Research on the Current Situation of Renewable Energy Investment In China

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Abstract. Vigorously investing in and developing renewable energy is a strategic measure for countries to solve energy security problems and cope with climate warming. This paper describes the investment status of commercial banks, government agencies, securities markets, public-private partnership mode and international financial institutions in the field of renewable energy in China. Then it analyses the investment channels and distribution areas and gives corresponding policy recommendations. This study can provide reference for the further development of renewable energy in China and other countries.

1. Introduction
Under the dilemma of increasingly tense international energy situation and increasingly serious climate problems, the development of renewable energy has become a strategic measure for most countries in the world to promote energy transformation and cope with climate change[1]. Take the most widely applied renewable energy power industry as an example. By the end of 2017, the global installed capacity of renewable energy power was 2195GW, with 650GW ranking first in China. In 2017, the annual power generation of renewable energy reached 26.5% of the total power production both in the word and in China, which shows that renewable energy has gradually replaced fossil energy as the development trend.

The adjustment of fossil energy to renewable energy cannot be separated from the extensive investment of governments and social funds[2]. As a firm promoter of energy transformation and climate change, China's investment in renewable energy is particularly large. In 2017, the global investment in renewable energy power and fuel fields was US $279.8 billion, with China accounting for 45% of the total. This shows China's firm determination to develop renewable energy.

The purpose of this paper is to clarify the investment status of renewable energy in China. By analyzing the investment of commercial banks, government agencies, securities market, public-private partnership mode and international financial institutions in the field of renewable energy in China, we can provide reference for promoting the further development of renewable energy in China and other countries.

2. Research status of renewable energy in China

2.1. Commercial Banks
The rapid development of green credit in commercial banks has greatly improved the shortage of funds in the field of renewable energy. In many investment channels, commercial banks rank first with the investment amount of 980.106 billion RMB, accounting for more than 50%, which is very
important for the development of renewable energy in China. Considering commercial banks and policy banks comprehensively, we can find that the investment scale of China's banking system in the field of renewable energy is huge. According to the data released by China Banking Regulatory Commission, as of the end of June 2017, the total credits of 21 major banks in the renewable energy sector amounted to 1449.018 billion RMB, of which more than half were concentrated in the water energy sector.

2.2. Government Agencies

2.2.1. Financial input. Financial funds support the development of renewable energy through subsidies, transfer payments, tax incentives and other policy tools[3]. According to the national general public budget expenditure final statement published by the Ministry of finance of the people's Republic of China, from 2008 to 2017, the total financial investment of the central and local governments in the field of renewable energy reached 115.832 billion RMB.

2.2.2. Policy bank. In recent years, China's three major policy banks have vigorously developed green finance and granted a large number of loans to support renewable energy fields such as wind power and solar power generation. By the end of June 2017, China's policy banks’ total credit in this field has amounted to about 468.912 billion RMB, which means that nearly one third of the investment in renewable energy of 21 banks counted by the CBRC comes from the contribution of policy banks. Among them, China Development Bank is the main force to promote the development of renewable energy, with an accumulated investment of about 422.05 billion RMB, accounting for 90% of the credit balance of policy banks in the field of renewable energy. And The Export Import Bank of China and the Agricultural Development Bank of China have also increased their support for renewable energy projects, with cumulative investment of about 17.342 billion RMB and 29.520 billion RMB, respectively, producing significant environmental protection benefits.

2.2.3. Policy funds. At present, China's policy funds related to climate change are trying to guide private capital to invest in renewable energy through grants and paid use. The most important one is China Clean Development Mechanism Fund (CDM Fund). According to the 2017 annual report of CDM fund, as of the end of 2017, the fund has approved 265 entrusted loan projects, with a total loan fund of 16.311 billion RMB, 17% of which is used to support the development and utilization of clean energy.

2.3. Securities Market

2.3.1. Stock market. According to the statistics of the projects that listed companies invest in the renewable energy field after financing in the way of first-class market IPO, additional share issuance and share allotment in wind database, we can get the investment amount of listed companies in the renewable energy field through stock financing in 2000-2018 is 60.865 billion RMB, of which 44% flows to the wind energy field.

2.3.2. Bond market. Since 2016, China's green bond market has made rapid development, and the issuance scale has led the world. According to the statistics of renewable energy related projects under the category of "green bonds" in the wind database, from 2016 to 2018, China's listed companies invested 42.235 billion RMB in the renewable energy field through bond financing, of which more than 50% went to the water energy field.

2.4. Public-Private Partnership Mode
Public-private partnership mode aims to encourage private enterprises and private capital to participate in the construction of public infrastructure through the cooperation of government and social capital[4].
In 2016, NEA clearly proposed to actively promote public-private partnership mode in the field of energy. According to the classification of China's public-private partnership service platform, this paper divides renewable energy project sources into Ministry of finance project database, national development and Reform Commission project database and local project database. Among them, 85 renewable energy public-private partnership projects are led by the Ministry of finance, with an investment of 42.433 billion RMB, 90% of which are invested in the field of biomass energy; 32 projects are led by the national development and Reform Commission, with an investment of 21.47 billion RMB, 50% of which are invested in the field of biomass energy; 9 renewable energy public-private partnership projects in the local project database have an investment of 4.059 billion RMB, involving only biomass energy and solar energy.

2.5. International Financial Institutions

2.5.1. Multilateral bank. Since the 1990s, the world bank has been actively focusing on renewable energy[5]. According to the statistics of the world bank project database, from 1989 to 2018, the world bank participated in 27 renewable energy projects in China, with a total investment of 1055 million dollars. Among many renewable energy subdivisions, the world bank pays the most attention to the development of biomass energy, and nearly a third of the funds are invested in the field of biomass energy. As a regional financial institution in Asia and the Pacific, the Asian Development Bank has been actively concerned about the application scope and utilization efficiency of renewable energy, and has made it an important part of its business to help countries resist climate disasters or adapt to the impact of climate change[6]. According to the data on the official website of the Asian Development Bank, from 2002 to 2018, the bank participated in 32 renewable energy projects in China through direct investment and joint investment, with a total investment of 1.317 billion dollars, of which more than 40% was invested in the field of biomass energy. The European investment bank also provides assistance to China's renewable energy, greenhouse gas and other pollutant emission reduction projects. During 2008-2010, the European Investment Bank invested 470 million euros in three renewable energy projects in China, 42% of which was invested in wind energy.

2.5.2. Multilateral climate fund. Multilateral climate fund is also an important channel for the transfer of renewable energy funds[7]. Its funds mainly come from grants, loans, international taxes and charitable donations of governments. At present, it is mainly the global environment facility. By the end of 2018, the investment of GEF in China's renewable energy sector had amounted to 1.593 billion dollars, of which 30% was concentrated in the field of biomass energy.

2.6. Conclusion

From the perspective of funds invested by various investment channels in renewable energy, commercial banks play an important role, ranking first with 56% of the total. Government agencies account for one third, which is mainly due to the extensive investment of policy banks represented by the National Development Bank. Although the securities market started late, it developed very rapidly. Public-private partnership mode plays a complementary role and can actively guide social capital to invest in renewable energy. Multilateral banks and the global environment facility also attract some international funds to support the development of renewable energy in China. In terms of the subdivision of renewable energy, at present, the main investors are most interested in the field of water energy, with nearly half of the funds flowing to the field of water energy, followed by wind energy, solar energy and biomass energy. Due to the low degree of resource exploration and utilization, China's current investment in the field of geothermal energy is very small[8].

| Table 1. Current situation of renewable energy investment in China a. |
|-----------------|-----------------|-----------------|-----------------|-----------------|
| **Investment channels** | **Investors** | **Total** | **Subdivision field** |
| Biomass energy | Geothermal energy | Wind energy | Water power | Solar energy |

- a.
3. Analysis and suggestions

3.1. Analysis of investment status

3.1.1. Diversified investment channels. From the perspective of investment channels of renewable energy, China has formed a multi-channel and multi-body diversified renewable energy investment system. Abundant capital sources and active investment enthusiasm have made China’s renewable energy industry achieve rapid development.

Commercial banks are the main force of renewable energy development in China. 56% of China’s renewable energy investment comes from the contribution of commercial banks, totaling 980.106 billion RMB. On the one hand, with the continuous optimization of the green credit system, commercial banks are increasingly concerned about the development of renewable energy; on the other hand, due to the improvement of renewable energy technology and the gradual improvement of supporting grid infrastructure, the risk of commercial banks’ investment in renewable energy has declined. Therefore, it is very important for the development of renewable energy industry to reasonably arrange the scale of credit funds of commercial banks.

Government organs provide credit support for renewable energy projects, which can form a win-win situation of achieving emission reduction goals and overcoming financial obstacles. From the perspective of specific investors, the financial funds represented by CDM fund are innovation of financing methods for renewable energy projects, which can form a win-win situation of achieving emission reduction goals and overcoming financial obstacles.

The analysis of specific individuals and enterprises shows that renewable energy, but also play an. The policy funds represented by CDM fund are innovation of financing methods for renewable energy projects, which can form a win-win situation of achieving emission reduction goals and overcoming financial obstacles. From the perspective of specific investors, the financial funds represented by CDM fund are innovation of financing methods for renewable energy projects, which can form a win-win situation of achieving emission reduction goals and overcoming financial obstacles.

The securities market, Public-private partnership mode and international financial institutions have played a good complementary role in the development of renewable energy. Listed companies invest in renewable energy by issuing shares and green bonds, but the share of securities market in the.

| Financial fund | CDM fund | Stock market | Bond market | Agricultural Development Bank of China | Export-Import Bank of China | China Development Bank | National Development and Reform Commission |
|----------------|----------|--------------|-------------|--------------------------------------|---------------------------|----------------------|---------------------------------------------|
| 1158.22        | 27.73    | 608.65       | 420.35      | 295.20                               | 173.42                    | 4220.50              | 424.33                                      |
| 9801.06        | -        | 26.98        | 12.14       | -                                    | -                         | -                    | 387.55                                      |
| -              | -        | 0            | 0           | 0                                    | 11.65                     | 0                    | 25.13                                       |
| -              | -        | -            | 0           | -                                    | -                         | -                    | 9.20                                        |
| -              | -        | -            | -           | -                                    | -                         | -                    | -                                           |
| -              | -        | -            | -           | -                                    | -                         | -                    | -                                           |
| -              | -        | -            | -           | -                                    | -                         | -                    | -                                           |
| -              | -        | -            | -           | -                                    | -                         | -                    | -                                           |
| -              | -        | -            | -           | -                                    | -                         | -                    | -                                           |
| -              | -        | -            | -           | -                                    | -                         | -                    | -                                           |
| -              | -        | -            | -           | -                                    | -                         | -                    | -                                           |
| -              | -        | -            | -           | -                                    | -                         | -                    | -                                           |
| -              | -        | -            | -           | -                                    | -                         | -                    | -                                           |
| -              | -        | -            | -           | -                                    | -                         | -                    | -                                           |
| -              | -        | -            | -           | -                                    | -                         | -                    | -                                           |

- The unit of measurement is 100 million RMB. The investment amount of renewable energy of international financial institutions is converted from the average exchange rate of USD / RMB or EUR / RMB in the current year, among which the average exchange rate in 2018 has not yet been published, so the exchange rate at the end of the period is used instead. The year interval of each investor's investment in renewable energy is calculated based on the data published on the corresponding official website. Since there are no renewable energy projects in some years, the years are not consecutive.
overall investment of renewable energy is only 6% at this stage, which still needs to play its investment potential through financial product innovation. Public-private partnership mode provides an important medium for social capital to participate in renewable energy projects. It can not only reduce the government’s debt pressure, but also make social capital obtain certain benefits. International financial institutions are a powerful channel to transfer international funds to China, but from the result of their investment in renewable energy in China of only 27 billion, the attraction of renewable energy projects in China to international funds needs to be further enhanced.

3.1.2. Concentrated distribution. In terms of the distribution of renewable energy, China has achieved varying degrees of development in the fields of water energy, wind energy, solar energy, biomass energy and geothermal energy. However, there is a large gap in the distribution of funds in various subdivisions. Nearly half of the funds are concentrated in the field of water energy, and little attention is paid to biomass energy and geothermal energy.

The credit funds of the banking system are more inclined to the field of hydropower. 21 major banks have a large amount of investment in the field of renewable energy, accounting for 80% of the total investment in renewable energy with 1449.018 billion RMB, with 50% going to the field of hydropower and 30% to the field of wind energy. The investment of the securities market in the field of hydropower and wind energy is almost the same, accounting for nearly 40% of the share, which is mainly from the areas rich in water and wind resources. These two kinds of energy are easy to form large-scale development, and the cost of power generation is relatively low. In addition, the solar energy sector accounts for one seventh of the share in the banking system and the securities market, which is mainly due to the fact that solar energy has almost no restrictions on its geographical location. It can not only promote the use of distributed energy, but also combine with agriculture to form a diversified use. In addition, the photovoltaic power generation technology continues to mature, so the development prospect of solar energy is quite broad. The investment of Public-private partnership mode is concentrated in the field of biomass energy, accounting for three quarters of the share. This is mainly due to the low pollution, wide distribution and rich total amount of biomass energy. Therefore, the utilization form of biomass energy represented by waste incineration power generation project has a strong development momentum in recent years, but the popularity is insufficient, the collection method is backward and other factors, and the benefit of biomass energy. There are many limitations in using.

In general, renewable energy funds in China are currently concentrated in the fields of hydropower and wind energy, accounting for one-half and one-third of the share respectively. Thanks to the improvement of photovoltaic power generation technology and the highlight of cost advantage, the field of solar energy has developed rapidly in recent years, accounting for 14% of the total investment in renewable energy. Since most of Public-private partnership mode are invested in waste power generation projects, the biomass energy sector has also gained a place with 84.5 billion RMB. However, for the geothermal energy field, the low degree of resource exploration and utilization makes the current investment in the geothermal energy field in China very small. With the statistical caliber of only 3.8 billion investment, more attention is still needed.

3.2. Policy recommendations

3.2.1. Broaden investment channels and target investment fields. The rapid development of renewable energy cannot be separated from the strong subsidy of financial funds. However, due to the continuous decline of its use cost and the burden of subsidy funds ultimately transferred to consumers, the gradual withdrawal of financial subsidies in various countries is inevitable. In order to solve the huge capital demand of renewable energy development, expanding investment channels and innovating financial products are important means. For the banking system, we should continue to expand the scale of green credit, optimize the structure of green credit, and allocate more credit funds to the development and utilization of renewable energy. For the government, we should design a
reasonable subsidy mechanism to avoid the sharp decline and shake the confidence of investors in the development of renewable energy. For the securities market, we should encourage financial innovation, make full use of asset securitization products, financial derivatives and other means to guide the flow of funds to the field of renewable energy. For Public-private partnership mode, the Ministry of finance, the national development and Reform Commission and local platforms should further strengthen the promotion and encourage social capital to participate in renewable energy projects. In addition, the establishment of carbon trading market will also have a positive impact on the development of renewable energy. It will not only increase the consumption cost of traditional fossil energy, but also invest the gains from carbon trading market in renewable energy projects. In the future, the investment in renewable energy should pay more attention to the technological progress in the fields of grid connection and energy storage. Although the installed capacity of renewable energy is increasing rapidly year by year, the problem of "focusing on construction and light utilization" is more prominent, and the phenomenon of water, wind and light abandonment is widespread. This is mainly due to the fact that the technical management system for the coordinated development of renewable energy and other power sources has not yet been established, and there are technical barriers for large-scale grid connection of renewable energy power generation. It is very important to encourage funds to invest in grid connection technology research and development for the utilization of renewable energy. At the same time, we should also guide funds to vigorously carry out the research and development of energy storage technology, which will help to improve the utilization of renewable energy, an intermittent energy, and enhance the stability of the power system.

3.2.2. Promote the common development of multiple energy sources in the power industry and increase the application proportion of other industries. Due to the differences in resource endowments, the pace of development and utilization of biomass energy, wind energy, water energy, solar energy and geothermal energy varies from country to country. However, there are still some rich resources, but due to the limitations of capital and technology, the utilization degree is relatively low, such as geothermal energy field. We should promote the common development of multiple subdivision areas, gradually realize the development and utilization of renewable energy, and turn from single mode to multiple energy complementary mode[9]. Increase the application proportion of renewable energy in heating, cooling and transportation industries[10]. At this stage, the world generally focuses on the development of renewable energy power industry, and pays little attention to the heating and cooling industry and transportation industry, which accounts for 80% of the total energy consumption. Compared with the fossil fuel system, the use of renewable energy technologies for heating, cooling and transportation requires higher initial investment. Governments of all countries should issue strong industry support policies and formulate clear renewable energy heating and transportation objectives to accelerate the global energy transformation.

References
[1] Changsong Liu. (2017). Policy progress in the development of renewable energy in Germany and its implications. World Environment, (3), 78-81.
[2] Mazzucato, M., & Semieniuk, G. (2018). Financing renewable energy: Who is financing what and why it matters. Technological Forecasting and Social Change, 127, 8-22.
[3] Yunfei Yang. (2010). Study on the carbon emission mitigations policy instruments for low-carbon economy development. Lanzhou Academic Journal, (4), 25-29.
[4] Yibin Wang, Jin Xu, & Junlin Lu. (2018). The "321" safety management mode for public private partnership projects. Modern Occupational Safety, (8), 77-79.
[5] Martinot, E. (2001). Renewable energy investment by the World Bank. Energy Policy, 29(9), 689-699.
[6] Agrawala, S., & Van Aalst, M. (2008). Adapting development cooperation to adapt to climate change. Climate policy, 8(2), 183-193.
[7] Nakhooda, S., Norman, M., Barnard, S., Watson, C., Greenhill, R., Caravani, A., & Banton, G. (2014). Climate finance: Is it making a difference. A review of the effectiveness of multilateral climate funds. London: Overseas Development Institute.

[8] Fangshu Zhao, & Zhanning Liu. (2016). Discussion on development modes of shallow geothermal resources. Resources & Industries, 18(1), 32.

[9] Haizhu Zhou, Neng Zhu, Caixia Yang, & Fengfeng Wang. (2018). Comprehensive performance evaluation method of hybrid renewable energy system based on exergy theory. Building Energy Efficiency, 46(08), 53-58.

[10] Xue Han, & Runqing Hu. (2017). A brief introduction of renewable heating and regional power-heat coordination. Distribution & Utilization 34(12), 19-24.