



Promote the development of renewable energy: A review and empirical study of wind power in China

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ABSTRACT

It is highly significant for China to improve its development of wind power. In order to promote the sustainable development, a more comprehensive evaluation of factors affecting the effectiveness of investment in the industry wind power is required to be conducted to formulate a relatively stable policy supporting mechanism for the development of wind power. Based on the green accounting framework, this paper evaluates a typical wind power project from economic, environment and energy alternative respects comprehensively. We simulate the main factors influencing cost and benefit of the wind power investment with the Monte Carlo method. Finally, we discuss how to promote wind power with respect to the concern of government, investors and environmentalists.

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1. Introduction

The development of renewable energy such as wind power has become one of the strategic choices for many countries that try to build a sustainable energy system and achieve low carbon

economies. Due to resource, technology, investment and other constraints, coal still dominates in China's energy consumption structure (shown in Fig. 1). In 2010, coal, oil and natural gas, non-fossil energy consumption accounted for 68%, 19%, 4.4% and 8.6% of the total consumption respectively, while wind energy only makes up a slight proportion of non-fossil energy. In order to achieve the goal that carbon dioxide (CO₂) emission per unit of GDP in 2020 is lower than that of 2005 by 40–45%, it is absolutely urgent for China to develop renewable energy. The studies by Li [1,2] show that wind energy has prominent technical and

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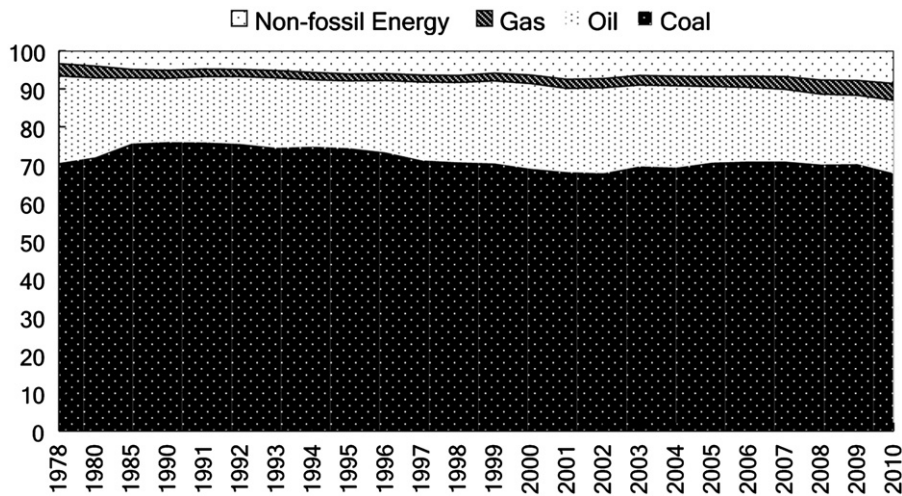


Fig. 1. Primary energy consumption structure of China (1978–2010).

economic advantages and potential compared with solar energy, biomass and other renewable energy.

The past few years witness rapid development in wind power in China. From 2006 to 2010, the installed capacity of wind power had an average annual growth rate of 104%. At the end of 2010, cumulative installed capacity of wind power reached 41.46 million kW. However, given the huge total energy consumption in China, especially the rapid increasing energy demand driven by urbanization and industrialization, the impact of the growth of wind power is not appreciable though; in terms of proportion wind power in primary energy consumption structure remained unchanged, even decreasing slightly.

Factors affecting investment returns of wind power include the following: natural factors such as wind strength and the effective wind time; technical factors like unit installation investment, conversion efficiency from wind energy into electricity, grid access, etc.; market factors, for example financing costs and coal prices and policy factors, such as tariff levels, land-use policies, and preferential tax policies. Instabilities in these factors magnify investment risk in wind power and consequently make financing the most challenging segment faced by wind power investment. Renewable energy industry development requires enormous amount of funding. According to UNEP, from 2005 to 2009 the world wind power capacity growth rate was 27% and the world wind power generation investment reached 67 billion dollars in 2009 [3]. The global renewable energy investment increases rapidly with huge financing gap. According to the long-term renewable energy development planning, China aims at realizing the goal that the non-fossil energy accounts for 15% of the total energy consumption by 2020. If it is estimated that 29 gigawatt(GW) new wind power will be installed and for each kW comprehensive investment is about 9000 RMB, tentative required investment is about 40 billion dollars.

Wind power development possesses great potential, but exploitation and utilization in scale, and its sustainable development are in need of support from government and a more comprehensive market mechanism. It is thus essential to evaluate the risks and benefits of renewable energy projects, and propose corresponding effective measures to them more attractive for investors. Based on this, this paper aims at solving renewable energy project financing problems and analyzes what impacts renewable energy project development, making collective decisions and raising some proposals from the perspectives of government, investors and environmentalists.

2. Literature review

In the context of renewable energy risk assessment and financing problems, a few scholars and institutions have carried out thorough and systematic research, some of which, home and abroad showed that the following were conducive to renewable energy financing difficulties: lack of start-up funding and necessary technical support, small project scale, high project risk, less investor's interest, and changeful policies [4–6], among which high risk was the major threat for wind power project financing. UNEP [7] suggested that cost in the initial stage of a project was relatively higher; however risk, incomplete information and technical obstacles exist in each phase but investors cannot get the precise project feasibility analysis and risk evaluation. Thus a higher yield is necessary as a compensation for the risk.

According to Pigou's theory, it is advisable for the government to restore the market incentive function by subsidization in the case of positive externalities, so as to make the supply reach the optimal level. Hohmeyer [8] quantified the external benefits embedded in the energy system and analyzed the influence of the external benefits of power tariff within the competitive mode. He pointed out that renewable energy would face serious competitive disadvantages without consideration of external benefits and large-scale wind power development would be delayed for about 15 years. Taking into account the uncertainty of wind speed and the value of clean air, Beenstock [9] calculated the economic benefit of wind power with a set of algorithms. The result showed that wind randomness did not impair the economic value of wind power. Wisser and Pickle [10], Wohlgemuth and Madlener [11] pointed out that it was because external benefits—such as environmental benefits and social benefits caused by renewable energy project—were ignored that some renewable energy incentive policies were ineffective. Manwell et al. [12] differentiated between the value of utilizing wind power and those of other renewable energies from the perspective of saving fossil energy and reducing pollution emission. Kennedy [13] defined social benefits as saving energy and reducing environmental loss by replacing conventional power with wind power.

At the early stage of wind power development, government support is indispensable to solve wind power project financing difficulties and promote wind power sustainable development. Numerous scholars and institutions put forward a series of measures to improve the profitability and reduce financing risks of wind power projects by means of risk management tools and

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