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Is biomass power a good choice for governments in China?

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ABSTRACT

To fulfill the target of emissions reduction, the Chinese government has made many efforts to develop renewable energy. Biomass power can provide stable power supply, avoid wasting straw resources and protect rural environment at the same time. However, the development of renewable power requires subsidies from the government, but increased subsidies placed heavy burden on the governments, whereas these governments want to develop renewable energy with minimum costs. This paper attempts to answer the question that whether the development of biomass power is a good choice for local governments in China. For this purpose, the goal of emissions reduction and subsidies of renewable energy powers were discussed. The main conclusion is that although the subsidies for biomass power were slightly higher than those for wind power, biomass power is a good choice for governments considering other benefits, especially for regions with rich agricultural and forest residues. In the future, regional and local conditions should be considered in the planning of biomass power development.

1. Introduction

1.1. Background

With dual pressures of preventing environmental deterioration and promoting energy security, a low-carbon energy structure based on renewable energies is becoming increasingly important in the development of China's economy. We need to convert large amounts of primary energy into electricity. In thermal power plants, burning fossil fuels has released greenhouse gases and other pollutants into the atmosphere. Currently, the thermal power in China, mostly coal-fired, comprises 72% of the total installed capacity and contributes 81% of total generated electrical energy [1]. Being the largest electricity generation and energy consumption country in the world, China' electricity sector bears a heavy burden in emissions reduction. In this context, to exploit the diversity of power generation is a solution to achieving emissions reduction without impairing electricity consumption. China has made many efforts to fulfill emissions reduction targets in recent years. The subsidy volume of renewable energy in China has increased rapidly since price subsidies and quota trading schemes were released in 2006. With strong policy support, the renewable power industry in China has developed rapidly. For instance, the installed capacity of wind power generation had increased from 2670 MW in 2006– 91,413 MW in 2013 and biomass power from 2500 MW in 2006–7800 MW in 2013. Among the renewable forms of power generation with special focus in China (wind, solar and biomass), both wind and solar power have the issue of maintaining a stable supply because of their intermittent nature. The running of wind and solar plants requires backup capacities relying on biomass power if carbon emissions have to be avoided [2]. The fact that the proportion of electricity production of biomass power is greater than the proportion of its installed capacity shows the stability of biomass power [3]. Meanwhile, the utilization of biomass energy can meet the requirement of multiple sectors by its conversion into various energy forms such as electricity, heating, gas, liquid and solid fuels. The comprehensive utilization of agricultural and forest residues, which are the main component of biomass materials in China, is an attractive option for boosting rural economy, because it can bring job opportunities and protect the environment at the same time. Fig. 1 illustrates the structure of biomass in China, which shows that the straw, other agricultural residues and forest residues accounted for 87% of all the biomass.

In 2013, the total energy consumption in China was 3.76 billion tons of Standard Coal Equivalent, and utilization of biomass energy was 33 million tons of Standard Coal Equivalent, accounting for 0.9% of all energy consumption. The generation capacity of biomass power

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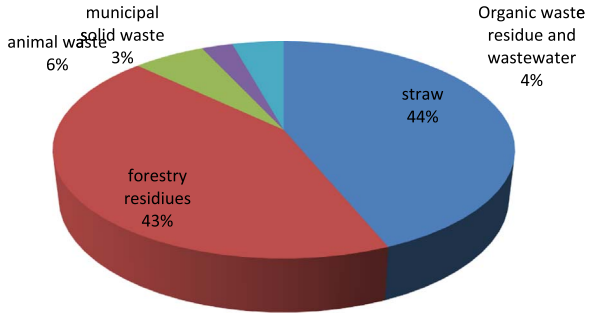

Fig. 1. The structure of China biomass resource.
Data sources: Report of the Development Renewable Energy Industry in China 2015

was 42 billion kWh, accounting for 0.8% of all electricity generation. The total biomass energy was about 460 million tons of Standard Coal Equivalent, and most have been abandoned or used in a less effective way. Therefore, the potential of biomass for energy purposes is huge if more energy crops are cultured in the future.

However, in order to develop the renewable energy, government subsidies have increased in intensity over the past few years. It placed heavy burden on the government considering that China is a large developing country. Like many countries, China faced a dilemma between promoting renewable energies and saving public expenditures. From the standpoint of the government, to reach a commitment in emissions reduction with minimum cost is a key issue. Some people may ask whether the development of biomass power is an effective way to fulfill emissions reduction targets. In other words, is biomass power a good choice in comparison with other forms of renewable energy power? The aim of this paper is to answer these questions.

The social, economical and environmental effects had been analyzed both from the government perspective and from the point of view of other partners involved in the literature of renewable energy. Bean et al. [4] assessed the cost effectiveness of wind energy policy options and found that an investment credit policy is the most cost effective option for promoting wind energy development from the government perspective. The development of renewable energy is dependent on the support of the governments to some extent. It was found that there is a significant and positive relationship between renewable energy consumption and different countries' government orientation [5]. The environment impacts and social benefits are the most studied in the field of renewable energy. In recent years, the utilization of renewable energy is increasing dramatically in the global market. However, the mitigation of greenhouse gas emission through increased utilization of renewable energy may also have negative environmental impact. Only focusing on greenhouse gas emissions may lead one to neglect other negative environmental impact [6]. Prakash and Bhat [7] assessed and ranked the renewable energy technologies against their impact, and environmental impact of renewable energy systems based on three different sustainability indicators. The results were that wind and small hydro are the most sustainable source for electricity generation. The environmental performance of small hydropower (SHP) and biomass energy was assessed, and the environmental merits and demerits of biomass were also discussed [8–10].

The effective use of renewable energy subsidies would help to promote compliance with climate policy targets. In this line, there is a wide spectrum of research studies in the literature. Badcock and Lenzen [11] presented estimation of subsidies for a number of different electricity-generating technologies at a global level, and showed that financial subsidies were always higher for solar and wind power than for other technology. Reichenbach and Requate [12] set up a model to investigate the performance of subsidy policies for wind or photovoltaic power. The study of Shahverdi et al. [13] focused on the impact of renewable energy subsidies on small scale generators' owners in Iran, and found reforming subsidies and incentives would affect distributed generation areas in terms of operation and investment. It means ineffective subsidies may have negative impact. For instance, subsidized additions of base capacity by governments are a costly and undue burden for taxpayers. It may also have the perverse effect of reducing the incentives for resource adequacy in the long run [14]. Therefore, a subsidy policy would prove better in reducing the risk of overcapacity and the optimal scale of subsidies should vary by industry [15]. Zhang et al. [16] used a renewable power planning (IRPP) model to evaluate potential subsidy to achieve a certain installation target.

For the governments, the cost-effectiveness of subsidies supporting renewable energy is the major concern. A number of studies had taken into the consideration of costs and benefits simultaneously. Ortega et al. [17] provide an assessment of the benefits and costs of the deployment of electricity from renewable energy sources in Spain. In the study, the benefits referred to reductions of CO2 emissions and fossil-fuel imports, and the cost was public support for renewable energy deployment. Similarly, in Spain, Burgos-Payán et al. [18] estimated the costs of integrating renewable energy into the electric system as well as the effects on the electricity wholesale market price, the environment, employment and so on.

Some studies about the cost-effectiveness of subsidies are focused on specific projects. Macintosh and Wilkinson [19] evaluated the cost-effectiveness and fairness of the Australian government's residential photovoltaic program, and found it to be environmentally ineffective and costly. The effectiveness of the subsidy policy for energy-efficient home appliances has been implemented by Yao et al. [20], and the results indicated there were significant rebound effects, leading to an overall increase in household electricity consumption. With respect to biomass energy, Thornley et al. [21] made an analysis of cost-effectiveness for various biomass energy technologies. In their study, costs per unit of greenhouse gas reduction for each technology were estimated and some technologies were found to be more cost effective than others in emissions reduction. Similar studies can be found in Li et al. [22], Burtt and Dargusch [23], Krozer [24].

The rapid growth of renewable energy resources in China was greatly enabled by the renewable energy policy framework created as the Renewable Energy Law [25]. After that, renewable energy policies have become a national priority for the Chinese government. China's rapidly developing renewable energy and energy efficiency policies were reviewed by Lo [26], which identified limitations and room for improvement. The effects of subsidy policies on renewable energy industry were assessed, and deficiencies and possible policy improvements were discussed [27,28]. Required subsidies of renewable energies, wind(onshore), solar photovoltaic energy(PV) and biomass power, in China were estimated [29]. Lin [30] analyzed cost of grid-connection of renewable energy and Grid integration. In the analysis, costs of grid infrastructure and system balancing are also investigated. Subsidies of renewable energy may have negative impact. The study of Xiong and Yang [31] indicated that subsidies for the PV industry had a very positive effect on the prosperity of the industry. However, many enterprises suffered losses in this industry. The study suggested that China's government need to take into account the exit mechanism for timely withdrawal of subsidies, such that the enterprises can gradually get rid of dependence on governmental subsidies. The industrial development of biomass power started from 2004, and it experienced a booming growth in recent years with policy support. However, there still exist various obstacles in the development of China's biomass power industry. Though the total installed capacity of biomass power increased, the growth rate fell rapidly. There are several studies focusing on problems of the biomass power in China. The study of Liu et al. [32] analyzed the current situation of biomass power in China and focused on the problems in practical operations, showing that the difficulties were fuel supply, limited financing channels, immature industry chain and small contributions of policies. Similarly, Zhang et al. [33] concluded that the existing dilemmas of the industry are raw material supply, technological capability, industry standards, policy