sustainability

MDPI

Article

Impacts of Government Policies on the Adoption of Biomass Power: A System Dynamic Perspective

Zhao Xin-gang [1,2], Wang Wei [1,2,*], Hu Shuran [1,2] and Liu Xuan [1,2]

[1] School of Economics and Management, North China Electric Power University, Beijing 102206, China
[2] Beijing Key Laboratory of New Energy and Low-Carbon Development, North China Electric Power University, Beijing 102206, China
* Correspondence: 120192106138@ncepu.edu.cn

Abstract: As a kind of renewable energy, biomass power has great development potential in mitigating greenhouse gas emissions. Therefore, under the background of carbon peak and carbon neutrality, the diffusion of biomass power generation technology has practical significance. To address these issues, this paper constructs a system dynamics model to study the impact of different policy effects on the diffusion of biomass power generation technologies. The results show that the feed-in tariff policy can significantly promote the installed capacity growth of biomass power generation projects; on the other hand, carbon emission trading increases the investment value of projects and promotes the growth of the installed capacity of biomass power generation projects, to a certain extent, so relevant policies need to be improved to achieve the promotion of biomass power generation technology in the future.

Keywords: government policies; biomass power; system dynamic; adoption

check for updates

Citation: Xin-gang, Z.; Wei, W.; Shuran, H.; Xuan, L. Impacts of Government Policies on the Adoption of Biomass Power: A System Dynamic Perspective. *Sustainability* **2023**, *15*, 1723. https://doi.org/10.3390/su15021723

Academic Editors: Dong Li, Fuqiang Wang, Zhonghao Rao and Chao Shen

Received: 30 November 2022
Revised: 10 January 2023
Accepted: 13 January 2023
Published: 16 January 2023

1. Introduction

1.1. Background and Motivation

China's economic transformation and structural adjustment have reached a critical point. The nation has a major strategic plan for its economic and social development, by promoting the revolution in energy production and consumption. In addition, China is dominated by a coal energy consumption structure, which has caused a large number of carbon emission problems. In this regard, China is facing severe pressure to reduce its carbon emissions. In order to meet this challenge, the Chinese government has made a solemn commitment to reach carbon peak emissions by 2030 and achieve carbon neutrality by 2060 (http://www.gov.cn/zhengce/2021-10/24/content_5644613.htm, accessed on 24 October 2021). Therefore, the development of the renewable energy industry can help to achieve this goal. As part of the renewable energy industry, electricity generation from biomass can reduce electricity generation from conventional fossil energy sources. Hence, biomass energy industry promotion can save energy and reduce emissions. The diffusion of biomass energy is a process that is widely adopted over time [1]. Biomass power generation has better economic and ecological benefits. On the one hand, biomass power generation can replace the coal consumption required by traditional coal-fired power generation, to a certain extent, thereby reducing carbon dioxide emissions [2]; on the other hand, biomass power generation can solve the environmental pollution caused by agricultural and forestry wastes, and enterprises can bring economic benefits to places with abundant resource endowments, to a certain extent, through recycling and the utilization of biomass resources [3].

Biomass power generation industry development is dependent on economic factors and social recognition [4]. To promote the development of the biomass power industry, the Chinese government has implemented a series of measures and incentives. These include feed-in tariffs, research and development subsidies and quotas. As a strategic emerging industry, the biomass power generation industry has developed more slowly than other renewable energy technologies, as shown in Figure 1. Therefore, the research questions of this paper are as follows: What are the factors leading to the slow development of the biomass power generation industry? What is the effect? Can government subsidies promote biomass energy investment? The motivation of this paper is to examine the impact of policy effects on the deployment of biomass power generation industries. To answer these questions, this paper selects a system dynamic approach to analyze policy effects on the adoption of biomass power technology. The research results of this paper can provide decision support for biomass energy investors. In addition, for policy makers, the top-level design of the system can be carried out in a scientific and reasonable way when making relevant policies.

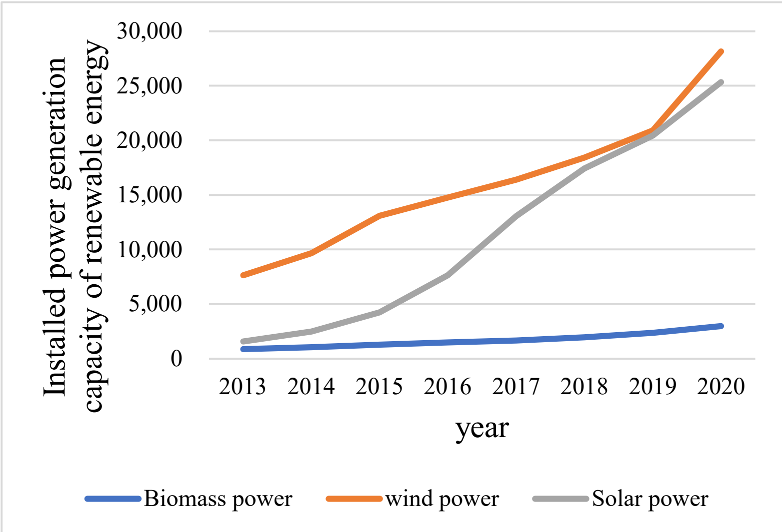

Figure 1. The installed capacity of renewable energy (unit: kW). (Source: China Electricity Council (https://www.cec.org.cn/, accessed on 26 October 2022).

1.2. Literature Reviews

The related research topics of the biomass power generation industry include the development status, cost problems of the biomass power generation industry, policy effects, investment decisions, environmental impacts, etc.

First, a review of the relevant research on the development status of the biomass power generation industry was conducted, since the industry has gradually gained attention. For example, Guan et al. [5] reviewed the problems existing in the development of the biomass industry and believed that in order to ensure the healthy development of the biopower industry, various policy combinations and government policies should be consistent. Lin and He [6] analyzed the feasibility of biomass power generation projects and believed that biomass power generation projects could have a great development potential in bioenergy-rich areas. Ref. [1] studied the diffusion of biomass energy technology and showed that resource potential and economic factors were the main reasons affecting the diffusion of technology. Liu et al. [7] believed that the biomass power generation industry faces the problem of a high production cost during the development process, so the future development of the industry needs to be improved regarding financing, the level of technological progress and the industrial chain. Zhao and Yan [8] believed that the advantages of China's biomass power generation industry lie in its abundant biomass resources, while the disadvantages lie in its high power generation cost and installation cost.

Second, in terms of cost, relevant studies have calculated the investment cost of biomass power using learning curves. This research shows that the learning effect caused by the accumulation of experience in the biomass energy industry can significantly reduce the cost [9]. For example, Nevzorova et al. [10] investigated the source of the driving force of biogas power in mature markets using the technology innovation system, and they found that policy support and technical capacity were the primary driving factors of the biomass power. Lin and He [9] calculated the investment cost of the biomass power generation industry by using a learning curve, and the results showed that cost reduction was the reason for the rapid development of biomass power generation.

Third, there is a focus on policy effect evaluation. Zhang et al. [11] analyzed the development prospect of biomass from the perspective of cost effectiveness and believed that high fuel cost was one of the main factors affecting biomass power generation. Irfan et al. [12] believed that biomass power generation industry development should be improved regarding the aspects of the financial mechanism, environmental awareness, policy incentives, and technology. Borges et al. [13] believed that information dissemination is important in the diffusion of biomass power generation technology and that the lack of relevant incentive production and R&D policies is a major reason for the slow diffusion rate.

Fourth, regarding the investment decision of bio-power projects, government policies generally encourage the development of the biomass power generation industry through financial rewards, thereby raising the enthusiasm of biomass energy investors. For example, Zhang et al. investigated the deployment of the biomass power industry through the lens of renewable energy incentive policies, and their findings revealed that, when compared to the feed-in tariff policy, the renewable energy quota policy could promote the development of the biomass power generation industry in the long run [14]. Biomass power generation project investors' perceptions of investment risk, income and other factors determine their decision-making behavior. Since the investment process has an uncertainty problem, this delays the investors' investment decision. For example, [15] believed that the adoption of renewable energy technology can be studied from the perspective of investors, and the key factors affecting the decision-making behavior of investors are risk and return. Wang et al. [16] used the real option model to investigate the uncertainty in the investment process of the biomass power generation industry. The study showed that government subsidies could stimulate the investment enthusiasm of biomass investors; however, despite full government subsidies, a difference still remained between the investment cost of biomass power and the market price. Liu et al. [17] indicated that the subsidy policy is critical to the development of the biomass power industry, and their results showed that with an increase in the investment subsidy, the scale of biomass grows rapidly.

As for the environmental benefits, some researchers investigating the potential of carbon emission reduction, such as He et al. [3], insisted that biomass energy to generate electricity can not only bring environmental benefits but also control greenhouse gas emissions. Ref. [18] analyzed the biomass power generation industry from the perspective of environmental benefits, and the results revealed that biomass power generation reduced GHG emissions.

1.3. Contributions and Innovations

Over time, the existing research has laid the foundation for the development of the biomass energy industry. However, compared with this related research, the contribution and innovations of this study are summarized as follows.

(1) The existing literature analyzed the technical and economic problems of the biomass power generation industry [19]; however, the problem of the diffusion of the biomass power industry from the perspective of technology adoption is lacking. Thus, this paper studies the adoption behavior of biomass power from the perspective of technology diffusion. At the same time, the related factors affecting the diffusion of biomass power technology are dynamically analyzed in order to clarify the diffusion mechanism.

(2) In order to understand the influence of policy effects on the diffusion of biomass power projects, this paper constructs a system dynamics model to explore the influence of

the interaction of the influencing factors on the diffusion, to provide support for investors' decisions.

2. Materials and Methods

In 2020, the National Development and Reform Commission and other departments issued the "*Implementation Plan on Improving the Construction and Operation of Biomass Power Generation Projects*", which showed that biomass power projects have attracted much attention [20]. This is the reason why this study chose the biomass power projects as a case study. The detailed reasons are as follows: Firstly, from the perspective of resource endowment, biomass energy resources are relatively abundant. Secondly, the biomass power industry has good environmental benefits. Given the targets for carbon peak and carbon neutrality, the development of biomass power technology can help to achieve the dual carbon target. Finally, biomass power generation has good economic benefits, and biomass power investors can bring considerable economic benefits to the resource endowment area by recycling biomass energy resources. Therefore, the large-scale deployment of biomass energy projects has reference significance for biomass energy diffusion in other regions.

2.1. Reasons for System Dynamic Model

Forrester of Massachusetts Institute of Technology first proposed system dynamics in 1956 [21]. System dynamics (SD) aims to analyze an information feedback system and understand its future development trend by imitating the internal structure and development dynamic behavior in the real world [22]. So system dynamics is suitable for the study of renewable energy technology. The advantages of this method are that it has the characteristics of dynamic feedback mechanism, which can well reflect the influence of key variables in the system on the whole system [23]. The diffusion of biomass power is also a complex social system, which involves many influences, and there are interaction behaviors between different factors that make the process show complexity characteristics. On the other hand, system dynamics aims at understanding the relationships among factors in the system and the decision-making behavior of the subject, rather than the pursuit of prediction accuracy. It is also called a "policy laboratory". Due to these advantages, system dynamics is widely used in renewable energy policy evaluation [24]. Moreover, the research topic of this paper conforms to the research paradigm of system dynamics method. Therefore, this paper chooses the SD model to investigate the dynamic diffusion process of biomass projects.

2.2. Model Construction

2.2.1. Model Description

The diffusion of biomass power generation technology is essentially an investment behavior, so investment willingness determines the decision behavior of investors [24]. However, there are many factors influencing investors' decision-making behavior, and this paper only examines the impact of key factors on the diffusion of biomass power generation technology. When measuring the diffusion level, existing studies usually use the installed capacity scale to characterize the diffusion level of renewable energy technologies [25,26]. Therefore, the installed capacity of biomass power is chosen to characterize the diffusion level in this paper.

When making investment decisions, investors usually consider the benefits and risks of investing in biomass power generation projects. Therefore, return on investment is an important factor affecting the promotion of biomass power projects [14]. Accordingly, the diffusion process of biomass power projects is shown in Figure 2. Since biomass power generation projects require high initial investment costs, government incentive policies are needed to support their development. Government policies can increase investment income for investors in biomass power projects. Investment in biomass power projects, driven by considerable income, can increase investors' enthusiasm for investment and making investment decisions.

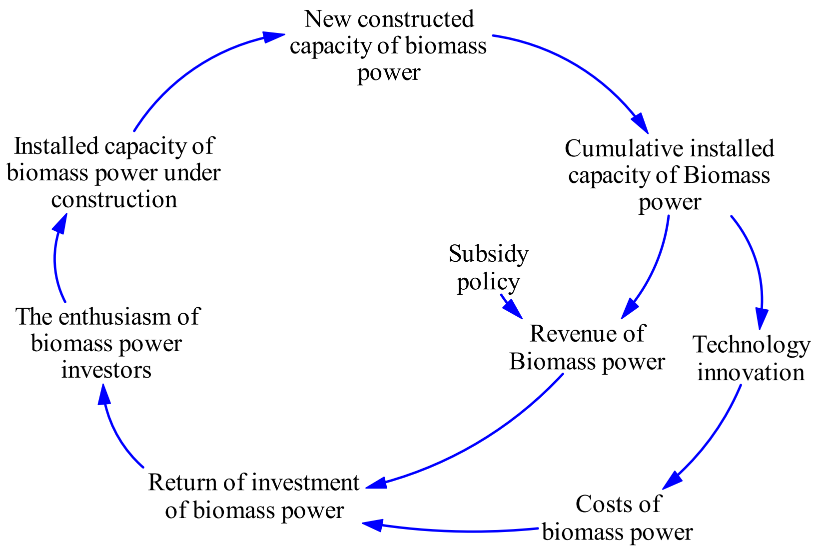

Figure 2. Causal loop diagram.

Finally, with the increase in investment in biomass power projects, the installed capacity of biomass power projects increases, to achieve the diffusion process. On the other hand, the impact of technological progress on the proliferation of biomass power projects reduces investment costs, as knowledge and experience accumulate during the installation of biomass power generation technologies, which is known as the effect of learning by doing. Biomass industry technological progress causes investment cost to reduce, which increases investors' return on investment for improvement of biomass power generation projects, boosts the enthusiasm lever of potential investors and also make more investors participate in biomass power generation projects, thus increasing the installed capacity of biomass power.

2.2.2. Mathematical Model

(1) Installed capacity of biomass power projects

$$CIC_{t,biomass} = CIC_{initial,biomass} + \int (NIC_{t,biomass} - DIC_{t,biomass})dt \quad (1)$$

$$DIC_{biomass} = CIC_{biomass} / LS_{biomass} \quad (2)$$

$$ICC_{biomass} = \int (IR_{biomass} - NIC_{biomass})dt \quad (3)$$

$$IC_{new,biomass} = Delay1(ICC_{biomass}, time) \quad (4)$$

where CIC_t denotes the cumulative constructed capacity of biomass power projects, NIC is new constructed capacity of biomass power projects, DIC is the depreciated capacity of biomass power projects over time, LS is working years during the life cycle of a biomass power project, and ICC denotes the installed capacity under construction of biomass power.

(2) Revenue composition of biomass power projects

For investors of biomass power projects, their income mainly comes from the income of electricity sales and the income generated by reducing carbon emissions. Since biomass power generation technology has great potential to mitigate the greenhouse effect, greenhouse gas emissions can be reduced through biomass power generation. Ahmad et al. [27] believed that renewable energy generation can avoid carbon emissions, so the reduced carbon emissions can be taken into account regarding the investment income of investors.

For the carbon trading market, the Chinese government has set up seven pilot cities. Therefore, reduced greenhouse gas emissions from biomass power projects can bring additional returns to investors in biomass power projects. Therefore, this paper considers the benefits of carbon emission reduction. The main formulas are as follows:

$$G_{power} = CIC \times h \tag{5}$$

$$R = R_{electricity} + R_{carbon} \tag{6}$$

$$PG = (G_{power} - EC) \times (1 - lr) \tag{7}$$

$$R_{electricity} = FIT_{biomass} \times PG_{biomass} \tag{8}$$

$$R_{carbon} = P_{ce} \times C_{effi} \times PG_{biomass} \tag{9}$$

where $R_{electricity}$ denotes the revenue from selling the electricity, R_{carbon} is the income from the sale of the reduced carbon emissions, PG is the amount of electricity that is connected to the grid system, EC is the biomass power plant self-consumption rate, and lr denotes the line loss rate.

(3) Cost composition of biomass power projects

For biomass power projects, cost is mainly composed of biomass equipment investment cost, material cost, and operation and maintenance cost. Therefore, the detailed formula is shown as follows:

$$TC = In_{cost} + Material_{cost} + OM_{cost} \tag{10}$$

where In_{cost} is investment cost of biomass power, $Material_{cost}$ denotes the cost of material, and OM_{cost} is the operation and maintenance cost during the lifetime. In renewable energy technology research, learning curve is often used to measure the impact of technological progress on cost.

The learning curve was first proposed by Wright [28], which means that the unit cost of a certain technology decreases with the accumulation of production experience. The calculation of equipment investment cost conforms to the general rule of learning curve, so it can be calculated by means of learning curve. The detailed formula is as follows:

$$In_{Cost,biomass} = A \times CIC^{\alpha}_{t,biomass} \tag{11}$$

$$LnIn_{Cost,biomass} = LnA + \alpha LnCIC_{t,biomass} \tag{12}$$

$$LR = 1 - 2^{\alpha} \tag{13}$$

where LR is the learning rate of biomass power, and $^{\alpha}$ is a coefficient.

Existing studies show that due to the disclosure of relevant data in the biomass power industry and other related reasons, there are certain difficulties in obtaining relevant data, and there are numerical differences in the learning rate estimated by the learning curve [3]. According to the research results of [9], the value range of coefficient is roughly between 5.6% and 7.8%. According to the research results of [29], the coefficient of biomass power in China is roughly 0.48. Yu-zhuo et al. [14] also assumed the value of coefficient is 0.48. In summary, according to the results of existing studies on the coefficient of biomass power generation industry, this value is roughly between 0.02 and 0.48 [3,14,30,31]. He [3] believed that there were great differences in the learning rate values of different studies, which were mainly explained by the stage of technological progress and the different types of technological maturity. Due to space limitations, only the main equations are listed. The rest of coefficient of this paper can be found in the Supplementary Materials.

3. Results

(1) Effect of different subsidy levels on installed capacity

This study set three scenarios to investigate the effect of different subsidy levels on the installed capacity of the biomass power industry. We evaluated the change in the installed capacity of biomass power generation projects under different subsidy policy scenarios by floating 10% or less under the benchmark scenario as a reference. The feed-in price subsidy in the benchmark scenario is set at 0.75 RMB/kWh. As shown in Figure 3, the feed-in tariff subsidy policy positively correlates with the installed capacity of biomass power generation projects. Higher levels of feed-in tariffs have increased investor interest, resulting in an increase in the installed capacity of physical power projects. The higher the subsidy level is, the greater the installed capacity of biomass power projects is, and vice versa. The reason is that the feed-in tariff subsidy is a direct financial subsidy policy, which provides corresponding capital support to biomass investors according to the power generation and can enhance the investment enthusiasm of investors. In addition, under the subsidy mechanism, investors in biomass power generation projects can obtain stable and expected investment returns. Therefore, the smaller the perceived investment risk is, the more investors are interested in investing in biomass generation projects. Figure 4 shows that the higher the subsidy price level is, the higher the revenue is, from which investors in biomass power generation projects can obtain profit. Driven by expected profits, investors are also more willing to invest in biomass power projects.

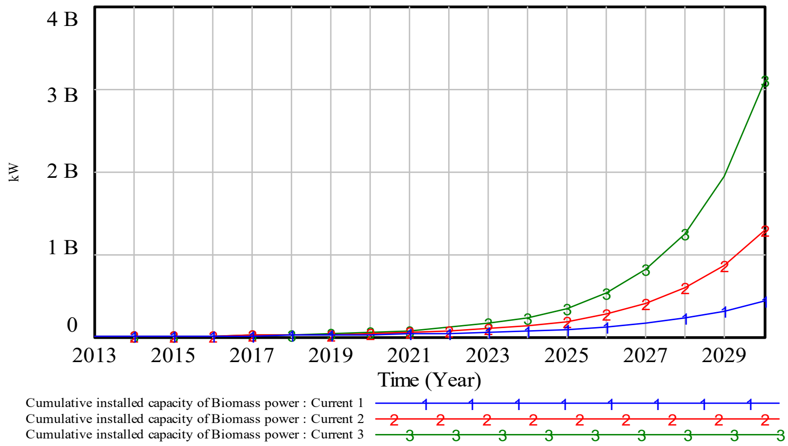

Figure 3. The cumulative installed capacity of biomass power under subsidy scenarios.

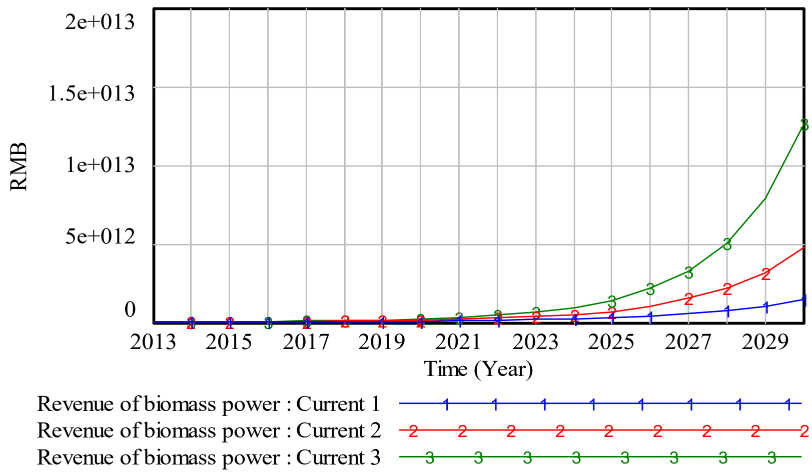

Figure 4. The revenue of biomass power projects under the subsidy scenarios.

(2) Effect of different carbon price levels on installed capacity

To evaluate the impact of carbon emission trading on biomass power project investment, this paper considers the effect of different carbon price levels on the biomass power generation. According to Figures 5 and 6, The carbon price level also has a significant impact on the installed capacity of biomass power generation projects. Specifically, the higher the carbon price is, the installed capacity of biomass power projects also increases. This is mainly because carbon price can increase the additional income of investors in biomass power generation projects. With the increase in profits level, investors' perception of future investment income can reduce investment risk, so they are willing to invest in biomass power generation projects.

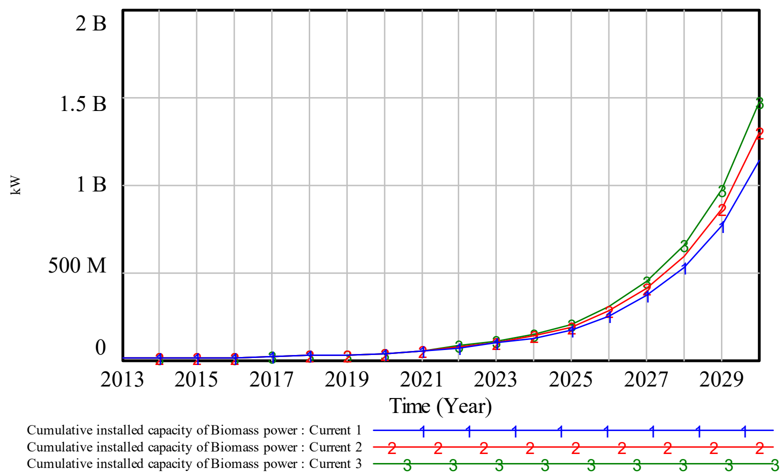

Figure 5. Cumulative constructed capacity of biomass power under the carbon price.

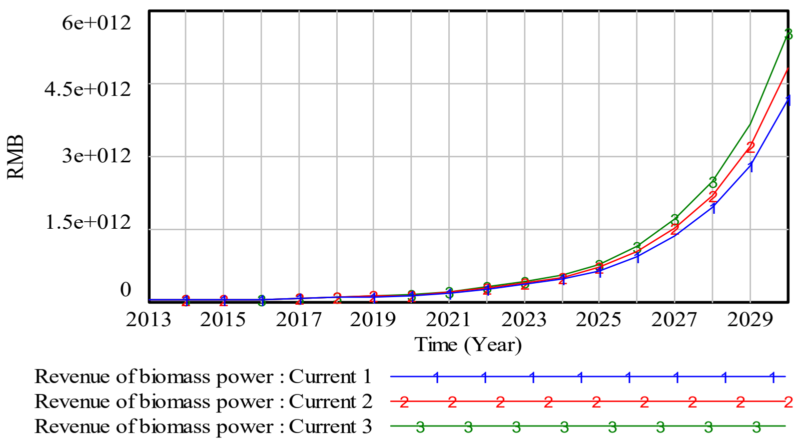

Figure 6. Revenue of biomass power projects under carbon price scenarios.

4. Discussion

To prove the scientific rationality of the research results of this paper, this paper is compared with the relevant research. Consistent with [14], the feed-in tariff subsidy policy boosts the growth of the installed capacity of renewable energy, because the feed-in tariff can compensate for the capital input of investors, thus producing reasonable profit returns. This is also the reason why the feed-in tariff policy significantly promotes the rapid development of the biomass power generation industry. However, with the improvement in the technological innovation level of the biomass power generation industry, the investment cost changes dynamically. Therefore, the level of government subsidy policy should be adjusted in a timely manner, according to the dynamic change of the biomass power generation cost.

In terms of carbon trading policies, Zhang et al. [29] believed that the revenue from carbon emission reduction can improve the investment value of renewable energy power projects. China's carbon trading market is currently in the stage of cultivation and development, so the design of relevant market institutional parameters needs to be constantly improved, which is conducive to carbon trading as a market-based tool to promote the development of the biomass power generation industry. Therefore, it is important for policy makers to improve the relevant institutional norms of the carbon trading market to promote renewable energy technologies. Therefore, the research conclusion of this paper is reasonable, to some extent.

Finally, technological innovation is a source of cost reduction. To improve the technology innovation of the biomass industry, policy makers should strengthen research and development subsidies for the biomass power industry, especially for the technological innovation of core equipment.

5. Conclusions

In order to alleviate the environmental problems caused by greenhouse gas emissions, the Chinese government has put forward ambitious targets for carbon peaking and carbon neutrality. As a kind of clean energy, biomass power generation can improve environmental quality; on the other hand, the development of the biomass power industry has good economic benefits. Therefore, the biomass power generation industry has a wide range of development scenarios under the double carbon targets. In order to study the diffusion of biomass power generation technologies under different policies, a system dynamics model is constructed to study the dynamic effects of policies on the diffusion level. According to the simulation results in this paper, the following conclusions can be drawn. First, the feed-in tariff policy can significantly promote the installed capacity growth of biomass power generation projects. With the increase in the subsidy level, the investment enthusiasm of biomass power generation investors is high, which expands the investment scale of biomass power generation projects. Second, carbon emission trading increases the investment value of the project and promotes the growth of the installed capacity of biomass power generation projects, to a certain extent.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su15021723/s1, Table S1: The explanation of relevant variables; Table S2: The key varia-ble's value.

Author Contributions: Conceptualization, methodology, software, formal analysis, writing—original draft, visualization, resources, data curation, W.W.; validation, investigation, funding acquisition, supervision, project administration, Z.X.-g.; formal analysis, writing—original draft, visualization, H.S.; formal analysis, writing, L.X. All authors have read and agreed to the published version of the manuscript.

Funding: This paper is supported by the Beijing Municipal Social Science Foundation (No. 16JDYJB031), the Fundamental Research Funds for the Central Universities (No. 2020YJ008) and the Fundamental Research Funds for the Central Universities (No. 2018ZD14).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: Many thanks to the editor for their time and effort in processing this manuscript and also many thanks to the anonymous reviewers for their valuable comments.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Zhang, M.; Zhou, D.; Ding, H.; Jin, J. Biomass power generation investment in China: A real options evaluation. *Sustainability* **2016**, *8*, 563. [CrossRef]
2. Li, Y.; Lin, J.; Qian, Y.; Li, D. Feed-in tariff policy for biomass power generation: Incorporating the feedstock acquisition process. *Eur. J. Oper. Res.* **2023**, *304*, 1113–1132. [CrossRef]
3. He, J.X. The Efficiency and Prospect of Biomass Power Development in China. Ph.D. Thesis, Xiamen University, Xiamen, China, 2019. (In Chinese).
4. He, J.; Zhu, R.; Lin, B. Prospects, obstacles and solutions of biomass power industry in China. *J. Clean. Prod.* **2019**, *237*, 117783. [CrossRef]
5. Guan, Y.; Tai, L.; Cheng, Z.; Chen, G.; Yan, B. Biomass molded fuel in China: Current status, policies and suggestions. *Sci. Total Environ.* **2020**, *724*, 138345. [CrossRef]
6. Lin, B.; He, J. Is biomass power a good choice for governments in China? *Renew. Sustain. Energy Rev.* **2017**, *73*, 1218–1230. [CrossRef]
7. Liu, J.; Wang, S.; Wei, Q.; Yan, S. Present situation, problems and solutions of China's biomass power generation industry. *Energy Policy* **2014**, *70*, 144–151. [CrossRef]
8. Zhao, Z.Y.; Yan, H. Assessment of the biomass power generation industry in China. *Renew. Energy* **2012**, *37*, 53–60. [CrossRef]
9. Lin, B.; He, J. Learning curves for harnessing biomass power: What could explain the reduction of its cost during the expansion of China? *Renew. Energy* **2016**, *99*, 280–288. [CrossRef]
10. Nevzorova, T.; Karakaya, E. Explaining the drivers of technological innovation systems: The case of biogas technologies in mature markets. *J. Clean. Prod.* **2020**, *259*, 120819. [CrossRef]
11. Zhang, Q.; Zhou, D.; Zhou, P.; Ding, H. Cost analysis of straw-based power generation in Jiangsu Province, China. *Appl. Energy* **2013**, *102*, 785–793. [CrossRef]
12. Irfan, M.; Zhao, Z.-Y.; Panjwani, M.K.; Mangi, F.H.; Li, H.; Jan, A.; Ahmad, M.; Rehman, A. Assessing the energy dynamics of Pakistan: Prospects of biomass energy. *Energy Rep.* **2020**, *6*, 80–93. [CrossRef]
13. Borges, C.P.; Sobczak, J.C.; Silberg, T.R.; Uriona-Maldonado, M.; Vaz, C.R. A systems modeling approach to estimate biogas potential from biomass sources in Brazil. *Renew. Sustain. Energy Rev.* **2021**, *138*, 110518. [CrossRef]
14. Yu-Zhuo, Z.; Xin-Gang, Z.; Ling-Zhi, R.; Ji, L.; Ping-Kuo, L. The development of China's biomass power industry under feed-in tariff and renewable portfolio standard: A system dynamics analysis. *Energy* **2017**, *139*, 947–961. [CrossRef]
15. Dinica, V. Support systems for the diffusion of renewable energy technologies—An investor perspective. *Energy Policy* **2006**, *34*, 461–480. [CrossRef]
16. Wang, X.; Cai, Y.; Dai, C. Evaluating China's biomass power production investment based on a policy benefit real options model. *Energy* **2014**, *73*, 751–761. [CrossRef]
17. Liu, D.; Liu, M.; Xiao, B.; Guo, X.; Niu, D.; Qin, G.; Jia, H. Exploring biomass power generation's development under encouraged policies in China. *J. Clean. Prod.* **2020**, *258*, 120786. [CrossRef]
18. Hiloidhari, M.; Baruah, D.C.; Kumari, M.; Kumari, S.; Thakur, I.S. Prospect and potential of biomass power to mitigate climate change: A case study in India. *J. Clean. Prod.* **2019**, *220*, 931–944. [CrossRef]
19. He, J.; Liu, Y.; Lin, B. Should China support the development of biomass power generation? *Energy* **2018**, *163*, 416–425. [CrossRef]
20. Improve the Implementation Plan of Biomass Power Generation Project Construction and Operation. 2020. Available online: http://www.gov.cn/zhengce/zhengceku/2020-09/16/content_5543821.htm (accessed on 1 October 2022).
21. Forrester, J.W. Counterintuitive behavior of social systems. *Theory Decis.* **1971**, *2*, 109–140. [CrossRef]
22. Selvakkumaran, S.; Ahlgren, E.O. Review of the use of system dynamics (SD) in scrutinizing local energy transitions. *J. Environ. Manag.* **2020**, *272*, 111053. [CrossRef]
23. Zhang, L.; Chen, C.; Wang, Q.; Zhou, D. The impact of feed-in tariff reduction and renewable portfolio standard on the development of distributed photovoltaic generation in China. *Energy* **2021**, *232*, 120933. [CrossRef]
24. Yu, X.; Ge, S.; Zhou, D.; Wang, Q.; Chang, C.T.; Sang, X. Whether feed-in tariff can be effectively replaced or not? An integrated analysis of renewable portfolio standards and green certificate trading. *Energy* **2022**, *245*, 123241. [CrossRef]
25. She, Z.Y.; Cao, R.; Xie, B.C.; Ma, J.J.; Lan, S. An analysis of the wind power development factors by Generalized Bass Model: A case study of China's eight bases. *J. Clean. Prod.* **2019**, *231*, 1503–1514. [CrossRef]
26. Lu, Z.Y.; Li, W.H.; Xie, B.C.; Shang, L.F. Study on China's wind power development path—Based on the target for 2030. *Renew. Sustain. Energy Rev.* **2015**, *51*, 197–208. [CrossRef]
27. Ahmad, S.; Tahar, R.M.; Muhammad-Sukki, F.; Munir, A.B.; Rahim, R.A. Role of feed-in tariff policy in promoting solar photovoltaic investments in Malaysia: A system dynamics approach. *Energy* **2015**, *84*, 808–815. [CrossRef]
28. Wright, T.P. Factors affecting the cost of airplanes. *J. Aeronaut. Sci.* **1936**, *3*, 122–128. [CrossRef]
29. Zhang, M.; Tang, Y.; Liu, L.; Zhou, D. Optimal investment portfolio strategies for power enterprises under multi-policy scenarios of renewable energy. *Renew. Sustain. Energy Rev.* **2022**, *154*, 111879. [CrossRef]

30. Wene, C.O. *Experience Curves for Energy Technology Policy*; International Energy Agency (IEA): Paris, France, 2000.
31. Junginger, M.; Faaij, A.; Björheden, R.; Turkenburg, W. Technological learning and cost reductions in wood fuel supply chains in Sweden. *Biomass Bioenergy* **2005**, *29*, 399–418. [CrossRef]