



清华大学
Tsinghua University



**Japan-China-Korea Green Technology Forum
-Session: Low Carbon Society**

Low-Carbon Town Development in China

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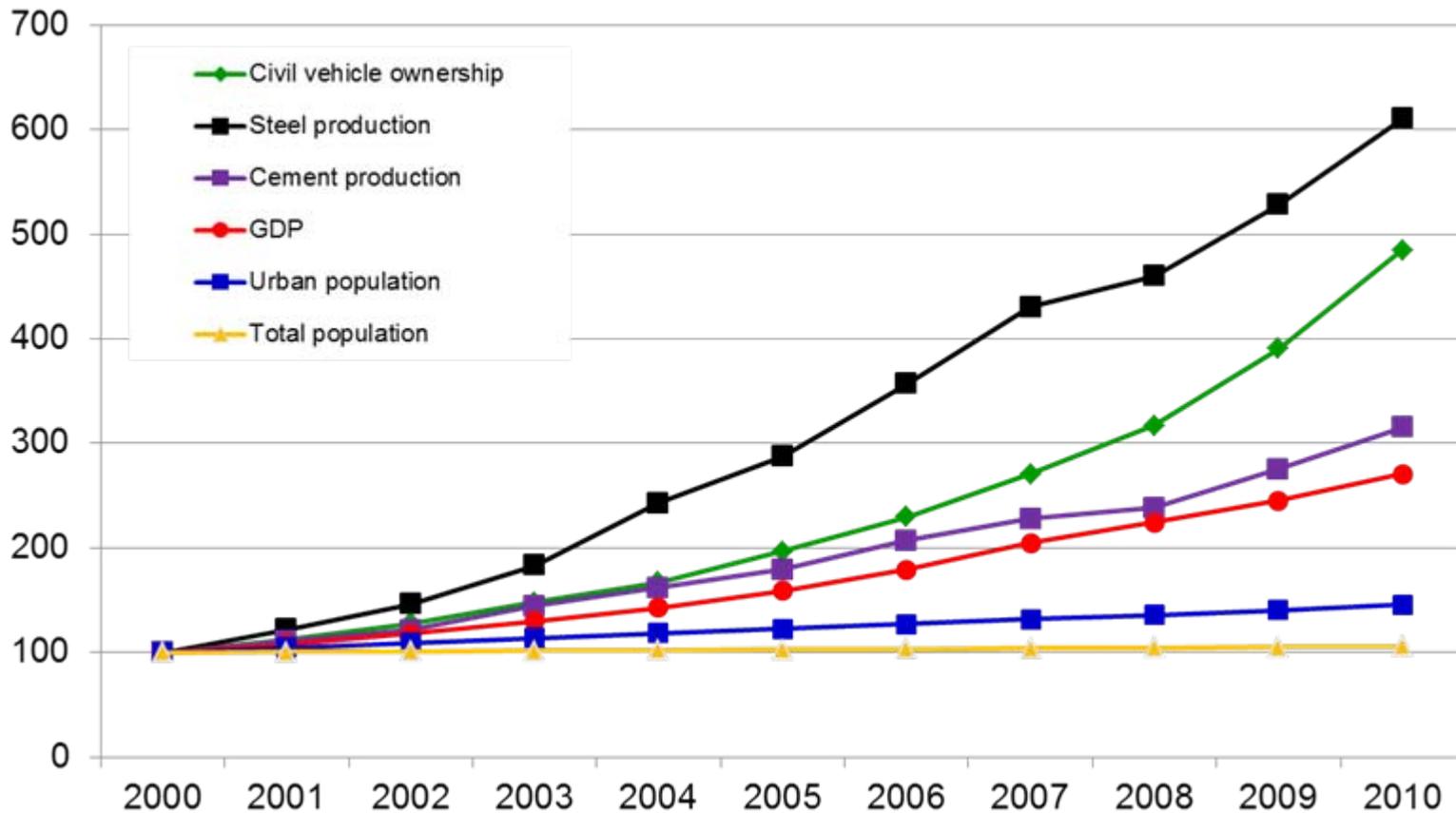




Outline

1. **Role of cities and towns in total energy consumption and carbon emission of China**
2. **Policies for climate change of China central government**
 - **Low carbon energy technologies in China**
 - **Promotion of low carbon town is a part of whole actions**
3. **Philosophy of low-carbon town development in China**
4. **Practices of low-carbon towns in China**
5. **International collaborations in low-carbon towns**
6. **Conclusions**

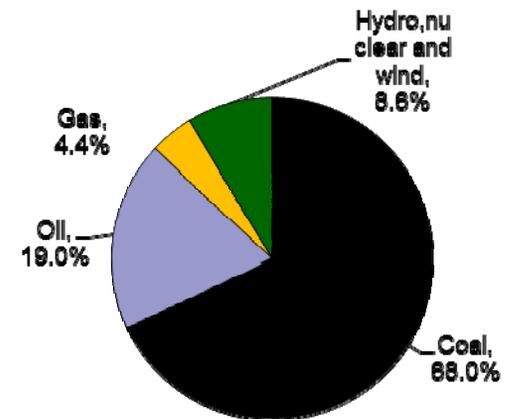
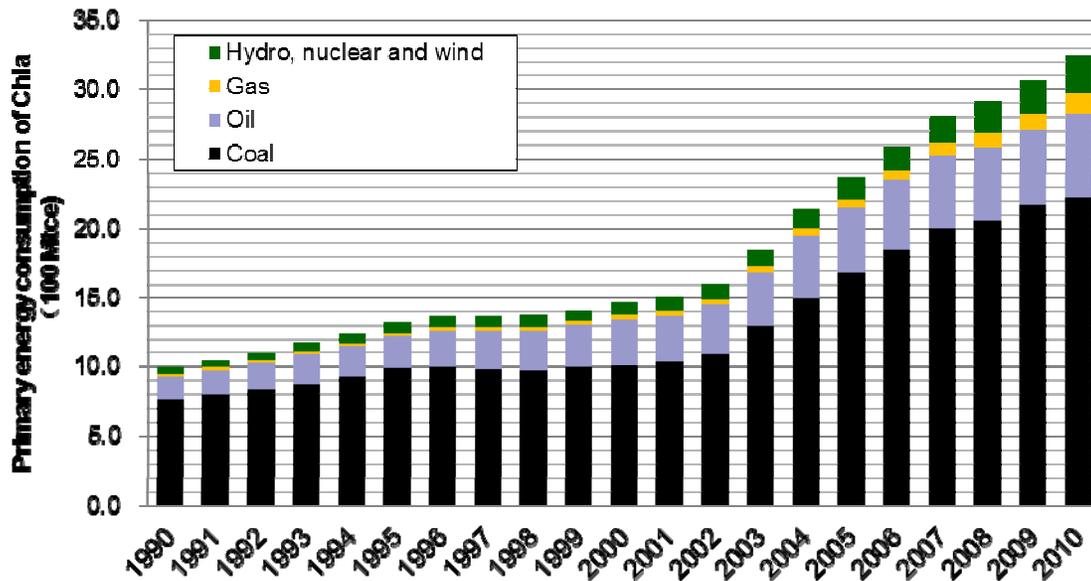
As the largest developing country with over 1.3 billion population, China is encountering a stage of rapid industrialization, urbanization, and mobilization



All indicators are relative ones, where the values in year 2000 are used as baseline 100.

China's primary energy consumption is coal-dominant, with huge and fast-increasing overall energy consumption

- Due to the **rapid** progress of industrialization, urbanization and mobilization, energy consumption of China increased by 180 million tce per annum between 2000 and 2010 in average, where 160 **million** tce came from fossil fuels.



industrialization

urbanization

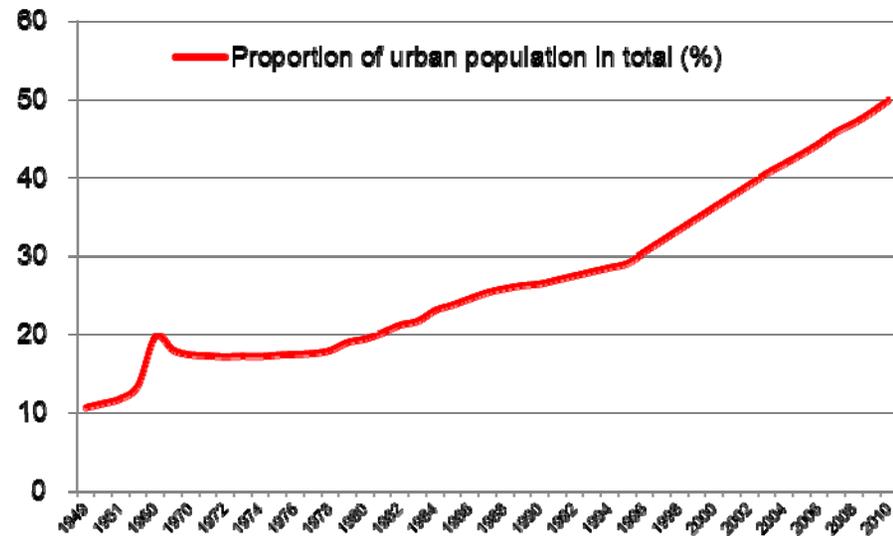
motorization

Mix of primary energy consumption of China in 2010



Towns and urban areas are the main body of energy consumption and carbon emissions in China

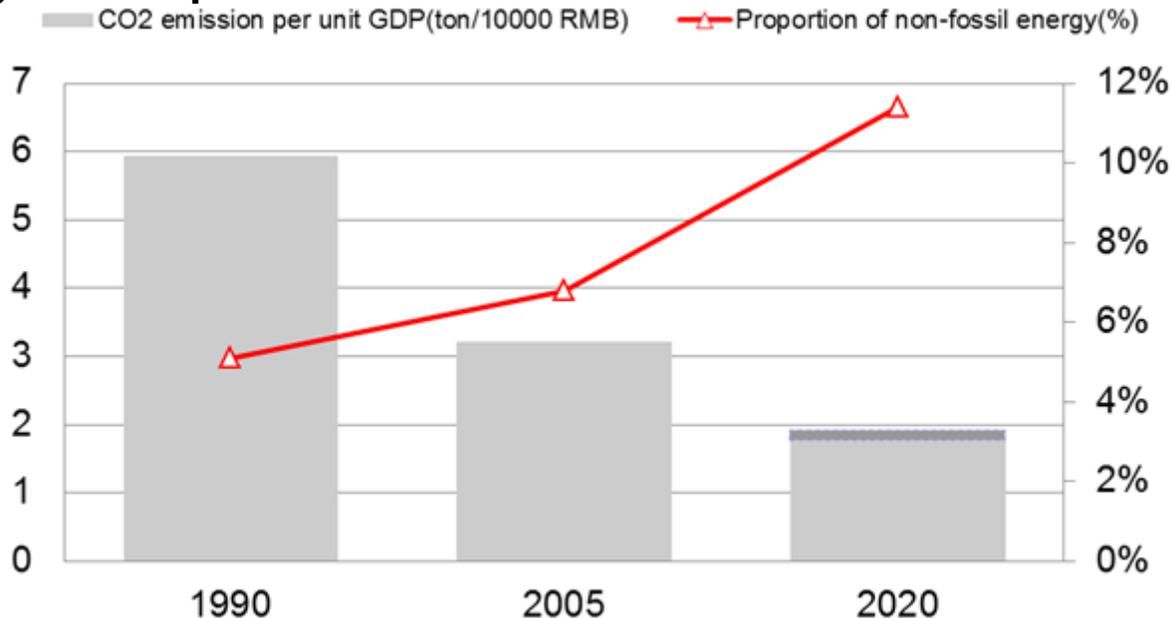
- **Accelerating urbanization.** In 2010, the urbanization rate in China was 49.7%, and the total urban population was 666 million. There are 657 designated cities, 1,578 country-level regions, and 19,410 towns. In 2000~2010, the annual growth rate of urbanization rate was 1.36%, and every year the urban population increased by 20.17 million in average.
- In China, three city-dense areas have emerged (Yangtze River Delta Area, Pearl River Delta Area and Beijing-Tianjin-Hebei Area), and city complex in central-and-south of Liaoning, the central plains, Shandong Peninsula, Wuhan, Changsha-Zhuzhou-Xiangtan, Chengdu-Chongqing, Central Shanxi-Tianshui, Southeast of Fujian, and the Northern Gulf Area. Constituted with one or more core cities and several surrounding cities, **the city-dense areas and city complex are becoming important economic growth poles, strongly leading the whole area's development.**



- **Cities and towns are the major energy consumers and carbon emitters in China.** In 2006, the energy consumption of 287 cities above prefecture level was 1370 million tce, accounting for 55.6% of the national energy consumption; and the CO₂ emission was 2920 million tonnes, accounting for 54.8% of the total emissions. The “Top 100” cities’ GDP was 67.4% of China, and the carbon emissions were 41% of the total emissions. (Source: 2050 Energy and Carbon Emissions Report of China)

Positive Reactions to Climate Change of the Chinese Central Government

- China is the first developing country to publish a national act on climate change, and it also has achieved the most intensive energy savings and carbon mitigation and the fastest increase in alternative and renewable energy in the last couple of years.
- Between 1990 and 2005, CO₂ emissions per unit GDP in China decreased by 46%, whilst the fraction of non-fossil fuels in primary energy consumption increased from 5.1% to 6.8%. Between 2005 and 2020, it is expected that CO₂ emissions per GDP will drop further by 40 to 45%, and non-fossil fuels will account for 15% of primary energy consumption.



Fast Development of Low-Carbon Technologies in China

- China is the top 1 country around the world in terms of newly installed wind power, nuclear power, supercritical, ultra supercritical pulverized coal power, accumulated capacity of wind power and solar heater, and production of solar heater. Solar PV production accounts for 50% of the world production.
- China has initiated the first IGCC demonstration project (GreenGen in Tianjian), full scale CCS demonstration (aquifer sequestration in Inner Mongolia), smart grid demonstration (Eco-city in Tianjin), a thousand alternative fuel vehicles per city in ten cities (more than 25 participants), and all newly built buildings are energy-saving ones.



Wind farm



Solar PV



Solar thermal heater



Nuclear plant



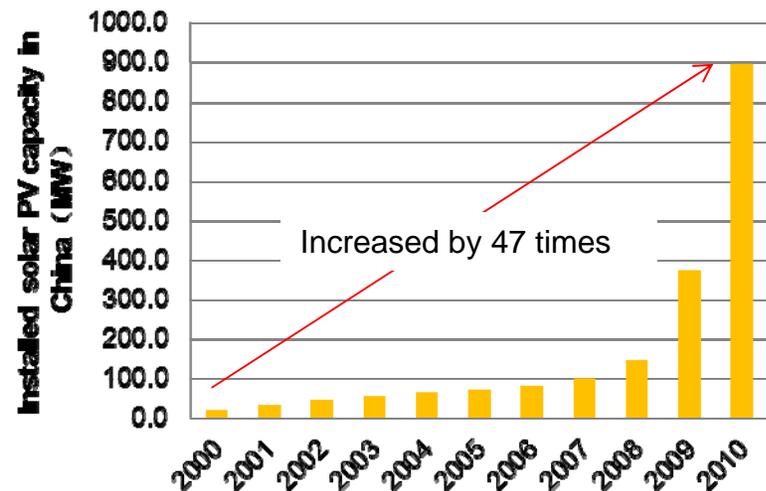
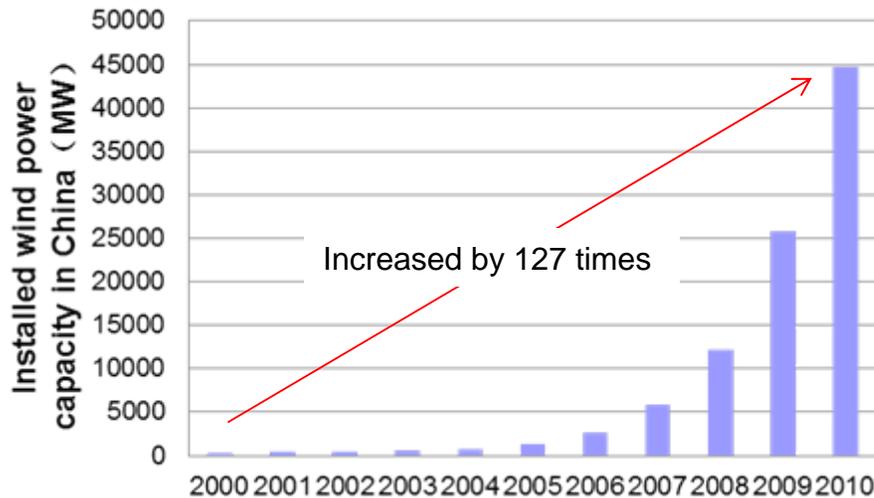
IGCC demo



Smart grid

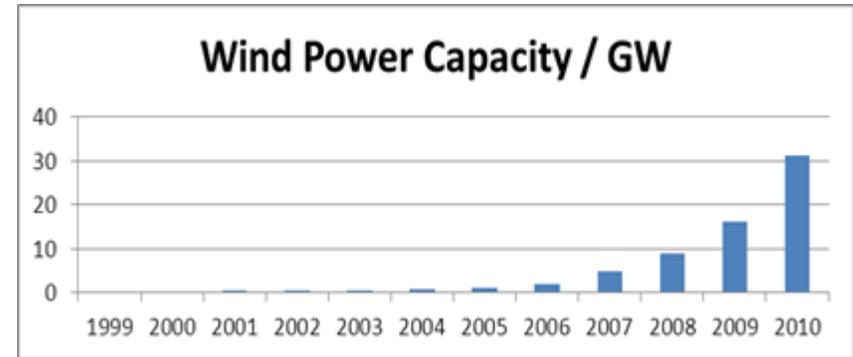
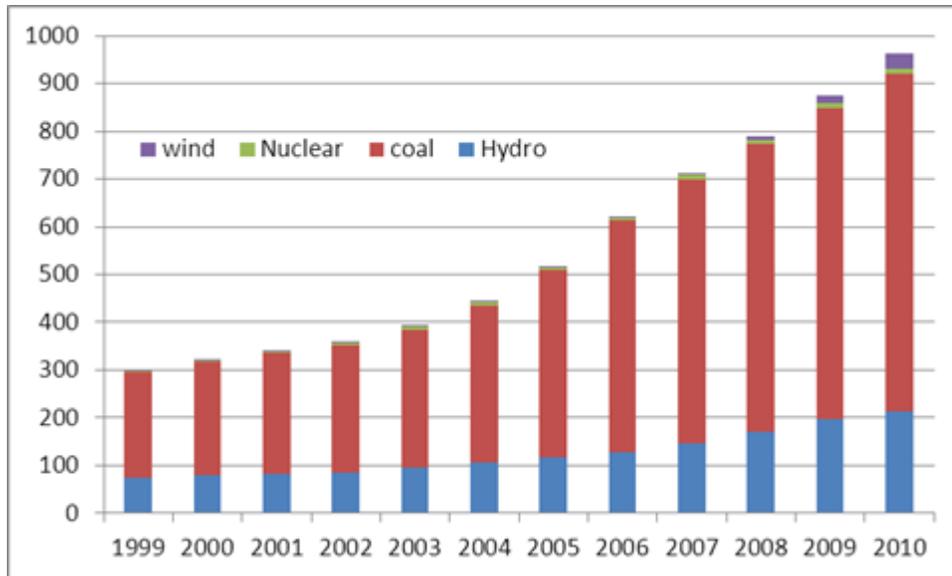


Energy saving building

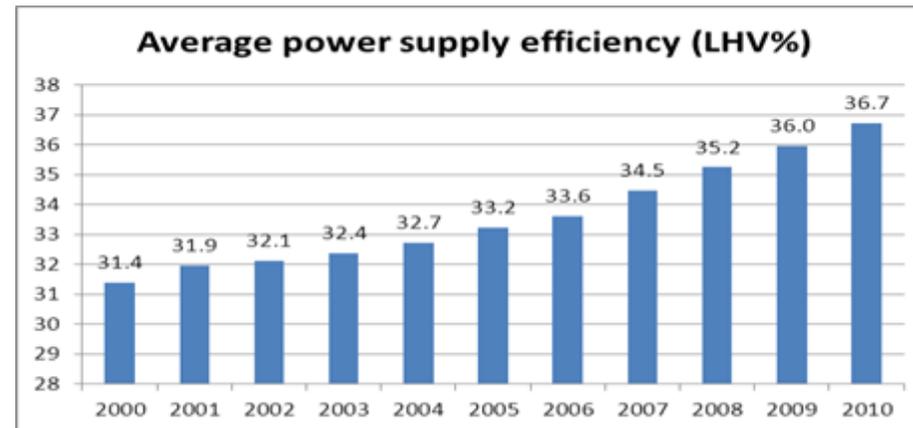




Chinese power industry @2010

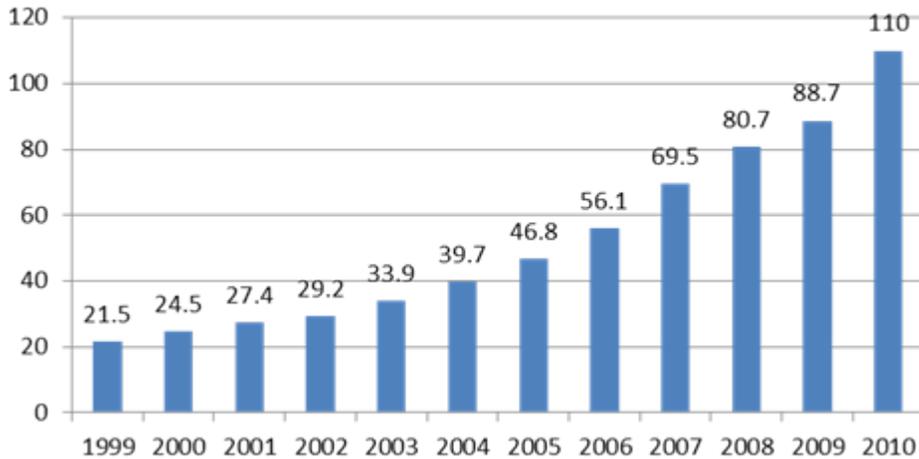


- many supercritical units, $\eta=40-42\%$
- 33 USC 1000MW in operation, $\eta=43-44\%$, 11 units in construction
- Two nuclear power units into operation
- One 250MW IGCC in construction
- 75GW old power plants closed in last 5 years

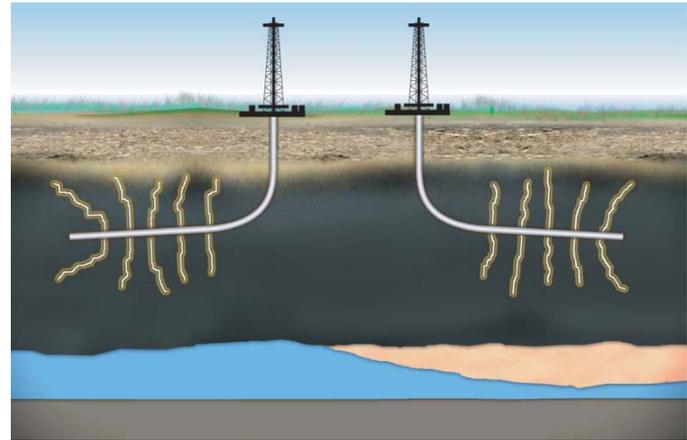


Natural gas consumption in China

Natural Gas Consumption / bcm



Shale gas: a new star?



- Total: 80.7bcm @2008
- Industrial fuel:30.5%
- Domestic fuel: 28%
- Chemical production: 31.5%
- Power generation: 10%
- Intention to have NG as a 10% pillar in 2030. But what for?
- Distributed Energy System?

Country	Proved NG reserves (tcf)	Technical recoverable shale gas resources (tcf)
US	272.5	862
China	107	1275

Source: http://www.eia.doe.gov/coal/coal/initial_assessment_of_14_regions_outside_the_us.html
Initial Assessment of 14 Regions Outside the United States



Nuclear Power

- Currently, 10.82 GW in operation
- 2010: 26 reactors/29.14 GW in construction
- 2020(expected): 70 GW in operation/30GW in construction
- Vision: 16% in total power supply
- Technologies:
 - 2.5 generation
 - 3rd generation: AP1000, EPR
 - 4th generation: 200MW HTR
- High policy uncertainties due to Fukushima disaster



← 10 MW pilot reactor
in Tsinghua University

200 MW HTR
demonstration plant in
Shandong Province →



高温气冷堆核电示范工程
(山东荣成宁津厂址)

CCS in China



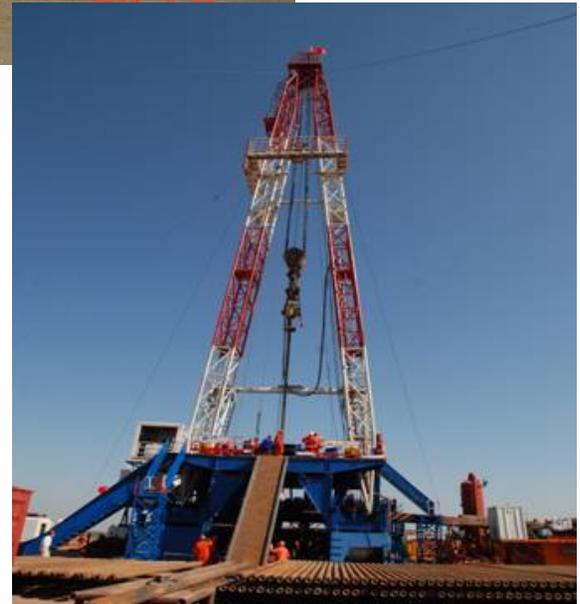
Post combustion capture
in power plant:

- Beijing 3000 t/a
- Shanghai: 120kt/a



Enhanced
Oil
Recovery
In Jilin

100kt CO₂
geological storage
from CTL plant





Chinese central government takes development of low-carbon towns as an important measure to address climate change and sustainable urbanization, and it has published a series of policies

- **Since 2005, Ministry of Housing and Urban-Rural Development published policies to encourage development of public transport and low-carbon buildings**
- **In 2010, National Development and Reform Commission (NDRC) officially announced low-carbon towns demonstration in five provinces and eight cities**
- **All these policies have got positive and wide responses from local government. Development of low-carbon towns has become an important ideological mark of a new round of urbanization in China**

Policies to encourage development of low-carbon towns by State Council and NDRC

2010.07: Demonstration of low-carbon towns in five provinces and eight cities, by NDRC

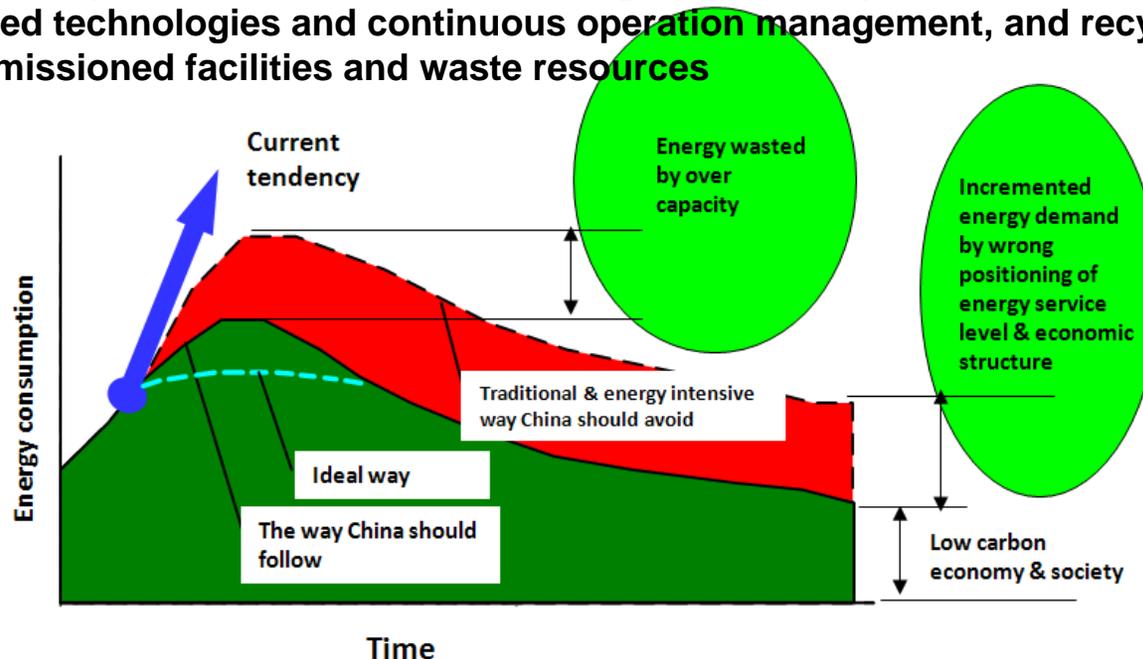
2010.12: State Council required to build low-carbon towns and reduce intensity of greenhouse gas emissions

2011.03: State Council required to enforce demonstration of low-carbon towns



Key Features of Development of Low-Carbon Towns in China

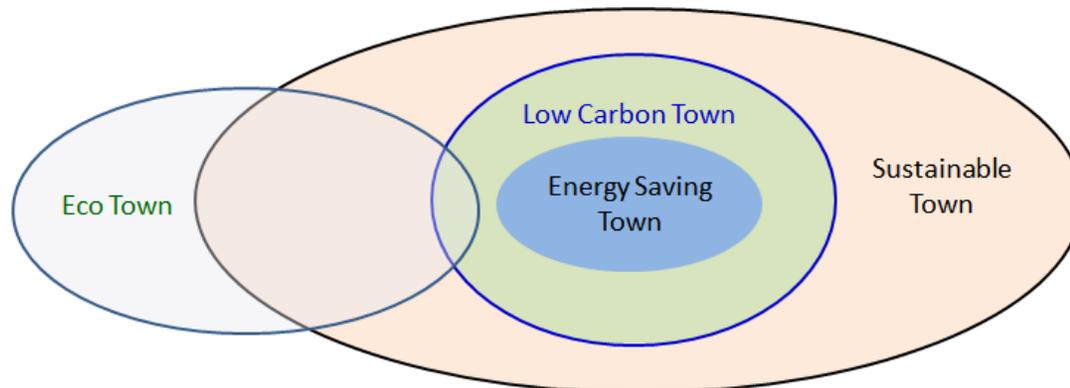
- Most towns in China are still in a dynamic increasing stage of **energy demand** where production and construction dominate the overall energy consumption, featuring:
 - Coordination of carbon mitigation and other indicators of sustainable urbanization, and focusing on relative carbon mitigation, for instance, reduction of carbon emissions per GDP
 - Planning and design targeting ultimately on a low-carbon economy structure and low-carbon lifestyle, avoiding high energy consumption due to wrong estimation of energy service level, and avoiding waste of energy due to repeated construction, wrong construction, and over construction
 - During the operation and decommissioning stages of key facilities of a town, using advanced technologies and continuous operation management, and recycling decommissioned facilities and waste resources





Philosophy of Low-carbon Towns Development in China: Ultimately Sustainable Development

- The concepts of ecological towns, low-carbon towns, energy-saving towns and sustainable towns relate to each other, but each of them has its specific features. **Sustainable towns are the ultimate target, and all other concepts are based on the concept of sustainability, focusing on different aspects of the target.**
- Development of sustainable towns is based on the idea of ensuring economic growth, ecological preservation and social justice, and policies related to this target to acquire multiple benefits. **The target of developing low-carbon towns is to reduce carbon emissions according to the sustainable development promise, and to couple with energy supply, demand, and environmental impacts.**
- Sustainability should always be considered in the course of towns development, whilst focusing on the low carbon emissions of a single unit or process could lead to increased carbon emissions of a system (relationship between units and a system). Carbon emissions should be evaluated at a systems level from life cycle and developing perspectives (sustainable development is the ultimate target, whilst low-carbon is a sub-target, and the sub-target serves for the ultimate target).



Relationship between low-carbon towns, sustainable towns, energy-saving towns and ecological towns

Source: W. Chen, Y. Lu. The Framework, Pathway and Vision of Low-carbon City Development: An Example of Shanghai. Beijing, Science Press. 2010: p93

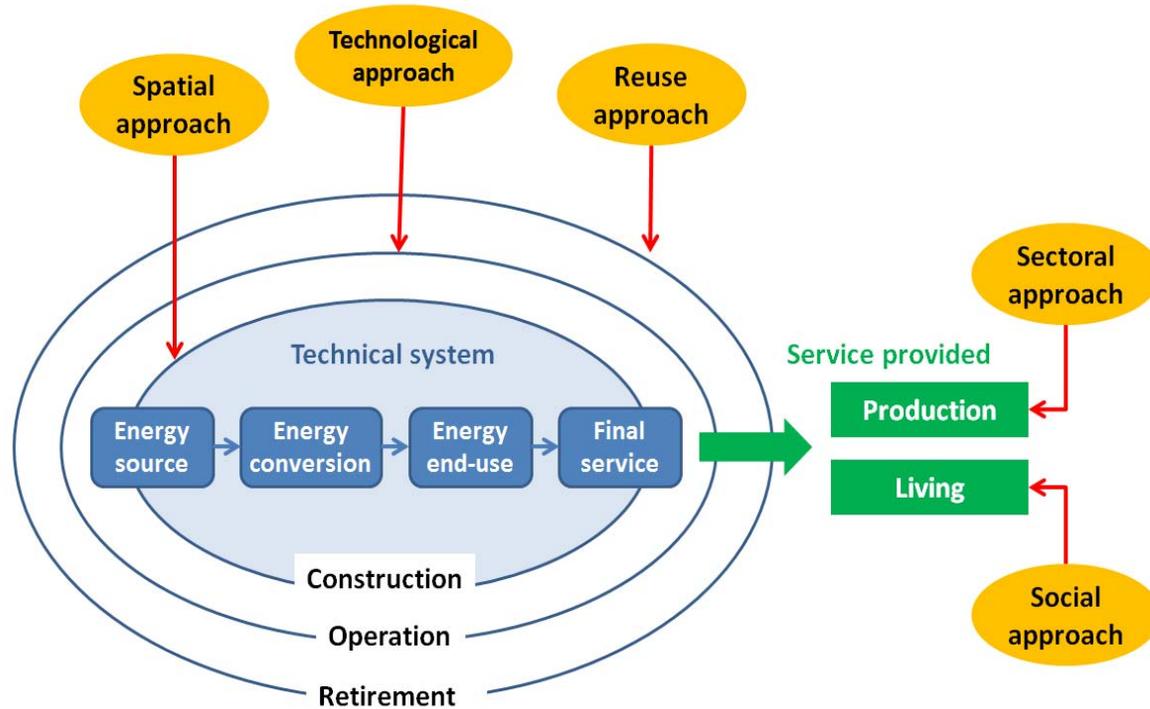


Values of Sustainable Towns Development: Human-being Oriented

- **The sustainable development is human-being oriented development. It guarantees the well-being of the current generation without sacrificing the right of enjoying the same level of well-being of future generations.**
 - **Production level: sustainable, low-carbon economy and transportation.**
 - **Living standard level: comfortable housing and environment, low-carbon buildings and facilities.**
 - **Social level: public participation, social justice, culture and knowledge continuity, low-carbon values and life style.**
 - **Natural resources level: effective utilization of land, minimum consumption of resources**
 - **Ecological level: minimum pollutions and emissions, sustainable ecological system**
- **Development of low-carbon towns is to absolutely or relatively reduce the carbon emissions according to the sustainable development target. It mainly relates to the energy system and corresponding carbon emissions of towns.**

Five Approaches of Low-Carbon Towns Development: from a Life Cycle Assessment Perspective

1. **Sectoral approach**
 - Low-carbon production, industrial structure, and carbon emissions **performance**
2. **Social approach**
 - Low-carbon values and lifestyle, public participancy
3. **Spatial approach**
 - Optimization of spatial structure, priority of public transport
4. **Technological approach**
 - Energy structure and efficiency
5. **Reuse approach**
 - Utilization of waste facility and recycling of waste resources

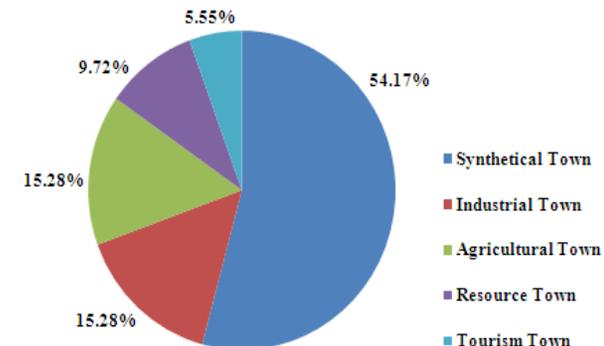




Practices of Low-carbon Towns Development in China: Typical Examples

- **Pilots of the State Development and Reform Commission: five provinces – Guangdong, Liaoning, Hubei, Shanxi, Yunnan; eight cities – Tianjin, Chongqing, Shenzhen, Xiamen, Hangzhou, Nanchang, Guiyang, Baoding**
- **China Low-carbon Town Development Project (WWF): Shanghai, Baoding**
- **China Low-carbon Economy Collaboration Project (State Development and Reform Commission): Chongqing, Nanchang, Baoding, Hubei, Guangdong**
- **The Pilot Project of the Public Low-carbon Activities: Tianjin, Shanghai, Xi'an, Yinchuan, Nanjing, Changzhou, Suzhou, Guangzhou, Xiamen, Shenyang and Chongqing**
- **The first low-carbon economy demonstration area (approved by the State Development and Reform Commission): Jilin**
- **China-UK Low-carbon Town Pilots (Ministry of Science and Technology and the British Research Council): Guangzhou, Minxing District of Shanghai, Xi'an, Xixia County of Nanyang**
- **Local governmental projects: Zhuhai, Tianjin, Hangzhou**
- **Other low-carbon practices: Beijing, Chengdu, Nanning, Wuxi, Shenzhen**

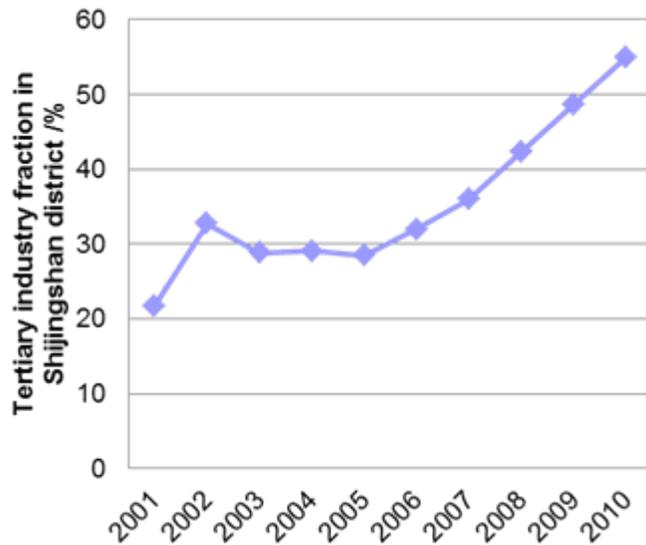
**Types of low-carbon town in China
(based on a questionnaire survey)**



Practice of Low-Carbon Towns Development (1): Sectoral Approach

- Shijingshan District in Beijing
 - Move of Beijing Steel Group except for its headquarter and R&D department
 - Development of cultural, high-tech, business, service, modern finance, tourism, and other low-carbon sectors

- Datong city: structural transition of resource cities. Development of coal processing and coal waste recycling
- Jilin city: transition of former industrial cities in Northeast China. Development of agricultural goods processing, biological and medicine sectors, railway transport and IT sectors



A coal company in Datong



High-speed trains produced in Jilin

Practice of Low-Carbon Towns Development (2): Social Approach

■ Xi'an

- Vehicle-free Day and thousands of people walking activity
- Promotion of cycling and walking



■ Hangzhou

- Free public bicycles service system (swipe card), and dedicated shuttle bus to move the bicycles
- More than 50,000 bicycles and 2050 stations, daily use of more than 250,000 times

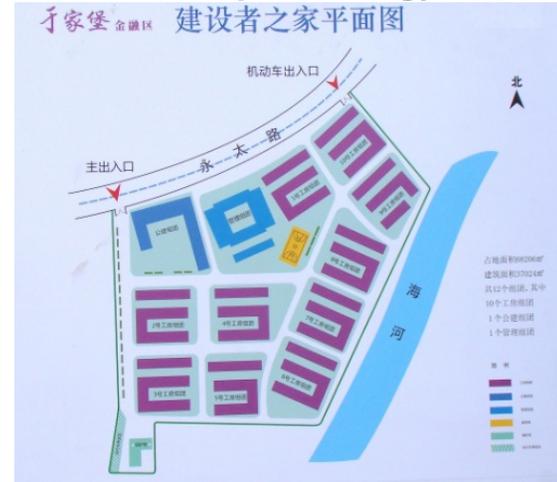


Practice of Low-Carbon Towns Development (3): Spatial Approach

- Very first APEC demonstration project of low-carbon towns: Yujiapu Finance District in Tianjin
 - Large amount of human resources and materials were allocated at the planning and design stage, in order to increase space utilization, optimize functional blocks and energy structure, increase energy efficiency, and reduce transport energy consumption



Long-term planning of Yujiapu: Green and ecological buildings



Home of Construction Workers, to avoid repeated construction



Planning of underground transport of Yujiapu



Practice of Low-Carbon Towns Development (4): Technological Approach

- Dezhou in Shandong: solar energy for domestic use
- Hami in Xinjiang: wind power and solar PV
- Shenzhen: electric vehicles



Rooftop solar heaters, solar PV, and solar lamps in Dezhou



Ongoing wind power and solar PV construction in Hami

An electricity charge station for EV's in Shenzhen



Practice of Low-Carbon Towns Development (5): Reuse Approach

- Shanghai: Public service platform for resources recycling
 - Free cards and stickers with a bar code. A customer can attach a sticker to an abandoned electric waste and drop it into a recycling box. Workers collect these waste periodically and send money to customers according to their bar codes.

- Wuhan: waste recycling in the heavy industry
 - Coke oven gas from steel plants is used in chemical plants and heat and power plants. Slug from steel plant is used as construction material.
 - Slug in heat and power plants is used as construction material. By-products in the desulphurization unit are used in plaster production. By-products in the de-NO_x unit are used in urea and ammonia production



Map of recycling boxes in a district



Slug in a steel plant (left) made into bricks (right)





International Collaboration during the Development of Low-Carbon Towns in China

- **Continuous extension of collaborating scope**
 - **Multilateral collaboration (APEC), bilateral collaboration (with Singapore, the UK, and Sweden), and collaboration of NGO's (WWF)**
 - **Collaboration in technical areas: production of alternative energy, ecological buildings, sustainable transport, bio-diesel, and eco-system protection (WWF)**
 - **Construction of low-carbon towns via full-scale collaboration as the case in Yujiapu finance district, Tianjin, where international collaboration covers low-carbon indicator systems, transport systems, underground planning, district energy supply, energy-saving building, analysis of heat island, energy efficiency management, and low-carbon construction.**
- **Continuous improvement of collaborating mechanism**
 - **APEC low-carbon towns demonstration: start-up of demonstration, setting up experts team, meetings of leaders, and forum of low-carbon towns demonstration**
- **Continuous importing advanced concepts around the world**
 - **Many international design teams work for the planning and design of Yujiapu finance district in Tianjin**
 - **Official release of plan of low-carbon development for Jilin**



Conclusions

- 1. Cities and towns are the major energy consumers and carbon emitters in China. Development of low-carbon towns is a significant measure to address the global climate change and sustainable development.**
- 2. Low-carbon towns development is fundamentally based on the philosophy of sustainability. Focusing on low carbon emissions of a unit could lead to increased carbon emissions of the whole system.**
- 3. There are sectoral, social, spatial, technological, and reuse routes for low-carbon towns development, and these measures should be implemented in an integrated manner.**
- 4. The Chinese government has issued and implemented a series of policies and actions to promote the development of low-carbon towns, and gained wide and positive support from local authorities. Many outstanding practices have emerged during development of low-carbon towns.**
- 5. International collaboration within the APEC framework is of great importance to the development of low-carbon towns in China. We hope to maintain this collaboration and extend it further and deeper.**