Methods Research to Calculate Equivalent of Environmental Cost in Power Industry

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Abstract：Power industry as an important means of primary energy consumption，occupies an important position In coal consumption and pollutant emissions, and causes a great impact on the environment. It is particularly important to define environmental costs while Environmental costs account for a heavy weight in the total cost of generating after the introduction of the Clean Development Mechanism (CDM) This paper analyzes the composition of environmental cost and its calculation methods,three cost equivalent pricing methods and its scope in environmental costs was proposed, there are Government pricing, market pricing and cost accounting,then analysed the cost of equivalent effect on electricity trade.

1 Introduction

Electric power industry has a high standard, obligatory targets for energy conservation and emission reduction, power plant capacity will be limited under this constraint. In order to deal with the relationship bewteen reduction and power generation efficiency based on the CDM, the emission of power plant is limited. Therefore, the power plant must consider the environmental cost when making decisions.

Currently there are some management cost methods which usually in the form of emission controlling cost divided by emission [2], but when calculating a specific pollutant emission which doped with other pollutants, it can lead to a high cost equivalent calculation of pollutants. The current Kyoto protocol specified 6 kinds of controlled anthropogenic greenhouse gas when calculating their governance cost [3], and there is no specific CO2 cost estimation program in it.

2 The introduction of equivalent cost

2.1 The original of equivalent cost

The total cost of electrical production includes production cost and environmental cost after the introduction of CDM. The equivalent cost needs a standard. The environmental cost can be carculated by measuring the emission cost.

2.2 Composition of environmental cost

The enviromental cost includes resource consumption cost and pollution control cost which is shown as figure 1.

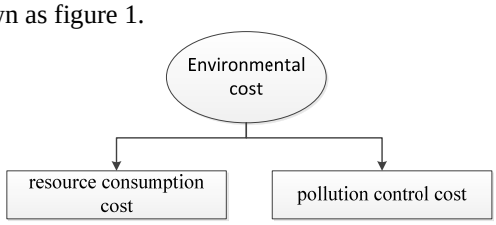

Fig 1 Composition of environmental cost

Resource consumption mainly means coal consumption because its cost belong to the production cost. The environmental cost in this paper means other costs except coal and water consumption cost.

Composition of pollutant control is made up by CO2, SO2, NOx, solid particulate matter and wastewater which is shown as figure 2.

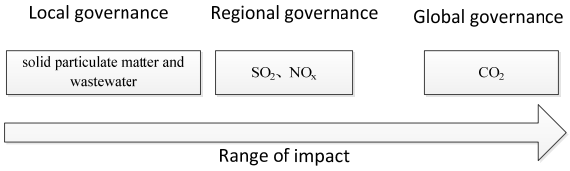

Fig2 Composition of pollutant control

Wastewater and solid particles sediment in the process of transmission, so its scope of impact is small; SO_2 and NO_x are gas so it can effect more; The emission of CO_2 is huge and its scope of impact is biggest. Therefore, the cost of controlling emission form the pollution control cost.

3 Equivalent cost pricing method

3.1 Government pricing

China has only carried out the resource tax but without carbon tax. The carbon tax can analogy foreign equivalent cost. Other pollutants cost carculated by national standards of discharge levy and determine the cost value.

(1) Equivalent cost calculation of resource consumption

Resource tax of coal is 0.3-5 yuan/t which measured by pollution level.

Pollution level is determined by API (Air pollution Index). The carculation method is as follows:

$$Tax_i = Tax_{\min} + \frac{API_i - API_{\min}}{API_{\max} - API_{\min}} \times (Tax_{\max} - Tax_{\min})$$

$API_{\max}$ is the biggest value of API and $API_{\min}$ is the smallest value of API. $[Tax_{\min}, Tax_{\max}]$ is the floating zone of resource tax. API_i is the index of API.

(2) The equivalent cost measurement of CO_2

The equivalent cost of CO_2 can be measured as other countries standard. The carbon tax is 50-80 yuan/t in America, 150-250 yuan/t in Japan and 200-300 yuan/t in European Union. The carbon tax is 50 yuan/t according to China reality.

(3) The equivalent cost measurement of other emssions

According to the "standard of discharge levy management method", sulfur dioxide and nitrogen oxides are 0.6 yuan for each pollution equivalent.

The method is:

$$pollutional\ equivalent\ amount = \frac{emission(\mathrm{KG})}{equivalent\ \ emission(\mathrm{KG})}$$

The equivalent emission of SO_2 and NO_x are 0.95kg, so their cost is 631 yuan/t.

3.2 Market pricing method

Under the background of emission trading, each area has a certain limit to the total amount of emission. The total amount of emission directly affects the power generation, thereby affecting the economic benefits. The use of new energy will not produce pollutants, so power generation companies will not have this part of the environmental costs. However, the pool purchase price of new energy is expensive. Therefore, under the constraints of the market trading mechanism, to use the new energy to replace the thermal power needs to meet the following constraints.

$$P_{\text{new}} \le P_{\text{fire}} + C_{\text{environment}}$$

The implication of the formula is that the pool purchase price of new energy need less or equal to the sum of the pool purchase price environmental costs of thermal power.

According to the proportion of new energy to determine new energy replacement costs, its calculation model is as follows.

$$P = P_1 \cdot R_1 + P_2 \cdot R_2 + \cdots + P_n \cdot R_n$$

In the formula, n is the new energy generation type, P_n is the N class stake electrovalence of new energy, R_n is the N class new energy accounts for the proportion of new energy power generation. According to the above, the calculated results of the $C_{environment}$ is 0.18 Yuan /kWh.

Based on the analytic hierarchy process, the weight coefficient of various factors in environmental cost is obtained.

Through the emission factor reverse, it is concluded that the equivalent cost of each environmental factor. As shown in the following table.

4. Cost accounting method

According to the emissions of power plants to allocate power generation. Whether the benefits brought by increase emissions is greater than to buy extra cost is the key to the electric power enterprise decision-making. Through calculating the initial investment of environmental protection device installation and the discounted value difference in service life of operation costs, calculate the corresponding equivalent cost of emissions. Calculation steps are as follows.

(1) According to the input and output values of different types of environmental protection device, calculate the net cash flow balance of operation.

(2) Through actual measured pollutant emission reduction of different types of environmental protection unit.

(3) Equivalent cost of different pollutants = different types of environmental protection unit net cash flow balance/corresponding reductions.

4.1 Benefit analysis before environmental protection device installation

In the power generation process, the first discharge of pollutants, and then control the pollutants. In the process of calculation efficiency, cash income as sell electricity income. Cash outflow including operating costs and pollutant control costs.

4.2 Benefit analysis after environmental protection device installation

Power plant is in the process of power generation in the condition of pollution control. After the investment environmental protection device installation, cash inflows including sell electricity income and national electricity price compensation.

4.3 The result of comparative analysis

Calculate the net present value of the two schemes. The calculation time limit is one year. The following calculations do not take into account the fixed investment of generating units and the investment interest rate. Basic data is shown as Table 1.

Table1 Basic data table

	Non environmental protection unit	Environmental protection unit
Unit Power (MW Steam)	30	30
Annual generating hours (h)	5000	5000
Pool purchase price (Yuan/kwh)	0.48	0.48
Electricity price subsidy (Yuan /kwh)	0	0.015
Investment (180 Yuan /kw)	0	54000000
Operating costs（Yuan /kwh）	0.089	0.095
Running cost (Yuan /kwh)	0	0.009
Governance cost (Yuan /kwh)	0.087	0.025

Because the calculation period is 1 years, all electricity generated is assigned to each month, the internal rate of return is 8%. So the residue value of the fixed assets of a year after convert the amount of one year before to cash inflows, depreciation by the average depreciation calculation, life expectancy is 20 years. So the equivalent of the first year of investment in environmental protection unit

$$I_{desulfurization} = PV(8\%,12,E_{salvage})$$

Among them, $E_{残值}$ is the amount of the environmental protection unit initial investment minus the total depreciation of 12 months. Table 2 and table 3 is respectively the cash flow statement of before and after installing environmental protection unit, due to the electricity generated according to the average monthly, after 11 month cash flow is the same.

Table 2 Cash Flow before installing environmental protection equipment

		1~12
Cash inflow		60000000
	Generated energy (mwh)	125000
	1 Power selling income	60000000
Cash outflow		22000000
	2 Pollution governance cost	10875000
	3 Operating costs	11125000
Net cash flow		38000000
	Net present value	286370964.64

Table 3 Cash Flow after installing environmental protection equipment

		1	2~12
Cash inflow		82246935.82	61875000
	Generated energy (mwh)	125000	125000
	1Generated energy	60000000	60000000
	2State subsidies	1875000	1875000
	3 Residual value of fixed assets	20371935.82	
Cash outflow		70125000	16125000
	4 Unit investment	54000000	
	5 Operating costs	11875000	11875000
	6 The desulfurization cost	1125000	1125000
	7 Governance costs	3125000	3125000
Net cash flow		12121935.82	45750000
	Net present value	313638472.81	

By calculating the net present value of both, the difference of the two net present value is used as the total sulfur equivalent cost. According to the difference of the sulfur emission , the cost of the unit's sulfur is calculated 116.7yuan/t。

According to the same method, the cost equivalent of each pollutant is obtained as Table 4.

Table 4 Cost equivalent results

Unit : yuan/t

SO_2	NO_x	Solid particles	sewage
116.7	272	915.7	1.8

4.4 Revelation of cost equivalent to the purchase and sale of electricity

Through the method can be used to calculate the environmental cost of the total cost, and then the total cost of the power generation can be obtained.

Usually in the purchase and sale of electricity, it is through the cost calculation method to calculate the cost of pollutants. In the purchase of electricity, can be less because of the purchase of electricity and reduce the amount of local pollution generated, in the multilateral trading auction, the purchase price can be included in the reporting of the cost, improve the successful rate, and in the sale of electricity, the province belongs to the sale of electricity, due to the need to convert the local power generation of waste, the cost of this part of the sale, to ensure their own benefit maximization.

5 Conclusion

This paper mainly presents three methods of cost calculation, based on the carbon tax analogy estimation, but the main basis for the national policy, it is need to determine the cost equivalent of CO2, SO2 and NOx cost equivalent, the three kinds of pollutants belong to the farer transmission range of pollutants, in order to ensure the accuracy of the cost equivalent of the price, it need consider this part of influence.

And through the cost accounting method to determine the cost equivalent, the calculation method is in addition to the source of pollutant emissions, estimates are more accurate. In this paper, based on the existing data to do a simple calculation, if there is enough data to support the calculation of the entire power generation unit within a certain period of the emission reduction benefits, the data can be more accurate. According to different units of different regions, different cost equivalent is obtained for the purchase and sale of electricity, which can be used to maximize the benefits of the purchase and sale of electricity.

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