vietnam	9.07	2.79	8	Taiwan	5.36	1.46
9	Iran	0.77	0.61	9	Bangladesh	4.25	1.31	9	Myanmar	4.88	1.33
10	Vietnam	0.41	0.32	10	Brazil	3.40	1.05	10	Malaysia	3.66	0.99
Others	1.08	0.86	Others	18.34	5.64	Others	33.61	9.14			
Total	126.79	100.00	Total	325.25	100.00	Total	367.94	100.00			
<b>HS 8406.90 : Parts of steam turbines and other vapor turbines</b>											
1	Japan	61.63	32.02	1	India	771.50	43.84	1	India	1,972.31	58.60
2	India	58.38	30.33	2	Indonesia	276.30	15.70	2	Indonesia	316.55	9.40
3	Indonesia	30.93	16.07	3	Japan	149.37	8.49	3	Japan	162.46	4.83
4	South Korea	18.43	9.57	4	Azerbaijan	100.91	5.73	4	South Africa	119.66	3.56
5	Bangladesh	6.52	3.39	5	Turkey	93.41	5.31	5	Saudi Arabia	119.20	3.54
6	United States	3.33	1.73	6	Vietnam	80.21	4.56	6	Vietnam	111.51	3.31
7	Pakistan	1.88	0.98	7	Malaysia	31.56	1.79	7	Botswana	47.50	1.41
8	Vietnam	1.77	0.92	8	Pakistan	29.46	1.67	8	Belarus	46.56	1.38
9	Germany	1.64	0.85	9	South Africa	23.93	1.36	9	Iraq	44.73	1.33
10	Italy	1.17	0.61	10	Brazil	22.90	1.30	10	Sri Lanka	38.62	1.15
Others	6.79	3.53	Others	180.19	10.24	Others	386.77	11.49			
Total	192.49	100.00	Total	1,759.75	100.00	Total	3,365.86	100.00			

Source: China Customs