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中国后化石燃料时代的城市发展议程：

关于辖区尺度的生态–高效城市与绿色基础设施的新理念

A Post-fossil-fuel Urban Development Agenda for China:

New Concepts of Eco-efficient City and Green Infrastructure at Precinct-Scale

摘要 ……

亚太地区最密集的城市化进程——其以不断流动和增长的城市人口为特点——正在中国上演，这使得这个国家成为了一个有关高能效城市未来发展研究的有趣案例。本文讨论了亚太地区的城市可持续发展，并将寻找未来城市化——尤其是中国的城市化——的替代资源和模式作为重点。

中国城市化进程预计将从2013年的53.7%上升到2030年的70%。本文为亚太地区的政策制定者指出了变革的必要性，以确定推动城市未来发展的新的方式，并鉴于中国目前的生态城市发展现状，制定出向“生态–高效城市”模式的转变策略。城市转型需要来自中央政府的策略导向与相关政策，以及在地方尺度中实施的试点项目与行动举措。其目的在于在辖区尺度，整合绿色基础设施的新理念，从而建立生产性景观和高效城市。因此，对于大尺度的规划和场地尺度设计来说，如何将能源效率融入到转变的设计实践都是非常重要的。

亚太地区快速的城市化进程很可能会继续持续至少20年。然而，该地区的城市迫切需要一项能够依据绿色都市主义的原则，将这些城市转变为可持续的生态城市的后化石燃料的城市发展议程。

关键词 ……

城市化；后化石燃料城市；中国；生态–高效城市；空气污染；城市可持续发展

Abstract ...

The most intensive urbanization process in the Asia-Pacific — characterized by a mobile and growing urban population — is currently happening in China, which makes this country an interesting case study for the future of energy-efficient cities. This article discusses sustainable urban development in the Asia-Pacific region and focuses on the need to find alternative resources and models for future urbanization, particularly in the case of China.

Urbanization in China is predicted to rise from 53.7 per cent in 2013 to 70 per cent in 2030. The article outlines the necessity for policy makers in the Asia-Pacific region to identify new ways to fuel future urban growth and highlights the complexities of making the paradigm shift towards "eco-efficient cities" by considering what is being done with eco-city development in China. Urban transformation requires both strategic guidance and policies from the central government and pilot projects and actions implemented within municipalities. The aim is to build productive landscapes and highly-efficient cities that integrate new concepts of green infrastructure at precinct-scale. Therefore, how energy efficiency is integrated into transformed design practice is important for both large-scale planning and site-scale design.

Rapid urbanization in the Asia-Pacific is likely to continue for at least another two decades. However, the region's cities urgently need a post-fossil-fuel urban development agenda, one that implements the principles of green urbanism to transform them into sustainable eco-cities.

Key words ...

Urbanization; Post-fossil-fuel Urban; China; Eco-efficient City; Air Pollution; Sustainable Urban Development

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1 引言

据预测，全球城市人口将从2010年的36亿上升到2050年的63亿，这些人口将主要集中在中国和印度的城市中。中国的城市化发展规模和速度继续保持着前所未有的速度。如果目前的态势不变，中国的城市人口将在2030年突破10亿大关[1]。面对城镇在未来20年内的预期增长趋势，意味着有必要为亚太地区的城市提出一种能够提升社会公平、环境可持续性，并推动经济繁荣的城市规划原则[2]。这一举措尤为重要，因为城市与气候变化密切相关。然而，现在对于“可持续城市”或“生态城市”的解读多种多样，使得我们很难对现有方案进行比较和分析（图1）。

大城市永远不会止于现状。它们争夺人才、商业和投资。比其他任何地区都更明显的是，亚太地区的城市正经历着飞速的城市化，并面临着需要满足住房、交通和公共空间等预期需求的巨大压力。截止2013年，亚太地区人口已达42亿，占世界人口

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1. 关于未来可持续城市形态理想模型的研究出现了许多名称。本图中展示了一种更加综合的城市化途径——“可持续城市”的诸多方面。© Steffen Lehmann
1. The search for the ideal model for tomorrow's sustainable urban form has many names. This diagram illustrates the many aspects of the “sustainable city” for a more integrated approach to urbanization. © Steffen Lehmann

1 Introduction

The global urban population is expected to rise from 3.6 billion in 2010 to 6.3 billion by 2050, and cities in China and India will be responsible for most of this urban population explosion. The scale and pace of China’s urbanization continues at an unprecedented rate. If current trends hold, China’s urban population will hit the one billion mark by 2030[1]. The anticipated growth of cities and towns over the next two decades means that there is a need for urban planning principles that will create socially just, environmentally sustainable and economically prosperous cities in the Asia-Pacific region[2]. This is especially important because cities are the largest contributors to climate change. However, there are numerous perceptions of the notion of the “sustainable city” or “eco-city”, which makes it difficult to compare and analyse existing proposals (Fig. 1).

Great cities are never at rest. They compete for talented people, commerce and investment. More than in any other region, cities in the Asia-Pacific are experiencing rapid urbanization and face immense pressure to meet projected needs, for instance for housing, transportation and public space. In 2013 the Asia-Pacific region was home to 4.2 billion people and represented 60 percent of the world’s population. While the region is still comparatively under-urbanized, with approximately 46 percent of people living in urban areas, (at a current urban growth rate of 2 percent p.a. predicted for the next two decades) the Asia-Pacific will account for 60 percent of the demographic expansion of all urban areas across the world by 2030[3]-[5]. The urbanization of this dynamic and populous region over the last two decades has been at a scale and speed that are most impressive. Electricity demand in Asia-Pacific countries is growing at 4 percent annually, but most of

的60%。尽管该区域的城市化程度相对较低，但仍有约46%的人口居住在城市区域，（以目前每年2%的城市人口增长率来对未来20年进行预测）到2030年，亚太地区中的城市人口将占世界所有城市地区人口总和的60%[3]-[5]。在过去的20年中，这一处于不断变化且人口稠密的地区的城市化发展规模和速度都是最令人印象深刻的。亚太地区国家的电力需求以每年4%的速率增长，但这些电能大多数（超过90%）仍是由化石燃料产生的。

亚太地区最密集的城市化进程正在中国上演，这使得这个国家成为了一个可供研究的有趣案例[6]。目前，中国超过100万人口的城市有120个，其中36个城市的人口超过了200百万。相比之下，今天，美国只有9个城市的人口超过100万人；中国人口超过500万的城市达到23个，而欧洲仅有3个。而且根据预测，到2030年，中国的城市人口将达到10亿（占全国总人口的70%）。中国城市增长的惊人规模和速度已成为21世纪的一大关键特征，并对世界各地的人们产生了深远的影响。如果我们能为中国制定出实用且成功的解决方案，那么其也将为全世界带来裨益，并且——但愿——能在其他各地得以推广。

中国计划于2020年迈入中等收入国家行列，并于2050年基本完成其现代化进程。在这一进程中，沿海地区特大城市区域（城市群）的发展——例如京津冀地区——起着重要的作用。根据预期目标，新增城市人口将聚集在特大城市区域，从而在沿海地区附近形成8~10个多中心大都市区域，每个区域中的人口将超过4 000万（居住密度达8 000人/km^2）。

目前，显而易见的是，中国农村人口向城市地区涌入的现象还将会持续一段时间。城市化和人口迁移是经济发展和社会转型的一个组成部分，而历史经验告诉我们，这种趋势不可能停止。那些贫穷的移民相继涌入城市，以廉价的劳动力从事于制造业和服务业。此外，中国还面临着人口老龄化的挑战：中国已经未富先老——当今，中国的老年人口（超过60岁）已超过1.85亿[7]。这也是城市化的挑战之一，因为越来越多的青壮年迁移到城市，把他们年迈的父母留在农村，疏于照料。

2 中国的可持续城市发展之路

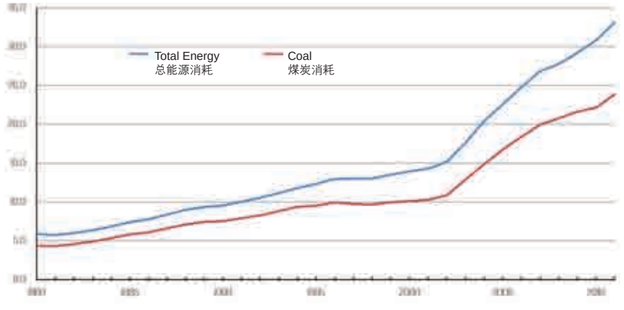
自1978年起，在过去30年中，城市化成为了中国惊人的经济增长的主要动因[8]。而其中最重要的驱动力来自中国能源密集型产业的快速扩张[9]。因此，能源消耗呈大规模增长，在过去30年间上涨了6倍，其中煤炭占中国总能源结构的70%左右（图2）。作为自2006年以来世界上最大的温室气体排放国，中国目前的温室气体排放量占全球总量的1/4以上[10]。由北京大学和清华大学合作进行的研究发现，出口型经济导致中国出现了碳转移排放的问题：“2006年，中国与出口产品相关的生产活动所生产的二氧化硫、氮氧化合物、一氧化碳和炭黑排放量分别占总排放量的36%、27%、22%，以及17%”[11]。

中国的《十二五规划》（2011~2015年）于2010年颁布，其中所提及的重要的二氧化碳减排目标、严重的空气污染、快速上升的消费水平和不断增长的温室气体排放量等仍然是目前面临的严峻挑战（图2）。据《全球二氧化碳排放量趋势》这一报告显示[12]，中国的人均二氧化碳排放量仅在2011年就增长了9%，达7.2吨/人。这一数据已接近欧盟同年的人均排放量（7.5吨/人）。

在学术领域，中国社会科学院的科研人员正在对城市可持续发展的议题展开研究。举例来说，对于中国的低碳转型，潘家华和张莹指出，“随着工业化和城市化进程，中国在过去的40年间，温室气体的排放量迅速且大幅增加。”[13]

然而，在中国，遏制高度能源密集型城市化发展的最有力因素不是气候变化，而是严重的空气污染。从全国范围来看，中国正在经一场空气污染危机。《全球疾病负担研究》显示，在2010年，中国有超过120万人因户外颗粒物污染而过早死亡[14]。中国政府和人民正密切关注空气质量。中国国务院于2013年9月14日颁布了《大气污染防治行动计划》

Annual Energy Consumption of China 中国的年能源消耗情况 (1980-2011)
(Unit: 100 million TCE)（单位：1亿吨标煤）



2. 1980~2011年中国能源与煤炭消耗图（图片来源：参考文献[35]）
2. China's Energy and Coal Consumption from 1980 to 2011 (Source: Refs. [35])

this electricity (over 90 percent) is still generated from fossil fuels.

The most intensive urbanization process in the region is currently happening in China, which makes this country an interesting case study[6]. It now has 120 cities with over one million people, including 36 cities over two million. In comparison, today, the United States has just nine cities with over one million people; 23 cities in China have populations of over 5 million while there are only 3 such in Europe. Furthermore, it is predicted that one billion people will be living in Chinese cities by 2030 (70 per cent of its population). By then, China is projected to have a staggering 200 cities with populations over one million; and one-eighth of the world's population will be residing in a Chinese city. The dramatic scale and pace of urban growth in China has become a defining feature of the twenty-first century, with profound implications for people everywhere. If we can identify practical and successful solutions for China, these will be of global benefit and, hopefully, replicability.

China is now in the process of becoming a middle-income society by 2020, and plans to basically complete its modernization process by 2050. In this process, the development of mega-city regions (urban clusters) in coastal areas, such as the Beijing-Tianjin-Hebei Region, plays an important role. It is expected that the newly added urban population will aggregate in mega-city regions, thus forming 8 to 10 polycentric metropolitan regions near coastal areas, each with a population of more than 40 million (with residential densities of up to 8,000 people per km^2).

It is now clear that the Chinese migration from rural to urban areas will continue for some time to come. Urbanization and migration are an integral part of economic development and societal transformation, and historical experience shows that it cannot be stopped. Poor migrants continue to arrive in cities where they contribute cheap labour for manufacturing and services. In addition, the challenge of an ageing population has reached China: the country is ageing before it becomes wealthy — today more than 185 million Chinese are over 60 years old[7]. This point is one of the challenges of urbanization, because more and more young adults move to cities and their ageing parents are left in the countryside being uncared.

2 China's Pathway to Sustainable Urban Development

Urbanization has been one of the major factors in China's phenomenal economic growth over the last three decades, which commenced in 1978[8]. The key driver is the rapid expansion of China's energy-intensified industries[9]. As a result, energy consumption boomed, increasing six-fold over the past thirty years, and coal accounts for around 70 per cent of China's total energy mix (Fig. 2). As the world's largest greenhouse gas emitter since 2006, China now accounts for over a quarter of all global greenhouse gas emissions[10]. Joint research conducted by Peking University and Tsinghua University has found that the export-based economy in China has caused significant embedded emission problems: "In 2006, 36 per cent of anthropogenic sulfur dioxide, 27 per cent of nitrogen oxides, 22 per cent of carbon monoxide and 17 per cent of black carbon emitted in China were associated with production of goods for export"[11].

While China's *Twelfth Five Year Plan* (*2011 ~ 2015*), issued in 2010, includes important CO_2 emission reduction targets, severe air pollution, rapidly rising consumption levels and rising greenhouse gas emissions remain serious challenges (Fig. 2). According to the report *Trends in Global CO_2 Emissions*[12], China's average per capita carbon dioxide emissions increased by 9 per cent in 2011 alone, to 7.2 tonnes per person. This figure is similar to the per capita emissions in the European Union (of 7.5 tonnes in the same year).

In the academic field, the topic of sustainable urban development is being researched by members of the Chinese Academy of Social Sciences. For instance, regarding China's low carbon transformation, Jiahua Pan and Ying Zhang note that, "along with the industrialization and urbanization processes, China's emissions of greenhouse gases have been increasing rapidly and substantially over the past 40 years."[13]

In China, however, the strongest driver to curb highly energy-intensified urbanization is not climate change, but severe air pollution. Nationwide, China

（2013~2017年），责成京津冀地区、长江三角洲地区及珠江三角洲地区（包括4省3市）降低煤耗，以确保空气质量改善目标的完成。因此，北京、天津、河北等省市出台了各自的行动计划，并制定了至2017年减煤8 300万吨（标准煤）的目标，这标志着新一轮能源和经济结构改革的开始。中国在全国开展的空气污染防治工作大大限制了煤炭消耗。尽管中国已经在增加天然气的使用量，但天然气资源在中国相当稀少，而且分布不均。根据世界银行2012年的评估，中国预计将在未来25年内新增3.5亿城市居民[15]。一项后化石燃料城市化议程对推动这些中国城市的可持续转型来说至关重要。

宏大的目标业已制定，实现低碳转型过程的积极进取的行动举措已然展开；然而，巨大的挑战依然存在，有效政策也仍需补充。另一位研究者罗勇指出，中国未来将不得不“更清晰地展示经济和社会发展的绿色一面，并就各方面进行整体性的绿色转型——这其中包括社会体系和思想方面——以提升整个经济的绿色程度。为成功实现这一目标并推动社会进步，中国将不得不探索新的社会管理模式，缓解高消耗生活方式所带来的资源和环境压力”。[16]

魏厚凯指出，中国的城市转型战略已于2013年左右进入了一个新的时期，摒弃了从前那种一味追求粗放型增长和快速扩张、高消耗高排放的发展道路。他评论道，中国政府已经认识到以往不可持续的发展道路已导致了环境和社会问题的出现，如“无序、低效的发展，不平衡的城乡及区域发展，以及不和谐的社会发展”[17]。

在《中国人类发展报告2013——可持续与宜居城市：迈向生态文明》中，张莹与她的同事对过去30年中国的不可持续的城市化进程进行了回顾，总结了建设可持续城市所面临的挑战，并为不同的未来预景提供了政策建议。研究人员明确了未来中国将在对“生态文明”这一术语的定义中发挥领导作用，并指出“需要在城市发展速度与更高质量的产出之间进行平衡”[18]。

在中国努力实现成为强大的中等现代化国家，并减少温室气体排放的进程中，城市扮演着重要角色。但是，快速的城市化能轻易地使得城市、景观和社区同质化。在如此日新月异的时代，诸如提升住房可负担性和建设适于各年龄层使用的社区等社会挑战是巨大的。现在，人们越来越意识到社会经济的不平等性，并认为需要在创新和知识的基础上——而非廉价的劳动力和环境开发——来发展经济。现在，对农业用地进行保护的意识日益增强，城市化模式已经开始摆脱西方国家蔓延式发展的概念。

3-1

3 中国政府政策及新近改革

相较于2005年颁布的“十一五计划”，中国的“十二五计划”包括削减17%碳排放量的目标。中国政府正在极力改变现有的不可持续的发展进程，并通过在城市化进程中引入更优的标准和环境价值取向，来设定新的基准。中国中央政府已经启动了一系列国家试点项目，以探索不同类型的城市中的可持续城市化发展模式。中国住房和城乡建设部推出了若干生态城市试点工程，与此同时，中国国家发展和改革委员会也在积极推行低碳省和低碳城市试点工作。许多省市已被纳入此类的计划当中，获得了来自中央政府、研究机构，以及国际基金会和发展机构（如能源基金会、世界自然基金会、瑞士发展与合作组织）的政治和技术支持。

今天，不是每个项目都必须（如10年前那样）立刻开工上马。年轻一代的城市居民要求更高的生活标准、更好的生活质量，并提供环境庇护；他们需要一个更清洁的环境与社会福祉，而不仅仅是增长[15]。

京津冀地区的城市遭受着来自燃煤工厂和电站，以及公路运输造成的严重的空气污染（图3）。如此高级别的空气污染已经引发了广泛的公众怨

has been experiencing an air pollution crisis. The *Global Burden of Diseases Study* revealed that in 2010 over 1.2 million premature deaths in China were attributed to outdoor particulate pollution[14]. The Chinese government and citizens are now paying close attention to air quality. On 14 September, 2013, China's state council issued the *Air Pollution Prevention and Control Action Plan* (*2013 ~ 2017*), which mandates the reduction of coal consumption in Beijing-Tianjin-Hebei region, Yangtze River Delta and Pearl River Delta (7 provinces) to ensure air quality improvement targets are met. Consequently, Beijing, Tianjin, Hebei and other provinces released their action plans and set a reduction target of 83 million TCE (ton of coal equivalent) by 2017, which marked the start of a new round of energy and economic structure reform. China's national struggle with air pollution leaves little space for the growth of coal consumption. Although China has already increased its use of natural gas, gas resources in China are quite limited and unevenly distributed. Chinese cities are expected to swell by another 350 million residents in the next 25 years, according to World Bank estimates made in 2012[15]. A post-fossil-fuel urbanization agenda will be essential to fuel the sustainable transformation of these Chinese cities.

Ambitious targets have been set and aggressive actions have begun to realize the process of low-carbon transformation; however, immense challenges remain and additional effective policies will be required. Another researcher, Yong Luo explains that in the future China will have to "more clearly demonstrate the greenness of economic and social development, and carry out a holistic green transformation of all aspects including aspects of the social system and thinking, to enhance the greenness of the whole economy. To be successful in this endeavor and to achieve social progress, China will have to explore new social management modes and alleviate the resource and environmental pressure brought by the high-consumption lifestyle."[16]

Houkai Wei notes that China's strategy of urban transformation entered a new period in around 2013, leaving behind the former pathway of single-minded extensive growth and rapid expansion, high consumption and emissions. He comments that China's government has recognized the environmental and social problems caused by this former unsustainable pathway, such as "disorderly and inefficient developments, an imbalanced urban-rural and regional development and the unharmonious social development" [17].

In *China National Human Development Report 2013 — Sustainable and Liveable Cities: Toward Ecological Civilization*, Ying Zhang and her colleagues review China's unsustainable urbanization process of the last three decades, summarize the challenges in building sustainable cities, and offer policy recommendations for different future scenarios. The researchers identify China's future leadership role in defining the term "ecological civilization" and point out "the need to balance the speed of urban development with higher quality outcomes"[18].

Cities are an important part of China's goal to develop into a modern state with a strong middle class, while lowering its greenhouse gas emissions. But rapid urbanization can easily overwhelm municipalities, landscapes and communities. The social challenges in such times of rapid change are immense, including the affordability of housing and the availability of age-friendly neighbourhoods. There is now an increasing awareness of socioeconomic inequality and the need to base the economy on innovation and knowledge rather than simply on cheap labour and environmental exploitation. Now that the need to protect agricultural land is being acknowledged, urbanization models have started to move away from Western sprawl concepts.

3-2

3. 日常交通拥堵造成了环境破坏，降低了生产效率。空气污染被公认为是当今中国城市中最严重的问题之一。交通是造成北京、上海等大都市空气污染的主要原因之一。
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3. Daily traffic congestion causes environmental and productivity damages. Air pollution is recognized as one of the most important issues in Chinese cities today. Traffic is a major contributor in mega-cities like Beijing and Shanghai.
© A. Frodesiak

言，有关官员出于社会安定考虑，实施了更加严厉的政策。例如，作为中国最大的钢铁生产省份，（据中国环境保护部每月公布的统计数据）河北省有7座城市位列中国十大污染最严重的城市名单之中。河北的污染常常蔓延到邻近的北京和天津地区[19]。中国已经制定了大量的相关法律和准则，以改善备受困扰的环境问题，并要在来自强势企业的压力下将之落实。

2012年12月和2013年1月，中国的空气污染达到了严重等级。根据中国环境保护部的报告，该期间遭受空气污染的区域达143万平方公里。北京监测站记录的PM2.5的小时最高浓度（细颗粒物）达到了993μg/m^3，已达到了损害健康的级别。2013年3月，成百上千名全国人大代表呼吁对空气污染防治的相关法律进行修订，以应对当下亟待解决的空气污染问题。2011年12月，中国国务院发布了《国家环境保护“十二五”规划》，其中对空气污染的防治做出了法律规定。2013年9月，国务院颁布了最新的《国家清洁空气行动计划》，较之2012年颁布的版本，该计划针对空气污染制定了更加严格的规定。

为对应空气污染，中国已开始禁止在若干重点工业区内新建燃煤电厂，并出台了一项行动计划：该计划旨在提高风能、生物能源及太阳能等非化石燃料能源的所占比例，并于2017年达到13%（2012年，可再生能源的所占比例为9%；风力发电很可能将从2030年开始为中国提供大量的电能）。然而，亚太区域能否具有足够的创新性以应对空气污染这一巨大挑战，城市化和可再生能源成为了其中的一个主要问题。政府和地方市政管理部门将需要为其所在地区提出更好的参与模式，并实施奖励措施，以鼓励人们保护生态系统——如果我们依旧按照过去30年的能耗模式发展，生态系统将岌岌可危。

4-1

4 迈向优化紧凑型发展，以及一个基础设施的新时代

当对居民在包括出行、商品、能源、食品和服务等方方面面一年以上的消费行为进行比较时，有证据表明，生活在郊区的每户居民的温室气体排放量要高于居住在紧凑型城市地区的居民。内城区居民的碳足迹往往要低得多，这是因为通常他们居住的房屋较小，且选用公共交通出行。影响消费的最重要的因素包括家庭收入、车辆持有率和家庭规模，郊区居民在上述方面均高于内城居民。交通（举例来说，交通排放量占美国家庭总排放量的26%~42%）是郊区和城区之间排放量差异体现得最明显的方面，居住地与工作地之间相距20~60km的居民所生产的排放量最高。郊区机动车所产生的交通排放量是城市地区的2.5倍。

这对中国城市（事实上，对所有城市）开发最佳密度的新辖区——而不是采用过时的城市化模式，并引发一系列的问题——至关重要。在过去的30年间，廉价的化石燃料的广泛使用促进了城市化的快速发展，并造就了效仿美国模式的城市形态，从而加剧了城市扩张，导致了机动车依赖型郊区的出现，使得城市效率降低、弹性减弱，竞争力也相应削减。另一方面，紧凑型和混合型的城市发展将有助于形成集约、高效的低碳公共交通（例如，轻轨或地铁作为交通导向型发展的一部分），从而实现低碳或无碳型出行（例如，骑自行车和步行），并促进汽车共享或合用。上述所有措施均可以大大降低辖区内的温室气体排放量[20]。

可持续城市发展方面的专家已经将关注的焦点从建筑尺度转移到较大的社区和辖区尺度，这将允许并促进新一代基础设施和分布式发电技术的整合。在中国，更高的密度通常可以使得分散化的、更高效的城市系统和基础设施得以实施（例如，热电联产、能源和废弃物基础设施、雨水储存及再利用），并有助于形成更加紧凑、适于步行的城市形态，任何区域的资源消耗模式将由其城市形态最终决定。21世纪的可持续性基础设施应在辖区尺度下运行：包括智能电网、互联式太阳能屋顶、自行车道网络、轻轨、污水处理站、当地资源回收站及社区花园——城市系统中的所有分散式部分都将在社区或居住区的尺度下运营。

5 中国公民的觉醒

中国正在吸取世界各地有关环境方面的更可持

4-2

3 Chinese Government Policies and Recent Reforms

China's *Twelfth Five Year Plan*, includes a 17 percent reduction target for carbon emissions, compared to 2005 levels. Chinese authorities are increasingly interested in altering the course of unsustainable development and setting new benchmarks by introducing better standards and environmental values in their urbanization programs. Chinese central government has initiated a series of national pilot programs to explore possible modes of sustainable urbanization in varied types of cities. The Ministry of Housing, Urban-Rural Development (MoHURD) launched the eco-city pilots, while the National Development and Reform Commission (NDRC) is leading the efforts of low carbon province and city pilots. Dozens of provinces and cities have been enrolled in such schemes to receive political and technical support from the central government, research intuitions, as well as international foundations and development agencies (for example, Energy Foundation, World Wildlife Fund and Swiss Agency for Development and Cooperation).

Today, not every project has to be rushed (as was the case a decade ago). A younger generation of urban dwellers is asking for higher living standards, a better quality of life and the kinds of environmental protection; they are demanding a cleaner environment and social wellbeing, not just growth[15].

Cities in the Beijing-Tianjin-Hebei region have severe air pollution from coal burning in plants and power stations and from road transport (Fig. 3). High air pollution levels have sparked widespread public anger and officials concerned about social unrest have responded by implementing tougher policies. For instance, Hebei, the country's biggest steel producer, is home to as many as seven of China's ten most polluted cities, according to statistics published monthly by the Chinese Ministry of Environmental Protection. Pollution in Hebei often spreads to neighbouring Beijing and Tianjin[19]. While China has drawn up dozens of laws and guidelines to improve the environment it struggles to enforce them in the face of powerful enterprises.

In December 2012 and January 2013 China experienced severe pollution levels. The Ministry of Environmental Protection reported that these air pollution episodes covered an area of 1.43 million km^2. The highest hourly concentration of PM 2.5 (fine particulate matter) recorded at a monitoring station in Beijing reached the health-damaging level of 993μg/m^3. In March 2013 hundreds of members of the National People's Congress appealed for a revision of the PRC Law on Air Pollution Prevention and Control to update and adapt legislation to the current urgent air pollution circumstances. In December 2011 China's State Council released the *Twelfth Five Year Plan of the State Environmental Protection*, which includes a chapter on air pollution prevention and control. In September 2013, the State Council announced an updated *National Clean Air Action Plan*, which laid out much more stringent requirements than the one released in 2012.

China has started to ban the construction of new

4-1. 重庆的“钉子户”房屋被标记上了“拆除”的字眼，以为2010年的一项新的开发项目腾出空间。© R. Saiget, AFP

4-2. 中国的新贫民区：图为位于深圳上沙东村年久失修的10层公寓楼，其居住密度非常高，建筑间距极为狭窄，居民无法获得充足的光照。© C. Bland

4-3. 失去控制的楼市热潮导致中国出现了一批崭新却闲置的城市。内蒙古鄂尔多斯市的康巴什新区于2003年动工兴建，计划有100万人口将居住于此，但截止2013年，仅有25 000人入住。图片来源：www.pinterest.com。

4-1. Marked for demolition, the residents of this "nail house" (a Chinese expressionfor homes belonging to people who refuse to move out) in Chongqing refused to makes pace for a new development in 2010. © R. Saiget, AFP

4-2. China's new slums: illegally constructed 10-storey apartment buildings at Shangsha East Village in Shenzhen; the density is so high; there are only narrow gaps left between the buildings, too small for sufficient daylight. © C. Bland

4-3. As a result of an out-of-control building boom, China has some brand new but abandoned cities. Kangbashi New Area, a new district in Ordos (Inner Mongolia), was commenced in 2003 for one million residents, but has only 25,000 people living there in 2013. Source: www.pinterest.com.

4-3

续的途径来支持其城市转型，以解决由过于迅猛的城市化所带来的严峻挑战。这些挑战包括由于中央和地方政府在城市化方面的自上而下的“命令式管控”方式，所导致的在民众间出现的不平等、过度拥挤和环境污染等问题。作为城市人口不断增长的结果之一，土地纠纷有可能成为社会动荡的一个潜在因素。

据《中国日报》2010年8月4日报道，仅北京一市自1990年来已拆除的老旧院落面积达443万平方米——这相当于北京市区面积的40%左右。这种快速的城市发展的主要受益者为开发商、国有企业和地方政府。在过去的30年中，中国农民已为城市开发“贡献”出了20万平方公里的农业用地，但得到的补偿少之又少。2009年，文化遗产的相关官员曾警示说，在过去的30年间，城市发展已毁坏了成千上万的历史遗迹和村庄。

虽然许多项目都未能带来社会福祉，也并非所有的新的开发都能获得财政上的成功。举例来说，众多城市综合体与大型购物区如雨后春笋般在中国各地涌现，二三线城市的房地产市场面临饱和，甚至崩溃（图4–3）。一个城市综合体通常可以直接影响约30万居民，这意味着一座100万人口的城市仅需3~4个城市综合体。但内蒙古自治区呼和浩特市目前正在建设中的城市综合体就达30多个，而这座城市的人口仅为300万。

由此可以料想到，越来越多的中国人在环境污染和缺乏公众参与方面开始觉醒（图4）。例如，2013年2月，调查记者兼具有影响力的活动家邓飞发起了一项活动，邀请中国的“网民”拍摄下他们家乡遭受污染的河流，并将照片上传到微博（一种中国流行的互联网平台），开展了“中国水危机独立调查”。他收到了数以千计的回应，并在网络上引发了第一次有关地下水安全的全国性辩论。

虽然一些新的法规和措施是大有前景的，但许多新的中国项目仍缺乏对于可持续性的思考；正如中国建筑师王澍所言（参见其2012年获得普林兹克建筑奖时发表的评论[21][22]），这些项目总在如何使建筑的体量吸引人们的眼球上大费心思。王澍以其自身的方式——通过细致入微的工作和多样而成熟的城市重建项目——对中国操之过急的城市化进程和翻天覆地的巨变提出了深刻批评。他鼓励社会创新，并反对技术驱动型解决方案。他认为，对现有的建筑物进行适应性的再利用（而非将它们拆除），以及对城市中心的再造，不但能够节约能源和材料，也有利于维系每个城市的形象。“只有10%的中国历史建筑保留到了今天。”[22]。他指出，有别于当今的消费主义现状，及遍布肤浅的、停于旧时的西方风格建筑的复制品城市风貌，批判式建筑才是我们所缺失的。通过适应性的方式对老旧建筑进行再利用和更新改造，可以使废弃构筑物的文化得以延续，并赋予其新的价值：这与总是在兴建新建筑和新城市的现代主义范式形成了鲜明对比。

在这些活动人士的带领下，环境污染和文化遗产惨遭破坏等问题逐渐激起了中国的社会名流和普罗大众的愤慨，也吸引了全世界社交媒体的广泛关注。中国官方媒体也开始对中国出现的污染问题进行大量报导，频见报端的一个核心问题是：在环境问题的影响下，中国的经济增长是否还能够继续维持？

6 中国生态城市：适应能力至关重要

在中国努力恢复可持续增长的经济模式的进程中，城市转型扮演着核心角色。通过采用新的城市化方法，中国政府可以保证更均衡的投资，解决主要的债务来源，并对中国的环境进行治理。今天，“总体规划”的刚性和不充分等问题正暴露得越来越明显，因为总体规划的概念太过僵化，而无法灵活应对发展中城市的时局变化和飞速的城市化进程；相反，灵活性和适应性的框架可以根据需要而做出调整[23][24]。那些重新思考城市和规划手段，并探索基于步行和公共交通的城市解决方案将为中国带来积极变革。自给自足的紧凑型生态城市项目正在中国各地涌现（例如，成都、万庄及青岛的生态城项目，以及宁波的生态园项目）（图5），这将会其他国家提供借鉴范本。

试图在后工业时代对城市进行重塑已不再是新鲜事。但是，与20年前相比，今天我们对于生态城市了解得更多，生态城市的概念也有了大举发展。因此，生态城市怎样才能成功运作？生态城市是在人的尺度下进行设计和建造的，并具有多种使用功能。它们涉及可持续发展的三大核心支柱：环境、社会/文化，以及经济。生态城市是能源和资源节约型城市，并能够带动社会和经济发展。生态城市亦是一种成熟的、能够在多个层面减少城市污染和温室气体排放的手段。

在中国，通常有两种类型的生态城市举措：新建的生态城项目（例如，天津中新生态城和青岛

coal-fired power plants in several key industrial areas to combat air pollution, and committed to an action plan: it aims to raise the share of non-fossil fuel energy, such as wind, biomass and solar power to 13 percent by 2017 (in 2012, the share of renewables was 9 per cent; wind power is likely to power a large amount of China’s electricity needs from 2030). But whether the Asia-Pacific region is innovative enough to meet the challenges of air pollution, urbanization and renewable energy remains a major question. Governments and municipalities throughout the region will need to develop better participatory models to involve their communities, and implement incentives to encourage people to take better care of the ecosystem, which we risk destroying if we follow the consumption patterns of the last three decades.

4 Towards Optimum Compactness and a New Generation of Infrastructure

When comparing everything that residents consume over a single year, including travel, goods, energy, food and services, there is evidence that suburbs account for more greenhouse gas emissions per household than more compact urban areas. Inner city residents tend to have much lower carbon footprints, because usually they live in smaller homes and use more public transit. The most important factors that influence consumption are household income, vehicle ownership and home size, all which are greater in suburbs. Transportation (which is, for instance, responsible for 26 to 42 percent of overall US household emissions) is the most important factor for the difference in emissions between the suburbs and cities, with households 20 to 60 km from workplaces producing the highest emissions. Suburban transport emissions from the automobile are as much as 2.5 times higher than urban ones.

It is important for Chinese cities (in fact, for all cities) to develop new precincts of an optimum density, rather than adopting out-dated urbanization models that will create a range of problems. In the last three decades, the availability of cheap fossil fuels has enabled rapid urbanization and the shaping of an urban form that followed the US model, leading to an increase in urban footprints and the emergence of car-dependent suburbs, making cities less efficient, less resilient and therefore less competitive. On the other hand, more compact and mixed-use urban development will facilitate access to integrated and efficient low-carbon public transport (for example, light railway or metro as part of a transport-oriented development), enable low-carbon or carbon-free mobility, such as cycling and walking, and promote car sharing or car-pooling, all of which can dramatically reduce a precinct’s greenhouse gas emissions[20].

The focus of experts on sustainable urban development has shifted from the building to the larger neighbourhood and precinct scale, which will allow and facilitate the integration of a new generation of infrastructure and decentralized technologies. The higher densities common in China allow for the implementation of decentralized and more efficient urban systems and infrastructure (for example, co-generation, energy and waste infrastructure, stormwater storage and re-use) and facilitate a more compact, walkable urban form that ultimately determines any precinct’s resource consumption pattern. Sustainable infrastructure for the twenty-first century operates at the precinct scale: it includes smart grids, interconnected solar roof tops, cycling path networks, light rail, wastewater recycling plants, local resource recovery stations and community gardens — all decentralized parts of an urban system that operates at the scale of the community or neighbourhood.

5 Growing Disenchantment among Chinese Citizens

China is seeking advice from around the world on more environmentally sustainable ways to support the transformation of its cities, to resolve the serious challenges caused by too rapid urbanization. These challenges include conflicts with citizens due to central and local governments’ top-down “command and control” approach to urbanization, which has led to inequality, overcrowding and environmental pollution. Land disputes, as a result of growing urban populations, have the potential to become a cause of social unrest.

The *China Daily* reported on 4 August 2010 that in Beijing alone 4.43 million square metres of

生态园），以及对城市进行生态改造和更新的项目（例如，万庄和淮南城市生态改造项目）的改造。虽然以上所进行的探索都值得称赞，但与中国迫在眉睫的环境危机相比，这些生态城市方面的努力显得杯水车薪。与建造几座生态城市相比，中国仍有大量的工作亟待展开。

在中国努力创建可持续发展的未来并提升城市居民福祉的同时，实际上，各种生态城项目的实施工作存在着重重困难，其中几个项目面临着非常严峻的问题。例如，目前正在建设中的天津生态城虽然被认为是中国最先进的生态城市项目，但也备受诟病：项目规划和能源供应过于保守，在绿地营建方面也缺乏真正意义上的宏图愿景，并没有实现人们对其所寄予的最初期望[25][26]。

天津生态城是中国和新加坡政府合作打造的一项“旗舰型”开发项目，展示了政府如何与私营企业相互协作。在这一创新型示范项目中，他们制定了26个关键的绩效指标，主要包括与资源效率相关的技术指标。青岛中德生态园项目采用了天津中新生态城的框架[27]。这两个项目都以在最终完成时，可容纳未来20年中的大量居民为目标——届时，天津中新生态城将容纳35万人，青岛生态园将容纳6万人——并均以经济、社会、环境和资源这4个维度作为可持续发展框架的基础。中国其他富有远见的生态城市项目在面临投资决策和政策缺乏连续性等灰暗、严酷的现实面前则停滞不前。例如，上海东滩绿色城市这一开拓型项目在政府领导变动之后便停止建设；其他项目只有在被当作普通房地产开发项目和绿地开发项目，甚至封闭式高收入住宅小区项目时才能得以实现，这与真正的生态城市的原则是相矛盾的。鉴于中国在帮助其他发展中国家实现可持续发展方面的引导作用，那些中国常规的开发项目中的“绿色外衣”广告常常误用生态城市的概念，是一件令人遗憾的事情。[28]

中国的城市仍将是推动国家经济增长的主要动力，但它们必须继续推进城市转型，以实现真正的长期可持续性，以及更好的社会融合[29]。其中有利的一面是，中国现在拥有的研究人员比任何其他国家都要多。随着向以知识型经济的转变，以及全球重心向亚太地区的转移，应是时候借鉴中国在可持续发展方面的努力和实验成果了。

宁波市正计划在镇海区的一个工业区内建造一座生态园与一处大型人工湿地。人工湿地将被用以净化受污染的水体，减少地表径流量；污水处理厂将处理过的水排入湿地中，其中种植的植被——连同微生物和土壤一起——将对径流中的有机废物和重金属元素进行吸收（图5–4）。工业区内的工厂将对生态园中的水体进行重新利用。最近几年，镇海区已大举投资建设了5条护林带，将居住区与工业区分隔开来，并营建了一座200m宽的带状森林（总面积达10km^2，种植树木150万棵）。


5-1


5-2


5-3

5-1. 成都生态城项目，由芝加哥Adrian Smith + Gordon Gill建筑与设计事务所设计。
5-2. 万庄生态城项目，由奥雅纳工程顾问公司与齐欣建筑设计咨询有限公司规划。
5-3. 青岛中德生态园项目，由德国GMP建筑设计事务所与青岛城市规划研究院规划。
5-4. 宁波市镇海区工业园区生态园方案：该生态园包括一处面积为2km^{2}的人工湿地。图片来源：www.ningbo.gov.cn。
5-1. Chengdu Eco-city project, designed by Adrian Smith + Gordon Gill Architecture (AS+GG), an architecture and design firm based in Chicago.
5-2. Wanzhuang Eco-city project, planned by Arup with Qixin Architects.
5-3. Qingdao Sino-German Eco-park project, planned by GMP Architekten (Germany) with Qingdao Urban Planning Research Institute.
5-4. Ningbo City's proposal for an eco-park, a 2 km^2 constructed wetland in the industrial zone in Zhenhai District. Source: www.ningbo.gov.cn.

7 结语

不论是在减少排放层面，还是在创造低碳繁荣层面，城市在向国家决策者展示其可行性方面扮演着重要角色。制定战略性城市政策的能力、市政当局独特决策能力，以及在社区层级的操作尺度，能够确保城市很好地在可持续城市发展中不断创新，并制定出博识的综合决策。

对于中国而言，与未来城市发展及其对空气

old courtyards have been demolished since 1990 — equivalent to around 40 percent of the downtown area. The main beneficiaries of this rapid urban development have been developers, state-owned enterprises and local governments. In the last three decades, China's farmers have "contributed" 200,000 km^2 (about 77,000 square miles) of former agricultural land to development, with little compensation. In 2009 cultural heritage officials warned that urban development had destroyed tens of thousands of historic sites and villages in the past three decades.

While many projects are failing to deliver social benefits, not all of the new developments are a financial success either. For instance, so many urban complexes with major shopping precincts have sprung up across the country that the property markets in second and third-tier Chinese cities are facing saturation and even collapse (Fig. 4-3). An urban complex can usually have a direct influence on about 300,000 residents, which means three or four complexes are enough for a city with a population of one million people. But in Hohhot, in the Inner Mongolia Autonomous Region, more than 30 urban complexes are being currently built for an area whose population is only 3 million.

Understandably, there is growing disenchantment with and opposition to China's pollution and lack of public participation (Fig. 4). In February 2013, for instance, Deng Fei, an investigative journalist and influential activist, initiated a campaign by inviting Chinese "netizens" to take photos of polluted rivers in their hometowns and upload them to Weibo (a popular Chinese internet platform), launching the "China Water Crisis Independent Investigation". He received thousands of responses and for the first time provoked a national debate on groundwater safety.

While some new legislation and initiatives are promising, many new Chinese projects are still not particular sustainable; instead projects that are spectacularly out of scale are favoured, as highlighted by the award-winning Chinese architect Wang Shu (see his critique on receiving the Pritzker Architecture Prize in 2012[21][22]). An architect who profoundly disagrees with China's rush to urbanization and gigantic developments, Wang has found a way to criticize it through his own more careful work and his diverse sophisticated urban renewal projects. He encourages social innovation rather than technologically driven solutions. He argues that the adaptive re-use of existing buildings (rather than their demolition) and the regeneration of city centers would not only save energy and materials but also help maintain each city's identity. "Only 10 percent of historical buildings in China have survived to the present day" [22]. He notes what is missing is critical architecture that goes against the present-day consumerist situation and superficial or nostalgic replicas of Western vernacular architecture. Recycling and up-cycling of old buildings through adaptive approaches creates cultural continuity and new value through the re-use of already existing derelict structures; this stands in sharp contrast to the modernist paradigm of always constructing new buildings and cities.

Led by these activists, outrage over environmental pollution and the frenetic destruction of cultural heritage has spread widely among both prominent and ordinary Chinese people and attracted attention on social media channels throughout the world. China's state-run media is now full of stories about the country's massive pollution problem and the central question that runs through many articles is whether, given its environmental impact, China's growth can be maintained.

6 Eco-cities in China: the Ability to Adapt is Critical

The transformation of its cities is central to China's effort to revitalize its economic model for


5-4

质量的改善的潜在影响相关的政策建议显得尤为重要。中央政府已经决定限制煤炭消耗量，以防止空气质量进一步恶化。现如今，城市的真正负担转变为寻找替代性能源，以落实煤炭消耗上限政策。除了缓解空气污染，市长们还承担着减少温室气体排放的责任。原先碳密集型和资源密集型的城市化模式正被逐渐摒弃，因为它们会导致过量的能源消耗、污染和温室气体排放等问题。人们愈发一致地认识到，城市化已被转向一条可同时应对污染治理和气候变化双重挑战的更可持续的道路。

那些推广环保行为的举措通过改变人们的价值观念和思维方式，能够带来巨大变革。行为改变是已被公认的，在向低碳城市的转型过程中和接受新型低碳技术方面的一个关键性因素，将这种认识整合到新的城市政策的制定中将是非常重要的。

在市场化环境下的中国，需要更加关注使农民工融入到规划过程和社会总体变革的参与模式中。政府和市政当局需要对亚太地区的生态城市问题的理论和政策选择进行推进，并建立一种新的“城市发展伦理”。通过全面的、以原则为基础的建议及与政策相关的分析，这项新的议程将：1）以一种合适的方式推进并形成绿色都市主义原则的基本应用元素；2）强调政策机遇，从而实施必要的范式转变。

2014年3月，中国全国人民代表大会已不再将预定增长目标作为其强调的重点；相反，全国人民代表大会将增长的质量、创造就业机会和环境保护视为比GDP增长更加重要的议题。这很可能会成为中国下一阶段经济发展的新焦点。史蒂芬·罗奇在《中国日报》上就这种转变发表了评论：“这一期待已久的向以服务业主导型经济增长为动力的转变是中国经济结构转型中的一个尤为关键的分水岭。”[30]。

中央政府层面的战略指导和政策，以及地方政府层面的试点项目和行动对实现城市转型来说都是不可或缺的。城市发展方面的政策建议必须就其对空气质量的潜在影响来进行评估。如今，空气污染问题正在推动中国包括能源效率、可再生能源和低碳发展在内的所有与环境相关的努力。

城镇未来20年的预期增长意味着，需要出台旨在为亚太地区的城市创建社会公正、环境可持续发展和经济繁荣的城市规划原则。若要实现上述目标，只有使我们的经济和社会摆脱高消耗的、依赖化石燃料的、浪费式的“常态型”城市化模式，并在不破坏环境和生态系统的同时，对能够创造财富、带来就业机会和发展的新的理念和方式进行研究[31]。

在世界各地的大部分城市，低碳的城市核心区周围往往是高碳排放的郊区，这就是为什么我们应该限制郊区发展，并通过慎重地填补以提升城市内部人口密度的一个原因[32]。生态效率和绿色都市主义的概念表明，这种做法是可行的。在城市规划方面，绿色都市主义所包含的15项整体性原则为规划繁荣而可持续的、能够与周边环境和谐共生的生态–高效城市提供了一种途径[33] [34]（图6）。这种范式转变是迫切的，也是必要的。

创建可持续和低碳城市包含以下4项准则[2]：

（1）生态–高效城市是一个有机整体，所以对它们的规划和管理必须是跨部门的，与城市服务和基础设施相整合，并通过协作框架得以建立；

（2）生态–高效城市的发展源自并同时依靠公众意识，因此需要对包括城市官员在内的所有居民进行教育，使其了解为什么城市可持续发展是必要的，并会带来经济效益；

（3）生态–高效城市需要实证研究，及知识和技能的共享；

（4）生态–高效城市（如同任何开发一样）需要稳定的资金来源、政治意愿与长期的贯彻。

改善亚太地区城市的城市化模式在以下几个方面具有重要意义：

（1）有助于从以化石燃料为基础的能源过渡到分散式的、辖区尺度的可再生能源；

（2）通过运用分散式系统，将建筑物和辖区改造为就地式小型可再生能源发电站；

（3）注重空气质量的改善和监测；

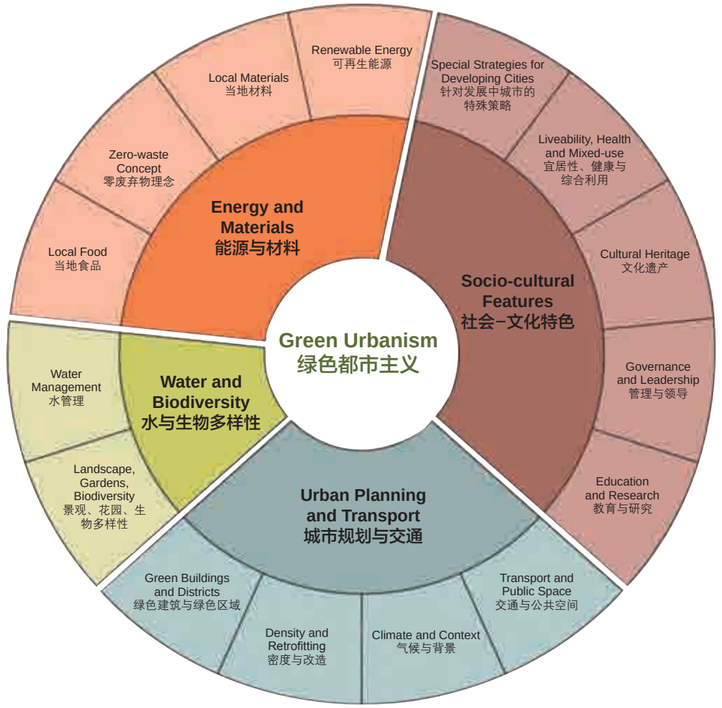
（4）开发并提升储能技术和能力（如氢能）；

（5）利用信息通信技术来开发智能的双向（对等）型能源共享电网；

（6）将运输系统改造为集步行、自行车、公共轨道交通，以及电动插电式和燃料电池型机动车于一体的多模态系统；

（7）提供更好的模式，并为健康生活创建多样化的公共开放空间。

正如本文中所展示的中国案例，通过采取强有力的低碳城市政策而向生态–高效城市发展的转变（无论是改造项目，还是新建项目），将有助于确保亚太地区的城市和社会在经济上与环境上能够以一种持久而健康的方式发展。LAF



6

sustainable growth. By adopting new approaches to urbanization, its leaders can assure more balanced investment, address a major source of debt and clean up the country’s environment. Today, “master plans” are increasingly seen as rigid and inadequate, because the concept is too inflexible to deal with the speed of change and rapid urbanization of developing cities; instead, flexible and adaptable frameworks that can accommodate change are needed[23][24]. There are promising major developments that are about rethinking cities and planning instruments, and exploring urban solutions based on walkability and public transport. Self-contained, compact eco-efficient city projects are underway in China (for instance, eco-city projects in Chengdu, Wanzhuang and Qingdao; and an eco-park project in Ningbo) (Fig. 5), which could become prototypes for other countries.

Attempts to reinvent the city in the post-industrial era are nothing new, however, today we know much more about eco-cities than twenty years ago and the concept has progressed much. So, what is it that eco-cities need in order to function successfully? Eco-cities are designed and built for the human scale and are mixed-use. They embrace the three core pillars of sustainability: environmental, social / cultural and economic. They are energy and resource-efficient; they promote social and economic uplift. Eco-cities are a proven means of reducing urban pollution and greenhouse gas emission across multiple sectors.

There are generally two types of eco-city initiatives

6. 由史蒂芬•莱曼归结的绿色都市主义的整体性理念。这张图表中将15项绿色都市主义原则分为4个部分，这些原则相互联系，构成了一个有机整体；它们需要被同时运用，不可分割，并可根据环境背景的变化而做出调整。© Steffen Lehmann

6. The holistic concept of green urbanism, as outlined by S. Lehmann. The green urbanism wheel shows the 15 principles grouped in four sections. The principles are interconnected and holistic: they need to be applied simultaneously, not individually, and adjusted to the changing context. © Steffen Lehmann

in China: new-built eco-city projects (for example, Sino-Singapore Tianjin Eco-city and Qingdao Eco-park); and eco-remodelling and retrofitting of existing cities (for example, Wanzhuang and Huainan). Although laudable, eco-city efforts are at risk of being just a drop in the ocean of China's rapidly looming environmental crisis and a lot more needs to be done than a few show-pony eco-cities.

While China is working hard to create its sustainable future and to enhance the wellbeing of its urban citizens, actually implementing the various eco-city projects has proven more difficult, putting several projects in serious question. For instance, Tianjin Eco-city, currently under construction and thought to be the most advanced of China's eco-cities, is widely seen as too conventional in its plan and energy supply, and lacking genuine green ambition, not living up to its early expectations[25][26].

Tianjin Eco-city is an initiative by the Chinese and Singaporean governments for a new-build flagship development; showing how governments can work together with the involvement of private corporations. They have identified 26 key performance indicators, mainly technical indicators around resource efficiency, in this innovative demonstration project. The Sino-German Eco-park initiative in Qingdao has recently adopted Tianjin's framework[27]. Both developments are expected to accommodate a large number of residents upon final completion in twenty years: 350,000 in Tianjin and 60,000 in Qingdao; and both share a common sustainability framework based on four dimensions: economy, society, environment and resources. Other visionary eco-city projects across China have seen little progress when facing the grey, harsh reality of investment decisions and lack of policy continuity; for instance, the pioneering green city project Dongtan (close to Shanghai) stalled after political leadership changes; and other projects have only been realized as ordinary real estate developments and greenfield developments, or even as gated communities for high-income households, in conflict with true eco-city principles. Chinese "green-washing" advertisements for conventional developments have cast the eco-city concept in the wrong light, which is a pity given the importance of China's role in leading the way for other developing countries to pursue sustainable development[28].

Chinese cities will remain the engine of the country's growth story, but they must continue their transformation towards real long-term sustainability and better social integration[29]. The upside is that China now has more researchers than any other country. With this shift to a knowledge-based economy and the global center of gravity shifting to the Asia-Pacific, it is timely to learn from sustainability efforts and experiments in China.

Ningbo City is planning to build an eco-park with a large constructed wetland in an industrial zone in the Zhenhai District. The constructed wetland will purify polluted water and reduce the amount of run-off; a wastewater treatment plant releases treated water into the wetland, where the plants, along with microbes and soil, will absorb the organic waste and heavy metal in the run-off (Fig. 5-4). The factories will re-use the water from the park. Over the last years, Zhenhai District has significantly invested in building five forest protection belts that separate the industrial zone from the residential zone, with a 200-metre-wide forest belt with a total area of 10 km^2 and 1.5 million trees.

7 Conclusions

Cities have an important role in showing national policy makers what is possible, not only in terms of reducing emissions, but also in terms of creating low-carbon prosperity. The capacity to formulate strategic urban policies, the unique decision-making capabilities of municipalities and the operational scale at the community level all ensure that cities are well placed to innovate in sustainable urban development and to make well-informed integrated decisions.

Of particular importance for China are policy recommendations for future urban development and their potential impacts on air quality improvement. The central government has already decided to limit coal consumption to prevent air quality from deteriorating further. The real burden now shifts to the cities to find alternative energy options to implement the coal consumption caps. Besides air pollution, city mayors also bear the responsibility for greenhouse gases emission reductions. Previous carbon- and resource-intensive urbanization models are now increasingly seen as outmoded as they will lead to excessive energy consumption, pollution and greenhouse gas emissions. There is a growing agreement that urbanization has to be shifted into a more sustainable pathway to address pollution control and climate change challenges at the same time.

Initiatives to promote pro-environmental behaviour can make a big difference, by changing values and mindsets. Behaviour change has been recognized as a key factor in the transition towards low-carbon cities and the acceptance of new low-carbon technologies; it will be important to integrate this understanding in the formulation of new urban policies.

In the process of marketization of China, more attention needs to be given to the integration of migrant workers into participatory models in the planning process and social change in general. Governments and municipalities will need to progress thinking and policy options on eco-cities in the Asia-Pacific region and to establish a new "ethic of urban development". Through holistic principle-based recommendations and policy-relevant analysis, this new agenda will: 1) establish the fundamental applied elements of green urbanism principles as a suitable way forward, and 2) highlight policy opportunities to implement the necessary paradigm shift.

In March 2014, the National People's Congress has been moving away from its emphasis on predetermined growth targets; instead it is now stressing the quality of growth, placing job creation and environmental protection above GDP growth. This is a new focus likely to shape the next phase of China's economic development. Stephen Roach commented in *China Daily* on this shift: "This is particularly relevant in light of the important threshold that has now been reached by the structural transformation of the Chinese economy — the long-awaited shift to a services-led growth dynamic". [30]

Strategic guidance and policies from the central government and pilot projects and actions in municipalities are both necessary to realize the transformation. Policy recommendations for urban development must be assessed for their potential impacts on air quality. Today, the air pollution issue is driving all related environmental efforts in China such as energy efficiency, renewable energy and low-carbon development.

The anticipated growth of cities and towns over the next two decades means that there is a need for urban planning principles that will create socially just, environmentally sustainable and economically prosperous cities in the Asia-Pacific region. This can only happen if our economies and societies move away from high-consuming, fossil fuel dependent and wasteful "business as usual" urbanization models and investigate new concepts and approaches that generate wealth, jobs and development without damaging the environment and ecosystem[31].

In most cities worldwide, low-carbon urban cores are surrounded by high-carbon-emitting suburbs that is a reason why we should limit suburban development and increase population density inside cities through careful infill[32]. The concepts of eco-efficiency and green urbanism show that it is possible to do so. In the area of urban planning, green urbanism is a set of 15 holistic principles that provide a way to plan for prosperous and sustainable eco-efficient cities that change in harmony with their environment[33][34](Fig. 6). The paradigm shift is urgent and essential.

There are four guidelines for creating sustainable and low-carbon cities[2]:

(1) Eco-efficient cities are holistic, so their planning and management must be cross-sectoral, integrated across urban services and infrastructure, and created through collaborative frameworks;

(2) Eco-efficient cities grow from and rely on public awareness, so all residents, including city officials, need education about why sustainable urban development is essential and economically beneficial;

(3) Eco-efficient cities require evidence-based research and sharing of knowledge and skills;

(4) Eco-efficient cities (like any development) need stable sources of money, political will and long-term commitment.

To improve the urbanization models of Asia-Pacific

cities, it will therefore be essential to:

(1) transition from fossil-fuel based energy sources to decentralized, precinct-wide renewable energies;

(2) transform buildings and precincts into on-site mini renewable energy generating plants, using decentralized systems;

(3) focus on improving air quality and monitoring;

(4) develop and up-scale energy storage technologies and capacities (for example, hydrogen);

(5) utilize ICT to develop smart and bi-directional (peer-to-peer) energy-sharing grids;

(6) transform the transportation system to a multi-modal system that integrates walking, cycling, public mass transit and electric plug-in and fuel cell vehicles;

and (7) provide better models and a diversity of public open spaces for active living.

As the cases in China illustrate, making the shift to eco-efficient city development (be it retrofitting or new-built) by adapting strong policies for low-carbon cities will help ensure that Asia-Pacific cities and societies grow in a way that is long-lasting and sound, both economically and environmentally. **LAF**

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