

# Research on the financing efficiency evaluation of listed companies in the new energy industry based on DEA model

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## Abstract

New energy pollutants, with low emission and high performance, is the cornerstone of the future energy of human society; vigorously developing new energy is of great significance to the sustainable and high-quality development of China's economy. The level of financing efficiency directly determines the survival and development of enterprises. The characteristics of long return period of investment, high investment risk and large capital demand in the new energy industry cause a series of problems, such as limited financing and difficult to effectively measure the evaluation of financing efficiency. In-depth and systematic research and evaluation of the financing efficiency of new energy enterprises is of great significance to the improvement of the financing quality of the new energy industry and the high-quality development of the new energy industry. This project is based on the evaluation of the financing efficiency of listed companies in China's new energy industry based on the data envelope analysis model (DEA). After related concept definition and theoretical basic research, build the DEA financing efficiency evaluation index system, with technical efficiency value of new energy industry of listed companies financing efficiency, the new energy financing efficiency contrast between enterprises in different industries, finally form the final conclusion, for the new energy industry financing efficiency of listed companies put forward feasibility Suggestions.

## Keywords

New energy, Financing efficiency, DEA model.

## 1. Introduction

### 1.1. Research background

#### 1.1.1. "Double carbon" and other national macro policy guidance

With the rapid development of the global economy, the global energy crisis is increasing, and environmental problems are becoming increasingly prominent, countries around the world are paying more and more attention to the development of environmental protection and energy conservation related industries. New energy refers to various forms of energy other than traditional energy. It has significant advantages such as green, clean and efficient. It has become an important trend in global energy development and is conducive to the transformation and upgrading of a country's economic structure and high-quality economic development.

As a major energy consumption country, the excessive abuse of traditional energy does not meet the requirements of China's sustainable economic development. The development of new

energy and promoting the transformation of energy structure is the only way for China to achieve high-quality development. In 2020, the 14th Five-Year Plan and the 2035 vision proposal clearly require to do solid work on carbon peak and carbon neutrality, formulate an action plan for the peak of carbon emissions by 2030, promote the clean and efficient use of coal, and actively develop the new energy industry. China's economic development is faced with the real demand of sustainable and high-quality development and the continuous growth of energy demand, so it is urgent to develop the new energy industry.

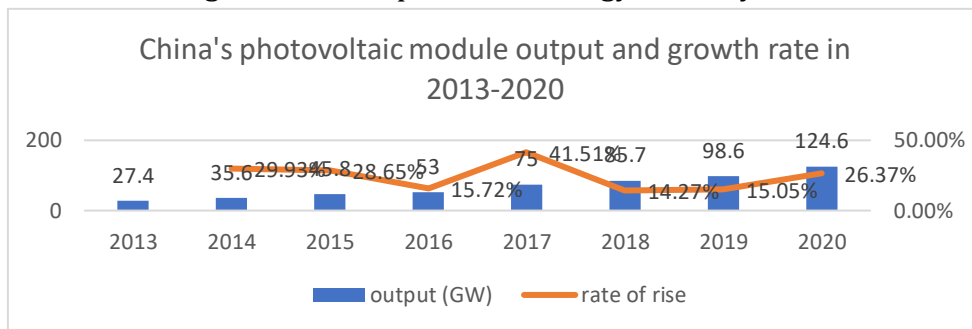


Figure 1: China's pv module output and growth rate from 2012 to 2020

Data source: "2022 China's New Energy Industry Analysis Report-Industry Survey and Market Opportunity Research"

### 1.1.2. Development status of China's new energy industry

Since the 13th Five-Year Plan, China's new energy industry has been developing rapidly. In 2020, China had 981 million kilowatts of installed power generation capacity, accounting for 44.6 percent of the country's total installed power generation capacity. At the same time, the global competitiveness of leading enterprises in China's new energy industry is becoming increasingly prominent. In 2020, 207 enterprises were listed in the "2020 Top 500 Global New Energy Enterprises 200 list", ranking the first in the world. During the two sessions in 2021, the National Energy Administration proposed to formulate more active new energy development goals and accelerate the steady implementation of carbon peak and carbon neutrality goals. According to the outline of the 14th Five-Year Plan, during the 14th Five-Year Plan period, China's new energy industry will implement a number of construction projects involving hydropower, wind power, nuclear power and power grid construction, to vigorously develop the new energy industry.

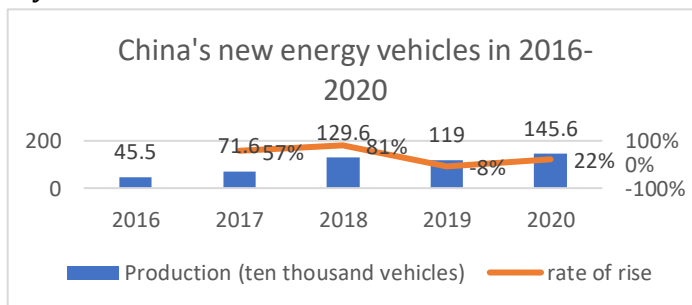


Figure 2: Production statistics of China's new energy vehicles from 2016 to 2020

Data source: "2022 China's New Energy Industry Analysis Report-Industry Survey and Market Opportunity Research"

The new energy industry is composed of countless new energy-related enterprises, and the efficient development of new energy enterprises is an important part of the efficient development of the new energy industry. To investigate the behavior of enterprises at the micro and micro level, the financing issues should be considered first. Although there are corresponding support or incentive policies for each segment of the new energy industry to escort the development of the industry, but the actual rapid financial market support for the

new energy industry is still very limited. At present, the most common channels in the financing market of China's new energy industry are: bank credit financing, equity financing, financial leasing, bond financing and other financing methods. Compared with other industries, the financing channels of new energy enterprises are relatively single and limited, and the financing efficiency is relatively low.

## **1.2. Research significance**

### **1.2.1. Theoretical significance**

New energy pollutants with low emissions and high performance, carrying the mission of gradually replacing traditional energy, is the inevitable trend of the future energy development of human society, and is crucial to the sustainable and high-quality development of a country's economy. This paper takes China's new energy industry as the main research body, Select the relevant indicators of the annual financial report of 2016-2021 of the listed companies with solar energy, nuclear energy, tidal energy, wind energy, biomass energy, geothermal energy, hydrogen energy and Marine penetration energy) as their main business, Using the data envelope (DEA) analysis method, The internal mechanism of the financing efficiency of the new energy industry, It is beneficial to enrich the research content of the financing efficiency evaluation of the new energy industry, To some extent, it provides a reference for the financing efficiency evaluation research of other similar industries, To some extent, it provides a theoretical basis for solving the problem of low financing efficiency of new energy enterprises and optimizing the financing method and capital structure.

### **1.2.2. Practical significance**

The level of financing efficiency directly determines the survival and development of enterprises. The characteristics of long return period of investment, high investment risk and large capital demand in the new energy industry cause a series of problems, such as limited financing and difficult to effectively measure the evaluation of financing efficiency. In-depth and systematic research and evaluation of the financing efficiency of new energy enterprises is of great significance to the improvement of the financing quality of the new energy industry and the high-quality development of the new energy industry. By studying the financing efficiency of new energy industry, analyzing the dimension of new energy industry type, provide reference for new energy listed companies to improve their financing efficiency, and provide reference for the government to formulate targeted and reasonable relevant policies and plans; so as to implement the "double carbon" policy, give full play to the advantages and role of new energy, optimize the energy industry structure, and promote the sustainable and high-quality development of China's economy.

### **1.2.3. Research content**

First of all, relevant literature research and concept definition of China's new energy industry and financing efficiency, appropriate indicators are selected from the perspectives of input and output to build the financing efficiency evaluation index system of listed companies in China's new energy industry, and evaluate the financing efficiency of listed companies in China's new energy industry based on DEA model. Secondly, explore the current situation of financing efficiency of listed companies in China's new energy industry, and analyze the existing financing problems in China's new energy industry. Thirdly, at the theoretical and empirical levels, the impact of financing efficiency on the survival and development of listed companies in the new energy industry is clarified, and the reasons for the low financing efficiency of some enterprises in the new energy industry are explored. Finally, the feasible path and policy suggestions to promote the financing efficiency improvement and high-quality development of the new energy industry are put forward from the perspectives of enterprises and policy makers.

#### 1.2.4. Research methods

This paper mainly from the connotation of financing efficiency, financing efficiency evaluation method, financing efficiency factors three aspects of literature review, from the new energy, new energy industry listed companies, enterprise financing efficiency related concept definition and theoretical basic research, finally determine the new energy industry listed company financing efficiency evaluation research tool — data envelope analysis (DataEnvelopmentAnalysis, DEA) model. Related concept definition and theoretical basic research, from the input and output index, sample selection, data source to build DEA financing efficiency evaluation index system, with technical efficiency of new energy industry financing efficiency, and based on the index system evaluation of the new energy listed company industry in China financing efficiency. Finally, the final conclusion is formed, and feasible suggestions are put forward for the improvement of financing efficiency of new energy industry from the perspectives of new energy enterprises and policy makers.

## 2. Literature review

### 2.1. Research on the situation of the new energy industry

First, research on new energy vehicles is the most common. Zhao Zheng (2022) highlights the good development prospects of new energy vehicles from three perspectives of sales of new energy vehicles, reputation of domestic brands and government support, but the shortage of chips and imperfect basic charging facilities will be hindered. Yang Yang (2021) mainly analyzed the utilization status and development prospects of the new energy industry under the background of low-carbon development in northeast China from the perspective of new energy vehicles.

Secondly, the related research on new energy power generation is also very mature. Ji Xiaoyong (2020) proposed that the post-epidemic new energy policy should accelerate the development of the power new energy industry, and the development of the power new energy industry has broad prospects.

To sum up, the research on the new energy industry is mostly limited to the automobile and electric power industry, and tends to be analyzed by industry to highlight the whole industry. The research on the overall state of the new energy industry tends to study the relationship between the development capacity of the new energy industry and some variables, and these aspects are quite mature.

### 2.2. Research on the financing efficiency

The existing literature research on financing efficiency is based on three aspects. One is to define the basic connotation of financing efficiency from different perspectives. The term "financing efficiency" can be traced back to the 1990s (Zeng Kanglin, 1993), which analyzes seven factors that affect the financing efficiency. Later, different scholars have defined the concept of financing efficiency. For example, Song Wenbing (1997) believes that financing efficiency includes transaction efficiency and allocation efficiency.

## 3. Relevant concepts and theoretical basis

### 3.1. Definition of new energy

New energy has been unanimously praised by countries and international organizations for its clean, environmentally friendly, and sustainable advantages. In 1981, the United Nations officially defined new energy and renewable energy for the first time. Based on new technologies and materials, renewable energy is used to replace fossil fuels with limited resources and environmental pollution, ensuring the modern development and utilization of

renewable energy. The explanation of the concept of new energy in China mainly comes from various related development plans. The 13th Five Year Plan for the Development of National Strategic Emerging Industries clearly mentions the industrial scale and development level that nuclear power, wind power, solar energy, biomass energy, and other industries need to achieve as sources of energy utilization and consumption for the Chinese people in the foreseeable future. Based on the summary of the above content, the definition of new energy mentioned in this article is to replace fossil energy with renewable energy based on new technologies and materials, ensuring its full development and utilization.

### **3.2. Definition of enterprise financing efficiency**

The financing process of enterprises is actually a two-way process in the open market. In this process, the demanders of funds need to seek corresponding resources, while the suppliers of funds judge the quantity and direction of funds provided through established standards. The main criterion for judgment is the return of funds. This article will comprehensively consider the financing efficiency. Therefore, The specific definition of financing efficiency described in this article is: enterprises invest a corresponding level of cost to finance funds, and invest in production to obtain a corresponding level of income. Enterprises with high financing efficiency achieve more financing at the lowest possible cost and obtain the highest possible returns in production activities.

### **3.3. The DEA model**

Data Envelopment Analysis (DEA) is a relatively novel evaluation and analysis method based on mathematical programming. It converts multiple inputs into outputs to evaluate the relative efficiency between comparable "departments" or "units" (known as DEA effectiveness). The evaluated objects are referred to as Decision Making Units (DMUs) under this method. In DEA, each DMU obtains the same set of output elements through the same set of input elements. They can freely choose any combination of input and output indicators to maximize their relative efficiency, which is the ratio of total weighted output to total weighted input. The process of evaluating whether DMU is DEA effective is essentially to determine whether the observed data of the various indicators represented by DMU falls on the frontier envelope of the production possibility set.

## **4. Financing status of China's new energy industry**

### **4.1. Development status of China's new energy industry**

From a broad range of view, new energy usually refers to new energy sources that have not been used on a large scale and have high development potential in the future. Due to the different economic aggregate and development environment of different countries, there may be some differences in the definition of new energy at home and abroad, but on the whole, it is still consistent. In the 1990s, the United Nations Development Programme gave the latest definition of new energy, that solar energy, wind energy, biomass energy, water energy, ocean energy, geothermal energy and other clean energy belong to the category of new energy. In 2006, China promulgated the Renewable Energy Law to continuously optimize the development structure of the new energy industry, promote its sustainable development, and the industrialization level is increasingly mature. As a result, China's new energy industry has made remarkable achievements, the overall development trend is good, but also facing new challenges.

#### **4.1.1. Development status of China's wind energy industry**

In recent years, environmental protection has become the trend of The Times, wind energy as a clean energy, with its pollution's free, renewable, huge advantages, occupy an important

position in China's economic development, become the first new energy, is the third largest power source only second to thermal power and hydropower.

With the support of "double carbon" and other national policies, China's wind power generation has increased significantly year by year. According to statistics, by 2021, China's wind power generation will be 652.6 billion KWH, with a year-on-year growth of 39.89%.

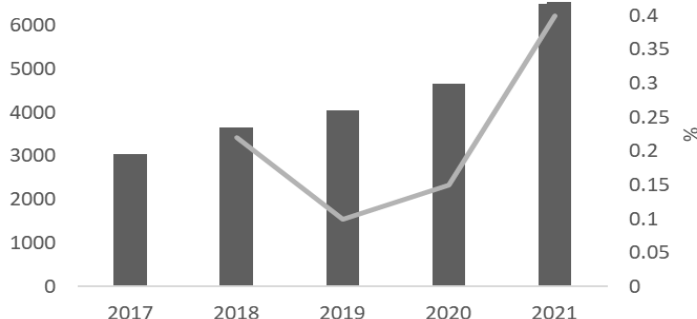


Figure 4: Wind power generation and its growth rate in China in 2017-2021

Source: China Electricity Union, Zhiyan consulting and collation

In terms of installed capacity, according to statistics, by 2021, China's installed wind power capacity was 328.48 million kilowatts, with a year-on-year growth of 16.68%, and the compound growth rate of 2016 to 2021 was 17.2%.

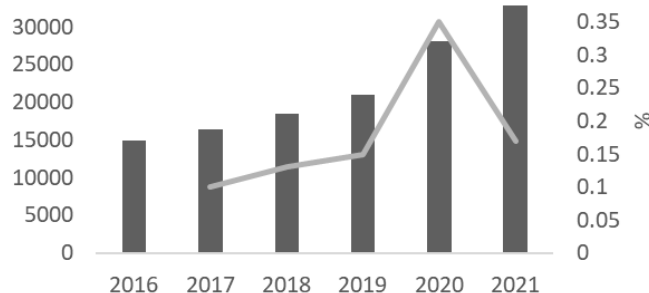


Figure 5: Wind power installed capacity and growth rate in China in 2016-2021

Source: China Electricity Union, Zhiyan consulting and collation

In 2020, China's wind power investment reached 261.8 billion yuan, an increase of 144.7 billion yuan compared with 2019, with a year-on-year growth of 123.57%. In 2021, it decreased slightly compared with 2020, but still at a high level. In 2021, China's wind power investment reached 247.8 billion yuan.

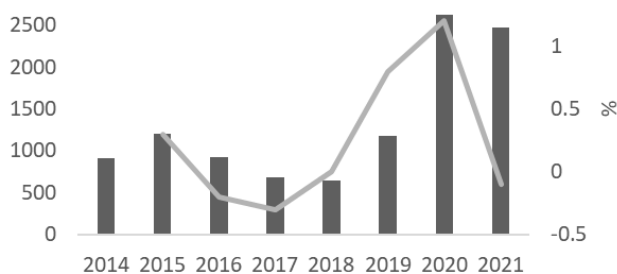


Figure 6: 2014-2021 Wind power investment completed amount

Source: China Electricity Union, Zhiyan consulting and collation

### 4.1.2. Development status of China's nuclear energy industry

Nuclear power, hydropower and thermal power are the three pillars of China's power energy, while nuclear power ranks the first because of its low operating cost. In 1991, China's first nuclear power plant was put into operation and completed. After more than half a century of development, nuclear technology has penetrated into energy, industry, medical care, agriculture and other fields. In particular, the application of nuclear energy in the power industry, which has greatly improved people's production and living standards.

China's nuclear power development started late, but the development speed is fast. From 2016 to 2019, China's nuclear power project investment has been fluctuating. Since 2019, China's nuclear power project investment has been increasing, reaching 53.8 billion yuan in 2021, up 42.3% year on year, and 16.1 billion yuan from January to May in 2022.

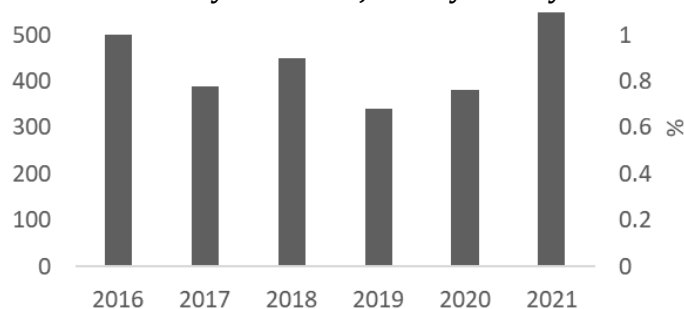


Figure 10: Investment amount of nuclear power supply project

Source: National Energy Administration

Since 1985, the construction of Qinshan Nuclear Power Plant started, after nearly 40 years of development, it has experienced from scratch, from small to large, forming a high-level industrial innovation chain and industrial chain. By the first quarter of 2022, China had built 54 nuclear power units in operation, with an installed nuclear power capacity of 54.43 million kilowatts.

Nuclear power generation is increasing year by year, and its proportion in the power structure is also expanding. By January to May 2022, China's nuclear power generation is 166.3 billion KWH, up 4.5% compared with the same period in 2021, accounting for 5.1%. However, overall, the current proportion is still small, and there is much room for subsequent penetration improvement.

China's nuclear power grid is also increasing, from 196568 billion in 2016 to 382084 billion in 2021. In the first quarter of 2022, the power grid of China's nuclear power was 92.899 billion, up 6.90% year on year.

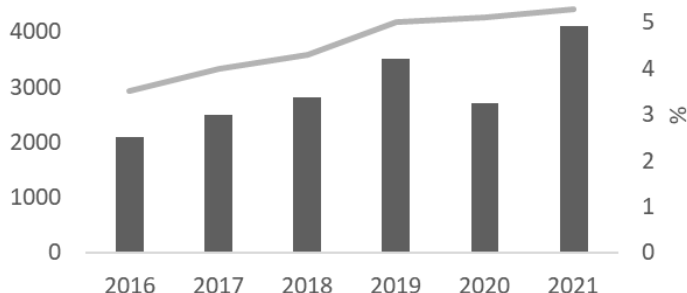


Figure 12: 2016-2021 Nuclear power generation capacity and its proportion in the total power generation capacity

Source: National Energy Administration

## 5. Positive analysis of the financing efficiency of listed companies in China's new energy industry

### 5.1. Construction of the financing efficiency evaluation index system

#### 5.1.1. The construction principle of the evaluation index system

##### 5.1.1.1. Scientific principles

As a tool for the evaluation and analysis of financing efficiency, the evaluation index system should be able to objectively and comprehensively reflect the relevant aspects of the financing activities of listed companies in the new energy industry. According to the above-mentioned definition of financing efficiency, the evaluation index system should accurately depict the financing scale and financing costs of listed companies in the new energy industry and the various results obtained after putting funds into production and operation, so as to ensure that the evaluation results are scientific and reasonable.

##### 5.1.1.2. The principle of integrity

Financing activity is one of the three major decisions that enterprises must face, which is closely related to the investment activities and surplus allocation of enterprises, and is an important link of the internal resource circulation system of enterprises. Therefore, in the construction of financing efficiency evaluation index system, the internal connection between indicators should be fully considered to ensure the comprehensive and organic nature of the evaluation process.

##### 5.1.1.3. The principle of practicality

In order to ensure that the evaluation and analysis can proceed orderly, the accessibility and objectivity of data are necessary. Therefore, when constructing the index system, we should choose the quantitative information that is easy to obtain and is widely accepted and applied as far as possible, so as to improve the reliability and practicability of the index system.

#### 5.1.2. Establishment of the index system

This project constructs the financing efficiency evaluation system based on the principle of scientific and systematic system, and will comprehensively consider the financing situation of each DMUs and the results of financing. In this study, the reference level analysis method (analytichierarchyprocess, AHP) established the output index system of listed companies in the new energy industry as shown in the following figure, and finally selected 9 indicators, including 3 input indicators and 3 output indicators, as shown in the following figure:

Table 3: Construction of the evaluation index system for financing efficiency

Indicator type	Specific indicators	Index interpretation
Investment index (import)	total assets	Reflect the enterprise financing scale
	asset-liability ratio	Reflect the current financial pressure and future financial expansion space of enterprises
	cost of financing	Reflect the enterprise financing costs
Output indicators (output)	Return on equity	Measure the use efficiency of shareholders' funds and reflect the profitability
	turnover of total capital	Represents the business results of the enterprise unit assets, reflecting the operating capacity of the enterprise
	Year-on-year growth rate of total operating revenue	Reflect the growth rate of change of the total operating results of the enterprise business activities

## 5.2. Analysis of the influencing factors of the financing efficiency of the listed companies in the new energy industry

Based on the above description of the overview of new energy listed companies, 30 listed companies in Shanghai and Shenzhen are selected as the research objects, and the screening process is divided into the following steps: (1) the screening criteria are new energy companies in the industry of listed companies; (2) considering the comparability between research objects, excluding ST and \* ST companies; (3) based on the screening criteria, the data in 2016 is more representative, so the screening is based on the 2016 audited annual report data of listed companies. Finally, we got 26 listed companies in the new energy industry. There are 6 indexes in this paper. An empirical criterion of DEA model requires that the number of DMU should be greater than 2 times the sum of input and output indicators. It can be seen that the relationship between the number of research objects and the number of indicators in this paper meets this requirement. This paper obtains the data of the above six indicators disclosed in the 2016 audit annual report of these companies through the Wind financial terminal, and calculates the efficiency value of each company as follows:

Table 4: The DEA evaluation efficiency value of the financing efficiency of the listed companies in the new energy industry

Company referred to as	industry involved	DEA efficiency values	Company referred to as	industry involved	DEA efficiency values
Sun and moon shares	wind electricity	2.28652E-07	GCL integration	photovoltaic	1.44193E-07
Hua Yi electrical	wind electricity	1.18378E-07	solar energy	photovoltaic	0.027470409
Silver Star Energy	wind electricity	0.101133344	Longji shares	photovoltaic	0.266821674
Jiangte motor	wind electricity	1.143083748	Expand the new energy	photovoltaic	0.088576927
Tianshun wind energy	wind electricity	0.062021622	Yi Chengxin can	photovoltaic	0.016490599
Energy-saving wind power	wind electricity	0.012236777	Beijing yuntong	photovoltaic	0.034874185
XEMC	wind electricity	0.024474329	Oriental zirconium industry	nuclear power	0.051391908

Goldwind technology	wind electricity	3.36435E-08	Wall nuclear material	nuclear power	0.066658416
Precision science and technology	photovoltaic	0.119672061	China nuclear power	nuclear power	0.010950903
Amarton	photovoltaic	0.022758505	Taiwan nuclear power	nuclear power	1.069060695
Sunshine power supply	photovoltaic	1.50301E-07	COFCO biochemical	biomass	8.83103E-08
Aikang technology	photovoltaic	6.07272E-08	Shao energy shares	biomass	0.042561888
Otter xun	New energy materials	0.082037376	TBEA	New energy materials	0.021141218

A DEA efficiency value of 1 indicates that the financing efficiency is relatively efficient, Lower values indicate lower efficiency, From the obtained DEA efficiency values, Wind power industry and nuclear energy industry respectively have 1 DEA effective enterprise, Jiangte Electric and Taiwan Nuclear Power, Other new energy industries do not have DEA effective companies in the sample, This paper believes that this is related to the improvement of external environment and internal financing efficiency of wind power industry and nuclear energy industry; Meanwhile, according to the data, the DEA efficiency of Goldwind is the lowest, Goldwind Technology and Jiangte Motor both belong to the wind power industry, DEA efficiency values are far apart, By comparing the financial data of the two companies, The main reason for this difference is that the financial costs of Goldwind technology are too high, Excessive financial pressure, And the high operating cost makes the operating income decline.

## 6. Conclusions and suggestions

### 6.1. Study conclusions

Based on the above discussion, through the study of listed companies in the new energy industry, this article selects listed companies in the new energy industry as the research object, and references existing literature to select total assets, asset liability ratio, and financial expenses as input indicators. Net asset return rate, total asset turnover rate, and year-on-year growth rate of total operating revenue are output indicators. Based on the DEA model, an evaluation index system for financing efficiency evaluation is established, Based on the evaluation of financing efficiency of listed companies in the new energy industry, this article draws the following conclusions:

In the entire new energy industry, there is one listed company in wind power and nuclear energy that has achieved DEA efficiency, and their financing efficiency is relatively good. This

article summarizes the reason as an improvement in the external environment, among which the rapid development of internal technology is also the main factor.

There are no DEA effective companies in the photovoltaic, biomass, and new energy materials industries, and companies in these industries still need to make significant efforts to improve financing efficiency.

## **6.2. Suggestions on the development of the new energy industry**

### **6.2.1. Suggestions based on the enterprise perspective**

#### **6.2.1.1. Avoid blind expansion and reasonable control of their own debt scale**

Early policy incentives and subsidy levels attracted a large amount of social capital to flow into the new energy industry. In order to seize subsidy qualifications and market share, enterprises actively increased their investment scale. However, the experience of the development of the new energy industry in recent years has shown that rapid capacity expansion can bring significant burdens to enterprises and finances. According to the financing efficiency evaluation analysis results of this article, 24 out of 26 listed companies in the new energy industry are considered non DEA effective. These ineffective enterprises need to simultaneously reduce three indicators: total assets, asset liability ratio, and financial expenses. Based on the above conclusions, it is recommended that new energy enterprises be vigilant about the rapid increase in financial leverage and ensure that cash flow is sufficient to cover debt principal and interest.

#### **6.2.1.2. Optimize the financing structure and improve their own capital accumulation capacity**

In order to pursue maximum returns to scale, new energy enterprises need to improve their financing structure. They can take measures to maximize financing returns based on their own development status. On the one hand, they can change the single financing model to reduce financing risks. On the other hand, they can utilize the capital market and expand financing channels through capital market financing tools. In addition, in order to achieve the goal of maximizing profits, new energy enterprises should provide maximum returns to venture capital investors.

### **6.2.2. Suggestions based on the perspective of policy makers**

#### **6.2.2.1. Improve financing policies and give full play to the role of the market**

The government can promote the development of new energy enterprises by improving financing policies and strengthening market supervision. Encouraging market-oriented means to improve financing efficiency is one of the key factors, such as shifting subsidy systems to a more focused model on technological development, in order to stimulate the technological innovation capabilities of new energy projects. Diversified financing policy innovation is also an important measure to address the low financing efficiency of new energy projects, enabling enterprises to finance more flexibly. In addition, it is also necessary to ensure effective intellectual property protection, especially for intellectual development products such as invention patents, which can provide legal support for enterprise research and development, and better promote scientific research and innovation.

#### **6.2.2.2. Improve the mechanism for providing government input and increase subsidies**

The government can establish a fiscal investment mechanism and increase subsidies for the new energy industry to encourage new energy enterprises to increase their research and development innovation efforts and attract more enterprises to join the new energy industry. Given the novelty of the new energy industry and the high research and development costs and technological risks of new energy projects, the government should increase its support for this industry. This includes establishing support funds for the new energy industry and providing necessary financial support for new energy enterprises. In addition, the government can

provide necessary tax incentives and other policy support to new energy enterprises for their technological innovation projects every year.

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