Analysis on the Incentive Policy of Vertical Greening in China: a Case Study of Shenzhen City

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Abstract. Through the comparison of the current vertical greening policies at home and abroad, the paper analyzes the overall value orientation and policy characteristics of the domestic vertical greening incentive policy based on the type of vertical greening practice, the matching analysis of the incentive policies related to vertical greening in Shenzhen; analyze the existing system, type, relevant departmental responsibilities and implementation effects of Shenzhen’s vertical greening policy, and deeply discuss the shortcomings of China’s current vertical greening incentive policy and propose optimization suggestions.

Keywords: vertical greening; spatial mode; incentive policy; reward criteria.

1. Introduction
“Vertical Greening” originated from the “sky garden” of the Babylonian dynasty. The modern sense of vertical greening was initiated in Italy in the 19th century. Germany has pushed the vertical greening into maturity and further in terms of technology and policy. Spread around the world, Boeri’s “bosco verticale” and Singapore’s Parkroyal on Pickering are typical representatives of vertical greening (Li & Wang, 2018, Xu, 2015). At present, China’s urbanization is developing rapidly, there is a lack of space resources in megacities, and urban ecological land is seriously insufficient. It is generally accepted that cities with a population density of more than 15,000/km2 or a building volume ratio of more than 2.0 can be defined as high-density cities (districts), while China has nine high-density cities (Li & Ye, 2015, Cai et al., 2016). Taking Shenzhen as an example, from 2010 to 2017, there were a large number of ultra-high-density development cases in Shenzhen. The average floor area ratio of more than 40% of the projects was 5-7, and the average volume ratio of some updated projects (about 15%) reached 7 Above (Yang & Song, 2017). The emergence of vertical greening has broken through the limitation of land resources shortage. By exploring the greening form of non-ground space, it provides a feasible way for the ecological development of the city.

With the concept of “smart growth” in the city, vertical greening has received increasing attention from scholars. In recent years, related research on vertical greening has also increased. For example, Xu Yibo, Long and others have proposed some vertical greening construction projects abroad, and proposed vertical greening construction (Xu & Boeri, 2016, Long & Sang, 2016); some scholars also pay attention to the relevant policies at home and abroad, and study the relevant policy differences at home and abroad. For example, Meng Xiaodong, Ma and others (Meng & Wang, 2016, Ma & Li, 2018); Chen Yu, Mao Chengzhe, Yang Jinyu and others through the field investigation and analysis of local vertical greening, the characteristics of vertical greening are summarized and discussed (Chen et al., 2011, Mao et al., 2016, Yang et al., 2014). At present, the research perspectives of domestic scholars mainly focus on the policy comparison of vertical greening and the summary of greening
methods. There are few studies on the practical application effects of domestic vertical greening incentive policies.

Taking Shenzhen as an example, this paper analyzes the type of vertical greening incentive policies, the analysis of the matching degree between policies and specific vertical green forms, the relationship between relevant greening administrative departments and the actual implementation, and attempts to analyze the domestic vertical greening incentive policies in cities. Actual utility. This provides a certain reference value for the country to develop a vertical greening incentive policy to further promote the development of urban vertical greening.

2. Status of China’s Vertical Greening Policy

2.1. “Vertical Greening” Concept

At present, domestic green building and greening standards and norms define “vertical greening”, in the early technical management documents such as “Basic Terminology Standards” and “Trial Greening Implementation Trial Measures in Luohu District, Shenzhen”. The expression of vertical greening is relatively broad, and all the ways of “green space other than ground resources” are classified as vertical greening. In the Shenzhen Greenland System Planning Revision (2014-2030), the vertical greening is clearly classified as G6.

The type definition of vertical greening mainly depends on the building carrier. Roof greening is the earliest form of vertical greening. Wall greening and overhead greening subsequently emerged, and balcony greening is still in the implementation stage of encouraging owners due to its property rights issues, and it is difficult to relate to public policies.

![Figure 1. Types of roof greening (self-drawn by the author).](image)

Based on the definition of vertical greening in Shenzhen, and considering the development trend of vertical greening, this paper defines roof greening, wall greening and overhead greening as the main forms of vertical greening of buildings, and the greening of balconies as the future vertical greening Supplementary types were analyzed.

2.2. Types of Vertical Greening and Related Incentive Policies

Based on the typical case of stereoscopic greening at home and abroad, this paper summarizes the vertical greening of buildings into five forms: supporting ground greening, wall greening, balcony greening, aerial layer greening and roof greening.

2.2.1. Supporting ground greening

In the definition of vertical greening, the greening in contact with the ground does not belong to vertical greening. However, in the actual building greening project, ground greening is an important part of the connection with vertical greening. Since the two always appear in the project, this article lists the supporting ground greening of the building as a separate category in the induction policy induction. The supporting grounding of the building mainly includes four types of underground greening of the ground floor, aerial greening of the ground floor, greening under the suspended structure of the building and soil covering and greening of the underground facilities.
2.2.2. **Roof Greening**

Roof greening generally refers to the greening mode which takes the top of buildings and structures as the carrier, plants as the main body, and does not contact with natural soil. It is the general term of various roof planting modes. Its types can be roughly divided into three types: simple type, combination type and garden type (Figure 1). It is the most important manifestation of vertical greening, but also the clearest incentive measures in China's greening incentive policy, the largest incentive type of vertical greening. At present, in the green incentive policies issued by provinces and municipalities, the main incentives for roof greening are direct financial subsidies and conversion of green space rate. In the financial subsidy, it can be divided into two types: subsidy per unit area and subsidy for overall projects; in the conversion of green space rate of roof greening, the conversion ratio is determined according to the thickness of the cover soil of roof greening.

2.2.3. **Wall Greening**

Wall greening is the vertical greening in a narrow sense, which means the greening form attached to the facade outside the building. According to the evaluation method of greening incentive policy and the way of plant attachment, wall greening can be divided into climbing type, modular type and other types (Figure 2).

![Wall greening types](image)

Figure 2. Wall greening types (self-drawn by the author).

1. **Climbing wall greening**

   It is characterized by the use of climbing plant adsorption, winding, tendrils, hooks and other climbing characteristics, so that it attaches to the vertical surface of the building in the growth process; will cause certain damage to the wall, slow greening speed, greening height is also limited; climbing plants have integrity, late management and maintenance is relatively difficult. In terms of the adaptability of incentive policy, due to the growth characteristics of climbing plants, it is difficult for relevant departments to evaluate the greening coverage of building walls, which is not conducive to the implementation of relevant incentive policies.

2. **Modular wall greening**

   Modular greening establishes a framework supporting container module on the outer surface of the wall, forms a planting soil layer perpendicular to the horizontal plane, and completes the wall greening. This form of greening usually requires framework support, and most of them need supporting irrigation systems. Property maintenance mode is relatively systematic and regular, which is convenient for real-time monitoring and maintenance of greening. In terms of the adaptability of incentive policy, because the greening distribution of facility wall is relatively uniform and the coverage is clear, it is easy for government departments to measure its area and greening evaluation, which is conducive to the implementation of relevant incentive policies.

3. **Other types of wall greening**

   Other types of wall greening generally belong to a relatively novel design, with a certain difference from the existing definition of wall greening, such as planting trees in the landscape grid of the building facade, the ownership of this kind of greening type is relatively vague, and the green coverage area is difficult to determine.
2.2.4. Overhead Layer Greening The aerial layer refers to the open space layer with only structural support but no external protective structure. The aerial layer greening refers to the greening form of greening planting in the aerial layer space. Based on the analysis of the vertical greening projects at home and abroad, this paper classifies the overhead greening into three types: incomplete overhead greening, semi-permeable overhead greening and complete overhead greening (Figure 3).

Incomplete overhead greening generally refers to the formation of an overhead depression space in a part of the size of the cut section at a certain height of the building, in which plant landscape construction is carried out; semi-permeable overhead greening is only part of the overhead floors, thus forming an east-west or north-south permeable overhead space, which is used to complete the overhead greening in the “corridor”; It refers to the green planting in the open space of a certain height overhead.

In the incentive policy of vertical greening, there is no explicit reward regulation for overhead greening. Shenzhen stipulates that vertical greening including overhead greening should be converted into supporting greening land, and overhead greening should also be included in roof greening. In actual architectural design and construction, overhead greening is usually integrated with public space. In terms of reward policy, it is realized by rewarding the area of overhead public space.

![Image of overhead greening types]

**Figure 3.** Types of overhead greening (self-drawn by the author).

2.2.5. Greening of Balcony in Singapore and other cities with higher requirements for vertical greening, the incentive measures for balcony greening have been clearly defined. The newer norms and standards in Shenzhen also involve balcony greening. The main content is to encourage and promote balcony greening, but no specific regulations and incentive policies have been put forward for balcony greening. According to different property rights, balcony greening is divided into two types: private balcony greening and public balcony greening.

1. Greening of private balconies
   Private balcony belongs to private property rights, and its distribution is more dispersed to ensure that each household can easily feel the actual effect of balcony greening. However, due to the unclear ownership of management, there are some difficulties in the unified maintenance of property, the monitoring and evaluation of balcony greening is also difficult to achieve, and the greening incentive policy is difficult to cover.

2. Greening of public terraces
   Public balcony belongs to the public property right, its area is relatively large and it can provide a variety of green use. Its management rights are clear, property maintenance is convenient, it is convenient for real-time monitoring and maintenance of greening, and it is also easy to assess and reward the implementation of greening policies.

3. Analysis of Incentive Policies for Greening in China and Abroad

3.1. Foreign Related Policy Types
The foreign vertical greening policy has been established earlier and the system is relatively perfect, which has a certain guiding significance for the formulation of relevant policies in China. Through sorting out the relevant foreign norms, this paper classifies foreign incentive policies for greening into
six categories: direct financial subsidies, low-interest loans, tax relief, volume rate incentives, conversion of green space area and incorporation into ecological scoring system or building certification system (Table 1).

**Table 1. Types of incentive policies of vertical planting of foreign countries.**

| Types                        | Countries       | Contents                                                                                                                                                                                                 |
|------------------------------|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Direct financial subsidies   | Germany         | 1 m² greening roof can obtain a subsidy of 10-20 Euros. Skyrise Greenery Incentive Scheme (SGIS) subsidizes the roof and wall greening projects, which will be up to half of the project’s greening costs (roof greening does not exceed 75 NT/m², vertical planting does not exceed 750 NT/m²). Singapore National Park Bureau has set up the Garden City Fund, which is mainly used for the research and development of vertical planting projects and the construction of parks. |
|                              | Singapore       | Since 1999, the government has provided low-interest loans to the owners of building roof gardens. When the building area is over 2000 m² and the roof garden area accounts for more than 40% of the total area of the roof, they can enjoy part of the low-interest loans for building roof gardens and the main construction funds. Singapore National Park Bureau has set up the Garden City Fund, which is mainly used for the research and development of vertical planting projects and the construction of parks. |
| Low-interest loan            | Japan           | The Chicago government can provide financial assistance such as low-interest financing for new buildings for roof greening projects.                                                                                                                                  |
|                              | America         | The Chicago government stipulates that when more than 50% of the roof area or no less than 185.8 m is covered by vegetation, developers will be allowed to build at a higher density than the policy. By relaxing the regulations on balcony construction for private houses, developers will get extra floor area rate to build balconies (10% over the ceiling), and divide the aerial balcony and roof display space into areas beyond the total area of the building. |
| Tax relief                   | America         | The Portland government provides for a 35% rainstorm management fee waiver when the roof greening coverage reaches 70%.                                                                                                                                               |
|                              | Germany         | 50% to 100% of the rainwater drainage fee will be reduced for the buildings with green roofs.                                                                                                                                                                      |
| Floor Area Rate Award        | America         | The Chicago government stipulates that when more than 50% of the roof area or no less than 185.8 m is covered by vegetation, developers will be allowed to build at a higher density than the policy. By relaxing the regulations on balcony construction for private houses, developers will get extra floor area rate to build balconies (10% over the ceiling), and divide the aerial balcony and roof display space into areas beyond the total area of the building. |
|                              | Singapore       | By relaxing the regulations on balcony construction for private houses, developers will get extra floor area rate to build balconies (10% over the ceiling), and divide the aerial balcony and roof display space into areas beyond the total area of the building. |
| Include Green Area           | Germany         | When the open roof greening achieves a certain greening form and construction quality, 50% of its area is included in the green space rate.                                                                                                         |
|                              | Japan           | Tokyo, Yokohama, Osaka, Kobe and other cities stipulate that the greening area of roof and wall can be calculated together when the greening index of ground is laid out.                                                                                   |
| Putted into ecological grade system or building certification system | America         | LEED Green Building Certification                                                                                                                                                                       |
|                              | Singapore       | Green Building Assessment                                                                                                                                                                                |
development of vertical greening are relatively clear, with high degree of implementation, and the overall development level of urban vertical greening is relatively high.

3.2. Domestic Policy Types
China’s vertical greening development started late, and the relevant policies are in the stage of rapid construction and improvement. China’s national and provincial vertical greening documents only grasp the general direction of development. Although the vertical greening policies in different cities have different development time, types and intensity, the overall framework and main incentive methods of the vertical greening incentive policy in China have been relatively clear from a national perspective (Table 2).

Because of the lack of mandatory requirements of China’s vertical greening policy, the actual greening promotion has limited effectiveness. Taking Shenzhen as an example, as one of the cities with the highest level of greening development in China, the proportion of roof greening in Shenzhen will still be less than 1% by 2016. In addition, in the documents issued by various cities, the incentives for stereo greening are generally low, and are still in a relatively conservative exploration stage. At the provincial level, the incentives for stereo greening mainly exist in the common score items in the evaluation criteria of green buildings. In the proportion of green building policies used in various provinces, only the fiscal subsidy policy is more than 50%, followed by the volume rate and land conversion. Jean, tax and award (Xu, 2014).

3.3. Comparative Analysis of Incentive Policies for Vertical Greening in China and Abroad

3.3.1. Analysis of Value Ideas in China and Abroad
The value orientation of vertical greening is the core foundation for formulating relevant standards and norms of green building. China Green Building Evaluation Criteria refers to LEED in the United States and CASBEE in Japan, and compiles it according to the actual situation in China. “Green Building Evaluation Criteria” advocates “providing people with healthy, applicable and efficient use space”, pays attention to the balance of land use efficiency and per capita index, and embodies the value of “people-oriented” on the basis of land intensive orientation. For example, in green building evaluation, the lower the per capita residential land area, the higher the score of building volume ratio, but at the same time, the higher the score. It is emphasized that the higher the per capita area of public green space, the higher the score.
### Table 2. Types of incentive policies of Vertical Planting of China.

| Policy types                        | Districts | Documents                                                                 | Time  |
|-------------------------------------|-----------|---------------------------------------------------------------------------|-------|
| **Financial subsidy**               | Shanghai  | Special Support Measures for Building Energy Conservation Projects of Shanghai | 2017  |
|                                    |           | Notice of the General Office of the Hangzhou People’s                      |       |
|                                    | Hangzhou  | Government on Further Promoting Vertical Planting in the                    | 2015  |
|                                    |           | Urban Areas of Hangzhou                                                   |       |
|                                    | Xi’an     | Subsidy Measures for Roof Greening and Vertical                           | 2015  |
|                                    |           | Planting in 2015                                                           |       |
| **Conversion of greening area**     | Ningbo    | Guidelines for Buildings (Structures) Vertical Planting of Ningbo          | 2017  |
|                                    | Jinan     | Urban afforestation ordinance of Jinan                                     | 2018  |
|                                    | Wuhan     | Matching Green Area of Construction Project                               | 2015  |
| **Building Area and Floor Area Rate Award** | Zhejiang | Zhejiang Green Towns Action Plan                                           | 2012  |
|                                    | Fujian    | Fujian Green Building Action Plan                                          | 2013  |
|                                    | Yueyang   | Supplementary Provisions on Volumetric Area of Vertical Planting          | 2018  |
| **Putted into ecological grade system or building certification system** | China | One of the Standards for the Selection of National Garden Cities           | 2016  |
|                                    |           | Implementation Plan of Green Building Action in Ningxia Hui Autonomous    |       |
|                                    |           | Region combines with green building. In the evaluation activities such as |       |
|                                    |           | Luban Award, Guangxia Award, Huaxia Award and various demonstration       |       |
|                                    |           | projects, priority is given to selection or recommendation and reporting. |       |
|                                    |           | Landscape Architecture Award, including Science and Technology            |       |
|                                    |           | Progress Award, Excellent Planning and Design Award and Construction Model |       |
|                                    |           | Engineering Award and other important awards.                            | 2013  |
|                                    | Shenzhen  | Selection of Vertical Planting                                             | 2018  |
|                                    | Hefei     | Selection of Vertical Planting                                             | 2018  |

Some developed countries abroad, such as Germany, the United States, Japan, Singapore and so on, started the vertical greening earlier. They have formed a relatively perfect vertical greening policy system and built a series of classical buildings with high greening level. Most of them are exploring ecological greening compensation under high-density development, which is consistent with the starting point of domestic vertical greening, but the realization of different projects. Concepts have different emphasis, such as the project of “Vertical Forest” in Milan, Italy, which emphasizes “non-anthropocentric ethics”, seeks the effect of greening compensation and reduces the actual use area of buildings, which is different from the greening development concept which emphasizes the efficiency of intensive development in China.

3.3.2. Comparison of Policy Types in China and Abroad Although China’s incentive policies for vertical greening still have systematic gaps compared with foreign countries, the overall policy
framework and positive incentive efforts have made remarkable progress. Domestic incentive policies are similar to foreign measures in direct financial subsidies, conversion of greening area and incorporation into rating and awarding system. The financial subsidies for roof greening in first-tier cities are close to those of foreign countries. Some or all types of vertical greening (roof greening, overhead greening and wall greening) can be converted into greening area. Vertical greening is included in the national standard of green buildings. Relevant scoring items, domestic construction can also apply for LEED similar rating.

Of course, there are still some deficiencies in volume rate and building area award. At present, there is no clear volume rate or building area award based on vertical greening construction, but a few cities have begun relevant exploration, such as Yueyang City has introduced the incentive of vertical greening, while other cities can only rely on public space and green building award. This is also an important development direction of vertical greening incentives, such as "Shenzhen City Greening Development Planning Outline" clearly pointed out that future research and development of incentives such as volume rate incentives. In terms of tax reduction and exemption and low-interest loans, there is no incentive policy for loans in domestic vertical greening projects at present. There are fewer types of tax in China, such as rainwater drainage fee and rainstorm management fee. The tax reduction and exemption policy does not conform to the national conditions. As generally speaking, vertical greening appears late in China, and the formulation of relevant incentive policies lags behind. However, with the increase of vertical greening practice projects and the accumulation of experience, the relevant policies in China will be more perfect.

4. Shenzhen vertical Greening Award Policy and Implementation

4.1. Policy Expressions and Indicators Analysis

China’s building greening started late, and can learn less from the practical experience. The relevant policy design of urban vertical greening in China is still in the exploratory stage. As one of the earliest special area cities in China, Shenzhen is highly short of land resources, which also promotes the rapid development of urban vertical greening. From 2016 to 2018, the city added 660,000 square meters of vertical greening. In terms of the expression and indicators of the vertical greening policy in Shenzhen, there are two levels: one is the direct and clear policy documents of the vertical greening, such as the “Shenzhen Stereo Greeing Implementation Measures (Draft for Opinions)”, in which direct indicators are required for different forms of vertical greening; the other is the indirect and public-related documents for the implementation of vertical greening construction. Common policy. It mainly concentrates on the relevant norms of green building evaluation. Its contents mainly appear in the ways of “encouragement”, “advocacy” and “appropriateness”. It expresses the support and encouragement of government departments to the practice of vertical greening. For example, in the “Rules for the Implementation of Green Design Standards for Civil Buildings in Shenzhen City”, it encourages the construction of public activity space, overhead floors and other leisure greening open spaces. Relevant incentive expressions mainly focus on site ecological construction and space utilization. It is not difficult to find that Shenzhen has a significant intention at the policy level to promote the development of public green space and ecological environment of buildings, and also has an open attitude towards the greening of balcony space and the participation of private capital in greening construction.

In order to better solve the serious shortage of local ecological land, Shenzhen’s vertical greening policy tends to rationally improve per capita greening and related indicators on the premise of intensive land use. In Shenzhen City Planning and Standards, the green coverage rate has been replaced by the green coverage rate. In the related conversion standard of vertical greening, vertical greening can be converted into green coverage area and matching green land area. However, because the overall vertical greening in China is in the exploratory stage, the consistency and compulsion of the vertical greening indicators in the norms are weak, especially in the reward content, the conversion and reward methods of overhead greening and vertical greening which appear later are not perfect.
There are also some problems in Shenzhen’s vertical greening specifications: different levels of specifications, different mandatory requirements for different documents in the same region, different calculation methods for different documents in the same region (Administration, 2017). Taking “Code for Green Design of Civil Buildings in Shenzhen Implementation Rules” and “Shenzhen Stereo Greening Implementation Measures (Draft for Opinions)” as examples, there are differences in compulsory requirements for wall greening and conversion standards for roof greening between the two.

4.2. Analysis of Policy-Related Departments
The policy system of vertical greening in Shenzhen is relatively complete, including laws, normative documents and local regulations. The upper basis of the main vertical greening documents is clear, and the level of the departments is clear (Table 3, Figure 4). The Implementation Measures of Vertical Greening compiled by Shenzhen City Administration Bureau is an important link between the upper legal documents and local regulations, but the local government documents. For example, “Trial Measures for the Implementation of Vertical Greening in Luohu District” did not take it as the basis for formulation.

The Shenzhen Municipal Administration Bureau is also the competent department of the city’s vertical greening. The people’s governments of each district are responsible for the formulation and implementation of the incentives for the vertical greening within their jurisdiction. However, the incentives should be approved by the municipal government, and should be supervised and guided by the Municipal Administration and the land department in the implementation process. When greening projects involve volume ratio and building area award, application and approval should also be submitted to the Housing Bureau (Figure 5).

4.3. Incentive Policy Types of Stereo Greening in Shenzhen

4.3.1. Direct Financial Subsidies in China’s vertical green incentive policy, direct financial subsidy is the most common form of subsidy. Taking Shenzhen as an example, roof greening, as a traditional vertical greening method, is the main subsidized object of financial subsidies. Vertical greening has also been included in the scope of financial subsidies in recent years. In terms of subsidy items, Shenzhen divides the subsidy funds into construction funds and maintenance funds. In terms of subsidy intensity, Shenzhen’s financial subsidy intensity is greater, such as the subsidy for garden-style roof greening is 300 yuan/m and the subsidy for modular vertical greening is 550 yuan/m (District, 2014). The former has basically reached the subsidy level of developed countries, while the latter has a large gap with developed countries. For example, Singapore’s vertical afforestation subsidy does not exceed 750 new coins (3720 yuan/m). In terms of the scope of subsidy, the requirements at the municipal level are stricter, the object of subsidy is vertical afforestation beyond the required area of afforestation, while the area of district-level documents is larger, and the actual vertical afforestation area is carried out Subsidies.
Table 3. Shenzhen Vertical Planting Policy-Making Department.

| Departments | Time  | Documents | Attribute |
|-------------|-------|-----------|-----------|
| Standing Committee of Shenzhen People’s Congress of Guangdong Province | 2016  | Greening Ordinance of Shenzhen Special Economic Zone | Law |
| District People’s Government | 2018  | Special Funds for the Development of Independent Innovative Industries in Nanshan District: Operational Guidelines for Subsidiary Funds for Green Building Development (Trial Implementation) | Local regulations |
| | 2015  | Measures for the Management of Special Funds for National Green Ecological Demonstration Urban Areas in Guangming District of Shenzhen (Revised Edition) | |
| | 2014  | Trial Measures for the Implementation of Vertical Planting in Luohu District of Shenzhen | |
| Shenzhen Planning and Land Resources Commission Shenzhen Administration Bureau | 2016  | Renovation of Green Space System Planning of Shenzhen (2014-2030) | |
| Shenzhen Urban Management Bureau | 2017  | Measures for the Implementation of Vertical Planting of Shenzhen (Draft for Comments) | |
| | 2012  | Outline of Urban Greening Development Planning of Shenzhen (2010-2020) (draft for comments) | Normative documents |
| Urban Planning, Land and Resources Commission of Shenzhen Municipality | 2016  | Urban Planning Standards and Guidelines of Shenzhen | |
| Shenzhen Housing and Construction Bureau | 2015  | Technical Guidelines for the Review of Planning Floor Area Rate of Urban Renewal Units in Shenzhen (Trial Implementation) | |
Green space rate and green coverage rate are the main control indicators of building greening in China. In recent years, green coverage has been replaced by green coverage in Shenzhen. The vertical green area can be converted into supporting green area or green coverage area. In addition, it can be converted into other types of green indicators such as compulsory tree planting. The vertical greening in Shenzhen is mainly converted by roof greening and wall greening. Although the overhead greening is also included in the roof greening in Shenzhen Urban Design Standards and Guidelines, it has not been reflected in other documents and implementation methods.

Conversion of Green Space Area

Figure 4. Vertical greening policy relations and departments.

Figure 5. Shenzhen green award relevant departments and duties.

4.3.2. Volume Rate Award Vertical greening project will increase construction cost and later operation and management cost, while the direct financial subsidy for vertical greening is relatively small, which is difficult to achieve effective guidance for developers. Volume ratio incentive measures can increase the volume ratio of building blocks to meet the requirements with the help of greening project
evaluation, so as to improve the economic benefits of the blocks and the enthusiasm of developers for the construction of vertical greening. According to the relevant experience of foreign countries, volume rate incentive is an effective incentive to promote the implementation of greening projects.

At present, China has not yet issued a clear incentive policy for the volume rate of vertical greening, but there is a volume rate incentive policy for vertical greening as a related condition, which can be roughly divided into two categories.

(1) Volume rate incentive based on green building. In the "Green Building Evaluation Criteria", vertical greening can be used as a sub-item to improve the score of green buildings in the section of festival land and outdoor environment, operation management, improvement and innovation, and the corresponding volume rate award can be obtained through the identification of green buildings. At present, Fujian and Guizhou provinces in our country have clearly put forward the reward for the volume ratio of green buildings (<3%), and Shenzhen has also proposed that the municipal planning and land department should explore and formulate the policy of rewarding the land supply and volume ratio of high-star green buildings, which should be implemented after being submitted to the municipal people’s government for approval (General Office Of Fujian Government, 2013, General Office Of Fujian Government, 2013, General Office Of Guizhou Government, 2013, Shenzhen People’s Government, 2013).

(2) Building area award based on public open space. Platform greening is the main manifestation of public space in building public space, especially in overhead floors. Shenzhen encourages greening and beautification in green building structural floors, encourages building to set up overhead floors and expand public open space, and provides overhead floors or indoor space in developing construction land and carries out building area as approved public space. Reward (Shenzhen People’s Government, 2013, Congress, 2016).

4.3.3. Incorporate into the Rating and Award System Stereo greening has been incorporated into the evaluation system of green buildings in China and abroad, such as China’s three-star standard of green buildings and the LEED standard of the United States, which indirectly promotes the development of vertical greening at the architectural level.

Different provinces and municipalities in China regard architectural awards as an important way to promote green buildings and vertical greening. Similar awards have also been set up in Shenzhen, for example, in the 2017 Shenzhen Landscape Architecture Award, the proportion of research and engineering related to vertical greening is considerable: “Research and industrialization of new technologies for wall greening integration” has won the first prize of scientific and technological progress (technology development category); and "Jindi Century Building Project vertical greening design and construction project" has won the excellent model project (vertical greening category) gold prize.

4.3.4. Implementation and Game of Incentive Policy Because the content of incentive policy in China is generally unclear, and the vertical greening is also in a conservative development stage, which leads to the establishment and implementation of the vertical greening incentives by government departments to regulate. Developers in the vertical greening incentive policy, especially the volume rate and building area incentives, need to have a certain game and consultation with the government departments, in order to maximize the benefits.

Taking the urban renewal unit planning practice of Nanhu Street Food Mansion in Shenzhen as an example, the stakeholders of the project, based on the reward volume rate standard of public open space stipulated in the Technical Guidelines for Reviewing the Planning Volume Rate of Shenzhen Urban Renewal Unit, gambled on the design of public space (landscape platform) and the reward of actual building area, and finally added the original application scheme. The volume rate reward of 1.9 is determined to be 1 (Wu & Cai, 2017).

In the reward of vertical greening, the game between stakeholders, especially developers and government departments, is one of the important links. The public interest represented by government
departments evaluates the greening effect and public usage in the development and design, guarantees the maximization of public interest realized by volume rate incentive, and limits the means of obtaining relevant incentives and increasing development intensity for low-quality stereoscopic greening by developers in pursuit of maximization of commercial interests. In the actual evaluation and incentive formulation of stereo greening projects by government departments, it is often relatively conservative and difficult to play an effective incentive role in stereo greening.

5. Problems and Suggestions on Stimulation Policy of Stereo Greening in China

5.1. Incentive Policy of Stereo Greening in China

5.1.1. Policy Hierarchy is not Clear and Cohesion Is Poor at present, China’s top-level planning has not yet defined the requirements of vertical greening, and the directivity and guiding significance of the lower-level planning is poor, which also leads to the different definitions and requirements of vertical greening in different provinces. The level of documents related to urban vertical greening is not clear enough and the degree of correlation is low. The various forms of documents issued often lead to unclear responsible departments, resulting in poor overall vertical greening system.

5.1.2. The Target of Reward Is Not Clear and the Incentive Intensity Is Low in the upper level planning, stereo greening is generally encouraged or advocated or rewarded, but there are no specific implementation rules. At present, the incentive policy for vertical greening of buildings is mainly aimed at roof greening. There are no specific guidelines for wall greening, overhead greening and balcony greening at the municipal level, which makes it difficult for the lower government to formulate clear indicators and implementation methods. Government incentives for vertical greening are still in a relatively conservative stage, such as volume rate and building area incentives, low-interest loans and other strong incentives have not yet been adopted, resulting in low enthusiasm of enterprises to explore vertical greening.

5.1.3. The Calculation Standard Is Not Clear and the Practicability is Weak in the relevant incentive policies for vertical greening, although the types of vertical greening are defined, the calculation standards for different types of vertical greening are not clear enough, and there is a lack of theoretical basis. Government departments play a dominant role in the evaluation process, and subjective factors are larger. In the implementation of project awards, enterprises need to play a large number of games with the government, which leads to weak policy reference in the project design stage and reduces the implementation of vertical greening.

5.2. Suggestions on Promoting Vertical Greening Incentive Policy

5.2.1. Promoting Top-Level Planning and Strengthening Planning System Vertical greening will be incorporated into the top-level planning to promote the construction of vertical greening from top to bottom. Strengthen the systematicness and relevance of vertical greening in different levels of planning, and ensure that the lower level planning further refines the incentive measures of vertical greening according to the guidance of the upper level planning. On the other hand, we should strengthen the systematic regulations of vertical greening from planning and design to implementation and maintenance to ensure that policies cover all aspects of vertical greening projects.

5.2.2. Strengthen Theoretical Research and Increase Green Innovation Index The government should strengthen the basic theoretical research on vertical greening, ensure the scientificity of the reward standard, promoting the theoretical research on the ecological, social and economic effects of vertical greening. At the same time, it should clarify the demand for vertical greening in different regions and the incremental cost of buildings, and formulate effective incentive policies in combination with the
actual situation. On the other hand, on the basis of the original policies and theories of vertical greening, innovative indicators of vertical greening are explored to promote the implementation of vertical greening in an all-round way.

5.2.3. Define the Basic Reward Standard and Improve the Local Reward Intensity

On the basis of certain theory and practical experience, the basic standard of vertical greening reward should be formulated to guide the implementation of the lower vertical greening. In the process of formulating specific implementation measures, all localities should further formulate incentive measures on the basis of reward standards in accordance with regional characteristics. On the other hand, local governments should increase incentives on basic standards, so as to promote the multi-party game of incentive evaluation and implementation towards the optimal and stable and balanced direction.

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