Energy consumption analysis and growth trend prediction of green energy saving buildings

Shan Liu*
School of Architecture and Art Design, Xi'an Peihua University, Xi'an, China
*Corresponding author e-mail: ls@peihua.edu.cn

Abstract. With economic development and technological progress, energy issues have become a key issue of world-wide concern. In energy consumption, building energy consumption accounts for a relatively high proportion. Therefore, the development of green buildings cannot be delayed. In this context, this paper analyzes the energy consumption of green energy-saving buildings and predicts their growth trend, which intuitively reflects the necessity of the development of green energy-saving buildings and helps promote the development of green energy conservation in the construction industry.

Keywords: green energy-saving building; energy consumption analysis; growth trend.

1. Introduction
China's building energy consumption accounts for more than 33% of the total national energy consumption, and the proportion of the total building energy consumption in the total social energy consumption is increasing year by year, and the society is paying more and more attention to the building energy consumption. Therefore, building energy conservation, the focus of our work is to reduce building energy consumption and improve building energy efficiency. Building energy saving refers to the economic activities of reducing energy consumption and providing services and management while ensuring the use function and indoor environmental quality of buildings. As an important symbol of the progress of building technology, building energy saving is an important part of the sustainable development strategy of the construction industry. The development of green energy-saving buildings becomes urgent. This paper analyzes the energy consumption of green energy-saving buildings and forecasts its growth trend, which is of great significance for the development and improvement of green energy-saving buildings.

2. Green ecological infrastructure and ecological optimization application
The concept of green building was introduced to China in the 1990s [1]. Due to economic constraints, the development of green energy-saving buildings in China started late, and the scale of industrial development was small, which led to the development of green energy-saving buildings in construction it's not valued in the industry. Although in recent years, we began to pay attention to the development of green energy-saving buildings, but there are still very serious problems in its development process [2].
2.1. There are deviations in understanding green energy-saving buildings
As an advanced architectural concept, green energy-saving building can not only provide a good living environment, but also achieve resource conservation, so that people and nature can get along peacefully. However, people's views on green and energy-saving buildings, there are cognitive biases in the concept, and due to the limitation of development, we are lack of experience in this field. Some people think that green energy-saving building is the use of high-tech, environmental protection and energy-saving materials in the process of engineering construction, which will lead to the increase of construction cost and low practicability and value. Therefore, people's acceptance of green energy-saving buildings is not high, which leads to the limitations of the development of green energy-saving buildings. Driven by interests, some developers vigorously publicize the green and environmental protection of their buildings in order to attract the interest of high consumers. However, they did not use green building materials in their projects, nor did they take any energy-saving measures, which failed to meet the standards and effects of green energy-saving buildings. Although the government has provided enough space and support for the promotion and application of green energy-saving buildings, the architectural designers did not integrate green energy-saving into the design due to the deviation of concept and insufficient understanding, which limited the promotion of green energy-saving building concept.

2.2. Green energy-saving building recognition is not high
The use of green energy-saving technology in building design will increase the cost of building, for profit-making developers, the profit will be reduced, therefore, green energy-saving technology in the architectural design will be limited. Another in addition, the current housing price is in a higher growth stage, and with the increase of people's demand, the real estate market is still in the stage of short supply, leading developers only pay attention to the immediate interests, ignoring the quality of housing and the development of green energy-saving buildings. From the perspective of buyers, the purchase cost of green energy-saving buildings is obviously higher than that of ordinary buildings. Although the state has corresponding subsidies when purchasing green energy-saving buildings, it is still far from offsetting the additional costs. Therefore, from the perspective of demanders, green energy-saving buildings are not enough to attract consumers, which makes it difficult to promote them in the market.

3. Energy consumption analysis of green energy saving buildings
Energy consumption analysis of green building refers to the calculation and analysis of energy consumption in the operation process of green building, obtaining the energy consumption situation of the whole green building, mastering the energy consumption characteristics of the building, and providing important guidance for the design, transformation and operation management of green energy-saving buildings [3].

3.1. Analysis on heating energy consumption of green energy saving buildings
For buildings in heating areas, the proportion of heating energy consumption is large, and the heating energy consumption of residential buildings is different due to different energy-saving design standards. Table 1 shows the heating energy consumption of civil buildings with different energy-saving design standards.
Table 1. Heating energy consumption of civil buildings with different energy-saving design standards

| Energy consumption index | Types of civil buildings |
|--------------------------|-------------------------|
|                         | Non energy saving | One step energy saving | Two step energy saving | Three step energy saving | Four step energy saving |
| Heat consumption index   | 31.68               | 25.3                   | 20.6                   | 14.65                   | 8.5                    |
| W/㎡                     |                      |                       |                       |                         |                        |
| Coal consumption index   | 25.17               | 17.4                   | 12.4                   | 8.82                    | 6.3                    |
| kgce/(㎡·a)              |                      |                       |                       |                         |                        |

In the design of green energy-saving buildings, due to the different standards of building energy-saving design between developers and designers, there are a variety of green energy-saving buildings with energy-saving standards. From table 1, it can be seen that the heating of green energy-saving buildings, the energy consumption is obviously less than that of non energy saving buildings. Compared with more advanced energy-saving buildings, one-step energy-saving buildings obviously adopt less energy-saving design and less application of energy-saving materials. However, compared with non-energy-saving buildings, its energy-saving index is still high. The heat consumption per square meter can be saved by 6.35W, while the four-step energy-saving building can save heat consumption of 23.18W per square meter. In terms of coal index, the coal consumption per unit building area of one-step energy-saving buildings is 17.4 kgce, which is 7.77 kgce less than that of non energy-saving buildings, while the coal consumption per unit building area of four-step energy-saving buildings is 6.3 kgce, which is 18.87 kgce less than that of non energy-saving buildings. Obviously, the four step energy-saving building will save a lot of heat and coal consumption per unit area, and the energy consumption saved is almost equal to that of one-step energy-saving building.

Through the above analysis, it can be concluded that the energy consumption of green energy-saving buildings is obviously much lower than that of non energy-saving buildings, and whether it is one-step energy-saving design or higher-level energy-saving design, it has achieved remarkable effect in energy-saving links, to a certain extent, to achieve the purpose of saving resources and protecting the environment.

3.2. Practical promotion of green energy saving buildings

So far, the regions with rapid economic development have begun to implement the building energy-saving design standards, and green energy-saving buildings have achieved leapfrog development. According to statistics, by the end of 2017, a total of 7235 projects across the country have obtained green building signs, with a building area of more than 500 million square meters. At the same time, the energy-saving transformation of residential buildings is also in full swing. By the end of 2015, many building designs in northern heating areas have completed the heating measurement and energy-saving transformation of residential buildings, with a total area of 990 million square meters, while the green energy-saving building reconstruction area in hot summer and cold winter area has reached 709 billion square meters. In the whole country, 11 large-scale high energy consumption public buildings have been transformed into green energy-saving buildings, 46 demonstration cities with renewable energy for architectural design and green energy-saving buildings in 100 counties have been constructed. By the end of 2015, in the green energy-saving buildings in cities and towns nationwide, the promotion area of solar thermal application will reach more than 3 billion square meters, and the construction area for shallow low-energy applications will reach more than 500 million square meters, and the replacement rate of renewable energy for residential building energy will exceed 4%[4]. Survey data show that the energy saving rate of green energy-saving buildings is 75% higher than that of ordinary buildings. In a word, flexible use of green energy-saving building technology, from all
aspects of the building to lay the foundation for the sustainable development of green energy-saving buildings.

4. Prediction of energy consumption growth trend of green energy-saving buildings

4.1. Growth trend of building energy consumption
The total amount of building energy consumption has been showing a continuous growth trend, but in the past decade, the growth trend of building energy consumption has been significantly slowed down, especially in recent years, the growth rate of building energy consumption has decreased significantly. From 2001 to 2005, the average annual growth rate of building energy consumption was about 12%, while from 2006 to 2015, the growth rate of building energy consumption decreased to about 5%, and the growth rate decreased by more than 50%. The average annual growth rate of building energy consumption in recent years is shown in Figure 1.

![Figure 1. The growth rate of building energy consumption from 2005 to 2015.](image)

The broken line chart of the growth rate of building energy consumption data in recent years can intuitively show that the growth rate of building energy consumption is obviously slowing down, which benefits from China's vigorous promotion of green energy-saving buildings and the implementation of green energy-saving buildings, and effectively reduces the energy burden brought about by industrial development.

4.2. Prediction of energy consumption growth trend of green energy-saving buildings
It can be seen from the above line chart that although the total amount of building energy consumption in China continues to grow, its growth rate shows an obvious downward trend, which is inseparable from the application of building energy conservation and green environmental protection technology. At present, some energy-saving buildings have applied solar collector technology, which can use conversion device to convert the absorbed solar energy into other energy; some energy-saving buildings use daylighting energy-saving and environmental protection technology to enhance the lighting time and illumination of the building and reduce the use of electric energy; some energy-saving buildings use green energy-saving materials to enhance the thermal insulation effect of buildings[5]. Building energy conservation is the key to achieve the goal of carbon emission peak in China. The 13th five year plan of building energy conservation and green building development points out that by 2020, the building area of green energy-saving buildings in new urban buildings will reach 50%, and the application of green materials will also exceed 40%. With the rapid development of the city, green energy-saving building will become the landmark of the city. Within a few years, green
energy-saving buildings will usher in a new stage of development. New technologies such as Internet, Internet of things, cloud computing and big data will be integrated to realize the saving and utilization of various energy sources, reduce carbon dioxide emissions, improve the quality of green energy-saving buildings, and make green energy-saving buildings highly integrated in terms of ecology and humanity. The investigation shows that by 2050, the emission reduction capacity of the construction sector is as high as 74%, which will contribute about 50% energy saving to the peak of carbon emission ahead of schedule.

In conclusion, with the development and progress of economy and technology, green energy-saving buildings will gradually replace ordinary buildings, which is in line with the sustainable development strategy of human beings. The overall growth of building energy consumption is the inevitable trend of human development, but the full implementation of green energy-saving buildings will slow down the growth rate of building energy consumption in China, save resources to the maximum extent, protect the environment and reduce pollution. Green energy-saving building will integrate the concept of sustainable development strategy into the construction industry, which will become the leading trend of the construction industry in the future.

5. Conclusion
China is a big country of energy consumption, the development of green energy-saving buildings is the only way to sustainable development. Compared with developed countries, the development of green energy-saving buildings in China is still lagging behind, and there are many problems. This paper discusses the development status of green energy-saving buildings, analyzes its energy consumption, and forecasts its energy consumption growth. Only by establishing the concept of green building in the field of architecture and strengthening the application of green energy-saving building technology, can we further realize the construction of green city and realize the harmonious development of man and nature.

References
[1] Tian lichen, Yang Yuguang, Liu diange. Situation and task of green building development and building energy saving [J]. House, 2020 (02): 13-14.
[2] Lai Ye. Analysis and reform of green energy saving building industry in China [J]. Oriental corporate culture. 2011 (18): 279+261.
[3] Han Hui. Analysis of building energy consumption based on BIM Technology [D]. Xi'an: Xi'an University of architecture and technology. 2015.
[4] Research Report on building energy consumption in China in 2019[J]. Architecture, 2020 (07): 30-39.
[5] Jin Shengwei. Analysis on application status and development trend of building energy saving and green environmental protection technology [J]. House, 2017 (23):97.
[6] Zhang Jing. Study on energy saving and emission reduction control of thermal insulation wall structure of green and environmental protection buildings [J]. Environmental Science and management, 2019, 44 (12): 15-20.
[7] Wu Yang, Wei Guoling, Liang sisi. Study on the structure of green energy saving exterior wall of civil buildings in Guangxi, 2019, 47 (12): 128-132+137.