

Singapore's Aarden City Construction and Green Building Development

Chenhui Xiong^{1, a}, Jian Chen^{1, b}

¹College of Art and Design, Hubei University of Technology, Wuhan 430068, China

E-mail: a907308543@qq.com, b759126337@qq.com

Abstract. The government of Singapore has a high demand for city construction planning always adhere to the implementation of "garden city" theory. Singapore's government has been following the "sustainable" of Singapore's requirement and fully embodies the "green building" and "environmental protection" concept. To set the ecological construction and protection of water resources as the total target, minimize damage to the environment of economic development, make Singapore a pioneer "green building". In recent years, the Chinese government is promoting green building but harvest little, in this case, for the development of "green building", China can draw lessons from Singapore's experience.

1. Introduction

This paper briefly introduces Singapore's urban garden construction theory and related government support policies, it summarizes the development of green building in Singapore with learning from its experience and learning methods, so that it can provide some useful suggestions for the development of green building in China.

2. Singapore's "garden city" construction

Singapore is composed of 64 islands and the main island Singapore Island accounts for more than 90% of the country's area. Singapore has almost no rural territory, the grass grows luxuriantly and the flowers bloom beautifully, the streets are clean and the trees are on both sides of the road, the small gardens and lawns are along the paths; people can smell the fragrance of flowers, see the green of the grass and enjoy the fresh air. So it is recognized as the world's "national garden city". The greening of Singapore is stereoscopic. Tall trees, low shrubs and green grass are shining with each other; the green of the facade building, overpass viaduct and vertical greening bring out the best in each other; all create a wonderful green world. The success of Singapore's greening should be benefited from the greening concept that they have been adhering to for many years.

2.1. Greening targets

Today, the "garden city" has become the pronoun of Singapore. According to the world bank in 2016, according to data from the Singapore has more than 340 large and small parks residential areas on average every 500 meters there is a park the green area of 45% of the total land area and green coverage of 80% or more. However, in more than 700 square kilometers of land Singapore's population density reached more than 7000 people per square kilometer and is now among the world's highest. Much less shortage of resources is it has to face the reality. In this case, Singapore has been exploring the effective avoid urban pollution and improve resource use efficiency.



As early as the beginning of the founding, Singapore government has made the construction goal of "garden city". Under the condition of the land resources are scarce they put forward 8 square meters per capita green space index and asked to have green space in front of the house seam greening. Now more than Singapore city covers an area of 20 hectares reach 44 park, 0.2 more than 240 hectare park on both sides of road 264 planting more trees and flowers. At the same time, the layout of the greening of Singapore attaches great importance to the fair. Singapore in different areas such as the central northeast and northwest established four nature with reserve and prohibited development to keep the original tropical rain forests; In the east and the southwest and set up two trees save area cut down trees must be approved this makes the nation each big region has a large piece of nature reserves and forest; Central city group and government flats where every once in a small region is to retain a clearing open up into a small park ensure that green uniform distribution.

2.2. Detailed goals and government support

Singapore afforestation goal was very clear and specific of planning design. Regional parks and green belts, street, neighborhood parks, in the parking lot, highway, sidewalks, the viaduct and building facade. The greening of location, area, standards, those responsible have specific provision, green area into planning blueprint for building regulations which as an important part of the planning and construction with fixed laws, ensure implementation in place make houses with green foil each other. In order to ensure that green Singapore also by fines and reward mechanism for the escort. From 20th century 70S, the government is strengthening green education to improve the green consciousness at the same time, strict punishment to greening the damage behavior. In addition, the Singapore law also provide incentives to contribute to green. Have a garden house, for example, if you don't wall let the flowers and trees for passers-by to enjoy to the reduction of the real estate tax. For the urban greening has outstanding contribution is to receive the high praise.

3. Singapore's "green building" process

In the dense urban environment of Singapore green buildings are essential for sustainable development because of the limited land and natural resources. In 2015, the construction bureau of Singapore began to implement the plan of building environment in Singapore, launched the Green Mark certification scheme and evaluated the negative impact of buildings on the environment and rewarded it sustainable development. Appraisal indicators include energy and water saving, environmental protection, indoor environment quality and other green features and innovation in five aspects.

As a city country of building energy consumption accounted for more than 50% of the energy consumption in Singapore. Different from other countries *Green building rating system Green Mark* more emphasis on energy efficiency *Green Mark* from high to low is divided into four criteria: platinum, most gold, gold and certification levels for building energy efficiency requirements ranging from 35% to 15%. For new buildings the Singapore government has also introduced a green building area incentive plan. If it is platinum green building the government give up to 2% of the additional construction area for up to 5000 square meters. If the level is most gold green building the government give up to 1% of the additional construction area for up to 2500 square meters. For existing buildings renovation the government has offered \$100 million incentive plan. Construction bureau in Singapore in 2005 officially launched the *Green Mark* the government leading and called for enterprise voluntary Green building implementation plan. Through several years of development the understanding of the green building gradually deepened. Energy saving equipment and materials manufacturers are beginning to realize that there is opportunity, the development of this area makes the cost of the green building gradually reduced. Since 2008 the government took a mandatory and reward two-way drive way. On the one hand, the government legislation to enforce new buildings must comply with *Green Mark's* eligibility criteria. Singapore construction bureau will inspect the construction qualified will send occupation permit to developers. On the other hand, the government introduced incentives for green buildings, for example, to achieve the corresponding standard of green building reward developers corresponding proportion of plot ratio so that they will have a high enthusiasm.

4. The development of green building in Singapore

The 2015 *International Green Building Conference* in Singapore. At the conference, Singapore construction bureau launched the latest version *Green Mark* certification. Has long been seen, Singapore's achievements in the field of Green building the *Green Mark* has been widely recognized in the industry. On the one hand, the government to achieve the corresponding standard architecture has rewards developers the corresponding percentage of volume rate; On the other hand, the government building mandating the use of the construction of the solar panels. Such as parks, and a set of house of building facilities are required to build solar panels and by the government as a whole to buy solar panels which can reduce the cost.

4.1. Focus on solar energy applications

2015 new *Green Mark* is the fifth edition, improve a lot to the requirement of Green building to pay more attention to building the overall energy performance and not one of them. Is particularly important, attaches great importance to utilize solar energy in Singapore they with enterprises emphasize the solar energy into the building design thus reducing the dependence on other energy sources.

In the new *Green Mark*, they hope to enterprises in the first time to use solar energy if the inconvenience at least to set aside space to add after use. Moreover they are in the *Green Mark* evaluation for solar energy utilization rate is very strict, not only buildings were used in the solar energy can be in the *Green Mark* assessment score but also must achieve a certain proportion. In 5 to 7 years ago, the solar panels cost is high investment payback period to more than 20 years. But now because of the development of photovoltaic industry in China and elsewhere that lower prices, so shorten payback period to seven to ten years.

4.2. Energy consumption data analysis

Electricity is Singapore main energy used in buildings so energy efficiency in buildings and "*Building Energy Consumption Index (EUI)*" limited to power consumption. From 2008 to 2016, total floor area of a 25% increase in the commercial building and the total power consumption increased by only 16% compared with low. As can be seen through the analysis of the *EUI* of enterprises, 8 years building energy consumption index was reduced by 7%. More specific effect that can by comparing the data in 2013 and 2014, for *Green Mark* certification office 15% less electricity than not certified in terms of retail buildings and hotels this data is 10% and 7% respectively.

4.3. The mechanism of promoting green building standards

The new *Green Mark* up to tackle climate change, building energy consumption, resource management and intelligent and healthy buildings four sorts of standards increase the incentive mechanism. Energy consumption of score is always the key point of the overall evaluation standards and demand is improving. The new emphasis on climate change request is actually and interrelated building energy consumption that is influence the score the higher proportion of energy consumption and score evaluation more scientific.

In addition, the elaboration to the requirement of office buildings the government will not only the appraisal of energy-saving building itself, but also requires the owner to the tenant's request for saving energy. For example, does the tenants themselves to decorate and transform to achieve the energy saving and energy coordination management standard. From building energy efficiency in 2016 benchmark report reflect, landlord and tenant's electricity use almost all the accounts for half the total electricity consumption of the building it shows that the tenant actively take measures to reduce power consumption that can promote the whole building energy saving. Government will lead by example, of course, they asked the government to the new construction must meet the highest standards of *Green Mark*. Transformation of old buildings must reach the standard of the second level of the *Green Mark*.

5. China's green building is in the works

5.1. China's green building construction target

For China, what is a green building? According to the national development and reform commission and housing in urban and rural construction ministry in 2013 "*Green Action Plan*" pointed out that green building is in the construction of the whole life cycle, maximum limit save resources, protect the environment and reduce pollution. For provide people with healthy applicable and efficient use of space and the natural harmonious coexistence of architecture. In 2012, the ministry of finance and the ministry put forward to the new green building area of 2015 to reach 1 billion square meters, by 2020, the green building will account for more than 30% of the new buildings.

5.2. Problems with green building standards

Released in 2006 the ministry of the green building standards for certification by the project is divided into two categories: design marks and operations. Logo design refers to the developers to submit the certification request in drawing design stage which experts in figure after the review of qualified design logo that will be valid for one year. Operating logo is actually built in "green building", identification is valid for three years. But the reality is that most of the developers in the design logo that no longer apply for operation. Because the operating logo should input should be used only after a year. That is to say, China is more than ninety percent of the green building but talk about "green" paper.

Since January 1, 2015 new green building evaluation standards. The new version of the standard is more strict than the 2006 version and the content is more extensive. One of the most notable is that the green building standards will boot from the past, gradually extended to the force and force will gradually expand the range. But the green building assessment "logo design" category is still there. "New standard" green building can be divided into three star although the two-star, three-star standard is strict but the star class standard is the personage inside course of study thinks is far lower than the standard in the United States, and future comments on the definition of rights will be sent to the local authorities. Once in so doing, the effect will be weaker.

6. Conclusion

Based on the study of the garden city theory and the development of green buildings in Singapore, the following conclusions can be drawn:

(1) Singapore's green building development is inseparable from the government's strong support, at the same time, for green building standards elaboration is also a necessary factor in the development of green building this suggests that want bigger achievements on green building requires the government's strong support and perfect laws and regulations.

(2) For different countries have different methods of energy utilization. China needs to adjust measures to local conditions to find suitable for their own further strengthening the construction of green building construction method. To make China out of the woods has been for the planned construction thereby the real realization of green building.

References

- [1] Liu Xing, Gao Bin. Urban Municipal Planning and Construction of Ecological City of Singapore and Experience Reference[C]//2011 Assembly Documents of Conference on Urban Development and Planning. Beijing: Urban Studies Magazine Editorial Office, 2011.
- [2] BCA. Leading Tropical Green Building in Singapore[EB/OL]. (2014-10-30) [2014-11-15]. <http://www.bca.gov.sg>.
- [3] Ministry of Construction of the PRC. GB 50189-2005 Public Building Energy Efficiency Design Standards [S]. China Architecture & Building Press, 2005.
- [4] China Academy of Building Research, etc. GB/T 50378-2006 Evaluation Standard for Green Building [S]. China Architecture & Building Press, 2006.
- [5] Li Baizhan. An Introduction to Green Building[M]. Beijing: Chemical Industry Press, 2007.
- [6] Zhang Mingming. Green Building in Singapore[D]. Tianjin: Tianjin University of

Technology,2012