

Summary of Research on Low-carbon Development of the Construction Industry under the "Dual Carbon" Goal

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Abstract

As an important pillar industry of the national economy, the construction industry is facing a transformation from resource dependent to green and low-carbon development. This article elaborates on the current research status at home and abroad from three aspects: the connotation of low-carbon development in the construction industry, the factors affecting carbon emissions in the construction industry, and the evaluation of low-carbon development level in the construction industry.

Keywords

Construction; Low Carbon Development in the Construction Industry; "Dual Carbon" Goal.

1. Introduction

National development and industry demand require low-carbon development in the construction industry, and industrialization is an important opportunity to suppress various high carbon emission inducing factors such as energy intensity and level in the construction industry. Taking the coordinated development of intelligent construction and new building industrialization as the driving force, accelerating the transformation and upgrading of the construction industry is the necessary path to achieve green and low-carbon development. According to the China Carbon Accounting Database (CEADs), China generated 10.5 billion tons of carbon emissions in 2020, an increase of about 14 times compared to the 1960s, and has enormous potential for carbon reduction.

2. Connotation of Low-carbon Development in the Construction Industry

The term 'low-carbon development' has evolved from 'low-carbon economy'. In 2003, the term 'low-carbon economy' first appeared in the UK government's white paper 'Our Energy Future: Creating a Low Carbon Economy'. Subsequently, many foreign scholars conducted research on the "low-carbon economy", and Campiglio et al. (2016) [1] discussed the role of banks and monetary policy in financing the transformation of low-carbon economy; Mohsin et al. (2019) [2] developed a comprehensive index for energy security and environmental sustainability (ACI) to rank countries with high global greenhouse gas carbon emissions in order to develop a low-carbon economy.

Chinese scholars have proposed corresponding insights on the concept and connotation of low-carbon economy. Teng Teng et al. pointed out in the section "Socio economic and technological analysis of low-carbon development" in the book "Concepts, Systems and Policies of Sustainable Development" that low-carbon development focuses on low-carbon, with the goal of development; Pan Jiahua et al. (2010) [3] defined the concept of a low-carbon economy as an economic form that achieves a certain level of carbon productivity and human development under the global shared vision of controlling greenhouse gas emissions; Li Yining et al. (2017) [4] pointed out that low-carbon development is a form of economic development that, under the concept of sustainable development, utilizes various means such as industrial

transformation, new energy development, and technological innovation to minimize the consumption of high carbon energy such as coal and oil, and reduce greenhouse gas emissions, in order to achieve a win-win situation between economic and social development and the ecological environment.

Therefore, this article refers to the concept research of low-carbon development by scholar Li Yining, and defines low-carbon development in the construction industry as: under the concept of sustainable development, reasonable utilization of natural resources can not only meet the current production needs of the construction industry, but also cannot harm the future industry demand. At the same time, the construction industry itself needs to expand industrial scale, optimize industrial structure, drive regional economic development, and achieve a sustainable and stable development state.

3. Research on the Influencing Factors of Carbon Emissions in the Construction Industry

The formation of low-carbon development in China has gone through four stages: "carbon reduction - low-carbon - low-carbon economy - low-carbon development - public participation in low-carbon development". In September 2020, China clearly proposed the goals of "carbon peaking" by 2030 and "carbon neutrality" by 2060. This is not only China's serious commitment to the international community to solve the problem of global climate change, but also China's internal requirement to promote the transformation and upgrading of the construction industry according to the current national conditions. Domestic and foreign scholars have also conducted research on transformation and upgrading in different fields. In the field of energy and electricity, Lin Boqiang (2022) [6], Shu Yinbiao et al. (2022) [7], Jiao Hong et al. (2022) [8] have respectively studied the challenges, development directions, and transformation paths faced by the energy and power system; In the field of urban development, scholars Wu Yiqing et al. (2022) [9] and Huang Heping et al. (2022) [10] respectively explored the low-carbon development path of cities with the Beijing Tianjin Hebei region and smart city construction as their target objects; In the financial field, scholars such as Zhang Youguo (2020) [11], Su Jing (2022) [12] and Wang Ren (2022) [13] measured China's green economy construction level, analyzed the development status of green finance, and explored the transformation path of the financial industry.

Scholars have conducted extensive research on the identification of factors affecting carbon emissions in the construction industry. Du Qiang et al. (2017) [14] decomposed the impact of carbon emissions in the construction industry into direct carbon emission proportion, unit value energy consumption, value creation effect, indirect carbon emission intensity, and output scale effect. The study found that output scale effect and indirect carbon emission intensity are the main positive and negative influencing factors in China's construction industry, respectively; Jiang Boya et al. (2021) [15] decomposed the driving effect of building carbon emissions in Jiangsu Province into six factors based on the log mean exponential decomposition (LMDI) model: energy structure, energy intensity, economic level of the construction industry, population density, new energy-saving building area rate, and new building area; Fan Linzi et al. (2018) [16] used Kaya's identity and LMDI model to decompose various influencing factors and establish an evaluation index system for the impact of optimization and upgrading of the construction industry on carbon emissions. The results showed that value effect had the greatest impact on the increase in carbon emissions in the construction industry, followed by technical efficiency, and the impact of low-carbon level was the weakest; Wu et al. (2019) [17] analyzed the influencing factors of carbon emissions in China's construction industry from 2000 to 2015 and found that the most effective strategy to reduce carbon emissions during the construction operation phase is to increase development density, improve emission factors,

energy structure, and industrial structure; Rasheed et al. (2022) [18] decomposed the influencing factors of carbon emissions in the cement manufacturing industry and found that the growth of the cement industry, labor productivity, energy structure, energy intensity, and carbon emission intensity are the driving factors of carbon neutrality. To sum up, energy structure, energy intensity and construction scale are the main factors affecting carbon emissions of the construction industry.

Identifying low-carbon development paths is the primary task for the transformation and upgrading of the future construction industry. In terms of governance of low-carbon development in the construction industry, Shang Mei et al. (2018) [19] analyzed the main driving factors of carbon emissions in the provincial construction industry from the perspective of low-carbon development level in the construction industry, and proposed its low-carbon development path; Wang Jiangbo (2019) [20] conducted a quantitative study on carbon dioxide emissions from the construction industry in Jiangsu Province, and used system dynamics for scenario simulation to propose a governance path and mechanism for low-carbon development of the construction industry in Jiangsu Province; Bohari et al. (2015) [21] explored the delivery path of green building projects in Malaysia and discussed the government's green policies and measures.

4. Research on Evaluation of Low Carbon Development in the Construction Industry

In order to smoothly promote the low-carbon transformation of the construction industry in the new stage of development, it is necessary to establish an evaluation system to clarify goals and tasks, grasp the progress of progress, and make up for shortcomings and weaknesses. Some researchers evaluate the low-carbon development level of a country or region by constructing an evaluation index system. Cao Bingru et al. (2014) [22] established an evaluation system for regional low-carbon economic development level, including economic development level, industrial low-carbon level, technological support level, and environmental support level; Shi Longyu et al. (2018) [23] constructed an evaluation system to measure the low-carbon development level of Chinese cities from six aspects: carbon emissions, economic development, social development, transportation, living environment, and natural environment; Wang Xiangying et al. (2019) [24] constructed an evaluation system to measure the low-carbon economic development level of regional manufacturing industry from three aspects: economic level, technological level, and environmental level; Zeng Gang (2021) [25] built a green and low carbon cycle development economic system from four aspects: low-carbon development, green development, circular development and economic development. Due to differences in the understanding of low-carbon development among different scholars, the construction of indicator systems often has strong subjectivity, and the methods for determining indicator weights vary, leading to differences in evaluation results. In addition, some scholars use the single indicator evaluation method to measure the low-carbon development level of related industries.

5. Conclusion and Outlook

For a long time, energy security, air pollution, and climate change have been the three major issues that plague sustainable development. Protecting ecology and promoting green development has become a consensus among all sectors, and all industries are actively responding to the call to embark on a path of green and low-carbon development. The research on low-carbon development in the construction industry at home and abroad mainly focuses on factors affecting carbon emissions, low-carbon development paths, and low-carbon development evaluation. For the factors affecting carbon emissions in the construction industry,

existing research mainly uses the LMDI model and Kaya identity for decomposition research; For the identification of low-carbon development paths, existing research mainly uses system dynamics for scenario simulation; Some studies have provided policy recommendations for low-carbon development in the construction industry through analysis of its development and prediction of potential policies.

In China's prefabricated building industry chain, key core entities include developers, construction units, R&D and design units, building materials suppliers, and component manufacturers. Their basic functions are shown in Table 1.

Table 1. Core subject of prefabricated building industry chain

Core subject	Basic function
Developers	The leader and promoter of prefabricated building project development, and coordinate the project progress
Construction unit	According to different project contracting modes, it is divided into general construction contractor, labor subcontractor and professional subcontractor to undertake the construction and installation tasks of prefabricated building projects
R&D and design units	Carry out construction drawing design for prefabricated building project according to national and provincial prefabricated building standards and specifications
Building material supplier	Provide the project owner with materials and tools required for the prefabricated building project
Component manufacturer	According to the construction drawings of the project developer and design unit, split and produce the industrial components of the building, such as prefabricated stairs, prefabricated balcony panels, etc

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