Frontiers in Economics and Management Volume 4 Issue 11, 2023
ISSN: 2692-7608 DOI: 10.6981/FEM.202311_4(11).0049

Research on " Pricing Method" of Carbon Emission Quota Calculation System

Mengyi Kong

Jiaxing Nanyang Technology Institute, Jiaxing, Zhejiang 314000, China

*Email: mengyikong0@gmail.com

Abstract

With reference to the PAS2050 specification in the international construction field and the "Construction Project Pricing Rules", a "top-up" calculation idea is adopted: construction project budget (budget) document - generate human resource machine summary quantity - calculate the carbon emissions of the construction subject - Calculate construction management carbon emissions-obtain the total carbon emissions of the construction project, include manual carbon emissions and construction management carbon emissions under the calculation category of construction project carbon emissions, and simplify the calculation process of mechanical carbon emissions. In practical applications, it is suitable for all kinds of engineering projects. It does not require high professionalism of practitioners, and the calculation results are highly oriented. It can realize the standardization, standardization and universalization of carbon emission calculation, and can provide theoretical reference for energy saving and emission reduction of construction projects.

Keywords

Pricing Method; Carbon Emissions; Quota Reconstruction; Low-carbon Emission Reduction.

1. Introduction

In 2020, China announced to the world at the United Nations General Assembly that China's carbon dioxide emissions will strive to peak before 2030 and strive to achieve carbon neutrality before 2060 [1] (hereinafter referred to as the "3060" policy). If China's construction industry wants to achieve the "carbon neutrality" goal as scheduled, it needs to carry out technological changes in the industry and build a more complete policy and testing technology system. The construction of a building carbon emission quota measurement system is one of the ways to support the realization of the "3060" goal. a basic work.

In recent years, building carbon emissions have become a research hotspot at home and abroad. Scholars have conducted a lot of research on this. By querying relevant literature on China National Knowledge Infrastructure in the past three years, it was found that there are three main categories of calculation methods for carbon emissions in construction projects, namely process-based. The inventory analysis method, the input-output method and the hybrid method that combine the two are used to analyze the carbon dioxide emissions generated by the production of office building building materials and equipment, and the carbon dioxide emissions generated by the transportation of office building building materials and equipment.

The sum of the physical carbon emissions and the carbon dioxide emissions generated by the construction of office buildings is the carbon emissions in the physicalization stage of the office building.

In view of this, this article attempts to convert the construction project budget quota into a carbon emission quota from the perspective of the project cost valuation system, with reference

ISSN: 2692-7608 DOI: 10.6981/FEM.202311_4(11).0049

to the PAS2050 specification in the construction field and the "Construction Project Pricing Rules", based on the division of project cost formation content, and according to the project cost Calculation ideas for cost components and sorting out the calculation theory of carbon emissions during the construction process of construction projects. Adopt a "top-up" calculation idea: Construction project budget (budget) document - Generate labor and machine summary quantity - Calculate the carbon emissions of the construction subject - Calculate the carbon emissions of construction management - Obtain the total carbon emissions of the construction project, and combine the labor Carbon emissions and construction management carbon emissions are included in the calculation category of construction project carbon emissions. The calculation process of mechanical carbon emissions is simplified by multiplying the amount of energy consumed during machinery operation by the carbon emission factor. Based on this, typical projects are used as examples for comparison and verification, aiming to promote the development of carbon emission measurement in construction projects to a more standardized, normalized and universal stage.

2. Basic Calculation Method

2.1. Research Scope

2.1.1. The Connotation of " Pricing Method " Carbon Emission Quota Calculation

The existence of "Construction Project Pricing Rules" and "Construction Project Budget Quotas" has made construction project costing more universal. The construction project pricing system basically includes information on various resources, energy inputs and other information of the construction subject and construction management of the construction project, and can comprehensively and systematically reflect the types of carbon sources and their corresponding quantities during the construction stage of the project. Therefore, the "price method" carbon emission quota calculation system can ensure comprehensive, accurate and rapid calculation of carbon emissions during project construction.

2.1.2. Scope of Carbon Emission Gases

Greenhouse gases include carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), sulfur hexafluoride (SF6), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs) [5]. This article uses CO2 as the greenhouse gas accounting boundary. As greenhouse gas measurement methods mature, the gas range can be expanded.

2.1.3. Carbon Emission Calculation Scope

(1) Time boundary. According to relevant research at home and abroad, the entire life cycle of a construction project is divided into four stages, namely the materialization stage, the construction stage, the operation and maintenance stage and the dismantling and recycling stage [8]. This article studies carbon emissions during the physical and chemical stages of materials and the construction stage. The materialization stage only considers the carbon emissions of main materials and high energy-consuming materials (such as cement and asphalt) during the construction process; the construction stage includes the building materials transportation stage and the on-site mechanical construction stage.

(2) Space boundary. The spatial boundary of carbon emissions from construction projects is the spatial location where the carbon emission sources that must be consumed for production activities during the project construction process are located. The construction site of a building project includes the construction area, processing area, operating area and living and office areas. The construction area and processing area mainly measure the carbon emissions of the construction body, while the operating area and living and office areas mainly measure the carbon emissions of construction management.

ISSN: 2692-7608 DOI: 10.6981/FEM.202311_4(11).0049

2.1.4. " Pricing Method " Carbon Emission Quota Calculation Ideas

The calculation of carbon emissions during the construction phase is based on the calculation method of project cost composition, and the carbon emissions of the construction main body and the carbon emissions of construction management are calculated separately. The first is to calculate the carbon emissions of the construction subject based on the calculation method of sub-item project fees (Part 1), by replacing the quantity multiplied by the unit price with the quantity multiplied by the carbon emission factor. This article multiplies the quantity of labor, materials, and machinery summarized in the first part by the corresponding carbon emission factor to obtain the labor carbon emissions, material carbon emissions, and machinery carbon emissions. The three are added together the calculation of carbon emissions during the construction phase is based on the calculation method of project cost composition, and the carbon emissions of the construction main body and the carbon emissions of construction management are calculated separately. The first is to calculate the carbon emissions of the construction subject based on the calculation method of sub-item project fees (Part 1), by replacing the quantity multiplied by the unit price with the quantity multiplied by the carbon emission factor. This article multiplies the quantity of labor, materials, and machinery summarized in the first part by the corresponding carbon emission factor to obtain the labor carbon emissions, material carbon emissions, and machinery carbon emissions. The three are added together to obtain the carbon emissions of the construction body; The second is According to the calculation ideas of construction organization measure fees and enterprise management fees (Part 2), the sum of labor costs + machinery costs as the base is replaced by the sum of labor carbon emissions + machinery carbon emissions as the base, and the carbon emissions of construction organizations are calculated, corporate management of carbon emissions. This article uses the sum of manual carbon emissions + mechanical carbon emissions as the base number, and multiplies the corresponding rates respectively to obtain the carbon emissions of the construction organization and the carbon emissions of the enterprise management. The two are added to obtain the carbon emissions of the construction management. The sum of the carbon emissions of the construction body and the carbon emissions of construction management is the carbon emissions during the building construction phase.

2.2. Calculation Method

The carbon emissions of construction projects include: carbon emissions of the construction body and carbon emissions of construction management. Among them, the carbon emissions of the construction entity include manual carbon emissions, material carbon emissions, and mechanical carbon emissions. The carbon emissions of construction management include corporate management carbon emissions and construction organization carbon emissions. As shown in Figure 1.

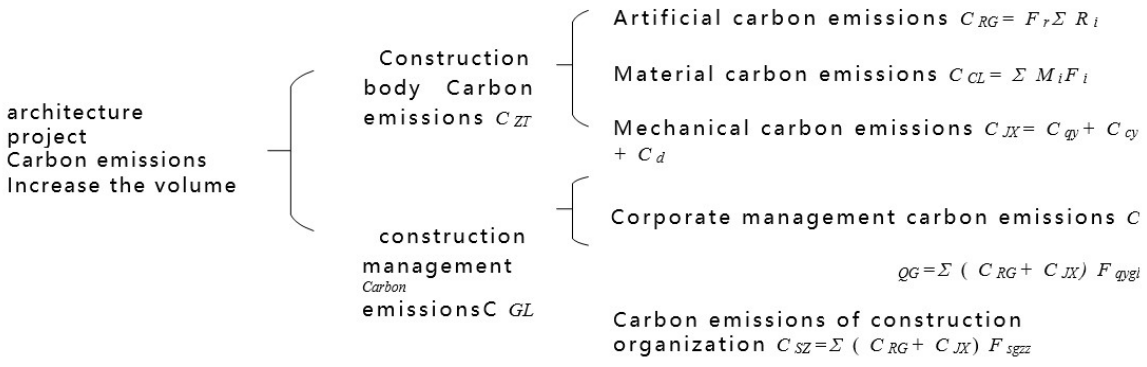

Figure 1. Composition of carbon emissions from construction projects

ISSN: 2692-7608 DOI: 10.6981/FEM.202311_4(11).0049

2.2.1. Artificial Carbon Emissions

Artificial carbon emissions refer to the carbon emissions produced by workers during the construction phase during construction operations and office life. Estimated based on China's per capita carbon emissions. Data from the Emissions Database for Global Atmospheric Research (EDGAR) show that China's per capita annual carbon emissions in 2018 were 8.0t, which is converted into days per working day (calculated as 8 hours). The per capita carbon emission is approximately 7.30kgCO2e/(working day) [9].

The number of working days summarized in the "Main Working Days List" is generated based on the budget document and calculated according to the following formula:

CRG = Fr Σ Ri (1) In the formula, CRG is the artificial carbon emissions; Fr is the carbon emission index per capita working day in the nth year, which is 7.30 with reference to the 2018 data; Ri is the consumption of the i-th type of labor.

2.2.2. Material Carbon Emissions

Material carbon emissions refer to the carbon emissions in the physicalization stage of materials. This article only considers the main materials and high energy-consuming materials in the engineering construction process. Other materials can be ignored due to their small usage. The quantity of materials summarized in the "Main Materials List" is generated based on the budget document and calculated according to the following formula:

CCL = ΣMiF (2) In the formula, CCL is the carbon emission of the material; Mi is the consumption of the i-th main material; Fi is the carbon emission factor of the i-th main material.

(1) Documents publish carbon emission factors. Material carbon emission factors are mainly obtained based on the "Building Carbon Emission Calculation Standard" (GB/T51366-2019), including C30 concrete, lime, sand, etc.

(2) Literature summary of carbon emission factors. Carbon emission factors not listed in the "Building Carbon Emission Calculation Standard" were summarized by searching relevant literature, including cement mortar, steel, etc. As shown in Table 1.

Table 1. Literature summary carbon emission factors

serial number	Material name	carbon emission factor
1	Cement mortar [10]	400.94kgCO 2 e/m 3
2	Section steel, I-beam [10]	3.71kgCO 2 e/m 3
3	Steel bars [11]	2.34kgCO 2 e/kg
4	Galvanized steel pipe [2]	2.53kgCO 2 e/kg
5	Steel strand [11]	2.38kgCO 2 e/kg
6	Steel plate [2]	2.40kgCO 2 e/kg
7	wood [10]	10.45kgCO 2 e/m 3
8	stone [10]	6.05kgCO 2 e/m 3
9	SBS modified asphalt waterproofing membrane [10]	2.38kgCO 2 e/m 2
10	Paint [10]	3.60kgCO 2 e/kg
11	…	…

2.2.3. Mechanical Carbon Emissions

Mechanical carbon emissions refer to the carbon emissions generated by energy consumption (gasoline, diesel, electricity) due to the use of mechanical equipment during the construction phase. It mainly includes the energy consumption of mechanical equipment during the transportation stage of building materials and the on-site mechanical construction stage [12]. The calculation of mechanical carbon emissions is based on the summary of the quantities of

ISSN: 2692-7608 DOI: 10.6981/FEM.202311_4(11).0049

diesel, gasoline, and electricity in the "Main Materials List" generated from the budget document, and is calculated according to the following formula:

$$CJX = Cqy + Ccy + Cd$$
$$Cqy = MqyFqy, Ccy = Mcy\ Fcy, Cd = MdFd$$

In the formula, CJX is the carbon emissions of construction machinery; Cqy is the carbon emissions of gasoline consumed in the operation of construction machinery; Ccy is the carbon emissions of diesel consumed in the operation of construction machinery; Cd is the carbon emissions of electricity consumed in the operation of construction machinery; Mqy and Fqy are gasoline consumption and carbon emission factors; Mcy and Fcy are the consumption and carbon emission factors of diesel; Md and Fd are the consumption and carbon emission factors of electricity.

(1) Fossil energy carbon emission factor. This article calculates CO2 emissions based on the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Use the carbon emission coefficients and carbon oxidation rates of various fossil energy sources in the IPCC, multiply them by their respective low-level calorific values, and then multiply the resulting carbon emissions by 44/12 (carbon dioxide molecular weight conversion), that is, CO2 emission factor = average low-level calorific value × Carbon emission coefficient in the combustion stage × Carbon oxidation rate × 44/12 + Emission coefficient in the production stage [13]. As shown in table 2.

Table 2. Fossil energy carbon emission factors

Fuel type	average low calorific value / KJ / Kg	carbon emission Conversion factor /Kg/GJ	carbon oxygen conversion rate	Combustion stage CO2 emissions / Kg / Kg	Production stage CO2 emissions _ / Kg / Kg	CO2 emissions _ factor //Kg/Kg
standard coal	29307	29.30	0.90	2.83	0.06	2.89
gasoline	43070	18.90	0.98	2.93	0.57	3.50
diesel fuel	42652	20.20	0.98	3.10	0.57	3.67

(2) Electric energy carbon emission factor. The data required to calculate the power marginal emission factor and capacity marginal emission factor include power generation, installed capacity, power consumption rate and power exchange between power grids, respectively, from the "China Electric Power Yearbook" from 2014 to 2016 and the "Electric Power Industry Statistics" from 2013 to 2015. Data Compilation"; Data such as power generation fuel consumption and low calorific value of power generation fuel are from the "China Energy Statistical Yearbook" and "Public Institution Energy Consumption Statistical System" respectively from 2014 to 2016; The potential emission factors of each fuel are from the "IPCC National Greenhouse Gas Inventory Guidelines" [14]. The results are shown in Table 3.

Table 3. Electricity carbon emission factor value table

Grid name	*EFOMy* / tCO2 / MW · h _	*EFBMy* / tCO2 / MW · h _
North China Regional Power Grid	0.9680	0.4578
Northeast Regional Power Grid	1.1082	0.3310
East China Regional Power Grid	0.8046	0.4923
Central China Regional Power Grid	0.9014	0.3112
Northwest Regional Power Grid	0.9155	0.3232
Southern Regional Power Grid	0.8367	0.2476

ISSN: 2692-7608 DOI: 10.6981/FEM.202311_4(11).0049

EFOMy represents the emission factor of currently operating power generation facilities; EFBMy represents the emission factor of newly built power plants, which is adopted uniformly in this article.

EFOMy as electricity carbon emission factor. Since the construction project selected for this case study is located in Zhejiang Province, based on the principle of regional attribution, the carbon emission coefficient of the East China regional power grid is selected, which is 0.8046 tCO2/MW·h[14].

2.2.4. Enterprise Management of Carbon Emissions

Corporate management carbon emissions refer to the carbon emissions generated by corporate administrative departments for the management and organization of construction project implementation activities, including offices, fixed assets, tools and tools, inspection and testing, night construction, equipment protection, etc. Enterprise management carbon emissions are calculated by multiplying "artificial carbon emissions + mechanical carbon emissions" by the enterprise management rate.

CQG = Σ (CRG + CJX)Fqygl (4) In the formula, CQG is the enterprise management carbon emissions; CRG is the artificial carbon emissions; CJX is the mechanical carbon emissions; Fqygl is the enterprise management rate.

2.2.5. Carbon Emissions of Construction Organizations

The carbon emissions of the construction organization refer to the carbon emissions generated by non-engineering entities before and during the construction of the project in order to complete the construction of the project, including safe and civilized construction, early completion, secondary transportation, winter rainy season construction, Traffic and pedestrian interference, other organizational measures. The carbon emissions of the construction organization are calculated by multiplying the "labor carbon emissions + mechanical carbon emissions" by the construction organization project rate.

CSZ = Σ (CRG + CJX)Fsgzz (5) In the formula, CSZ is the carbon emissions of the construction organization; Fsgzz is the construction organization measure rate.

3. Suggestion

Good scientific research results have been achieved on carbon emissions from construction projects. How to better apply these existing results in practice is a technology that urgently needs breakthroughs.

(1) Government agencies should incorporate construction project carbon emissions into project management, compile "Construction Project Carbon Emission Quotas", combine it with "Construction Project Cost Software", and add a "Carbon Emission Module" to facilitate the promotion of carbon accounting and carbon optimization in construction projects. application.

(2) Calculate the carbon emissions of different structures of the same scale, such as span steel-concrete composite beam bridges and integral cast-in-situ continuous beam bridges, frame structures and frame-shear structures of the same building height, reinforced concrete round tubes and steel-plastic corrugated structures of the same diameter Guan et al., through comparative analysis of carbon emissions of different structural types, provide optimization solutions for carbon reduction and carbon control.

(3) Relevant units integrate the carbon emission measurement system into the digital cost management platform to form "digital cost + carbon management" to achieve organic collaboration between project cost and carbon emission management, and increase digital carbon indicators, digital carbon structure, and digital carbon reuse. module. Form the analysis

ISSN: 2692-7608 DOI: 10.6981/FEM.202311_4(11).0049

basis of carbon data and provide technical reference for the development of digital carbon and cloud carbon emissions.

4. Conclusion

The "Pricing Method" carbon emission quota calculation refers to the calculation idea of the project cost composition in the "Construction Project Pricing Rules". The total quantity of labor, materials and machinery summarized in the construction project budget document is multiplied by the corresponding carbon emission factor to obtain the labor Carbon emissions, material carbon emissions, and mechanical carbon emissions are added together to form the carbon emissions of the construction body. Taking the sum of manual carbon emissions and mechanical carbon emissions as the base number, multiplying by the corresponding management coefficient to obtain the corporate management carbon emissions and the construction organization carbon emissions, the two are added to the construction management carbon emissions. The sum of the carbon emissions of the construction body and the carbon emissions of construction management realizes the calculation of the total carbon emissions of the construction project. The "Pricing Method" carbon emission quota calculation adopts a "top-up" model, which realizes clear calculation principles, simple calculation steps, accurate calculation results, advanced calculation time, and facilitates the formation of quota standards, reconstructing the existing carbon emission quota measurement system. In practical applications, it is suitable for all kinds of engineering projects. It does not require high professionalism of practitioners, and the calculation results are highly oriented. It can realize the standardization, standardization and generalization of carbon emission calculations, and promote the early realization of "energy saving and emission reduction of construction projects" in my country. 3060” goal produces important theoretical value and practical significance.

References

[1] Wang Youwei. Talking about "carbon": Thoughts on China's building energy conservation work under the vision of carbon peak and carbon neutrality [J]. Building Energy Efficiency (Chinese and English), 2021, 49(1): 1-9.

[2] Luo Zhixing, Cang Yujie, Yang Liu, et al. Research on the calculation method of building physical and chemical carbon emissions oriented to the whole design process [J]. Architectural Science, 2021, 37(12): 1-7, 43.

[3] Luo Z, Yang L, Liu J. Embodied carbon emissions of office building: a case study of China's 78 office buildings[J]. Building and Environment, 2016, 95: 365-371.

[4] Zhang X & Wang F. Assessment of embodied carbon emissions for building construction in China: comparable case studies using alternative methods[J]. Energy and Buildings, 2016, 130: 330-340.

[5] Xu Pengpeng, Shen Yicun, Fu Yan, et al. Quota-based carbon emission measurement and analysis of prefabricated components of prefabricated buildings[J]. Journal of Engineering Management, 2020, 34(3): 45-50.

[6] Chen Binbin, Chen Chanlu, Yang Jianyu, etc. Research on carbon emission quota estimation method during construction stage [J]. Building Energy Efficiency, 2020, 48(11): 147-150.

[7] Zhang Zhongqiu, Lao Yanling, Wei Jinhong, et al. Calculation method and application of carbon emission quota for land remediation based on PAS2050 specification [J]. Soil and Water Conservation Bulletin, 2021, 41(6): 190-200.

[8] Fang Hai, Cao Zilong, Feng Zhenhua, et al. Carbon emission accounting method and empirical research on highway construction period based on full life cycle theory [J]. Highway Engineering, 2021, 46(1): 92-97, 124.