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IN THE PEOPLE'S REPUBLIC OF

CHINA

**An Overview concerning Chinese Domestic Laws,
and the Instruments and Measures of Climate Change Mitigation**

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This paper aims to summarize China's policies and measures to address Climate Change, and to introduce major determinants and consequences of that policy, as well as the actors involved in the policy process. An overview of sector-based mitigation policies is also given. The report is focused on Energy Efficiency and Renewable Energies, as these involve major mitigation strategies and embrace many of the key components aimed at reducing greenhouse gas emissions.

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List of Abbreviations and Acronyms

CDM	-	Clean Development Mechanism
CNCCP	-	China's National Climate Change Programme
CNOOC	-	China National Offshore Oil Corporation
CO_2	-	Carbon Dioxide
COD	-	Chemical oxygen demand
CRED	-	Centre for Renewable Energy Development
DSM	-	demand-side management
EB	-	Energy Bureau
EE	-	Energy Efficiency
EPB	-	Environmental Protection Bureaux
ERI	-	Energy Research Institute
FYP	-	National Five-Year Plan for Economic and Social Development of People's Republic of China
gce	-	Gram of coal equivalent
GDP	-	Gross domestic product
GHG	-	Greenhouse gas
Gtc	-	Giga tons of carbon
GW	-	Gigawatt
IPCC	-	Intergovernmental Panel on Climate Change
Kgce	-	Kilogram of coal equivalent
Kwh	-	Kilowatt hour
LNG	-	Liquefied natural gas
Mb/d	-	Millions of Barrels per Day
Mt	-	Million tons
Mtce	-	Million tons of coal equivalent
Mtoe	-	Million tons of oil equivalent
MOC	-	Ministry of Construction of People's Republic of China
MOE	-	Ministry of Energy of Peoples' Republic of China
MOFCOM	-	Ministry of Commerce of People's Republic of China
MOF	-	Ministry of Finance of People's Republic of China
MOST	-	Ministry of Science and Technology of People's Republic of China
MWR	-	Ministry of Water Resource of People's Republic of China
NCCCC	-	National Coordination Committee on Climate Change
NDRC		National Development and Reform Commission of People's Republic of China
NELG	-	National Energy Leading Group
NGO	-	Non-Governmental Organization
NO_x	-	Nitrogen Oxides
NPC	-	National People's Congress
ONELG	-	Office of the National Energy Leading Group
PV	-	Photovoltaic
RE	-	Renewable Energy
SAC	-	Standardization Administration of China
SASAC	-	State Asset Supervision Administration Commission
SEPA	-	State Environment Protection Administration
SERC	-	State Electric Power Regulatory Commission
SO_2	-	Sulphur Dioxide
SUV	-	Sport utility vehicle
TWh	-	Terawatt-hours
PPP	-	Purchasing Power Parity

1. Background – developments & recent trends

Over the past two decades China has emerged as the manufacturing workshop of the world. The country is experiencing a sustained period of rapid economic growth, accompanied by significant increases in energy demand. Meanwhile, China's greenhouse gas emissions are growing quickly to become number one in the world – an event that may have already happened.[1]

Fast-paced economic growth has gone hand-in-hand with a steep decline in poverty and improving human development indicators. But China has paid a high price for these outstanding developmental achievements that are at once wasteful in the use of scarce natural resources and highly polluting. Concentrations of both air and water pollutants are among the highest in the world, causing damage to human health and loss of agricultural productivity. According to a report from the World Bank and the State Environment Protection Administration (SEPA, recently was upgraded to Ministry of Environment Protection), the total costs of air and water pollution alone account for 5.8% of China's GDP (World Bank, 2007). Including groundwater, soil and indoor air pollution in those calculations, China's Green GDP performance would be much worse, Pan Yue, vice-minister of SEPA said.[2]

1.1 Climate change impacts in China

China is highly vulnerable to climate change. By 2020 average temperatures in China are projected to be between 1.1 and 2ºC above 1961–1990 levels. The effects will be severe: more extreme weather events, more droughts, spreading deserts and reduced water supplies. Various impacts of climate change have already been observed in different sectors and regions in China: the damage caused by intense cyclones has risen significantly; annual rain declined in past decade in North-East and North China and increased in Western China, the Yangtze river area and along the south-east coast; a seven-fold increase in frequency of floods since 1950s has been recorded; increasing frequency of extreme rains in western and southern parts including Yangtze river; an increase in dust storms and an expansion of areas affected; and an increase in the territory affected by drought has exceeded 6.7 Mha since 2000 (IPCC, 2007a; Cruz et al. 2007).

Projections for agriculture estimate that the impact of climate change could lead to a fall of the production of rice, maize and wheat by 10 percent by 2030, and by up to 37 percent during the second half of the century - if climate change remains unchecked (Lin et al., 2007). The river systems of northern China, the Hai, Huai and Huang (Yellow) River Basins - which supply just under half of China's population with water - have suffered severe ecological pressures generated by rapid economic growth. Riverbeds already run dry before they reach the sea and groundwater tables are sinking significantly in some places. As drought, rising temperatures and reduced runoff under climate change take effect, the river systems of northern China could rapidly turn an ecological crisis into an outright social and economic disaster (UNDP, 2007).

One in every two of the rural poor lives in an area affected by climate change. As most of them directly dependent on agriculture, they are especially vulnerable and the least able to protect themselves

[1] Netherlands Environmental Assessment Agency: (June 2007): "China now no. 1 in CO2 emissions; USA in second position" available at: http://www.mnp.nl/en/

[2] China Daily (September 2006): "GDP takes on a green hue in new figures" available at: http://www.chinadaily.com.cn/china/2006-09/08/content_684086.htm

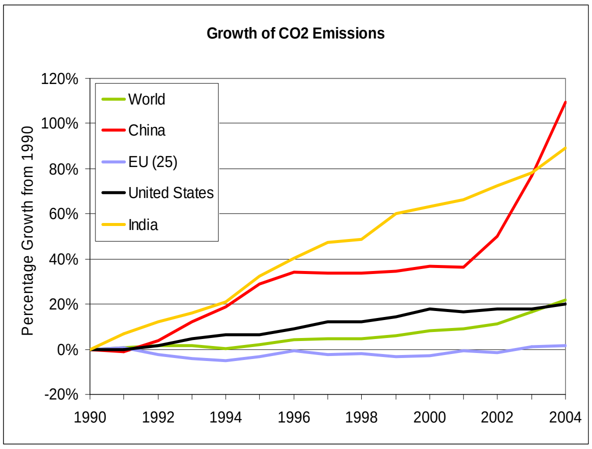
against the impact of environmental degradation and climate change - conditions which could lead to sudden spikes in rural-to-urban migration levels in China (Cruz et al., 2007).

The glaciers of Qinghai-Tibet plateau are retreating at the dramatic rate of 131.4 square kilometres annually; the permafrost in Tibet has gotten thinner by up to 25 meters. The increased flows of water from ice melt are likely to lead to more flooding in the short term. In the long term, deglaciation will cause water shortages, deprive communities of their water, transform large swathes of China's environment, and reduce water flow into the main river streams that originate on the Qinghai-Tibet plateau. This decline of water flow, in combination with rising temperatures and unsustainable land-use practices, will drive up the rate of desertification and increase the number of sand storms (UNDP, 2007).

Economic centres in coastal zones are particularly at risk to climate-related hazards. The IPCC's Fourth Assessment Report anticipates 40-60 cm of sea level rise and flooding up to 5,500 sq km in the Pearl River Delta. Shanghai, located at an elevation of only 4 metres above sea level, faces acute flood risks caused by summer typhoons, storm surges and excessive river runoffs (Parry, M.L. et al., 2007).

The most recent extreme weather event illustrates China's close link between climate and energy security. Extreme snowstorms in February 2008 have directly impacted more than 100 million people across central, eastern, and southern China. The worst snowstorms in half a century, claimed 129 lives, affected over 11.86 million hectares of cropland and one destroyed tenth of China's forests. The Government estimates the economic losses to be $21.11 billion. According to state media, 7 percent of China's coal-fired power plants were shut because snow hampered the necessary coal shipments.

Energy resources are distributed imbalanced - the bulk of coal is mined in the western provinces of Shanxi and the north-western region of Inner Mongolia and Xinjiang whereas the industrialized south-eastern and central coastal provinces are the main consumers (State Council, 2007). More than 40 percent of rail capacity is devoted to transport the coal across the country (IEA, 2007). While the extreme weather China recently encountered has undoubtedly hurt coal supplies, they also demonstrate the fragility of the existing infrastructure to secure adequate and consistent supplies of coal to fuel the economy.



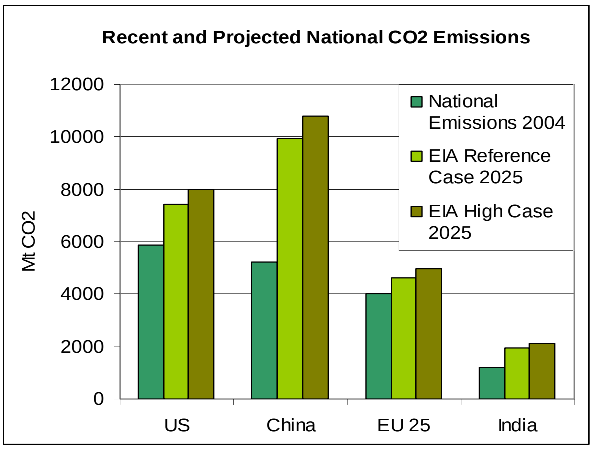


Figure 1: Growth of CO2 Emissions, Country Comparison 1990-2004, left side; Recent and Projected CO2 Emissions by EIA, right side (Source: Climate Analysis Indicators Tool (CAIT), World Resource Institute, 2008)

1.2 The energy challenge

Chinas carbon dioxide emissions have grown by about 110% since 1990, driven in large part by increased consumption of electricity generated from coal (see Figure 1). In 2006, China's CO_2 emission growth rate reached 1.6 GtC per year, about 20% of global CO_2 emission growth (Zeng et al., 2008). However, its per capita carbon emissions level is still below the world average; over three times less than the EU average and six times less than the US average.[3]

Much of China's economic growth is fuelled by the country's heavy dependence on coal. Coal is the backbone of its energy system (see Figure 2). The main strategy for domestic energy security involves having reliable access to coal. 99 percent of the demand of coal was met by domestic coal production in 2005 (Eifert et al. 2007). 96% of the fossil fuel reserve is coal, petroleum and natural gas together accounts for just 4% (Zhou, D., 2003). Despite efforts to diversify the country's primary energy sources, the substantial resource base and relatively low costs has made China to the largest global coal consumer and producer in the world. China produces and consumes 38% of the world's coal, approximately double the share of any other country. Without radical government interventions, coal as the cheapest resource - which is cheap only to the extent that public health and environmental costs are ignored - still remains dominant in the nearer future (Lewis, 2007).

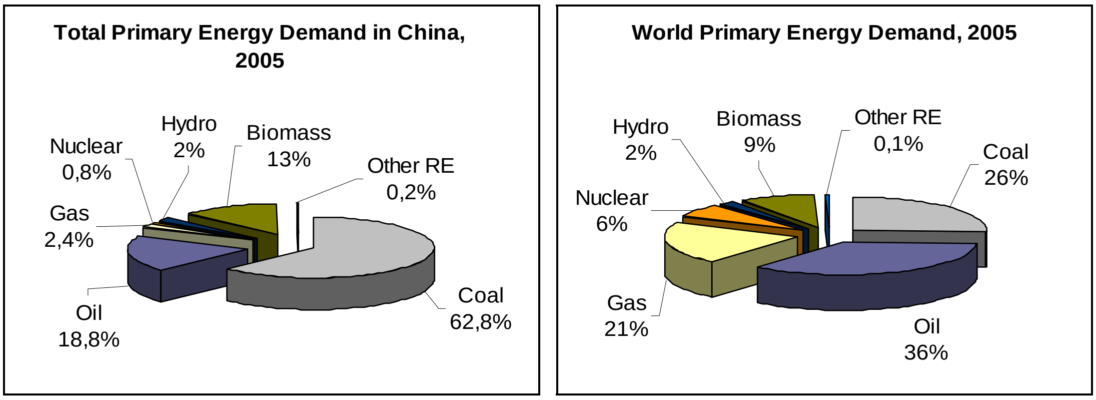


Figure 2: Total Primary Energy Demand in China (left) and the World (right), 2005 (Source: IEA, 2007)

If China's carbon usage keeps pace with a GDP growth rate of 7%, the country's carbon dioxide emissions will reach 8 Gtc a year by 2030, which is equal to the entire world's CO_2 production today (Zeng et al., 2008). Fortunately, this is still only a possible scenario, as the potential capacity of renewable energy (especially of wind power and solar power, see Chapter 5) and energy efficiency is huge. Nevertheless, the current development path gives reason for concern: every week last year, two additional coal-fired power plants 500 megawatt are connected to the electric power grid (see also Figure 3). This pattern means that each year an additional capacity equivalent to the entire UK power grid (Katzer et al., 2007). Many of these plants are constructed without proper environmental approval.

It is important to note here that China is not just producing and consuming for itself. The outsourcing of manufacturing industries from industrialized nations to China as well as the active demand from consumers in Europe and America has to be counted. Wang and Watson (2007) have released a brief study, indicating that the net exports from China accounted for 23% of its total CO_2 emissions in 2004.

[3] World Resource Institute: Tons CO_2 Equiv. Per Person in 2003 (excludes land use change), available at: http://cait.wri.org

China's energy imports have risen sharply as well. Among other concerns, the transition from a largely self-sufficient energy consumer to a major player on the global energy market is raising national anxiety about energy supply security. In 2006, China's net oil imports reached 3.5 Mb/d - the third largest in the world after the United States and Japan. Over the past two years, China has also started to import natural gas in the form of liquefied natural gas (LNG) and became a net importer of coal for the first time in 2007 (IEA, 2007).

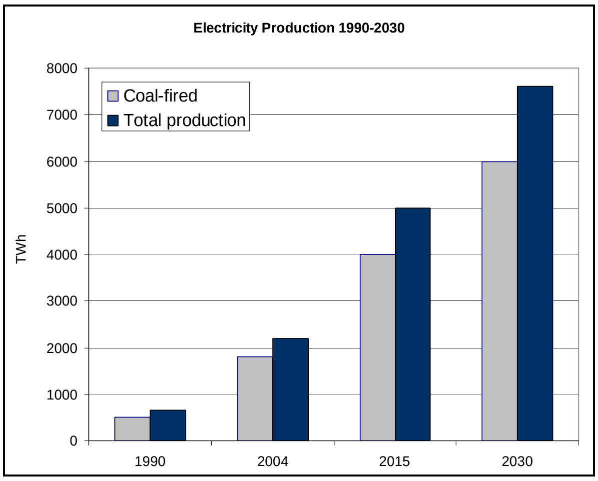


Figure 3: Electricity Production in China, 1990-2030**;**
IEA's reference scenario (Source: IEA, 2007)

China achieved exceptional energy efficiency during the period from 1980 till 2000 (see Carbon Intensity of Economy, Figure 4, left side). The GDP quadrupled, with only a doubling of the energy consumption. If we trust the statistics, this decoupling of the relationship between economic growth and energy consumption is a remarkable achievement, since it is widely accepted that growth in energy use is likely to be faster than economic growth in the early stage of economic development (Lin et al., 2006). During this stage, industrialization and urbanization tend to lead to extensive infrastructure and housing development: both are energy- and material-intensive activities.

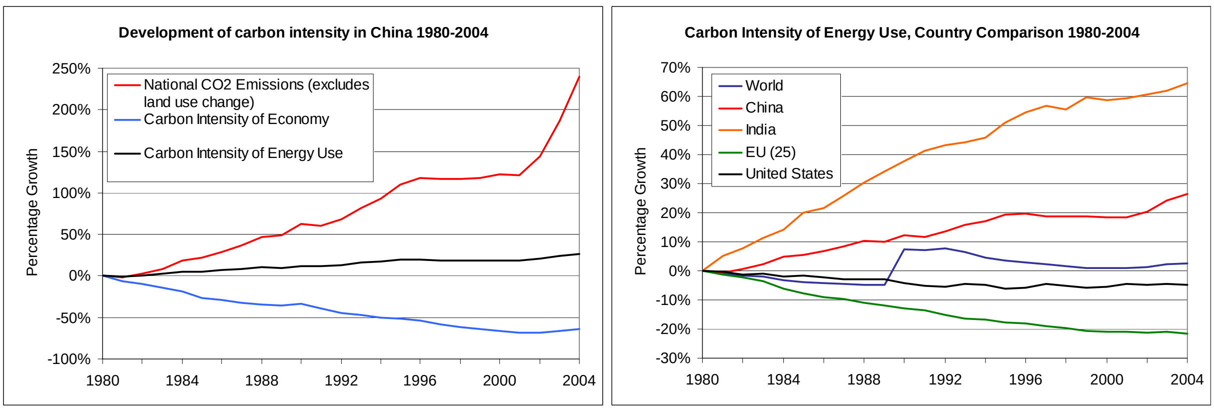


Figure 4: Left side: Development of carbon intensity in China 1980-2004; right side: Carbon Intensity of Energy Use, Country Comparison 1980-2004 (Climate Analysis Indicators Tool (CAIT), World Resource Institute, 2008)

China's performance in this respect has been ascribed to extensive and profound policy reforms by the Chinese government, mainly the allocation of capital investment to energy efficiency. The most widely used instruments have included low-interest loan programs, interest subsidies, tax credits, and tax reductions and exemptions as well as the establishment of a network of energy conservation service centres throughout China (Wang, 1995; Lin, 2007b). Additionally, energy resources were extremely scarce in the 1980s and the government regulated the distribution of resources in the mainly planned Chinese economy, which both made energy conservation easier to achieve (Andrews-Speed, 2005).

Still, the transition China is facing now related to the energy sector has various dimensions. China is moving from a planned to a more open market; from a predominantly agricultural economy to increasing urbanization and industrialization; from a country with low motorization to a rapid growth of motorization; from a mainly low efficient coal dominated energy supply to a to a more-sustainable energy supply mix; and at least from a country that was largely energy self-sufficient to a significant energy importer.

Since 2001, the energy transition is largely dominated by the accelerated growth of energy-intensive heavy industry (cement, iron and steel, chemicals, etc.) that is driving the high economic growth rate. China is now extensively producing the type of energy-intensive basic products (such as cement, steel and aluminium) to construct the roads and buildings that investment pays for. China now accounts for 48% of global cement production, 49% of global flat glass production, 35% of global steel production, and 28% of global aluminium production (Rosen & Houser, 2007).
As in Figure 5 shown, the energy efficiency in the main industry sectors has improved significantly over the last years. But no matter how much more efficient, the efficiency gains alone have not been nearly sufficient to compensate the structural shift towards these energy-intensive heavy industries and the relative growth in output of these sectors (Sinton et al., 2005). As a result, the overall energy intensity of industries is higher today than in the period 1980-2000. This rebound can be seen in Figure 4 (left side), where the carbon intensity of economy is rising slightly after 2002.

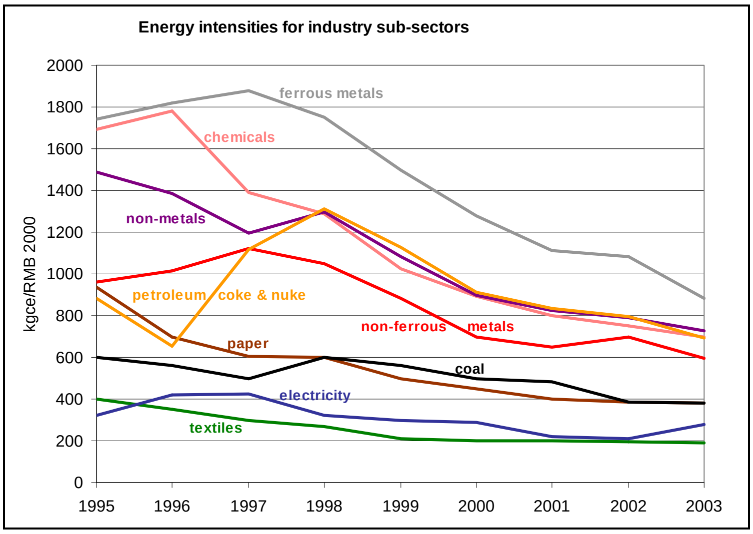


Figure 5: Energy intensities for selected industry sectors in China (Lin et al, 2006).

Energy supply is one of the most critical bottlenecks for the booming Chinese economy. In response to rapidly rising energy demand, the Chinese Government has put forth a number of ambitious national targets to diversify the energy supply and to improve efficiency in supply and demand. For example, the Renewable Energy Law requires an increase in the share of renewable in total primary energy supply from the current 7% to 15% (NDRC, 2006). Concerning energy efficiency, the Government established an ambitious near-term goal of 20% reduction of energy consumption per unit GDP by 2010 (baseline 2005) and furthermore a 10% pollutant emissions reduction target till 2010. The achievement of the 20% energy intensity improvement will save up to 1.5 billion tons of CO_2 emissions by 2010 and is therefore one of the most significant carbon mitigation efforts in the world today (Jiang et al., 2007).

These goals signal a shift in China's strategic thinking about its long-term economic and energy development. Even though environmental goals have been released in previous FYPs, they are prioritized as prerequisite targets for the first time in the 11th FYP. However, the extremely ambitious energy intensity reduction target is difficult to achieve, considering that energy consumption has grown more rapidly than GDP in the last five years and, as a result, energy use per unit of GDP (energy intensity) has increased. For example, in 2006, the energy intensity decreased only by 1.2%, which missed the yearly national target of 4%.

Therefore, achieving the 20% target requires even further major policy changes. Without large incentives to support energy-efficient technologies, discouraging wasteful practices, and shifting to less energy-intensive and more economically productive sectors, it is almost certain that this target would not be met (Lin et al., 2007).

In fact, current research further indicates that the failure of energy efficiency target during 2001-2005 can be traced back to the lack of energy efficiency investment in this period. Energy conservation investment was about 13% of energy supply investment in 1983, marking its highest level. By 2003, this proportion has dropped to about 4% (Lin, 2007b). As past experiences in China already showed that in addition to the administrative measures, financial incentives played a major role in mobilizing investment in energy conservation, the lack of financial support also describes a weakened policy commitment to energy conservation during the transition to a more market-based economy.

During the 1990s, China underwent great transformations, which weakened the effectiveness of administrative energy conservation policies. Administrative planning measures have been gradually replaced by market functions and the central government's authority to lead local governments and enterprises is not as marked as before. With the Chinese economy transforming from a planned to a market based structure, old administrative measures become ineffective.

The new energy conservation targets as well as the development of renewable energies, which the Chinese Government has set recently, are very important steps and drivers towards environmental technologies and developments to mitigate climate change. An important turning point towards policy support and financial incentives for energy conservation was the RMB 23.5 billion fund to promote energy efficiency and pollution reduction, allocated by the Ministry of Finance end of 2007.
Still, beneath the energy transition China has to cope with, there are so far still many challenges and open questions concerning the legal framework, the responsibilities and finally the financial system, to implement the targets and policies.

2. Responsibilities – Who is in charge?

Climate change mitigation is about transforming the way that we produce and use energy. Understanding the background for energy policy - one of the key priorities in China's development process - can help to reach a better understanding of one crucial determinant for its climate policy.

2.1 China's energy policy institutions

In the last decades, China's institutional basis for setting and implementing energy policies has experienced several substantial changes. The transition from plan to market has been characterized by a shift of strict hierarchical power and resources from centralized planning agencies and ministries to state-owned energy companies (Sinton et al., 2005). In general, the reorganizations have been incremental, piecemeal, and occasionally contradictory, but overall laid the basis for broad liberalization (Yang, 1995).

The first reorganization between 1981 and 1983 focused on the oil sector. Since a major concern of the central government was to stimulate oil production and eliminate direct governmental interference, the Ministry of Petroleum Industry was split into three **state-owned companies**: the China National Offshore Oil Corporation (CNOOC); Sinopec; and the China National Oil and Natural Gas Corporation (CNONC).

During the second reorganization from 1985-1988, the Ministries of Coal, Petroleum, and Electric Power were turned into state-owned enterprises to improve the efficiency of energy supply and the **Ministry of Energy (MOE)** was established to act as a coordinating body. In fact the function of the MOE was limited to the electricity sub-sector. As a result, again no central institution was actively coordinating the various sectors of the energy industry (Yang, 1995).

Furthermore these efforts also created an energy policy vacuum in Beijing. Most of the industry expertise that was once housed inside the industrial ministries became a part of the nation's energy companies (Rosen & Houser, 2007). Erica Downs describes the result as "ineffective institutions and powerful firms", where corporate interests of China's energy firms often dominate the national interests of the Chinese state (Downs, 2006).

During another round of administrative reforms in 1993, the Ministry of Energy was again abolished. Following that round, the State Planning Commission (today's National Development and Reform Commission, NDRC) exerted de facto control of the energy sector.

In March 2003, the Chinese energy administration was again reorganized. **The National Development and Reform Commission (NDRC)** became a "super ministry" and retained control in energy affairs. Matters concerning energy consumption and efficiency were referred to the environment department of the NDRC. After serious electricity supply shortages in 2003 and 2004, the government set up the **National Energy Leading Group (NELG)** in 2005, headed by Premier Wen Jiabao. All ministers relevant to the energy question became members and for the first time, the Ministry of Commerce (MOFCOM) was included, indicating the new importance of foreign energy trade. The NELG has the authority to coordinate among ministries and other government agencies to achieve energy policy goals.

Today most of the formal government mechanisms for shaping energy outcomes in China reside within the NDRC. The delegation of energy administration to state-owned companies generated a focus on the supply side, in spite of continued efforts to remain focused on moderating growth in energy demand (Sinton et al., 2005). Attempts have been made to create an MOE in the past, but have failed in the face of opposition from other ministries and state energy companies (Andrews-Speed, 2006). Nevertheless, what China does not have (since 1993) is a powerful institution or ministry to formulate and implement a cohesive energy policy.

The 11th National People's Congress (NPC) in March 2008 has been seen as a possible chance to re-establish a Ministry of Energy. But the result so far is again an interim solution on the way to a single ministry, due to the strong resistance of the big state-owned energy companies and the power struggle of various government agencies.

According to the reshuffle plan, China will establish a high level **National Energy Commission (NEC)**, acting as an inter-ministerial consultation and coordination body to develop national energy strategies and an extended **State Energy Bureau** under the NDRC, which will control administration and oversight of the energy sector. The NEC will replace the former National Energy Leading Group (NELG), which sought to draw together the various elements of policies led by other ministries that were also dealt with energy-related issues. The new State Energy Bureau is a fusion of the Office of the National Energy Leading Group (ONELG), the new nuclear energy branch from the cancelled National Defence and Science Committee and the former EB. (The former EB was special department of the NDRC and had the national authority over energy supply including the approval of energy projects of any meaningful size. Issues, including objectives, strategies, policy regulations etc., related to renewable energy are covered by a separate subsection of the EB.) The Office of the National Energy Leading Group (ONELG) continues to have the responsibility to advise long term energy strategies and coordinate the drafting of energy legislation (IEA, 2007).
These moves are seen as a step towards a more cohesive energy policy. However, the difficulties and obstacles to integrate all energy sectors still remain. NDRC is still the key body in the institutional architecture. The coordination of energy issues involves following ministries (see Table 1):

Energy sectors and the respectively responsible Ministries	
Coal power	Ministry of Land & Resource (MOLR)
Hydro power	Ministry of Water Resources (MOWR)
Biomass	Ministry of Agriculture (MOA) and National Forestry Administration (NFA)
Energy efficiency	new Ministry of Environment (formerly coordinated by division under NDRC)
Industry sector	new Ministry of Industry and Information (formerly coordinated by the Industry Bureau of the old EB)
Building sector	Ministry of Construction (MOC); responsibility includes district heating, gas supply and enforcement of building codes
Transport sector	new Ministry of Transportation (formerly regulated by Ministry of Communication)
Energy trade issues	Ministry of Commerce (MOFCOM)
Energy price regulations	State Bureau of Taxation
Energy Science and Technology Research	Ministry of Science and Technology (MOST); Tsinghua University and the Academies of Science, Engineering and Social Studies are allocated to MOST

Table 1: Ministries involved in the energy policy, based on the reorganisation plan of the 11th NPC, March 2008

Further important players related to gas, coal and oil issues are the powerful **state-owned enterprises -** Sinopec, China National Offshore Oil Corporation (CNOOC), China National Oil and Natural Gas Corporation (CNONC) and China Coal Corporation. The two grid-operating companies South China Grid Corporation (SCGC) and State Grid Corporation (SGC) are the single buyers who manage transmission, distribution and supply for end-customers across China. There are also non-governmental actors on a national level, and these are associated with implementation of policies are the national associations of relevant industries (e.g. the National Steel Association).

The State Council **Development Research Centre (DRC)** is a comprehensive policy research and consulting institution with strategic significance, operating directly under the State Council. The Centre's main function is to undertake research on the strategic and long-term issues related to the national economic (e.g. industrial development) and social development (including environmental protection) and provide policy suggestions and consulting advice to CPC Central Committee and the State Council.

The **Energy Research Institute (ERI),** formally tied to the NDRC, is the only energy economics and policy research institute at the national level in China; it occupies a position of considerable importance in the debate on energy policy and its implementation (GTZ, 2007). The ERI's main function is to develop a scientific and technical basis - especially in economic evaluation and assessment - for the development of the government's energy strategy and policy, including energy efficiency and renewable energy. Furthermore the ERI is conducting climate policy research (see 2.2). The **Center for Renewable Energy Development (CRED)** is subordinate to ERI and mainly carries out research work on technologies and strategic policies of renewable energy and rural energy.

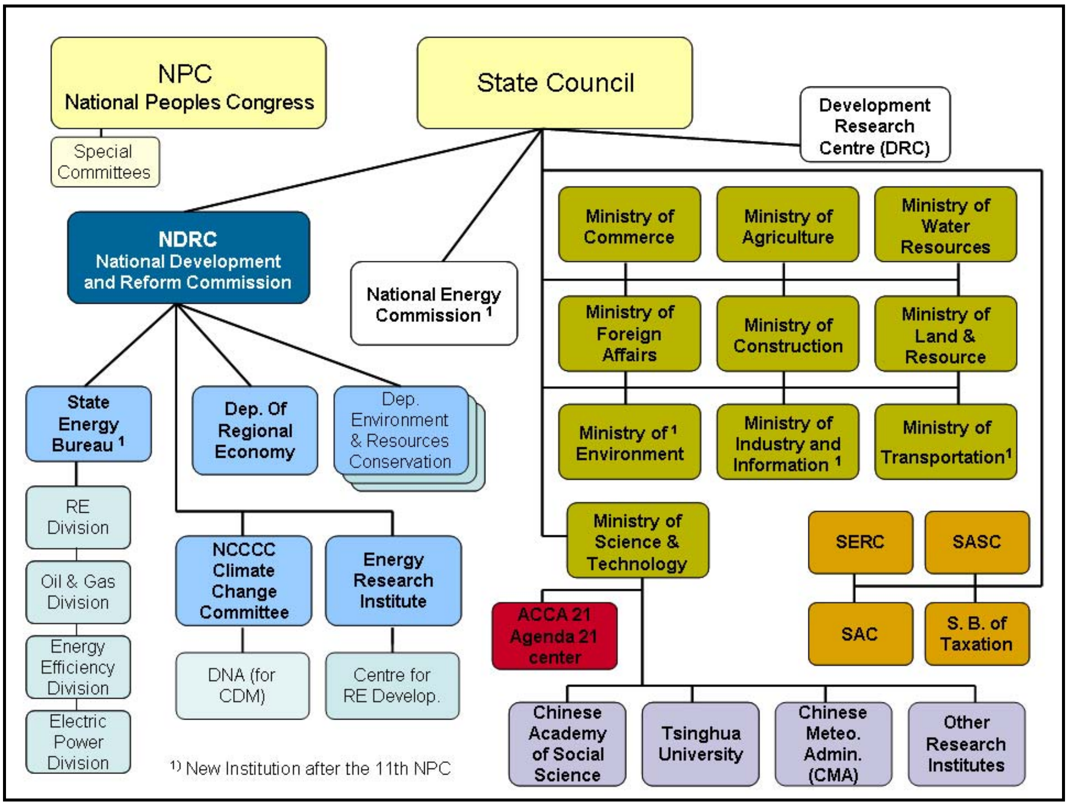


Figure 6: Chinese energy and climate policy institutions

The **State Asset Supervision Administration Commission (SASAC)**, established in 2003, is responsible for supervision of the assets, performance, finances and management personnel of the state-owned companies and therefore for the most important enterprises in the electricity sector. Through its ability to appoint and dismiss the executive leadership of powerful energy firms, the SASAC can be seen as an informal channel of the Communist Party to influence the industry decisions. Still, from an operational standpoint, these large corporations are increasingly independent (IEA, 2007).

A separate regulatory authority, the China **State Electric Power Regulatory Commission (SERC)**, was created in 2002 to regulate the electricity industry. The primary tasks of the SERC are supervision of the reform process and consistent regulation of enterprises in the power sector (GTZ, 2007). SERC will also have assumed nationwide oversight of the new requirements according to the Renewable Energy Law starting in September 2007 - a development which will force power companies to purchase the maximum amount of 'green' electricity available in their cover areas. However, an earlier assessment concluded that regulations would fail to give the SERC substantial power to carry out independent regulation and that the supervisory role of the SERC had not been brought fully into play. "People have heard stronger voices from the NDRC than from the SERC" (Austin, 2005). SERC's functions do still overlap to some extent with those of the price-setting authorities in the NDRC, which fears loss of control and the decline of political pricing criteria (World Energy Council, 2005).

The **Standardization Administration of the People's Republic of China (SAC)** is a key policy player in setting and regulating environmental and energy standards, such as energy efficiency standards for buildings, the labelling system for household appliances, fuel economy standards, as well as standards for grid access provided to renewable energy sources. The SAC was established in April 2001 and authorized by the State Council to exercise overall coordination of standardization works in China, including the formulation, implementation and supervision of standardization.

2.2 Environment and climate actors

Climate policy in China should be viewed not mainly as an environmental problem but as an issue related to energy, economic development and foreign-policy. The central and most influential governmental actors in Chinese climate change policy-making are therefore grouped within the NDRC and **Ministry of Foreign Affairs (MOFA)**.

Under the chair of NDRC, the **National Coordination Committee on Climate Change (NCCCC),** established in 1998, is the highest climate policy-making body in China (Bjørkum, 2005). The NCCCC presently comprises 17 ministries and agencies and is assigned with the formulation and coordination of China's climate change-related policies and measures and providing guidance for central and local governments' response to climate change. The Office, also appointed Designated National Authority (DNA) for the Clean Development Mechanism (CDM), is located in the NDRC´s regional department and works closely with departments of the MOFA as well as MOST (GTZ, 2007).

MOFA, one of the most influential ministries represented in the NCCCC, is leading China's participation and negotiation in the international climate change regime, emphasising the principle of common but differentiated responsibilities and also ensures that China's political and economic interests are served in international negotiations. This role was formerly held by the **China Meteorological Administration (CMA)**, one of the lead agencies in the initial stages of China's climate policy and the coordinator of China's participation in international scientific process (IPCC).The influence of this more proactive player in the climate change debate, diminished clearly, when the **Energy Research Institute (ERI)** gained importance after main responsibilities were shifted to NDRC, and now conducts relevant research (Bjørkum, 2005).

Most research institutions advising on climate policy are currently related to the leading bodies of the NCCCC. The Energy Research Institute (ERI) gained importance after main responsibilities were shifted to NDRC, and now conducts relevant research. Further important academic institutions working on climate policy, is the Research Centre for Sustainable Development at the **Chinese Academy of Social Sciences (CASS)** and Tsinghua University. **MOST** deals with the technical aspects of China's participation in the climate change debate. The ministry plays a crucial role in China's participation in the CDM, which is China's main point of involvement in the international efforts to reduce GHG-emissions (Heggelund, 2007).

The **State Environmental Protection Administration (SEPA)** was established as the lead agency for environmental protection, represented at all levels of national and local governance. While China's environmental agency was initially an active advocate for a proactive climate change policy both at international and domestic level (Bjørkum, 2005), climate change issues are not SEPA's area of responsibility and therefore it has a just a limited influence on climate policy making. The agency with its small staff of 220 professionals has mainly responsibilities for domestic policy formulation in: (a) Regulatory, Environmental Assessment and Planning; (b) Pollution Control; (c) Setting Standards; and (d) Environmental Monitoring and Public Participation.

The recent institutional restructuring, announced at the 11^{th} NPC in March 2008 included the establishment of a **Ministry of Environment** and an upgrading of SEPA to ministry status. This event would strengthen the position of today's SEPA and allow its participation in major national policy making processes and decisions. Prior to this development, SEPA did not enjoy full cabinet status in the government, and thus the agency's participation in critical environmental decision-making involving policy planning, coordination with other ministries and agencies, the setting of national environmental priorities, and in resolving environmental disputes was hindered (see OECD, 2005; Lan et al., 2006).

SEPA's policy capability and the implementation of environmental policy generally in China depends heavily on the commitment of local officials and leaders, such as mayors and governors. The power of SEPA also depends on the active support of the State Council, the commitment of mayors and local government leaders to environmental management, and increasingly, public opinion. Implementation of environmental policies is the responsibility of 100,000 provincial and local government employees in the Environmental Protection Bureaux (EPB.) They are nominally under SEPA supervision but paid by the local administrations, creating the potential for a conflict of loyalties (OECD, 2005; Lan et al, 2006).

Whether the upgrading to ministry status will also include an expanded budget and responsibility remains open by the date of writing. An actual change however, would also involve a strengthened capacity and authority on a local level, as well as a more comprehensive responsibility for policy making on a national level.

There are other agencies and institutions affected. For example, the new **Ministry of Transport** will overtake the responsibility on vehicle emissions control, which was regulated by SEPA, alongside with the Ministry of Communications and the Public Security Bureaus.

In 1994, the **Administrative Centre for China's Agenda 21 (ACCA 21)** was established under the Ministry of Sciences and Technology. ACCA 21 drafts the national sustainable development reports and related action guidelines, which are the basic framework for implementing sustainable development at the state level. Another major task of ACCA 21 is to subsidize important projects that will help build national capacity in sustainable development and act as a bridge between domestic and international partners for the implementation of China's Agenda 21. ACCA 21 also provides information on sustainable development, consultancy services for projects, training and public awareness material.

In the realm of law and administration, two committees of the National People's Congress (NPC) are working on environmental and energy related legislation. The Committee of Finance and Economy led the drafting, reading and approval of the Energy Conservation Law and its amendment, which was eventually approved in 2006. The Environmental and Nature Resources Protection Committee, established to organize the formulation and examination of laws related to environmental and resources protection, helped shape the Renewable Law.

2.3 Civil society

Chinese civil society has become increasingly active in recent years. Independent think tanks and research institutes are influencing policy making in a way unthinkable a few years ago. The awareness of environmental devastation across the country, as well as impacts of pollution and resource scarcity, has mobilized a rising number of citizens. The results are diverse: unaccountable environmental initiatives, environmental protests[4], as well as new alliances within the civil society.

One climate-related example that has had significant and measurable success was the "26° Campaign", an initiative of a several NGOs to urge companies, embassies and other institutions to set their air condition to 26 ° C in order to save electricity and protect the environment. Two years later the government issued a regulation that no air conditioner in public buildings should be turned lower than 26 degrees (Lehrack, 2007). Even though the stimulation of policies is not always directly successful, public participation and campaigns are likely to contribute to behavioural changes, or voluntary actions to decrease GHG emissions (IPCC, 2007b).

The media in China plays a critical and growing role in pushing for environmental reforms and addressing climate change issues. Media outlets contribute to public education, awareness raising and mobilization of the society; additionally, they may enforce or support implementation of or compliance with environmental standards. The role of the media as a 'social watchdog' is appreciated and demanded by SEPA (Altmeyer & Yi, 2007), which has emerged as a strong supporter of public participation in China. The agency works closely with NGOs to achieve common goals. While the government is still the major player within the institutional structure in China, agencies have realized that sustainable development may not be achieved without the participation of civil society and NGOs. However, channels and mechanisms for civil society to participate in the decision-making process directly are rare and have to be developed further.

One of the biggest challenges for environmental NGOs is that there is still little capacity to address their issues in a broader political, economic and social context. In terms of climate change, the involvement in a national and international climate and energy strategy debate still remains limited[5].

[4] According to the state media, China's State Environmental Protection Administration (SEPA) reported 51,000 environmental protests in 2005

[5] In cooperation with CANGO, the Heinrich-Böll-Foundation China Office supports a climate network of more than 20 Chinese NGOs. The project aims to strengthen capacities on climate change and energy issues and to engage Chinese NGOs in the national and international climate debate. An expert group of the network represented the Chinese NGOs at the UNFCCC Climate Conference in Bali in December 2007 (see: http://www.boell-china.org)

But there have been a few projects being undertaken to improve the situation and therefore allow civil society to participate on upcoming policy consultation opportunities in the future, such as china civil society climate action network.

3. Policies – Laws, instruments & programmes

Local and regional impacts of energy use have long been considered more urgent than climate change, and water quality issues are even more pressing than air quality. But concerns about GHG emissions are growing. The release of the first "National Climate Change Program Report" - a national action plan to respond to climate change (NDRC, 2007) on the eve of the G8 Summit in Heiligendamm (Germany, June 4, 2007) - and a follow-up first meeting of the new National Climate Change Leading Group, headed by Premier Wen Jiabao on 9 July 2007[6], are the latest indices that the climate change debate reached the political leaders within China.

Nevertheless, for most scholars and Chinese energy experts, the climate change debate is still seen as a foreign-policy issue on the government's political agenda and a place where Beijing would seek to protect development rights and opportunities.

The 'unilateral' efforts to reduce China's greenhouse gas emissions are domestic programs that are not climate policies per se, but first and foremost, policies addressing development goals and energy security. GHG emission reduction is a by-product of energy efficiency policy (see Wang, 2006; Heggelund, 2007; Lewis, 2007). Renewable energy is recognized as a good solution worldwide to global warming and emission reduction, but there is no reference to climate change or GHG emissions in the "Renewable Energy Law of People's Republic of China" that became effective on 1 January 2006 (Wang, 2006).

For China, the climate challenge goes along with an energy transition – the latter of which is especially challenging. And as in any country, China's energy-policy challenges are largely framed by national socio-economic policy goals: climate policy competes with economic development policy, particularly as the costs of climate and environmental protection measures are usually higher in the short term than the collective benefits which evolve from an improved environmental situation.

Still, energy conservation and renewable energy - the core elements of the energy transition - are now near the top of the political agenda. Consequently, efforts made to date to cope with these twin problems should not go unrecognized.

China's policies on environment and energy conservation can be categorized into three classes, in terms of their scope of impact and characteristics. The first level consists of those policies that provide general direction and guidance. Second level policies set objectives and form development plans. The third level consists of practical and specific incentives and managerial guidelines, such as non-compliance penalties. Generally speaking, the first two levels are set by Central Government and its relative departments, while the third level is decided by local governments, including the provincial and municipal governments as well as county governments (Yao et al., 2005). Policies made by local governments have more explicit and practical functions but also may differ, depending on the awareness, willingness and priorities of the respective authorities.

[6] Xinhua (Sept. 2007): "China vows to tackle climate change", available at: http://www.chinadaily.com.cn/china/2007-09/21/content_6125696.htm

3.1 General Policy: the Five-Year Plans

The National Five-Year Plan for Economic and Social Development (FYP) is a key strategy document of the Chinese government - even seen in terms of many crucial documents that have directed policy since the establishment of the Peoples' Republic in 1949. The FYP sets the development priorities and basic governmental objectives of the country in the five-year period covered.

Beginning in the 1980s, the Five-Year Plans have shown a growing attentiveness to energy concerns (Yao, 2005): The Sixth FYP (1981-1985) put the equivalent of 10% of energy supply investment into energy conservation projects. This policy continued in the Seventh FYP, though the percentage was reduced to 8%. The implementation of the Agenda 21 followed in the Ninth FYP and from 2001 to 2005 a plan for Sustainable Development as well as a plan for Renewable Energy Development was introduced, offering general objectives, as well as recommendations for the development of RE.

China's current **11th Five-Year Plan (2006-2010)**, directed by the "scientific development perspective" （科学发展观）– an development approach that stresses integrated sets of solutions to economic, social and environmental problems - took the most important step towards the development of RE, by implementing the Renewable Energy Law (effective since January 1, 2006). Under this law, China has set a target of producing 15% of primary energy from renewable sources (including large hydropower) by 2020, up from about 7.5% in 2005 (NDRC, 2007b). For the electricity sector, the target is 20% of capacity from renewable by 2020, including 30 GW of wind power, 30 GW of biomass power, and 300 GW hydropower capacity (there from 76.8 GW small hydro power, see also chapter 5).

Concerning energy efficiency, the plan set up the mandatory and ambitious near-term goal of 20% reduction of energy consumption per unit GDP by 2010 (baseline 2005), which can be considered as one of the most significant initiatives, and also most ambitious one to reduce GHG emissions (see chapter 3.4 for further details). The difficulties in realising this target show the more rapid growth of energy consumption relative to GDP occurring in the last five years, which resulted in an increase of energy use per unit of GDP (energy intensity). In 2006, the energy intensity decreased only by 1.2%, which missed the yearly national target of 4%, an objective which is necessary to fulfil the total 20% reduction target. Accordingly, Chinese central government decided to evaluate the overall target at the end of 2010 which is the last year of 11th 5 year plan responding the lagging effect of policy and reality.

Another main target in this FYP is the reduction by 10% of the total discharge of major pollutants (SO_2 and NO_x) in five years. Next to these, diversifying energy resources and ensuring an affordably supply of clean energy are central objectives. Furthermore, the plan points out the need for further institutional and legislative changes to realise the objectives, including, for example, pricing reforms.

In 2003, the first monitoring and evaluation of a FYP took place. For the eleventh FYP, the NDRC is building up an overall monitoring and evaluation framework and working to institutionalize arrangements for future plans. The framework will be used in the mid-course evaluation of the Eleventh Plan in mid-2008 (Wang & Lin, 2007), an important step to strengthening accountability and improving transparency.

3.2 China's Agenda 21

China's quick response to the Rio Declaration in1992 was the 'Agenda of the 21st century', a *White Paper on China's Population, Environment and Development in the Twenty First Century*. In 1994, the

State Council issued a directive calling on government institutions at all levels, to consider China's Agenda 21 as an overarching strategic guideline for the formulation of economic and social development plans, and particularly to integrate it into the Five Year Plans and into day-to-day management.

The Agenda 21 combines several specific measures into a national strategy of sustainable development. Nine priority programmes have been launched, including capacity building, cleaner production technologies, resource conservation, as well as climate change research. Many demonstration projects have been carried out to promote these programs, for e.g., solar heating, pollution control, or cleaner steel-production. China's Agenda 21 requires to priorities the development of renewable energy in the state energy development strategy and the promotion of energy-saving – as the document notes, 'energy efficiency and developing renewable energy should become the fundamental state policy'.[7]

3.3 The National Climate Change Programme (CNCCP)

On 4 June 2007, the Government announced "China's National Climate Change Program" (CNCCP), which identifies China's basic stand, current achievements and challenges as well as its goals, principles and key areas of efforts in the coming years concerning climate change. The Program is the first ever comprehensive policy paper issued by the Chinese government in the context of growing global climate concerns (NDRC, 2007).

The Six Guiding Principles of the CNCCP:

- *Address climate change within the framework of sustainable development;*
- *Place equal emphasis on both mitigation and adaptation;*
- *Integrate climate change policy with other interrelated policies;*
- *Rely on the advancement and innovation of science and technology;*
- *Follow the principle of "common but differentiated responsibilities"; and*
- *Actively engage in wide international cooperation.*

Projected Results by 2010:

- *500 Mt CO_2 emissions to be avoided by developing hydropower;*
- *30 Mt CO_2 emissions to be avoided by developing biomass energy;*
- *60 Mt CO_2 emission prevention by developing wind, solar and geothermal energy;*
- *50 Mt CO_2 emission prevention by developing nuclear power;*
- *200 Mt CO_2 emissions to be avoided by utilizing coal mine methane;*
- *110 Mt CO_2 emissions to be avoided by expediting technological advancement in thermal power generation;*
- *550.Mt CO_2 emissions to be avoided by implementing 10 key energy conservation priority programmes*

The majority of the policies described in the plan were already in place but this strategy underscores the severe environmental and economic risks China faces in a warming world and outlines a broad array of government policies that are helping to moderate the growth of China's greenhouse gas emissions. However, few specific measures are identified.

[7] China's Agenda 21 online at: http://www.acca21.org.cn

A highly questionable principle of the CNCCP is the intention to "actively promote the development of nuclear power". Nuclear power is seen as a strategy to mitigate climate change, with an expected GHG emission reduction of about 50 Mt CO_2 by 2010. But as nuclear power poses multiple threats to people and the environment it can not be considered as a solution or mitigation strategy.

3.4 China's energy efficiency policy

Energy efficiency, long held up as high priority by Chinese policy makers, has attained even greater prominence over the past few years as the approach to addressing both energy security and environmental concerns (IEA, 2007). **China's Energy Conservation Law** came into force on 1st January 1998.[8] The law initiated a range of programs to increase energy efficiency in buildings, industry and consumer goods, aiming to promote energy conservation activities throughout society. The Energy Conservation Law can be classified into Category One (see above) and is therefore general and brief. It requires the provincial and local administration to formulate sets of implementing regulations, taking local economic and environmental conditions into account. The newly revised Energy Conservation Law expanded the scope of regulations and established a range of institutions to evaluate and encourage the development of energy efficient manufacturing. It also arranged public finance to support the implementation and established specific entity to monitoring the implementation.

The "**Medium and Long Term Energy Conservation Plan**" followed in November 2004, highlighting key sectors of emphasis; providing a conceptual roadmap for increasing energy efficiency; setting conservation targets for the demand side like industry, transport and buildings, as well as for the supply side like energy transformation, transmission and distribution. Specific consumption targets are given for important industrial products and transport services, and efficiency bands are planned for energy facilities and equipment (Lin et al., 2006). These targets are to be reached by a range of energy policy measures. Ten prioritized key programmes have been set up, each of which contain a high potential for increasing efficiency (NDRC, 2005):

1. Upgrading of Low-efficiency Coal-fired Industrial Boiler (Kiln),
2. District Heat and Power Cogeneration,
3. Recovery of Residual Heat and Pressure,
4. Oil Saving and Substitution,
5. Energy Conservation of Motor Systems,
6. Optimization of Energy Systems,
7. Energy Conservation in Buildings,
8. Green lighting projects,
9. Energy Conservation in Government Agencies,
10. Energy Conservation Monitoring and Technological Support System

[8] The amendment of the law was approved by the NPC on October 28, 2007 and will become effective on April 1, 2008. The amendment prioritizes energy conservation in China's energy strategies.

Further details are given in the corresponding sectors.

Indicator	***Unit***	***2000***	***2005***	***2010***	***2020***
Power generation (coal-fired)	gce/kWh	392	370	355	320
Industrial boilers (coal fired, small & medium size)	Efficiency (%)	65	-	70-80	-
Generation units (design)	Efficiency (%)	87	-	90-92	-
Wind turbines (design)	Efficiency (%)	70-80	-	80-85	-
Pumps (design)	Efficiency (%)	75-80	-	83-87	-
Room air conditioners	Efficiency ratio	2.4	-	3.2-4.0	-
Refrigerators	EE index	80	-	62-50	-
Household gas water heaters	Efficiency (%)	80	-	90-95	-
Average automobile fuel	l/100km	9.5	-	8.2-6.7	-
Raw steel	kgce/t	784	700	685	640
Cement	kgce/t	181	159	148	129
Tiles	kgce/m^3	10.04	9.9	9.2	-
Aluminium	tce/t	9.92	9.60	9.47	9.22
Copper	tce/t	4.71	4.39	4.26	4
Oil refining	Factor	14	13	12	10
Ethylene	kgoe/t	848	700	640	600

Table 2: Selected Energy Efficiency Targets in the 11th FYP and the "Medium and Long Term Energy Conservation Plan" Source: NDRC (2007); Yang (2007).

The Chinese government further sharpened the targets for energy conservation and energy efficiency improvement in the **11th Five-Year Plan** (approved by the People's Congress in March 2006). Energy intensity (energy consumption per unit of GDP) is to be reduced by 20% from 2005 to 2010, which would reduce China's greenhouse gas emissions 10% and achieve an estimated 1.5 billion tons of CO_2 reductions, according to the "National Climate Change Program" report (NDRC, 2007). A further target is the reduction by 10% of major pollutants emissions (COD & SO_2) by 2010 (when compared to 2005). The forest coverage rate is targeted to reach 20%. Achievement of the 20% energy intensity target will require savings of 640 Mtce. Through the implementation of the ten key programmes, it is estimated that 240 Mtce of energy can be conserved during the 11th FYP period, equivalent to 550 Mt CO_2 reductions (Yang, 2007)

These national targets are divided and assigned to all 27 provinces and four provincial-level municipalities, based on criteria such as level of economic development, industry structure, and total energy consumption. The ambitious targets signal a major shift again in China's thinking about its long-term economic and energy development.

The "**State Council Decision on Strengthening Energy Conservation Work**", issued in 2006, outlines a number of further policies that are being developed in support of the 20% target (State Council, 2006). The following excerpt shows areas of future activities and key aspects of the release:

- Strengthen energy conservation management in major energy-consuming enterprises: enterprises should establish a strict management system and an effective incentive mechanism in energy conservation. Departments and local governments at all levels should strengthen the tracking, guidance and supervision of energy consumption status in major energy-consuming enterprises. Among them, NDRC should sign letters of responsibility for energy conservation goals, with provincial governments and the state-owned enterprises, and strengthen energy-saving responsibility and assessment.

- Intensify government support to energy conservation: governments at all levels should support efforts to promote energy-saving technologies and products, pilot projects, training and information services. During the 11th Five-Year Plan period, the state will set aside a certain amount of funds for the support of major energy-saving projects, demonstration projects and the promotion of efficient and energy-saving products.

- Implement fiscal policies and tax incentive for energy conservation: the NDRC should formulate the "energy saving product inventory", the Ministry of Finance and Taxation Administration should propose specific tax incentives for products included in the "energy saving product inventory" and submit it to the State Council for approval; implementation of policy and measures that restrict export of high energy-consuming, high pollutant and resource products should all be tightened; fuel taxes should be established; taxation reform plans where different types of energy and mineral resources are concerned should be enhanced;

- Explore an energy conservation financing channel: Various financial institutions should increase credit support for energy conservation projects and strengthen the investment on energy conservation. Enterprises should be encouraged to engage in direct financing through the market, and accelerate their technological transformation in energy conservation.

- Implement an energy conservation reward system: Each region and department should recommend and reward units and individuals who have made remarkable achievements in research and dissemination of energy conservation technology and conservation management.

At the end of 2007, the Ministry of Finance began a RMB 23.5 billion **fund to promote energy efficiency** and reduce pollution.[9] This financial measurement to achieve the targets during the 11th FYP period was divided in the following packages:

- 7 billion Yuan reward scheme aimed at encouraging companies around the country to conserve energy and reduce emissions;
- 6.5 billion Yuan will be used to build sewage networks in central and western cities;
- 2 billion Yuan will be used to compensate workers from closed down, inefficient enterprises (small power units, paper mills, etc.) and provide them with vocational training;
- 3 billion Yuan will be invested to improve the collection of statistics and environment monitoring;
- 5 billion Yuan would finance the treatment of the polluted lakes and rivers.

The disbursement of the energy efficiency funds used will be based on the total budget of the project, dependent on the value of energy savings of the project - that is, "the more they save, the more grants they will get". Projects will be appraised by independent third-party institutions. Funds for pollution

[9] China Daily (Nov. 2007): "$3.2b to raise energy efficiency" available at: http://www.chinadaily.com.cn/china/2007-11/27/content_6280528.htm

reduction will be provided to provinces, based on the total length of the networks and a water pollution index.

4. Sector-based mitigation policies

The following chapter gives an overview of sector-based initiatives and programs related to Greenhouse Gas emission reduction.

4.1 Industry

- **The "Top-1000 Energy-Consuming Enterprise Program"**

This Action Plan is a key initiative for realizing China's 20% energy intensity reduction goal. Formally launched by the NDRC in April 2006, the program focuses on energy efficiency in enterprises with the highest energy consumption. China's 1,000 largest enterprises consumed 673 Mtce in 2004, which is 33% of national and 47% of industrial energy usage in 2004 (NDRC, 2006). The goal of this program is to realize total savings of 100 Mtce from the expected energy consumption of these 1000 enterprises in 2010 (Price & Wang, 2007).

The industries included in the program are large-scale, financially independent enterprises in nine major energy consuming industries: iron and steel (dominant in terms of number and consumption); petroleum and petrochemicals; chemicals; electric power generation; non-ferrous metals; coal mining; construction materials; textiles; and pulp and paper. The reduction targets were announced for each enterprise. Activities undertaken include benchmarking, energy audits, development of energy saving action plans, information and training workshops, and annual reporting of energy consumption (Price & Wang, 2007).

The Program was modelled after a successful target-setting energy efficiency agreement pilot project with two iron and steel enterprises in Shandong Province in 2003. It is based on the model of a voluntary agreement, which is, in principle, a contract between the government and industry or negotiated targets, with commitments and time schedules on the part of all participating parties (Prince & Wang, 2007). To improve accuracy and reliability, the enterprises are required to report their energy consumption by fuel quarterly via a website to the National Bureau of Statistics (NBS), though not through regional statistical bureaus.

The first results have seen a decline in energy consumption per unit of GDP of 1.23% in 2006. The steel industry experienced a decrease in overall energy consumption of 8.8% between 2005 and 2006 and unit energy consumption for producing one ton of steel declined 7.1% (Gao, 2007). Although the annual target of 4% reduction in energy intensity was not reached, this is the first drop in this metric since it began to increase in 2002.

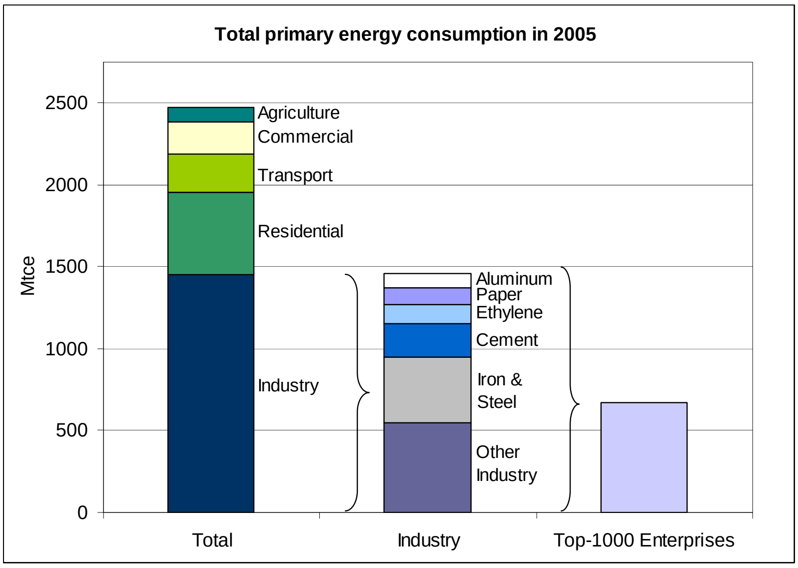


Figure 7: Total primary energy consumption in 2005, industrial sector, and the Top-1000 Energy-Consuming Enterprises (Source: Price & Wang, 2007)

- **Energy-Saving Standard for Cement Industry**

The estimated number of Chinese cement plants are around 5000, as reported in the year 2005.The NDRC specified goals for a structural adjustment of the cement industry between 2005 and 2010. Provincial governments are required to shut all cement plants with annual capacity of less than 200,000 tons by the end of 2008, and to increase of production scale of big enterprises. Overall, the NDRC plans to eliminate 250 million tons in outdated cement capacity by 2010 and reduce the total number of cement enterprises to 3500, as a way of contributing to the nation's targets for cutting energy consumption and pollution.

The NDRC fixed quotas of cement capacity reductions for each province and region. Provincial officials have to sign agreements with the central government holding them accountable for the required targets. To ensure compliance, the NDRC would carry out inspections around the country and refer defying provincial governments to the State Council, or cabinet, for potential disciplinary action.[10]

In November 2007 the first energy-saving standard for cement manufacturing plants were released by the Ministry of Construction.[11] The standards covered every aspect of cement manufacturing, including plant construction, manufacturing technology, power systems and equipment use. The implementation of this new standard seeks to decrease the integrated energy consumption by 25% and emissions of air pollutants by 50% (Price & Galitsky, 2007). This effort would be an important step towards the goal of cutting energy consumption per unit of GDP in the cement industry by 25 percent till 2010 and an incentive to phase out the outdated technology in the sector.

[10]Reuters (2007): "China Orders Small Cement Plants to be closed" available at: http://www.planetark.com/dailynewsstory.cfm/newsid/40623/story.htm
[11] Available at: http://www.china.org.cn/english/environment/231968.htm

- **Structural Shift**

To discourage growth in energy intensive industries and to further optimize the industry structure, the Ministry of Finance implemented a market mechanism to restrain exports on certain resource-intensive commodities in November 2006. These attempts include an increase of 15 percent export tax on copper, nickel, aluminium and other metallurgical products; a 10 percent tax increase on steel primary products and a five percent tax increase on petroleum, coal and coke. At the same time, import tariffs on 26 energy and resource products, including coal, petroleum, aluminium and other mineral resources, will be cut from their current levels of three to six percent to between zero and three percent.[12]

- **Performance Supervision**

New regulations of SEPA and MOFCOM is planned to supervise the environmental performance of Chinese exporters. A database will be established to collect data about the performance of enterprises; violators will be banned from trading abroad for one to three years[13], or disqualified from receiving loans from any bank.[14] The credit blacklist is another means and according to Pan Yue, deputy chief of SEPA, the most forceful measure the environment agency could impose to tackle pollution.[15] The companies on the list that fail to pass environmental assessments or to implement China's environmental protection regulations are disqualified from receiving loans from any bank or financial institution. Companies that already have loans, but are later discovered to have violated environmental protection regulations, will have their loans recalled, according to the policy.

This attempt is another shift in the style of punishment doled out by the SEPA to polluters. Long-term restrictions designed to affect business operations are now favoured over one-off fines. Further measures, considering incorporating environmental standards in tax, insurance and stock market are being discussed. In November 2007, twelve heavy polluting enterprises had bank loans recalled, suspended or rejected as China's new "green-credit policy" became effective.[16]

- **Energy Efficiency Audit**

All new manufacturing projects have to be evaluated based on an energy efficiency audit. Projects that cannot follow the energy efficiency standards are not to receive approval. Existing industries that cannot improve their energy efficiency performance to meet the standards are to be shut down. Energy performance audits for energy-intensive industries aim to phase out aging equipments, and there will be mandatory labelling system for energy efficiency products introduced.

Following regulations are part of the 10 key programs launched in connection with the “Medium and Long Term Energy Conservation Plan” (NDRC, 2005):

[12] China Daily (2006): “Tariffs aim to reduce energy consumption” available at: http://english.people.com.cn/200610/31/eng20061031_316629.html
[13] Xinhua (2007):”Supervision of exporters to be tightened” available at: http://chinadaily.com.cn/china/2007-10/30/content_6217395.htm
[14] China Daily (2007): ”To fight pollution, China takes capitalist route”, available at: http://www.chinadaily.com.cn/china/2007-07/31/content_5446655.htm
[15] Reuters (2007): “Green credit: To fight pollution, China takes the capitalist route” available at http://www.iht.com/articles/2007/07/30/business/pollute.php
[16] Xinhua (2007): “12 heavy polluters punished under new 'green-credit' policy” available at: http://www.chinadaily.com.cn/china/2007-11/16/content_6259777.htm

- **Coal-fired industrial boiler (kiln)**

China is now using estimated 500, 000 medium-sized and small industrial boilers[17], which, on average have a capacity of only 2.5 tons of steam per hour and an actual operating efficiency of around 65 percent. 95 percent of these are coal-burning, with an annual consumption of 350 to 400 million tons of coal. Through measures such as quality coal, boiler renovation, and establishment of proper management, 10-15 million tons of coal could be saved till 2010.

- **Recovery of Residual Heat and Pressure**

The recovery potential where industrial heat and gas discharge is concerned - in steel production, cement industry, and coal mine industry - is 10 billion cubic meters of coal gas by 2010, with a saving of 2.66 million tons of standard coal. The proposed techniques - “coke dry quenching” (CDQ), and “blast furnace top gas pressure recovery turbine” (TRT) - utilize the exhaust pressure and heat generated from these production processes to generate electricity.

- **Energy Conservation in Electrical Motors**

Currently, the totally 420-million-kw electrical motors, which consume 60 % of the country's total electricity consumption, are running with an efficiency 10-30 % lower than that in the developed countries. An annual 2% average upgrade is the target, which will save estimated 20 billion kilowatt-hours of power per year.

- **Optimization Energy System**

System optimization as well as retrofit and improved sound management will be initiated in key industries such as metallurgy, petrochemical industry, and chemical industry. Lower energy use and higher competitiveness for these enterprises is foreseen.

4.2 Buildings

China’s construction sector is booming. The urbanization rate increased unprecedented rapidly from 23% in 1990 to 44% end of 2006.[18] (This rate of expansion took Britain more than 100 years.) Thus far, an additional 2 billion m^2 is being constructed each year in China. To date, over 90% of the new buildings are still high energy consumption buildings. Out of the 43 billion m^2 existing buildings in China, only 4% have adopted energy saving standards (Shen, 2007).

The energy demand in buildings has been increasing rapidly in recent years. The final energy consumption in the sector jumped 175% from 1990 to 2005 (ERI, 2007). Currently, the energy consumption in buildings accounts for around 22% and 11% of the residential sector respectively of the total energy consumption in China (Lai, 2007; Long, 2005).

The energy consumption level for heating in residential buildings in North China per unit area is 14-25 kgce/ m^2, which is more than 2-3 times than those of the regions with similar climate conditions in Western European or North American countries. This level can be traced back to a high heat loss by

[17] People’s Daily (2004):” China outlines ten programs for energy efficiency”, available at: http://english.people.com.cn/200412/09/eng20041209_166706.html
[18] Chinaview (2007): “China’s rural population shrinks to 56% of total“, available at: http://news.xinhuanet.com/english/2007-10/22/content_6925292.htm

the outer wall of buildings in North China, which is 3-5 times higher as well as heat loss by windows - twice as much as those of the comparable buildings in the Northern Hemisphere. The total electricity consumption is 70-300 kwh/yr per unit area and again 1.5-2 times of that of the developed countries (Lai, 2007). A survey on commercial buildings in Shanghai showed that the annual primary energy consumption of these buildings is 1.8GJ/(m^2/a), which is 43.3% higher than that of the energy saving standard [1.25GJ/(m^2/a)] set for commercial buildings in Japan (Lai, 2007). Air conditioners in buildings are the major reason for the continuous climbing of electricity consumption peak value in most of the cities.

These data illustrates the huge potential in energy efficiency, which to date is underutilized. The outlook of the prospective developments in the building sector demonstrates the need for oversight, incentives, and a regulative framework: an estimated 25 to 30 billion m^2 of additional floor space will be constructed in China by the end of 2020 (Lai, 2007). The rapid urbanisation along with the continuous growing demand on higher living standard will result in the rigid growth of energy consumption in buildings. The Chinese government is already experiencing the biggest rural-to-urban migration in human history.

For its new future urban citizens, some 400 million people in 2020, new houses will be constructed to accommodate these new urban dwellers – and the way these buildings are designed has a major impact on Chinese future energy consumption in the next decades. According to this scenario, energy consumption in buildings is likely to increase from the current 22% to 35% of the overall energy consumption by 2020 (Long, 2005) and will capture around 860 Mtce (Kang & Wei, 2005). If all these new buildings would stick to energy-efficiency standards, it would help save some 335 Mtce, and reduce 80 million kilowatts of electricity from air conditioning, which is equal to 4.5 times the total hydro-electric output generated by the gigantic Three Gorges Power Station on the mid reaches of the Yangtze River.[19] The IPCC itself estimates that global CO_2 emissions related to energy use in buildings in china could be cost-effectively cut by 29% by 2020 (IPCC, 2007b).

As there is less control over driving factors in energy consumption such as population growth, urbanization, per capita floor area, and higher living standards, energy consumption reduction in the buildings sector has to be tackled with efficiency improvements and changing consumer behaviour. To address this challenge, the government set several targets in the building sector according to the FYP and the Energy Conservation plan. The Ministry of Construction forecasts a total energy saving potential for buildings of 380 Mtce by 2020 (Lai, 2007). It will be divided into:

- 280 Mtce in heating supply
- 32 Mtce in residential buildings
- 68 Mtce in public buildings

During the 11th Five year Plan Period, the target for total energy savings in buildings will be 120 Mtce. Insofar as the major tasks and targets for energy saving from buildings during the 11th Five year Plan Period are concerned, these are the categories and the targets:

- **Energy saving from newly constructed buildings**

[19] Xinhua (2005): "China thirsts for energy-efficient buildings", available at: www.chinadaily.com.cn/english/doc/2005-12/04/content_500214.htm

The Ministry of Construction (MOC) has been formulating energy standards for building construction since the early 1980's. After further revisions, a targeted energy saving rate of 50%, based on total space heating and space cooling consumption, took effect in July 1996 (Hogan et al., 2001). The application of the design standard should save approximately 70 Mtce. 200 demo projects on low energy consumption and green lighting in buildings were installed in 2007.Up to now, the implementation of these standards has been poor (see above) and sometimes nonexistent.

- **Energy consumption in government agencies**

The implementation of energy conservation measures in government agencies should not only decrease energy consumption and save on administrative expenditures, but also effect and promote energy conservation in the society as a whole. The program focuses on retrofitting of buildings (20% of the total building stock), and retrofitting space-heating systems, air-conditioning and illumination systems. In 2010, the energy consumption per building area of the Central Government Agencies and that per capita is to decrease by 10% from 2002.

- **Introduction of energy saving services**

Government agencies at all levels should take the lead in purchasing energy-efficient products and ensuring that all government-funded buildings meet the best energy performance code. Furthermore the government institutions should promote the energy performance contract model (EPC or EMC), standardized energy services and energy saving retrofitting for government buildings, large public buildings, public facilities and schools, in order to create and cultivate a market for energy saving measurements.

- **Reforms on Heating System**

The Ministry of Construction is working on a new heating pricing system, charging heat consumption according to the meter used rather than an allowance based on the floor space, which is the general method in China. New buildings will also be required to obtain equipment with heat-measuring capabilities. To develop the requirements for energy saving measures in existing buildings, metering systems will be implemented in existing residential buildings in North China (total 150 million m^2 area) within the next 2 years.

- **Green Lighting**

Compared with the incandescent lamp, green lighting products can save electricity by 80%. Currently 3 billion incandescent lamps are in use in China. The replacement of 1.2 billion by the energy-saving lamps would achieve an electricity saving as much as the total generation of the Three Gorges Power Plant (Zhang & Zhao, 2006). The Green lighting program aims to reduce the energy consumption for lighting of 10% by 2010. In order to achieve this target, the city lighting system will be tightened, the development of EE standards for lighting products in cities will be strengthened, and the utilization of lighting appliances with high efficiency will be promoted.

- **Standards and labelling of household appliances**

Appliance standards and labels have become a critical component in China's new portfolio of energy efficiency policies. The first set of standards related to energy efficiency in consumer appliances was released in China in 1989. Today, the Standardization Commission of China has issued minimum efficiency standards for refrigerators, air conditioners, televisions, linear and compact fluorescent lamps, fluorescent lamp ballasts, small and medium motors, and clothes washers; the Commission is currently reviewing more energy efficiency standards for household appliances. The potential for energy savings through raising the energy efficiency of Chinese appliances is substantial: efficiency improvement in refrigerators, room air-conditioners, and gas water heaters can reduce almost 19 million tons of carbon emissions per year by 2020, and 46 million tons of carbon per year by 2030 (Lin, 2006; Fridley & Lin, 2001).

4.3 Transport

The transportation sector in China presently accounts for an estimated 9 percent of the country's total CO_2 emissions. However, this percentage is still well below equivalent levels in developed countries (>30%), and current trends are indicating that this gap is closing rapidly: both freight and passenger transportation activities and correspondingly the total transportation energy consumption nearly tripled between 1990 and 2004 (Wagner et al., 2006). In addition, China has grown to the world's No. 2 vehicle market after the United States in 2006.[20]

In terms of per-capita car ownership ratio, China has a relatively low rate with 24 cars per 1000 people, compared to developed countries (North America lists 765 cars per 1000 people), but it is forecast to increase by 67% to 40 cars for every 1,000 citizens by 2010.[21] The oil consumption of automobiles is expected to be 138 million tons a year by 2010, accounting for 43% of the nation's total consumption. The proportion will jump to almost three-fifths by 2020.[22] The CO_2 emissions from on-road transport can be expected to increase by 3.4 times to 2035 - the fastest growing GHG emission sources in China, and also the major source of China's urban air pollution (ADB, 2006).

In recent years, clear incentives have been introduced to reduce motor vehicle emissions. However, the relative market share of railways has decreased, while all transport modes have increased in absolute terms (Zhou & Szyliowicz, 2006).

Motorization in urban areas also correlates with urban land use patterns. The transportation demand in urban areas is rising because of spatially separated urban land use structure. Examples include: the decentralization of employment; automobile oriented suburban developments increasing in number; few transit connections to the urban centre; and an emphasis on road infrastructure, which is developed to support high car use (Gaukenheimer, 1996; ADB, 2006). The location changes reduce central city population densities and produce dispersed travel patterns that are less easily served by public transit. The willingness of urban authorities to change focus from highway-oriented construction to transit-oriented development is thrown into question.

In a booming mega-city like Beijing where more than 1,000 new cars hit the street everyday and car ownership represents status and the new middle class lifestyle, it is not easy to encourage its drivers to shift their mode towards public transportation or bicycle. This situation persists even though the average speed on the main roads in the city centre has declined to less than 10 km/h - which is slower than bicycles.

[20] International Herald Tribune (2007):"China surpasses Japan as biggest vehicle market after U.S." available at: http://www.iht.com/articles/2007/01/11/business/chicar.php
[21] See: http://www.chinanews.cn//news/2005/2006-05-24/23021.html
[22] See: http://news.xinhuanet.com/english/2006-03/23/content_4336185.htm

A range of policies and actions will be required to address energy and climate change concerns related to transportation in China. Following is a summary of some of the key measures being taken to tame fuel consumption and pollution where transportation is concerned:

- **Fuel Economy Standards**

China is to date the only country in emerging Asia that has nationwide-implemented fuel economy standards (ADB, 2006). The "Fuel Consumption Limits for Light Duty Passenger Vehicles" was published in 2004 and implemented in July 2005. The main goal of this regulation was to help control the national total oil consumption to less than 400 million metric tons per year against a background of increasing domestic and international energy demands (ADB, 2006; see also [23]).

The implementation takes place in three phases: the first phase, targeting a reduction of 5% in per-distance fuel consumption was implemented in 2005 (equivalent to Euro II); the second phase, with a goal of 10% reduction in fuel consumption for each weight category (equivalent to Euro III) in 2008; and a more stringent standard, equivalent to Euro IV will take effect in 2010 nationwide.[24] The Standard is a set of requirements defining the acceptable limits for exhaust emissions (NO_X, HC, CO, and particulate matter) of new vehicles sold within China.

One distinctive feature of the Chinese standards is that, rather than being based on fleet average, they set up maximum allowable fuel consumption limits by weight category. To create incentives for manufacturers to produce lighter vehicles for the Chinese market, the standards become relatively more stringent in the heavier vehicle classes than in the lighter weight classes (Wagner et al., 2006).

The Chinese standard is more stringent than the US standard, given that the limits are maximum values instead of average values and that the phase two standard is for 2008 model-year vehicles (see Figure 8). However, the technical requirements of this standard are not as stringent as those of the EU or Japanese standards (ADB, 2006).

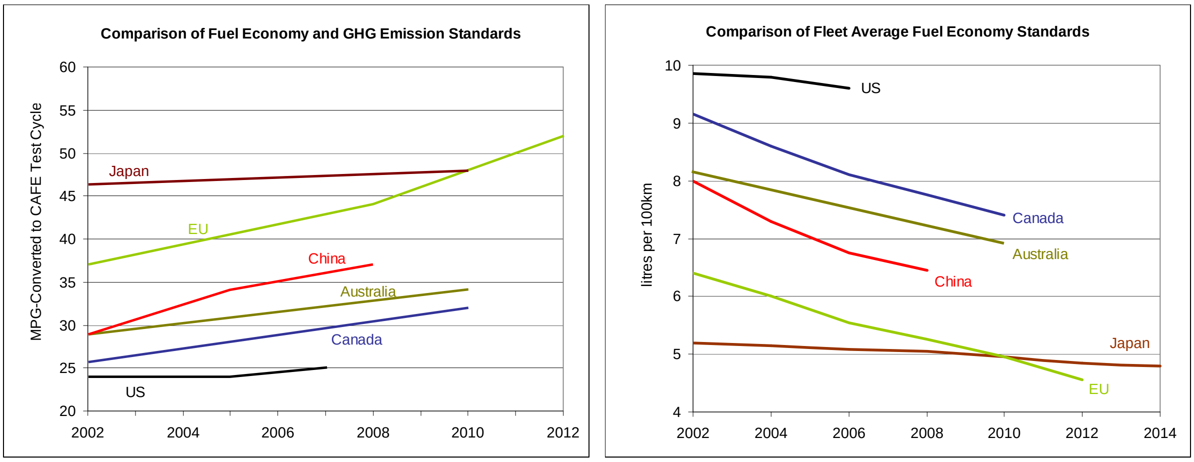


Figure 8: Comparison of Fuel Economy and GHG Emission Standards normalized by CAFE-converted MPG, left side (CAFÉ = Combined Average Fleet Economy; MPG = miles per gallon); Comparison of Fleet Average Fuel Economy Standards, right side (Source: ADB, 2006; IAE, 2007)

[23] See: http://news.xinhuanet.com/english/2007-11/03/content_7002334.htm

[24] The EU adopted EURO- II, III and IV standards for light duty vehicles in 1996, 2000 and 2005 respectively and will go to EURO V in 2008.

As a leading city to control vehicle emission in China, the Beijing Government is ahead of the national standards. It will adopt the Euro IV standard already in January 2008 (originally planned for January 2007) while Euro I, II and III standard were already adopted in 1999, 2003 and 2005.[25] The local government also launched an environment labelling system for vehicles according to their emission standard. To control vehicle emissions, a tight fuel quality standard (National Standard III) also has been implemented from 2005.

- **Tax Regulation**

On 1st April 2006, a new tax regulation for cars was implemented, intended to discourage people from buying fuel-intensive engines (see Table 3). Consumption taxes on passenger vehicles with engine capacity larger than 2 litres have been lifted from 8% to between 9 and 20% according to the engine. At the same time, levies on cars with engine capacity between 1 and 1.5 litres have been cut to 3% from 5%.

In similar efforts, China has also revised its exception policy for SUVs (sport utility vehicle), which until recently enjoyed a special excise tax rate of 5%. SUVs are now taxed by engine size along with other passenger vehicles (Wagner et al., 2006). Cars with engines larger than 2.5 liters account for 20% of all the autos sold in China, and those exceeding 3 litres account for 10%.The state will also offer tax breaks to owners of energy-efficient hybrids powered by gas engines and electric motors.

Category by Engine Displacement	***Tax Rate***
Automobiles	
1.0 to 1.5 liters	3%
1.5 to 2.0 liters	5%
2.0 to 2.5 liters	9%
2.5 to 3.0 liters	12%
3.0 to 4.0 liters	15%
4.0+ liters	20%
Commercial Buses	5%
Motorcycles	
<250cc	3%
>250cc	10%

Table 3: Vehicle manufacturing excise tax rates in China (Source: MOF, 2006).

Presently, China does not have a fuel tax. However, the Ministry of Finance is currently considering rolling out a series of tax policies encouraging manufacturers to develop cars that are more fuel-efficient and environmentally friendly, including tax on gasoline, diesel and kerosene.[26]

China has an extensive in-use vehicle fee collection like road maintenance, toll roads, toll bridges, toll tunnels. The fees are effective in raising revenue for construction, but much less effective in promoting fuel saving (ADB, 2006).

[25]See: http://china.org.cn/english/news/230661.htm
[26]Chinese Government Officials Web Site, available at: http://english.gov.cn/2007-09/14/content_749513.htm

- **Alternative transportation fuels**

Alternative transportation fuels are being promoted to help solve urban air pollution problems, reducing greenhouse gas (GHG) emissions and relieving dependence on imported oil. Technologies which are readily available are compressed natural gas vehicle (CNG), liquefied petroleum gas vehicle (LPG), ethanol and biodiesel vehicle. Ethanol is currently blended with gasoline, and biodiesel is blended with petroleum-based diesel for use in conventional diesel-fuelled vehicles. Alternative transportation fuels vehicles could achieve 15-20% CO_2 reduction versus conventional gasoline vehicles, based on per km driven (Fu, 2007).

Beside the government target of replacing 10 million tons of petroleum-based fuel annually with bio-ethanol biodiesel by 2020, there is so far no nationwide policy released to promote the utilisation of alternative transportation fuels. However, the local government in five provinces have made E10 blends mandatory, a fuel that accounts for 16 percent of the nation's passenger cars (GTZ, 2006). In some cities, gas powered buses and taxis are promoted primarily to cope with the massive pollution problem. By the end of 2006, estimated 200,000 CNG cars and buses were used in China and in early 2007 and more than 650 natural gas stations have been built (Fu, 2007). According to an estimation of the IEA, biofuels will reach a share of only 2% of road fuel consumption in 2030 (IEA, 2007).

For further biofuel policies see chapter 5.2.

- **Alternative Engine Technologies**

A new regulation regarding new energies (e.g. electric, fuel cell, hydrogen) in vehicles was promulgated in November 2007 by the National Development and Reform Commission (NDRC).[27] This regulation is a step towards the research, development and production of new energy vehicles. The document itself is a guideline for enterprises applying to manufacture vehicles powered by new energies, concerning the research, production and after-sales service capacities as well as the reliability of the technique. Special testing institutions will be entrusted to supervise the quality of the vehicles powered by new energies, according to the regulation.

- **Environmentally-Friendly Vehicle (EFV)**

Another policy currently under development is a National Environmentally-Friendly Vehicle (EFV) rating system. The system is designed to give manufacturers, consumers, and policy-makers a metric by which to measure the total environmental impact of different vehicle models (based on its tailpipe pollutant emissions, CO_2 emissions, and weight) (Wagner et al., 2006).

- **Public Transportation**

In order to reverse the trend of increasing fuel consumption and air pollution, the Ministry of Construction in 2004 established a national policy stipulating that public transport should be prioritised and developed as the dominant mode of urban passenger transport and urged local governments to increase investment in urban transport stations construction. Bus rapid transit (BRT) mode is recommended to be used for developing large and medium cities (Wang, F. & Wang, J., 2004). The MOC further stipulated that 30% of all trips in the large cities should use public transport and defined a minimum speed of public transportation of 20km/h.

[27] See: http://news.xinhuanet.com/english/2007-11/03/content_7002334.htm

Some BRT projects, such as the Kunming bus ways or the Beijing North -South Central Axis Line have been implemented; further metro lines are being build in Beijing; public transport fares in Beijing were cut by more than 30 percent in 2007; and a car free campaign covering 108 cities in China are examples of the local promotion of sustainable transport in China.

4.4 Land-Use Change and Forestry

The area of forests in China increased from 1980 to 2005 by 6.21% to a total area of 175 million hectares (SEPA, 2005). The afforestation [28] programs and campaigns during this period were launched mainly to tackle soil erosion and to combat desertification and choking rivers. Massive sand dunes are drifting towards the capital, causing yearly sandstorms and water shortages because of silting reservoirs.

Afforestation could mitigate human-induced climate change through carbon sequestration, i.e. through the uptake of CO_2 and storage of carbon in biomass, soils and wood products. Afforestation efforts from 1980 to 2005 achieved estimated 3.06 billion tons CO_2 absorption in China (Gao, G., 2007), and CO_2 emissions of land-use change and forestry were in the negative range in the year 2000 (-47.3 Mt CO_2, see Figure 9) due to the afforestation efforts.

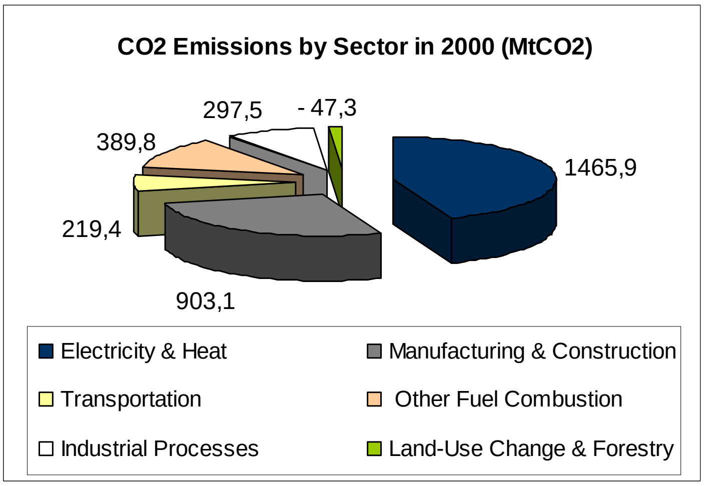


Figure 9: CO_2 Emissions of China in 2000 (Source: Climate Analysis Indicators Tool (CAIT), World Resources Institute, 2008)

4.5 Electricity

On the supply side, energy efficiency improvement in the power sector is a key area. In a research project commissioned as part of the Stern Review, Zhang Anhua and Zhao Xingshu defined seven challenges and potentials for improving energy efficiency and conservation in the Chinese power industry (Zhang & Zhao, 2006):

(1) Electricity generation is with over 80% strongly dominated by coal-fired power;
(2) The high proportion of low efficiency units is currently responsible for 100 million tce waste of energy per year;

[28] The term afforestation describes the establishment of forests on lands that have been cleared in recent times.

(3) 45 billion kwh is wasted each year due to the loss in electricity transmission and distribution;
(4) Backward energy conservation technologies hinder efficiency;
(5) Inferior demand side management inhibit energy consumption reduction;
(6) 1280 loss making enterprises in the power sector are unable to invest in efficiency improvement;
(7) Ineffective market mechanisms.

The following policies and measures are addressing the supply side aspects of energy efficiency and emission reduction:

- **Retiring Inefficient Power Plants**

The Chinese Government plans to phase out a total capacity of 50 GW (around 8% of the country's total generating capacity) of small generating, inefficient power plants by 2010 (about 40 GW coal-fired and 10 GW of fuel oil-fired capacity). Small power units use 30 - 50% more coal to generate the same amount of power as large and efficient units. All newly launched power plant projects, as required by the NDRC, are slated therefore to adopt super-critical or ultra super-critical power generation units of at least 600 megawatts in capacity. Proposing new coal-fired plants requires shutting down smaller, older plants at the same time (NDRC, 2005).

Furthermore, all coal-powered plants with capacity under 50 MW, and 100 MW generators operating for 20 years or more, will be ordered to close by 2010. Generators with coal consumption more than 10% above the provincial average or 15% above the national average are also targeted for closure.

- **Equipment upgrading and technology innovation**

The “Top-1000 Energy-Consuming Enterprise Program”, launched by the NDRC in April 2006, focuses on energy efficiency in enterprises with the highest energy consumption from nine sectors including electric power. The technological upgrade of low-efficiency equipments such as cooling fans, water pump, and large-scale electricity engines can reduce significantly the self consumption in power plants. The overall goal of this 1000 enterprise program is to realize total savings of 100 Mtce from the expected energy consumption of these 1000 enterprises in 2010 (Price & Wang, 2007).

- **District Cogeneration Projects**

This program - related to the supply side - is one of the 10 prioritized programmes for energy conservation as presented in China’s Medium-and-Long-Term Energy Conservation Plan. The effort promotes cogeneration - combined heat and power (CHP) - as an up-to-30% more efficient solution compared to separate generation of heat and electric power. The program aims to install a total of 40 GW cogeneration units with environmental protection features during the 11th FYP. Furthermore, the rate of district heating in urban areas is to be increased from 27% in 2002 to 40% in 2010. The heat supply efficiency of district heating is 50% more than that of scattered small boilers. The resulting annual energy savings will be 35 million tce.

- **Clean Coal**

As coal will be the main resource for decades to come, China is seeking ways to use coal in a cleaner way. China is investing heavily in research and manufacturing of clean coal technology, including super-critical coal, coal mine methane capture and utilization, carbon sequestration, as well as coal liquidification[29] and gasification (State Council, 2007).

- **Energy-saving grid performance**

The NDRC together with SEPA, State Electricity Regulatory Commission and the National Energy Leading Group issued a pilot programme to optimise the potentials of an energy-saving scheduling method (节能调度)[30]. Energy generation will be implemented in the grid according to a specified demand schedule, which aims to result in an optimised allocation of power-generation and finally in a more eco-efficient power grid.

- **Demand-side management (DSM)**

In the last few years, China has begun to integrate the concepts of DSM[31] into national plans, policies, regulations and standards. These are, however, not widely applied in China, though some are already being tested and developed (NDRC, 2005). The State Power Corporation included DSM as a qualification factor in a regulation (Tentative) in 2001, which stipulate that top-level power supply enterprises must take active steps to plan and launch effective DSM programs (Finamore, B.; Hu, Z.; Lei, T. et al., 2003).

Significant load management efforts - including substantial shifts to time-of-use power pricing with large differences between peak and off-peak prices interruptible tariffs that compensate consumers for voluntary demand reductions during peak periods, as well as off-peak storage techniques like ice-storage air conditioners and heat-storage electric boilers - have been implemented in the past few years (Hu et al., 2005). The shortages of generating capacity and fuel in the year 2003 and 2004 have caused the government to focus for on load management as an energy conservation measures. Actions taken reduced peak load by over 20GW in 2003 and nearly 30GW in 2004, of which 30% was due to DSM (Hu et al., 2005).

Furthermore, several pilot DSM studies have been conducted so far, all of which found tremendous electricity savings potential and environmental benefits. Except one peak load management, none of these initial pilot DSM studies were ever implemented. More recently, however, Jiangsu and Henan Provinces has begun to carry out a number of DSM projects (Finamore, B.; Hu, Z.; Lei, T. et al., 2003).

According to the latest White Paper on energy conditions and policies in China (State Council, 2007), the Government will continue to strengthen power demand-side management, exert control over power use for the purpose of conserving energy and emphasis the increase in energy utilization efficiency.

5. Renewable Energies in China

[29] Producing coal liquidification or Coal-to-Liquid (CTL) will require large amounts of coal and water, and most alarming roughly double climate-changing greenhouse gas emissions. Yet, it is unsure if the carbon dioxide could be remedied by capturing and storing the carbon underground.
[30] See: http://www.cpeinet.com.cn/new/displaynews.aspx?id=f5b7c755-4a40-4634-b831-f6397b2d5b53 (in Chinese).
[31] DSM refers here to measures (sponsored, funded and/or implemented) by utilities that are designed to encourage consumers to modify their level and pattern of electricity consumption. Measures which either reduce overall consumption through energy efficiency, or using load management to smooth out the peaks and dips in energy demand, by reducing consumption at peak times ("peak shaving") and increasing it during off-peak times ("valley filling") or vice versa.

Dealing with China's statistics and numbers means also dealing with superlatives. Beneath being a world leader in coal consumption or emissions, China also leads the list of total existing renewable power capacity in 2006. Furthermore, the country is number one in the categories of installed rooftop solar heat collectors to provide hot water and small hydro power. [32]

Investment in China increased to $12 billion in 2007, mostly for small hydropower, solar heat collectors, and wind power. China ranks on position two right after Germany which invested over $14 billion in 2007, mostly in wind and solar PV (REN21, 2008). However, nearly 90% of new power-generation capacity was coal-fired in 2006, compared to 70% in 2000, indicating the strong emphasis on coal as a major energy resource (IEA, 2007).

Renewable energy accounted for about 15% of China's total primary energy consumption in 2005. This number includes traditional biomass energy[33], mainly used for cooking and heating in rural households. Excluding traditional uses of biomass energy, the total amount of renewable energy utilized in China in 2005, was about 166 Mtce, accounting for 7.5% of total national primary energy consumption (NDRC, 2007b).

Figure 10 and Figure 11 give an overview about the share of renewable energies in the electricity generation.

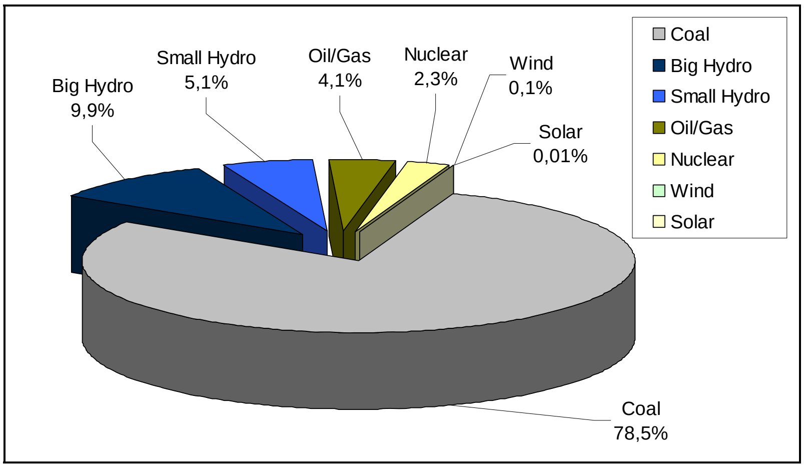


Figure 10: Generated electricity in China, 2004
(varies from the installed capacity; source: Eifert et al., 2007)

Grid-connected electricity generation on the basis of solar photovoltaic power, biomass energy applications and geothermal energy has still not reached a level of notable significance. Currently, more than half a million non-grid-coupled applications are providing energy to individual households in China, powered one third each by small wind energy units, photovoltaic and micro-hydropower systems. More than one million inhabitants in small settlement centres are supplied with electricity generated from renewable energy (small-scale hydro, PV systems and PV/wind hybrid systems) in isolated schemes (GTZ, 2007).

In the next 5 to 15 year, demand and production of electricity are projected to increase rapidly. Coal power will also increase by some 50% in capacity; the generating capacity from hydropower will be nearly doubled compared to 2006 level; and renewable will experience fastest expansion, though their

[32] China defines and report small hydro based on a threshold of up to 50 MW capacity - common practice instead is to define small hydro only up to a capacity of 10 MW.
[33] Traditional biomass refers to the use of fuel wood, animal dung and agricultural residues in stoves with very low efficiency

share in total is somewhat negligible in the future development of Chinese power industry. Nevertheless, the percentage of coal-fired electricity will be reduced (see Figure 11).

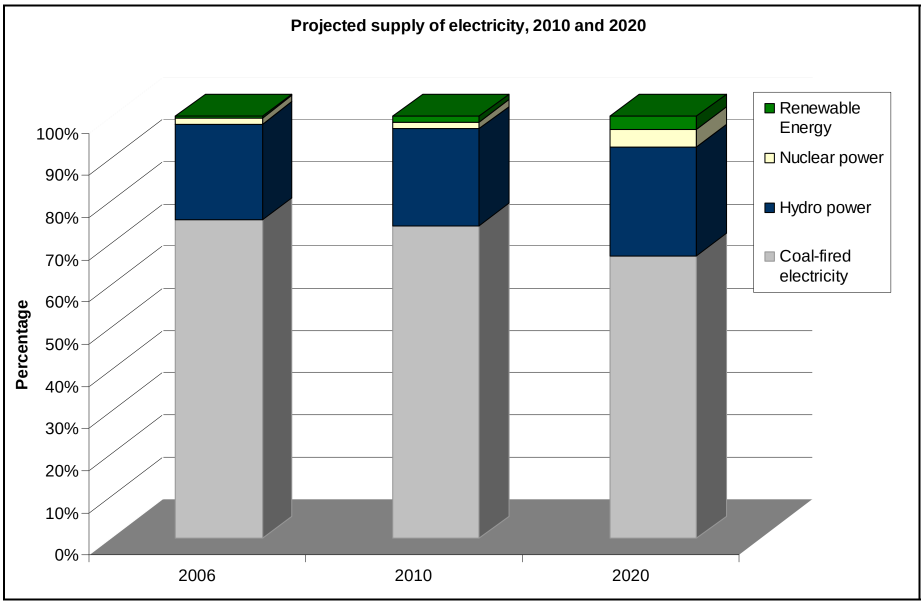


Figure 11: Projected supply of electricity generation in China in 2010 and 2020 (Source: Zhang & Zhao, 2006)

5.1 Policy framework for Renewable Energy

The significant challenges to the rapid expansion of renewable energy in China are characterized by high initial capital costs (compared to carbon-based sources of energy) resulting in low initial profit margins for producers. Small scale hydropower is 1.2 times the cost of coal, biogas is 1.5 times, wind power is 1.7 times, and PV is 11 to 18 (Zhang, Z. et al., 2006). The high cost of renewable energy weakens its competitive ability, which is the biggest obstacle to its commercialization and distribution.

Additionally, the geographical feasibility of renewable energies do often not fit the demand side. Consequently, government support is extremely important at the initial stages of the development of markets for renewable energy to provide to overcome these barriers.

The basis of the legal framework for renewable energy - the Chinese Renewable Energy Law - was released in 2006. Earlier versions of a renewable energy framework dating back to the 1980s included previous recommendations on promoting renewable energy for the development of rural energy and rural electrification. With the progress of RE-power-generation technologies, particularly wind power technologies, the former Ministry of Electric Power made a decision in 1994 to develop wind farms as a new clean power source. Regulations were issued to cover grid connection and the payment for electricity generated, making wind power commercially viable. Further policy recommendations and progress in removing barriers from the development of renewable energy followed, before the Government began to formulate its Promotion Law for renewable energy development and utilization in 1999. The China Renewable Energy Law was finally issued on Feb. 28th, 2005, and took effect on Jan. 1st, 2006.

The Renewable Energy Law marks a shift in energy policy towards market supporting policies of renewable energies. The Law institutionalizes a number of policies, instruments and indicative renewable energy targets for China's renewable energy development and utilization (People's Republic of China, 2005). The renewable energy law encompassed among others the establishment of responsibilities, e.g. for of provincial targets, development and supply plans or feed-in prices and provisions such as:

- the obligation for developers to conduct a competitive tendering process if there is more than one applicant for a project licence;
- the "economic and reasonable" fixing of the grid power price, based on the results of bidding process, is placed in the hands of the pricing authorities of the State Council;
- the law gives renewable energy priority grid-access and obliges state grid corporations to offer a grid connection service in their grid area and to purchase all electric power generated from renewable resources according to the feed-in tariff (Grid operators, in turn, can include their costs in the selling price);
- grid operators have to pay compensation in case they are unable to meet their purchase obligation;
- the central government supports renewable energy power systems in rural areas and encourages the setting of technical standards, especially for solar energy utilization systems and construction;
- the promotion of renewable energy through fiscal and tax measures (low-interest loans, tax concessions or a development fund) has to be made available.

The "Medium and Long-Term Development Plan for Renewable Energy in China", released in September 2007, intends to speed up the development of renewable energy and mitigate climate change. The plan puts forward the guiding principles, objectives and targets, priority sectors, and policies and measures for the development of renewable energy in China up to 2020 (NDRC, 2007b). The objective is an overall raise in the share of renewable energy in total primary energy consumption to 10% by 2010 and 15% by 2020. The renewable energy plan estimates that, if its targets are met by 2010, China will emit 600 Mio. tons less carbon dioxide a year. By 2020, the annual reduction in carbon dioxide emissions should reach 1.2 billion tons.

The overall objectives for China's renewable energy development in the coming 15 years are: to increase the proportion of renewable energy in total energy consumption; to resolve the problem of lack of electricity of people living in remote off-grid areas and the shortage of fuel for daily life needs in rural areas; to stimulate the utilization of organic wastes for energy; and to promote the development of renewable energy industries.

Following development targets for the several renewable sources have been put in force (Table 4):

Development Targets	***2005***	***2010***	***2020***	***Potential***
Big hydro power	80 GW	120 GW	225 GW	540 GW [34]
Small hydro power	35 GW	60 GW	75 GW	
Wind power	1.3 GW	5 GW	30 GW	1000 GW [35]
Biomass power	2 GW	5.5 GW	30 GW	500 Mtce [36]
Solar PV	0.07 GW	0.3 GW	1.8 GW	5000MJ/m^2
Solar hot water	80 Mio. m^2	150 Mio.m^2	300 Mio. m^2	-
Ethanol	0.8 Mio. tons	2 Mio. tons	10 Mio. tons	150 Mtce
Biodiesel	0.05 Mio. tons	0.2 Mio. tons	2 Mio. tons	
Biomass pellets	~ 0	1 Mio. tons	50 Mio. tons	-
Biogas and biomass gasification	8 billion m^3/y	19 billion m^3/y	44 billion m^3/y	-
Geothermal Energy	30 MW	110 MW	0.5-1 GW	6 GW
Share of total primary energy (including large hydropower)	~7.5%	10%	15%	-

Table 4: Development Targets for Renewable Energies (Source: NDRC, 2007b; REN21, 2008; Ying, 2007; Zhang et al., 2006)

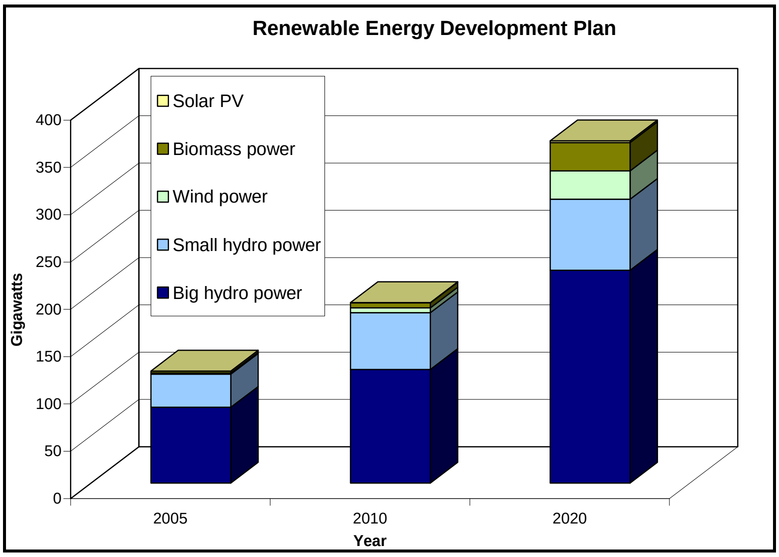


Figure 12: Renewable Energy Development Plan of the P.R. China (Source: NDRC, 2007b)

[34] China's total potential capacity of technically exploitable hydropower is 540 GW; the economically feasible potential capacity of hydropower instead is 400 GW, mainly located in Southwest China.
[35] The exploitable potential onshore wind capacity is 300 GW, offshore wind resources are about 700 GW.
[36] 500 Mtce is the nation's total biomass resource that can potentially be converted into energy and fuel (forestry and forest product processing, animal manure, energy crops and plantations, organic effluents from industry, municipal wastewater, solid waste, etc.).

In order to achieve the objectives and targets of the "Medium and Long-Term Development Plan for Renewable Energy in China", the government plans establish sustainable and stable market demand by means of favourable price policies, mandated market share (MMS) policies[37], government investment and government concession programs. The MMS policies will be adopted for non-hydro renewable power generation according to the following targets: (1) the share of non-hydro RE in large scale power grids has to reach 1 percent by 2010 and over 3 percent by 2020; (2) power generators with a capacity of over 5 GW will be required to have a non-hydro RE share of 3 percent of their total self-owned capacity by 2010 and over 8 percent by 2020 (NDRC, 2007b).

At present, there is no nationwide comprehensive legal framework and incentive system to implement the development targets of renewable energy in China at present. The government support changed in the past from supply subsidy to tax reduction or exemption, preferential price and credit guarantee.

However, compared to the mechanism needed for reaching the ambitious target mentioned above, the measures are not systematic and strong enough (Li, 2006). The following main measures have been introduced to date:

- **Grid connection**

The Renewable Energy Law provides for the compulsory connection of renewable energy generators to the grid (People's Republic of China, 2005). The regulation covers hydropower, wind power, biomass (including forest and agricultural residue, direct combustion and gasification, land fill gas power generation, biogas generation), solar power generation, geothermal power generation, and tidal power.

Local power grid companies must provide grid-connection services. These companies are responsible for the construction of transmission lines for renewable power stations and related technical support. Further, they have to provide priority of access to renewable energy sources. China's State Electricity Regulatory Commission (SERC) will assume nationwide oversight over power companies that are required under the country's renewable energy law to prioritize purchases of the maximum amount of renewable electricity available in their coverage areas.[38] Gas, heat and liquid fuel sourced from renewable energy must be allowed to be connected to the grid if they satisfy the standards of grid connection. The Renewable Energy Law emphasises that penalties will be imposed for violations.

- **Feed-in-tariff**

Price is the key barrier to the commercialization of renewable energy generation as the cost for renewable energy power generation at its present stage of development is higher than conventional energy. The China Renewable Energy Law has defined the guiding principles of China's feed-in tariff approach and requested the government to formulate concrete measures to implement the approach. Some directives regarding feed-in tariff implementation have already been enacted in China, such as Directive on Renewable Energy Power Generation and Directive on Renewable Power Pricing and Incremental Cost Sharing. A feed-in tariff system for all the renewable energy power is planned to be adopted in the near future.

[37] An MMS requires a specific percentage of electricity to come from renewable energy; those utilities/grids that do not generate renewable power are required to purchase credits from RE resources, via a secondary market.
[38] See: http://www.serc.gov.cn/opencms/export/serc/zwgk/jggz/news/tongzhi000044.html

Two types of pricing systems have been implemented thus far: feed-in tariffs (“government-fixed pricing”) and competitive tendering (“government-guided pricing”). The feed-in tariff is a government regulated production subsidy, as the grid utilities must purchase the renewable energy at a fixed price. To date only the price for biomass energy has been fixed at RMB 0.25 per kWh (similar to coal). This subsidy will no longer be available once a biomass project has been in operation for 15 years. For all renewable power projects approved after 2010, the subsidy provided per kilowatt-hour generated will decrease at an annual rate of 2 percent.

The government runs a bidding process for a wind project to provide a specified amount of renewable energy. Wind power generation projects are priced according to a competitive tendering. Usually, the developer with the lowest price bid and the highest proportion of locally made components wins the tender. As a result, wind developers (as well as other RE developers) will encounter different costs and conditions, depending on the concession and tendering process and the province (Li, J.; Gao, H. et al., 2008).

The price setting method of solar PV and solar thermal is based on a feed-in tariff but with the stipulation that the government approves all solar projects. After each solar power project is approved, the government will set an appropriate feed-in tariff on a project-by-project basis. The tariff will be determined by the pricing department of the State Council, based on the principle of reasonable production cost plus reasonable profit. Both building-integrated PV systems and large-scale desert PV power plants will be subject to this “feed-in tariff” policy.

So far, only wind, solar and biomass prices have been developed, although a framework methodology for wave-hydro and geothermal power price is set out in the Renewable Energy Law.

- **Tax measures**

The Renewable Energy Law has pointed out the importance of tax measures, and requested the relevant government departments to formulate concrete regulations such as tax and/or tariff relief and preferential loans to support China’s renewable energy industry development.

Taxation for renewable energy in China can be classified as shown in Table 5.

Items	***VAT***	***VAAT (value-added annex tax)***	***Income Tax***
General	17%	8% of VAT	33%
Small hydro power	6%	8% of VAT	33%
Biogas	13%	8% of VAT	15%
Wind	8.5 %	8% of VAT	15%
Landfill gas	0	0	33%

Table 5: Classification of Taxation in China (Source: Li, 2006)

For example, VAT (value added tax) is about 17% in general. However, a favourite taxation rate can be applied to some renewable energy, such as wind, biomass and small hydropower. Presently, wind farms enjoy a 50% reduction in Value Added Tax – the tax for wind-generated electricity was halved from 17% to 8%. Therefore, the price of wind power will be reduced about 0.05-0.07 RMB per kWh, according with the cost difference in various wind farms. Furthermore, the import of wind power equipment and accessories is presently exempt from customs duties (GTZ, 2007). Other taxation measures in favour of renewable energy investment and use are under formulation or investigation.

- **Fiscal measures**

A supplementary regulation on renewable power pricing and cost sharing has been in force since June 2006, requiring power suppliers on the grid to purchase renewable electricity at either a government-fixed or a government-directed price. The additional cost of renewable energy is added to the individual household utility bills as an extra “renewable energy” charge of 0.001 Yuan for every unit (Li, J.; Gao, H. et al., 2008).

According to the Renewable Energy Law, the central government financial authority is to set up a renewable energy fund, to support investments in renewable energy projects by providing grand or subsidizing low interests. The scale of investment in the fund will be determined according to the requirements for developing renewable energy and the financial strength of the nation. At the local level and also according to the requirements of the Renewable Energy Law, the financial authorizes should, according to specific local circumstances, also allocate the necessary funds to support renewable energy development (NDRC, 2007b).

As an example, Research & Development funds on renewable energy offered by the Ministry of Science and Technology (MOST) and the central government during the Ninth & Tenth Five-Year Plan period was 1 billion RMB in total (Li, J. et al., 2006b). Another example during the 9th FYP period was a low-interest loans of about 300.0 million RMB for small hydropower development, provided by the Ministry of Water Resource (MWR). Beside these efforts, the government also provided interest subsidies (50% of commercial bank loan interest) to some government approved renewable energy projects (Li, J et al., 2006b).

5.2 Biomass Energy

Traditional biomass energy is so far the main renewable energy source in China and, with a total consumption of 227Mtoe in 2005, it is also the largest in the world. Only 1.5% of the biomass was used for power generation in 2005 (IEA, 2007).

Total biomass consumption is likely to remain broadly unchanged through to 2030. However, the utilisation pattern will change considerably. According to government targets, the biomass-fired generation capacity will rise from 2GW in 2005 to 30GW by 2020. The NDRC stated that China’s annual available biomass resource that can potentially be converted into energy is about 500 Mtce. This figure includes crop straw, forest disposables, methane from stock feeding and industrial waste and urban garbage (NDRC, 2007b).

By the end of 2005, the installed capacity of **biomass power** in China reached 2 GW (sugar cane residue 1.7 GW; urban garbage 200 MW; agricultural or forestry waste 100 MW). The total annual production of **biogas** was about 8 billion m^3 generated from 18 million household biogas digesters (7 billion m^3) and about 1,500 large-scale biogas plants for livestock farms and for organic industrial (1 billion m^3). China emerged as the world’s third largest producer of **ethanol biofuels** (after the U.S. and Brazil). The production capacity for bio-ethanol using food grains as a feedstock was 1.02 million tons, the capacity of bio-diesel made from waste of edible oil from restaurants, oil pressing factories and edible oil-yielding crops reached 50,000 tons in 2005 (NDRC, 2007b).

However, the actual and targeted high level of bio-fuels production will force a conflict between food security and "oil farming", as the price of crude oil continues to increase. Food-based alternative fuel turns out to be far more expensive both economically and environmentally. The Government announced a moratorium on the production of ethanol from corn and other food crops in June 2007, underlining the concerns that ethanol production is driving up rapidly the costs of corn and grain. [39] The damage to the region's forests and biological diversity and intensified soil erosion and water shortages from massive monoculture plantations of biofuel crops undermines the efforts towards a sustainable development. A new study indicates that growing and burning of many biofuel crops may actually raise greenhouse gas emissions (Crutzen, P.J. et al. 2007). These results highlight the importance of correct full life-cycle assessments for biofuels and raise questions about the strategy of biofuel crops as a climate change mitigation concept.

According to the "Medium and Long-Term Development Plan for Renewable Energy in China", priorities for biomass energy development will be biomass power generation, biogas, biomass pellets (used directly as fuel), and liquid bio-fuels. By 2020, the installed capacity of biomass power will increase from 2 GW in 2005 to 30 GW. Biomass power based on agricultural and forestry wastes and energy crops plantations (bagasse included) will account for 24 GW; large-scale biogas projects on livestock farms and biogas projects utilizing industrial organic effluent will add another 3 GW; and urban waste combustion plants are planned to deliver further 3 GW till 2020. To address the integrated priorities of meeting basic rural energy needs and in order to diversify the energy mix in rural areas, the development plan stipulates the production of 1 million tons of biomass pellet in 2010 and 50 million tons by 2020.

A capacity of biomass gasification of agricultural and forestry wastes is planned to provide fuel for about 40 million rural households by 2010 and 80 million households by 2020, respectively. China aims to utilize an additional 2 million tons of bio-ethanol from non-food-grain feedstock and increase biodiesel use to 200,000 tons by 2010. By 2020, the Development Plan for Renewable Energy intends to utilize 10 million tons bio-ethanol and 2 million tons bio diesel, replacing 10 million tons of petroleum-based fuel annually (NDRC, 2007b).

No specific regulations and requirements for biofuels as an alternative to petrol and diesel have been issued thus far. As coal is the primary processing fuel for ethanol production in Chinese mills, upstream CO_2 emissions may offset the carbon benefit from such biofuel production (Fu, 2007). This feature is a further example indicating that a proper regulative, monitoring and control framework is needed for a sustainable employment of biofuels.

5.3 Hydro Power

In the electricity sector, hydropower is the main renewable energy source, accounting for 16% of total generation in 2005, including big hydro. The share of small-scale hydropower instead was only around 5 %, but remains the most important renewable energy component of the grid-coupled electricity generation in China (IEA, 2007).

During the period 2002–2006, China has seen the highest growth in hydro capacity with over 8 percent per year. The hydro growth has kept pace with the rapidly growing power sector, with about 6

[39] China Daily (June 2007): "Ban on use of corn for ethanol lauded", available at: http://www.chinadaily.com.cn/china/2007-06/22/content_899837.htm

GW of large hydro and 6 GW of small hydro added in 2006 (REN21, 2008). By 2010, the installed capacity of hydropower in China will reach 190 GW (300 GW by 2020) according to the Medium and Long-Term Development Plan for Renewable Energy (NDRC, 2007b). As a consequence, only two large rivers in China still run dam-free.

Today there are more than 25,800 large dams in China, more than in any other country in the world. These projects have forced more than 10 million people from their homes and land, many of whom are still suffering the impacts of displacement and dislocation.

Although environmental constraints and resettlement impacts, large hydropower remains one of the low-cost energy technologies and still a favourite option for the Chinese Government. China has plenty of hydropower resources – the total potential capacity of technically exploitable hydropower is 540 GW, the economically feasible hydropower capacity is 400 GW, with an annual power generation potential of 1750 TWh, mainly distributed in Southwest China. The hydropower resources are generally remote from the developed regions, though the exploitation conditions are complicated and expensive, hydropower is given top priority especially in rural areas without electricity, where it would not be economically feasible to extend the power grid (NDRC, 2007b).

By 2010, the installed capacity of hydropower in China will reach 180 GW (300 GW by 2020) according to the Medium and Long-Term Development Plan for Renewable Energy (NDRC, 2007b).

Today, it is generally recognized that large hydroelectric power stations have proved to be not nearly as feasible as their designs claimed, especially after seeing their vast and irreversible environmental and social impacts. Many impacts of large hydro projects go unacknowledged or underestimated. While there is still much scientific controversy about the measurement and comparability of hydropower emissions with emissions from fossil fuel plants, it appears that hydro projects with large reservoirs in the tropics can have a greater climatic impact per unit of power generated than fossil fuel generation, due to methane and carbon dioxide emissions of rotting organic matter in the hydropower reservoirs.

Furthermore, impacts of climate change on the hydrological system like new extremes of drought or floods are not taken into account. This has serious implications for dam performance and safety (IRN, 2004).

5.4 Wind Energy

China's wind industry is growing rapidly. In three recent years, installed wind generation capacity has increased by 40 percent each year (Martinot & Li, 2007). By the end of 2005, more than 60 wind farms had been connected to the power grid in China, with a total installed capacity of 1.26 GW. About 250,000 small wind turbines with a total capacity of 50 MW are operating off-grid in remote areas of China (NDRC, 2007b). By the end of 2007, the power generating capacity climbed up to 5.6 GW, but over a quarter of it is still not connected to the grid due to bad planning and low support of the grid companies.

The Government target for (grid connected) wind power of 5 GW by the end of 2010 is therefore likely to be reached well ahead of time. Nevertheless, while 5.6 GW is a large amount of wind power by international standards, it is less than 1 percent of China's total current electricity generation capacity and small compared to the country's size and potential.

China has abundant wind energy resources. The Chinese Meteorology Research Institute estimates an exploitable potential onshore wind capacity of 300 GW and an offshore wind resource of 700 GW. The resources are mainly distributed in two major "wind belts" (NDRC, 2007b): the "Three North Region" (which includes Northeast China, the north part of North China, and Northwest China); and East China (including coastal areas, offshore areas, and nearby islands).

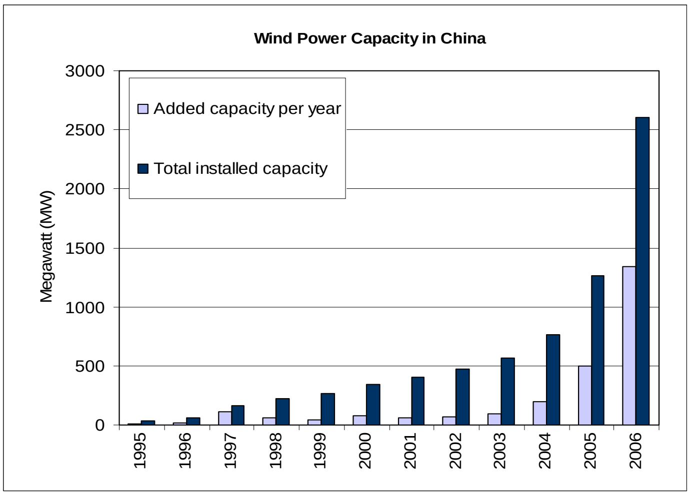


Figure 13: Development of wind power capacity in China
(Source: GWEC, 2006; Eifert et al., 2007)

The Chinese government launched several programs (e.g. the "Ride the Wind Program", the "National Debt Wind Power Program") in the 1990s, to support the domestic development and commercialisation of wind power. The emphasis in this initial demonstration and industrialisation period was to create a demand, to provide subsidized interest bank loans, and to produce domestically by new joint venture enterprises. These programs initiated the first domestic production of wind generators and installed several hundred megawatt capacities (Li, J.; Gao, H. et al., 2008).

In 2004, the NDRC initiated the "Wind Power Concession Project", with a 20-year operational period in order to promote large scale commercial development. This program aims to reduce the in-grid wind power tariff by building large capacity wind farms and achieving economies of scale.

In an annually tendering procedure, domestic and international companies are encouraged to develop large-scale projects (100 MW), making them more competitive with coal-fired power by bringing down the generating cost and to increase the proportion of locally made components (70 % of the wind turbine components). The project investors are selected by public bidding coordinated by the NDRC - the company which commits the lowest feed-in tariff (price per kWh) and the highest proportion of localised production usually wins the bid. After the first 30,000 full load hours of operation, the feed-in tariff will be adjusted to the average for the power market at that time.

The length of the contract is 25 years. All electricity generated by the wind project must be purchased by provincial power grid company, who have the obligation to take a certain mandated market share of electric energy generation by RE and are responsible for providing transmission lines to the sub-station. All end-users of the grid's electricity share the tariff increase due to wind power purchase. Since 2006, the increment cost of wind power will be shared nationwide.

Up to end of 2006, 4 phases of the wind concession programme have been launched with 15 projects and a total capacity of 2,550 MW, with approval by the central government. A further 3,000 MW have been approved by the local wind bidding procedures based on the same principles (Li et al., 2006; Li, J.; Gao, H. et al., 2008).

However, both domestic and international wind developers, investors and manufactures, have serious concerns about the price decision through a competitive bidding process. The main weakness of this process is that in order to win the contract, unreasonable low prices are committed, especially by state-owned enterprises. The result is a discouragement of domestic and foreign manufacturers and developers from participating, due to price volatility, uncertainties and non profitable pricing (Li et al., 2006).

The government arranges the wind resource assessments and feasibility studies to determine the wind farm sites for further biddings. The fact that the authority in charge of determination of the locations and coordinating the tendering, will not operate the wind parks, the incentive to find the sites with the best wind potential is likely to be lower (GIC, 2006). But so far, the NDRC sees its concession approach confirmed in the rapid growth of wind power (Haugwitz, 2007).

5.5 Solar Energy

In general, solar resources (average solar radiation) in China are abundant. Two-thirds of China's territory enjoys over 2,200 hours of sunshine annually, with a median radiation value of 1626MJ/ m2. The Solar potential in China is therefore 50% higher than in Germany, about the same as in Spain, and a little bit lower than in the USA (NDRC, 2007b; GIC, 2006). The favourable conditions are found in West China.

By the end of 2005, the total installed capacity of solar PV power in China was about 70 MW, whereof 45% were installed in rural (off-grid) areas. Communications and industry account for 37% and consumer products 14% of the total capacity. Grid-connected PV is still marginal, about 3 MW total (Martinot & Li, 2007).

Thermal heating is the second main usage of solar radiation. 64% of the worldwide rooftop solar collectors to provide hot water are installed in China. The total heat collecting area of solar water heaters installed to date in China had reached 80 million m2. China now represents 75% of global annual additions of solar hot water (REN21, 2008).

The Chinese government is currently aiming to increase the country’s solar power capacity to 300 MW by 2010 and 1.8 GW by 2020. The 2020 target includes 300 MW of rural electrification projects, 1 GW of PV power generation projects installed on rooftops and public infrastructure (building-integrated grid-connected PV), 200 MW of large-scale solar power plants and 200 MW of solar thermal power.
The Chinese government is also aiming to promote building-integrated solar thermal systems. The NDRC aims to increase the cumulative installation of solar energy water heaters from 15 million m2 in 2004 to 150 million m^2 (equivalent to 30 Mtce) in 2010 and to 300 million m^2 (equivalent to 60 Mtce) in 2020 (NDRC, 2007b).

The current policy framework to support the development of solar power falls under the rubric of the national development plans and the Renewable Energy Law. That framework is based primarily on subsidies of solar PV in remote rural areas in order to secure an electricity supply, and also includes various support schemes for research and development, and some pilot projects.

Over the past decade, the Chinese government has introduced many initiatives and programs, such as the “Bright Project” (1997) and the “Township Electrification Programme” (2002-2004), with funding mainly from the central and local government budget.

The Township Electrification Program, launched in order to meet the power needs of public utilities and residents of un-electrified townships in remote, border regions of Western China, inaugurated 19 MW of solar PV panels, providing relatively strong stimulation to the manufacturing and utilization of solar PV in China. The Programme received 2 billion RMB from central government and 1 billion from local government (Li & Gao et al., 2008). Electricity supply was introduced to over 700 villages, representing more than 200,000 households and about 1 million people. The program has, to a large extent, pushed the initial development of China’s PV industry (Martinot and Li, 2007).

Beside various supports for research and development of solar PV, pilot projects are installed to accumulated valuable experience for the development of solar PV in China and support the industry technically and financially. Local authorities are encouraged to carry out their own solar PV pilot projects. Examples of local initiatives are: Shanghai’s “100,000 Solar PV Roof Plan”, which plans to build 100,000 Solar PV on roofs in the five years from 2006 to 2010; and Beijing’s “Solar Road Lighting Project”, which plans to supply road lighting with solar PV power in rural streets and some main roads using government funding (Li and Gao et al., 2008).

In the near future, solar power development in China is expected to be driven mainly by the rural electrification programme, a government program to provide access to electricity in rural areas (Martinot and Li, 2007). On-grid solar power generation may take time to develop in China, given that the generation cost is up to 5 times higher than for traditional fossil fuel energy and other forms of renewable energy. A supportive pricing system and smooth operation should be implemented.

Currently, the grid price is determined trough a feed-in-tariff system by the pricing department of the State Council (See also feed-in-tariffs chapter 5). For off-grid central PV power plants in villages, the initial investment will be paid by the government (household systems are not included) and the portion of the cost of operation and maintenance that exceeds the revenue from electricity fees (including the cost of renewing the storage batteries) will be apportioned to the nationwide electricity network by increasing the electricity tariff.

But there are challenges. Li and Gao concluded that the government target of 1.8 GW solar power by 2020 is too low, as huge development has taken place in PV manufacturing industry in China and a high amount of domestic solar PV production was exported. Targets are important drivers for investment. So, a low target will not further expand the domestic market nor support the development of manufacturing industry (Li and Gao et al., 2008).

6. Clean Development Mechanism

China approved and ratified the UN Framework Convention on Climate Change in 1992 and approved the Kyoto Protocol in 2002. The protocol established three flexible mechanisms to realize cost effective emission reductions: a) emissions trading (ET); b) joint implementation (JI), both among

Annex I countries; and c) Clean Development Mechanism (CDM) between Annex I countries and Non-Annex I (developing) countries.

China has no binding emission limits under the first commitment period (2008-2012) of the Protocol, but as non-Annex I country, it is able to participate in the CDM. The CDM is an instrument allowing industrialised countries (Annex I countries) with a greenhouse gas reduction commitment (emission caps) to invest in projects that reduce emissions in developing countries as an alternative to more expensive emission reductions in their own countries. The GHG benefits of each CDM project will be measured according to avoided tons of CO_2 emission and quantified in standardised "Certified Emission Reductions" (CERs), which can be traded at the market.

The CDM is furthermore intended to be a vehicle for investment and technology transfer between developed countries and developing countries including China. One important condition of a CDM project is that the emission reductions or sequestration must be additional to any that would occur without the project. They must result in a net storage of carbon and therefore a net removal of carbon dioxide from the atmosphere.

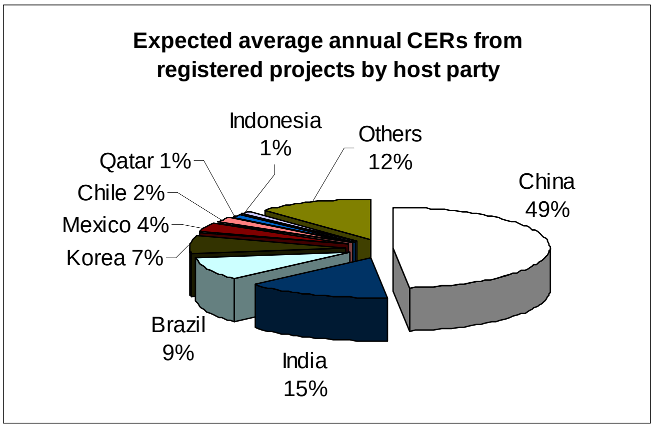


Figure 14: Expected average annual CERs from registered projects by host party (Source: UNFCCC, 2008).

The Coordination Committee on Climate Change (NCCCC) within the NDRC is China's Designated National Authority. It is responsible for the approval of all CDM projects – irrespective of their size and importance.

China has with 48% the largest source of CDM credits generated to date (see Figure 14). Quantitatively, in terms of approved projects, renewable energy such as wind power and small hydro power hold the majority of CDM-projects in China.

However, in terms of total estimated CERs, HFC-23 decomposition plants and destruction of N_2O from adipic or nitric acid production[40] dominate with more than 70%. About 80% of the global HFC-23 destruction under the CDM is taking place in China.

HFC-23 decomposition projects get credits from the destruction of HFC-23, a highly potent GHG that is an unwanted by-product of HCFC-22 production, which is mainly used for the refrigerant

[40] Adipic acid is the feedstock for the production of nylon-66 and produces abundant N_2O as a production by-product.

manufacture for air-conditioners. Due to the high global warming potential[41] of HFC-23 – one ton of HFC-23 is considered equivalent to 11700 tons of CO_2 – a single project will enable large volumes of CERs, thus producing high profits and attract investors. Studies have shown that the revenue generated from the CERs will outweigh the cost of building any new HCFC-22 production facilities. A developing world producer of HCFC-22 can earn nearly twice as much from its CDM subsidy than it can gross from sale of its primary product (Wara, 2007).

Given these incentives for increasing HCFC-22 production, the CDM HFC-23 decomposition projects heavily subsidy the air-conditioner industry instead of supporting sustainable development and allocating resources needed for clean technologies and real energy alternatives. Moreover, HFC-23 as well as N2O destruction projects do not induce a long-term transition of energy consumption patterns, but largely apply end-of-pipe technologies (Schneider, 2007).

In October 2005, the Chinese government released the ruling CDM regulation in China “Measures for Operation and Management of Clean Development Mechanism Projects in China”, declaring that 65% of the revenue that generates from HFC and PFC projects, 30% of N_2O projects and 2% of priority project areas and afforestation/ reforestation are to be collected by the Government (NCCCC, 2005). In return, the expected taxes of 1.5 billion EUR by 2012 (Schneider, 2007) will be invested in a new Clean Development Fund (CDF), established to finance projects in priority sectors such as energy efficiency, renewable energy, and coal bed methane recovery and use. This opportunity might give the Chinese government a mechanism through which it can direct substantial financial flows into sustainable development initiatives.

Even though the share of HFC-23 projects is now steadily diminishing and a broader range of projects are now being brought forward, the main target of the market are large-scale projects with a high CER prospects, low transaction costs and resulting high revenues. As the number of projects in the pipeline indicates (see Table 6), the share of N_2O destruction projects, another high GWP industrial gas that can hardly expect sustainable development impacts, could increase by 9 times.

[41] The global warming potential (GWP) describes the global warming effect of a GHG over a certain time horizon in mass relation to carbon dioxide. The 100-year GWP of HFC-23 is 11700 (Schneider, 2005).

CDM Projects in China, March 2008				
project type	no. of projects (registered)	estimated emission reduction(ktCO2/yr)	MW (capacity)	no. of projects (in pipeline)[42]
Wind	57	6194	2866	171
Small Hydro (≤10MW)	12	364	99	134
Big Hydro (>10MW)	39	4640	1422	382
Solar	0	0	-	3
Biomass	8	1225	185	30
Biogas	1	110	1.1	11
Landfill gas	9	2373	40	31
Coal bed/mine methane	7	4455	150	44
Fossil fuel switch	1	624	400	25
EE own generation[43]	14	4196	849	170
Cement[44]	0	0	-	6
Reforestation	1	26	-	3
N_2O	3	14414	-	27
HFCs	9	54312	-	11
total	161	92933	6012,1	1056

Table 6: CDM Projects in China, registered by the CDM Executive Board (Source: "UNEP Risoe CDM/JI Pipeline Analysis and Database, March 1st 2008").

The trend of the mechanism to attract investment in large-scale projects can also be stated for the hydro sector. Under the CDM framework, small hydro projects are producing only 1/15 of the total hydro capacity. Compared to the 6GW newly added small hydro power station in China in the year 2006, the 100MW total capacity of the CDM projects shows also a low share of CDM in the hydro-power development in China.

Instead, the share of wind power developed under the CDM framework is significant. 2.8 GW of the current 5.6 GW total wind capacity in China has been approved as a CDM project and many more are in the pipeline. Nearly all of the wind power projects initiated so far are using CDM revenue as a central component of their financial planning. The sale of certified emission reductions (CERs) for projects harnessing wind power can meet about 10% of project costs (GTZ, 2007).

The CDM Board China identified three priority areas for the CDM project development in China (NCCCC, 2005): 1) energy efficiency improvement, 2) development and utilization of new and renewable energy, and 3) methane recovery and utilization. As an indicator of the governance support to achieve the 20% efficiency target, the number of EE projects in the pipeline has risen steeply. Nevertheless, it also shows the possible incentive of the CDM for industry and for investors to take necessary actions towards a more energy-efficient economy.

China is often cited as an example of the generally low contribution of the CDM to sustainable development to date (Wara, 2007; Olsen, 2007). Renewable energy projects are at a comparative

[42] Including also those under validation and the process of being registered by the EB
[43] "E-own generation" are energy efficiency projects mainly in the cement and iron & steel industry where electricity is produced from waste gas or wasted energy
[44] Projects to reduce CO_2 emissions in the cement production process

disadvantage in the CDM compared to projects which reduce high potential greenhouse gases, because the CDM is essentially a market instrument - one that attracts equity investors where costs are cheapest and purchasers where they can gain as many CERs for a minimum of transaction costs. Furthermore, expansion seems unlikely or questionable for a significant number of projects that were registered in the past three years (Schneider, 2007).

However the CDM created a market for GHG emission with 100 million credited CERs and is an important step towards the integration of climate change issues in the political and economic decisions. The CDM can play a substantial role in greenhouse gas emission reduction. Many projects illustrate this. China is expected to account for more than half of all credits to be generated by CDM projects to 2012, making it to a crucial actor in the development and improvement of the instrument. For example, the first CDM project according to the "Gold Standard"[45] was registered in January 2008 - this is one approach to tackle some of the open problems.

7. Discussion

Climate change requires a global response and the need for a fundamental transition towards a low-carbon society based on renewable energies and high energy efficiency. The decoupling of economic growth from the greenhouse gas emissions must be achieved – a development China already experienced between 1980 and 2000. The very low energy elasticity during this period was in large part a result of money wisely invested in energy conservation.

China has obvious incentives for reducing its energy intensity, for the pressures on energy and resource supplies and the environment are increasingly severe. Nevertheless, GHG emission reductions and stabilization targets are so far minor priorities, a by-product of existing energy efficiency policies. Local and regional impacts of energy use have long been considered more urgent than climate change, and water quality issues are even more severe in many areas than air quality.

Furthermore, as in every country, China's climate policy challenges are largely framed by national socio-economic policy goals. The economic development in China is an ethical and political imperative. However, a development model, that addresses the severe environmental problems and impacts of climate change, which China already experiences, is unavoidable.

In recent years, China has instituted various programs and an expanding set of legal, voluntary and economic instruments to pursue energy efficiency, as well as increased market opportunities for alternatives to coal-fired generation. Ambitious targets have been set and pave the way. Some regulations are even stricter than those of developed countries.

- **Energy efficiency**

Nevertheless, the first evaluation shows that the energy efficiency target has not been achieved so far. In 2006, the energy intensity decreased by 1.2%, which missed the yearly national target of 4%. Although later the government admit that the measure taken will take longer time to be effective, therefore they will publicize the final outcome of the implementation by the end 2010.

[45] The Gold Standard is a quality standard for CDM, JI and voluntary offset projects, which ensures that a project is truly additional, sustainable and executed in a participatory way. With the extra quality check, it is hoped that Gold Standard projects will fetch premium prices and thus promote high quality projects. See http://www.cdmgoldstandard.org/index.php

Generally, energy intensity as a measure of how much energy is consumed for each dollar of economic output, can either be reduced by cutting the amount of energy consumed or by raising the value of the output. The incentive to consume less and more efficiently can be achieved by directly raising the cost of energy. But that approach has led to resistance by some provincial leaders from least industrialized areas as it would reduce the competitiveness of existing state-owned heavy industry. According to state media, local governments failed to raise the power price finally; instead some of them continued to offer preferential power tariffs for such industries.

Another way to improve energy intensity is to raise the value (and thus the price tag) of the industrial goods that energy is being used to create. By assigning energy intensity targets to each province (who in turn delegate them to local energy-intensive enterprises) without addressing the cost of power and environmental compliance, the cheapest method for industry to reach their goals is to raise total revenue faster than energy consumption. Yet, shifting the production to higher value steel, aluminium, glass or chemical products, raises the energy intensity as total revenue grows (see Rosen & Hauser, 2007). That path is not necessarily a shift towards emission reduction.

As a developing country, China needs a lot of fundamental informational and knowledge capacity building. For example, energy auditing is one of such instruments to monitor the energy policy implementation and find out further energy conservation potential. Realizing the necessity of such information system, the government has conducted a nationwide program in order to collect the data.

- **Policy instruments**

Political instruments are not yet fully adapted to the new political and economic situation in China. Nowadays, the classical regulatory policy instruments like emission and technology standards have less impact than other factors.

Generally speaking, political commitment and appropriate political structures, a functioning, responsive legal system for compliance and enforcement, as well as effective monitoring systems are requirements for the establishment and the implementation of regulatory instruments (see OECD, 2001; Huppes, G. & Simonis, 2000). These framework conditions are not complied with area-wide in China. The monitoring system is still weak and not yet fully established; the legal system for compliance and enforcement is used sparingly; and fines are often daily allowances for the companies.

One explicit example of these difficulties is building standards, which are applied by only 4% of the buildings nationwide. The rules and standards on energy conservation are still incomplete and inadequate; the monitoring and servicing capacity building is insufficient; and penalties for violations need to be raised significantly. Local government agencies are perceived as being less committed to enforce the building energy codes and being vulnerable to corruption. Furthermore, few or rather no effective incentive policies (e.g. electricity and heating tariffs on the demand side) support the development and application of more efficient technologies so far (see Lin et al., 2006; Sinton et al., 2005). Developers or constructors will not improve efficiency performance without additional market and regulatory incentives, since their sole objective is profit maximization. Implementing energy efficiency in buildings requires a holistic approach integrating energy efficiency technology, energy pricing and public policies.

The policy approach in China is rather a top-down process than an introduction of policies with positive incentives. New economic instruments (e.g. tax measures, price policy, subsidies) have been initiated by the government, yet offer too few incentives to be fully effective. New market approaches are still in an initial stage.

The general thrust of the Government in self-regulation is carried out through higher prices, voluntary commitments or tax measures and is not very strong in any event(WEC, 2005). Furthermore, policy through pricing is a sensitive topic, as the increase in energy prices and taxes may lead to great resentment and opposition among the citizen, as well as among local governments as they are often linked closely to state-owned heavy industry. For example, although coal subsidies fell significantly from 61% in 1984 to 11% in 1995, energy prices are still disproportionately low, exclude environmental externalities and therefore do not offer sufficient incentives for energy savings.

Similar to these regulatory instruments, the economic and political framework conditions need to be supportive for economic instruments. Applying financial measures requires considerable regulatory capacities, enforcement capacity and political commitment at different stages.

- **A cohesive energy policy**

As shown in the second chapter, there are many actors involved in energy policymaking apparatus: the NDRC, several ministries and planning agencies, the strong state-owned energy companies – and the relative weakness of the central government in the face of vested interests leads to inconsistent, inefficient and weak policies (Sinton et al., 2005). Given that policy instruments cover a range of legal, fiscal and economic issues, including capacities within and across government levels, a coherent policy approach is needed.

In this debate, the establishment of a Ministry of Energy is often seen as a chance to formulate and implement a cohesive energy policy: from the emphasis on the supply side and a focus on several key projects, towards a sustainable management of energy demand and the consequent implementation of energy efficiency in every sectors and renewable energies.

This institutional restructuring, determined at the 11th National People's Congress in March 2008, has been considered as a chance to re-establish the Ministry of Energy. However, again as a result of strong resistance and a power struggle of various government agencies and big state-owned energy companies, only an interim solution that divides authorities over energy has been found. Experts see this step as an important one towards a more cohesive energy policy, but predict that a ministry will not exist for at least a few more years.

- **Implementation on the local level**

Beneath the inherent weakness of policies, the implementation and enforcement on the local level is commonly seen as another major problem. Generally, targets and programmes are announced at the national level but concrete implementation and details of the policy required to reach these targets are mostly the duties of the provinces and municipalities and rural districts. Provincial and local governments need to define, among other elements, the respective responsible institutions, the specific guidelines and programs, the role and reach of the relevant monitoring systems. Without these components, which also require time, expertise and political strength for a rigid enforcement, a national programme is not fully operable.

Local governments are usually politically more conservative than the national government, with a tendency towards regimentation and often to discretionary measures (Lan et al., 2006). Furthermore, the policy approach on the local level tends to be reactive - responding to problems once they occur, rather than proactive and preventive (see OECD, 2005).

Another major barrier for the implementation is the local prioritization of investment and employment. In many cases local governments have been giving preferential treatment to steel, cement and other high energy consuming and polluting industries despite the national policy to reduce investments in heavy industry. Heavy industry is still seen as a fast track to economic success and healthy profits, which benefit credits within the official assessment system of cadres. This problem was recently addressed by the central government, which has announced a new accountability system under which officials' career paths will be tied to their performance in environment protection and energy efficiency.[46] Other decisive factors in the current official assessment system are economic growth, family planning, and workplace safety.

- **Financial obstacles**

Beneath the legal and institutional framework, financial obstacles are further major barriers for many energy efficiency projects. Debt finance is constrained in several ways and corporate bonds do not currently exist in China.

A main financial obstacle for small and middle scaled energy saving projects (energy contracting) is getting access to available funds at local financial institutions. There is still a disconnection in current lending practices of local financial institutions and needs of energy efficiency and savings-based renewable projects. Local financial institutions are not familiar with the unique intricacies of the energy saving projects; do not have the internal capacity to properly evaluate risks and benefits; and are often unwilling to invest in building capacity, due to relatively small size of these energy saving projects (see Chandler, 2007; Dressen, 2007). The new five-year-plan emphasise the promotion of energy saving services and technologies, but still insufficient economic incentives and regulatory laws are released to enable a broad access to funds for the projects.

- **Renewable energies**

Regarding renewable energies, diversification alongside cleaner ways of using coal is a high priority of the Chinese Government. And to date, the trend in China's renewable energy technology industries has been one of rapid growth. China adopted its first law on renewable energy in 2006 and has since issued successfully several supplementary rules and regulations to encourage the use of renewable energy. It is likely that China will meet and even exceed its renewable energy development targets for 2020.

But, concerning the 15% target of renewable energies, the strong emphasis on large hydro-power has to be taken into account. Hydro-power will continue to claim the main share of outlays and attention and with it the severe negative environmental and social impacts of large dam projects. Despite the boost of renewable energies in China, the 60GW target for non-hydro renewable capacity designated for development by 2020 is small, relative to the estimated 225GW of big-hydropower capacity and 270 GW of new coal power capacity and planned to be built over the same time frame (NDRC, 2007b).

The cheap and easy way to install coal power will dominate the total installed capacity for many years to come, as even the exploitable wind resources in China represent a potential power generation capacity of 1000 GW. And the rapid economic growth has already taken its toll. In 2006, nearly 90% of

[46] China View (Oct. 2007): "Green performance goals may decide careers", http://www1.china.org.cn/english/environment/229612.htm

new power-generation capacity was coal fired, compared to 70% in 2000 (IEA, 2007). Over 90 GW of new coal-fired power plant capacity have been added in 2006 – the equivalent of almost 2 large coal power plants a week. These plants alone will add about 500 million tons of carbon dioxide (Mt CO_2) to China's annual emissions, which is about 13 % of China's current coal-fired emissions, and 5 % of the world total.[47]

Regarding the price system of renewable energy especially the wind power generation, a well designed payment mechanism, based on a realistic feed-in tariff instead of an auction pricing system is needed to develop renewable energy and tap its full potential. Since the price is determined through a project-based system using concessions, both foreign and private investors are more reluctant to invest in wind power given the financial insecurity that results from unclear investment signals. For example, after the implementation of the recent pricing policies, no foreign or private companies won concession projects.

At present, in both the national wind concession projects and projects initiated by local government, the developers are all state-owned companies. The fact that some local government authorities launched wind projects outside the national wind concession projects - resulting in price differences between projects being built in the same place – has contributed further to doubts in the Chinese pricing system. One can see that the average price gap between national concession projects and projects initiated by local government is about 0.1Yuan/kWh (Li, J.; Gao, H. et al., 2008).

Yet, the high cost of renewable energy by comparison with coal-fired generation continues to be the most significant barrier. The Chinese government faces the conflict between ensuring a low electricity price in order to support GDP growth as well as to avoid public criticism versus the promotion of renewable energy development by adding the higher cost to the grid price (Cherni & Kentish, 2007).

Local governments are approving new wind farms, as the central government promotes the green growth, but lack of proper planning persists. Further, the monitoring of the feed-in tariff conditions need to be enhanced. A grid provider, who has the obligation to purchase the wind power according to the feed-in contract and furthermore to install net-access, has very little interests in wind power, as wind power costs more than coal fired electricity and the provider will need to find back-up energy sources for less windy times. And as a result, over a quarter of the total capacity is still not connected to the grid. Many PV power systems capable of being connected to the grid have been built in China, with capacities up to 1 MW, but in no case has a feed-in tariff been implemented and no system has as yet been permitted by the power companies to connect to the grid as a commercial venture (EPIA, 2007).

- **Nuclear energy**

Nuclear energy, as a carbon-free energy source, has been added to the list of energy diversification projects with a capacity of 40GW by 2020. The "National Climate Change Program" (CNCCP) projects 50 Mt CO_2 emission prevention by developing nuclear power by 2010. China is currently constructing five new nuclear power reactors with a combined capacity of 3.3GW, revitalising the downward nuclear power market. The plan to quadruple the country's share of power from nuclear energy by 2020 to 40GW is widely seen as ambitious, though unrealistic to establish in China.

However, as a basic principle, nuclear energy is not compatible with the concept of sustainable development due to unresolved challenges related to long-term management of nuclear wastes,

[47] Pew Center (2007): "Coal and Climate Change Facts", available at: http://www.pewclimate.org/global-warming-basics/coalfacts.cfm

transfer of nuclear technology, procurement limitations, proliferation risks, fuel availability and procurement constraints, and environmental and safety aspects. "The security threat... would be colossal" (IPCC, 1995). Nuclear power does not provide a viable option to combat climate change.

- **Realizing potentials**

To realize the potentials of energy efficiency and renewables towards a decarbonisation and a sustainable development, the framework under development still needs to be adjusted and extended with various instruments to close the gap between the national objectives and the local implementation and to trigger the developments necessary to enhance energy efficiency and renewable energy. Likewise, effectiveness and efficiency of the implementation of the policies have to be strengthened. Moreover, the integration of environmental concerns into economic decisions has to be enhanced.

As mentioned above, the heavily subsidized energy price and price regulation are both major obstacles for energy efficiency improvement in China. There have been extended discussions about reducing the subsidy. But with the growing shortage of oil and electricity generation, the government realized the unavoidable negative impact from this regulation. On 19th June 2008, the government announced that gasoline and diesel prices will increase 1000 RMB per ton. Government officials also said that it will begin a gradual process whereby both oil and electricity prices will be closer to their real value as the government sees that as a necessary incentive for achieving energy efficiency target.

China's government has defined targets, released binding time-frames and measures – important steps to cope with climate change. Nevertheless, even if China could limit carbon intensity at half of the economic growth rate, a quadrupling of GDP in 20 years would still lead to CO_2 emissions of 3-4 GtC/year, which is around 50% of today's world emissions (Zeng et al., 2008). The outlook points out the importance of the decisions China has to make today. Not only must China work to curb current energy consumption and reduce energy intensity, but Chinese officials will need to create opportunities and infrastructure for future reductions to avoid a critical lock-in of greenhouse gas emissions.

These decisions are not only relevant for China. It is a common responsibility which requires co-operation to spread 'green' technology and policy models for progress.

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