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# Green Development Status in Zhejiang Province and the City of Ningbo, China: Examination of Policies, Strategies and Incentives at Multiple Levels

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**Abstract.** China is undergoing the largest scale of urbanization in history and at an unprecedented pace. The construction and operation of buildings have inevitably brought severe pressures on resource conservation and environmental protection. China has initiated policies, strategies and financial incentive schemes at national level to address these issues. It is also seen that there is a growing interest in recent years at local government level in promoting green buildings. This paper will examine the current national policies, targets and standards and then discuss how these national initiatives are reflected at provincial and city level by taking Zhejiang Province and Ningbo City as case studies. A comparison between different levels of initiatives is conducted by reviewing incentive mechanisms, technological development and compliance requirements. It is concluded that the national initiatives may be not effective without local enhancement.

## 1. Introduction

China's urbanization is progressing rapidly at has gone through a phase of unprecedented pace in 1980s and 1990s. Currently, China's urbanisation is steady but still progressing at a large scale. Between 1991 and 2012, China's urban population has increased from 26.4% to 52.6% of the whole population, which signifies a major shift, doubling the number of urban residents in only two decades. The urban built areas are expanded from 12,856 km<sup>2</sup> to 45,566 km<sup>2</sup> over the same period, an increase of 3.5 times greater in about two decades National Bureau of Statistics [1]. The number of new buildings - and often large scale structures - in cities is increased significantly in these decades in order to accommodate the increased urban population. In return, the rural population has been perceptible in this process of transition, from a rural country towards an urbanising nation. For instance, as Li and Shui [2] argues, in recent years China has been adding about 1.7 billion square meters of new floor space on an annual basis. As estimated by the 'Building Energy Conservation Center (BECC)' of Tsinghua University, the annual rate of new construction in China equals the total amount of new building in all developed countries BECC [3]. In 2005 Shanghai alone added more space in the form of residential and commercial towers than exists in all of New York City [4]. Taking the annual addition to the residential building stock, the number has soared from 0.4 billion m<sup>2</sup> to approximately 0.7 billion m<sup>2</sup>, a growth rate of 69% in the last one decade [2]. Such significant increase certainly puts major pressures on construction industry. The rapid pace of development often results in poor quality development that may not necessarily be sustainable. Now that China has gone through



this rapid phase, a larger emphasis is expected to be given on quality of development to address issues of sustainability and green development. Cities in general and the built environment in particular, during their life-cycle, have a significant environmental impact both at local and global levels. The suggestions given on rapid expansion of urbanisation level has inevitably brought severe pressures on resource conservation and environmental protection in Chinese cities. This factor is highlighted significantly in recent research in the field. As a result, we now experience major urban pressures (and some are global) of increasing pollution, traffic and energy consumption in the urban areas. Major criticism is given on the pace and mode of development in most cases, which has resulted in mass development of low-quality or unsustainable development projects across major cities in China. These mainly include cities of tier 1, tier 2 and tier 3 that have mostly experienced rapid pace of development or are still facing that phase of growth and expansion. For instance, only eight of 74 major Chinese cities, have satisfied the national air quality standards in 2014 [5], which indicates a major nationwide challenge. Moreover, given the long lifetime of buildings, choices made today on the construction of buildings will have long-term effects influencing the overall environmental performance of cities for decades to come [6].

In this process of rapid development and urbanisation progress, buildings have become a major energy consumer in China. The most significant impacts are on building operational consumption that varies between 16% and 30% of the total national consumption based on various data (e.g. IEA [7], BEEC [3], Yang and Kohler [8], He et al [9]). If embodied energy used for manufacturing building materials is taken into account, the total building energy consumption may be around 40% of the national total energy consumption [10], cited in [8], which is relatively higher than just consideration of the operational energy consumption. However, this is not yet the energy consumption cap as further growth and urbanisation is under process. For instance, BEEC has estimated that the 2030 national total building energy consumption will be based on three variables that are: a) floor area per capital b) life-style changes; and c) technology evolution. The variables may not be so significant individually, but their combined effects would determine an estimated increase of minimum 14% (the best scenario) consumption increased from the building operation in 2030. The worst case scenario is the increase of 270% that is estimated based on the worst case scenario of all three variables combined together. This also implies there is huge potential to reduce energy use in building sector in China BECC [3]. It is therefore foreseen to comprehend more emphasis on initiatives, incentives and policies – and if not merely technologies – on this almost ever-growing sector of building construction.

### *1.1. Green Building Development Policies at the National Level.*

At the national level, there is a list of programmes that are discussed in here.

*Green Building Action programme* – Announced in January 2013 by the state council, the GBAP has the clear objective of completing 10 billion square meters area of new green building construction and 20% of the new construction in the city meets the green building standard requirement till the end of 2015. Also since 2014, all of the construction invested by the government, affordable housing and large public building should implement the green building standard.

*Notice on Implementation of Green Building Action in Protected Housing* – promulgated in December 2013 by the Ministry of Housing and Urban-Rural Development (MOHURD), this specific programme requires a full understanding of the importance of green housing action in affordable housing. In this respect, since 2014 the municipal area of affordable housing, should implement green building action, at least meet one-star green building standards. During conducting annual plan of affordable housing projects, green building action requirements should be made clear. This is also required to strengthen publicity of affordable housing.

*Planning for New Urbanization in China (or commonly as New-Type Urbanisation Plan)* – Developed over the course of several years and announced in March 2014, the CPC Central committee and The State Council put together a list of key requirements on: 1) implementation of green building action plan; 2) improvement of the green building standards and certification system; 3) expansion of

the scope of enforcement; 4) speeding up energy-saving transformation of the existing building; 5) development of green building materials; and 6) promotion of the construction industry as a whole.

*Notice on Printing and Distributing the Action Plan for Energy Conservation, Emission Reduction and Carbon Reduction from 2014 to 2015* – Also announced by The State Council and in May 2014, the main requirement of the programme is to deeply develop the green building action plan. The public welfare buildings invested by government, large public buildings and affordable housing in cities should therefore fully implement the green building standard. Till 2015, Implementation rate of new urban construction which meets the green building standard should reach to 20%, and the area of new green building up to 3 billion square meters.

*Notice on Promoting the Green Building Action in the Public Welfare Buildings Invested by Governmental and Large Public Buildings* – Also developed by MoHURD and in October 2014, the requirements of the programme are to fully address the importance of government investment in public buildings and large public buildings to promote green building action. This is also required to encourage the use of industrialization construction model and the use of green building materials. As a result, the programme aims to strengthen management of the whole process of construction.

*Opinions of the CPC Central Committee and the State Council on Accelerating the Construction* – Developed jointly by the CPC Central Committee and The State Council and announced in April 2015, the programme requires vigorous promotion of green urbanization. During the process, this aims to strengthen the concept of energy conservation, development of low carbon and convenient transportation systems, and promote the construction of green ecological city.

### 1.2. Green Building Technical Standards and Strategies at the National Level.

In recent years, China has also developed several technical standards at the National Level.

*Green Construction Evaluation Standard for Building Engineering (GB/T 50640-2010)* – Lunched in October 2010, this standard includes eight categories of: 1) Construction preparation; 2) Construction site; 3) Foundation and foundation works; 4) Main structural engineering; 5) Construction and decoration works; 6) Insulation and waterproofing works; 7) Mechanical and electrical installation works; and 8) Demolition works.

*Code for design of civil green building (JGJ/T 229-2010)* – Developed in Oct 2011, the standard is applicable to design of the new built, alteration and extension of green building. It also includes general rules, terms, basic regulations, design plan, site and outdoor environment, water supply and sewerage, architectural design and indoor environment, HVAC and building electrical systems.

*Evaluation Standard for Green Industrial Building (GB/T 50878-2013)* – Lunched in March 2014, it includes an evaluation index of: 1) Land saving and sustainable development; 2) Energy saving and energy utilization; 3) Water saving and water resources utilization; 4) Materials saving and materials resources utilization; 5) Outdoor environment and contaminant control; 6) Indoor environment and occupational health; 7) Operational management; and 8) Technology progress and innovation.

*Green Building Inspection Technology Standard (CSUS/GBC 05-2014)* – announced in July 2014, this standard includes comprehensive list of: 1) Outdoor environmental testing; 2) Indoor environmental testing; 3) Thermal performance test of enclosure structure; 4) HVAC system testing; 5) Water supply and drainage system testing; 6) Lighting and power supply and distribution system testing; 7) Renewable energy system testing; 8) Monitoring and control system verification; and 9) Building energy consumption and total energy consumption of air conditioning in heating.

*Green Building Evaluation Standard (GB/T 50378-2014)* – Developed in 2014 (second edition), this standard provides scope of application for various types of civil construction and public building. It also provides scope for Green Building Evaluation Index System, which highlights the following seven aspects of: 1. Land saving and outdoor environment; 2. Energy saving and energy utilization; 3. Water Saving and Water Resources Utilization; 4. Materials saving and Materials Resources Utilization; 5. Indoor environment quality; 6. Operation management; 7. Construction management. The evaluation indexes are then graded and the green building level is determined by the total score.

*Green Evaluation Criteria for Existing Buildings (GB/T 51141-2015)* – Developed recently in August 2016, the standard is provided to mainly supplement and enhance the green building evaluation standard system in China. The evaluation index is considered for seven categories of: 1) planning and architecture; 2) structure and materials; 3) HVAC systems; 4) building electrical systems; 5) water supply and sewage systems; 6) construction management; and 7) operational management.

*Evaluation Criteria for Green Eco-City* – currently at soliciting opinion stage, this standard comprehensively include: 1) Land use; 2) Ecosystem; 3) Green building; 4) Resources and carbon emissions; 5) Green transportation; 6) Information management; 7) Industry and economy; 8) Humanities; and 9) Technological innovation.

### 1.3. Green Building Incentive Schemes at the National Level.

At the national level, there is a list of incentive schemes at the National Level.

*Green Building Action Program* - Giving the finance incentives to buildings that reach the national green building evaluation standard: 45 RMB per square meter for two-star green building, 80 RMB per square meter for three-star green building.

*Tax Policy* - National ministries and commissions: the Ministry of Finance should consider and formulate preferential policies on taxes, encourage real estate developers to build green buildings, and guide consumers to buy green houses. For instance, Xiamen province aims to give back 20% deed tax to owners who brought the 2-star green house and 40% to those who brought the 3-star green houses.

*Financial Policy* – National ministries and commissions: Improve and optimize the financial services for green building, financial Institutions could give appropriate concessions on house loan interest rate to consumers who buy the green house. For instance, Jiangsu province gives loan amount can go up 20% for who buy two-star or above green housing using housing provident fund loans.

*Land Policy* - National ministries and commissions: Ministry of Land and Resources should consider and formulate policies which can promote green building development in land transfer. Ministry of Housing and Urban-Rural Development should consider and formulate policies in volume rate incentives. For instance, Fujian province proposes for green building district developed by real estate developer can awarded 1%, 2% and 3% of volume rate respectively according to one-star, two-star and three-star green housing.

## 2. Reflection of National Policies at Provincial and City Level

In China, the concept of green building was defined in the first edition of GBES in 2006, which elaborates that a green building should be ‘energy-saving’, ‘water-saving’, ‘material-saving’, ‘land-saving’ and ‘environment-benign’, summarised as “four savings and one benign”. Generally the Chinese legal and policy systems for developing green buildings comprise four levels, including; 1) The Energy Conservation Law; 2) Renewable Energy Law; 3) Construction Law; and 4) Environmental Protection Law constitute the legal basis and give the general principles for developing green buildings. The State Council has issued regulations to enforce the laws and some provincial and local governments also have developed their own regulations for improving building environmental performance. Building design standards for various climatic zones have been issued by the Ministry of Housing and Urban-Rural Development (MoHURD). GBES is the first comprehensive system for whole building assessment and has been a national standard since its development as the assessment standard in China. Before GBES, there were fragmented assessments on various aspects of building environmental performance such as energy, material and water. As a result, policy and financial incentive schemes have been proposed at both national and local levels.

At the local level, some local governments have developed their own green building evaluation systems, which often have more rigid requirements on building environmental performance than national standards. A remarkable example is in Beijing, where they execute the new goal of 75% building energy efficiency since 2011 [11][12], compared to the national requirement of building energy saving of 50%. Similarly, two cities of Shanghai and Tianjin also require a minimum of 65%

energy saving for new buildings. Therefore, we can see a transition from national level to local level policies and initiatives.

### 2.1. Case Study Analysis: The Cases of Zhejiang Province and City of Ningbo

In this study, we also demonstrate the policies, technical standards, and incentive schemes at the Provincial level of Zhejiang Province first and the at the City level of Ningbo. Sub-sections 2.1.1 to 2.1.3 cover the provincial level, while 2.1.4 to 2.1.6 cover the city level.

**2.1.1. Green Building Development Policies at the Provincial Level.** At the Zhejiang provincial level, there is a list of programmes that are discussed in here:

*Opinions of Zhejiang People 's Government on Actively Promoting the Development of Green Buildings* – Developed in August 2011, the requirements of the programme are to mainly to enhance social awareness of energy conservation and form a green building development system in order to achieve the leaping development of transferring the energy-saving construction to green construction.

*Notice of the General Office of the People's Government of Zhejiang Province on Deepening Printing and Distributing the Implementation of Promoting New-type Industrialization of Buildings and Promoting the Development of Green Buildings in Zhejiang Province* – Developed in December 2014, the main requirement is to construction invested by the government, indemnificatory housing in Hangzhou and Ningbo cities, and large public buildings with area larger than 20,000 m<sup>2</sup> are required to meet green building standard, as well as implementing new building industrialization.

*Three-year action plan of Green Building Development in Zhejiang Province* – Developed in September 2015, this programme proposes to build new green construction. Green Design Standard for Civil Buildings in Zhejiang Province has been implemented on new civil construction within the province; government investment public welfare housing and large public buildings which reaches to 20,000 m<sup>2</sup> of area and are encouraged to meet the two-star or three-star green building standard. The programme also includes requirements to build new prefabricated building. The areas of industrialisation projects both completed and under construction, reach 1 million m<sup>2</sup> in 2015, 3 million m<sup>2</sup> in 2016 and 5 m<sup>2</sup> meter in 2017. It also includes energy saving renovation for existing building.

**2.1.2. Green Building Technical Standards and Strategies at the Provincial Level.** In recent years, Zhejiang Province has also developed two technical standards (Table 1).

**Table 1.** Two Technical Standards developed in Zhejiang Province

Green Building Evaluation Standard (DB33/T 1039-2007)	Started in 2008.8.1	Basically continuation the framework system of GB/T 50378-2006.
Code for design of civil green building (DB33/T 1092-2013)	Started in 2014.1.1	Basically continuation the framework system of JGJ/T 229-2010 .

**2.1.3. Green Building Incentive Schemes at the Provincial Level.** Also Zhejiang Province has proposed for one incentive scheme at the Provincial Level:

*Financial subsidy* - The only incentive scheme is the financial subsidy which proposes requirements according to the three-year action plan of Green Building Development in Zhejiang Province, including giving the financial incentive to those new construction industrialization projects, which have awarded national green construction two-star or three-star level. These are based on the Opinions on Accelerating the Development of Green Building in China enacted by Ministry of Finance and Ministry of Housing and Urban-Rural Development.

**2.1.4. Green Building Development Policies at the City Level.** At the City level, there is a only one major programmes that is discussed in here:

*Ningbo Green Building Action Plan* – Developed by Office of Ningbo Government, the policy action plan is for new built construction projects. From 2014, construction invested by government,

indemnificatory housing in Ningbo, and large public buildings which area larger than 20,000 m<sup>2</sup> are required to meet green building standard. By the end of 2015, the area of new built green construction reaches 10 million m<sup>2</sup>, accounting for 20% of the whole new construction area. Also the other requirement is the energy saving renovation for existing buildings. By the end of 2015, the area of completed energy saving renovation for existing building reaches to 1 million m<sup>2</sup>, the renovation rate of high energy consume building up to 30%.

*2.1.5. Green Building (Local) Technical Standards and Strategies at the City Level.* In recent years, Ningbo city has also developed two local technical standards (table 2).

**Table 2.** Two Local Technical Standards developed in Ningbo City

Document name	Promulgation time	Content
Implementation Rules of Ningbo Green Building Evaluation (SS-01)	2014.7.1	Included in: 1. Land saving and outdoor environment 2. Energy saving and energy utilization 3. Water Saving and Water Resources Utilization 4. Materials saving and Materials Resources Utilization 5. Indoor environment quality 6. Operation management 7. Technological innovation for both residential building and public construction
Implementation Rules for Civil Green Building Design in Ningbo City	2016.10.1	Combination of Green Building Evaluation Standard (GB/T 50378-2006) and Green Building Evaluation Standard (DB33/T 1039-2007), summarize of Ningbo city green building practice experience and research results.

*2.1.6. Green Building Incentive Schemes at the City Level.* Also Ningbo City has proposed for one incentive scheme at the City Level (table 3).

**Table 3.** One Incentive scheme at the city level, Ningbo City

Notice on the adjustment of green building pre-sale conditions of commercial housing enacted by Ningbo City Housing and Urban Construction Committee	Through the establishment of special funds to support green building, both energy-saving and building renovation work. Encourage all localities to carry out green building volume rate of incentives and supporting policies.
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### 3. Further Discussions: Green Development and A Cross-level Transitional Approach

China has initiated major policies, strategies and pilot projects at both national and local levels to address the key issues of resource and environmental challenges. These are heavily reflecting the construction sector and operation of buildings. Thus, China has developed a broad concept of development a “resource-conserving and environmental friendly society” in order to achieve a more harmonious development pattern. This seems to become a necessity as the estimated figures (some shown above) indicate major consumption challenges across the country. In this respect, China’s focus is at both national and local levels in order to address these issues. The focus is therefore on three key aspects of: 1) low-carbon/green buildings; 2) new urban areas; and 3) retrofits for the existing contexts. Accordingly, there are key policy mechanisms implemented as incentives, which promote approaches to green building design. In recent years, we can witness a growing interest in green buildings and development in Chinese cities. According to Green Building Map [13], the following progress has occurred in less than one decade:

- 2098 projects have been certified by the Chinese Green Building Evaluation System (GBES) since it was launched in 2006. This includes 398 three-star certified buildings;
- 446 projects have been certified LEED certification;
- four projects are currently under BREEAM evaluation;
- There are also around 280 Chinese cities that have declared an ambition to develop “eco-city” or “low carbon city” China Society for Urban Studies [13][14].

More importantly, such large scale to implementation has deeply shapes the local construction industry, from design, material manufacturing, and construction to operational management. Therefore, the green development sector has become a valuable contributor to the local economy.

#### 4. Conclusions

What is important to note and has been briefly demonstrated in this research paper is the policy transitions from national initiatives to the local scale. The examples of provincial level and city level policies, technical standards/strategies and incentive schemes demonstrate the importance of local enhancement for implementation. Also other city-level cases across the country show the importance of local enhancement in development of policies and strategies, if not financial incentive schemes.

Across various cases, it is visible to identify many Chinese cities that have allocated quantitative targets for energy saving and carbon emissions at the city or regional level. Green buildings are seen as a key area to achieve these targets and have become highlight of the green development plans in recent years. At the local level, there is still a major scope for policy improvement, such as incentive mechanism and coordination of various stages of green building development. These are yet to be addressed in the process of local enhancement based on national initiatives.

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