

## Study on China's wind power development path—Based on the target for 2030



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### ARTICLE INFO

#### Article history:

Received 24 October 2014

Received in revised form

10 May 2015

Accepted 1 June 2015

#### Keywords:

Wind power

Development path

Learning curve

Technology diffusion model

Dynamic programming

### ABSTRACT

As an important form of clean energy, China's wind power has developed rapidly and been given priority in the national energy strategy in recent years. Factors such as resource potential, technological progress, GDP growth, emission regulation scheme, and grid absorptive capacity may all affect wind power development. This study aims to explore China's wind power development optimization path during the period 2013–2030 from the perspective of minimum cost. The model is based upon a dynamic programming approach with the restraints of the learning curve and the technology diffusion model to indicate the influence of the above-mentioned factors. We have the following findings: (1) The government could achieve its established 2030 cumulative installed capacity target; GDP growth and incentive policies, which are closely related to construction cost, are critical factors that may impact on wind power development; (2) The grid absorptive ability is the most crucial factor constraining wind power development in the initial stage while learning rate and carbon emission permit price, are critical factors affecting the wind power development in subsequent stages; (3) With the interactions among the relevant factors considered, the wind power development goal of 400 GW for 2030 could be achieved several years ahead of schedule even under extremely unfavorable scenarios.

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### Contents

1. Introduction	198
2. Literature review	199
3. Methodology	200
3.1. The dynamic programming model for China's wind power development	200
3.2. The learning curve model	200
3.3. The technology diffusion model	200
3.4. Constraints and parameter setting	201
4. Results and discussions	202
4.1. The results of the base case	202
4.2. Sensitivity analyses	203
4.2.1. Sensitivity of the base case results to GDP growth	203
4.2.2. Sensitivity of the base case results to investment proportion	203
4.2.3. Sensitivity of the base case results to learning rate	203
4.2.4. Sensitivity of base case results to grid absorptive capacity	204
4.2.5. Sensitivity of the base case results to carbon permit price	204
4.3. Scenarios analyses	205
4.3.1. FLOS scenario	205
4.3.2. FHOL scenario	206

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5. Conclusions .....	206
Acknowledgments .....	207
References .....	207

## 1. Introduction

To mitigate climate change and achieve sustainable development, it is important to vigorously develop renewable energy [1]. Among the popular forms of clean energy, hydropower is at a relatively mature stage, and its impacts on the ecological environment are still controversial; solar power has not been put into large-scale use yet, partly due to its high cost [2]. Meanwhile, wind power has gained worldwide popularity in recent years as a result of its rapid technology development and has become one of the main forms of newly installed renewable energy technologies [3]. According to a report of the International Energy Agency (IEA), the proportion of the installed capacity of wind power in world renewable energy increased from 0.5% in 2000 to 6% in 2011 [4]. By the end of 2011, the cumulative installed capacity of global wind power had reached 237.67 GW, nearly 10 times of that in 2001, and its annual growth rate was above 20% over the ten years period [5]. The growth of the wind power is expected to continue as more countries have promoted preferential policies to speed up the wind power development in their future energy strategies [4].

The same situation applies to China. Since its first attempt to develop wind turbines in the 1970s, China has promoted the development of wind power by increasing investment and accelerating technology research. Fig. 1 shows the changes in China's new and cumulative installed capacities of wind power from 2002 to 2013. The figure also indicates that after the promulgation of the Renewable Energy Law of the People's Republic of China in 2005, China's wind power entered a period of extremely rapid development, with an average annual cumulative installed capacity doubling in the following five years [6]. According to the statistics of the Global Wind Energy Council, the new and cumulative installed capacity of China's wind power reached 16.1 GW and 91.42 GW in 2013, respectively, both of which are the highest in the world [7]. This implies that the policies of giving priority to renewable energy have promoted wind power development significantly [8].

In 2012, the "Twelfth Five-Year National Strategic Emerging Industry Development Plan" issued by the State Council and the "Wind Power Technology Development Specialized Plan during Twelfth Five-Year Plan" issued by the Ministry of Science and Technology set the goals for wind power development for different periods. These policies stipulated that China's on-grid installed capacity would reach 100 GW and the wind power generation would achieve 190 TW h in 2015 [9]. The latest long-term target of China's wind power development is reported in China Wind Energy Development Roadmap 2050 issued by the IEA, which indicates that the wind power cumulative installed capacity of China is expected to reach 200 GW, 400 GW, and 1000 GW in 2020, 2030, and 2050, respectively [10].

On the other hand, China has also faced enormous challenges in stimulating wind power development. One major challenge is the intermittence nature of wind power. One way to counteract this is to couple wind farms with hydropower. However, there is limited hydropower potential in the northern and western regions where the wind power resources are rich. At the same time, these areas are abundant in coal and oil resources, and then more thermal power plants are built. Wind power curtailment happened frequently after 2010 due to the power supply surplus in these areas. To some extent, the increasing investment cost and decreasing workload have already hindered the wind power development.

Moreover, the southern and eastern regions consume more power than they generate, and these areas lack both fossil fuel and wind resources. Long distance power transmission cannot be avoided to solve the power supply dilemma. The grid unreliability has resulted in a decline in capacity utilization ratio, and a slower growth of wind power development [11]. Therefore, special attention should be paid to the construction of high voltage (HV) and ultra-high voltage (UHV) power grids to avoid wind power curtailment.

China enacted a series of incentive policies to boost the construction of wind farms in the earlier period. Although these policies have greatly accelerated the pace of wind power development, they led to some unintended consequences during the

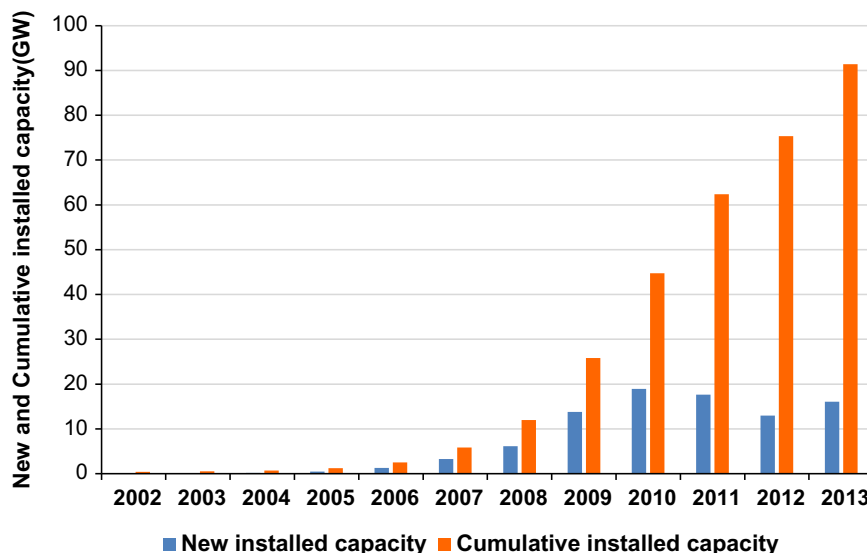


Fig. 1. The new and cumulative installed capacities of China's wind power from 2002 to 2013.

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