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Spatial patterns and influencing factors of China's wind turbine manufacturing industry: A review

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ABSTRACT

With climate warming and the energy crisis growing throughout the world, China as a developing country must undergo a revolution in energy production and consumption to change the traditional structure and patterns of energy utilization and establish a safe, green, and efficient energy system. Accelerating the development of new energy, increasing the proportion of clean energy, and developing high-voltage transmission and smart grids is the strategic choice for China's energy security and energy restructuring as well as for atmospheric environment improvement and reduction in carbon dioxide emissions. As a strategically emerging industry, the wind power industry in China, particularly its spatial patterns and influencing factors, should be provided close attention. This paper presents a large amount of data on Chinese wind power equipment manufacturing companies from statistics on China's installed wind power capacity (CWEA) from 2000 to 2014. The spatial patterns and influencing factors in China's wind turbine manufacturing industry are analyzed, and its features and factors are discussed to provide a scientific reference in an ordered pattern. Results on spatial patterns are discussed according to the following two distinct points. First, China's wind turbine manufacturing has formed a relatively complete "production, marketing, transportation, installation, operation and management, maintenance and overhaul" industrial chain, and enterprises own many bases but display a multi-point scattered spatial distribution. However, different parts of manufacturing enterprises adopt different exhaustive strategies as shown in this research. Overall, national and regional manufacturing centers are being formed. Second, China's domestic wind power equipment manufacturing enterprises are mainly established through relevant equipment manufacturing business investment and are located in the same city as their investment companies; meanwhile, foreign enterprises are generally located in cities with a solid foundation equipment manufacturing industrial base. The subsidiary firms of wind turbine manufacturing enterprises are located in Northwest, North, and Northeast China, whereas wind farms are generally located in eastern coastal areas with abundant wind resources. Furthermore, the influencing factors in China's wind turbine manufacturing industry are analyzed as a composite issue from several aspects of wind resource endowment, industrial base, policy support, and economic and technical support. (1) The industrial base primarily affects the choice of location of the wind power equipment business parent company. (2) Wind resource endowments mainly affect the location selection of subsidiary companies; cities with many wind resource areas contain a large number of wind power equipment company subsidiaries. (3) Local government support considerably affects choice of location of wind power equipment company subsidiaries. (4) Among wind resource endowment, industrial base, and local government support, the industrial base plays the most important role. Overall, the strong support provided by government policy is the foundation, and improving the technical level is a necessary condition. The industrial base often plays a decisive role. Regional economic openness has a significant impact on the spatial patterns of foreign wind power manufacturers in the early development of the wind power industry. Market and labor capabilities are also vital factors that affect the spatial patterns of China's wind turbine manufacturing industry. The results of this study provide important information for wind equipment manufacturing companies to select new locations and for local governments to develop strategic industrial development policies. The results also provide a useful reference for foreign firms that intend to explore the Chinese wind power market.

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Contents

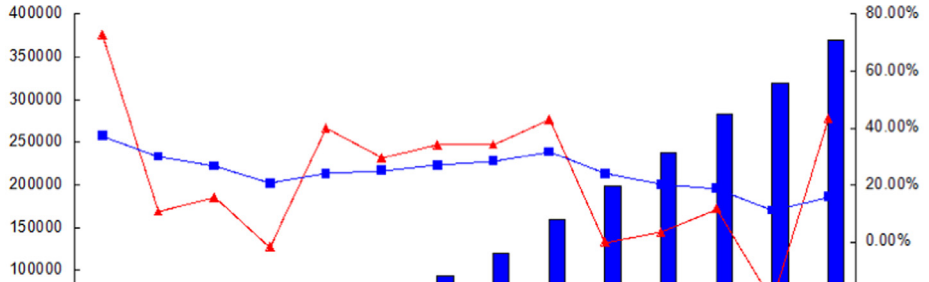
1. Introduction . . . 483
2. Development situation of China's wind power industry . . . 485
3. Development situation of China's wind turbine manufacturing . . . 487
4. Spatial patterns of China's wind turbine manufacturing industry . . . 489
   - 4.1. Spatial patterns of large machine manufacturing enterprises (parent firms) . . . 489
   - 4.2. Spatial patterns of parts manufacturing enterprises (subsidiary companies) . . . 490
     - 4.2.1. Spatial pattern of wind power blades . . . 490
     - 4.2.2. Spatial pattern of wind power gearboxes . . . 491
     - 4.2.3. Spatial pattern of wind power generators . . . 491
     - 4.2.4. Spatial pattern of wind power bearings . . . 491
     - 4.2.5. Spatial pattern of wind power converters . . . 491
5. Factors that affect the spatial patterns of China's wind turbine manufacturing industry . . . 491
   - 5.1. Wind resource endowment . . . 491
   - 5.2. City equipment manufacturing base . . . 491
   - 5.3. Policy support . . . 492
   - 5.4. Economic and technical policies . . . 492
6. Conclusions and prospect . . . 492
   - 6.1. Conclusions . . . 492
   - 6.2. Prospect . . . 493

Acknowledgments . . . 494

References . . . 494

1. Introduction

Climate warming, energy security, and other issues have motivated countries to develop and utilize new energy to limit the use of fossil fuel. The development of low-carbon economies and establishment of a new energy structure are at the global level [1–3]. China as a developing country must undergo a revolution in energy production and consumption to change the traditional structure and patterns of energy use and establish a safe, green, and efficient energy system. Accelerating the development of new energy, increasing the proportion of clean energy, and developing high-voltage transmission and smart grids is the strategic choice for China's energy security and energy restructuring as well as for atmospheric environment improvement and reduction in carbon dioxide emissions [4–6]. Compared with the other types of new energy sources, wind power technology is relatively mature, inexpensive, and involves large-scale commercial development conditions. As a result, the wind power industry has developed rapidly. Global wind power capacity has improved significantly [7–9]. From 2001 to the end of 2014, global wind power capacity obtained an average annual growth rate of 23.45%, with a value of 370 GW. The development in global wind power from 2001 to 2014 is shown in Fig. 1 [10–12]. Top 10 new installed and cumulative capacities of global wind power in 2014 are shown in Figs. 2 and 3. Strong market demand stimulated the rapid development of the wind power equipment manufacturing industry [12]. The number of individuals employed in the wind power equipment manufacturing industry exceeded 2 million, and the annual output



	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
NIC/MW	6500	7200	8331	8189	11471	14868	19952	26814	38364	38864	40186	44929	35528	50957
CIC/MW	23900	31100	39431	47620	59091	73959	93911	120725	159089	197953	238139	283068	318596	369553
GRNIC	72.87%	10.77%	15.71%	-1.70%	40.08%	29.61%	34.19%	34.39%	43.07%	0.00%	3.40%	11.80%	-20.92%	43.43%
GRCIC	37.36%	30.13%	26.79%	20.77%	24.09%	25.16%	26.98%	28.55%	31.77%	24.11%	20.34%	18.87%	11.15%	15.99%

Fig. 1. The situation of global wind power development from 2001 to 2014 (EWEA, GWEC, CWEA, 2015) (NIC: New Installed Capacity, CIC: Cumulative Installed Capacity, GR NIC: Growth NIC %, GR CIC: Growth CIC %).