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Analysis of the Utilization Status of Biomass Energy in China and Power Generation Technology

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ABSTRACT

This study introduces the utilization of biomass energy in China, analyzes the application background of biomass energy, and elaborates on how the development and utilization of biomass energy fully align with the rural revitalization strategy, serving as an effective path for achieving sustainable rural development. On this basis, it analyzes the relevant policies of China's biomass energy industry and studies the current technologies related to biomass energy power generation.

KEYWORDS

Biomass energy; Utilization; Power generation

1. INTRODUCTION

Compared to fossil energy, biomass energy is a form of solar energy stored in biomass in the form of chemical energy. Biomass energy is the energy carried by "biomass". Thus, biomass energy has become a renewable energy source that is inexhaustible and inexhaustible, and it is also the only renewable carbon source widely regarded as an indispensable component for limiting global warming and achieving carbon neutrality. Biomass energy not only has zero carbon energy attributes but will also actively contribute to negative carbon energy. The sulfur content in biomass is extremely low, so using biomass as an alternative energy source greatly benefits the environment, reduces the CO2 content in the atmosphere, and mitigates the greenhouse effect. On December 12, 2020, at the World Climate Summit, China once again clarified further measures to achieve the goals of "carbon peaking and carbon neutrality." China will increase its nationally determined contributions, aiming for carbon dioxide emissions to peak before 2030 and striving for carbon neutrality before 2060. The "dual carbon" goals are an intrinsic requirement and inevitable trend for our country's economy to enter high-quality development. China is a major agricultural country, and in the future, biomass energy will contribute significantly to achieving carbon peaking before 2030 and carbon neutrality by 2060 in various fields, serving as an effective pathway to fulfill the "dual carbon" goals.

2. BIOMASS ENERGY CONTRIBUTES TO RURAL REVITALIZATION

The Fifth Plenary Session of the 19th Central Committee of the Communist Party pointed out that village construction should be placed in an important position in the modernization of socialism. It is necessary to implement actions for rural construction, strengthen the comprehensive service capabilities of county towns, and transform towns into regional centers serving farmers. Planning and constructing county urban areas and villages in a coordinated manner is essential to protecting

traditional villages and rural landscapes. We must improve rural infrastructure such as water, electricity, roads, gas, communication, broadcasting and television, and logistics to elevate the quality of rural housing construction. "Gasifying the countryside" means providing rural residents with clean, high-quality, affordable, and convenient clean energy, and ensuring continuous improvement in the rural ecological environment. Accelerating the use of biomass energy not only aligns with the decisions and deployments of the Party Central Committee but also promotes a revolution in energy production and consumption in counties, facilitates improvements in the rural living environment, enhances rural infrastructure, drives rural revitalization, and contributes to ecological civilization construction. It is a livelihood project that benefits both the country and the people. The development and utilization of biomass energy fully align with the rural revitalization strategy. Since ancient times, traditional biomass energy sources such as firewood and straw have played an important role in the production and lives of farmers, tying biomass closely to farmers.

In the process of rural revitalization, the concepts and methods of energy use in rural areas need to be transformed. Biomass natural gas energy, as a high-quality energy source for rural areas, promotes higher value-added production in small agricultural processing and workshops, boosting farmers' incomes; it transforms locally sourced firewood, straw, livestock manure, household waste, and distributed biomass gasification stations into clean energy, serving as the primary energy source for clean and efficient modern rural living and heating. This not only enhances the energy quality for rural residents but also addresses the issue of local burning and improves environmental quality. Biomass energy optimally utilizes the limited resources in rural areas and is a sustainable development path for conducting rural energy reform and achieving rural revitalization. Therefore, developing renewable biomass energy to replace dwindling petrochemical resources such as natural gas, coal, and oil—especially biomass gasification technology for gas supply—is a crucial strategic decision related to the sustainable development of China's economy and energy strategic security. The role of biomass energy in the rural revitalization of energy is indispensable.

3. NATIONAL INDUSTRIAL POLICIES FOR THE USE OF BIOMASS ENERGY

In recent years, China has vigorously promoted its clean energy strategy, implementing a series of policies to accelerate the deployment of the biomass energy industry. On October 26, 2021, the State Council issued the policy document "Action Plan for Carbon Peaking Before 2030." This plan encourages the development of biomass power generation, biomass energy for clean heating, and biomass natural gas according to local conditions. On January 24, 2022, the "Comprehensive Work Plan for Energy Conservation and Emission Reduction during the 14th Five-Year Plan" was published, focusing on energy-saving and emission-reduction projects in agriculture and rural areas. The plan accelerates the application of renewable energy such as wind, solar, and biomass in agricultural production and rural life, and aims to systematically promote clean heating in rural areas. On February 11, 2022, the "14th Five-Year Plan for Promoting Agricultural and Rural Modernization" was released, which strengthens the construction of clean energy in rural areas and increases the proportion of electricity in rural energy consumption. It aims to promote the development of photovoltaics and wind power in rural areas based on local conditions, as well as diversified utilization of biomass energy, accelerating the establishment of a rural clean energy utilization system based on renewable energy. The plan emphasizes enhancing the construction of clean heating facilities, increasing the promotion and application of biomass boilers and solar collectors, and promoting clean heating in northern winter. On May 23, 2022, the State Council published the "Implementation Plan for Rural Construction Actions," which aims to implement clean energy construction projects in rural areas. It seeks to consolidate and improve the rural electricity supply assurance level, promote the construction of urban and rural distribution networks, and enhance the supply assurance capabilities in remote areas. It also aims to develop clean energy sources such as solar, wind, hydro, geothermal, and biomass, and explore the construction of distributed low-

carbon integrated energy networks with complementary energy sources in areas with suitable conditions.

On May 29, 2024, the State Council issued a notice on the "2024-2025 Energy Conservation and Carbon Reduction Action Plan." It requires that by 2025, the proportion of non-fossil energy consumption reaches about 20%, with a target of saving about 50 million tons of standard coal in key areas and industries through energy conservation and carbon reduction modifications, and reducing carbon dioxide emissions by about 130 million tons, striving to accomplish the binding targets for energy conservation and carbon reduction set for the 14th Five-Year Plan. Policies will be implemented to ensure that energy use for raw materials and non-fossil energy is not included in the total energy consumption and intensity control, orderly construction of large hydropower bases, and the active, safe, and orderly development of nuclear power, developing biomass energy according to local conditions, and promoting hydrogen energy development comprehensively. In July 2024, the National Development and Reform Commission and the National Energy Administration issued the "Coal Power Low-Carbon Transformation Construction Action Plan (2024-2027)" which points out that by utilizing biomass resources such as agricultural and forestry waste, halophytes, and energy plants, and considering the supply of biomass resources, safety requirements for coal power unit operations, needs for flexible regulation, operational efficiency guarantees, and economic feasibility, the implementation of coupling biomass power generation with coal power units will occur. After the transformation and construction, coal power units should have the capability to co-fuel with more than 10% biomass fuel, significantly reducing coal consumption and carbon emissions. On August 6, 2024, the General Office of the State Council released the "Work Plan for Accelerating the Establishment of a Dual-Control System for Carbon Emissions." The plan states that by 2025, the carbon emission statistical accounting system will be further improved, and related measurement, statistics, and monitoring capabilities will be enhanced, laying the foundation for implementing carbon emissions dual control nationwide during the 15th Five-Year Plan period. During the 15th Five-Year Plan, a dual-control system for carbon emissions will be implemented, primarily focusing on intensity control, with total volume control as a supplement, establishing a comprehensive evaluation and assessment system for carbon peak and carbon neutrality, strengthening the carbon emission accounting capacity in key areas and industries to ensure the timely achievement of carbon peak goals. Carbon emission targets will be included in national economic and social development planning, and during the 15th Five-Year Plan period, reducing carbon emission intensity will be set as a binding indicator for national economic and social development, conducting total carbon emission accounting work, and no longer treating energy consumption intensity as a binding indicator.

4. RESEARCH ON BIOMASS ENERGY GENERATION TECHNOLOGY

Currently, the biomass power generation technology in our country can be generally divided into two categories: one is direct combustion power generation technology, and the other is gasification power generation technology. The direct combustion power generation technology uses modern boiler technology to directly feed biomass fuel into the boiler for combustion, generating steam that drives the steam turbine generator set for power generation. Its advantages include a simple system, relatively high power generation efficiency, mature technology, and the ability to utilize biomass fuel on a large scale. Most biomass power plants in our country currently adopt this technology. The disadvantages of direct combustion technology include the high cost of biomass boilers compared to ordinary boilers due to the special nature of biomass fuels. The feeding and charging systems are also relatively complex. Additionally, due to the inorganic elements primarily found in biomass fuels like straw, such as potassium, sodium, chlorine, and sulfur, these elements are the main contributors to slagging, ash accumulation, and corrosion in boilers. In a high-temperature combustion environment, alkali metals and their related elements may form molten slag in the furnace or enter the gas phase, depositing on heat exchange surfaces in the form of steam and fly ash particles, thereby affecting the

thermal efficiency of the boiler while causing severe corrosion to the heat exchange surfaces, impacting the safe operation and economic benefits of the power plant.

In recent years, many researchers in Europe have conducted a lot of research on biomass gasification power generation technology and achieved considerable results. Biomass, when heated, can release a large amount of volatile matter at relatively low temperatures, with the volatile content of biomass fuels reaching over 70%. Therefore, gasification technology is very suitable for the energy conversion of biomass materials. The gasification power generation process mainly includes three steps: first, biomass gasification, where biomass is converted into gaseous fuel in the gasifier; second, gas purification, where impurities in the gas are removed through a purification system; and third, gas power generation, which can utilize internal combustion engines or gas turbines for power generation, or the gas can be sent to a gas boiler for combustion, generating steam that drives the steam turbine generator set for power generation. Research on biomass gasification technology in our country began in the 1980s, and several demonstration power plants for biomass gasification with internal combustion engine power generation have been established.

5. CONCLUSION

In summary, the efficient and comprehensive utilization of biomass energy can further achieve resource utilization, which is beneficial for protecting the ecological environment, reducing natural gas consumption, and lowering carbon dioxide emissions, thus having significant importance for ecological environmental protection.

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