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Wind turbine manufacturing in China: A review

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ABSTRACT

Domestic wind turbine manufacturing sector in China has experienced development stages starting from scratch to mass production. During the 11th FYP period (2006–2010), the main goal of wind power policy in China is to promote the commercialization of wind power by large-scale deployment of wind farms. This goal has been realized to a great extent and now the cost of wind power generation is nearly comparable to coal-fired power generation in China. The industry policy, which devotes to mass production of domestic wind turbines, is also largely successful. The purpose of the paper is to provide an overview on wind turbine manufacturing sector in China. The policy evolution in different stages, achievements and challenges pertinent to the sector are addressed in the paper. Key findings are that the misleading industry policy, which provides strong incentive to blind entrance and "competition for scale and price" and restrains innovation as well, is the key obstacle for the sustainable development of the sector. Deficient technology standard and qualification system and the misplaced franchise bidding system also indulge vicious competition and oversupply. Creating a level playground for all turbine supplies, providing strong incentive to innovative manufacturers, establishing thorough and practicable standard and qualification system, and fine-tuning the directive of the franchise bidding system towards technology and service are the primary policy implications proposed by our study.

Contents

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1. Introduction

Renewable energy is an integral part of energy system, due to its superior characters of wide distribution, vast potential, sustainability and little environmental impact. At present, striving to develop non-fossil energy is an important measure for many countries to ensure energy security, adjust primary energy structure and respond to climate change.

Wind power is commercially and operationally the most viable renewable energy technology and has the advantages of high energy conversion rate, large industrial scale, and high social benefits. China's wind energy industry has experienced a rapid growth for the last decade. Since the issue of *Renewable Energy Law* in 2005, wind power has enjoyed a favorable environment in China. By the end of 2007, the cumulative installed wind capacity reached 6.04 GW, which enabled China to surpass Denmark to become top five wind developer in the world [1]. In 2008, the cumulative wind capacity exceeded 10 GW and enabled China to fulfill the target of 11th Five-Year-Plan for wind power development in advance of two years. In 2009, China added another 13.8 GW, a total of 10,129 wind turbines, which surpassed the U.S. and became top one in terms of new installation. The rank for total capacity also rose from the fourth to the second. The annual growth rate for annual growth and total installations were remarkably spectacular in 2009, at 124.3% and 124.8% respectively [2]. In the same year, Donghai Bridge Offshore Wind Power Plant located in Shanghai, the first offshore project in China and in Asia as well, was completed and accessed to the power grid, an indication that China has successfully taken the first step in the development of offshore wind power [3]. In 2010, the newly installed wind capacity was 18.9 GW and cumulative capacity reached 44.7 GW. At that year China surpassed the US and became the leading country in terms of total wind capacity. In the end of 2011, the total installation in China reached 62.4 GW, or 45,894 wind turbines, which keeps China on the top position in the world [4].

But it is worth noticing that, after a continued boom, China's wind power growth has slowed down as what has happened in the rest of the world. According to field statistics by China Wind Energy Association (CWEA), in 2011 newly increase of wind power declined by 6.9%, and in 2012 it declined by 26.5% [5]. Overcapacity, restriction of grid integration, curtailment of wind power generation, supply price collapse, various quality problems, and many other issues pose threat to the development of the industry [6,7]. All the wind manufacturers are caught in a vicious circle: declining growth, shrinking profit margin and deteriorated economic performance.

There is a large body of literature addressing China's wind power development and most concerns the downstream, namely wind farm and its access to power grids. Ref. [8] pointed out that issues of grid infrastructure and backup power plants must be critically tackled in the medium term. Ref. [9] analyzed the distinct characteristics of wind power development in China, including large-scale, centralized pattern, long-distance and high-voltage transmission and put forward relevant measures against them. Ref. [10] argued that robust trans-regional power grids and diversified generation mix are essential for wind power's sustainable development.

The upstream of the supply chain or wind turbine manufacturing is rarely studied in the literature. Ref. [11] explored the driving forces underlying wind turbine manufacturing sector by reviewing the transition of the innovation modes and the dynamic interactions among the technology capability, innovation modes, market formation, and renewable energy policy. In [12] a hierarchical structure for analyzing the competiveness of the sector was established and was consisted of five indicators, including cost, quality, flexibility, delivery capability and R&D. Ref. [13] reviewed the status of the sector in China and analyzed the problems from a macroscopic view.

Wind turbine manufacturing plays an essential role in the entire wind power supply chain, but with the exception of [11,14–16] few authors have addressed it. This paper is a systematical review on the policies and current status of wind turbine manufacturing sector in China. The remainder of the paper is organized as follows. Section 2 will give an overview of the relevant policies and regulations along the development of wind power industry in different stages. Section 3 will discuss the achievements, especially during the 11th Five-Year-Plan (FYP) period (2006–2010). Section 4 will address the challenges and Section 5 will outline the underlining obstacles and the corresponding policy recommendations. Section 6 concludes.

2. Policy evolution

2.1. Kick-off of the sector

In 1996, the State Development and Planning Commission (SDPC) formulated the *Riding the Wind Program*, and unfolded the development of wind turbine manufacturing in China. At that time, there was essentially no industrial capability to produce wind turbine in China. The program proposed to import technology with exchange of domestic market and promote international cooperation by establishing joint venture for wind turbine manufacturing [17]. Then in 2005 the *Renewable Energy Law* was issued, providing a strong legislative base for renewable energy development [18]. The law proposed incentive policies to encourage the generation companies to participate in wind power generation. For example, the law requires the government to provide financial support such as tax deduction or exemption, and loan interest subsidy to wind power developers, and requires grid companies to fully purchase power generation from renewable energy which is accessed to the grids. To deal with the high price of wind power, the law provides subsidy and stipulates that price addition will be burdened by all the customers. The implementation of the law has significant effect. With strong policy incentive, the scale of wind turbine manufacturing in China had grown immensely and the sector began to move forward in big strides.

2.2. Rapid industrialization

During 2006–2010, the focus of industry policy was developing wind power bases in GW scale and promoting the industrialization of wind turbine manufacturing. A clear signal is that in 2009 China