Policy Reforms of Biomass Power Generation Industry in China:
Biomass CHP

Li-ping YAN*
Department of Economic Management, North China Electric Power University, Baoding City,
Hebei Province, China
*Corresponding author

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Abstract. China's biomass power generation industry has experienced more than 10 years of development, and under the new situation of clean heating policy, it is facing a good opportunity for the transformation and upgrading of CHP. A series of incentive policies issued by the Chinese government, such as financial subsidies and income tax relief, provide a good policy environment for the development of the biomass CHP industry. Private capital is the main force of China's biomass CHP investment. In order to broaden the financing channels of enterprises, the government encourages the listing of biomass CHP companies or the issuance of bonds. Biomass CHP has the characteristics of high efficiency, low carbon and energy saving. It helps to improve the utilization rate of biomass resources, control haze, build beautiful countryside and increase farmers' income.

Introduction

Global warming has attracted worldwide attention to greenhouse gas emissions, and the Kyoto Protocol stipulates the limits of greenhouse gas emissions from States parties. In order to achieve the emission reduction targets of the Kyoto Protocol, the development and utilization of renewable energy and the improvement of energy efficiency have been paid much attention by all countries. After the promulgation of the "renewable energy law" in 2006, China's biomass energy industry is developing rapidly. The main way to use it is biomass power generation. Biomass direct fired power generation projects are mainly concentrated in North China, Northeast China, central China and eastern China with abundant crop straw. The installed capacity accounts for about 94% of the total biomass fired power generation installed capacity in China. However, most of them only generate electricity without heating, resulting in the low efficiency of biomass power generation industry in China, especially the annual equivalent load hours averaging less than 5200 hours. Only 7 provinces have an annual equivalent load of more than 6000 hours, including Liaoning, Ningxia, Jiangsu, Shaanxi, Zhejiang, Guangxi and Guangdong. In 2017, the Northern Region's Winter clean heating Plan (2017-2021) created a good opportunity for biomass power generation to transform into biomass CHP.

The aim of this paper is to present an overall policy framework based on the development process of biomass CHP in China. In addition, it also introduces the latest projects in order to realize the government's policy of cleaning and heating, including the overall situation, the development model and the main characteristics. In the end, it analyses the environmental and social benefits of the development of the biomass CHP project.

Development Process of Biomass CHP in China

Start Stage

China is rich in biomass resources and has great potential for energy utilization. The species of biomass resources include crop straw and processing surplus of agricultural products, forestry surplus
and energy crops, domestic waste and organic waste. It is estimated that the total amount of biomass resources available in China is about 4.6 million tons of standard coal a year[1].

Before 2005, the large-scale grid connected power generation project with agroforestry waste as raw material was almost blank in China. In 2005, the national development and Reform Commission approved 3 demonstration projects of straw power generation in Rudong, Shanxian, Jinzhou, which opened the prelude of China's biomass power generation.

**Rapid Development Stage**

After the promulgation of the Renewable Energy Law in 2006, China's biomass power generation industry has entered a rapid development track. In 2006, the world's first biomass power project with corn straw as the main fuel settled in Shanxian County, Shandong province. By 2017, the capacity of biomass power generation in China was 14880 MW, and the biomass power was 79.4 billion kWh.

![Figure 1. 2006-2017 biomass power installed capacity and electricity generation in China.](62)

Source: China National Renewable Energy Center.

In 2017, the Chinese government carried out clean heating policy to create a good opportunity for the transformation of CHP of the biomass power generation enterprises. A large number of scattered coal-fired small boilers and small stoves are used for heating in surrounding cities, rural-urban fringe zone and rural areas in northern China. According to the calculation, the same 1 tons of coal, the pollution emission of small coal fired boiler is more than 10 times as much as that of the coal-fired power plant[2,3]. More than 50% of the emission of PM2.5 in the atmosphere comes from the burning of coal, which has become an important reason for the severe haze in winter in northern China. In rural-urban fringe zone and rural areas with relatively rich agroforestry, biomass boiler heating can not only improve air quality and rural ecological environment, but also make full use of local biomass resources, extend industrial chain and increase farmers' income[2,3].

In 2017, 54 biomass CHP projects were approved with a gross installed capacity of 1948MW. Henan province is the area with the largest number of projects and the largest installed capacity. The areas with installed capacity above 100MW include Henan, Shandong, Hebei, Inner Mongolia, Jiangsu, Jilin, Liaoning and Hubei, as shown in Figure 2.
Prospects

It is expected that by 2020 and 2035, China's biomass CHP industry will achieve considerable development. As shown in Table 1.

Table 1. Prospects for the development of biomass CHP in China in 2020 and 2035.

<table>
<thead>
<tr>
<th>Target</th>
<th>2020</th>
<th>2035</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installed Capacity (MW)</td>
<td>&gt;12000</td>
<td>&gt;25000</td>
</tr>
<tr>
<td>Amount of utilization</td>
<td></td>
<td></td>
</tr>
<tr>
<td>biomass pellet fuel (10^4 t)</td>
<td>3000</td>
<td>5000</td>
</tr>
<tr>
<td>biogas (Billion m³)</td>
<td>10</td>
<td>25</td>
</tr>
<tr>
<td>Heating area (Billion m²)</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Annual replacement of coal combustion (10^4 t)</td>
<td>3000</td>
<td>6000</td>
</tr>
</tbody>
</table>

Source: NDRC, NEA(2017)

China’s Biomass CHP Incentive Policies

The rapid development of biomass CHP industry in China has benefited from a series of incentive policies issued by the government, including guiding policies, price policies and fiscal and tax support policies.

Guiding Policies

Since 2014, the National Development and Reform Commission (NDRC) and the National Energy Administration (NEA) have issued policies to encourage the development of biomass CHP and improve the utilization efficiency of biomass resources.

Table 2. Guiding policies of biomass CHP.

<table>
<thead>
<tr>
<th>Time</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014-12-09</td>
<td>Notice on the requirements for strengthening and standardizing the management of biomass power generation projects</td>
</tr>
<tr>
<td>2016-10-28</td>
<td>Biomass energy development planning &quot;in 13th Five-Year&quot;</td>
</tr>
<tr>
<td>2017-12-06</td>
<td>Guidance on promoting the development of biomass energy heating</td>
</tr>
<tr>
<td>2018-01-19</td>
<td>Notice of the National Energy Administration’s comprehensive division on the construction of demonstration projects on clean heating in the county of biomass CHP</td>
</tr>
<tr>
<td>2018-03-07</td>
<td>Guidance on energy work in 2018</td>
</tr>
</tbody>
</table>

Price Policies

The NDRC issued a series of policies on biomass and garbage generation, and the price of clean heating, so as to create a good price policy environment for industrial development.
Table 3. Price policies of biomass power generation.

<table>
<thead>
<tr>
<th>Time</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010-07-18</td>
<td>Notice on improving the price policy of agroforestry biomass power generation</td>
</tr>
<tr>
<td>2012-03-28</td>
<td>Notice on improving the price policy of waste incineration power generation</td>
</tr>
<tr>
<td>2017-09-19</td>
<td>Opinion on the price policy of clean heating in the North</td>
</tr>
</tbody>
</table>

Financial and Tax Support Policies

**Subsidy policies.**

a. Conventional electricity price subsidy

From the date of production, the biomass power generation project will enjoy the electricity price subsidy of 0.25 yuan/kWh. After 15 years of operation, the subsidy electricity price is canceled. Since 2010, the annual subsidy price of newly approved and approved power generation projects is 2% less than that of the newly approved and approved construction projects in the last year[^4].

b. Accessing to power grid’s cost subsidy

The investment and maintenance costs of power transmission and transformation of renewable energy power generation projects are subsidized according to the length of the line: the subsidy within 50km is 0.01 yuan/kWh, the subsidy of 50 to 100km is 0.02 yuan/kWh, and the subsidy of 100km and above is 0.03 yuan/kWh[^5].

c. Boiler replacement and terminal heating subsidy

The heating of biomass energy enjoys the same subsidy policy as "coal to gas" and "coal to electricity". The funds of Extra Charges of Renewable Energy Electricity Price are given priority to support the biomass CHP project. In order to improve the air quality of the regional environment, in 2017, China promoted the clean heating in winter in an all-round way, and carried out the project of "coal to electricity" and "coal to gas". A series of subsidy policies have been issued by local governments.

Table 4. The subsidy policy of "coal to gas" and "coal to electricity" in Beijing, Tianjin and Hebei.

<table>
<thead>
<tr>
<th>Region</th>
<th>Boiler replacement subsidy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beijing</td>
<td>The subsidy of coal fired boiler in suburban county is 130 thousand yuan per T/h. The reform investment of coal fired boilers with 20 T/h or more according to the original scale, 30% of the investment is subsidized by the government.</td>
</tr>
<tr>
<td>Tianjin</td>
<td>Each household is free to install a wall hanging stove and a meter.</td>
</tr>
<tr>
<td>Hebei</td>
<td>The government subsidies 85% of the purchase amount of the &quot;coal to electricity&quot; equipment. The maximum subsidy of each household is not more than 7400 yuan. The government subsidizes 70% of the purchase amount of the &quot;coal to electricity&quot; equipment. The maximum subsidy of each household is not more than 2700 yuan. The province and the city (county) bear the 1/2 of the subsidy funds respectively.</td>
</tr>
</tbody>
</table>

Source: adjusted from the policies of Beijing, Tianjin and Hebei

d. Agricultural machinery subsidy

The collection and processing machinery of biomass CHP raw materials is included in the subsidy range of agricultural machinery[^6]. According to the People's Republic of China Agricultural Mechanization Promotion Act, which came into effect in November 1, 2004, the Ministry of Finance and the Ministry of agriculture jointly launched the implementation of the subsidy policy for farm machinery purchase. The government subsidies for individual farmers, farm workers, the agricultural machinery specialized service households and agricultural machinery operation service organization directly engaged in agricultural production in the purchase and replacement of farm machinery.

**Preferential Tax Policy**

a. Business income taxes

The biomass generating enterprises engaged in eligible environmental protection, energy saving and water saving projects are exempt from the business income tax from the first year to third years from the tax year of the first operation income, and the business income tax is reduced by half from
fourth to sixth years. Taking the resources stipulated in the preferential list of business income tax of comprehensive utilization of resources as the main raw materials, the income obtained by the production of products in accordance with the relevant standards of the state and industry is reduced to 90%.[7]

b. VAT, property tax and urban land use tax

From January 1, 2016 to the end of the heating period in 2018, the heating fee income obtained by heating enterprises from the residents is exempt from the value-added tax. From January 1, 2016 to December 31, 2018, the heating enterprises are exempt from the house property tax and the urban land use tax of the plant and land used for the heating of the residents.[8]

New Projects of Biomass CHP in China

Overall Situation

In 2018, the Chinese government launched a “One Hundred Urban Demonstration Projects”. The demonstration projects are mainly the new projects or technical transformation projects of the county level agriculture and forestry biomass CHP and the municipal solid waste incineration CHP project, and a few of them are biogas CHP projects. 136 demonstration projects were approved, involving 21 provinces, with a total installed capacity of 3800MW, a total investment of about RMB 40 billion 652 million yuan. The installed capacity of the projects in each area, the annual agricultural and forest biomass consumption, and the annual replacement of coal burning are shown in Figure 3.

Figure 3. Specific Situation of New Biomass CHP Projects in each area in 2018.


As a province in the national strategy of Beijing, Tianjin and Hebei coordinated development, Hebei province has been able to undertake the non-capital function of Beijing in the areas of ecological and environmental protection. But Hebei province is one of the most haze provinces in China. The burning of coal for heating in winter is an important cause of haze in this area. Therefore, Hebei province is the key area of the demonstration project. Hebei province is the area with the maximum number of projects and the largest installed capacity in the “One Hundred Urban Demonstration Projects”. Hebei province will build 21 demonstration projects of clean heating in the county of biomass CHP. After the completion of these projects, it will provide civil clean heating for 14 counties and 14 villages and towns in Hebei province. The heating area is about 20 million 90 thousand m². It will provide clean heating for 11 industrial parks or development zones and 18 industrial projects. The annual amount of heat can be provided by 11 million 515 thousand GJ, which can replace coal about 1 million 726 thousand tons in a year.
Development Model

At present, the biomass CHP industry in China adopts the distributed energy production mode at county level, and builds a distributed clean heating production and consumption system. The enterprise collects and processes the raw materials in the local area. The products are consumed locally. The scope of production and consumption of energy is the county, township, and small and medium-sized industrial park, which is less than 3 million m².

The development model of biomass CHP is "Farmers + Agricultural Machinery Cooperation Organization + Biomass CHP Enterprises + Residents or Industrial Parks". Firstly, the agricultural machinery cooperation organization signs the raw material supply agreement with the biomass CHP enterprise. After the harvest of the farmers, the agricultural machinery cooperation organization carries out the straw baling recovery operation and pays the farmers a certain reward. Then the agricultural machinery cooperation organization sell the collected straw to the biomass CHP enterprise. Finally, Biomass CHP enterprises provide heating products to local residents or small and medium industrial parks through their own heating pipes.

Characteristics

Biomass CHP Installed Capacity is Small. Unlike coal fired power plants, the installed capacity of biomass power plant with wood combustion as raw material is usually less than 50MW, and the average installed capacity is 20MW[9]. In 2017, the average installed capacity of the newly approved project in China was 36MW, and only 28MW in 2018. The reason is that the biomass energy is a typical distributed energy, and the cost of transportation is the main part of its cost composition. The most sensitive factor that affects transportation costs is the collection radius[10]. In addition, the household contract system which has been implemented for a long time has made the agricultural production in China have the characteristics of decentralization and small scale. Therefore, the biomass energy is suitable for use and consumption in situ.

The Private Enterprise is the Absolute Investment Subject of Biomass CHP. From the nature of the investment subject, the private enterprise is the absolute investment subject of the biomass CHP, but the concentration of the enterprise is low. In July 2017, China biomass energy alliance released the ranking of Chinese biomass power enterprises in 2016. Among the top ten enterprises, seven enterprises are private, and only three enterprises are state owned. The KAIDIECO and Guoneng bio-electricity Group Co., Ltd. ranked the top two. The capacity of the two enterprises is 2155 MW, which accounts for 33.3% of the national gross capacity. There were 42 investment companies in 54 projects approved in 2017. There were 129 investment companies in 136 projects approved in 2018. This is closely related to the Chinese government's encouraging private capital to enter the field of clean heating, and encouraging social capital to participate in the investment and operation of clean heating projects through the cooperation of government and social capital (PPP) mode.

Benefit Analysis of Biomass CHP in China

Environmental Benefit

Biomass CHP has significant environmental benefits. The utilization of agricultural and forestry wastes has avoided the pollution of the atmosphere, soil and water caused by the incineration. Moreover, the replacement of fossil energy by biomass energy has reduced the emission of CO₂, which is beneficial to control haze and reduce the greenhouse effect.

According to the calculation, a biomass generating set with installed capacity of 25MW can reduce CO₂ emissions by 10x10⁴t a year, and can replace 70 thousand tons of standard coal in a year[11]. In 2018, the newly approved 136 biomass CHP projects can consume 36 million 149 thousand tons of agricultural and forestry waste and domestic solid waste in a year, replace 11 million 209 thousand tons of coal. It is estimated that by 2020, the total biomass energy in China can replace about 58
million tons of fossil energy. The annual reduction emission of CO\textsubscript{2} is about 1.5 billion tons, dust is about 52 million tons, sulfur dioxide is about 1 million 400 thousand tons and nitrogen oxides is about 440 thousand tons.

**Social Benefit**

The large-scale development of biomass CHP is conducive to improving the rural environment and promoting the construction of new urbanization in China. The core features of the new urbanization are ecological civilization, green and low carbon\textsuperscript{[12]}. The advantages of biomass CHP, such as high efficiency, environmental protection, energy saving and carbon dioxide emission reduction, coincide with the requirements of the new urbanization construction.

Moreover, the biomass CHP also has the advantages of benefiting farmers, which will help to increase the income of farmers. A biomass generating set with installed capacity of 25MW consumes about 200 thousand tons of biomass per year. According to the calculation of 200 yuan per ton, it will increase annual income of about 40 million yuan for farmers in the area. Moreover, the traditional agricultural industry chain will be extended to form a new industrial chain of crop straw collection, processing and transportation, which can provide more than 1000 employment opportunities for the locals. It is expected that by 2020, China's Bio-energy Industry can provide 4 million jobs and an increase of 20 billion yuan for farmers' income\textsuperscript{[1]}.

**Conclusions**

China's biomass power generation industry has experienced 10 years of development. The installed capacity and power generation capacity were increased from 1400MW and 700 million kWh in 2006 to 14880MW and 7 billion 940 million kWh in 2017, and the growth rate was 962.86\% and 1034.29\% respectively. The clean heating policy makes China's biomass power generation industry facing a new opportunity for the comprehensive transformation and upgrading of biomass CHP.

Based on the distribution characteristics of biomass energy, the distributed energy production mode of the biomass CHP is adopted at county level in China, and the installed capacity is mainly about 30MW small units. It can greatly shorten the transportation radius of raw materials and reduce the operation cost of enterprises. Biomass CHP’s benefits are obvious. It can not only achieve the harmless and resource utilization of biomass resources, but also reduce environmental pollution and increase farmers' income.

In order to encourage private capital to enter the area of clean heating, the government supports eligible clean heating companies to issue stock, a variety of debt financing instruments, such as corporate bonds, short term financing vouchers and medium-term bills, etc. or the listed companies to refinance according to law. Of course, the continuous and healthy development of biomass CHP industry in China also needs the competent department to establish and improve the biomass energy heating industry system, improve project management and technology management, formulate the technical norms of biomass CHP, and establish and improve the environmental monitoring system.

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**References**


