Climate Change Mitigation in Beijing, China

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1. Introduction

China has become one of the largest greenhouse gas (GHG) producers in the world,[1] and successfully constraining GHG requires effective climate change mitigation actions in urban areas, where energy consumption and anthropogenic GHG emissions are highly concentrated. Studying climate change actions at the city level also provides a valuable window for understanding a country's capacity to address climate change. However, to date most studies on climate change actions in urban areas have focused on cities in Western countries (e.g., Bestill and Bulkeley, 2007), with few detailed studies of this issue in China. This case study addresses this gap in the existing literature by studying climate change mitigation responses in Beijing.

Beijing is one of the 20 largest cities in the world and one of the world's most heavily polluted cities (Hao and Wang 2005; UNEP, 2007). Beijing made great efforts to achieve a "Green Olympics", for example, by raising auto emission standards earlier than the rest of the country and investing in a fleet of alternative fuel buses and taxis. Given these efforts, and Beijing's status as a political and economic centre, Beijing is an exceptional case that to some extent defines what is possible for other cities in China. It also serves as an interesting comparison city for the case studies of other global cities such as London, Los Angeles, and Mexico City. The dynamic economic and political context of economic transition in China may also influence climate change mitigation measures.

The case study of Beijing is based on analysis of semi-structured interviews conducted in Beijing during two field trips in 2008 and data collected from secondary sources.[2] It examines and identifies the drivers and constraints behind the strategies and actions being undertaken, and proposes policy implications for promoting more climate actions at the city level. The section below provides background information on the context of China's climate change policy at the national and local levels and Beijing economic and environmental profile. Section 3 outlines the climate policy and governance and initiatives taken in Beijing in response to climate challenges. Section 4 analyzes four key drivers and constraints behind the actions. Section 5 provides a short conclusion and policy implications for promoting climate change efforts in Chinese cities.

2. Background

2.1 China climate change policy at the national and local levels

China is emerging as an increasing contributor to global warming. China's GHG emissions have been caused not only by an enormous population and extraordinary economic growth, but also by China's heavy reliance on coal and low energy efficiency. Chinese emissions are still very low on a per capita basis compared to OECD countries, but total emissions have increased rapidly (Leggett et al, 2008). There is huge potential for emissions to continue to increase at a rapid rate along with China's continued economic development unless China adopts strategies to reduce GHG emissions.

1. Some believe that China has already the No. 1 GHG producer in the world since 2006 (MNP, 2007).
2. The interviews in this paper were conducted by Jimin Zhao and Ke Bi, 2008, Beijing.

China ratified the Kyoto Protocol in 2002 as a non-Annex I country and so like other developing countries is not subject to specific reduction targets. China has opposed any binding commitment to total emission control for developing countries, citing China's low per capita emissions, lack of historical responsibility for carbon emissions, and lack of technological and financial resources required to reduce emissions (e.g., Bjørkum, 2005; Heggelund, 2007). China has insisted that it should take responsibility for carbon mitigation but it cannot take responsibility beyond its capabilities, re-emphasizing that efforts to address climate change should be done in a manner that enhances sustainable development and sustained economic growth of developing countries (Xie, 2009). Despite the frequent meetings between the US and China on climate change under the Obama administration, there is still a long way to go to reach a common agreement on climate change, which creates a huge challenge to the United Nations climate change negotiations in Copenhagen in 2009. Energy or emission intensity targets based on the ratio of the amount of energy or greenhouse gas emissions per unit of economic output are more likely to be accepted by China.

China's rejection of binding emission targets for developing countries does not mean that China is unwilling to change its behaviour in response to the impacts of climate change. China is de facto enacting a number of measures that will slow the growth of GHG emissions. A set of policies and laws were enacted to restructure China's energy sector, improve energy efficiency, and explore alternative energy sources, which have the additional benefit of reducing GHGs. China released the National Climate Change Programme on 4 June 2007, which is the first plan on climate change drawn up by a developing country. The program sets ambitious measurable targets to address climate change: reduce energy intensity in terms of energy consumption per unit of GDP by 20 per cent from 2005 to 2010, achieve a 10 per cent renewable energy share of primary energy supply by 2010 and 15 percent by 2020, and realize a forest coverage rate of 20 per cent by 2010 (NDRC, 2007).

China succeeded in lowering its energy consumption per unit of GDP by 1.79 per cent, 4.04 per cent, and 4.59 per cent, respectively, in 2006, 2007, and 2008, which strongly suggests China will meet the above-mentioned 20 per cent energy intensity reduction target by 2010 as required by China's National Climate Change Programme. Most carbon reduction in China has been achieved within the overall context of a national sustainable development strategy and energy policy**.** Another way in which China has reduced GHG emissions, albeit much smaller in scale, is through clean development mechanism (CDM) projects. China now is by far the largest source of CDM credits, accounting for 73 percent of global CDM credits in 2005 and over 40 percent of all CDM credits ever traded through 2007.[3] If China meets its energy intensity reduction target by 2010, it could eliminate as much as 1.4 billion tons of CO_2 (NDRC, 2007). China could end up by 2010 with "*by far the most aggressive global warming pollution reduction policy of any country in the world*."[4]

China's climate change governance system is a traditional centralized top-down climate governance system, with the nation-state still the key actor in implementing most climate policy and activities. In 2007, China set up a top-down centralized climate change governance system to organize climate change regime negotiations and domestic activities to reduce CO_2 emissions. The National Leading Group on Climate Change, led by Premier Wen Jiabao, is the highest level decision-making agency for climate change policy. The National Climate Change Coordination Committee, composed of representatives from 17 national agencies, is a coordination body for implementing climate policy.

3. For CDM projects in China, see http://cdm.ccchina.gov.cn.
4. Douglas Ogden, Director of the China Sustainable Energy Program at the Energy Foundation.

Local governments often act as "implementers" of national climate and climate-related policies even though there are signs that local governments, including provincial and city governments, are starting to initiate local policies and strategies for climate actions. In order to improve local implementation and accountability to meet the 20 per cent energy intensity reduction target by 2010, the national government allocated targets among provinces and industrial sectors based on their economic and technological capabilities. Provinces distributed targets to city governments and major industrial companies. Energy efficiency improvement now is one of the criteria used to evaluate the job performance of local officials. Some international organizations and foreign governments are assisting China's provincial and city governments and businesses in moving to a low-carbon economy. For example, UNDP, the Government of Norway, and the European Union supported the National Development and Reform Commission (NDRC) to develop a demonstration project to assist 14 provinces to set up provincial programmes for climate change mitigation and adaptation since June 2008.[5] WWF China is implementing a five-year Low Carbon City Initiative (LCCI) in China, aiming to explore low carbon development models in different cities.

This centralized top-down governance system is very consistent with China's long history of central planning and vertically hierarchical governance. The centralized governance system has its advantages such as high efficiency and clearly defined and distinct political and administrative responsibilities. However the top-down approach also has disadvantages. A centralized top-down governance and policy approach may discourage the development of innovative policies at local levels and cannot gain the experimental benefits of local expertise and experience in enforcing programs and policies or in testing new policies.

2.2. Beijing's socio-economic and environmental profile

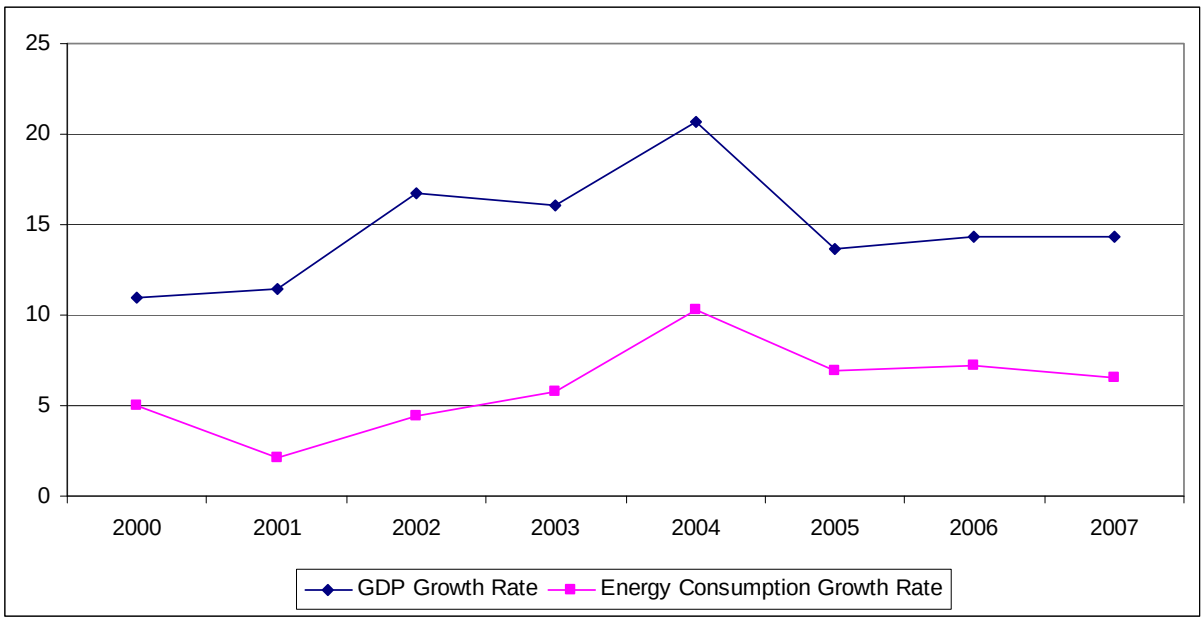
As China's capital city, Beijing is the cultural, economic, educational and political centre. In 2007, Beijing's population exceeded 16.3 million, and it is estimated that by 2020 the population will reach 21 million (BMSB, 2008). Beijing is amongst the most developed cities in China with a very fast economic growth rate (see Figure 1). Economic output doubled between 2001 and 2007, with annual growth averaging 12.4 per cent. Beijing's GDP reached 900 billion RMB (118.5 billion US dollars) and per capita disposable income grew by 10 percent from 2006 to 2007, reaching $3,030. The largest share of the economy, 71.4 per cent of total GDP, comes from the tertiary sector, which includes restaurants, tourism, real estate, information technology, and finance and insurance. The secondary and the primary sectors account for 27.8 per cent and 1.3 per cent, respectively (BMSB, 2007). Beijing's real estate and automobile sectors have continued to boom in recent years. In 2005, a total of 28 million square metres of housing real estate were sold at a total value of 176 billion RMB (22 billion US dollars). The vehicle population of Beijing has been growing rapidly and reached 3.3 million in 2008. The share of privately owned vehicles in the total vehicle population increased from 48 per cent in 2001 to 80 per cent in 2008.[6]

Beijing is a high energy consumption city, ranking second behind only Shanghai among China's cities. In 2006, Beijing's energy consumption reached 59 million tons of coal equivalent (tce), or 3.6 tce of consumption per capita, more than double the national average. However, such high energy consumption is primarily supplied by other regions in China, due to Beijing's very limited local energy resources. About 90 per cent of its energy is transported

5. This project is contributed by US$ 2 million from the Norway government, US$ 400,000 from UNDP China, and US$2 million from the European Union.

6. Beijing 2008 Traffic Working Conference, 13 January, 2008, Beijing.

Figure 1. Beijing GDP and energy consumption annual growth rate



Source: BMSB, 2006, 2007, 2008.

from other provinces, with about 60 per cent of electricity from the North China electric grid, 95 per cent of coal from Shanxi, Mongolia, and Hebei provinces, and oil and natural gas from Shanxi and other areas (Zhu, 2004; ITSD, 2006). Locally, Beijing only supplies a limited amount of coal and even more limited hydropower.

Five industrial sectors, including iron and steel, electricity generation, construction materials, petrochemicals, and chemicals, accounted for 38.5 per cent of the city's total energy consumption in 2005 (BMSB, 2006). The city's energy infrastructure is dominated by coal-fired power plants, which emit large quantities of sulphur dioxide, particulate matter, and CO_2. Industries account for half of the total energy consumption in Beijing. The GHG emissions from Beijing's energy consumption witnessed 25 per cent growth from 2000 to 2005, and coal-originated GHG accounted for half of total emissions (Zou and Pang, 2008). Beijing is among the cities in China with the highest CO_2 emissions per capita, 1.92 metric tons in 2005, behind only Shanghai.

3. Climate Change Mitigation Responses in Beijing

3.1 Climate governance and policy

Directly working with NDRC, the Beijing Municipal Development and Reform Commission (BMDRC) is the key city government agency in charge of climate change-related policies and actions, including energy intensity reduction activities. The BMDRC is also the main municipal government agency in charge of energy policy and energy development planning. Other city government agencies involved in the climate change decision making process include the Beijing Municipal Environmental Protection Bureau, the Beijing Municipal Construction Committee, and the Beijing Municipal Science and Technology Commission. The Beijing Energy Saving and Environmental Protection Centre is an agency established in 1982 by the Chinese government, French government, and UNDP to assist the Beijing

municipal government in energy policy, energy planning, and energy saving education and services. In order to support and monitor energy intensity reduction actions to meet the 2010 energy intensity targets, two agencies were established with the support of the Beijing Municipal government. The Beijing Council for Promoting Environmental Protection and Energy Saving was established in 2007 to help high energy intensity industries such as cement, electricity, and construction materials by providing training, assessing energy saving technology, and supporting the transfer of advanced technology. The Beijing Energy Saving Monitoring Team is in charge of the enforcement of laws, regulations, and rules regarding energy conservation and the monitoring of energy conservation by major energy-consuming actors.

Thus far there is no policy or target established by Beijing solely targeted at addressing climate change. Rather, in line with China's National Climate Change Programme and national energy policy, most policies and measures focus on energy efficiency improvement, renewable energy promotion, promoting a recycling economy, and sustainable development. At the city level, the Beijing Municipal Government is primarily the "implementer" of national policy. With the support of Beijing's municipal government, the Beijing Academy of Environmental Sciences and Tsinghua University started to draft Beijing's climate change programme and policy in 2008 in response to the National Climate Change Programme.[7] Table 1 demonstrates this relationship between national and city levels by listing some policies and regulations that have the co-benefit of carbon reduction.

Table 1. Policies and measures that promote greenhouse gas reduction: relationship between national and local levels of governance

National level		City level	
Issuing Time	**National Policy, Regulation, or Plan**	**Issuing Time**	**Beijing Municipal Policy and Regulations**
2007	China National Climate Change Programme.	Drafting	Beijing Climate Change Programme.
1 January 2003	Clean Production Promotion Law.	2003	Provision of Beijing Municipality Guidelines on Implementation of Trial Methods on Clean Production Audit .
2005	National Energy Development and Energy Saving for the 11th Five-Year Plan. Energy intensity target: 20 per cent reduction in energy intensity by 2010 compared to the 2005 level.	2005	Beijing Programme for Energy Development and Energy Saving for the 11th Five-Year Plan. Beijing Energy Intensity Investigation Method. Beijing Implementation Opinions on Strengthening Energy Statistics and Monitoring. Beijing Municipal Energy Intensity Reduction Plan for the 11th Five-Year Plan (20 per cent reduction target for Beijing).

7. Author's interview in Beijing, August 2008.

National level		City level	
Issuing Time	**National Policy, Regulation, or Plan**	**Issuing Time**	**Beijing Municipal Policy and Regulations**
2008	Energy Conservation Law.	2008	Provision of Beijing Municipality Methods of Reinforcing Energy Conservation. Provision of Beijing Municipality Methods of Energy Saving Supervision. Beijing Programme of Buildings Energy Saving During the 11th Five Year Plan. Beijing Energy Saving Standards for Public Building.
1 January 2009	Recycling Economy Law.	2006	Beijing Programme of Recycling Economy Development for the 11th Five-Year Plan. Speeding Recycling Economy and Establishing Energy Saving Act (2006-2008).

3.2 GHG mitigation initiatives

The Beijing Municipal Government has conducted many initiatives to increase energy efficiency, change energy structure, promote renewable energy, and advance education and awareness of energy conservation and environmental protection. The primary objective of these initiatives is to improve air quality and reduce the energy shortage problem in Beijing. However, the measures have also produced GHG reduction co-benefits and promoted lower-carbon economic development in Beijing.

3.2.1. Increasing energy efficiency

Increasing energy efficiency is a major approach of the Beijing municipal government to deal with energy shortage and local environmental pollution. It also is the most effective approach by far to reduce GHG emissions in Beijing. This work occurs primarily in the building, industrial, and transport sectors. Government offices took the lead in energy conservation: in 2005, 54 governmental departments reduced their consumption by a total of 11 per cent through energy-saving behaviour and building renovation (UNEP, 2007). In 2006, ten city government departments were selected for energy saving and technical renovation pilot projects. Beijing plans to complete its energy efficiency innovations for government buildings by 2010. Beijing adopted implementation measures to enforce the standards for new buildings to be 65 per cent more efficient as required by the national regulations. New techniques and products have been adopted in new buildings to reduce energy consumption for heating and cooling, such as heat preservation/insulation techniques for outer walls and new types of energy saving windows and doors. Some large public buildings also have increased their commitment to energy conservation, renovating air conditioners, elevators, power supply systems, and other equipment.

The "Green Lighting Programme" has been implemented since 2004 to promote a more efficient, energy-saving lighting system for the entire city (BMG, 2006). One of the programmes replaces normal lights with energy efficient lights in 2,046 primary and middle schools in 18 counties and districts, and was completed successfully in November 2006. It

replaced 1,508,889 lights (lamps), which saved 14.40 MW of electricity valued at 8.21 million RMB (1.05 million US dollars), and reduced CO_2 emissions by 14,535 metric tons. More importantly, the project increased student awareness and knowledge of energy saving. In 2008, this project was extended to install energy efficient lighting in 1, 263 bathrooms inside the 2nd Ring Road, 70 subway stations, 114 km of subway tunnels, and in government buildings, hotels, commercial buildings, and hospital buildings. The Beijing Development and Reform Commission estimates that 39 MW of electricity can be saved each year through the installation of energy-efficient lights.

Industrial energy conservation is an important sector for increasing energy efficiency and carbon reduction. Beijing has conducted a series of activities, including closing small but high energy consumption enterprises, restricting the new development of high energy consumption enterprises and products, promoting the phase-out of outdated equipment and upgrading technology, and strengthening the monitoring of heavy energy intensity sectors such as petrochemicals, construction materials, and electricity (ITSD, 2006). The municipal government worked directly with the 10 largest enterprises to develop annual plans for energy saving and conducts energy consumption audits for 50 major enterprises in Beijing. Between 2001 and 2006, total energy consumption by Beijing industries was reduced by 20.7 million tce, which reduced the total reduction of CO_2 emissions by 53.9 million tons (Wu and Zhang, 2008). In addition to working with the city government, enterprises also turn to CDM financing to increase energy efficiency. For example, the proposed Beijing Taiyanggong Combined Cycle Gas Turbine (CCGT) Trigeneration Project will install and operate a 780 MW grid connected to a natural gas-fired combined cycle power plant in a district of Beijing, and will provide local employment for about 200 workers. It will generate annual average reductions of 1.5 million tons of CO_2 equivalent (CO_2eq) over a seven-year period.[8]

Another area of energy saving is urban transportation, through stricter vehicle fuel efficiency standards, promotion of clean vehicle technologies, and improved urban transportation infrastructure. To improve air quality and reduce traffic for the 2008 Olympic Games, the Beijing municipal government invested heavily in three rapid bus transit lines and eight new subway/train lines. The number of person-trips using public transport increased by 420 million person-trips from 2001 to 2006 (which excludes increase associated with population growth). The daily capacity of the city's subway increased to 2.66 million people in 2008 and public ground transport capacity rose to 19.5 million people per day during the Olympic period in August 2008 (Greenpeace, 2008). This shift reduced CO_2 emissions by an estimated 13.44 million tons (Wu and Zhang, 2008). About 500 advanced alternative fuel vehicles, including hybrid, hydrogen, and battery vehicles, were used for the Beijing Olympic Games and Paralympics (Greenpeace, 2008). Beijing also promoted small and energy efficient vehicles by lowering national consumption tax rates for such vehicles. Under the new consumption tax, buyers of low or zero-emission vehicles are granted low consumption taxes while those who purchase bigger cars pay higher taxes.[9]

8. Beijing Taiyanggong CCGT Trigeneration Project, CDM-PDD, version 3, available at http://cdm.unfccc.int/UserManagement/FileStorage/DAZBWGLI80970CW0GHMUCAFN3C1ONN.

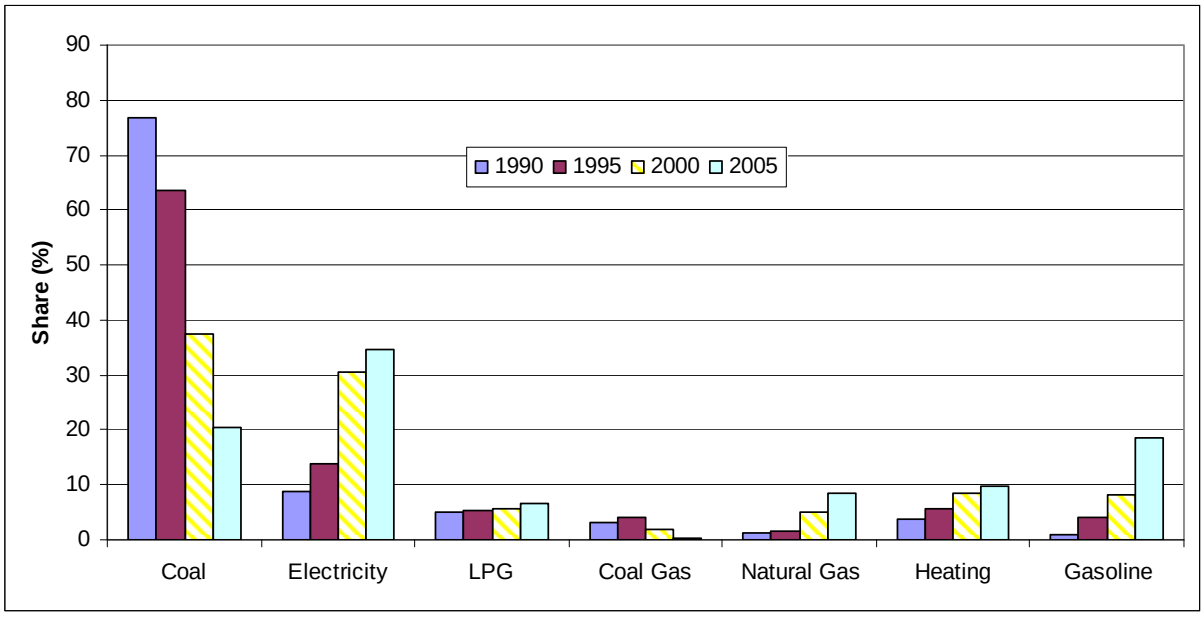
9. China's Ministry of Finance and Sate Administration of Taxation issued a notice to adjust vehicle consumption tax from September 1st, 2008. The rate for passenger cars with engine displacement from 3.0-litre up to 4.0-litre (including 4.0-litre) is raised from 15 percent to 25 percent, and rate for engine displacement over 4.0-litre is doubled from 20 percent to 40 percent. However, the tax rate for displacement below 1.0-litre (including 1.0- litre) is reduced from 3 percent to 1 percent. For more information, see http://en.ce.cn/Insight/200809/18/t20080918_16844123.shtml.

3.2.2. Energy shift to natural gas and renewable energy

Beijing is attempting to diversify its energy system by reducing coal use and switching to cleaner energy technologies such as natural gas, geothermal energy, district heating networks, wind energy, and other forms of renewable energy (UNEP, 2007). Even though coal remains the major energy source, the share of coal in total energy consumption has been decreasing as a result of national and local polices on industrial restructuring. Coal accounted for 43 per cent of total energy consumption in 2005, falling from 68 per cent in 2000, reaching a level much lower than the 70 per cent coal share for China as whole (BMSB, 2006).

Since Beijing began importing natural gas from Shanxi, Gansu and Ningxia Provinces in 1997, natural gas consumption in Beijing has increased by 300–450 million m^3 annually. By April 2008, the daily supply capacity of natural gas reached 47 million m^3 and the number of households benefiting from the service reached 3.42 million.[10] It has been estimated that natural gas consumption in Beijing reached about 5 billion m^3 in 2008.[11] China's 11th Five-Year Plan on energy development states that the country aims to increase the share of natural gas in the primary energy mix from 2 per cent to 5.3 per cent by 2010 and up to 10 per cent by 2020 (Jiang et al, 2008). Beijing's ratio of natural gas consumption to total energy consumption increased from 0.5 per cent in 1997 to 7 per cent in 2007 and is expected to reach 12 per cent by 2020 (UNEP, 2007).[12] According to 2006 data, end-use of natural gas is dominated by central heating for residential and commercial buildings (50 per cent) and residential use for cooking (22 per cent) (UNEP, 2007). The remaining natural gas was used in electricity generation (8.0 per cent), industry (4.5 per cent), and other commercial uses (UNEP, 2007; Jiang et al, 2008). Figure 2 illustrates the remarkable change in residential energy consumption pattern in Beijing.

Figure 2. Residential energy consumption structure, Beijing



Source: BMSB, 2006, 2007.

10. Beij ing Daily, 2008.
11. People's Daily Online, 2008.
12. Beij ing Daily, 2008.

Starting in 1998, the Beijing Environmental Protection Bureau (EPB) launched a ten-year project to control coal-fired equipment to reduce air pollution in Beijing.[13] The Beijing EPB took measures to close small-scale coal-fired boilers or convert such boilers to use cleaner energy, such as natural gas (the majority), liquefied petroleum gas (LPG), solar, or geothermal.[14] Small-scale boilers are primarily used to provide heating for residential and public buildings. By the end of 2007, a total of 16,300 small-scaled coal-fuelled boilers operating in Beijing had been converted to cleaner energy or were closed. As for large-scale coal-fired boilers that provide heating for central heating systems and industrial use, it is not possible to convert these boilers in the short-term future due to the limited availability of natural gas and other renewable energy and the cost of conversion. The EPB adopted a different strategy, focusing on three measures to reduce pollution: adopting high-efficiency dust removal technologies; controlling dust in coal storage facilities; and adopting end-of-pipe desulphurization systems (UNEP, 2007). In addition, the Beijing EPB launched a project to electrify coal-fired small stoves operated by restaurants, commercial activities, small businesses and households for heating or cooking. From 2003 to 2006, the 'Coal to Electricity' demonstration project involved 11,421 families and 288 million RMB (US $38 million) in investment. An additional 10,000 families were converted by the end of 2007. In addition to reducing SO_2 and CO by 55 per cent and 36 per cent, respectively, between 1998 and 2006, Beijing reduced coal consumption by 6 million tons annually through these measures, which was equivalent to more than 10 million tons of CO_2 reduction.[15]

Renewable energy accounts for a very low percentage of Beijing's energy use. It accounted for only 1 per cent of total energy consumption in 2005, much lower than the national average level of 8 per cent. Geothermal and solar energy are the primary renewable energy sources. To improve air quality and achieve its energy saving goals, the Beijing Municipal Government has accelerated the development of clean energy sources, such as geothermal resources. In addition to the 118 plants already in operation by end of 1998, 174 new geothermal wells were constructed between 1999 and 2006, through investments worth 35.4 million RMB (4.52 million US dollars). Of the 174 new wells, 141 provide heating to the city. Beijing now consumes about 8.8 million m^3 of geothermal water each year, which saved 326,000 tce of energy and reduced CO_2 emissions by 850,000 tons during the period 2001-2006 (Wu and Zhang, 2008; Greenpeace, 2008). By 2010, Beijing plans to focus on wind power and biomass generation, increasing their energy share to 4 per cent, which is still much lower than the national target of 10 per cent.

The Guanting Wind Farm, located on the southern bank of the Guanting Reservoir, is Beijing's first wind power generation station with 33 wind turbines capable of generating 49.5 MW of electricity per year (Greenpeace, 2008). It was completed in January 2008 as a CDM project. The Guanting Wind Farm, and two other wind farms in Inner Mongolia provided 20 per cent of the electricity used by Olympic venues in 2008. The farm will be able to provide up to 93.65 GWh of electricity annually to the North China Power Grid, which will be enough to meet the demand of 100,000 households per year and reduce GHG emissions by 100,720 tons of CO_2eq per year by avoiding CO_2 emissions from electricity generation in grid-connected fossil fuel power plants.[16] The Guanting Wind Farm is planning to expand its

13. For more information see the Beijing Environmental Protection Bureau website http://www.bjepb.gov.cn/bjhb/tabid/68/InfoID/12057/frtid/459/Default.aspx.

14. Small-sale boilers refer to boilers weighing less than 20 tons.

15. Information available at the Beijing Environmental Protection Bureau website http://www.bjepb.gov.cn/bjhb/tabid/68/InfoID/12057/frtid/459/Default.aspx.

16. Clean Development Mechanism Project Design Document Form (CDM-PDD) (version 3), 28 July 2006.

capacity to 100 MW during the second phase, which will be completed by 2010.[17] Another low-speed wind farm project in Beijing with 10 wind turbines and 15 MW capacity of electricity generation and a project recovering methane gas from chicken manure to generate 140 MWh of electricity annually by Deqingyuan Egg Farm were approved by NDRC as CDM projects in 2009. There two projects will achieve carbon reductions of 23,133 and 87,784 tons of CO_2eq annually, respectively.[18]

3.2.3. Education and awareness

One of the largest climate actions in Beijing was in the area of education and awareness. In this regard, non-governmental organizations (NGOs) have been effective in getting the message out to the public. A series of campaigns launched jointly by NGOs have focused on aspects of people's behaviour that can make a difference in carbon reduction. The joint campaign to maintain a room temperature of 26°C or above during the summer in hotels, shopping malls, and office buildings in Beijing was initiated by six environmental NGOs including Friends of Nature and WWF China in 2004, and was successful in raising public and business awareness about energy conservation.[19] In addition to educating the public directly, some international NGOs also work with businesses and city governments to raise their knowledge and capacity in addressing climate change. For example, with the support of the Climate Group China, the CEOs of China Mobile, Broad Air Conditioning, and Suntech Power have pledged to reduce corporate greenhouse gas emissions and to work with their stakeholders to accelerate the shift to a low carbon economy.[20] The Climate Group also announced plans to develop 15 to 20 low carbon cities in China in the next three to five years to encourage the reduction of carbon dioxide emissions and address the problem of climate change.

The national government encourages environmental NGOs to conduct such activities, which they regard as complementary to their own efforts to respond to the climate change challenge.[21] As for other environmental issues in China, NGOs have been less confrontational with government than their counterparts in other countries (Economy, 2004). For example, Greenpeace is well known for its uncompromising attitude toward the government, but has adopted a different approach in China, emphasizing cooperation rather than confrontation in dealing with climate change issues.[22] However, NGOs still have a very limited role in influencing city climate change policies and activities. Even with the public awareness campaigns, the public's knowledge of climate change is still very superficial with much room for improvement. Simple online and street surveys find that the public knows very little about climate change and often confuse climate change with air pollution.[23]

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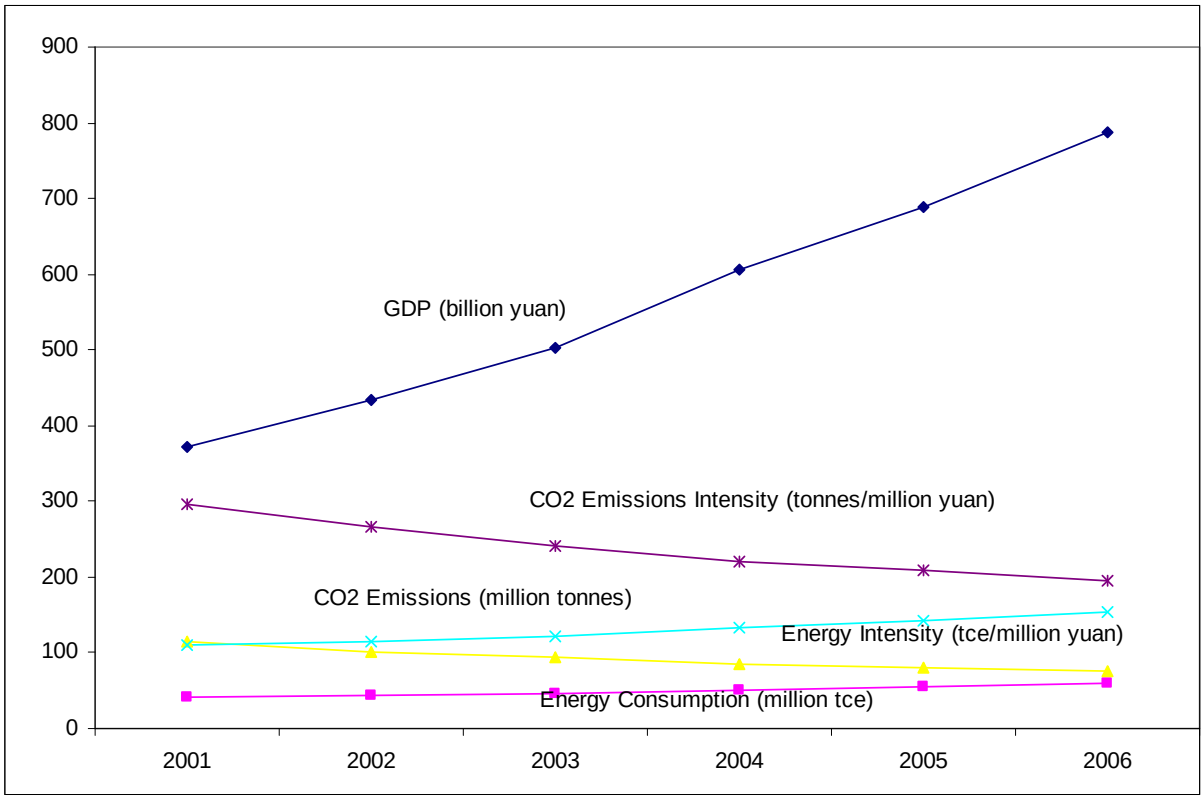
17. See Beijing Energy Conservation and Environmental Protection website, http://www.bjjnhb.com.cn/xwkx/200801/t205168.htm
18. More information see http://www.agri.gov.cn/dfxxlb/bjxxlb/t20080519_1042570.htm and http://english.cri.cn/4406/2009/07/28/1701s504756.htm
19. See http://www.panda.org/who_we_are/wwf_offices/china/news/?13951/26C-campaign-launched-in-China.
20. See http://www.chinacsr.com/en/2008/10/28/3463-three-chinese-enterprises-join-the-climate-group/.
21. Author's interview with national government officials, 2008, Beijing.
22. Author's interview with national government officials, 2008, Beijing.
23. The survey was conducted by Ke Bi, Beijing, 2008.

3.2.4 Emission reduction achievements and target realization

The total amount of energy consumption and CO_2 emissions in Beijing have been increasing along with rapid economic growth, but energy consumption and CO_2 emissions per unit of GDP production have decreased (see Figure 3). As mention-above, Beijing has made great efforts to increase energy efficiency and its energy intensity reduction is ahead of other Chinese cities. Energy intensity was reduced by 39 per cent from 1.31 tce in 2000 to 0.714 tce in 2007, which is about 38 per cent lower than the national average (ITSD, 2006; Greenpeace, 2008). The 5.9 per cent average annual growth rate of energy consumption supported a 12 per cent annual GDP growth rate during this period. Beijing reduced its energy intensity by 5.25 per cent and 6.04 per cent in 2006 and 2007, respectively, compared to 1.23 per cent and 3.66 per cent for the nation as a whole.[24] Beijing is in a very good position to meet its own target.

In addition to energy efficiency improvement and switching to cleaner and renewable energy, Beijing's efforts to increase forest coverage and wetlands also has contributed to CO_2 reduction through the absorption of more CO_2 by forests and wetlands. Beijing increased its rate of forest coverage from 30.7 per cent in 2000 to 35.5 per cent in 2005 (Wu and Zhang, 2008). Between 2001 and 2006, it was estimated that the above activities including energy efficiency improvement, shifting to renewable energy, and forestation generated 80 million tons of CO_2 reduction (Wu and Zhang, 2008).

Figure 3. Beijing energy intensity and CO_2 emission intensity



Sources: Wu and Zhang, 2008; BMSB, 2006, 2007, 2008.

24. See http://www.sina.com.cn.

4. Drivers and Constraints to Climate Change Mitigation Efforts

4.1 Drivers for climate mitigation and adaptation

Beijing is a leading city in China in the effort to improve energy efficiency, which is mainly driven by Beijing's economic restructuring from the secondary sector to the tertiary sector, and its energy structure change from coal to cleaner energy sources such as natural gas and renewable energy. The city was motivated by the pressing need to significantly improve air quality for the Olympic Games, and the desire to deal with local environmental problems and energy security concerns.

4.1.1. "Trigger" of the Beijing 2008 Olympic Games

An important catalyst for environmental improvements was the trigger of the 2008 Beijing Olympic Games. The Games put Beijing in a spotlight, creating urgency to address air quality and climate change. Beijing still has serious local environmental problems, including air pollution and water pollution, and was ranked as the 13th most polluted city in the world in 2004 (UNEP, 2007). The 2006 Winter Olympics in Turin and the 2006 World Cup in Germany provided models of climate protection driven by large sporting events, and ahead of the Olympics the international community called for Beijing to take actions to address local environmental pollution. Beijing made great efforts to change its energy mix from coal to cleaner natural gas and renewable energy, improve energy intensity, invest in research and development on hybrid, battery, and hydrogen vehicles, and build public transport infrastructure. The Olympic Games also provided Beijing with a platform to test alternative energy technologies developed through collaboration between the government and private companies. Solar panel and geothermal hot water systems were installed in many Olympic venues to heat tap water and advanced alternative fuel vehicles (e.g., hydrogen, battery, and hybrid) were operated to transport athletes and Olympics staff between venues. All these efforts related to the Olympics produced huge benefits for reducing carbon emissions. The Chinese government believes that the Olympics were "carbon neutral"; a reduction of 1 million to 1.29 million tons of carbon offset the 1.18 million tons of carbon generated by the event. The Olympics also led to an increased awareness of climate change among both Chinese government officials and the public. Beijing and the national government invested US$12.2 billion to promote sustainable development, a level of investment which may be hard to repeat in other cities in China. Moreover, city-wide activities such as energy saving, switching to cleaner energy and renewable energy, absorption of CO_2 through tree planting and the conservation of the ecosystem in preparation for the Olympic Games during the period 2001-2006 generated 80 million tons of CO_2 reduction for these five years (Wu and Zhang, 2008).

4.1.2. Co-benefits with other environmental/economic/social objectives

Studies show that there is a strong linkage between global and local environmental concerns, and policies targeted at one will have benefits for the other. Many local air pollution control measures also have significant GHG reduction effects. For example, the clean energy consumption and industrial restructuring measures for air pollution control in Beijing will produce a reduction of 10.5 million tons of CO_2 emission annually (Wu and Zhang, 2008). Structural shifts in the economy have contributed greatly to climate mitigation in Beijing. The manufacturing sector accounts for a large portion of Beijing's energy consumption, accounting for about 46.5 per cent of the total. The growth of the service industry sector has

contributed to Beijing's ability to achieve its energy intensity reduction targets. The ratio of primary, secondary and tertiary industries changed from 2.5:32.7:64.8 in 2000 to 1.3:28.7:70 in 2006 (Wu and Zhang, 2008; Wang, 2007).

Actions to address climate change can also bring environmental, and economic and social benefits. Beijing is growing in population and energy demand, with significant dependency on energy purchased from other parts of China and through imports, especially to support increased car use. Therefore, environmental protection and energy supply have been key parts of its economic policies for decades. Since greenhouse gas mitigation brings co-benefits of reduction in energy dependency and in emissions of other pollutants, it can be political viable.

4.1.3 Gradual changing government practice and the establishment of public-private partnership

Beijing has gradually changed its way of development: from the single-minded pursuit of GDP growth to the multiple objectives of managing the economy, society, resources, and ecology; from the sole use of fossil fuels to a mixed energy structure that includes cleaner and renewable energy. Beijing's Sustainable Development Plan, it's Plan for Recycling Economy, and its plans for building a harmonious society, carry significant co-benefits for addressing climate change through an integrated approach to economic development.

Beijing has also shifted from heavy reliance on regulations and provisions to a mix of regulations and public partnerships through voluntary programmes or market-based instruments. For example, the success of the "Green Lighting Programme" described above in section 3.2.1 is attributed to a good collaboration between government, light manufacturers, and light dealers. The effective public-private partnership was enhanced through the following activities: 1) strong support by the government; the Beijing municipal government provided 20 million RMB (2.56 million US dollars) in subsidies which provided incentives for dealers and consumers; 2) careful organization with a clear project roadmap, principles, objectives, and a work schedule to enhance the transparency of the programme and the engagement of suppliers; 3) responsibilities distributed among the city government, light manufacturers, and consumers in a coordinated way; and 4) a transparent market-based bidding process and monitoring by a third party.[25] Another large-scale public-private partnership is the implementation of CDM projects, facilitated through international climate change agreements and overseen by a CDM board composed of state and non-state actors. Companies in Beijing have strong incentives to apply for CDM projects. By July 2009, 13 projects were in the process of becoming official CDM projects registered with the CDM Executive Board (EB) and approved by NDRC. The projects further energy efficiency improvement, the switch to renewable energy, and fuel substitution, together potentially reducing carbon emissions by 4.3 million tons CO_2eq annually.[26]

4.2 Constraints for Climate Mitigation

However, there remain significant constraints to climate change efforts in Beijing. The top-down political system in China and competition over resources to deal with local and global climate change provides few incentives for the local government to take the lead in climate change mitigation and adaptation policies and actions.

25. Author's interviews, 2008, Beijing.
26. Clean Development Mechanisms in China, http://cdm.ccchina.gov.cn/web/index.asp.

4.2.1 Limited powers and interests for local governments to act independently

Beijing has not had specific city climate policies City governments are embedded within a governmental jurisdictional system and therefore the local government's capacity to take action is constrained by the level of local autonomy (Bai, 2007). Traditionally, global environmental problems such as climate change are not the "business" of local governments; rather local governments are often "implementers" of national policy and regulations. Local governments' involvement in issues being managed by upper levels is not always encouraged or welcomed by upper-level government. The top-down political system in China provides little pressure for Beijing's municipal government to move ahead in climate change mitigation policies and actions if the nation has not officially committed to an absolute carbon reduction target. In particular, the political sensitivity of the climate change issue makes local governments feel politically safe if they align with national policy.[27]

4.4.2 Conflicting interests in political economy

Climate change policies may conflict with other economic, social and political interests. Beijing has faced more urgent local environmental protection and economic growth issues, especially before the 2008 Olympic Games. In addition, as a rapidly developing city, continued economic development, urbanization, and motorization pose even more challenges to carbon reduction. Climate change expenditure competes with more urgent local environmental issues such as air, water pollution, and thus it is difficult to gain and maintain "political priority" for climate change mitigation in competition with other pressing local issues.

5. Conclusions

Beijing is leading energy intensity reduction efforts in China, but it does not yet have specific climate actions and policies. The top-down governance system puts little pressure on local governments to adopt local climate change mitigation policies ahead of national climate policies. Most local city initiatives focus on energy efficiency improvement, energy structure change, and renewable energy development. These are in line with national energy security policy, and the national climate change programme. Efforts to improve air quality for the 2008 Beijing Olympics produced huge co-benefits of addressing climate change and other environmental issues. As for reducing long term GHG emissions, Beijing needs to continue to invest in alternative and renewable energy, and public transport infrastructure, and change human behaviour by education. Climate change-related policies are formulated in the context of the city's sustainable development. In order to take a leadership in shifting to low-carbon economy development, Beijing needs to begin to undertake a long-term aggressive strategy to shift its energy structure away from coal and take other actions against climate change including establishment of mandatory emission reduction targets.

Cities across China should follow in the footsteps of Beijing to reshape energy structure and to introduce some of the energy saving technologies used at the 2008 Olympics. If all of China reaches the energy intensity level of 0.76 tce per 10,000 RMB (0.52 tce per 1,000 US dollars), the level of Beijing in 2006, China will save 1.8 trillion tce per year (Wu and Zhang, 2008). This would lead to reduction of 4.68 trillion tons CO2eq, which is equal to the total CO_2 emissions of China in 2004. However, Beijing's special status as China's capital and the great efforts made by the national and municipal governments to increase energy efficiency

27. Author's interview, 2008, Beijing.

and reduce pollution may be hard to replicate in other cities. Cities in China must confront many issues at the same time whereas in the past they often arose at different stages of social and economic development. Success in climate change governance is contingent upon the ability to deliver co-benefits and to frame issues in a way that is relevant to other local political, economic and social agendas. Appropriate integrated incentive policies and mechanisms from the national government are necessary to encourage local governments and businesses to take actions. It is also necessary to establish public-private partnerships to engage enterprises in climate actions taking a long-term perspective.

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