Research on the Impact of Rooftop Photovoltaic on Reducing Carbon Dioxide Emissions

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Abstract: At present, the biggest environmental problem facing mankind is the rapid change of climate. In order to be able to mitigate climate change, we must attach importance to carbon reduction actions. China has taken many measures to adjust the energy structure to reduce petrochemical energy consumption and carbon emissions as much as possible. In the development of the power industry, the universal application of renewable resources such as solar energy can adjust and upgrade the traditional thermal power structure. The effective development of renewable resources such as solar energy can greatly reduce carbon dioxide emissions, which is an important measure to reduce carbon emissions. The establishment of solar photovoltaic power generation systems on the roof can improve the development level of China's photovoltaic power generation systems. At the same time, this can also reduce the energy consumption of coal-fired power, which is of great help in reducing carbon emissions. In the process of researching rooftop photovoltaic power generation systems, we need to analyze the importance of solar photovoltaic power generation. Meanwhile, we also need to explore the practical application of rooftop photovoltaic power generation systems, and conduct research and analysis on the factors affecting rooftop photovoltaic carbon emission reductions. Only in this way can we accurately grasp the impact of rooftop photovoltaics on carbon dioxide emissions, and provide a corresponding reference for promoting the widespread application of rooftop photovoltaic power generation systems.

1. The Significance of Solar Photovoltaic Power Generation
In the process of accelerating industrialization, China's economic development is getting faster and faster, the population is increasing, and the society is constantly improving. China is changing from a low energy consumption country to a high energy consumption country, and China's energy consumption is dominated by fossil energy. Among them, the consumption of coal energy accounts for up to 70% of the primary energy consumption. The application of coal is mainly direct combustion, which will lead to a significant increase in carbon dioxide emissions. At the present stage, China's power companies are still dominated by thermal power generation. Coal is the most consumed of fossil energy, and a large amount of greenhouse gases will be emitted into the atmosphere during the combustion of coal, which will lead to a sharp increase in carbon emissions. Therefore, in the development of the power industry, we need to reduce the energy consumption of coal-based electricity and promote the effective application of renewable energy such as solar energy. This is an important way to reduce carbon dioxide emissions [1].

In the process of adjusting China's energy structure, we must reduce the proportion of coal in the energy structure as much as possible, actively develop new and renewable energy sources, and promote energy diversification and clean development. Solar energy is a renewable energy source with a relatively large amount of clean energy. The theoretical value of solar radiation received on the land of
China each year can reach 1.47 to 108 billion kilowatt-hours. Moreover, solar energy is a pollution-free and clean energy. The use of solar energy for photovoltaic power generation will not produce any waste or an energy crisis. Therefore, vigorously promoting solar photovoltaic power generation systems can greatly reduce the pollution of carbon dioxide to the atmosphere. In the process of deteriorating ecological environment development and the current energy crisis is becoming more and more prominent, in order to promote the sustainable development of the energy industry, countries around the world are constantly increasing the development of renewable energy. Various countries have begun to study solar energy resources since the last century, and many countries have extensively developed and utilized solar energy sources. This can promote the sustainable development of the economy and energy. The solar photovoltaic industry is also the fastest and most stable development field in the world.

2. Overview of Rooftop Photovoltaic Power Generation System

At the present stage, in the application process of photovoltaic power generation systems, distributed photovoltaic power generation systems have the most extensive application range. It is also the main photovoltaic power generation project in the rooftop photovoltaic power generation system of urban buildings. However, this type of project must be connected to the public grid in the application process to provide electricity to users together with the public grid. If the roof of the building is relatively open, the exposure time is relatively long, and the influence of the orientation of the building is relatively small, the adverse impact of the application on the distributed photovoltaic power generation system can be minimized. According to the specific conditions of the distributed photovoltaic power generation system, solar cells can be prefabricated with bricks, coils and other building materials to become part of the building, which can improve the stability of the solar photovoltaic power generation system [2].

When applying the rooftop photovoltaic power generation system, first of all, we need to connect photovoltaic modules in series and parallel according to the characteristics of photovoltaic grid-connected. Second, connect to the lightning protection combiner box. At this time, the lightning protection combiner box can complete the secondary return connection to the DC power distribution cabinet according to the actual characteristics of the photovoltaic grid-connected inverter. The output of the output side of the DC power distribution cabinet directly corresponds to the DC input side of the photovoltaic grid-connected inverter. Finally, the photovoltaic grid-connected inverter can uniformly connect the AC output power to the AC power distribution cabinet after the inverter is completed. The AC power distribution cabinet will be connected to the step-up transformer system and the national high-voltage power grid. This is the main strategy for paralleling distributed photovoltaic power generation systems with the public grid. The working principle of grid-connected solar photovoltaic power generation system includes the following. First, in the application process of the solar cell module square array, the received light energy is converted into electric energy. Afterwards, the current passed through the DC distribution box into the grid-connected inverter is first loaded and used. If there is residual current, it can be supplied to power transformers and other equipment and stored in the public grid. This is a process of selling electrical energy. Second, during the application process of grid-connected photovoltaic system, because the light is relatively weak, the power generation is relatively small, and its own power consumption is large, the public grid sometimes in turn provides power to the AC load, which is the purchase of electrical energy the process of. Among them, the grid-connected inverter mainly includes power regulation, grid-connected protection switching AC, inverter, and charge and discharge control. In the application process of the system, we also need to design the display system, test system and monitoring system. In this way, not only can accurate statistics of various data such as electricity, but also the working status of each part can be monitored and detected. Furthermore, this can also use the computer network system to remotely control the file transfer process.
The grid-connected photovoltaic power generation system has no energy storage process in the application process. Compared with other photovoltaic power generation systems, its energy consumption is relatively small, which can save some space and costs. Hence, in the future solar photovoltaic power generation system application process, grid-connected power generation system is its main development trend, and it is also the most promising photovoltaic application project.

3. Factors Affecting the Carbon Emission Reduction of Rooftop Photovoltaic

3.1 Electricity Emission Factor
In different power grid regions, there are certain differences in the changing trends of emission factors of power systems. Because China's fossil fuels are mainly coal, oil, and natural gas. Among them, coal has the highest carbon emission coefficient, which will lead to more carbon emissions. In the process of China's continuous improvement of energy conservation and emission reduction technology, the corresponding energy conservation and emission reduction efforts have also been continuously increased. The proportion of fuel coal in the development of thermal power has been declining, and the grid emission factors in different regions are on a downward trend. In particular, the decline of the Northwest Power Grid is relatively large, and the reduction of the power emission factor will lead to a reduction in the carbon emissions of the baseline power generation, thereby improving the carbon emission reduction effect. Taking the rooftop photovoltaic power generation project as the research object, the calculation of its running time can accurately determine the carbon emission reduction of the project. When using the evaluation method to estimate the carbon emission reduction over the entire life...
of the project, including the electricity emission factor into the current year's emission factor for estimation will lead to a certain error in the calculation result of the carbon emission reduction. The actual carbon reduction is even greater [3].

3.2 Comprehensive Efficiency of Photovoltaic Power Generation System

The overall efficiency of photovoltaic power generation systems generally refers to the loss coefficient caused by different factors such as temperature changes, reduced battery transmittance, wire loss problems, and inverter efficiency. According to the research conducted by the International Energy Agency on grid-connected photovoltaic systems, we can find that the overall efficiency of grid-connected photovoltaic systems is usually between 0.6 and 0.8. When calculating the carbon emission reduction of the rooftop photovoltaic power generation project, the coefficients of 0.6 and 0.8 were selected to calculate the carbon emission reduction of the project. When the overall efficiency is 0.6, the carbon emission reduction is 1812.19tCO2e. The overall efficiency is 2416.26tCO2e of carbon emission reduction of the project. The choice of overall efficiency when calculating carbon emission reductions will have a greater impact on rooftop photovoltaic grid-connected systems. When calculating the actual carbon emission reduction and selecting the overall efficiency, we need to install the rooftop grid-connected photovoltaic system based on the best inclination angle. The recommended value of overall efficiency is 0.76. At this time, the carbon emission reduction value of 2265.24tCO2e may have a certain error with the carbon emission reduction during the actual operation of the project.

3.3 Temperature Difference

During the operation of the rooftop grid-connected photovoltaic power generation system, the temperature of the photovoltaic modules will change to a certain extent. Generally, the temperature is in the range of 20°C to 100°C, and the temperature power will change with the temperature. Normally, the higher the temperature, the lower the conversion efficiency and the lower the power. This will have a great impact on the power generation of the rooftop photovoltaic power generation system and the carbon emission reduction effect. In the application process of this project, the battery components used are polycrystalline silicon, and the battery power factor is 0.45%/°C. When the temperature is 20 degrees Celsius, its conversion efficiency is 22%, and the carbon emission reduction is 2831.55tCO2e. When the temperature rises by 1°C, the power coefficient drops by about 0.4%, and when the temperature rises to 120°C, the conversion efficiency drops to 12%, and the carbon emission reduction is also reduced to 1698.93tCO2e. When calculating the carbon emission reduction of the project, we will calculate the conversion efficiency of the module at 18%. If the temperature of the same photovoltaic module exceeds 25 degrees Celsius, the higher the module temperature, the carbon emission reduction effect of the photovoltaic system will be greatly affected. In consequence, we need to prevent the solar cell temperature from being relatively high as much as possible. We can increase the air flow around the components and reduce the heat of the components.

3.4 PV Module Differences

Differences in photovoltaic modules will also have a certain impact on the carbon emission reduction of rooftop photovoltaic power generation systems. According to different manufacturing materials and manufacturing processes, we can divide photovoltaic modules into crystalline silicon cells, CIGS cells and thin film cells. The photoelectric conversion efficiency and power generation performance of different types of photovoltaic cells are affected by weather changes and temperature changes. These will all have an impact on the amount of electricity generated, leading to differences in emission reduction effects. In the application process of batteries of different materials, the photoelectric conversion efficiency is different. This is an important factor affecting the power generation of rooftop photovoltaic power generation systems and the effect of carbon emission reduction. Crystalline silicon cells are relatively early developed and relatively mature types of photovoltaic modules, and their conversion efficiency can reach 17% to 22%. The new thin-film solar cells have relatively high manufacturing costs, relatively low photoelectric conversion efficiency, and relatively poor stability.
Because of the differences in photoelectric conversion efficiency and battery performance, the cumulative power generation in the application process is also quite different. Compared with crystalline silicon, the maximum power generation of thin-film batteries is 5.3%, and the minimum power generation is 3.7%. It is also greatly affected by the weather. During the period from March to May, there are more sunny days, and different types of batteries have relatively high power generation during this time period. In winter, the power generation capacity of crystalline silicon batteries is stronger than that of thin film batteries, and the power generation capacity can be about 10% higher, and the difference will gradually decrease and then continue to increase. From April to July each year, thin-film batteries are similar to crystalline silicon batteries, and can generate up to 17% more electricity. Second, the output characteristics of different types of batteries are similarly affected by changes in irradiance. However, the irradiance output characteristics of these three batteries in different seasons have certain differences. In winter, CIGS batteries have the largest changes, while thin-film batteries and crystalline silicon batteries have relatively small changes. In summer, the changes in thin-film batteries are relatively large, and the changes in crystalline silicon batteries and CIGS batteries are relatively small.

Third, there are certain differences in the effects of temperature and humidity on cells or photovoltaic modules of different materials. The main manifestation of the battery's temperature influence is the influence of the temperature coefficient on the battery power generation performance. The temperature coefficient of crystalline silicon and thin film batteries is generally -0.45% to 0.27%, and as the temperature continues to rise, the output power of crystalline silicon batteries will be greatly reduced. The temperature coefficient of CIGS battery is generally 0.3%-0.36%. Affected by temperature, its power generation is between thin film batteries and crystalline silicon batteries. However, the power generation of CIGS batteries is greatly affected by humidity, and the greater the humidity, the smaller the power generation [4].

3.5 Irradiation in Installation Area
In the application of solar photovoltaic cells, the radiation intensity of solar energy is the main factor affecting the power generation and application performance of photovoltaic power generation systems. If the irradiance fluctuates, the photovoltaic power generation will also change significantly. There is a direct relationship between the trend of power changes and the amount of solar radiation and the amount of power generated by the project, and they will have an impact on the carbon emission reduction effect. In the application process of the same photovoltaic power generation system, if the installation area is different, the carbon emission reduction effect will be very different. Because the illuminance of solar radiation in different areas is quite different. According to the abundance of solar energy, solar energy in different regions can be divided into 4 levels. Among them, the total annual radiation is relatively abundant in the central and western parts of Qinghai and the western part of the Hexi Corridor in Gansu. The total annual radiation in parts of China's eastern Sichuan Province and Guizhou and Yunnan provinces is relatively low. This leads to a certain difference in the power generation of photovoltaic power generation systems, which has an impact on the carbon emission reduction effect. Under the same other conditions, the rooftop photovoltaic system generates more power generation in areas with abundant solar energy resources, and its emission reduction effect is better [5].

4. Conclusion
All in all, we need to analyze the application characteristics of solar photovoltaic power generation systems, discuss the carbon emission reduction issues of rooftop photovoltaic grid-connected power generation systems, and conduct research and analysis on the carbon emission reduction effects that affect rooftop photovoltaic power generation systems from various aspects. This is conducive to providing a corresponding reference for the further research of China's rooftop photovoltaic power generation system, and is positively helpful to improving the application level of China's rooftop photovoltaic power generation system.
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