# Carbon emission peaking and emission trading in the building sector

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**Abstract.** China has established the goal of a carbon emission peak and neutrality schedule. With the life cycle carbon footprint of building in China taking half of the country's total emission, thus reducing emissions in the building sector is critical to achieving the goal. This paper examines the relevant literature and data, summarizes the focal point and challenging aspects in the process of carbon emission peaking in the building sector and discusses the role of emission trading in this process.

**Keywords:** Carbon Emission Peaking, Emission Trading, Building Sector.

## 1. Background

Carbon peaking and carbon neutralization, as key nodes in reducing human-induced climate change and decoupling social activities from carbon emissions, are challenges and opportunities in China's development process. At The 2021 Leaders' Summit on Climate, President Xi once again emphasized that China will strive to achieve carbon peaking by 2030 and carbon neutrality by 2060 [1]. In the Action Plan for Carbon Dioxide Peaking Before 2030 issued by the State Council on October 24, 2021, the implementation process of the carbon peaking strategy was planned [2]. As one of the key tasks in the Action Plan, urban-rural development area carbon peaking shows that the country attaches great importance to carbon reduction in the urban and rural building sectors.

In 2018, the life cycle carbon footprint of building in China was 4.93 billion tCO2, accounting for 51.3% of the national carbon emission. It contains three stages: building materials production, operation and construction (including construction and demolition). The proportions of these three stages that take in the carbon emissions in the country are building materials production (28.3%), building operation (21.9%), and building construction (1%) [3].

From the perspective of the scope of carbon emissions, building carbon emissions can be divided into three broad scopes: Scope 1 (direct emissions), Scope 2 (indirect emission) and Scope 3 (implicit emissions). This division method is also the accounting boundary used in the Guidelines for Compiling Provincial Action Plans for Carbon Dioxide Peaking. According to the classification method in the Guidelines, direct emissions from the construction industry include carbon dioxide generated from the consumption of different types of fossil energy, while indirect emissions include carbon dioxide generated during the production of electricity and thermal energy. The two scopes combined are emissions from building operations. Emissions generated during the production of building materials and building construction can be classified as implicit carbon emissions in buildings [4].

In 2020, the national carbon emissions trading market was established, covering eight industries including power generation, petrochemicals, chemicals, building materials, steel, non-ferrous metals, papermaking and domestic civil aviation, providing a market-based carbon reduction mechanism for the covered industries [5]. Among them, the inclusion of building materials, steel and power generation industries has made the trading market cover most of the carbon emissions in the production of building materials and part of the carbon emissions in the operation of buildings. However, since the building operation process includes various carbon emission sources such as coal, gas, and electricity, the current trading system does not fully cover it, leaving a vacuum in the carbon reduction mechanism for the building operation.

Each part of the carbon emission in the life cycle footprint of the building sector is going through different peak stages. According to the calculation of the completed buildings in that year, the

emissions from building materials production and construction links in the implicit carbon emissions of buildings were affected by the peak of the total area of completed buildings, which both peaked in 2014, and then showed a steady and slow downward trend. The direct carbon emission of buildings is also about to reach a peak. Indirect carbon emissions from buildings are the part that is still increasing steadily. The annual growth rate of building electricity carbon emissions is about 7%, and the annual growth rate of thermal carbon emissions is about 3.5% [6].

From the perspective of energy consumption sectors, the energy consumption of building operation can be divided into four parts, including urban residential, rural residential, public buildings and central heating. As of 2018, the total energy consumption of these four parts was 240 million, 190 million, 290 million and 180 million tons of standard coal equivalent, of which the energy consumption per unit area from small to large was rural residential, urban residential, central heating, public buildings [7].

According to forecasts, under the basic scenario, China's building sector energy consumption will peak in 2037 and remain stable thereupon. Among the four energy consumption sectors, the energy consumption of urban residential and public buildings will increase significantly, while the energy consumption of rural residential and central heating has little increase compared with the current scale [8].

As a sector that accounts for over half of the country's total carbon emissions, carbon emission reduction in the building sector is crucial in achieving the 2030 goal. The proper mechanism that can be used to guide this process, and the role of carbon emissions trading in this process, will be the main issues discussed in this paper.

## 2. Method

In this paper, I collect and sort out the current information on carbon emissions from the building sector in China, summarize the focal point and challenging aspects of carbon emission reduction at the current stage, and put forward reference suggestions for carbon emission reduction policies in the building sector.

The research object of this paper is the carbon emission of China's building sector and the corresponding emission reduction policies.

The research design of this paper adopts the method of descriptive research. Collect the current status and research progress of carbon emissions in the building sector. By sorting out the collected data, a preliminary summary of the intensity of carbon emissions from buildings at the current stage and the corresponding management measures are made. Summarize the focal point and challenging aspects in the future carbon emission reduction process under the development trend of carbon emissions in the emerging stage. Next, I make recommendations according to the focal point and challenging aspects identified in the induction, combined with the related policies and existing research. This research aims to find a path for carbon reduction in the building sector.

The keywords used in the data collection process are cities, buildings, carbon emissions, policies and emission trading. The focused geolocation and time range are China and within the past five years. Relevant information in the corresponding time and space range is collected through the combined search of keywords.

## 3. Results

### 3.1. Focal point and challenging aspects in the process of carbon emission peaking in the building sector

This section summarizes the existing data and gives a brief overview of the distribution of building sector carbon emissions, to further clarify the focal point and challenging aspects that will appear in the process of peaking carbon emission.

From the perspective of lifecycle carbon footprint, the building materials production stage and the building operation stage account for 49.7% and 46.2% of the total emission, respectively, and the two combined account for the vast majority of building carbon emissions, while the building construction stage accounts for 4.1% of the total emission [9].

The carbon emissions in the building materials production stage are affected by the completed area of buildings. According to different statistical calibers, in recent years, it has been in a state of low growth (carbon emissions measured by the building materials department and upstream departments) [9] or peaked (carbon emissions measured by the number of completed buildings) [6]. Categorized by product type, the composition of emission sources at this stage is relatively simple, and the total carbon emissions in the production of steel, cement and aluminum account for 98.9% of the building materials production stage.

The carbon emissions in the building operation stage are still increasing, and the growth rate has gradually slowed down in recent years, with an average annual growth rate of 3.6% during the 13th Five-Year Plan period [9]. The carbon emission in this stage can be divided into direct and indirect emissions, of which indirect emissions can be further decomposed into emissions from generating electricity and heat. Direct emission, emission from the generation of electricity and heat account for 26%, 53% and 21%, respectively. Past data shows direct emissions have peaked and shown a downward trend. The annual growth rate of electricity-source emissions is about 8%, and the annual growth rate of thermal-source emissions is about 3%.

According to the type of energy consumption sectors, as of 2018, the carbon emissions of public buildings, urban residential buildings, rural residences and central heating were 630 million tons, 430 million tons, 480 million tons, and 550 million tons, respectively [10]. According to the forecast, under the basic scenario, by 2030, the carbon emissions of each part are (in parentheses are the changes compared with the emissions in 2020): urban residential buildings carbon emissions of 841 million tons (+59.6%), public buildings Carbon emissions of 796 million tons (+18.8%), rural residential carbon emissions of 546 million tons (+17.9%), and central heating carbon emissions of 773 million tons (+47.8%). The carbon emissions of the four energy-consuming parts in the operation stage currently account for a similar proportion, of which the carbon emissions of public buildings are slightly higher than the other three parts. According to the forecast data, the carbon emissions of urban residential buildings will experience a substantial increase. The second increase level is the carbon emission of central heating, while the growth rate of carbon emission of public buildings and rural residences is relatively trivial.

According to the existing data and changing trends of various parts of carbon emissions in the building sector, the following conclusions can be drawn: In the process of peaking carbon emissions in the entire building sector, there are three focal points, which account for the highest proportion of total carbon emissions, they are emission from steel production (26.7%), emission from cement production (22.6%) and emission from electricity (22.6%). Two challenging parts are emissions from electricity and heat generation, which still are growing and yet to peak.

### 3.2. Current application of emission trading market on building sector

As a method of applying economic means to solve environmental problems, the carbon emission trading system has been widely used in emission reduction management in many fields. Traditional command-and-control management methods usually set uniform emission standards or technical standards in an industry field to enable emitters in this field to achieve emission reductions at the same technological level. The management method based on economic means, on the other hand focuses on establishing an emission rights trading market or the levy of emission taxes to unify the cost of polluters of their next unit of emission reduction. This difference in principle makes the command-control mechanism and the economic mechanism have different advantages and disadvantages in achieving environmental management goals. Specifically, managing carbon dioxide emissions by establishing a carbon emissions trading market has a significant advantage since it has a higher potential to reach lower social costs [11].

Currently China adopts a management method combining command-control mechanisms and market mechanisms in the management and control of the life cycle carbon emission of the building sector. On the one hand, there are corresponding technical standards in building materials production, construction and operation. Although a considerable number of technical standards were initially established to reduce the emit of other common pollutants, these standards still objectively provide emitters with the drive to improve energy efficiency, thereby reducing carbon dioxide emissions [12]. On the other hand, carbon emission trading has also been introduced, which covers part of the emission from building materials production and building operation stages.

Analyze the role of carbon emission trading in building sector emission peaking through the view of focal point and challenging aspects. The eight industries (power generation, petrochemicals, chemicals, building materials, steel, non-ferrous metals, papermaking, and domestic civil aviation) covered by the national carbon emissions trading market contain all the challenging aspects and focal points identified [13]. Some current research and practice work is also trying to directly incorporate the emission from buildings' operation stage into the carbon emission trading market [14, 15]. Some pilot cities (Shenzhen and Shanghai) initially include public buildings that reach a certain emission level in the pilot program [16].

## 4. Discussion

In the process of formulating emission reduction policies, factors such as achieving the lowest total social cost, achieving dynamic efficiency in policy implementation, fairness amount stakeholders, and potential side effects of policies need to be considered simultaneously. The combination of carbon emission reduction in the building sector and the carbon emission permit market in the next stage that achieves a balance between these factors will be the key to the smooth and effective implementation of emission reduction. In the following section, I will discuss the potential problems that may occur when applying the emission trading system to the emission reduction of the building sector, the reason that causes these problems and the solutions.

### 4.1. Duplication of emission rights

As a specific way to solve environmental problems through the economic mechanism, the carbon emission trading market is based on the principle of the economic mechanism. That is to say, for a product with negative externalities to society, if there is no intervention, its transaction volume is too large, causing market failure and loss of social welfare. Use carbon taxes or emission permit restrictions to increase the cost of this product and internalize the product's negative externalities, controlling the product's transaction volume to the level that achieves optimal social welfare. For carbon emissions in the building operation stage, the energy suppliers in this link, the power generation industry and the petrochemical industry have entered the national carbon emissions trading market. In this process, electricity, heat, and fossil energy, as products with negative externalities, have been incorporated into the management system in the production process. Through the market process, both producers (supplier of energy) and consumers (users of the building) are affected.

Including buildings in the carbon emissions trading system is repetitive management of carbon emissions generated by the energy used in buildings. If the carbon emission rights of the building operation stage and the carbon emission rights of electricity, heat and fossil energy production are included in the unified market, it will inevitably lead to repeated trading of these emission rights. This action leads to an increase in the total social cost and the complexity of the policy.

### 4.2. High transaction costs

Research by Coase et al. shows that clear property rights and low transaction costs are required to achieve optimal social welfare when the market is in equilibrium. In the case of buildings, there are situations such as numerous non-unique owners, non-unique users, and separation of owners and users. Making building property rights more complex than corporate emitters, and the cost of validating and

participating in emissions trading is much higher. When faced with the externality problem of carbon emission in the building operation stage, due to the nature of the building, it is difficult to solve this problem through the market mechanism. This fact makes it difficult to achieve desired results in managing carbon emissions in the operation of buildings with a building carbon emission trading market.

### 4.3. Potential countermeasures

For the problems analyzed above, a solution is to strengthen the market nature of energy prices so that changes in energy prices can be transmitted to the user of building energy. Under this measure, the energy supply constrained by carbon emissions trading will have the ability to affect the energy consumption behavior of consumers during the operation of buildings. Thereby directly promoting energy-saving behavior or promoting the popularization of low-energy-consumption technologies in the building sector. This method can simultaneously avoid repeated trading of emission rights and the complexity of property rights issues.

Another solution is to establish a separate market for carbon emission rights during the operation phase of buildings, independent of the existing national carbon emission permit market. Distinguish the trading parties of emission rights and provide the impetus for the adoption of low-carbon technologies by the differences in the energy efficiency of buildings in the market. Through this scheme, the production-side carbon emissions and consumption-side carbon emissions of energy during the building operation phase are actually included in different trading markets, avoiding duplication of emission rights.

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