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Evaluating China's pilot low-carbon city initiative: national goals and local plans

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Executive Summary

In the past decade, China's unprecedented urbanization has paralleled a 250% growth in primary energy demand. With urban per capita commercial energy use three times higher than rural, urban areas are the crux of energy and CO₂ emissions reduction in China. In recognition of cities' importance in future energy use and CO₂ emissions increase, the Chinese government launched a demonstration program of 5 low-carbon pilot provinces and 8 pilot cities in 2010 to promote low-carbon urban development. As one of the first national scale programs to promote low-carbon urban development, China's pilot low-carbon cities aim to decouple economic growth from fossil fuel use by shifting to an economy based on energy efficiency and renewable energy. This paper analyzes the current development of low-carbon cities in China in order to evaluate if and how these cities can shape China's future energy and emission trajectories.

This paper first reviews the historical development and context for the pilot low-carbon cities and related eco-city initiatives in China as strategies for addressing urbanization challenges. An ex-ante assessment of China's pilot low-carbon cities is then conducted through comparative review of the low-carbon development plans and supporting measures formulated for each pilot city. These plans are compared and evaluated in terms of the policy scope, targets and focus areas as well as supporting local policy measures, strategies and tools already put in place to date. A case study of the pilot city of Hangzhou's planning and implementation process is used to illustrate progress in implementing low carbon plans. We find that while the 8 pilot cities have made progress in establishing low-carbon plans, key barriers such as a lack of explicit definition for low-carbon city, complexity and confusion resulting from several parallel programs, and insufficient supporting policies and market-based instruments may hinder urban development that is truly low carbon.

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1. Introduction

The Chinese government has started to emphasize greenhouse gas and particularly carbon emission mitigation as part of its national strategy for development in recent years. In 2007, China issued its National Climate Change Program (NDRC, 2007); in 2008, a White Paper on China's actions and strategy on climate change was published (State Council, 2008); in 2009, the State Council announced a target of reducing the carbon intensity of its GDP by 40-45% by 2020 compared to the 2005 level (State Council, 2009). This emissions mitigation target was incorporated into the national 12th Five Year Plan (FYP) for the very first time with the setting of a binding target of 17% reduction in CO₂ emissions per unit of GDP from 2011 to 2015 (National People's Congress, 2011).

As the centers of population, industry, transport and infrastructure, cities have a profound impact on global carbon emissions. Cities and urban areas are estimated to use 75% of the world's energy and produce up to 80% of its greenhouse gas emissions (Williams 2007). China has been undergoing fast urbanization, with the annual migration of approximately 13 million people from rural areas to urban centers. The number of cities in China has also increased from 193 in 1978 to 657 in 2010. By the end of 2011, China's urbanization rate reached a record 51.3% and is expected to further rise to 75% by 2050. Because urban energy use per capita is estimated to be three times higher than that of rural areas (excluding non-commercial energy sources such as biomass), and indirect energy use (i.e., embodied energy use) through infrastructure and urban consumption of goods is even higher, the development of low-carbon cities is crucial to mitigating the growth of carbon emissions in China.

At the beginning of 2008, Shanghai and Baoding became the first cities to join a new World Wildlife Fund (WWF) initiative to explore low carbon development strategies for China's urban areas. Domestically, the National Development Reform Commission (NDRC) – China's top planning agency responsible for formulating and implementing national economic and social development strategies - initiated a low carbon pilot province and city program in July of 2010, including five provinces and eight cities across the country. The eight low carbon pilot cities are located across the country and include the municipalities of Tianjin, Baoding, Hangzhou, Chongqing, Nanchang, Guiyang, Xiamen and Shenzhen and the five low carbon pilot provinces include Yunnan, Guangdong, Hubei, Shaanxi, and Liaoning provinces. These pilot cities and provinces were selected based on geographic, social and economic diversity and

representativeness, existing foundation and/or preparation work in low carbon development and demonstrated interest by the local regions to be a pilot location (NDRC 2010).

Figure 1 shows the geographic distribution of the pilot locations and the eight pilot cities' announced energy and carbon-related reduction targets. The carbon and/or energy intensity targets for each of the pilot cities were set by the local government, using the national targets as a baseline.

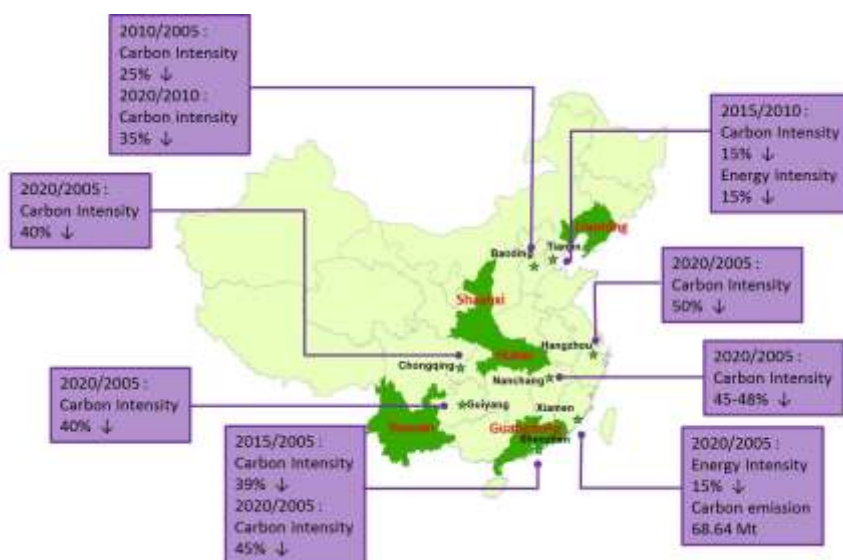


Figure 1. Location and major targets of NDRC's eight low carbon pilot cities

As part of the pilot program, each pilot city was asked by NDRC to develop and propose a low carbon development plan, formulate supporting policies, develop low carbon industry, establish CO₂ emission statistics and data management system and encourage low carbon lifestyles and consumption. Table 1 shows the status of the action plans of the eight pilot low carbon cities. As seen from the table, these pilot cities are in different stages of developing and implementing their action plans. As a low carbon pilot city under both the WWF and NDRC programs, Baoding was the first to propose its low carbon action plan and program while Chongqing's low carbon action plan was approved by NDRC as recently as March 2012.

Table 1. Summary of low carbon plans for eight pilot cities

City	Action plan	Issue date	Drafting institution
Baoding	Baoding city people's government views on building low carbon city	December, 2008	Baoding Municipality Government
Hangzhou	Hangzhou city people's committee and government views on building low carbon city	December, 2009	Hangzhou Municipality Government
Xiamen	The overall planning framework for low carbon city of Xiamen	January, 2010	Xiamen Construction & Administration Bureau
Tianjin	Tianjin's climate change program	March, 2010	Tianjin Development and Reform Commission
Guiyang	Guiyang city low carbon development action plan framework (2010-2020)	July, 2010	Guiyang Municipality Government
Nanchang	The action plan for Nanchang low carbon pilot city	November, 2011	Nanchang Municipality Government

Shenzhen	Medium- and Long-term plan for Shenzhen low carbon development (2011-2020)	February, 2012	Shenzhen Development and Reform Commission
Chongqing	The action plan for Chongqing low carbon pilot city	March, 2012	Chongqing Development and Reform Commission

Table 2 lists some key socioeconomic parameters of the eight low carbon pilot cities in 2010. It illustrates the divergence of these cities in terms of population size, urbanization¹, economic development and industrial structure. The urbanization rate of these eight cities² range from 38.9% in Baoding to 100% in Shenzhen, and the per capita GDP of Shenzhen is almost 5 times that of Baoding. Additionally, the size of each city's population varies vastly among the eight cities; the population of the provincial-level city Chongqing is approximately 8 times that of Xiamen. Agriculture contributes a mere 0.1% of Shenzhen's GDP compared to nearly one-third in Chongqing, where the service sector remains relatively undeveloped—28% of total GDP—compared to over half in Guiyang and Shenzhen. Industry (including construction) accounts for more than half of GDP in all cities except Hangzhou, Guiyang, and Shenzhen. The divergences in socioeconomic indicators underscore the cities' differing stages of urbanization and hint at possible differences in priorities, focuses and strategies for pursuing a low-carbon pathway of development.

Table 2. 2010 Socioeconomic indicators of low carbon pilot cities

City	Population	Per capita GDP (RMB ³)	Primary sector Share of GDP	Secondary sector Share of GDP	Tertiary sector Share of GDP	Urbanization
Tianjin	12,938,224	72,994	2%	53%	45%	79.6%
Baoding	11,194,379	18,462	15%	52%	33%	38.9%
Hangzhou	8,700,400	68,398	4%	48%	49%	73.3%
Chongqing	28,846,170	27,596	32%	69%	28%	53.0%
Nanchang	5,042,565	47,174	6%	56%	38%	65.7%
Guiyang	4,324,561	25,941	5%	41%	54%	70.2%
Xiamen	3,531,347	71,808	1%	51%	48%	52.7%
Shenzhen	10,357,938	95,000	0.1%	48%	52%	100%

After briefly introducing some of the parallel low-carbon and eco-city development programs currently being implemented in China, this paper will focus primarily on the actions and progress to date of the eight NDRC low carbon pilot cities.

2. Low Carbon and Eco-City Development Programs in China

In addition to the low carbon pilot program launched by the NDRC, parallel programs have also been initiated at both central and local government levels in recent years. By February 2011, 230 of 287 prefecture-and-above level cities have proposed plans to develop new “eco-cities”, while 133 of these cities have gone a step further by setting targets for “low-carbon cities.” In addition, China currently has 11 major indicator systems for low-carbon and eco-city development. Zhou et al. (2012) compared the

¹ Urbanization is defined as the share of urban population.

² Chinese cities are defined by administrative boundaries and contain at least 100,000 non-agricultural residents. City size classes, however, are defined by the non-agricultural inhabitants only. Three administrative types of cities (provincial-level municipalities, prefecture-level cities and county-level cities) exist in China, and are designated based on non-agricultural population, total GDP and share of GDP in tertiary sector and on-budget revenues

³ In 2010, 1 Euro = 8.97 RMB according to the European Central Bank.

major concepts of eco-city, low carbon city and low carbon eco-city and found the following defining traits:

Eco-city: enhances well-being of citizens and society through integrated urban planning and management that harness benefits of ecological systems and protects and nurtures assets for future generations

Low carbon city: emphasizes the climate change challenges that cities may be confronted to, decouples economic growth from fossil fuel use by shifting towards consumption characterised by energy efficiency, renewable energy and green transportation

Low carbon eco-city: combines both concepts by featuring energy-saving and environmentally-friendly city symbolizing low energy consumption and low environmental impact (e.g., low pollution and low carbon emissions)

The following sections present a summary of these programs based on (Zhou et al. 2012).

2.1. Eco-city program of the Ministry of Environmental Protection

To promote the scientific development of a “resources saving and environmental friendly society”, the Ministry of Environmental Protection (MEP) initiated a program to establish eco-counties, eco-cities and eco-regions within China by issuing the “Development of Indicators for National Ecological County, Municipality and Province (trial)” on December 13, 2003. The program requirements were revised by the MEP in 2005. Under the revised plan, basic requirements had to be met by cities to be considered eco-cities, including (MEP 2007):

- Establishing an "eco-city construction plan", promulgated and implemented by the Municipal People's Congress.
- Establishing independent environmental agencies
- Achieving energy saving levels of beyond government-assigned targets
- Achieving eco-environmental quality evaluation index that is among the best in the province.
- 80% of counties (including county-level cities) must reach the national ecological construction targets to be named National Environmental Protection Model City.

By July of 2011, 38 cities have been named “Ecological City (County)” under MEP’s guideline and assessment, including cities in Jiangsu, Zhejiang, Shandong, Guangdong, Sichuan, Anhui, Shaanxi, Liaoning provinces and the municipalities of Shanghai, Beijing and Tianjin.

2.2. Eco-garden city program of the Ministry of Housing and Urban-Rural Development

The Ministry of Housing and Urban-Rural Development (MOHURD) initiated the National Garden City program as early as 1992 and by the end of 2010; MOHURD had announced the selection of 13 groups of National Garden Cities with a total of 184 participating cities under this program. In June 2004, MOHURD decided to initiate the establishment of Eco-garden City based on the program on National Garden City.

The general requirements to be qualified as an Eco-Garden City are as follows:

- Developing complete urban ecological development strategy, measures and action plans
- Establishing a complete urban green space system
- Emphasizing both cultural landscape and the natural landscape
- Improving city infrastructure
- Providing environmentally-friendly urban living environment
- Active participation by the community and the general public in the public interest policies and measures related to the formulation and implementation of the Eco-Garden City
- Implementing exemplary national and local urban planning, ecological and environmental protection laws and regulations.

Those cities already awarded as “National Garden City” can apply to be nominated as Eco-garden Cities. Going further than the requirements of a Garden City, an Eco-garden City places more emphasis on the urban environmental quality. Compared to the "Garden City" evaluation standards, "Eco-garden City" assessment includes additional indices such as measurement of ecological protection, ecological construction and restoration standards, comprehensive species index, index of native plants, the proportion of urban heat island effect, urban ecological environment, and public satisfaction evaluation.

2.3. Eco- and Low carbon cities in Local Governments

The recent launch of several eco- and low-carbon city programs have resulted in some overlaps; the cities of Zhangjiagang, Nanjing and Kunshan qualify and participate in both the MEP and MOHURD programs while Hangzhou is in both the MOHURD and NDRC programs. In addition, with the policy push by NDRC on low carbon development, many other cities have proposed establishing targets to become low carbon cities. By conducting city-wide low carbon planning and setting up city-level energy and emission targets, these cities aim to receive the central government’s policy and program support. Those efforts have strengthened the movement to develop low carbon cities in China but the implementation details of these plans and targets are still not well addressed.

While the guidelines for these three eco-city related programs are relatively broad and based on mostly qualitative criteria, quantitative indicator systems have been developed for evaluating low-carbon eco-cities. However, Zhou et al. 2012 found that the methodology for selecting and using the indicators vary across systems and are insufficient for helping meet the needs of low-carbon eco-city development in China.

2.4. International Programs

In addition to domestic government programs, many organizations and research institutions have partnered with government and other stakeholder to start exploring the planning and best practices of low carbon cities in China. In the fall of 2007, the Rockefeller Brothers Fund started to support a study in order to develop a low-carbon economy roadmap for Guangdong province and Hong Kong⁴. In 2008,

⁴ For more information, see The Climate Group’s low carbon development project on the Pearl River Delta region at http://www.theclimategroup.org.cn/major_initiatives/policy/pearl_river_delta/.

WWF launched its pilot project on "low carbon city development program" and selected Baoding and Shanghai as the first two pilot cities in recognition for their leadership.⁵ In October 2008, the United Nations Development Programme, the Government of Norway and the European Union jointly launched a project to support Chinese provincial climate change programs and projects.⁶ By end of 2010, more than 30 provinces, autonomous regions and municipalities in China have started to prepare for provincial level climate change action plans with cities identified for key parts of the program. The United Kingdom Strategic Programme Fund (SPF) has provided support to Jilin City, Nanchang, Chongqing and Guangdong province in its low carbon city development research and planning.⁷ With support from the Energy Foundation's China Sustainable Energy Program, Tsinghua University and Suzhou and Shandong research institutions conducted preliminary studies of developing a low-carbon strategy for Suzhou.⁸ In June 2010, the Switzerland-China Low Carbon Cities Project was launched, and Yinchuan, Beijing Dongcheng District, Dezhou and Meishan were selected as pilot cities, with emphasis on city management, low carbon economy, transportation and green buildings.⁹

3. Overview of NDRC Low Carbon City Plans

The NDRC program requirements mandate that the pilot cities' low carbon plans include clear targets as well as key achievements and specific measures for reducing CO₂ emissions, industrial structure adjustment, energy structure optimization (i.e. structural change), energy efficiency improvement and the increase of carbon sinks. However, the NDRC has neither provided a definition for a low carbon city nor recommended specific guidance and methods on how to compile a low carbon city plan. In order to highlight the key elements behind low carbon city planning, we compare and assess the low carbon city plans of the eight pilot cities in terms of their targets, scope, planning procedure and measures. The comparison and assessment is based on desk research, discussions with local government officials involved in the development of low carbon plans and in-depth review of published reports and documents on the low carbon strategies in these eight municipalities.

3.1. Targets

Besides an overall energy and/or carbon intensity reduction target as shown in Figure 1, the low carbon city plans also include a series of sub-sectoral targets for industrial, building and transportation sectors as well as ecological and other targets. The process for defining and setting these sectoral targets is conducted at the discretion of the local city government leadership, typically by the local Development and Reform Commission (DRC), and may include other local agencies as seen later in the Hangzhou case study. Table 3 categorizes and summarizes the detailed low carbon targets proposed in the low carbon city plans of the eight pilot cities. Several differences among municipal low carbon plans can be identified from the perspective of target setting and allocation.

⁵ For more information, see the Low Carbon City Initiative in China by World Wildlife Fund (WWF) China. http://www.wwfchina.org/english/sub_loca.php?loca=1&sub=96.

⁶ For more information, see the UNDP report titled "China and a sustainable future: towards a low carbon economy and society." http://hdr.undp.org/en/reports/national/asiathepacific/china/nhdr_China_2010_en.pdf.

⁷ See the full report at Chatham House: <http://www.chathamhouse.org/publications/papers/view/109265>.

⁸ More on the program can be found at The China Sustainable Energy Program's website at <http://www.efchina.org/FProgram.do?act=list&type=Programs&subType=1>.

⁹ More information about the project can be found at the Swiss Agency for Development and Cooperation's website at

The city government needs to decide whether to adopt a relative or absolute carbon target. Following the country's commitment to a carbon intensity reduction target for 2020, all pilot cities except Xiamen have set a carbon intensity reduction target. Baoding and Chongqing have both carbon intensity and emission reduction targets. Xiamen has gone a step further than other cities by not only setting an overall municipal carbon emission target, but also specific emission targets for industrial, building and transport sectors.

Most pilot cities have set only a final target for 2020, but Shenzhen has proposed both an intermediate target for 2015 and a final target for 2020. Setting an intermediate target helps link the low carbon plan with the city's 12th Five Year Plan and enables intermediate policy evaluation and adjustment. Because linkages between carbon intensity and energy intensity targets in the low carbon plan have not been clearly formulated by the NDRC, only few pilot cities have set energy-related targets. For example, Tianjin and Xiamen have adopted energy intensity targets, while Chongqing, Nanchang and Shenzhen aim to improve their share of non-fossil fuels in the future. In Shenzhen's plan, the share of natural gas, solar PV, biomass and wind energy will be at least 50% and 60% of the total primary energy use in Shenzhen in 2015 and 2020, respectively.

The sectoral targets vary significantly among the eight pilot cities. Even though the sectoral targets do not necessarily represent the comprehensive efforts required in each sector, they can nevertheless reflect each municipality's sectoral focus to some degree. In the industrial sector, Baoding, Hangzhou, Chongqing and Nanchang emphasize developing high-tech industry and increasing its value-added share in the future; while Chongqing and Shenzhen have set clear targets for low carbon industry development, focusing on the manufacturing of wind, solar photovoltaic and electric and alternative fuel vehicles. In the building sector, Shenzhen is the most ambitious municipality in terms of green buildings, targeting a 40% and 80% share of new certified green buildings by 2015 and 2020, respectively. In the transport sector, Hangzhou and Shenzhen have both actively promoted public transport and high efficiency and alternative fuel vehicles by creating a set of transport indicators. For instance, the modal share of public transport in Hangzhou and Shenzhen is expected to reach 50% and 65%, respectively, by 2020. Shenzhen has also proposed other innovative and relevant targets such as the share of R&D investment in low carbon technologies and public awareness in its low carbon plan.

Table 3. Comparison of overall and sectoral targets in low-carbon pilot cities

Target	Tianjin	Baoding	Hangzhou	Chongqing	Nanchang	Guiyang	Xiamen	Shenzhen
Overall targets								
Carbon intensity (CO ₂ per unit GDP)	×	×	×	×	×	×		×
Carbon emissions		×		×			×	
Energy intensity (tce per unit GDP)	×						×	
Share of non-fossil fuels				×	×			×

Energy saving				×				
Industrial targets								
Industry emissions							×	
High-tech industry's share of total value-added		×	×	×	×			
Service sector share of total value added			×		×			
Cultural and creative industry's share of total value added			×					
Low carbon industry's share of total value added				×				×
Building targets								
Building emissions							×	
green buildings' share of total new construction								×
Transport targets								
Transport emissions							×	
Share of public transport in modal split			×					×
Buses per 10,000 people			×					
Electric bus share			×					
Metro length			×					
Increase in number of new energy (i.e., electric) cars by 2015					×			×
Increase in number of free bicycles by 2015			×					
Ecological targets								
Forest coverage rate	×		×	×	×			
Wetland coverage rate	×							
Number of natural reserves	×			×				
Water saving	×			×				
Pollution control	×							
Per capita public green area			×					
Other targets								
R & D investment in low carbon technologies								×
Information dissemination				×				×

The energy, carbon and sectoral targets highlighted above reflect the broad spectrum of areas that local policymakers have started to consider in developing their low carbon action plans. As pilot cities, local policymakers have an opportunity to consider or begin emphasizing different aspects of urban development beyond the traditional priority of economic growth. For example, some cities such as Tianjin and Chongqing have expanded the focus of local targets beyond traditional demand sectors into the broader scope of ecological targets. However, because there has not been clear top-down direction or sufficient experience at the local level for comprehensive target-setting, existing targets in the low carbon plans of these pilot cities are inadequate and fragmented. Few cities adopted both energy and

carbon emission reduction targets, though the vast majority of a city's carbon emissions are directly energy-related. Only two of the eight pilot cities have adopted some kind of targets for all three of the major energy end-use sectors (industry, buildings and transport), illustrating that most cities are emphasizing only selected sectors rather than focusing on all major end-use sectors. Similarly, no single pilot city has formed a comprehensive indicator system, in part because an explicit definition of low carbon city was missing. Additionally, the close linkages between carbon mitigation and energy conservation need to be better recognized in government policy documents with targets that focus on both energy and carbon reductions.

3.2. Scope

The specific content and strategies of the municipal low carbon plans of the NDRC programme can be summarized and categorized into a total of 76 low carbon strategies within 10 different sectors. The 10 categories include education, dissemination and cooperation, citizen lifestyle, industrial structure adjustment, industrial energy efficiency, clean energy supply, transport, building, circular economy, urban ecology and spatial development and planning. The distribution of the strategies among the 10 sectors is illustrated in Figure 2. The greatest diversity in low carbon strategies exists within the sector of “clean energy supply”, which includes strategies related to clean energy technologies. A relatively large variety of strategies can also be found in the transport, building and industrial structure adjustment sectors. A similarly broad focus also applies to urban ecology. Altogether, the proposed strategies within these five sectors account for 54 out of the 76 different strategies.

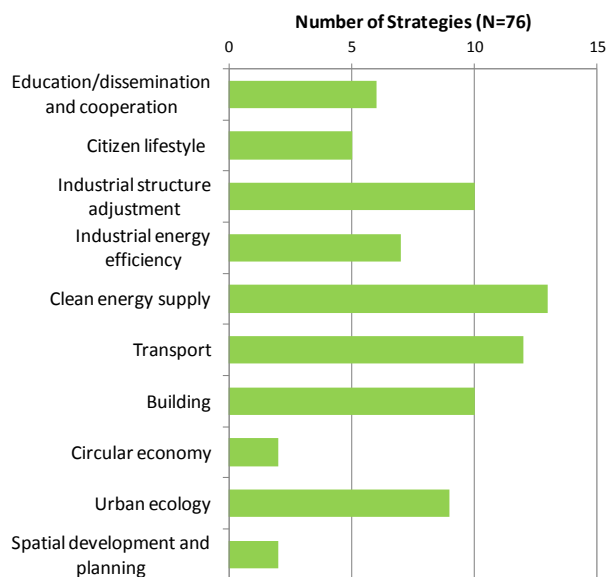


Figure 2. Comparison of measures in municipal low carbon strategies

A detailed overview of the strategies and their distribution among the cities can be found in Figure 3.

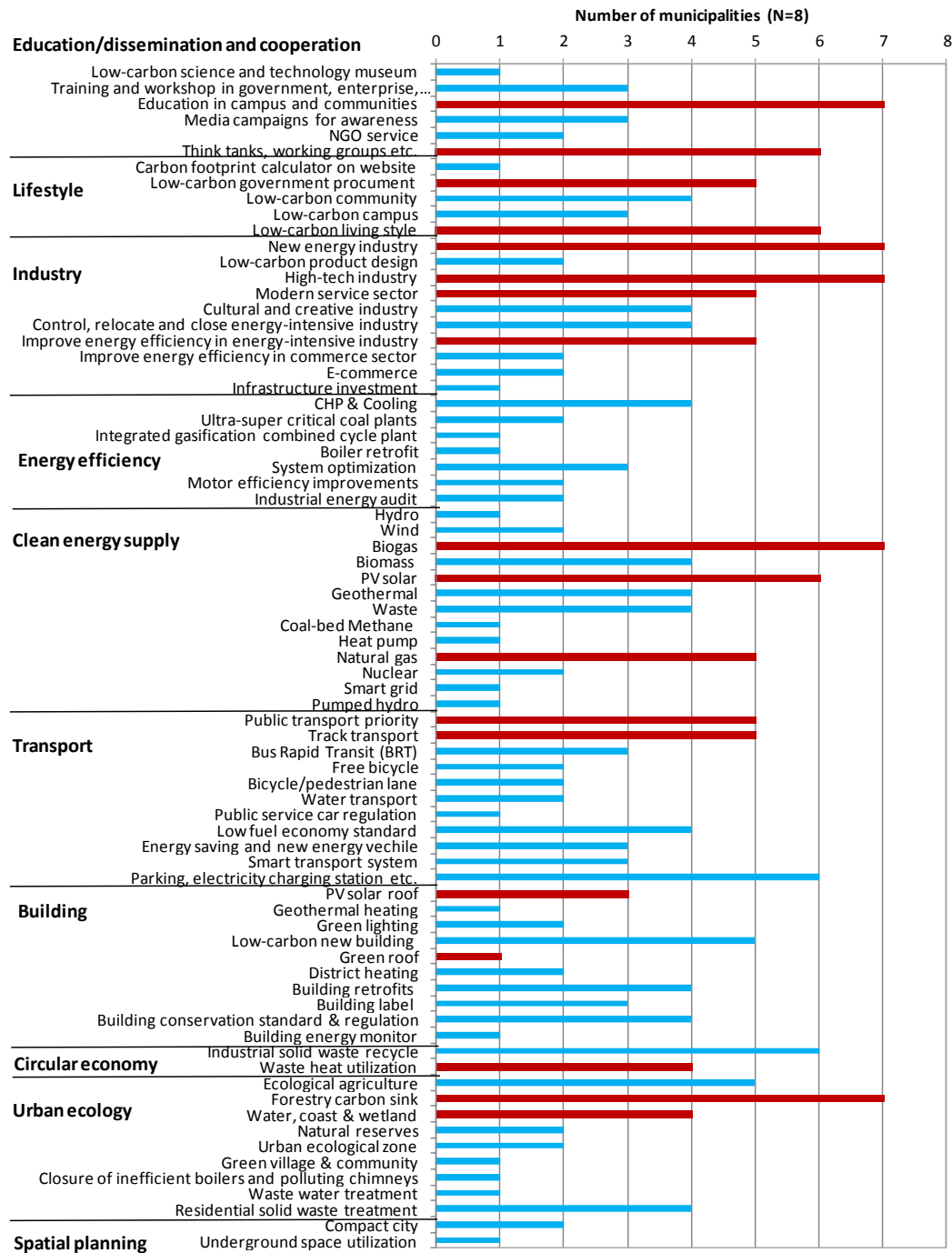


Figure 3. Comparison of strategies identified in low carbon plans

Identifying the most frequently cited strategies in low carbon plans helps shed light on how different local governments perceive and define low carbon development in the absence of national guidance. As seen in the figure, popular strategies shown in red have been adopted by more than half of the pilot cities while the strategies shown in blue are less commonly adopted in low carbon development plans.

For example, in terms of industrial structure adjustment, 7 out of 8 municipalities included the development of high-tech and low carbon industries in their plans. Other interests lay in developing modern service and cultural and creative industry sectors. Regarding the clean energy supply sector, biogas and solar PV are the two most popular technological options recognized in low carbon city plans, followed by biomass, geothermal and waste incineration power plants. In addition, there is also increasing awareness and emphasis on utilizing industrial solid waste and preserving forestry carbon sinks. Surprisingly, despite the central government's ardent energy efficiency efforts over the last five year, energy efficiency improvement measures including industrial energy efficiency, fuel economy standards, building labels and building energy conservation standards have received only modest coverage in low carbon city plans. However, this may reflect the city's relative inability to affect programs that are driven by central government policy. The awareness for solid waste and waste water treatment and recycling is also low, and there is a lack of diversified strategies for developing a circular economy.

Overall, the scope of existing measures and strategies for low carbon city development is very broad. Most measures and strategies are also still at the infancy stage and lack explicit targets, specific program and implementation mechanisms. Therefore, the effectiveness and potential impacts of these measures and strategies in promoting low carbon city development might be limited and insufficient. This suggests that detailed plans focused on renewable energy and energy efficiency and conservation are needed to evaluate and prioritize a multitude of technologies and measures based on their respective contributions to the overall carbon target. Xiamen has exemplified this approach by supplementing its low carbon development plan with separate plans for renewable energy, building energy conservation, underground space development and utilization, urban ecology, green transport as well as low carbon campus.

3.3. Supporting Measures Adopted in Low Carbon City Plans

Supporting measures are crucial component to the effective implementation of low carbon city plans. These supporting measures can be categorized as administrative, planning and legal, financial and tax-based, market, scientific research and other measures.

Table 4 lists the main supporting measures mentioned in low carbon city plans of the eight pilot cities. It shows that local governments rely more on administrative, planning and legal measures rather than market-based measures to implement the low carbon city plans. All eight municipalities created a low carbon advisory group to plan and implement their low carbon city plans and most have incorporated the plan's targets into the performance evaluation system for government officials. Even though the establishment of GHG emission statistics, verification and management are prerequisites for the implementation and evaluation of low carbon city plans, there is actually little information available on detailed arrangements for this task, such as the allocation of personnel, funding or task timelines. Similarly, almost all low carbon plans have emphasized the need for relevant supporting plans but most municipal governments have not defined the role for special plans in supporting the low carbon city plan

or laid out a process for comprehensive planning and implementation. Xiamen has developed the most comprehensive supporting plans for low carbon city development while Chongqing and Shenzhen are pioneers in formulating energy efficiency regulations. Both Chongqing and Shenzhen issued regulations on building energy conservation prior to finalizing their low carbon city plans, with Chongqing's regulation being published as early as 2007.

Financial and tax measures aimed at promoting the implementation of low carbon programs are generally ambiguous and lack program diversity. Tianjin, Chongqing and Nanchang have committed to establishing special funding for low carbon city development in their plans, but have not released any follow-up documents on the total amount or allocation of the special funding. Hangzhou stated that it will provide financial incentives of 0.5 to 1 million RMB for exemplar government institutions (rather than enterprises) that have applied and successfully chosen to be a national low-carbon industrial park pilot project authorized by the State Council or ministries. This financial incentive will come from special funding of industrial plan but it is unclear how effective this financial incentive will be and if potential financial conflicts exist with other projects in the industrial plan. In addition, the low carbon plan encourages diversifying financial sources for low carbon projects such as asset financing, venture capital/private equity investment, public stock as well as low bank interest rates. Guiyang has promised to lower the consumption tax for low carbon projects but there have been no other regulations or preferential policies for ensuring that low carbon projects can enjoy financial and tax benefits.

The establishment of market mechanisms in support of low carbon development is still at the trial stage. In October 2005, carbon trading under the Clean Development Mechanism began in China, administered at the national level by the NDRC. In 2008, several environmental and carbon trading schemes were established, including the Tianjin Climate Exchange, China Beijing Environment Exchange and Shanghai Environment and Energy Exchanges. In 2009 to 2010, additional environmental and carbon trade exchanges were created, covering Wuhan, Hangzhou, Kunming, and Guiyang. In August 2010, the NDRC encouraged low carbon pilot provinces and cities to include carbon trading as part of the overall development strategy. In November 2011, China approved pilot carbon trading in seven provinces and cities – Beijing, Chongqing, Guangdong, Hunan, Shanghai, Shenzhen and Tianjin. Some of the pilot regions can start trading as early as 2013 to 2014 and a national trading scheme is expected by 2016. Given that the pilots are all under design and will not be operational for some time, it is impossible to evaluate the contribution of carbon trading to low carbon city development. Moreover, there are no signs that environmental or carbon tax schemes are being considered at the municipal level.

Scientific research, international collaboration, information and dissemination are other important aspects of supporting measures in low carbon city plans. Tianjin, Baoding, Chongqing and Nanchang have plans to establish low carbon research centers, while Nanchang and Shenzhen are interested in building low carbon service centers to provide technical support for enterprises. All pilot cities also mentioned strengthening international collaboration in terms of scientific research, technology transfer, and information sharing and financial resources. For example, Tianjin has been collaborating with Singapore to build an eco-city since September 2008, and further established low carbon economic

demonstration district through collaboration with Japan in the beginning of 2009. Nanchang has also initiated cooperation projects with the U.S., UK and Austria.

Table 4. Comparison of main supporting measures in low carbon city plans

Measure	Tianjin	Baoding	Hangzhou	Chongqing	Nanchang	Guiyang	Xiamen	Shenzhen
Administrative								
Advisory group	×	×	×	×	×	×	×	×
Performance evaluation system	×	×	×		×			×
GHG emission statistics, verification and management	×	×	×	×	×			
Energy audit and label	×		×	×	×			
Low-carbon industrial park enterprise requirements							×	
Planning and Legal Framework								
Special planning	×	×	×	×	×	×	×	×
Regulation				×				×
Preferential policies (land, fiscal, procurement policies)			×	×	×			×
Financial and Tax-Based								
Low-carbon fund	×			×	×			
Financial incentives			×					
Financial funding	×		×	×	×			
Consumption tax						×		
Energy price	×							
Market								
CDM				×	×		×	
Energy and carbon trading market	×		×	×		×	×	×
Industry and technology trading center								×
Scientific research								
Low carbon research center	×	×		×	×			
Low carbon service center					×			×
Talent introduction			×	×	×			
Other								
Information disclosure	×		×	×	×			
International collaboration	×	×	×	×	×	×	×	×
Public awareness and promotion	×	×	×	×			×	

4. Case Study: Hangzhou's Planning Process

While all eight pilot cities have adopted low carbon city development plans, very few have provided details on the process through which the plan was developed and the framework and processes for

implementing the measures and targets in the plan. One exception is the city of Hangzhou, which was one of the earliest cities to propose a low carbon city plan to the NDRC and has already formed a comprehensive top-down framework for low carbon planning. Hangzhou provides a good case study of how local government support and actions have supported and promoted the city's low carbon plan. There is far much information publicly available for Hangzhou than for other pilot cities since a multitude of relevant plans have already been made public.

Figure 4 shows Hangzhou's model for low carbon development planning. It is mainly based on the decision-making process of the Hangzhou municipality government in response to the NDRC's low carbon pilot city program. However, this model can also represent some common characteristics of other pilot cities.

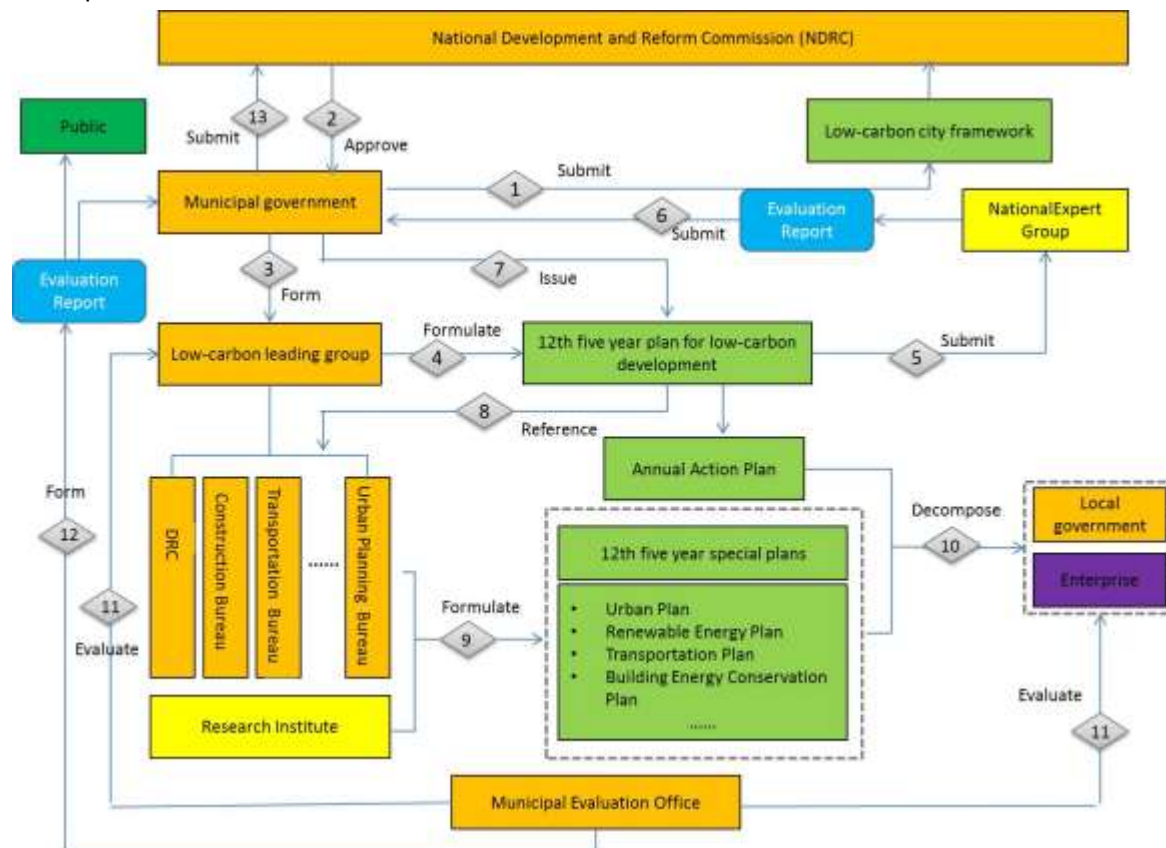


Figure 4. Hangzhou's Model for Low Carbon Planning

The low carbon planning process begins first with the municipality government expressing its interest in low carbon city development to NDRC. NDRC then issued the Notice on Low-carbon Pilot Provinces and Cities on July 19, 2010 and requested each pilot province/city to submit a low carbon plan (steps 1 and 2). Typically, a low carbon advisory group consisting of the mayor and leaders of other relevant departments is established and placed in charge of planning and implementing the low carbon city program (steps 3 and 4). After discussions and negotiations with different stakeholders, a more detailed low carbon plan is compiled and submitted to NDRC for further evaluation (step 5 and 6). Once the NDRC has approved the city's low carbon plan, the municipal government then issues the low carbon

plan to each bureau as guidance for formulating their respective 12th FYP special plans and releases the plan to the public (steps 7 and 8). The low carbon advisory group is also responsible for decomposing the overall target and measures of the low carbon plan into the annual action plan (step 9). Together with the sectoral 12th FYP special plans, annual targets will then be allocated to lower levels of governments (district, country and local governments) and enterprises (step 10). In addition, the municipal evaluation office will evaluate the performance of each level of government and enterprises and submit a report to the municipal government (steps 11-13). The evaluation report summary is published online and open to the public for review and oversight. Table 5 shows the timeline of the low carbon city plan in Hangzhou.

Table 5. Regulatory timeline of Hangzhou's low carbon city plan

Institution	Plan/Action	Date of Issue
State Council	GHG emission control targets set for 2020	November 25, 2009
Hangzhou Municipal Committee	Hangzhou municipal committee and government's views on building low-carbon city is issued	December 29, 2009
Hangzhou Municipal Committee	Advisory group for low-carbon city development	May 25, 2010
National Development and Reform Committee	Notice on Low-carbon Pilot Provinces and Cities	July 19, 2010
Hangzhou Development and Reform Committee Zhejiang Development and Planning Institute Expert Group Review	Hangzhou's 12 th Five year Plan for Low-carbon City Development	July 31, 2010
Leading group for low-carbon city development	Hangzhou's Action plan for Low-carbon City Development in 2011 Implement 12 th FYP for low-carbon city development Implement 12 th FYP for building energy conservation Formulate support regulations for building energy conservation management Implement the 12 th FYP for transportation Decompose the municipal emission target to districts, counties and key enterprises Establish the performance evaluation mechanisms Establish emissions data statistic and management system Establish the indicator system for low-carbon city Carbon label pilot project	March, 2011
Hangzhou Development and Reform Committee Hangzhou Municipal Transportation Bureau Hangzhou Municipal Construction Committee Hangzhou Urban Planning Bureau	12 th FYP for Transportation	August 28, 2011
Hangzhou Municipal Construction Committee	12 th FYP for Building Energy Conservation	November 25, 2011
Hangzhou Municipal Government	Notice on Hangzhou's 12 th FYP for Low-carbon City Development	December 14, 2011
Office of Hangzhou Performance Measurement Commission	Annually monitor and evaluate low-carbon plan implementation in related bureaus	

Hangzhou illustrates a transparent example of a comprehensive planning process that is not representative of other pilot cities. With the exception of Hangzhou and Xiamen, other pilot cities have

not considered adopting sector-specific 12th FYP special plans to complement their low carbon city plans. Furthermore, most of the pilot cities have not gone as far as to decompose the overall targets into specific annual targets and projects for local governments and enterprises. Some pilot cities such as Nanchang and Baoding have set specific programs but not annual targets, which are important in improving the efficiency of project implementation as well as performance evaluation. Last, even though most pilot cities pledged to strengthen oversight and supervision of their low carbon city plan implementation, few have actually appointed a specific institution to take on this responsibility. Without third-party monitoring and evaluation of the low carbon city plan implementation, local competing priorities for economic growth may delay or hamper the fruition of the proposed strategies.

5. Key findings and conclusions

A review of the background, parallel programs and practice of the low carbon city pilot program launched by the NDRC in July of 2010 was presented. Although the multiplicity of domestic and international low carbon and eco-city programs in China creates duplicative efforts and may not be the most efficient approach, it nevertheless allows China to try different approaches rather than adopt a single program for promoting low carbon urban development. Along the same lines, NDRC's low carbon city pilot program also allows local governments to experiment with and develop tailored local pathways of low carbon urban development rather than require all cities to follow a generic top-down mandated low carbon action plan.

In evaluating the low carbon pilot city plans, an in-depth comparison of the eight pilot cities was conducted in terms of their low carbon city plans' target, scope, planning procedure and supporting measures. Several conclusions can be drawn as follows:

- The absence of explicit definitions for low carbon city and the multitude of parallel programs have created complexity, confusion, and overlaps in the development of low carbon cities. Some cities belong to several pilot programs, and while it might be beneficial to receive technical and financial support through different programs, the overlap of programs has resulted in unclear focus, repetitive planning processes, and ineffective implementation of low carbon development planning.
- There is a need to provide explicit definitions, guidelines and methodologies for municipal low carbon plans from the national level. From the above analysis, we found large divergence among the low carbon plans in terms of targets, scope, content and planning procedures. Clear definitions, guidelines, methodologies and tools would help provide a much needed comprehensive framework with clear targets and focused scope for low carbon development planning for municipal governments, particularly for those that are relatively new to the energy and carbon field.
- The overall targets of the low carbon city plan should include both carbon emission and energy consumption targets, which correspond to 12th FYP and 2020 targets. Besides, roadmaps of the low carbon city plans need to be formulated and sector-based targets should be decomposed from the overall targets to enable better implementation, performance evaluation and policy adjustment.

- A series of supportive special plans needs to be developed under the guidance of the low carbon city plan. The sectoral targets in the low carbon city plan can serve as the overall target for each special plan, while special projects and measures proposed in the special plan can help to ensure effective implementation of low carbon city plan.
- Existing regulations and policies are insufficient for implementing low carbon city plans and more relevant regulations and policies on energy conservation, efficiency, energy auditing and monitoring need to be established.
- More market-based, rather than administrative, instruments need to be introduced and greater public education and awareness of low-carbon concepts and practices need to be promoted in order to facilitate greater participation and implementation of the low carbon city plans.
- Third-party monitoring and evaluation of low carbon city plan implementation at the different levels of governments are needed. Public disclosure and dissemination of information should be more consistent and comprehensive, allowing the public to participate and oversee implementation of the low carbon city plans.

From an overall point of view, this paper found that many of the current low carbon city plans under the NDRC program have a very broad scope and may not necessarily address key concepts related to carbon mitigation (e.g., energy efficiency). One underlying reason for the plans' broad scopes and insufficient focus on energy and carbon reduction could be the differing stages of urbanization that the pilot cities are undergoing and their need to address a multitude of pressing issues simultaneously. Another reason could be that the top-down approach of developing low-carbon action plans in the local governments limits input from stakeholders and the public, making it difficult to develop a comprehensive plan that adequately represents the various aspects of urban development. Other contributing factors could include the relatively new government push on promoting low carbon and local city planners' subsequent lack of knowledge in low-carbon policies and practices. This suggests that for a city to be truly low carbon, city planners and local policymakers need to not only clearly define goals and priorities specific to their city in formulating the low carbon plan but also have access to clear guidelines and tools to help develop suitable policies.

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