

Research on the Path of Urban Buildings' Emission Reduction under the "Dual Carbon" Goal

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Abstract

Construction industry in China has always been a "high-carbon" industry, based on China's goals of reaching "carbon peak" in 2030 and "carbon neutrality" in 2060, it is particularly important to carry out low-carbon transformation of traditional buildings. Under the background of the "dual carbon" goal, this paper analyzes the whole life cycle of urban buildings and explores the four stages of preparation, construction, operation and recycling to find possible problems and solutions in the development of low-carbon green buildings. Low-carbon, environmentally friendly green buildings are the development trend of urban buildings, which can meet people's growing needs on the one hand, and accelerate the transition of original urban buildings to green buildings on the other hand, ensuring the smooth realization of China's "dual carbon" goal.

Keywords

Carbon Peaking; Carbon Neutrality; Green Buildings.

1. Introduction

A large amount of greenhouse gases are produced, and the Earth's temperature continues to rise. Since the beginning of industrialization over 200 years ago, a large amount of greenhouse gases, especially carbon dioxide, have been released, leading to global temperature rise and climate change. In September 2020, China clearly proposed the goals of "carbon peaking" by 2030 and "carbon neutrality" by 2060, and incorporated the "dual carbon" goals into its national strategy. Based on the "dual carbon" goal, the construction industry, as one of the three major "energy consumers," plays an important role in achieving the "carbon peak, carbon neutrality" goal. It is very important to carry out low-carbon reforms at all stages of the entire life cycle of urban buildings. The World Green Building Commission stated in its "Net Zero Carbon Building Commitment" that it aims to achieve net zero carbon operation of all directly managed construction projects under its umbrella by 2030 and all buildings by 2050. With the development of society, humanity is currently in a transitional stage from the era of industrial civilization to the era of ecological civilization. The key theme of this era is to vigorously promote low-carbon economy and create ecological civilization. As the world's largest developing country, China should prioritize promoting low-carbon economic growth, building a society that saves resources, and respects the environment.

2. Problems in Low-carbon Development of Urban Architecture

2.1. People's Level of Understanding of Green Buildings is Not Sufficient

High quality buildings that save resources, protect the environment, reduce pollution, provide people with healthy, useful, and efficient use of space, and maximize the peaceful coexistence of humans and nature throughout the entire life cycle are known as "green buildings". Green buildings do not refer to the general sense of building greening. The goal of green building is the coordinated development of people, buildings, and the natural environment, while utilizing natural and artificial means to create a good and healthy living environment. Green buildings

also aim to fully reflect the balance between material extraction and feedback to nature by limiting the use and destruction of the natural environment.

There are five different indicators that constitute the evaluation index system for green buildings - safety and durability, health and comfort, convenience of life, resource conservation, and environmental livability. After the construction drawing design of the construction project is completed, a pre evaluation can be conducted, with ratings ranging from high to low, divided into three stars, two stars, and one star categories.

Green buildings place great emphasis on the indoor environment. After the construction of green buildings, the activities of the indoor environment are the main force of carbon emissions. Efficient indoor environments can effectively reduce carbon emissions, such as prolonged winter lighting that can reduce people's use of heating appliances; Effective insulation can reduce people's demand for air conditioning in summer. Simultaneously using clean energy greatly reduces carbon emissions.

People's inadequate understanding of green buildings will fundamentally reduce the development speed of green buildings in China. At present, there are very few green building projects put into operation in China, and it is not clear how these projects will affect the economy in the medium term. Therefore, the overall benefits of green buildings are currently not significant, with poor sales and low social acceptance. People generally believe that green buildings are expensive high-tech buildings, without realizing the healthy and comfortable living environment they create and the overall advantages provided by the entire life cycle of buildings, which greatly limits the promotion and popularization of green buildings.

2.2. The Improvement of Per Capita Energy Consumption Level

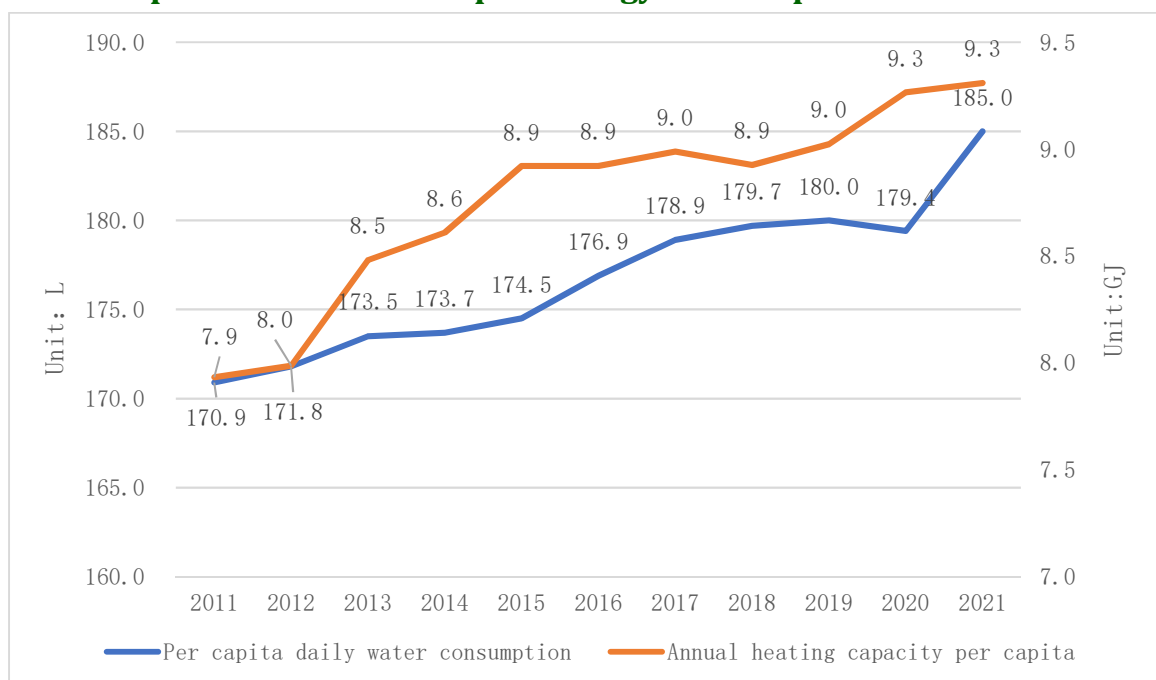


Figure 1. Per capita partial energy consumption in cities

The demand for energy is increasing day by day. Taking the per capita water use and per capita heating situation as an example, Figure 1 shows the per capita daily living water use and heating situation in urban areas of China. From Figure 1, it can be seen that the per capita demand for domestic water and heating has shown an overall upward trend. From 2011 to 2021, the average annual growth rate of per capita daily living standard was 0.80%, and the average annual growth rate of per capita total annual heating supply was 1.63%.

Table 1. Standard Carbon Conversion of Heating Capacity

Name \ Year	Unit	2017	2018	2019	2020	2021
Total heat supply	10000GJ	368285	381396	392542	410058	425879
Per capital heating	GJ	8.99	8.93	9.02	9.27	9.31
Standard carbon	t/per person	0.306649	0.304528	0.307854	0.31614	0.317614

Table 1 takes heating consumption as an example to convert per capita annual heating into standard carbon consumption. Converting the heating amount to the carbon consumption of standard coal can clearly and intuitively show the energy consumption situation. Between 2017 and 2021, the annual increase rate of standard coal consumption per capita for heating was 0.89%. Therefore, the additional amount of carbon dioxide required for heating per person per year is approximately 24.48 kilograms. Based on the urban population of 45747.9 in 2021, the annual increase in heating is approximately 1120 tons of carbon dioxide emissions.

Therefore, the increasing energy demand of people will directly lead to huge carbon emissions, which is not conducive to achieving the "dual carbon" goal, and it is very urgent to reasonably improve people's energy demand.

2.3. Urban Construction Land Tends to Saturate

With the rapid development of public buildings in China, such as the construction of airports, high-speed rail stations, train stations, and transportation stations, the urban construction area has been reduced. Based on China's large population base, people's housing area requirements need to be guaranteed. Secondly, China's arable land area must be guaranteed, and the red line of arable land area must not be exceeded to ensure food security. The speed of urban expansion must be suppressed, so the urban construction area has become very limited. At the same time, the rapid development of urban economy has led to developers building residential buildings on a large scale, resulting in oversupply and a lack of funds for demolition of old buildings, leading to the gradual saturation of urban construction land.

2.4. Uneven Development of Green Buildings

Firstly, green buildings in China attach great importance to the design and construction of buildings, while neglecting the operation of buildings. After the completion of building construction, it does not mean the end of building carbon emissions, and high carbon emissions are considered the official start. Through green building technology, how much carbon emissions can a 27 story building reduce in one year? According to the UAE Landmark Group headquarters building located at Dubai Pier, the answer is 1332 tons. Due to the long lifespan of buildings, the carbon emissions during the construction operation phase cannot be ignored. Secondly, the green building area in Chinese cities is very small. Although green buildings have been developed for a long time in China, the existing building area is very small for the huge building area in China. Thirdly, the geographical distribution of green buildings is uneven. Green buildings in China are mainly distributed in economically developed eastern coastal areas such as Jiangsu, Guangdong, Shandong, and Shanghai, while economically underdeveloped areas in the central and western regions are relatively less distributed.

2.5. Short Lifespan of Urban Buildings

The average lifespan of urban buildings in China is only 30 years, compared to 74 years in the United States and 132 years in the UK. There are several reasons for this phenomenon: firstly, China lacks supervision and responsibility for urban building quality, and in recent years, many areas in China have encountered construction safety hazards; The second is that in some places, urban planning is set by officials, and urban planning is related to the duration of the official's

tenure in a certain location; Thirdly, some places regard urban architecture as a political achievement project, which inevitably leads to rapid construction and demolition of buildings. The low lifespan of urban buildings leads to waste of building materials, manpower and financial resources, and ultimately leads to a significant increase in carbon emissions.

2.6. Insufficient Development Capacity of Innovative Technologies in Green Buildings

Some provinces lack clear long-term development strategic plans for green buildings, have low levels of informatization, relatively backward production and operation methods, and incomplete technical standardization systems. They also have little investment awareness. The use of green building technology is not widespread, such as prefabricated buildings, self-insulating walls, energy-saving doors and windows, building shading, natural lighting, and natural ventilation. There are problems such as low data utilization and low data processing level, and the promotion of building energy efficiency through technologies such as intelligence, big data, and artificial intelligence is relatively lacking.

2.7. Policy Deficiencies

China's "Building Law", "Urban Rural Planning Law", and "Energy Conservation" do not involve the field of green buildings. Although there are various relevant laws in different provinces, cities, and autonomous regions, they play a normative role in promoting regional green buildings. However, the application of local laws and regulations is limited, the regulatory authority is limited, and the effectiveness is poor, which cannot fully solve the problem of national green building development. At the national level, there is still a need for specialized green building laws and a set of rules to encourage the orderly and healthy development of green buildings through legal means.

At present, China has not established a comprehensive evaluation system for green buildings, including design standards, certification requirements for building energy-saving products, and evaluation standards for building energy consumption. Although some provinces have already issued local building energy efficiency standards, the evaluation scope, evaluation indicators, and indicator settings are unreasonable. At the same time, the evaluation system for green buildings in China mainly focuses on effect evaluation, which is not compatible with the evaluation standards and technical standards for various stages of the entire construction process.

At present, policy documents such as the Green Building Action Plan are the main basis for encouraging the development of green buildings. However, effectively coordinating the work of different departments may be challenging, which has a negative impact on the implementation of relevant policies.

3. Measures for Developing Low Carbon Urban Buildings

3.1. Vigorously Promote the Concept of Green Buildings

At present, the overall development level of green buildings in China is in its early stages, and people are not familiar with green buildings, to the extent that people's demand for green buildings is not very strong. Therefore, how to spread the concept of green building is very important.

Firstly, the country has formulated relevant authoritative laws, and local governments have vigorously encouraged the construction and development of green buildings. National publicity is carried out through newspapers, books, television, and the internet.

Secondly, building typical green and low-carbon buildings in China, with the main characteristics of low-carbon, environmental protection, health, safety, and comfort, will have

a social impact, enabling people to intuitively perceive the significance of green and low-carbon buildings.

Only by infiltrating the concept of green building into the public, allowing them to better understand the positive significance of developing green buildings, enabling them to psychologically identify with green buildings, and allowing them to accept green buildings from a conceptual perspective, can the development of green buildings become easier.

3.2. Reasonable Green Transformation of Existing Buildings

The rapid development of coastal cities in eastern China has led to a gradual saturation of urban construction land. Currently, most of the existing buildings are modern products, and direct demolition is clearly not conducive to achieving the "dual carbon" goal. For existing urban buildings, only reasonable green transformation can be adopted, and it only occurs during the operation and recycling stages of the building.

The quality of modern urban architecture in China is good, which is very conducive to green transformation. The main method of green transformation is to change people's way of life: firstly, to use new energy and comprehensively promote the use of wind, solar, and tidal energy; The second is to expand the green area of urban buildings and consume carbon dioxide generated during the operation stage of urban buildings through plant photosynthesis; The third is to reasonably allocate and utilize the waste generated in people's daily lives, such as sewage biological treatment, waste recycling, waste power generation, etc.

For the building itself, replacing outdated and inefficient equipment, especially outdated processes and equipment that are explicitly prohibited or eliminated by the state, with low energy consumption equipment, especially equipment with a high proportion of energy consumption such as central air conditioning, elevators, pumps, ventilators, transformers, and lighting equipment, should choose high-efficiency and energy-saving products recommended by the state.

One of the reasons for the rapid increase in building energy consumption is the strong demand for electricity among residents. Electricity is almost a necessity for all equipment, and the best way to meet people's demand for electricity is to use solar energy. The reason is that solar power generation technology has made significant progress; Especially the third-generation photovoltaic power generation technology, due to its low power generation price, will rapidly develop in the near future. At present, the roof area in China is about 10 billion square meters, and it may reach 30 to 40 billion square meters in the future. It is the "best" location with the lowest cost of "land occupation" and the ability to build small photovoltaic power stations.

Demolish buildings with safety hazards and high energy consumption, rebuild green buildings, and minimize carbon emissions from urban buildings as much as possible.

3.3. Strengthen the Development of Innovative Technologies and Talent Cultivation

Vigorously developing intelligent technology, renewable energy technology, and green building materials, shifting the traditional energy structure towards a new energy ecosystem. Enhance environmental protection in heating, ventilation, air conditioning, and other areas, achieve technological breakthroughs and progress, improve energy utilization efficiency and ecological friendliness. Improving energy utilization efficiency can effectively reduce the operational carbon emissions of the existing energy structure. At the same time, efficient energy utilization can effectively solve the problem of insufficient renewable energy supply, meet low energy needs with renewable energy, reduce carbon content throughout the entire life cycle of buildings, and reduce the operating carbon of existing buildings through energy efficiency. At the same time, digitization and intelligence will be closely combined to improve overall energy efficiency through terminal energy interconnectivity.

Strengthen the application of technology research and development and talent cultivation. Close cooperation with research institutions, in-depth research and development of BIM comprehensive optimization processes, 3D printing, construction robots, prefabricated buildings, etc., to build green design, green development, green construction, green marketing, and low-carbon operations; Regularly organize enterprises to participate in technology expos, support enterprises in establishing innovation platforms, and strive to enhance their research and development capabilities; Optimize the curriculum of universities, form a virtuous cycle of talent cultivation and management system, cultivate theoretical academic and applied technical talents, and promote a new pattern of green development through circular utilization.

3.4. Policy Supporting

It is very important to establish new laws and regulations, improve and supplement existing laws and regulations related to energy-saving buildings and green buildings, and coordinate relevant domestic laws and regulations to ensure the effectiveness of relevant laws and regulations. The significance of formulating relevant laws and regulations is to break traditional design principles, reasonably change traditional design ideas, fully consider the natural conditions of the project location, fully consider local climate and environmental conditions, as well as local environmental, economic and social issues, and strive to integrate buildings into nature as much as possible. In addition, administrative supervision is an important guarantee for the smooth implementation and completion of green buildings. Government departments should establish an effective regulatory system, strengthen law enforcement and supervision work, and ensure the smooth implementation of legal standards related to green buildings.

4. Conclusion

By vigorously promoting the concept of green buildings, enabling people to better understand its significance, stimulating market demand, and providing policy support, the development of green buildings will become easier. Strengthen the application of emerging technologies, improve the quality of green buildings, extend the lifespan of buildings, and achieve harmonious coexistence between humans and nature.

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