





Review

Biomass power generation: A pathway to carbon neutrality

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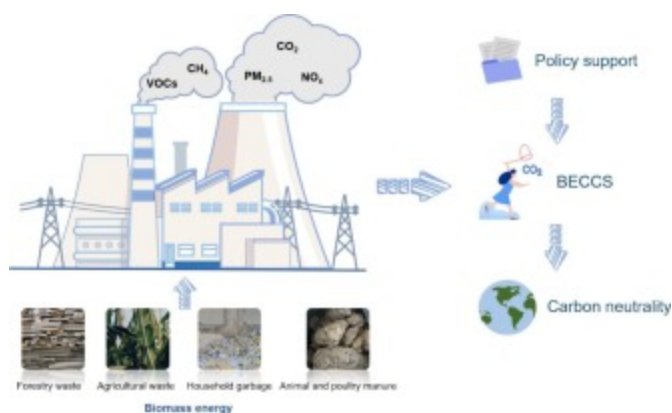
Highlights

- Biomass power generation industry in China is systematically reviewed.
- Uneven distributions of biomass resources and power generation were observed.
- Tax, finance, and subsidy policies are main drivers for the industry development.
- Market-oriented development and appropriate policies are crucial for the industry.

Abstract

In light of the pressing need to reduce carbon emissions, the biomass power generation industry has gained significant attention and has increasingly become a crucial focus in China. However, there are still considerable gaps in the historical background, status, and prospects of biomass power generation. Herein, the historical and current status of biomass power generation in China are systematically reviewed, with a particular emphasis on supportive policies, environmental impacts, and future projections. By 2022, the newly installed capacity for biomass power generation reached 3.34MW with a total installed capacity of 41 MW. The power produced from biomass power generation is 182.4billionkWh in China. The total installed capacity and generated power in 2022 were 1652 and 1139 folds higher than in 2006 when the first biomass generation plant was established. However, disparities in the distribution of biomass resources and power generation were observed. Key drivers of the industry development include tax, finance, and subsidy policies. Under the implementation of the 14th Five-Year Plan for renewable energy development and the goal of carbon neutrality, biomass power generation may achieve great success through more targeted policy support and advanced technologies that reduce air pollutant emissions. If combined with Bioenergy with Carbon Capture and Storage (BECCS) technology, biomass power generation will make its contribution to carbon neutrality in China.

Graphical abstract



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Section snippets

List of abbreviations

MW

megawatts

kWh

kilowatt hours

Mt

megatons

LCA

life cycle assessment

VAT

value added tax

MARA

the Ministry of Agriculture and Rural Affairs of the People's Republic of China

GHG

greenhouse gas

VOCs

volatile organic compounds

EF

emission factor

PE

polyethylene

MMBtu

million British thermal units

IEA

the International Energy Agency

IPCC

Intergovernmental Panel on Climate Change

OPG

on-grid power generation

FPG

full-load power generation

IC

installed capacity

FIC

forecasted installed capacity

BECCS

bio-energy with carbon capture

Status of biomass power generation in China

China promulgated the Renewable Energy Law in 2005, which proposed to encourage the utilization of biomass fuels and the cultivation of energy crops. Under the policies and financial subsidies from the government, biomass power generation has continued to grow since 2006 (Guo et al., 2022b). From 2006 to 2015, the development of biomass power generation was relatively slow, with the share of biomass installed capacity among renewable energy remaining below 4%. However, the biomass power

Policy supports

The development of the biomass power generation industry in China has received many policy supports (Zhang et al., 2014), including industrial policy, subsidy policy, and tax and fiscal policy. In the long term, government subsidies will effectively promote the development of the biomass energy industry (Lin et al., 2013). Apart from providing electricity, it is also encouraged to accelerate the transformation and upgrade of biomass power generation to cogeneration. By the end of 2022, biomass

Environmental impacts of biomass power generation

As one of the renewable energies, biomass is environmentally friendly and plays a positive role in mitigating greenhouse gas (GHG) emissions (Freiberg et al., 2018; Li et al., 2020; Song et al., 2012; Wang et al., 2018; Xu et al., 2016). However, in addition to CO₂, biomass combustion can emit many other GHGs, such as CH₄, CO, and N₂O, thereby affecting the climate (Demirbas, 2008). For example, Dang et al. (2022) confirmed that compared with traditional coal power, a 12MW biomass direct

Development trends

The wide use of fossil fuels is unsustainable and has resulted in climate change. Global energy is developing towards diversification, low carbon emissions, decentralization, and globalization (Hasanuzzaman et al., 2017; Kurbatova and Perederii, 2020; Wang et al., 2022; Yang et al., 2020), and has significantly changed the global energy governance structure (Yang et al., 2020). Thus, the utilization of renewable energy is becoming more and more crucial. In China, renewable energy will become

Future perspectives

To achieve the goal of carbon neutrality, the Chinese government has made continuous efforts in various aspects, including promoting the development of renewable energy and shifting its development mode from gradual and small-step development to large-scale, high-proportion, and big leapfrog development (Hasanuzzaman et al., 2017; Kurbatova and Perederii, 2020). Municipal sludge is also considered as biomass. In recent years, there have been cases of using it and coal to generate electricity.

Conclusion

Biomass plays an important role in China's energy structure. As an ideal technology for the clean treatment of biomass energy and the reduction of carbon emissions, biomass power generation has been encouraged in China for decades. The abundant biomass resources in China ensure the development of the biomass power generation industry, while the broader industrial development is limited by the unbalanced spatial distribution and low utilization rate of various biomass resources. Numerous of

CRedit authorship contribution statement

Wei Du: Writing – review & editing, Writing – original draft, Supervision, Investigation, Funding acquisition, Conceptualization. **Zhanpeng Cui:** Writing – review & editing, Writing – original draft. **Jinze Wang:** Writing – review & editing. **Yiming Qin:** Writing – review & editing. **Jianhuai Ye:** Writing – review & editing. **Nan Lin:** Writing – review & editing. **Yuanchen Chen:** Writing – review & editing. **Wenyan Duan:** Writing – review & editing. **Zhaofeng Chang:** Writing – review & editing. **Hao Li:** Writing

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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