Progress and Prospects:

China's Cities Transitioning toward Energy Sustainability, and Pursuing Early Peaking of Carbon Emissions

2017 results from the 'China LOGIC' city index
('LOGIC' : Low-carbon & Green Index for Cities)

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Forward

Cities in China are at the frontlines in the fight against global warming and domestic pollution. Cities are also the key venue for China to achieve its sustainable development goals. Already, a number of cities have committed to peak their carbon emissions earlier than 2030 (ahead of the national goal). However, these goals come with great challenges: over the coming decades, an additional 300 million people will join China's urban population; and it has been estimated that more than $1.02 Trillion USD[1] of investments for low-carbon urban projects (clean energy, efficient buildings, and green transportation) is required to achieve China's climate and environment goals between 2016 to 2020. Cities need to take extraordinary actions to get there.

In 2009, China first set a national goal for climate action; and since then, cities have done a lot of work – led by the low carbon pilot cities and provinces. Understanding these cities' progress and performance – *what actions cities have taken, whether those efforts have been effective, and which policies have driven the most change* – will help China to accelerate and achieve its goals for early carbon peaking, followed by a rapid decrease in carbon emissions to climate-safe levels.

This report introduces China "LOGIC" – a new city index system designed to measure and inform China's progress on these goals. China LOGIC is the *"Low-carbon & Green Index for Cities". It* provides a system to track progress, a database to evaluate performance, and an analytical tool to help cities identify improved solutions for low carbon and clean energy development, and early carbon peaking. The research team behind LOGIC gathered a large collection of city-level data on low-carbon development in China – data from 115 cities, across 23 low-carbon and green indicators, and characterizing cities across ten economic and demographic dimensions. Data was collected and compared across two annual sets (2010 and 2015). Overall, the analysis found that Chinese cities have made noteworthy progress and significant improvements in recent years in their green and low-carbon goals. However, important room for improvement remains. Gaps in specific performance areas will require cities to take significant actions; and these efforts can be accelerated through wide knowledge sharing and peer learning from top-performing cities. One risk area is the discrepancy between political will and actual performance. While most of China's low carbon pilot cities have done well in the LOGIC results, some pilot cities fell short in meeting their green goals. This suggests that efforts are needed to ensure the effectiveness of policy commitments. And at the same time, for all cities, the LOGIC results need to be taken as a baseline. The immediate next steps should focus on converting identified priority areas into solid action plans that can achieve the best green and low-carbon development outcomes through cost-effective implementation strategies for cities with different development needs.

Looking forward, LOGIC aims to provide ongoing and timely analysis through two-yearly updates of the city database and city index scores. Additional analysis and special case studies in the near future will help yield more insights and actionable information from the city performance data. Our team is also developing an interactive online tool that gives cities access to LOGIC, enabling them to benchmark their progress, and learn from their peers to identify new, feasible green and low-carbon actions. We hope that policy-makers will use the LOGIC tool to aid their work, and that LOGIC design updates will benefit from feedback based on real world needs and practical experience. Our goal is to help all cities in China transition to a green and low-carbon future.

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[1] *Paulson Institute, Energy Foundation China, Chinese Renewable Energy Industries Association. Green Finance for Low-Carbon Cities. Available at: https://www.bbhub.io/dotorg/sites/2/2016/06/Green-Finance-for-Low-Carbon-Cities.pdf . 2016-06/2017-10*
[2] *China's State Council. National Population Development Plan (2016-2030). Available at: http://www.gov.cn/zhengce/content/2017-*

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Executive Summary

Chapter E1. China's Low Carbon City Policy System

China is one of the two largest economies in the world. China is also in the midst of the largest wave of urbanization the world has ever seen – with 770 million people currently living in cities, up from 190 million in 1980. China is forecasted to have more than 1 billion urban inhabitants by 2030 – which will represent 70% of China's population, and 11% of the global population living in Chinese cities[2] at that time.

China also exerts a significant influence on the environment – locally and globally. China's industrial and urban development over the past 30 years has been a miracle – lifting 700 million[3] people out of poverty, and positioning China as a global leader in manufacturing, trade, business, and urban development. But this development miracle has come with steep environmental costs. Air pollution, soil and water pollution, energy use, and carbon dioxide emissions in China are well documented, well recognized, and China's government is responding through a range of measures.

China has reached a genuine turning point. With the urban population still expected to increase by more than 300 million people over the next 15 years, Chinese cities will continue to expand – requiring more infrastructure and housing, requiring new industries and jobs, consuming more land, energy, and natural resources, and at the same time producing more waste, pollution, and emissions. The choices that Chinese city leaders and policymakers make today will significantly shape future development patterns across China's cities. This matters for city residents, for their local environments, and for the entire planet.

Cities around the world are increasingly recognized as the primary centers of resource consumption and greenhouse emissions. Cities are also on the front lines facing the most intense early effects of climate change – from intensified flooding, dangerous heat waves, or water supply shortages. But cities around the world are also the primary centers for *action*. It is at the local level of cities that real climate and environment action takes place – i.e. improving energy efficiency, shifting to renewable resources, protecting of local environments, and safeguarding human health and livelihoods. Cities across the globe are coming together to share information and practices for more sustainable and resilient urban development.

And China is already seizing this opportunity. In recent years, Chinese government agencies have established many policies and initiatives aimed at transforming economies, improving local environments, reducing pollution, and piloting new innovations for greener growth in Cities. During the 11th Five Year Plan (FYP), China's Ministry of Housing and Urban/Rural Development (MOHURD) launched an eco-city pilot program to promote urban sustainability. Since 2010, China's National Development and Reform Commission (NDRC) has launched low-carbon pilots in 81 cities and six provinces[4]. In 2014, the State Council issued the National New-type Urbanization Plan – setting indicators and targets for urban infrastructure and urban socio-economic development[5]. And in 2015, 21 Chinese cities joined a pledge to peak energy-related CO_2 emissions before the national target year of 2030 (Alliance of Peaking Pioneer Cities (APPC)). In the critical area of urban air quality, the Ministry of Environment Protection (MEP) and the State Council in 2012 and 2013 announced tougher controls on air pollution[6]; issued a new Atmospheric Pollution Prevention Action Plan[7]; and established a network of 500 PM2.5 monitoring stations across 70 Chinese cities. There have also been a number of sectoral measures of implemented in cities for buildings, industry, energy efficiency, and electric vehicles, among others.

China is taking these challenges seriously and is rapidly moving in the right direction to meet its green and low-carbon carbon city goals.

[2] *China's State Council. National Population Development Plan (2016-2030). Available at: http://www.gov.cn/zhengce/content/2017-01/25/content_5163309.htm. 2017-01-25/2017-10-10 (in Chinese)*

[3] *China's State Council. China's Progress in Poverty Reduction and Human Rights. http://news.xinhuanet.com/politics/2016-10/17/c_1119730413.htm. 2016-10-17/2017-10-10*

[4] *China's National Development and Reform Commission. Available at http://www.ndrc.gov.cn (in Chinese)*

[5] *China's State Council. National New-type Urbanization Plan. Available at http://www.gov.cn/zhengce/2014-03/16/content_2640075.htm. 2014-03-16/2017-10-10*

[6] *China's Ministry of Environmental Protection. 12th Five-Year Plan on Air Pollution Prevention and Control in Key Regions. Available at: http://www.mep.gov.cn/gkml/hbb/bwj/201212/W020121205566730379412.pdf. 2012-12/2017-10-10 (in Chinese)*

[7] *China's State Council. Atmospheric Pollution Prevention Action Plan. 2013Available at: http://www.gov.cn/zwgk/2013-09/12/content_2486773.htm. 2013-09-10/2017-10-10*

Chapter E2. Introducing the China Low-Carbon and Green Index for Cities (LOGIC)

China LOGIC

Despite the above efforts, there remains a need for a practical framework to measure, report, and analyze the progress made by a city as a whole – across a full and balanced set of green and low-carbon urban indicators. This project developed the China Low-Carbon and Green Index for Cities (LOGIC) to meet that need.

LOGIC is intended to provide a holistic assessment of China's transition to both "green" and "low-carbon" urban development. "Green" indicators evaluate multiple environmental parameters related to urbanization and climate change: air quality, water use, solid waste, transport networks, and urban green space. "Low-carbon" indicators measure reduction of GHG emissions, with a focus on energy-related CO_2.

LOGIC is a new index. It builds off existing international and domestic-Chinese city indicator systems, and includes indicators commonly used internationally (see section below), but it offers a new system that more fully reflects balanced 'economic, green, and low-carbon' objectives within China's unique urban and policy context. Importantly, LOGIC relies on indicators that have publicly available data in China's statistical system.

LOGIC builds upon past work on indicator systems, including China Academy of Social Sciences' Regional or Local Economic and Social Progress Evaluation Methodologies, iGDP's City-Level Carbon Emissions Calculator, iGDP's Policy Mapping Tool, as well as LBNL's Benchmarking and Energy Saving Tool for Low Carbon Cities (BEST Cities) and the Eco and Low-carbon Indicator Tool for Evaluating Cities (ELITE Cities) tools. LOGIC is scientifically rigorous and is designed to have meaningful practical applications. The process developing LOGIC involved many rounds of data review, analysis and testing, and review by key experts in China.

The main purpose of LOGIC is to evaluate the status of environmental ("green") and low-carbon development across a range of energy use, carbon emission, and environmental and socio-economic indicators for a large number of Chinese cities. LOGIC can be used to track city performance over time, in conjunction with policy cycles, recognizing that low-carbon development requires both immediate and sustained action. LOGIC can also inform current and future policy, and the data gathering needed to support it. The 2017 report analyzed data from 115 Chinese cities, making comparisons over the period from 2010 to 2015. The goals of the analysis and the report are to:

- Achieve a representative sampling of different kinds of Chinese cities
- Assess the state of green and low-carbon urban development in China in 2015; and look at changes in low-carbon city performance over the 2010 to 2015 time period
- Demonstrate the utility of LOGIC by exploring the index categories and indicators, as well as a few case studies in detail

Selecting Chinese *Cities* for LOGIC

LOGIC team gathered the largest collection of city-level data on low-carbon development, with data for 115 cities, 23 indicators, plus ten economic and demographic characteristics, and two annual sets of data (2010 and 2015). In order to compare patterns and trends for different kinds of cities, five different city groups were examined, with each of the 115 cities being assigned to a sub-group under each group. The groups and sub-groups are listed here:

Economic Groups	Size Groups	Geographic Regions	Low-Carbon Pilot Status	Functional Zone
- Group P (*post-industrial*) - Group I (industrial) - Group T (transitional)	- Mega (>10M) - Very Large (5-10M) - Large (1-5M) - Medium/Small (<1M)	- East - Central - Northeast - West	- Low-Carbon Pilot - Non-Pilot	- Optimized Development Zone - Key Development Zone

Chapter E3. Key Findings

China's cities are getting greener – overall green and low carbon index scores improved from 2010-2015.

The average overall index score across all of China's cities grew 2.5 points, or 6.6%, from 2010 to 2015[8]. In aggregate, cities of all types saw growth in their average overall scores – the economic groups, size groups, regional groups, and policy groups in this study all saw LOGIC score growth, ranging from 4% to 13%. China's large "Mega" cities, "post-industrial" cities, and low-carbon pilot cities performed particularly well over this period. Moreover, within the LOGIC framework, 6 out of 7 Categories saw average scores increase from 2010-2015 (ranging from 1% (Energy & Power) to 30% (Economic Dimension); and 11 out of 19 indicators saw an increase (ranging from 1.7% {Heavy Industry Share} to 121% (Urban Rail Extent). The index allows exploring and understanding of these trends, along with observations, such as: how the Environment & Land Use category dropped by 4.7%, and how seven out of 19 indicators' scores dropped.

Figure 1 - LOGIC Score Changes from 2010 to 2015; Overall, and by City Groups
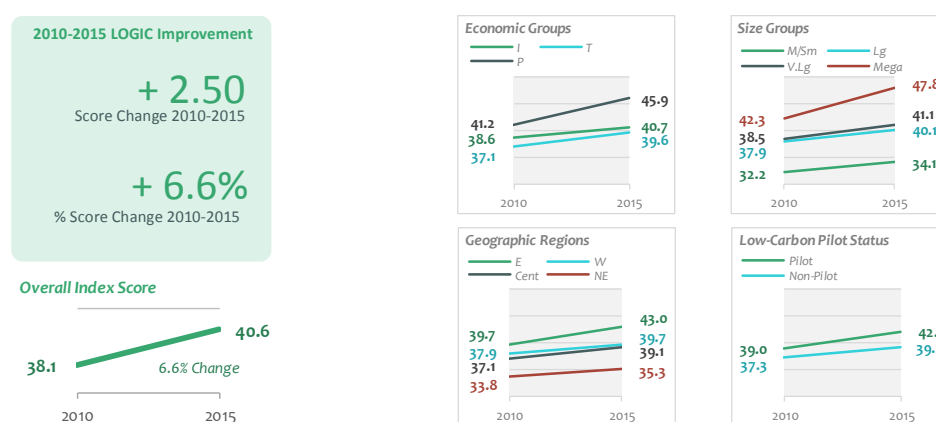
More than 90 out of 115 cities in the sample saw both GDP growth <u>and</u> LOGIC score growth over the 2010-2015 time period.

All of the 115 cities in the sample saw significant GDP growth from 2010-2015 (ranging from 40%, to greater than 100% growth over the five-year period). More than 90 of these cities also increased their LOGIC scores over the same period – some with slight increases, others with as much as a 25% increase. Among these, there are two unique clusters of high-performing cities (see Figure 2). One cluster showed the highest total GDP growth (in the 90th percentile), and also had LOGIC score growth between 5-15% over five years. Another cluster showed the highest LOGIC score growth (in the 90th percentile), and also had GDP growth that was well above the national average. Cities in both of these clusters demonstrate that green and low-carbon goals do not need to come at the expense of economic performance.

Figure 2 - Change in GDP Growth vs. Change in LOGIC Index Growth, 2010-2015; for all 115 cities in the sample

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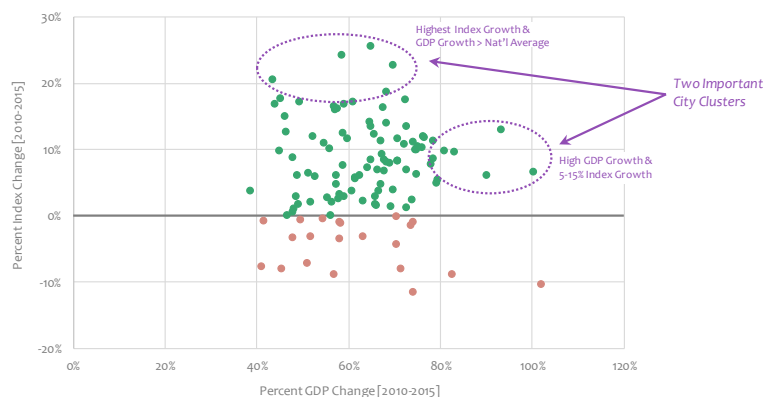
[8] *Note that in this report, LOGIC score comparisons between 2010 and 2015 <u>exclude</u> the 'Policy & Outreach' index category, because this category refers to planning and outreach efforts mandated after the year 2010. See further discussion in Chapter 4 of this report. However, if the Policy & Outreach category is included in the comparison, average overall LOGIC scores increased by 6.8 points, or 17.8%, from 2010 to 2015.*

Chinese cities have significant potential to improve their Green & Low Carbon performance.

While Chinese cities' LOGIC scores and economies have both grown in recent years, the average overall index score for all Chinese cities in 2015 is still only 44.9, out of 100. Chinese cities have room to improve. Yet, within the sample, some Chinese cities did achieve high scores; and the large margin between the average score, and scores achieved by China's best-performing cities indicates a positive pathway for all cities to catch up. China is early in the green & low-carbon transition of its cities and has made strong commitments to restructuring urban and economic development away from resource-intensity and pollution. Furthermore, LOGIC, by definition, is ambitious – its indicators are designed using world-class green benchmarks and are intended to push Chinese cities to do more, and quicker. LOGIC provides a scale to measure China's continuing progress; and the top-ranking cities, as well as the international benchmarks can help to point out a low-carbon path forward.

Figure 3 - Comparing Average LOGIC Scores by Category, along with performance relative to category benchmark values
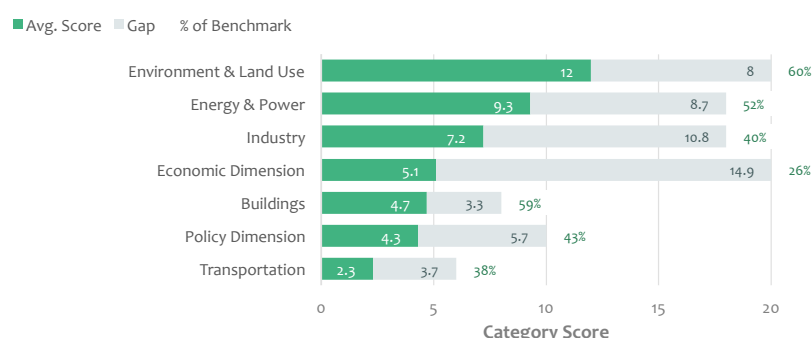
China's Low-Carbon Pilot Cities have been quicker and more successful in achieving green & low-carbon results.

The average overall index sores in 2015 for *Low-Carbon Pilot Cities* was 47.0, compared to an average of 42.9 for non-pilot cities. Furthermore, *Low-Carbon Pilot Cities* make up 80% of the list of Top 20 LOGIC cities in 2015 (despite being less than half of the sample population). And, pilot cities saw a quicker increase in their scores over the 2010-2015 period – this quicker growth is true for the overall index score, as well as for most of the index categories/sub-categories[9]. Relative to all cities, China's low-carbon pilot program is working so far, although more work is required overall to fully achieve China's green and low carbon goals.

Figure 4 - – Comparing Low Carbon Pilot City and Non-Pilot City Performance; 2015 average scores, and improvement from 2010 to 2015
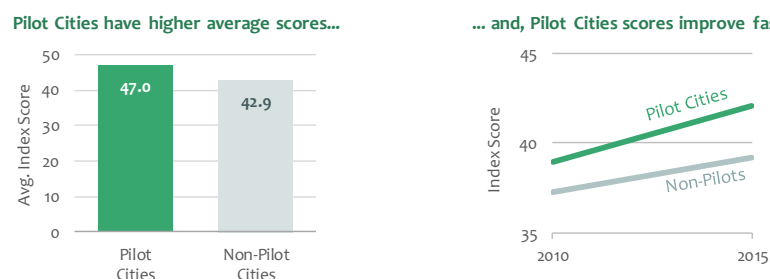
Cities of all types can be Top-Performers in green & low-carbon development.

Results from LOGIC indicate that cities of all types can be top-performers; and that no matter which type of city, or which category of measurement, cities can always learn from others and explore ways to be greener. Table 1 shows that the list of Top 20 LOGIC cities in 2015 includes a diverse range of cities from most *Economic Groups*, *Size Groups*, *Regions*, and policy groups (only Medium-Small cities, and Northeastern cities are not represented on the list). Furthermore, within each group, there are high performers and low; and peer cities can learn from their high-performing counterparts. Likewise, within each of the index categories/sub-categories, there is a range of city performances – high and low. Peer cities can learn specific green and low-carbon policies and actions from high-performers in any category. LOGIC can be used for city knowledge sharing, and to analyze pathways for any kind of city, across any metric.

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[9] *Note: comparison of LOGIC scores between 2010 and 2015 excludes the Policy & Outreach category. See Chapter 4 for more discussion on this.*

Table 1 - List of Top 20 Cities, Ranked by 2015 Overall Index Score

City Name	Rank, Overall Index	Overall Score	Economic Group	Size Group	Region	Low Carbon Pilot Status
Shenzhen	1	69.7	Group P	Mega	East	Pilot
Xia'men	2	66.0	Group P	Large	East	Pilot
Changde	3	58.5	Group I	Large	Central	Non-Pilot
Nanning	4	58.2	Group I	Large	West	Non-Pilot
Haikou	5	57.7	Group T	Large	East	Pilot
Ganzhou	6	57.5	Group I	Large	Central	Pilot
Guangzhou	7	57.5	Group P	Mega	East	Pilot
Shantou	8	57.4	Group T	Large	East	Pilot
Jieyang	9	56.7	Group I	Large	East	Pilot
Guilin	10	56.3	Group I	Large	West	Pilot
Zhanjiang	11	55.8	Group I	Large	East	Pilot
Beijing	12	55.5	Group P	Mega	East	Pilot
Hangzhou	13	55.3	Group P	Very Large	East	Pilot
Nanchang	14	54.8	Group T	Large	Central	Pilot
Wenzhou	15	54.8	Group T	Very Large	East	Pilot
Guangyuan	16	54.7	Group I	Large	West	Pilot
Jiangmen	17	54.5	Group I	Large	East	Pilot
Kunming	18	54.5	Group T	Large	West	Pilot
Chengdu	19	53.7	Group T	Mega	West	Non-Pilot
Yangzhou	20	53.6	Group T	Large	East	Non-Pilot

Large (but not too large) cities, and post-industrial cities are greener.

LOGIC results show that cities with larger populations have higher overall index scores – **_except_** for the largest mega cities (with populations above 11 million people), where overall index scores _decline_ with increasing population. This is illustrated in Figure 5 below, with the scatter plot showing two groups of cities by population size with two trend lines going in opposite directions. One explanation for this is that generally, as cities grow, agglomeration effects allow greater efficiency (in terms or resources, transport travel times, and other urban services); but at a certain scale, large cities lose these size and efficiency benefits. Therefore, the largest mega cities will need special policy attention, and different strategies to maintain and improve green and low-carbon performance.

Also observed in LOGIC is that cities at the post industrialization stage (Group P) show a decoupling between economic growth and carbon & pollution emissions. For Group P cities: higher incomes, come with higher index scores. While for Group T and Group I cities, the reverse is true: higher incomes go with _lower_ scores. There appears to be a turning point marking the shift in economic development pattern from manufacturing and transitioning cities (Groups T and I, which rely on heavy industry), to post-industrial cities (Group P, which focus on more efficient manufacturing and the service sector for growth). This again indicates that special attention needs to be given to cities' green and low-carbon policy actions, based on their level of economic development. An important aim will be focusing on how to improve industrial and transition cities, and how to maintain and promote the performance of wealthier post-industrial cities.

Figure 5 - LOGIC Turning Points: (left) the largest mega cities' scores decline; and (right) the wealthiest post-industrial cities' scores increase

A major driver of green & low-carbon performance in Chinese cities is their Energy, Industrial, and Economic structure.

As might be expected, within the LOGIC framework, the three inter-related categories of *Economic Dimension*, *Industry*, and *Energy & Power* are assigned relatively high weights in the model (i.e. importance). This also reflects an ongoing challenge and primary driver of China's ability to pursue its green & low-carbon objectives. Looking at the 2015 LOGIC results can provide some insights. Examining the categories that contributed most to the differences between high-performing and low-performing cities shows that the *Economic Dimension*, *Industry*, and *Energy & Power* categories had the most influence. Figure 6 shows all 115 cities lined up from lowest to highest score. Beneath, the category differences that contributed to cities being among the Bottom 20 cities, the Middle Range cities, and the Top 20 cities are shown as a waterfall diagram. However, city performance overall in these three categories is relatively weaker in 2010 and 2015. This is related to China's well-known challenge of transitioning from an energy- and resource-intensive economy based on investment, heavy industry, manufacturing, and export and toward a more modern, high-tech, and high-value knowledge and service economy.

So, while overall the weak performance in the Economic Dimension category (i.e. 26% of benchmark) drag down the total index score for many/most cities, for the Top 20 cities, an improved Economic score was one of the key drivers of their higher scores. This pattern is similar for the Energy & Power and Industry categories. All three of these categories are intertwined and related to China's overall industrial and economic structure. This will continue to be a major and important area of focus in China's green & low carbon urban transition.

Figure 6 – All cities' LOGIC scores, and category contributions to Top Performing and Bottom Performing scores

(Top) Distribution of city LOGIC scores, low to high; showing Bottom 20 (red) and Top 20 (dark green)

(Bottom) Showing contributions of index categories to LOGIC score change; Bottom 20 and Top 20 cities compared to middle scoring cities.
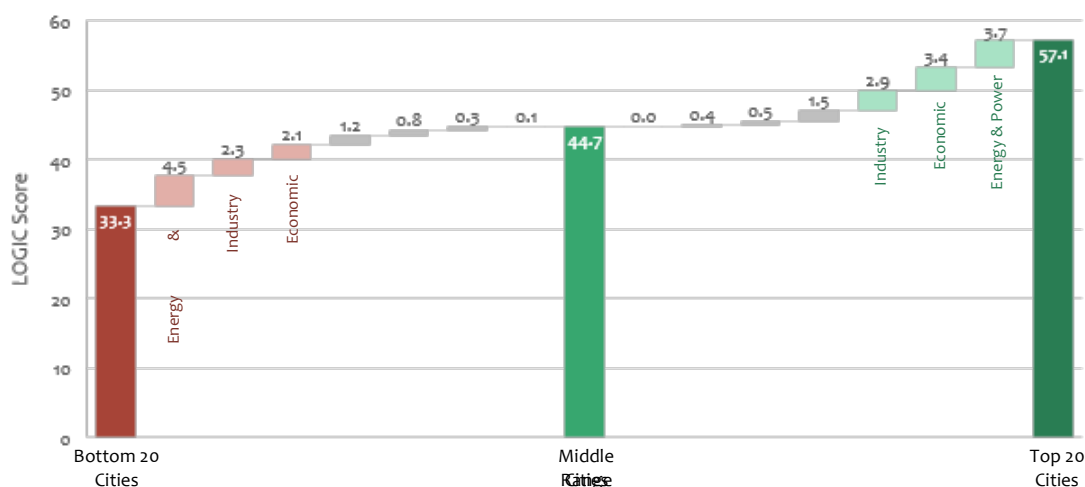
The Environment & Land Use category also needs special attention – this was the only category to have an overall decrease in scores from 2010 to 2015.

Rapid urbanization in China has come with the cost of severe environmental degradation; and these well-known challenges (air quality, water pollution, etc.) will need a new focus on implementation of policies and the right political and economic structures to reverse this trend.

The LOGIC methodology and tool allows deep and detailed exploration of city performance: to identify promising opportunities, and to understand challenges.

LOGIC has been designed to answer key questions such as: *which types of Chinese cities perform better?* And, *what factors most determine cities' green and low carbon success?* Exploring index results and trends over time allows answers to these questions. The rest of the report is devoted to exploring these kinds of questions in more detail.

- *Which types of cities tend to perform better in the index?*
- *How does city performance vary across LOGIC component categories?*
- *What are the overall trends, and what potential policy pathways can cities pursue for green & low-carbon development?*

Chapter E4. Recommendations

LOGIC gives us a snapshot of how cities in China have been performing with respect to their green and low-carbon transition goals. Looking forward, LOGIC also helps to identify and highlight the priorities and challenges that will help China's cities to effectively pursue low-carbon development and energy sustainability in smart and effective ways. Based on the results of the 2017 LOGIC analysis, our team makes the follow recommendations for the low-carbon and green transition in China's cities:

o *Cities and high-level policymakers in China can use the LOGIC framework and benchmarks to accelerate their progress and promote the best green & low-carbon policy pathways according to their specific contexts and needs.*

Clearly, there is no single set of solutions to apply to all cities – especially for China's cities, which vary widely in economic, population, and natural conditions. The LOGIC framework and tool can be used as a guide for cities to tailor individual pathways in their green and low-carbon transition. LOGIC's set of seven categories and 23 indicators help cities identify which aspects are important. The benchmarks and scoring process help cities to evaluate their performance against international best cases, against other cities in China, and against their own past and future performance. This helps cities to identify their strengths, and also identify key gaps for future attention. Most importantly, LOGIC includes data and scores from 115 cities across China – from different regions, different economic development stages, and different population sizes. Any city using LOGIC can identify with one of these groups, and look to the top-performing cities in each group, and in each category (energy & power, environment, transport, etc.) to make connections and find specific actions to implement in their own green and low-carbon pathway.

o *Cities at different stages of economic development have different priorities and should design low-carbon policies and pathways to suit their unique needs.*

Analysis of the 2015 LOGIC scores indicates that the economic development stage of a city (industrial, transition, or post-industrial) plays an important role in green and low-carbon performance, and that these different types of cities all have their own unique challenges and priorities. Sample cities' economic development stages ranges widely – from cities with GDP per capita of $3,678 USD (such as Wuwei in 2015, which is still under the national average), to cities with GDP per capita of $24,690 USD (such as Shenzhen, which is above the level of 'high-income' countries[10]). In LOGIC, cities are analyzed and compared in three economic groups: Group I (industrial), Group T (transitional), and P (post-industrial). These economic groups vary in their scoring and show different patterns of performance for different index sub-categories and indicators. These differences suggest that cities need to focus on different priorities, but also that cities with similar levels of economic development can learn from each other. Industrial cities (Group I) need to focus on improving industrial energy efficiency and investing more in low-carbon and non-fossil fuel power sources (i.e. upgrading existing industrial facilities and setting high energy-efficiency standards for new industrial projects). Transitioning cities (Group T), which have somewhat higher income levels, could prioritize decarbonizing their economies, reducing the share of heavy industry in the economy, and investing in the service sector (including consumption, technology, and information-oriented growth). The post-industrial cities (Group P) need to focus on transportation systems, and energy efficiency levels in buildings, as well as promoting low-carbon lifestyles among their residents.

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[10] *High Income countries are defined by the World Bank as having per capita GDP values above $12,615 USD*

○ *Chinese cities should continue to demonstrate strong political leadership and ensure consistent follow-through and action on their low-carbon commitments.*

Policy leadership and political will are critical factors for cities to achieve a green and low-carbon transition. And it is clear from the 2015 LOGIC results that China's Low-Carbon Pilot Cities performed, on average, better than non-pilot cities. Pilot cities had higher overall index scores; and for six out of seven index categories, pilot cities had higher average category scores, and faster growth between 2010 and 2015, as compared to non-pilot cities. In this regard, the policy efforts promoted through these pilot cities have been effective. However, it is interesting and surprising to note that for the *Environment & Land Use* category, pilot cities had lower scores than for non-pilot cities. Also, that among the 21 cities in China whose LOGIC scores dropped from 2010 to 2015, eight were pilot cities. This implies that so far, the low-carbon policies and actions applied in this set of cities have not been working, despite the political attention and momentum they have enjoyed. At this stage, further analysis and deeper study of these cities is required to understand the drivers behind both the most-successful and least-successful pilot cities. This will be follow up work for our team, based on the 2015 LOGIC results. However, the immediate conclusion is that political leadership is important and does make a difference (pilot cities were spurred to perform and improve faster); but the "will to be green" is not enough – the political will needs to be backed up by real actions that make a real difference in transitioning cities onto the green and low-carbon pathway. The LOGIC framework and tool gives fairly high weight to the "policy and outreach category", and can be used to track city green performance into the future.

○ *As Chinese cities continue to develop and become wealthier, they should promote policies for green citizen lifestyles, backed by green urban planning and infrastructure development as the key to ensuring they can meet early carbon peaking goals.*

China has already committed to peaking its carbon emissions before 2030, at national level. Reaching this goal will depend on the local polices and performance in hundreds of cities across China. Analysis shows that China can potentially reach its CO_2 peaking goal by 2030, at which time it is expected to have an income of $14,000 USD GDP per capita, which is lower than many developed countries. Reaching this peak level and this income level would mean that most of the cities will have developed into the post-industrial (Group P) cities analyze in this report. The 2015 LOGIC results showed that while there is an overall trend for the wealthier and more economically developed cities (i.e. Group P cities, larger cities, and cities with higher GDP) to have higher overall index scores; these cities also tended to perform worse in the *Energy & Power*, *Buildings*, *Transport*, and *Environment* index categories. This implies certainly that in order to improve in these areas, wealthier cities need new policies and action in these areas. But more importantly, if the trend is for all cities in China to become wealthier and more developed, then there is a risk that increasing wealth will come with lower performance in these key LOGIC categories. Cities and policy makers across China need to take strong actions now to avoid high energy and high carbon urban lifestyles. Cities instead need to promote more energy efficiency in buildings and transport, low-carbon lifestyles, and reductions in resource use and environmental pollution. To that end, to avoid lock-in effects cities need to start early to introduce green urban planning rules, tighter building codes and high efficiency home appliances. Cities also need to cultivate lifestyles which are less material-oriented, curb high levels of car ownership, and avoid energy waste in heating and cooling of empty houses, etc.

○ *Mega-cities in China need special attention, to avoid pitfalls and backsliding on low-carbon and green development goals.*

A number of recent reports have shown that, up to a point, as cities become bigger, their increasing population size comes with density and efficiency advantages that help to improve their green and low-carbon performance[11]. However, this beneficial trend breaks down for very large, mega cities – which tend to have weaker green and low-carbon index scores than their smaller peers. This finding was illustrated in a 2017 study by the Urban China Initiative and McKinsey and Co.[11]; and is consistent with the 2015 LOGIC results. LOGIC finds a linkage between city size, in terms of population, and index performance: up to a population of 11 million people, as a city grows, it's overall LOGIC score increases; but when city population passes a 11 million, the overall index scores decrease as population grows. In most cases, these mega cities are also the wealthier and more developed cities (i.e. Group P cities, in this study). As noted before, these larger, higher-income cities tend to have higher energy use and elevated carbon emissions in the transportation and building sectors. Therefore, LOGIC suggests that mega cities need to consider green and low-carbon transitions carefully, and differently than other, smaller cities. This includes special attention to population size and city sprawl, and consideration of the need to set development constraints (not only in terms of territory, but also population), while planning their long-term green and low-carbon development vision.

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[11] *Urban China Initiative. Urban Sustainability Index – USI 2016. Available at: www.urbanchinainitiative.org. 2017-04-13/2017-10-10*

o *Cities and high-level policymakers should continue to use comprehensive data-driven analysis to evaluate, track, and compare low-carbon and green performance.*

Using data and indicators is critical for cities to understand their progress and performance in their green and low-carbon goals. LOGIC was built as a third-party framework and tool to serve the need for transparent and consistent data measurement and reporting for China's green transition. And the 2015 LOGIC results show the benefit of green measurement and tracking – with the ability to evaluate individual cities, or groups of cities over time, and across a wide range of index categories and indicators. Cities in China need to further employ this data-driven approach to evaluate their own plans and progress. Cities need to develop official measurement, reporting and evaluation (MRE) systems; which help to evaluate and prioritize low-carbon actions and investments. Such MRE systems can also serve as important communication tools for cities to share performance and actions with other cities, with the public, or with the international community. LOGIC can provide such a tool and platform.

o *The critical steps to turn political will into action will be for city leaders and policymakers to prepare integrated low-carbon action plans, coupled with robust policy implementation and social-economic analysis that support decision-making and concrete action.*

The LOGIC tool provides snapshots in time to evaluate the green and low-carbon performance indicators across the different index categories. The next steps are for cities to take these results and conduct deeper, integrated cross-sector analysis to understand the real opportunities for actions in all categories; and to develop strategic action plans to implement the most cost-benefit pathways. Developing the low carbon action plans or city early peaking plans should be a practice in all cities. And improving the quality of these plans is key to really identifying actionable measures and projects to capture the best mitigation gains.