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Allocation of carbon emission permits among industrial sectors in Liaoning province

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Abstract

China will establish its national ETS to reduce carbon emissions gradually. A reasonable CO_2 emissions allocation method helps to stimulate the emitters actively at the beginning stage. The paper takes industrial sectors of Liaoning province as a case to distribute the carbon emission permits. Considering the principles of fairness and efficiency, it analyzes the distribution of carbon emission permits among sectors in detail based on the method of CRITIC and fuzzy optimization model. The final allocation proportions are profitable to build the future carbon trading market in Liaoning province and provide reference for policy makers.

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Keywords:CO_2 emissions allocation, CRITIC and fuzzy optimization, industrial sectors, indicators;

1. Introduction

With the highly development of economy, large amounts of CO_2 are emitted into the environment. Carbon emission trading is an effective way to decrease emissions. Its success attracts global attention. Many other countries gradually get involved in the trading market. China has established a carbon trading market in a number of pilot cities to promote emission reduction, and propose the establishment of a national carbon trading market in 12th Five-Year .

The initial distribution of allowances is important since it is fundamental for the whole process of carbon emission trading. Industrial carbon emissions occupy a large proportion of the total emissions in Liaoning province, because industrial sectors consume abundant fossil energies every year. Different sectors have different technology levels, energy consumption structures and emission reduction potentials. How to allocate the quota of carbon emissions will have a great influence on the carbon market and the balance of industrial development. In the initial stage, most emission allowances are allocated to emitters

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free of charge. The remainder will be auctioned, with the auctioned proportion to increase over time after the first phase. A lot of researches have been done on the free initial allocation of CO_2 emissions. In literature, the allocation methods can be divided into the following types: indicator optimization, multi-objective optimization, game method and hybrid method [1-2]. Kong et al. [3] used the Boltzmann method on the enterprise distribution, considering the carbon emissions intensity, historical cumulative emissions and future carbon emissions. Song et al. [4] established the two stages distribution mechanism based on the regional comparison, considering the actual development of the electric power industry. According to the principles of fairness and continuous production, Kong et al. [5] established a multi-objective decision model for initial emission permits allocation. The information entropy method [6] is also effective and fair, mainly because it is based on industry heterogeneity and has an objective consideration of the needs of the industries' development and reduction potential.

Literature of distribution are mainly about the various regions or a particular industry, but among different kind of industries it is relatively few. This paper combines the method of CRITIC and Fuzzy optimization selection model, and makes an initial allocation for the industrial sectors in Liaoning province. As a kind of objective method of giving weights, the CRITIC method gives different weights for the five indicators: number of employees, historical cumulative emissions, gross industrial productions, carbon emission intensity, consumptions of energy. The fuzzy optimization model determines the relative inportance degree of these indicators by Generalized Euclidean distance, and calculates the final allocation proportions among these sectors.

2. Principle and method

2.1. Calculation of basic indicators of industrial sectors in Liaoning province

Since there is no official monitoring data of carbon dioxide emissions, the paper calculates CO_2 emissions as Eq. (1) according to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. The calculated energies mainly include crude oil, raw coal, coke, gasoline, kerosene, diesel oil, fuel oil, gas and electricity. The data of energy consumptions come from the Liaoning Province Statistical Yearbook (2011-2015).

$$CE = \sum_{i=1}^{7} CE_i = \sum_{i=1}^{6} E_i \times CV_i \times CF_i \times CR_i \times M + E_e \times w_e \tag{1}$$

Where CE means the total CO_2 emissions, i means the different varieties of energies, E means the consumptions of the fossil fuel, CV means the average low calorific value, CF means the coefficient of carbon emissions of the energy, CR means the carbon oxidation rate, M means the equivalent coefficient between the carbon and carbon dioxide, namely 44/12. E_e means the consumption of electricity, and w_e means the average emission coefficient of electricity. w_e varies in different regions. Liaoning Province is located in the northeast region, and its average emission coefficient is 1.096 kg CO_2 per kWh according to the Provincial Greenhouse Gas Inventories. COE means the total CO_2 emission coefficient of the energy. The relevant values are as Table 1.

According to Classification and Code Standard of National Economy Industry, the paper merges industries of similar consumption pattern into a larger sector [7]. The industrial sectors in Liaoning province are divided as Table 2.