

# Explore the current situation and development trend of China's straw power generation industry

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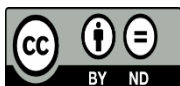
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**ABSTRACT**

China's crop straw scale power generation industry is still in the initial development stage. In recent years, China has attached great importance to the development of biomass energy and issued a series of industrial technology policies to promote crop straw and power generation. Based on the foundation and characteristics of the current development of China's straw power generation industry, this study combs and analyzes the current policy situation focusing on laws, regulations, technical specifications, economic policies and other aspects, and makes it clear that the straw scale power generation industry market is still in the stage of continuous expansion during the 13th Five-Year Plan and even longer, cogeneration is the national key support direction, the profit level of the industry is continuously improved, and the requirements of industry supervision and environmental protection will be continuously tightened.

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## 1. INTRODUCTION

As one of the main sources of biomass energy resources, crop straw scale is the fourth largest energy source in the world after coal, oil and natural gas. In recent years, smog has become a "national pain", and air pollution control has reached an urgent point. To protect the environment, control smog and prevent air pollution, it is urgent to reduce the use of fossil energy. Accelerating the adjustment of energy structure and increasing the consumption of renewable alternatives, especially biomass energy, will become an important measure to promote the revolution of energy production and consumption. At present, China's crop straw and power generation are still in the initial stage of development, and the government has issued a series of industrial technology policies to promote the development of crop straw scale power generation, which clearly indicates the direction of its comprehensive utilization. Based on the development foundation and characteristics of China's straw power generation industry, this study focuses on the analysis and interpretation of the policy status and development trend of straw power generation industry.

## 2. DEVELOPMENT CHARACTERISTICS OF STRAW POWER GENERATION INDUSTRY IN CHINA

### 2.1 Resource distribution

Crop straw scale is a kind of renewable biomass resources rich in nitrogen, phosphorus, potassium and organic matter, which is the main by-product of agricultural production. Based on the output of various crops in 2016, from the perspective of regional distribution, the straw resources in East China and Northeast China are the richest, with theoretical resources of about 213 million tons and 207 million tons respectively, accounting for 21.20% and 20.57% of the total; Followed by Central China, North China and Southwest China, with about 184 million tons, 143 million tons and 126 million tons respectively, accounting for 18.34%, 14.20% and 12.53% of the total; The theoretical resources of straw scales in Northwest China and South China are relatively low, about 79.7357 million tons and 52.5113 million tons respectively, accounting for 7.94% and 5.23% of the total. From the provincial distribution, Henan, Heilongjiang, Shandong, Jilin, Hebei, Inner Mongolia, Sichuan, Anhui, Jiangsu, Hunan and other provinces have the richest output, accounting for 65% of the total straw scale in China [1].

## ***2.2 Development history***

There are five comprehensive utilization methods of crop straw in China, such as fertilizer, feed, fuel, base material and raw material. At present, fertilizer returning and feed utilization are still the main methods, with great potential for fuel utilization and raw material utilization. The raw material utilization is in the initial stage, and the overall comprehensive utilization is still in the primary extensive stage. Biomass power generation started late in China. In 2003, the government approved three demonstration projects of straw power generation in Jinzhou, Hebei Province, Shan County, Shandong Province and Rudong, Jiangsu Province. On January 1, 2006, "Renewable Energy Law" was promulgated and implemented, followed by a series of detailed rules for the implementation of biomass power generation, and the biomass power generation industry entered the fast lane of development. Over the past 10 years, the agricultural and forestry biomass power generation industry has been supported by government policies, especially price and tax policies, and its utilization scale has steadily expanded. According to the China Biomass Energy Alliance's 2016 China Biomass Power Generation Enterprise Report, by the end of 2016, 665 biomass power generation projects had been put into operation in China, with a grid-connected installed capacity of 12.248 million kilowatts, an annual power generation of 63.41 billion kilowatt hours and an annual on-grid power of 54.28 billion kilowatt hours. Among them, there are 254 agricultural and forestry biomass power generation projects with grid-connected installed capacity of 6.463 million kilowatts, annual power generation of 32.67 billion kilowatt hours, annual on-grid power of 29.85 billion kilowatt hours and annual utilization hours of 5,719 hours [2].

## ***2.3 Regional layout***

By the end of 2016, from the perspective of regional concentration of installed capacity, Shandong Province with the highest installed capacity accounted for 10% of the country, and Shandong (12.21%), Anhui (12.20%), Heilongjiang (9.60%), Henan (9.43%), Hubei (7.06%) and other provinces and cities with the highest installed capacity accounted for the national installed capacity. Generally speaking, the concentration of power generation by straw scale is high in China.

# **3. PRESENT SITUATION OF INDUSTRIAL DEVELOPMENT POLICY**

With the accelerating pace of global low-carbon development and increasing environmental constraints, biomass power generation, as an important means of energy structure adjustment and energy conservation and emission reduction, has gradually attracted widespread attention. In recent years, the government has issued a series of industrial policies to promote the development of crop straw and power generation, which clearly indicates the direction for the comprehensive utilization of biomass energy [4].

## ***3.1 Laws and regulations***

In 2005, "Renewable Energy Law" was promulgated, which defined renewable energy, defined the applicable scope, regulatory agencies and regulatory system, and at the same time defined the policy orientation of encouraging and supporting renewable energy, as well as the measures and ways of supporting it. In 2010, the Amendment of Renewable Energy Law was based on promoting the development of China's renewable energy industry, and determined that the country should implement the full guaranteed purchase system for renewable energy power generation and set up a renewable energy development fund. Biomass energy was explicitly included in the legal system, and encouraged the development of its upstream industrial energy crop planting industry. Subsequently, the Regulatory Measures for Full Acquisition of Renewable Energy Electricity by Power Grid Enterprises has further refined the policies for full acquisition of renewable energy electricity by power grid enterprises and preferential access to the Internet.

### ***3.2 Technical specification***

#### ***3.2.1 Industrial policy***

In 2005, the "Guidance Catalogue for the Development of Renewable Energy Industry" issued by the National Development and Reform Commission pointed out that the use of crop straw scales and direct combustion of forest wood to generate electricity entered the stage of technical improvement and project demonstration; Used in matching biomass direct combustion power generation system, the technical performance and specifications should be suitable for the direct combustion of biomass to enter the technical improvement stage. The Ministry of Housing and Urban-Rural Development compiled Code for Design of Straw Scale Power Plant (CB50762-2012) for the first time, in order to further promote the scientific and standardized design of straw scale power plant. In 2014, in order to further improve the utilization efficiency of biomass resources, the National Development and Reform Commission issued the Notice on Strengthening and Regulating the Relevant Requirements of Biomass Power Generation Project Management, encouraging new and existing biomass power generation projects with conditions to implement cogeneration or cogeneration transformation. [5] In 2017, the National Development and Reform Commission once again issued the Notice on Guiding Opinions on Promoting the Development of Biomass Energy Heating, which gave the development direction of biomass energy industry, and clarified and refined the utilization targets of various biomass energy one by one.

#### ***3.2.2 Related planning***

In recent years, the relevant plans issued by China have stipulated the development goals and key tasks of straw power generation industry. The Medium and Long-term Development Plan of Renewable Energy (Development and Reform Energy [2007] No.2174) pointed out that in 2020, the total installed capacity of agricultural and forestry biomass power generation (including bagasse power generation) will reach 24 million kilowatts by 2020; The "Thirteenth Five-Year Plan for Renewable Energy Development" (Development and Reform Energy [2016] No.2619) pointed out that it is necessary to accelerate the development of biomass energy, accelerate the pace of industrialization of non-electric utilization such as biogas and biomass energy heating, and improve biomass. Energy utilization efficiency and efficiency; The "Thirteenth Five-Year Plan for Biomass Energy Development" (Guoneng Xinneng [2016] No.291) pointed out that it is necessary to promote the distributed development and utilization of biomass energy, expand the market scale, improve the industrial system, and accelerate the development of diversified industrialization of biomass energy. pace; The "Thirteenth Five-Year Plan for Energy Development" (Development and Reform Energy [2016] No.2744) clarifies that the installed capacity of biomass power generation will reach about 15 million kilowatts in 2020; "Guiding Opinions on Promoting the Development of Biomass Energy Heating" (Development and Reform Energy [[2017] No.2123) pointed out that biomass energy heating is a green, low-carbon and clean economic renewable energy heating method, and it is an important alternative

to coal-fired heating in county and rural areas. Measures; Guiding Opinions on Promoting the Development of Biomass Energy Heating (F.G.Y. [2017] No.2123) clearly requires vigorous development of biomass energy heating [6].

### ***3.2.3 Environmental policy***

Guiding Opinions on Promoting the Development of Biomass Energy Heating (F&G Energy [2017] No.2123) pointed out that it is strictly forbidden to mix fossil energy such as coal with biomass boilers. In accordance with the relevant provisions, equipped with bag filter and other flue gas treatment facilities, installation and operation of continuous automatic monitoring system of flue gas emissions, biomass boiler pollutant emissions should meet the national or local air pollutant emission standards, reaching the emission level of gas boilers.

## ***3.3 Economic policy***

### ***3.3.1 Fiscal policy***

In 2015, the Ministry of Finance promulgated the Interim Measures for the Administration of Special Funds for Renewable Energy Development (Cai Jian [2015] No.87), which pointed out that special funds for development should be set up to support the localized production of renewable energy development and utilization equipment, with emphasis on supporting the development and utilization of renewable energy such as power generation. Discount funds should be determined according to the actual bank loans in place, the interest rate agreed in the contract and the actual amount of interest paid. The discount period is 1-3 years, and the maximum annual discount rate should not exceed 3%. In order to further promote local straw burning ban and comprehensive utilization, the Ministry of Agriculture issued the Notice on Promoting Cultivated Land Quality by Carrying out Comprehensive Utilization of Crop Straw Scales (Nongbancai [2016] No.39), which requires that crop straw and comprehensive utilization pilot should adopt the method of "replacing compensation with awards". The central government should give appropriate subsidies according to the comprehensive utilization of straw in the pilot provinces, and the subsidy funds should be independently arranged by the pilot provinces to support key areas and key links of comprehensive utilization of straw [7].

### ***3.3.2 Tax policy***

(1) preferential enterprise income tax. According to the "Regulations on the Implementation of the Enterprise Income Tax Law", biomass power generation enterprises enjoy the reduction and exemption of enterprise income tax, and the income of enterprises engaged in environmental protection, energy conservation and water saving projects that meet the conditions stipulated in the terms is exempted from enterprise income tax from the first year to the third year, and the enterprise income tax is halved from the fourth year to the sixth year; In accordance with the "preferential catalogue of enterprise income tax for comprehensive utilization of resources", the income from products that are the main raw materials and meet the relevant standards of the state and industry shall be reduced by 90% and included in the total income; "Preferential Catalogue of Enterprise Income Tax for Comprehensive Utilization of Resources (2008 Edition)", more than 70% of the raw materials of the products come from crop straw scales and peels, and the income obtained from the production of electricity, heat and gas is reduced by 90% when calculating the taxable income. Included in the total income of the current year; The Catalogue of Enterprise Income Tax Preferential for Special Equipment for Environmental Protection (2017 Edition) stipulates that if an enterprise purchases and actually uses special equipment for environmental protection within the scope of the Catalogue of Enterprise Income Tax Preferential for Special Equipment for Environmental Protection (2017), the investment amount of the special equipment 10% can be deducted from the taxable amount of the enterprise in the current year; If the credit is insufficient in the current year, the credit can be carried

forward in the last 5 tax years [8].

(2) VAT discount. Notice on VAT Policy for Comprehensive Utilization of Resources and Other Products (Cai Shui [2008] No.156), which implements the VAT refund policy for the sale of electricity or heat produced by garbage as fuel.

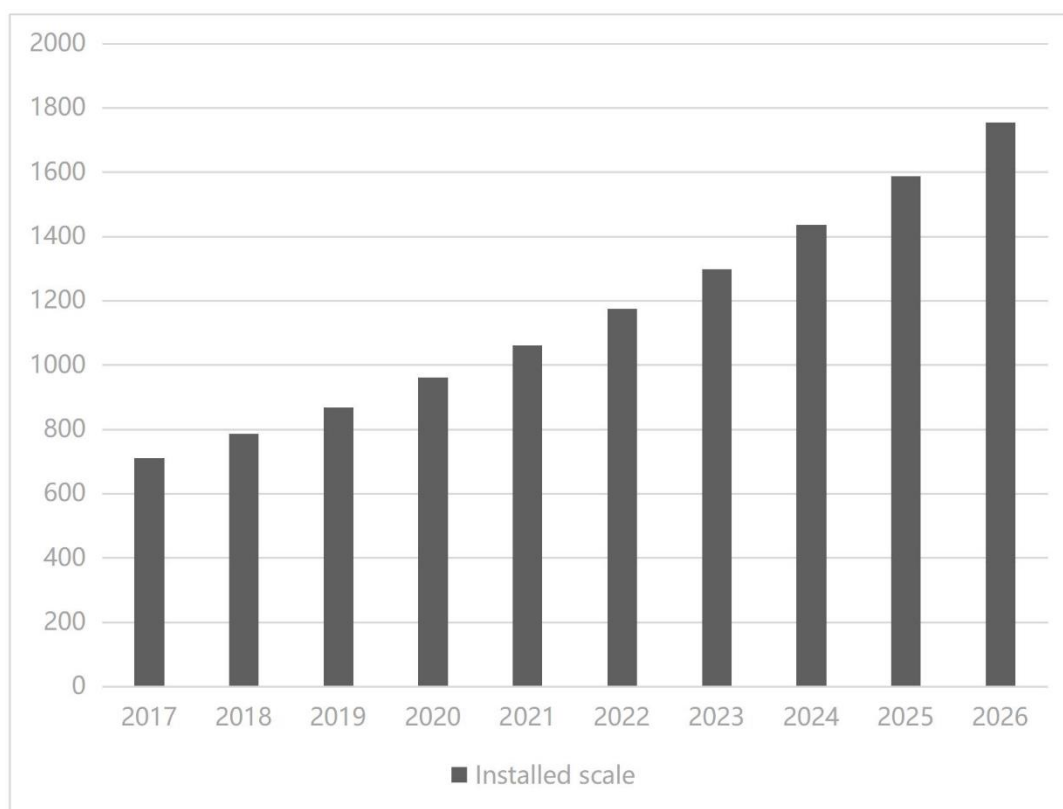
### ***3.3.3 Pricing policy***

The Trial Measures for the Management of Renewable Energy Power Generation Price and Cost Allocation (Fa Gai Jia [2006] No.7) provides detailed regulations on the on-grid price and cost allocation of renewable energy. The on-grid price standard for straw scale power generation consists of the benchmark on-grid price and subsidy price of desulfurization coal-fired units in each province in 2005, and the difference higher than the benchmark on-grid price of local desulfurization coal-fired units is allocated in the sales power of provincial and above power grids. In 2007, the Interim Measures for the Allocation of Additional Income from Renewable Energy Electricity Prices (Development and Reform Price [2007] No.44) further clarified the issue of electricity price subsidies. First, the subsidy for network connection fees was set according to the length of the line, within 50 kilometers. It is 1 cent per kWh, 2 cents per kWh for 50-100 km, and 3 cents per kWh for 100 km and above; Second, power grid companies fully accept the on-grid power of biomass power generation enterprises. In 2010, the National Development and Reform Commission issued the Notice on Improving the Price Policy of Agricultural and Forestry Biomass Power Generation (F&G Price [2010] No.1579), which officially determined the national unified benchmark on-grid electricity price of agricultural and forestry biomass power generation (0.75 yuan per kWh, including tax).

## **4. DEVELOPMENT TREND AND POLICY DIRECTION**

### ***4.1 The market demand space continues to increase***

According to various laws, regulations and planning policies issued by the state in recent years, the market demand space is still expanding continuously. Biomass power generation is about to usher in another development peak. Judging from the policy development trend, the role of energy base in supporting development under the new economic normal, and the requirements of environmental protection, energy conservation and emission reduction, the state will continue to increase its support for biomass power generation industry in the 13th Five-Year Plan and even longer. According to the installed capacity of straw scale power generation in China from 2010 to 2016, it is conservatively estimated according to the growth rate of 10.56% when the installed capacity of straw scale power generation tends to be stable in the next 10 years. The predicted results of the installed capacity of straw scale power generation in the future are shown in Figure 1. If the above-mentioned target investment and construction are roughly calculated, the biomass energy industry will increase direct investment by nearly 10 billion yuan every year, driving investment of upstream and downstream and related industries by nearly 100 billion yuan. This not only solves the problems of energy structure adjustment, environmental protection projects, people's livelihood projects and urban infrastructure construction in the economic development of some counties (cities) in China, but also injects fresh blood into the healthy and sustainable development of the national economy.



**Fig. 1.** Prediction of installed capacity of Jiexuan power generation (unit: 10,000 kilowatts)

#### ***4.2 Cogeneration is the main support mode***

In December 2017, the National Development and Reform Commission and the National Energy Administration jointly issued the Guiding Opinions on Promoting the Development of Biomass Energy Heating (Fa Gai Energy [2017] No.2123), which pointed out that during the "Thirteenth Five-Year Plan" period, it is necessary to speed up the heating transformation of conventional biomass power generation projects, promote the transformation of small thermal power into biomass cogeneration, build a regional comprehensive clean energy system and accelerate the technological progress of biomass cogeneration. Compared with biomass direct-fired power generation, biomass cogeneration has higher energy utilization efficiency, which fully conforms to the support direction of clean heating in northern areas actively promoted by the state at present. It is a feasible way to use rural resources locally according to local conditions, solve rural heating problems, improve the living energy quality of rural residents, effectively replace fossil energy such as coal burning, and realize the transformation and development of rural energy. At the same time, at the national level, "the construction of biomass boiler demonstration project using agricultural and forestry biomass as fuel" was put forward for the first time, which is a major favorable policy for the development of biomass energy heating industry. While reducing the energy consumption cost on the consumer side, it will greatly improve the economy, popularity and market competitiveness of biomass energy heating. It will further promote the leap-forward development of biomass energy heating industry in China [9].

#### ***4.3 The profit level is constantly improving***

With the continuous localization of the core technology and equipment of straw burning, the innovative development of fuel collection, storage and transportation mode and the full launch of the carbon emission trading market, the overall profit level of straw scale power generation industry has been continuously improved. After years of development, China has accumulated a large number of advanced coal-fired boiler

design and manufacturing technologies, and independently developed the design and manufacturing of biomass specialized combustion boilers. At the same time, the promotion of biomass power generation technology effectively improves the thermal efficiency of the unit, and under the condition of using the same fuel, it outputs more electric energy. At present, high-temperature and ultra-high-pressure units have been used in biomass power plants, and the conversion efficiency has increased to over 30%. With the application of thermochemical technology in straw and power generation projects, the conversion efficiency of power generation will continue to improve in the future. The localization of equipment and the improvement of power generation efficiency directly or indirectly reduce the cost of straw power generation. The fuel cost accounts for 75% of the operation cost of the project. With the optimization and innovation of the collection and transportation mode, the break-even point of the project will be greatly improved. Rural areas are rich in biomass resources and have sufficient supply. Enterprises can enhance the management and control ability of fuel market by innovating acquisition mode and strengthening refined management. At present, the fuel market is gradually being cultivated, and the acquisition, distribution, quality and price of fuel have entered a benign development track. The maturity of fuel collection, storage and transportation system will directly improve the profitability of straw scale power generation enterprises. In addition, the carbon trading market will supplement the environmental and economic benefits of biomass power generation enterprises.

#### ***4.4 Regulatory requirements are constantly improving***

Biomass power generation belongs to distributed energy, with small scale, large quantity, wide distribution and long industrial chain, which is not conducive to industry supervision. According to the recent policy documents, the state will further introduce the construction and operation standards of biomass power generation industry, and strengthen the supervision of the industry. Guiding Opinions on Promoting the Development of Biomass Energy Heating (F.G.Y. [2017] No.2123) clearly requires that fossil energy such as coal should not be mixed with biomass boilers. In accordance with the relevant provisions, equipped with bag filter and other flue gas treatment facilities, installation and operation of continuous automatic monitoring system of flue gas emissions, biomass boiler pollutant emissions should meet the national or local air pollutant emission standards, reaching the emission level of gas boilers. At the same time, the energy authorities of all provinces (autonomous regions and municipalities) are required to establish and improve the biomass energy heating industry system, incorporate biomass energy heating into the energy management system, improve project management and technical management, and establish a heating information statistics and monitoring and evaluation system. The national energy department will organize the formulation of technical specifications for biomass cogeneration. The environmental protection department will formulate national or local standards for pollutant emissions from biomass boilers, establish and improve environmental monitoring systems, and strengthen the supervision of air pollutant emissions from biomass cogeneration and biomass boiler heating projects.

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