Original Research Article

The Study of energy conservation and emission reduction environmental performance auditing --A case study of wind power projects

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Abstract: Environmental conservation is in contradiction with economic development for ages in our country. The auditing work which part related to environment, however, did not match with the speed of economic development. Wind power as a kind of clean renewable energy, developing rapidly in recent years. Wind power generation as one of the crucial measures for environmental protection, its performance appraisal is differ from the general construction project. Hereby, we take the wind power electricity generation project as the starting point in this paper, from the related concept and the existing problems of environmental performance audit two angles, we lucubrate the environmental performance audit in our country at present state; from the economic analysis, financial assessment, environmental performance from three aspects, in order to analyze the existing shortage.

Keywords: Environmental performance auditing; Wind power generation; Environmental conservation Performance appraisal

1. Introduction

With the rapid and steady advancement of China's economy, the conflict between economic development and environmental protection has become increasingly severe. This is evident in various sectors: from power generation in electricity plants to energy-efficiency in home appliances; from the expansion of the automotive industry to the management of air pollution; from corporate emissions to waste sorting, all of which highlight the intricate yet interconnected nature of these seemingly conflicting themes.Currently, to achieve a balance between these two aspects, China has implemented numerous energy conservation and emission reduction projects, drawing from foreign technologies while also focusing on independent domestic research and development. For instance, Shandong Yaotong Energy Saving Company represents a wave of industrial enterprises in China that have introduced bromine lithium absorption refrigeration machines and other emission reduction equipment. Government entities have initiated energy-saving renovations for buildings and comprehensive electrical efficiency upgrades, promoting government procurement of energy-efficient products. In terms of public welfare, efforts range from the conservation of "water, electricity, gas" in households to the widespread implementation of various environmental protection measures. This underscores the national emphasis on the pragmatic issue of energy conservation and emission reduction.

2. Current status of energy conservation and emission reduction projects in China

2.1. Representative projects and their effectiveness

Through collaboration across various sectors and individual efforts, as of the end of 2023, the installed capacity of wind and photovoltaic generation has increased tenfold compared to a decade ago, with clean energy generation capacity now accounting for 58.2% of the total installed capacity, and new clean energy

generation exceeding half of the overall increase in electricity consumption. The share of clean energy consumption in total energy consumption has risen from 15.5% to 26.4%, while the proportion of coal consumption has decreased by 12.1 percentage points. Significant progress has been made in the clean and efficient utilization of energy.

2.2. Future development goals

According to China's latest environmental protection development plan, carbon dioxide emissions must be reduced by 60%-65% compared to 2005 levels by the year 2030.

3. Current Status of wind resource application in our country

3.1. Calculation standards for wind energy

3.1.1. Wind energy formula

When harnessing wind energy, the fundamental task is to convert the kinetic energy generated by wind flow into other forms of energy, which necessitates the calculation of the energy contained in the airflow. The wind power flowing per unit time through an area A (m^2) perpendicular to the wind velocity is represented as:

$$E = 1/2\rho V^3 A1$$

Where E represents wind energy, measured in watts (W, which is $kg \cdot m^2 \cdot s^{-3}$); ρ is the air density in kg/m^3; and v denotes the wind speed in m/s.

3.1.2. Estimation of total wind energy resource reserves in our country

For the scientific and effective utilization of wind energy, a preliminary estimation of the total reserves is essential to ensure rational allocation for future usage and to maximize efficiency. According to Gustafsson's estimation method[1] and the aforementioned formula, the national wind energy reserve at the 10m contour line is calculated to be 322.6 x 10^{10} watts, equivalent to 32.26 billion kilowatts (kW). This reserve is referred to as the theoretical development capacity.

3.2. Distribution of wind energy and wind power in our country

The distribution of wind power plants in our country[2](see **Figure 1**).

Figure 1. Distribution of wind power plants in our country.

The wind power plants in our nation are established in accordance with the distribution of wind energy, as illustrated in the above figure.

4. Current status of environmental performance auditing in our country

4.1. Environmental performance auditing

4.1.1. Definition of environmental performance auditing

Environmental performance auditing involves conducting audits on the environmental aspects of a project. Throughout this process, a multi-tiered auditing network is established, effectively assessing and controlling the project's impact on the environment.

4.2. Evaluation indicators for environmental performance auditing

4.2.1. Project execution evaluation

The processes and stages of construction projects are typically divided into project proposal, feasibility study, assessment, planning and design, project approval, bidding, contract formation, supervision, construction, quality inspection, and final completion. The primary indicators are the continuity and execution rate of the stages, calculated as follows:

*Continuity and Execution Rate = (The number of execution phases/ The number of necessary phases) *100%*

4.2.2. Compliance evaluation of project implementation

*Budget Execution Rate = (Estimated number of project executions/ Total number of items within the budget estimate) *100%*

If this indicator exceeds 100%, it indicates the presence of projects outside the approved budget, necessitating an analysis of their rationale; if it is below 100%, it indicates that some projects have not been executed, requiring an analysis of the reasons.

4.2.3. Design capability and effectiveness

*Project Benefit Realization Capacity = (Actual capabilities/estimate capabilities) *100%*

4.3. Existing issues in environmental performance auditing

The field of environmental performance auditing in our country has encountered challenges due to its late inception and lack of a solid theoretical foundation. As the focus of current audit work, the performance auditing of energy conservation and emission reduction projects faces urgent theoretical issues such as unclear evaluation standards, indicator systems, and evaluation methods that need resolution.

5. Environmental performance audit of wind power generation projects

5.1. Economic analysis of wind farm construction projects

The primary objective of conducting an economic analysis is to determine whether it is feasible to achieve established or necessary goals with minimal investment, within the bounds of legality and reasonableness.

5.2. Financial evaluation of wind farm construction projects

To facilitate understanding, we will present a case study of a wind power project, supported by data.

5.2.1. Basic data setup

(a) The planned total installed capacity of the wind farm is 100,000 kW, with an annual utilization hour count of 2,300 hours. The total investment in the project amounts to 770.91 million yuan, with an annual electricity generation of 230 million kilowatt-hours.

(b) The project was executed through a public bidding process, adhering to relevant national legal requirements.

(c) The evaluation period for this project is set at 21 years, with a construction phase lasting one year.

5.2.2. Financial evaluation

(a) Calculation of Generation Benefits

① Generation Revenue = Grid-Connected Electricity Volume[1] * Grid-Connected Electricity Price

The grid-connected electricity price is determined based on repayment requirements, ensuring the financial internal rate of return exceeds 8% for total investments. The calculated inclusive tax electricity price is 0.64 yuan/kilowatt-hour.

② Taxes

The taxes associated with this power engineering project include value-added tax, sales tax surcharge, and income tax. The value-added tax rate stands at 13%, while the income tax rate is 25%.

(b) Investments and Funding Related to the Project (refer to **Table 1**).

Table 1. Investment plan and fundraising schedule.

Series No.	Items	Sum Amount (CNY)	Construction Period 1(CNY)
1	Total Investment	79,251	79,000
1.1	Investment in fixed assest	77,091	77,091
1.2	Interest in construction	1,909	1,909
1.3	Working capital	251	-
2	Raising Capital	79,251	79,000
2.1	Equity capital	15,851	15,600
	Of which: allocated for working capital	251	-
2.2	Loans	63,400	63,400
2.2.1	Long-term loans	63,400	63,400
	Domestic loans	61,491	61,491
	Interest loans during the construction period	1,909	1,909
2.2.2	Working capital loans	-	-

5.2.3. Profitability analysis

Based on the existing data, the following metrics can be derived:

① . The post-tax internal rate of return[1] for the project is 11.63%, exceeding the benchmark rate of 10%. The net present value stands at 19.19 million yuan.

② . The project's payback period is 8 years, with a financial net present value of 26.41 million yuan. Following the full repayment of loans, the investment return rate, the investment tax profit rate, and the capital profit rate are 4.47%, 5.46%, and 22.33%, respectively.

5.3. Environmental benefit assessment of the wind power plant construction project

5.3.1. Responsibilities of the project

As a key energy-saving and emission-reduction initiative outlined in China's 12th Five-Year Plan, the wind power project should strive to facilitate the achievement of national environmental protection goals, ensuring harmonious coexistence between the environment and the economy.

5.3.2. Contributions of the project

The combustion process releases sulfur dioxide and nitrogen oxides, posing direct threats to plants and

various animal species, and can lead to acid rain under severe conditions, thereby damaging the ecological environment. Furthermore, the carbon dioxide emitted from coal combustion is a greenhouse gas that contributes to global warming. Although thermal power plants can utilize existing technologies to reduce the emission of sulfur and nitrogen compounds, the release of carbon dioxide is unavoidable.

6. Measures for resolution and evaluation system

6.1. Measures to address existing issues in auditing

1. Strengthening theoretical research on environmental performance auditing and exploring new auditing concepts.

Currently, our auditing practices often draw on foreign references; however, it is essential for auditors to grasp the essence of these methodologies and apply them in conjunction with our specific context.

2. Expanding the current scope of accounting responsibilities and establishing a specialized accounting system for environmental audits.

Given that the existing accounting framework does not comprehensively support the work of environmental performance auditing, auditors often find it challenging to commence many projects, with significant difficulties in gathering auditing evidence and materials. This hinders progress in auditing from both internal and external perspectives.

6.2. The scope of the evaluation system

The evaluation framework for performance audits should be established with consideration to five key aspects based on the characteristics and requirements of performance auditing: economy, effectiveness, efficiency, equity, and environmental impact. From an economic perspective, it is essential to determine whether the project can meet the enterprise's anticipated objectives; regarding effectiveness, it is important to assess whether the project can contribute as expected to the economy.

About the author

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