

Cost Calculation of Carbon Emissions in Universities and Design of Financial Mechanism for Ecological Compensation

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Abstract: Campus governance and financial management have the same problems. Based on the logic of cost accounting and the method of carbon emission accounting, first determine the scope of the calculation and calculate the emission volume, then aggregate the carbon cost for each department, and finally analyze the operation of the ecological compensation fund. Build a carbon emission list based on activity data and emission factors in this study, and then convert the emission volume into practical cost information using an internal carbon price. At the same time, there are budget constraints in the process of responsibility allocation, and the collection of compensation funds and the performance evaluation system are also linked. This Design will facilitate the incorporation of carbon emission responsibility into the financial decision-making of universities by linking emission-reduction investment with costs, forming a stable connection with ecological benefits, and thus providing executable financial tools for low-carbon governance at universities.

Keywords: University carbon emissions; Cost accounting; Internal carbon price; Ecological compensation; Financial mechanism

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1. Introduction

University campuses are large in area and have various energy-use scenarios, as well as different loads for research equipment. Electricity consumption is the main source of emissions, and heating and gas use at the school also release carbon. The foundation for presenting the characteristics of carbon emissions and developing reduction plans is the science and technology of carbon emission accounting. At present, research on carbon emission calculation at different spatial scales generally falls into the categories of large-scale, regional, urban, community, building, and product scopes, etc. Systems of national and regional carbon emission calculations have been established around the world according to the 1996 IPCC National Greenhouse Gas Inventory

Guide. The three kinds of basic carbon emission calculation methods in this system are the emission factor method, the mass balance method, and the measurement method. To strengthen the financial feasibility of carbon governance, a full chain of emission identification, cost accounting, and ecological compensation should be established in research, and universities can allocate resources according to their actual emission levels to generate sustained motivation for emission reduction through responsibility constraints and interest regulation.

2. Logical foundation of carbon emission cost accounting in universities

Carbon emission cost accounting for universities should start from the campus organizational boundary and business activity boundary, include the indirect emissions caused by purchased electricity, and also calculate the emissions from fuel and heating for teaching and research activities based on stable data sources ^[1]. First, the finance department needs to build a data interface with the logistics department and open data channels for the laboratory management and asset management departments. The energy bill is the foundation of the data, and measurement system information and equipment operating records are used for verification. Use an emission factor to determine the quantity that will be released. Based on the above, the university can establish an internal carbon price, convert the emission amount into a carbon cost, include the emission information in the departmental cost and project decision-making, and thus provide a verifiable value scale for subsequent compensation standards.

3. Construction of carbon emission cost accounting system in universities

3.1. Confirmation and aggregation of carbon emission cost

Universities can establish a carbon price based on the relationship between energy consumption and the responsible party, set up a center of responsibility according to business attributes, etc. Teaching units and research platforms are responsible for the emissions in their own areas, and administrative departments and public service areas determine responsibility according to the scope of management ^[2]. Directly measurable electricity emissions should be charged to the actual user, and gas and heating emissions should also be identified according to the user object. Allocate the public area emissions based on the building area and adjust according to the usage time and personnel scale. The finance department should ensure the consistency of the scope and time of the activity data, review abnormal energy consumption, reflect the carbon cost in relation to the department's actual emissions, and correspond it with budget subjects and cost centers to avoid misallocation of responsibility ^[3]. Missing data will be handled reasonably, and only after the correction environment is stable will corrections be made to ensure the accuracy of the accounting results.

3.2. Carbon cost measurement and budget embedding

Calculate the emission amount and then, considering the carbon market price, set an internal carbon price according to the marginal cost of emission reduction and the university's own management goals to establish a dynamic adjustment rule. The financial department multiplies the departmental emission amount by the internal carbon price to get the budget carbon cost, and then adds the budget carbon cost to the annual budget control and project economic evaluation ^[4]. For high-energy-consuming equipment purchase projects, experimental platform construction, and building renovation projects, the project argumentation should first compare the initial investment and operating costs, and then add the expected carbon cost to this amount to determine how

far apart the schemes are in terms of the entire life cycle. At the time of budget execution, the actual carbon cost should be regularly compared with the budget amount to provide a quantitative basis for energy-saving renovation and resource allocation.

3.3. Carbon cost reporting and variance analysis

Add the cost of carbon emissions to the departmental budgets and, at the same time, set up a regular reporting and variance analysis mechanism for accounting results. The Finance Department can prepare carbon cost reports by responsibility center and compare actual emissions and carbon costs with the budget. The main report contents are shown in **Table 1**. For teaching and research units, differences should be analyzed according to workload, equipment operation, and actual energy consumption; for administrative and public service areas, only the allocation of shared emissions needs to be considered. If the carbon costs are below the budget due to verifiable energy-saving measures, the results can provide a basis for supporting green projects; if the costs continuously exceed the budget without a reasonable explanation, the responsible unit should identify the reasons and propose corrective measures. Regularly submit reports and conduct variance analysis on carbon cost data to adjust the budget accordingly and arrange ecological compensation.

Table 1. Main contents of carbon cost reporting

Reporting object	Main content	Management purpose
Teaching units	Energy use and carbon cost	Compare budget implementation
Research platforms	Equipment energy use and emissions	Identify abnormal carbon costs
Public service areas	Shared emissions and allocation	Improve cost allocation
Projects	Budget and actual carbon costs	Support project evaluation

4. Design of the financial mechanism for ecological compensation

4.1. Fundraising and allocation for ecological compensation

Universities allocate compensation funds according to the cost that exceeds the carbon budget of each responsibility center ^[5]. They establish a special budget for energy-saving renovation in a separate account and allocate funds from green projects and other sources. Allocate funds according to the emission reduction commitments that have been agreed upon. The Department of Energy-saving Construction will pay a bonus for meeting its pollution reduction goals. The division has consistently exceeded its carbon budget and will therefore have higher internal costs ^[6]. The Finance Department determines the source of funds and the amount to be paid based on the annual emission inventory, directs the compensation funds from the emission responsibility end to the emission reduction effectiveness end, and thus establishes an internal regulatory mechanism that links cost constraints with emission reduction incentives.

4.2. Evaluation and accounting management of ecological compensation projects

The compensation fund will be used to renovate energy-saving equipment, optimize the energy system, and establish campus carbon-sink projects, and the allocated funds should be in line with measurable emission-reduction results. In the project application stage, the responsible department should provide baseline emissions, expected emission reductions, funding requirements, payback period, etc., and the finance department will work with the energy management department to conduct a joint review. The primary assessment indicators are

presented in **Table 2**. The support sequence is based on the unit emission-reduction cost and fund utilization efficiency. After the completion of the project, the university should confirm the actual emission reduction and record the use of funds to allow for cross-verification of compensation expenditure and emission-reduction results^[7]. Connect the project ledger to the carbon emission inventory and improve the traceability and financial transparency of both. If the verified reduction does not reach the application goals, then the compensation amount shall be reduced according to the actual ecological performance.

Table 2. Main evaluation indicators of ecological compensation projects

Indicator	Evaluation content	Purpose
Baseline emissions	Emissions before implementation	Set the comparison basis
Expected reduction	Planned emission reduction	Evaluate ecological benefits
Unit reduction cost	Cost per unit of emission reduction	Compare project efficiency
Payback period	Investment recovery period	Evaluate financial feasibility
Actual reduction	Verified reduction after completion	Determine compensation results

4.3. Performance feedback and optimization of financial constraints

Build a system in the university to evaluate budget utilization, including unit emission reduction costs and the performance of compensation funds. The results will be provided for the budget for the next year. Schools that achieve lower-than-expected emissions within the budget and demonstrate sustained reductions in emissions will be selected for budget rewards or enhanced support for green projects. If the emissions are still high and there is no reasonable cause, the finance department can increase the constraint on carbon costs and ask the responsible center to propose equipment renewal or operation optimization plans. Performance feedback will adjust the internal carbon price and compensation standards, and use the calculation results as the foundation for resource allocation. The school management should also periodically adjust the weights of the indicators to ensure that the evaluation considers both the extent of emission reduction and the efficiency of fund utilization, and avoid separating investment from the performance of emission reduction.

5. Conclusion

Integrate emission data and cost information into the financial management system for university carbon emission governance, and include an ecological compensation fund in the management chain. Set up an accounting and responsibility office in the university, implement an internal carbon price for emissions, and incorporate the results into the budget and project evaluation. Thus, it will be possible to attribute emissions and the costs of reducing emissions to specific activities. Based on the above, the compensation fund will be based on the difference in carbon budgets, the distribution of funds will be according to verifiable emission reduction results, and budget limits will be changed annually based on assessments. This will be an all-weather financial management system. The above mechanism can enhance the decision-making value of carbon emission cost information and change ecological compensation from a principle-based system into a school-based financial system with a measurement basis, enforceability, and acceptability for evaluation. Improve the quality of the data and then allocate separate process funds for various projects, such as research activities and public services. It will be more in line with the new form of campus management at that time.

Disclosure statement

The authors declare no conflict of interest.

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