Chapter 2
Report on China's Eco-City Development

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China has entered a critical growth stage where the percentage of population living in urban areas is rising rapidly. Strategic considerations during rapid urbanization include reviewing the current urban development pattern, abandoning traditional approaches to urban development, seeking sustainable eco-city development approaches, and improving urban development coordination with environmental protection and resource conservation. The report to the 17th CPC National Congress clearly expressed that China will "promote a conservation culture by ensuring that industry structures, growth patterns, and consumption habits become efficient in use of energy and resources and are environmentally friendly. We will implement a large-scale circular economy and considerably increase the proportion of renewable energy sources out of total energy consumption. Major pollutant discharges will be brought under effective control and the resulting ecological and environmental quality improvements will be notable. Conservation awareness will be firmly established throughout society." This statement adds new components to the traditional definitions of civilization and development, opens the door to a new era of sustainable development in China, and specifies new tasks and requirements for urban development and management. Urban development is changing its focus onto a better quality life, away from simple economic growth. Eco-cities have become a widely accepted model to develop toward the field of urban development in China.

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2.1 The Current Status of Eco-City Development in China

2.1.1 Eco-City Development in China

China is working through the earliest eco-city development stage. Although the work has provided some experience and led to certain achievements, China faces problems and challenges in the continued development of eco-cities.

The Initial Eco-City Construction Wave Eco-city development in China has already surpassed several milestones. The city of Yichun in Jiangxi Province was the first Chinese city to announce its goal of developing into an eco-city in 1986. The local government drafted an eco-city development plan and launched a pilot program in 1987, pioneering efforts in China toward eco-city construction. Several scholars including Huang Guangyu developed an eco-city development plan for the city of Leshan in Sichuan Province in 1987. The Chinese government has been conducting pilot eco-civilization demonstration zone initiatives since 1995 such that today there are 389 state-level eco-civilization demonstration zones across China. The Hainan Provincial People's Congress promulgated the *Decision on Building an Eco-province* and approved the *Plan for Developing Hainan into an Eco-province Outline* in 1999, when the former SEPA authorized Hainan Province to join the national pilot eco-province development program. The former SEPA also authorized the city of Guiyang in Guizhou Province to join a national pilot eco-city development program in 2002 that was specifically focused on circular economy development. Guiyang has since provided significant contributions to national efforts that push cities rich in resources to develop eco-city structures. The Chinese and Singaporean governments jointly held the opening ceremony for a project known as the Sino-Singapore Tianjin Eco-city (SSTEC) in 2007, the world's first international eco-city development project. This project signaled the aggressive shift China decided to adopt in international cooperation for eco-city development. Eco-friendly reconstruction was an important objective in the efforts after the 2008 Sichuan earthquake. Some experts insisted that post-quake urban reconstruction focus on building small- and medium-sized cities that will be safe, comfortable, and environmentally friendly.

Another wave of eco-city development swept China since 2000, thanks to the implementation of the sustainable development strategy and increased awareness of the eco-civilization concept and the Scientific Outlook on Development. Jilin, Heilongjiang, Fujian, Zhejiang, Shandong, Anhui, Jiangsu, Hebei, Guangxi, Sichuan, and Liaoning provinces have announced their intentions to become eco-provinces. Beijing, Shanghai, Shenzhen, Suzhou, and Ningbo have likewise announced their intention to become eco-cities. As of February 2011, 230 of 287 Chinese cities at the prefecture level or higher, that is 80.1 % of these larger cities, had expressed their intentions and aims of developing into eco-cities, according to statistics from the Chinese Society for Urban Studies (CSUS) academic exchange department. Of the same 287 cities, 46.3 % or 133 cities had announced plans for

becoming low-carbon cities. The combined result is that 90.2 % of cities, that is 259 of the 287, have announced plans to become eco-cities, low-carbon cities, or both.[1] Eco-city developed has moved to the top of the priority list for Chinese cities developing under the Scientific Outlook on Development and transforming their economic development pattern.

Eco-City Development Standards Multiple indicator sets exist to measure eco-city or sustainable development in China. These indicator sets are released by different government authorities, and each one focuses on a particular facet of the city, including the former SEPA indicators for assessing which Chinese cities serve as environmental protection role models in the 11th Five-Year Plan period; the former SEPA indicators for assessing and accrediting pilot eco-civilization demonstration zones across China; the former MOC national standard for garden cities; the former MOC *National Standard for Eco-cities and Garden Cities (Trial)*; the former MOC reference indicator set for the China Habitat Award; the CSUS scientific assessment standard for livable cities; the NDRC, NBS, and former SEPA circular economy indicator set; the SFA indicators measuring a National Forest City; the National Afforestation Commission (NAC) national inspection and scoring standard for cities that serve as landscaping role models; the Communist Party of China Central Guidance Commission for Building a Spiritual Civilization (CGCBSC) National Civilized City Assessment System (Trial); the National Patriotic Public Health Campaign Committee national clean city standard; the MOST primary indicators of socioeconomic and environmental conditions in the national pilot sustainable development zones; and the China National Tourism Administration (CNTA) national inspection standard for excellent tourism-oriented cities. *The Indicators of Eco-districts, Eco-cities, and Eco-provinces Development (Trial)* was released by the former SEPA on May 23, 2003 and includes 28 eco-city indicators that span economic development, environmental protection, and societal advances. A revised version of this standard, published on January 15, 2008, reduced the number of eco-city indicators to 19. According to the eco-city indicators' descriptions, the primary elements present in an eco-city include strong and balanced ecosystems; low environmental pollution; effective natural resource protection and use; a stable, reliable, and ecological safety assurance system; effective enforcement of environmental laws and regulations; faster socioeconomic development through a circular economy; harmony between people and nature as well as progress in green culture development; ability to create and maintain clean and beautiful urban and rural environments; and a higher quality of life in all respects. A Chinese municipality must satisfy the following requirements to be named an eco-city: a published eco-city development plan, approved and promulgated by the municipal people's congress for implementation; effective enforcement of local and national environmental laws and regulations; an independent environmental protection agency at the district or municipal level; factoring environmental protection in the CPC committee and district, city, and municipal governments' performance assessments of officials

[1] Li and Liu [1].

using an established assessment mechanism; ability to achieve energy conservation and emission reduction targets set by higher government departments; absence of severe environmental incidents over the previous 3 years; effective responses to the public's environmental complaints; no significant presence of invasive foreign species in local ecosystems; leading in the environmental quality index among municipalities in the same province; at least 80 % of all districts (or district-level cities) in the municipality must be recognized for meeting the national eco-district development requirements; and the central city is recognized as a role model in environmental protection based on assessment standards. The standard was significantly revised in its second draft. In the new standard, the ability to achieve energy conservation and emission reduction targets specified by the higher governmental departments is established as a basic eco-city requirement. "Environmental protection" was renamed as "ecological and environmental protection" to apply over a wider range. The indicator set was reduced to 19 by eliminating indicators deemed insignificant or too difficult to calculate. Only three societal advancement indicators remain in the new set. Some indicators were renamed and adjusted to more aptly guide eco-city construction. Water consumption per unit GDP was replaced by freshwater consumption per unit of industrial added value and the agricultural irrigation water use coefficient to more specifically reflect the pressure on water resources caused by economic development. The standard values of multiple indicators were adjusted to make eco-city development targets more consistent with relevant national policies. The standard value of energy consumption per unit of GDP was reduced to 0.09 tons of standard coal/1,000 yuan of GDP from the original 0.14 tons of standard coal/1,000 yuan of GDP. This stringent requirement aligns with the national policy regarding energy conservation and emission reduction. The indicators are now grouped into reference and restrictive indicators. The indicators are all restrictive except for those measuring the percentage of the tertiary sector in GDP and the three societal advancement indicators.

Different Types of Eco-Cities Various types of eco-cities can be found across China. The first type includes some newly built satellite towns that are classified as eco-cities, such as the first batch of pilot eco-cities, which include the SSTEC, Caofeidian International Eco-city, Wuxi Eco-city, Zhuzhou Eco-city, Fengxian Eco-city in Shanghai, as well as the Guangming and Pingshan New Areas in Shenzhen. China has built a dozen of these eco-cities, which already in their planning stages emphasize energy conservation, emission reduction, environmental protection, biodiversity, improvements to the living environment, and harmony between people and nature. The second type of eco-cities is built upon existing cities. The Chinese government has developed a series of standards for this process including the national standards for garbage classification and recycling, water recycling, green transportation, green buildings, low-carbon industries, and renewable energy. Existing Chinese cities may evolve into eco-cities through gradual improvements in infrastructures, functions, and other dimensions toward the established standards. The third type of eco-city results from post-disaster reconstruction, examples of which include Beichuan and Yushu. These eco-cities focus on meeting national

environmental protection, energy conservation, emission reduction, and livability standards from the beginning. Examining Chinese eco-cities reveals six categories: landscape and recreation-oriented cities, green industry-oriented cities, resource-conserving cities, environmentally friendly cities, circular economy-oriented cities, and green consumption-oriented cities. Landscape and recreation-oriented cities operate at a high eco-civilization level. Urban landscapes serve as the primary recreation spaces in these cities, the majority of recreation activities are done outdoors, and ecosystem services are found at the core of urban development. The city of Suzhou, known for cultural landscapes, provides a typical example. Green industry-oriented cities promote green concepts, utilize advanced technology, and establish green industry systems to achieve sustainable social, economic, and environmental development, balance the natural ecosystem, and allow for harmony between cultural landscapes and ecosystems. The city of Kunming focuses on building green industry systems, providing a typical example of this type of city. Resource-conserving cities take legal, economic, administrative, and other measures in production, distribution, and consumption to realize efficient resource use, optimized economic and social benefits with the lowest possible resource consumption, and ensured sustainable socioeconomic development. The city of Beijing has long worked toward energy conservation and emission reduction, providing a representative example of this type of city. Environmentally friendly cities build in consideration of the environment's carrying capacity, obey the laws of nature, deploy green technologies throughout all sectors, and advocate for a green culture and an eco-civilization. The city of Guilin boasts easy access to unique natural landscapes, providing a good example of this type of city. Circular economy-oriented cities are known for good spatial arrangements, sound infrastructure, a clean and beautiful environment, high levels of safety and comfort in life, efficient utilization of materials and energy, and sustainable resource use, as factors reliant upon a circular economy. The city of Guiyang focuses on developing circular economy and so represents this type of city. Green consumption-oriented cities promote green product consumption to further environmental protection and conservation. The city of Dalian has long been promoting green lifestyles and serves as a typical example of this type of city.

Shared Ideas for Eco-City Construction Chinese organizations accumulated some experience in building eco-cities during the eco-city construction wave, leading to some agreements on strategies and points deserving attention. The first agreement is that a clear eco-city development plan is needed as the cornerstone for the eco-city's construction. Objectives and indicators are defined in the eco-city development plan for each phase of each city's development, providing a series of projects that ensure the scientific implementation of the plan. The second agreement dictates that ecological function zones shall play a significant role in eco-city construction. Eco-city development in China distinguishes itself by emphasizing ecological function zoning. The relevant government authority drafts an ecological function zoning scheme based on comprehensive assessment on the current ecological and environmental conditions, ecological vulnerability, and ecosystem services,

keeping in mind current spatial arrangements and local ecosystem characteristics. Relevant organizations further study each ecological function zone to determine the ecosystem's characteristics, functions, and trends and resources in need of protection. The studies guide local natural resources extraction, utilization, and protection, providing a scientific analysis for industrial arrangements across the city. The third agreement stipulates that developing a circular economy is critical for eco-city construction. Only a circular economy can minimize the natural resources needed for economic activities and their environmental impact. Chinese society has gradually come to accept the need to achieve sustainable economic growth with the lowest possible resource consumption and environmental costs. A comprehensive circular economy and green industrial development systems are planned into industry policy, industrial arrangements, adjustments to the industry mix, and new industrial parks. The fourth agreement demands that eco-cities are built from a systemic and comprehensive perspective. The former SEPA proposed that eco-city development focuses on key issues, in particular on construction of the four central urban systems, at a site meeting about nationwide eco-district and eco-city development held in Suzhou in 2004. The first central urban system is an efficient production system with low energy and resource consumption and low pollution levels developed by promoting green industries. The second central urban system is a stable, harmonious, and high-quality environmental system achieved through environmental improvements. The third central urban system is a beautiful, comfortable, and harmonious human settlement system comprised of eco-friendly structures. The fourth central urban system is a modern and distinctive green culture system achieved by promoting green culture.

2.1.2 Recent Eco-City Developments in China

Diversification Every city enjoys unique geographic, historical, cultural, and infrastructure characteristics. Local governments should research these characteristics before drafting an eco-city development program so they can account for local conditions and highlight local advantages and characteristics in relevant fields. Such diligence will allow eco-city development to profit from a city's advantages and create a remarkable image for the city. Eco-cities are rapidly built across China. A variety of patterns have emerged in a diversified coexistence that includes garden cities, mountain and river cities, mountain cities, livable cities, forest cities, green cities, and low-carbon cities. These patterns share a common goal – achieving harmony between the built and natural environments and creating an environment supportive of humanity and its growth. Despite the common goal, these patterns do not share the same priorities. These patterns align with the complex and diverse natural and cultural circumstances found across China. Chinese eco-cities can be divided into three categories based on implementation and organizational structure, including international cooperation, ministry–province (or city) partnership, and independent. The SSTEC and the Caofeidian International Eco-city are examples of

type 1 international cooperation between China and Sweden, and Chongqing Yuelai Eco-city is the result of cooperation between China and the United States. The Wuxi Eco-city and Guangming New Area in Shenzhen are examples of type 2 partnerships. The Anji District in Zhejiang Province, Huainan City in the Anhui Municipality, and Yanqing and Miyun Districts in Beijing all provide as examples of type 3 independent development. Chinese eco-cities are also grouped into two categories determined by the scope of implementation. Implementation focused on a specific issue, like the focus on concentrated gas and the ecological rehabilitation of coal mining subsidence areas in Huainan, is one possible scope. The other scope focuses on integrated implementation, found in Anji District and many other eco-cities in China. A large number of Chinese cities are pursuing unique eco-city development patterns ideal for their local situation by implementing stylized projects. The Caofeidian International Eco-city is focused on establishing a circular economy in accordance with its strengths; the Wanzhuang Eco-city, part of Langfang City in Hebei Province, is concentrated on creating a green transportation system; the Dongtan Eco-city in Shanghai City is developing eco-friendly farms and wetland parks; Yuxi City in Yunnan Province is developing aquatic ecosystems adjusted to the plateau environment; and the Lanzhou New Area in Gansu Province is establishing a demonstration zone for the rehabilitation of mountain ecosystems and a sports-themed ecological park.

Focus on Low-Carbon Emissions All countries have agreed that alleviating global warming and reducing carbon dioxide emissions are necessary as the world enters the twenty-first century. The 1997 Kyoto Protocol followed by the 2007 Bali Road Map and the 2009 Copenhagen Climate Change Conference chart the approaches countries have adopted to fulfilling their respective obligations to reduce carbon dioxide emissions and achieve set targets. All humans are now searching for low-carbon development patterns. China's agenda must prioritize energy conservation, emission reduction, and environmental protection to address its position as the world's largest carbon dioxide emitter. The term "low carbon" has become the China's eco-city development theme. Over 200 Chinese cities at the prefecture level or higher have announced their intention to become a low-carbon city, including Baoding, Shanghai, Beijing, Hangzhou, Wuxi, Wuhu, Dezhou, Zhuhai, Shenzhen, Xiamen, Chengdu, Chongqing, Wuhan, Nanchang, Guiyang, Jilin, and Harbin, following a general rising trend in China. Shenzhen has announced that it will create a long-term low-carbon development program, improve its carbon trading market, promote low-carbon technology development and application, and cooperate on low-carbon development internationally. Guangzhou unveiled its plans to advocate low-carbon lifestyles, build low-carbon communities and transportation systems, and encourage public organizations to conserve energy. Xiamen has announced its plans to become China's leading low-carbon city by aggressive promotion of an eco-civilization. Baoding has announced that it will lower carbon emissions in a growing number of fields and become a distinctive model for low-carbon cities. Shanghai is working to develop renewable energy and improving traditional energy

efficiency. It has identified Chongming Ecological Island, Lingang New City, and Hongqiao Central Business District as low-carbon demonstration zones.

The NDRC launched a pilot low-carbon development program in five provinces and eight municipalities in 2010, including in Guangdong, Liaoning, Hubei, Shanxi, and Yunnan provinces and in Tianjin, Chongqing, Shenzhen, Xiamen, Hangzhou, Nanchang, Guiyang, and Baoding. The NDRC requires these municipalities and provinces to include their respective pilot low-carbon development schemes in their local 12th Five-Year Plan for economic and social development. The Chinese government has defined an integrated, three-stage strategy for building low-carbon cities. Stage 1 (2010–2020) will focus on a "no regrets emission reduction" strategy. Stage 2 (2020–2030) will implement the "alternatives to fossil energies" strategy. Stage 3 (2030–2050) will cover the implementation of the general emission reduction strategy.[2] The "no regrets emission reduction" strategy requires Chinese cities to adopt low-carbon measures including developing new energy industries such as clean coal and new energy vehicles (NEVs) to achieve green industry-based emission reductions; developing various low-carbon or zero-carbon products such as LED lights to reduce emissions through reduced energy use; developing public transportation, improving rail infrastructure, limiting private vehicle use, implementing the fuel-to-gas project, and encouraging walking and cycling to reduce transportation-related emissions; developing green building designs and energy conservation technology for buildings to reduce emissions from the building industry; establishing low-carbon consumption patterns to reduce consumer emissions; promoting energy-efficient technological advances to reduce emissions through new technological capabilities.

Promoting "Microcirculation" and Related Technologies A national conference on urban development and planning was held in the city of Yangzhou in Jiangsu Province in June 2011. Qiu Baoxing, the Deputy Minister of the Ministry of Housing and Urban–Rural Development (MOHURD), use the conference to proclaim that China had entered the intermediate and advanced stages of urbanization, requiring city managers to accept independent organization and replace their early aggressive and forceful demolition and rebuilding with urban microcirculation system restoration. The microcirculation system encapsulates degradation, energy, impact, revival, transportation, landscaping, control, etc., all circulation on the microlevel. The restored system must become the new standard for urban transformation and for planning and construction of eco-cities and urban residential buildings.[3] Micro-degradation solves degrading urban waste concerns at the source to alleviate the impact of urban garbage on development. Micro-energy combines energy supply and consumption with a focus on energy acquisition, utilization, and recycling at the same location. Micro-impact aims to minimize the impact of urban development on local ecosystems, steering urban planning to reduce disruption of surface water and groundwater systems. Micro-revival promotes organic urban revival and

[2] Fan et al. [2].

[3] China Society for Urban Studies [3].

development of urban areas that maintain integrity by preserving history, culture, and memory and ensuring sustainable development. Micro-transportation replaces daily trips that span long distances with more convenient and comfortable micro-trips. Micro-landscaping designs landscapes in parks, on rooftops and other structures, and along streets, moving them nearer to city dwellers, alleviating the UHI effect, and improving air quality. Micro-control refers to digital ecosystem management in every community to scientifically control systems and manage the city intelligently. Many Chinese cities are currently testing and applying microcirculation systems as part of eco-city development efforts. As Beijing's separate sources, the eco-friendly drainage system is an example of a micro-degradation effort; the Taihu New City in Wuxi City has an energy plan that introduces micro-energy; municipal roads in the Guangming New Area and the Niushan Technology Park in Shenzhen City implement micro-impact principles; the Sanli River course improvement program in Qian'an City in Hebei Province boosts micro-revival; Hangzhou's bicycle rental system and Hong Kong's pedestrian system are examples of micro-transport; the Shenzhen Greenway and the Green Balcony program in Beijing are micro-landscaping projects; and the SSTEC Green Intelligence city management system and the Intelligent Community program in the Tianjin Binhai New Area offer micro-control.

Development of Theories and Practices Relevant to Green Building Green buildings minimize resource consumption (including energy, land, water, and materials) and pollution to provide healthy, suitable, and efficient spaces for people and to create greater harmony between people's lifestyles and nature. An eco-city is an integrated system that includes green building technology, and green buildings are an essential component of an eco-city. Developing green and energy-efficient buildings is not only the most important and direct approach to building an eco-city but further addresses global energy concerns, environmental crises, and climate change. The attendees at the Eco-city and Green Building Summit held in Chengdu on October 17, 2011 discussed the latest developments in renewable energy applications for buildings and future prospects. The attendees at the Eighth International Conference on Green and Energy-Efficient Buildings & New Technologies and Products Expo held in Beijing on March 29–31, 2012 discussed promoting green buildings to create a low-carbon, livable environment. The conference also presented a variety of the latest technological advances in the fields of green building materials, construction, interior design, renewable energy applications, green lighting, public building energy consumption regulation, wall materials, HVAC (heating, ventilation, and air conditioning,) and intelligent appliances. Both conferences contributed to developing theories and practices for green buildings in China and thus encouraged eco-city development by means of energy conservation in buildings.

Green buildings are an integrated, optimal configuration for comfort and resource conservation. The Chinese government called for increases in the energy efficiency of existing buildings and construction of new, energy-efficient buildings in the 12th Five-Year Plan. Most green building projects are currently focused on increasing energy efficiency through technological and management improvements. China's

green building are evolving from nonselective technologies to selective technologies, according to a study by Tian Huifeng et al. Shanghai, Guangdong, and Jiangsu are the leaders in the number of applications for green building certificates compared with other Chinese municipalities and provinces. Water- and energy-efficient technologies are the most frequently applied in green building construction in China, whereas technologies concerning material conservation and operation and management improvements are the least used. Chinese organizations are aggressively promoting the use of solar energy technologies. Geothermal heat pumps, Energy Performance Contracting (EPC), enveloping thermal insulation, energy-efficient windows, energy consumption simulation and optimization, water-conserving equipment, and soundproof designs are the most frequently energy conservation technologies used in green buildings.[4]

Improved Eco-Industrial Park (EIP) Construction and Management The *Report on Low-Carbon Eco-cities in China 2012* mentions that EIPs will help reduce pollution, enhance infrastructure designed for pollution prevention and control, and continually improve the environmental risk prevention and control mechanisms. EIPs will also provide critical support for energy conservation, emission reduction, and environmental safety at the regional and industrial levels and for eco-city construction in China. The MEP, the Ministry of Commerce (MOFCOM,) and the MOST co-issued the *Guiding Opinion on Enhancing the Building of State-Level Eco-industrial Demonstration Zones* on December 5, 2011 in accordance with the *Opinion of the State Council on Enhancing Major Environmental Protection Projects*, the *Notice on Building State-Level Eco-industrial Demonstration Zones*, and the *Administrative Measures for State-Level Eco-industrial Demonstration Zones (Trial)* in order to further implementation of the Scientific Outlook on Development and encourage eco-civilization development. The document urges organization to enhance the sustainability of relevant eco-industrial demonstration zones through conceptual, technical, and managerial innovations; follow the three Rs of reduce, reuse, recover, treat wastes into harmless materials, and encourage the development of low-carbon industry clusters functioning on a circular economy in the demonstration zones; lead sustainable socioeconomic development by demonstrating successful solutions and improving the industry mix in demonstration zones; combine policy incentives and market forces with public engagement to establish long-term development of state-level eco-industrial demonstration zones.[5]

The Chinese government has announced a series of policies for EIPs such as prioritizing approval and initiation of intra-EIP projects designed for pollution prevention and control infrastructure, comprehensive utilization of energy and resources, and a complete eco-friendly industry chain; providing EIPs with financial support and tax incentives; implementing pricing policies that facilitate more

[4] Tian et al. [4].

[5] The Ministries of Environmental Protection, Commerce, and Science and Technology, the *Guiding Opinion on Enhancing the Building of State-level Eco-industrial Demonstration Zones*, December 5, 2011.

efficient energy and resource use in state-level EIPs, such as differentiated electricity and water prices; and developing and improving state-level EIPs' incentives.

Higher Public Awareness Surrounding Environmental Protection Public awareness of environmental protection efforts includes the extent to which the public participate in environmental protection on their own initiative and the public's sense of responsibility for building an eco-civilization. The awareness provides fundamental support that humanity needs in order to eliminate the environmental crisis, prevent and control environmental pollution, and conserve resources. Environmental awareness can be increased through government encouragement, environmental incidents, mass media guidance, and environmental NGOs promotion. Numerous events in 2011 and 2012 suggest that public awareness surrounding environmental protection was increasing in China. The four factors for increasing public awareness about environmental protection can be analyzed as pertaining to the situation in China. Development toward an eco-civilization was highlighted in a report to the 18th CPC National Congress. This report defined a five-in-one national development strategy that pursued development toward an eco-civilization in combination with economic, political, cultural, and social development. The eco-civilization has become an important part of the national ideology, to the point where the public have learned to recognize and accept it. The Scientific Outlook on Development has become the primary guideline of the CPC promoting ideas such as human-oriented action, comprehensive coordination, and sustainability. As these terms have become more common in media reports, environmental friendliness and resource conservation have grown in popularity with the public. Public protests against a Paraxylene (PX) project in the city of Ningbo in Zhejiang Province in 2012 demonstrated a public concern about the safety of the living environment and led to national discussions on environmental impact assessments (EIA). A growing number of media reports on environmental incidents have drawn the public's attention. The *Southern Weekly* has an environmental section focused on going green, environmental protection, and new energies. Sohu, one of the leading Web portals in China, launched the Low-Carbon Stars program, which received support from approximately 100 important players across various sectors and spread many green concepts. Massive media coverage directed the attention of city managers to green GDP, explained technical terms such as PM 2.5 to a considerable part of the public, and introduced low-carbon efforts as a common environmental topic for many urban residents. A variety of environmental events launched by environmental NGOs have contributed to higher environmental awareness and to promotion of an eco-civilization. Environmental NGOs provide relevant information and propose solutions through their events and projects. They have been playing an important role in increasing public engagement in environmental protection, assisting governments in rehabilitating the environment, and promoting environmental legislation. Environmental NGOs have recently begun a new phase, expanding their breadth and reach through the Internet.

2.1.3 Noteworthy Eco-City Development Issues in China

Much progress remains on the road toward eco-city development in China. Many eco-city development incidents and problems emerged across China in 2011 and 2012. These incidents and problems deserve close attention and reflection to provide new ideas and solutions for eco-city development.

A Rapidly Growing Automotive Industry The automotive industry is a pillar of any industrialized country, fueling national economic growth and particular growth in associated industries such as iron, steel, and petrochemicals. The automotive industry has greatly enhanced human mobility, expanding possibilities at work and in daily life. The rapidly growing automotive industry has also produced many negative effects on cities, such as air pollution from exhaust, environmental pollution from oils and coolants, disturbing noise pollution, a growing amount of urban space redistributed for parking lots, travel difficulties due to traffic congestion and the associated time that is wasted, and the global energy crisis triggered by the massive consumption of crude oil. In his book *EcoCities: Rebuilding Cities in Balance with Nature*, Richard Register attacked automobiles, highlighting their negative effects on urban development. He believes that cars are the dinosaurs of our time and are destroying the reasonable and happy structures of cities, towns, and villages.[6] He further asserts that the entire automotive transport infrastructure spanning automobiles, urban sprawl, freeways, and oil produces horrible effects that have taken a dominant role in life on Earth and are the cause of resources exhaustion, habitat destruction, climate change, and species extinction.[7] Register thinks that cities should be compact and designed for humans, not for automobiles. Eco-cities change to city dwellers' production, and consumption patterns can help them end their automobile dependency, eliminating the consumption pattern rooted in fossil energy.

An overview of the global history of urban development reveals a consistent thread along urban development stories – the city's focus shifts from pedestrians to automobiles. Urbanization and automobile saturation are both experiencing immense growth in China today. The number of automobiles is growing fast in every major Chinese city as car prices drop and residents' income rises. China has become a major automobile producer and consumer. Production and sales of automobiles grew steadily in 2011, exceeding 18.4 million units and setting another world record, according to a report on the status of China's automotive industry published by the Ministry of Industry and Information Technology (MIIT) on January 20, 2012. By the end of June 2012, there were more than 114 million vehicles across China, including 86,130,000 private cars, according to a xinhuanet.com report from November 10, 2012. Seventeen major Chinese cities are home to more than one million cars, and Beijing, Chengdu, Tianjin, Shenzhen, and Shanghai each

[6] Richard [5].

[7] Richard [6].

have more than two million cars in their streets. The nonrenewable economic and consumption pattern prevalent in many developed countries that relies on petrochemical fuels and centers on automobiles is not suitable for the huge population base and high population density in China. Before cars become the primary urban transportation mode, aggressive regulatory action should seek opportunities to properly handle urban problems caused by automobiles. Cities should prioritize proximity, and city sizes should remain controlled and compact. Green urban transport systems should give walking a first priority, followed by cycling, railroad, public rail systems, cars, and trucks. Chinese cities involved in pilot energy-saving vehicle and NEV demonstration programs should gather their experience so that more efficient vehicles and intelligent transportation systems can be aggressively pursued.

Infrastructure Development An unusually large flood swept Beijing on July 21, 2012 as a result of the heaviest rain in 61 years. Traffic was interrupted all over the city, many vehicles were submerged, and 77 people were killed as a result of drowning, electric shock, collapsed houses, debris flows, traumatic shock, falling objects, and lightning. Floods were recorded in 62 % of Chinese cities between 2008 and 2010, among which 137 cities experienced at least three serious floods, according to an MOC survey of 351 cities in 2010.[8] These events have exposed urban development problems in China. Investment in the infrastructure networks, especially drainage systems, is far below a satisfactory standard considering rapid urbanization. Rapid expansion of the city has severely damaged and disrupted urban vegetation and natural hydrological conditions. Many cities have not yet developed comprehensive coordinated design plans for rain and flood control with regard to landscaping, water resource utilization, road systems, and administration. A large number of cities lack early warning mechanisms, technologies, and techniques that would be useful in the event of extreme rainfall. The floods have forced new perspectives on how infrastructure relates to urban development. China is increasingly struggling with outdated urban flood control and drainage systems that do not keep pace with rapid urban expansion. Urban expansion has irrationally prioritized what is on the ground over what is underground, leaving no rooms for considerations of urban flood control and drainage infrastructure. City development trends often lead to short-sighted and arbitrary occupation of water areas near rivers and lakes. Cities regularly expand beyond the flood control boundaries or into low-lying areas without employing necessary protection measures. The expansion leaves floods with huge potential to cause great damage.

Urban human settlements include natural, human, social, residential, and support systems, with infrastructure including public utilities such as tap water, energy, wastewater treatment, transportation, communications and IT systems and a physical environment plan composing most of support systems.[9] A scientific, convenient, safe, and reasonable infrastructure support system that complies with ecological

[8] Che [7].

[9] Wu [8].

laws is critical for eco-city development. New urban areas are being built in many Chinese cities, and old areas are reconstructed. Urban planning and road construction must correspond with a network of underground pipes during this construction. This practice will satisfy drainage, sewage, water, gas, heat, electricity, communications, and other needs as the city develops. A systematic plan is needed for urban sewer and other pipe network construction. Careful and precise urban water resources supply, drainage, and wastewater treatment and recycling system designs are also crucial. Advanced rainwater treatment methods and technologies from other countries should be introduced. Damage to infrastructure construction and to the city's ecological footprint and natural environment should be avoided.

Air Quality Monitoring Standard Smog appeared in many cities such as Beijing, Shanghai, Nanjing, and Jinan during 2011 and 2012 pushing discussions of air quality monitoring standards to the forefront. Observed air quality data and public sentiment vary greatly. Pollutant emissions in China are high, regional air pollution problems are severe, and the overall atmospheric environment is grim. Ambient air quality monitoring points in Chinese cities reflect the overall environmental quality. However, not enough monitoring points are available to properly represent the area covered. Monitored items, monitoring networks, the number of point monitored, and the points' locations are unsatisfactory based on human health impact assessment requirements. Embassies in Beijing and some civil society actors in China have requested that PM 2.5 be incorporated in the air quality monitoring standard over the last few years. The State Council approved a newly revised ambient air quality standard at an executive meeting on February 29, 2012 in order to bring ambient air quality assessments in line with reality and citizens' personal experience and to strengthen air pollution prevention and control. The new standard incorporates PM 2.5 monitoring indicators and 8 h ozone concentration limits, thereby officially incorporating PM 2.5 into China's air quality standard. The State Council meeting dictated that the fine particulate matter, ozone, and other substances will be monitored in the Beijing–Tianjin–Hebei region, the Yangtze and Pearl River Deltas, in municipalities directly under the central government's responsibility, in provincial capital cities, and in other key regions in 2012 and that the monitoring effort be extended to 113 key cities in 2013 that serve as environmental protection role models, before all prefecture-level cities or higher engage in monitoring in 2015.

PM 2.5 is a measure of particles which are no larger than 2.5 μm in diameter. PM 2.5 is a primary contributor to smog and carries substances that seriously harm human health because they are small enough to enter directly into the lungs and even into the blood stream through the nasal cavity. The Beijing–Tianjin–Hebei region has suffered frequent smog incidents as a result of growing PM 2.5 pollution in recent years as the number of motor vehicles and coal-fired energy consumption has increased dramatically in the region. Now that PM 2.5 has been incorporated into China's air quality monitoring standard, each big city monitors air quality, indicating the country's determination to strengthen comprehensive air pollution prevention and control and promote continuous air quality improvement by implementing higher standards and more effective measures. The following points

demonstrate the importance of air quality monitoring standards to eco-cities. First, obsolete technology and equipment in industries such as electric power, iron, steel, building materials, nonferrous metals, petrochemicals, and other chemicals should be phased out at faster rates in every city. Promoting the clean energy use, relocating heavily polluting enterprises, and encouraging energy-efficient, environmentally friendly technologies in those enterprises will further optimize the local industry mix. Second, raising environmental requirements for market and industry access, implementing more stringent air pollutant emission limits in key areas, and prohibiting construction or expansion of coal-fired power plants except for cogeneration facilities, steel mills, and cement factories are also crucial in improving air quality. Tight control over new projects and closely monitoring environmental law enforcement is pivotal to these ends. Third, motor vehicle pollution control, improved fuel quality, and emission standards form another important tool. Fourth, intercity collaboration on air pollution prevention and control, especially between cities in the Beijing–Tianjin–Hebei region, Yangtze and Pearl River Deltas, and other key areas needs strengthening for effective action. Air pollution warning systems for extreme weather conditions are also advised.

Environmental Impact Assessment (EIA) An EIA analyzes, predicts, and assesses the possible environmental impact of implementing a plan or project so that countermeasures preventing or mitigating adverse environmental effects can be provided and the progress tracked and monitored. An EIA analyzes the possible effects of a project on the environment after it is put into operation and proposes strategies and measures to prevent pollution. The EIA system encourages environmental consideration during planning phases, with a hope to ultimately render human activities more compatible with the environment. The State has strengthened project EIA regulations in recent years and imposed harsh measures against projects that do not comply with environmental law. The State has explicitly prohibited the following: projects that do not comply with industrial policies; projects that will cause serious environmental pollution, diminished product quality, increased energy and material consumption, and projects that do not comply with pollution emissions regulations; projects that do not meet environmental function requirements even if they provide positive economic benefits; and projects located in nature reserves, core zones, and buffer zones. The State further introduced a series of strict rules including tight limitations on projects involving drinking water sources, nature reserves, scenic areas, and important ecological function zones; tight control over projects that will lead to high energy and material consumption and high pollutant emissions; banning projects that will negatively impact technological improvement or domestic demand stimulation; and constraints on regional, industrial, and enterprise development based on total pollutant discharges. Regional EIA approval has been suspended on a regular basis by environmental regulators in accordance with the Water Pollution Prevention and Control Law of the People's Republic of China and the Regulations on Environmental Impact Assessment of Plans. Regional EIA approval suspension allows the environmental authority with in jurisdiction to suspend the approval of all enterprise and regional projects for enterprises and regions

that have violated environmental regulation, with exception of projects stimulating a circular economy, until the noncompliant projects have been adjusted to regulation standards. This measure has given the EIA enormous power to adjust China's industry mix and shift its economic growth. The Chinese public has become increasingly concerned in recent years over the possible effects of certain projects on their living environment. Some of these projects were launched secretly, and the responsible government departments and organizations failed to grant the public full access to relevant information or participate in project evaluation and in the EIA process, causing great commotion. An example of this issue can be found when hundreds of villagers in Wantang and other villages in Zhenhai District, part of Ningbo City in Zhejiang Province, went to the district government on October 22, 2012 to complain about a PX project requested by a local oil refinery as part of an integrated expansion project, because it was too close to these villages. The municipal government talked with the project investor on October 28, after which it decided to cancel the PX project, suspend preliminary work for the integrated project, and conduct scientific research about the project. This was one of many incidents against PX projects covering many Chinese cities over the past few years. In 2011, Dalian citizens similarly demonstrated against a local PX project. Earlier, in 2007, Xiamen citizens staged a march to oppose a local PX project. PX is a low toxicity, flammable chemical that causes irritation. It causes irritation to the eyes and upper respiratory tract and has an anesthetic effect on the central nervous system, causing acute poisoning when in high doses. The anti-PX incidents demonstrate two things. First, the NIMBY ("Not in My Backyard") attitude is growing among the public. The "NIMBY effect" refers to strong and sometimes highly emotional opposition against certain projects, such as dumping grounds, nuclear power plants, crematoria, etc., led by local residents due to fear of the projects' potential negative effects on physical health, environmental quality, and asset value. Second, the current EIA system in China needs immediate improvements, most importantly granting the public full participation in the EIA process to provide a greater understanding of relevant issues and offer an opportunity to discover, analyze, and solve problems.

The 18th CPC National Congress established that economic development must incorporate political, cultural, and social development in working toward an eco-civilization and that China's comprehensive sustainable development relies on a national development strategy that incorporates all five components. The Ningbo incident will encourage more cities to use the five-in-one strategy for eco-civilization construction, including an emphasis on EIA. The EIA requires strengthening and alignment with governing laws and regulations. Public information disclosure and access to EIA information, including government commitments at all levels, are also critical. Increased public participation in the EIA process, respect for people's rights to be informed, and careful consideration of public opinion will help EIA's emphasis. Social risk assessment mechanisms for important projects with full consideration of their potential environmental damage against local residents can be established and improved, as can resolute implementation of all of the listed EIA policies, particularly regional EIA approval suspension.

2.1.4 Main Issues Facing Eco-City Development in China

Although China has made impressive achievements in eco-city development over recent years, it still faces many problems and challenges in this field when compared with other countries.

Eco-Friendly Development Is Overemphasized in Central Cities While Regional Interaction Is Overlooked, Especially Urban and Rural Interaction A city and its surrounding region are inseparable – the city is the core of the region, and the region forms a foundation for the city. Materials, energy, and information are continuously exchanged within the city and the region. The exchanges will become increasingly frequent, and the interactions will intensify alongside urban development. Intercity and interregional collaboration will provide benefits to eco-city development. Central cities' eco-friendly development is overemphasized in China's current eco-city development phase, ignoring interregional cooperation and development. Government departments and organizations have not considered the complementary effect of the impact of large-scale regional development and city clustering on eco-friendly development. Urban and rural areas tightly connected and have particularly profound internal correlations in the field of eco-friendly development. A city planning eco-friendly development must consider the development of affiliated rural areas. The city must draft an overall plan for the socioeconomic development of urban and rural areas, paying attention to the complementary effect between eco-friendly industry and agriculture in developing into an eco-city and using the circular economy concept to guide its policies. The city can thus develop holistic green industries and realize sustainable development.

A Lack of Legal Support for Eco-City Development and Ineffective Implementation of Eco-Friendly Standards Eco-city construction has been normalized across Chinese society as the sustainable development strategy was implemented and greater knowledge about the eco-civilization and the Scientific Outlook on Development has become available. The public is now aware of the urgent need for eco-cities. Mandatory constraints and regulations for eco-city development are still lacking however, as both governments and enterprises tend to prioritize economic indicators over environmental indicators. This phenomenon is most pronounced in the following aspects. Economic benefits are overemphasized, and the environment is overlooked in urbanization processes. The city plan contains reference designs for green spaces, building height and density, and infrastructure, but the references are not properly adhered to during urbanization. Urban development management is fragmented and lack unification. Some organizations arbitrarily occupy public spaces regardless of the aesthetic effects on the urban environment or the public interest to meet their own interests. Some enterprises fail to meet relevant pollutant discharge and emission standards, and such environmental pollution remains a major concern in the city. These challenges have prevented efforts to effectively curb the trend of ecological deterioration in Chinese cities.

A Lack of Synergy in Eco-City Development and Limited Public Engagement The comprehensive project of eco-city development requires close cooperation and collaboration among various organizations across society. It cannot thrive if broken down among administrative departments where personnel organize piecemeal implementation. The government must formulate policies based on careful consideration of public opinion to recognize the large role of the public in eco-city development. Policies that fully reflect people's needs can be persuasive and influential enough to gradually urge the public's attention to environmental protection and further personal initiative and engagement, thereby contributing to development toward a harmonious society. Eco-city construction requires the efforts of every citizen. Every person is both responsible for environmental damage and a victim of the resulting damage, linking environmental trends directly to every individual. Current eco-city construction involves government departments and enterprises but suffers from a blatant lack of public participation. Eco-city development will remain vapid unless all people are invited to participate. Strengthening public participation, including that of environmental organizations, environmental education, etc., is of topmost priority in furthering eco-city development. This shift the current eco-city development trend where government are work without much citizen input.

Failure to Consider Local Conditions and the Lack of Focus and Uniqueness Eco-city development outside of China often seeks problem-specific projects with outstanding results. Foreign cities tend to focus on addressing one or two major urban development problems, such as traffic congestion, surface hardening, and garbage pollution instead of attempting eco-city projects all across the city. The practice accumulates experience, develops human resources, educates the public, and builds a desirable image while solving one problem at a time. The city of Curitiba, Brazil, focused on urban transportation and on converting garbage into usable resources; some Japanese cities focused on EIP and circular economy development; and some European cities focused on eco-friendly communities. Eco-city development in China lacks this focus and unique solutions. Chinese cities tend to design and build green spaces without considering local conditions. Many of these cities waste their financial and environmental resources on lawn creation. Landscaping should be adapted to local conditions and focused on mixing and diversifying trees together with bushes, grasses, vines, and flowers. Chinese cities generally suffer from unreasonable spatial arrangements. Local terrain features have changed as urbanization has increased. Excessively built landscapes, uncontrolled scenic development, and other undesirable phenomena have been rampant, replacing architecture unique to the area and leading cities to become increasingly similar. Architectural plans and designs fail to reflect local cultural characteristics. Pressure to be eco-friendly and respect and care for natural topography, landscape, and other living things have caused neglect of the city's humanistic spirit and culture. Buildings consistent with the city's nature and the unified eco-city development plan will provide a desirable role for buildings in urban development. Chinese cities should determine personalized focus and development strategies reflective of

the diversity of local natural conditions, economic development levels, societal backgrounds, and other basic conditions as they pursue eco-city development.

2.2 Eco-City Development in China: Principles, Ideas, and Practices

Building eco-cities to model an eco-civilization and modern cities is new to China and lacks established patterns and methods. The gap must be bridged through openness to new ideas and innovation.

2.2.1 Principles

A System's Perspective The city differs from any other biotic community because it is an artificial ecosystem based upon human behavior, the environment, the flow of materials, and social institutions. A sustainable city depends on a sustainable supply of resources; the underlying self-adjustment capacity of the ecosystem; the socioeconomic systems' ability to organize and adjust itself, the coordination among ecological functions such as production, consumption, and restoration; macroscopic regulation and control; intersectoral coordination; and public awareness and participation that cover a broad swath of society. Weakening or enhancing any function will affect the other components and the city's sustainable development. Eco-city development must adhere to ecosystem principle to maintain balance. It requires comprehensive and systematic analysis and assessment of nature, of the economy, and of society as a whole.

Recycling Resource, product, and waste reuse and recycling in the urban system are crucial for enhanced ecosystem support to urban development in light of limits on physical resources in a city. Reuse and recycling in an eco-city are also necessary for long-term survival and development. Urban ecological and environmental problems stem primarily from underdeveloped internal recycling mechanisms for materials and products. The city requires large quantities of physical resources to create a relatively small amount of products, most of which are later discarded or emitted in the form of waste. This inefficient resource utilization also induces a large number of environmental problems. Urban ecosystem's resource use habits must be transformed from a single linear "chain" into a composite "net" for this situation to shift. Conducive recycling channels linking resources and waste inside the city and to its surroundings are needed to improve the city's ecological and environmental effects.

Harmony and Symbiosis Harmony is at the core of regulation geared toward eco-cities. Eco-cities strive to mediate relationships between humanity and nature, cities

and the countryside, and the built and natural environment. Failure to properly maintain any of these relationships will negatively affect normal urban ecosystem functions. Eco-cities require coordination and organic coupling of the various components. Harmony and order within any individual component are insufficient to guarantee healthy eco-city development. Harmony and symbiosis spread along all system components are necessary for the system to achieve its optimal status. An optimal symbiotic system will conserve resources and energy and provide multiple benefits for itself. Unreasonable resource utilization and weak component coupling will weaken the symbiotic relationship and lead the system's health and vigor to deteriorate.

Sustainable Endogenous Development The urban ecosystem is self-contained, providing for internal regulation, stabilization, and development within a certain ecological threshold range. Ecological thresholds and ecosystem's carrying capacities draw the line where the effects of human society become too much for a particular environment to bear without harmful changes to human survival and development introduced alongside and detrimental effects to the state and structure of the environment. These effects are measured by scale, strength, and rate. An ecosystem's carrying capacity includes the carrying capacities of resources, technology, and pollution. The capacity depends on the structure and functions of the city and is a combination of objective and subjective factors. An objective carrying capacity exists even if it can be altered through human action. Changes to the carrying capacity will cause structural and functional changes in the urban ecosystem, pushing the ecosystem toward normal or reverse succession. The urban ecosystem can evolve in complexity, optimal energy use, and productivity (i.e., normal succession), leading to sustainable development, if the intensity of urban activities remains below the carrying capacity. Urban sustainable development is otherwise impossible.

2.2.2 Ideas

Eco-city development is a process by which a city's construction and management plan are unified with respect to ecological laws (regarding nature, the economy, and humanity.) This process coordinates various ecological relationships – competition, symbiosis, revival, and self-development – among the social, economic, and natural environments of a city; changes the production and consumption patterns, decision-making, and management practices and culture; and increases ecological and environmental awareness by advocating for corresponding values and advancing institutional reforms and technological innovation. Eco-city development in China aspires to eco-friendly and sustainable socioeconomic development. In order to accomplish that goal, China is establishing a healthy and safe environmental support system rooted in ecological safety and an internationally competitive eco-industrial economy, promoting comprehensive landscape protection and the

development of ecological landscapes and concentrating socioeconomic development around an eco-friendly culture.

(1) China is striving to develop eco-friendly industries and establish an efficient production system with low consumption and pollution. Cleaner production and industrial restructuring along with an eco-economy and new industrialization approaches using advanced technology, high economic returns, low resource consumption, minor environmental pollution, and efficient utilization of human resources provide first steps toward eco-friendly industries. Businesses, industrial parks, industries, and regions can help the transition by focusing on circular economy development. Recycling industries in industrial parks and in regions that process material flows, energy, and information can boost circulation on multiple layers of the production process. Communities and organizations can participate by normalizing recycling in society. (2) Another effort focuses on improvements to the environment and establishing a stable, harmonious, and high-quality environmental system. Strengthened EIAs and environmental regulations will prevent introduction of major ecosystem damages caused by humans. Avoiding new environmental damages whenever and wherever possible will further stabilize the development process. Increased environmental rehabilitation efforts and new solutions to environmental pollution and damages are necessary. Local governments' role is to create eco-friendly environments and raise air and water quality within their administered areas by balancing their ecosystems. (3) Our surrounding can be improved by creating eco-friendly human settlements and beautiful, comfortable, and harmonious living systems. Construction plans for urban communities and small towns should focus on the people they are meant to serve and combine modern ideas with traditional culture. Plans for human settlements and living systems that consider local economic conditions and the natural environment will yield beautiful, harmonious, fully functional, convenient, and comfortable results. (4) Creating a modern unique eco-culture focused on the environment will form a basis for future work. Disseminating ecological knowledge, popularizing modern civilization concepts and national cultural traditions, improving environmental protection laws and regulations, and respecting environmental ethics will spread the eco-culture. Improving overall human qualities will further solidify the foundation for regional sustainable development.[10]

Along with these national efforts, eco-cities have a number of developmental goals that will strengthen efforts. (1) A sustainable economy is necessary for long-term development. A sustainable economy abandons the old focus on increasing output by increasing input in favor of a distinctive and efficient knowledge economy. This transformation requires bolstered knowledge and technology for economic growth. Further steps include strengthening horizontal interregional cooperation. The result is a competitive sustainable economic system. (2) A sustainable social system is likewise crucial. In order to achieve sustainability, urban population size must be controlled to maintain optimal density and educational systems that will properly educate the populace. A focus on health and desirable behavior in

[10] Zhu [9].

public values is more conducive than the current focus on making money, as is consumer behavior aimed at conservation and going green. Reliable social security and community services are key. This social system will focus on people and provide harmony between humanity and nature. (3) Eco-city resource systems must also be sustainable. Eco-cities rely on science and technology to promote cleaner production and integrated resource utilization to improve their system, as well as to find general ways to increase resource use efficiency. They can further promote growth and accumulation for ecosystem assets to create favorable survival and development condition for current and future generations. (4) An integral part of eco-city development is assuring the sustainability of the environment. Eco-cities can begin by enhancing environmental governance and restoring and protecting the natural environment. Improved environmental quality and protection and development of natural landscapes are also of key importance. Natural landscapes can be used as a framework for a complex structure that shows the city's unique ecological landscapes on multiple levels, functions, and interconnections. (5) Sustainable eco-city urban function is another piece of the solution. Urban infrastructure can be strengthened and enlarged to eliminate bottlenecks and ensure safety and reliability while fully satisfying the socioeconomic development requirements and people's needs. Effective use of infrastructure services will provide smooth transfer of materials, energy, people, and information across the city. (6) Sustainable management systems allow for proper maintenance of all other systems. Sustainable eco-management must replace traditional regional management. Historical and cultural resources can be used and integrated to benefit management operation, and celebrating urban culture, human spirit, and poetic tone of urban culture provides further material. A mature and integrated sustainable management system covering managerial decisions, cultural heritage, cognitive ability, policy systems, public participation, and regional cooperation is needed to ensure comprehensive functionality.

2.2.3 Practices

Based on eco-city development theories and practices around the world and applied to China, the best developed strategy can be summed up with five practices: five in one, two supports, three belts, four parties, and harmonious development.

Five in One China's best developmental approach will simultaneously focus on five goals: expanding villages into towns, building garden cities, introducing cleaner production, promoting green lifestyles, and ensuring an eco-friendly environment. These five goals pave the path toward integrated and eco-friendly urban and rural development.

Expanding Villages into Towns China's 12th Five-Year Plan proposed building "two latitudinal and three longitudinal axes" along which urbanization can develop strategically. This pattern optimizes eastern coastal cities and lends attention to constructing new city groups in the central and western regions with an environment

rich in resources and with a solid carrying capacity. This pattern promotes economic growth and expands the market from east to west and from south to north. The two latitudinal and three longitudinal axes follow the continental bridge and the Yangtze River as latitude markers, and the coastlines, Beijing–Guangzhou line, Beijing–Harbin line, and Baotou–Kunming line, as three longitude markers to create a strategic urbanization pattern that uses major urbanized areas as primary supports and other urbanized areas along the axes as important components. The Chinese government should optimize the development of the Bohai Sea, Yangtze River Delta, and Pearl River Delta regions to form three ultra-large city groups. It should further develop several new large regional and city groups in other important areas such as the Harbin–Changchun zone, the region sandwiched between the Yangtze and Huaihe Rivers, the west side of the Taiwan coast, Central China, the middle reaches of the Yangtze River, the Beibu Gulf (commonly known in the West as the Gulf of Tonkin), the Chengdu–Chongqing zone, and the Guanzhong–Tianshui zone. The strategic plan forces eco-cities to develop in parallel with rural urbanization. Urbanization is a dynamic, natural, social, and historic process wherein rural residents migrate into urban areas, growing the secondary and tertiary sectors in these areas, leading to a growing number of towns and cities, and increasing urban population and urban expansion. Villages' transformation into towns is an important part of urbanization. It captures the urbanization of rural lifestyles and production patterns. This transformation will further transform the economic growth pattern and promote industrial restructuring. It grows alongside industrialization and modernization in China and improves rural areas' industry mix. Population, capital, technology, land, and other production factors will be increasingly concentrated as urbanization continues, producing strong economies of scale and clustering effects that contract with the scattered and empty poverty common in rural areas. The following ideas are useful for promoting village urbanization. (1) Resource, environment, land, population density, and ecological carrying capacity require close attention as China urbanizes. Initial planning and urban management adherent to eco-city development standards carried out by the necessary authorities will help avoid mistakes. (2) The spatial arrangement of small, medium, and large cities deserves the Chinese government's attention as it manages urbanization. The 2010 No. 1 central government document hones the government focus onto development of towns and small and medium cities to boost the rural economy using new villages and urbanization. This represents an important strategic shift in China's agricultural policy. Coordinated towns and city development and positive interactions between urbanization and new villages are crucial. Coordinating agricultural modernization with industrialization and urbanization is a priority in this respect. (3) The spatial structure requires optimization. Reducing spaces occupied by industrial facilities, mines, and rural residential areas while expanding services, transportation, urban residential areas, public facilities, and green spaces ensures a balanced trajectory. Urban sprawl, overubiquitous industrial facilities, and scattered economic and industrial development zones prevent this progress and must be combated. (4) Town and city spatial arrangements can also be optimized. Building of compact urban areas and clearly defining the functions and industrial arrangements of cities around

the central city in the region will provide great benefit to the urban system. Ensuring economic links and complementary functions between cities will increase the overall competitiveness of the region. (5) Village urbanization requires a more optimal human population distribution. Controlling population size in the main urban areas of every megacity while encouraging surrounding areas and other cities to absorb floating population balances the population distribution. (6) The industry mix also requires optimization. Advanced and efficient industries with high added value can make up an increasingly larger proportion of the industry mix at the behest of governments. High-tech industries, modern services, and advanced manufacturing should adopt a leading role in economic growth. Further steps by governments include encouraging urban agriculture, water-efficient agriculture, and green organic agriculture; aggressively developing energy-efficient, land-conserving, and environmentally friendly advanced manufacturing high-tech industries that grant local enterprises control over intellectual property rights; pushing the marine industry toward advanced technology and greater added value; and accelerating the development of modern services to promptly form an industry mix led by the service economy. (7) Development patterns in for urbanization projects need optimization. In order to fundamentally transform the economic development pattern, increase clean energy consumption in proportion to total energy consumption, and expand the circular economy, governments should encourage broad application of low-carbon technologies to significantly reduce carbon dioxide emissions, develop stringent energy and water consumption standards as well as pollutant discharge and emission standards, ensure that all garbage is rendered harmless and that sewage is dumped in accordance with the set standards, and strengthen regional environmental regulations as a regional mechanism for collaborative pollution prevention and control. (8) Improved urbanization is also dependent on optimized infrastructure distribution. Transportation, energy, water, telecommunication, environmental protection, disaster prevention, and other infrastructure distribution systems can be better integrated in the region with optimized functionality. (9) Eco-friendly urbanization is necessarily dependent on an optimal ecosystem. Ecological restoration and environmental protection require binding targets, development intensity must be controlled, environmental protection requires increased investment, and stronger environmental governance and ecological restoration are needed to ensure an optimal ecosystem. Cleaner river systems, improved water quality, and protection for arable land, water areas, wetlands, woodlands, grasslands, cultural and natural heritage sites, and open green spaces between cities provide further key steps for improving the living environment.

Building Garden Cities Gardens are beautiful and eco-friendly spaces created using natural and social factors, science, and technology to provide people with joy. Garden cities are an important approach to eco-city development. Building garden cities improves the urban ecosystem and beautifies the urban environment by diversifying plant variety, providing complete green space systems, creating beautiful landscapes, and offering a full range of facilities, so that the general public can rest, walk around, or engage in scientific and cultural activities to enhance physical and

mental health in the gardens. Gardens further provide a space to protect, breed, and research endangered species. The Chinese government proposed 12 requirements for the national garden city standard, covering everything from urban green space classification and distribution to measurement indicators. This basic garden city national standard is primarily intended to ensure advanced landscaping indicators, reasonable plans and spatial arrangements, continuous urban landscapes, pleasant environmental quality, unique urban style, urban ecosystem improvements, and sustainable development. The standard requires a reasonable arrangement and comprehensive functions of various green spaces to form a holistic system that will produce ecological and environmental benefits. The standard demands that the urban green space system be linked with landscaping for a larger area of land and for large gardens planned by the city. Natural landscapes, woodlands, and agricultural land in suburbs also receive protection for an integrated urban and rural environment. Government departments and organizations responsible for areas in connection with garden city construction have the following tasks before them. Urban landscaping needs strengthening, and urban green spaces require appropriate growth. Green spaces must be large enough to ensure a virtuous urban ecosystem. The total area of green spaces has become an important measure of the modern urban living environment. Green spaces should account for more than 50 % of the total urban land area according to health science experts. Each person requires 30–40 m^2 of green space, and vegetation should cover 30–40 % of the area to ensure a proper oxygen and carbon dioxide balance in the air. The United Nations has proposed eco-city targets of vegetation covering at least 50 % of urban area, green spaces covering an area of at least 60 m^2 per person, and green spaces in the residential areas covering an area of at least 28 m^2 per person. Landscapes in Chinese cities are usually relatively small for various reasons including historical developments that have led to high population density. Chinese cities need appropriate increases to the area of urban green spaces and vegetation coverage to meet the stated targets. Urban landscaping should be planned and designed according to local geographical features by maintaining the original natural and cultural landscapes wherever possible and minimizing disturbances and damage to the local environment; improving urban green space plans and distribution; effectively coordinating the relationship between urban residents and the environment; systematically designing urban landscapes to match the city's climate and the local residents' living environment quality requirements; developing functional zones across the city and determining green space area distribution, plant varieties and population, and types of biotic communities; and building environmental and ecological control zones that adhere to ecological function zone theories where natural ecosystem characteristics and processes are preserved, maintained, or imitated. Urban landscaping should prioritize the ecosystem and become integral in urban development project planning and implementation. All urban spaces can be ecologically reasonable using diverse landscapes. Urban landscaping should not be confined to aesthetic purposes but should be constructed to also perform important functions like cleaning the urban environment. Relevant organizations should increase the biodiversity of urban landscapes and build reasonable plant populations as well as properly identify plant varieties to

create green landscapes with local characteristics typical of the city. Foreign species can be introduced slowly and carefully. Three-dimensional greening across the city is an additional useful tool. Substantial three-dimensional greening can cool and decontaminate the city while reducing noise and promoting an urban ecological balance. Water landscapes' bodies of water play an important role in improving the urban environment. Urban bodies of water increase humidity and regulate it over space and time as well as increase and diversify plants and animal and assist green spaces in forming a better vegetation structure and performing more powerful ecological functions. Bodies of water are also the city's main channel to external ecosystems, river systems being among the city's most important landscape corridors. Urban landscaping emphasizes forestation along local rivers. Green spaces are a city's lungs, and rivers, lakes, and other wetlands are its kidneys. Green spaces need a healthy environment to improve environmental quality in the rest of the city. A river system combined with the land and its biological environment is extremely effective at purification for itself and for the microclimate along the river. A river system reduces the average temperature around it and accelerates air flow, which creates a healthier environment for humans. Rivers provide a habitat for a variety of urban species and purify water. An ecologically resilient river system provides a network of green channels for flood storage and drought mitigation. River's functions are closely related to its neighboring ecosystems so that the isolation from other ecosystems (e.g., by hardening a river's bank slopes with concrete) reduces inter-ecosystem exchanges and purification leaving "dead" water. A city gains its beauty, fresh air, and a pleasant environment from forests and bodies of water. Forests combine with water to facilitate the virtuous urban ecosystem cycle. Urban afforestation provides another key component. Urban forests are becoming an urban landscaping norm. "People in the city, city in the forest" sums up a twenty-first century urban development target. A design philosophy centered around human lies at the core of an eco-friendly urban environment – creating living spaces wherein the city is integrated with forests to establish harmony between humanity and nature. Urban afforestation espouses this harmony and uses green spaces to build a network in a green city. A complete urban forest ecosystem will thoroughly improve the urban environment and ensure material and energy supplies. Urban forest landscapes must be agreeable, friendly, culturally educative, and comfortable to attract people. Efforts must also remain compatible with nature. Relevant organizations should ensure spatial arrangements and plans to match the city's topography and its style, structural characteristics, and spatial attributes. Urban forests should incorporate the structural characteristics of natural vegetation, landscapes, and biotic communities. They should be self-sustaining and comprehensively beneficial. China's twenty-first century sustainable forest development strategy prioritizes urban afforestation. China launched the "build garden cities" campaign in 1992. Twelve cities including Hefei, Zhuhai, Hangzhou, Ma'anshan, Zhongshan, Shenzhen, Weihai, Dalian, Nanjing, Xiamen, and Nanning are currently listed as garden cities. A garden city development wave is currently seeping even further across China. Green space networks incorporating cities and suburbs are important in further development. Chinese urban areas typically have dense buildings, high population density,

and small green spaces. Chinese suburbs have comparatively small populations and large natural vegetation areas, including forests, meadows, rivers, lakes, marshes, etc. Large tracts of farmland in the suburbs provide immense ecological benefits unavailable in urban areas. These resources should be well protected and utilized. Governments can capitalize on suburban ecology by promoting farmland shelter belts and bridging the gap between urban and suburban green spaces with lines of plants grown along roads. This practice will complete the green spaces network, create green channels between urban and suburban areas, and supply fresh air for the city to mitigate urban air pollution. Rational plans for the urban green space system covering green points, lines, and areas are needed to create garden cities. The established boundaries for the green points, lines, and areas must then be respected. The boundaries must then be incorporated into green spaces. A green space system that matches urban characteristics is needed from relevant government department and organization to create a livable garden city.

Achieving Cleaner Production Cleaner production was defined by the UNEP in 1990 as "the continuous application of an integrated environmental strategy to processes, products, and services to increase efficiency and reduce risks to humans and the environment." China's Agenda 21 defines cleaner production as "practical production methods and measures that meet people's needs, enable rational natural resource and energy use, and protect the environment. It implements an integrated pollution prevention strategy for production processes and the entire lifecycle of products." Cleaner production conserves production energy and raw materials, eliminates hazardous materials, minimizes the use of toxic and hazardous chemicals and raw materials, and eliminates pollution and harms to humans and the environment. Cleaner production further improves processes, corporate management, and procedures, implements closed-loop material and waste recycling, and reduces waste, converting it to new resources or harmless substances. Cleaner production implies that the city effectively changes the socioeconomic development pattern and actively promotes circular economy growth by developing eco-friendly industries. The following steps will begin the process toward cleaner production. (1) Circular economy concepts should be used to build urban EIPs and accelerate industry mix optimization. Specific measures may include developing energy-efficient high-tech industries with a high added value such as electronics, IT, biomedicine, new energies, and new materials and utilizing advanced technologies to transform traditional industries and to enhance resource efficiency and environmental protection; accelerating energy and water conservation developments; developing industries that use renewable resources and absorb industrial wastes and strictly limit the expansion of polluting industries; implementing tight controls over discharge and emission of industrial pollutants, eliminating obsolete processes, technologies, equipment, and products that waste resources and pollute the environment, and gradually molding an industry mix that is conducive to saving resources and protecting the environment; and developing industrial parks in existing urban development zones and industrial areas following cleaner production policies, regulations, and technical standards and encouraging enterprises that will role model high

cleaner production standards. (2) Environmentally friendly products and processes that enable energy conservation, cleaner production, and pollution prevention and control require further research and development along with development of the environmental protection industry. Specific measures may include building development, production, and testing centers for technologies and products critical for environmental protection; supporting enterprises and groups at the foundation of the environmental protection industry; nurturing environmental protection industry centers; using specialization and market principles to promote an environmental service system that covers financing, project implementation, facility operation, technology consulting, information services, and personnel training; increasing the share of environmental services in the environmental protection industry; and improving the quality and competitiveness of environment services.

Living Green Going green stresses innovation and changes to human civilization and traditional industrial thinking to discover lifestyle changes and developmental ideas that can solve environmental problems. The green lifestyle is compatible with ethic values centered on sustainable development. The immediate goal is to promote a low-cost green option that will appeal to people rationally and provide them a happy life that is adapted to societal expectations. The following steps pave the way toward a green life. (1) A more prominent green culture is needed in society. Education about resource conservation and environmental protection should be promoted across society by creating green schools, communities, businesses, hospitals, shops, hotels, etc., and by using a variety of channels such as the media, the Internet, and display spaces to increase the public's environmental awareness and sense of environmental responsibility. Forums, seminars, contests, and other activities on occasions such as the World Environment Day, Earth Day, World Water Day, "Protect the Mother River" Day, Technology Week, and Arbor Day are also useful outreach tools. (2) Green living requires a livable community. Livable community standards and residential areas that concentrate on eco-friendly options during location selection, design, construction, residence, and services are key to a livable community. Governments should aggressively promote eco-friendly residential areas that conserve energy and land and further encourage the use of eco-friendly building materials and of water- and energy-conserving appliances as well as garbage separation and recovery. Community service centers, environmental protection facilities, and other infrastructure and similarly important. (3) A further step involves creating and eco-friendly industrial culture. Businesses and industrial parks can develop an eco-friendly culture by embracing emerging industrial systems and locally distinctive industries. Governments should assist individuals and organizations by promoting environmental awareness and environmentally friendly behaviors, conserving resources, and recycling wastes. Governments should also guide enterprises toward green products, people-oriented services, and environmental protection. Enterprises should establish a corporate culture that supports green technology innovation. Governments should encourage enterprises to design eco-cultural identity projects and build a green business image through product lifecycle management (PLM) and cleaner production implementation. (4) A green

consumption concept must be popularized. The Scientific Outlook on Development and concepts such as environmental friendliness, resource conservation, and green consumption should become rooted across society by popularizing ecological knowledge and nurturing eco-friendly attitudes and values. Low-carbon lifestyles should shape consumption through green design, production, packaging, marketing, and consumption method to minimize its negative environmental effect.

Building an Eco-Friendly Environment An eco-friendly environment requires environmental protection that focuses on pollution prevention and control along with ecological safety, as well as harmony between humanity and nature in the environmental system. Clean water and air and safe foods are necessary for this positive living and working environment. The following steps are necessary to lay the foundation for an eco-friendly environment. (1) Environmental protection should be developed into a network. Specific measures may include factoring local conditions in decisions; building and protecting a variety of ecological function zones; establishing ecosystem protection zones with complementary natural and built environments; protecting wetland resources and implementing wetland ecosystem restoration projects through legal, technical, economic, administrative, and other means; enhancing ecosystem protection provided by forests by nurturing and protecting forest resources; and protecting biodiversity and ecosystem safety and stability of wildlife habitats.

(2) Pollution should be prevented and controlled in cities. Specific measures may include implementing a robust environmental access system, developing municipal pollutant discharge and emission standards at levels stricter than their national counterparts; strengthening industrial governance in pollution prevention; implementing clean water projects to reduce water pollution, blue sky projects to reduce air pollution, and low noise projects to reduce noise pollution; promoting circular economic growth; establish a garbage classification and sorting system alongside a recycling network system; reducing solid waste pollution; and encouraging resource reuse.

(3) The urban environment should be focused on people's needs. Specific measures may include using historical and cultural resources such as historic buildings and sites; protecting and promoting the historical, cultural, and folkloric characteristics of the city; and improving urban culture. The Chinese government announced in the 12th Five-Year Plan that it would implement an ecological safety strategy establishing "two zones and three belts" to further a prosperous, democratic, harmonious, modern, and socialist China and to ensure China's sustainable development. China will follow the strategy to build an ecological safety system using the zones of the Qinghai–Tibet Plateau and of the Loess Plateau joined with Sichuan and Yunnan as two ecosystem protection zones. Another zone will be framed by the northeastern forest, northern desertification prevention projects, southern hill and mountain belts, and major rivers. Other ecological function zones critical for the country will be used as important supports, and development zones will be largely excluded from the system. Efforts in the Qinghai–Tibet Plateau ecosystem protection zone will focus on protecting diverse and unique ecosystems and ensuring they

properly supply water to major rivers and regulating climate. Efforts in the Loess Plateau, Sichuan, and Yunnan ecosystem protection zone will focus on preventing soil erosion, protecting natural vegetation, and ensuring the zone maintains the ecological safety of the lower and middle reaches of the Yangtze and Yellow Rivers. Efforts in the northeastern forest belt will focus on protecting forest resources and biodiversity and ensuring the maintained ecological safety of the Northeast Plain. Efforts in the northern desertification prevention belt will focus on developing the shelter belt, protecting grasslands, and preventing sand movement. It is currently impossible to significantly improve the desertified land, but the relevant authorities should ban any human activities that may damage the local ecosystems. The Chinese government should work to ensure that shelter belts in North, Northeast, and Northwest China maintain ecological safety. Efforts in the southern hill and mountain belt will focus on restoring vegetation, preventing soil erosion, and ensuring South and Southwest China's ecological safety.

Integrating Urban and Rural Areas in Eco-City Construction Urban development in China modernizes cities, urbanizes the countryside, and integrates urban and rural areas. Eco-city construction must be coordinated with a new countryside and an eco-friendly integration of urban and rural areas. Many eco-cities outside of China incorporate urban areas and their subsidiary rural areas. Many Chinese cities currently overemphasize areas around the city in eco-city development plans but overlook connections between the city and other areas, especially the ecological interactions with rural areas. An eco-city development plan must look beyond the urban area to urban–rural integration in order to address this problem. The eco-friendly integration of urban and rural areas will allow a complete use of complementary effects gained through urban–rural interaction. Urban and rural eco-friendly integration originates from Sir Ebenezer Howard's garden city theory developed in the United Kingdom. Howard presented this theory in his book *Tomorrow: a Peaceful Path to Real Reform* published in 1898. Howard wrote that "town and country must be married, and out of this joyous union will spring a new hope, a new life, a new civilization," to highlight urban–rural integration as the core of his theory. He believed that the town, the country, and the town–country functioned as three magnets attracting people to live there as illustrated in his famous Three Magnets diagram. He suggested the town–country magnet, or the garden city, as the ideal city, which draws urban and rural advantages. "A garden city is a city designed to provide the population of healthy living and working; the dimensions should be just sufficient to allow the full development of social life, surrounded by a rural belt, soil in its entirety being public property administered or held in trust on behalf of the community." Howard envisaged a garden city that includes both urban and rural components. The garden city is an eco-city on several bases. The city and the countryside surpass simple coexistence to form an organic whole. Coordination between urban and rural areas promotes the entity's growth and establishes a healthy mechanism for internal balance. Both recognize a city's developmental limitation. When a city reaches a certain size, it is restricted, and a new growth is shifted to a neighboring city. A permanent rural belt between these two cities aids in this process. Size

restrictions favor higher quality for work and life in the city. Howard's garden city covers only 6,000 acres, housing about 32,000 people. The city center covers 1,000 acres and houses 30,000 people and is surrounded by the remaining 50,000 acres of agricultural land, where 2,000 people live. Howard's garden city and eco-cities both hold that the land and the community belong to the people and not to political or religious leaders. Community facilities are arranged for convenient use by residents. Government departments and organizations must advance two goals to achieve eco-friendly urban and rural integration – strengthening eco-friendly human settlements in the city and developing the new areas in the countryside with preserved ecosystems. Eco-friendly human settlements in the city need to be safe, convenient, comfortable, and focused on people's needs, as well as promoting harmony between humans and nature and society. This can be achieved by optimizing urban spatial arrangements and improving urban infrastructure and urban and rural communities. A number of specific initiatives may be implemented for these purposes. (1) River, lake, wetland, and other bodies of water development plans can be bolstered, along with human settlements surrounding rivers and other bodies of water, to form livable and integrated urban and rural eco-communities. (2) Greening plans along with planting trees and plants cultivate livable and integrated urban and rural eco-communities around the green spaces. (3) Resident migration from populous central cities to peripheral villages and towns will better make use of open spaces, fresh air, and the beautiful and peaceful environment found on the periphery, forming livable eco-communities near farmland. Building a new countryside with preserved ecosystems accelerates rural infrastructure construction, protects rural drinking water sources, improves the rural energy mix, and comprehensively improves the rural environment. Farmer's quality of life will benefit from these changes. A number of specific initiatives may be implemented. (1) Rural settlements require rational planning to avoid inefficient land use and relatively poor rural infrastructure and service facilities that result from overly scattered rural settlements. A six-level city–country system, including primary and secondary city centers, new cities, the central town, general towns, the central village, and grassroots villages, will improve urbanization. (2) Urban infrastructure expansion into rural areas including rural road building; rural infrastructures projects such as water, gas, and heat supply and sewage and garbage treatment facilities; rural drinking water safety projects; and information technology applied in agriculture and rural areas will further rural development. (3) Biogas, solar, wind, biomass, and other clean energies and renewable resources can transform the countryside of introduces. Environmental protection in rural areas and the rural energy mix also need improvement. (4) Landscaping in rural residential areas is not optimal. Rural drinking water and latrine quality are too low, and human health is further endangered by animals housed alongside human and improper river courses and ditches in villages. A village resource recycling system that integrates straw conversion, biogas generation, organic fertilizer use, and eco-friendly farming benefits both farmers and the environment. These steps will clean the home environment, use resources more efficiently, and turn waste to harmless agricultural production, leaving the countryside much more eco-friendly. (5) New towns and villages should be beautiful and eco-friendly.

Two Supports An eco-city has two primary supports for production and life in the city that enable cleaner production and green lifestyles – EIPs and green communities.

Developing EIPs to Enable Cleaner Production in the City Governments have advocated and popularized a circular economy in the wake of eco-city development. EIPs are a standard tool used by the international community to implement circular economy concepts. The CPC declared at the Fourth and Fifth Plenary Sessions of the Sixteenth CPC National Congress that China would develop a circular economy to adjust the industry mix and distribution and to change the economic development pattern. China has begun building EIPs using circular economy concepts to bolster the recycling economy. Six batches of 389 state-level EIPs have been built so far. Many now serve as circular economy examples and support eco-city development across China.

EIPs are new industrial parks that address cleaner production, a circular economy, and the principles of industrial ecology. EIPs connect factories and businesses together using logistics or energy flows to form a symbiotic industry combination where resources and by-product are shared and exchanged. Wastes or by-products at one factory become raw materials or energy sources for another factory. Producers, consumers, and decomposers mimic natural systems to form a circular path in this industrial system and create a closed-loop material cycle, use energy on numerous levels, and minimize waste. EIPs provide economic, ecological, and social benefits by integrating environmental protection and sustainable development into industrial development. EIPs are significant for many reasons. (1) EIPs emphasize cooperation and overall interests. An EIP creates a community of manufacturing and services that produce environmental, economic, and social benefits through cooperation among enterprises across the industry chain. (2) EIPs benefit from systematic planning. Systematically integrating material, energy, and information flows can increase an EIP's operational efficiency and allow infrastructure to be shared. (3) The environment is emphasized in industrial production. The entire industrial production process is planned and designed to match natural ecology so that it integrates into the whole natural system organically and increases harmony with the environment. (4) Sustainability is emphasized. EIP development is sustainable because it minimizes resource consumption and maximizes environmental protection through resource recycling and cascade energy flows. Companies in an EIP implement cleaner production in a transition from traditional passive responses to pollution toward preemptive and thorough pollution control, and they replace old and inefficient production methods known to pollute and consume resources and energy heavily with cleaner, efficient methods that do not pollute as much and reduce resource and energy consumption. The systematic construction of an eco-friendly industry chain has fueled the development and application of technology that conserves energy, recycles waste, and is environmentally friendly, providing a strong technical support system for eco-city development. Chinese cities need more new EIPs as part of urban development. Industrial parks with better spatial distribution,

consolidated industrial enterprises across the city, and more examples of a circular economy are also positive intermediary steps.

Building Eco-Communities for a Green Life in the City An eco-community is a green and sustainable community. An eco-community emphasizes integrating ecological relationships between human settlements and the environment with an organic combination of households, buildings, infrastructure, the natural environment, and community-based social services. Howard's garden city theory imagines an ideal city with a strong socioeconomic environment and a beautiful natural environment. This theory has led to the eco-community concept and began reflection on relationships between humanity and nature in human settlements. The *Machu Picchu Charter* published in 1977 defines the goal of urban planning as creating a multifunctional living environment that emphasizes harmony between the living and natural environments. China has increasingly sought environmental plans and designs for residential areas in the twenty-first century. The State has introduced many residential area construction policies and guidance documents, such as the *Points of the Comfortable Housing Project*, the *Guidelines on the Planning and Designing of Demo Urban Residential Areas in the Housing Technology Industry Program for Moderately Prosperous Urban and Rural Areas* (2000), and the *Points of and Technical Guidelines on the Construction of* Green *Residential Areas* (2001). These documents suggest an invigorated focus on residential environmental planning in China that is evolving toward eco-community planning. China is progressing in eco-community development with large-scale projects like the Guangzhou Science City, Hangzhou Ecopark, and the transformation of older urban areas in Shanghai and Xi'an. Green space system design, pleasant and eco-friendly spaces throughout the ecosystem, land and resource conservation, general environmental protection, energy conservation, waste treatment rendering it harmless, waste reduction, and waste recycling all work together to form a green regeneration mechanism for an eco-community. Eco-communities function like cells in an eco-city to promote harmony between humanity and nature and increase people's ecological awareness. Eco-communities require people to protect, utilize, and manage natural resources and cannot tolerate ecosystem damage or environmental pollution. Planners, designers, real estate developers, government departments, community residents, and property management service providers (or community resident committees) each have their role in developing eco-communities.

Three Belts The natural, agricultural, and cultural ecosystem belts are each necessary for urban development. Proper plans and spatial arrangements for these three belts will promote the overall development of the urban eco-civilization. They should be built within each city and among city belts, groups, and circles.

Building a Natural Ecosystem Belt to Optimize the Urban Environment A natural ecosystem belt in the center of the city improves the urban environment. There are several major tasks to accomplish this goal. (1) Protecting forests, developing the forest industry, improving the quality and ecological functions of forests, and developing forests' role in green protection will guarantee the forest contribution.

(2) Building and maintaining urban green corridors and protecting wildlife habitats by preserving river corridors, strip-shaped city parks along rivers, and lines of plants along urban roads will provide necessary ecosystem space. (3) Protecting native plants and biodiversity in urban areas by rescuing and protecting rare and endangered wildlife, protecting original habitats, and creating new habitats will improve the ecosystem's resiliency. Plant communities specific to certain zones should be protected during urban development. Native tree species play a leading role in local natural landscapes and reflect the regional natural ecosystems. Native species and the regional stable plant communities require protection, and foreign species should be introduced sparingly. (4) Protect rivers, lakes, and wetlands and developing environmental protection plans and comprehensive management systems for river basins will ensure their protection. (5) Tourism resources also require protection. Natural landscapes that look artificial, tourist spots that look like cities, and degraded or damaged tourist resources will harm this important industry.

Building an Agricultural Ecosystem Belt to Ensure Urban Sustainability China has been implementing an agricultural strategy focused on 7 areas and 23 zones as part of the 12th Five-Year Plan. The seven areas include the Northeast Plain, North China Plain, Yangtze River basin, Fen-Wei Plain, Hetao Irrigation District, South China, and Gansu–Xinjiang region. The strategy also covers farmland and agricultural areas that function as important components. High-quality rice, special corn, soybean, and livestock industry zones will be built in the Northeast Plain; high-quality special wheat, high-quality cotton, special corn, soybean, and livestock industry zones will be built in North China; high-quality rice, high-quality special wheat, high-quality cotton, canola, livestock, and aquatic industry zones will be built in the Yangtze River basin; high-quality special wheat and special corn industry zones will be built in the Fen-Wei Plain; a high-quality special wheat industry zone will be built in the Hetao Irrigation District; high-quality rice, sugarcane, and aquatic industry zones will be built in South China; and high-quality special wheat and high-quality cotton industry zones will be built in the Gansu–Xinjiang region. This national strategy urges eco-city development to include agricultural ecosystem belts around the city. (1) Each city should use their unique ecological resources to develop eco-agriculture by building green and organic food production centers, establishing a green agricultural production and processing certification system, and increasing green agricultural production. (2) Other features include eco-agriculture development based on biogas, a rotation pattern shifting between grains and cash crops, and the use of pesticides, fertilizers, and plastic films to reduce nonpoint source (NPS) pollution.

Building a Cultural Ecosystem Belt to Promote the Development of the Urban Ecosystem The cultural ecosystem belt in an eco-city encompasses people's cultural values, ways of thinking, and living conditions. This belt is a social living environment composed of systems, institutions, mechanisms, and organizations. The urban cultural ecosystem belt is complex, covering three levels. The first level regards physical objects such as urban buildings, public facilities, cultural heritage sites, artwork, and inventions created during urban development. The second level

regards cultural development, including intangible cultural heritage, values, ethical conduct, and religious beliefs, as well as the cultural and artistic heritage embedded in the hearts of city dwellers. Humanism, urban culture, and urban ideology reside at this level. The third level regards management and institutions along with rules, regulations, policies and laws, management mechanisms, and social organizations that can restrict and regulate urban residents. These three levels interact with each other and form the bulk of the urban cultural ecosystem belt.

The cultural ecosystem belt is critical to eco-city development. The most important difference between cities and the natural environment is the cultural environment present in cities. Eco-cities cannot advance to long-lasting development that addresses the deeper identity of eco-cities without a coordinated cultural ecosystem. The cultural ecosystem belt that is inherent in urban development is crucial for eco-city development. People's initiative and cultural strength serve as the inner spiritual core and cultural root of urban development due to their predominant role in the process. An organic balance between natural and cultural ecosystems in the eco-city can be realized by developing urban culture, harnessing people's creativity and wisdom, and promoting positive interactions between cultural and natural ecosystems, thereby protecting natural ecosystem resources and boosting eco-city development. The cultural ecosystem provides cultural support for eco-city development and its growth motivates urban development. A city's historical and cultural heritage can spawn a culture unique to that city and furthers urban culture industry growth. Improved values, stronger public ecological awareness, urban cultural buildings, and intangible cultural heritage culturally educate people in subtle ways as part of the cultural ecosystem. Cultural inheritance, development, and innovation improve a city's internal qualities and show its distinctive charm. A strong cultural ecosystem is conducive to protecting the natural environment of the city. The strong spiritual power inherent in the cultural ecosystem will guide the public to take initiative in protecting the environment and unite people in urban development. Developing systems, policies, laws, regulations, institutions, and organizations involved in managing the relationships among social, economic, and natural ecosystems protects natural ecosystems, including an eco-city's intangible environment and creates a people-oriented eco-city with a beautiful, livable environment. What must be done to create a cultural ecosystem that guides and supports eco-city development? Urban history and culture must be fully recognized and incorporated. The urban cultural ecosystem includes unique cultural elements that are accumulated during a city's evolution, such as lifestyle, traditions, and customs, which can be observed around the city at historic sites, nationally unique buildings, and cultural activities with national characteristics. The traditional character of the city is important to maintain, as is protecting historic sites. Maintaining the city's culture should not rely on preserving traditional streets and nationally unique buildings but should also promote distinctive history and culture, hold various cultural activities, and visually present traditional culture and virtues. The cultural charm of an eco-city can also be found in unique local cultural elements. The municipal government should instruct relevant organization to protect traditional culture and use it to enrich emerging modern culture. The process also requires a humanistic core for the city. The city

thrives on humanism, which provides spiritual support for urban entrepreneurship. Establishing the city's humanistic core at this stage of eco-city development requires people-oriented actions, harmonious development, a harmonious socialist culture, enriching cultural activities for citizens, improving the cultural character of the city, innovation, cultural literacy, elegance, and inclusivity, which are indispensable to the urban cultural ecosystem. Intangible cultural heritage must remain in use and be protected. Intangible cultural heritage differs greatly from culture by only incorporating the nonphysical elements of the cultural ecosystem. Protecting intangible cultural heritage is essential for the development of the urban cultural ecosystem. Intangible cultural heritage needs protection to promote sustainability, even against economic interests. Laws and regulations can ensure that intangible cultural heritage is developed, used, and protected from local interest groups interested in exploiting it for their own interests. Efforts should be made to restore diversity and vitality to intangible cultural heritage. Protecting intangible cultural heritage should incorporate the government as well as public engagement and awareness around its importance. Including the public will increase coordination between protection and development. Greater ecological awareness among the public is key. The urban cultural ecosystem's sustainability and development toward a socialist eco-civilization depend on the public's ecological awareness. The urban cultural ecosystem requires a public awareness of its roles, responsibilities, and obligations in the ecosystem and demands that people should adapt themselves to their surroundings as needed. A new set of values conducive to harmony among human beings and in their relations with society and nature is also needed. Governments should encourage public participation in environmental protection and development, promote a harmonious eco-civilization, advocate for environmental ethics and healthy lifestyles, and motivate the public to independently protect the environment.[11]

Four Parties Eco-city development plans and strategies require a strong implementation mechanism. China's eco-city development is led by the government, in contrast with various mechanisms that have emerged in the international community, such as international cooperation, government and business partnerships, and community-driven development. International experience dictates that governments, businesses, NGOs, and the public each have an important role in eco-city development. The four parties should work together to form urban development and management mechanisms that effectively coordinate multiple sectors.

Governments Lead Eco-City Development Governments should coordinate and guide eco-civilization development and provide planning and technical guidance. An eco-friendly government is necessarily collaborative. Social systems must work together to promote harmony between humanity and nature. Governments should coordinate among these social systems, strengthen central and local administration and integrated cooperation, and implement holistic policies to ensure system-wide interests are met. Consensus on environmental protection and PES focused on ecological interests is needed. Governments should coordinate environmental,

[11] Ye et al. [10].

economic, and social development, prioritizing the environment. They should further a balanced view of developmental activities to balance economic, social, and ecological relationships related to human development. The central government should plan for nationwide eco-civilization development, summarize experiences and lessons, and rework plans to best meet eco-civilization goals. It should consider the country's ecological reality and needs in the implementation scheme to guide nationwide eco-civilization activities and ensure efficient and effective coordination among all levels and sectors. Governments should provide policy and institutional support for eco-civilization development. Eco-friendly institutions that adhere to the legal system are critical to ensure the compliance and orderliness of eco-civilization developmental activities because the institutions supplement the legal system. Many factors affect eco-civilization development, and a lack of a public administration mechanism that favors eco-civilization development is an important factor in China. Economic development and environmental protection are unbalanced in some regions of China where local governments overemphasize GDP growth and ignore environmental and resource protection. Some local governments evaluate performance on economic growth and ignore holistic development. This phenomenon has adversely affected eco-civilization development, which requires institutional improvements and innovation to eliminate long-term institutional barriers blocking environmental protection and to harbor institutions conducive to environmental protection. Clearly define developmental ideas and objectives that adhere to essential requirements for eco-civilization development are needed. Governments should establish and improve institutions to favor eco-civilization development and provide support policy and institutional support. Governments must guide development toward eco-civilization goals. Governments should guide the public to systematic participation in environmental protection and encourage various public environmental movements and activities to raise environmental awareness and motivate independent environmental protection. Governments should encourage consumption and lifestyles changes, the resource and energy conservation, the natural environment protection, thrift, and waste recycling. Enterprises and other organizations also need governmental guidance toward environmental information transparency. Access to EIAs can be improved by ensuring that project managers disclose information and promptly provide it to the public to protect the public's right to know and be involved. Advisory bodies and public information networks can provide the public access to timely information on eco-civilization development that will permit people to monitor decision-making processes. Governments should ensure environmental decisions are democratic and strictly adhere to laws and regulations. They should also provide guidance for green consumption transformation, eco-friendly industry growth, and eco-friendly marketing, logistics, and ecological education systems.

Companies Fuel Eco-City Development An eco-civilization requires companies with defined ecological responsibilities that guide operations and business management to achieve sustainable development involving humans, companies, ecosystems, and society. Companies can promote eco-city development by establishing a

corporate ecological responsibility system that includes ecologically responsible production and products; ecological responsibility toward nature that abandons traditional values that only emphasize humans' rights to nature in favor of value that includes humans' obligations to protect the natural environment and that ceases robbing nature of its resources during exploitation in order to protect it; ecological responsibility across the market with green market approaches, green products, compliance with environmental protection rules and regulations, and healthy products that meet market needs; and ecological responsibility to the public through shared ecosystem resources and environmental benefits and through proper responses to ecological consequences. It is unjust for the current generation to satisfy their interests at the expense of developmental opportunities for future generations. A corporate environmental management system will support an eco-friendly corporate culture. Environmental guidelines that outline corporate environmental understanding and goals are needed. They include corporate commitments to pollution prevention; observing and improving environmental laws, regulations, and requirements; and creating a framework for setting and reviewing environmental objectives and indicators. Companies should get ISO14001 certification. Certified companies will benefit by establishing a good corporate image and receiving recognition across society; eliminating green barriers to international trade and increasing access to international markets; conserving raw materials and energy while reducing waste to lower costs; and boosting competitiveness through green products. Companies should also establish green corporate values. They need strong green corporate systems embedded in their culture and increased ecological awareness and goodwill among executives. Companies should improve corporate values to contribute to sustainable, environmental, economic, and social development. They should raise the employees' ecological awareness through trainings, seminars, ecological improvement projects, active participation in environmental protection, and public and cultural activities conducive to sustainable development. Companies need corporate ecological management and evaluation systems. A green code of conduct is also needed. Companies can disseminate information on corporate environmental awareness to educate employees and establish a green code of conduct. Corporate ecological and environmental ethics help mediate between corporate interests, public interests, all living things in nature, and future generations. Companies should adopt eco-civilization values at the core of the corporate culture and abide by corporate environmental ethics that respect public interests, natural life, and future generations. These steps lead to a first-rate company. A green corporate image can be crafted through green production, marketing, and management. Chinese enterprises should work together to help China's industrial sector go green, promote efficient corporate resource use, and vigorously promote cleaner production to better conserve resources.

NGOs Contribute to Eco-City Development Many diverse Chinese NGOs are active in environmental protection. The most famous include the Friends of Nature (FON), Global Village of Beijing (GVB), Green Earth Volunteers (GEV), China Small Animal Protection Association (CSAPA), China Environmental Protection

Foundation (CEPF), Beijing Environmental Protection Foundation (BEPF), China Wildlife Conservation Association (CWCA), Beijing Wildlife Conservation Association (BWCA), China Green Foundation (CGF), China Association of Environmental Protection Industry (CAEPI), Beijing Association of Environmental Protection Industry (BAEPA), Botanical Society of China (BSC), Chinese Society of Natural Resources (CSNR), Chinese Society for Environmental Sciences (CSES), Green Camp of University Students in China (GCUSC), China Green Student Forum (CGSF), Student Green Association of Tsinghua University (SGATU), PKU Green Life, Scientific Exploration and Outdoor Life Society of Beijing Forestry University (SENOL), Shanghai Teen Environmental Enthusiast Association (STEEA), and Center for Legal Assistance to Pollution Victims (CLAPV). These organizations lead environmental activities that provide Chinese society with many public benefits that are difficult for governments and companies to provide and promote environmental movements across China since the country first began reform and opening up. Local environmental organizations work on eight issues. (1) They hold promotional and educational activities to increase environmental awareness. Many NGOs hold awareness activities including various environmental initiatives and practical activities; televised and live lectures, trainings, speeches, and other educational activities about environmental awareness; and seminars, experience sharing opportunities, symposia, etc. (2) They promote and facilitate public participation in environmental protection. Governments and NGOs are increasingly cooperating on public participation in environmental protection in many Chinese cities, especially Beijing. (3) They fund environmental protection activities. International and overseas NGOs and foundations active in natural resource and environmental protection and Chinese foundations and NGOs related to environmental protection provide support through financial, equipment, technical, and other means for activities protecting natural resources and the environment. (4) They conduct projects protecting natural resources and the environment. Many NGOs are implementing various environmental projects, including wildlife and biodiversity protection, natural ecosystem maintenance and protection, tree planting, water purification, air pollution control and treatment, desertification prevention, soil erosion prevention in the upper reaches of the Yellow River, community-based environmental protection, garbage classification and separation, recycling, etc. (5) They research, develop, and popularize science and technology for environmental protection. Environmental protection societies, research institutes, and other NGOs employ many Chinese authorities and experts in academic fields related to the environment. Research and development of the related disciplines and technologies along with R&D results promote science and technology that protects the environment in China. (6) They manufacture and promote products that protect the environment and form industry alliances. Chambers of commerce, industry organizations, and other economic organizations active in environmental protection facilitate the development, production, distribution, and consumption of environmentally friendly products among other important activities. (7) They help environmental pollution victims. Pollution victims form a special disadvantaged group that receives attention from across society as pollution worsens. NGOs provide pollution victims

assistance and legal advice. (8) They hold international exchange activities for environmental protection. The vast majority of environmental NGOs exchange information intentionally. They actively seek support from the international community for information, finance, equipment, technology, and in other fields. Environmental NGOs are further strengthening international cooperation for environmental protection by holding and attending international conferences and symposia, sending personnel for training, receiving visitors, and making visits. The Chinese government must follow and nurture NGOs, allow them to contribute to environmental protection, and encourage NGOs to participate in cooperation and exchanges for eco-city development projects. NGOs should continue advocating for an eco-civilization.

Increasing Public Participation in Eco-City Development The public produces and consumes in the city and builds and protects it, so that successful eco-cities outside China encourage the broadest possible public participation. Specific measures ensure broad public participation in the development and implementation of plans and schemes and in follow-up and monitoring. Many cities have benefited from such participation. Broad public participation is considered indispensable to the success of eco-cities outside China. Behind each objective in the local Agenda 21 developed by Seoul, South Korea, are specific fields and means for public participation to ensure project implementation. The government of Osaka, Japan, launches an annual public garbage collection event in September. It sends pamphlets to one million households that explain how to treat and recycle waste. The government of Montreal, Canada, uses T-shirts printed with public service ads, calendar cards, notebooks, and buses to call for public participation in waste recycling.

Eco-city development's massive scope requires broad public participation. A city must provide its citizens with environmental education on its way to becoming an eco-city in order to raise environmental awareness, create a sense of responsibility to protect the environment, increase resource and energy conservation and material recycling, promote a green and thrifty consumption pattern, and instill adherence to environmental laws. Public participation is initiated by governments in most cases and focuses on environmental education and monitoring but lacks pre-project participation. Governmental organization is more important that institutional support in boosting public participation. The Chinese public often discusses the environment but is not prone to act. China needs an established system for public participation in environmental protection.

The public can participate in environmental protection by learning and disseminating environmental information, making environmental decisions, and monitoring environmental policies. Environmental coverage and education must be enhanced to raise awareness of environmental rights and of the right to participate in public affairs and to spread eco-civilization ideology to individuals, families, and the entire society if public participation is to increase. Governments should hold more activities for public participation in environmental protection. Clear approaches to public participation in environmental protection will increase it. The public cares about and wants to participate in environmental protection, but surveys indicate

people do not know how to engage specific environmental issues. Rules and regulations, such as the 2006 *Interim Measures for Public Participation in Environmental Impact Assessment*, help ensure the public's right to participate in environmental decisions. Public monitoring of environmental protection can stand improvement. The public is most concerned about environmental issues because its quality of life is directly intertwined with the environment. Public monitoring of environmental protection can improve by informing people of hotlines for reporting environmental issues. Promoting and improving environmental public interest litigation provides another avenue to involvement. Environmental public interest litigation can be any citizen, community group, or government agency that files a lawsuit to protect the public interest. It is necessary to systematically manage the growing public requirements for environmental rights. The eco-civilization is an entirely new form of human civilization based on reflections and adjustments to traditional civilizations, especially the industrial civilization. The eco-civilization is a major milestone for human civilization development.[12] It emphasizes human consciousness, self-discipline, interdependence, and mutual promotion and harmony between humanity and the natural environment. Eco-city development is integral to eco-civilization development and should respect nature; achieve and maintain harmony between human beings, nature, and society and between human beings among themselves; establish sustainable production and consumption patterns; and guide people toward sustainable and harmonious development. Eco-city development requires mobilization of positive factors; coordination of relationships between human beings, nature, and society and between human beings themselves; and planning and management based on ecological principles, in order to establish harmony for human, society, and nature.

2.3 Recommendations for Future Eco-City Development in China

China is shifting its attention from the rapid economic growth pursued over the past 30 years to enhancing public welfare. Urban development should make a similar shift away from economic growth focus and toward people. Many Chinese cities are still struggling to coordinate livability, economic growth, and productivity. How can Chinese cities develop into eco-cities? Four approaches present themselves. First, Chinese cities must go green to address urban economic growth and reduce carbon emissions. Second, Chinese cities must develop a circular economy to achieve cleaner production. Third, Chinese cities must promote low-carbon lifestyles to improve the living environment. Fourth, Chinese cities must advocate cultural livability to solve ecological problems within urban residential areas.

[12] Zhou [11].

2.3.1 Promoting Green Development

What Is Green Development? Green development encompasses a new, integrated pattern of economic, social, and environmental development that employs reasonable and low consumption, low emissions, increased ecological capital, and green innovation. Green development accumulates green wealth and welfare for human beings and achieves harmony between human beings and nature and among human beings.[13] Green development contrasts black development, which accepts pollution with plans for later treatment. Green development advocates symbiotic coexistence between human beings and nature and incorporates sustainable development. This includes sustainable development of the planet and humanity, striving to achieve green economic growth, accumulating green wealth in natural systems, increasing green welfare in social systems, and shifting a country's or region's ecological deficit toward ecological surplus. Going green is a universal solution to issues such as global warming and is the only path to promoting China's green rise.

How Does Green Development Relate to Eco-City Development? Green development guides urban development toward a green city and leaves profound and lasting effects on the development process. (1) Green development promotes green innovation during urban development. Eco-cities around the world have been the leaders in green innovation. Freiburg, Germany, harnesses solar power; Kathmandu, Nepal, has adopted green roof measures and limitations on building heights; Reykjavik, Iceland, is using hydrogen fuel instead of oil; and Toronto, Canada, has adopted a LED lighting system. (2) The concept develops green industries. Specific measures may include developing the forest industry to increase forest coverage; developing new energy, materials, and renewable resources; eliminating energy-intensive and polluting industries; and developing low-carbon, green, modern services to create a green production system. (3) The concept promotes green consumption in cities. Specific measures may include promoting green food and medicine; encouraging energy-efficient appliances and household products; promoting green travel such as walking, cycling, and public transport; etc. (4) The concept promotes increasing green wealth and welfare in cities. Plenty of sunshine, fresh air, clean water, rich green spaces, vegetation, and other elements constitute green wealth and welfare in a city, and all contribute to a healthy and happy life and work environment for ordinary people. Initiatives for green development can accumulate green wealth for the city and improve green welfare for local residents.

Measures for Green Development in Chinese Cities Ouyang Zhiyun et al. wrote an evaluation report on green development in Chinese cities that brought attention to the low investment in pollution treatment, infrastructure, and waste recycling and the successes of greening efforts, municipal solid waste (MSW) treatment, reduced water consumption per unit of GDP, high air quality, and industrial wastewater treatment. Cities with particularly high investment are directly under the central

[13] Hu [12].

government or provincial capitals, but output value from comprehensive waste recycling in these cities is not high. Cities with particularly high water consumption per unit of GDP and failing industrial wastewater discharge standards tend to be smaller. Cities in Fujian, Guangdong, Hainan, Hebei, Hubei, Jiangsu, Jiangxi, Shandong, Zhejiang, and other coastal provinces or provinces near the coast, as well as the four municipalities directly under the central government, are further developed in these fields when compared with cities in Gansu, Jilin, and Shanxi and northwestern provinces such Shaanxi.[14]

Qu Geping, the former head of the Chinese NPC Environmental and Resources Protection Committee, proposed six criteria and nine approaches to building green cities. The six criteria include reasonable plans and spatial arrangements, reliable urban infrastructure, effective pollution prevention and high environmental quality, clean energy use, a minimum percentage of natural landscape covering the city, and residents with strong environmental awareness. The nine approaches include developing reasonable urban plans; implementing an economic development pattern around a circular economy; building a fully functional urban environmental infrastructure; establishing a fast, convenient, and clean urban transportation system; creating an energy system led by clean energy sources; building beautiful, eco-friendly, residential areas with necessary services and high environmental quality; researching and developing an environmentally friendly technical support system; improving the sustainable development legal system; raising awareness around environmental protection and resource conservation across society; and promoting eco-friendly values and green consumption and urging public figures, especially government leaders, to accept sustainable development and meet environmental requirements in when making decisions and shaping consumption.[15] These criteria and approaches determine developmental goals for green cities and provide an ecological perspective to development and environmental protection efforts, which is key for overall green development in Chinese cities.

2.3.2 Developing a Circular Economy

What Is a Circular Economy? A circular economy is an economic growth pattern that efficiently uses resources, adheres to the 3Rs (reduce, reuse, recycle), enjoys low consumption and emissions, and is highly effective. Reduction happens as people use fewer raw materials and energy inputs produce and consume, conserving resources and reducing pollution at the first phase of economic activities. Reuse is realized as people use purchased articles, reuse wastes, and extend product and service lifecycles. Recycling requires waste discharge and emission minimization and conversion of used items into usable resources instead of disposing them as useless garbage. The circular economy establishes a "food chain" and "food web"

[14] Ouyang et al. [13].

[15] Guo et al. [14].

in the eco-economic system by simulating natural ecosystems, creating a producer-to-consumer-to-decomposer circulation path in the economic system, and using a symbiotic network to achieve closed-loop material recycling and multilevel energy utilization.

The circular economy is a new pattern of economic development that appeared as resource, environmental, and economic problems worsened. The circular economy organically combines industrialization, urbanization, and eco-friendly development, provides a path toward sustainable development, and offers a solution beneficial to the economy and the environment. It is significant in two dimensions. First, the circular economy marks a departure from the old and unsustainable economic system of mass production, consumption, and waste. It reconstructs the economic system to material and energy circulation in natural ecosystems, enabling a harmonious and cooperative relationship. Second, the circular economy integrates cleaner production with comprehensive waste recycling and respects ecological laws when using natural resources and environmental capacity. All raw materials and energy are used in a reasonable and exhaustive fashion in ongoing economic circulation, minimizing the environmental impact of economic activities and improving ecological growth. The change renders economic activities increasingly eco-friendly.

How Does the Circular Economy Relate to Eco-City Development? The circular economy satisfies eco-city requirements by achieving low input, high output, and low emissions production linking it closely to eco-city development. (1) Circular economy theory forms a basis for eco-cities, and developing a circular economy provides a new paradigm for eco-city development. A city can maximize economic and social development with minimal environmental and resource costs and can protect resources and the environment with minimal economic and social costs by following circular economic theory. Cities are not required to sacrifice the environment for development nor abandon development for protection. A city can maintain the finest environment and quality of life for local residents and at the same time ensure sustainable, healthy, and rapid socioeconomic development. The circular economy prompts the city to embark on a technology-led, resource-conserving, and eco-friendly modern development pattern. (2) Eco-cities result from circular economy development, ensuring their economic systems will follow circular economic principles. The current open-loop economic process moving from resources to products to waste should be closed into a circular economic process going from resources to products to resources using the producer–consumer–decomposer mechanism found in natural ecosystems, thus reducing resource consumption and recycling wastes into resources. (3) The circular economy is a necessary method and pattern of eco-city construction. Developing a circular economy requires organizing economic activities under ecological and economic laws. The circular economy requires a city to better utilize nonrenewable resources, replace nonrenewable resources with renewable alternatives to the greatest extent possible, and establish a green consumption system, thus achieving maximum reduction to resource and the environmental damage caused by human consumption and sustainable consump-

tion. The circular economy also requires a green GDP accounting system and a focus on resource conservation and environmental protection.

Measures for Developing a Circular Economy in Chinese Eco-Cities Resource use reveals three reasons for serious environmental problems across China including rapidly growing resource consumption, inefficient resource use, and a low recycling rate. China must address these problems by developing circular economy if the trend is to shift. China has formed a unique circular economy development pattern referred to as the "3 + 1" pattern, which includes small-, medium-, and large-scale circulation plus waste treatment and reproduction. Small-scale circulation occurs at the enterprise level. Large and average enterprises are selected for pilot eco-industrial projects that implement green product design, cleaner production, and other measures with a goal of eco-efficiency, reducing the consumption of materials and energy for products and services and minimizing pollution. Medium-sized circulation occurs at the regional level. Inter-enterprise integration of materials, energies, and information creates a symbiotic relationship among enterprises and develops EIPs in accordance with industrial ecology. Large-scale circulation occurs at the national level. It focuses on building cities and provinces with circular economic systems. Liaoning Province has begun building circular economy demonstration zones focused on transforming old industrial centers. Guiyang City in Guizhou Province is developing into a circular economy city focused on comprehensive use of local resources unique to the area to create a new industrial pattern. Waste and used resources are treated, disposed of, and reused in production as per the relevant regulation for recycling waste and used resources across society. Planning, design, and construction of circulation systems are at the center of circular economic development needed for eco-cities. Urban circulation planning and design uses clean and renewable energies, improves resource utilization, and generates no wastes or garbage. Urban circulation planning and design should rely on local natural resources and with a consideration of socioeconomic and technological development. The focus should remain on assessing the carrying capacity of ecosystems, natural landscapes, and the hydrographic environment. Relevant organizations should integrate the city's economic system with the natural environment. Urban circulation planning and design include circulation design for production and industry. Product circulation planning and design ensure that product design, production, and sales are all green. Product designers should consider quality, functionality, price, aesthetics, and other factors that routinely satisfy human consumption utility as well as the environmental impact of a product throughout its lifecycle to ensure green product designs. Such considerations minimize the product's environmental impact without reducing its consumption utility. Green manufacturing and production including resource conservation and rational utilization can be achieved through tight control over resources and the entire production process. Wind power, solar power, bioenergy, and other clean renewable energies should be used widely, and energy efficiency can increase through cogeneration, energy sharing, and multilevel energy use. Nontoxic, renewable, and environmentally degradable raw materials should replace toxic, nonrenewable, and nonbiodegradable materials to

reduce environmental impact. Sales prices in the product marketing stage should include profits from marketing events while reflecting environmental damage caused through product consumption to meet corporate interests, consumer demand, and environmental interests. Extra attention should be paid to green product packaging, ensuring reusable package materials. Waste caused by packaging, production, and consumption should be returned to the manufacturing process and recycling energy and materials. Circulation design should focus on building an eco-friendly industry chain. The entire process results in resource–product–resource circulation within the enterprise, ensuring an eco-friendly industry chain for the production process and an ecosystem network between production and consumption that covers all three activity sectors. The core of all circulation rests in circulation within enterprises, which allows circulation throughout the city. The Law of the Human Body theory sees a city like a human body and business communities consisting of interrelated downstream and upstream enterprises as its organs, which perform specific complex functions that circulate materials, energy, and information through the city's arteries and veins, thus connecting the city with the country, its suburbs, and other cities.

2.3.3 Advocating a Low-Carbon Life

What Is a Low-Carbon Life? The world is shifting toward a low-carbon economy, and countries are competing for leadership in this trend. A low-carbon economy seeks the highest possible output that still reduces greenhouse gas emissions. It is one of fundamental tools for humanity in dealing with climate change and among the most recent economic trends around the world in the twenty-first century. Greenhouse gases in the atmosphere absorb and emit thermal infrared radiation. Human activities alter levels of greenhouse gases such as carbon dioxide, methane, nitrous chloride, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. Carbon dioxide has the greatest impact on climate change. A low-carbon economy reduces carbon content in the production or consumption process to yield lower carbon dioxide emissions and cleaner air. A low-carbon economy is an economic development pattern based on low energy consumption, pollution, and emissions that marks a significant milestone for human society following the agricultural and industrial civilizations. A low-carbon economy works toward efficient energy use, clean energy development, and green GDP. Energy and emission reduction technology innovation and development in industry form the core of a low-carbon economy along with fundamental changes to the concept of human survival and development.

All economies are facing significant pressure to reduce carbon as resources are exhausted, energy prices soar, environmental pollution worsens, and the global climate loses balance. The traditional high-carbon development pattern that relies on the massive consumption of fossil fuels is no longer sustainable. Future development must seek low-carbon solutions offering strategic advantages to lead new

energy and low-carbon technology development, as they will lead the future green industrial revolution and a new round of global economic growth. China has been attentive to energy conservation and environmental protection since it began reform and opening up and has increased interest since the 1990s. China's economic growth pattern remains inefficient, engaging in economic development largely at the expense of the environment, because of the traditional GDP-focused evaluation system. The Chinese economy has arrived at a crossroads in the twenty-first century after a burst of rapid economic growth and new development in the industrial and chemical sector. China must embark on a low-carbon transition focused on energy conservation and emission reduction to transform the economic development pattern following the Scientific Outlook on Development.

How Does a Low-Carbon Life Relate to Eco-City Development? Cities around the world house more than half of the world's population and account for 75 % of total greenhouse gas emissions. Cities have a massive demand for resources and huge carbon emissions that go far beyond their carrying capacities and have negatively affected their continued development and their role in local and global environments and economies. The high density urban environment and wide range of activities available in cities that create their huge resource demand do not excuse cities from developing a low-carbon economy. Cities can use their large and dense populations and variety of commercial and industrial activities to more effectively control resource and energy consumption per capita than low density areas. Large cities wielding regional power have advantages for developing a low-carbon economy than their political and institutional frameworks. Low-carbon cities are crucial for leveraging these advantages. A low-carbon economy results from efforts to reduce greenhouse gas emissions but is also a broader revolution in economic development, energy consumption, and human lifestyles. A low-carbon economy will transform the entirety of the modern industrial civilization based on fossil fuels for energy sources into an eco-economy and eco-civilization. It increases energy efficiency and improves the clean energy source mix. Energy technology and institution innovations such as minimizing high-carbon energy sources such as coal and oil in economic activities and furthering low energy consumption and low pollution in the economy are at the center of the low-carbon economy. A low-carbon economy is the only way to achieve sustainable urban development. Implementing these economic values in the city by furthering low-carbon production and consumption, conserving resources, greening society, and promoting a healthy and sustainable energy ecosystem creates a low-carbon city. A low-carbon city begins foremost with developing low-carbon energies but can also include cleaner production, recycling, and sustainable development as an end objective.

Measures for a Low-Carbon Life in Eco-Cities China is industrializing and urbanizing rapidly. It has entered the second half of the intermediate industrialization stage. Heavy industries and chemical industries are developing rapidly leading energy-intensive industries to an increasing share of the economy and to increased energy consumption. China's total greenhouse gas emissions increased sevenfold between 1970 and 2007. China overtook the United States as the world's largest

carbon dioxide emitter in 2007. Coal-fired power plants in China's industrial sector account for over 84 % of total carbon emissions. The industrial sector has higher emissions intensity per unit of GDP than agriculture and services. China could reach 9.5 billion tons of carbon emissions in 2020, which would represent 27.8 % of the world's total carbon emissions, according to forecasts by the International Energy Agency (IEA). In 2030, that amount will go up to 11.6 billion tons of carbon or about 30 % of the world's total carbon emissions. China's urbanization process has developed rapidly alongside economic development. China's urbanization level is only at 46.6 % and will only reach 75 % in 30 years if growth remains at one percent per year. Such a trend means China's urban population will increase by 450 million by the end of 2040, equivalent to 1.5 times the US population and equivalent to the population of the EU. Rapid urbanization has significantly increased the scope of urban housing, transportation, and other infrastructure, as well as energy and resource consumption, multiplying the city's greenhouse gas emissions. This presents China with a complex set of domestic and international factors in addressing sustainable development and environmental protection. China must avoid energy demand and greenhouse gas emissions locking into economic development if it is to continue urban development. It must quickly transform the economic development pattern, using low-carbon, energy-conserving, and environmentally friendly technologies, developing low-carbon cities and eco-cities, and promoting green low-carbon development in urbanization.

The NDRC, the MOHURD, the Tianjin Municipal Government, and the China Center for International Economic Exchanges (CCIEE) held the Second China (Binhai Tianjin) International Eco-city Forum & Expo (Binhai Forum) on September 23–24, 2011. NDRC Deputy Director Xie Zhenhua attended the opening ceremony and delivered a keynote speech titled "Promote opportunities through green low-carbon development for low-carbon cities" at the main forum, proposing a number of measures for low-carbon cities. (1) He proposed optimizing the industry mix; developing the service sector and emerging strategic industries such as energy conservation, environmental protection, and new energies; and preventing energy-intensive, high-emission industries from rapid growth. Enhancing binding targets for energy conservation, environmental protection, land use, and safety, eliminating obsolete production equipment and technologies, and promoting the transformation of traditional industries for an energy-efficient, low-carbon industrial system further aid optimization. (2) He recommended optimizing the energy mix, controlling total energy consumption, strengthening cleaner production and coal use, and developing clean, efficient, high-capacity coal-fired generation units. Further steps include increasing oil and gas exploration and development, developing unconventional oil and gas resources, and developing nonfossil energy sources. Safe nuclear power, eco-friendly hydropower, wind power, solar power, biomass, geothermal energy, and other renewable energy sources can be developed based on local conditions. (3) He proposed strengthened energy conservation and low-carbon development management, energy efficiency benchmarking activities, and energy conservation and emission reduction projects in buildings, transportation, and other sectors. The "10,000 low-carbon businesses" initiative can help the industrial sector, the "green

building" initiative can help the construction industry, and the "1,000 low-carbon transportation companies" initiative can help the transportation sector. Energy conservation and emission reduction can be better applied in agriculture, rural areas, commerce, households, and public institutions, and low-carbon projects are needed across society, including building low-carbon governments, campuses, and avenues. (4) He recommended accelerating research, development, and application of low-carbon technologies, strengthening basic scientific research on greenhouse gas emissions control, and researching and developing of cutting-edge technologies critical to reducing carbon. Governments should offer incentives for the broad application of energy conservation and carbon reduction technologies and equipment and support energy-efficient motors, semiconductor lighting, low-frequency waste heat utilization, and other important low-carbon technologies to advance their production and application.[16]

2.3.4 Advocating Cultural Livability

What Is Cultural Livability? The concept of livability first appeared in the garden city movement in the United Kingdom in the nineteenth century. Sir Ebenezer Howard presented the garden city theory in his book *Tomorrow: a Peaceful Path to Real Reform* in an effort to solve urban problems at that time by building comfortable, convenient, and beautiful garden cities (Howard, 1898). Urban planning has focused on creating comfortable and pleasant environments since World War II. In his book *Amenity and Urban Planning*, David L. Smith used examples from the second half of the nineteenth century to advocate for a pleasant environment using the amenity concept. Amenities cover public health and pollution, a comfortable living environment, historic buildings, and a beautiful natural environment. The WHO summarized the basic living requirements for human beings in 1961 as safety, health, convenience, and comfort to form the concept of a living environment. The second United Nations Conference on Human Settlements (Habitat II), held by the UN-Habitat in 1996, adopted the Habitat Agenda and declared a city a human settlement suitable for living. The conference established three fundamental criteria for livability including spatial, social, and environmental characteristics and qualities of an urban community, and it recognized democracy, consultation, public participation, and system development as external support for forming livable cities and towns. The concept of livability has since spread to other fields.

The famous Chinese scholar Wu Liangyong developed a living environment theory dividing it into five levels: global, regional, urban, community, and building. He proposed five principles for solving living environment problems, including recognizing the ecological predicament and raising ecological awareness; achieving positive interactions between living environment and economic development; developing science and technology and promoting economic development, social

[16] Xie [15].

prosperity, and the living environment through diverse methods and techniques; caring for the general public and respecting the overall public interests; and combining science with art.[17] Luo Yameng analyzed Chinese traditions and human settlement history to conclude that livability in China has evolved from seeking an affordable, pleasing, and large place to live with a positive, comfortable, and healthy living environment to become a search for a positive, healthy, peaceful, and safe place to settle permanently.[18] China promulgated the Scientific Evaluation Criteria for Livable Cities in 2007, realizing nearly 100 indicators spread over six categories: social civilization, economic prosperity, environmental beauty, resource-carrying capacity, living convenience, and public safety. Gu Wenxuan believes that a livable city and evaluation criteria for livable cities incorporate a wide range of disciplines and that efforts must look beyond comfortable living conditions and environment to thriving cultural and social environments with moral behavior, stable social order, extensive social welfare, full employment, etc.[19] For anything in China's current state of social development to be considered livable, it must be oriented around people. Livability depends predominantly on whether the needs of residents are met and whether they are satisfied with the city's living environment. A community with a high livability index and high life satisfaction will satisfy residents' need and is therefore a truly livable community. Building livable cities has gained prominence among twenty-first century cities around the world. Beijing first announced livability goals in 2005. A livable city is suitable for work and life using coordinated economic, social, cultural, and environmental development, a good living environment, and meeting the physical and cultural needs of residents. A livable city coordinates cultural and natural environments, continuous economic prosperity, social harmony and stability, a vibrant cultural atmosphere, and a full range of amenities. Shanghai, Guangzhou, Chengdu, Hangzhou, Dalian, Qingdao, etc. have all announced livability goals, greatly popularizing livability in Chinese urban development. Livable means suitable for human habitation so that livability efforts require orientation toward people. A livable city views a city as a collection of people's lives and aims to improve the overall quality of life and to achieve harmony between humanity and the natural environment. A city's livability should be present in its economy, culture, society, and environment. A livable city should meet comprehensive livability requirements including a prosperous urban economy, a pleasant environment, excellent public services, a harmonious cultural atmosphere, etc. We define a city's livability by the quality of urban life available to its residents. A livable city must meet a number of requirements. (1) It must be livable as a whole. A livable city must extend to economic, cultural, social, and environmental domains. (2) A livable city should have a prosperous urban economy with a stable and healthy economic environment, a rational industry mix, developed and modern services, adequate and stable employment opportunities, and job providing high disposable income necessary for a livable city. (3) A livable city should have a flourishing envi-

[17] Jin [16].

[18] Luo [17].

[19] Gu [18].

ronment providing fresh air, clean water, lush greenery, and beautiful natural landscapes, all necessary for ecological livability. (4) Comprehensive public services, including urban public facilities, transportation, housing, safety and security, disaster reduction, employment, medical care, education, welfare, etc., constitute livable service in a city. (5) A livable city should have a harmonious cultural atmosphere, including social order, morality, culture, entertainment, etc., to provide cultural livability.[20] Li Liping and Guo Baohua, researchers at the Institute of Regional Economy and Urban Management and Renmin University of China, codeveloped an indicator system for evaluating livable cities that offer a set of Level 1 indicators covering economy development, social harmony, cultural richness, living comfort, landscape, and public safety. (1) A livable city should enjoy continuous economic prosperity. A city centralizes economic organization, management, and coordination. Various economic actors and nonagricultural activities find their home in the city. A strong economic foundation, an advanced industry mix, and growth potential allows a city to provide the adequate job opportunities and high incomes desired by urban residents in a livable city, as well as resources for infrastructure. (2) A livable city should harbor social harmony and stability. A city with political stability, security, peace among ethnic groups, harmony among classes, attractive communities, and coordinated urban and rural development provides residents the opportunity to live and work contently, to fully enjoy modern urban life, and to regard the city as their physical and spiritual home. (3) A livable city should offer rich culture. Rich culture can include rich historical and cultural heritage, a full range of cultural facilities, frequent cultural activities, and a supportive cultural atmosphere. Rich culture in a city offers a rallying point for ideology, education, technology, and cultural experiences, providing education unique to an urban environment and improving the urban population. (4) A livable city should offer comfort and convenience in all domains but especially in residence. A livable city should provide a full range of amenities, residential buildings that meet health requirements, convenient transportation that include a developed public transportation network, as well as sufficient public goods and services. Examples include sufficient and quality education, medical care, sanitation services, and maintenance of healthy ecosystems, good air and water quality, quiet and clean residential areas, and a large per capita green space area. (5) A livable city should provide pleasant and beautiful landscapes. Beautiful and pleasant landscapes are a basic requirement for the cultural and natural mix present in urban development. Cultural and natural landscapes must be coordinated in the city to allow a good mix of cultural landscapes such as roads, buildings, squares, and parks that address human needs and development to improve residents' moods. (6) A livable city should be a place where the public feel safe. A city can provide public safety and security by protecting its residents and their property against natural disasters such as earthquakes, floods, storms, and infectious disease epidemics and against disasters caused by humans. Residents can live and work contently only if they feel

[20] Tong [19].

they are safe, making public safety and security an absolute necessity for a livable city.[21]

Measures for Building Culturally Livable Eco-Cities in China Urban development aims to improve people's lives. China should take the following measures to develop culturally livable eco-cities:

(1) Promote public participation in eco-city construction. Public participation in major urban planning decisions, management, and development is a key part of urban development. Public participation promotes urban sustainable development by helping managers understand the public's needs and the way various plans and decisions will impact them, guiding managers toward innovation that will satisfy the public's wishes, and producing plans that pursue urban diversity and energize the city. Livable cities outside of China have demonstrated that public participation guides livable city development. Chinese cities may refer to the experience foreign cities have in integrating public participation to increase public participation in policy making and coordinate and balance the relationships among all stakeholders through techniques like phased implementation, tracking and feedback, and regular evaluation and revision.
(2) Promote economic development. A livable city should enjoy a developed economy. Economic development is the foundation of social progress. Sustainable economic development is the only means to solving a series of urban problems such as poverty, environmental pollution, and underemployment and to creating a tangible and vibrant living environment for residents, which promotes the creation of an intangible living environment. A livable city must have strong economic growth potential to ensure sustainable economic development, improve residents' living standards, and provide a positive living environment for residents. Chinese cities may attract investment from more international companies because of their low level of economic development through flexible policies and can access local resources to develop related industries and unique city qualities while furthering industrial restructuring and enhancing advanced technology research and development, which can be used to revitalize obsolete enterprises. These measures will contribute to the sustainable development of livable cities.
(3) Create beautiful spaces. A beautiful and pleasant environment is the most intuitive symbol of a livable city. Typical livable cities outside of China have almost all realized many benefits of eco-cities and developed specific skills geared toward creating beautiful spaces. Most Chinese cities have clearly stated their intention to conduct eco-friendly urban development and create a pleasant living environment and pleasant living and working spaces, but they are still new and inexperienced in environmental development leaving room to learn. Many Chinese cities are still learning how to fully profit from natural ecosystem resources, effectively organize natural landscapes, design green spaces, create a pleasant urban atmosphere, and build various activity spaces.

[21] Li et al. [20].

(4) Create livable residential spaces. The housing problem encompasses fundamental household interests and affects social fairness and stability. A livable city must address these extensive housing concerns. Livability implies that every person who needs to live in a city permanently has access to a decent residential space. Singapore is widely recognized for its competence in this regard. The government provides housing and runs an agency specializing in related policies. Housing prices are determined according to most residents' purchasing power, and incentives are available to ensure residents can afford a house. A livable city should ensure local residents can afford decent apartments or houses and rest permanently. Community environment must be incorporated into urban development. Relevant organizations should focus on improving community safety, greening, health, culture, and other projects. It is necessary to enhance community facilities, provide aid to disadvantaged groups, create a positive cultural atmosphere in the community, and help residents improve their behavior. Efforts should be made to create a quiet and clean living environment where residents have a sense of belonging and feel safe.

(5) Establish an efficient transportation system. Transport development is a necessary priority to ensure convenient travel around a livable city. Convenient and comfortable transportation is a primary factor leading many people to stay in livable cities outside of China. The number of vehicles in rapidly urbanizing Chinese cities has been rising sharply, creating consistent transportation issues that affect urban efficiency, socioeconomic development, and public health. A livable city should have reliable and efficient transportation. It should build reasonable transportation infrastructures, improve traffic management, and develop public transportation options to achieve this goal. A people-oriented, pleasant, and complete pedestrian network will further facilitate citizens' recreation and travel. A livable city can reduce unnecessary motor vehicle traffic by coordinating the flow of passengers and cargo and urban land use.

(6) Strengthen urban safety and security. Cities inside and outside of China have historically always prioritized safety and security. A safe city can maintain a dynamic, stable, balanced, and coordinated environment, ecosystem, socioeconomic development, culture, health, resource supply, government performance, etc. It can protect against natural disasters and socioeconomic anomalies or emergencies. Urban safety and security increasingly concerns governments and the public across China as urbanization increases and complicated interests and conflicts emerge between human populations and resources and between the environment and development amid the social transition. Chinese cities do not properly address safety and security measures nor do they have a comprehensive urban safety and security system as part of eco-city development. Some cities have begun taking steps toward safety and security but remain in the early stages. A safe city provides citizens with security surrounding the environment, food, the society, production, the economy, and culture.

(7) Preserve the city's cultural characteristics. A livable city celebrates its own character and qualities rather than imitating other cities. The culture of a city best reflects its character. A city with unique character and qualities is competi-

tive, has great growth potential, and is likely to develop into a livable city because it resonates with the regional culture. Chinese cities currently lack many of these key characteristics. Most cities resemble concrete jungles. A livable city's cultural characteristic goes beyond a continuation of the traditional culture but does not amount to arrogance. A livable city's distinctive cultural environment can flourish when the traditional culture is mixed with modern elements. A livable city preserves its historical and cultural heritage, tangible and intangible to enrich local citizens' cultural life. It integrates a diversity of cultural elements, drawing from different times and geographic areas, and concentrates native cultural elements in the city.[22]

Building eco-cities is a basis for building a beautiful China. The report to the 18th CPC National Congress states that "promoting ecological progress is a long-term task of vital importance to the people's well-being and China's future. Faced with increasing resource constraints, severe environmental pollution, and a deteriorating ecosystem, we must raise our ecological awareness and respect, accommodate, and protect nature. We must prioritize ecological progress and incorporate it into all aspects of advancing economic, political, cultural, and social progress, work hard to build a beautiful country, and achieve lasting and sustainable development of the Chinese nation." This will fuel eco-city development across China, usher more Chinese cities toward eco-city development, and further enrich theories regarding eco-city development.

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