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RECAST Urumqi

Deregulation, Environmental Protection and China's Electric Power Industry

Report

RECAST Urumqi – Steigerung der Ressourceneffizienz in einem semiariden Milieu: Urumqi als Modellstadt für Zentralasien

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Deregulation, Environmental Protection and China's Electric Power Industry

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1 Introduction

In the last two decades, China has achieved rapid economic growth, industrialization and urbanization. Economics tells us, people face trade-offs, say, equality and efficiency, butter and guns etc. Concerning economic growth and environmental protection, historically, Chinese government has often put more weight on the former one. Between 1979 and 2007, the Chinese economy grew at an average annual rate of 9.8%, not surprisingly, at the cost of environmental deterioration, which threatened the social and political stability, as well as sustainable economic growth in China. Officially recognized "public order disturbances" grew from 58,000 in 2003 to 87,000 in 2005 (Lum, 2006), many due to environmental pollution and land takings stemming from government corruption. The estimated cost of outdoor air and water pollution to China's economy was around US$100 billion annually, or 5.8% of China's GDP (World Bank, 2007).

However, Chinese policymakers began to realize these problems caused by the unbalanced development path, national targets being made, legislations being enacted and initiatives being carried out to control air, water, and soil pollution (see Attachment 7). Which is worth to mention is that, China's Prime Minister Wen Jiabao, promised at Copenhagen Climate Summit in December 2009 that China is going to reduce 40% to 45% CO_2 emissions per unit GDP by 2020 compared to the level of 2005. To fulfil the commitment, the electric power sector is of particularly importance, since the generation of electricity contributed to 42% of China's 3,307 million tonnes of GHG emissions (IEA, 2002). As China is a transition as well as densely populated developing country with great regional income difference, the enforcement of the target at the regional level depends on political institution reform and marketization process, which will influence the power industry structure and the development pathway of the electricity sector. Therefore, to look into the ever-changing regulatory framework of electric power industry facilitates the understanding and assessment the national environmental protection policy enforcement at local and regional level, as well as provides an insight for refining and reforming it for a better regulatory performance.

This report lays groundwork in clarifying, analysing and assessing the deregulation, environmental protection of China's electric power industry. In the following section, an in-depth analysis was done for the regulatory reform in China's electric power industry, including a historic overview of the evolution of regulatory institution and an outline of the current regulatory framework. Then, the environmental protection and emission reduction measures taken by China's power sector and the performance achieved have been summarized. A brief study was made concerning the environmental performance of Xinjiang province. Furthermore, international experiences in applying different policy instruments in fulfilling the energy efficiency and environmental protection target were clarified. An attempt was made to build up the conceptual framework for China's practices in using economic, regulatory and policy instruments. Lastly, the challenges and opportunities that China is confronting at present and in the near future for reaching the national goal in emission reduction are analysed.

2 Regulatory Reform in China's Electric Power Industry

Since the communist party took over the power from the defeated regime in 1949, the newly-built Chinese government began to manage the economy and adopt a strictly centrally planned system until 1979. The planners controlled all major sectors of the economy and took the place of enterprises and consumers in formulating all decisions about production, distribution, prices of goods and services etc. Power industry was no exception. Until 1993, China's central government took its initial step towards the transition from "socialist planned economy" to "socialist market economy". Since then, the market economy has achieved tremendously success in some industries, where production, distribution, pricing, and investment decisions are made by the private owners of the factors of production based upon their own and their customers' interests. Other parts such as the strategic industries and public utilities still lagged behind in the marketization process. Electric power industry is an example. Different levels of governments have got into act in forecasting, planning, constructing, investing and operating as well as managing power plants and grids, setting retail tariffs and collecting revenues. Unfortunately, the visible hand turned out to be both inefficient and inequity. Lack of capital, low efficiency, poor service reliability, unreasonable pricing structure and widespread corruption were not new in power industry.

The above problems directly pushed forward the first big step of regulatory reform in China's electric power industry in 1985. Different combinations of reform measures were taken and resulted in mix success. Later on, in 2002, China showed its resolution in restructuring the power sector in the so-called No. 5 governmental document issued by State Council, of which, a proposal was brought out for electricity tariff reform. The following year, a market regulator was created to supervise the forthcoming competitive power market.

Hereafter, the author overviews the electric power industry regulation reform from historic, economic and institutional perspectives in the hope that could help understanding in China. The first section is about evolution of regulation framework and in the second part the regulators, regulated firms and regulation institutions at the current situation will be discussed. For a better understanding of the undergoing regulation reform, one shall always bear in mind that, the initial condition of the regulatory reform in China was a highly centralized system, quite a contrast to western developing countries which deeply root in the free market and legal institutions. The latter experienced regulation strengthening, deregulation and re-regulation in different period of time while the former struggles to break or improve the traditional administrative management and suffers from problems such as lack of legislation, mix-up of government and enterprise function etc.

2.1 Historic overview

2.1.1 Investment Decentralization in the power generation sector:1985-1996

The initial step of the reform took place in 1985 with the intention of attracting diversified investment resources to expand the power industry. However, the decentralization of investment authority was limited in power generation sector. The central government devaluated the power in approving power generation projects to provinces and only kept the authority to verify large scale projects and foreign direct investment projects. Favourable policies and tariff were implemented to newly built power plants through diversified financial resources.

At this time, China's power industry was a vertically integrated monopoly (see Figure 1). It was an administrative monopoly as well as a business monopoly. SOEs in the power industry not only undertook the business operation but had also some social responsibilities such as providing health insurance, school education, housing and social security. The emergence of IPPs changed the landscape at generation sector and also complicated the administrative and business management of the industry. The conflicts between different generation power plants brewed the next phase of reform.

2.1.2 Restructuring government institutions and depriving their enterprise management function: 1997-2001

The institutional changes took place in 1997, which can be seen as the second milestone in the power industry reform. The focus was to separate government administration from business operations. The Ministry of Electric Power Industry (MEPI) was eliminated in 1998, with its business functions taking over by the newly created State Power Corporation (SPC); its administrative functions were assigned to other government agencies. SPC was later corporatized to fashion a western style holding company, owning generation and transmissions assets across China that were routinely operated by SPC's provincial subsidiaries.

Following the Asian financial crisis, China experienced an unexpected turn from chronic power shortages to surplus starting in 1996. The SPC initiated experimental wholesale market competition in 1999 in six provinces. The SPC hoped that market competition could help resolve political fights among diverse investors about whose power would be dispatched and also increase sales by lowering tariffs. However, the experiment was soon halted because the quick return to a tighter power market in 2001 absorbed excess capacity and alleviated any immediate pressure for competition. At the same time, economic inefficiencies, exposed during the slack market, arising from the political operation of a system combining central and decentralized ownership, made it clear that the partially reformed industry organization needed further revamping.

2.1.3 Seperating power plants from vertically integrated monopoly and introducing competitition into power generation: 2002- present

In 2002, China took a significant step in breaking up the vertically integrated monopoly SPC, which symbolized the third milestone on the way of the power industry reform. The SPC was split into two grid companies, five state generation companies, consulting companies and construction companies with the relevant assets going into the corresponding companies (see Figure 3).

Since then, there is no big movement concerning the changing of the landscape of power industry. The proposed regional markets are still at a trial phase. The government still has not taken any strong measures in launching competition in retail and wholesale market. The pricing authority is under the control of government hierarchy.

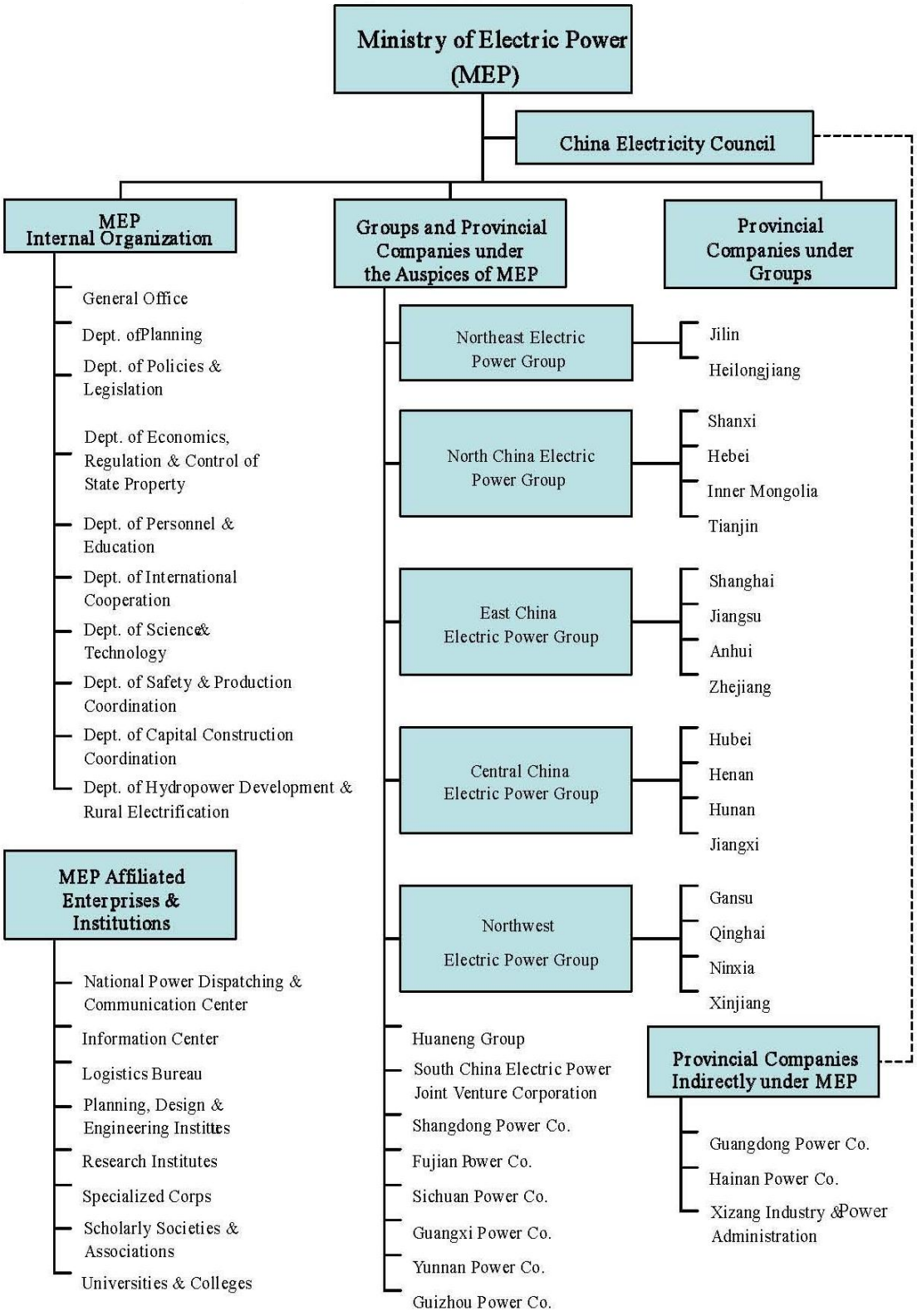

Figure 1 Organization Structure of MEP

Source: World Bank [1994], China Power Sector Reform: Toward Competition and Improved Performance, Washington, DC: World Bank, p.2.

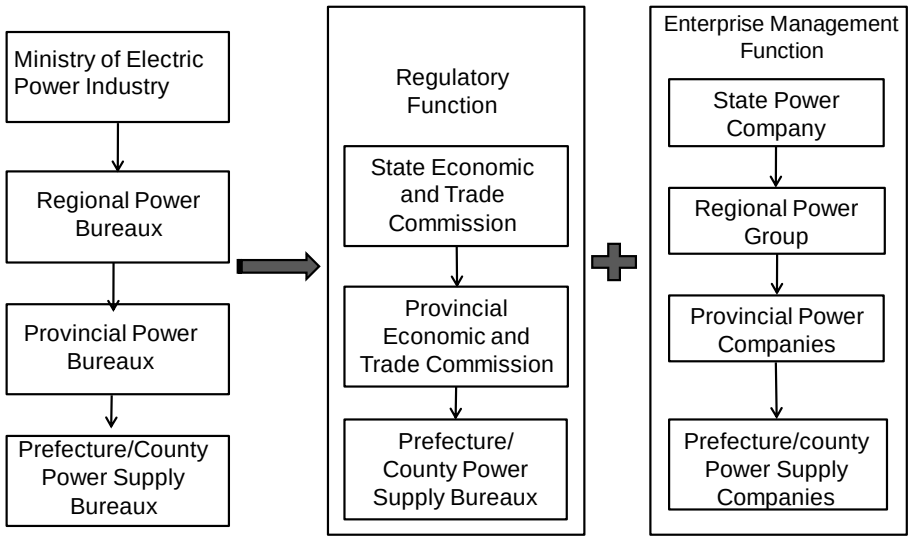

Figure 2 Separation of Government Function and Enterprises Management Function in the Electric Power Industry

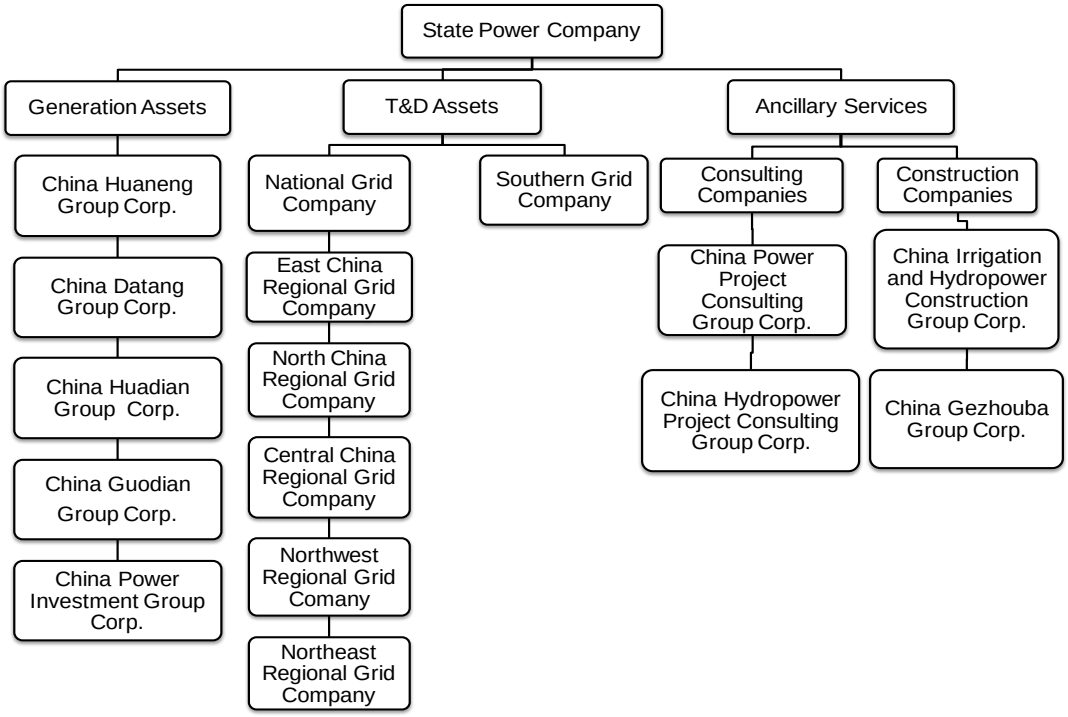

Figure 3 Reform of the SPCC in 2002

2.2 Current Situation on electricity regulation

2.2.1 Regulatory body

2.2.1.1 Administrative Authorities

- **Power Sector Reform Working Group (PSRWG).** PSRWG was established by the State Council in 2002. The group members include the following government departments, i.e., the former National Planning Commission, the former National Economic and Trade Commission, the former National Power Company, Organization Department of the CPC Central Committee, Central Enterprise Working Committee, Central Organization Committee Office, the State Council Legislative Affairs Office, Economic Restructuring Office of State Council, Guangdong Province and State Electricity Reform Committee. PSRWG and its role were specified in the State Council Document No.5. After the SERC was founded, the Director of National Development and Reform Commission (NDRC) and SERC's Vice Chairman were appointed respectively the group leader of PSRWG and the office director of PSRWG with PSRWG's office moved into the SERC's premises. The appointment of the group leader and the office director of PSRWG from different government departments may improve the efficiency of policy making and enforcement. However, SERC does not play a dominant role in power industrial reform. Besides designing the electricity market, SERC does not have much say for designing the framework of the regulatory, or the electricity price reform. PSRWG was not designed to be an entity organization but a coordination agent. It didn't perform an active role until 2006. With relevant administrative officers being appointed to PSRWG and personnel augmentation, PSRWG is expected to play a more important role in pushing forward the reform process.
- ***National Development and Reform Commission (NDRC).*** NDRC1 is responsible for regulation and control of macro-economy. China does not have a ministerial level government hierarchy which regulates energy industries. On one hand, NDRC practically perform the role for long-term energy development and planning strategically as well as energy demand projection and energy selection. On the other hand, the Energy Bureau and Pricing Department of NDRC have been controlling the examination and approval of large scale energy investment projects and price setting for years. NDRC also dominates electricity sector reform and approves the price and revenues of SOE generation companies and grid companies. These regulation functions dispersed among provincial SETC, local price bureau etc. According the past performance, NDRC is lack of capacity in economic projection and energy planning. There exists long term imbalance between electricity demand and supply, while power surplus and shortage takes place in turn. Energy planning generated out of political decisions and complex and tedious procedures in examination power project

[1] The predecessor is National Planning Committee established in 1952, which was renamed as National Development and Planning Commission in 1998. With the governmental institution restructure in 2003, part of the function of the former State Economic and Trade Committee and the former Economic Restructuring Office of the State Council were merged into the National Development and Reform Commission.

investment are the institutional roots of alternatively occurrence of frequent and widespread blackouts and over investment in power sector.

- ***National Energy Bureau (NEB) and National Energy Commission (NEC)***. The newly established National Energy Commission and National Energy Bureau are the energy industrial regulators. The latter is responsible for industrial regulation concerning coal, oil, natural gas, electricity and renewable energy, which includes energy industry planning, industrial policy and standards generation, relevant energy legislation enaction, energy system reform promotion, renewable energy development and energy conservation motivation. The former is a high-level deliberative organ, which is responsible for policy decision and coordination in national energy development strategy, energy security and energy development. The above establishment might help in ameliorate conflicts in energy industry regulation. The predecessor of NEB was NDRC energy bureau, comparing with which, NEB probably enjoys more autonomy in organization and personnel but still falls into the jurisdiction of NDRC. On one hand, there existed controversy opinions in building up Ministry of Energy before the establishment of NEB and NEC. However, because of the difficulties in institutional restructuring and function re-allocation, the tentative plan of MOE was aborted. On the other hand, large energy companies, such as National Grid Company, PetroChina Company Limited and China Petrochemical Industry have ministerial level. The former NDRC energy bureau has lower political rank compared with the above companies. NEB and NEC might play a more important role in energy industrial regulation. NEB took over energy projects examination and approval authority from NDRC to a large extent.

- ***Ministry of Finance (MOF).*** MOF is responsible for regulating some financial rules and cost standards for electric power enterprises as well as framing the capital operating budget for central power SOE. State Council issued Opinions on State-owned capital operating budget in 2007, which claims that the government as shareholder of the SOEs has the right to share profit. The State-owned Assets Supervision and Administration Commission is responsible for drafting up the budget and submits for the approval of MOF. Take power plants as an example, central SOEs which accounts for 52.95% of the installed capacity will apply to the above-mentioned regulation and consequently are required to submit 10% of the total profit to MOF every year. Currently, there is no time schedule of issuing relevant regulation for local SOEs. Local governments have been awarded the authority to formulate the rules. These revenues might shape the future electric power industrial structure. Taking into account that MOF has considerably wide duty, a pointed regulation towards electric power industry (especially the monopolistic sector) is hardly practical. Electricity price regulation and cost regulation is highly relevant to each other. A clear definition of the respective function and a close cooperation shall be ensured to guarantee the transparent and effective information flow and the possible political power conflicts among SERC, NDRC and MOF.

- ***Provincial Economic and Trade Commissions (PETC).*** The State Economic and Trade Commission was reorganized as the State-owned Assets Supervision and Administration Commission (SASAC) of the State Council in 2003. Local Economic and Trade Commissions (ETCs) continue to exist and play the role as industrial regulator in many provinces. As to electric power industry, local ETCs take the responsi-

bilities such as making electricity generation plans, coordinate dispatch, supervise energy conservation and push forward power industry reform. With the tax-share reform, China's political institution is highly decentralized practically. Local governments perform the most regulation functions in electric power industry. The establishment of SERC actually sent a signal that China's intention to centralize the power industry regulation. Currently, SERC has offices only in a limited provinces and cities, which have overlapping regulatory functions with ETCs. There seems to be no clear schedule for further establishment of SERC local offices at city/county level. If more SERC local offices is to be built in the future and the regulation to be centralized, institution restructure and function reallocation will be inevitable.

- ***State-owned Assets Supervision and Administration Commission (SASAC).*** SASAC was established in 2003, which represents the country and exercises ownership responsibilities over state-owned enterprises (SOEs). SASAC's functions include the supervision of the performance of SOEs, the appointment and dismiss of senior executives, the accredition board of supervisors to SOEs, drafting out relevant laws and regulations, approval of major decisions, etc. Since more than 90% of power companies are SOEs, SASAC has a definitive influence on decision making of these companies, such as enterprises mergers and acquisitions, performance evaluation etc. Currently, the central power SOEs are under the regulation of SASAC, while the local power SOEs are under the local offices of SASAC.

2.2.1.2 Legislative Authorities

Generally speaking, the constitutions in most countries stipulate that the country or legislative authority enjoy the right to regulate the economic activities. National People's Congress (NPC) is the highest state body and the only legislative house in China. NPC standing committee, which in consort with NPC, exercises legislative power according to China's Constitution. Law of Legislation specified that the political hierarchies directly under State Council (SC) have the right for administrative legislation according to the laws or rules and regulations of SC, which is the legal basis for legislation of regulatory bodies.

Legislation power is awarded either by law or granted by authority. For example, the Electric Power Law stipulated that the relevant regulations concerning the pricing of feed-in tariff shall be drafted out by SC. Consequently, SC has been awarded the right to legislation by law. SERC prescribed quite a few regulations concerning electricity market, which performs the legislation according to its functions.

2.2.1.3 Independent regulator

Since 1985, the electric power system has been going through restructuring reform, specifically from vertically integrated monopoly to a competitive market. Accordingly, the central government introduced a market regulator in 2003, i.e. State Electricity Regulatory Commission (SERC), to supervise the behaviour of market players, which include power plants, transmission companies, distribution companies and end-users.

Although SERC was established as a regulator for the expected forthcoming market competition in the power sector, the historic institution and structure of the planning system still exists. SERC is supposed to develop laws and regulations, formulate the power sector devel-

opment plan, monitor electricity market operations, propose tariffs and adjustments to government pricing authority on the basis of market conditions and organize the implementation of sector reform programs etc[1]. But it is still lack of enough authority and furthermore the status of SERC has not been legislated yet. Other government body, such as NDRC still plays a significant role in setting up the electricity tariff and examining and verifying electric power projects.

SERC has 9 internal departments and divisions with regard to different responsibilities; 6 affiliated public institutions and 1 non-governmental organization; 6 regional agencies and 11 provincial offices (see Table 1).

Table 1 Organization Structure of SERC

Regional subsidiaries	**North China Electricity Regulation**	**Northeast China Electricity Regulation Bureau**	**Northwest China Electricity Regulation**	**East China Electricity Regulation Bureau**	**North China Electricity Regu-**	**Central China Electricity Regulation**
Municipally subsidiaries	Taiyuan Electricity Regulation office	Taiyuan Electricity Regulation office	Taiyuan Electricity Regulation office	Taiyuan Electricity Regulation office	Taiyuan Electricity Regulation office	Taiyuan Electricity Regulation office
Municipallysubsidiaries	ZhengzhouElectricity Regulation office	Changsha Electricity Regulation office	Chengdu Electricity Regulation office	Kunming Electricity Regulation office	Guiyang Electricity Regulation office	

Source: State Electric Regulation Commission website. See www.serc. gov.cn.

2.2.1.4 An analysis on the regulatory framework

- ***A fragmented institutional framework***

The creation of almost all China's regulatory institutions involved a reordering of existing power within an entrenched bureaucratic machine. Although it is relatively easy to grant regulatory rights to a new organisation, it is hard to take such rights away from organisations that once asserted substantial control and often maintain ongoing interests. A consequence of various government reshuffling programmes is the highly fragmented institutional framework for policy making. Protracted negotiation and bargaining among different bureaucratic actors is endemic to the system, even more so than in the relatively fragmented systems of some other OECD countries (Eisner, 2000; Lieberthal, 1992). A major result of fragmentation is that many agencies within the government have a role in policy formulation.

The difficulty arising from situation in which old bureaucracies, if not dismantled, retain an interest in regulatory policy is made worse. Many of the new agencies have a bureaucratic status within the political system similar to institutions that do not wield formal political authority. The electric power regulator is shiye danwei (事业单位), usually translated as institution, which is subordinate in the State Council hierarchy to traditional administrative agencies(xingzheng jiguan, 行政机关), such as ministries, and governmental organisations

[1] See http://www.serc.gov.cn/english/index.htm for detail.

(zhengfu jigou, 政府机构). The poor statutory demarcation of roles and responsibilities among the new regulator continues to cloud its authority, and hence it effectiveness.

From an institutional perspective, extremely fragmented politics characterised by protracted bargaining among interested bureaucracies remains a fact of political life, as does the conscious attention to formal government hierarchy and the positioning of units within it. Reformers designing China's new system of economic governance face the age-old problem of how to invest new regulatory institutions with authority in the context of powerful competing claimants to that authority. Based on experience in other countries, the lack of clearly defined regulatory powers in the hands of a single regulatory entity, which caused the present diffuse and unclear allocation of regulatory powers, is potentially a major obstacle for private-sector investors when considering entry to the sector.

- ***The Independence of SERC***

SERC is a regulatory agency which was built-up according to the western standard. Unfortunately, SERC has an ambiguous and ultimately weak status in the system.independence and its underlying assumptions the status of regulatory agency in China. Independence of a regulator refers to institutions that operate at arm's length from either political or private interests. However, regulators in China owe their positions to the political bureaucratic elite, and the possibilities for the exercise of independent judgements and action may be limited(Minogue, 2006). Thus, the core ideal of independent regulation in China may rest on the simplistic view given that economic governance cannot be insulated from overriding political considerations(Minogue and Carino, 2006). Creating an institution outside the realm of government does not of its own accord reduce the imperatives of politics, or render regulatory policy making any less deeply political than it already is.

Clearly, the Chinese government has seriously engaged the need to remake itself-that is, to undertake substantial administrative restructuring and institution building along lines followed by many OECD countries. Efforts to reform the administrative system and to create new institutions of the regulatory state have gone hand in hand with the corporatisation of the economy and attempts to radically separate state firms from their former government patrons. But efforts to add new institutions, processes and ideas, and even to eliminate some of the old hindrances, have not created a seamless transformation to a brand new system of economic governance. Rather, the new system of economic governance has, for the most part, been grafted onto other parts of the system that appear much less adaptable to change.

- ***Regulation at different levels of government***

The regulation reform pathway on China's electric power industry shows the central government's variability between decentralisation and centralisation governing idea(Xu, 2002). Empirical studies (Yiping Wu, 2007; Chunhui Yu and Yiping Wu, 2005) show that regulation performance under decentralisation in China does not provide a satisfactory result. There exists abundant evidence of conspiracy between local government and regulated firms. Decentralisation leads to local protectionism and malfunction of national policy implementation and enforcement (close-down small scale thermal units as an example).

From the perspective of political structure, China has a multi-level governance system with five sub-national levels: province, prefecture, county, township and village. The government is divided into a functional system. State Council is at the top of the administrative hierarchy. Then come Ministries and Commissions, which may have functional bureaus at different levels of government. The political system bears an inherent potential for conflict, i.e., the

functional authority among the vertical relations of the administrative units versus the horizontal functional authority from territorial government at the same level. Chinese administrative system has long been characterised by conflicts between centralised authority and the vertical structure (tiao-tiao, 条条) and territorial authority and horizontal structure (kuai-kuai, 块块) (Lieberthal, 2004). Leadership relations (lingdao guanxi, 领导关系) and professional relations (yewu guanxi，业务关系) are widely used to describe the relationship between different administrative units. The former refers to relations between higher and its direct lower administrative hierarchy. The administrative orders are obligatory from the superior. The latter refers to relations among any political units. Non-binding instructions describe their interactions with each other.

Back to the electric power industry, take SERC and MEP as an example, SERC plays the role of an independent regulator. It has regional and prefectural offices. At the same time, the local government has authorities, for example, Provincial Economic and Trade Commission (PETC), to take the responsibility of making electricity production plans etc. They are so-called leadership relations. SERC's local branch and PETC are professional relations. So is the case for MEP, which has regional offices since 2006 to perform the function of monitoring and supervision. Not surprisingly, there exists double political administration for industrial regulation. Practically, more than 80% of the specific regulation is carried out by local government's administration. Considering personnel and budget constraints and political power struggle, the relatively new SERC may not play a decisive role.

Since late 1990s, the central government initiated partial centralisation of a number of key bureaucracies, in the hope to regulate local government and guarantee the implementation of national policies thoroughly. This is so-called Centralised management (chuizhi guanxi, 垂直管理), i.e., individual units within these bureaucracies are no longer beholden to superiors within local governments, instead, they are directly controlled by their functional administrative superiors and remain a consultative relationship with their former local government bosses. MEP is not among the list (see Attachment 6). The reason may rise from consideration of highly uneven development among different regions. Discrimination electricity tariff provides an example.

2.2.2 Laws and Regulations

Laws that are related to electric power regulation include three categories. First, general regulatory laws, such as, anti-illegitimate competition law, anti-trust law and law on protection of rights and interests of consumers etc.. Second, specific laws for industrial regulation, such as energy law, electric power law etc., Third, related laws for regulation, such as, company law, price law and contract law etc..

The Electric Power Law of the People's Republic of China was firstly promulgated in 1996, at the background of China's chronic electricity shortage and its intention to attract investment from other sources, including foreign direct investment.

The Law makes it clear the principle that "whoever invests, benefits" and all the investment in power industry applies to this principle[1]. At the same time, the Law stipulates that, the re-

[1] See Article3, The State encourages and guides legal investment in the development of power sources and the establishment of power production enterprises by domestic and overseas economic organizations or individuals. Investment in the power industry shall implement the principle of "whoever invests benefits."

sponsibilities to supervise and monitor the electric power industry nationwide and at and above the county level falls upon the administrative department under the State Council and the comprehensive administrative departments under the local people's governments[1].

Thus, on one hand, the legal status of power plants as commercial entities was established, since the Law defines the administrative role of the government in the power industry apart from operating the power companies by itself in the past. On the other hand, the private ownership of the power plants was legislated. Prior to the enactment of the Company Law and the Electricity Power Law in 1996, there was no legal basis for private sector participation in developments of the power sector. The central government tightly controlled all aspects of the sector, subject to more than 500 laws, regulators, and administrative directives.

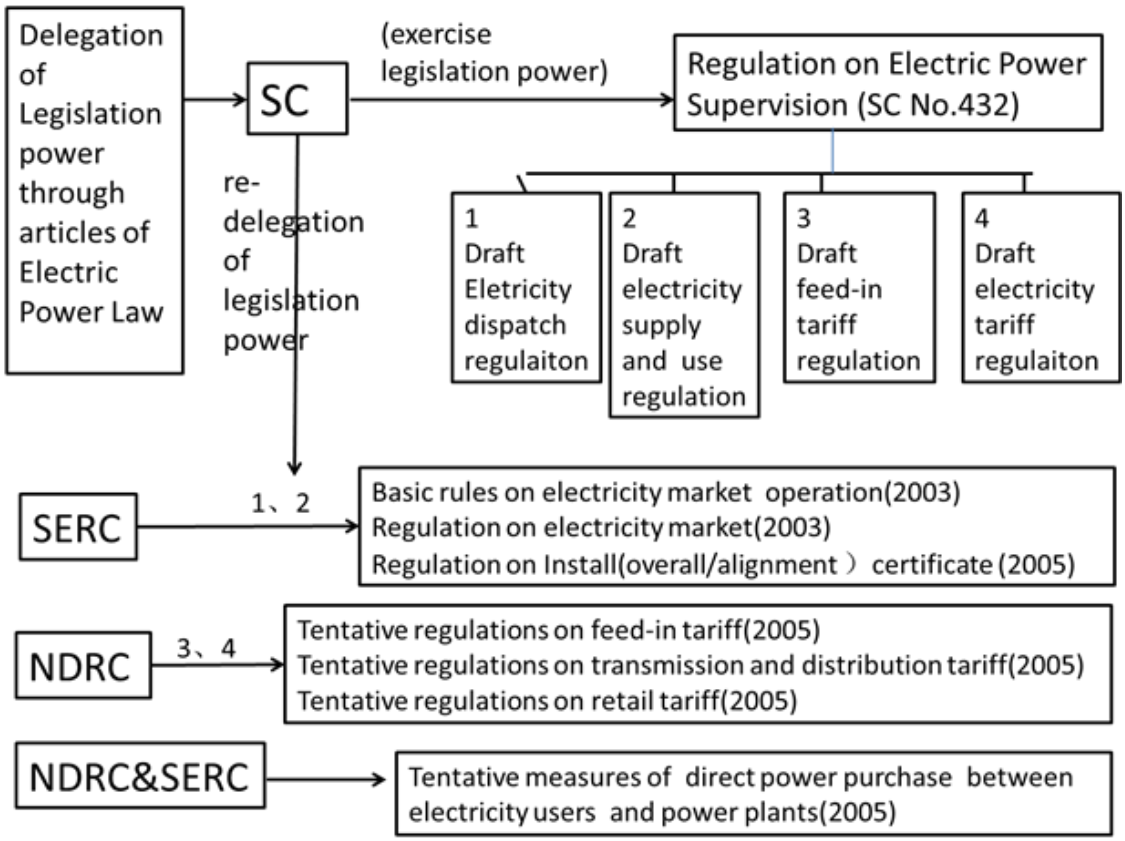

Figure 4 Laws, regulations and legislation authorities in China's electric power industry

2.2.3 Regulated firms

2.2.3.1 Power generation SOE: grabbing future market share

Since Chinese government took the first step deregulation in power generation sector in 1985, China's electric power industry, which was exclusively owned and controlled by the central government, welcomed investors associated with diverse levels of government, industrial entities and private ventures at the periphery. As the regulation reform goes further,

[1] See article 6 for detail.

the industrial concentration intensified instead of a diversified investment portfolio in power generation sector. The Five-big power generation SOEs, local and central SOEs[1] expand dramatically and take more market share in recent years (see Figure 6). The most recently statistics shows that the state-owned power plants and those power plants partially owned by the state accounts for over 90% of the total installed capacity (see Figure 5). The relatively smaller even shrinking share of foreign and private owned power plants could result from economic, political, investment and legal risks[2] and Chinese government's ambitious plan in expanding its power industry.

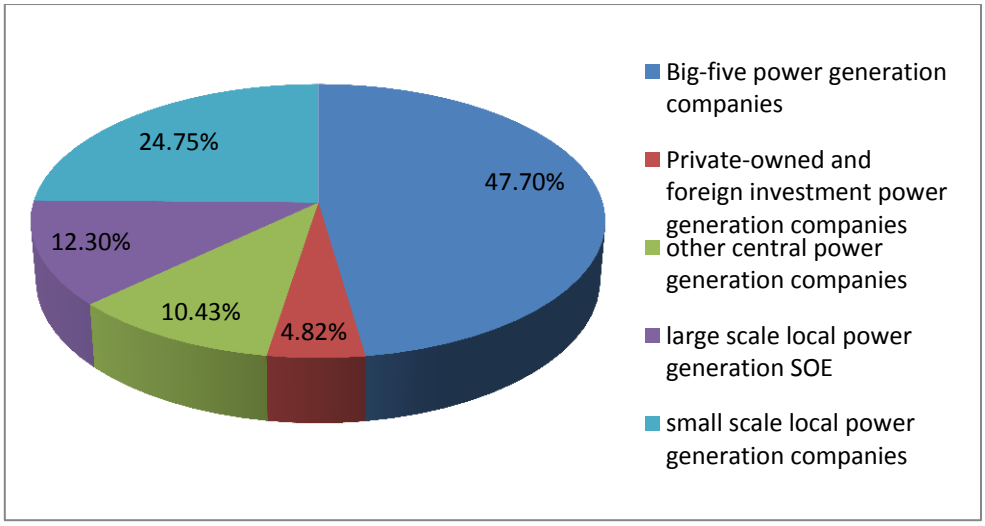

Figure 5 Ownership of installed capacity nationwide in 2009

Data source: Annual Report of Electric Power Industry Regulation (2009)

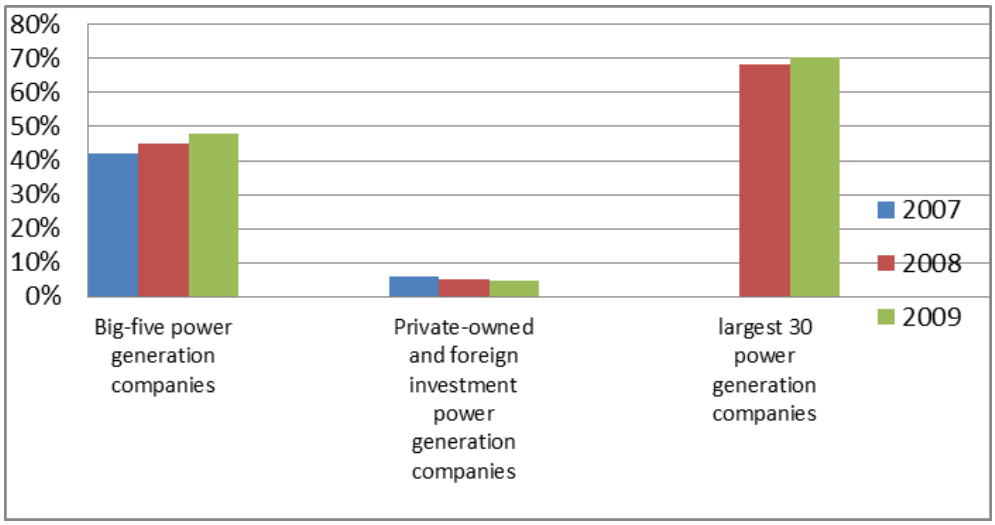

Figure 6 Changing structure of power generation industrial concentration

Data source: Annual Report of Electric Power Industry (2007, 2008, 2009)

[1] Five-big power generation SOEs are directly administered by central government, i.e. China Huaneng Group corp.(Huaneng), China Datang Group Corp.(Datang), China National Power Group Corp.(National Power or Guodian), China Huadian Group Corp.(Huadian) and China Power Investment Group Corp.(Zhongdian Investment). Other 6 centrally-administered power generation SOEs refer to State Development & Investment Corp.(SDIC), Shenhua Group Corp. Limited(Shenhua Group), China Three Gorges Project Corporation(CTGPC), China Resources Power Holdings Company Limited(CR Power, Stock Code: 0836.HK), China National Nuclear Corporation(CNNC), China Guangdong Nuclear Power Holding Co., Ltd. (CGNPC).

[2] See Russell Pitman and Vanessa Yanhua Zhang(2008) for detailed discussion.

2.2.3.2 State Grid Company: towards strengthening market power

State Grid Company (SGC) is the largest public utility in China as well as in the world. The proposed reform in No. 5 document is to separate state grid into 6 regional grid companies and introduce competition in generation and electricity retail. SGC sees its fate to be split with the development of the reform.

- ***Weakening the market space of regional grid companies by initiating extra extra high voltage projects***. As a countermeasure, SGC initiated the extra high voltage projects. In the early 2009, 1000 kV AC transmission pilot project, designed and built by SGC, was put into operation. In addition, SGC plans to build up extra high voltage transmission grid as the backbone and other grids as distribution. The total estimated static investment 406 billion RMB, dynamic investment 800 billion RMB. The theoretical foundation of SGC lies in extra high voltage helps to realize the optimization of resource distribution nationwide, with the consideration of highly unbalanced distribution of primary energy and electricity load in China. West China has rich water and coal resources. Electricity load centers on southeast coastal China. Internationally, extra high voltage transmission grid still stays at the phase of experiment. The safeness and economic efficiency is yet to be proved. Opponents believe inter-regional industrial re-structuring is a better option. For example, electricity transmission in short distance and coal transportation for long distance is more efficient economically. Extra high voltage grid will provide the possibility of a single grid nationwide and the technological obstacle of monopoly. 500 kV regional grids shall step out. Besides, SGC requests provincial grid companies to hand over their transmission grid above 500 kV and strengthens control towards accounting, personnel and project management of regional grid company.
- ***Strengthening the monopolistic power by merging power plants and electric equipment manufacturers.*** Breaking down the vertical monopoly through the separation of grid and power plants is always the first step of electric power industry reform. China implemented the same process in 2002. The central government allowed the SGC to keep 33.8 GW generation assets for the potential reform cost. But SGC built up Xinyuan Co. Limited in 2005 to take over these generation capacity. Moreover, SGC required its affiliated research institutes to build up the so-called secondary manufacture sector. Through merger and acquisition with domestic and foreign companies and even voluntary conveyance from local SASAC, SGC strengthened its market power. On one hand, these strategies taken by SGC will hinder the further reform (i.e. the separation of transmission and distribution). On the other hand, with SGC holding shares in manufacture companies, related-party transaction is unavoidable, which will cause malfeasant competition and violate the Law of Public Bidding.

2.2.3.3 Corporate governance in state-owned and state-holding power companies

The growth path of power generation and grid SOEs shows that investment decisions have been made to guarantee the possibly large scale or market share; or to exclude the proposed the successors.

- ***Principle-agent relationship in SOEs.*** Government is the agent to enforce the state power, which raises two questions, first, does the government represent the interest

of the state? Second, do the civil servants represent the government? Government organization consists of different interest groups and different objectives. The government always play a role to adjust interest conflicts, which in turn can hardly reflect the national interest. On the other hand, the government represents the state to exercise the ownership right of SOEs. Civil servants will take the operators. Although they do not enjoy the residual claim right, they are motivated by economic and self-interest consideration.

- ***Insider control under administrative intervention***. Insider control bases on the following three preconditions: 1.Transition economy from central planning towards market system; 2. Insiders, i.e., managers practically or legally take the control of the enterprise; 3. External supervise mechanism is not perfect, such as lack of sophisticate manager market, capital market etc., difficult to carry out effective supervision and restriction. Therefore, take-over is not easy to realize or corporate shares are not allowed to trade in stock exchange. Board of supervisor performs practically no function. Insider control is embodied in related party transaction and insider transaction, which shows already in the recent operation of State Grid Company.
- ***Ownership concentration and insider control***. State-owned shares and corporate shares always take a predominantly proportion. Because of principle-agent problem, residual claim and residual control right is separated in SOEs. Therefore, enterprise operator and owner have different objective functions. The former often chooses to pursue the maximization of the employees' wage income instead of enterprise' profit, and/or his own welfare, such as company-paid consumption (luxury office, business trip etc.). Empirical research has showed plenty of evidences to support that. According to estimation in 2005, electric power, telecommunication, petroleum, financial, insurance, public utilities and Tobacco industries hired 8% of the nationwide employees, who were paid 55% of the total wage income nationwide (Xiaolu Wang, 2007). Jun He(1998) investigated a sample of 406 listing companies and concluded that state ownership concentration and insider control significantly positive correlation.

3 Environment Protection and China's Electric Power Industry

3.1 The landscape of China's Power Industry

3.1.1 The electricity production and consumption in China

- ***Electricity production and installed capacity in 2009 nationwide.*** The total amount of electricity produced nationwide in 2009 was 3,587 TWh, of which, 496 TWh was from hydro power, 2,990 TWh from thermal power 70 TWh from nuclear power, 29 TWh from wind energy. Until the end of 2009, national installed capacity is 874 GW, with a growth rate of 10.23% compared with 2008. Specifically, the hydro power installed capacity is 197 GW, with an annual growth rate of 14.01%. The thermal power installed capacity is 652 GW, increased by 8.16%. Wind power which is connected to the grid reached 16 GW, increased by 92.26% compared with 2008, making China the fastest growing wind power country in the world.
- ***Electricity consumption in 2009 nationwide***. The total amount of electricity consumed nationwide in 2009 was 3658.7 TWh. Except for Shanxi province, the rest of the country all experienced a certain extent of increase in electricity consumption, of which, Xinjiang (13.69%), Guizhou (12.46%), Hebei (11.90%), Tibet (11.53%), Jiangxi (11.42%), Anhui (10.88%) and Hunan (10.18%) were among the top list. From the perspective of industries, the primary industry, the tertiary industry and urban and rural residential electricity demand kept on increasing. But the secondary industry remains the main force in pulling the demand. The primary industry, the secondary industry and the tertiary industry consumed 94.8 TWh, 2712.5 TWh and 394.6 TWh respectively, which accounts for 2.59%, 74.14% and 10.79% of the total electricity consumption. The urban and rural residential electricity consumption was 456.8 TWh, which accounts for 12.49%.
- **Electric power industry and economic growth.** The electricity demand always mirrors the development of the economy. China's electric power industry development follows the dramatic economic boom since 1980s in which both the total electricity generation and total installed generation capacity increased rapidly. The growth rate varied from 3% to 16% for generation, from 4% to 12% for installed capacity (see Figure 7 & Figure 8). As to the pathway, the electricity generation growth rate decreased from over 11% in 1993 to 3% in 1998 before moving sharply up again to 15% in 2003. The installed capacity experienced more than a decade of rapid growth from 1987 to 1998, with an average increase of 8.1% per year and followed by a marked decline from 9.1% in 1998 to 4.4% in 2002 before moving upward again. As shown in Figure 8 & Figure 9, both electricity generation and installed capacity have tracked the growth in GDP fairly close over time. However, generating capacity has done so with a lag of few years. The pattern of growth for installed capacity apparently lags the pattern of growth for generation for about 5 years. It is not hard to understand since the government holds the authority in approving the construction power projects according to its forecasts (which sometimes turned out to be wrong) and power industry planning. The five-year plan itself causes some kind of investment (economic) cycle. Not to mention the relatively long construction period of power plants.

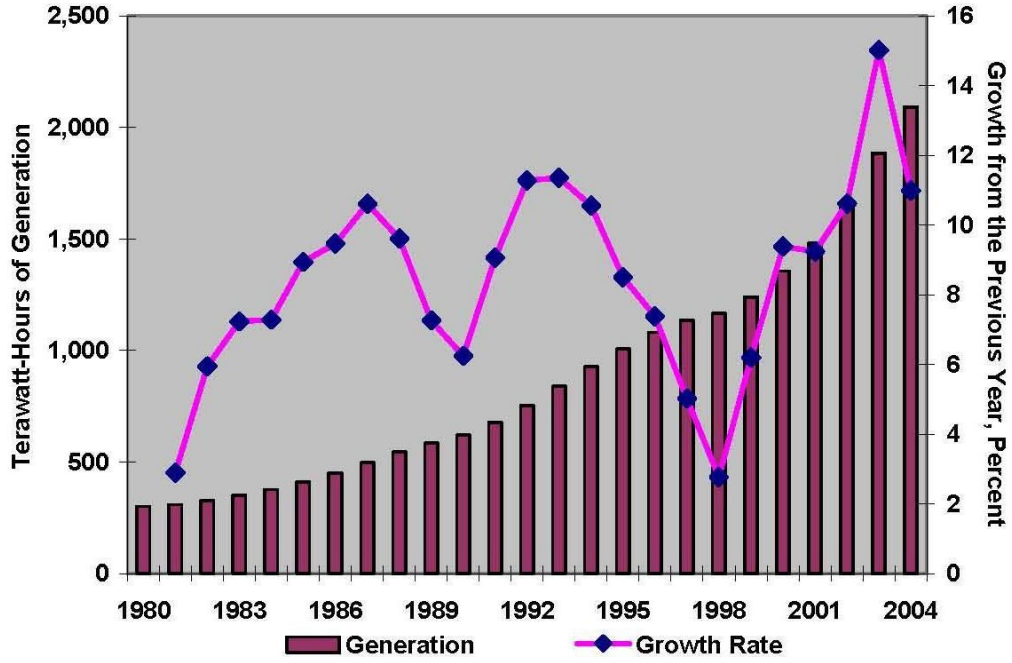

Figure 7 Total electricity generation and generation growth rate in China

Source: APERC(2004). Energy in China: transportation, electric power and fuel market. P55.

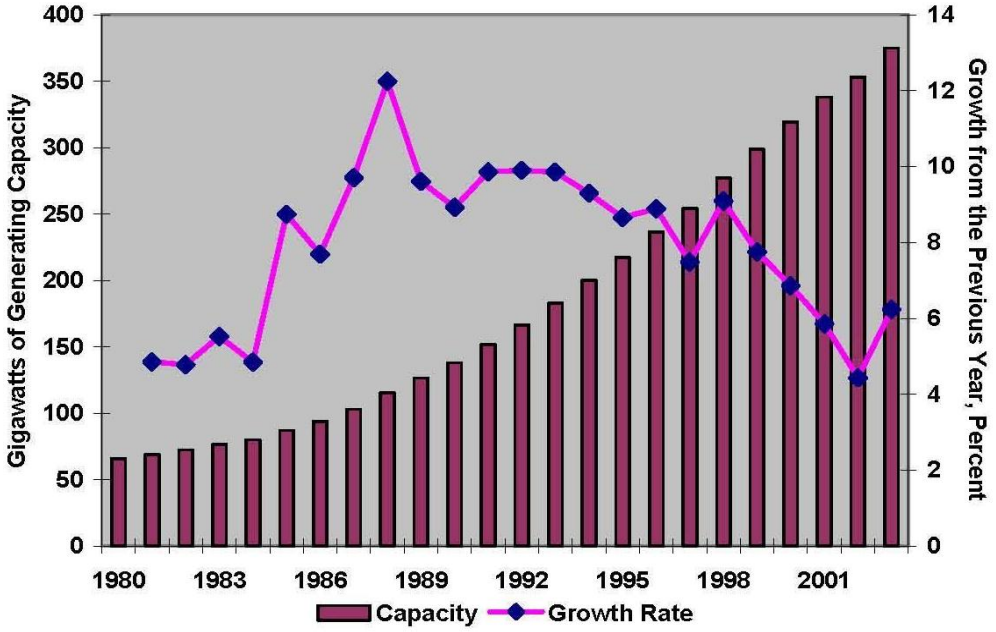

Figure 8 Total generation capacity installed and capacity growth rate in China

Source: APERC(2004). Energy in China: transportation, electric power and fuel market. P55.

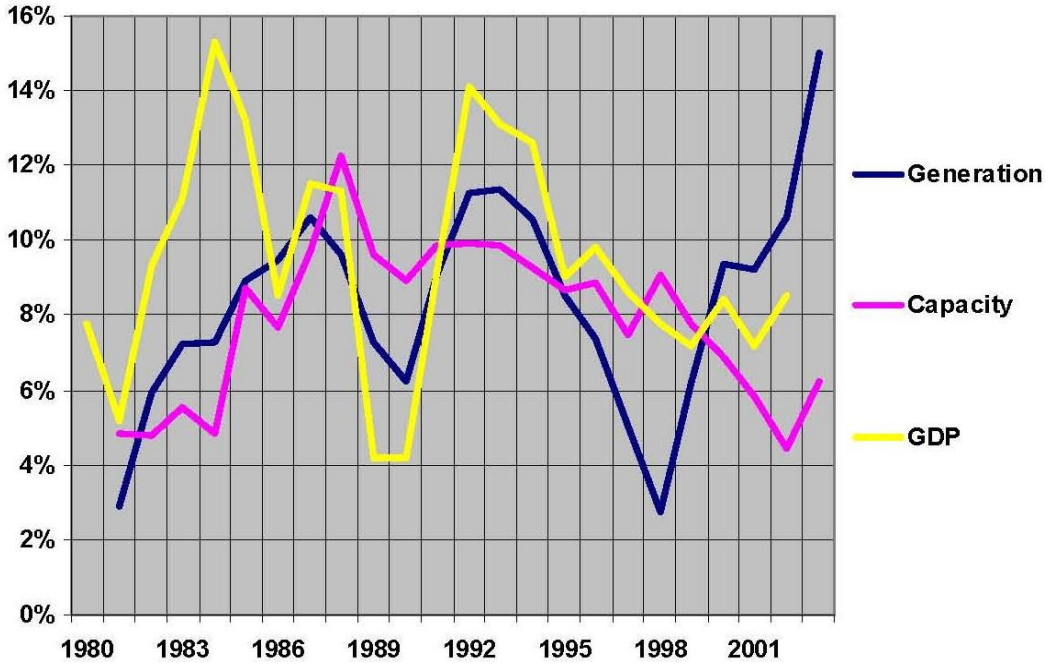

Figure 9 Growth rate of generation, installed capacity and GDP in China

Source: APERC(2004). Energy in China: transportation, electric power and fuel market. P56.

3.1.2 Xinjiang as an example

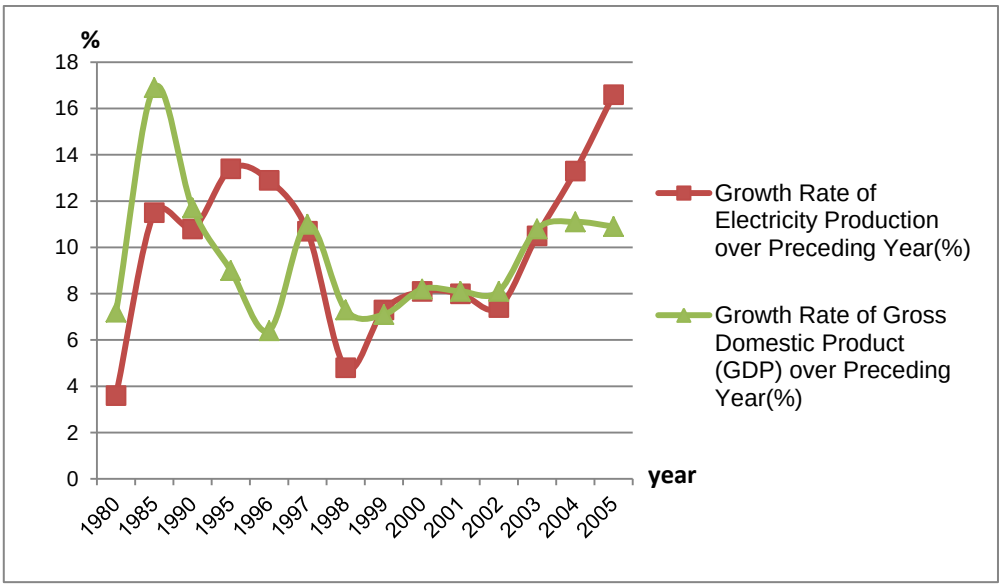

Figure 10 GDP and electricity generation growth rate in Xinjiang from 1980-2005

Data Source: Xinjiang Statistical Year Book 2007

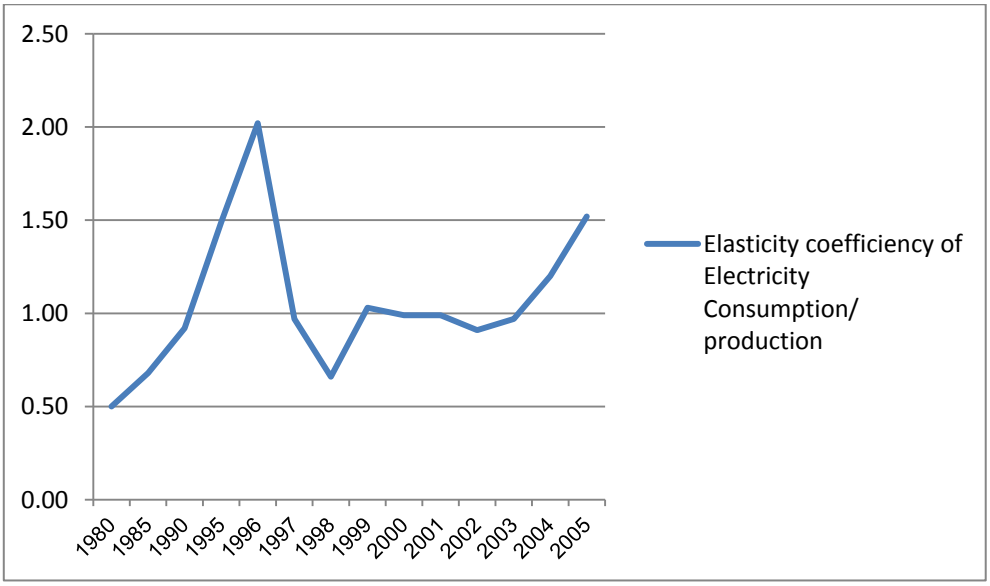

Figure 11 Elasticity coefficiency of electricity consumption/ production in Xinjiang

Notes: 1. Elasticity coefficient of electricity consumption= annual electricity consumption grow rate/ annual GDP growth rate; Elasticity coefficient of electricity production= annual electricity production growth rate/ annual GDP growth rate.
2. Because the power grid in Xinjiang is not connected to the other provinces, the above two elasticity coefficiency values are equal.

Data Source: Xinjiang Energy Statistical Year Book 2007

- **Electricity generation and consumption.** Thermal power electricity generation is dominating in Xinjiang, followed by hydro power generation. The reasons lie in the abundant coal reserves and comparatively low cost for coal-fired generation. However, according to the state's power industry planning, the hydro power and nuclear power shall play an active role gradually out of the environmental and sustainable development consideration. The central government also issued relevant feed-in laws to encourage the development of renewable energy generation. The surcharge on top of the tariff increased in 2007 from 0.001 yuan/kWh to 0.002 yuan/kWh. Xinjiang has rich resources in renewable energy such as solar and wind power. An increasing share of power generation from renewable energy is to be expected with the favourable policies, maturing technology and decreasing cost.

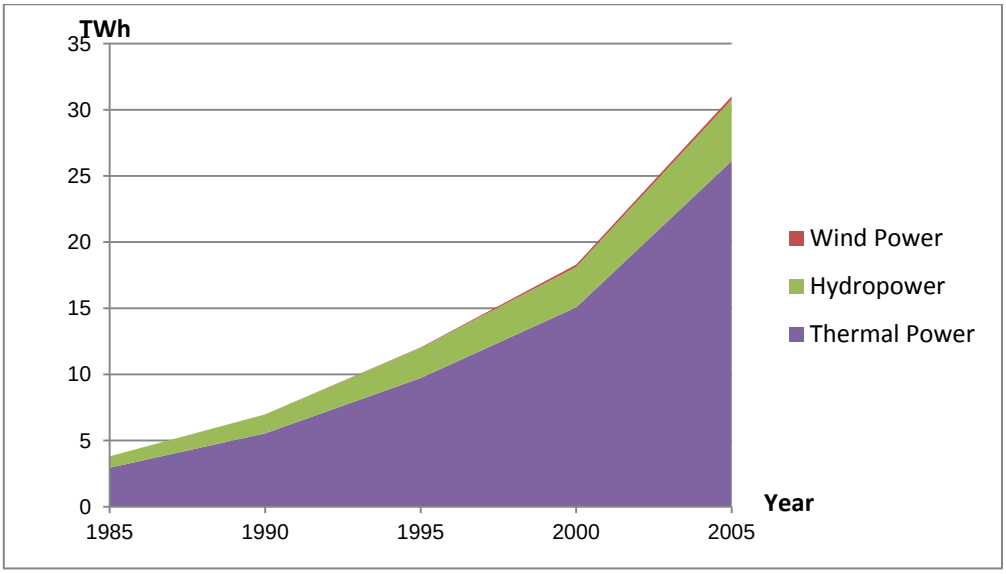

Figure 12 Electricity generation in Xinjiang from 1985 to 2005

Data Source: Xinjiang Energy Statistical Year Book 2007

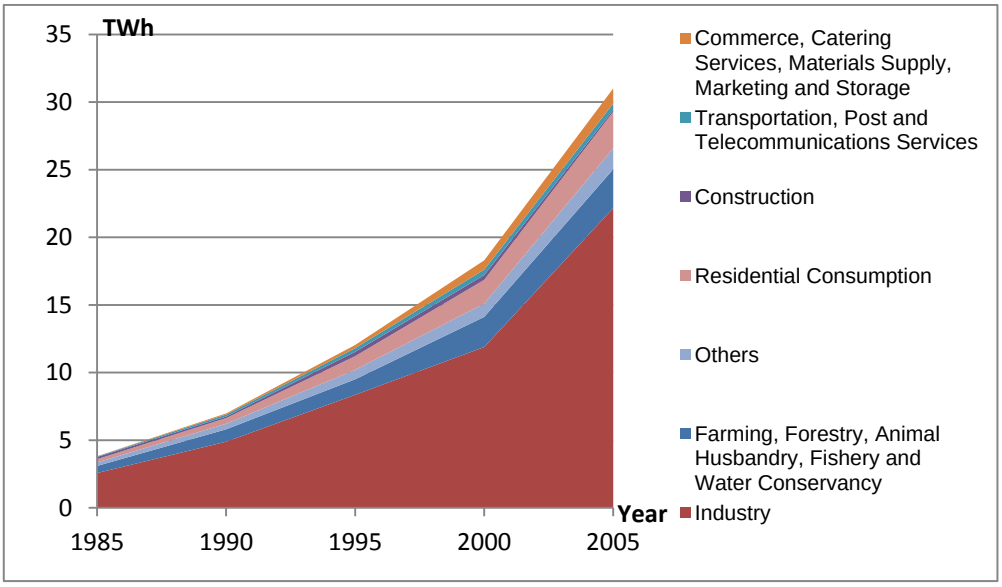

Figure 13 Electricity consumption in different industries in Xinjiang

Data Source: Xinjiang Energy Statistical Year Book 2007

- **Waste discharge in different industries.** Figure 14, Figure 15 and Figure 16 roughly described the profile in Xinjiang in breaking down of waste gas, waste water and solid gas discharge in different industries. Of which, electricity and thermal production and supply accounts for 49% (i.e. 198,821 tonnes) of the total SO_2 emission, and 13% (i.e., 24,073,700 tonnes) of the total waste water discharge and 20% (i.e., 3,134,200 tonnes) of the total solid waste discharge in the major investigated enterprises in Xinjiang.

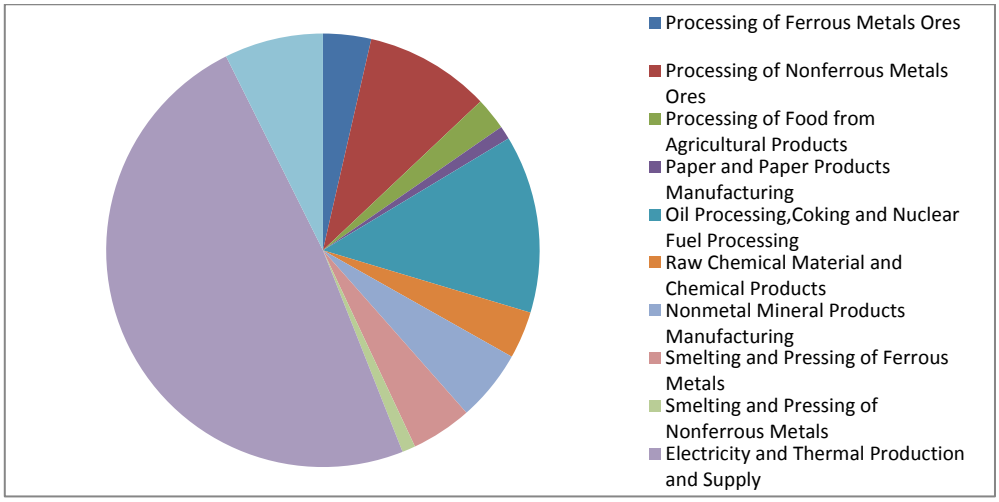

Figure 14 Industrial SO_2 emission in 2006 of investigated enterprises in Xinjiang

Data Source: Xinjiang Energy Statistical Year Book 2007

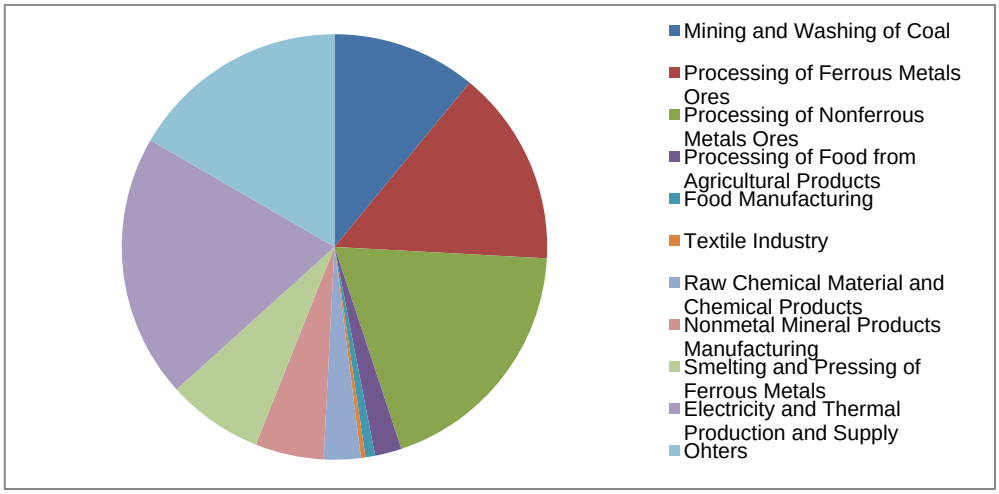

Figure 15 Industrial waste water discharge of 2006 of investigated enterprises in Xinjiang

Data Source: Xinjiang Energy Statistical Year Book 2007

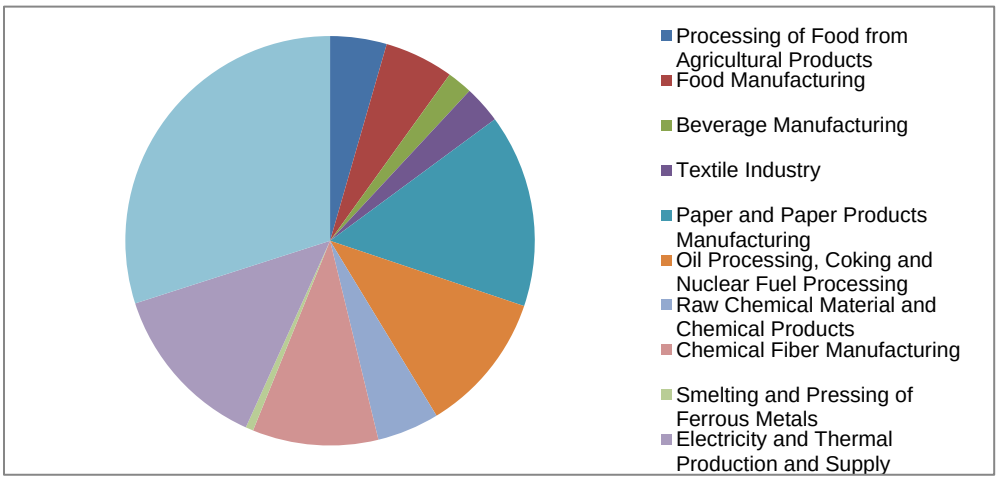

Figure 16 Industrial solid waste production in investigated enterprises in Xinjiang

Data Source: Xinjiang Energy Statistical Year Book 2007

3.2 Environment Protection and China's Power Industry

In China, the power generation sector consumes a large quantity of fossil fuels every year and is of great significance for CO_2 mitigation. According to IEA estimates, CO_2 emissions from coal combustion in the power sector of China in 2005 were about 3.5 billion tonnes, over half of the total CO_2 emissions in China. The technological options available are as follows: (1) efficiency improvement (or energy conservation); (2) switching to less carbon-intensive fossil fuels; (3) increasing the use of nuclear energy and renewable energy, such as hydro power and wind power; (4) CO_2 capture and storage (CCS). Compared with other options, CCS is a new technology developed in recent years, and for a power plant deployed CCS, 80-90% of the CO_2 emission could be reduced.

Practically, efficiency improvement (energy conservation) and emission reduction (SO_2) have been the two most important keywords, which Chinese government seems to care and shape the roadmap of China' electric power industry in recent years.

3.2.1 Energy conservation

- ***Close-down of small scale thermal power plants***. The central government has been pushing forward the close-down of small scale thermal power plants since 1990s. But there was never a stringent enforcement locally because of the fluctuation of power supply and demand. With the change-over of the national development strategy, the turning point shows in 2007[1]. 553 small scale thermal units, with a total capacity 14380 MW were closed down. Afterwards, the close-down speeds up. In 2009, 26170MW were shut down and at the same year, the goal specified in Eleventh Five-year plan (2006-2010) to close down 50GW was achieved in advance. With large scale units generate the quotas of the above small units, the calculated annual coal consumption saving is 18800000 tonnes and CO_2 emission reduction is 290000 tonnes.
- ***Technology upgrading.*** Due to the more stringent environmental regulations, power plants have been motivated to apply new technologies, such as supercritical, ultra-supercritical, air cooling, seawater desalination, variable-frequency motor, plasma circulating fluid bed etc. 8 ultra-supercritical units have been installed until 2007 with 7 of 1GW and 1of 600MW capacity. Additionally, the first home-made 600MW air cooling coal-fired unit has been completed and commissioned, which makes thermal power plants technically feasible in areas rich in coal and short in water.
- ***Energy conservation electricity dispatch.*** On the premise that the security of power supply is guaranteed, electricity generated from renewable shall be dispatched preferentially in order to maximum reduce energy consumption and waste discharge upon the principle of energy saving and economic feasibility[2]. The sequence in dispatching shall comply with the following priority: (1) unadjustable units

[1] The central government carried out a policy, i.e. Big up small down, which associates building up large scale new power plants projects with close-down of small scale thermal units. In order to motivate local governments and power companies to carry out this policy, a decreasing ratio has been applied according to the installed capacity, i.e., if a 300MW unit is to be built up, the close-down capacity for small scale thermal units shall be equal to 80% of the newly-built unit capacity; for 600MW unit, 70%; 100MW unit, 60%; 200MW CHP unit, 50%.

[2] See Energy Conservation Electricity Dispatch Measures (Tentative) (SC(2007)53), issued by General office of State Council in August 2007.

of renewable energy, such as, wind power, solar energy, ocean energy, hydro power; (2) adjustable hydro, biomass, geothermal renewable energy units and waste incineration units which meets the environmental protection regulations; (3) nuclear power units; (4) coal fired CHP units which generate electricity according to the heat requirements, units which utilize residual heat, steam, pressure, coal refuse, coal bed gas etc.; (5) natural gas, coal gasification units; (6) other coal-fired units, including CHP without heat load; (7) oil fired units. The priority in dispatching the same type of thermal power units shall be decided by the energy consumption level and waste discharge amount.

3.2.2 Emission reduction

- ***Emission reduction targets in China during eleventh five-year period (2006-2010).*** Authorized by the State Council, the former State Bureau of Environmental Protection signed contracts, i.e., SO_2 emission reduction targets during Eleventh Five-year period, with 31 provinces (autonomous regions or prefectures), State Grid Company and the biggest five power generation companies in 2006 respectively, which break down the national emission target into different administrative hierarchy and power companies to ensure the achievement of 10% SO_2 emission reduction until 2010. As we can see, SO_2 emission targets are relatively more stringent for economically developed provinces or prefectures, such as Beijing, Shanghai, Shandong and Zhejiang, with a double digit percentage goal to fulfil. But more tolerant for west China, such as Xinjiang, Tibet, Gansu and Qinghai, with keeping SO_2 remaining the same level as in 2005 until 2010 (see Attachment 5). Additionally, Xinjiang experienced an increase of 5.5% SO_2 emissions in 2007 compared to 2006.
- ***Completion and operation of desulfurization units***. Since 2006, 80% of the newly commissioned coal-fired units' desulfurization equipment has been designed, constructed and operated simultaneously with the generation units. The year 2007 experienced an explosive increase, i.e., completion and operation of 266 GW desulfurization coal-fired units (not including circulated fluid bed boiler units), 81.4% increase compared with 146,365 MW of 2006[1] which accounts for 51% of the total capacity of coal-fired power plants. Compared with 2000, the capacity of desulfurization units in coal fired power plants increased by a factor of 53; 90% of the units apply wet method lime stone/gypsum flue-gas desulphurization technology. Specifically, some units in coal-fired power plants in Xinjiang Province began to install desulfurization equipment. But no desulfurization units were completed or put into use until the end of 2007.
- ***SO_2 emission reduction in China.*** The SO_2 emission in 2007 was 24,681,000 tonnes and decreased 4.7% compared with 2006, which was the first time in the recent years that national SO_2 emission reduced. As to the power sector, electricity generated from thermal power plants increased 14.6% in 2007, while SO_2 emission of power sector decreased 9.1%. According to the estimation of SERC, China's electric power industry in 2007 discharged 15380000 tonnes of SO_2 and 2.8 billion tonnes of CO_2, calculated with historic emission performance, i.e., SO_2 emission

[1] See *Notice on urban waste water treatment facilities and desulfurization equipment*, issued by Ministry of Environmental Protection No.1 (2008)

5.7g/kWh, CO_2 emission 1,050 g/kWh. Through energy efficiency improvement (including transmission loss and coal consumption reduction), renewables generation and demand side management, SERC's estimation shows that the power industry saved primary energy 64,920,000 tonnes of SCE (standard coal equivalents), reduced SO_2 emission 1,032,300 tonnes in 2007(equivalent to 7.65% of total SO_2 emission of power industry, 3.99% of total national SO_2 emission in 2006) and 181,790,000 tonnes of CO_2 emission compared with 2006 (see Table 2).

Table 2 Estimated SO_2 and CO_2 emission reduction in China by SERC

	Energy efficiency improvement from		**Additional electricity generated from**		**Demand side management**	**Total**
	coal consumption	*transmission loss*	*nuclear power*	*renewables (wind, hydro power)*		
SO_2 emission reduction	39.29	3.06	4.14	39.74	17	103.23
CO_2 emission reduction	6,916	539	729	6,995	3,000	18,179

(unit: 10000 tonnes)

Source: Energy conservation and emission reduction report in 2007, SERC.

- ***Renewable energy investment.*** From the perspective of investment structure, non-fossile energy investment exceeds half of the incremental investment. From 2005 to 2009, thermal investment proportion decreased from 70.3% to 40.2% of the total, while nuclear power investment increased from 1.0% to 15.5%，and wind energy from 1.4% to 20.4%. Average annual growth rate of thermal power plant was 3.76%，and decreased since 2006.Average annual growth rate of nuclear power was 82.65%(see Table 3). Xinjiang has experiences dramatic increase in renewable energy as well, especially wind power (see Figure 17& Figure 18).

Table 3 Change in annual growth rate of energy investments from 2005 to 2009 values in percent

Year	**2005**	**2006**	**2007**	**2008**	**2009**
Hydropower	55.58	-9.07	9.60	-1.18	2.33
Coal, oil, gas	58.06	-1.82	-10.08	-16.26	-11.10
Nuclear power	-16.14	179.21	73.89	101.38	74.91
Wind power	250.31	37.76	173.54	208.27	43.92
Other renewables	325.88	56.26	9.88	-99.80	12650.27
Total	-1.73	-1.01	0.97	5.61	8.92

Source: Annual regulation report of electric power industry (SERC, 2009).

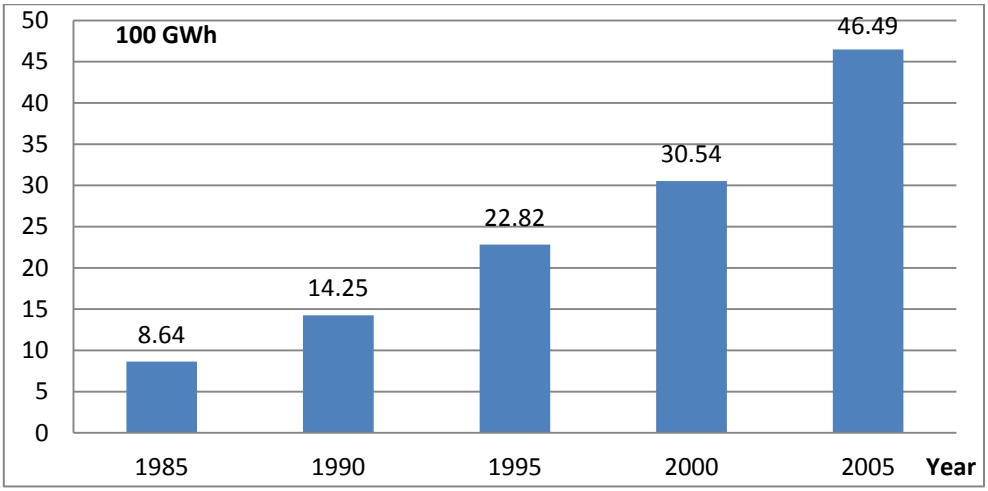

Figure 17 Hydro power generation in Xinjiang from 1985 to 2005

Data Source: Xinjiang Statistical Year Book 2007

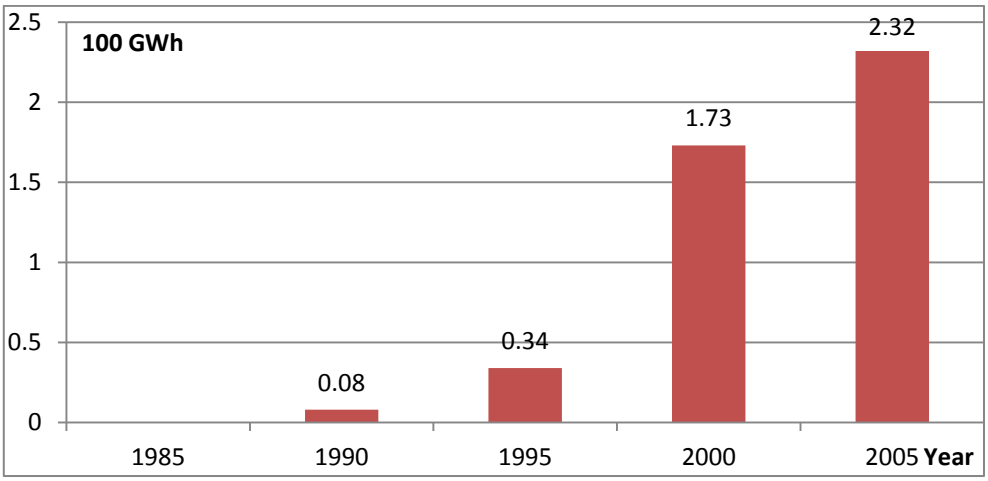

Figure 18 Wind power generation in Xinjiang from 1985 to 2005

Data Source: Xinjiang Statistical Year Book 2007

3.2.3 Energy conservation performance

Coal consumption per kWh. Power plants with capacity of 6 MW and above supply electricity at 356 g SCE/kWh in 2007, which is 11 g SCE/kWh lower than 2006. Raw coal consumption nationwide in 2009 was 1.399 billion tonnes. Average coal consumption in supplying 1 kWh electricity in coal-fired power plants was 339 g SCE/kWh in 2009. From 1997 to 2009, coal consumption per kWh has been decreasing continuously, i.e., from 408 g SCE/kWh to 339 g SCE/kWh (see Figure 19).

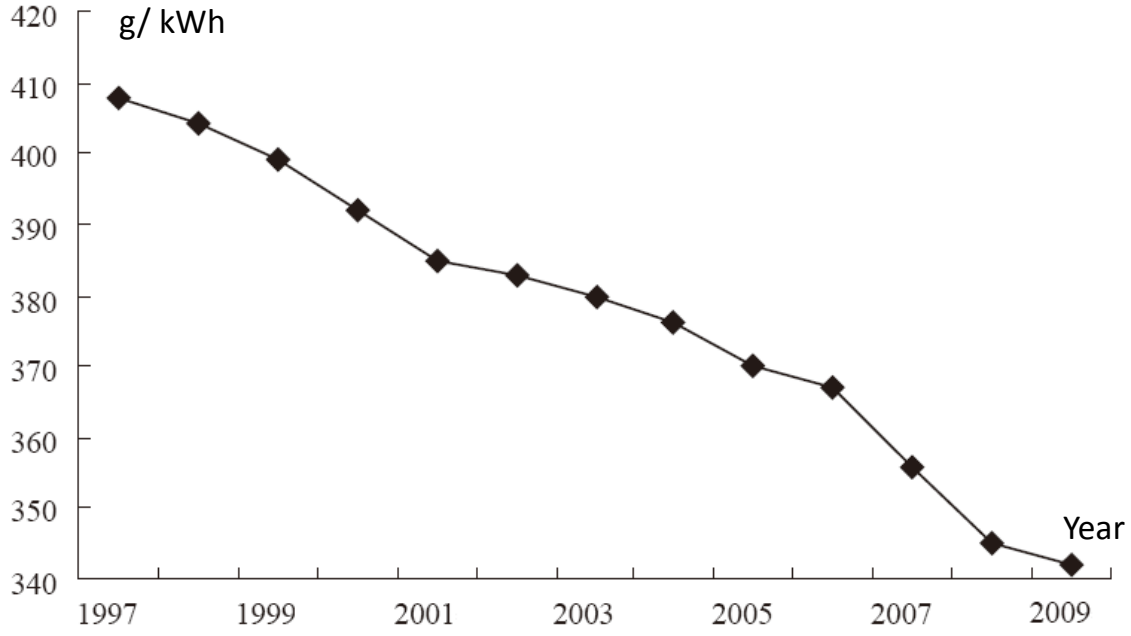

Figure 19 Development of average coal consumption (g SCE/kWh) in power supply from 1997 to 2009

Source: Annual regulation report of electric power industry (SERC, 2009)

- ***Electricity consumed at the power plants.*** Electricity consumed at the power plants nationwide was 5.69% in 2009, of which, 0.58% of hydro power and 6.51% of thermal power respectively. From 1997 to 2009, electricity consumed at the power plants have been decreasing from 6.80% to 5.69%(see Figure 20).

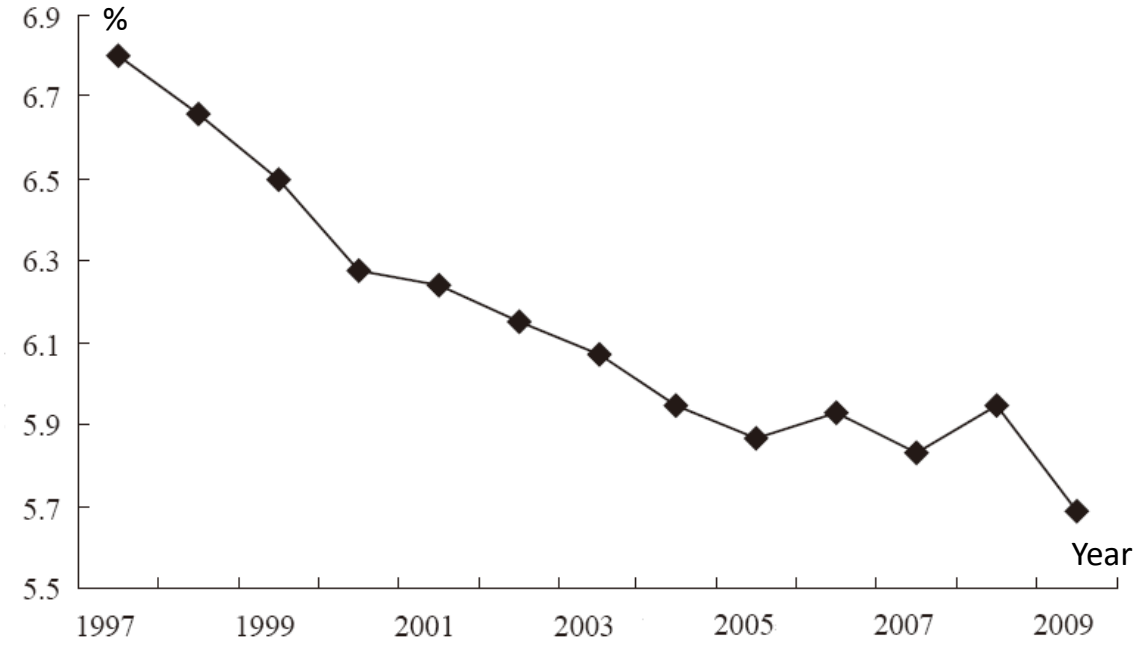

Figure 20 Development of electricity consumption in power plants from 1997 to 2009

Source: Annual regulation report of electric power industry (SERC, 2009)

- ***Transmission loss***. Transmission loss nationwide 6.39%. From 1997 to 2009, transmission loss has been decreasing continuously, i.e., from 8.20% to 6.39% (see Figure 21).

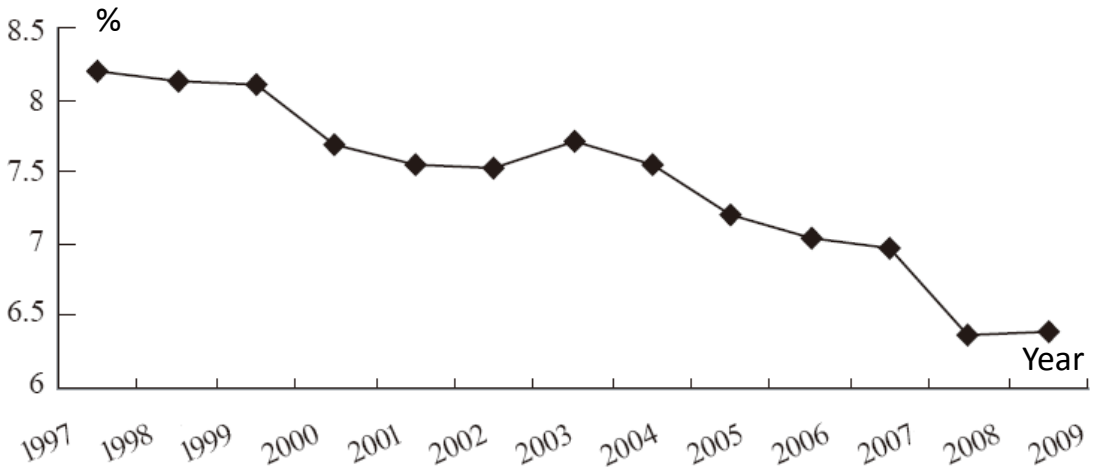

Figure 21 Development of transmission loss from 1997 to 2009

Source: Annual regulation report of electric power industry (SERC, 2009)

Specifically, among the different provinces and regions nationwide, statistics shows that the environmental performance for the power sector of Xinjiang lags far behind. Power plants in Xinjiang province need 453 g standard coal to supply 1kWh electricity in 2007, with 16 g reduction from 2006, but until much higher than the national average (see Figure 22)[1]. Average electricity consumption at the power plants in Xinjiang is 8.02%, with thermal power plants at 9.20% (see Figure 23). As to transmission loss, Xinjiang is higher than national average, with 8.83% in 2007 and 9.13% in 2006 (see Figure 24). For more detailed information, please refer to Attachment 2, Attachment 3 and Attachment 4.

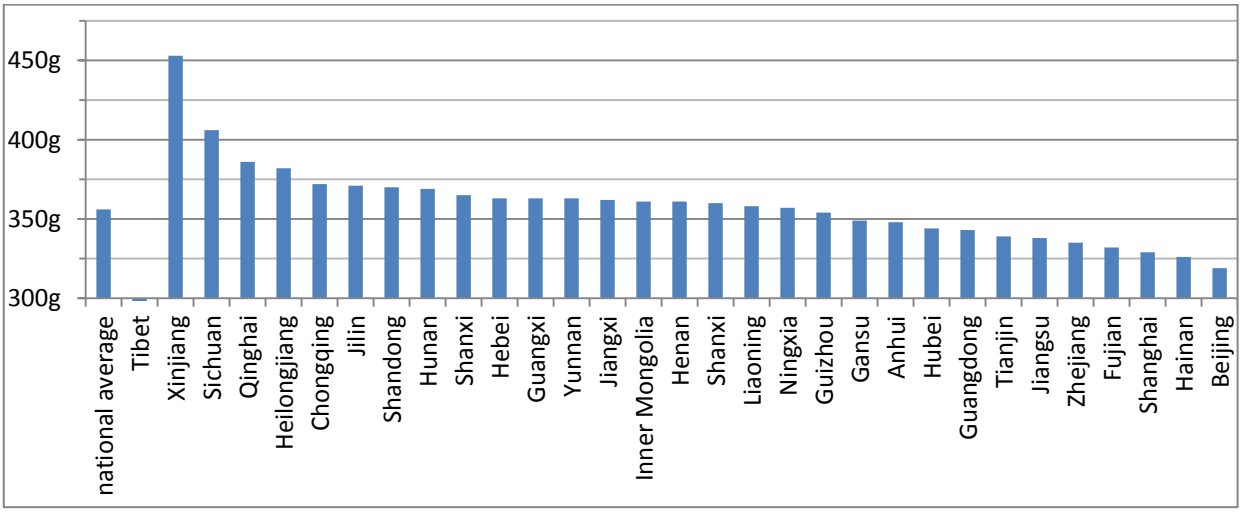

Figure 22 Coal consumption per kWh in different provinces in 2007

Data source: Energy conservation and emission reduction report of power industry in 2007 (SERC)

[1] Data source for Figure 22, Figure 23and Figure 24 is not complete. Some provinces have no available data as we can see from the figures.

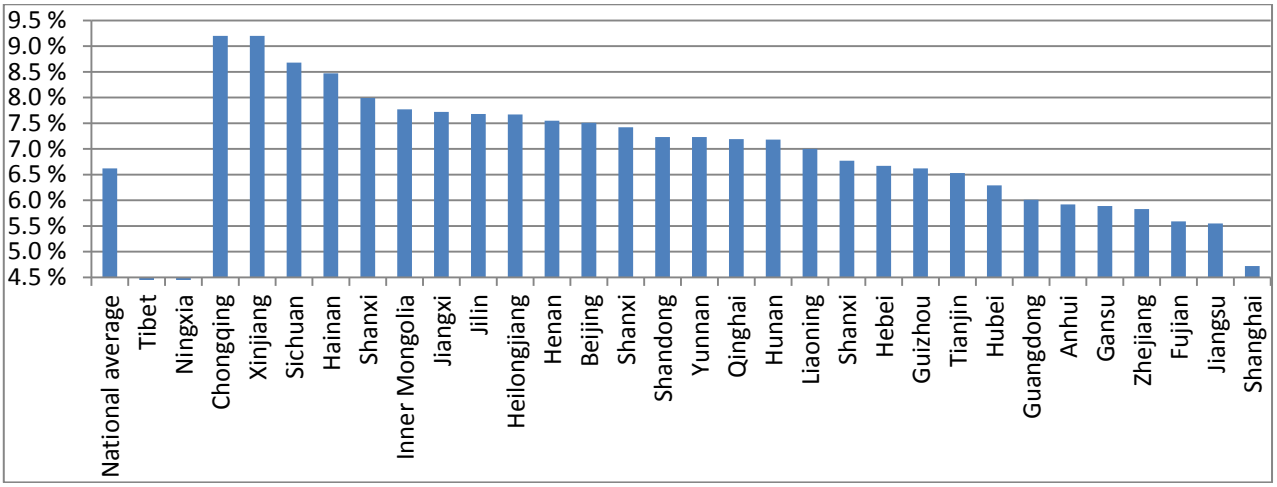

Figure 23 Average electricity consumption ratio at thermal power plants in different provinces in 2007

Data source: Energy conservation and emission reduction report of power industry in 2007 (SERC)

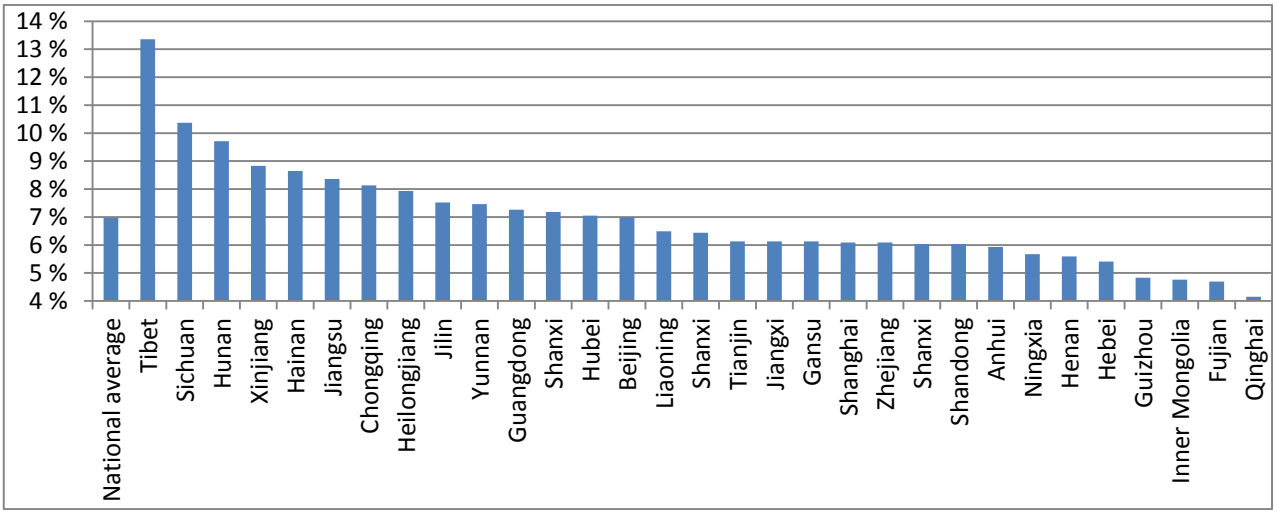

Figure 24 Average transmission loss in different provinces in 2007

Data source: Energy conservation and emission reduction report of power industry in 2007 (SERC)

4 Instrument and its performance: China's practices and international experiences

4.1 International experiences

The reduction of GHG emissions from energy-supply is being actively pursued through a variety of government policies and private sector research. There are many technologies, behavioural changes and infrastructural developments that could be adopted to reduce the environmental impacts of current energy-supply systems. Whereas planning policies provide background for climate change mitigation programmes, most climate policies relating to energy supply tend to three policy categories (OECD, 2002):

- economic instruments (e.g. subsidies, taxes, tax exemption and tax credit);
- regulatory instruments (e.g. mandated targets, minimum performance standards, vehicle exhaust emission controls);
- Policy processes (e.g. voluntary agreements and consultation, dissemination of information, strategic planning).

4.1.1 Economic Instruments

Economic instruments are policy mechanism that encourages behaviour change through the use of financial incentives and disincentives without forcing market actors through laws to change their behaviour. Examples that have been widely used are as follows.

- Carbon and energy taxes
- Tradable emission permits
- Fiscal measures and capital grants
- Feed-in tariffs
- Quota obligations(renewable energy standards) with tradable certificates
- Removable of subsidies for carbon-intensive fuels

4.1.2 Regulatory instruments

Regulatory instruments are policy mechanisms that use governments' traditional powers of regulation to change behaviour, which often regulate the following relevant content.

- Minimum efficiency standards and best available technologies
- Fuel portfolio standards
- National targets
- Grid access for distributed and remote low-carbon technologies

4.1.3 Policy process

Besides economic and regulatory approaches, governments have long been using other policies and measures to shape the behaviour of stakeholders of energy sector. Metz et al. (2007) defined them as policy process (see Table 4 for application of different instruments). The most prevalent is as follows.

- Voluntary agreements
- Information and education
- Research and development investment

Table 4 Different policies and measures towards a low-carbon supply

	Economic instruments	**Regulatory instruments**	**Policy processes**		
			Voluntary agreements	*Information*	*Technology R&D*
Improvement of energy efficiency	Energy taxes Lower energy subsidies Carbon taxes Fiscal incentives Tradable emissions permits	Minimum standards for power plants Best available technology	Voluntary commitments to improving efficiency	Information and education campaigns	Funding to improve efficiency of cleaner fossil fuel generation
Switching to lower-carbon fuels	GHG permits Fiscal incentives Tradable emissions permits	Power plant fuel portfolio standards	Voluntary commitments to fuel switching	Information and education campaigns	Funding to improve efficiency of low-carbon generation technologies
Encouraging renewable alternatives	Capital grants Feed-in tariffs Quota obligations and permit trading GHG taxes Tradable emission permits	Targets Supportive tariffs Grid access support	Voluntary commitments to install renewable capacity	Green electricity validation Information campaigns	Funding to improve efficiency of renewable generation technologies
Carbon sequestration	GHG taxes Tradable emission permits	Emission restrictions for major point emitters	Voluntary agreements to use CCS	Information campaigns	Chemical and biological sequestration sequestration in underground geological formations

Source: Metz et al. (2007)

4.2 China's practices

China has been taking multiple measures, including economic incentives, command and control methods and support for R&D. The above-mentioned attempts in controlling pollution have met a mix of success. Hereafter, I summarize China's practices and try to open up a whole picture of the instruments adopted, focusing on the flue gas treatment in thermal power plant. A case study concerning close-down of small scale thermal power plant was brought up for the purpose of comparing the performance of different kinds of instruments.

4.2.1 Economic incentives

Economic incentives are widely used in China and include charges and fees and subsidies. Recently, Chinese government began to take into account collecting a carbon tax. From the perspective of economics, tradable emission permits is the most efficient instrument to realize the same amount of emission reduction. The rationale is Coase Theorem, i.e., when there are no transaction costs, trading and bargaining will lead to an optimized reallocation of resources regardless of the initial allocation of property rights.

Table 5 Economic incentives for thermal power plants' flue gas desulfurization

	Economic incentives
Charges & fees	*Air Pollution Control Law* 2000)14 stipulates, the national government is entitled to charge fees according to the types and quantity of atomospheric pollutants.
	Regulations on Administration of Discharge Fee Collection and Expenditure, issued by State Council in 2003, standardizes discharge fee collection administrative procedures. Specifically, units with installed capacity above 300MW shall be verified by environment protection administration of provincial government.
	Proposals in Collection and Reallocation of Discharge Fee Revenue, issued by Ministry of Finance in 2003, re-allocate levy from discharge fee according to the ratio of 1：9, i.e., 10% as central budgetary revenue and 90% as local budgetary revenue.
	Administrative regulations on levy of discharge fee, issued by NDRC in 2003, thermal power plants shall be charged according to the types and amount of pollutants, i.e., 0.6yuan per pollutant equivalent.
	General Workplan for Energy Conservation and Emission Reduction, issued by State Council in 2007, increases SO_2 discharge fee from 0.63 yuan/kg to 1.26 yuan/ kg within three years.
Capital grants& subsidy	In 2006, Ministry of Finance issued *Application Guidance of Central Government Special Fund for Environment Protection Project* (2006-2010), which supports especially coal-fired power plants desulfurization and denigration renovation projects with the purpose to guarantee regional environment security.
	In 2007, Ministry of Finance issued *Interim Measures of special fund for main pollutants emission reduction*, which initiated the Special Fund for main pollutants emission reduction.
Emission permits trading	*Decisions on Implementing Scientific Concept of Development and Strengthening Environment Protection* (SC No. 39), promulgated by State Council in 2005, and propose the introduction of market mechanism in pollution control. Administrative regions and firms shall carry out SO_2 emission quota trading when possible.
Tariff mark-up policy	*Administrative Regulations on desulfurization tariff mark-up and desulfurization equipment operation for coal-fired power units* (2007) stipulates that, thermal power units with desulfurization equipment shall apply to desulfurization feed-in tariff mark-up, i.e., 0.0015 yuan/ kWh.
	NDRC issued *Notification on Acceleration of close-down for small scale thermal power units through feed-in tariff abatement* (2007).
Emission reduction dispatch	The General Office of State Council issued *Energy Conservation Power Dispatch Measures(tentative)*, which dispatches electricity generated with fossil fuels through sequencing unit's energy consumption and waste discharge.

Emission permits trading is currently at a trial phase in China. Power plants rely more on political manipulation instead of market power to trade to emission permits on the basis of an agreed price. Usually, the environmental protection administration of a local government acts as a go-between. Emission permit trading begins with aggregate emission control, target allocation, and completes with trading and emission monitoring. It is worth to mention the following issues. First, *The Law of the People's Republic of China on the Prevention and*

Control of Atmospheric Pollution contains regulations about aggregate emission control, but the penalty provisions are not clearly clarified. Local governments do not always enforce the laws and regulations so stringent due to the consideration of employment and tax revenue. Practically, emission permits trading is lacks a proper legal basis, limited practical experiences exist with it. Second, the central government breaks down the aggregate emission reduction into provincial (prefecture/region) targets. Afterwards, local environmental administrations reallocate among different enterprises. If emission permits are tradable, the possibilities of administrative intervene towards market transaction; the possibilities of regulatory capture and rent seeking between regulated firms and environmental administrations, shall be taken into account.

Case Study: Regulatory vs. economic instruments in the shutdown of thermal power plants

Shutting down thermal power plants provide a natural experiment to compare the performance of regulatory and economic instruments. Since the 1990s, central government has been urging the close-down of thermal power units below 50MW_{el}.

NDRC tends to use regulatory or administrative instruments to realize the target. For example, if NDRC required the grid company to stop purchasing electricity from such units, coal companies will stop selling coal to them, transportation companies stop transporting coal for them, banks and other financial institutions stop to give loans, governmental land and resource administration stop to allocate land and water resource administration stop to offer them water quotas for electricity generation. However, it turned out that local government and the regulated power plants conspired to keep these small scale units operating and build even more. The reason for this has two aspects. First, a close-down influences employment, tax revenue and original investors, which in turn confront local governments with financial and social stability pressures. In addition, local governments sometimes are the investor and owner of these units and the local environmental administrations are under the political hierarchy of local government and therefore controlled by it through financial, labour force and material resources. Second, the criteria in evaluating political performance and hence a promotion to higher position, is mainly decided by the GDP within the administrative division. Different from politicians in Western developing countries, China's government officers have tiny chance to get another equally paid job (Huang, 1996). This can be one of the explanations for China's government officers' enthusiasm in developing the economy compared to the situation than other developing countries (Li, 2004).

Small scale thermal units were built up approved by different levels of hierarchy during the power shortage periods. With a diversified ownership structure, the close-down will affect different stakeholders, the investment return of private investors, cause unemployment of former employees and result in lower local tax revenues. A purely regulatory instrument without consideration of interests of other stakeholders does not bring us a satisfactory outcome and also is a bad example of consistency and credibility of government decisions.

In contrast to Guangdong province, Henan province took a first step in allowing the transaction of generation quotas and emission permits from small scale units to high efficiency units, on the basis of bilateral negotiations. Generation quota transaction refers to transaction of quotas between generation units and power plants, which is also called substitute electricity transaction as well. Small scale power plants which are supposed to close down according the eleventh five-year plan are entitled to transact their generation quotas before the dead-

line. The transaction method was popularized and expanded nationwide by SERC and NDRC. Generation quota transaction is supposed to take place between high efficiency and environmental friendly units and small scale low efficiency and high pollution units, or clean energy (hydro power, nuclear power) and thermal power plants. Electricity transacted includes different contractual electricity generation quotas, which currently refer to the annual electricity production plan of the provincial government. A total of 23 provinces carried out generation quota transaction in 2007 whereby 54 TWh of electricity was transacted, and lead to a reduction of 6,200,000 tonnes of SCE and 140,000 tonnes of SO_2 emissions.

4.2.2 Command and control

Command and control regulation is the most extensively used instrument in China for environmental amelioration. In practice, however, the power industry regulation including environmental aspects is highly decentralized. Taking into account the unbalanced regional development and different local priorities, insufficient enforcement of the law is not a rare event in the power industry. In this section, market access regulations concerning pollution control and dynamic regulations concerning emission performance are being reviewed.

Table 6 Environmental command and control regulation concerning market access

	Laws and regulations	
Market Access	*Three Simultaneity* regulation (term 26)	*Environmental Protection Law* (1989), 26, facilities to prevent pollution shall be designed, installed and put into use at the same time with the main project.
		The former MEP promulgated *Power Industry Environment Protection Management Measures* (1996) and implements the above term 26 to power industry.
	Environmental impact assessment regulation	*Environmental Protection Law* (1989), 13, projects' construction shall compile environment impact assessment report. Government planning administrative shall examine and endorse the proposed project after the approval of the above report.
		Power Industry Environment Protection Management Measures (1996) stipulates, power projects construction shall enforce and comply with national environmental impact assessment regulations.
		Air Pollution Control Law (2000) standardizes the management and supervision of air pollution prevention for projects' construction.
		Environmental Impact Assessment Law (2003) upgrades environmental impact assessment from project-based to planning-oriented.
		National Bureau of Environmental Protection promulgates *Environmental Impact Assessment Public Participation Interim Measures* (2006), specifies the channels and procedures of public participation of environmental impact assessment for projects' construction.
Market Exit	*Environmental Protection Law* (1989)29stipulates, firms and institutions which cause serious environmental pollution shall undertake treatment within a prescribed limit of time.	
	Air Pollution Law (2000)19stipulates, out-dated technology and equipment, which seriously influences air quality and environment, shall be phased out.	
	The notification concerning close-down of small scale thermal power plants and units(1999), issued by the General Office of State Council, requires that units with capacity below 50MW shall be closed down before 2003.	
	*Interim regulations to accelerate industrial restructuring (*2005), issued by State Council, differentiates proposed investment projects into 4 categories, i.e. phase-out, restriction, permission and support.	
	Industrial restructuring category (2005) stipulates that, thermal power units with capacity below 100MW connected to the grid and completed the term of service, and small scale thermal power unit with capacity of 50MW and below, are listed at phase-out categories.	
	Several Proposals towards accelerating close-down of small scale thermal power units issued by State Council in 2007, includes units completed the term of service with capacity below 200MW, and coal-fired units with standard coal consumption in power supply 10% more than average province/region/prefecture level or 15% more than national level in 2005, and units which do not meet the environment protection and emission standard regulations, shall close down during the Eleventh Five-year.	

Table 7 Emission command and control regulation for thermal power plants' flue gas desulfurization

	Laws and Regulation	
Emission quota	Emission cap control	*Air Pollution Control Law* (2000), article 3 stipulates，china's central government will take measures to control or reduce gradually total amount from main atmospheric pollutant emission nationwide.
		State Council issued *Plan for national main pollutants emission cap control in the Eleventh Five-year Period* in 2006, which separately lists the SO_2 emission cap control towards power industry.
		State Bureau of Environmental Protection issued *Proposals for SO2 emission allocation* in 2006, which distribute SO_2 emission quotas directly to specific units according to their emission performance, installed capacity and annual working hours.
	Emission Standard	*Air Pollution Control Law* (2000)stipulates, newly-built or extension of thermal power plant that discharge more SO_2 than emission standard or the cap amount as stipulated, shall install accordingly the desulfurization and dust removal equipment.
		Thermal power plants atmospheric pollutant emission standard (GB13223-2003) builds up mandatory emission standards for flue gas, SO_2 and NO_x of thermal power plants.
Emission Permits	*Air Pollution Control Law*(2000), article 15 stipulates, within the atmospheric pollutant emission cap control regions, local government shall verify the total amount of atmospheric pollutant emission cap for firms and institutions according to the conditions and procedures stipulated by State Council, and issue the corresponding main atmospheric pollutant emission permits.	
Dynamic Emission Monitorien	*Air Pollution Control Law*(2000), article 22 stipulates, State Council environment protection administration build up air pollution monitoring system, draw up monitoring network and formulate unified monitoring methodology.	
	Environmental Monitoring Regulations on Thermal Power Industry (1996) stipulates that, environmental monitoring shall be a part of production control in power industry.	
	Atmospheric Pollutant Discharge Standard for Thermal Power Plants (GB13223-2003) stipulates, boilers for thermal power generation shall install time-lage emission monitoring equipment.	
	State Bureau of Environmental Protection issued *Notification on the implementation of the newly revised ``thermal power plants atmospheric pollutant emission standard*``(SBEP No.82 (2004)) stipulates, all the thermal power units shall install flue gas emission continuous monitoring equipment in accordance with the requirements of HJ/T75-2001, i.e., Technical standards for Flue gas emission continuous monitoring of thermal power plants, and be connected with environmental protection administration's network before January, 1st, 2008.	

4.2.3 Technology proliferation support

Private sectors often do not invest sufficiently in R&D. Because of the positive externality of environmental protection, it is quite common that governments offer direct capital grants or favourable tax reductions to stimulate the development and deployment of new innovative energy conversion technologies and create markets for them.

Table 8 Policy processes for thermal power plants' flue gas desulfurization

	Technology support policies
Clean coal technology	In 1995, National clean coal technology promotion and planning leading group compiled *the China's Ninth five-year plan and development programme until 2010 for clean coal technology,* which developed a general plan for the proliferation for clean coal technology.
	In 2002, State Bureau of Environment Protection, State Economic and Trade Commission and Ministry of Science and Technology jointly formulated *Technologies for Coal-fired SO_2 Emission Control* as a guidance for industries and firms.
	In 2005, State Council promulgated *National Middle and Long Term Science and Technology Development and Planning Programme: 2006-2020*, which proposed the proliferation of clean and efficient utilization of coal to prevent environment pollution.
	In 2005, NDRC issued *Several Proposals towards Accelerating Flue Gas Desulfurization Industrialization in Thermal Power Plants,* which clarified the principles for the choice of technology in flue gas desulfurization.
R&D support	*Notification on trial preferential policies towards power generation demonstration project with clean coal technology*, promulgated by SPC in 2001, decided to carry out preferential policies for power projects adopted clean coal technology.
	In 2002, *Administrative regulations on capital grants for industrial technology research and development* listed separately budget outlays concerning scientific expenditure under the management of SPC and SETC, for the support of industry technology development and research.
	In 2007, NDRC issued Eleventh Five-year planning for national independent innovation capacity building, which proposed to build up technology development and experiment facilities for the efficient exploitation and clean utilization of coal.
Industrialization	In 2002, State Economic and Trade Commission issued Development planning of desulfurization technology for thermal power plant and equipment localization production: 2000- 2010, which outlined the general planning for the localized production of desulfurization equipment.
	In 2005, NDRC issued Notification on acceleration the industrialization of flue gas desulfurization equipment, which detailed the development planning.

5 Opportunities and Challenges

The world witnessed the improvement of standards of living of hundreds of millions of Chinese. With the nation held $1.5 trillion foreign exchange reserves by the end of 2007, the estimation shows that up to 200 million people in China still lived on less than $1.25 a day in 2005 (Chen and Ravallion, 2008). Eradicating poverty and raising incomes toward the global average has long been the priority for China. However, China has been gradually setting ambitious goals concerning energy efficiency, pollutants control as well as emission reductions in recent years under the domestic and international environmental amelioration pressures. Given China's economic expansion has heavily relied upon coal, which provides 70% of the total primary energy; the energy structure transition will be seen to meet the abovementioned national targets. With the expectation that Low carbon movement may bring green recovery for the local economy, provincial and municipal governments respond positively as to the most recent target of 40-45% emission reduction until 2020. Different from the pollution control goals implemented before, not only the challenges, but also opportunities have been realized by the local governments. Since the national emission reduction target is going to break down to local targets. Research on low carbon roadmap and scenario designs at provincial level have been proposed by NDRC while local governments are confronting a common problem of lack of research personnel and capacity. These provide perfect time and chances for international research cooperation.

Xinjiang, with relatively low environmental performance and underdevelopment economy, failed to fulfil the 20% decrease of energy intensity during the Eleventh Five-year Plan. Nevertheless, Xinjiang provides perfect natural conditions with its unique rich renewable energy resources in solar, wind and geothermal power to realize a low carbon roadmap. Historically, Xinjiang's economic development has long being relying heavily on the investment of central government due to the Party's policies towards ethnic minorities. Likewise, the central government urged the construction of a model of 8.8 km^2 low carbon city in Xinjiang Turpan, which is designed to depend only on non-fossil energy and the first experimental project in west China arid area to develop energy-efficient and pollution-free cities.

RECAST Urumqi project has been helping Xinjiang to facilitate a low carbon roadmap through improving energy efficiency in buildings, industry, and will focus on transportation issues in the future as well. Construction for pilot projects such as extra low buildings has started in Urumqi. Energy flow has been analysed for a major chemical company. In the next research phase, the proposed work plan is on energy development and emission scenario design. For this, I will use LEAP model for a regional application for Xinjiang province. LEAP is an integrated software tool for the long-range energy alternatives planning system, which is developed at Stockholm Environment Institute and widely-used in over 80 countries for energy policy analysis and climate change mitigation assessment. Energy related GHG emission sources will be tracked and emissions of regional air pollutants in Xinjiang will be analysed. The local research partners will be provincial development and reform commission, Xinjiang New Energy Research Institute, Xinjiang Academy of Environmental Protection Sciences and Xinjiang Agriculture University. Ultimately, the energy development scenarios with LEAP model will show Urumqi and Xinjiang towards a low carbon roadmap to a cleaner, more beautiful environment and more promising future.

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Attachment 1 Installed capacity, electricity generation and consumption, annual growth rate in 2009

Province/ prefecture/ region	Installed capacity (MW)	Growth rate (%)	Electricity generation (TWh)	Growth rate (%)	Electricity consumption (TWh)	Growth rate (%)
Beijing	5,920	1.9	24.642	-0.6	73.915	7.17
Tianjin	10,040	34.0	41.239	3.8	55.016	6.64
Hebei	37,230	15.9	176.048	10.3	234.418	11.90
Shanxi	40,820	13.3	187.036	4.4	126.754	-3.56
Inner mongolia	54,070	10.6	225.029	9.5	129.248	5.89
Liaoning	25,380	14.4	119.035	4.9	148.817	5.39
Jilin	16,010	23.2	54.432	4.0	51.525	3.78
Heilongjiang	19,150	5.7	72.823	-1.3	68.867	2.80
Shanghai	16,690	-0.8	78.179	-1.6	115.338	1.33
Jiangsu	56,890	4.3	297.340	3.3	331.399	6.27
Zhejiang	56,420	6.2	220.657	5.6	247.144	6.40
Anhui	28,680	8.7	131.842	20.7	95.231	10.88
Fujian	30,040	14.4	107.992	10.7	113.492	5.72
Jiangxi	15,450	18.1	48.620	7.2	60.922	11.42
Shandong	60,000	4.6	283.386	5.3	294.107	7.85
Henan	46,950	2.7	206.131	4.9	208.138	5.61
Hubei	46,210	6.8	177.247	2.7	113.513	7.24
Hunan	27,170	8.3	89.073	12.9	101.009	10.18
Guangdong	65,080	8.0	253.386	0.6	360.940	2.93
Shanxi	25,300	4.4	85.292	4.4	83.637	9.93
Hainan	3,890	39.4	12.847	9.0	13.377	8.78
Chongqin	11,320	5.5	41.534	8.6	53.234	9.55
Sichuan	39,690	13.4	137.255	25.0	132.461	9.46
Guizhou	30,190	13.3	129.789	13.9	76.379	12.46
Yunnan	31,950	23.6	94.169	22.9	89.010	7.31
Tibet	540	—	—	—	1.770	11.53
Shanxi	21,810	10.9	83.081	6.9	74.011	4.53
Gansu	17,620	17.3	70.325	1.9	70.551	4.09
Qinghai	10,680	35.0	37.178	15.4	33.724	7.67
Ningxia	9,810	20.4	47.206	2.0	46.296	5.31
Xinjiang	13,090	20.2	54.544	13.6	54.500	13.69

Attachment 2 Coal consumption in electricity generation at different province (prefecture/ region) in year 2006 and 2007

Province/ prefecture/region	**Coal consumption (g/kWh/year)**		**Change from 2006 to 2007 (g/kWh)**
	2007	**2006**	
National average	356	367	-11
Beijing	319	333	-14
Tianjin	339	342	-3
Hebei	363	370	-7
Shanxi	365	371	-6
Inner Mongolia	361	369	-8
Liaoning	358	371	-13
Jilin	371	382	-11
Heilongjiang	382	393	-11
Shanghai	329	338	-9
Jiangsu	338	354	-16
Zhejiang	335	349	-14
Anhui	348	357	-8
Fujian	332	352	-20
Jiangxi	362	380	-18
Shandong	370	379	-9
Henan	361	377	-16
Hubei	344	363	-19
Hunan	369	375	-6
Guangdong	343	352	-9
Guangxi	363	374	-11
Hainan	326	324	2
Chongqing	372	403	-31
Sichuan	406	426	-20
Guizhou	354	368	-14
Yunnan	363	373	-10
Tibet	—	—	—
Shanxi	360	368	-8
Gansu	349	361	-12
Qinghai	386	418	-32
Ningxia	357	365	-8
Xinjiang	453	469	-16

Attachment 3 Electricity consumption ratio at the power plants in different provinces (prefecture/ region) in 2006 and 2007

Province/ prefecture/ region	Electricity consumption at the power plants (%)						Change from 2006 to 2007 (%)
	2007			2006			
	average	hydro	thermal	average	hydro	thermal	
National average	5.83	0.42	6.62	5.93	0.43	6.77	-0.10
Beijing	7.40	1.39	7.51	7.51	1.52	7.58	-0.11
Tianjin	6.64	—	6.53	6.86	—	6.86	-0.22
Hebei	6.66	1.96	6.67	6.63	1.88	6.66	0.03
Shanxi	7.88	0.45	7.99	7.45	0.34	7.56	0.43
Inner Mongolia	7.67	0.39	7.77	7.58	0.38	7.67	0.09
Liaoning	6.83	1.87	7.00	6.62	2.11	6.78	0.21
Jilin	6.89	0.85	7.68	6.78	0.91	7.54	0.11
Heilongjiang	7.55	1.48	7.67	7.85	1.14	8.00	-0.30
Shanghai	4.80	—	4.72	5.06	—	4.98	-0.26
Jiangsu	5.61	1.44	5.55	5.69	1.42	5.72	-0.08
Zhejiang	5.66	0.59	5.83	5.62	0.49	5.83	0.04
Anhui	5.85	0.66	5.92	6.05	0.26	6.12	-0.20
Fujian	4.36	0.15	5.59	4.51	0.13	6.43	-0.15
Jiangxi	7.14	1.07	7.72	6.17	0.92	6.91	0.97
Shandong	7.22	—	7.23	7.12	—	7.13	0.10
Henan	7.22	0.54	7.55	7.06	0.29	7.41	0.16
Hubei	2.50	0.13	6.29	2.75	0.13	6.43	-0.25
Hunan	5.12	0.50	7.18	4.95	0.55	6.98	0.17
Guangdong	5.48	0.55	6.01	5.27	0.48	5.86	0.21
Shanxi	3.95	0.40	7.42	4.45	0.45	7.97	-0.50
Hainan	7.94	0.60	8.47	7.56	0.67	8.29	0.38
Chongqing	7.79	0.73	9.20	8.45	0.66	9.65	-0.66
Sichuan	3.78	0.46	8.68	4.51	0.59	9.14	-0.73
Guizhou	5.74	0.32	6.62	5.36	0.29	6.55	0.37
Yunnan	4.30	0.37	7.23	4.12	0.30	6.76	0.18
Tibet	—	—	—	—	—	—	—
Shanxi	6.27	0.41	6.77	6.97	0.80	7.30	-0.70
Gansu	4.27	0.68	5.89	4.29	0.66	6.01	-0.02
Qinghai	2.90	0.79	7.19	2.57	0.78	7.49	0.33
Ningxia	—	—	—	—	—	—	—
Xinjiang	8.02	1.20	9.20	—	—	—	—

Attachment 4 Transmission loss of different province (prefecture/ region) in 2006 and 2007

Province/ prefecture/ region	Transmission loss (%)		Change from 2006 to 2007 (%)
	2007	2006	
National average	6.97	7.04	-0.07
Beijing	6.99	7.17	-0.18
Tianjin	6.13	6.29	-0.16
Hebei	5.41	5.50	-0.09
Shanxi	7.18	7.13	0.05
Inner Mongolia	4.76	4.66	0.10
Liaoning	6.49	6.58	-0.09
Jilin	7.52	7.63	-0.11
Heilongjiang	7.93	7.61	0.32
Shanghai	6.09	6.15	-0.06
Jiangsu	8.36	8.60	-0.24
Zhejiang	6.09	6.27	-0.18
Anhui	5.93	6.01	-0.08
Fujian	4.69	4.75	-0.06
Jiangxi	6.13	6.17	-0.04
Shandong	6.03	6.28	-0.25
Henan	5.59	5.77	-0.18
Hubei	7.05	7.37	-0.32
Hunan	9.71	9.62	0.09
Guangdong	7.26	7.25	0.01
Shanxi	6.44	7.33	-0.89
Hainan	8.65	9.18	-0.53
Chongqing	8.13	8.33	-0.20
Sichuan	10.37	9.34	1.03
Guizhou	4.83	4.77	0.06
Yunnan	7.46	7.95	-0.49
Tibet	13.36	10.24	3.12
Shanxi	6.04	6.05	-0.01
Gansu	6.13	6.20	-0.07
Qinghai	4.15	4.83	-0.68
Ningxia	5.67	5.74	-0.07
Xinjiang	8.83	9.13	-0.30

Attachment 5 Breakdown of national SO_2 emission reduction target during eleventh five-year period (2006-2010)

Province/ prefecture/ region	Emission in 2006 (10,000 tonnes)	2010 (10,000 tonnes)		Emission reduction target from 2010 to 2005 (%)
		Target	Of which, electric power industry	
Beijing	19.1	15.2	5.0	-20.4
Tianjin	26.5	24.0	13.1	-9.4
Hebei	149.6	127.1	48.1	-15.0
Shanxi	151.6	130.4	59.3	-14.0
Inner mongolia	145.6	140.0	68.7	-3.8
Liaoning	119.7	105.3	37.2	-12.0
Of which, Dalian	11.89	10.11	3.54	-15.0
Jilin	38.2	36.4	18.2	-4.7
Heilongjiang	50.8	49.8	33.3	-2.0
Shanghai	51.3	38.0	13.4	-25.9
Jiangsu	137.3	112.6	55.0	-18.0
Zhejiang	86.0	73.1	41.9	-15.0
Of which, Ningbo	21.33	11.12	7.78	-47.9
Anhui	57.1	54.8	35.7	-4.0
Fujian	46.1	42.4	17.3	-8.0
Of which, Xiamen	6.77	4.93	2.17	-27.2
Jiangxi	61.3	57.0	19.9	-7.0
Shandong	200.3	160.2	75.7	-20.0
Of which, Qingdao	15.54	11.45	4.86	-26.3
Henan	162.5	139.7	73.8	-14.0
Hubei	71.7	66.1	31.0	-7.8
Hunan	91.9	83.6	19.6	-9.0
Gongdong	129.4	110.0	55.4	-15.0
Of which,Shenzhen	4.35	3.48	2.78	-20.0
Guangxi	102.3	92.2	21.0	-9.9
Hainan	2.2	2.2	1.6	0
Chongqin	83.7	73.7	17.6	-11.9
Sichuan	129.9	114.4	39.5	-11.9
Guizhou	135.8	115.4	35.8	-15.0
Yunnan	52.2	50.1	25.3	-4.0
Tibet	0.2	0.2	0.1	0
Shanxi	92.2	81.1	31.2	-12.0
Gansu	56.3	56.3	19.0	0

Province/ prefecture/ region	Emission in 2006 (10,000 tonnes)	2010 (10,000 tonnes)		Emission reduction target from 2010 to 2005 (%)
		Target	Of which, electric power industry	
Qinghai	12.4	12.4	6.2	0
Ningxia	34.3	31.1	16.2	-9.3
Xinjiang	51.9	51.9	16.6	0
Of which, Xinjiang Production and construction corps	1.66	1.66	0.66	0
Total	2,549.4	2,246.7	951.7	-11.9

Note: 1. The national target of SO_2 emission reduction during eleventh five-year period is to reduce 22,944,000 tonnes, which is equal to a 10% decrease until 2010 compared with the level of 2005. 22,467,000 tonnes were assigned to different administrative hierarchy. 477,000 tonnes were set aside, for the sake of SO_2 emission permits trading trial.
2. SO_2 emission from Xinjiang Production and Construction does not include the residential consumption and Shihezi city.

Source: *National target of waste control during eleventh five-year plan period*, i.e., SC No.70 [2006], issued by State Council.

Attachment 6 Centralisation of regulatory institutions

Name of agency	**Centralised management**	**Form of integration and function**	**Since**
State administration for industry and commerce	Yes	Sub-provincial units by province	1999
Financial services and products (insurance, banking, stock market)	Yes	All with regional branch offices	1998
Qulaity and product safety(AQSIQ)	Yes	Sub-provincial units by province	2000
Environmental protection(SEPA/ MEP)	No	Regional offices	2006
State land	Yes	Sub-provincial units by province	2004
Statistics	Yes	All survey teams, stats collection and report	2004
Food and drug(SFDA)	Yes	Sub-provincial units by province	2000
Occupation safety(SAOS)	Partial	Coal mining safety regulation	2005
Public health(MOH)	No		
State Audit	No		

Source: Lu, 2009

Attachment 7 Mitigation of GHG Emissions in China: Selected Measures and Mitigation Targets, Expected GHG Reductions, and Reported Progress

Mitigation Measure	Mitigation Target	Expected GHG Reductions	Reported Progress
Adopt National Building Codes for Residential and Commercial Buildings	Between 2006-2010, new buildings are subject to the design standard of 50% energy conservation, and major cities (e.g., Beijing and Tianjin) are subject to a 65% energy-saving standard.	Not available	National building codes have been passed; implementation is underway in 6 cities.
Establish Energy Efficiency Appliance Standards	Reduce residential electricity use by 10% by 2010.	In 2010, 33.5 billion kilowatt-hours and GHG emissions are expected to be reduced by 11.3 Mt of CO_2, as a result of standards and labels for refrigerators, air conditioners, clothes washers, and color televisions.	Largely on track. China has mandatory minimum efficiency standards for most residential and commercial appliances, lighting, and heating/cooling equipment. New standards are under development for other appliances.
Fuel Economy Standards for Vehicles	By 2008, average Chinese passenger vehicles are required to meet 36 mpg requirement. In process of setting fuel economy standards for trucks and agricultural vehicles.	Passenger, truck, and agricultural vehicle policies combined should reduce 488 Mt of CO_2 by 2030.	Phase 1 standards have increased overall passenger vehicle efficiency by about 9%, from 26 mpg in 2002 to 28.4 mpg in 2006. Standards are about 40% more stringent than those of the United States. Taxes have been increased on large vehicles and reduced on small ones.
Promote Nuclear Power	Operating power capacity to hit 40 GW by 2020 from 8.6 GW in 2008.	50 Mt CO_2 reduction by 2010	Appears to be on track.
Improve Power Sector Efficiency	Close 50 GW of small, inefficient and dated power plant capacity by 2010 and develop 600 MW or above supercritical (SC) or ultra-supercritical (USC). 70-80%of new installations will be SC/USC units Improve coal to electricity efficiency from 366 to 345 Gt coal equivalent per kWh from 2006 to 2020.	110 Mt CO_2 reduction by 2010	In 2007, China reportedly shut 553 small coal-fired power plants, accounting for 14.4 GW of capacity. This exceeded the official target of shutting down 10 GW of capacity. In 2008, 13.0 GW of small units are to be closed. Challenges remain, however, given shortages of electricity in China through mid-2008. By end-2007, 74% of ordered thermal capacity is SC or USC.

Mitigation Measure	Mitigation Target	Expected GHG Reductions	Reported Progress
Develop Coalbed Methane Industry	China targets 10 billion cubic meters of gas production by 2010, and 40 BCM by 2020. The 11th Five-Year Plan (2006-2010) also calls for the construction of 10 CBM pipelines.	200 Mt CO_2 eq. reduction by 2010	In 2005 and 2006, China drilled as many CBM wells as it did from 1990 to 2004, according to Sun Maoyuan, head of China United Coalbed Methane Company. Suntil, China produced only 200 million cubic meters of CBM in 2006. In June 2008, China started construction on the first of 10 CBM pipeline projects.
Top 1,000 Enterprise Efficiency Program	Cut energy use of the 1,000 most energy-intensive enterprises.	Cut consumption of 100 million tonnes of SCE and 61 million tonnes of CO_2 emissions annually by 2010.	Many staff of the top 1000 enterprises have taken training in energy savings, and firms have had energy saving audits performed. A preliminary survey reports that the enterprises saved 20 million tonnes of coal equivalent in 2006, indicating that the program is on or ahead of target to meet its goals.
Adopt National Building Codes for Residential and Commercial Buildings	Between 2006-2010, new buildings are subject to the design standard of 50% energy conservation, and major cities (e.g., Beijing and Tianjin) are subject to a 65% energy-saving standard.	Not available.	National building codes have been passed; implementation is underway in 6 cities.
Establish Energy Efficiency Appliance Standards	Reduce residential electricity use by 10% by 2010.	In 2010, 33.5 billion kilowatt-hours and GHG emissions are expected to be reduced by 11.3 Mt of CO2, as a result of standards and labels for refrigerators, air conditioners, clothes washers, and color televisions.	Largely on track. China has mandatory minimum efficiency standards for most residential and commercial appliances, lighting, and heating/cooling equipment. New standards are under development for other appliances.

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Closing Inefficient Industrial Facilities	Decommission inefficient cement and steel factories with production capacity of 250 million tonnes and 55 million tonnes, respectively, by 2010.	Reduce coal consumption by 60-90 Mt per year by 2010.	China claims to have closed cement plants with 87 million tonnes of production capacity and steel with 37 million tonnes of capacity, but the time period for these closures is unclear.