CHAPTER 5

Macro Level: Eco-City Cases in China

5.1 Introduction

In China, eco-city projects are not city-scale projects and they do not cover a whole municipality. They are often developed as new zones, or new districts nearby to or within the municipality of the main urban regions. These can be regarded as experimental projects, satellite towns, or simply developed as new urban expansion zones or new districts to a larger municipality. As argued by Joss (2011), eco-city initiatives were traditionally focused on three primary aspects: the 'physical layout'; 'infrastructural layers'; and 'energy and material flows of cities', all of which shape a tangible spatial form. In China, all three primary aspects are visible, particularly for the larger eco-city projects that lie within close proximity to major urban regions. In comparison to the scale of existing cities in China, these projects are mostly defined as eco-districts, or eco-zones. However, in the national documents and international studies, these projects are referred to as eco-city projects. However, these boundaries are not clear as they represent a wide range of scales under one category of eco-city development. In most cases, they appear as a new district area, such as the case of Guangming eco-city in Shenzhen, Meixi Lake eco-city in Changsha, and so on. In our horizon scanning of eco-city projects in China, we have not come across a complete eco-city development of an existing city or zone by conducting comprehensive retrofitting of the existing built environment. However, there are still comparatively few cases that are focused

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on improving existing urban environment through effective policy intervention. Having said this, many Chinese cities have a specific agenda with regard to green or eco-development and nearly all of them claim to have specific policies to address these concerns.

For our eco-city categorisation, we explored the existing literature and only came across one categorisation proposed by Joss et al. (2011) who identified three eco-city categories, namely: 'new cities', 'expansion of existing urban areas', and 'urban retrofits'. Based on our horizon scanning of eco-city projects in China, very few cases are focusing on retrofitting the existing urban built environment. However, some cities, such as Guiyang, are exemplary for illustrating how policies moving a city towards eco-development. Nevertheless, we anticipate seeing new cases of retrofitting the urban built environment in the coming years, but perhaps on a smaller scale. Moreover, we moderately argue against such a categorisation of eco-cities, as this can in fact be the categorisation of any new urban development. Therefore, we propose a new categorisation based on the project's stakeholder constellations and the project's status at the national level. Across all tangible cases of eco-city development in China, we have seen a variety of actors in terms of their involvement in the projects. In this regard, we propose a new categorisation that includes three types of eco-city projects in China, namely: (1) eco-city with local initiatives; (2) national flagship projects; and (3) international cooperation projects (also regarded as Sino-foreign projects), which are jointly developed between the local and international partners and often include a strong group of governmental agencies. In this chapter, we explore two eco-city cases for each category. These case studies are selected based on their locations and their current status of development.

5.2 Chongming Eco-Island, Shanghai

Type: Local Initiatives

Project Overview

With an overall land area of 1267 km^2, Chongming Island is the third-largest island in China, and the world's largest river alluvial island. The project sought to develop Chongming Island and two small surrounding islands (Changxing and Hensha) into 'eco-islands'. These thoughts were encapsulated in the so-called Chongming Three Island Master Plan, as part of the earlier 'Chongming County'. Although it is located at a fairly

reasonable distance from the City of Shanghai, Chongming Island only became a district of Shanghai in 2016. Chongming Island and its two surrounding smaller islands are located in the mouth of the Yangtze River, north of Shanghai City. With a total population of around 0.7 million people in 2015, the urbanisation rate of Chongming Island is recorded at 41.7% (Chongming 2017).

The association of Chongming Island with the City of Shanghai is more of a peri-urban interface than an urban area. The overall land area is 20% of Shanghai's land base, and its activity accounted for around 1.2% of Shanghai's GDP in 2012. Since then there are recorded increases of GDP as a result of more connections, business development and real estate projects in recent years. Nevertheless, Chongming Island remains the least developed area of Shanghai City. In 2009, the new Shanghai Yangtze River Tunnel-Bridge was opened to create a better connectivity to Shanghai. The positioning of Chongming Island in relation to Shanghai is changed over the years; i.e., from a satellite town in 1950s and mainly with agricultural farmlands into a key town area of Shanghai, supporting the development of new industries and enterprises producing household electrical appliances, and now into an eco-island (Xie et al. 2017).

Very different to other eco-development projects on the same scale, Chongming eco-island proposes a unique project case in the context of China. This is mainly driven by the geographical feature of this development as an island, and the ambitions of the project. Most people recall the project with the name of Dongtan eco-city, a globally renowned project which received media and research attention several years ago. However, Dongtan was only a small part of this 81 km-long island, lying on the northern side of Shanghai's mega-city. The project of Dongtan aimed to create a new model of eco-city development and was planned to open in time for the Shanghai World Expo in 2010. It was heralded as one of the first Sino-British eco-city projects, involving multiple key actors from both China and the UK, and was intended to develop a new eco-city area in the island, enabling increased population flow and creating a self-sufficient city. The project was first showcased to attract investors in the domestic housing market and involved some of the main real estate companies.

Nevertheless, with some major changes among the local governmental authorities, the project first fell behind the original schedule and then never took place as initially planned. In 2005, contract was first awarded to the British engineering consultancy firm, Arup, and a local developer, the Shanghai Industrial Investment Company (SIIC). The project also

involved several Chinese and British state agencies, industries and institutions. The project soon gained an international image and was highlighted as a new eco-city model at the United Nations World Urban Forum, held in Nanjing in November 2008. With zero-carbon development strategies in mind, Arup proposed a comprehensive planning of the eastern corner of Chongming Island. However, the project was halted around 2009, and since then there has been a series of different plans for the overall development of Chongming Island.

Although some argue that there are separate directions of development between Dongtan eco-city and Chongming eco-island (Chang and Sheppard 2013), it is now clear that the Dongtan area is now only a major part of the island's eco-development strategy. With SIIC's continuous involvement, Dongtan is now home to a new wetland park, which preserves the existing ecology and minimises construction in the area. Nowadays, Chongming eco-island is a distinct national-level eco-island project, with current planning in progress towards achieving a world-class standard. It is also formally included in the 13th Five-Year Plan for National Economic and Social Development in Shanghai (Shanghai Municipal Government 2016). Although it is considered to be a national-level pilot project, its local initiatives are worthy of attention, including several community-led eco-farm projects and 'Yingdong Ecological Village', both of which represent the local citizens of Chongming Island (Xie et al. 2017). Almost in parallel, the island includes a major international experimental eco-community development of 'Chenjia Town', which is strategically located nearby the entry point to the island (ibid.). In the later sections, we elaborate on these key eco development projects.

Project Layout and Planning

In 2006 the Shanghai Municipal Government and Chongming County government issued the Chongming Three Island Master Plan, covering the rest of Chongming County outside Dongtan eco-city (Fig. 5.1). This was a locally-driven independent plan based on Arup's proposal, focusing on smaller-scale environmental improvements and aiming to develop Chongming Island and two small surrounding islands (Changxing and Hensha) into 'eco-islands'.

Land on all three of the islands is zoned into several functional regions, including ecological system demonstration areas, leisure and tourism, sport and vacation, a garden city, education and innovation, forest, theme park, conference centre and offices, and a shipbuilding industry special area (Shanghai Municipal Government 2016). These are set out as follows:

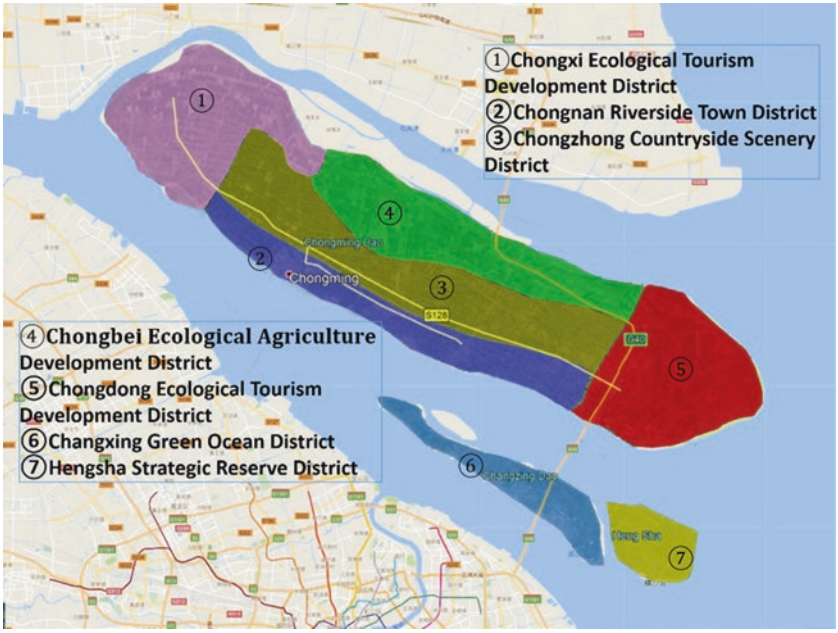

Fig. 5.1 Overview of Chongming Eco-island plan (adapted and redrawn by the authors based on the most recent masterplan strategy development of Chongming Eco-island provided by the local government in the project exhibition hall)

1. Forest Garden Island: To form an ecological-conservation island mainly based on the Yangtze River Estuary Wetland Reserve, the International Migratory Bird Reserve, the Plain Forest and the River Estuary Water System.
2. Ecological Inhabitation Island: To form an ecological inhabitation island that is properly designed, quietly surrounded, conveniently located and culturally advanced.
3. Leisure Vacation Island: To form an ecological tourist island that mainly caters for the leisure vacation, sports and entertainment, recuperation, training, conferences and exhibitions.
4. Green Food Island: To form an eco-farming island featuring the organic agricultural products industry, characteristic cultivation and aquaculture industry and the green food processing industry.

5. Marine Equipment Island: To form a marine economy island mainly engaged in the modern shipbuilding and the port machinery manufacturing.
6. Science and Technology Innovation Island: To form a knowledge-economy island assigned to the headquarters offices, technology research and development, international education and the consultation forums.

However, most of the initial ideas never happened and they remained as options for the future development of the island. The overall project plan has been altered on several occasions and few small-scale projects are under development as at the current date. It is still unclear what the future direction will be, as the current projects remain incomplete. The most remarkable change has taken place after the visit of mayor of Shanghai to the island in 2016, where the new developments of medium- to high-rise buildings were put on hold. As a result of this change, new developments should not include any buildings higher than 18 m. The intention of this change was to bring back the image and spatial feeling of Chongming as an ecologically-friendly island, capturing the ecological values and image of the island. In our view, this means a new direction should be considered to avoid any typical urban development projects taking place in the Chongming region.

According to Xie et al. (2017), the overall plan for Chongming has been in transition since its inception. The following three stages summarise the progress since 2005:

- In 2005, "Overall Plan for Chongming Three Islands (2005–2020)"
  Planning ideal: (1) adhere to "*Ecological Modernisation*" pathway; (2) Conserve adequate "natural ecological space" and "space for future international projects planning"; (3) "*Three Concentration*": concentrating land operation, concentrating industries in parks, concentrating farmers' residence in towns/cities.
- In 2010, "Chongming Eco-Island Construction Outline (2010–2020)"
  Action programs: focusing on ecological and environmental indicators, taking into account economic and social indicators. Established the evaluation index system for 2020 Chongming eco-island construction, and developed action measures.

- In 2016, "Thirteenth Five-Year Plan for National Economic and Social Development of Chongming (2016–2020)

  Implementing "*Eco+*" development strategy, and introducing more demanding indicators.

In this respect, what we can witness is a clear case of eco-development in transition. With several major changes in the past, the project is now under progress with clear eco-strategies. The approach to the overall island development is very much centralised with several county and town developments. The current phase of the project only demonstrates few of these new projects that are currently under construction in various parts of the island. In what follows, we highlight some of the main eco-development projects at various scales and models in several parts of Chongming Island:

Individual Eco-Farm Projects—With no governmental policy or incentives, the eco-farm projects are mainly led by the individuals of the local community. Some examples of these bottom-up initiatives are located in Chenxi Collage of Chenjia Town, close to the entry point of the island, and in Meiyuan village. The main intention of such small-scale projects are to create the idea of new eco-farm industries and promoting the existing rural community (some information is based on interview transcripts contained in Xie 2016). Such projects are believed to be key to local industries and the enhancement of local communities, where the least impact on the natural environments is expected. The location selection is based on the three key factors of: (1) low rental prices; (2) environmental quality; and (3) proximity to the Shanghai region (ibid.). It is unclear if such small-scale initiatives would be sustainable for a long period of time, but current progress show some success for community-led movements in several parts of the island.

Yingdong Ecological Village—Initiated by the local village committee and collective initiatives from the community, Yingdong Ecological Village represents one of the key bottom-up and local projects of Chongming Island. In 2013, after the reform of property rights system, a collective-owned enterprise in Yingdong Village was established. The village community became the stakeholders, enabling them to work as part of their new vocational enterprise. The project had the central goal of 'ecological development' and included a building of a 10 km-long ecological river. Led by Tongji University and the Shanghai Research Institute of Building Sciences Group, the project was to create a new living environment for the local communities (some information is based on interview transcripts in Xie 2016).

Chenjia Town—In close proximity to the Dongtan area lies a major new eco-development of Chenjia Town. Proposed to have new water bodies and a lake, the new development is one of the key eco-development projects of Chongming Island (Xie et al. 2017) and, since its inception, has gained major attention in the media. Another similar type of project is Chengqiao New Town, which is around 38.7 km^2 in total. The new development of Chenjia Town is roughly 2.5 times larger, at 94 km^2. This large-scale development is three times the size of the Sino-Singaporean Tianjin Eco-city, and is the major business hub of Chongming Island. Its zoning plan is part of the island's county and town development strategy, including ten function zones, such as the International Experimental Eco-community, the International Forum Business District, Yu'an Modern Community, and the Dongtan International Education R&D Area that constitutes the 'Central Town Area'; while the other six areas, including the Wetland Tourism Area, the Riverside Leisure Sports Area, the Green Industry Area, the Theme Park Area, and so on. The new development proposes for urban fringe development and the low-carbon industrial zone of the island. The existing Dongtan wetland park is enclosed in the new area. The project layout is an ecological city in the island garden style, and focuses on ecological preservation. The current strategy is believed to be capable of being scaled up for other parts of the island, where the proposals are focused on additional green zones and green spaces, population growth and limitations on the new built environments.

Green Technologies

Based on the Chongming Eco-Island Development Outline 2010–2020, a number of green features are proposed. The proposals include a long-term development plan for green industries (based on Shanghai Development and Reform Commission 2010), which has so far catalysed the completion of several tourist farms, vacation homes, forest and wetland parks, a conference centre with a five-star hotel, and trail routes. In 2009 and 2010, parts of some agricultural villages at the eastern end of the island were relocated to create space for modern medium- to high-rise housing zones. As mentioned earlier, the building heights are readjusted to reflect the local context and the Chinese identity. Moreover, the opening of the Tunnel Bridge connecting Shanghai and Chongming Island opened in 2010 further enhanced the eco-island fortunes.

With regard to waste management, Chongming Island is actively promoting the application of solid waste classification and source reduction in a number of different ways. Confined transition and transportation sys-

tems have effectively avoided secondary pollution during the transition. The Chongming Solid Waste Disposal Site was rated as a Grade I hazardous-free disposal site. A kitchen waste treatment plant has also been built and put into operation. The Chongming Solid Waste Disposal Utilisation Centre has been launched to further promote resource utilisation. The recycling and reuse of both agricultural and construction waste is also steadily increasing in the Island. In addition, a low-carbon energy structure mainly supported by clean electricity and supplemented by renewable energy and a smart grid. The other additions include a low-carbon industrial structure framed by advanced eco-agriculture and service industries, a low-carbon infrastructure system through the localisation and application of green building designs and low-emission vehicle technologies, a natural carbon sinking system supported by forests and wetlands, and a relatively low-carbon lifestyle anchored on the Chinese traditional philosophy of unity of nature and human-being.

In 2011, UNEP and the Science and Technology Commission of Shanghai Municipality (STCSM) came to an agreement to involve UNEP in evaluating the development plans and progress of Chongming eco-island. UNEP's focus has been mainly on suggesting methods of ecosystem management and sustainable development practices that are applicable to the context of Chongming (UNEP 2014). After the first round of evaluations, UNEP provided specific action plans in seven key areas: (1) Society, life and culture; (2) Biodiversity and protected area; (3) Water management and conservation; (4) Solid waste management; (5) Low-carbon economy and energy efficiency; (6) Agriculture and organic products; and (7) Transportation (UNEP 2014). Under each key area, specific action plans were provided for the next phase of development. Additionally, UNEP (2014, p. 8) provided four general recommendations for Chongming Eco-Island, including key action points to:

1. Establish the Chongming Special Ecological Zone for Eco-Civilisation;
2. Accelerate the dissemination of transformative scientific achievements through a systematic promotion of demonstration projects to amplify the role of science, technology and innovation (STI);
3. Strengthen and expand the Chongming Eco-Island International Network as a platform for exchanging best practices, lessons and promoting the Chongming Eco-Island Construction Model;
4. Strengthen human resource capacity, build support systems and enhance stakeholder coordination and collaboration.

Currently, Chongming follows multiple eco-strategies that consist of various green technologies and design. Since its development in 2016, the key direction is focused on an 'Eco+' development strategy, enabling the promotion of ecological economy, development of modern agriculture, building new outdoor activities and preserving the ecological areas of the island. By doing so, the project aims to implement a comprehensive 'pollution source control', by continuing the closure of heavily-polluting industries and factories. For instance, over the past 15 years, about 1000 factories in the Chongming region have been closed down (Xie et al. 2017). The other major action plan is to have more tree planting, in order to increase the forest coverage. This increase is a continuation from previous attempts, from 10% forest coverage in 2000, to 22.53% in 2015. 'Sewage treatment' is also considered part of the overall plan, where the previous attempts have increased the treatment of the county and town areas from 10% in 2000 to 85% in 2015 (ibid.). In additional to this key progress in the past, the project has achieved the most optimal air quality in the region of Shanghai municipality, achieving the lowest rate of PM 2.5 amongst all districts. Not only does it supply the core water source of the whole city of Shanghai, but it owns the best water quality as part of the water management and reservoir development. These key factors demonstrate the island's strong focus on ecological development.

In contrast to other eco-cities, the Chongming development was inspired on the basis of the 'failed' Dongtan eco-city project. Having said this, some of the smaller-scale projects were undergoing before the proposal of Dongtan eco-city. Currently, most of Chongming Eco-island's key development projects are still in their infancy and some show tangible progress regarding the preservation and enhancement of the existing ecological zones. It is unclear when the project is set to be completed; as it stands at the moment, however, some of the smaller-scale projects need further attention. And if they are to be considered, propositions can be made to scale up some of the key local initiatives. However, Chongming eco-island represents a fusion between local initiatives, national programmes and international cooperation. The focus here is on local initiatives, since the project has gained significant attention from the local authorities in recent years. Also, as expressed by Chang and Sheppard (2013, p. 71), Chongming eco-island is more of a '"local version of sustainability … overlaid onto Euro-American conceptions of eco-cities, one that is constructed and conditioned on, and shaped by, local desires for

economic development, the geographical imagination of an island, and the ambition to make global cities'. This factor is also one of the reasons why most development plans were not rushed for construction, and in comparison to many other cases of eco-development in China, much better care has been given in various stages of the project's development.

Case Study Reflections

It is noted that main reason for the 'green development' of Dongtan and Chongming was a desire for environmental and economic development in the light of strengthening relationships with Shanghai (Chang and Sheppard 2013). Thus, it can be seen that Eco-cities and/or Eco-islands can also be a form of green capitalism, with the island's natural capital being the only resource to enable Chongming Island's economic development and realisation of overall sustainability. Also, according to UNEP's report (2014), and after several years of change and development, we can witness a remarkable number of development projects and transitions; however, much more needs to be done to achieve the maturity status so envisaged. As suggested by UNEP, exact data on technologies deployed as compared to the baseline will also need to be monitored closely.

5.3 Guiyang City, Guizhou

Type: Local Initiatives

Project Overview

Located in South-western China and east of the Yunnan–Guizhou Plateau, Guiyang is the capital city of Guizhou province with a population of 4.7 million by the end of 2014. Guizhou is a less developed region in China, ranking 25th in terms of GDP among 31 provinces and province-level municipalities in 2014. Likewise, Guiyang was ranked 28th in GDP among all provincial capitals in 2014. However, both Guizhou and its capital city have gained momentum in recent years with a higher growth rate than the national average; for example, in the first half of 2017, the city Guiyang has the highest GDP growth rate of 11.6%.

Guiyang is also China's top-ranked city in terms of implementing ecological civilisation. In December 2012, the city was approved by the central government to become the country's first national model city for ecological civilisation. It is also a national pilot city for urban innovation development, and a leading area for coordinated urban and rural

development. Guiyang is the first city in China to propose and implement local regulations on the development of circular economy and ecological civilisation. It provides an example of promoting sustainable development through strong policy interventions.

Project Layout and Planning

Ecological civilisation is a new term, proposed by the party in the 18th National Congress in November 2012. In the keynote speech delivered by President Xi in the congress, he stressed that building a beautiful China is an important part of the Chinese dream of national rejuvenation. Xi emphasised four tasks to promote ecological civilisation—optimize land comprehensive exploitation; comprehensively promote resource conservation; reinforce the efforts to protect the ecological environment; enhance institutional systems for ecological civilisation.

One month after the national congress, in December 2012, Guiyang was approved as the first city by the central government to construct a model city for ecological civilisation. Guiyang was picked out largely because of its long history of maintaining a sustainable profile during the course of rapid industrialisation in China. A chronological record of the awards for its sustainability performance in recent years are listed below:

- The first national pilot city for circular economy in 2002;
- Guiyang Master Plan for Constructing Circular Economy Eco City was launched in 2003, this is the first urban masterplan focusing on circular economy;
- The first global pilot city for circular economy in 2004 by UNEP;
- The first batch of the national pilot city for low-carbon development in 2010;
- The first national pilot city for constructing eco-civilisation in 2012;

As the most renowned city in terms of developing circular economy and eco-civilisation in China, it is the country's intention that the practices pursued through the pilot projects in Guiyang should be applied to other Chinese cities, in particular those cities that are less developed and facing twofold challenges for improving economic growth and the urbanisation level while moving towards sustainability.

In 2013, over 400 foreign guests from foreign government agencies, heads of international organisations, internationally renowned scholars and heads of think-tanks, and leaders of international eco-environmental protection enterprises attended the first International Conference on

Ecological Civilisation in Guiyang, which has become an annual event since then, and is the only state-level and most important international forum on green development and ecological civilisation in the country. The Guiyang Consensus 2013 was issued by the participants that addressed four pillars of eco-civilisation—to accelerate green development and green industrial transformation; to promote social harmony and inclusive development; to take the strictest measures possible for the repair of damaged ecosystems and depleted natural resources; and to popularize ecological values across the whole society (IUCN Environmental Law News 2013). A specific theme is selected for an annual conference. These themes have responded to the recent policy upgrading and enriched the concept of ecological civilisation. The themes selected from 2013 onwards are listed below:

- 2013 theme: Green reform and transition—sustainable development led by green industry, green urban development and green consumption;
- 2014 theme: Driven by policy reform and global partnerships—governments, enterprises and public: policy framework and roadmap for green development;
- 2015 theme: Entering a new era of ecological civilisation—new agenda, 'new normal' and new action;
- 2016 theme: Toward a new era of ecological civilisation—unity of knowledge and practice;
- 2017 theme: Sharing the benefits of green development—green development and poverty relief.

In 2012, the Guiyang Plan for Building National Eco-civilisation Model City was approved by the central government. This indicated that Guiyang had advanced the concept of eco-civilisation to guide its economic and social development and that it is determined to become the eco-civilisation pioneer in China. In 2015, the local party commission proposed the targets for the period of the 13th Five-Year Plan (2016–2020):

- Building an innovation-oriented city;
- Develop a comprehensive innovation zone for Big Data technology;
- Building an eco-civilisation model city, and;
- Building an overall well-off society at a higher level.

In March 2016, the Guiyang 13th Five-Year Plan for Building Eco-civilisation has been approved by the Municipal People's Congress, which proposed a range of targets to be achieved by 2020. Figure 5.2 indicates the roadmap and the targets to be achieved by 2020.

Setting Targets for Achieving Comprehensive Eco-Civilisation in 2020

The municipal government proposed a set of indicators in 2015 to monitor the progress towards eco-civilisation. This comprises 33 controls targets and 37 optional targets which are classified into six categories—ecological economy; natural resources conservation and intensive use; improvement of ecological environment; liveable urban and rural environment; ecological culture; and ecological civilisation system. As the first city aiming to achieve eco-civilisation, these targets represent what an eco-civilised city should be like at the current economic and social stage in

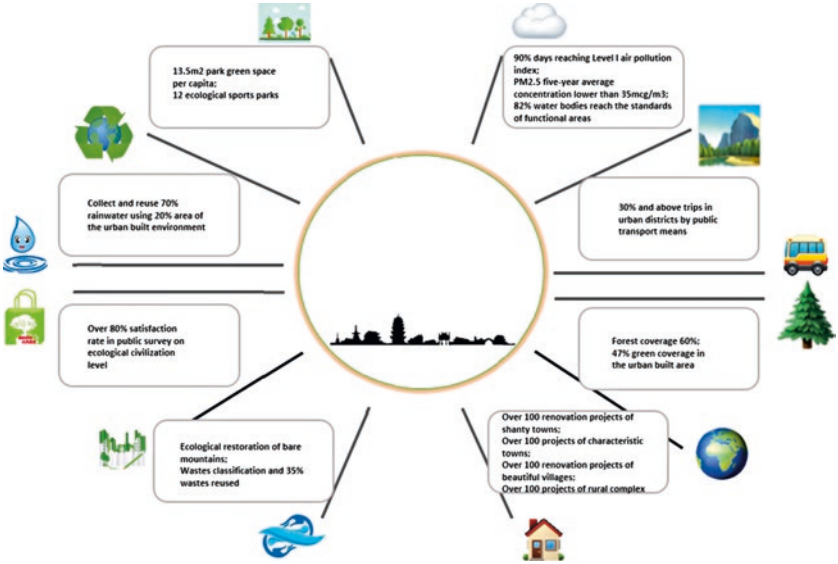

Fig. 5.2 Roadmap and targets to be achieved by 2020 for constructing ecological civilisation in Guiyang. Source: Adapted and redrawn from Guiyang Evening News, http://wb.gywb.cn/epaper/gywb/html/2017-10/01/content_32894.htm

Guiyang, and create a model for other Chinese cities. Apart from a number of ecological targets, such as energy and water consumption, renewable utilisation, promoting green buildings and urban air pollution, it is noted that the plan also incorporates indicators in the socio-economic and institutional arenas, for example, health insurance coverage, urban unemployment rate. These targets are broken down and allocated to governments at different levels such as districts and townships.

Restructuring of Industrial Pattern

The city has moved its industrial pattern to be increasingly service-economy-oriented by zoning the territory into four types of land use:

- Exploitation-prohibited area;
- Exploitation-constraint area;
- Exploitation-optimised area, and
- Exploitation-implemented area.

Project proposals have been evaluated carefully based on the degree of environmental friendliness. One priority area chosen by the government is Big Data industry—which has been designated as one of the three strategic sectors in Guizhou province. Accordingly, Guiyang has released preferential policies to boost Big Data industry. Guiyang aims to host several international and national data centres. Renowned international companies like Hewlett-Packard and the national cloud computing have launched their data centres in the city. The city also enhances the construction of infrastructure facilities for IT technologies. For example, the city is working to provide free city-wide Wi-Fi. The project's first phase was completed in May 2015 to allow free Wi-Fi on the city's major roads and main public areas, covering an area of 12.8 square kilometres.

Promoting Low-Carbon Living Community

It is an important part of Guiyang's strategies to encourage changes to low-carbon living behaviours and consumption patterns. The city has implemented a low-carbon community scheme and established a set of indicators that provided a quantitative way to monitor low-carbon community development; for example, an estimate of carbon emissions of 161 tonnes a year has been saved by replacing the street lights and installing smart control lighting system in households in a small residential district. The government also publishes regularly green product lists, including

energy-rated, water-rated and environmentally- labelled products to encourage the change of consumption patterns. In particular, 80.5% of government purchases must be from green product lists by 2020 that is a control target for eco-civilisation construction.

Promoting New Technologies in Sustainable City Management
A so-called 'ecological cloud' platform is currently under development, which will use the city's booming Big Data technologies and cloud platform to promote sustainable city management. Guiyang aims to establish an ecological cloud computing database in 2017 at three levels—city, county and township and in 2018 incorporate forest management, urban greening and environmental information databases to form an integrated 'ecological cloud' platform.

Case Study Reflections
Unlike Beijing and Shanghai, Guiyang is a less developed city and faces twofold challenges—economic growth and sustainable development. Some cities undertake industrial transfer by accepting industries with high energy and resource intensity from prosperous regions. This is an easy choice and a lure. Guiyang, however, has devoted itself to restructuring its economic system, adopting new technologies to promote the idea of a sustainable city, encourage low-carbon consumption pattern and, most importantly, develop a vision and measurable targets to monitor its progress towards eco-civilisation.

5.4 Meixi Lake Eco-City, Changsha, Hunan

Type: National Flagship Project

Project Overview
The Meixi Lake Eco-City (MLEC) is one of the first batch of eight state-level eco-city model projects in China (Franshion Properties (China) Limited 2014; Cheshmehzangi and Deng 2015). The total cost of this large-scale project is estimated at £6 billion (equivalent to approximately US8 billion), including almost 15 million square metres of new development. The project was first initiated in February 2009, after the bilateral agreement was made between the Municipal Government of Changsha and the real estate developer Gale International. The first intention was to develop a new green development of 1675 acres (or 1887 for the larger area, in other sources), as a new satellite town to the city of Changsha, the capital of Hunan Province. The developer team previously worked on the

Songdo International Business district of Incheon City, in South Korea (Joss et al. 2011). The project is currently partially completed and is partly operational. It is due to be completed by 2020.

The backbone of the MLEC project is focused on three key aspects of 'plan, develop, and operate', central to the new development strategy towards an ecological city (Gale International 2010). Some of the earlier works focused on project marketing and a feasibility analysis for the next steps of developing and implementing the final masterplan and infrastructure design.

With regard to the project's governance and financing, apart from the support of national and municipal governments, the project benefited from the financial support of China Merchants Bank (CMB) with an additional 10 billion RMB in credits for key new development areas and enterprises of the first phase of project (Hunan Government 2009). The project also benefits from an extensive partnership network of international planning and engineering firms, and real estate developers, such as Kohn Pederson Fox (KPF), Arup, Gale International, Atkins, and Cisco. In the project development plan, it is stated that Cisco plans to deploy video-networking technology and energy- management software tools city-wide and meld municipal systems, such as education, health care, transportation and hospitality into a common network (Woyke 2009). In this regard, Cisco focuses on the provision of several services as part of their Smart + Connected communities initiative. In summary, the project is supported by multiple partnerships, but is principally regarded as one of the national eco-city flagship projects.

The new eco-development was first named the 'Meixi Lake District' of Changsha. Its title was later altered to the 'Meixi Lake International District'. The project is located in the core region of Xiangjiang New District, located in the outskirts of Changsha and around six kilometres from the centre of the city. Once completed, it is anticipated that MLEC house around 180,000 residents (Alusi et al. 2010). According to the project's masterplanning and design team, KPF, the project is proposed to offer 'a new model for the future of the Chinese city', as it focuses on merging the metropolitan features and natural environments as exist around the new development area. The MLEC also proposes for the construction of a smart grid system, new urban agricultural areas, innovative transport networks, and waste energy recovery (McGraw Hill Construction 2010). The new development also fits in well with Changsha's expansion plan and economic development strategies.

Project Layout and Planning

Benefitting from good feng shui, the MLEC development is backed by Taohua Ridge and the Yuelu Mountain Range, and is surrounded by the centrally located Meixi Lake with a total surface area of 18.05 km^2. There is a long islet inside the lake, with several smaller islets are part of the park/green space development of the MLEC. The plan is that once the project is completed, it should appear as a national eco-city model, and propose for new benchmarks and standards for future developments (Franshion Properties (China) Limited 2014). This was also highlighted as part of Changsha City's 12th Five-Year Plan (FYP), in which the project was proposed in two phases of development.

Similar to the layout of an earlier and similar project, Songdo District in South Korea, the masterplan is comprised of a high-rise business district located around Meixi Lake and is linked to several residential communities by a series of canals (Joss et al. 2011). The project benefits from linking to Changsha's metro system, bus system and also its own boat system. Most of the area is under development for grey and black water treatment systems and distributed energy plants (ibid.). In addition, the MLEC features 45 ecological indicators ordered into eight key categories which cover the overall planning and design of the project. These broad categories are: (1) Green culture; (2) Urban planning; (3) Ecological environment; (4) Energy; (5) Water resources; (6) Solid waste; (7) Transport; and (8) Green building (Cheshmehzangi and Deng 2015). For instance, all newly-constructed buildings should be certified as green buildings, and the UK's Building Research Establishment (BRE) has played a significant role in achieving this target plan. All green construction projects are also subject to constant monitoring, which is conducted by the energy consumption system throughout the whole design and construction processes (Franshion Properties (China) Limited 2014). Since 2012, the project has also been also named as one of the nation's most representative in terms of resource-saving and environmentally-friendly communities that has enhanced the national positioning of the project.

The overall masterplan of the MLEC project includes nine core areas as functional areas of the new Meixi Lake Region (Fig. 5.3). For instance, the Central Business District (CBD) project is the central part of the first phase of the Changsha Meixi Lake Primary Land Development Project (Franshion Properties (China) Limited 2014). It is important to note that the new development model proposed by the masterplanning team is now known as the 'Meixi Lake Model' in the Chinese industry. In this

Fig. 5.3 The multiple layers of green strategy for green spaces, green corridor, and key spatial qualities of Meixi Lake Eco-City (adapted and redrawn by the Authors, from the KPF masterplan documents)

particular model, the approach is to integrate the new technologies and the new proposed planning methods to develop well-connected and ecologically-sound living urban environments. Unlike other eco-city cases in China, the MLEC model is planned in a radial layout with the combination of residential neighbourhoods and villages in the surrounding areas. In this respect, the project has the central primary design element

of 'water', with multi-functions, from ecological values to leisure activities. It is also regarded as a central park of the new eco-city providing a better natural cooling effect, better natural qualities, better spaces for various uses and events, and partly operational for transportation needs (e.g., boats and ferries). The radial layout also enables a more manageable layout for neighbourhood design creating eight neighbourhood clusters that accommodate 10,000 people each (KPF website). The connected transportation network of the MLEC, and in connection with the surrounding areas and the City of Changsha, is considered a very efficient model that aims to reduce needs for car usage and target low-carbon modes of local transportation. The radial layout, according to the master-planning team (obtained from KPF), also offers a highly efficient transportation system, a well-established infrastructure for water management, and a well-distributed network of energy plants and urban agriculture across the development. The project also benefits from holistic design strategies which are seen as some successful global examples, and focus on advanced environmental engineering, pedestrian planning, cluster zoning and garden integration in the built environment (KPF website).

In addition, Atkins Global (2013), a UK-based consultancy firm, provided a comprehensive low-carbon plan for the entire development. The other technologies included in the project were the provision of water-cooled air-conditioning systems for buildings and energy-saving elevators (Alusi et al. 2010). The intention was to cut energy consumption by 20% for the main services of individual buildings across the development. In addition to energy-saving strategies, new energy technologies, such as digital signs and 'stick-on film' for building façades, were introduced to the newly constructed buildings. Cisco has also played a significant role in implementing some of their smart technologies and innovations in the project.

Case Study Reflections

It is repeatedly reported that construction of the MLEC project is on schedule (Franshion Properties (China) Limited 2014) and the project has entered its second phase of development. There are no official data available on building occupancy, but based on our observation on several site visits (2014 and 2015), the real estate projects are partially occupied and mostly completed as part of the project's first phase. The project is positioned to develop a new international image of Changsha City and a new model of eco-development in Central China, which embraces the

concept of a two-type model district, i.e., achieving both and environmentally friendly development and a resource-saving new city project. The WLEC is believed to adhere to the group's initial strategic thinking by providing an ecological development as well as achieving a high-end development with quality.

Once just a farmland in a traditional rural setting, the MLEC is now one of the remarkable examples of new urban developments in China. As one of the pioneering national eco-city models in China, the MLEC project represents a unique model of itself. The project, while named 'international' and involving several key international actors (mainly in planning, feasibility analysis, technologies and engineering), is a national-level eco-development project. The low-carbon and green approach to building design is consistent across the whole region, and the project represents a model of multiscalar and multifunctional planning.

While we can question the ecological aspect of the project since the new built environment is built over the existing agricultural lands, it is significant that the MLEC has undertaken a comprehensive plan to minimise the overall impact from the new built environment on the existing area. Hence the project's low-carbon agenda appears stronger than some of the other eco-city projects of the same scale in China. The MLEC, in many ways, is argued as not only a new city development, but is also comprised of new urban planning methods that makes it into a national model.

5.5 Guangming Eco-City, Shenzhen, Guangdong

Type: National Flagship Project

Project Overview

Guanming Eco-City (GEC) is one of the first batch of eight national eco-city projects in China in 2012. It is often described as 'Shenzhen Guangming New District' and is now one of the seven districts of the City of Shenzhen in South China. The Guangming region used to be part of the larger Bao'an District of Shenzhen, but was made into a new district in 2007; after which the proposal of GEC was under consideration. The new development project has a combined approach to eco-development and low-carbon construction, including key strategies for optimising the existing structure of urban space, enhancing green municipal planning, developing low-carbon industrial development, forming a green transport system, and promoting green building design. Since the establishment of

the new district in 2007, rapid development has taken place across the district, one of which is the GEC project. The new development is aimed to scale up at a later stage, while currently creating a hybrid of eco-city and low-carbon town model. The GEC project has so far received three national recognitions for green development, including: National Green Building Model Town in 2008; China's first low-impact development model town in storm water management in 2011; and National Green and Ecological Model District in 2013. The project is also highlighted as one of the eight national-level pilot projects for reform demonstration.

In recent years, GEC has become one of the national projects that has received significant international attention (Yu 2014) and is led by several layers of governmental bodies, many high profile at the national level (Ji et al. 2017). This new eco-development project also acts as a sub-centre to the City of Shenzhen, where the new high-tech zone is designated as an industrial hub to support surrounding industrial estates and high-tech firms (Zacharias and Tang 2010). The construction of GEC was initiated in 2011, after the official announcement of national demonstration projects were made by the National Development and Reform Commission (NDRC) in 2010. The project follows the 'Shenzhen Guangming New District Green City Index System', with a medium- and long-term plan for Shenzhen's low-carbon development. The overall plan (2011–2020) is drafted by the Shenzhen Development and Reform Commission.

In 2007, a merger between two street districts, 'Guangming' and 'Gongming', created the Guangming New Town District, which used to be a state-owned farm. It is located to the northwest of Shenzhen, and back then as one of the rural outskirts of the city. Its location makes it the gateway linking Guangzhou–Dongguan–Shenzhen–Hong Kong. With such a strategic location, in the middle of the 'urban and high-tech industrial development axis, Guangming has rapidly developed and urbanised over the years, while preserving some of the surrounding mountainous landscape, the Maozhou River, nearby water reservoirs and lakes. Since then, Guangming has developed both physically (e.g., infrastructure and the built environment) and economically. The GEC project is in reality part of a larger economic growth zone in the city of Shenzhen.

The total area of the Guangming district is around 156.1 km^2, and nearly 46% of the area is given to urbanisation and new urban expansion projects, including the development of GEC as part of the overall planning of the new district. The remaining area is officially part of the Basic Ecological Control Line, which also acts as one of buffer zones to the

expansion of Shenzhen. Although not very urbanised, the whole district is home to about one million people (some sources indicate 0.8 million people), largely part of the existing farmland and new high-tech industries.

Project Layout and Planning

The eco-city indicators for this eco-city was developed in close collaboration between the Shenzhen Branch of China Academy of Urban Planning and Design, the Chinese Society for Urban Studies, Cardiff University and the Shenzhen Municipal Institute of Urban Planning and Design (Yu 2014). A close collaboration was also established with close collaboration with environmental consultants Fulcrum and leading engineering firms Techniker, and Alan Baxter Associates.

The total size of the central part of the GEC project is around 7.4 km^2, with the defined areas for development within the new district covering 3.4 km^2 (340 ha), of which 67 ha are the built-up areas. The land uses include industry, rural housing, administration and office plots, road, infrastructure and public utilities (Fig. 5.4). The Guangming area is essentially a fertile farming area, thus the planning sought to integrate the farming into eco-city planning. As mentioned in their policy brief, Birch et al. (2014) argue that the new district is planned to be a 'Green New City, Entrepreneurship New City, and Harmonious New City', following the two key national directions of the new urbanisation plan and industrialisation. Alongside development of new services and a new industrial hub for Shenzhen, Guangming aims to develop high- quality living areas, strong public facilities and tourism industry. In this respect, the new development is divided into three zones of: (1) traditional industry development zone; (2) high-tech industry development zone; and (3) ecological industry development zone. The latter is where the GEC project is located, and includes agricultural activities and eco-friendly tourism. The key spatial strategies that are considered as part of the planning of the new eco-city project include (ibid., p. 33):

- A convenient network of public transport and a slow-traffic system;
- Compact and transport-oriented development (TOD) in station areas;
- Introducing greenery from the ecological zone and surroundings by green wedges;
- The use of recycled energies, waste, and rainwater;
- Green building technologies.

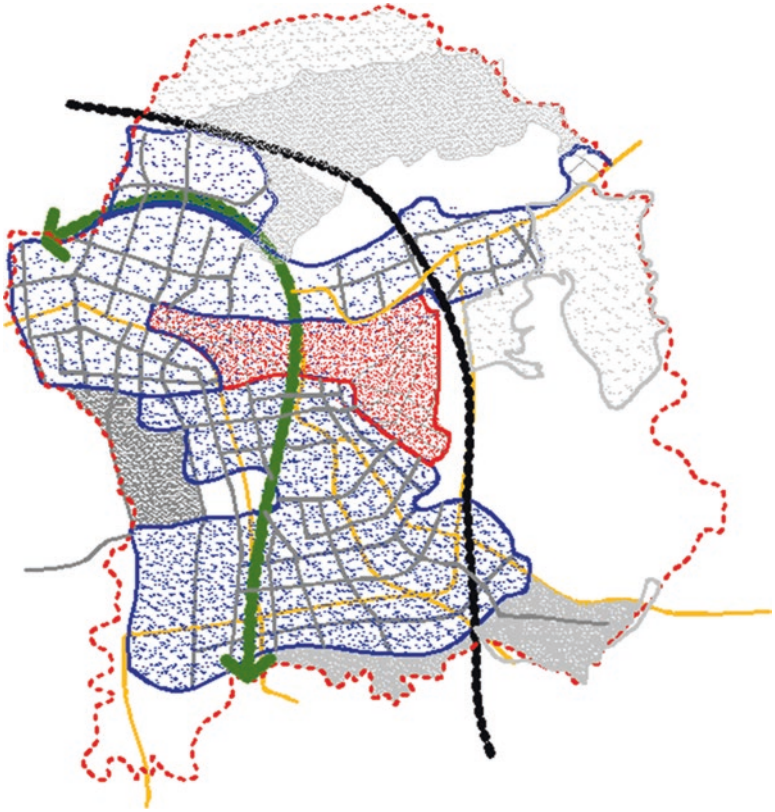

Fig. 5.4 Overview of Guangming Eco-City plan (adapted and redrawn by the authors based on the most recent masterplan strategy development of Guangming Eco-city)

The mentioned green building technologies explicitly focus on the use of measures for the emission reductions, vertical farming methods and using the roof top farms of 12 circular towers, land allocation for solar panels at the ground level, and water reuse of up to 50%.

As part of the whole district development, there are more than 40 green projects that are proposed as part of the ecological and low-carbon development strategies. All aspects are incorporated in the local development, whereby all new projects are anticipated to address the green target plan of Guangming new district.

As described in their report, Wang (2012) highlight the key green development characteristics of GEC (2007–2020) that are adapted in planning process of the project, as shown in the following: (1) TOD mode plays a major role in increasing land-use efficiency and preserving the ecological values of Guangming, creating a better growth boundary management and compact layout; (2) the overall plan encourages a better distribution of large-scale infrastructure that attracts low-carbon and highly efficient economic activities in the local setting; (3) pollution control is considered holistically as part of the project plan, including sponge city development, urban flood control, and development of new urban ecological parks to protect the water system associated with river branches of Maozhou River; forming an ecological framework that reflects on green space expansion and green land preservation; (4) the integration of green transport plan of the Guangming into the city's transit network, including key public transport systems and other public services in the district; (5) consideration of integrated design for new road network and public transport system, allowing for better arrangement of transportation layout, non-motorised traffic priority zones and express traffic corridors for better connectivity to the surrounding regions and the central Shenzhen; and (6) promoting sustainable methods for engineering projects allowing for sustainable design, using local products and achieving high performance after completion.

In addition to the above six broad characteristics of GEC which are implemented in all new development areas of the project, the GEC also follows seven 'key strategic paths' that are taken into consideration as part of strategy planning and the project's key performance indicators. Each strategic path comes with a set of guidelines that are given for a better direction of the project (based on the site visit conducted by Ali Cheshmehzangi in 2016):

- Strategic path 01: Adhering to and maintaining innovation as a development driver in the project;
  Key guideline: including cultivating new impetus to innovation and development.
- Strategic path 02: Adhering to quality-oriented leadership in development;
  key guideline: including exploring new paths for high-end development.
- Strategic path 03: Adhering to green and low-carbon development;
  key guideline: including shaping the new advantages of green development.

- Strategic path 04: Adhering to people livelihood priorities and community-led development;
  key guideline: including building shared development new pattern.
- Strategic path 05: Adhering to keeping an open development (for current and future expansions);
  key guideline: including expanding new cooperation and creating space for win-win opportunities.
- Strategic path 06: Adhering to key tasks of the new development;
  key guideline: including promoting new breakthroughs in harmonious development.
- Strategic path 07: Adhering to continuing to deepen reforms;
  key guideline: including stimulating the comprehensive development of new energy

In order to achieve the project goals, the planning outline was proposed to combine the 'national five major development concept plan' and the 'Shenzhen development strategy plan' to put forward the above strategic paths/approaches for the development of new areas. This outline plan was also addressed in the 'Thirteenth Five-Year Plan of Guangming New District Economic and Social Development'. Moreover, the above key strategic paths demonstrate a clear indication of the project's political status at the national level; an example, with which we can see multiple objectives of eco-development and multi-level governmental actors whom are involved in the whole development process.

Case Study Reflections

While efforts are being made, the city is not yet fully operational, and it is currently on phase two where the majority of the infrastructure and major development projects are in progress. The current project status indicate that the completion date of 2020 is possible and most of the key transportation network are already in place. The GEC's location and its TOD mode are potentially key factors to some of the earlier successes of the project, some of which are based on its rapid GDP growth, industry development, and infrastructure growth. Although described as a striking example in China (i.e., both in research and media), Schwoob et al. (2011, p. 25) argue that 'it is to be feared that the desire for standardisation will prevail over originality'. Similar to some other cases that we have studied in China, real estate projects are now playing a significant role in the GEC project.

Described as one of the ubiquitous eco-city examples by Joss et al. (2013), the GEC project does not represent a unique model of eco-city development in China. Rather, it gives us an overview of a typical national-led model of eco-city. In fact, for the case of GEC, location plays a major role and unlike other similar cases (i.e., in terms of size and project timeframe), such as Cao Feidian Eco-City (Tangshan, in Hefei Province) and Kunming Eco-city (in Yunnan Province), it is accessible to nearby urban and industrial hubs. On the other hand, the TOD mode of GEC allows for more economic vitality and industrial development.

While in the case of Dongtan project in Chongming Island of Shanghai, Arup was working on a complete new development zone, the case of GEC demonstrates more emphasis on a sustainable social/economic community and strikes a balance between modernisation and environmental preservation. The GEC (or as part of the district plan, known as the Guangming New Town Centre) takes an interesting approach by combining urban design and eco-sustainability, arranged into human-scale clusters of housing/farming suburbs in the form of towers/craters conceived as augmentation of existing topography. The project, once completed as planned in 2020, will be a supporting sub-centre to the city of Shenzhen as well as supporting the nearby industries.

5.6 Sino-Singaporean Tianjin Eco-City (SSTEC), Tianjin

Type: International Cooperation

Project Overview

The Sino-Singaporean Tianjin Eco-City (SSTEC) project is a new city development located at the Eastern side of City of Tianjin in China. With its coastal setting, this new development is one of the first eight Chinese eco-cities from the first batch of eco-city projects in China. SSTEC is located 40 km out of Tianjin City Centre and is within the 150 km proximity to the Capital City of Beijing. It is also nearby to Tianjin Economic Technological Development Area (TEDA) and Tianjin Binhai New Area (TBNA), which are two new economic zones of Tianjin. The project is the result of a bilateral agreement between the Chinese and Singaporean governments. The construction of this eco-city project initiated in September 2008 and is expected to be completed by early-to-mid-2020s. When fully developed, SSTEC's expected overall population is estimated

to be 350,000 residents within its total area of 34 km^2. Although nearly half of Chinese urban growth is constructed on arable land, SSTEC is sited on non-arable land, formerly sites for large areas of saltpan, deserted beach and wastewater pond. The overall spatial density in SSTEC is relatively high, at about 10,000 persons per km^2 (Singapore Government 2016). This is somewhat lower than the projected density in Tianjin's core city, which is anticipated to be 12,500 persons per km^2 by 2020, but almost double the projection for Binhai's urban core area.

The project started with three key visions to be 'socially harmonious', 'environmentally-friendly' and 'resource-efficient', which all signify the importance of sustainable development. This vision is supported by the concepts of 'Three Harmonies' and 'Three Abilities' (Singapore Government 2016). While three harmonies include 'social harmony', 'economic vibrancy', and 'environmental sustainability', three abilities are focused on the nature of the eco-city being: (1) practicable—including the key elements of affordability and viability of technology use and adaptation in this new development city; (2) replicable—including the knowledge transfer from the principles and models achieved from the development of SSTEC; and (3) scalable—including the application and adaptation of the project's achievements for another development on a different scale (i.e., a larger scale). The project also encompasses two main politically-driven slogans of 'harmonious urbanisation' and 'ecological civilisation' which have both been widely used since 2007, when the SSTEC was also approved for construction.

In July, 2007, The Sino-Singapore Joint Commission set out two key principles for eco-city site selection, which were:

- Capable of demonstrating an eco-city development under the scarce conditions of natural resources, no occupation of arable land and area with limited water resources; and,
- Close to an urban center, capitalizing on the big city transportation and services, so as to minimize the cost for infrastructure development.

Based on the above two selection principles, four possible sites of Baotou (Inner Mongolia), Tangshan (Hebei province), Tianjin municipality and Urumqi (Xinjiang) were singled out for further evaluation. SSTEC's site was finally selected based on the state of existing surrounding infrastructure, the notion of accessibility and connectivity in its region

and future commercial capacity and viability. Located in one of the fastest-growing regions in China, SSTEC's close proximity to two main cities of Beijing and Tianjin makes it an ideal location for regional connectivity and economic development. Moreover, there was no arable land within the site. While its economic growth may be overshadowed by the municipal area of Tianjin and two of its viable economic zones, SSTEC can focus on developing a harmonious society which can represent sustainable development in the region.

Project Layout and Planning

There are two unique ecological features of the Tianjin project which differentiate it from the other eco-city projects in China: (1) the eco-city is built in an area lacking water resources and no arable land is occupied; and (2) one-third of this new eco-city is a deserted saltfield, another one-third was polluted land and the rest was wasteland. As urbanisation in China is normally characterised by the expansion into nearby farmland, taking no cropland for the construction of a new city was unprecedented and may provide alternative models for China's urbanisation. The Tianjin initiative also contains other interesting ecological features, such as increasing the use of non-conventional water, expanding the use of renewable energies to power the local economy and dramatically reducing the use of vehicles. It was proposed by the plan that around 25 km^2 of the land should be reclaimed as the new development land in order to accommodate 350,000 residents (Yu 2014). Although lagging a bit behind schedule, more than 70,000 people and over 1000 enterprises have chosen to base themselves in the eco-city by the end of 2016. According to UNEP (2013) it is noted that an upgrade from the currently 31 km^2 area is being considered to a total of 143 km^2, reflecting its high-profile national and international status.

The Sino-Singapore Tianjin Eco-City Administrative Committee (SSTECAC) is the Chinese local authority overseeing the project and exercising political and administrative power. A joint venture, the Sino-Singapore Tianjin Eco-City Investment and Development Co, Ltd. (SSTEC), acts as the master developer for developing infrastructures, residential and commercial real estates. The joint venture is established by a Singaporean consortium led by Keppel Group from Singapore and a Chinese Consortium led by Tianjin TEDA Investment Holding from China (UNEP 2013).

Masterplan

SSTEC's masterplan was jointly developed by parties from both countries. The team includes the China Academy of Urban Planning and Design, the Tianjin Urban Planning and Design Institute and the Singaporean Planning team led by the Urban Redevelopment Authority. Other technical team members were included during the process of project development. This includes key members, such as Bluepath City Consulting team, Siemens and several others, whom have supported the development of KPI system, KPI breakdown and provision of technologies at meso and micro scales. While the SSTEC project is less than half-way to completion, the masterplan endorses new possibilities for small-scale city development in China. With three principle planning elements of 'land-use planning', 'transport planning' and 'green and blue network planning', SSTEC is planned to be compact, mixed use and based on a transit-oriented development (TOD) pattern. Divided in to one central district, two sub-centres and eco-districts, the masterplan of SSTEC proposes for two large central areas of eco-core and eco-chain. There are also six eco-corridors around the new development zone that are expanded towards outside of these districts. All these centres (including the sub-centres) are developed based on a TOD pattern in order to promote a better connectivity between the inner districts and the outer areas of SSTEC. This is proposed under the theme of one axis as a network, three centres and four districts. The axis of SSTEC is referred to as the eco-city valley spine, which goes through all centres and districts and also links the southern and northern surrounding areas of the eco-city.

The most innovative concept in SSTEC's masterplan is the 'Eco-cell' planning idea, which forms the blocks of the eco-city at a smaller scale (Fig. 5.5). Each cell is proposed at a block size of 400 m by 400 m area, including a reasonable walking catchment area to local amenities, transportation and other neighbouring areas. The combination of four neighbouring eco-cells forms an eco-community or eco-neighbourhood. Also the combination of four eco-communities form an eco-district, which enables a better infrastructure development, smart grid pattern and connectivity on a small scale. There are four Eco-districts in the Eco-city.

The use of green corridors and the maximisation of green spaces in SSTEC are key elements of achieving an environmentally-friendly living environments. While all four districts are planned in a compact pattern, the in-between green spaces put more emphasis on developing a harmonious city layout. This reduces the surface coverage for the built environment and proposes for green corridors that link the central green core to the outer green environments.

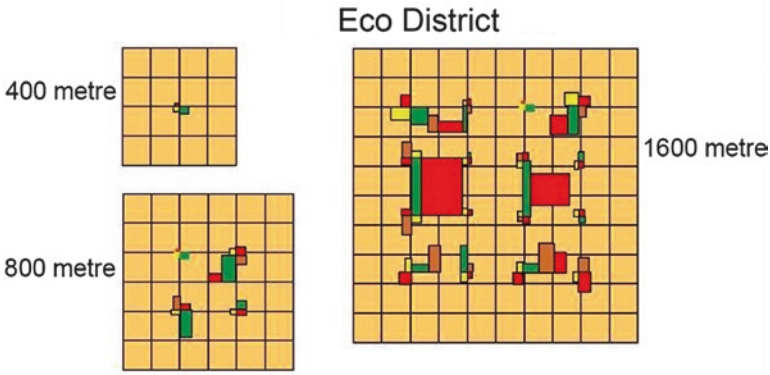

Fig. 5.5 The neighbour layout in SSTEC indicating the concept of 'eco-cell' (adapted and redrawn by the authors, based on the SSTEC documents from the project website)

Key Performance Indicators (KPIs) Guiding Eco-City Development in SSTEC

The concept of eco-city implies that planning for sustainability is to plan our cities in a way to conserve global resources based on ecological principles. At the end of 2007, the Ministry of Housing and Urban-Rural Development (MOHURD) has also issued a policy directive to provide guidance to all local planning authorities on the use of planning key performance indicators in the city-wide land use masterplan preparation and monitoring (MOHURD 2007). In this guidance note, the local planning authorities are requested to adopt a system of key performance indicators (KPIs) for their city-wide Master Plan. This system of indicators has been revised specifically to include new requirements on resource management, such as: water resources balance, water reuse, efficient use of land resources, energy efficiency, emission reduction, as well as recycling activities indicators.

One key point is to translate the KPIs into the masterplanning, and more importantly, into the control plans and then down to individual site/plot level by putting a set of planning constraints. The SSTEC is the first eco-city development model that uses a KPI framework to guide its planning process and attempt to set up an urban management system with support from the decomposed sub-indicators (control targets in SSTEC).

A set of eco-city-related KPIs were developed in April 2008, and were formally approved by the MOHRUD in September 2008. As initially agreed, any future changes to the KPIs will require review and approval via a formal process. The development of these KPIs is based on national standards of both China and Singapore, as well as international best practices that are used for certification of the new development. The KPI framework includes 22 quantitative indicators and 4 qualitative indicators. These are grouped into four assessment categories: environment, resource, economy and society. These KPIs and their decomposed sub-indicators have been used to guide the development of the city's masterplan and also used to evaluate the overall performance of the city.

Based on the SSTEC's division of KPI system into the named four categories, it is required that each category addresses several eco-features. For society, it is indicated that: >90% of trips should be categorised as green trips; there need to be >20% public housing provision; employment housing equilibrium is set at >50%; there need to be coordinated regional policies; and it is also highlighted to include social and culture coordination. For economy, there are two KPIs of having: >50 researchers and engineers per 10,000 labour force; and the regional coordinated economy. For environment, there are several KPIs to achieve: ambient air quality to meet Grade II >310 days per year; Grade IV water bodies; noise pollution to meet 100% of respective functional area standards; zero loss of natural wetland; >70% of preserving the local plant; and towards a coordinated natural ecology for the whole area. Finally, the resource dimension carries the largest load by aiming to achieve the following:

- 100% potable tap water;
- <150 tonnes of carbon emission per US$1 million GDP;
- provision of 100% green buildings;
- provision of >12 m^2 green space per capita;
- domestic water use of <120 litres per day per capita;
- >60% waste recycling rate;
- free recreational and sports facilities within 500 m of walking distance;
- 100% barrier-free accessibility;
- 100% non-hazardous treatment of wastes;
- 100% coverage of municipal pipelines;
- >20% renewable energy use;
- >50% non-traditional water resource.

The KPI decomposition process includes the breakdown of the 26 KPIs into 51 core factors, 129 key areas and 275 control targets (Fig. 5.6). Here, core factors are referred to the factors that affect the achievability of the original KPIs. For instance, SSTEC requires over 20% renewable energy usage in the city (original KPI), which involves two core factors of 'Increase of Renewable Energy Supply' and 'Reduction of Total Energy Consumption'. Subsequently, key areas refer to the areas that have significant impact on the core factors. For instance, buildings, transport, infrastructure and industry are the four key areas that directly affect the attainability of 'Reduction of Total Energy Consumption'. In addition, control targets are the quantitative and qualitative measurements used to measure performance of the key areas. The control targets are also integrated into corresponding government authorities' routine management. For example, building is a key area to achieve renewable energy usage in SSTEC. Four quantitative control targets are thought to be important for the building sector to contribute positively to the renewable usage target:

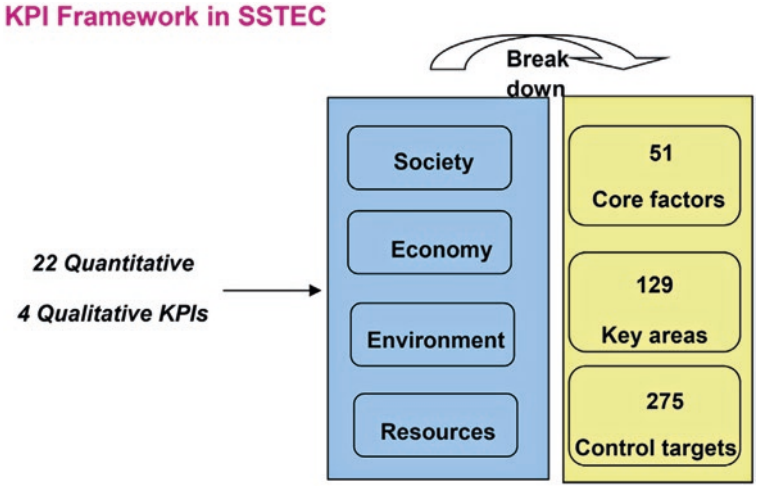

Fig. 5.6 The breakdown of KPIs in SSTEC (drawn by the authors)

- All buildings in the city must be certified by a green building rating system;
- Minimum 70% energy reduction for residential buildings in the design phase and 50% for public buildings;
- Minimum 15–20% operational energy reduction compared to conventional buildings;
- Minimum 5% onsite renewable generation for commercial buildings and 10% for residential buildings.

Green Technologies

SSTEC is developed along a one-axis, three-centres, four-districts concepts. These are described as follows (SSTEC homepage 2016):

- 1 Axis—this refers to the Eco-valley cutting across the Eco-city, which is the green spine of the city. It links up the City Centre, the 2 sub-centres and the 4 districts in the Eco-city, and provides a scenic trail for pedestrians and cyclists. The tram system, which will be built to meet the Eco-city's transport needs, will run along the Eco-valley.
- 3 Centres—this refers to the main City Centre on the promontory on the south bank of the Old Ji Canal and the two sub-centres in the south and the north.
- 4 Districts—this refers to the residential districts in the southern, central, northern and north-eastern parts of the Eco-city. Each district contains several housing neighbourhoods comprising a variety of housing types, as well as their respective commercial and amenity centres serving their communities.

Green and blue spaces—The Eco-city is planned with extensive green (vegetation) and blue (water) networks in mind to provide an endearing living and working environment. The green network will comprise a green lung at the core of the Eco-city and green-relief eco-corridors emanating from the lung to the other parts of the Eco-city. Water bodies in the Eco-city will be linked together for greater water circulation to enhance the ecology and to provide an attractive environment for waterfront development and water-based recreational activities. A wastewater pond will be rehabilitated and transformed into a clean and beautiful lake.

Transport Sector—The transport sector has set a target of 90% green transport. It assumes that only 30% of trips are conducted by walking and cycling. This will be achieved largely through public transport in the form of a Light Rail Transit system, trams and buses. To promote walking and cycling, there will be a 12 km Eco-Valley which connects all major centres and nodes. There will also be community walkways cutting through estates and wide cycling paths on both sides of the roads in the Eco-City (UNEP 2013).

Energy Sector—Energy supply to SSTEC is exogenous from two combined heat and power plants outside the project boundaries. In renewable energy, the main challenge is that there are few sources in Tianjin except for geothermal heat which, together with solar energy for hot water and street lighting, will provide the bulk of renewable energy. Reaching the renewable energy target could therefore become a challenge.

Water Sector—Residents of the Tianjin Eco-City will be able to drink directly from taps. Rainwater will be harvested and, together with recycled water, will be used for landscaping irrigation and general cleaning purposes. With the integration of water-saving technologies into everyday life, residents will also play an important role in conserving water.

Solid waste Sector—To promote effective waste management, residents will be encouraged to sort their waste into categories. Recyclable waste will be sent to recycling stations located within the Eco-City. Non-recyclable waste will be collected via a Pneumatic Waste Collection System and incinerated to generate electricity.

Smart Eco-City Development

The SSTEC was one of the eight national eco-city pilot projects in 2012 and became one of the first batch of national smart city pilot projects in 2013. SSTEC Smart City Action Plan 2013–2015 was approved by the SSTEC Administrative Commission in January 2013. During this period, the new plan was used to guide the development of the smart city in the SSTEC project. The plan proposed a number of projects, which were classified into three categories, i.e., information infrastructure, public information platforms, and applications. It also divided the SSTEC Smart City development into three phases (SSTEC Smart City Action Plan 2013):

- Phase 1 Development Phase (2013): focuses on the architecture design of the SSTEC Smart City and infrastructure construction with a possible budget of 207 million RMB;
- Phase 2 Improvement Phase (2014): focuses on the construction of public information platforms with a possible budget of 168 million RMB;
- Phase 3 Breakthrough Phase (2015): focuses on the area of 'smart ecology', form a smart city application system addressing green government, green industry and green living, with a possible budget of 106 million RMB.

The SSTEC Smart City Plan attempts to improve the city's ecological performance through the adoption of smart technologies. In 2013, the Siemens Corporate Technology launched a research project, led by one of the authors of this book. This research aimed to identify the smart technologies that were being used or planned to use in order to achieve the KPIs in SSTEC, which included: (1) Smart green building technologies—High energy efficiency; building renewable energy use; highly efficient water usage; building energy metering and carbon reporting system; building management system; (2) Smart renewable technologies—Distributed renewable energy generation management; Micro grid energy storage; Power consumption information acquiring system; intelligent-visualised smart grid operation and management system; (3) Smart clean energy technologies—Residual heat reuse; Combined Cooling, Heating and Power (CCHP) and heat pumps; Smart energy management; Comprehensive energy/carbon monitoring and reporting system; (4) Smart green transport technologies—Intelligent transport and facilities management; Traffic simulation tool; Fuel-efficient and low-emission vehicles; the Internet of Things (IoT)- based smart logistic transport; E-mobility; (5) Solid wastes—Solid waste recycling and reuse; IoT-based waste tracking monitoring and management system; and (6) KPIs monitoring system—An IT system focusing on environmental KPIs which can evaluate the performance of KPIs and report annually thus help the work of various governmental agencies

Case Study Reflections

The SSTEC project involves multiple stakeholders as well as a major governmental agreement between the two countries of China and Singapore. This alone indicates a major achievement in linking the local, national and international players of the project. The introduction of the

KPI system and the holistic vision that it offers are used as not only a development instrument but also a monitory system towards achieving a sustainable development model. The current status of the project, being partly completed, cannot fully justify or measure the success of the project. The steady pace of development, however, creates a possibility for researchers and practitioners to assess the effects of such eco-city project in a wider range of practices, mainly in planning and green building design. While the initial expected completion date of 2020 is possibly out of the updated target plan, the eco-city committee's latest update in 2014 indicate further implementation in revising the vision, development of further mechanisms for financial incentives and support as well as enhancement of transport network and the new development's economic viability.

At the masterplan level, several aspects are yet to be addressed. First is the adaptability of SSTEC beyond its first phase and it may sustain in a larger scale, when fully completed or extended. These need to directly respond to current issues of ecological friendly environments, land-use pattern and socio-economic sustainability of SSTEC. Second, the strategy for green connections between the inner and outer areas is yet to play a major role in promoting harmonious planning. This effect can be further promoted through the proposed eco-corridors. Third, the eco-cell planning approach should aim to promote the permeability of the blocks as well as enhancing the connectivity between the blocks. While each cell is conceptually divided in to four smaller sections, this practice should fulfil the detailed design of each of the blocks. And fourth, the project's next phase of development should go under careful revision as it proposes for further development our reclaimed land. This poses risks on ecological quality of the SSTEC project in the future.

The SSTEC project's approach to implementation of both national and international standards in practice puts an emphasis on potential policy and planning transitions at the detailed design level. While on the planning scale, SSTEC offers fewer new plans, some common issues of large block sizes, lack of green corridors and lack of network between the proposed centres are visible as part of the transitions in the overall planning of the eco-city. Here, the common practice of large block layout in China is replaced by the eco-cell planning approach; the introduction of six green corridors, linking outer green spaces and the eco-city's green core, propose opportunities for compact layout for the built environment and the allocation of more space for functional green corridors; and the main network between the four districts and three centres responds to the often lacking network in polycentric city planning approach of China.

Top international developers have launched around 12,000 green homes in the Eco-City for sale with over 5500 homes already completed. The Eco-City has also attracted more than RMB 60 billion in registered capital and around 850 companies, including leading corporations such as Hitachi, Siemens and Phillips, to set up presence in the Eco-City. With a resident population of 70,000 (by the end of 2016) and growing, the Eco-City is springing to life. A range of amenities such as schools, banks, restaurants and shops are progressively opening to service the first waves of residents and companies moving into the Eco-City.

As demonstrated by the SSTEC, win–win public–private partnerships can be harnessed to develop an Eco-City that is practical and affordable (World Bank Report 2009). To achieve this goal, it is important to have good political leadership in partner countries to set the direction and channel the society's resources in the direction of promoting sustainability. A balance also needs to be struck between going for radical, but possibly unaffordable improvements (especially for developing countries) and opting for more cost-effective, practical improvements that can make huge differences on a large scale almost immediately. With the SSTEC, the latter is the approach that Singapore and China have chosen (UNEP 2013)

According to de Jong et al. (2013b), it is noted that the Sino-Singaporean model offered consistent and stable high-level political involvement, substantial public sector investment, and relatively easy cultural understanding, while economic growth figures had also been promising. In this specific case, local governments did not view ecological concerns and economic development as incompatible interests, but rather tried to strike a balance between them.

The key to success in the SSTEC project can be noted as there were multiple joint organisations set up for the project. While the political and administrative power is still held by the Chinese partner (the Administrative Committee), the joint-venture company which is co-managed by both sides is responsible for implementing the project. All of the benefits accruing from operating the eco-city are shared by both parties. More than half of the investment projects in SSTEC come from Singaporean companies, and the Singaporean government contributed resources and expertise to help Singaporean companies locate suitable investment opportunities in the project.

5.7 Sino-Swedish Wuxi Eco-City, Wuxi, Jiangsu

Type: International Cooperation

Project Overview

The Sino-Swedish Wuxi Eco-City (SSWEC) is the result of collaboration between the Chinese local government and several Swedish stakeholders aiming to create a sustainable urban infrastructure comprising environmentally-conscious energy systems (Tan-Mullins et al. 2017, p. 68). This new city-scale development is one of the first batch of eight eco-city projects in China. This project is proposed to create an urban area mainly focusing on the use of new technologies for renewable energies, waste management systems and low-carbon development. According to earlier reports, the SSWEC project is destined to be the home for approximately 20,000 inhabitants. Although the project is still in its initial phase, many of its goals and performance indicators are successfully met. In this project, the integrated systems of sustainability that forms the concept of eco-city, go beyond existing facilities and also comprise of the awareness of sustainability with the people living in it.

The project's ability to succeed is understood to depend on how much its residents embrace the mission that the city has set out to fulfil. One example is provided by the eco-city's transportation. The plan is to assign 80% of the total commuting in the area to public transport, and by doing so, encourage the residents to travel by buses or trains in order to lower total emissions. Approximately, 50% of transportation vehicles are set to run on renewable energy sources (Qian 2011), which is a major target plan in comparison to other projects of the same scale. Another goal for the SSWEC is to exemplify the local inhabitants' cooperation in terms of local waste management. By educating and promoting sound recycling and proper discharge of household organic waste and combustibles, the systems can work in a superior way, where energy, gas and other rest products can be extracted from the waste (Qian 2011; Tan-Mullins et al. 2017, pp. 68–69).

Figure 5.7 shows a conceptual model of environmental strategies adopted in the SSWEC, comprising five sub-models—energy, water, waste, transport and built environment. The aims of this eco-city project, in addition to the promotion of Swedish technologies, is to use the best systems and processes available in order to create an urban environment that minimises its negative environmental impact without affecting the

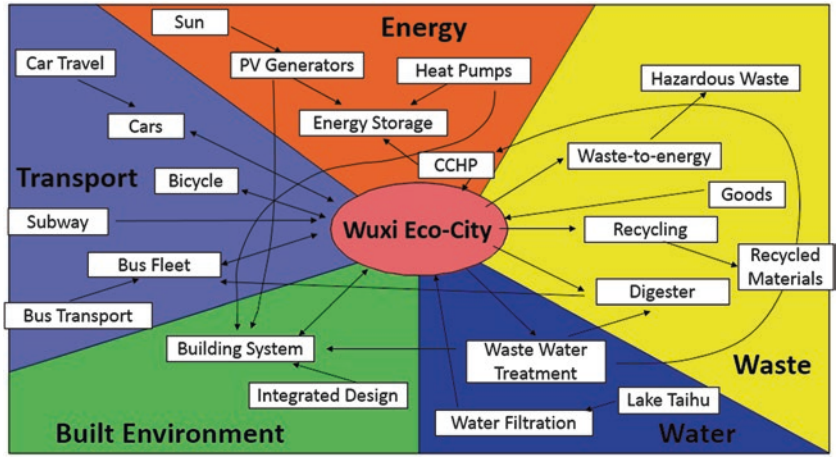

Fig. 5.7 Conceptual model of the Sino-Swedish Wuxi Eco-City (adapted and redrawn by the authors based on the Swedish counterparts 2013)

quality of the city's residents (Tan-Mullins et al. 2017). The ambition is to create an eco-city that serves as both a role-model flagship for eco-cities as well as an educational showcase for future peers (Qian 2011).

Project Layout and Planning

The SSWEC, also known as Wuxi Taihu New Town, is located south of the city of Wuxi in southern Jiangsu Province and Yangtze River Delta.

The overall area is proposed to cover around 150 km^2, with the buildings covering 95.7 km^2, and the green lands covering 54.3 km^2, combining various functions, including government, office, finance and business, culture and entertainment, science and research and, finally, residential areas. As part of the SSWEC, a total area of 2.4 km^2 is dedicated to the 'national demonstration zone of low carbon eco-city'. The planning is very much based on a Transit-oriented Development (TOD) layout with a central development core area, two major residential districts at the sides and two scientific and R&D parks at the edges of the new eco-city area. The new development is planned on the waterfront with several waster bodies and preserved ecological lands in between (Fig. 5.8).

The SSWEC's target plan is to accommodate around one million residents (and some reports indicate 0.8 million) and 500,000 jobs with a high density CBD at its centre (Wu et al. 2015). The new development

Fig. 5.8 Layout of SSWEC/Wuxi Taihu New Town (adapted and redrawn by the authors based on the Swedish counterparts 2013)

adapted a particular spatial layout, which is divided into three districts: East, Central and West. The masterplanning for the city was led by the Swedish architect firm Tengbom, Export Swedish environmental technologies and management, and used the well-known Swedish eco-city of Hammarby as a precedent. After overpassing the conceptual plan development for the SSWEC, there are two main actions that the government took into consideration: Firstly, they developed a set of innovative ideas to produce a plan which aimed to achieve similar outcomes to those in Hammarby Sjöstad in Stockholm in terms of both ecological performance and economic success. And secondly, the plan was to include a list of target plans as the statutory requirements. Although the seemingly large scale may suggest otherwise, the plan in reality covered an area of 2.4 square kilometres with only amount to 20,000 residents (Wu et al. 2015).

The key planning features include:

- Urban function and urban space—development of a park-front high-end residential neighbourhood, mixed-use redevelopment and a commercial corridor. In addition, the creation of a collection of neighbourhoods each with a distinct characteristic to attract diverse residents. A high-end department store, retail street, exemplary kindergarten and semi-private community green are part of the urban developments;
- Transport—Walkways from residential areas to station and retail destination are planned. A sunken plaza and metro station are also part of the wider mobility plans;
- Green space—A green spine connect adjacent park and waterfront are planned. In addition, roadside green space are planned for. In addition, semi-private interior landscapes are planned for within residential blocks;
- Energy use—It is estimated that about 10.2% of the traditional energy will be replaced by renewable energy. With solar thermal, Solar PV, Ground Source heat pump and Sewage source heat pump being the main technologies to be deployed;
- Water and wetland—With around six wetlands, the aim is to ensure their sustainability. In addition the use of reclaimed water will be emphasised, while the sewage plant will be expanded to handle about 150,000 cubic meter of sewage.
- Green building design—A low-carbon exhibition hall (3 start green building, LEED –NC Platinum) is planned
- Non-conventional water use—There is increased rained water collection and utilisation, planning area is divided into 11 drainage areas with storm water collection facilities. Using infiltration and permeable construction the storm water runoff is guided into a the central green space and the green belt with a storage in a concave green space

Overall, the project developers aims to achieve a comprehensive planning for the project by including various key elements of energy utilisation and solar energy, green building, water recycling, waste treatment; public transport and vehicles with clean energy (de Jong et al. 2013a). The entire recycling system is expected to be completed by the end of 2012. In the meantime, a batch of exemplary projects are in progress, including the development of eco-tech exhibition centre, new energy centre,

international school, and eco-community (Chen 2012). Also the project benefits from implementing the certification process. For instance, according to the plan, 70% of buildings should pass the one-star standard of the national green building standard, 20% should pass two-star, and 10% should pass three-star. As per records, until the end of 2013, there were a total of 12 projects (116,600 m^2 floor space) with Green building design logo. These includes 61,000 m^2 for three-star, 18,200 m^2 for two-star and 923,000 m^2 for one-star. The implementation of such system is continued for any new buildings for the new development.

The SSWEC project also focuses on the mainstream of 'energy' with the following aims (Stoltz 2013): (1) to develop a systems model, taking into consideration all major energy subsystems; (2) to conduct an in-depth analysis of the energy system; and (3) to develop an innovation system model for the eco-city. The conceptual system is to achieve efficient energy systems at five levels, including the building level, the eco-city as a whole new development, Taihu new city in a larger context, the Wuxi region, and the national level. However, this is simply a conceptual framework that is considered to be a part of branding and developing SSWEC as a national eco-city model.

The project also benefits from two tools (proposed by the Swedish team) to assist the eco-city development.

The first tool, called 'Innovation Idea to Deployment Model (EI2D)', consists of 13 qualitative criteria that characterise an eco-project. The focus of these criteria is on a comprehensive idea that includes technical implementation and deployment and how the planning process in an e-city project is to be comprehensively organised, and particularly, from the ecological standpoint. In addition, the EI2D model has been processed and matched against the identified subsystems with the purpose of obtaining additional tools in the matrix of a matrix, where two sets of 'eco-city planning criteria dimensions' and 'eco-city system dimensions (sub-systems)' are introduced. The innovation matrix is used for evaluating the eco-city project, but is also utilised as an aid in the planning of eco-city development. The aim is to keep all the subsystems in mind at each stage of the planning process, in order to avoid so-called 'technological lock-ins' and stimulate innovation as well as synergies. The eco-city planning criteria dimensions are divided into 12 dimensions: (A) Planning and goal setting process; (B) Identification of set goals; (C) System integration; (D) Innovation eco-system; (E) A balanced mix of work, living and shopping/leisure; (F) System management and leadership; (G) Wider

energy system access and leadership; (H) Dynamic local and regional energy system; (I) Water supply and water management; (J) Energy efficient buildings; (K) Minimise unnecessary traffic; and (L) Energy Information system. The sub-systems are also categorised into seven dimensions: (1) Energy production and transmission; (2) Energy utilisation systems and the built environment; (3) Urban planning processes; (4) Waste management subsystem; (5) water management sub-system; (6) Transport sub-system; and (7) Energy and information systems (including user behaviour).

The second tool, called 'Energy Target Identification and Deployment Model (ETID)', provides the opportunity to visualise the energy-saving potential of the proposed technology for implementation in an eco-static. ETID has generated scenarios that have been created in connection with the identified sub-systems to reflect different ambition levels for energy saving within the ecosystem. With this, ETID can be a tool for targeting in the planning process. ETID has been developed with the STELLA software and has had the identified sub-systems as a starting point. With an interactive interface, the model aims to assist a wide range of stakeholders in the decision making process. In addition to this, a so-called 'Participatory Approach' was used in the development of the model where a number of key parameters were identified as a result of a workshop with a wide range of invited stakeholders. The actual modelling has been carried out by having inputs from five hierarchical system levels: national, regional, urban, district and building level. The model's evaluations include energy use and CO_2 emissions, which further provide the opportunity to visualize the energy-saving potential of various proposed technologies for implementation in the eco-project. One of the model's main functions is the possibility of active participation of various stakeholders in the goal-setting process in the e-project. This methodology is called 'Participatory Simulation' and aims to incorporate stakeholders' views as quantitative parameters in the model which further serve as validation for the scenarios obtained. Thus, all parameters are resonated and determined and the results visualised. The process is interactive and the result reflects the unified vision of the stakeholders involved (Stoltz and Shafqat 2013).

Case Study Reflections

The construction of SSWEC has started in early 2012 with an expected completion time of 2020. The construction has been slower than initially planned. The Sino-Swedish collaboration can be characterised as a client–provider relationship, but one where the integrated package of solutions is

offered with active political support. This approach is valued by the Chinese counterparts of the project, but to a lesser extent than the more comprehensive Singaporean approach (de Jong et al. 2013b), the end-results being that there are no significant stakes of financial investors or academic institutes nor has it led to the establishment of Sino-Swedish joint ventures (ibid.). It is also an exemplar of how it is possible to create values such as housing developments and new employment by adopting a pro-growth planning approach (Chen 2012). Currently, the second phase of the project is under progress and due to completion soon.

A key innovative aspect of the SSWEC is that it is an eco-low-carbon model, which is located as a city within a larger city. Secondly, the planning of the SSWEC was done within the bigger planning of setting up the larger city by introducing a raft of eco-measures into the existing detailed development plan

As the development plan is an official government document, it means the eco-measures were able to be implemented since the project has been initiated. Thus, it provides a new approach of eco-city development through the gradual standardisation of planning requirements. This has the advantage of obtaining central or local government funding and has become one of the key Sino-foreign projects of the first round of eco-cities in China. Furthermore, the project's overall planning was codified by the promulgation of the Wuxi Taihu New town Eco-city Ordinance—the first local legislation for eco-cities in China (Wu 2015). A similar model is seen in some of new joint ventures across the country.

5.8 Conclusions

This chapter has presented six macro-level case studies, categorised in three types of eco-city development, namely 'eco-city with local initiatives', 'national flagship projects', and 'international cooperation projects (also regarded as Sino-foreign projects). Two case study projects represent each of the named categories. Most of these eco-city projects are part of the first batch of macro-level eco-development projects in China. They also represent some of the main experimental eco-city initiatives across the country. Our categorisation is effective in representing the variety of these projects, as we see significant differences in strategies and practices undertaken in individual projects. While the Sino-foreign examples are projects of direct international collaboration, the local initiative and national flagship projects have considered a more localised approach to their develop-

ment. The main eco-/green features of these projects are mainly embedded in their layout, infrastructure, and spatial arrangements, and how they are implemented in planning practices. Some of these projects have developed a set of key performance indicators (KPIs) while the others have developed a general agenda of eco-development.

At such spatial level of development, as noted earlier (see Sect. 2.3.6), the four dimensions of planning, infrastructure, governance, and policy play significant roles in developing a holistic eco-city project. In comparison to the other two levels of meso and micro (in Chaps. 6 and 7), this requires a more top-down approach from the local governments and allowing for a better utilisation and integration of eco-/green features in the planning practices. Some of these integration models can then be broken down into smaller spatial levels, allowing for a better interplay between spatial levels of the built environment (also discussed further in Chap. 9). More importantly, the macro-level eco-development projects should be able to provide us with a more holistic ecological agenda. In the project examples studied here, although considered in their case study agendas, the role of ecological planning would require to be more effective in the implementation phase. Hence, the approach to macro-level eco-development should eventually shift from these experimental cases of new development and towards more of retrofitting and renewal projects. By scaling up the achievements from these case study examples, we can also propose for new ecologically-friendly masterplans of brownfields and inner-city areas. This, of course, would require a more complex analysis of the existing city environments. However, it is important to recognise the role of these current experimental projects that can later be adopted for future cases of either large-scale projects or smaller scale infill projects in the cities.

Medium to large cities of China have already gone through a phase of redevelopment, and soon some of the early cases would need to revitalise their urban areas. To do so, the eco-development approaches that are demonstrated in this chapter would play a major role in revitalising and restructuring the urban areas. These lessons learnt can set new target plans for cities, and can support the next generation of urban redevelopment in China. A combined method with smart technologies and/or low-carbon agendas will potentially improve the quality of these urban environments. As such, we anticipate to see more hybrid between eco-/green development and other trends, such as smart, low-carbon, resilient, and sponge (Cheshmehzangi 2017). To do so, China needs to re-emphasise on the

importance of eco-development on the large scale. Therefore, eco- should not become a sub-matter as we can see already happening in some cases of large-scale projects. This may even require to explore a larger scale of regional planning, through which some of the goals of China's National New-Type Urbanisation Plan (NUP) can also be achieved.

As illustrated in our macro-level cases, not all projects have a set of green technologies. Some of these cases are unique cases (e.g., Chongming Eco-Island) and some are experimental in nature. Therefore, it is important to see how these projects would eventually scale up and their technologies and eco-strategies would then be utilised in other cases at a larger or even a smaller scale. This will then put many of the existing cities into a transitional phase, which we have already seen in the case of Guiyang City. For the past three years, one of the authors of this book has been working on this phenomenon of smart and eco- transitions for the cities and city environments (Smart-Eco-Cities project 2015–18). The more we study various cases, the more we value the importance of transition as a matter of 'necessity' for the cities that are highly polluting or currently lacking in environmental quality. The impacts would then be on development of a circular economy for some, green economy for others, and an eco-development mode for many.

Finally, what we see here is the representation of some of the early eco-city projects of China. These cases represent local initiatives of eco-city models, national flagship projects with the attention of the national government, and Sino-foreign cases of eco-city projects that initiated some of the projects in the first batch of eco-cities in China. Most of these projects are still under development, and hence we avoided to evaluate them in detail. However, it is important to consider these projects based on the varieties they offer. Some of these models are new even at the global level, and some are just at their inception in terms of proposing major planning and land-use reforms in China. To achieve these, we suggest a better integration of multiple dimensions at multispatial levels. The current smart-city initiatives in China may help to better achieve these from the perspective of governance. However, governance alone may not necessarily improve the planning practices. Therefore, what we require is the evaluation of current experimental cases, localising them, and adopting them for the next round of eco-city projects in China. As expressed earlier, some of these may occur at a larger scale, but others can simply be effective at a smaller spatial level of the built environment, namely the district level and also the neighbourhood/community level. Hence, the next chapter will

discuss some case studies at the meso level and will further explore the possibilities of eco-development at a smaller scale of community level in China. And later, in the final chapter of the book, we continue to highlight the importance of interplay between these spatial levels. The next few cases, at the meso level, will certainly continue this chapter's discussion of eco-development strategies and implementation.

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