Scholar Publishing Group
Academic Journal of Energy
https://doi.org/10.38007/RE.2021.020306
ISSN 2790-2714 Vol. 2, Issue 3: 50-58

Major Issues Related to Wind Power Development and Consumption under the Ecological Footprint Method

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Keywords: Ecological Footprint, Wind Power Development, Wind Power Consumption, Problem Research

Abstract: In recent years, with the depletion of conventional fossil energy, renewable energy such as wind energy has attracted more and more attention. The purpose of this paper is to apply the ecological footprint method to the evaluation and calculation of wind energy development and absorptive capacity, and then to study related major issues. First, through the in-depth analysis of the existing wind energy development and consumption theories, the current factors affecting wind energy development and consumption and the existing wind energy consumption patterns are summarized. Taking the wind farm in province M as an example, the weights of each index of wind power development project and wind power consumption capacity are calculated. The calculation results show that, among the technical factors of wind farm projects in M province, wind resources account for 39%, accounting for the largest proportion, followed by site selection and wind farm technical conditions, accounting for 12% and 3% respectively. According to the calculation results of the ecological footprint calculation method, it is estimated that wind energy can absorb 1547 MWh in summer and 1164 MWh in winter. The technical level of the wind farm is excellent, indicating that the technical level is suitable for the construction of wind farms in M province.

1. Introduction

With the rapid development of my country's economy, the country's demand for energy continues to increase, but the non-renewable nature of traditional energy makes us think about how to better develop and utilize renewable energy to support social and economic development [1]. As the actual location of the power grid, use the existing power renewal management system of the local power plant to comprehensively analyze and calculate the wind power and energy consumption of the current power grid, and formulate analysis and methods to evaluate the development and energy efficiency of wind power in the power grid, and provide the power supply and design for the future power grid. necessary motivation [2].

Scholars at home and abroad have made great breakthroughs and development in major issues related to the development and consumption of wind power under the ecological footprint method. The The Genta C Energy Study was designed to analyze the current EF on the main campus. Data were collected from multiple domains and controls to determine the stress of horticultural activities on ecosystems. Possible scenarios were then drawn across five different design levels: electricity, water, landscape, food and navigation. Field trips through a user-friendly design require an in-depth understanding of the prospective university's future needs and a broader assessment of the most appropriate approach based on all university advisors, not just the idea of avoiding EF [3]. Mayer T compared low pressure storage at 5 MPa and 20 MPa in hydrogen transport mode. For all plant configurations and sizes, a medium voltage grid connection is made if the electrical load exceeds certain limits. For on-site production equipment, plan the electricity load of the hydrogen production unit (electrolyte or regeneration gas) according to the electricity load. Due to compliance with other plant assumptions, the cost and energy efficiency of power generation equipment were not planned for this study. Therefore, the cost of connecting to the network is limited to the workstation part, not the power supply. The operating system of the generator set is also considered to be affected by the power output of the bottom compressor or pump and the required low pressure storage. All port proposals, hydrogen powered hydraulic stations and LPG-supplied hydrogen filling stations or on-site hydrogen filling stations have the potential for significant cost reductions [4]. Dindar We propose and compare the OC-enhanced safety concept in DS, which is based on previous wind speed prediction data from dual array wind turbines (DFIG), comparing wind power generation, paying attention to wind speed uncertainty and low pressure motion. The production capacity of DFIG and renewable energy systems is an offline decision between each time frame and possible operational locations. The results show that the proposed safety concept prevents erroneous and random motion operations and provides faster home isolation compared to the traditional OC safety concept [5]. To sum up, that wind power development have received extensive attention in academia, but there are few unified analysis and evaluation methods for wind power development and consumption capacity.

Combining with the specific situation of M provincial power grid, this paper divides the regional wind belt. With the help of the power modernization management system platform of M Province Electric Power Co., Ltd., the analysis and evaluation methods of M Province power grid development and wind energy absorption capacity are studied, and the necessary technical support is provided. This paper studies the theory of technical and economic evaluation of wind farm projects, establishes a scientific and perfect technical and economic evaluation system for wind power projects, and solves some key problems in the feasibility of the research.

2. Research on Major Issues Related to Wind Power Development and Consumption under the Ecological Footprint Method

2.1. Definition of Ecological Footprint

Economic development and social progress are based on the development and utilization of natural resources. The natural resources that exist in nature and are used by human beings include: land, forests, minerals, energy, water, organisms and other natural resources. As the material basis of social and economic development, how to measure the extent to which a region utilizes nature for its own survival and development and the demand for ecological resources, so as to evaluate the impact of regional social production activities on the ecosystem? The concept of ecological footprint is of great significance to these The questions are answered [6-7]. Ecological footprint refers to the land area with ecological productivity that can continuously provide resources or accommodate waste, and describe the area of natural resource consumption from the perspective of specific biophysical quantities. The Ecological Footprint is designed to trace the final consumption of various products, resources and services necessary for human existence in the ecologically productive areas of the land that provide the raw materials and energy consumed by these items. Ecological footprint analysis is done by measuring the biologically productive areas that people use to survive [8-9].

2.2. Analysis of Wind Power Consumption Factors

(1) The adjustment ability of the system Wind energy has the characteristics of volatility, intermittentness and randomness

A careful analysis of the characteristics of wind power generation throughout the year is not difficult to see that the wind power generation in many regions in my country is high in spring and winter and low in summer and autumn. Judging from the day and night characteristics of wind power generation, my country's wind power generation generates more electricity during the peak hours of the day, and generates more electricity during the higher hours after midnight [10-11]. The large-scale development of wind power has exposed power systems to increasingly challenging high-frequency and high-frequency regulation. Intelligent power system and suitable energy storage capacity are very important for wind power, and sufficient process power is also an important condition for wind power development. While developing wind power in the energy field, western developed countries also attach great importance to supporting the production of natural gas, pumped storage and other energy sources in other fields [12-13].

(2) Randomness and intermittent characteristics of power grid transmission

Improving the power transmission capacity of the power grid can make wind power produce a balancing effect in a large range, so as to make full use of the system backup capacity and eliminate the impact of wind power changes on the power generation system. The time difference between the peak load in different regions and the time when the pipeline is connected to the grid. There are several airports at the end of the network. Large-scale wind power will be connected to the grid in large numbers, the scale of power supply will increase, and the load lines will increase. Under the conditions of high power supply and renewable energy systems that are difficult to solve in the short term, the energy transmission capacity of various power grids in various regions has become the most important factor restricting wind power in my country [14-15].

(3) Technical level

After large-scale wind power is connected to the power grid, it may ensure the safety and stability of the system, which is an important factor for the efficient utilization of wind power. Compared with developed countries in the West, my country's wind power development started very fast, and the necessary requirements for wind power-related technologies were not introduced until recently. Many manufacturing companies need to introduce foreign designs to produce and assemble air turbines, and their independent R&D and innovation capabilities are not enough. However, most of the air turbines put into production do not work, regenerating power functions and transmitting forces at low pressure [16-17].

2.3. Principle of Wind Power Generation

The rotor blades of the wind turbine convert energy under the action of the wind turbine to drive the rotor shaft to rotate, and the charged force is transmitted to the rotating system through the rotor shaft. Typical forms of wind turbines are: fixed pitch generator systems, direct frequency speed turbines using fixed magnet generators, and variable speed variable frequency wind turbines using asynchronous two-shaft composers [18].

The process of converting energy into wind energy production has two aspects: wind energy is converted into mechanical energy, mechanical energy is converted into electrical energy, and the blades are driven by air to rotate at high speed. The process of converting kinetic energy into mechanical energy; the rotation of a wind turbine allows the wind turbine to generate light. The process of converting machine power into electrical energy. Some large wind turbines have very large blades in order to get more wind, resulting in a lower rotational speed of the wind turbine. Install gears between the two to solve the mismatch between the two.

3. Model Construction and Research of Wind Power Development and Consumption under the Ecological Footprint Method

3.1. Data Sources

The wind farm data used in this study are mainly from the M Province Yearbook and the M Province Statistical Yearbook. The basic data of the ecological footprint supply part comes from the environmental index data, and the other part comes from the environmental bulletin and the national economic and social development bulletin.

3.2. Construction of Wind Power Development Index System

In this paper, an evaluation index system for wind farm development is constructed, as shown in Figure 1.

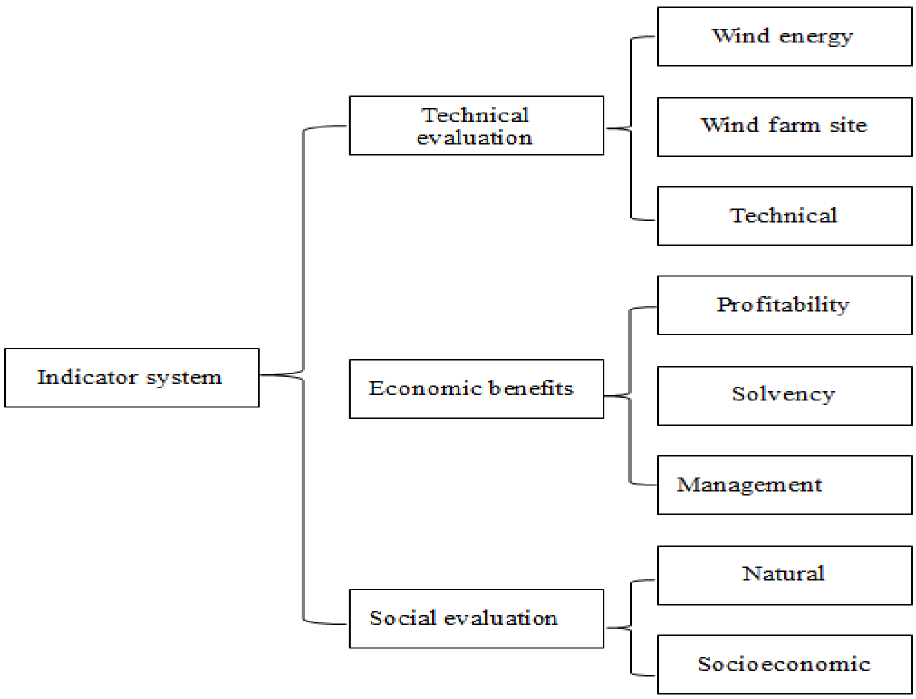

Figure 1. Wind farm development evaluation index system

3.3. Calculation of Ecological Footprint

This paper calculates the ecological footprint of 30 provinces (autonomous regions and municipalities) in China with reference to the National Ecological Account Footprint Calculation Method (2010 Edition). The formula is as follows:

$$EF = EF_B + EF_C = \sum_i \frac{P_i}{Y_{W,i}} \times EQF_i + \frac{(P_C - S_{ocean})}{Y_C} \times EQF_C \quad (1)$$

In the formula, EFB is the ecological footprint of biomass; EFC is the carbon footprint; PC is the CO2 emission; Socean is the ocean absorption ratio of CO2 in a specific year.

Because the existing statistical data do not record the consumption data of biomass resources completely, domestic mathematicians all adopt the same treatment method, that is, they think that biological resources reach a balance between supply and demand, and use production instead of consumption. According to WWF estimates, the CO2 ocean absorption rate in the carbon footprint account is 21.75%, and the CO2 absorption rate of forest land is 0.97t/ha. The specific expression is calculated as follows:

$$P_c = \sum_i E_i \times NCV_i \times CEF_i \quad (2)$$

In the formula, NCVi represents the average low calorific value of the ith energy; CEFi represents the CO2 emission coefficient of the ith energy provided by IPCC; Ei is the total consumption of the ith energy.

4. Case Analysis of Major Issues Related to Wind Power Development and Consumption under the Ecological Footprint Approach

4.1. Index Weight of Wind Power Development Capability

In order to determine the density of wind turbines at all levels in the M area, this paper adopts an ecological approach, based on expert judgment of the relative importance of different factors. Through the calculation, the weight results of all levels of the wind power development capability index system of the wind farm project in M province are obtained. Table 1:

Table 1. Wind power development capacity index weight

First-level indicator	Indicator weight	Secondary indicators	Secondary indicator weight
Technical evaluation	0.54	Wind energy resources	0.39
		Wind farm site selection	0.12
		Technical conditions	0.03
Economic benefits	0.37	Profitability	0.28
		Solvency	0.07
		Management capacity	0.02
Social evaluation	0.09	Natural environment	0.06
		Socioeconomic	0.03

As can be seen from the above table, among the indicators of technical factors of wind farms in M province, wind energy resources account for 39%, the largest proportion, followed by wind farm site selection and technical conditions, which are 12% and 3% respectively. Indicating that wind resources, wind farm site selection, project management and wind farm technical conditions are all very good, technically suitable for the construction of wind farms in M province.

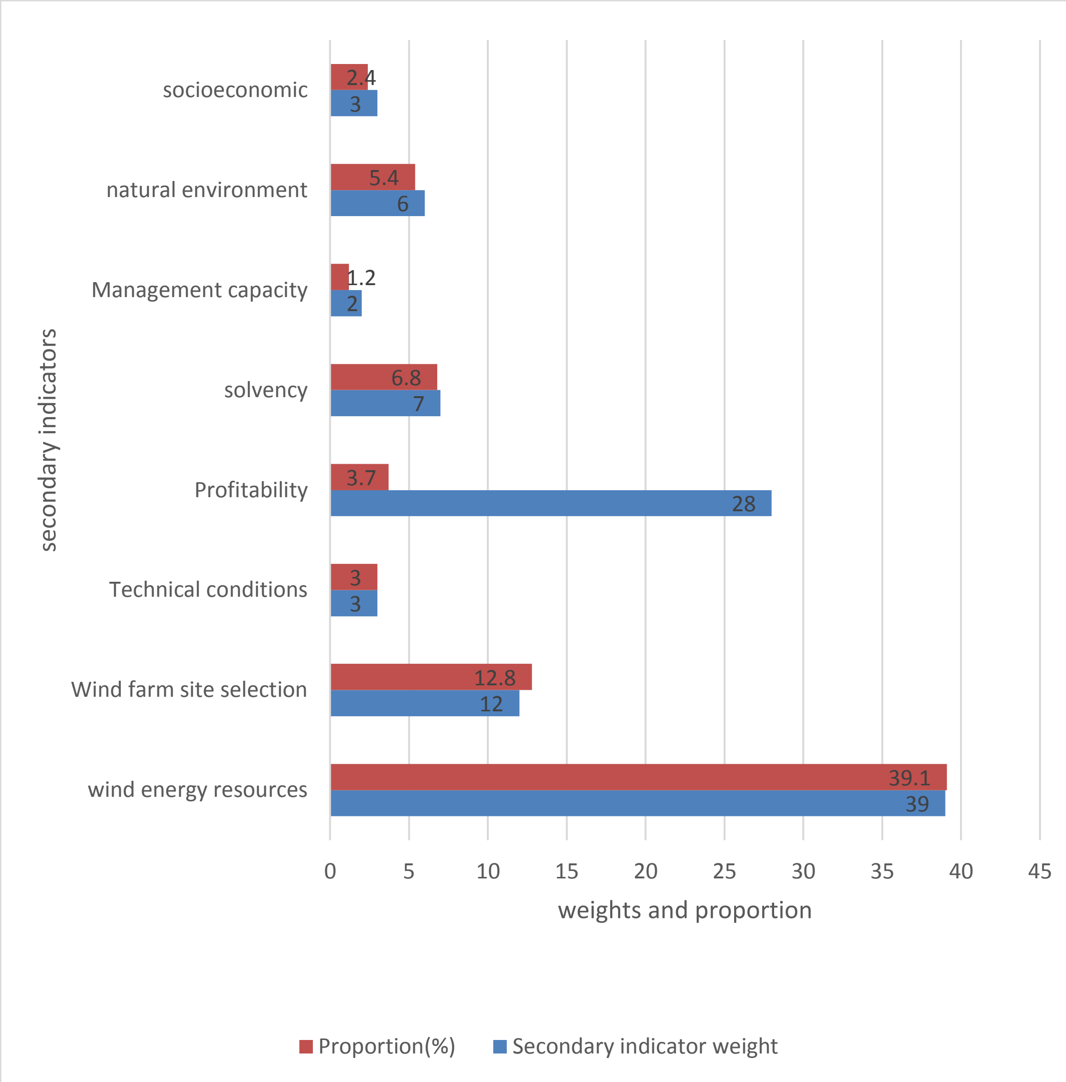

Figure 2. Proportion of wind power development capacity indicators

According to Figure 2, the profitability index of wind farm projects in Province M accounts for the largest proportion in terms of economic benefits, accounting for 28%, followed by solvency and operating ability, accounting for 7% and 2% respectively. The economic benefits of this wind farm project are good, mainly due to the huge investment in wind power projects. At present, due to technical and grid-connected problems, wind power projects are slightly less profitable and have a relatively short payback period. Therefore, the economic benefits of wind power projects are not as good as those of general thermal power plants.

4.2. Calculation Analysis of Wind Power Accommodation Capacity

In this paper, the whole network of M province is taken as an example. The test data is only used to verify the calculation method of the system, not as a practical basis. Taking the summer and winter large-load operation mode as an example, the test data and calculation results of the whole network data calculation results are shown in Table 2.

Table 2. Wind power consumption capacity in heavy load operation mode

Season	0:00	5:00	10:00	15:00	20:00
Summer	1596	957	2648	1689	1547
Winter	546	98	984	1084	1164

Comparing the calculation results of winter and summer, it can be found that the daily wind power absorption capacity in summer is higher than that in winter. This is because the number of heating units operating in winter increases, the minimum output of peak-shaving units increases, and the wind is strong in winter, and the output of grid-connected wind power is increased. On the premise that the delivery capacity of the contact line remains unchanged, the absorption capacity has declined. The 5-month data are calculated according to the ecological footprint calculation method, and it is calculated that the wind power can absorb 1547MWh of electricity in summer and 1164MWh in winter.

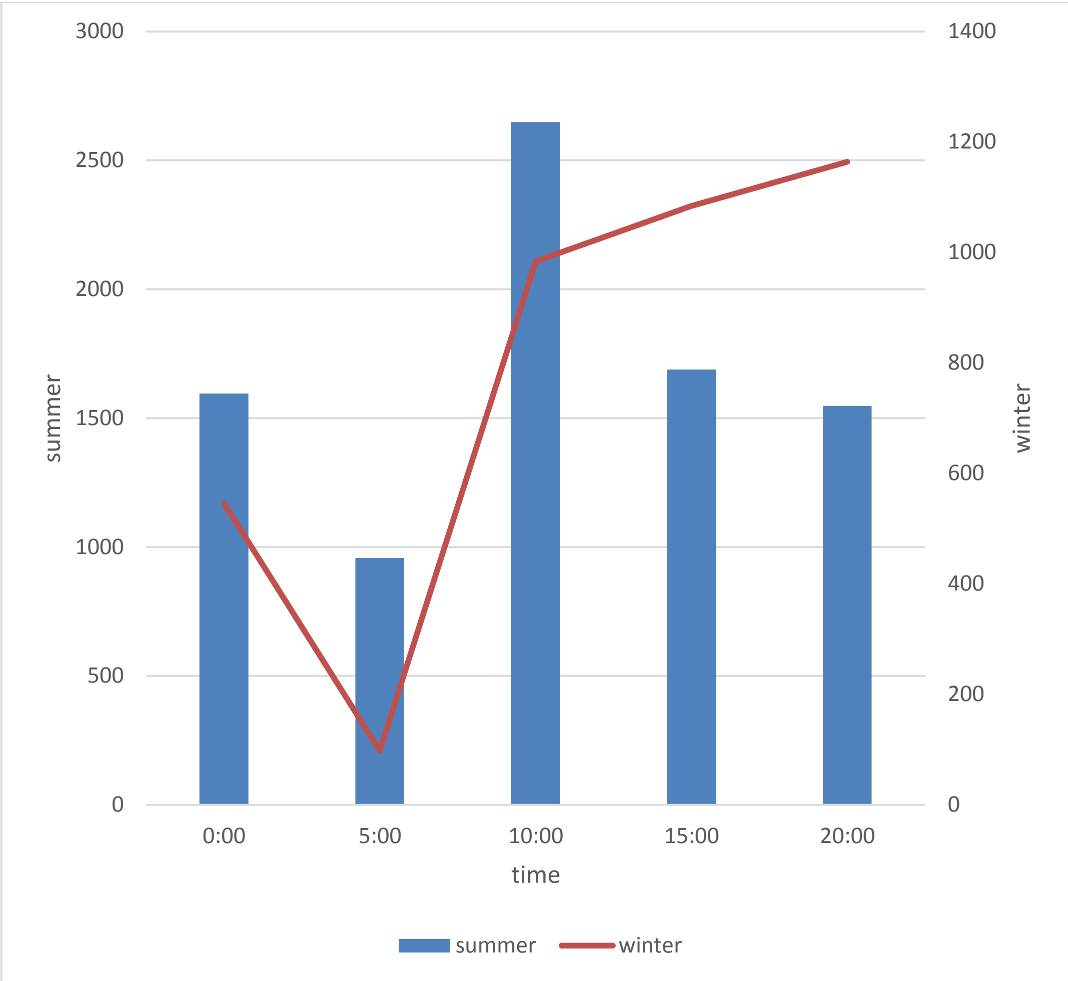

Figure 3. Seasonal comparison of wind power consumption capacity in heavy load operation mode

From the calculation results in Figure 3, the wind power absorption capacity at each moment is not the same, and the maximum wind power absorption capacity is often in the peak load period, and the minimum absorption capacity is in the valley load period, which is different from the theoretical and actual situation.

5.Conclusion

This paper studies the evaluation method of wind power development and consumption based on the ecological footprint method. The massive use of fossil fuels has caused a sharp rise in global carbon emissions, which has caused the climate problem of global warming, and has brought a serious impact on the ecological environment. Facing the severe reality of energy shortage and climate warming, improving the overall utilization efficiency and increasing the consumption ratio as much as possible are of great significance for future energy utilization. Although some research results have been achieved in this paper, there are still some problems to be further studied. For example, the impact of national policies on the development and consumption of wind power is not considered in the discussion process. How to quantify the impact of policy factors on the development is an important issue in the development and consumption strategy of wind power further research.

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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