Scholar Publishing Group
Academic Journal of Energy
https://doi.org/10.38007/RE.2022.030106
ISSN 2790-2714 Vol. 3, Issue 1: 49-56

Investment Risk Management of Solar Photovoltaic Power Generation Project Based on Wireless Sensor Network

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Keywords: Wireless Sensor, Solar Photovoltaic, Power Generation Project, Investment Risk

Abstract: At present, my country has built many new energy projects, such as alcohol fuel projects and wind power projects, but the most attractive one is the solar photovoltaic power generation project. Solar energy was also assessed as the most likely renewable energy source to replace oil and coal. The purpose of this paper is to study the investment risk management of solar photovoltaic power generation projects based on wireless sensor networks. The advantages of using ZigBee self-organizing wireless sensor network in photovoltaic power station are analyzed. Apply it to the photovoltaic power station collection node program. According to the typical characteristics of photovoltaic power generation projects in my country at this stage, a comprehensive risk assessment index of solar photovoltaic power generation projects based on wireless sensor networks is established. Combined with the actual situation of the three photovoltaic power generation projects, an empirical analysis is carried out. The results show that the risk of project B is the lowest, and the enterprise should decide to choose this project for investment.

1. Introduction

Solar photovoltaic power plants have a short construction period and low power generation costs. Small distributed power plants can be built in areas such as rooftops and wasteland, and centralized power plants can also be built in the Gobi, desert, and sea areas [1-2]. In view of the wide branches and large scale of photovoltaic power plants. The wiring of wired communication is complex, and maintenance is difficult. Especially in the environment with complex field terrain, the operation and maintenance personnel have a large workload of line maintenance, and it is difficult to determine the line fault point [3]. The weak current lines are arranged in the wild and are easily damaged by wild animals. Based on the wireless sensor network, it is of great significance to realize the real-time data collection and transmission of photovoltaic power generation to ensure the long-term stable operation of photovoltaic power plants [4-5].

In recent years, there have also been many studies to support the photovoltaic industry. The main goal of Medellin V is to bring extensive project knowledge to investors participating in the auction. Therefore, the main goal of modern networking is to be able to analyze the strength of items. The question is: using Monte Carlo simulation and how to reduce the cost. Various investment values, competitiveness and maximum returns are analyzed [6]. HH Zsiborács wants to differentiate everyday photovoltaics from the actual sources of photovoltaic systems. Using a simulation approach, various energy storage capacities (ranging from 10 MW to 10,000 MWh of nominal storage capacity) were considered to reduce grid demand. The practical value of this model lies in its application to enable detailed design, analysis, and evaluation of systems that can create high-level efficient solar planning and optimization from sodium-sulfur and lithium ions [7]. This series of development backgrounds has prompted more and more investors to enter the development of solar photovoltaic power generation projects, so it is more and more necessary to analyze the investment risk management of their projects.

This paper first briefly introduces the application of wireless sensor network technology to photovoltaic power plants, and then establishes a photovoltaic power generation investment decision-making model based on comprehensive risk assessment. The grayscale correlation degree can show the positional variation between the curves of the flat data and the similarity of the curve geometry, while the distance measure in the TOPSIS method can better show the relationship between the locations of the flat data plots. The model combines the relative degree of gray level with the TOPSIS method, which can display the closeness of the object to be evaluated to the optimal solution from two aspects of shape similarity and position, which is an effective evaluation method.

2. Research on Investment Risk Management of Solar Photovoltaic Power Generation Project Based on Wireless Sensor Network

2.1. Risks of Investment Projects

The risks of investment projects generally include market risks and company risks [8]. Among them, market risk is a risk factor that is simply affected by the industry and market where the project is located, and is not affected by other variables and cannot be eliminated. Generally, it is expressed by the beta coefficient of the investment project. Corporate risk is from the perspective of the company as an investor, by analyzing the correlation between multiple projects to analyze the impact on the company's overall investment expectations [9-10].

The main indicators used in this paper to analyze and evaluate the risk of solar photovoltaic power generation projects based on wireless sensor networks are technical risk, market risk, economic risk, operational risk and natural risk [11].

2.2. Application of Wireless Sensor Network Technology in Photovoltaic Power Plants

(1) Features of ZigBee for photovoltaic power plants

Low power consumption: In low power mode, two ordinary AA batteries can be used for 6 to 24 months [12].

Low cost: Due to its simple protocol, low-performance control chips can meet the control requirements, so the cost is greatly reduced [13].

Short delay: usually the delay is 15ms~30ms.

Security: Provides data integrity check, using AES-128 encryption algorithm.

(2) Acquisition node program

Inverter acquisition module: The main control chip of the inverter is DSP2812, which mainly uses these functions: event manager, A/D conversion and some external resources [14]. The functions of the TMS320LF2812 series controller used are as follows: complete the sampling of the output side AC voltage, AC current, and the input side DC voltage analog quantity, and then perform calculation processing; set the state detection function. In order to avoid device damage, overcurrent, overvoltage, undervoltage and other protection functions are set to ensure normal operation of the inverter; closed-loop control algorithm is used, so that the output voltage can track the set voltage in real time, so that the system output characteristics are normal [15] .

Temperature acquisition module: The temperature acquisition module is mainly composed of MSP430 single-chip microcomputer and SHT10 temperature sensor. The main functions completed are: regular temperature sampling, periodic reporting of temperature data, and temperature data sent to the ZigBee communication module through the serial port [16]. Receive the configuration information of the upper layer, including the setting of the reporting period and the setting of the upper and lower temperature limits, all the configuration information will be updated to the Flash, and the configuration information will not be lost when the machine is restarted. If the collected temperature is within the set normal temperature range, it will be reported according to the set reporting period; if the collected temperature exceeds the set temperature threshold, an alarm message will be reported immediately [17-18].

Power acquisition chip module software design: ATT7022B driver is mainly driven by the controller by reading and writing the SPI port. The timing of reading the output register starts to read 24bit data after writing a command through the SPI interface.

3. Empirical Investigation and Model Building

3.1. Background of the Project

A certain enterprise is a large independent power generation company established in M city in 2000. By the end of 2021, the total assets will reach more than 200 billion yuan. Today, affected by my country's new energy policy, the company has decided to invest in the construction of photovoltaic power generation projects, and selected three photovoltaic power generation projects based on wireless sensor networks as investment alternative projects. Since the company has never set foot in the field of photovoltaic power generation before, the company is more cautious and conservative when making investment decisions, and decides to invest in the project with the lowest risk among the alternative projects.

The following is the background introduction of the three wireless sensor network-based photovoltaic power generation alternative projects selected by the company:

Project A is located in N Province, an inland hilly area, with gentle undulating terrain, small slopes, and normal environmental conditions. Occasionally, natural disasters such as sandstorms may occur. The provincial government of N has a general level of support for the photovoltaic power generation industry, and the photovoltaic power generation market is developing well and has not yet appeared saturated. The project covers an area of about 45 hectares, with an initial investment of 3 billion yuan. The planned long-term power generation capacity is 50MW. The first phase of 20MW is expected to be connected to the grid by the end of 2023.

Project B is located in the northeastern part of M Province, in the coastal plain area, with flat terrain, adequate environmental protection, and low probability of natural disasters. The provincial government of M has a general level of support for the photovoltaic power generation industry, and the photovoltaic power generation market is developing well, and there is no saturation trend yet. The project covers an area of about 45 hectares, with an initial investment of 3.5 billion yuan. The planned long-term power generation capacity is 100MW, and the first phase of 30MW is expected to be connected to the grid in early 2023.

Project C is located in the central part of Province X, in the coastal plain area. The terrain is flat and the environmental protection is in place, but there is the possibility of being hit by typhoons. The provincial government of X has a general level of support for the photovoltaic power generation industry. The photovoltaic power generation market is in good development, but it is basically saturated. The project covers an area of about 28 hectares, with an initial investment of 3 billion yuan. The planned long-term power generation capacity is 60MW, and the first phase of 30MW is expected to be connected to the grid by the end of 2024.

3.2. Project Investment Decision-making Model Based on Comprehensive Risk Assessment

In this paper, the grey relational degree analysis method is combined with the TOPSIS method to reflect a new approximate scale of the ideal solution, which is used as the criterion for judging the pros and cons of the scheme. The steps for establishing a PV power generation project investment decision-making model based on comprehensive risk assessment are as follows:

(1) Establish an initial decision matrix

Assuming that there are m items to be evaluated and n indicators, the corresponding initial values of each indicator are xj (1⩽i⩽m, 1⩽j⩽n). Build the initial decision matrix:

$$X = (x_{ij})m \times n \tag{1}$$

(2) Determine the indicator weight

The entropy weight method is used to determine the weight of each index.

(3) Determine the ideal solution and negative ideal solution of the evaluated item

$$U_0^+ \left\{ \left(\max_{1 \le i \le m} u_i(j) \middle| j \in J^+ \right), \left(\max_{1 \le i \le m} u_i(j) \middle\| j \in J^- \right) \right\} = \left(u_0^+(1), u_0^+(2), \ldots, u_0^+(n) \right) \tag{2}$$

$$U_0^- \left\{ \left(\max_{1 \le i \le m} u_i(j) \middle| j \in J^+ \right), \left(\max_{1 \le i \le m} u_i(j) \middle\| j \in J^- \right) \right\} = \left(u_0^-(1), u_0^-(2), \ldots, u_0^-(n) \right) \tag{3}$$

Among them, J+ is the set of indicators that the larger the value is, the better, and J- is the set of indicators that the smaller the value is, the better.

(4) Calculate the relative closeness

The relative closeness reflects the closeness of the change trend of the internal factors of the evaluated project.

$$\delta_i = \frac{T_i^+}{T_i^+ + T_i^-}, (i = 1,2,3,\ldots, m) \tag{4}$$

In the formula, δi represents the relative closeness.

4. Empirical Analysis

4.1. Entropy Weight Method to Determine the Weight of Evaluation Indicators

In this study, the selected data came from the results of the questionnaire survey. After finishing the questionnaire, the three items in the questionnaire were scored 0-1 by means of expert scoring. The specific results are shown in Table 1 below:

Table 1. Risk scoring results of various solar photovoltaic power generation projects of A company

Project	Technical risk	Market risk	Economic risk	Operational risk	Natural risk
A	0.3	0.8	0.6	0.8	0.2
B	0.5	0.7	0.7	0.6	0.1
C	0.4	0.9	0.4	1	0.4

Figure 1. The score of each evaluation indicator

According to the scores as shown in Figure 1, the entropy weight of each evaluation index is calculated. First, standardize the evaluation matrix, then calculate the entropy, and finally calculate the entropy weight to obtain the entropy weight of the quasi-side layer relative to the evaluation index are shown in Table 2 below.

Table 2. The entropy weight of the quasi-side layer index relative to the target layer

Project	Technical risk	Market risk	Economic risk	Operational risk	Natural risk
Entropy weight	0.15	0.21	0.12	0.10	0.18

The TOPSIS model is used to calculate the Euclidean distance of each project plan and the positive and negative ideal solutions, so the positive and negative ideal solutions are calculated first, and the results obtained are shown in Table 3.

Table 3. Ideal and negative ideal solutions for each indicator

	Technical risk	Market risk	Economic risk	Operational risk	Natural risk
Ideal solution	0.15	0.16	0.06	0.14	0.10
Negative ideal solution	0.08	0.10	0.02	0.11	0.05

4.2 Investment Risk Evaluation Results of Enterprise Solar Photovoltaic Power Generation Projects

After the above calculations for the TOPSIS model and the gray correlation model, it is necessary to determine the relative closeness of the three project plans of enterprise solar photovoltaic power generation to the positive and negative ideals, and set the values of e1 and e2 to 0.5. Then, the relative closeness of the three investment project schemes to the positive and negative ideal solutions should be calculated, and the results obtained are shown in Table 4.

Table 4. Proximity of item ideal and negative ideal

Project	Ideal solution proximity	Negative ideal solution proximity	Relative closeness
A	0.53	0.42	0.44
B	0.37	0.58	0.25
C	0.79	0.40	0.63

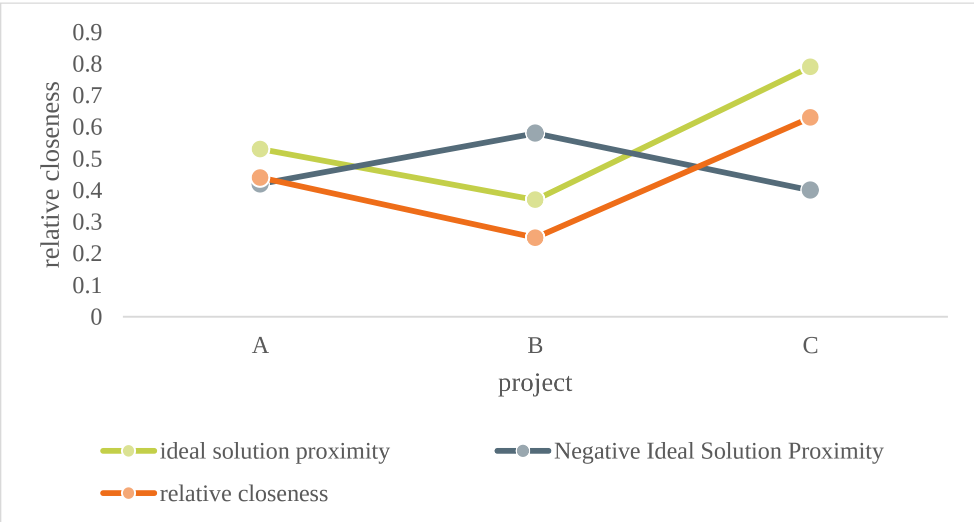

Figure 2. The relative closeness of different project options to positive and negative ideals

The relative closeness of the items is finally obtained from Fig. 2, according to the descending order, the obtained results are as follows: Item C, Item I, Item B. From the above results, the risk of project B is the smallest. The final score of project C is the largest, which means that the risk of project C is the largest. This paper conducts in-depth research on different projects, and the results show that: as far as M province is concerned, the government has not regarded the photovoltaic power generation industry as the pillar industry of the province, so in general, the support for the photovoltaic power generation industry is relatively small. However, a horizontal comparison of different photovoltaic power generation projects shows that although project B has not received the attention of the local government. However, the geographical location of area B has certain advantages, and B is located in the coastal plain area. When developing the photovoltaic power generation industry, the impact of the local environment on the project is relatively small. More importantly, when developing the photovoltaic power generation industry, the development space of M province is relatively large. Considering the above factors comprehensively, enterprises should choose project B as the investment object.

5. Conclusion

Due to the close relationship between solar energy and people, no pollution, and can be used for energy production, the development and utilization of solar energy resources has become the main subject of new energy development in my country. Through project evaluation, investment decisions can be made, which can further improve the scientific level of photovoltaic power generation project investment decisions. Based on the theory of venture capital, this paper takes the investment of a solar photovoltaic power generation project of a wireless sensor network technology as a research case, carries out risk analysis and evaluation, and draws the following conclusions: the solar photovoltaic power generation market prospect of wireless sensor network technology is good. Although there has been a phenomenon of blind investment in solar photovoltaic power generation in my country in recent years, from the perspective of future energy demand, solar photovoltaic power generation projects are still sunrise projects and will develop with social and economic development.

Funding

This article is not supported by any foundation.

Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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