Accounting ERP Costing System of Electric Energy Enterprise Based on Energy Saving and Emission Reduction

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Abstract. The paper proposes an accounting cost accounting system for power plants based on energy conservation and emission reduction. It is found that the factory needs to improve the cost control system including environmental costs, and incorporate various subjects such as carbon trading, carbon emission reduction, and carbon tax. The cost control in the era of low-carbon economy is to determine the optimal exhaust gas temperature value under each load to further reduce the coal consumption of the generator set. At the same time, in order to reduce energy loss, the paper also proposes a costing method based on elastic network algorithm, which will amortize the environmental cost of power generation in power companies, and then calculate the cost of the project to realize the power generation of power companies.

1. Introduction
With the rapid development of Chinese economy, the demand for electricity is increasing year by year. According to information from the National Bureau of Statistics, Chinese total power generation in 2020 is 501058 billion kWh, of which thermal power generation accounts for 82.72% of the country's total power generation output, but thermal power generation brings economic benefits while also causing serious pollution to the environment. In this regard, the method of environmental cost is widely used internationally to quantify this environmental damage in currency. The environmental cost related to power production refers to the cost that is generated during the process of power production and consumption that has an impact on the outside world and is not borne by the producers and consumers, that is, the environmental damage that is not shown in the market price. According to the calculation method of the pollutant emission amount of the power plant and the environmental cost of the unit pollutant, this paper establishes a power generation external cost calculation model [1]. This model can calculate the environmental cost of power generation by using conventional data according to the actual situation of the power plant. At the same time, the dissertation proposes the distribution of the transmission network loss based on the conjugate current loss component for the distribution of the network loss of the grid with the transhipment service business method.

The existing literature research is generally a green ERP management information system for power generation companies that considers energy saving and emission reduction indicators. Based on the company's existing ERP system, the detection and control of the company's plant power and unit emissions are enhanced, and the implementation effects are incorporated into the department. Performance appraisal can effectively improve the energy efficiency and carbon emission level of
enterprises. This article proposes an accounting cost accounting system based on energy saving and emission reduction. In the era of low-carbon economy, cost control is to determine the best exhaust gas under each load. Temperature value to further reduce the coal consumption of the generator set. To reduce energy loss, a cost accounting method based on elastic network algorithm is also proposed, which amortizes the environmental cost of power generation of the power company, and then calculates the project cost of realizing power.

2. Calculation of pollutant discharge

2.1. Calculation of pollutant emissions from power generation

2.1.1. The amount of soot emissions is related to the ash content of coal and the proportion of soot in the flue gas. In the formula: \( G_d \) is the smoke and dust emission; \( B \) is the coal consumption; \( A \) is the ash content of coal; \( d_{fh} \) is the percentage of soot in the flue gas, and its value is related to the combustion method, and the pulverized coal furnace can take 75% to 85%; \( C_{fh} \) is the percentage of combustibles in the smoke and dust, which is related to factors such as coal type, combustion state and furnace type; \( \eta \) is the dust removal efficiency of the dust removal system.

\[
G_d = \frac{B \times 10^5 \times A \times d_{fh} \times (1-\eta)}{1-C_{fh}} \quad (1)
\]

2.1.2. The main factor affecting \( SO_2 \) emissions from coal-fired power generation are the sulfur content in coal. In the formula: \( G_{SO_2} \) is the sulfur dioxide emissions; \( B \) is the coal consumption; \( S \) is the total sulfur content in the coal; \( \eta_s \) is the sulfur dioxide removal efficiency [2]. If there is no desulfurization device, \( \eta_s = 0 \).

\[
G_{SO_2} = 1.6 \times B \times 10^3 \times S \times (1-\eta_s) \quad (2)
\]

2.1.3. \( NO_x \) Calculation. In the formula: \( G_{NOx} \) is the emission of nitrogen oxides (calculated as \( NO_2 \)); \( B \) is the coal consumption; \( \beta \) is the conversion rate of fuel nitrogen to fuel \( NO \), which is related to the fuel nitrogen content \( n \). Under normal combustion conditions, the pulverized coal furnace 20% to 25% can be taken; \( n \) is the nitrogen content in the fuel, generally 0.5% to 2.5% in coal; \( V_y \) is the amount of flue gas generated by 1kg of fuel; \( C_{NOx} \) is the concentration of temperature-type \( NO \) generated during combustion, usually 93.8 mg/m\(^3\) (standard state, the same below).

\[
G_{NOx} = 1.63 \times B \times 10^3 \times (\beta \times n + 10^{-6} \times V_y \times C_{NOx}) \quad (3)
\]

2.2. Calculation of pollutant emissions from fuel-fired power generation

2.2.1. Smoke and dust emissions from fuel-fired power generation. In the formula: \( B \) is the fuel consumption; \( A \) is the ash content of the oil; \( C_R \) is the residual carbon content in the flue gas of oil combustion.

\[
G_d = B \times C_A \times 10^3 \times (1-C_R) \quad (4)
\]
2.2.2. *SO*$_2$ Discharge volume *G*$_{SO_2}'$. *In the formula:* B is the fuel consumption; *C*$_S$ is the sulfur content in the oil.

\[
G'_{SO_2} = B \times 1900 \times C_S \tag{5}
\]

2.2.3. *NO*$_x$ Discharge amount *G*$_{NO_x}$. *In the formula:* B is the fuel consumption; *p* is the *p* value of the burner (related to the burner, can be found in the "Environmental Statistics Manual" and "Environmental Supervision Practical Manual"); *C*$_N$ is the nitrogen content in the oil.

\[
G'_{NO_x} = B \times 1630 \times (p \times C_N + 0.000938) \tag{6}
\]

2.3. *CO*$_2$ Calculation of emissions. The calculation of thermal power generation emissions *CO*$_2$ uniformly adopts the IPCC calculation method: fuel consumption = basic fuel consumption × fuel low calorific value; carbon content = fuel consumption × fuel carbon emission factor; carbon fixed amount = carbon content × carbon fixed rate; net Carbon emissions = carbon content-carbon fixed amount; actual carbon emissions = net carbon emissions × oxidation rate; actual CO2 emissions = actual carbon emissions × (44/12).

3. Environmental cost calculation of national conventional power generation

The environmental cost of thermal power generation is determined according to the environmental cost of pollutants and the pollutant emissions of thermal power generation, as well as the power generation methods and governance conditions commonly used in China to set and calculate [3]. The thesis takes the power plant's installed capacity of 500MW, the annual utilization time is 6000h, and the annual power generation is 3 billion kWh. (1) Coal-fired power plants: the unit calorific value of coal is 21.2MJ/kg, and the power plant efficiency is 38%, and the annual coal consumption is 1.341 million tons. The sulfur content in coal is 1%, the raw coal ash content is 28%, the electrostatic dust removal efficiency is 99%, and the desulfurization efficiency is 95%. (2) Oil-fired power plant: the low fuel calorific value is 41.4MJ/kg, and the thermal efficiency is 45%, the annual fuel consumption is 580,000 tons. (3) Gas-fired power plant: the low calorific value of natural gas is 36MJ/m$^3$, and the thermal efficiency is 50%, so the annual gas consumption is 600 million m$^3$.

4. Environmental cost accounting for energy saving and emission reduction of power plants

4.1. Basic idea

Currently, grid companies apportion the cost of each grid project according to the proportion of common assets. However, the reform of transmission and distribution prices puts forward new requirements for the environmental cost accounting of power generation. Traditional methods cannot fully and objectively reflect the economic and social value of grid construction projects. Therefore, the introduction of efficiency standards in this paper, based on the contribution of a single project to the transmission and distribution tasks to allocate environmental costs, can effectively consider the actual benefit value of power grid projects [4]. First, this paper uses the Elastic Net algorithm to screen the key influencing factors of environmental costs and determine the efficiency standard; secondly, calculate the weight of the key influencing factors by the CRITIC method; finally, determine the environmental cost allocation coefficient of the power grid project, and calculate the environmental cost of a single power grid project. The basic idea of this article is shown in Figure 1.
4.2. Determination of performance standards based on Elastic Net algorithm

For an existing sample \((X_j, Y)\), \(j = 1, 2, ..., n\), where \(X_j \in R^p\) the \(p\) characteristic variables of the sample, and \(Y\) is the 1-dimensional dependent variable, define a multiple linear regression model:

\[
Y = \sum_{j=1}^{p} \beta_j X_j = X \beta + \varepsilon
\]  

In the formula: \(X\) is the \(n \times p\) characteristic variable matrix; \(\beta\) is the regression coefficient vector; \(\varepsilon\) is the random error. The accurate estimation of the relationship shown in equation (7) from the existing samples is the basis for the analysis of the distribution of grid environmental costs under the power transmission and distribution reform. Screening and regression analysis of non-dominant influencing factors for each input variable is a more appropriate method. The optimization function of Elastic Net algorithm regression is shown in formula (8). The key to solving is to measure the error between the actual value \(Y\) and the fitted value. In this paper, we consider minimizing the mean square error to solve \(\beta\), and the process of solving is the process of minimizing \(F\) as shown in equation (8).

\[
F(\beta) = \frac{1}{2} \| Y - X \beta \|^2 + \lambda (\alpha \| \beta \| + \frac{1-\alpha}{2} \| \beta \|^2)
\]  

In the formula: \(\alpha\) and \(\lambda\) are the penalty term coefficients. The solution is:

\[
\hat{\beta} = \arg \min_{\beta} F(\beta)
\]  

When the thesis uses the Elastic Net algorithm to filter factors, it is first necessary to select the \(\alpha\) and \(\lambda\) values. In this paper, the K-fold cross-validation method is selected to select the values of \(\alpha\) and \(\lambda\). First, randomly divide the training set \(M\) into \(K\) sets; second, randomly select one set as the verification set, and use the remaining \(K-1\) sets as the training set; finally, test the generalization error of the data. For each given value of \(\alpha\), the training set \(M\) is randomly divided into \(M = \{M_1, M_2, ..., M_k\}\), and after training the samples, the mean square error of the K-fold cross-validation verification method under different \(\lambda\) values can be obtained:

\[
C(\lambda) = \frac{1}{K} \sum_{j=1}^{K} \frac{1}{NM_j} (Y_j - \hat{Y}_j)^2
\]
Where: $N_{Mj}$ is the number of samples in the set $Mj$; $\hat{Y}_j$ and $Y_j$ are the predicted and measured values obtained after training. When $C(\lambda)$ takes the minimum value, $E_{\lambda}$ is the evaluated value.

4.3. Environmental cost allocation process

The environmental cost allocation process is shown in Figure 2. First, input the data to quantify the environmental cost factors; secondly, set the initial parameters of the penalty item, divide the training set and the test set, perform cross-checking, and use the smallest mean square error as the criterion to perform iterative solution to determine when the mean square error is the smallest And use Elastic Net algorithm to screen the key factors that affect the environmental cost of power grid engineering; again, in order to further eliminate the linear relationship between the screening factors, the preliminary screening variables are tested for significance and the variables with strong correlation are eliminated. Determine the efficiency standard proportions that pass the test of key factors, and use the CRITIC method to measure the efficiency standard weights of key factors; finally, calculate the environmental cost allocation ratio coefficient of a single power grid project, and calculate the environmental cost of a single project according to equation (10).

![Figure 2. Flow chart of environmental cost allocation based on Elastic Net algorithm.](image)

5. Example analysis

5.1. Example data

The calculation example data is based on the grid operation data of a province from 2012 to 2020. This province contains 11 regions and nearly a hundred sets of data. These data are used as the basis for the key variable screening of the Lasso method. In the indicator weight confirmation, the recent 120 specific sub-project data of different voltage levels are selected for weight calculation [5]. On this basis, an apportionment model based on the efficiency value method is proposed, and five typical engineering data are selected to conduct an experimental study on the apportionment model based on the efficiency
value method proposed above, and the efficiency standard and apportionment of the project environmental cost allocation are obtained. Proportion, accurately calculate the environmental cost of a single project, which is suitable for the requirements of refined investment in the power grid after the power reform.

5.2. Data calculation

On the basis of the basic power transmission business of the system, two transhipment businesses are added. The transhipment business situation is shown in Table 1, and the network losses that each transhipment business and the basic power transmission business should bear are calculated. Before and after joining the transhipment business, the total active power loss of each branch is calculated by PSASP, and the allowable error is 0.0001; the total active loss of each branch undertaken by the transhipment business 1, 2 and the basic power transmission business of the grid is through equations (7) and (8) Calculated.

| Transhipment business | Node into Set | Node out | Power Factor | Node set | Active power/MW | Power Factor |
|-----------------------|---------------|----------|--------------|----------|----------------|--------------|
| Business 1            | 5             | 8        | 1            | 26       | 8              | 1            |
| Business 2            | 13            | 10       | 1            | 21       | 15             | 1            |

Table 2 describes the power loss that should be borne by the basic power transmission business of the power grid and each transhipment business, reflects the extent of its use of the line, and verifies that the transhipment business with a high degree of use should bear more network losses; the basic power transmission business of the power grid and each transhipment business The sum of the active power loss of each branch undertaken by the business is equal to the total active loss of the branch.

| Start node | End node | Total active power loss/MW | Basic business active power loss/MW | Transhipment business 1 active power loss/MW | Transhipment business 2 active power loss/MW |
|------------|----------|---------------------------|-------------------------------------|-----------------------------------------------|-----------------------------------------------|
| 1          | 2        | 1.40922                   | 1.42096                             | -0.00639                                      | -0.00535                                      |
| 1          | 3        | 0.99996                   | 1.00206                             | -0.00109                                      | -0.001                                        |
| 2          | 4        | 0.52871                   | 0.52669                             | 0.00125                                       | 0.00077                                       |
| 3          | 4        | 0.26314                   | 0.26227                             | 0.00097                                       | -0.0001                                       |
| 2          | 5        | 1.22298                   | 1.32433                             | -0.06175                                      | -0.0396                                       |
| 2          | 6        | 0.90991                   | 0.91762                             | -0.00098                                      | -0.00673                                      |
| 4          | 6        | 0.2061                    | 0.21769                             | -0.00548                                      | -0.00611                                      |
| 5          | 7        | 0.01497                   | 0.01875                             | -0.0026                                       | -0.00118                                      |
| 6          | 7        | 0.22439                   | 0.32633                             | -0.06252                                      | -0.03941                                      |
| 6          | 8        | 0.00694                   | 0.01017                             | -0.00272                                      | -0.00052                                      |
| 9          | 11       | 0                         | 0                                   | 0                                              | 0                                              |
| 9          | 10       | 0                         | -0.01876                            | 0.02165                                       | -0.00289                                      |
| 12         | 13       | 0                         | -0.29654                            | 0                                              | 0.29654                                       |
| 12         | 14       | 0.0899                    | 0.06843                             | 0.00491                                       | 0.01656                                       |
| 12         | 15       | 0.3075                    | 0.21048                             | 0.02184                                       | 0.07518                                       |
| 12         | 16       | 0.09909                   | 0.04692                             | 0.00431                                       | 0.04786                                       |
| 14         | 15       | 0.01347                   | 0.00615                             | 0.00171                                       | 0.00561                                       |
From the data in Table 2, it can be seen that the active power loss allocated by the transhipment business on the 3-4, 7-8, and 8-6 branches is negative [6]. This is because the transhipment business has generated a direction opposite to the main trend of the system on these branches. "Reverse trend" makes the losses incurred by the transhipment business on these branches to be negative. However, the sum of the loss reduction caused by each transhipment transaction on the line that caused the reverse flow is less than the sum of the loss increase caused by it on other lines, so the final allocated active loss of the transhipment business is still positive. The apportionment result is reasonable.

6. Conclusion
According to the efficiency standard idea and considering the impact of other key factors on the environmental cost in addition to the original value of fixed assets, this paper proposes a calculation model for the allocation of environmental costs of power grid projects based on the Elastic Net algorithm to share the environmental costs into the environmental costs of power grid projects, Adopt the CRITIC method to select historical engineering data to calculate the weight of key factors, obtain the allocation coefficient and the allocation cost, and realize the scientific calculation of the environmental cost of a single project.

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