Research on the development of green building in China

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Abstract: Since 2014, China's economic development has entered a new normal, and the downward pressure on the economy has significantly increased. Various industries need to adjust their structure and make positive changes. Green buildings can save energy and resources, which is the development direction for the construction industry to adapt to the new economic situation. This paper introduces the development status of green building at home and abroad, analyzes the problems in the development of green building in China, and puts forward the strategies to promote the development of green building, explore the new opportunities for the development of green building in China, in order to provide new ideas and inspiration for the development of green building in China.

1. The introduction
Under the "new normal" of economic development, the construction industry has shown new development characteristics: in terms of speed, the output value of the construction industry has decreased from the average increase of more than 20% in the "eleventh five-year plan" report to between 10% and 15%. In the previous stage, the growth brought by policy stimulus has been digested, and the construction industry has shifted from high-speed growth to low and medium-speed growth. In terms of structure, the slowdown of economic growth has forced the construction industry to constantly adjust and transform, constantly change the mode of production, and gradually rise of new construction industrialization. The structure of the construction industry will accelerate the optimization and upgrading. In terms of power, affected by the rising labor, resource and environmental costs, the vitality of the development mode driven by low factor costs continues to decline, and technological innovation will become the driving force for the development of the construction industry. The construction industry is shifting from factor-driven, investment-driven to innovation-driven. In addition, with the improvement of the living standard of residents, the human demand for housing is further expanded. According to incomplete statistics, in the world, building energy consumption accounts for 45% of total energy consumption, and carbon dioxide emissions account for 35%. The exploitation of drinking water accounts for 80%, and the consumption of raw materials and resources accounts for 50%. The main reasons for consumption include unreasonable design, construction and use of buildings. To realize the sustainable development of the construction industry, green building is the only way out. With the increasing appeal of environmental protection, urbanites are more and more eager to live in harmony with nature. Housing is the most closely related form of architecture, and the sustainable development of architecture has attracted more and more attention from relevant experts and scholars.
2. Development status at home and abroad

The exploration of green building in developed countries is earlier than that in China, and the evaluation standard of green building is constantly improved. In 2013, the U.S. green building council revised the LEED green building assessment system. The new LEED details are constantly improved and the content and structure are more reasonable, which further improves the application scope of LEED evaluation system. The British construction industry is developing rapidly and is recognized as the most open construction market in Europe. The UK government has proposed a climate change bill that would cut carbon dioxide emissions by 26 to 32 per cent by 2020 and 60 per cent by 2050. Energy conservation and environmental protection have become the political fashion in Britain. Germany's mandatory legislation and financial incentives are combined to promote energy conservation and environmental protection.

In May 2005, the ministry of housing and urban-rural development issued the guideline on the development of energy-saving, land-saving housing and public buildings, pointing out that "new concepts and technologies such as green building, ecological building and sustainable building, which are increasingly popular abroad, have been actively introduced and popularized", and green building has begun to attract attention in China. In August 2007, "regulations on the management of green building evaluation marks (trial)" was issued to guide the healthy development of green buildings with standardized label management. In January 2013, the general office of the state council forwarded the green building action plan formulated by the national development and reform commission and the ministry of housing and urban-rural development on the basis of no. 1 [2013] issued by the state council, which clearly proposed to complete the quantitative development target of 1 billion m2 of new green buildings during the 12th five-year plan period. In February 2017, the ministry of housing and urban-rural development issued the 13th five-year plan for building energy conservation and green building development, which set the development goal of "green building area accounting for more than 50% of new urban buildings by 2020". In June 2018, the central committee of the communist party of China (CPC) and the state council issued the opinions on comprehensively strengthening ecological and environmental protection and resolutely fighting pollution prevention and control, proposing to "promote the formation of a green development mode and lifestyle, encourage the use of green building materials in new buildings and increase the proportion of new green buildings".

At the same time, Beijing, Shanghai, Tianjin, Shenzhen and other provinces and cities have also formulated green building policy system, Jiangsu, Guizhou, Zhejiang and other provinces and cities have promulgated the "green building development regulations", in the form of local legislation to force the development of green building; many provinces and cities have also established relevant incentive subsidy policies. The construction of green building policies and regulations presents a policy atmosphere of multi-level linkage between the central and local governments, compulsion and incentive.

According to the data, by the end of 2017, more than 9,400 construction projects in China have been awarded the green building evaluation mark. The figure below shows the number of green building evaluation projects from 2008 to 2017.

![Fig. 1 2008-2017 Chinese green building quantity](image-url)
3. Problems existing in the development of green buildings in China

3.1 Lack of green concept in the construction process
The local practice of green building technology is less, and the implementation process and operation efficiency are not good. There are some gimmicks and forms in the market, and the tendency of technology piling up blindly. The core of green building is to adapt measures to local conditions, pay more attention to the use of natural conditions to adopt appropriate technology so as to achieve energy saving, ecological and environmental protection, human and nature, building harmonious symbiosis effect. However, some projects in the market make excessive use of a large number of energy-saving high and new technologies and equipment piling up, use less passive technology, and use more active technology measures, which not only causes high investment costs, but also brings a lot of unnecessary energy consumption waste of energy-saving equipment operation.

3.2 Green building industry has not been industrialized
Due to the late start of green building in China, most green building projects have not been tested in the operation process. At present, more than 80% of China's green building projects are concentrated in the design stage, while there are few green building projects in the operation stage. Moreover, the green building consulting service market is not yet perfect, and the consulting agencies lack the qualification and ability of green building service. In addition, the construction industry lacks evaluation standards for the economic benefits, social and environmental benefits of green buildings, resulting in low investment enthusiasm for green buildings. Since the green building market has not yet been established, China's green building construction still relies on the government's policy preference and lacks market-driven operation mechanism.

3.3 Lack of a complete system of standards and specifications
The basic research on green building in China started 15 years later than that in the world. Although China has made some progress in building energy saving, the overall consumption is still relatively large, which is mainly reflected in the average energy consumption in heating period and the average standard coal consumption in heating period. Based on this situation, China has put forward the three-stage building energy saving targets of 30%, 50% and 65%.

| Energy saving phase | Exterior wall (W/m²°C) | Outside the window (W/m²°C) | The roof (W/m²°C) | Average energy consumption during heating period (W/m²) | Average standard coal consumption during heating period (kg/m²) | Boiler efficiency | The efficiency of heat supply network |
|---------------------|------------------------|-----------------------------|-------------------|--------------------------------------------------------|---------------------------------------------------------------|-----------------|-----------------------------------|
| Boilers efficiency  | 35%                    | 55%                         | 65%               | 75%                                                    | 85%                                                           | 55%             | 75%                               |
| Stage 1 (30% energy saving) | 1.28                   | 6.4                         | 1.26              | 31.5                                                   | 23.7                                                          | 60%             | 90%                               |
| Stage 2 (50% energy saving) | 1.16                   | 4.0                         | 0.8               | 25.3                                                   | 16.6                                                          | 68%             | 90%                               |
| Phase III (65% energy saving) | 0.8                    | 3.0                         | 0.5               | 15.8                                                   | 8.3                                                           | 74%             | 90%                               |
| The British         | 0.35                   | 2.0                         | 0.16              |                                                        |                                                               |                 |                                   |
| Germany             | 0.2 to 0.3             | 1.5                         | 0.2               |                                                        |                                                               |                 |                                   |
| The United States   | 0.32 to 0.4            | 2.04                        | 0.19              |                                                        |                                                               |                 |                                   |

Further comparison of building energy consumption between China and foreign countries shows that although China's building "insulation level needs to be improved", China's unit building energy...
consumption and per capita building energy consumption is not high.

After comparing the data, it can be known that the building energy consumption index is related to people's pursuit of comfort. For example, in the United States, there are more people living in villas, while in China, there are more people living in assembly houses. The size coefficient of villas is 2 to 3 times larger than that of apartment buildings, and their test level, heating cycle and ventilation volume are different, so their overall energy consumption is high. Therefore, there are differences in building energy conservation goals between China and foreign countries. Developed countries pursue a higher comfort level, so the overall energy consumption is higher. China's overall energy consumption is not high, but the comfort level is not high, so the evaluation of China's building energy consumption standards, cannot directly borrow the international evaluation standards and norms, need to adapt to local conditions, develop green building standards in line with China's construction industry.

4. Strategies to promote the development of green buildings in China

4.1 Change the construction mode

In the process of leading the development of green buildings, we should not only inherit the excellent architectural mode of traditional buildings, but also actively integrate new green concepts. China's green building development must follow the development path of technology localization, constantly develop new technologies, and gradually introduce international advanced technologies into China's unique green building development process. However, we should not only rely on high and new technologies, but also carry out innovation and reform according to actual development needs and select appropriate and effective green building technologies. The development of green building is bound to affect the development of traditional construction industry. Construction personnel are transferred from the open air construction site to factories, and a large number of construction workers
are transferred to industrial bases to become industrial workers, and the production of prefabricated components for prefabricated buildings. Industrialization and greening must become the new direction of construction mode transformation.

4.2 Improve the industrial chain of green building
The most fundamental way to develop China's green building industry is to form a corresponding industrial chain for the green building industry and save resources while saving resources. The construction of green building industrial chain can refer to China's real estate industrial chain. Firstly, we should study the market situation and promote the concept of green building. On the technical level, a large amount of capital needs to be invested in the early stage. After capital improves the technology, the profit margin will also increase, which is also a good investment. The technical methods here include wall energy saving Windows and doors energy saving system, artificial wetland system, rainwater collection and utilization system, etc. The higher the integration degree of green technology, the higher the positioning level of green building. In this way, low cost requirements can be achieved, so as to provide more profit space for the relevant industrial chain. If the later management can keep up, the maintenance and construction costs can be reduced to a considerable extent, so as to achieve the unity of social benefits and economic benefits.

4.3 Improve technical specifications and intensify publicity
The development of green buildings may be affected by economic, technological and regulatory aspects. Therefore, it is suggested that the government formulate relevant regulations to support the sustainable development of green buildings. At the same time, green building industry associations and enterprises publicize, popularize the concept of clean energy and green energy and utilization mode, let the concept of green building infiltrate into the public psychology. In terms of energy saving, emission reduction and the use of environment-friendly materials, relevant technical specifications should be improved from various aspects to establish and improve the green building safety system. Although China's green building development is faced with many difficulties, under the new normal of economy, the construction industry, as the main component of China's national economy, has to carry out the self-revolution of the industry. Therefore, there are some new opportunities for the development of green building.

5. Opportunities and prospects of green building development

5.1 Development opportunities

5.1.1 Green development has become a long-term goal
At the 19th national congress of the communist party of China (CPC), China formally decided to take green development as its long-term goal and stick to the general secretary's concept of "strengthening institutional reform for ecological progress and building a better China". Take the road of sustainable development. The main activity is to establish green production and life style, which is inseparable from green building. According to the statistics of the European Union institute of architects, carbon emissions, energy consumption and material consumption during the whole life cycle of buildings account for 40% of the total social pollutants, and these pollutants and consumption account for 50% of the environmental impact on human beings. According to the policies and guidelines put forward at the 19th national congress, the green building industry will be heavily favored by policies, and the green building industry will usher in a huge space for development.

5.1.2 Establishment of China's carbon market
Under the guidance of general secretary Xi Jinping, the national development and reform commission and various ministries and commissions announced the establishment of a carbon market with Chinese characteristics. It means China's firm attitude towards energy conservation, emission reduction and
climate change. In the previous Kyoto protocol, the international market has established carbon market and its management mechanism. Due to the rapid development of China's economy, 85% of carbon market transactions are conducted by Chinese companies, which is extremely inappropriate for China's current development situation. In the carbon trading market with Chinese characteristics, we can control carbon emissions at a reasonable price according to the timing. This means that China's green building industry can conduct reasonable carbon trading, which provides a strong economic support for China to vigorously develop green building.

5.1.3 Fight for the protection of blue sky and white clouds.
At the National Economic Work Conference, General Secretary Xi clearly stated that we have to fight three hard battles, one of which is the battle for environmental protection against the blue sky and white clouds. At the work conference, xi stressed that the key to winning the battle for environmental protection lies in how to solve the problem of building new energy cities. New energy cities want to shift their energy consumption from coal to clean sources like electricity and natural gas. China is a country with less coal, less natural gas and less oil, among which the external dependence of natural gas reaches 40%. If the construction industry can reduce the consumption of natural gas in buildings, it will be critical for us to win this battle. This also provides a lot of opportunities for the development of green building.

Therefore, the important decisions of the three major party central committees have given our green building a good track of rapid development, and also brought new opportunities for the rapid development of green building industry.

5.2 Future direction outlook

5.2.1 Regional development of green buildings
At present, many cities in China have put forward the goal of 100% green building standard for new buildings. The centralized and continuous promotion of green building promotes the comprehensive development of regional green industry and promotes the extension of green building to "green ecological city". On the basis of the green development of individual buildings, regional green development should be realized by optimizing urban spatial layout, urban planning, building and operating urban infrastructure, low-carbon transportation, ecological system and industrial development.

5.2.2 Industrial development of green buildings
Building industrialization is significant changes to the way the building, is the important measure of construction industry transformation and upgrading, the current our country "the green building evaluation standard" (GB/T50378-2014), also contains the building industrialization development related provisions, to encourage green building steel structure and wood structure, the overall prefabricated hutch defends, energy saving, saving material and saving land. With the continuous development of building industrialization in China, there will be more and more integration points between green building and building industrialization. The mutual promotion of green building and building industrialization will help the building develop towards a safer, more economical and lower carbon direction, which is one of the important directions of building development at present.

5.2.3 Intelligent development of green buildings
In the future, green buildings should have more humanized architectural service schemes and better living experience. The development of intelligent green buildings is of great significance for the implementation of the "people-oriented" green concept and the coordinated development of people, buildings and the environment. With the gradual deepening of the concept of smart city in the newly built urban areas, the gradual popularization of smart and information technology means, smart green building has an important development prospect.
5.2.4 Healthy development of green buildings
Healthy building is an important component unit of urbanization construction in response to the construction of healthy China and one of the ways for people to pursue a healthy life. At present, air pollution, water pollution and aging are prominent. Health on the basis of the green building construction, for indoor and outdoor environment, health, humanities, etc to give more and more intensive attention, relative to the green building, increase the building and human interaction, construction to better provide service for residents, guide the construction to realize self regulating and self growth, promote construction to a higher quality improvement.

6. Conclusion
Although the development of green building in China is faced with problems such as late start, incomplete industrial chain and insufficient experience, the self-revolution of the construction industry is imperative under the new normal economy. As the direction of the development of the construction industry in the future, green building has ushered in unprecedented development opportunities. Through the rational use of policies, the understanding of green building is constantly strengthened. Green building will gradually become market-oriented and large-scale, and more and more green building will greatly improve our living environment.

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