

世界自然基金会上海低碳发展路线图课题组 著  
WWF Shanghai Low Carbon Development Roadmap Research Team

# 2050

## 上海低碳发展路线图报告

2050 Shanghai Low Carbon Development Roadmap Report



科学出版社

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北京

## 内 容 简 介

本书总结了对上海低碳发展的研究成果,不仅从能源、技术等传统的低碳研究角度入手,更重要的将情景分析与上海以及我国未来的几个重大问题联系起来。提出上海比较现实的低碳发展路径是立足弱干预情景,即转型+能效提升+能源结构优化,争取实现强干预情景。

本书可供各类环保人士及科研人员和国内外相关领域专家、学者阅读,也可供节能减排、环境保护领域相关政策制定者参考。

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第二篇 人口变化与低碳城市	陈婧、张真
第三篇 上海市能源发展战略	朱聆、陈红敏
第四篇 产业发展与能源消耗	陈红敏、陈越
第五篇 低碳建筑的发展	陈飞、陈红敏
第六篇 低碳视野中的城市规划	李京生、吴亚萍
第七篇 交通发展与低碳城市	潘海啸、刘峰成
第八篇 低碳城市与上海碳汇建设	马涛、马彩华
第九篇 上海碳金融机制设计与碳减排激励	刘婧、张真
第十篇 上海低碳城市建设的法律保障体系	张梓太

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### 2. Demographic Change and Low Carbon Shanghai

CHEN Jing, ZHANG Zhen

### 3. Energy Development Strategy of Shanghai

ZHU Ling, CHEN Hongmin

### 4. Shanghai Industrial Development and Energy Consumption

CHEN Hongmin, CHEN Yue

### 5. Development of Shanghai Low Carbon Buildings

CHEN Fei, CHEN Hongmin

### 6. Urban Planning for Shanghai from Low Carbon Point of View

LI Jingsheng, WU Yaping

### 7. Transportation Development and Low Carbon Shanghai

PAN Haixiao, LIU Fengcheng

### 8. Carbon Sink Construction for Shanghai

MA Tao, MA Caihua

### 9. Shanghai Carbon Finance Mechanism Design & Emission Reduction Stimulation

LIU Jing, ZHANG Zhen

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# 序一 中国城市低碳发展， 以全球视野鼓励本地方案

很高兴看到由世界自然基金会(WWF)发起和支持的《2050 上海低碳发展路线图报告》的正式出版。这是 WWF 依据从实际工作总结出的“低碳发展的六个步骤”(编制排放清单、分析发展情景、设置减排目标、制定规划方案、实施行动计划、开展后续评估)，委托上海市相关研究单位共同推出的符合当地实际情况的低碳发展路线图。项目进程中也很荣幸地得到了不同利益相关方代表的宝贵意见和大力支持，对于他们为项目贡献的远见与智慧，我代表世界自然基金会北京代表处表示衷心感谢。

中国已经成为全球第二大经济体，加速的城市化进程给中国的发展带来了更大的挑战。在资源环境压力尤其是全球气候变化的背景下，想要尽早从发达国家工业污染和过度消费的老路上跳出来，中国的工业化和城市化就应尽早实现经济发展与碳排放的“脱钩”。而中国的城市要“脱钩”，切实减少发展中的“生态足迹”，先锋城市(诸如上海)的发展路径选择就具有引领性的意义。

气候变化是一个全球性问题，解决这个问题必然需要全球视野。只有立足于本地资源、经济与社会条件，才可能找到恰当的解决方案。位于长江河口的上海，需要增强应对气候变化影响的弹性，也需要推动和输出城市低碳发展方案。上海的正确选择将对长三角乃至全流域的可持续发展具有很好的示范作用，甚至还可以推广到全球其他重要流域。

我们欣喜地看到中国已经开始了从行业到示范区的各种低碳探索，其中上海低碳世博会是一个重要的里程碑。尽管如此，我们还迫切需要一个长远的发展愿景与路线图，这也就是本报告所要展现的内容。

我们相信上海有实力在“脱钩”问题上成为先行实践者。因此，我们愿意继续与相关合作方一起努力，探索整合气候变化“适应”与“减缓”的可行性方案的地方实践，打造可操作、可复制、可验证的示范性项目。同时，我们期待城市决策者、智库、企业以及公民社会

## **2050 上海低碳发展路线图报告**

的共同努力,实现城市“清洁与绿色”的低碳发展目标。

我们希望本报告中的分析与结论能对上海市低碳发展路线图有所帮助;也希望相关理念与研究方法能为中国乃至全球的其他城市提供参考与借鉴。

关德辉

WWF 中国首席执行官



## PREFACE I

### **China Low Carbon City Development, Global Perspectives Inspired Local Solutions**

I am delighted to endorse this publication of the *2050 Shanghai Low Carbon Development Roadmap* developed by WWF, and I am proud that this is the first report ever published by an international NGO in China. Based on WWF's practical "6-step approach to low carbon development" (Inventory study; Scenario analysis; Target setting; Action planning; Implementation; and Post evaluation), this *Roadmap* is developed by a Shanghai research team who has received valuable opinions and supports from various stakeholders during the entire process. On behalf of WWF China, I offer my heart-felt gratitude to all contributors for their insight and wisdom.

China is now the second largest economy in the world, and is facing increasing challenges from more rapid urbanization, accompanied by limited environmental resources and the effect of global climate change. In order to free itself from the path that developed countries took where industrial pollution and excessive consumption were common, China must find its own way to decouple the correlation of economic development and CO<sub>2</sub> emissions while pursuing its goals of industrialization, urbanization and economic growth. To achieve this "decoupling" and to substantially reduce its "ecological footprint", pioneering cities such as Shanghai must play a leading role in terms of selecting development paths.

Climate change is a global issue, hence a global perspective is required to address it. However, proper solutions must be aligned with the context of local environmental, economic and social conditions. Located at the estuary of the Yangtze River, Shanghai should take bold steps to enhance its climate resilience and promote low carbon



development solutions. This will serve as important reference for sustainable development, not only in the Yangtze River Delta, but also the whole river basin. Even beyond China, best practices developed in this metropolitan can act as a model for other major river basins throughout the world.

We are excited to have witnessed the various experiments and demo projects of industries and exemplary regions in China, among which, the Low Carbon Shanghai World EXPO was a notable milestone. Nevertheless, a commitment to long-term development vision as embodied in this *Roadmap* is quite imperative.

We believe Shanghai has the potential to pioneer the decoupling of CO<sub>2</sub> emissions and economy development. To this end, we wish to continue our work by partnering with all key stakeholders to explore feasible plans combining climate change “adaptation” and “mitigation”, and to promote practical, replicable and verifiable demonstration programs. Meanwhile, we look forward to joint efforts and collaboration by municipal decision makers, think tanks, businesses and the civil societies, so that the city’s “clean and green” low carbon development targets appropriate to local conditions can be achieved step-by-step.

We hope the analysis and conclusions in this *Roadmap* could be helpful to the official roadmap for Shanghai low carbon development; and the concepts and methodologies introduced would be referenced and adopted by other cities in China and around the world as well.

Jim Gradoville  
CEO  
WWF China

## 序二 上海低碳发展的关键是适度放慢高速增长的经济速度

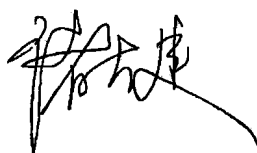
展望从现在起到 2050 年的上海低碳发展路线图,我最想说的是:上海未来低碳转型的关键是适度放慢经济增长速度,从过去 30 年快字当头的数量增长阶段转入未来 30 年好字当头的质量发展阶段。没有这样的战略思路转型,上海要走上低碳发展的道路,基本上是不可能的。对此谈三点看法:

其一,适度放慢经济增长速度需要成为上海低碳发展的关键措施。按照  $\text{CO}_2$  排放的影响因素,即  $\text{CO}_2 \text{ 排放} = \text{经济规模} \times \text{经济的能源强度} \times \text{能源的碳强度}$ ,实现低碳发展一般有三种路径,即能源替代的路径、提高能效的路径、控制规模的路径,前两者属于技术性措施,后者属于规模性措施。当前,许多人在强调发展新能源对低碳发展的作用,但是我的看法是在未来的 10~20 年里,新能源替代化石能源的比重是极其微弱的,中国到 2020 年的目标是 15%,上海到 2020 年最多不会超过 10%。因此能源替代无法成为低碳转型的主导战略,虽然上海可以增加外来电与碳基能源内部的替代。提高能效路径指降低单位经济产出的能源强度(在能源替代相当微弱的情况下,降低单位产出的碳强度基本上等于降低单位产出的能源强度),包括结构能效与技术能效两个方面。这确实是发展中国家低碳转型的有效途径。上海相对全国已经有很高的能源效率,虽然仍然存在重要的改进机会(例如产业结构进一步服务化),但是在不控制经济增长规模的情况下,过去的发展已经证明能源效率方面的任何改进最终都被增大的经济规模所抵消。由于经济规模扩张总是伴随着能源消耗与  $\text{CO}_2$  排放的增长,因此上海如果真的需要实现低碳发展,就不得不认真地思考放慢经济增长速度的可能性与必要性,要研究什么是可以接受的经济规模以及相应的经济增长速度问题。

其二,人均 GDP 超过 1 万美元以后经济增长对社会福利的贡献开始递减。经济增长导向的学者与官员肯定不同意采取放慢经济增长速度的办法来实现低碳发展。理由是持

续的经济增长是社会福利与生活质量提高的前提条件,并认同自然资本从来不会成为经济增长限制因素的看法。然而,经济增长可以提高生活质量的想法只适用于发展的初中级阶段。联合国等组织的研究证明,在人均 GDP 超过 1 万美元达到发达水平的入口以后,进一步消耗能源与排放对生活质量提高的贡献明显开始递减;而到 2 万美元以后,在发达国家已经出现了经济持续增长但是生活质量没有相应提高的状况。因此,经济增长可以永恒地提高生活质量的想法是受到怀疑的。另一方面,当今世界化石能源供给和 CO<sub>2</sub> 容量稀缺的状况,也证明了持续高速的经济增长是不可能的。当前上海已经进入人均 GDP 超过 1 万美元的发展阶段,需要更多地从单纯的高速经济增长转向相对慢速但是质量为重的发展阶段。虽然放慢速度并不必然导致好的发展,但却是经济社会发展与化石能源消耗和 CO<sub>2</sub> 排放脱钩的重要条件。

最后,放慢经济增长速度不是学术智慧问题而是政治智慧问题。实际上,许多专家与官员都从理论上明白,上海延续过去 30 年来 10% 以上的平均经济增速,既无不必要也不可能。这不是学术智慧而是政治智慧问题。确实,在全国大多数地区都仍然在开展 GDP 竞赛的情况下(应该承认中国未来发展仍然需要有 10~20 年的高速经济增长用以解决贫困问题),上海主动地降低经济增长的速度,在政治上是要冒风险的。但是应该看到,上海即使放慢经济增长速度,从过去的 10% 增长率降低到未来的 7% 以内,这样的速度在国内看起来是低的,但在国际上仍然是相当高的。因为按照 7% 的平均年增长,到 2020 年上海的人均 GDP 会比 2010 年再翻一番,达到 25 000 美元左右水平。我的看法是,上海的政治智慧应该是在降低增长速度的同时,在全国率先花更多的力气专注于提高城市发展的质量,要力争用不超过发达国家人均能源消耗与 CO<sub>2</sub> 排放的水平上实现福利水平与生活质量的提高(包括就业、教育、卫生、住房、交通等),以便为全国 10 年后进入人均 1 万美元的普遍转型做出有意义的示范!



同济大学可持续发展与管理研究所所长、教授

2011 年 1 月

## PREFACE II

### The Key to Low-Carbon Development of Shanghai is to Properly Slow Down Its Economic Development

Looking at the low-carbon development roadmap for the city of Shanghai into 2050, what I want to say most is that the key to low-carbon development of Shanghai is to properly slow down its economic development — a shift from the pursuit of quantity in the past 30 years into the pursuit of quality in the next 30 years. Without such strategic transformation, it's basically impossible for Shanghai to achieve its low-carbon goals. I have three points to make:

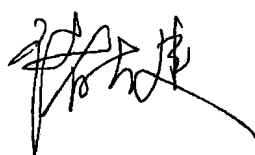
Firstly, to properly slow down its economic development speed has to become the key measures for Shanghai's low-carbon development. According to the factors impacting CO<sub>2</sub> emission, i. e.  $\text{CO}_2 \text{ Emission} = \text{Economy Scale} \times \text{Energy Intensity of Economy} \times \text{Carbon Intensity of Energy}$ , there are basically three paths towards low-carbon economy, i. e. path of alternative energy, path of energy efficiency promotion, and path of scale control. The former two paths are technological measures, while the last belongs to scale measure. Currently, many people are stressing upon the impact of new energy upon low-carbon development, but I think that in the next 10 to 20 years, the proportion of fossil energy replaced by new energy would be insignificant. The target for China is 15% by 2020, and in Shanghai that figure would be no more than 10% by 2020. Therefore, alternative energy strategy cannot become the leading strategy for Shanghai's low-carbon transformation, though the city can raise the proportion of energy replacement with electricity from outside of the city and internal replacement of carbon-based energy. The path to energy efficiency promotion is to reduce the energy intensity per unit economic output (in the scenario of very weak energy replacement, to cut carbon intensity per unit economic output is basically equivalent to cutting energy

intensity per unit economic output), which covers structural energy efficiency and technological energy efficiency. This path is an effective approach for developing countries to achieve low-carbon transformation. Shanghai already enjoys very high energy efficiency compared with the rest of the country, though there still exists major opportunities for improvement (such as more service orientation in industrial structure). History has already proven that without curbing economic growth speed, any improvement in energy efficiency would be finally cancelled out by growing economic scale. That's because economic expansion is always accompanied by growing energy consumption and CO<sub>2</sub> emission. Thus, for Shanghai to truly achieve low-carbon development, it has to seriously consider the possibility and necessity to slow down its economic development. It has to study what is acceptable economic scale and corresponding economic growth speed.

Secondly, after per capita GDP passes USD 10 000, the contribution by economic growth to social welfare is diminishing. Growth-minded scholars and officials will definitely disagree to the idea of achieving low-carbon development with slower economic growth. Their reasoning usually is that economic growth is the prerequisite of enhancing social welfare and quality of life, and they believe that natural capital will never become the bottleneck for economic growth. However, the idea that economic growth can enhance quality of life only applies to the primary stage of development. Studies by UN and other organizations have proven that after per capita GDP passes USD 10 000 to reach advanced level, the contribution to quality of life by further consuming energy and emitting CO<sub>2</sub> is significantly diminished. While after per capita GDP reaches USD 20 000, quality of life in advanced countries tend not to rise in line with economic growth. Therefore, the idea that economic growth can perpetually drive up quality of life has been cast into doubt. Furthermore, in today's world supply of fossil fuels and capacity of CO<sub>2</sub> have become limited, a further evidence that continuous high growth speed is unattainable. Currently, Shanghai has reached the development stage of more than USD 10 000 per capital GDP. It needs to shift from the development stage of pursuing pure speed towards a stage with more focus on quality. Though lower speed will not necessarily lead to good development, it is an important condition for decoupling economic and social development with fossil fuel consumption and CO<sub>2</sub> emission.

Lastly, slowing down economic development speed is not an issue of academic wisdom, but rather of political wisdom. In fact, many experts and officials have come to realize in theory that it's neither necessary nor possible to maintain the 10% and above average economic growth in the past 30 years. This is rather an issue of political wisdom than academic wisdom. Indeed, under the circumstances that most regions in China are still competing on GDP (we have to admit that China still needs to have another 10 to 20 years of high growth to solve poverty issues), it's politically risky for Shanghai to take

the initiative to lower its economic growth speed. However, even if Shanghai cuts its economic speed from 10% in the past to 7% in the future, a low figure within the country, it is still a very high rate in the world. Because with 7% average annual growth, by 2020, Shanghai's per capita GDP will double that in 2010 to reach USD 25 000. My view is that Shanghai should have the political wisdom that while reducing its economic development speed, it should lead the rest of the country to focus more on raising the quality of development. It should try to achieve the enhancement of social welfare and quality of life (including employment, education, health, housing, transportation, etc) with less per capita energy consumption and CO<sub>2</sub> emission than advanced countries, so as to set a meaningful example for economic transformation for the country in anticipation of the USD 10 000 stage 10 years later!



Prof. Zhu Dajian  
Head of Research Center of Sustainable  
Development and Governance,  
Tongji University  
Jan. 2011

# 前言

近来随着低碳经济的升温,我国许多城市提出了建设低碳城市的口号或设想,甚至有的还提出“零碳城市”。这反映了我国各级政府和社会各界正紧随中央的步伐,以更为积极的姿态应对全球气候变化和由此产生的碳减排要求。但蜂拥而上的低碳城市也暴露了一些问题,如基础不扎实,准备不足等。

低碳城市道路是艰难坎坷的,但在许多人意识中,常常视之为纯粹的技术活。人们倾向于忽视问题的复杂性,而选择相信低碳尤其是新能源技术带给我们的一切都是美好的,不仅会赠予我们美好的环境,还会带给我们新的产业和发展机遇。于是展示在我们眼前的,装了几块光伏板的建筑就被称为低碳建筑,拥有一两家光伏企业或风机生产商的城市就敢称低碳城市或“太阳城”之类。

成本必须是认识问题的切入点。以电力为例,无论煤电还是风电,对能源消费者而言在效用上并无区别。如果清洁能源或低碳能源价格较高,其本质相当于对能源用户加税。而众所周知,税收对经济有抑制作用,这是真正的宏观工具,清洁能源与高碳基能源的价格差距越大,普及新能源所带来的对经济的抑制作用也越大。由此可以获得关于低碳能源的两种基本的立场:

其一,清洁能源如天然气和核电的使用或能源结构升级是有代价的。一座城市要实现能源升级,必须使其经济运行的整体效率提升到能够承受相应成本的水平。也就是说,经济发展方式的转型、经济运行效率的提升、自主创新能力的增强是能源升级的前置条件。以产业升级为能源升级开拓承受空间,以稳步的能源升级推进经济发展方式转型,应该成为低碳城市的一项重要策略。试图在粗放经济的老路上实现低碳目标,似在脑袋东顾而双脚西行。

其二,新能源的开发是一个民族对未来的投入。没有未来的能源,就没有未来的文明。为此,有志于在新能源领域建功立业的城市需要坚持不懈地努力。不要试图以大跃进的方式在短期内建立起庞大的先进产业,不要搞泡沫经济或政绩工程,而是着眼未来,重视基础,扎扎实实地突破并拥有自己的核心技术,注重新能源发展所必需的技术配套和产业配套,最终方能大有作为。



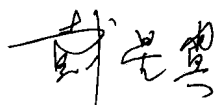
在优化能源结构的同时,低碳城市需要控制对能源的需求并提高能效。以往相关思路也是技术化的,或注重产品能耗的降低,或推动高能效产品如节能灯之类的普及,或强调节约。应该说这些措施都是必要的,但远远谈不上充分。依据我国承诺的强度减排的特点,打造品牌、提高品牌价值,提高产品质量、开发新品,加强管理、减少浪费,都是提高能效和控制需求的手段。更进一步,优化产业结构,注重服务业的成长,防止因 GDP 主义而导致的重化工业过度发展,所有这一切,都能够显著降低单位 GDP 的能耗和碳排放,是更为宏观的碳减排措施。

在最根本的意义上,低碳城市应该用尽可能少的碳排放,为人民群众创造尽可能高的福利。任一城市设施,无论道路或建筑还是其他,其建设过程导致的碳排放会沉淀其中,也就是所谓碳足迹,其使用和维护也会继续造成碳排放。低碳城市的一项基本原则,应该是这两类碳排放创造的人类福利最大。由此提出的要求是设施确实向市民提供了充分的效用,而不是面子工程或政绩工程。门庭冷落的机场是高碳的,大拆大建通常是高碳的,豆腐渣工程必定是高碳的,重复开挖的道路必然是高碳的。城市只有消除了此类现象,才有资格进入低碳城市的行列。

但即便如此,低碳城市的困惑还是很多。为实现低碳目标,似乎应该倡导节俭;为拉动内需,似乎应该促进消费,千方百计地激发人们的消费欲望;两者间的平衡点何在?我们能够把握吗?我们应该怎样看待奢侈和豪华,是倡导,包容,还是抑制?上海人均能源消费已经超过 5 t 标准煤,它还处于社会主义初级阶段吗?如果是,上升至社会主义中级阶段或高级阶段的上海每年要吞噬多少能源?

诸如此类的问题也许无法准确回答,但值得我们深思。由 WWF 组织编写的这份报告,本质上是一种思考过程,一种理念的碰撞过程。将一座城市的低碳道路置于经济发展方式转型的架构内分析,即由工业化向后工业化阶段转型,由人口红利期向老龄化阶段转型。将各种可能遇到的问题和对策简化为不同的情景,探讨低碳发展之路。

需要承认,以研究的复杂性和工作量,本课题在时间上有些紧。这意味着有许多问题还有待深入探讨分析。当然这也意味着在短短的四个月里,来自各研究单位和相关政府部门的咨询专家,以及全体研究人员,为本报告付出了艰辛的努力。对他们的汗水,心血和智慧,深表谢意。



于复旦大学

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## FOREWORDS

With the rising popularity of low carbon economy, many cities in China have put forward slogans or ideas to build low carbon cities. Some of them even propose the concept of “Zero Carbon City”. All of this is the reflection of the active attitudes of governments at different levels and the society as a whole to follow the guidance of the central government to cater for global climate change and the need for CO<sub>2</sub> reduction. However, the swarming low carbon cities also expose some of the habitual weaknesses in China, such as poor foundation and inadequate preparation.

The road towards low carbon city is a bumpy one. Many people just regard it as a pure technical thing. They tend to overlook the complexity of the issue, and choose to believe that low carbon, especially new energy technologies, will bring all the good stuff to us, not just in terms of beautiful environment, but also new industries and development opportunities. Buildings with several photovoltaic cells are called low carbon buildings, and cities with just one or two photovoltaic or wind power manufacturers are claimed to be low carbon cities or “sun cities”.

Cost is at the core of all the issues. Take electricity for example. It makes no difference to energy consumers to use either coal electricity or wind electricity. If clean energy or low carbon energy is more expensive, it's in fact a tax on energy users. As we all know, tax will curb economic development. It's a true macro tool. The greater the gap between clean energy and fossil energy, the more inhibitive effect there will be on economy. Therefore, we can have two basic standings on low carbon energy.

One, there is a price to pay for clean energy such as natural gas or nuclear power, or the upgrade of energy structures. For a city to achieve energy upgrade, it's overall economic efficiency must be raised to the level to withstand the corresponding cost. It means that the transformation of economic model, the enhancement of economic efficiency and the improvement of indigenous innovation capabilities are the prerequisite