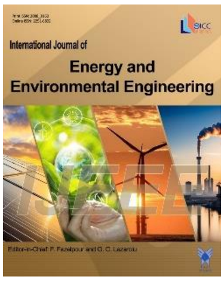

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Research on Carbon Finance Risk Prediction of the Optimal Integration Index of New Energy Resources

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Abstract

As a research hotspot in the field of energy, the development degree of new energy is related to the development of carbon finance market. In order to quickly promote the realization of the dual carbon goals and improve the sustainability of new energy development, this paper proposes a carbon finance analysis method, combined with ant colony algorithm to analyze new energy data such as wind, photovoltaic and hydropower, and judge the carbon finance market. Then, risk prediction is carried out based on the energy value created by wind and photovoltaic power, as well as the depth of energy development. Finally, the utilization effect of new energy sources such as wind power and photovoltaic power is output, the stability of energy output, and the development depth of wind power and photovoltaic energy. The results show that there is a fluctuating relationship between the energy output of wind and photovoltaic power generation and their risk level, and the increase of electricity will inhibit the financial risk, and the energy output value is greater than the threshold of 15%. The risk reduction rate was 36.28% and 34.50%, and the integration of new energy and carbon finance was -0.2896, indicating that new energy has an impact on carbon finance, and the score of carbon emission was relatively low, which was 0.0178. The index integrates energy to reduce the risk rate of carbon finance, and the reduction rate is about 25%. Therefore, the research on carbon finance risk prediction can provide support for the development of wind power and photovoltaic power generation, expand the application scope of new energy, and realize the application depth of wind energy and photovoltaic power.

Keywords: New energy, Photovoltaic, Wind power, Resource, Fusion index, Carbon finance risk, Prediction

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1. Introduction

With the increase in the use of wind power and photovoltaic energy, the integration stability and proportion of new energy and thermal power generation have become research hotspots. In order to improve the depth of development of new energy, it will be integrated with carbon finance to realize the sustainable use of wind power and photovoltaic energy. Although new energy sources such as solar, wind, hydro, and biomass are renewable, the stability of energy output and the amount of energy output are controversial [1]. The rapid development of wind power and photovoltaic new energy industry, and its integration effect with thermal power generation, have also become a hot spot in research, such as voltage, current and power flow, etc., to achieve sustainable use of energy, reduce carbon emissions, improve the economic value of new energy, and provide vital role for social and economic development. Some scholars believe that the integration of new energy and carbon finance can promote the development and utilization of new energy, optimize its industrial structure, and improve power generation efficiency. The main purpose of new energy is to reduce greenhouse gas emissions, and carbon emission trading can generate indirect economic benefits, support the construction of wind power and photovoltaic power generation, maintain the stability of power generation, and improve the financial risk prediction effect [2]. Some scholars believe that the integration of new energy and carbon finance market will provide financial support for the structural optimization of the new energy industry, promote the improvement of its operation and maintenance management, and promote the integration of new energy and thermal power generation [3]. Nassar et al. provides valuable insights into estimating CO2 emissions from the electricity generation sector, which is crucial for understanding the environmental impact of energy systems and their integration into carbon finance models, aligning with the focus on renewable energy's influence on carbon markets [4]. Nassar et al. emphasizes the transition towards a green economy in Libya's electricity sector, offering a framework for evaluating the integration of renewable energy, which complements the investigation of financial risks associated with renewable energy systems in carbon finance [5].

Some scholars believe that new energy resources need turbines, fan blades, polysilicon and other technologies, and the integration, application, and expansion of technologies need financial support, and the carbon finance market provides support for the development of new energy, and can also promote the application of new energy technologies, promote the development of energy forms, and the organic integration of related industries to achieve efficient development, utilization, and output of energy [6]. In short, the market effect can deepen the new energy structure and improve the stability, reliability and sustainability of the energy system. At present, the integration of new energy resources remains at the surface layer, which belongs to the superposition of multiple energy sources, and does not realize energy complementarity and synergy, so technological innovation, energy structure optimization, and operation and maintenance management are needed to realize the complementarity and synergy of different new energy sources in time, space, and function, so as to improve the utilization efficiency of new energy [7,8]. Some scholars believe that there are various forms of integration of new energy resources, which can be divided into different types according to different classification standards, so it is necessary to realize the economic benefits of new energy and maintain stable production capacity [9]. At present, the integration modes of new energy resources include "wind and solar complementation", "water and light complementation", "wind-solar-storage integration", and "multi-energy complementation", but multiple energy forms have not been effectively integrated [10]. Abodwair et al. discusses the feasibility of hybrid renewable energy systems, relevant to the integration of renewable energy into the grid and the financial implications of such systems, providing context for the financial risk modeling in our paper [11]. The focus on CO2 emission estimations within Libya's power industry by Nassar et alhelps to strengthen the understanding of the environmental impact of energy systems, which is directly relevant to carbon finance risk modeling and the integration of renewable energy into carbon finance markets [12].Some scholars believe that the construction of the optimal integration index of new energy resources can comprehensively and scientifically evaluate wind power and photovoltaic power generation, judge the degree of integration of new energy resources, and provide a strong basis for the deepening of the new energy industry and the improvement of power generation effect [13]. In the construction process, it is necessary to follow the constraints of light, wind, season, region, technology, power, voltage and other indicators to integrate new energy and achieve structural optimization. Therefore, some scholars believe that it is necessary to comprehensively analyze the power, voltage and current of new energy resource integration to ensure that the financial risk prediction can fully reflect the operation and maintenance of new energy and be connected to the grid stably. At the same time, the risk prediction is related to multiple dimensions such as energy supply stability, energy utilization efficiency, environmental benefits, and technology application, and stability indicators, such as the volatility of wind power and photovoltaic power generation, and the investment in new energy technology research and development, reflect the development potential of new energy[14,15]. Nassar et al. on the life cycle assessment of wind energy’s carbon footprint provides an important reference for evaluating the sustainability and financial implications of renewable energy projects, supporting the integration of such projects in the carbon finance risk framework of our study[16,17]. Harikumar and Surendar focuses on balancing the integration of wind and solar energy for environmental sustainability and improved energy performance. In the proposed work, this balanced approach is adopted to develop an optimal integration index for new energy resources, assessing their stability and financial impact on carbon markets. This strategy enhances the accuracy of carbon finance risk prediction, promoting sustainable energy integration while optimizing financial outcomes [18].

The correlation of -0.2896 between new energy and carbon finance indicates that with increased integration of renewable energy, financial risks in the carbon market decrease. This also aligns with evidence from existing literature that points out that renewable energy stabilizes energy production and reduces dependence on fossil fuels, which in turn reduces carbon emissions and hence financial risks. However, everything is interconnected in a very complex manner, based on factors such as stability in energy output, regulatory changes, and maturity of markets. Huang et al. and Gao et al. have pointed out that while renewable energy reduces financial risks, seasonal variability and integration challenges have to be sorted out for continued benefits. Further research can optimize renewable energy integration to maximize both environmental and financial outcomes.

In summary, wind power, photovoltaic and other power generation are the main energy contents of new energy resources, and the analysis of power, voltage and current, as well as the energy output stability performance fusion index, and the correlation with the carbon financial risk prediction results, can provide support for new energy development and structural optimization. Therefore, this study optimizes the energy structure of new energy sources such as wind power and photovoltaic power to improve the resource allocation rate of the new energy industry, and provides a scientific basis for new energy expansion and operation and maintenance management. At the same time, the prediction of carbon financial risks is conducive to the expansion of new energy application fields and the realization of multi-field development of new energy.

1.1. Contribution for this paper:

The Optimal Integration Index: This paper presents a new optimal integration index, which forms a combination of energy stability and carbon finance risk, which enables a comprehensive instrument for quantifying the impact of renewable energy on carbon finance markets.

The ant colony optimization algorithm uses an ant colony optimization algorithm to improve risk prediction models in carbon finance with a significant improvements over the traditional models without dynamic optimization.

Applied Quantitative Evaluation of Renewable Energy and Carbon Finance Interaction: This study demonstrates the correlation between the stability of wind and photovoltaic energy production and financial risk indicating valuable insights regarding new energy sources, the influence that energy resources can have on carbon finance markets.

Practical implications for Policy and Investment: With the proposed index in place, future investments in renewable energies can be directed and financial support structures can be improved, resulting in better integration and stronger energy systems.

2. Optimal utilization of wind, photovoltaic and other energy sources and carbon finance forecasting

2.1. Carbon financial stability of wind and photovoltaic energy

Wind and photovoltaic data are nonlinear and non-stationary continuous data, and there are interference factors. Wind and photovoltaic equipment collect carbon financial data, including voltage, current, and power flow signals, at fixed intervals, and then mine new energy data according to the data values . The data collected by wind power and photovoltaic power are all nonlinear data, and there are noise data such as weather and season, which completes the multi-fitting ratio, realizes the generalization ability of carbon finance, and indirectly improves the accuracy of new energy mining. In the process of new energy data processing, the abnormal signal is analyzed in detail by zooming, and the noise data such as weather and light are removed, the mining space of new energy is expanded, the characteristics of new energy data information are preserved, the structure of new energy is optimized, and the stability of voltage, current and power flow is realized. The data used for this study is sourced from publicly available renewable energy data; wind and solar energy generation data; carbon finance data. These three samples of 4 months are sampling seasonal energy expenditure variations. The data preparations of data were noise extraction, outlier detection with the One-Class SVM approach, and normalization via Robust Scaler to ensure consistent accuracy and model accuracy. Mismatches were handled by k-NN imputation and categories were encoded using Target Encoding with Bayesian smoothing. In order to reduce the collection time of wind and photovoltaic data, the decomposition of qualitative data and quantitative data is realized in the form of wavelet decomposition, and the comprehensive output of wind and photovoltaic energy is constructed, as shown in equation (1).

$$X_0 = X_t + D_t + D_{t-1} \dots D_2 + D_1 \quad (1)$$

In the formula, X_t represents the characteristic values of wind power and photovoltaic power generation, and D_t represents the balance of wind power and photovoltaic power generation. Qualitative data can quickly simplify the noise in the data and obtain the initial processing data, so as to avoid the influence of complex data structure on the calculation results, and enhance the ability of photovoltaic and wind data processing, as shown in equation (2).

$$H(x) = \underset{y \in Y}{\operatorname{argmax}} \cdot \sum_{t=1}^{T} P\left(h_t(x) \cup y\right) \quad (2)$$

In the formula, $h_t(x)$ represents the new energy dataset and y is the carbon finance data set, and the matching function in the set is constructed. The risk comparison of the indicator data is carried out, and it is integrated with the maximum risk combination to form the optimal feature combination. T It is mainly the quantitative value of the new energy data, and the equilibrium set of wind power and photovoltaic can be obtained, as shown in equation (3).

$$y_m = a_0 f_0(x) + a_1 f_1(x) \dots + a_m f_m(x) \quad (3)$$

In the formula, a_m represents the classification of wind power and photovoltaics, and $f_m(x)$ represents the weight of data, and the proportion of wind power and photovoltaics.

2.2. The ratio of energy transmission and financial risk prediction of new energy

According to the form of randomly selected data, the risk of new energy data is increased. After the risk value is improved, the data features are selected to match with the combination of data that is greater than the risk value, and the objective function is calculated and recorded, as shown in equation (4).

$$L = \sum_{i=1}^{n} a \cdot (y_i, y_i) + \sum_{k=1}^{k} \Omega(f_k) \quad (4)$$

In the formula, $\sum_{i=1}^{n} a \cdot (y_i, y_i)$ represents the potential of wind power and photovoltaic power, and $\sum_{k=1}^{k} \Omega(f_k)$ represents the deviation value between the predicted value of carbon financial risk and the actual energy output value. According to the treatment of new energy characteristics, risk ranking and numbering are carried out, and the final prediction sign-off value is calculated. Therefore, the carbon financial risk prediction is completed from the balanced processing of sampling wind power and photovoltaic power, which is calculated as shown in equation (5).

$$H'(x) = \operatorname{sign}\left(\sum_{i=1}^{T} h_i(x) - \sum_{i=1}^{T} \theta_i\right) \quad (5)$$

In the formula, $\sum_{i=1}^{T} h_i(x)$ represents wind energy capacity and $\sum_{i=1}^{T} \theta$ is photovoltaic capacity. The above process is used to complete the optimal decomposition, and the carbon financial risk status in the new energy is predicted in time, and the optimal production capacity calculation value is completed.

The ant colony algorithm applies because it is efficient in solving highly complex optimization problems and is therefore most suitable for nonlinear and dynamic system scenarios, like integrating renewable energy and carbon finance risk prediction. Unlike the conventional optimization methods, the algorithm is able to perform multi-solution exploration with a converging solution towards the optimum value through the use of heuristics derived from nature. Other advantages of the proposed AI method over other approaches like genetic algorithms or simulated annealing are its robustness and adaptability for handling multidimensional, uncertain data and their complex relationships in renewable energy and financial systems.

2.3. The coupling process of new energy and carbon finance risks

Based on the application of power flow, voltage and current in wind power and photovoltaic, all the extracted carbon financial risk characteristics are combined to realize the stability calculation of wind power and photovoltaic, as shown in equation (6).

$$Q_l^{(\phi)} = \int \left[W_{i,l}(z)\right]^{\omega_i} \left[W_{j,\phi(l)}(z)\right]^{\omega_j} dz \quad (6)$$

In the formula, $\int\left[W_{i,l}(z)\right]^{\omega_i}$ represents the stability of photovoltaic and wind power generation under carbon financial risk, $\left[W_{j,\phi(l)}(z)\right]^{\omega_j}$ is the continuous output of wind photovoltaic under carbon financial risk, and dz is the impact of eliminating interference factors, as shown in equation (7).

$$\bar{G}_l = \sum_{L_i \in \mathcal{F}(\mathbb{L}_i)} \sum_{\phi \in \mathcal{M}(L_i)} s_{L_i} f^{(L_i,\phi)} \quad (7)$$

In the formula, $\sum_{\phi \in \mathcal{M}(L_i)} s_{L_i}$represents the role of wind power and photovoltaic power generation on carbon financial risks, and$f^{(L_i,\phi)}$is the role of new energy structure on risk prediction, and the specific results are shown in equation (8).

$$\bar{\delta} = \sum_{i \in \mathcal{N}} \mu_i \, \nu_i \quad (8)$$

In the formula,μ_i is the characteristic indicators extracted from the carbon financial risk prediction information， $\nu_i$represent the carbon financial risk monitoring information, and the fusion results of wind power, photovoltaic power generation and carbon finance$\bar{\mathbb{R}}_l$ are calculated as shown in equation (9).

$$\bar{\mathbb{R}}_l = \varepsilon_i s_{i,l} + \varepsilon_j s_{j,\phi(l)} \quad (9)$$

In the formula, $s_{i,l}$ represents the maximum development capacity of new energy,$s_{j,\phi(l)}$ represents the minimum value of carbon financial risk, and $\varepsilon_i$is the balance coefficient. $\phi_{i,g}$is the coupling process of new energy and carbon finance is as follows, and the calculation is shown in equation (10).

$$\phi_{i,g} = \delta_{i,g} / \sum_{i \in \mathcal{N}} \delta_{i,g} \quad (10)$$

In the formula,$\delta_{i,g}$represents the probability of carbon financial risk and$\sum_{i \in \mathcal{N}} \delta_{i,g}$ is the mining probability of new energy, so the final calculation result is a dynamic result.

2.4. Calculation steps of new energy and carbon finance

According to the results of wind power and photovoltaic power generation, the risk prediction of carbon finance is mainly carried out in the following steps:

The first step is to collect data on wind power generation equipment, photovoltaic polysilicon, and objective results such as season, weather, and region to form a data collection.

The second step is to combine the probability of carbon finance risks and the expectations of the entire financial industry to carry out risk prediction and establish a coupling relationship between new energy and carbon economy.

The third step is to complete the accuracy calculation of carbon financial risk and realize multi-indicator analysis. According to the output results of the new energy structure, an objective analysis content is formed.

In the fourth step, the coupling between the optimization of the new energy structure and carbon finance, as well as the characteristic values, are calculated, and their characteristics are determined, otherwise the above process will be repeated.

3. Results and discussion

3.1. Cases of carbon finance with optimal integration of new energy resources

Based on the research of wind power and photovoltaic power generation, this paper analyzes the development potential of new energy and constructs the power grid diagram of new energy, as shown in Figure 1.

From the analysis in Figure 1, it can be seen that the distribution grid of new energy resources mainly includes the distribution system, inverter, and transformer, to realize the adjustment of power indicators, and to carry out the energy supply control and power flow analysis of the microgrid, so as to maintain the stability of the grid-connected microgrid and the main grid. At the same time, current, voltage, and power flow signals are transmitted via Wi-Fi to support the synthesis of post-production data.

Among them, the time of the test data is 4 months, and the financial data is published online, and the data is divided into grades, and the I~V level represents low, low, medium, high and high risk levels respectively. At the same time, the wind power, photovoltaic power generation energy, power generation, power flow, voltage and current indicators in the microgrid are collected, and the data are mapped and processed during the test process to remove the complex attributes of the data, so as to establish a link between new energy and carbon financial risks, and the specific data collection results are shown in Table 1.

From the data analysis in Table 1, it can be seen that in terms of the number of data collection times and fitting values, power operation and maintenance and carbon finance have obtained good results, indicating that the data collection meets the requirements. Among them, the amount of data in carbon finance is relatively large, and the amount of electricity data is relatively small, mainly because in the data collection, new energy removes complex data and has more data duplication. In terms of the number of collections, the number of collection of power and operation and maintenance indicators is relatively large, and the carbon finance is relatively small, mainly because the data of carbon finance is updated annually, while the power data collection is realtime collection. In terms of fitting value, the operation and maintenance index and power index are poor, mainly because of the interference of nature and policy, and the fitting value of carbon finance is relatively good. However, all of the above data met the test requirements and there were no abnormal results. 4.2 The correlation between wind power, photovoltaic power generation and carbon finance In the process of wind power and photovoltaic power generation, the power signal fluctuates, which may affect the power output of the power system, which in turn causes the lag in energy sales, or the lack of power output, and the problem of unstable energy management. Therefore, the output instability has an impact on carbon finance and increases its risk level, so it is necessary to deeply analyze the correlation between wind power, photovoltaic power generation and carbon finance, and measure the change of risk value on a regular basis, as shown in Table 2. According to the analysis in Table 2, the ratio of wind photovoltaic power generation is at 1:1, and the adjustment of the ratio is mainly affected by natural factors, such as wind speed, topography, season and light, so the proportion value remains fixed; The impact of microgrid connection on the power index and carbon neutrality index is less, indicating that the power index after grid connection has been better intervened, and the energy output is stable. In terms of economic benefits, the economic benefits of current, tidal current, and carbon emissions are relatively high, all greater than 80%, indicating that tidal currents and carbon neutrality can bring financial benefits.

The impact of current on economic benefits is mainly to identify the failure rate of power generation equipment, improve the level of operation and maintenance, and reduce the indirect impact of carbon finance.

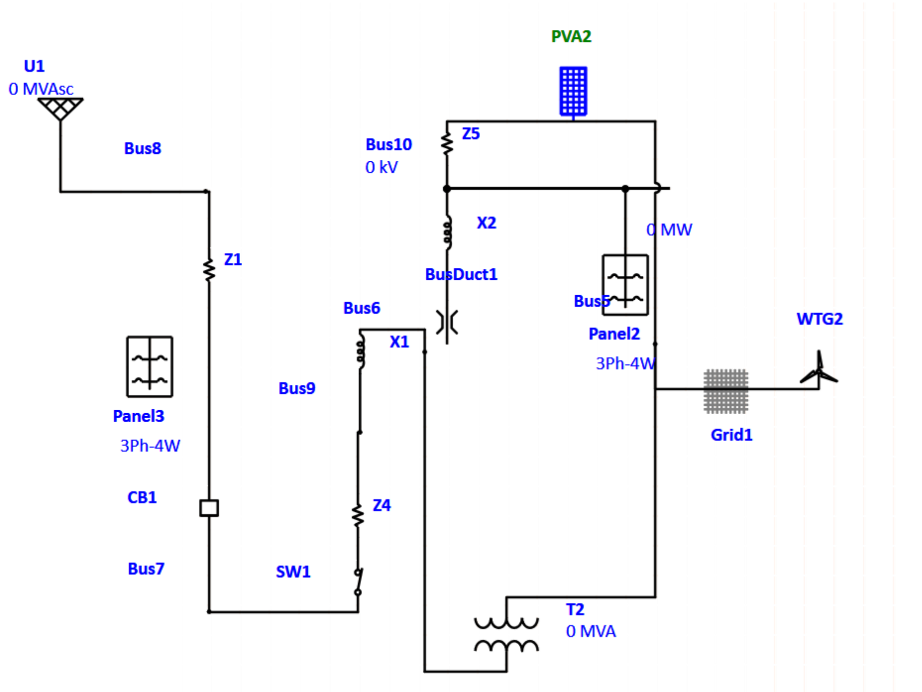

Figure 1. Circuit diagram of the new energy power grid

Table 1. Data structure of wind power, photovoltaic energy and carbon finance

content	Amount of data	Number of data collections	Fit value
Electricity metrics	15.866 ~82.32	4 ~9	0.251~0.852
O&M metrics	15.866 ~78.25	6 ~10	0.395 ~0.736
Carbon Finance	84.134 ~92.452	< 4	0.657 ~0.835
rationality	0.855	0.725	0.952

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Table 2. The integration effect of new energy and carbon finance

item	Wind/PV ratio	Microgrid Connected (%)	Economic Gain (%)	Risk level
current	0.4297	0.1513	0.3088	3
voltage	0.5505	0.1667	0.8389	1
tidal current	0.3612	0.1469	0.9962	4
power	0.4849	0.1565	0.5145	4
Carbon emissions	0.4179	0.1422	0.9014	2
Integration of new energy and carbon finance	0.4714	0.1667	0.6973	5
Overall value	0.6036	0.1667	0.9340	3
Adjusted results	0.5321	0.1667	0.8060	2

In terms of risk level, the risk level of current, power flow and power is relatively high, which is 3~4, indicating that strengthening the detection of power signals has a practical effect on financial risk prediction. Since the proportion of carbon emissions in the microgrid is fixed, the risk level is relatively small. In addition, the risk level of the integration of new energy and carbon finance is the highest, which is level 5, indicating that the two are effectively integrated and can accurately predict the risk of carbon finance. On the whole, the change range of power indicators and carbon finance indicators is small and within the constraints of the industry, so the results are ideal. In-depth excavation of the relationship between power indicators and carbon finance indicators can clearly identify the comprehensive risk of new energy resources and carbon, as shown in Figure 2.

From the data analysis in Figure 2, it can be seen that there is a fluctuating relationship between the energy output of wind power and photovoltaic power generation and their risk level, and the change direction of the two is the same, indicating that energy output can promote the development of carbon finance. At the same time, the increase in wind and photovoltaic power generation will inhibit financial risks, and the energy output value is greater than the threshold of 15%, which can maintain the stability of the output power. This shows that the stable supply of new energy can not only enhance the benefits of carbon finance, but also curb financial risks. In the process of measurement, the financial risk in the early stage is relatively large, and the financial risk in the later stage shows little volatility and gradually tends to stabilize. This shows that the integration of multiple indicators of new energy can curb financial risks, improve its energy output effect, and bring considerable economic benefits. The research indicates that current, due to its stability and the fact that it influences the amount of power generated directly, therefore making the financial outcomes more predictable, contributes to a 36.28% risk reduction. On the other hand, tidal current contributes to a 34.50% risk reduction but its variability, stemming from the influence of geographical and seasonal factors, introduces higher volatility and less predictability in financial risk. These differences in actual reductions are attributed to the intrinsic stability that characterizes current and the fluctuations typical of tidal currents. Future research should target ways of stabilizing the contribution of tidal currents or their integration with other forms of energy to minimize risks.

3.2. The role of wind power and photovoltaic power grid sustainability on carbon finance risks

The main problem of wind power and photovoltaic power generation is continuity, and the current problem of solving the sustainability of wind power and photovoltaic power generation is to achieve alternating power generation, so as to avoid the impact of seasons and sunshine on wind power and photovoltaic power generation. Through the rational allocation of power generation, the effect of new energy power generation can be improved, and stable energy can be exported to the market, but the impact and effect of wind and photovoltaic power generation on financial risks need to be further analyzed, as shown in Table 3.

From the data analysis in Table 3, it can be seen that the current and power flow have a significant impact on wind power, photovoltaic power generation, carbon finance and risk reduction rate, especially the risk reduction rate, whose values are 36.28% and 34.50%, indicating that the signal identification of power indicators can promote the development of carbon finance and effectively predict its risks. In terms of the integration of new energy and carbon finance, it is found that the correlation between the two is negative, -0.2896, indicating that the correlation between new energy and carbon finance is a one-way relationship, mainly because new energy has an impact on carbon finance, which further proves that new energy can play its role in the field of carbon finance. Among them, the score of carbon emissions is relatively low, at 0.0178, mainly because carbon emissions are affected by factors throughout the industry, so their values are fixed. In terms of comprehensive score, it is proved that power signals such as current and power flow have a promoting effect on carbon financial risk prediction, and can prompt carbon financial risks. In addition, the prediction of carbon financial risks also deepens the structure of new energy, rationally allocates the proportion of wind power and photovoltaic power generation, and improves the effect of energy generation. In order to deeply judge the relationship between wind power, photovoltaic power generation and financial risks, a single continuous analysis of its indicators is carried out, and the specific results are shown in Figure 2. According to the analysis data in Table 2, the wind and photovoltaic power generation signals fluctuate without exceeding the predetermined values under the condition of improving the level of index fusion. At the same time, the index integration energy reduces the risk rate of carbon finance, and the reduction rate is about 25%. In the analysis of the fusion index, it will be found that the change range of the risk point is irregular, indicating that the fusion of new energy resources index can inhibit the carbon financial risk, but the index itself is still unstable, and the reason for the instability is irresistible interference factors such as season and light. Therefore, the data results meet the objective requirements, and the results have strong feasibility.

4. Summary

Carbon finance is an economic issue of new energy, which has certain risks, and is related to the power generation and stability of wind power and photovoltaic power. This study focuses on the optimal integration index of new energy resources and carbon finance risk prediction, and reveals the intrinsic relationship between new energy resource integration and carbon finance risk through multi-dimensional theoretical analysis. The results show that there is a fluctuating relationship between the energy output of wind and photovoltaic power generation and their risk level, and the increase of electricity will inhibit the financial risk, and the energy output value is greater than the threshold by 15%. The risk reduction rate was 36.28% and 34.50%, and the integration of new energy and carbon finance was -0.2896, indicating that new energy has an impact on carbon finance, and the score of carbon emission was relatively low, which was 0.0178.

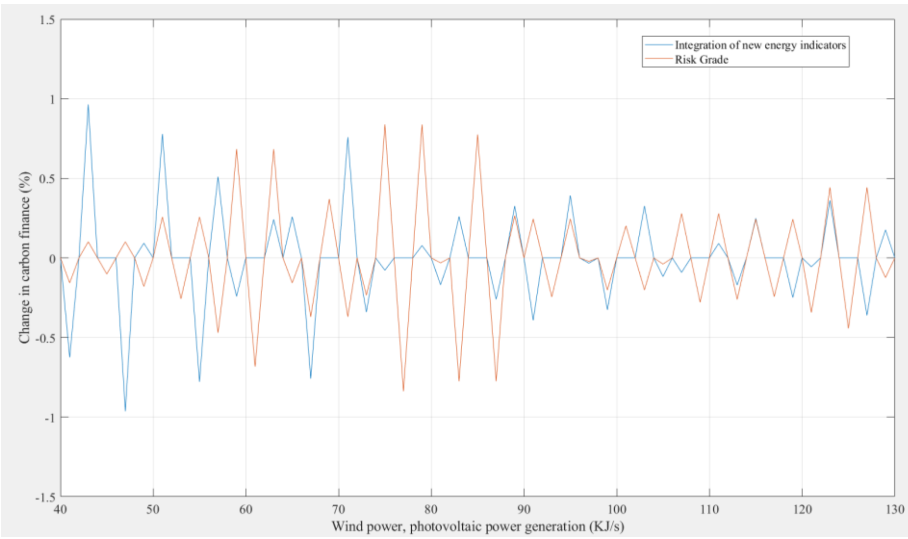

Figure 2. The relationship between wind power, photovoltaic power generation and other financial risks

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Table 3. The impact of wind PV grid sustainability on carbon finance risk

content	Photovoltaic, wind discharge	Carbon Finance	Comprehensive score coefficient	Risk reduction rate
Rate of action	2.299	1.732		
Comprehensive lift rate	38.31%	28.87%		
current	0.4551	0.5199	0.4829	36.28%
voltage	0.3219	0.6416	0.1641	1.34%
tidal current	-0.0890	0.1595	0.4593	34.50%
power	0.2329	-0.2826	0.0114	0.85%
Carbon emissions	0.5584	-0.3591	0.0178	12.33%
Integration of new energy and carbon finance	0.5615	-0.2896	0.1958	14.70%

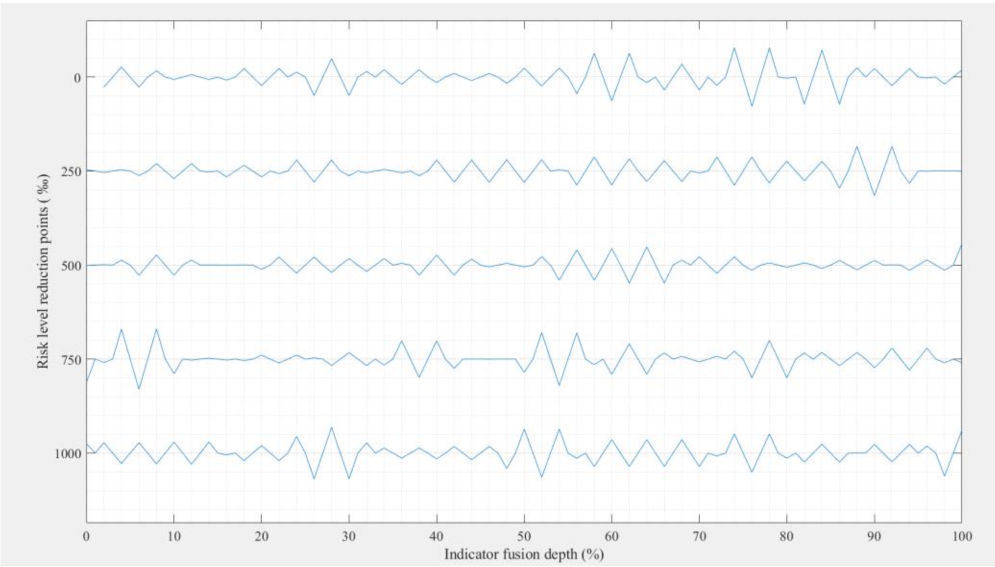

Figure 3. The persistence of the integration of new energy indicators on carbon finance risks

The index integrates energy to reduce the risk rate of carbon finance, and the reduction rate is about 25%. Therefore, the multi-index integration of wind power and photovoltaic power generation can promote the development of carbon finance and suppress its risks, indicating that the integration of new energy resource indicators can analyze the problems in its economic field and expand the application scope of new energy in the economic field. At the same time, financial risk prediction can also deepen the structure of wind power and photovoltaic power generation, and enhance the potential of new energy development. There are some deficiencies in the research, mainly because the financial risk data adopts the classification analysis method, and the quantitative analysis method will be used in the future to concretize and quantify the numerical value, and the research on carbon financial risk prediction is low.

Limitations and future work

Qualitative data on risk inherently lacks precision and could be subjective, which might limit the accuracy of financial risk predictions in this study. The analysis does not fully investigate quantitative methods such as regression or machine learning that could give more substantial and data-driven insights. Moreover, a lack of detailed granular data regarding the risk factors affects comprehensive understanding of the impact that these risk factors have on carbon finance. The generalization of conclusions also suggests a need for an extended dataset and quantitative modeling for more reliable and accurate results.

Declarations

Funding: Authors did not receive any funding.
Code availability: Not applicable.

Authors Contribution
Jiantao Jiang is responsible for designing the framework, analyzing the performance, validating the results, writing the article, collecting the information required for the framework, provision of software, critical review, and administering the process.

Availability of data and materials
No datasets were generated or analyzed during the current study.

Conflict of interests
Authors do not have any conflicts.

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