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ANALYSIS ON THE CURRENT STATUS AND INFLUENCING FACTORS OF BUILDING ENERGY CONSUMPTION IN CHINA

Based on the current status of building energy consumption in China, this paper analyses the main influencing factors of building energy consumption and explores strategies and measures to reduce building energy consumption. Through literature review and data analysis, the study found that due to the accelerated level of social and economic development, the total energy consumption of China's buildings has continued to grow. After the country raised energy-saving standards and adopted energy-saving technologies, the energy intensity showed a downward trend. China has a vast territory, with significant climate differences between the east, west, south and north, and the energy demand for heating in winter and cooling in summer is different. The main influencing factors of building energy consumption include the level of economic development. Building energy consumption is positively correlated with the level of economic development, but the growth rate of energy consumption is often lower than the economic growth rate, which reflects the effect of technological progress and energy-saving measures. Population size and urbanization. China's continuously growing population size and rapid urbanization process have led to the continuous expansion of building scale and the continuous increase in building energy demand. Climate conditions. The northern region is cold in winter, and heating energy consumption accounts for a large proportion of building energy consumption; while the southern region is hot in summer, and cooling energy consumption is relatively high. Building scale and structure. The size of the building and the building structure system have a direct impact on energy consumption. The larger the building area, the higher the total energy consumption. There are also energy-consuming equipment and technology. The promotion and application of energy-consuming equipment has significantly reduced building energy consumption. Through the above analysis, measures to improve energy efficiency are proposed, such as improving the policy and regulatory system, promoting energy-saving technologies and products, optimizing building design and construction, and strengthening operation management and maintenance. The research results can provide a reference for the formulation of building energy-saving policies and measures.

Keywords: *China; building energy consumption; current situation analysis; influencing factors.*

General statement. With the rapid development of China's economy and the acceleration of urbanization, the proportion of building energy consumption in the total

social energy consumption has continued to rise, and has become an important factor affecting national energy security and sustainable development. Building energy consumption is not only related to the effective use of energy resources, but also closely related to global issues such as environmental protection and climate change. Therefore, in-depth research on the current status of China's building energy consumption and its influencing factors is of great significance for the formulation of effective energy-saving policies and measures.

Analysis of recent studies and publications. Li, L., Wang, Y., Wang, M., Hu, W., Sun, Y. (2021)^[1] conducted an analysis of factors affecting energy consumption is very important for saving energy and reducing consumption in residential buildings. Existing research on this matter lacks an analysis of multiple interacting factors and has not solved the problem of high energy consumption. Chen, Y., Ren, Z., Peng, Z., Yang, J., Chen, Z., Deng, Z. (2023)^[2] facing global warming, the construction industry, as one of the main sources of carbon emissions, is facing challenges. Assessing the changes in urban building energy consumption and the potential for energy savings is crucial. Vandenbogaerde, L., Verbeke, S., Audenaert, A. (2023)^[3] the review examines energy savings reported in the literature, encompassing field studies and dynamic energy performance simulations, to assess the validity of EN 52120-1's proposed factors. Guo, S., Yan, D., Hu, S., Zhang, Y. (2021)^[4]: building energy use is becoming increasingly important in China. Despite a rapid growth in recent years, energy use intensity in China is still relatively low compared to other advanced economies. Therefore, in-depth research on China's building barbecue stoves and their influencing factors is of great significance for formulating effective energy-saving policies and measures. González-Torres, M., Pérez-Lombard, L., Coronel, J.F., Maestre, I.R., Yan, D. (2022)^[5]: however, energy use in buildings will only curb if global cooperation enables developing nations to break the link between economic growth, urbanisation and consumption. Ma, Z., Yan, Z., He, M., Zhao, H., Song, J. (2025)^[6]: against the backdrop of factors influencing building operation energy consumption, we reviewed the advancements in research pertaining to the supervision and prediction of building energy consumption, deliberated on more energy-efficient and low-carbon strategies for buildings within the dual-carbon context, and synthesized the relevant research progress across four dimensions: the contemporary state of building energy consumption supervision, the determinants of building operation energy consumption, and the prediction and optimization of building energy consumption. Chen, Y., Wu, Y., Chen, N., Kang, C., Du, J., Luo, C. (2022)^[7]: the type of energy used in the construction process has the greatest degree of influence on energy consumption and carbon emission, and the local GDP, population factor, construction machinery performance specifications, and shift usage also show a positive correlation with the growth of total energy consumption and carbon emissions. Ding, Y., Xiang, Y., He, Y. (2024)^[8]: a working method is proposed, and the effects of building factors and usage characteristics are considered accounting for different energy usage patterns in residential buildings. Wen, L., Cao, Y. (2020)^[9]: to predict the trend of residential energy-related CO₂ emissions accurately, it is significant to analyze the influential factors. Olu-Ajayi, R., Alaka, H., Egwim, C., Grishikashvili, K. (2024)^[10]: a prerequisite for decreasing the intensification of energy in buildings is to evaluate and understand the influencing factors of building energy performance (BEP). These factors include building envelope features and outdoor climatic conditions, among others. Wu, J., Chen, S., Ying, X., Shu, J. (2023)^[11]: a prerequisite for decreasing the intensification of energy in buildings is to evaluate and understand the influencing factors of building energy performance

(BEP). These factors include building envelope features and outdoor climatic conditions, among others. Jiao, L., Rong, X. (2022)^[12]: as commercial transportation complexes, expressway service buildings have large passenger flow and a poor energy-saving effect, and have become the focus of energy conservation and emissions reduction efforts in the transportation field. At the same time, the particularity of the function determines that it is within the scope of no municipal supporting facilities, which renders them typical energy island-type buildings. Based on the above analysis, a low energy consumption operation strategy for the air-conditioning system is proposed.

The purpose of this study. This paper aims to analyze the current status of building energy consumption in China, explore the main factors affecting building energy consumption, and propose corresponding energy-saving strategies. The study adopts a combination of literature review and data analysis to systematically sort out the overall situation, changing trends and regional differences of building energy consumption in China, and analyzes the key factors affecting building energy consumption from multiple perspectives such as economic development, population, climate, building characteristics and technology. Finally, based on the analysis results, strategies and measures to reduce building energy consumption are proposed, in order to provide reference and reference for promoting building energy conservation in China^[6].

Methods and instruments of this study. This paper adopts the literature research method, through systematically arranging and analyzing the existing literature materials, forming screening literature, conducting induction, comparison or critical analysis, summarizing the research status and development trend of China's architectural yarn, discovering the deficiencies, and conducting a literature review.

The main research results.

Current status of building energy consumption in China

(1) Total building energy consumption

The total building energy consumption in China has been growing continuously. According to relevant statistics, in recent years, the proportion of building energy consumption in China's total social energy consumption has exceeded 20%, and this proportion is still rising (as shown in Figure 1). The growth of building energy consumption is mainly driven by economic development, accelerated urbanization, and improved living standards^[7].

From the above analysis, it can be seen that due to the acceleration of urbanization, building energy consumption continues to increase. In 2019, green buildings and energy-saving renovations were gradually promoted, but the total energy consumption is still growing. In 2020, under the influence of the epidemic, residential energy consumption increased, while public building energy consumption decreased. In 2022, building energy-saving policies continued to be promoted, but urbanization and improved living standards still promoted energy consumption growth. As of October 2023, detailed statistics on China's building energy consumption have not been fully disclosed, but according to recent trends, building energy consumption accounts for about 20%-30% of the country's total energy consumption, and is on an upward trend^[8].

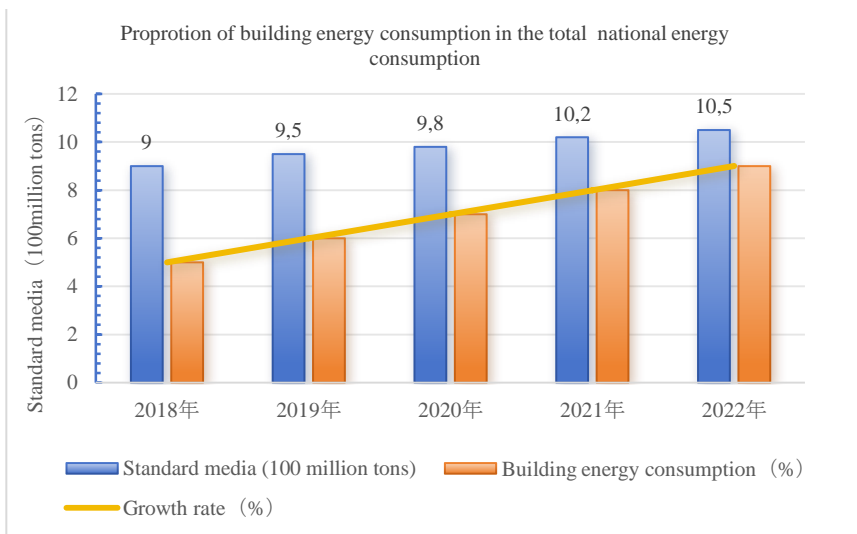


Figure 1. Building energy consumption proportion

With the increase of urban population and the expansion of building scale, the demand for building energy continues to rise. my country's building energy consumption is mainly composed of the following parts: public building energy consumption accounts for about 30%-35%, including office buildings, shopping malls, hotels, etc. Residential building energy consumption accounts for about 50%-55%, mainly residential buildings. Industrial building energy consumption accounts for about 10%-15%, including factories, warehouses, etc. (as shown in Figure 2)^[9].

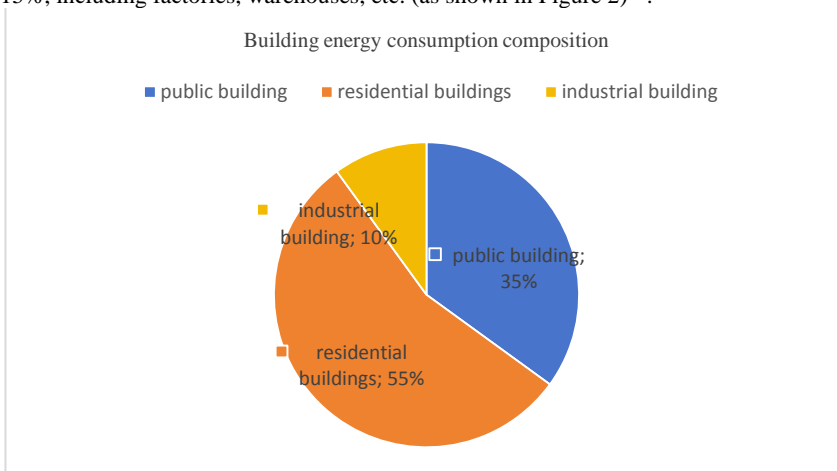


Figure 2. Building energy consumption composition

Although the total amount of building energy consumption continues to increase, the energy intensity of Chinese buildings has shown a downward trend, as shown in Figure 3). This is mainly due to the promotion and application of energy-saving technologies and the continuous improvement of building energy-saving standards. Through measures such as implementing building energy-saving renovation, promoting high-efficiency energy-using equipment, and optimizing building envelope structures, the energy consumption per unit building area has gradually decreased. However, compared with developed countries, China's building energy intensity is still at a relatively high level, and there is huge potential for energy saving^[10].

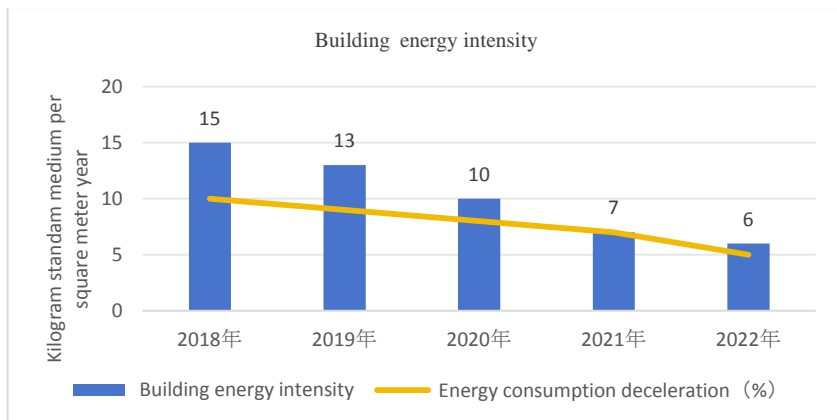


Figure 3. Building energy intensity

(2) Regional differences in building energy consumption

China is mainly affected by factors such as geographical location, topography and monsoon, with significant climate differences and diverse types. There are obvious differences from south to north and from east to west. The eastern monsoon climate is significant, the northwest is dry, and the Qinghai-Tibet Plateau is a plateau mountain climate. First, the northern region is cold in winter, the heating demand is large, and the building energy consumption is high, especially in the centralized heating area. The southern region is hot in summer, air conditioning is frequently used, and the cooling energy consumption is large, as shown in Figure 4. Secondly, in terms of energy structure, the northern region relies on traditional energy such as coal, and the building energy consumption is high and the carbon emissions are large. The southern region uses more electricity, and the energy structure is relatively clean, but the demand for electricity is large^[11].

Thirdly, in terms of building types and usage patterns, urban areas have many high-rise buildings and commercial complexes, and energy consumption is concentrated in heating, cooling, lighting, etc.; rural areas are mainly low-rise residential areas, and energy consumption is mainly used for heating and daily electricity use. The total amount is low but the energy efficiency is poor^[12].



Figure 4. China's architectural climate zoning map

According to relevant statistics, heating energy consumption in the northern region accounts for more than 50% of the total building energy consumption. Cooling energy consumption in the southern region accounts for 30%-40% of the total building energy consumption. Nationwide, building energy consumption accounts for 20%-30% of the total national energy consumption, and is on an upward trend. This regional difference reflects the significant impact of factors such as economic development level and climate conditions on building energy consumption^[13].

Main factors affecting building energy consumption

(1) Economic development level The level of local economic development is an important factor affecting building energy consumption. With the increase of per capita GDP, people's requirements for building environmental comfort continue to increase, leading to an increase in building energy demand. At the same time, economic development has also led to the expansion of building scale and the complexity of building functions, further increasing building energy consumption. For example, the eastern coastal areas have a developed economy, high building density, many commercial and public buildings, and a large total energy consumption. The central and western regions have a relatively backward economy, low building density, and a small total energy consumption, but a faster growth rate. Studies have shown that building energy consumption is positively correlated with the level of economic development, but the growth rate of energy consumption is often lower than the economic growth rate, which reflects the effects of technological progress and energy-saving measures^[14].

(2) Population size and urbanization process China's continuously growing population and rapid urbanization have led to the continuous expansion of building scale and the continuous increase in building energy demand. The concentrated living pattern of urban population has improved the energy efficiency of buildings, but it has also increased the pressure on energy infrastructure. For example, in rapidly urbanizing areas, building

energy consumption has increased rapidly, there are many new buildings, and energy-saving technologies are widely used. In areas with slower urbanization, building energy consumption has increased steadily, there are many old buildings, and there is a great demand for energy-saving renovation. In addition, urbanization has also brought about changes in lifestyle, which further affects the structure and total amount of building energy consumption.

(3) Climate conditions China has a vast territory and significant climate differences in different regions, which directly affects the heating and cooling needs of buildings. The northern region is cold in winter, and heating energy consumption accounts for a large proportion of building energy consumption; while the southern region is hot in summer, and cooling energy consumption is relatively high. In addition, climate conditions also affect the design of building envelopes and the selection of energy-consuming equipment, thereby indirectly affecting building energy consumption.

(4) Building scale and structural characteristics The size of the building and the building structure system have a direct impact on energy consumption. The larger the building area, the higher the total energy consumption. Building structural characteristics, such as building height, shape coefficient, window-to-wall ratio, etc., will affect the lighting, ventilation and thermal performance of the building, thereby affecting energy consumption. In addition, the type of building function (such as residential, office, commercial, etc.) will also lead to differences in energy consumption characteristics. For example, in urban areas, there are many high-rise buildings and commercial complexes, and energy consumption is concentrated in heating, cooling, lighting, etc. In rural areas, low-rise residential buildings are the main ones, and energy consumption is mainly used for heating and daily electricity consumption. The total amount is low but the energy efficiency is poor.

(5) Energy-using equipment and technology level Energy-using equipment and technology level are key factors affecting building energy consumption. With technological progress, high-efficiency energy-saving equipment continues to emerge, such as LED lighting, high-efficiency air-conditioning systems, intelligent control systems, etc. The promotion and application of these equipment has significantly reduced building energy consumption. At the same time, the application of building energy management systems has also improved building energy efficiency. However, there is still room for improvement in the overall energy efficiency level of China's building energy-using equipment, especially in the renovation of existing buildings and buildings in rural areas, the application of energy-saving technologies still needs to be strengthened.

Strategies and measures to reduce building energy consumption

(1) Improve policies and regulations Improving the policy and regulatory system is an important guarantee for promoting building energy conservation. The government should continue to improve building energy conservation laws and regulations, formulate more stringent building energy efficiency standards, and strengthen supervision and law enforcement. At the same time, a sound building energy conservation incentive mechanism should be established to encourage the research and development and application of building energy conservation technologies through policies such as financial subsidies and tax incentives. In addition, the construction of building energy consumption statistics and monitoring systems should be strengthened to provide data support for the formulation of scientific and reasonable energy conservation policies.

(2) Promote energy-saving technologies and products With the development of science and technology, energy-saving technologies and energy-saving products continue to emerge. Vigorously promoting the application of energy-saving products is the key to reducing building energy consumption. Such as efficient enclosure structures, energy-saving doors and windows, efficient heating and cooling systems, LED lighting and other energy-saving technologies and products. At the same time, we should actively promote the application of renewable energy in buildings, such as solar photovoltaics, ground source heat pumps and other technologies. In new buildings, energy-saving standards should be enforced; in the renovation of existing buildings, advanced energy-saving technologies should be encouraged. In addition, we should strengthen the research and development and innovation of energy-saving technologies and continuously improve the level of building energy-saving technologies.

(3) Optimize building design and construction In the entire life cycle of a construction project, the design stage plays a decisive role. Optimizing building design is the basis for reducing building energy consumption. In the building design stage, full consideration should be given to local climate conditions, and passive design strategies should be adopted, such as optimizing building orientation, using natural ventilation and lighting, etc., to reduce building energy demand. In the construction stage, the construction quality of the building envelope should be strictly controlled to ensure that the thermal insulation performance meets the design requirements. At the same time, green construction technology should be promoted to reduce energy consumption and environmental pollution during the construction process. In addition, attention should be paid to energy consumption management throughout the life cycle of the building, and energy-saving measures should be considered from design, construction to operation and maintenance.

(4) Strengthen operation management and maintenance During the operation phase of construction projects, strengthening operation management and maintenance is an important part of continuously reducing building energy consumption. A sound building energy management system should be established and refined energy management should be implemented. The building energy management system should be promoted to monitor and analyze building energy consumption data in real time, and timely discover and solve energy waste problems. Strengthen the maintenance of building energy-using equipment to ensure efficient operation of the equipment. At the same time, the energy-saving awareness of building users should be improved, and energy-saving behaviors should be encouraged, such as reasonably setting indoor temperature and making full use of natural light. For large public buildings, energy audits and energy efficiency benchmarking should be implemented to continuously improve energy management.

Conclusion

By analyzing the current status of building energy consumption in China and its influencing factors, this study draws the following conclusions: China's total building energy consumption continues to grow, but the energy intensity shows a downward trend, with significant regional differences. Economic development level, population size and urbanization, climate conditions, building scale and structure, energy-using equipment and technology are the main factors affecting building energy consumption. In order to reduce building energy consumption, it is necessary to take comprehensive measures from the aspects of improving the policy and regulatory system, promoting energy-saving technologies and products, optimizing building design and construction, and strengthening

operation management and maintenance.

In the future, China's building energy conservation work will still face many challenges, such as the difficulty of energy-saving renovation of existing buildings and the low energy-saving level of rural buildings. It is recommended to further strengthen the innovation of building energy-saving technology, improve the building energy-saving policy system, enhance the energy-saving awareness of the whole society, and promote the in-depth development of building energy-saving work. At the same time, attention should be paid to the coordinated governance of building energy conservation, environmental protection and climate change, and contribute to the realization of sustainable development goals.

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Чен ЮЛОНГ, Алла МОРГУН

Аналіз поточного стану та факторів впливу на енергоспоживання будівель у Китаї

Базуючись на поточному стані споживання енергії будівлею в Китаї, у цій статті аналізуються основні фактори впливу на споживання енергії будівлею та досліджуються стратегії та заходи щодо зменшення споживання енергії будівлею. Завдяки огляду літератури та аналізу даних дослідження показало, що через прискорений рівень соціального та економічного розвитку загальне споживання енергії в будівлях Китаю продовжує зростати. Після підвищення в країні стандартів енергозбереження та впровадження енергозберігаючих технологій інтенсивність енергоспоживання показала тенденцію до зниження. Китай має величезну територію зі значними кліматичними відмінностями між сходом, заходом, півднем і північчю, і потреби в споживанні енергії для опалення взимку та охолодження влітку також різні. До основних факторів, що впливають на енергоспоживання будівель, відноситься рівень економічного розвитку. Енергоспоживання будівель позитивно корелює з рівнем економічного розвитку, але темпи зростання споживання енергії часто нижчі за темпи економічного зростання, що відображає вплив технічного прогресу та заходів з енергозбереження. Чисельність населення та урбанізація. Чисельність населення Китаю, що постійно зростає, і процес урбанізації, що швидко розвивається, призвели до постійного розширення масштабів будівництва та постійного збільшення попиту на енергію для будівель. Кліматичні умови: зима на півночі Китаю холодна, і споживання енергії на опалення становить велику частку споживання енергії будівлею; Південний регіон має спекотне літо та високе споживання енергії на охолодження. Масштаб і структура будівлі, масштаб будівлі та система будівельних конструкцій безпосередньо впливають на споживання енергії. Чим більша площа будівлі, тим вище загальне споживання енергії. Є також енерговитратне обладнання та технології. Просування та застосування енергоспоживаючого обладнання дозволило значно знизити енергоспоживання будівлі. За допомогою вищезазначеного аналізу пропонуються заходи щодо підвищення енергоефективності, включаючи вдосконалення політики та системи регулювання, просування енергозберігаючих технологій і продуктів, оптимізацію проектування та будівництва будівель, а також посилення управління експлуатацією та технічного обслуговування. Результати дослідження можуть бути джерелом для формулювання політики та заходів з енергозбереження будівель.

Ключові слова: *Китай; енергоспоживання будівлі; аналіз поточної ситуації; фактори впливу.*