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The effectiveness of China's wind power policy: An empirical analysis

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HIGHLIGHTS

- We study the impact of price policy on China's new wind power capacity.
- Four non-price policies impact on China's new wind power capacity is studied.
- Price policy is more effective in wind power increase than non-price policy.
- Price policy is more effective than non-price policy in wind non-rich areas.
- Non-price policy is more effective than price policy in wind rich areas.

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ABSTRACT

Along with China's rapid industrialization and urbanization, challenges in reducing pollution and CO_2 emissions are increasing. One of the major approaches to coordinate economic growth and environmental protection is to substitute coal-fired power with renewable energy. Since 2003, in order to promote wind power development, China has put in place many support policies which fall into either price policy category or non-price policy category. By using a variable intercept and mixed regression model with provincial panel data during 2001–2013, we analyzed the impacts of both categories on the increase of installed capacity in areas with different wind resources. We found that price policy and two non-price policies had positive impacts on the increase of wind power installation, price policy played a greater role than non-price policy did in promoting wind power development, and price policy was more effective in areas with poor wind resources, whilst non- price policy was more effective in areas with rich wind resources. Built on these findings, conclusions and policy recommendations are provided at the end of the paper.

1. Introduction

1.1. China is facing the great pressure of environmental protection

China's rapid industrialization and urbanization have led to dramatic energy consumption increase, serious ecological degradation and environmental pollution (heavy smog in particular). China's "Cancer Villages" phenomenon resulted from air, land, and water pollution has been startling. According to the data issued by the 22nd Asia-Pacific Anti-Cancer Conference and the 3rd Inquiry of National Population Death Cause, the annual newly added cancers in China account for more than 20% of the global total, and the death rate from lung cancer has increased by 465% over the past 30 years.

Meanwhile, China is also facing growing pressure from the international community to reduce its CO_2 emissions. As early as 2006, China surpassed the US, becoming the world's largest producer of CO_2. At the Copenhagen Climate Change Conference in December 2009, China pledged to cut its CO_2 intensity of GDP by 40–45% by 2020, based on 2004 emission levels. In 2013, at the Third Plenary Session of the 18th Central Committee of the Communist Party of China, the issue of ecological civilization construction was addressed. In 2014, the *Sino-U.S. Joint Statement on Climate Change* was issued, in which China's government promised to reach the CO2 emission peak around 2030, and by then, its CO_2 intensity of GDP will be cut by 60–65%. All of these indicate the coordination between economic growth and environmental protection in China has been paid high attention by the central government.

One of the choices to achieve the goal of China's environmentally friendly economic growth is to stimulate renewable

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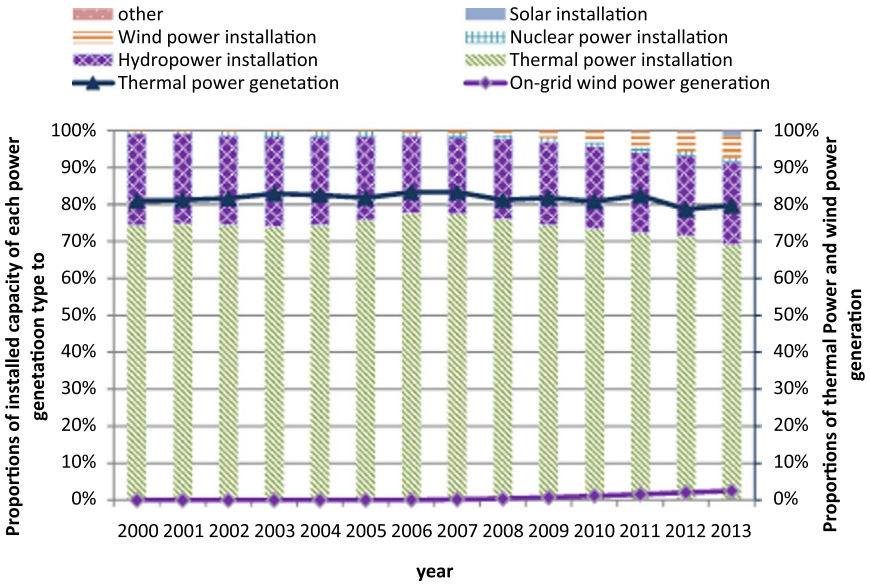

Fig. 1. Proportion of various Types of Installed Capacity and Proportion of Thermal Power and Wind Power Generation in China.
Sources: Wang Wei, China's energy and power generation structure chart, 2013, 4, 17 http://www.cnrec.org.cn/cbw/zh/2013-04-17-381.html

energy production increase. China's electric power industry is dominated by thermal power which accounts for 70% of its total power capacity and 80% of its total power generation (see Fig. 1). Accordingly, the coal consumption in power industry accounts for around 60% of the country's total, and the CO_2 emissions in power industry accounts for 40% of the total. This suggests it is imperative for China to adjust its power generation mix by increasing renewable energy ratio.

1.2. China has abundant wind resources but low exploration rate

China has abundant wind resources. Its exploitation potential of onshore (70 m high) and offshore (5–50 m deep, 100 m high) wind resources amounts to 2600 GW and 500 GW respectively.[1] Based on technologies available as of 2011, China's onshore wind resources has the capacity to produce more than 1000 GW of wind power (Table 1).[2] According to the Collection of China's Power Statistics (2013), by the end of 2012 China's overall power capacity was 1100 GW, which means that, if the 1000 GW wind power capacity is realized, wind power can account for more than 90% of China's current total power capacity. Generally, the capacity factor of wind power is around 30% (Note: capacity factor is ratio of the total amount of energy the power plant produced during a period of time to the amount of energy the plant would have produced at full capacity). This is lower than the capacity factors of both coal-fired power and hydropower which are around 55% and 45% respectively. Nevertheless, evidently wind power will contribute greatly to China's total generation if all wind power resources can be fully explored.

Meanwhile, China's wind energy resources are widely distributed (Fig. 2) and wind resources zones are divided into 4 levels based on the wind resources available (see Table 2) which are: (1) coastal and inland areas, including Shandong, Jiangsu, Shanghai, Zhejiang, Fujian, Guangdong, Guangxi and Hainan provinces/municipalities, where the annual wind power density is more than 200 W/m^2; (2) northern areas, including three northeast provinces (Heilongjiang, Jilin, Liaoning), Hebei, Inner Mongolia, Gansu, Ningxia and Xinjiang provinces/autonomous regions, where wind power density is 200～300 W/m^2, with some areas reaching 500 W/m^2 or more. (3) inland areas, where the wind power density is 100 W/m^2 or below, and (4) offshore areas.

However, the current installed capacity and generation of wind power in China remains relatively low compared with its rich wind resources (potential installed capacity). As of 2012, China had utilized only 1.98% of its total wind resources available (The total wind resources available includes potential onshore wind resources at a height of 70 m with a density of 300 W/m2 or more, and potential offshore wind resources in areas 5–50 m deep, at a height of 100 m above sea level with a density of 300 W/m^2 or more). Meanwhile, in 2014 wind power generation in China accounted for only 2.78% of the total though the share of wind power installation was higher but also very low—7% in the total.[3] Therefore, there is a great potential for China's wind power development in the future and it is urgent to explore how to promote China's wind power effectively.

1.3. The empirical study of China's wind power policy effectiveness is scarce

Many studies show that wind power policy plays a significant role in promoting wind power (Menanteau et al., 2003; Meyer, 2003; Rowlands, 2005; Menz and Vachon, 2006; Carley, 2009; Sovacool, 2010; Shrimali and Kniefel, 2011; Schmid, 2012). For example, Menanteau et al. (2003) studied the effectiveness of different incentive mechanisms using economic theory and charts, and found that fixed feed-in tariff (FITs) were more effective than bidding, but a quota-based trading system policy is most effective in promoting renewable energy development. Sovacool (2010) constructed a multi-index evaluation framework and evaluated renewable energy policy effectiveness in Southeast Asia from the perspectives of dynamic efficiency, cost efficiency, fairness, and fiscal responsibility, and concluded that FITs were the most effective measure for promoting renewable energy increase.

[1] Data source: Energy Research Institute National Development and Reform Commission and IEA, China Wind Roadmap 2050, December 2011.

[2] Data source: the national development and reform commission energy research institute and the IEA, China's wind power development roadmap 2050, 2011, 10.

[3] Data source: China National Energy Administration: Wind power capacity increased by 19.81 GW in 2014, and it has reached a new record. http://money.163.com/15/0212/15/AI8UQGLT00253B0H. html. 2015, 2, 12.