Final Report

Regarding the study of carbon governance at sub-national level in China

Yu WANG, Fei TENG

Institute of Energy, Environemnt and Economy

Tsinghua University

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1 Introduction

1.1 Background

China currently hosts 1.3 billion people, a fifth of the entire world population, and has a rapidly growing economy, despite still being a lower middle income country. China is currently the world's largest emitter and accounted for more than 22% of global emissions in 2007 according to IEA's statistics. China is ranked by German watch as number 51 out of 60 when it comes to climate performance. China's economy is mainly industry-based which makes it very dependent on energy-intense processes powered by coal and oil. Despite this bad record, low carbon development is crucial for China. China is very vulnerable to climate change, mainly in the fields of agriculture, livestock breeding, forestry, natural ecosystems, water resources, and coastal zones. China recently had to cope with severe droughts and floods which had devastating effects on poor farmers and the country's food supply. As a consequence, China has signed the UNFCCC, the Kyoto Protocol and the Copenhagen Agreement and has ambitious national plans for promoting renewable energy, developing a low carbon economy and tackling climate change. Milestones are for example China's Renewable Energy Law and its Renewable Energy Targets which aim for 15 per cent of total primary energy consumption to be from renewable energy by 2020. China introduced a National Climate Change Programme in 2007 and developed an ambitious Low Carbon Economy Roadmap in 2009 which outlines how China will move towards a low carbon economy. The roadmap indicates the following measures: increasing the share of renewable energy and natural gas among the total energy supply and demand, closing inefficient coal-fired power plants, increasing energy efficiency, promoting energy conservation, restructuring the economy from energy-intensive sectors to energy-extensive sectors, shifting to climate-friendlier transport options, promoting afforestation and building low carbon cities.

China's Nationally Appropriate Mitigation Actions (NAMA) under the Copenhagen Accord are to reduce CO2 emissions per unit of GDP by 40-45% by 2020 compared to 2005 level, increase the share of non-fossil fuels in primary energy consumption to around 15% by 2020 and to increase forest coverage by 40 million hectares and forest stock volume by 1.3 billion cubic meters by 2020. In addition, China is currently the world's leader in wind turbine and solar panel production and renewable energy technology plays a key role in rural electrification.

In addition, communities in rural and urban areas and the Chinese people seem to become increasingly aware of the urgency to tackle climate change. Initiatives such as "one day without driving" are taking place in various urban communities and in rural communities

solar panels are often a key strategy to provide power to the poor. The municipality of Beijing has launched large-scale solar energy and biogas programmes in the rural areas around the city, and Wuxi City in Zhejiang Province launched its “solar street lights” programme. However, significant restructuring of the economy and investments in low carbon innovation will be required to move towards a low carbon economy in the long term.

China is an authoritarian state which might facilitate the introduction and implementation of low carbon policies compared to other political arrangements, however at the same time there is evidence that national policies for LCD are not always implemented at the provincial or local level.

1.2 Objective

Institute for Global Environmental Strategies (IGES) is going to conduct the study on Establishing New Market Mechanism through the Development of Methodological and Institutional Framework for MRV in Asian Developing Countries from May 2011 to March 2012. The objective of the study is to promote proper evaluation methods on the activities initiated by the Japanese government in developing countries and assist developing systems to measure, report and verify GHG emissions reduction and/or sink in those countries in order to develop a crediting mechanism which will provide a win-win situation between Japan and those countries. In concrete terms, the following topics are planned:

1) Examination of methodological framework for the MRV of GHG;
2) Support and research for the establishment of institutional and governance structure, and capacity building for the MRV of GHG.

1.3 Methodology

The main method for this research will be case study analysis which is well-established in social sciences. We use the following research design.

- Research questions: Questions related to carbon governance at sub-national level in China
- Propositions: Schematic mapping of carbon governance at national and sub-national levels in selected sectors relevant to urban planning.
- Unit of analysis: Macro- and meso-level country case study
- Criteria for interpreting the findings: Using both qualitative and quantitative data

Our general analytical strategy for the case study research is the dual use of qualitative and quantitative data. We use two major sources of evidence: 1. documentation such as qualitative data from in-depths interviews, policies, peer-reviewed journal publications, book chapters and 2. archival records such as quantitative data about emissions, energy use, energy access, investments, deforestation, afforestation, Gross Domestic Product (GDP), income per capita, poverty headcount ratio etc. The quantitative data will come both from international organizations such as the World Bank's World Development Indicators (World Bank, 2010), the International Energy Agency (IEA, 2011) and the IPCC (2007), as well as from national organizations such as Environmental / Climate / Energy Ministries, planning commissions and other local authorities.

The case studies are being assessed at a macro- and meso-level, focusing on carbon governance at national and sub-national levels and the role of relevant sectors involved. To analyze the case study evidence, we apply cross-case synthesis as an analytical technique. The cross-case synthesis as a technique which is used for the analysis of multiple cases, which can strengthen the findings of case studies. The reason for choosing this approach is 1. the findings can be more robust than a single case study as several cases with similar findings are presented, 2. to assess different approaches in low income, lower middle income and upper middle income countries, 3. to show regional variety and diversity.

We will evaluate the case studies according to their approach to carbon governance at sub-national level, their policies, strategies and practices in place on one side and their actual implementation on the other side. We will assess the actors which are driving this process such as governments, businesses and civil society. We will also evaluate different success stories and failures (if any), how the success stories can be scaled up and contribute to GHG mitigation. Finally, we will evaluate the potential and current states of enforcement regarding GHG emission and who and in what manner.

This analysis will be done by conducting in-depths interviews and evaluating policy documents and analysis of data such as the share of low carbon energy amongst energy supply, investments in low carbon technology, rate of deforestation, GDP growth etc.

1.4 Schedule

	Work plan	Literatures review	Interviews	Interim report submit	Case study	Final report submit
5-19 July						
20-31 July						
1-31 Aug						
1-6 Sep						

6-30 Sep						
1-31 Oct						

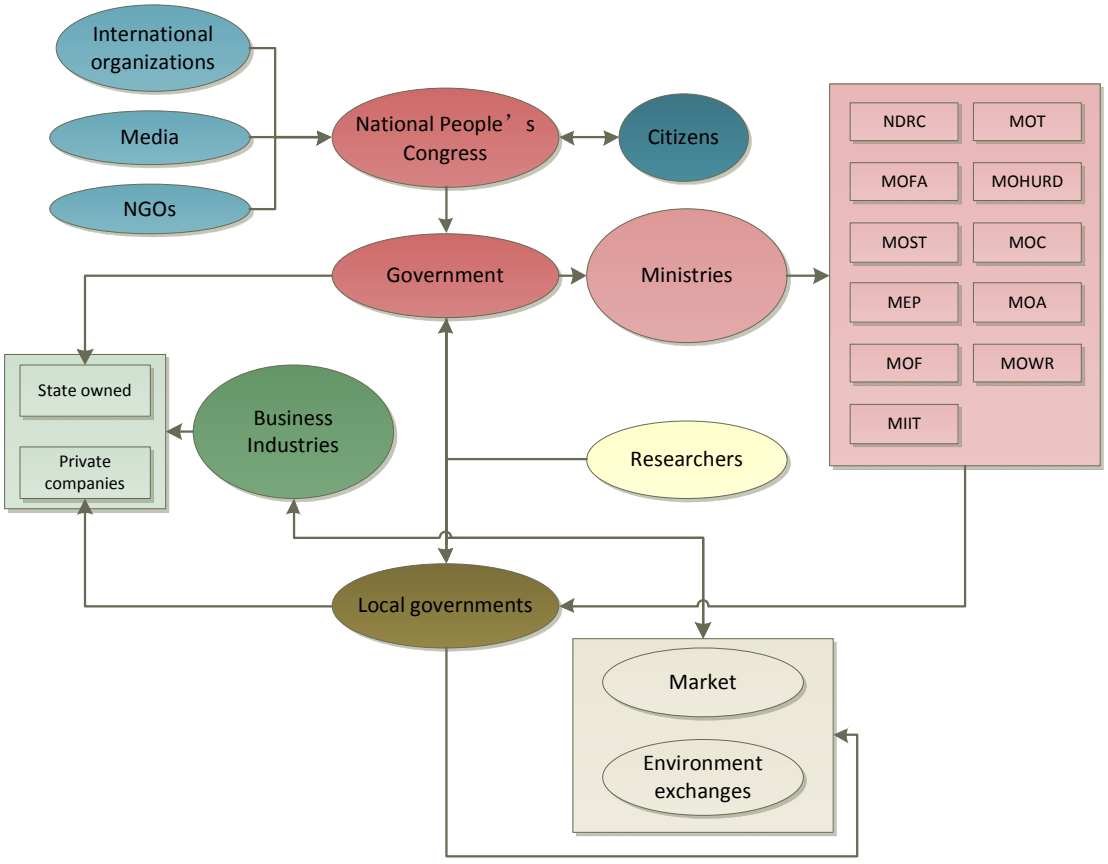
2 Findings

2.1 Carbon governmence at sub-national level in China

2.1.1 Stakeholders map

National level

There are about four category of actors involve in NAMAs for China's addressing climate change and play different roles separately. In which, government is thought to be play the most important and powerful role in NAMAs of China (Figure 1).



MITT: Ministry of Industry and Information Technology
MOHURD: Ministry of Housing and Urban-Rural Development of the People's Republic of China
MOT: Ministry of Transport of the People's Republic of China
MOA: Ministry of Agriculture of the People's Republic of China
MOWR: Ministry of Water Resources of the People's Republic of China

Figure 1 Stakeholders involved in NAMAs and their roles

- ✧ Government including its affiliated departments and local governments plays the most important and powerful role in NAMAs in China. Government is the key driver of NAMAs' implementation in China. They mainly carried out policies, guidelines, measurements to direct the implementation of NAMAs.

- ✧ Business and industries are the entities to implement NAMAs. The actions or technologies adopted by business and industries result in CO2 mitigation.
- ✧ Researchers supply suggestion to policymakers. Researchers get support from departments and international organizations to engage on research projects about addressing climate change, and supply decision suggestions to donors based on research results.
- ✧ International organizations, NGOs, media and citizens can urge and monitor the implementation procedure and results of NAMAs. On the other hand, the public awareness should be enhanced badly, which is a huge mitigation potential too.

Establish complete organizations and working mechanisms at provincial level

Up to now, all the provinces or cities in China have established a leadership group for addressing climate change. At the same time, all the provincial departments for development and reform have established their offices to response for the work of addressing climate change. These offices draft and implement the provincial scheme for responding to the challenge and other related plans, organize the implementation of the CDM projects, undertake the capacity building for addressing climate outcomes, and guide the international cooperation concerning the problems.

Provincial governments held various training and learning activities to deepen the officers' understanding of climate change, clarify the areas and tasks of relevant work, and gain a stronger sense of urgency and responsibility about how to respond to the challenge.

The provinces have also engaged in scientific research and monitoring of climate change, evaluated the impact, and research the countermeasures depending on the following research:

- ➢ Development planning and research;
- ➢ Environmental protection research;
- ➢ Agricultural and forestry research;
- ➢ Monitoring of climate change;
- ➢ Evaluate the impact.

Tianjin city

Tianjin city organized municipal research institutions and some colleges including Nankai University or research an indicator system for low carbon economy and the low carbon development patter. One after another, the colleges of various localities established their institution specialized for the research of climate change and low carbon economy, providing scientific support to the local effort to address climate change.

2.1.2 National communication development

In order to enhance the integrity and accuracy of China's GHG inventory, the central government began to compile the new GHG inventory of 2005 and 2008. Based on this the government could have a clear picture of CO2 emission situation, and implement the CO2 mitigation policies more reasonably and economically. The "Ceremony & Project Inception Workshop on Enabling China to Prepare Its Second National Communication" was held on 23 December 2008, with the delegates from governments, institutes and universities, NGOs participated in this workshop (table 1).

Table 1 organizations involved in preparing China's National Communication

No.	Category	Name
1	Government	NDRC, National Development and Reform Committee
2		MOST, Ministry of Science and Technology
3		MOEP, Ministry of Environmental Protection
4		CMB (China Meteorological Bureau)
5		Environmental Protection Department of the Government of the Hong Kong Special Administrative Region of the People's Republic of China
6		Meteorological and Geophysical Bureau of Government of the Macao Special Administrative Region of People's Republic of China
7	UN	UNDP
8		GEF
9		UNESCO, United Nations Educational Scientific and Cultural Organization
10		WHO, World Health Organization
11	Institution and university	ERI, Energy Research Institute
12		Tsinghua University
13		China Environmental Research Institution
14		CAS, China's Academy of Sciences
15		CAAS, China's Academy of Agriculture Sciences

Generally speaking, no sub-level governments involved in the compiling of National Communication up to now. Only related ministries under central government supply and experts from famous institutions and universities support the preparation of National Communication. But if the concrete contents were taken account, provincial statistic bureaus contributed a lot in supporting national basic situation.

The possibility of compile provincial GHG inventory

China has discussed the possibility and necessary of compiling provincial GHG inventory, based on which to summary the national GHG inventory. But the proposal was given up at the first and second National Communication compiling because of limited capacity of provincial governments, for example:

- Provincial governments lack of experiences on compiling National Communication;
- There are little professional experts to support the compiling work;

- It's hard for provincial governments to get necessary data at local level.

With the deepened knowledge of climate change, more and more provincial governments involve in addressing climate change. NDRC also published 'The Notice of Starting the Compilation of Provincial Inventory of GHG Emission' on November 5, 2010. In which, require local governments to:

- Identify special department to take on this responsibilities, and select experts to do this work;
- Begin to collect related data and information, mainly focus on energy, industry production procedure, agriculture, land use change and forest, waste management.

At the same time, Shaanxi, Zhejiang, Hubei, Yunnan, Liaoning, Guangdong, Tianjin were selected to participate the pilot project and began to compile regional GHG inventory from October 2010. And 5 large scale training were also held to enhance the provincial governments' ability, which laid a solid foundation for the local GHG inventory compilation.

But there are also many barriers in the compilation of GHG inventory. The most difficult is hard to collect data, especially the data about land use change and forest, the double counting problem, inflow and outflow of electricity between various provinces, and so on.

Table 2 Sub-level governments involved in national communication

Items	Sub-level governments involving	Trends
GHG inventory	No.	Some pilot provinces have begun to compile provincial level GHG inventory. Provincial governments have incepted field observation and measurements to get specific data of GHG emission factors and activity levels to enhance the accuracy of the data.
Measures to fighting against climate change	No. Regional policies and measures should be included in National Communication.	Provincial level governments should also supply policy information about addressing climate change, which is also the contents needed in National Communication
Others information related to climate change	No	Not detail information got.
Activities to enhance public awareness of climate change	No	Provincial governments paid more attention to enhance public awareness through media.
Capacity building	No	Provincial governments had set special organizations and positions to in charge of climate change.

2.1.3 Low carbon development strategy at provincial level

Pilot programs of national level low carbon provinces and cities

In July 2010, NDRC issued a notice requiring a pilot program of national-level low carbon provinces and cities be carried out throughout the country as an important way to materialize the 2020 target of China in controlling GHG emission. The provinces of Guangdong, Liaoning, Hubei, Shaanxi and Yunnan and the cities of Tianjin, Chongqing, Shenzhen, Xiamen, Hangzhou, Nanchang, Guiyang, and Baoding were chosen as the first batch for the program. These national level low carbon provinces and cities will engage in active exploration mainly in the following 5 aspects:

1) Compile low-carbon development plans. The provinces and cities must fully integrate the work of addressing climate change into the 12th Five-year Plan, and research and formulate low carbon development plans. These provinces and cities should explore a pattern of low carbon and green development.
2) Formulate matching policies that support low carbon and green development. The provinces and cities will tap the synergetic effect of the integration of climate change addressing with energy conservation, environment protection, new energy development and ecological construction, actively search the systems and mechanisms conducive to energy conservation and emission reduction and the development of low carbon industries. They should research how to use market mechanisms to advance the fulfilment of the targets of GHG emission reduction.
3) Accelerate the establishment of an industrial system characterized by low carbon emission. In combination with local industrial features and development strategies, they will speed up the innovation of low carbon technologies, advance the research, demonstration and industrialization of these technologies, and actively engage in absorption and renovation of foreign technologies or cooperative research and development with foreign counterparts.
4) Establish a system for the statistics and management of GHG emission data. They will work on GHG emission statistics, setting up complete system for collecting and computing the data, and set up their capacity building to provide the institutional and personnel guarantee.
5) Vigorously advocate low carbon and green life styles and consumption patterns. They will hold training for the leaders of all levels and departments so that they will energetically sponsor the publicity and educational activities, advocate low carbon life styles and conduct, popularize low carbon products, spread the concepts of low carbon life, and inspire the extensive participation by and conscientious action of all the residents.

Compile and implement local schemes for addressing climate change

Up to now, the 31 provinces (or regions or municipalities) of China have fulfilled the compilation of their local schemes for addressing climate change, and have entered the stage of implementing such schemes. The whole provincial level schemes stipulate that the climate change work should adhere to the concept of low carbon, recycling and green development, seek to control GHG emission and promote low carbon development, centre on the sustainability of economic development, depend on technological progress and the enhancement of independent innovation, achieve breakthroughs in energy conservation, new energy development, and enhancement of ecological protection and construction, emphasize the strengthening of the awareness of government, enterprises, and the public of climate change. Most of the local schemes were effectively enforced, which ensured the implementation of the national climate change program.

Formulate special plans and policies

In order to enhance local governments' ability to address climate change, they have formulated special plans for energy conservation and the development of clean energy and recycling economy, and have made solid progress in relevant works. Furthermore, they also researched and formulated a series of directive documents in connection with their actual situations (table 3).

Up to now, there are 27 provinces for recycling economy experiment issued their plans or implementation schemes for recycling economy. Some provinces and cities, including Hunan, Ningxia, Heilongjiang, Inner Mongolia and Guangxi, also made plans for the development of emerging industries such the new energy industry. Some provinces, including Beijing, Hubei and Yunnan, started the compilation of the special plan for addressing climate change for the 12^{th} Five-year Plan period.

Practice low carbon development

All provinces and cities have speeded up the implementation of the sustainable development strategy, and green development concept has gradually come into public's mind. As we all know, Chinese government has set the 2020 target for GHG emission reduction in November 2009, and the localities have taken voluntary activities to implement the decisions of the central government. Developing low carbon industries, building low carbon cities, advocating low carbon life, and boldly exploring the experiences of green and low carbon development are the main measures through which the localities to practice low carbon development.

The national low carbon pilot provinces have actively explored the pattern of low carbon development according to their actual situations (table 4).

Table 3 special plans and policies for addressing climate change at provincial level

	Yunnan	Chong qing	Hubei	Hainan	Qinghai	Hunan	Ningxia	Heilongjiang	Inner Mongolia	Guang xi	Beijing	Fujian	Liaoning	Zhejiang	Sichuan	Guang dong	Hebei
LC economy plan	√																
Plan for GHG Control		√															
Mid/long-term plans for energy conservation			√	√													
Plan for recycling economy					√												
Plan for the development of strategic new emerging industries[1]						√	√	√	√	√							
Plan for addressing climate change			√								√						
Opinions on LCD			√	√													
Work schemes on energy conservation and emission reduction								√		√		√	√	√	√		

[1] In China, strategic new emerging industries include energy saving and environment protection, new generation IT, biology, top level equipment manufacture, new energy, new material, and new energy vehicle industries. These industries could bring high value added with low energy consumption, so that the development of strategic new emerging industries could decrease the energy intensity and carbon intensity of GDP, which has been a significant measure to address climate change in China.

Public institutions of energy conservation				√									√				
Commending energy conservation																√	
	Yun nan	Chong qing	Hu bei	Hai nan	Qing hai	Hu nan	Ning xia	Hei long jiang	Inner Mong olia	Guang xi	Bei jing	Fu jian	Liao ning	Zhe jiang	Si chuan	Guang dong	He bei
Guiding catalogue of key energy conservation technologies								√					√				
Directive doc or standards for the key sectors		√						√					√				
Adjustment of economic structure												√				√	
Recycling economy		√	√											√	√		
Support service industry														√			
Support strategic emerging industry									√		√	√					√
Advancing afforestation								√		√				√			

Table 4 Low carbon development practices at provincial or city level

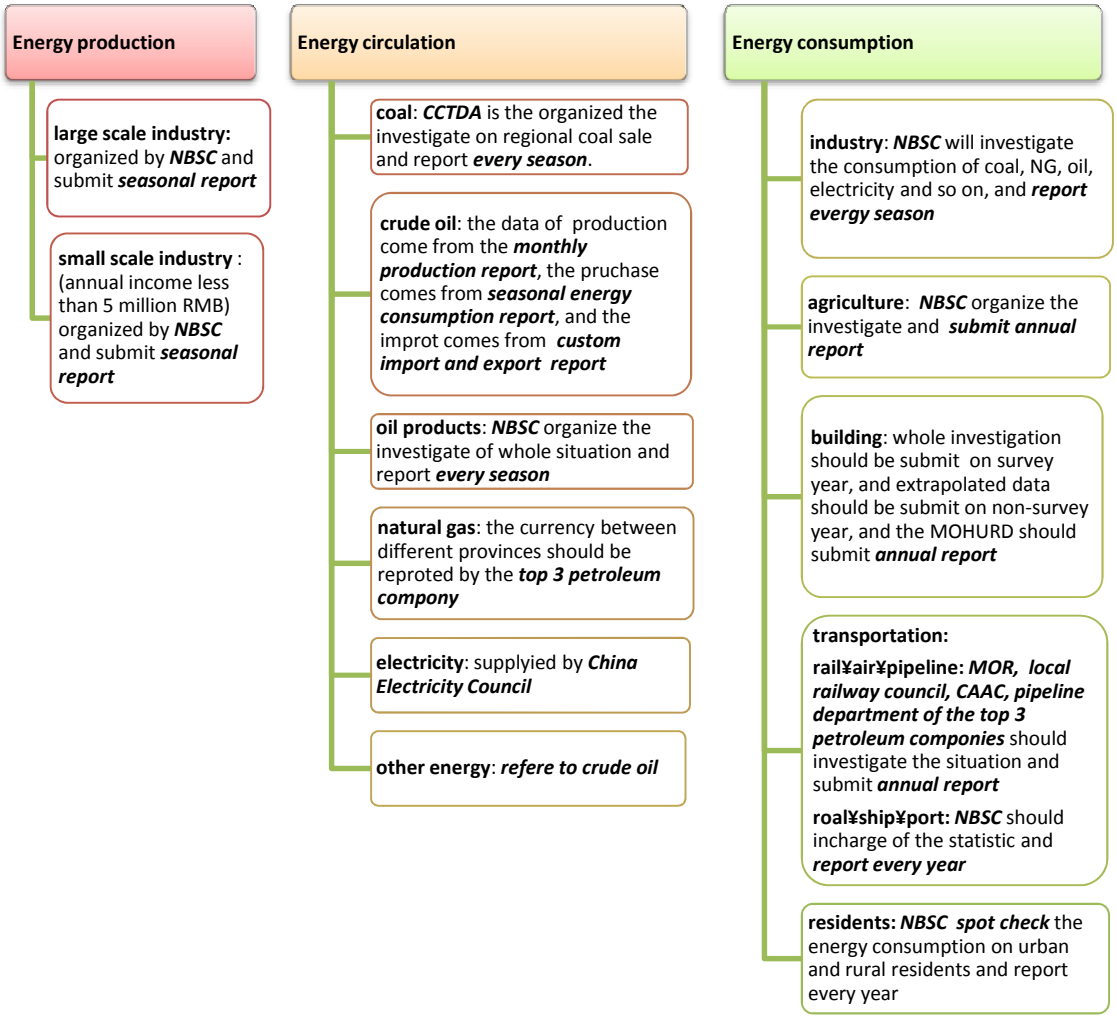
Guangdong	➢ Advanced the adjustment of industrial structure and transformation of economic development pattern ■ Substituting green industries for the traditional carbon intensive industries ■ Accelerating the development of strategic emerging industries and the service industry ■ Checking the irrational expansion of high energy consumption and high emission industries ■ Improving the energy structure by actively developing low carbon industrial system and consumption pattern
Liaoning	➢ Concentrated on the structural adjustment ■ Pursued large scale, clustering , high end and low carbon industrial development ■ Speeded up renovating he traditional industries with low carbon technologies, developing modern industries and energetically phasing out backward production capacity ■ Facilitated the formation of an economic development pattern characterized by low carbon emission
Hubei	➢ Speeded up the technological renovation in the traditional industries ■ Iron and steel ■ Petrochemical ■ Automotive ➢ Lowered the energy consumption levels of the key enterprises ➢ Accelerated the development of certain industries.
Shaanxi	➢ Accelerated the development of the plane and machine tool manufacturing industries, modern agriculture, emerging service industries ➢ Implemented the project of “substituting gas for coal in Shaanxi”, ➢ Constructed the key ecological projects of restoring farmland to forestland and restoring grazing pastures to grassland ➢ Endeavoured to build a new homeland in the west with a good ecological environment
Yunnan	➢ Developed non-fossil energy including hydropower, solar power and biomass energy ➢ Promoted tourism as a pillar industry and gave it greater support ➢ Engaged in afforestation and forest operation
Tianjin	➢ Forged a high-end, high quality and hi-tech industrial system, fostered 8 pillar industries ➢ Cooperated with Singapore and Japan to build an ecological city and an exemplary low carbon zone
Chongqing	➢ Integrated low carbon experiment with the adjustment of industries structure urban planning and construction, and the promotion of technological innovation

	➢ Expand the proportion of emerging industries such as the energy conservation and environmental protection industries ➢ Speeded up the development of low carbon transportation and green building and green lighting ➢ Try to build a "Liveable Chongqing" and "Forest Chongqing"
Hangzhou	➢ Accelerated the "6 dimension" construction of a low carbon city with ■ Low carbon industries ■ Low carbon buildings ■ Low carbon transportation ■ Low carbon life ■ Low carbon environment ■ Low carbon society
Nanchang	➢ Upheld the philosophy of "Ecological Subsistence, Green Development" ➢ Adhered to the concept of "Development is Valuable, but Environmental Protection is Invaluable" ➢ Speeded up the implementation of the action plans for developing low carbon industries and building a low carbon city ➢ Tried to forge an exemplary city of low carbon and ecological economy
Baoding	➢ Achieved fast development in new energy and manufacturing of energy equipment ➢ Speeded up the application of new energy in the construction of urban infrastructure and the daily life of residents
Xiamen	➢ Attached importance to energy consumption in industries and clean production ➢ Developed low carbon buildings and low carbon transportation
Guiyang	➢ Accelerated the development of recycling economy ➢ Constructed an ecological and civilized city
Beijing	➢ Made "Green Beijing" action plan ➢ Explored the road of green development through forging the system of green production, green consumption and green environment
Shenzhen	➢ Formed 4 pillar industries ■ Hi-tech ■ Modern finance ■ Modern logistics ■ Culture ➢ Constructed a system of regulations and policies for energy conservation and environmental protection
Shanghai	➢ Explored the pattern of green and low carbon development in the process of Chongming ecological island, Lingang New Town, and Hongqiao Hub.

2.1.4 Statistics, monitoring and information system

MRV system in China

The main metric used is energy intensity of GDP, which is measured through an energy accounting system. The State Council to the NDRC and the National Bureau of Statistics (NBS) jointly set the standards and implemented a comprehensive system to review performance towards its goals. NBS collects the data and the NDRC leads a verification and inspection process. The NDRC has allocated energy conservation targets to every province, autonomous region and municipality. The regional governments have further allocated targets to cities, counties and key energy-intensive enterprises. All levels of government then report through their Statistics Departments. The Provincial and National levels of the NDRC then inspect enterprises to ensure compliance. The energy accounting system covers three areas: energy production; energy circulation (transmission and distribution) among different provinces; and energy consumption. The system is intended to collect energy data from specific sectors as needed to calculate the energy intensity of GDP as accurately as possible. Figure 2 demonstrates the primary data and end use sectors covered by this process.



NBS: National Bureau of Statistics of China

CCTDA: China Coal Trade & Development Association

MOHURD: Ministry of Housing and Urban-Rural Development of the People's Republic of China

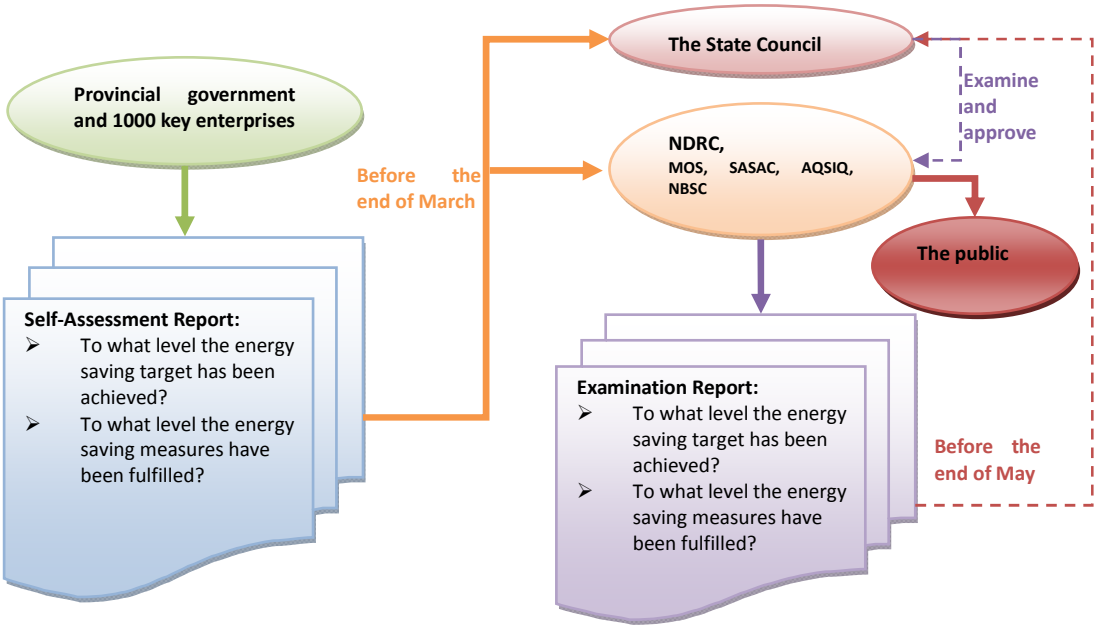
CAAC: Civil Aviation Administration of China

MOR: Ministry of Railway

Figure 2 Data Sources for Measuring Energy Intensity of GDP

The procedure for reporting the data identified in Figure 3 is depicted in Figure 3:

1) First, the provincial government submits a self-assessment report to the State Council and the NDRC by the end of March, based on data from the energy accounting system.
2) Second, the NDRC and other related departments, such as the National Bureau of Statistics and the State-Owned Assets Supervision and Administration Commission (SASAC) verify and assess the implementation of energy conservation in the local government. Based on an onsite assessment and spot checks, the NDRC drafts an examination report and submits it to the State Council by the end of May each year.
3) Third, the State Council examines and approves the examination report and returns it to the NDRC.
4) Finally, the NDRC reports the energy savings to the general public



MOS: ministry of supervision

SASAC: State-owned Assets Supervision and Administration Commission of the State Council

AQSIQ: General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China

Figure 3 Examination and reporting system for energy intensity of GDP

The Central government assesses and verifies the progress of provincial governments in achieving their energy conservation targets (see Figure 4).

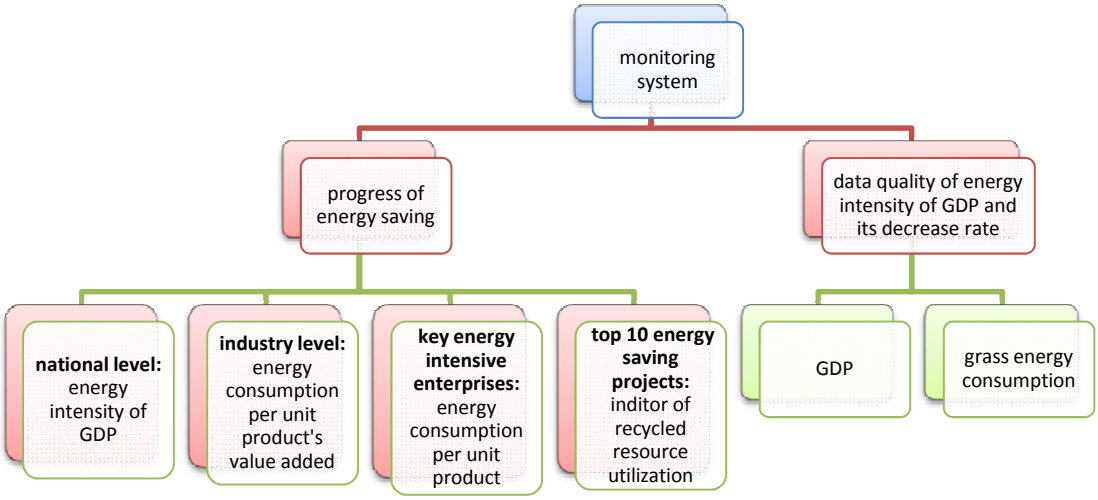


Figure 4 Verification system for energy intensity data

Construct better systems of statistics, monitoring and information

NDRC organized the compilation of the national inventory of greenhouse gas emission of 2005, built the greenhouse gas inventory database of China, and started the work of compiling local greenhouse gas inventories in certain provinces and cities. The relevant departments have actively engaged in the monitoring and experiments of greenhouse gases, and established a number of provincial-level experimental monitoring stations. A number of typical enterprises in key industries like power, iron and steel, and cement were selected for the pilot projects of automatic monitoring of carbon dioxide, and typical sites for burying urban living garbage were selected for the online methane monitoring tests. These projects will enhance China's ability to compute greenhouse gas emissions.

China has improved the system for climate change statistics. It has revised and supplemented some contents of energy consumption statistics, added and subdivided the energy categories so that they basically agree with the international standards for energy classification, and incorporated renewable energy generation and international fuel tanks into the statistics. It has stiffened the statistics of energy supply and consumption and the computation of energy consumption per unit of GDP, and performed timely monitoring and analysis for energy conservation, providing the basis for the national policies on energy conservation and emission reduction.

China has formulated "The Plan for the Development of an Integrated Meteorological Observation System (2010-2015)", by which to integrally plan and construct the national climatological observation network, national weather observation network, regional meteorological observation networks, and specialized meteorological observation networks, raise the operational reliability of the observation system, encourage the sharing of various observing resources, and set up a platform for the unified data collection, processing and sharing for the integrated meteorological observation system. Since 2009, the central

government has invested 2.4 billion yuan into the meteorological projects, including the meteorological observation and disaster early warning project, the new generation of weather radar system, meteorological satellites, and the system of monitoring and analysing the greenhouse gases in carbon circulation, laying a foundation for greater capabilities of meteorological anticipation and forecast, meteorological disaster prevention and mitigation, climate change addressing, and climatological resource exploitation. Besides, China has also strengthened capacity building for marine climate observation, constructed and installed GPS observation facilities for 57 tidal stations, maintained and renovated the inshore buoys of 3 stations and locations, and renovated the equipment of over 10 volunteer oceangoing vessels.

During the 12th five-year plan period, China will strengthen the statistics, monitoring and examination system for energy conservation. The actions include:

- Strengthen the statistics of energy production, circulation and consumption;
- Establish and improve energy consumption statistics institution in construction, transportation, public building sectors;
- Establish seasonal statistics institution for regional energy consumption per unit of GDP;
- Improve statistic accounting, monitoring methodology, to enhance the accuracy and timeliness;
- Edit emission mitigation statistic monitor and verification methodology;
- Unify standard and analysis methodology, to share the monitor data and information;
- Establish indicator system for emission statistic and monitor from agriculture sector and vehicles;
- Improve examination system for energy conserving and emission mitigation;
- Further improve national and regional communique for energy consumption of per unit of GDP and other major pollutants.

Table 5 Carbon governance in China

Sector	level							
	National government			Provincial government			City government	
	GHG inventory	Emissions reporting (emitters to government)	notes	GHG inventory	Emissions reporting (emitters to government)	notes	GHG inventory	Emissions reporting (emitters to government)
Energy Supply	yes	yes, specified large energy user / GHG emitters	China government organized related departments to work on GHG inventory of the year 2005 and 2008. The new inventory will be more complete and accurate.	yes, NDRC selected 7 province to pilot the compilation of GHG inventory project, including Guangdong, Hubei, Liaoning, Yunnan, Zhejiang, Shaanxi, Tianjin	No, local government only report energy consumption data to national government.	NDRC published the '***notice to start the compilation of provincial inventory of GHG emission'*** on November 5, 2010. Although almost all provinces NRC have begun to work on GHG inventory, but the first versions will not be available until the end of 2011.	Yes, only cities involved in Pilot Programs of National-level Low-carbon Provinces and Cities need submit GHG inventory.	no
Transport and its infrastructure	yes	yes, specified large energy user / GHG emitters						no
Residential and commercial buildings	yes	yes, part of commercial, specified large energy user / GHG emitters						no
Industry (non-agricultural)	yes	yes, specified large energy user / GHG emitters						no
Waste management	yes	yes, specified large energy user / GHG emitters						no

2.1.5 CDM in China

China has taken an active part in the Clean Development Mechanism (CDM) cooperation and published "***The Administrative Measures for the Operation and Management of Clean Development Mechanism Projects***". Based on this, central government annually organized related experts to calculate baseline emission factor of electric grid, and timely published and shared these data, and greatly enhanced the efficiency of the development, review, and verification of CDM projects. By October 2010, China had approved 2732 CDM projects, of which 1003 projects had been successfully registered with the CDM Executive Board. These projects are estimated to reduce emission by 230 million tons of CO2 equivalent, accounting for 60.8% of the global reduction. The structure of CDM projects are as follow figure.

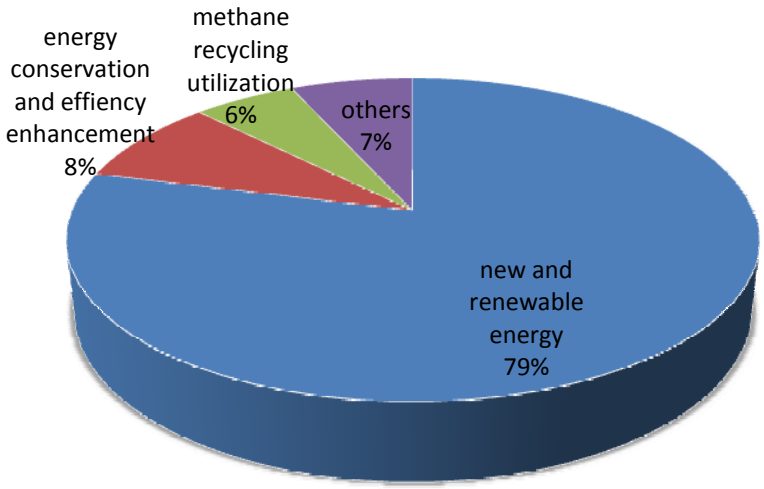


Figure 5 Structure of CDM projects in China

Through the development of CDM projects, China has effectively promoted the international cooperation in addressing climate change, intensified the enthusiasm of the enterprises in participating in greenhouse gas reduction, facilitated the efforts of the enterprises in pursuing energy conservation and technological progress, and made a contribution to the continuous invigoration of the international carbon market.

Provincial governments are also active in developing CDM projects. Up to now, there are 28 provincial technology service centres, and there are almost 10,000 persons got regular training cumulatively, which enhanced the capacity building of national CDM projects development.

2.2 Industry actions to address climate change

2.2.1 Electric power industry

China tried to enhance technological capacity and optimize the power supply structure, so that energy efficient and environmentally friendly coal fired generating units with large capacity, high efficiency, low energy consumption and low emissions took up an increasing proportion gradually. Up to now, 300 MW and larger units account for more than 67% of thermal power generating units currently in service. And there are 21 GW-class ultra-supercritical units in operation across the country, in addition to 24 units under construction, making China to be the largest country of GW-class ultra-supercritical units. Clean energy including hydropower, wind power, and nuclear power sees the fastest development.

On the other hand, China paid more attention to reinforced power grid upgrading for energy conservation and consumption reduction. The world first ±800 kV DC transmission line and the demonstration project of 1000 kV AC transmission line were completed, which declined the transmission loss by 3.57 percentage from 9.64% down to 6.07%.

Outdated capacities were eliminated at a faster pace in China from the beginning of 11th Five-year Plan period. About 72 GW of small scale thermal power generating units were closed down accumulatively nationwide during 2006 to 2010. To generate equivalent electricity with large scale units, more than 100 million tons of standard coal equivalent will be saved, and almost 300 million tons of CO2 emissions be reduced.

Innovation in management and mechanisms was advanced and allocation of resources optimized. For example, generation rights were traded actively in China now, which played a positive role in reducing energy consumption and emission in power generation to larger extent and promoting market based electricity development. By November 2009, the standard coal consumption for power supply declined from 345 g/kWh in 2008 to 339 g/kWh. The goal of 355 g/kWh set by the 11th Five-year Plan was met ahead of schedule, which rank China among leading nations.

2.2.2 Steel industry

In order to step up the efforts in energy conservation and emission reduction, China implemented 'The Opinions on Further Stepping up Efforts in Energy Reduction and Emission Reduction and Accelerating Restructuring of Steel Industry' and the 'Plan for Adjustment and Revitalization of Steel Industry. According to the plan, the steel industry should:

i. From March 2009, phase out 300 m^3 or smaller blast furnaces and 20t or smaller converters and electric furnaces, including 53.4 million tons of capacity of 300 m^3 or smaller blast furnaces and 3.2 million tons of 20t or smaller converters and electric furnaces by the end of 2010;
ii. Phase out 400 m3 or smaller blast furnaces and 30t or smaller converters and electric furnaces by the end of 2011, together with 72 million tons outdated iron-making capacity and 25 million tons outdated steel-making capacity;

iii. At medium- and large-sized key enterprises, control the overall energy efficiency per ton of steel at or below 620 kg standard coal equivalent, keep CO_2 emission per ton of steel below 1.6t and recycle 100% of secondary energy.

Merger and reorganization of steel businesses were accelerated. Some major steelmakers not only have completed massive tasks relating to industry upgrading, technical revamps and energy conservation and emission reduction, but also play a guiding and exemplary role in industry integration. Based on above measures, energy consumption per unit of output has declined significantly in the steel industry. According to 2009 statistics, overall energy consumption per ton of steel was 619.43 kg standard coal equivalent for medium- and large-sized steelmakers, down 1.74% from one year ago; freshwater consumption per ton of steel was 4.43 m^3, down 12.75% during the same period. In the first half of 2010, medium- and large-sized steelmakers saw a 2.15% decline in overall energy consumption per ton of steel and a 9.06% decline in freshwater consumption when compared with the same period of 2009.

2.2.3 Petrochemical industry

China implemented 'The Plan for Adjustment and Revitalization of Petrochemical Industry". So that, industry restructuring and elimination of outdated capacities have been advanced through revising industry policies, raising the threshold for entry and the criteria for product quality, encouraging large capacities and discouraging small ones and replacing outdated capacities with up-to-date ones. From 2009, following measurements have been adopted:

i. Refining units with a capacity of l million tons or below have been phased out through regional equivalent replacement;
ii. Refining units with a capacity of 1-2 million tons have been closed, merged or transferred;
iii. A number of small refining enterprises and underperforming nitrogenous and phosphate fertilizer makers have been closed 18.09 million tons of outdated coke capacities and 460000 tons of calcium carbide capacities were eliminated.

Relevant department such as MOST paid more attention to advance industry technologies and deliver measurable outcomes in terms of technology-driven energy conservation. Thanks for process improvements, energy consumption of some key energy consuming products has reached or gotten closer to international leading levels.

What's more important is that, energy audit of key energy consuming enterprises has been conducted and energy efficiency benchmarking of key energy consuming products had been properly done. Compulsory national standards have been developed for energy consumption limits of 18 key energy consumption products.

Up to now, the gaps with foreign leading performance in energy consumption of major energy consuming products have been narrowing gradually. By the end of 2009, energy

consumption rate per ton of oil refined dropped 13.5% and energy consumption rate per ton of chemical products declined by 19.2%.

2.2.4 Building material industry

First of all, industry structure has been optimized and outdated capacities have been eliminated. Totally 74.16 million tons of outdated cement clinker capacities and 6 million weight cases of sheet glass have been eliminated in 2009. 107 million tons of outdated cement capacities and 9.9 million weight cases of sheet glass were planned to be eliminated by 2010. Up to now, the 1o largest cement manufacturers produce 45% of the national total of the new dry-process cement clinker capacities per year. In this industry, processes have been improved to develop recycling economy. Fly ash, gangue and other solid wastes have been reused to develop new walling materials, taking up over 50% of current walling materials. Low temperature residual heat power generation has been promoted in the cement and glass industries; technologies for disposal of urban sludge, industrial wastes and domestic wastes have been applied in an increasingly broader scale in the cement industry.

Energy consumption per unit of cement clinker dropped to 120 kg standard coal equivalent in 2010, down 17.7% from 2005. The declining energy consumption per unit of clinker during the 11th Five-year Plan period has translated into 116 million tons of coal saved across the cement industry.

2.2.5 Construction and waste treatment

Energy consumption of buildings accounts for about 30% of the national total of China. And there is huge potential for building energy conservation. In order to advance energy conservation in building sector, energy efficiency standards have been tightened, upgrading of existing buildings has been intensified, and energy conservation of public buildings has been promoted.

China government has formulated and issued following policies. Based on these polices and measurements, 99% of new urban buildings had complied with compulsory energy conservation standards in the design stage by the end of 2009, and 90% in the construction stage meeting the State Council's goal that "90% or more of new buildings should comply with compulsory energy conservation standard in the construction stage".

- The Circular on Further Stepping up Efforts to Ensure Achievement of Building Energy Conservation Objectives in the 11th Five-year Plan
- Reporting Procedures for Energy Consumption and Conservation of Civil Buildings
- Circular on Further Strengthening Work Regarding Energy Efficiency Identifiers of Building Doors and Windows

The energy supervision system has also been created for governmental office buildings and large public buildings. And the 'Circular on Effectively Strengthening Energy Management of Governmental Office Buildings and Large Public Buildings' and the 'Technical Guidelines for Establishment of the Energy Supervision System of Higher Education Institutions' were formulated. Building energy efficiency certification agencies and supervisory measures have been defined; energy transmission regarding energy consumptions of public buildings has been realized. The individual household circular heating system has been applied to new buildings for household heat metering.

In order to upgrade existing buildings for energy conservation in Northwestern China where heating is required, the Measures for Acceptance of Heat Metering and Energy Efficiency Upgrading Projects for Existing Residual Buildings in Northern Regions with Heating Provinces and the Circular on Stepping up Efforts to Ensure Completion of Tasks regarding Heat Metering and Energy Efficiency Upgrading of Existing Residual Buildings in Northern Regions with Heating Provision were issued. The Technical Guidelines for Treatment of Domestic Wastes and the Technical Specifications for Sludge Treatment at Urban Wastewater Treatment Plants were also issued. Waste landfill gas treatment has been carried out. Landfill gas collection, discharge and treatment have been done in the majority of waste landfills and 64 landfill gas reuse projects have been executed to effectively reduce the impact of landfill gas on greenhouse effects.

Furthermore, China government encourages the development of green buildings, including construction of renewable energy applications and so on. As of July 2010, 43 green building label projects have been identified, including 25 public buildings and 18 residential buildings.

2.2.6 Transportation sector

Technical standards and detailed rules were the major energy conservation measures implemented in transportation sector. An array of policies have been formulated or issued, including:

- The Administrative Measures for Testing and Supervision of Fuel Consumption of Road Transportation Vehicles,
- The Code for Inspection of Fuel Consumption Parameters and Configuration of Road Transportation Vehicles
- The Rules on Application for Technical Review of Compliance of Fuel Consumption of Road Transportation Vehicles
- The Rules on Management of Testing Agencies for Fuel Consumption of Road Transportation Vehicles
- The Rules for the Implementation of Testing of Fuel Consumption of Road Transportation Vehicles

Fleet operators have been also encouraged to replace old vehicles through issuance of the Financial Incentive Policy on Early Exit of Fuel-intensive Vehicles from Road Transportation Market (Draft), so as to guide road transportation towards diesel-fuelled, large-sized, multi-axle and wagon-type vehicles.

China government also paid attention to create the road transportation information service network where cargo hubs and main freight terminals serve as freight nodes, so as to increase the mileage and tonnage utilization of freight vehicles, increase the actual load rate and transportation efficiency of passenger vehicles and reduce energy consumption and emission.

The government issued the 'Policy on Development of Resource-efficient and Environment-friendly Road and Waterborne Transportation'. Six campaigns have been completed, including:

- Fuel-consumption based admission
- Phase out of commercial vehicles
- Standardization of inland vessels
- Limitation on ship-discharged pollutants
- Trainings
- Low carbon transportation campaign.

Table 6 Schematic mapping of policies and measures at national level

Sectors	11th five-year plan period	12th five-year plan period
Electric power	300 MW and larger units account for more than 67% of thermal power generating units currently in service 21 GW-class ultra-supercritical units in operation, in addition to 24 units under construction, making China to be the largest country of GW-class ultra-supercritical units. About 72 GW of small scale thermal power generating units were closed down accumulatively nationwide during 2006 to 2010. To generate equivalent electricity with large scale units, more than 100 million tons of standard coal equivalent will be saved, and almost 300 million tons of CO2 emissions be reduced. By November 2009, the standard coal consumption for power supply declined from 345 g/kWh in 2008 to 339 g/kWh.	Encourage CHP and green coal fire power generation development. By 2015, the installation capacity of each power technology will be about: ➢ coal fire power: 933 GW ➢ hydro power: 284 GW ➢ gas power: 30 GW ➢ nuclear power: 43 GW ➢ wind power: 100GW ➢ solar power: 2 GW ➢ biomass power 3 GW ➢ geothermal and ocean power: 10 MW
Steel industry	Phase out 300 m3 or smaller blast furnaces and 20t or smaller converters and electric furnaces, including 53.4 million tons of capacity of 300 m3 or smaller blast furnaces and 3.2 million tons of 20t or smaller converters and electric furnaces by the end of 2010; Phase out 72 million tons outdated iron-making capacity and 25 million tons outdated steel-making capacity; Control the overall energy efficiency per ton of steel at or below 620 kg standard coal equivalent, keep CO2 emission per ton of steel below 1.6t; According to 2009 statistics, overall energy consumption per ton of steel was 619.43 kg standard coal equivalent for medium- and large-sized steelmakers, down 1.74% from one year ago.	Phase out 400 m3 or smaller blast furnaces and 30 t or smaller converters and electric furnace; Control the overall energy efficiency per ton of steel at or below 580 kg standard coal equivalent for medium- and large-sized steelmakers
Petrochemical	Refining units with a capacity of l million tons or below have been phased out through regional equivalent replacement; Refining units with a capacity of 1-2 million tons have been closed, merged or transferred;	Energy consumption and CO2 emission of per 10000 industry value added both decreased by 15% during 2011 to 2015 Quicken phasing out 2 million tons or below refining units

	A number of small refining enterprises and underperforming nitrogenous and phosphate fertilizer makers have been closed 18.09 million tons of outdated coke capacities and 460000 tons of calcium carbide capacities were eliminated. By the end of 2009, energy consumption rate per ton of oil refined dropped 13.5% and energy consumption rate per ton of chemical products declined by 19.2%.	7 million tons of underperforming nitrogenous capacities will be closed Oil consumption of per ton of ethane production will reduce to 0.6 toe 75% of the petrochemical solid wastes should be reused or recycling and they should be efficient treated by 100%
Building material	Totally 74.16 million tons of outdated cement clinker capacities and 6 million weight cases of sheet glass have been eliminated in 2009. 107 million tons of outdated cement capacities and 9.9 million weight cases of sheet glass were planned to be eliminated by 2010. Fly ash, gangue and other solid wastes have been reused to develop new walling materials, taking up over 50% of current walling materials. Energy consumption per unit of cement clinker dropped to 120 kg standard coal equivalent in 2010, down 17.7% from 2005. The declining energy consumption per unit of clinker during the 11th Five-year Plan period has translated into 116 million tons of coal saved across the cement industry.	Heat consumption of cement clinker on the production line with capacity of 5500 – 6000 t/d should below than 650kcal/kg.cl, while the electricity consumption should less than 52kWh/t.cl, electricity of cement should less than 80kWh/t (P. 042.5) Heat consumption of sheet glass decrease by 15% by the float glass new energy saving furnace and oxygen combustion technology
Construction	As of July 2010, 43 green building label projects have been identified, including 25 public buildings and 18 residential buildings.	upgrade existing buildings for energy conservation: ➢ in North-western China where heating is required: 400 million m2; ➢ in regions with hot summer and cold winter: 50 million m2 ➢ public buildings: 60 million m2
transportation		Phase out vehicles that fail to meet the European No.1 standard for exhaust emissions registered before 2005; Enhance fuel's quality for vehicles Adopt the fourth standards on vehicle emission to low pollution by cars Popularize energy saving vehicles and new energy vehicles

2.3 Potential of carbon crediting in sectors relevant to urban planning

2.3.1 National targets and strategies

The integration of addressing climate change and sustainable development has become the mainstream of China's development strategy from the 11th five-year plan period. China government laid out a set of policies and measurements to control CO2 emission, which had been included in the 11th five-year national social and economic development planning, and covered energy supply, agriculture, industry, energy end use, buildings and transportation sectors.

The seven major objectives and tasks for the 12th five-year plan (2011-2015) period are:

1) Propel economic development to a new level. The target annual economic increase is set at 7 percent over the next five years. The overall level of prices will kept basically stable and domestic demand further expanded.
2) Accelerate changes to the pattern of economic development and restructuring. The manufacturing industry will be upgraded and the service industry's value-added contribution to GDP will be raised by 4 percentage points. The urbanization level will be increased from the current 47.5 percent to 51.5 percent.
3) Work hard to develop social projects, such as increasing investment in education, R&D, cultural, sports and health sectors.
4) Effectively conserve resources, protect the environment and actively respond to climate change. The proportion of non-fossil fuels in primary energy consumption should reach 11.4 percent; energy consumption and CO2 emission per unit of GDP should be reduced by 16 percent and 17 percent; the release of major pollutants should be reduced by 8 percent to 10 percent. Water conservation facilities will be greatly improved and the efficiency of water usage will be enhanced.
5) Comprehensively improve the people's well-being. An extra 45 million urban jobs will be created over the next five years. A more reasonable income distribution pattern will be developed, and the per capita disposable income of urban and rural residents will be raised by an annual average of more than 7 percent.
6) Deepen reform and opening up.
7) Strengthen the government's internal reforms.

From the objectives and tasks of China's next five year development, we can see that addressing climate change has become one of the most important targets in China, and clarified quantitive targets for energy consumption and CO2 mitigation.

Here we compared the detail targets and polies and measurements of 11th and 12th five-year planning, which showed the continuous of China's policies and measurements for climate change mitigation (table 7).

Table 7 Existing low carbon policies and measurements by China national government

Targets of 11th 5 year plan	**Policies & Measurements**	**Achievements**	**Targets of 12th 5 year plan**
Share of service sector in total GDP increase to 43.3% by 2010 from 40.3% in 2005	Accelerate service sector's development; Foster high tech industry and strategic emerging industries; Upgrade conventional manufacturing; Contain rapid growth of high energy consumption and high emission.	43% in 2010	Share of service sector in total GDP should increase by 4% during 2011 to 2015.
Energy intensity of GDP decrease by about 20% by 2010 compared to 2005	Revise "Energy Conservation Law" to supply legal guarantee; Establish and strengthen accountability system; Accelerate industry structure adjustment and phase out backward production capacity; Publish energy efficiency standard and label system; Implement key energy conservation project; Implement financial and tax incentive policies.	Energy intensity of GDP decrease by 19.1% during 11th 5 year plan period	Energy intensity of GDP decrease by 16% during 11th 5 year plan period, **carbon intensity of GDP decrease by 17% in the same period**. Energy intensity of GDP reduced to 0.869 tce/10000 yuan GDP (2005 price) Total energy conservation reaches 670 million tce.
There are no quantitive target of non-fossil energy development	Revise "Renewable Energy Law"; Laid out a set of planning about renewable energy and nuclear energy development; Improve policies and measurements to match the law and planning; Invest more finance and technology support.	Total non-fossil energy consumption reached about 300 million tce by the end of 2010.	The share of non-fossil energy will rise to 11.4% of total primary energy consumption.
Forest coverage increase to 20% in 2010 from 18.2% in 2005.	Protective forest programme; Laid out laws and regulations;	Forest store reached 13.7 billion m^3; forest coverage reach 20.36% in 2008.	Forest stock increase by 600 million m^3; Forest coverage increase to 21.66%.

2.3.2 Conserve energy and enhance efficiency

Energy conservation is a major strategy for the social and economic development of China. The 11th Five-year Plan sets a goal of reducing the energy consumption per unit of GDP of the country by about 20% during the period from 2005 to 2010. All of the local governments and all the departments of the central government of China have enhanced their efforts in energy conservation in order to realize this goal since the 11th Five-year Plan period began. Various measures, such as improving laws, regulations and standard, intensifying accountability, phasing out backward production capacities, executing key programs, promoting technological progress, expanding policy incentives, strengthening supervision and administration, and launching nationwide campaigns, and have made impressive progresses in the work of energy conservation, have been taken. During 2005 to 2010, the energy consumption per unit of GDP dropped by 19.1%, which means that the target of the 11th Five-year Plan has been almost attained.

Reinforce assessment of objectives and responsibilities for energy conservation

China has divided the energy conservation targets for the 11th Five-year Plan period and assigned them to various provinces, autonomous, and municipalities directly under the central government, and has instituted a system of objectives and responsibilities to subject officials of local governments to accountability for failures to accomplish the assigned targets. The State Council issued '***The Notice on Making Even Greater Efforts to Ensure the Fulfilment of the Energy Conservation and Emission Reduction Targets for the 11th Five-year Plan Period***' and has carried out assessments of the performance of 31 provincial-level governments and 1,000 key enterprises in accomplishing their energy conservation targets and implementing energy-conserving measures, and has announced the conclusions of such assessments. The State-owned Assets Supervision and Administration Commission under the State Council formulated '***The Interim Measures for Supervising and Administering Energy Conservation and Emission Reduction of the Enterprises Managed by the Central Government***', and thus further tightened the administration of the key enterprises in terms of energy efficiency. Till the end of 2010, all provinces, excepting Xinjiang had accomplished their targets.

Table 8 Rate of progress on the 11th Five-year Plan energy conservation target

	2005		2010		2015	2006-2015
	Energy intensity (tce/10,000 Yuan)	Target (%)	Energy intensity (tce/10,000 Yuan)	Real decreased (%)	Target (%)	Target (%)
Beijing	0.792	-20.00	0.582	-26.59	17	39.07
Tianjin	1.046	-20.00	0.826	-21.00	18	35.22

Hebei	1.981	-20.00	1.583	-20.11	17	33.69
Shanxi	2.890	-22.00	2.235	-22.66	16	35.03
Neimenggu	2.475	-22.00	1.915	-22.62	15	34.23
Liaoning	1.726	-20.00	1.380	-20.01	17	33.61
Jilin	1.468	-22.00	1.145	-22.04	16	34.51
Heilongjiang	1.460	-20.00	1.156	-20.79	16	33.46
Shanghai	0.889	-20.00	0.712	-20.00	18	34.40
Jiangsu	0.920	-20.00	0.734	-20.45	18	34.77
Zhejiang	0.897	-20.00	0.717	-20.01	18	34.41
Anhui	1.216	-20.00	0.969	-20.36	16	33.10
Fujian	0.937	-16.00	0.783	-16.45	16	29.82
Jiangxi	1.057	-20.00	0.845	-20.04	16	32.83
Shandong	1.316	-22.00	1.025	--22.09	17	35.33
Henan	1.396	-20.00	1.115	-20.12	16	32.90
Hubei	1.510	-20.00	1.183	-21.67	16	34.20
Hunan	1.472	-20.00	1.170	-20.43	16	33.16
Guangdong	0.794	-16.00	0.664	-16.42	18	31.46
Guangxi	1.222	-15.00	1.036	-15.22	15	27.94
Hainan	0.920	-12.00	0.808	-12.14	10	20.93
Chongqing	1.425	-20.00	1.127	-20.95	16	33.60
Sichuang	1.600	-20.00	1.275	-20.31	16	33.06
Guizhou	2.813	-20.00	2.248	-20.16	15	32.05
Yunnan	1.740	-17.00	1.438	-17.41	15	29.80
Xizang	1.450	-12.00	1.276	-12.00	10	20.80
Shaanxi	1.416	-20.00	1.129	-20.25	16	33.01
Gansu	2.260	-20.00	1.801	-20.26	15	32.22
Qinghai	3.074	-17.00	2.550	-17.04	10	25.34
Ningxia	4.140	-20.00	3.308	-20.09	15	32.08
Xinjiang	Till further assessment				10	18.02

Data source: http://www.stats.gov.cn/tjdt/zygg/gjtjjgg/t20110610_402731394.htm
http://www.gov.cn/zwgk/2011-09/07/content_1941731.htm

During the 12th five-year plan period, China also decomposed its energy intensity target to provinces and cities. They are divided into 5 catalogues according to the resources situation, economic development stages of various provinces and cities as followed:

Table 9 Target decomposing to local level

Target	Regions
18%	Tianjin, Shanghai, Jiangsu, Zhejiang, Guangdong
17%	Beijing, Hebei, Liaoning, Shandong
16%	Shanxi, Jilin, Heilongjiang, Anhui, Fujian, Jiangxi, Henan, Hubei, Hunan, Chongqing, Sichuan, Shannxi
15%	Inner Mongolia, Guangxi, Guizhou, Yunnan, Gansu, Ningxia
10%	Hainan, Xizang, Qinghai, Xinjiang

Data source: http://www.21cbh.com/HTML/2011-3-16/3NMDAwMDIyNjg3NQ.html

Accelerate adjustment of industrial structure

To optimize the industrial structure, foster and develop strategic emerging industries, and continued to increase the support to the R&D and commercialization of the related technologies have been taken as the breakthrough points in view of the disproportionately large share of industrial energy consumption in the total. In October 2010, the State Council promulgated '***The Decision on Accelerating the Fostering and Development of Strategic and Emergency Industries***', which in light of the characteristics of such industries, the current conditions and the scientific and industrial bases of China, specifies the emphasis of the current stage, namely the fostering and development of energy-conserving and new generations of IT, biology, high-end manufacturing, new energy, new material, and new energy car industries, and clarifies the goal and policy direction for the next period. By the end of 2010, the percentage of the tertiary industry in the growth increased from 40.5% in 2005 to 43.0% in 2010.

On the other hand, China organized the revision of '***The Catalogue for Guiding the Adjustment of Industrial Structure***', and issued the plans for adjusting and renovating 10 major industries, so as to reduce energy consumption and promote the level of integral utilization of resources. In July 2009, the State Council forwarded '***Several Opinions on Restraining Excessive Capacities and Repeated Construction in Certain Industries and Guiding the Health Development of These Industries***' issued by relevant departments, which sets forth policy requirements for the work of checking excessive capacities, and preliminarily contained the trend of repeated construction in sectors with excessive capacities.

China government takes the phase out of backward production capacities as an important means of energy conservation and emission reduction, and has continuously intensified its efforts in this regard. During the 11th Five-year Plan period, China shut down small power generation units of a total capacity of 72 GW, and phased out the backward production capacities of 121.72 million tons of iron, 69.69 million tons of steel, and 330 million tons of cement.

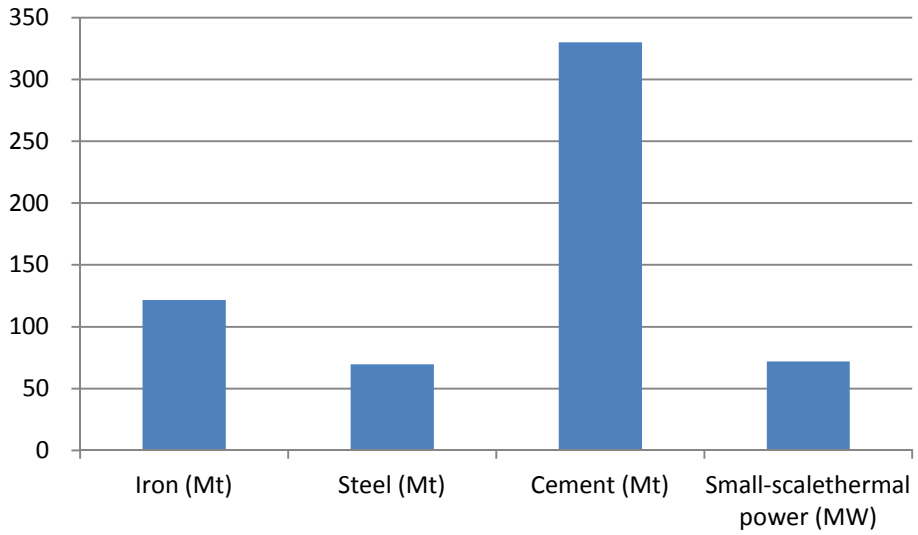


Figure 6 Backward production capacities phased out from 2006 to 2010

Improve systems, standards and price policies

China has established all-encompassing and sound systems and standards for energy efficiency. Up to now, China has promulgated 7 groups of implementation rules for the energy efficiency labelling, covering 5 fields and 23 catalogues of products. To ensure the implementation of related policies and standards, the country has organized local agencies for energy conservation supervision to conduct law-enforcing inspection of the limits of energy consumption for the products, the phase-out of backward production capacities, and the outfitting of energy measuring instruments and tools of the major energy consumption enterprises.

China has further reduced energy consumption through deepening the reforms of energy prices (refer to Table 10). Based on this, local governments may further raise the extra power price as the situation requires. For example, , and if the excessiveness reaches twice as much as such standards, the extra power prices against the enterprises to be phased out will applied.

Table 10 Price policies list

2009	China reformed the prices and taxes of oil products, adjusted the prices of oil products for multiple times, and continuously improved the formation mechanism of such prices.
November 2009	China raised power prices nationwide, which further optimizing the power price structure and better embodying the principle of fair cost sharing.
June 2010	China raised the factory-gate benchmark price of natural gas, cancelled

	the dual-track price system, and expanded the scope of price fluctuation, to induce reasonable allocation of natural gas resources.
June 2010	Extra power price charged against the enterprises of which the development is restricted.

Carry out key programs of energy conservation

In order to implement "The Outline of the 11th Five-year Plan for National Economic and Social Development and attain the mandatory goal of reducing the energy consumption per unit GDP by around 20%, the National Development and Reform Commission (NDRC) together with other departments, on the basis of The Mid- and Long-term Special Plan for Energy Conservation, formulated and issued The Opinions on Implementing the 10 Key Programs of Energy Conservation in the 11th Five-year Plan Period. The 10 key programs of energy conservation are the following:

i. The programs of renovating coal-burning industrial furnaces (kilns),
ii. Regional combination of heating and power generation,
iii. Utilizing residual heat and pressure,
iv. Petroleum conservation and substitution,
v. Energy conservation of electric motor systems,
vi. Optimizing energy systems (systematic energy conservation),
vii. Energy conservation of buildings,
viii. "Green" lighting,
ix. Energy conservation of government agencies,
x. Constructing the monitoring and technological service systems for energy conservation.

According to preliminary statistics, during the last 5 years, 30 billion yuan was accumulatively arranged within the central government budget to support the key projects of localities and enterprises for energy conservation and emission reduction, forming a capacity of conserving 160 million tons of coal equivalent per year.

Promote energy conservation and accelerate development of energy conservation services

In April 2010, the General Office of the State Council forwarded '***The Opinions on Facilitating Energy Performance Contracting Speeding Up the Development of the Energy Conservation Service Industry***' issued by NDRC and other relevant departments, which gives greater support to energy performance contracting (EPC) projects and energy management companies in investment, fiscal arrangement, tax and finance, and has basically eliminated the policy and systematic obstacles to EPC popularization. In June 2010, the Ministry of Finance and the NDRC jointly issued '***The Interim Measures for the Administration of Public***

Finance Incentive Funds for Energy Performance Contracting' to support the energy management companies carrying out energy conservation renovation for enterprises on the basis of EPC.

Promote energy-conserving and low carbon consumption

Chinese government has issued 'The Interim Measures for the Administration of the Subsidy Funds from Public Finance for the Popularization of High-efficiency and Energy-conserving Products' and 'The Implementing Details for the Popularization of High-efficiency and Energy-conserving Room Air-conditioners under the Program of Benefiting the Public through Energy-efficient Products. China encourages small displacement cars, strenuously promotes cars fuelled by gasoline or diesel oil (including the hybrid and bi-fuel cars) with an engine displacement no higher than 1.6 L and an overall general conditions fuel consumption level 20% less than the current standards, and grants the consumers a one-time subsidy of 3,000 yuan, which is from the central government finance, for each car. The above policies and measures have played a positive role in helping the whole society to form low-carbon and green consumption concepts and adopt the corresponding life style.

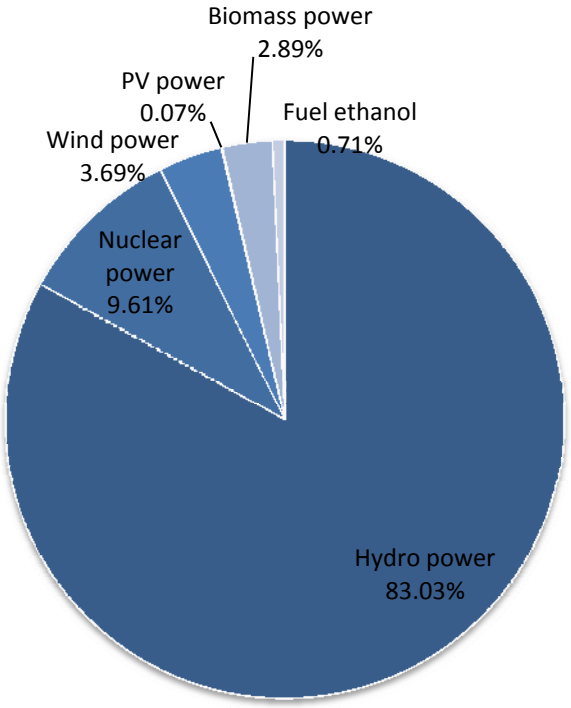
Table 11 Comparison of policy and measures adopted to climate change mitigation between 11th and 12th five-year plan period

Policies and measurements	11th five-year plan period	12th five-year plan period
Accelerate adjustment of industrial structure	➢ The share of service industry increased by 2.6% during 2006 to 2010. ➢ Value added of high-tech industry increased to 1.35 billion yuan in 2009 from 0.8 billion of 2005. ➢ Energy intensity of per unit of value added of middle and large scale enterprises reduced from 2.59 tce of 2005 to 1.92 tce of 2010.	The share of service industry in total GDP should increase by 4% during 2011 to 2015, The service industry will take about 47% and strategic new emerging industry take 8% in total GDP through: ➢ Upgrade industry ➢ Foster strategic new emerging industry ➢ Reform energy generation and utilization pattern ➢ Establish compositive transportation system, preferentially develop public transport ➢ Enhance information level ➢ Foster ocean economic growth ➢ Rapidly develop service industry
Improve systems, standards and price policies	China has promulgated 7 groups of implementation rules for the energy efficiency labelling, covering 5 fields and 23 catalogues of products	➢ Establish "leader" standard institution, and set advanced energy efficiency for heavy energy consumption productions and end use productions; ➢ Quicken the upgrading of standards to enhance the energy efficiency level; ➢ Establish commanding national standard for energy consumption limitation, energy intensity and pollutants emission of key industries; ➢ Establish energy conservation and design standard for construction sector, and enhance threshold of industry entrance; ➢ Establish environmental protection productions and equipment standards; ➢ Encourage provincial or city government to carry out more strict standard.
Carry out key programs of energy conservation	During the last 5 years, 30 billion yuan was accumulatively arranged within the central government budget to support the key projects of localities and enterprises for energy conservation and emission reduction, forming a capacity of conserving 160 million tons of	Compared with the level of 2010, the efficiency of industry boiler will increase by 5%, furnace increase by 2%, motor increase by 2-3% by 2015. Additional waste heat generating capacity increase by 20 GW, energy saving building reaches more than 500 million m^2. And totally achieve 300 million tce of energy conserving through following: ➢ Energy conservation design of the reconstruction project ➢ Project to promote energy-efficiency for the benefit of the people

	coal equivalent per year.	➢ Energy-conserving technology projects to demonstrate their commercial viability ➢ Energy performance contracting promoting project
Promote energy conservation and accelerate development of energy conservation services	In 2010, 1.24 billion yuan out of the central government finance has been earmarked to support the energy management companies carrying out energy conservation renovation for enterprises on the basis of EPC	➢ Encourage EPC development, supported with financial, tax policies ➢ Research on energy conservation verification and exchange institution of EPC ➢ Foster third party verification and evaluation institute ➢ Encourage various financial institutions and guarantee agencies to supply risk allocation service
Promote energy-conserving and low carbon consumption	Till the end of October 2010, a total of over 20 million high-efficiency and energy-conserving air-conditions had been sold, and the market share of such products had increased to over 80% from 5% before the popularizing campaign. In 2009 and 2010, over 300 million energy-conserving lamps have been sold. China encourages small displacement cars and grants the consumers a one-time subsidy of 3000 yuan, which is from the central government finance, for each car.	➢ Strengthen energy saving and emission reduction of national public institutions, and complete energy saving transformation for 60 million square metres of public building ➢ Implement charge by heating supply instead of by heating area ➢ Establish 2000 energy saving domestic public institutions in China ➢ Push reform of official vehicles system, strengthen oil consumption quota management ➢ Enhance the share of new energy vehicles and energy saving cars

2.3.3 Develop green and low carbon energy

China has actively optimized its energy mix, and made great efforts to develop low carbon energy such as renewable energy and nuclear energy. In 2010, China ranked first among all countries in newly installed capacity of wind power, nuclear power capacities in progress, and production of photovoltaic solar cells. Till the end of 2010, China ranked first in installed capacity of hydropower, wind power and heat collection area of solar water heaters. China has made remarkable progress in developing non fossil energy.



Data source : China's policies and action in addressing climate change, 2010.

Figure 7 Non-fossil fuel in China, 2009

In the12th five-year plan, cliamte change mitigation has also been integrated into the package strategies, which is a system framework to support China's future development. The detail policies and measurements include:

1) Set banding targets for energy consumption and CO2 emission of per unit of GDP reduction to control the GHG emission effectively;

2) Control the excessive growth of high energy consuming industries, and enhance energy efficiency;

3) Reinforce assessment of objectives and responsibilities for energy conservation, improve related regulations and standards, carry out key programs of energy conservation;

4) Promote energy conservation and accelerate development of energy conservation services, pay more attention to energy conservation in the key fields such as industry, construction, transportation ;

5) Develop green and low carbon energy, adjust energy supply structure;

6) Enhance forest coverage, increase forest store and carbon sequestration capacity;

7) Establish complete GHG emission and energy conservation statistics and monitoring system;

8) Establish carbon emission exchange market step by step.

2.4 Case study

2.4.1 Shanghai

In Shanghai's 12th five-year plan (2011-2015), Shanghai set its key targets include economic development goal of 8% annual growth rate of GDP, and the service sector will take about 65% in the total GDP. Under this framework, Shanghai government also set its energy saving and pollutants mitigation targets in 2011:

- Energy consumption and CO2 emission per unit of 10000 yuan GDP should decrease by 3.6% in 2011
- The total increment of energy consumption will be controlled under 5 million tce
- Energy consumption per unit of 10000 yuan GDP should decrease by 3.6%, and the total increment of energy consumption will be controlled under 2.7 million tce in industry sector
- Energy consumption increment controlled under 1.5 million tce
- Energy consumption per unit of 10000 yuan GDP should decrease by 2% in construction sector, 2.5% in commercial sector
- Energy consumption per unit of building area decreases by 1% in hotel sector
- Energy consumption of government institutions should decrease by about 4%
- Energy consumption per unit of building area decreases by 1% in sanitation system

To achieve above targets, Shanghai government carried out a package of policies and measurements to achieve energy conservation and GHG mitigation.

Table 12 Low-carbon development policies and practices of Shanghai （2011）

Area of policy	Policy tool	Contents
industry	Energy consumption limitation, and standard	Energy consumption limitation per unit of glass epoxy
		Energy consumption limitation per unit of tempered glass
		Energy consumption limitation per unit of ferrous metal products
		Energy consumption limitation per unit of nonferrous metal products

		Energy consumption limitation per unit of petrochemical products
		Energy consumption limitation per unit of textile products
	Administration standard	Establish Shanghai energy audit technology guideline
		Establish Shanghai energy benchmarking management guideline
		Establish energy saving audit and calculation methodology for boiler system, motor system and air compressor system
		Establish standards for energy saving management, methodology, monitor and evaluation
	Adjust and phase out backward capacity	Complete 600-700 phasing out projects, to achieve energy conservation of 600 to 700 thousand tce
		Adjust completely reform in leather industry
		Continue the reform in metal industry enterprises
	Energy conservation audit, monitor and verification	Carry out “Shanghai energy audit management methodology”
		Implement energy audit on 80 enterprises whose annual energy consumption beyond 50 thousand tce
		Complete energy consumption audit on 11 government buildings, 69 hospital buildings, 177 school buildings, 10 commercial buildings, 19 hotel buildings
		Improve energy efficiency monitor platform management in Shanghai industry sector
Building	Energy consumption limitation and guideline	Research on reasonable energy consumption methodologies, and carry out guidelines for government buildings, schools, hospitals, hotels, and commercial buildings.
	Energy saving standard for building design and construction	Energy conservation design standard for public building
		Energy conservation design standard for residential building
		Energy conservation reformation guideline for existing buildings
		Research and set energy consumption limitation for building construction
Transportation	Energy consumption limitation and reasonable guideline	Research on standard framework system for energy conservation in transportation sector
		Research on complete energy consumption limitation standard for per unit of port throughput
		Research on fuel consumption limit standard for operational marine vessels
		Research on fuel consumption limitation for civil transportation enterprises
		Establish fuel consumption limitation standard for taxi
		Establish fuel consumption limitation standard for bus
		Establish reasonable fuel consumption guideline for rail traffic
Household	Renewable energy	Pilot project to integrate renewable energy with building, covering 1.2 million m2 of building area
		Install solar water heaters on building no higher than 6 floors
		Encourage enterprises and residents to buy “green electricity”

	Standard and reform	Construct 600 thousand buildings according to new high energy conservation standard
		Reform existing building about 500 thousand m2
Waste	Recycle	Industry solid waste harmless disposal and resource utilization
		Domestic waste sorting collections and source reduction
		Improve the circulation use of the kitchen waste and organic waste; complete recovery system for “renewable resources”
		Encourage appropriate packaging
		Build waste incineration power plant

2.4.2 Tianjin

In Tianjin’s 12th five-year plan (2011-2015), Tianjin set its key targets include economic development goal of 8% annual growth rate of GDP, and the service sector will take about 65% in the total GDP. Under this framework, Shanghai government also set its energy saving and pollutants mitigation targets:

- Energy consumption and CO2 emission per unit of 10000 yuan GDP should decrease by 18% during 2011 to 2015
- Forest coverage increase to 23%
- The share of non-fossil energy in total primary energy increase by 2%

To achieve above targets, Tianjin government carried out a package of policies and measurements to achieve energy conservation and GHG mitigation.

Table 13 Low-carbon development policies and practices of Tianjin （2006-2010）

Area of policy	Policy tool	Contents
industry	Adjust and phase out backward capacity	During 2006 to 2010, phased out backward capacity including: 2.55 million ton of cement; 5.9 million ton of steel, 25 million meter of dyeing and printing, 1.5 million box of flat glass, 18 thousand ton of alcohol, 75 thousand ton of paper
		Close down 300 thousand kW of small scale thermal power capacity
		Invested 5 billion on 289 key energy conservation reform projects
	Energy conservation audit, monitor and verification	Carry out “Tianjin energy conservation examination procedure and standard”
		Implement energy audit on 50 key energy consumption enterprises
		Complete energy consumption audit on enterprises whose annual energy consumption beyond 5 thousand tce.
		Improve energy efficiency monitor platform management in Shanghai industry sector
Building	Energy consumption limitation and guideline	Research on reasonable energy consumption methodologies, and carry out guidelines for government buildings, schools, hospitals, hotels, and commercial buildings.
		The temperature is fixed on 26 ℃ in summer in government buildings
	Energy saving	Energy conservation design standard for public building

	standard for building design and construction	Energy conservation design standard for residential building
		Energy conservation reformation guideline for existing buildings
		Research and set energy consumption limitation for building construction
Transportation	Energy consumption limitation and reasonable guideline	Reformed more than 30 thousand buses, resulted in 5% decrease of fuel consumption
		Research on complete energy consumption limitation standard for per unit of port throughput, energy consumption per unit of port throughput decreased by 23%
		Encourage fuel saving driving measurements
		Public transportation priority development strategy
		Develop clean energy bus
		Public transportation share rate reach above 30% by 2015
Household	Renewable energy	Pilot project to integrate renewable energy with building, covering 1.2 million m2 of building area
		More than 400 thousand household installed solar water heaters
		Built 100 straw gasification stations, 30 thousand biogas pools
		10 million m2 building area supplied with geothermal heating
	Standard and reform	Constructed 120 million m2 of domestic buildings according to new high energy conservation standard, take 62% of total urban residential buildings
		Carry out "Tianjin heating supply metering methodology for residential building". Heating supply metering implemented on 30 million m2 building in Tianjin, whose heating consumption level is 11% lower than average level.
		Broadcast 7 million high efficiency lamps
Waste	Recycle	Built the first waste incineration power plant in Tianjin

2.4.3 Liaoning

In Liaoning's 12th five-year plan (2011-2015), it set its key targets include economic development goal of 11% annual growth rate of GDP, and the service sector will take about 42% in the total GDP. Under this framework, Liaoning government also set its energy saving and pollutants mitigation targets during 2011 to 2015:

- Energy consumption per unit of 10000 yuan GDP should decrease by 17%
- CO2 emission per unit of 10000 yuan GDP should decrease by 18%
- Forest coverage increase from 38% of 2010 to 42% in 2015
- The share of non-fossil energy in the total primary energy consumption increased to 4.5%

To achieve above targets, Liaoning government carried out a package of policies and measurements to achieve energy conservation and GHG mitigation.

Table 14 Low-carbon development policies and practices of Liaoning

Area of policy	Policy tool	Contents
industry	Energy consumption standard	Energy consumption per unit of production: Steel: 0.64 tce/ton (2010);0.60 tce/ ton (2015) Non-ferroalloy: 4.5 tce/ ton (2010); 4.0 tce/ ton (2015) Oil refining: 12 kgoe/ ton (2010) 11 kgoe/ ton (2015)
		energy consumption per unit of cement, flat glass deceased by 20% during 2006 to 2010, and decrease further 10% during 2011 to 2015
	Administration standard	Implement "adjustment of industry structure guideline"
		Implement national industry entrance standard on 13 industries, such as steel, ferroalloy and coke.
	Adjust and phase out backward capacity	Reform coal fired boilers/furnaces with low efficiency
		Adopt high efficient motor, turbine, pump
		Implement waste pressure and waste heat reutilization
		Phased out backward capacity by the end of 2010: Iron: 3 million ton; steel: 5 million ton; small scale thermal power: 1 GW; ferroalloy: 240 thousand ton; coke: 1.6 million ton; calcium carbide: 240 thousand ton; paper: 850 thousand ton; alcohol: 1 million ton; cement: 7 million ton
	Energy conservation audit, monitor and verification	Carry out "Liaoning energy conservation monitor methodology"
		Provincial monitor department implement energy conservation monitor on enterprises whose annual energy consumption beyond 100 thousand tce, city monitor department implement energy conservation monitor on enterprises with annual energy consumption between 2 to 100 thousand tce.
		Complete energy consumption audit on 11 government buildings, 69 hospital buildings, 177 school buildings, 10 commercial buildings, 19 hotel buildings
		Verification institutions evaluate the reasonability of enterprises' energy consumption (annual energy consumption beyond 3000 tce or electricity consumption beyond 3 million kWh.
Energy	Renewable energy[2]	Installation capacity of wind power increased beyond 1.5 GW in 2010, 6 to 10 GW in 2015
		Installation capacity of hydro power increased beyond 1.5 GW in 2010
		Installation capacity of solar power increase to 300 MW by 2015
		Installation capacity of nuclear power increase to 4 GW by 2015
		300 large and middle scale biogas project were built in 2010
Building	Energy consumption	Implement national energy saving standard for buildings
		New buildings should achieve energy conservation by 65%

[2] There are 27 large scale state owned electricity generation companies in China, who take a share of 70% of total installed capacity in China. And they usually set sub companies in various provinces and cities. Renewable energy was highlighted in Liaoning province here does not mean Liaoning government has province-owned power company, it just because Liaoning has rich of renewable energy resources which was set to be an important path to control carbon emission.

	limitation and guideline	Rural regions residential buildings should achieve energy conservation by 50%
	Energy saving standard for building design and construction	Implement national energy saving standard for buildings
		Encourage energy saving reform for commercial buildings with area more than 10,000 m2
		10 pilot projects for low energy consumption and green buildings
		30 pilot project of renewable energy utilization in buildings
		Popularize 5 million high efficient lamps through bulk purchase
		High efficient lamps supply 60% lighting in 2010, and try to achieve 100% by 2015.
Transportation	Energy consumption limitation and reasonable guideline	Encourage the development of public transportation
		Establish city public transportation system pillar with bus and rail traffic
		Encourage the utilization of energy saving vehicles and hybrid vehicles[3]
		Implement fuel consumption limitation standard for passenger cars and light commercial vehicles
Household	Renewable energy	Spread solar water heaters to be installed in rural areas; Solar heating and cooling technology to be demonstrated in urban regions.
		Water source heat pump and ground source heat pump supplied heating for more than 110 million m2 buildings
		Biogas supplied energy for 6000 thousand households
	Standard and reform	Energy saving reform on 10 million m2 of existing residential buildings
Waste	Recycle	Built 99 sewage disposal work additionally
		Improve gray water reuse, enhance reuse rate of gray water
		Improve the circulation use of the kitchen waste and organic waste; complete recovery system for “renewable resources”
		Encourage appropriate packaging system
		Build waste incineration power plant
		Waste harmless disposal rate reach 85% by 2015

2.5 Impeding factors to generate and use data needed for carbon management

2.5.1 GHG inventory compiling

2.5.1.1 Limitation of GHG inventory compiling

Lack of GHG emission factor consistent with China practical status

[3] The limitation on small displacement (engine) vehicles traveling in a stipulated region or during a certain time was revoked by Liaoning government.

Emission factor cited from IPCC usually derive from developed countries, which have large differences with the situation of China. So that China has to develop its own emission factors consistent with its practical situation.

Lack of data of activity level

China lacks of some regular statistic data because of premature statistic system. So that collected data can't satisfy the demanding of compiling GHG inventory. Or the data can't be used directly because of the poor reliability.

Dispersion of information

Climate change covers a lot of fields, so that the related policy information also littered in many fields. Furthermore, many policies don't aim at addressing climate change, but they do brought co-benefits on climate change mitigation, which enhance the difficulties of information collection and summary.

But there are also many barriers in the compilation of GHG inventory. The most difficult is hard to collect data, especially the data about land use change and forest, the double counting problem, inflow and outflow of electricity between various provinces, and so on.

2.5.1.2 GHG inventory compiling in Tianjin

The GHG inventory compiling in Tianjin was incepted on 13th May, 2011. Tianjin DRC held kick-off meeting to arrange the data collection, management and reporting of related sectors and industries, while Tianjin Environment Science Institute published technical statement for GHG inventory compiling on the meeting. The stakeholders involved in the GHG inventory compiling map please refer to figure followed.

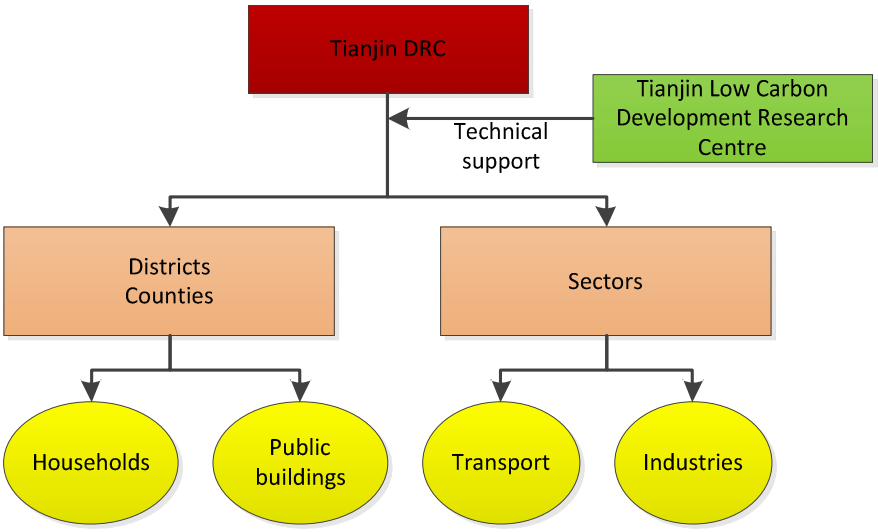


Figure 8 Stakeholders map of Tianjin GHG inventory compiling

Tianjin Low Carbon Development Research Centre was just established on July 2011, which is a supporting institution of Tianjin Environment Protection Science Institute. At present, this

Centre mainly focus on the Tianjin GHG inventory compiling, including inventories at city level, district/county level. The centre try to establish an interactive database and analysis system based on GHG inventory, to serve technical consult for Tianjin and other provinces/cities in the future.

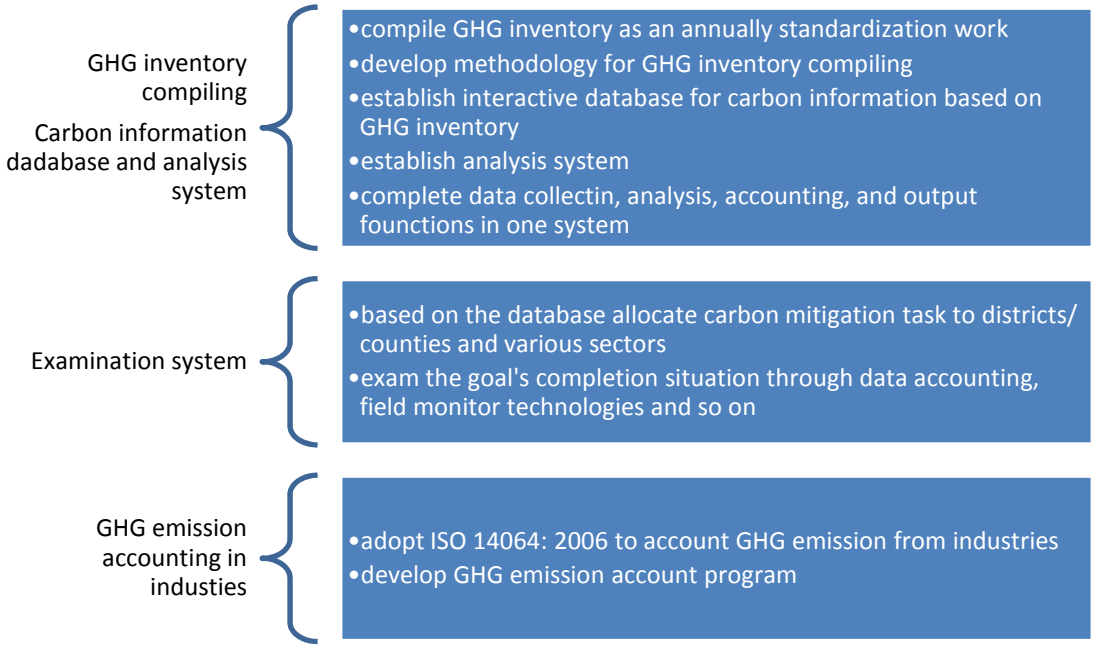


Figure 9 GHG inventory compiling in Tianjin

Because GHG inventory compiling is a new and hard work for provincial officers and experts, the centre established cooperation relationship with domestic and international institutes or universities such as WRI (World Research Institute), Tsinghua University, Guangzhou Energy research institute of CAS, IVL, and ICETT to learn experience.

2.5.1.3 Energy consumption statistics in Shanghai

From 2008, Shanghai establishes the methodology for energy consumption statistic, which includes following items. Shanghai also established energy efficiency monitor platform to monitor energy consumption situation for 660 industries whose annual energy consumption beyond 50 million tce every month.

2.5.1.4 GHG inventory compiling in Liaoning

As the province included in pilot projects of provincial GHG inventory compiling, Liaoning mainly depends on experts from national group. Some expert involved in this project said the GHG inventory compiling at provincial level will do some correction based on the national level. For example the inflow and outflow of electricity between various regions, and also the direct and indirect emission accounting are the key points of provincial inventory. But there are no further detail information disclosed.

Table 15 Energy consumption investigation system

	Scope	Frequency	Organization
Complete current investigation on large scale industries	Energy bought, consumption, stocks, transform, and renewable energy, and fuel with low heat, industrial waste	Seasonal	Statistics bureau of Tianjin
Establish survey for middle and small scale industries	Electricity, coal, coke, gasoline, diesel, LPG, NG, manufactured gas	Seasonal	Sampling survey by statistics bureau of Tianjin
Establish survey for agriculture sector	Coal, gasoline, diesel, NG, electricity	Annual	Statistics bureau of Tianjin
Establish survey for construction sector	Coal, manufactured gas, NG, gasoline, diesel, other petroleum products, electricity	Seasonal	Survey of main units by transportation and construction committee of Tianjin
Establish survey system for wholesale, retail and hotel sector	Coal, manufactured gas, NG, gasoline, diesel, kerosene, other petroleum products, electricity	Seasonal	Statistics bureau of Tianjin
Establish survey system for restaurant sector	Coal, manufactured gas, NG, gasoline, diesel, kerosene, other petroleum products, electricity	Seasonal	Establish survey system for wholesale, retail and hotel sector; Full survey for large scale units, sample survey for small scale ones
Establish survey system for transport sector	Coal, manufactured gas, NG, gasoline, diesel, kerosene, other petroleum products, electricity	Seasonal	Statistics bureau of Tianjin Transport and construction committee
Establish survey system for education	Coal, manufactured gas, NG, gasoline, diesel, kerosene, other petroleum products, electricity	Seasonal	Tianjin Education Committee
Establish survey system for hospitals	Coal, manufactured gas, NG, gasoline, diesel, kerosene, other petroleum products, electricity	Seasonal	Public health bureau of Tianjin
Complete energy consumption survey system for households	Coal, gasoline, diesel, NG, LPG, electricity, coal gas	Seasonal	Statistics bureau of Tianjin
Complete new and renewable energy survey system	Wind, solar, biomass, hydro, nuclear	NA	NA

2.5.2 Estimated CO2 mitigation

2.5.2.1 Tianjin

Tianjin will adopt 5 main measurements to improve its industry structure and control the CO2 emission, including:

Table 16 Measurements and energy saving potential in Tianjin

Measurements	Mitigation potential
Substitution power generation	Electricity generation: 663 GWh, energy saving: 66 thousand tce
Heat supply metering for residents buildings	Energy consumption reached 98.75 kWh/m2, decreased by 11%
Solar energy utilization in buildings	Implemented for 14000 m2
Static var compensation utilized in light rail train	6220 tons of CO2 mitigation
Diesel to electricity in container terminal	Energy consumption per standard container decreased from 0.783 L diesel to 1.096 kWh, and the cost decreased by 79% per unit
Implement EPC	Estimated to achieve 340 thousand tce of energy saving by June, 2011

2.5.2.2 Shanghai

Shanghai published a package of policies and measurements to improve energy efficiency and conservation, and made great progress.

Table 17 Measurements and energy saving potential in Shanghai (2010)

Measurements	Mitigation potential
10 key energy saving technology transform	0.6 million tce
Phase out 600-700 low efficient projects	0.9 million tce
More than 200 EPC	60 thousand tce
Spread 12 million high efficient lamps	Electricity saving: 600 GWh
Spread 500 thousand high efficient AC	Electricity saving: 60 GWh
Cleaner production and resources comprehensive utilization pilot projects	150 thousand tce
Comprehensive utilization of fly ash	2.15 million tce, and achieve CO2 mitigation 5.29 million ton

2.5.2.3 Liaoning

In 2009, public buildings included in energy statistics were 10935, with a total area of 48.2 million square meters, and vehicles of 39 thousand. The energy consumption in public buildings please refers to the table followed:

Table 18 Energy consumption status in public buildings in Liaoning

Items	**2008**	**2009**	**Decrease rate**	
			per m2	per capita
Electricity (TWh)	1.10	1.05	4.64%	4.48%
Water (million ton)	139	99	29.3%	29.19%
Coal (million ton)	1.26	1.18	6.41%	6.55%
Natural gas (million m3)	3.21	3.67		
LPG (ton)	2234	1353	1.77%	1.67%
Manufactured gas (million m3)	7.22	8.76		
Gasoline (thousand L)	21.4	19.5	4.94%	1.67%
Diesel (million L)	22.0	22.0		

During the 12th Five-year plan period, Liaoning Province will further implement energy conservation measurements for public buildings. The whole measurements and mitigation potential refers to table followed.

Table 19 Measurements and mitigation potential

Measurements	Scale	Targets
energy conservation transform	10% of public buildings	Energy consumption per capita decreased by 15%; and energy consumption per m2 decreased by 12%
high efficient lamps	100% saturation	
new and renewable energy	Take at least 20% energy in total energy consumption in public building	
energy saving and new energy cars	Amount to 50% of new buy cars for public organizations	
Water efficient appliance	100%	

2.5.3 Perceived roles & influence

As one might expect in an authoritarian state, the government is seen as the central driver of LCD in China. As demonstrated by the following statement made by the National Resources Defence Council (NRDC):

"The government plays the most important and powerful role"

The National Development and Reform Council (NDRC) is the government department in charge of LCD planning, strategy and implementation. However, addressing climate change and forwarding low carbon development is a complex and cross-sector cutting issue requiring the collaboration of multiple actors. In order to meet this challenge, the Chinese

government has set up the 'National Leading Committee on Climate Change' comprised of multiple government departments.

Civil Society

The civil society actors included in the research can be divided into two sub groups: NGOs and research institutes. The NGOs interviewed understood their role to be slightly different, reflecting the alternate priorities of these separate organisations. The roles described by the NGOs interviewed ranged from raising public awareness about low carbon development in order to mobilise public support, to carrying out research on specific areas of LCD in order to inform policymakers in government. The NRDC stated that its 'primary role in China is to support leading domestic efforts on energy efficiency and environmental pollution', exemplifying their stated objectives. On the other hand, China Dialogue stated that their role was to provide 'independent media' relating to shared environmental challenges.

There were two representatives from separate research organisations interviewed who described themselves as civil society organisations. After some background research was undertaken, it became apparent that the 'Energy Research Institute' (ERI) actually operated under the NDRC, the government ministry that leads LCD efforts in China.

The research institutes described their role in regards to LCD planning and implementation as one in which they undertake 'exploratory research' on LCD initiatives in order to provide advice and policy suggestions for central government. The institute has also been approached by local government to provide expertise on local level LCD planning.

Overall, the civil society organisations interviewed viewed the government as the central driver of LCD in China, setting national policy to be implemented by local government agencies and imposing regulations upon the private industry.

Government

In regards to LCD planning and implementation, the government departments and government affiliated research institutes interviewed were unanimous in their understanding of the power and influence that resides with government organisations. All respondents ranked government influence very highly and asserted that central government is the key driver of LCD in China.

3 List of interveiwees and references

1) China's Policies and Actions for Addressing Climate Change (2010, in Chinese)

2) The Renewable Energy Law of the People's Republic of China (2010)

3) Forest Law of the People's Republic of China (2004)

4) The 12th Five-Year Plan for National Economic and Social Development (2011, Chinese version)

5) China's Policies and Actions for Addressing Climate Change (2009)

6) China's National Climate Change Programme (2007)

7) China's Scientific & Technological Actions on Climate Change (2007)

8) China's Energy Condition and Policies (2007)

9) Notice about low carbon provinces and cities pilot project by NDRC (2010, Chinese version)

10) Measures for Operation and Management of Clean Development Mechanism Projects in China (2005)

11) China's Regional Grid Baseline Emission Factors 2009 for "new grid connected fossil fuel fired power plants using a less GHG intensive technology projects" (2009, Chinese version)

12) Climate Change Program in local level (including 31 provinces and cities in China, Chinese version)

13) National Communication on Climate Change. http://nc.ccchina.gov.cn/web/NewsInfo.asp?NewsId=211

14) 国务院关于印发"十二五"节能减排综合性工作方案的通知. 2011 年 9 月 7 日. http://www.gov.cn/zwgk/2011-09/07/content_1941731.htm

15) 电力行业"十二五"规划——优化发展煤电. http://www.cec.org.cn/zhuanti/dianlixingyeshierwuguihua/youhuadianyuanjiegouhebuju/2011-01-18/38643.html

16) 电力行业"十二五"规划——大力发展核电. http://www.cec.org.cn/zhuanti/dianlixingyeshierwuguihua/youhuadianyuanjiegouhebuju/2011-01-18/38642.html

17) 电力行业“十二五”规划——积极发展风电等可再生能源发电. http://www.cec.org.cn/zhuanti/dianlixingyeshierwuguihua/youhuadianyuanjiegouhebuju/2011-01-18/38641.html

18) 电力行业“十二五”规划——适度发展天然气集中发电. http://www.cec.org.cn/zhuanti/dianlixingyeshierwuguihua/youhuadianyuanjiegouhebuju/2011-01-18/38640.html

19) 电力行业“十二五”规划——因地制宜发展分布式发电. http://www.cec.org.cn/zhuanti/dianlixingyeshierwuguihua/youhuadianyuanjiegouhebuju/2011-01-18/38639.html

20) 电力行业“十二五”规划——优先开发水电. http://www.cec.org.cn/zhuanti/dianlixingyeshierwuguihua/youhuadianyuanjiegouhebuju/2011-01-18/38639.html

21) 钢铁“十二五”规划“浮出水面”. http://news.xinhuanet.com/fortune/2011-01/26/c_121023986.htm

22) 石油和化学工业“十二五”发展指南

23) 建筑材料工业“十二五”科技发展规划. http://www.ocn.com.cn/market/201110/jiancai251057.shtml

24) 上海市国民经济和社会发展第十二个五年规划纲要

25) 上海市人民政府关于印发上海市 2011 年节能减排和应对气候变化重点工作安排的通知

26) 天津市国民经济和社会发展第十二个五年规划纲要

27) 辽宁省国民经济和社会发展第十二个五年规划纲要

28) 新区九成垃圾将变电能 更多垃圾“变身”能源. http://www.tjdpc.gov.cn/templet/default/ShowArticle.jsp?id=23729

29) 天津超六成住宅为节能建筑 达到全国先进水平. http://www.tjdpc.gov.cn/templet/default/ShowArticle.jsp?id=23597

30) 本市节能工作获国务院通报表扬“十二五”主抓五大领域打好节能降耗持久战. http://www.tjdpc.gov.cn/templet/default/ShowArticle.jsp?id=23500

31) 本市分解“十二五”规划任务 确保完成十一个“硬指标”. http://www.tjdpc.gov.cn/templet/default/ShowArticle.jsp?id=23593

32) 上半年超额完成节能降耗任务 全市单位 GDP 能耗同比下降 4.59%. http://www.tjdpc.gov.cn/templet/default/ShowArticle.jsp?id=22477

33) “十二五”天津公共交通出行分担率将达30%以上. http://www.tjdpc.gov.cn/templet/default/ShowArticle.jsp?id=19439

34) 50亿元实施289项重点节能技术改造项目. http://www.tjdpc.gov.cn/templet/default/ShowArticle.jsp?id=21271

35) 天津市应对气候变化方案

36) 上海市应对气候变化方案

37) 上海市单位GDP能耗统计指标体系实施方案

38) 辽宁省应对气候变化方案

39) 辽宁省节约能源监察办法

40) 辽宁省节能减排综合性工作方案

41) 辽宁省人民政府关于确保实现全省“十一五”节能减排目标的通知

42) 辽宁省首批重点节能减排技术目录

43) EU-China Trade project (EUCTP) (2011) ‘English Translation of China’s Twelfth Five Year Plan’. Available at: <http://www.euctp.org/index.php?option=com_jdownloads&Itemid=19&view=finish&cid=193&catid=42&m=0&lang=eeu> (accessed 10/08/2011)

44) Heburn, C., (2007) ‘Carbon Trading: A Review of the Kyoto Mechanisms’, Annual Review of Environment and Resources, Vol. 32, 375-393.

45) Hu et al., (2011) ‘Study on China's low carbon development in an Economy–Energy–Electricity–Environment framework’, Energy Policy, Vol. 39, 2596-2605.

46) Price et al., (2011) ‘Assessment of China's energy-saving and emission-reduction accomplishments and opportunities during the 11th Five Year Plan’, Energy Policy, Vol. 39 (4) 2165-2178.

47) Urban, F. & Yu, W. (2009) ‘Climate Change, Energy, and Low Carbon Development in the Chinese Context’, IDS in Focus 8.2, IDS, Brighton.

48) Zhang, Z.X. (2010) ‘China in the transition to a low carbon economy’, Energy Policy, Vol. 38 (11) 6638-6653.

49) Zhou, N., Levine, M.D., Price, L. (2009) ‘Overview of current energy-efficiency policies in China’, Energy Policy, Vol. 38 (11) 6439-6452.

Organisation Interviewed	Organisation type
Natural Resources Defence Council	Civil society
Liaoning Development and Reform Committee	Government
Tianjin Development and Reform Committee	Government
Shanghai Development and Reform Committee	Government
World Wide Fund for Nature	Civil society
China Dialogue	Civil society
Institute of Energy, Environment and Economy, Tsinghua University	Civil society
Civil Aviation Administration of China	Government
National Development and Reform Committee	Government
Chinese Academy of Environmental Planning	Government
Research Institute for Fiscal Science, Ministry of Finance	Government
The Administrative Centre for China's Agenda 21	Government
Energy Research Institute, National Development and Reform Committee	Government
DFID – China	Donor
Huaneng Group	State-owned enterprise
CDM review experts for DNA	NGO
Tianjin University of Technology	Civil society
Shanghai Environment and energy exchange	Civil society
Research Institute of Urban & Regional Economics, Shanghai Academy of Development & Reform	Civil society
Science and Technology Committee of Chongming, Shanghai	Government
Shanghai Institute for Science of Sciences	Civil society
Institute of Atmospheric Environment, CMA, Shengyang Liaoning Meteorology Institute	Civil society
Tianjin Climate Exchange	Civil society