Research on the Impact of Carbon Price on Power Cable Price

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Abstract

In response to the national development requirements and the people's desire for a low-carbon society, more and more enterprises have joined the work of carbon emission reduction. This paper use the whole life cycle assessment (LCA) method to analysis the carbon footprint of power cable. We use data from a cable factory to quantitatively evaluate energy consumption and greenhouse gas emissions during the whole life cycle of power cable production. The results show that the carbon footprint of 1km cable is 0.9821tco2e/t. Furthuremore, we also analysis the influence of carbon price on the profit of power cable manufacture. When the carbon price increased from the basic price 50 yuan / ton, the profits of the cable manufacture will be decreased. Therefore, cable enterprises should make improvements in the application of new energy power and the selection of low emission suppliers, so as to reduce the impact of future carbon price fluctuations on enterprise profits.

***keywords**: carbon price, power cable price, carbon footprint, life cycle mentassess*

1. Introduction

In recent years, the greenhouse effect and climate change have become the focus of global attention. The new term "carbon footprint" is more and more widely used all over the world. Product carbon footprint (PCF) refers to the sum of greenhouse gas emissions of a product at each stage of its life cycle, that is, the accumulation of various greenhouse gas emissions from raw material mining, product production (or service provision), distribution, usage to final recycling. With the overall growth trend of turnover in China's carbon trading market, carbon prices are also rising. The sensitivity of product prices to carbon prices in the future has become an urgent problem to be solved in academic circles. In order to better measure the impact of carbon price change on cable price, our study uses the full life cycle carbon footprint of cable to further clarify the impact of carbon price on cable price[6].

With the increase of trading price in carbon market, carbon price will have a far-reaching impact on production. Existing studies have focused more on the impact of product carbon emission quotas on production and operation. Kuan Liu (2014) studied the impact of carbon emission tax on the choice of transportation mode. Li Wei[13], Weida Chen and Ye Yang (2022) studied the impact of carbon emission policies on the business decisions of iron and steel enterprises[16]. With the increase of carbon market price, the operation decision of power grid enterprises is also affected more and more. In the process of power grid construction, the research on cable carbon emission has become an inevitable link in the construction of low-carbon power grid. Xiaoyuan Wang (2014) studied the carbon emission characteristics of Jiangsu wire and cable industry, the technical path of carbon emission source identification, quantification and external verification[14]. Zhihua Huo (2020) studied the carbon emission law of cable in the process of power transmission, and on this basis, he calculated the impact of carbon price on power transmission cost, and then determined the method of cable selection, so as to explore the possibility and specific operation method of realizing carbon emission reduction in the process of power transmission for power grid enterprises[15]. With these studies, corresponding ideas have been put forward, but the research on the whole life cycle of cable production has not received enough attention. In order to fill this research gap, the whole life cycle theory of this study studies various greenhouse gas emissions of cables from raw material mining, product production (or service provision), distribution, usage to final recycling, and finally evaluates the impact of price changes of carbon trading on cable manufacturers.

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2. Life cycle assessment theory

The concept of full life cycle assessment covers a wide range, starting from the industrial field and touching on the fields of economy, environment, technology, society and so on. From the perspective of industrial production, a product is called the whole life cycle of the product from the mining of raw materials to processing, transportation, manufacturing, packaging, usage and maintenance, and finally treated or recycled in the form of waste[1].

Based on the LCA assessment method, a variety of carbon footprint assessment guidelines and requirements have been established internationally for product carbon footprint certification. At present, there are three widely used carbon footprint assessment standards: (1)pas2050:2011 specification for greenhouse gas emission assessment of goods and services in the life cycle, which is jointly issued by British Standards Institute (BSI), Carbon Trust and Defra, It is the earliest international standard with specific calculation methods, and it is also the most widely used product carbon footprint evaluation standard at present; (2) Greenhouse gas accounting system: product life cycle accounting and reporting standard, which is a product and supply chain standard issued by the World Resources Institute (WRI) and the World Business Council for sustainable development (WBCSD); (3) ISO / TS 14067:2013 greenhouse gases - carbon footprint of products - Requirements and guidelines for quantification and information exchange. This standard takes PAS 2050 as the seed document and is prepared and issued by the international organization for Standardization (ISO). The purpose of product carbon footprint accounting standard is to establish a consistent and internationally recognized method for evaluating product carbon footprint[10-12].

3. Calculation process of carbon emission in the whole life cycle of cable

The product carbon footprint calculation only includes the greenhouse gas part of a complete life cycle assessment (LCA). The life cycle flow chart of 1km cable products is drawn according to pas2050:2011 specification for greenhouse gas emission evaluation of goods and services in the life cycle. Its carbon footprint evaluation mode is from business to consumer (B2C) evaluation: including the emissions from the whole process of raw material acquisition, manufacturing, distribution and retail, customer usage, and final disposal or recycling. The life cycle flow chart of cable products is as follows:

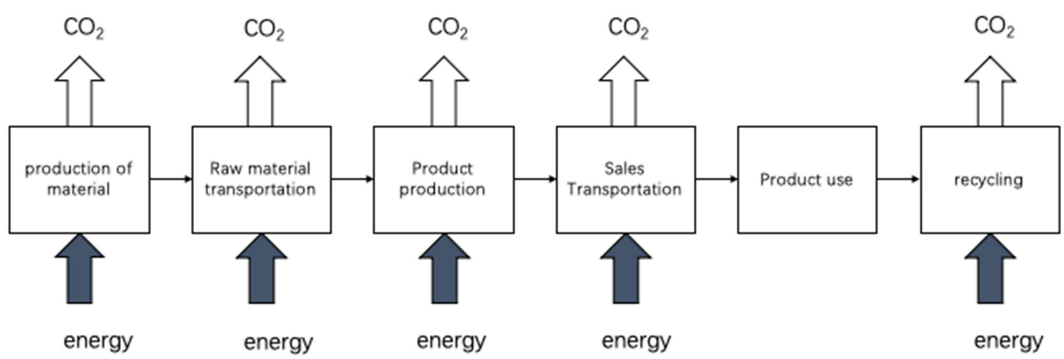

Figure 1. boundary diagram of cable life cycle assessment

In order to ensure the reliability of the calculation results, we select the primary data directly provided by a manufacturer and supplier in the research process, in which the empirical data provided by the enterprise is taken as the average value. This study will investigate, collect and sort out the data in March 2021. When primary data is not available, we try to select secondary data representing regional average and specific technical conditions. Most of the secondary data are from CLCD China database, Swiss Ecoevent database, European life cycle reference data (ELCD) and EFDB database; When there is no completely consistent auxiliary data in the current database, we use the approximate replacement method to select the data in the database. The data in the database has been strictly reviewed and widely used in LCA research in the world.

3.1. measuring boundary

Cable production process mainly includes raw material production stage, raw material transportation stage, product production stage, sales and transportation stage, product use stage and recycling stage. The data of copper rod, galvanized steel strip, PVC sheath and polyethylene insulating material in the production stage of raw materials mainly come from the actual production data of suppliers in 2020[7-9]. The main data of aluminum alloy rod comes from CLCD-China database and Swiss Ecoevent database. The carbon emission in the transportation stage of raw materials mainly uses the database data and the average transportation distance of suppliers to calculate the carbon emission generated in the transportation process of raw materials. In the product production stage, the process boundary is mainly from the incoming of copper rod, galvanized steel strip, sheath and insulating material to the outgoing of cable, production processes mainly include copper rod, aluminum rod, alloy rod, wire drawing, annealing (when needed), extrusion, steam crosslinking (when needed), inspection and other processes. At the stage of product transportation, enterprise products mostly use land transportation, our study uses database data and customer average transportation distance to calculate the carbon emission generated during product transportation. In the product use stage, we use database data and software modeling to calculate the carbon emissions generated in the product use stage. In the product recovery stage, we use database data and software modeling to calculate the carbon emissions generated in the product recovery stage[2-5].

3.2. carbon footprint identification

Table 1. Carbon footprint identification

Serial number	Subject	Activity content	Activity data source	
1	Production equipment	Power consumption	Primary activities data	Invoice and production report
2	Refrigerator, air conditioner, heating and other auxiliary equipment prepare	Power consumption		Invoice and production report
3	Raw material production	Consumption of electricity and heat	Secondary activities data	
4	Transportation of raw materials	Gasoline consumption		Address and number of suppliers
5	Product transportation	Gasoline consumption		Customer address, database
6	Product recycling	Consume electricity, heat, etc		

3.3. calculation formula

The formula of product carbon footprint is all materials of all activities in the whole product life cycle energy and waste are multiplied by their emission factors and then added. The calculation formula is as follows:

$$CF = \sum_{i=1,j=1}^{n} P_i \times Q_{ij} \times GWP_j$$

Where CF is the carbon footprint, P is the activity level data, q is the emission factor, and GWP is the global warming potential. Emission factors are derived from EFDB database and relevant references. Since there are no emission factors in some material databases, the values are from the emission factors of similar materials.

3.4. carbon footprint data calculation

Table 2. Calculation of carbon footprint data

project	Component	Consumption data	Emission factor	GWP	CO2e
Electricity	CO2	9525.96	0.6829tCO2/MWh	1	6505.28

(MWh)					
Raw material production (t)		17877	/	1	32178.6
Transportation of raw materials (tkM)		8613571.43	0.14kg/tkm		1205.9
Product transportation (tkM)		6756214.29	0.14kg/tkm		945.87
Product usage (km)		43730	0tCO2/km		
Product recovery (km)		30611			2109.6
total (tCO2e)					42945.25

3.5. carbon emission data analysis

According to the above formula, the carbon dioxide emission of the company in 2020 is 42945.25t. A total of 43730km cables were produced throughout the year. Therefore, the carbon footprint of 1km products E = 42945.25/43730 = 0.9821tco2e/km, the carbon footprint of 1km cable is calculated to be 0.9821tco2e/t. From the contribution proportion of the cumulative carbon footprint of the cable life cycle, it can be seen that the carbon emission link of the cable is mainly concentrated in the energy consumption activities of raw material production.

Table 3. product carbon footprint

Environment type	Equivalent unit	Raw material production	Transportation of raw materials	Product production	Product transportation	Product use	Product recycling	total
Product carbon footprint (CF)	tCO2e	32178.6	1205.9	6505.28	945.87	0	2109.6	42945.25
		74.93	2.81	15.15	2.20	0.00	4.91	100

4. Impact of carbon price change on cable price

Taking a cable company as an example, our paper briefly analyzes the impact of the increase of production costs brought by carbon emission rights on the net profit of enterprises. In 2020, the company produced a total of 43730km of cables, with a revenue of 1.31 billion yuan and a cost of 1.18 billion yuan. Its power structure is thermal power. Assuming that the benchmark price of carbon emission trading price is 50 yuan / t, and 70% of the carbon price plus is transmitted to the actual cost of the enterprise, so the impact of changes in carbon emission right price and cable price on the net profit of enterprises is shown in the table. It can be seen that after carbon emission trading, under the condition that the cable price remains unchanged, the net profit of cable enterprises will lose at least more than 2972.78, and increase the loss with the rise of carbon emission right price.

Table 4. impact of carbon emission on net profit of cable manufacturers

Cable price change	Cable price	Carbon emission price change						
		0	benchmark	10%	20%	30%	40%	50%
-20	23965	-3018	-3052	-3056	-3059	-3063	-3066	-3070
-15	25463	-1520	-1555	-1558	-1561	-1565	-1568	-1572
-10	26960	-22	-57	-60	-64	-67	-70	-74
-5	28458	1474	1440	1437	1433	1430	1426	1423
0	29956	2972	2938	2934	2931	2928	2924	2921
5	31454	4470	4436	4432	4429	4425	4422	4419
10	32952	5968	5934	5930	5927	5923	5920	5916
15	34450	7466	7431	7428	7425	7421	7418	7414
20	35947	8964	8929	8926	8922	8919	8915	8912

5. Summary

This paper uses the data of a cable company to calculate the carbon footprint and net profit. The main conclusions are as follows: (1) based on the analysis of the whole life cycle assessment theory, by calculating the contribution proportion of the cumulative carbon footprint in the cable life cycle, it can be concluded that the carbon emission link of the cable is mainly concentrated in the energy consumption activities of raw material production. (2) Through the data analysis of a cable company, it can be concluded that after carbon emission trading, under the condition of constant cable price, cable enterprises will have net profit loss, and increase the loss with the rise of carbon emission right price.

In order to reduce the carbon footprint of cable suppliers in the production process, we should focus on the assessment of cable suppliers and reduce the carbon consumption in the production process. In order to reduce the carbon footprint of products, suggestions are as follows: (1) production power is provided by the State Grid. It is suggested to further investigate the power production process and improve the accuracy of data. It is recommended to introduce photovoltaic equipment. (2) Strengthen energy conservation, improve energy efficiency from the technical and management levels and reduce energy investment. Energy conservation transformation can be considered in the plant. (3) In the case of little difference in the price of raw materials, try to select suppliers with small carbon footprint of raw materials.

Due to the influence of objective factors and the limitation of data collection, the model established in this paper only uses the cable data of a cable company for checking calculation, which needs to be further deepened and developed in the future research. The construction of low-carbon society will be the main theme of future social construction, and the low-carbon of power grid enterprises will be an important goal of the development of power grid enterprises. With the continuous research and progress of low-carbon technology, the means of low-carbon power grid construction will be diversified, so we must constantly optimize the carbon footprint calculation model of this paper to make it more scientific and reasonable.

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