Photovoltaic building integration industry development trend analysis and forecast

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Abstract. In the context of the "carbon neutral" era, this study attempts to analyze and forecast the development trend of the photovoltaic building integration segment, comparing multiple factors so as to determine the mechanism behind the development of the segment's index and achieve the goal of effectively solving the problem of stock investment and realistic investment analysis in the field of photovoltaic construction. In this paper, firstly China PV building development pattern is analyzed, respectively from its own advantages of development, policy advantages, competitive pattern, etc., combined with policy research interpretation and model prediction, the future development trend of China PV building integration is summarized.

Keywords: Photovoltaic building integration, Development Trends, carbon neutral.

1. Introduction

China's Fourteenth Five-Year Plan and Vision 2035 outlines the achievement of "carbon peaking" by 2030 and "carbon neutrality" by 2060 as an important vision to combat global warming. In the "National 14th Five-Year Plan and 2035 Vision", it is proposed to achieve "carbon peak" by 2030 and "carbon neutrality" by 2060 as one of the important visionary goals to combat global warming in China [1-2]. Building Integrated Photovoltaic (BIPV) is a distributed photovoltaic power generation project that makes full use of industrial buildings and public buildings' rooftops, which plays an important role in achieving "peak carbon" and "carbon neutral" in China. At present, Beijing, Tianjin, Shanghai, Chongqing, Inner Mongolia, Zhejiang and other 31 places have issued policies related to PV building integration in the next three to five years, which will have a certain impact on the development of listed companies related to PV building integration [3].

For the investment industry, the change of listed companies will certainly drive the stock market trend. For the new sector of PV building integration, which is closely related to "Carbon Dafeng Carbon Neutral", how to apply modern information technology to predict the future development trend of the corresponding industry in this sector and make reasonable investment becomes an urgent problem to be solved [4-5].

In this paper, we try to establish a mathematical model to reasonably analyze and predict the development trend of the photovoltaic building integration sector in the context of the "carbon neutral" era, and establish reasonable indexes to modify the established model and compare multiple factors [6]. In order to determine the mechanism behind the development of the index of this sector, and to achieve the purpose of effectively solving the problems given in the topic and realistic investment analysis [7].

Photovoltaic people's thinking is investment thinking, is how large an area, how much installed, how much money a watt, how many degrees of electricity, and then how much a degree of electricity sold, if the construction sector to push photovoltaic, he first immediately thought of new buildings, we are now playing so many years are basically existing buildings home furnishing or renovation [8-9].Housing and construction sector will be combined with civil building analysis, these two parts to actually involve two very important role, the first is the architect, so that architects have products to choose from, there are atlases can be referred to, which is still more difficult [10]. There is also a role is the investor, why investors should choose PV. In addition, photovoltaic to be grid-connected to have subsidies, for the building unit, to find the grid, application, to get subsidies for this process is very complex. The current situation is policy-driven, carbon emission reduction tasks have begun to decentralize, the most important question is whether PV products are able to meet the needs of architects, followed by security cannot be guaranteed. Further is the aesthetics of the city, the service life and the green building related scoring.

2. Advantages of integrated photovoltaic buildings

According to the information of IEA database, about 44% of the global carbon dioxide emissions are from burning and using coal, about 34% from oil consumption, and about 21% from burning and using natural gas, which are more than 99% of the carbon emissions from the three major energy sources, and the carbon emissions from the highest sector is 41.7% for the power sector, followed by 24.6% for transportation, which is the second highest; the carbon emissions from the industrial sector accounts for Third, China's energy consumption is more dependent on coal, with 80% of China's CO_2 emissions coming from coal, followed by natural gas and oil. In terms of carbon emission sectors, China is basically the same as the global structure, with the power sector ranking first, followed by the transportation sector, and the industrial sector accounting for the third largest share of carbon emissions. As we all know, the emission of greenhouse gases, especially carbon dioxide, is the main cause of global warming. In this context, China proposes to "strive to reach the peak of carbon dioxide emissions by 2030 [11].

We will strive to achieve carbon neutrality by 2060" and other solemn goals. Photovoltaic building integration is a new concept of solar power generation that meets the requirements of carbon neutrality and is a new technology needed for carbon neutrality. It is the direct use of power generation devices as part of a building, such as roofing, which not only effectively reduces costs but also provides an aesthetic effect. Although China's PV building integration market is in its infancy, its market potential is huge and its development prospects are broad.

The roof of a building is the part of the building that receives the most solar radiation and, in general, is also the part that is least shaded. Therefore, from the perspective of energy efficiency, the roof is the best place for building PV integration. While vertical walls are not the best location for PV, building facades often have more surface area to integrate PV systems. Often the building façade is the focal point of the design, not only to express the form but also to meet the necessary functional requirements, thus placing higher demands on the way the PV system is integrated [12].

In addition to the above two forms of PV building integration construction, PV shading is also a more effective form of construction. The purpose of external shading is to shade the building from direct sunlight so as to improve the thermal environment of the building and reduce the energy consumption of building operation, which is a common energy saving measure in buildings.

The "2030 carbon peak action plan" points out that, in the photovoltaic building, the future to deepen the application of renewable energy building, continue to promote the integration of photovoltaic power generation and building applications, the construction of photovoltaic power generation, energy storage, DC power distribution, flexible power in one "light storage straight soft" building, by 2025, the new public institutions buildings, the New plant rooftop PV coverage is expected to reach 50%. Policy is conducive to the accelerated development of the BIPV industry, bringing more incremental market [13-14].

3. Photovoltaic building integration industry's own advantages

Although the domestic market is still the home of PV equipment dependent buildings. But PV building integration is clearly superior to PV equipment dependent buildings. There are five reasons, first, photovoltaic building integration directly solar power generation equipment as the building's roof, walls and other locations, more beautiful. Second, photovoltaic equipment dependent buildings need other fixed structures for reinforcement, security is not high enough. Third, PV building integration has obvious price advantages, according to Polaris solar PV network of a steel structure plant actual engineering data show that PV building integration than PV equipment dependent building per square meter savings of about 164 yuan. Fourth, photovoltaic building integration construction is less difficult, no secondary construction, and faster installation. Fifth, PV building integration has a longer life span, while most of the important components are located in the house, which is conducive to maintenance combined with many advantages, compared to PV equipment dependent buildings, PV building integration should have a broader market in the future.

It is green energy, solar PV building integration produces green energy, it is the application of solar energy to generate electricity and does not pollute the environment. Solar energy is the cleanest and is free, the development and utilization process does not produce any ecological side effects. It is also a renewable energy source, which is inexhaustible.

It does not take up land. Photovoltaic arrays are usually installed on unused roofs or external walls, without taking up additional land, which is especially important for urban buildings where land is expensive; summer is the peak season for electricity consumption, which also coincides with the period of maximum sunshine and power generation of photovoltaic systems, which can play a peaking role for the power grid.

Solar photovoltaic building integrated technology using grid-connected photovoltaic system, no need to equip the battery, not only to save investment, but also not limited by the battery charge state, can make full use of the power issued by the photovoltaic system.

It plays a building energy-saving role. Photovoltaic array absorbs solar energy into electricity, greatly reducing the integrated outdoor temperature, reducing the wall heat and indoor air conditioning cold load, so it can also play a building energy-saving role. Therefore, the development of solar photovoltaic building integration, can "energy saving and emission reduction".

4. Photovoltaic building integration industry's own advantages

Photovoltaic and architecture are entering a new stage of development, and the integration of the BIPV industry chain is accelerating, with cross-border integration and model innovation emerging frequently. Upstream: solar cell manufacturers, the battery route currently mainly includes monocrystalline silicon and thin film, monocrystalline silicon battery manufacturers including Longi, Orient Sunrise, Trina Solar, JA Technology, etc. Leading enterprises have layout in both upstream and midstream, such as Longi, Trina, etc. Midstream: BIPV system integrators, mainly building enclosure, steel structure, curtain wall enterprises, with architectural design, construction strength and experience, as well as rich customer resources, including Southeast Grid, Centro shares focus on developing roof resources, precision steel structure "roof + curtain wall" both, River Group won two consecutive PV curtain wall projects.

Downstream: corresponding to each segment of the building application scene, including public buildings, residential (household), industrial plants, commercial buildings, etc. In terms of BIPV upstream, the upstream is mainly photovoltaic cells and other photovoltaic modules, the current PV industry chain as a whole is driven by policy, PV module production continues to grow, according to data, China's PV module production in 2021 is 182GW, an increase of 46.1% compared to 2020; China's PV module production in 2020 is 124.6GW, an increase of 26.4% compared to 2019. Policy-driven, China's installed PV power generation continues to grow, driving sustained growth in demand for PV inverters.

According to the data, China's installed photovoltaic power generation from 19.42GW in 2013 to 305.99GW in 2021. 7 years in a row ranked first in the world. Among them, distributed PV reached 107.5GW in 2020, accounting for about one-third of all installed PV power generation capacity on the grid. Overall, distributed PV has the advantage of convenience and overall application method wide, as the PV industry continues to advance, has gradually become the key PV installed source, and BIPV as distributed PV is currently the best application method, benefiting from the overall demand and scale of distributed PV industry continues to grow. In terms of the current situation of the global BIPV market, the global building and infrastructure industry accounts for 50% of the total energy consumption, in the context of excessive energy consumption in buildings, zero energy buildings have become an inevitable trend of development. BIPV has the advantages of saving building materials, reliable and flexible power supply, energy saving and consumption reduction, etc. BIPV will become the mainstream form of zero-energy buildings. According to the data, the global cumulative installed capacity of BIPV will be about 2.3GW in 2020, an increase of about 100% compared with 2019, and the market size will be 14.4 billion yuan, which is a blue ocean for future development. In terms of the application structure of the global BIPV market, industrial building applications currently account for more than 40% of the market. Government initiatives to reduce dependence on traditional power generation resources and increase the share of renewable energy in the energy mix are expected to continue to promote the application of BIPV in industrial buildings.

BAPV and BIPV projects together account for 80% of distributed PV projects in China. At present, due to the cost of components and the existing building renovation difficulty restrictions, domestic building rooftop PV installation is still dominated by BAPV, especially the "whole county to promote" the project will mostly be dominated by BAPV, BIPV is limited to a small number of large public buildings such as airports, stations and other projects for the time being. But because of the advantages of BIPV, BIPV penetration rate will be higher and higher, there is more room for growth. According to the China photovoltaic industry association photoelectric building special committee statistics show that the year 2020, China's major photoelectric building products manufacturers BIPV total installed capacity of about 709 MW, the total installed area of 3.774 million square meters, accounting for 4.5% of the installed domestic distributed PV capacity that year. After the new construction area is measured, the market size will exceed 130 billion yuan in 2021.

5. The competitive landscape of the photovoltaic building industry

In terms of the current situation of the BIPV market in China, the domestic market is still in the early stage of development, and in 2020, the installed capacity of BIPV of six major enterprises in China reaches 709MW, corresponding to a total installed area of 3.77 million square meters. The overall market is relatively concentrated, and the industry scale still has more room for development. From 2020 onwards, PV companies have laid out the BIPV market. The global market, the main players in the BIPV market include ONYX Solar Group, Merck, AGC, Astor and Amadon, etc. The downstream customers are mainly divided into industrial, commercial and residential. Domestic listed companies are also competing to enter the market, and currently there are Longi, Orient Sunrise, Follett, Amadon, Sunshine Power, CITIC Bo, Orient Rainbow and others laying out BIPV-related businesses.

Policies promote the development of BIPV, foreign policies are relatively strict, and domestic policies gradually follow. Internationally, the European Union, the United States, Japan and other countries have put forward goals for green buildings, such as Japan proposed that all new buildings and homes on average achieve zero energy consumption in 2030; some areas of the United States policy is more stringent, the net zero energy residential building-related regulations in effect in Pennsylvania in 2018 require that each square foot of new housing must be installed 2W PV system, California from 2023 all new housing All new homes in California will be required to install solar energy on a mandatory basis starting in 2023, and BIPV may become standard.

The trend of mass data in power system provides a basis for load characteristic analysis and prediction model establishment, but the classical load forecasting method cannot afford such a huge time and computing resource consumption. The problem of over fitting in large sample set will affect the prediction accuracy. In this paper, a power load forecasting model is built by using the BP neural network model, making full use of the powerful data processing function of Clementine and preventing the over fitting function. The experimental results show that the BP neural network model has good predictability and robustness, and has a certain practical application value.

6. Conclusions

In this paper, firstly China PV building development pattern is analyzed, respectively from its own advantages of development, policy advantages, competitive pattern, etc., combined with policy research interpretation and model prediction, the future development trend of China PV building integration is summarized. Influenced by the surge of social electricity demand and accelerated energy structure adjustment, PV building integration has become an emerging industry supported by the state. The introduction of relevant policies will promote the development of PV building integration on a large scale, and the increase of financial subsidies given by the state to PV building integration projects will drive the continuous increase of PV building integration penetration. Driven by the policy, PV building integration is now ready to take off. At the same time, technology first, so that the PV building integration conversion efficiency is higher, the appearance of more beautiful and diverse, to help the PV building integration building cost reduction and efficiency, the industry or will usher in a big explosion.

References

[1] Xu W, Liu ZL, Wang X. Study on factors influencing energy efficiency of solar photovoltaic buildings and evaluation of comprehensive benefits of energy saving [J]. Shanghai Energy Conservation, 2022, (10): 1292 - 1302.

[2] Xiao Mengqing,Li Yong. Heat dissipation study of 2 mounting structures of roof integrated photovoltaic panels [J]. Energy and Environment, 2022, (05): 43 - 46.

[3] Yu J. Study on the installation method of photovoltaic building integration on building façade and roof [J]. Energy Science and Technology, 2022, 20 (04): 58 - 61+74.

[4] Zhang Xinliang, Zuo Shaolin, Tao Yuxuan. Difficulties and countermeasures of photovoltaic building integration project construction [J]. China Electricity Enterprise Management, 2022, (24): 48 - 49.

[5] Cao Lei, Yuan Tianchi. Analysis of the current situation and prospect of photovoltaic building integration development under the goal of "double carbon"[J]. Intelligent building electrical technology, 2022, 16 (04): 42 - 45+54.

[6] Ren Xiaoling, Zhou Yicheng, Yang Chenxu. Analysis of photovoltaic building integration application and economic benefits [J]. Construction Economics, 2022, 43 (S1): 975 - 978.

[7] Wang Jun, Yu Bentong, Wang Zhuyao, Ji J. New advances in solar photovoltaic building-integrated photothermal (BIPV/T) research [J]. Journal of Solar Energy, 2022, 43 (06): 72 - 78.

[8] Huang Xinyu, Chen Steady. Current status and development prospects of building-integrated photovoltaic (BIPV) applications[J]. Journal of Civil Engineering and Management, 2022, 39 (03): 160 - 166.

[9] Wang Qiong, Wang Guo Guang. Introduction to the application of building photovoltaic integration engineering [J]. Intelligent building electrical technology,2022,16(02):163-168.

[10] Peng Shou. Promote the integration of photovoltaic building to guide the industry to green [J]. Construction enterprise management, 2022, (04): 46.

[11] Bao Binbin. CE Group CIGS photovoltaic building integration project construction quality control countermeasures research [D]. Zhejiang University, 2022.

[12] Jiang Culture. Analysis of the design points of photovoltaic curtain wall in solar photovoltaic building integration [J]. Engineering Construction and Design, 2022, (05): 25 - 27.

[13] Song Yimeng, Chen Xingchi. Construction of prediction model for PV building integration industry sector index--an empirical analysis based on ARIMA model [J]. Technology and Industry, 2021, 21 (12): 238 - 243.

[14] Xu YL, Cao MZ, Wang Xuesen, Li HENG. Study on the application potential and benefits of photovoltaic building integration in general hospitals [J]. Energy Conservation, 2021, 40 (12): 1 - 3.