

OPERATION MODE ANALYSIS AND ECONOMIC ANALYSIS RESEARCH OF TIANJIN 8MW DISTRIBUTED PHOTOVOLTAIC POWER GENERATION PROJECT*

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Abstract

At this stage, China's distributed photovoltaic power generation projects are still based on the EMC operation cooperation model, and the EPC operation mode is a supplementary pattern. The choice of operation mode will directly affect the economic analysis results of the distributed photovoltaic power generation project.

This paper collects a large amount of information on photovoltaic projects and combines its own work experience to conduct an in-depth analysis of the operation mode and economic analysis methods of photovoltaic projects, and form recommendations for the selection of the operation mode of distributed photovoltaic power generation projects. New ideas for economic analysis of power generation projects and an economic analysis model for comparison and selection of operating mode income distribution options were established. Finally, take Tianjin 8MW distributed photovoltaic power generation project as an example. Based on the analysis of various basic conditions in the examples, specific project operation mode selection and detailed multi-scheme economic analysis comparisons are carried out, which proves that the optimized economic analysis model can effectively help distributed photovoltaic power generation projects to choose the best operation mode.

Keywords: Distributed photovoltaic, Operating model, Economic Analysis

Introduction

With the continuous growth of the global population and economic scale, the use of coal, oil, natural gas and other energy sources has not only brought great benefits to social development and human life, but also increased the concentration of carbon dioxide in the atmosphere, leading to global climate Changes threaten the survival and development of mankind. Countries in the world are increasingly aware of the far-reaching impact of energy issues on the sustainable development of the future economy. At this time, the development of new energy sources has become a good way to solve these problems. As an unconventional energy source, solar energy has received strong support from most countries in the world by virtue of its wide distribution, cleanness of resources, and renewable energy, and has been developing rapidly in recent years.

In 2009, China successively proposed the "Interim Measures for the Management of Financial Subsidy Funds for the Application of Solar Photovoltaic Buildings", the Golden Sun Demonstration Project and other policies to encourage the development of the photovoltaic power generation industry. The photovoltaic power generation target in

* Received: September 19, 2023; Revised: November 28, 2023; Accepted: 31, December 2023

2020 has been increased from the original 1.6GW to the current 20GW. A series of policy support and long-term planning have made China's photovoltaic power generation development road broader.

The Central Economic Work Conference pointed out that China's carbon dioxide emissions will strive to reach a peak by 2030 and strive to achieve carbon neutrality by 2060, referred to as the "30-60 target".

In October 2021, the State Council issued the "Carbon Peaking Action Plan by 2030", the plan is clear: vigorously develop new energy. Comprehensively promote the large-scale development and high-quality development of wind power and solar power, adhere to the simultaneous development of centralized and distributed, and accelerate the construction of wind power and photovoltaic power generation bases. By 2030, the total installed capacity of wind power and solar power will reach over 1.2 billion kilowatts.

Distributed photovoltaics, as a highly efficient method of solar power generation, advocates the principle of "power generation nearby, grid-connected nearby, conversion nearby, and nearby use". It makes full use of the local solar resources of the project. It reduces the loss of traditional power in the process of boosting and long-distance transportation, and there is no problem of grid connection difficulties, large losses, and impacts that exist in the construction of traditional large-scale grid-connected photovoltaic power stations. It can more effectively replace and reduce fossils. The consumption of energy has huge development momentum and broad prospects. With the increasing maturity of the photovoltaic industry and the decreasing cost of photovoltaic modules year by year, distributed photovoltaic projects have increasingly shown huge economic and social benefits.

Research Problems and Aim

Based on the full study and reference of previous research results, this article first analyzes and predicts the current situation of the development of photovoltaic power generation at home and abroad, predicts that distributed photovoltaic will become a key area for the future development of solar photovoltaic; summarize the project in the initial selection of the operation mode, The five main basic conditions that need to be considered; summarize and summarize the five basic data required for economic analysis of distributed photovoltaic projects and analyze their composition and characteristics; propose new ideas based on traditional probability analysis, and build a distributed photovoltaic power generation project An economic analysis model for the comparison and selection of specific income distribution plans for the operation mode; finally, the operation mode analysis and economic analysis research are carried out in combination with examples.

As the mainstream direction of the new energy industry in the future, distributed photovoltaic projects have broad development prospects. However, due to the lack of experience in distributed photovoltaic projects in my country, in the actual development process of the project, enterprises need to explore and select an appropriate operation mode by themselves. Different operating modes will directly affect the final profitability of the project and the specific operational implementation. The research purpose of this article is to guide the distributed photovoltaic project to choose the appropriate operation mode, and to provide The economic analysis of photovoltaic projects provides a new way of thinking.

Literature Review

In the past ten years, the new energy industry has developed vigorously. As its representative, the solar photovoltaic industry has received more and more attention from researchers from all over the world. Many experts and scholars at home and abroad have conducted many fruitful researches on various aspects of the solar photovoltaic industry. Furkan (2011) has conducted various analyses and predictions on the current policy status and future trends of countries that are already in the leading position in the field of solar photovoltaic power generation such as the United States, China and Japan. Govinda , Lado and Patrick (2012) analyzed the economic and policy situation of renewable energy in countries around the world in recent years and explained that although solar technology has achieved large-scale deployment worldwide, it still needs to overcome a series of technical, financial, and Obstacles to government supervision and systems. Stefan and Michael (2013) conducted a comprehensive assessment of the cost competitiveness of power resources. Based on the cost data of the second half of 2011 in the United States, it is concluded that the cost of utility-scale solar photovoltaic power generation cannot compete with fossil fuel power plants. In a sense, commercial-scale photovoltaic power generation facilities have reached the conclusion of cost parity. It is predicted that utility-scale photovoltaic facilities are expected to become competitive in ten years, while commercial-scale facilities can achieve large-scale "on-grid parity" within the next ten years. Wajid , Kankar and Claudio (2011) took the solar photovoltaic project in Ontario, Canada as a case, and proposed and discussed how to use optimized models and technologies to develop the best investment for large-scale solar photovoltaic (PV) power generation projects for potential investors The plan finally proved that the proposed methods and tools have practical applicability. Tasneem , Kirn , Junaid and Andrew (2016) analyzed the complex electrical distribution network system in Pakistan, as well as the regional frequent limited or intermittent power supply, and even power outages, and analyzed the local large-scale 750 MW from both technical and economic aspects. Grid-connected photovoltaic power station case. Shahzad, Kashif, Ankur and Mohammad (2016) conducted a comprehensive cost analysis study on the 1 kW off-grid photovoltaic power generation project in New Delhi, India, from the design and installation of solar photovoltaic power generation systems, and proved that 1 kw solar power is off-grid. Photovoltaic projects are of value in rural areas of India. Zhang and Tian (2015) put forward their own views on the possible problems and risks of photovoltaic projects during the entire investment operation cycle, especially land use, grid access, quota allocation, and investment recovery. Yu and Li (2015) discussed the current situation of home distributed photovoltaic projects, predicted their future development trends, and put forward countermeasures and suggestions for current problems. Lv, Cai and Wang (2015) analyzed China's current distributed photovoltaic policy, combined with the development status of China's energy storage, evaluated the economics of the combined application of the two, and based on the evaluation results, made recommendations for promoting its development. Ma, Shi and Cong (2014) conducted an in-depth study on the issue of grid parity for photovoltaic projects through the comparison between the purchase price of photovoltaic power in China and the normal price of electricity. Zhang and Wang (2015) established a new economic evaluation method and system based on conventional economic analysis methods and combined with the characteristics of photovoltaic projects, providing new ideas for investment decision-making in photovoltaic projects. Su, Zhou and Li (2013) constructed a project economic evaluation model for cost/benefit analysis through the analysis of

China's photovoltaic operation mode and economic evaluation system.

Through the above analysis, it is not difficult to see that the research on photovoltaic projects by domestic and foreign experts and scholars is more about analyzing the problems commonly faced by the photovoltaic industry in the current development process and the corresponding countermeasures. Most of the research involving economic policy is also from the unilateral analysis of cost composition, economic benefits and support policies. There is a lack of comprehensive analysis for different types of photovoltaic projects, and the analysis methods used are also lacking in pertinence, especially for distribution. There is no further research in the future key development area of solar photovoltaic, and there is still relatively little research on the comprehensive analysis of the combination of distributed photovoltaic project operation mode analysis and economic analysis.

Research Methodology

This article adopts qualitative and quantitative research methods.

1. Qualitative research methods: summarize the theories and methods of domestic and foreign photovoltaic projects, and organize and analyze relevant domestic and foreign documents related to project model analysis and economic analysis.

2. Quantitative research methods: According to the research purpose and content of this article, quantitative research methods are adopted, combined with past actual case experience, select typical cases for operation mode selection and economic analysis research, and distribute the same type in the future Provide reference for analysis of solar photovoltaic projects.

Findings and analysis

With the advancement of photovoltaic power generation technology and the continuous expansion of industrial scale, photovoltaic construction costs and power generation costs continue to decline, I believe there will be a large number of distributed photovoltaic project investment and construction in the future. However, considering the economic characteristics of distributed photovoltaic projects with a long payback period, large policy influences, and strong investment income uncertainty, distributed photovoltaic projects have been greatly restricted in the selection stage of the project operation mode.

This paper collects a large amount of data on photovoltaic projects, combined with its own work experience, conducts an in-depth analysis of photovoltaic project operation mode analysis and economic analysis methods, and takes Tianjin's 8MW distributed photovoltaic power generation project as an example, based on the various foundations in the example The analysis and summary of the conditions, the analysis and selection of specific project operation modes and the economic analysis and selection of multiple income distribution schemes, provide a reference for the analysis and decision-making of the same type of distributed photovoltaic power generation projects in the future.

The main conclusions of this article are as follows:

1. With the gradual rationalization of photovoltaic policies in various countries and the continuous reduction of photovoltaic module costs, coupled with the advantages of distributed photovoltaic solar energy with high availability, no site restrictions, and flexibility and convenience, distributed photovoltaics will achieve faster growth in the

future.

2. Distributed photovoltaic power generation projects need to consider the five basic conditions of the project site's solar resources, local scale indicators, national policies, grid connection conditions, and power consumption capacity during various decision-making analysis stages such as project operation mode analysis and economic analysis condition.

3. At this stage, the operation mode adopted by the owners of distributed photovoltaic power generation projects is roughly divided into EPC mode and EMC mode. Considering that in the current composition structure of China's distributed photovoltaic project owners, industrial parks and individual industrial users account for a larger proportion, so China's distributed photovoltaic power generation projects still adopt the EMC operation mode.

4. Before the economic analysis of the project, many data related to the project need to be collected and summarized and analyzed into basic economic data in order to prepare financial statements and calculate economic indicators later. For distributed photovoltaic projects, it mainly includes five economic basic data: total project investment estimate, project power generation estimate, project agreement electricity price, project operating cost, and tax situation.

5. In the process of selecting the operation mode of distributed photovoltaic power generation projects, there may be multiple scenarios in the income distribution plan. You can refer to the economic analysis model constructed in this article for analysis and comparison, so as to select the best operation mode of the project.

Discussion

This article analyzes and forecasts the current situation of photovoltaic development at home and abroad, and comprehensively analyzes various aspects of existing domestic and foreign operating modes, and proposes new economic analysis ideas based on traditional probability analysis, taking into account the development of distributed photovoltaic projects. Economic characteristics, established an economic analysis model that can be used for the comparison and selection of specific income distribution schemes of distributed photovoltaic project operation mode, and carried out operation mode analysis and economic analysis research in combination with actual cases, for the future operation of the same type of distributed photovoltaic project in China. The ultimate goal of any project's construction investment is to obtain benefits. Therefore, before investing in a distributed photovoltaic project, the investor will conduct the necessary basic analysis, select a reasonable operating mode, and then make a financial forecast, and finally refer to it. The result of economic analysis determines whether to invest and which method of income distribution to choose. It can be seen that in the investment consulting stage of distributed photovoltaic projects, it is particularly important to analyze the operation mode and economics of the project. Therefore, both model selection and economic analysis are of great significance.

Conclusion and Recommendations

The outline of China's "14th Five-Year Plan" proposes to build a modern energy system, advance the energy revolution, build a clean, low-carbon, safe and efficient energy system, vigorously increase the scale of photovoltaic power generation, accelerate the development of distributed energy in the eastern and central regions, and build a group

of multi-energy complementary Clean energy base.

On the basis of the continuous introduction of encouraging policies and the continuous innovation of financing, construction, operation and maintenance, and business models, I believe that China's distributed photovoltaic power generation market has a bright future.

The research in this paper provides new ideas and methods for future operation mode analysis and economic analysis of the same type of distributed photovoltaic projects, but there are also some shortcomings. In view of the complex conditions involved in distributed photovoltaic projects, this article only selects a few key basic conditions that are concentrated in the actual work process for analysis. The economic analysis model for the profit distribution plan of the distributed photovoltaic project operation mode also ignores a lot. The influence of factors. Therefore, when making investment decisions or feasibility studies for photovoltaic projects in the future, specific issues still need to be analyzed in detail.

References

- Chang, F.R. (2018). Comprehensive economic benefit evaluation of distributed photovoltaic power generation projects. *Economic Research Guide*, 8(31), 36-38.
- Furkan, D. (2011). The analysis on photovoltaic electricity generation status, potential and policies of the leading countries in solar energy. *Renewable and Sustainable Energy Reviews*, 5(15), 713-720.
- Ge, X. (2015). Research on the construction and operation mode of distributed photovoltaic power generation. North China Electric Power University, Beijing.
- Govinda, R.T., Lado, K., & Patrick, A.N. (2012). Solar energy: Markets, economics and policies. *Renewable and Sustainable Energy Reviews*, 3(16), 449-465.
- Guo, Z.Y. (2018). Research on the Construction and Operation Mode of Distributed Photovoltaic Power Generation Projects. *Great Science and Technology*, 13(24), 107-121.
- Huang, N.B. (2019). Feasibility Study on Financial Lease of Distributed Photovoltaic Power Generation Project. *Solar Energy*, 1(2), 8-12.
- Huang, Y.Q. (2017). Analysis of the economic benefits of rooftop distributed photovoltaic power generation in enterprise projects. *Smart City*, 4(3), 62-64.
- Jiang, F. (2016). Income analysis of distributed photovoltaic power generation under different operating modes. *China Engineering Consulting*, 2(6), 58-60.
- Jin, Y.M., Jiang H., & Qiang Y.Z. (2021). Review of China's photovoltaic industry in 2020 and outlook for 2021. *Solar Energy*, 3(4), 42-50.
- Li, B. (2021). Research on the Economic Benefits of Distributed Photovoltaic Power Generation. *Encyclopedia Forum Electronic Magazine*, 3(5), 17-27.
- Li, F.W. (2016). Research on the operation mode of distributed photovoltaic power generation investment and construction. *China High-tech Enterprise*, 3(13), 178-179.
- Li, Y.Z., & Li, Z. (2016). Comparison and selection of solar radiation data for photovoltaic power generation projects. *Building Electric*, 3(4), 35-40.
- Liu, X. (2011). The application of "plan review technology" in engineering construction. *Commodity and Quality (Academic Observation)*, 1(5), 159-163.

- Lv, S.H., Cai, S.X., & Wang, S.X. (2015). Economic evaluation and development suggestions for distributed photovoltaic-energy storage systems. *China Electric Power*, 48(2), 139-144.
- Ma, C.P., Shi, D., & Cong, X.N. (2014). Research on the cost of solar photovoltaic power generation and grid parity. *Contemporary Economic Science*, 36(2), 85-94.
- Stefan, R., Michael, Y. (2013). The prospects for cost competitive solar PV power. *Energy Policy*, (55), 117-127.
- Su, J., Zhou, L.M., & Li, R. (2013). Cost/benefit analysis of grid-connected distributed photovoltaic power generation. *Proceedings of the Chinese Society of Electrical Engineering*, 33(34), 50-56.
- Sun, H.J. (2021). Discussion on the construction and operation mode of distributed photovoltaic power generation. *Science and Wealth*, 13(30), 13-14.
- Sun, Y.P., Zhang, J., & Yang, X.L. (2016). Technical and economic evaluation of rooftop photovoltaic system and analysis of operation mode selection. *SME Management and Technology Journal*, 3(5), 150-151.
- Tan, R.F. (2017). Talking about the status quo and development prospects of China's photovoltaic industry. *Science and Wealth*, 3(9), 208-218.
- Tasneem, Z., Kirn, Z., Junaid, Z., & Andrew, A.P.G. (2016). Integration of 750 MW renewable solar power to national grid of Pakistan—An economic and technical perspective. *Renewable and Sustainable Energy Reviews*, 3(59), 1209-1219.
- Teng, S.B. (2009). Application of probability analysis in project uncertainty analysis. Beijing University of Posts and Telecommunications, Beijing.
- Wajid, M., Kankar, B., & Claudio, A.C. (2011). Large-Scale Solar PV Investment Models, Tools, and Analysis: The Ontario Case. *IEEE Transactions on Power Systems*, 15(26), 2547-2555.
- Wang, D.L. (2019). Exploring the comprehensive economic benefit evaluation of distributed photovoltaic power generation projects. *Encyclopedia Forum Electronic Journal*, 3(12), 453-454.
- Wang, N., Xu, B., & Guo, M.L. (2020). Development status of China's photovoltaic industry. *Science Education Journal-Electronic Edition (first ten days)*, 3(11), 282-283.
- Wu, Q. (2015). Analysis of innovative financing models to solve the financing problems of distributed photovoltaic power generation. *Jiangsu Commercial Theory*, 6(28), 51-52.
- Xie, X.X., & Gao, H. (2015). Research and Suggestions on Current Issues Restricting the Development of Distributed Photovoltaics in China. *China Economic and Trade Guide*, 3(8), 46-49.
- Yang, D.M. (2016). Analysis of Financing Leasing in the Photovoltaic Industry. *Science and Technology Innovation Herald*, 13(16), 95-97.
- Yu, W.M., & Li, L. (2015). The status quo and development trend of photovoltaic household distributed power stations: Taking Xinyu City as an example. *China New Communications*, 9(3), 36-36.
- Zhang, G.Y. (2004). Research on prediction method based on PERT. *Journal of Zhengzhou Institute of Aeronautical Industry Management*, 6(3), 111-112.
- Zhang, J., & Wang, Y. (2015). Construction of financial evaluation system for photovoltaic power generation projects. *Economic Research Guide*, 6(3), 122-124.

- Zhang, R. (2016). Operation mode and benefit analysis of distributed photovoltaic power generation. *China Science and Technology*, 3(6), 148-148.
- Zhang, T.Y., & Tian, Y. (2015). Analysis of the future development trend of photovoltaic power plants. *Science and Technology Wind*, 2(3), 65-65.
- Zhang, W. (2018). Research on the construction and operation mode of distributed photovoltaic power generation. *Science and Technology Wind*, 3(1), 179-186.
- Zhang, Y. (2021). Talking about the development suggestions of the photovoltaic industry. *Energy and Energy Conservation*, 3(3), 18-19.