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Is It Fair to Treat China as a Christmas Tree to Hang Everybody's Complaints? Putting its Own Energy Saving into Perspective

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Abstract
China had been the world's second largest carbon emitter for years. However, recent studies show that China had overtaken the U.S. as the world's largest emitter in 2007. This has put China on the spotlight, just at a time when the world community starts negotiating a post-Kyoto climate regime under the Bali roadmap. China seems to become such a Christmas tree on which everybody can hang his/her complaints. This paper first discusses whether such a critics is fair by examining China's own efforts towards energy saving, the widespread use of renewable energy and participation in clean development mechanism. Next, the paper puts carbon reductions of China's unilateral actions into perspective by examining whether the estimated greenhouse gas emission reduction from meeting the country's national energy saving goal is achieved from China's unilateral actions or mainly with support from the clean development mechanism projects. Then the paper discusses how far developing country commitments can go in an immediate post-2012 climate regime, thus pointing out the direction and focus of future international climate negotiations. Finally, emphasizing that China needs to act as a large and responsible developing country and take due responsibilities and to set a good example to the majority of developing countries, the paper articulates what can be expected from China to illustrate that China can be a good partner in combating global climate change.

JEL classification: Q42; Q48; Q53; Q54; Q58

Keywords: Energy saving; Renewable energy; Post-Kyoto climate negotiations; Clean development mechanism; China; USA

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1. Introduction

China had been the world's second largest carbon emitter behind the U.S. for years. On the trends in the early 2000s, the U.S. EIA estimated that China's CO_2 emissions are not expected to catch up with the world's largest carbon emitter by 2030 (EIA, 2003). This seems to have been implanted in people's mind until the Chief Economist at the International Energy Agency (IEA) remarked in April 2007 that China will overtake the U.S. as the world's largest carbon emitter in 2007 or 2008. The Chinese senior official at the National Coordination Committee on Climate Change immediately rebutted that claim, criticizing it a lack of statistical evidence (Zhang, 2007e). This early remark by the IEA had been incorporated into the findings of its flagship report "World Energy Outlook 2007", reaffirming that China was already number one in 2007 (IEA, 2007b). Other study even estimates that China CO_2 emissions surprised those for the U.S. by 8% in 2006 (MNP, 2007).

It is conceivable that China will argue that its high absolute emission levels are the combined effects of large population and coal-fueled economy and the workshop as the world, the latter of which leads to a hefty chunk of China's emissions embedded in goods that are exported to industrialized countries. China's arguments are legitimate. The country has every right to do that. Anyhow, China's share of the world's cumulative energy-related CO_2 emissions from 1900 to 2005 was only 8%, far less than 30% for the U.S. and 23% for European Union. While China's share is projected to double by 2030, it is still lower than those for the U.S. (25%) and the EU (18%) by that time. On a per capita basis, China's CO_2 emissions of 3.9 tons in 2005 were only one-fifth of that for the U.S. (19.5 tons). While China's emissions rise a little faster on a per capita basis than on an absolute basis, its emissions per head are still less than half of that of the U.S. and about the two-thirds those for the OECD as a whole by 2030 (IEA, 2007b). However, the number one position has put China on the spotlight, just at a time when the world's community starts negotiating a post-Kyoto climate regime under the Bali roadmap. There are the renewed interests and debates on China's role in combating global climate change. China seems to become such a Christmas tree on which everybody can hang his/her complaints. The question then: is it really fair to do that?

This paper will first discuss whether such a critics is fair by examining China's own efforts towards energy saving and pollutants cutting, the widespread use of renewable energy and participation in clean development mechanism. Next, the paper puts carbon reductions of China's unilateral actions into perspective by examining whether the estimated greenhouse gas emission reduction from meeting the country's national energy saving goal is achieved from China's unilateral actions (namely, actions outside the clean development mechanism (CDM) projects in China) or mainly with support from the CDM projects. Then the paper discusses how far developing country commitments can go in an immediate post-2012 climate regime, thus pointing out the direction and focus of future international climate negotiations. While China is signaling its recognition of the increasing importance of climate changes issue, the paper argues that expecting China to commit internationally to specific emissions targets in the immediate post-Kyoto climate discussions is unrealistic. Said that, the paper emphasizes that China needs to act as a large and responsible developing country and take due responsibilities and to set a good

example to the majority of developing countries. Finally, the paper articulates what can be expected from China to illustrate that China can be a good partner in combating global climate change.[1]

2. Putting China's Own Efforts towards Energy Saving and the Use of Clean Energy into Perspective

2.1 Increasing Energy Efficiency and Cutting Pollutants

While China has been calling for energy saving since the early 1980s, this country has set for the first time the goal of cutting energy use per unit of GDP by 20% in its current five-year (2006-10) economic plan. China achieved a quadrupling of its GDP with only a doubling of energy consumption between 1980 and 2000, as indicated in Figure 7, but since 2001 China has experienced faster energy consumption than economic growth (Zhang, 2005 and 2007f). Clearly, this is very challenging goal in light of the recent increase in energy intensity in China. Given that industry consumes about 70% of the country's total energy consumption (Zhang, 2003), this sector is crucial for China to meet its own set goal. So the Chinese government has taken great efforts towards changing currently energy-inefficient and environmentally unfriendly pattern of industrial growth. To that end, China is exploring industrial policies to promote industrial upgrading and energy conservation. With surge in energy use in heavy industry, the Chinese government started levying export taxes from November 2006 on energy and resource intensive products to discourage exports that rely heavily on energy and resources and to save scarce energy and resources. This includes a 5% export tax on oil, coal and coke, a 10% tax on to non-ferrous metals, some minerals and 27 other iron and steel products, and a 15% tax charged on copper, nickel, aluminum and other metallurgical products. From July 2007, China eliminated or cut export tax rebates for 2831 exported items. This is considered as the boldest move to rein in exports since China joined the World Trade Organization (WTO). Among the affected items, which account for 37% of all traded products, are 553 "highly energy-consuming, highly-polluting and resource-intensive products", such as cement, fertilizer and non-ferrous metals, whose export tax rebates were completely eliminated. This policy will help to enhance energy efficiency and

[1] Unless indicated otherwise, the paper focuses on what China as a whole has done and needs to do in the future. However, the economic reforms over the past three decades in China have shifted control over resources and decision-making to local governments. This devolution of decision-making to local levels has placed environmental stewardship in the hands of local officials who are more concerned with economic growth than the environment. As often be the case, what the center wants is not necessarily what the center gets. An old Chinese saying goes, "The mountains are high, and the emperor is far away". There are big variations in, e.g., energy-saving performance, vehicle emission standards and hosting CDM projects among the 31 Chinese provinces or equivalent. Clearly, the central government needs local officials' cooperation to get work done. See Zhang (2007a and 2008a) for detailed discussion on a variety of the tactics for the Chinese central government to incentivize local governments and enterprises for saving energy and preserving the environment.

rationalize energy and resource-intensive sectors as well as to control soaring exports and deflate the ballooning trade surplus (Zhang, 2008a). On the specific energy saving front, China established the "Top 1000 Enterprises Energy Conservation Action Program" in April 2006. This program covers 1008 enterprises in nine key energy-supply and consuming industrial subsectors. Each of them on the list consumed at least 0.18 million tons of coal equivalent (tce) in 2004, and all together consumed 33% of the national total and 47% of industrial energy consumption in 2004. The program aims to save 100 million tce cumulatively during the period 2006-10, thus making a significant contribution to China's overall goal of 20% energy intensity-improvement (NDRC, 2006). Empowered by the State Council, the National Development and Reform Commission (NDRC), China's top economic planning agency, signed energy-saving responsibility agreements with these enterprises. To ensure the goal to be met, making energy efficiency improvements has been considered a criteria for job performance evaluations of heads of these enterprises. This will help them realize that they should take their jobs seriously because they have a very real stake in meeting energy-saving goals. The first-year's results of the program's implementation are encouraging. More than 95% of these enterprises appointed energy mangers, and with the energy saving of 20 million tce in 2006, the top-1000 program is right on track to meet its 2010 target (NDRC and NBS, 2007). For power generation, China plans to decommission thousands of small, inefficient coal- and oil-fired power plants (namely, those plants of an unit capacity of 50 MW or less) with a combined capacity of 50 GW during the period 2006-10. By the end of 2008, China had closed small plants with a total capacity of 34.21 GW, relative to a total capacity of 8.3 GW decommissioned during the period 2001-05 (NDRC, 2008c). In the meantime, an increasing number of newly built plants are more efficient supercritical or ultra-supercritical plants. For residential buildings, China has taken the three steps to improve energy efficiency. The first step requires a 30% cut in energy use relative to typical Chinese residential buildings designed in 1980-1981. Next, China requires that new buildings have to be 50% more efficient by 2010. Then, the third step is to increase the energy-saving goal to 65% for new buildings by 2020 (Zhang, 2005 and 2008a). Tianjin is the first metropolitan city in China to embark on reform for heat supply and charge. As indicated in Table 1, by the end of 2006, 73.49 million m^2 energy-efficient residential buildings were built in this city, accounting for 47.8% of the total residential buildings (Zheng and You, 2007). In Beijing, the building sector consumed 28% of its total energy use in 2004. By the end of 2004, 175.2 million m^2 energy-efficient residential buildings were built in China's capital, 37.1% of which met with the 30% more energy-efficient standards and the remaining 62.9% met with the 50% more energy efficient standards (see Table 1). All these energy-efficient buildings in Beijing accounted for 65.1% of its total residential buildings. Beijing plans that all new residential buildings have to meet with the 65% more energy-efficient standards by 2010, one decade ahead of the national schedule (BMCDR, 2006).

Table 1 Residential Buildings by Energy Efficient Standards in Beijing and Tianjin, China

Region	Non-Energy-Efficient Buildings	Energy-Efficient Buildings in the First Step	Energy-Efficient Buildings in the Second Step	Energy-Efficient Buildings in the Third Step
Beijing by 2004	35%	24%	41%	0%
Tianjin by 2006	52%	23%	15%	10%

Sources: BMCDR (2006); Zheng and You (2007).

In the transport sector, on March 21, 2006, China's Ministry of Finance and the State Administration of Taxation issued the joint circular enacting to adjust the existing levels of consumption taxes levied on a variety of products. The big adjustment has been for the excise tax for vehicles. The existing excise tax levied at the time of purchase was introduced in 1994 when China reformed its taxing system, and the rate increases with the size of engines, setting at 3% for cars with engines of 1.0 liter or less, 8% for cars with engines of more than 4 liters, and 5% for cars with engines in between. These tax rates for cars had since remained unchanged. The new vehicle excise tax has broadened the tax base from the existing range of 3-8% to 3-20%, and has broken down the size of engines into the six categories instead of the existing three ones. Since April 1, 2006, the rate for small cars with engines of 1.0 to 1.5 liters decreases to 3%, two percentage points lower than before. Cars with engines of 1.5 to 2.0 liters continue to enjoy a tax rate of 5%, and consumers who buy cars with engines of no less than 2 liters but no larger than 4 liters are required to pay a consumption tax of 9–15%. In the meantime, the tax on cars with engines of larger than 4 liters more than doubles from 8% to 20% (see Table 2). To further rein in the production and use of gas-guzzler cars and promote the production and use of energy-efficient small cars, China announced on August 13, 2008 that since September 1, 2008, the rate for small cars with engine of 1.0 liter or less further decreases to 1%, whereas the rate for cars with engines of no less than 3 liters but no larger than 4 liters goes up to 25%, 10% higher than the existing rate. Cars with engines of larger than 4 liters are now taxed at the highest rate of 40%, 20% higher than the existing level.[2] This

[2] China lost its first-ever dispute with WTO on July 18, 2008, when a panel on the WTO compliance of its auto part tariffs found in favor of the complainants - Canada, the EU and the U.S.. China imposed in 2005 a 25% tariff on imported auto parts, if the parts made up 60% or more of the value of a whole vehicle (Sina Net, 2008). This tariff rate equals the duty that China applies on imported automobiles but exceeds its 10% tariff ceiling on imported auto parts. China had contended that the higher tariff was necessary to prevent tax evasion by companies that import whole cars as spare parts and then assemble them together inside China to avoid the higher tariffs applicable to entire automobiles. However, the three complainants in the case maintained that these higher charges unfairly discriminate against the use of foreign auto parts and effectively

big upward adjustment in consumption tax for gas-guzzler cars clearly reflects that the Chinese government's determination to use consumption taxation as an important economic instrument to promote the production and use of energy-efficient small cars and enhance its policy guidance on energy conservation and environmental protection.

Table 2 Consumption Tax Rates for Cars in China

Engine (liters)	Excise Tax Since 1 January 1994 (%)	Excise Tax Since 1 April 2006 (%)	Excise Tax Since 1 September 2008 (%)
1.0 or less	3	3	1
1.0 < engine ≤ 1.5	5	3	3
1.5 < engine ≤ 2.0	5	5	5
2.0 < engine ≤ 2.5	5	9	9
2.5 < engine ≤ 3.0	5	12	12
3.0 < engine ≤ 4.0	5	15	25
Greater than 4	8	20	40

Sources: Sina Net (2006); People Net (2008a).

China has set even more stringent fuel economy standards for its rapidly growing passenger vehicle fleet than those in Australia, Canada, California and the United States, although they are less stringent than those in Japan and the European Union (see Figure 1). Implemented in the two phases, the standards classify vehicles into 16 weight classes, covering passenger cars, SUVs and multi-purpose vans. Converted to the U.S. CAFF (Corporate Average Fuel Economy) test cycle, the average fuel economy standards of new vehicles in China are projected to reach 36.7 miles per gallon in 2008 (An and Sauer, 2004).

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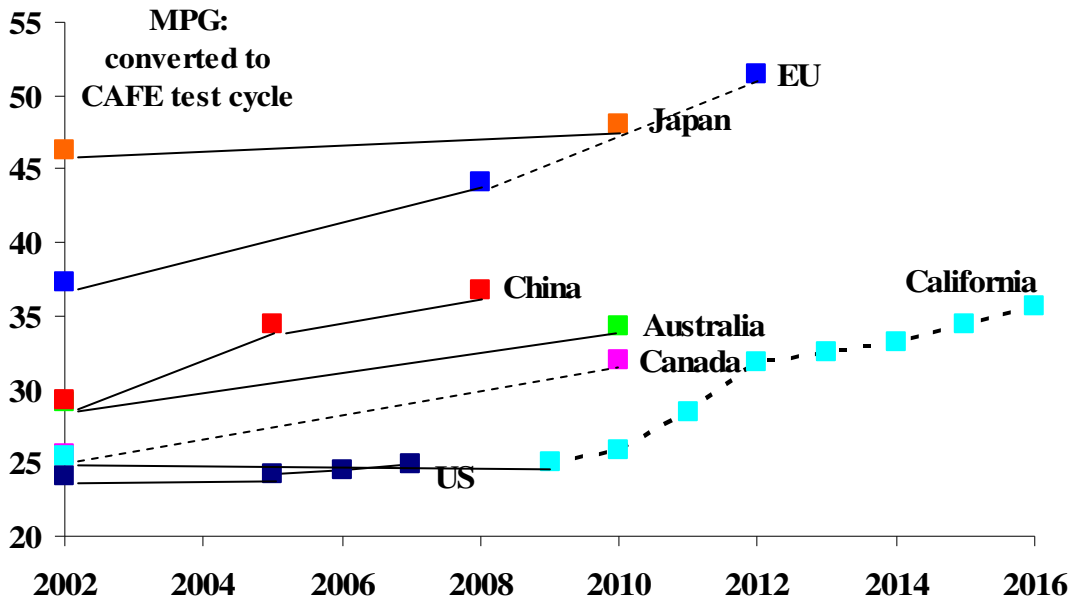
subsidize domestic production. The complainants argued that the tariff not only discouraged auto manufactures in China from using the imported parts, but also that the higher tariff put pressure on foreign producers of auto parts to relocate manufacturing facilities to China. Given the fact that Chinese auto manufactures tend to produce cars with engines smaller than 2.5 liters and an amazing coincidence of timing (Time to decide to introduce this green tax is less than a month after China lost its WTO dispute), this big upward adjustment in consumption tax for gas-guzzler cars may be seen as a way for China to cut car imports without offending the WTO.

Figure 1 Comparison of Fuel Economy Standards for Vehicles
Notes: Dotted lines denote proposed standards; MPG – Miles per gallon.
Source: An and Sauer (2004).



In the meantime, growing Chinese cities are prioritizing public transport and are promoting efficient public transport systems. However, given an inevitable increase in the number of vehicles on road, China has also taken significant steps to control vehicle emissions. Following the phasing out of leaded gasoline nationwide in July 2000, the State Environmental Protection Agency of China requires all new light duty vehicles sold after April 2001 to meet State Phase I (similar to Euro I) vehicle emission standards and after July 1, 2004 to meet State Phase II (similar to Euro II) standards across China. Beginning July 1, 2007, China started implementing State Phase III (similar to Euro III) vehicle emission standards, with State Phase IV (similar to Euro IV) vehicle emission standards scheduled to be introduced on July 1, 2010 (see Table 3). Pollution from State Phase III standards is 30% lower than that from State Phase II standards. Pollution from State Phase IV standards even goes down below 60% of that from State Phase II standards (Xinhua Net, 2007b). Clearly, more stringent vehicle emission requirements by these new standards will help to reduce substantially the environmental stress in China.

Table 3 Vehicle Emission Standards and the Time to Enter into Force in China, ASEAN and European Union

	Euro I	Euro II	Euro III	Euro IV	Euro V
European Union	July 1992	January 1996	January 2000	January 2005	September 2009 (proposed)
China	April 2001	July 1, 2004	July 1, 2007	July 1, 2010	
Beijing	1999	August 2002	December 30, 2005	1st half of 2008	
India	2000	2005	2010		
ASEAN		December 2005 (targeted)		December 2010 (targeted)	
Indonesia		Early 2006	1st Q 2007	2012	
Malaysia		Mid 2006		2010	
Philippines		Dec 2006		2010	
Singapore		2005		Oct 2006 (Diesel)	
Thailand			Early 2005	2010	
Vietnam		July 2007		2012	

Source: Zhang (2008a).

New vehicles that do not comply with the new standards cannot be sold in China. Clearly, vehicle emission standards in China have been become increasingly stringent over time. While the time schedules to implement these regulations in China are a couple of years ahead of the schedules of India and most ASEAN (Association of Southeast Asian Nations) countries that have about the same levels of vehicle emission standards as China does, China still lags behind the European Union regarding the schedule of the emissions requirements for new vehicles. However, China's gap with the EU requirements is gradually reduced from about nine yeas in 2001 to five and a half years in 2010. With the population of registered vehicles reaching to 148 million by the end of March 2007 in China (Xinhua Net, 2007b) and continuing their explosive growth, and the emissions from vehicles as the main source of air pollution in many Chinese cities, these cities have been proactive in controlling vehicle emissions. With the largest population of registered vehicles in China (Xinhua Net, 2005),[3] Beijing took the lead. China's capital started a pilot program to stop sales of leaded gasoline by July 1997, three years ahead of the

[3] It took 48 years for the population of registered vehicles in Beijing reached to one million in February 1997 from 2300 in the early 1950s. It took six and a half years to reach two millions in August 2003. But it took only 3 years and nine months to reach three millions on May 27, 2007, much quicker than what experts expected (Xinhua Net, 2007c).

nationwide ban, and enforces State Phase II standards two years ahead of the national schedule and State Phase III standards one and a half years ahead of the national schedule. By enforcing State Phase III standards ahead of the national schedule and speeding up the eliminating of existing vehicles with lower standards, total pollution from vehicles in Beijing is estimated to be cut by 20% by 2008, compared with the existing level of pollution (Xinhua Net, 2005). As commitments to the Green Olympic Games, Beijing introduced State Phase IV fuel standards on January 1, 2008, and required all pump stations to supply State Phase IV fuel by March 1, 2008. Cars with State Phase IV vehicle emission standards and powered by State Phase IV fuel can cut pollution in half, relative to cars with State Phase III vehicle emission standards and powered by State Phase III fuel (People Net, 2008b). China's capital also introduced State Phase IV vehicle emission standards in the first half of 2008, prior to the Beijing Olympic Games on August 8, 2008 (Xinhua Net, 2007a).

2.2 The Use of Renewable Energy

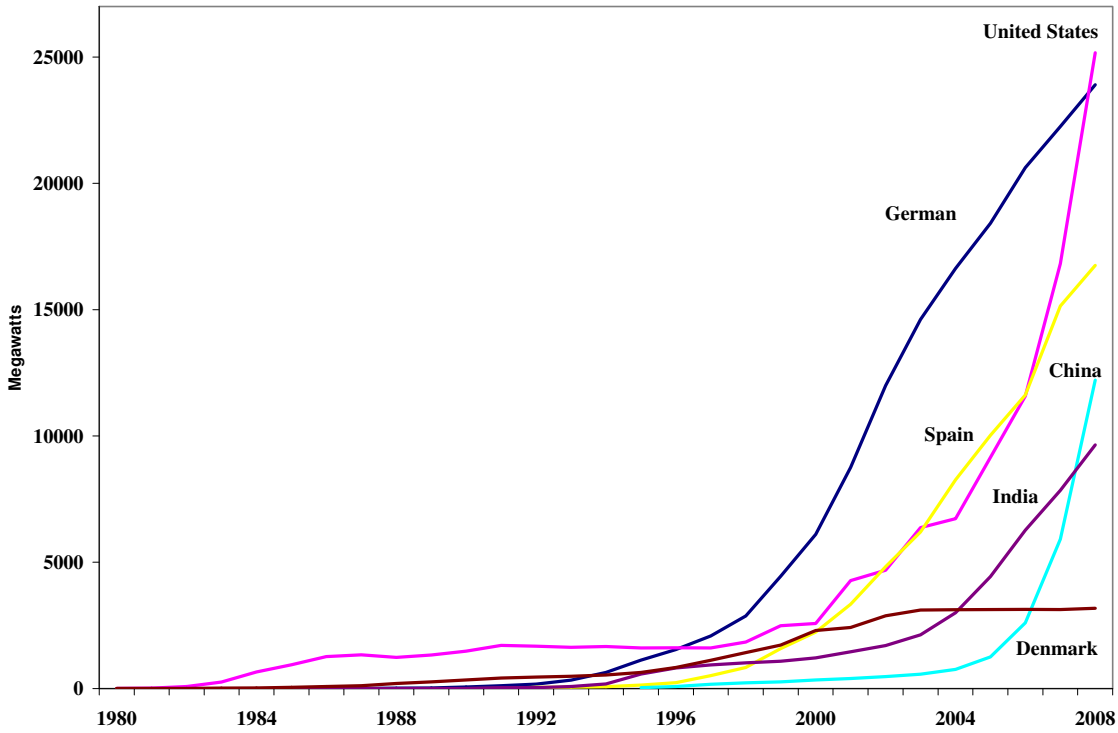
China plans to look to alternative energy sources to meet up to 16% of the nation's energy needs by 2020, up from about 8% in 2006. This is a big step up from the previous goal of 10% by 2020. Under this ambitious government plan, China aims to have an installed capacity of 300 gigawatts (one gigawatt equals one million kilowatts, GW) for hydropower (including large hydropower), 30 GW for wind power and 30 GW for biopower (power generated from biomass), and produce 10 million tons of ethanol and 2 million tons of biodiesel by 2020 (Zhang, 2007b).

The European Union is widely considered to be the world's leader in renewable energy. Let us look at the EU to put China's renewable energy goals into perspective. The EU aims at renewable energies meeting 12% of its primary energy by 2010 and 20% by 2020 from its current level of 6.5% (European Commission, 2007a and 2007b). At first glance, the EU's goal of tripling the share of renewable energy from the current level to 20% by 2020 seems even more ambitious than China's renewable energy goal. But because energy demand in China grows at least three times faster than EU does, doubling renewable energy in China's total energy mix by 2020 requires that renewable energy in China grows at a rate of four times that the rate of the EU.

Not only setting the ambitious renewable energy goals, more importantly China is taking dramatic efforts to meet the goals. China invested $12 billion in renewable energy in 2007, which trails the leader Germany that invested $14 billion (REW 21, 2008). Given that the size of the Chinese economy was only slightly smaller than that of the German economy in 2007, this suggests that, in terms of renewable energy investment as a percentage of GDP, China probably scored as good as Germany. Take wind power as an example. In 1986, the first wind farm in Shandong Province, China, was connected with the electric grid. In 1995, the then Ministry of Electric Power set up the target of having total wind power capacity installed of 1GW by the year 2000. But by the end of 2003, the wind power capacity installed totaled only 0.56 GW, falling short of the target (Zhang, 2005). China had been suffering from power shortages from 1980s and to mid-1990s, and was able to achieve the first time the balance between power demand and supply in 1997. This was considered as the unique opportunity to adjust power generation mix and to

encourage the development of wind power. But unfortunately, the opportunity was passed by.

Figure 2 Cumulative Installed Wind Power Capacity by Country, 1980-2008
Sources: Drawn based on data from Global Wind Energy Council (2009) and Earth Policy Institute (2008).



The turning point for wind power development occurred in 2003. In that year, the government put in place a series of policies favorable to wind power development. These policies include value added tax for wind power being cut in half, from the normal rate of 17% to 8.5%; low duty rate for domestic investment being levied for wind power (6%), in comparison with the normal rate of 23%; and duty free for equipments imported for renewable energy technologies in joint venture. Some local governments provide even favorable policies. For example, in Inner Mongolia, value-added tax of 6% is levied for wind power. With these favorable policies in place, the total wind power capacity installed doubled between 2003 and 2005, rising to 1.26 GW in 2005. With China's Renewable Law entered into force in January 2006, the pace of installation accelerated considerably. The total installed wind power capacity rose to 2.60 GW in 2006, with new installations in that year alone more than the combined total over the past 20 years. Wind power capacity in China has doubled for the past consecutive three years (see Figure 2). With 5.9 GW of total installed capacity at the end of 2007, China had already surpassed its goal to achieve 5 GW in 2010. With new installations of 6.3 GW and a total installed capacity of 12.2 GW in 2008, China overtook India in wind power installations. In its

response to the financial crisis, the Chinese government has identified the development of wind power as one of the key economic growth areas, and new installed capacity in China is expected to nearly double again in 2009. At this growth rate of new capacity installations, China would overtake Germany and Spain to reach the second place in wind power installations in 2010, and would have met its 2020 target of 30 GW ten years ahead of schedule (Global Wind Energy Council, 2009).

2.3 Participation in Clean Development Mechanism

The CDM is an innovative mechanism built into the Kyoto Protocol. The CDM allows industrialized countries to generate emission credits through investment in emission abatement projects in developing countries while helping developing countries to meet their sustainable development objectives. While many Annex I countries have put and continue to put pressure on developing countries to take on emissions limitation commitments, the CDM so far is the only mechanism with an authentic global reach. If designed appropriately, the CDM could prove to be a win-win-win mechanism. First, the CDM could provide an opportunity for developing countries to get increased access to more advanced energy efficiency and pollution control technologies and additional funding and could thus accelerate their future development along a more sustainable path. Second, it will help industrialized countries to meet their Kyoto emission commitments at a lower overall cost than would otherwise have been the case. Third, the CDM enhances international cooperation in combating global climate change and thus is beneficial to the global environment as well (Zhang, 2000a).

The implementation of CDM projects has progressed. In December 2004, only one project was registered with the CDM Executive Board, with another 60 in the pipeline. A year later those numbers were 40 and 500 respectively (Zhang, 2006c). As of September 1, 2008, there are 1152 registered CDM projects and another 2667 CDM projects at the validation stage or beyond. As indicated in Figure 3, renewables are the most popular types of CDM projects worldwide, accounting for 63% of the total number. The reduction potential of all these currently known CDM projects is estimated to be 2744.7 million tons of carbon dioxide ($MtCO_2$) equivalents by 2012, the end of the first commitment period under the Kyoto Protocol, with 28% from HFCs, PFCs and N_2O types of CDM projects (see Figure 4). To put into perspective, this reduction potential is over 55% of the current total emissions in the European Union 25. Contrary to arguments put forth by opponents to the Kyoto Protocol, these numbers speak for themselves. Developing countries are indeed already participating in global efforts to cut greenhouse gas emissions in a meaningful way.

Figure 3 Number of CDM Projects by Category (as of 1 September 2008)
Source: UNEP Risoe Center (2008).

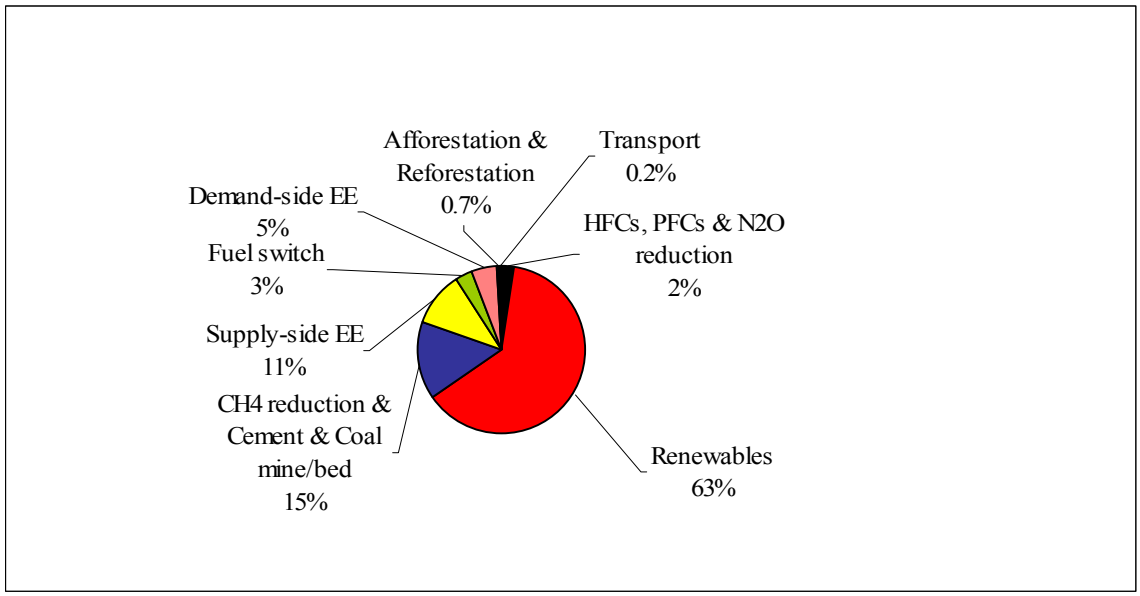
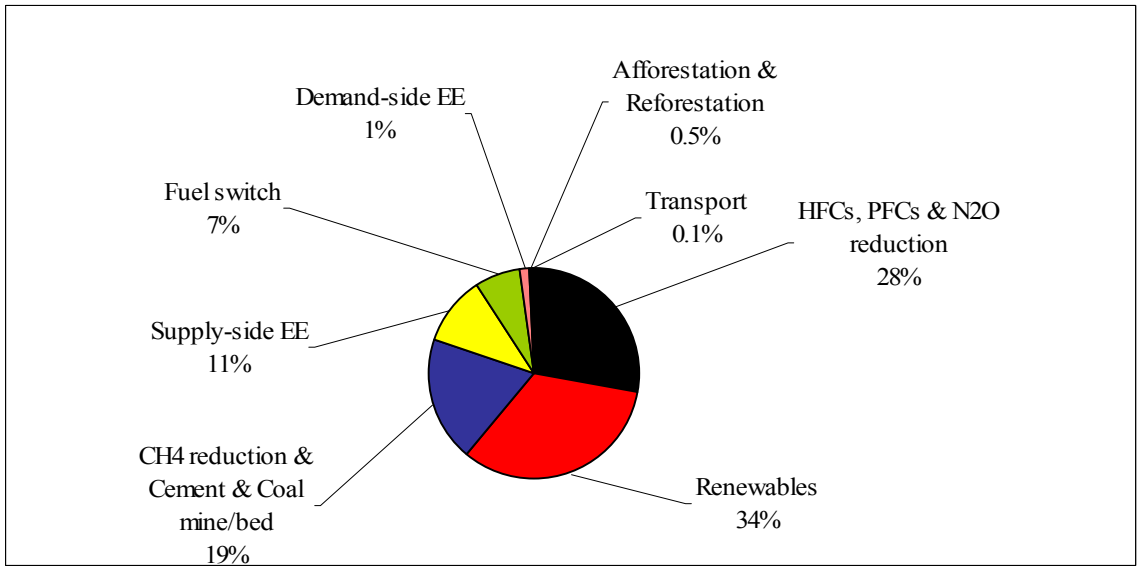


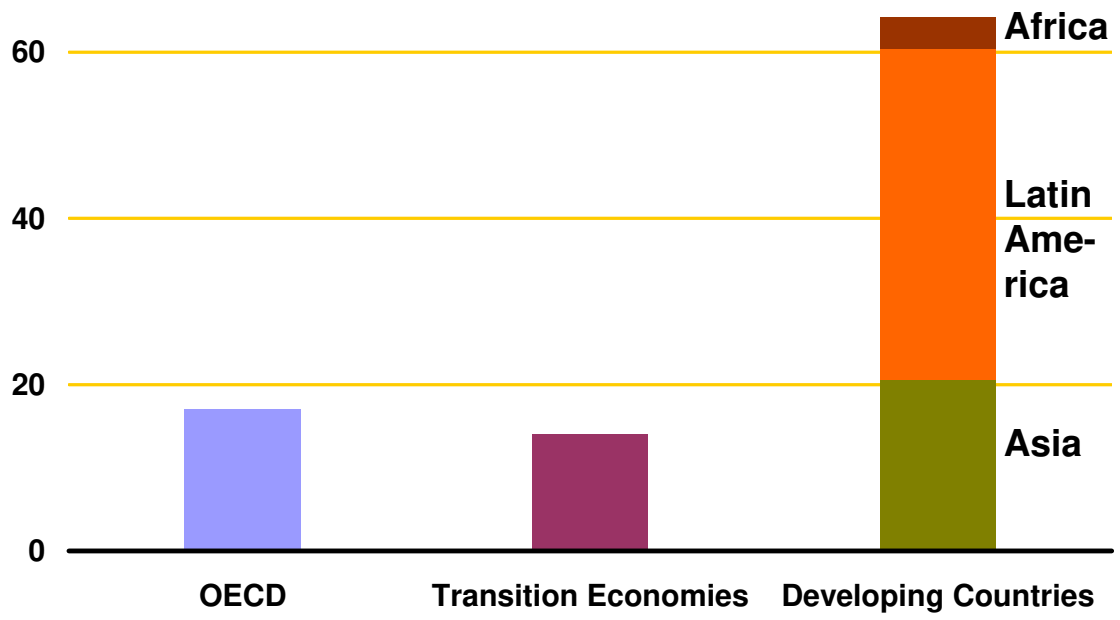
Figure 4 Projected CERs until 2012 by Category of CDM Projects (as of 1 September 2008)
Source: UNEP Risoe Center (2008).



Along with the growth in CDM projects are significant changes in their geographical distribution. Asian countries including China and India had not rushed into the CDM process, as they were concerned about the quality of the CDM and the integrity of the

Kyoto Protocol (Zhang, 2006a and 2006b). Until late 2003, both China and India lagged behind Latin America, which made the biggest strides in the CDM and, as shown in Figure 5, had taken the lead in the CDM market. But, India had caught up very quickly. As of late 2005, India had emerged as the leading supplier of carbon credits in the world (Zhang, 2006c).

Figure 5 The Location of Project-Based Emissions Reductions Generated in 2002 – Q3 2003 ($MtCO_2$ equivalent)
Source: Lecocq and Capoor (2003).



China, however is another story. There were very few CDM projects in China at that time. With the U.S. withdrawal from the Kyoto Protocol, however, China gradually comes to realize that the size of the CDM market is much smaller than originally projected and that the CDM market is a competitive one. This realistic expectation and the sense of urgency to gain real experience through learning-by-doing, combined with positive development in international negotiations on the rules and modalities for governing the operation of the CDM, have led to a positive and determined attitude of China towards the CDM (Zhang, 2006a). Working with a growing number of international and bilateral donors on many CDM capacity building projects, China gains more insight into the CDM and enhances its capacity to initiate and undertake CDM projects. China has also prioritized the areas of the CDM investment, and put in place clear institutional structure, streamlined and transparent CDM procedures and sound governance of clearer lines of responsibility and functions to facilitate the smooth implementation of CDM projects in the country without making a lengthy administrative and legislative procedure a precondition for project approval (Zhang, 2006a).

Table 4 Pipeline of CDM Projects at the Validation Stage or Beyond (as of 15 August 2005)

Country	Validated CDM projects		Projected CERs	
	Number	%	Amount (kilo tons CO_2/yr)	%
Brazil	67	33.2	12247	26.3
India	38	18.8	8185	17.6
Mexico	11	5.4	4564	9.8
China	**9**	**4.5**	**1247**	**2.7**
Honduras	9	4.5	90	0.2
Philippines	8	4.0	48	0.1
Chile	7	3.5	367	0.8
World	202	100.0	46563	100.0

Source: Zhang (2006c) - calculated based on information on CDM projects compiled by the UNEP Risoe Center.

Table 5 Pipeline of CDM Projects at the Validation Stage or Beyond (as of 14 November 2005)

Country	Validated CDM projects		Projected CERs	
	Number	%	Amount (kilo tons CO_2/yr)	%
India	173	37.9	16329	20.0
Brazil	91	20.0	16541	20.3
Mexico	22	4.8	5574	6.8
Philippines	20	4.4	283	0.3
Chile	17	3.7	2446	3.0
China	**16**	**3.5**	**17724**	**21.7**
Honduras	14	3.1	288	0.4
World	456	100.0	81616	100.0

Source: Zhang (2006c) - calculated based on information on CDM projects compiled by the UNEP Risoe Center.

In the mean time, China implemented huge transactions on credits from a few large HFC23 projects. HFC23 is a by-product in the production of the refrigerant HCFC22. Its global warming potential is 11,700-times that of carbon dioxide. This means the releasing of one ton of HFC23 into the atmosphere is equivalent to 11,700 tons of carbon dioxide emissions. This significantly boosted China's ranking. This is clearly reflected in Tables 4 and 5 listing the top 7 host countries, based on information on CDM projects reached

the validation stage or beyond at the two specific points of time, namely, as of 15 August 2005 and 14 November 2005 respectively. These two tables indicate how China performs in comparison with other major hosting countries. During the two specific points of time, the number of CDM projects reached the validation stage or beyond in the world increases from 202 to 456, more than doubled. Although the number of CDM projects in China increased from 9 to 16, its share in the world's total declined from 4.5% to 3.5%. The total projected amount of annual certified emission reductions (CERs) from all the CDM projects in the world increased from 46.6 $MtCO_2$ equivalent to 81.6 $MtCO_2$ equivalent. China topped the share in the world's total, which increased significantly from 2.7% to 21.7% during this period. This was largely because of huge transactions on credits from a few large HFC23 projects.

However, HFC23 types of CDM projects only have climate benefits but don't have other social and environmental benefits. These types of projects helped China top in the list of expected carbon credits, although India still leads the market in terms of number of projects at the same stage of development. However, they are not the prioritized types of CDM projects in China. Ironically, carbon credits from the so-called prioritized types of CDM projects only accounted for few percentages of the total carbon credits from China at that time (Zhang, 2006c).

Table 6 Pipeline of CDM Projects at the Validation Stage or Beyond (as of 1 September 2008)

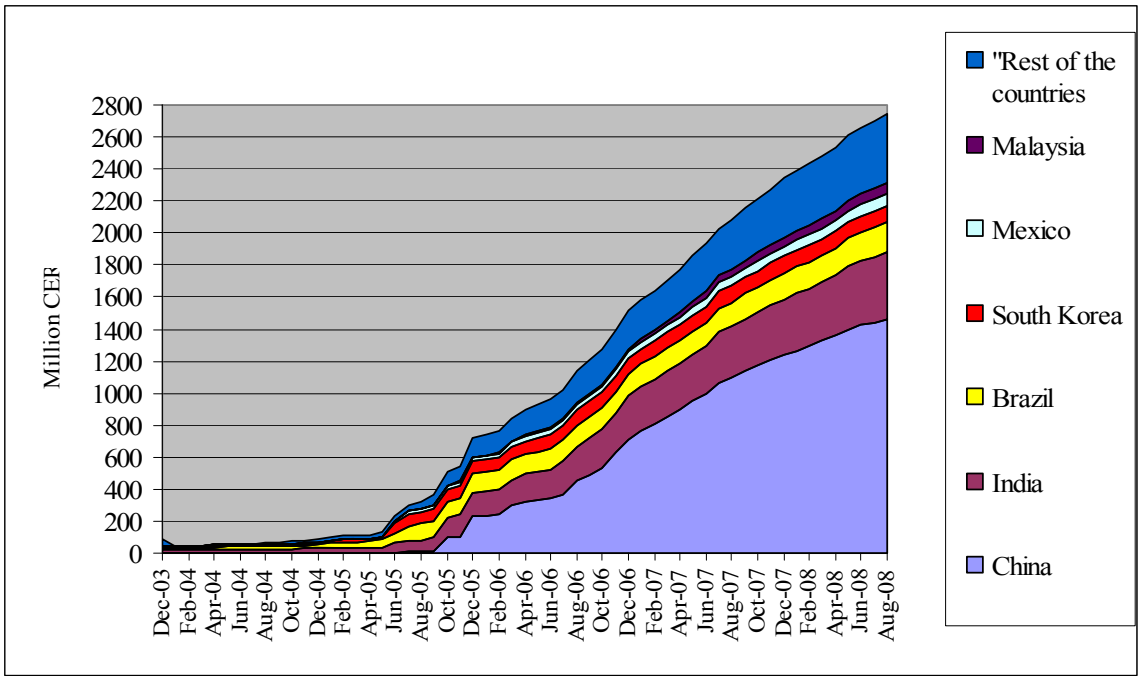
Region	**CDM Projects at Validation or beyond**		**Projected Certified Emission Reductions by 2012**	
	Number	**%**	**Million tons CO_2**	**%**
Latin America	757	19.8	417.1	15.2
Asia & Pacific	2899	75.9	2177.2	79.3
China	1377	36.1	1464.0	53.3
India	1046	27.4	417.7	15.2
Europe & Central Asia	40	1.0	19.5	0.7
Africa	71	1.9	94.4	3.4
Middle-East	3	0.1	2.9	0.1
Total	**3819**	**100.0**	**2744.7**	**100.0**

Source: UNEP Risoe Center (2008).

Since then, both number and type of CDM projects in China have been significantly changed. As indicated in Table 6, as of September 1, 2008, there are 3819 CDM projects that are registered, in the process of registration and at the public validation stage, with 2899 projects (75.9% of the total number) located in Asia. As the biggest host country, China hosts 1377 CDM projects that are at the public validation stage or beyond, accounting for 36.1% of the world's total CDM projects. These CDM projects are now

much broader in types than that in late 2005. In terms of the number of projects, hydropower, wind power, and energy efficiency projects in the energy sector are the three most popular types of CDM projects in China. The number of CDM projects in the three types is 672, 235 and 226, respectively, accounting for over 82% of the total CDM projects in China. Their share in expected emissions reductions in China is significantly increased, accounting for 43% of the total estimated emissions reduction. If operated as planned, all these currently known CDM projects in China are projected to generate reduction of 1464 $MtCO_2$ equivalent by 2012, accounting for 53.3% of the world's total estimated carbon credits by 2012 (UNEP Risoe Center, 2008).[4] China's share is 50% up from that three years ago (see Table 4). To put into perspective, this amount of the total emissions reductions by 2012 is more than the current greenhouse gas emissions of Germany and Spain combined (or that of the United Kingdom, Italy and the Netherlands combined), and corresponds to about 30% of the current total emissions in the European Union 25. India – the world's second largest supplier of carbon credits, hosts the somewhat lower number of CDM projects (1040) than China does (see Table 6), but the estimated emissions reductions from these CDM projects in India as a share of the world's total are 38.1% less than those from China, meaning that the average scale of each CDM project in India is about 40% of that in China. Together, the two Asian giants are responsible for over two-thirds of the world's expected entire emissions reductions by 2012, with China well positioned to be the largest supplier of carbon credits (see Figure 6).

Figure 6 Growth of Total Expected Accumulated CERs by 2012 (as of 1 September 2008)
Source: UNEP Risoe Center (2008).



[4] This is very in line with the economic model-based estimates of Zhang (1999, 2000b, 2001, 2004), which show that about 60% of the total CDM flows in 2010 go to China.

2.4 Putting CO_2 Reductions from China's Unilateral Actions into Perspective

If the goal of 20% energy intensity reduction in China would be met, that would translate into a projected reduction of its 2010 CO_2 emissions by over 1320 $MtCO_2$ (NDRC, 2007a).[5] The Top 1000 Enterprises Energy Conservation Action Program would lead to a cumulative CO_2 reduction of 220 $MtCO_2$ during the period 2006-2010. For comparison, energy-related CO_2 emissions in all Annex 1 countries committed to participating in the Kyoto Protocol are projected to be reduced by 422 $MtCO_2$ relative to the reference case in 2010 (EIA, 2006). This is just about 30% of the estimated CO_2 reduction from meeting the aforementioned 20% energy saving goal in China.

Let us put it aside for a moment whether that energy intensity target is going to achieve. Assume that it will. The question then arises: is that estimated reduction achieved from China's unilateral actions (namely, actions outside the CDM projects in China) or mainly with support from the CDM projects? As of September 1, 2008, China hosts 1377 CDM projects. All these currently known projects lead to annual reduction of 294 $MtCO_2$ equivalent. HFCs and N2O decomposition and landfill gas types of CDM projects only have climate benefits but do not offer energy saving and other social and environmental benefits to host countries. Moreover, China's CDM regulations require that solely Chinese or Chinese-controlled enterprises are eligible for project development, indicating that the foreign company undertaking a CDM project could not be allowed to own more than 50% of equity in the project (Zhang, 2006a). Taking out contributions from HFCs, N2O, landfill gas types of CDM projects and factoring in the Chinese company owning more than 50% of equity in a CDM project, portion of that reduction from foreign investment in the CDM projects in China is estimated to only contribute about 5% of China's projected CO_2 reduction in 2010. This clearly indicates that CDM does not make much of a difference to China, but China is definitely making a difference to CDM. The overwhelming majority of the estimated CO_2 reduction from meeting the aforementioned 20% energy saving goal in China is expected to achieve through its own domestic actions, rather than support from the CDM projects. China clearly does more than what you think. It is unfair to criticize China without acknowledging what the country has done.

3. How Far Can Developing Country Commitments Go in an Immediate Post-2012 Climate Regime?

In the meantime, China is signaling its recognition of the increasing importance of climate change issues. China released the National Climate Change Program on June 4, 2007. This program is the first national program of its kind in developing countries, and requires to cut the country's greenhouse gas emissions by 950 $MtCO_2$ equivalent per year by 2010 (NDRC, 2007b). To fulfill that goal and better coordinate efforts and responses to climate change, China has reshuffled the existing National Coordination Committee on

[5] The estimates vary. Some estimates a reduction of over 1500 $MtCO_2$ if the goal of 20% energy intensity reduction in China would be met. Here I take the more conservative estimate from the Chinese government.

Climate Change (NCCCC), and elevated that minister-ranked official-led Committee into the National Climate Change Response Leading Group on June 12, 2007. This Group is now headed by Premier Wen Jiabao and includes 29 ministerial officials from 28 ministerial agencies. This clearly reflects that China is recognizing the increasing importance and complex of climate change issues. This importance is further illustrated by incorporating strengthening adaptability to adverse effects of climate change and contributing to combating global climate change into the Communiqué of the 17th Central Committee of the ruling Chinese Communist Party in October 2007 and incorporating climate issues in the 11th Five-year National Environmental Protection Blueprint in November 2007. In China, it has been a tradition that line programs/blueprints are always released by line ministries/agencies. Only comprehensive programs are released by the State Council, China's cabinet. The 11th Five-year National Environmental Protection Blueprint is for the first time released by the State Council. This clearly reflects the importance of environmental protection. That Blueprint also incorporates for the first time climate change into the category of environmental protection (e.g., control GHG emissions in industrial production, increase carbon sinks, and strengthen adaptability to climate change). Because the NDRC is in charge of the national development plan and national project evaluation and because climate change potentially has serious social and economic implications, China's top economic planning agency has recognized that it needs to strengthen its role in coordinating and implementing national efforts towards climate change. To that end, the NDRC has recently reshuffled the Climate Change Office - the executive office of the NCCCC and affiliated with its Department of Regional Economy, and has established the Department of Climate Change as one of its 28 independent and functional departments (Zhang, 2006a; NDRC, 2008a).

All this raises the expectation for China's commitments. What then can be expected from China? Many economic studies by Zhang (2000b and 2004) and those examined by Stanford University's Energy Modeling Forum (Weyant, 1999) show that China would reap significant benefits from participating in a global cap-and-trade regime. Even if such a regime is so beneficial to China, it has been suggested for China to participate in a global cap-and-trade regime. However, China has consistently refused to participate in international negotiations on this issue. Zhang (2007e) has examined why China has not embraced an international greenhouse gas emissions trading scheme from the following perspectives that impact upon China: a) fairness: how do developing countries perceive emissions caps?; b) why have China and India been skeptical about international emissions trading?; c) what would China's political perceptions be on an inflow of CDM investment in comparison with the exports of emissions permits to the U.S.?; d) what are the implications of "lock in" to an emissions cap, particularly when no rules and principles exist for setting emissions targets for post-2012?; and e) the complex question of establishing future emissions caps for developing countries.

Some American analysts (e.g., Stewart and Wiener, 2003) suggest joint accession by the U.S. and China as a way to move beyond the Kyoto impasse. This proposal does have the merit of enhancing environmental effectiveness of the Kyoto Protocol and helping stabilize the price of permits on the international market. It is certainly in the interest of

the U.S.. Zhang (2007c) argues that while the strengthened cooperation between the two largest emitters is crucial to any global efforts towards emissions reductions, joint accession by the U.S. and China is not in the interest of China by examining this issue from the following perspectives: a) how does China value importance of maintaining unity of the Group of 77?; b) what lessons has China learned from bilateral negotiations with the U.S. to work out the terms for China to get accession to the WTO?; c) what is the legitimacy of the U.S. insistence that it re-joins the Kyoto Protocol only if major developing countries join?; d) what are implications of the U.S. strikingly reversed position on the commitments of developing countries in New Delhi for initiating discussions on joint accession by the U.S. and China?; and e) how would joint accession by the U.S. and China be perceived?.

Even if such a regime is not an option for China at the time being, what other options can be expected from China? To address this issue, let us go back to international climate negotiations prior to Kyoto and subsequently until the U.S. withdrawal from the Kyoto Protocol.

Prior to Kyoto, developing counties' demand for the U.S. to demonstrate the leadership and the EU proposal for a 15% cut in emissions of a basket of three greenhouse gases below 1990 levels by 2010 put collective pressure on the U.S., which led the world in greenhouse gas emissions. At Kyoto, the U.S. had made legally binding commitments. The Kyoto target is seen as not enough but yet not unreasonable given that the U.S. economy would not be disrupted unreasonably. This may give the U.S. some "moral" right to persuade developing countries to take meaningful mitigation action. After Kyoto, the ball was kicked into China's court. The U.S. had made it clear that bringing key developing countries, including China, on board had been and would continue to be its focus of international climate change negotiations. According to some U.S. Senators, it will be countries like China, India and Mexico that will decide whether the U.S. will ratify the Kyoto Protocol. It is therefore conceivable that the pressure will mount for China to make some kind of commitments at the negotiations subsequent to Buenos Aires. The world's media will undoubtedly bring attention to China's non-participation, which will be seen as holding up the ratification of the Protocol by the U.S. Senate and possibly even be blamed for "blowing up" subsequent negotiations aimed at dealing with developing countries' commitments. The U.S. commitments at Kyoto and diplomatic and public pressure on China had put China in a very uncomfortable position. Under these circumstances, I envisioned a decade ago the following six proposals that could be put on the table as China's plausible negotiation position, which is described in ascending order of stringency (Zhang, 2000a).[6]

"**First**, China could regard its active participation in CDM as 'meaningful participation'. **Second**, just as Article 3.2 of the Kyoto Protocol requires Annex I countries to 'have

[6] Zhang (2000a) was originally prepared for the United Nations Development Programme in 1998. When the draft of that paper was ready, the Washington DC-based Resources for the Future made a press release titled "Is China Taking Actions to Limit Its Greenhouse Gas Emissions?", September 15, 1998.

made demonstrable progress' in achieving their commitments by 2005, China could commit to demonstrable efforts towards slowing its greenhouse gas emissions growth at some point between the first commitment period and 2020. Securing the undefined 'demonstrable progress' regarding China's efforts is the best option that China should fight for at the international climate change negotiations subsequent to Buenos Aires.

Third, if the above commitment is not considered 'meaningful', China could make voluntary commitments to specific policies and measures to limit greenhouse gas emissions at some point between the first commitment period and 2020. Policies and measures might need to be developed to explicitly demonstrate whether or not China has made adequate efforts. Such policies and measures might include abolishing energy subsidies, improving the efficiency of energy use, promoting renewable energies, and increasing the R&D spending on developing environmentally sound coal technologies.

Fourth, China could make a voluntary commitment to total energy consumption or total greenhouse gas emissions per unit of GDP at some point around or beyond 2020. In my view, carbon intensity of the economy is preferred to energy intensity of the economy (i.e., total energy consumption per unit of GDP), because all the efforts towards shifting away from high-carbon energy are awarded by the former.

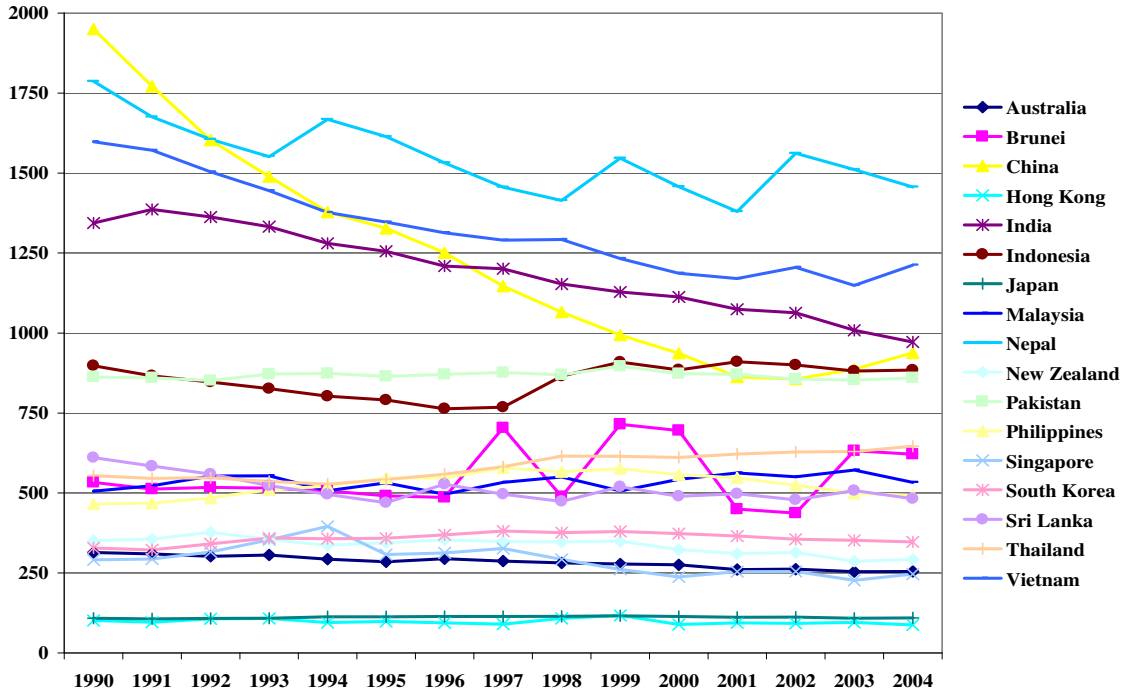
The fifth option would be for China to voluntarily commit to an emissions cap on a particular sector at some point around or beyond 2020. Taking on such a commitment, although already burdensome for China, could raise the concern about the carbon leakage from the sector to those sectors whose emissions are not capped.

This leads to **the final option** that China could offer: a combination of a targeted carbon intensity level with an emissions cap on a particular sector at some point around or beyond 2020. This is the bottom line: China cannot afford to go beyond it until its per capita income catches up with the level of middle-developed countries." At that time, it looked like China would be pressured to take on commitments at much earlier date than what China wished. This situation changed once the U.S. withdrew from the Kyoto Protocol.

Anyhow, international efforts towards a post-Kyoto climate regime continues. At the Bali Climate Change Conference in December 2007, all governments agreed to launch a far reaching negotiation process to reach an agreement to a successor to the Kyoto Protocol, with a clear deadline for the conclusion by 2009. The carbon intensity and sectoral approaches-based commitments, which were discussed in the academic literature ten years ago, are formally incorporated into the Bali roadmap. This is a very positive development, and clearly indicates the policy relevance of the once-sound-theoretical ideas. However, given the very short timeframe to conclude the negotiations, in all likelihood, it would be impossible to reach the necessary agreement on the rules, countries and sectors covered and the levels of ambitions for developing countries, especially due to the amount of the data that would be required. As it has been indicated by the Asian-Pacific Economic Cooperation (APEC) Leaders Summit in September 2007, setting a carbon intensity target, even if it is not binding, is not that easy. Australia, the

host country, proposed that all 21 APEC economies, regardless of whether they are developed and developing economies, agree to reduce energy intensity by at least 25% by 2030, but in the end the leaders only agreed to work towards achieving an *APEC-wide* (emphasis added) aspirational goal in energy intensity by at least 25% by 2030, relative to 2005 levels (Zhang, 2008a). This should not come as a surprise because energy use per unit of GDP, a key indicator of patterns of energy use, is still high in many developing Asian countries, and even increased in countries such as Brunei, the Philippines, Malaysia, South Korean and Thailand between 1990 and 2004. Indonesia and Pakistan consumed almost the same amount of energy per unit of GDP as they were in 1990 (Figure 7). Even the rate of energy efficiency improvement in IEA countries has been less than 1% per year since 1990 – much lower than in the previous decades (IEA, 2007a).

Figure 7 Energy use per unit of GDP in the selected Asia Pacific countries, 1990-2004 (Tons of oil equivalent/million 2000 US$).
Source: Zhang (2008a).



Moreover, it is inconceivable that developing countries would ever go beyond the aforementioned third option between 2013 and 2020 without an effective financial mechanism. This is the lesson learned from the Montreal Protocol.[7] The CDM under the Kyoto Protocol serves as a channel to provide finance and technology transfer to developing countries. The CDM market increased from 563 $MtCO_2$ equivalent of CERs

[7] See Zhang (2008b) for further discussion on the lesson learned from the Montreal Protocol and its implications for multilateral trade measures in a post-2012 climate regime as well as whether the funds established within the climate regime can deliver as the Multilateral Fund under the Montreal Protocol did.

and €3.9 billion in 2006 to 947 $MtCO_2$ equivalent of CERs and €12 billion in 2007 (Point Carbon, 2008). While the CDM has emerged as a financing mechanism to mitigate greenhouse gas emissions as the implementation of CDM projects has progressed, it still does not work to full potential scale. To that end, change needs to take place both at national and international levels. At the national level, for those developing countries that have not truly benefited from the CDM, they need to put in place clear institutional structures, streamlined and transparent CDM procedures and sound governance of clearer lines of responsibility and functions to facilitate the smooth implementation of CDM projects in their countries. At the international level, post-Kyoto climate negotiations need to reform the CDM to overcome its current structural limitations and to make it accommodate those players and types of small projects that have been left out to date. When taken together and combined, they will help to expand the number and geographical reach of the CDM, thus spreading its benefits to more countries (Zhang, 2008a). Nevertheless, markets cannot deliver miracles. Market instruments like CDM, as useful as it may be, must be complemented with traditional fund solutions that provide a stable source of funding.

Now let us have a look at the funds established within the climate regime. The Special Climate Change Fund, and the Least Developed Countries Fund are established under the UNFCCC. The contributions from these two funds are expected to be US$227 million a year (UNFCCC, 2007). The only fund under the Kyoto Protocol is the Adaptation Fund. The level of its funding depends on the quantity of CERs issued and their prices. Assuming annual sales of 300-450 million tons of CERs and a market price of US$24 per ton of CERs, the Adaptation Fund would receive US$80-300 million per year for the period 2008-2012 (UNFCCC, 2007). The Global Environment Facility (GEF) as an entity operating financial mechanism of the UNFCCC has targeted the amount of US$950 from its fourth replenishment at climate change projects over the period 2006-2010. Combined together, the pledges and contributions from all these three funds and the GEF Trust Fund are well below US$1 billion a year. By contrast, developing countries will need the investment of at least US$100 billion in climate change mitigation and adaptation. So, the contributions from all these three funds and the GEF Trust Fund only amount to less than one percent of the anticipated needs from developing countries. Unless this funding situation changes significantly, which is most unlikely to happen, developing countries cannot afford to make commitments beyond the third option above-envisioned a decade ago.[8]

Furthermore, the U.S. factor will continue to play a role in affecting developing country's willingness to take on commitments and the ambition of that commitments. Let us look at the Lieberman-Warner Climate Security Act of 2008 (S.3036), the most detailed bipartisan bill to date to require domestic, mandatory and economy-wide GHG emissions reductions in the U.S. beginning January 1, 2012. On June 6, 2008, the U.S. Senate debated and held votes on this bill. While it failed to secure the 60 votes needed to close

[8] See Zhang (2008c) for detailed discussion on estimates for developing country needs for climate change mitigation and adaptation and on the possibility of using these multilateral funds to leverage co-financing from other sources to close this financing gap.

debate on the bill and move to a final vote (i.e., to "invoke cloture"), the bill has made more headway than any of its precursors because it was the first time that a GHG cap-and-trade bill had ever come to the floor of the U.S. Senate through regular order—that is, having been debated and voted out of a committee. Both the presidential candidates John McCain and Barack Obama supported the bill in the Senate, and President Obama reiterated his campaign promise of a system to cap and trade greenhouse gas emissions in the U.S..Therefore, this Act is likely to serve as a template for any future bill. Under the Act, 87% of the U.S. GHG emissions are estimated to be subject to the emission caps that are set 19% below the 2005 level by 2020 (Pew Center on Global Climate Change, 2008). However, the U.S. GHG emissions were 16.8% higher in 2005 than that in 1990 (EIA, 2007), and not all emission sources are capped under the Act. As a result, even if the Act became law, the U.S. GHG emissions in 2020 would be probably still above their 1990 level. From a U.S. perspective, that emission reduction would appear quite ambitious and require serious actions and investment, but is still far short of a 7% reduction of the U.S. GHG emissions during the period 2008-2012 required by the Kyoto Protocol and a 25-40% cut by 2020 suggested by the IPCC and demanded by developing countries. In anticipation that the U.S. would take on the more stringent commitments subsequent to the first compliance period (namely, far below its 1990 level), I envisioned a decade ago that developing countries may go beyond the aforementioned third option. However, the U.S. emissions in 2020 are at best kept at their 1990 level as estimated under the Lieberman-Warner Climate Security Act. This is far from the point where it is likely that developing country would do that.

All this suggests that developing country commitments are most unlikely to go beyond the third option above-envisioned a decade ago. Rather than attempting the unrealistic goal, international climate negotiations may instead need to initially frame the post-2012 developing country participation in terms of certain policies and policies as envisioned in the aforementioned second and third options.

4. What Can Be Expected from China Domestically?

The question is then whether China can take on more stringent commitments than what might be agreed in the ongoing post-Kyoto negotiations. Let me make the point clear at the outset. The U.S. has both responsibility and capability (both economical and technological) to take the lead, but has not done so. Until the U.S. efforts have at least been elevated up to the point so it is viewed as a credible international partner, expecting China to commit internationally to specific emissions targets in the post-Kyoto discussions is unrealistic. In the meantime, China is anxious not to be cast as a global warming villain (The Economist, 2008). To show itself a good and constructive partner in combating global climate change, China needs to act as a large and responsible developing country and take due responsibilities, and to set a good example to the majority of developing countries, regardless of what commitments would be agreed on for developing countries in the ongoing post-Kyoto negotiations.

In my view, the best and most realistic way for China to demonstrate its role is to make credible domestic commitments to energy saving and the use of clean energy. They

include but are not limited to continuing to set energy-saving and pollutant control goals in the subsequent national five-year economic blueprints as challenging as the current 11th five-year blueprint does, increasing investment in energy conservation and improving energy efficiency, significantly scaling up the use of renewable energies and other low-carbon technologies, in particular wind power and nuclear power, and providing additional support policies to accomplish its own ambitious energy-saving and clean energy goals. Currently, China has set to decommission thousands of small, inefficient coal-fired power plants with an unit capacity of 50 MW or less. To the benefits of energy saving and the environment, China should consider doubling that unit capacity to 100 MW below which coal-fired plants need to be decommissioned.

Calling future goal as challenging as the current one requires to establish why the current 20% energy saving goal is considered very challenging. As discussed earlier, China sets the goal of cutting energy use per unit of GDP by 20% by 2010. In 2006, the first year of this energy efficiency drive, while China reversed a rise in its energy intensity in the first half of that year, the energy intensity only declined by 1.79% (revised from the originally reported 1.33%) over the entire year. Although this decline is for the first time since 2003, it is far short of the target of 4%. Among the 31 Chinese provinces or equivalent, only Beijing met that energy-saving goal in 2006, cutting its energy use per unit of GDP by 5.25%, followed by Tianjin, another metropolitan city in China, with the energy intensity reduction of 3.98%, Shanghai by 3.71%, Zhejiang by 3.52% and Jiangsu by 3.50% (NBS et al., 2007).[9] In 2007, despite concerted efforts towards energy saving, the country cut its energy intensity by 3.66% (revised from the originally reported 3.27%). There are still big variations in energy-saving performance among the 31 Chinese provinces or equivalent. Beijing still took the lead, cutting its energy intensity by 6%, followed by Tianjin by 4.9% and Shanghai by 4.66% (NBS et al., 2008). This clearly indicated the Beijing's commitments to the 2008 Green Olympic Games. In the meantime, there were 7 provinces whose energy-saving performances were below the national average. With the country's overall performance of the first two years, to meet that national energy intensity target would need the energy intensity reduction averaging 5.44% for each of the remaining three years. This required energy saving rate is even higher than the annual saving rate of 5.25% during the period 1980-2000 in which China achieved a quadrupling of its GDP while cutting its energy intensity by about three quarters (Zhang, 2003). Although it is not absolutely impossible to achieve that rate, it will certainly not be easy to do that. The country needs to further strengthen existing policies and measures towards energy saving. For example, China cut its total energy subsidies to around US$ 11 billion in 2006 (IEA, 2007b). This corresponds to a reduction of 58% compared to its 2005 level of around US$ 26 billion (Zhang, 2008a). On June 20, 2008, China further increased its producer prices of gasoline and diesel by about 20% (NDRC, 2008b). Despite this is encouraging, removing such subsidies is but a first step in getting the energy prices right. Further steps include incorporating the costs of resources themselves to reflect their

[9] Beijing is the first provincial region in China to establish in 2006 the bulletin system to release data on energy use and water use per unit of GDP, quarterly releasing these and other indicators by county. See Zhang (2007a, 2007d and 2007f) for detailed discussion on why Beijing met but the country missed the energy-saving goals.

scarcity and internalizing the costs of externalities. More importantly, China needs to significantly scale up its efforts towards strengthening industrial restructuring to keep the frenzied expansion of highly energy-consuming, highly-polluting and resource-intensive industries under control. While the decline in real energy intensity was the overwhelming contributor to the decline in China's industrial energy use in the 1980s and 1990s (Zhang, 2003), structural change in the next two years will be a decisive factor to determine whether China will meet its energy saving goal by 2010.

Moreover, shifting control over resources and decision making to local governments and enterprises as the result of the economic reforms in China over the past three decades has led to insufficient investment in energy saving, with its share in the total investment in the energy industry in China declining from about 13.4% in 1983 to the level of about 3% in 2005 (Zhang, 2007f). China needs to increase investment in energy conservation and improving energy efficiency. Faced with the prospect for not meeting the ambitious energy intensity target, the central government embarked Yuan 10 billion in mid 2007, in addition to Yuan 11.3 billion already allocated in early that year (the total of Yuan 21.3 billion, about US$ 3.2 billion, or 4.5% of the total investment in the energy sector in 2005) specifically for energy saving, of which Yuan 9 billion to support the Ten Key Energy-saving Programs, 13 times that of the funding support in 2006 (Yuan 0.68 billion). This is a helpful step in promoting energy conservation, but the amount of fund allocated for energy saving needs to further increase. To encourage local governments to eliminate outdated production capacities, I repeatedly called for payment of transfer both from the central government to provincial governments in the less developed regions and from the provincial governments to those cities and counties in which a large amount of outdated production capacities have been closed down. Moreover, the amount of that transfer needs to be indexed with the real energy saving as the result of closing down the production capacities. The Chinese government has gradually recognized the importance of the payment of transfer in getting local government's cooperation. This is reflected by the central government's decision in November 2007 to transfer Yuan 2 billion to provincial governments. This is a very positive development, but this amount of payment transfer is far short of the needs. It needs to further increase, in particular given that the central government only accounted for about 25% of the country's total government expenditure but received over 50% of the total government revenue in China (National Bureau of Statistics of China, 2008).[10] The good news is that the Chinese government has

[10] Since the tax-sharing system was adopted in China in 1994, taxes are grouped into taxes collected by the central government, taxes collected by local governments, and taxes shared between the central and local governments. All those taxes that have steady sources and broad bases and are easily collected, such as consumption tax, tariffs, vehicle purchase tax, are assigned to the central government. VAT and income tax are split between the central and local governments, with 75% of VAT and 60% of income tax going to the central government. As a result, the central government revenue increased by 200% in 1994 relative to its 1993 level. This led the share of the central government in the total government revenue to go up to 55.7% in 1994 from 22.0% in the previous year (see Table 7). In the meantime, the share of the central government in the total government expenditure just rose by 2%. By 2007, local governments only accounted for

recognized these needs, increasing the amount of fund allocated for energy saving to Yuan 41.8 billion in 2008 (including funding support for urban sewage treatment that was allocated to Yuan 4 billion in 2007) from Yuan 23.5 billion in 2007 (The State Council, 2008).

Table 7 Shares of the Central and Local Governments in the Government Revenue and Expenditure in China

	Government Revenue		Government Expenditure	
	Central Government (%)	Local Governments (%)	Central Government (%)	Local Governments (%)
1993	**22.0**	**78.0**	**28.3**	**71.7**
1994	**55.7**	**44.3**	**30.3**	**69.7**
1995	52.2	47.8	29.2	70.8
1996	49.4	50.6	27.1	72.9
1997	48.9	51.1	27.4	72.6
1998	49.5	50.5	28.9	71.1
1999	51.1	48.9	31.5	68.5
2000	52.2	47.8	34.7	65.3
2001	52.4	47.6	30.5	69.5
2002	55.0	45.0	30.7	69.3
2003	54.6	45.4	30.1	69.9
2004	54.9	45.1	27.7	72.3
2005	52.3	47.7	25.9	74.1
2006	52.8	47.2	24.7	75.3
2007	54.1	45.9	23.0	77.0

Source: National Bureau of Statistics of China (2008).

5. Conclusions

China overtaking the U.S. as the world's largest carbon emitter has put China on the spotlight, just at a time when the world community starts negotiating a post-Kyoto climate regime under the Bali roadmap. China seems to become such a Christmas tree on which everybody can hang his/her complaints. By examining China's own efforts towards energy saving, the widespread use of renewable energy and participation in clean development mechanism, this paper shows that CDM does not make much of a difference to China, but China is definitely making a difference to CDM. The overwhelming majority of the estimated CO_2 reduction from meeting China's 20% energy saving goal

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45.9% of the total government revenue, but their expenditure accounted for 77.0% of the total government expenditure in China. Objectively speaking, this improper tax-sharing scheme in China plays a part in driving local governments to seek higher GDP growths at the expense of the environment (Zhang, 2007a and 2008a).

by 2010 is expected to achieve through its own domestic actions, rather than support from the CDM projects. China clearly does more than what you think. It is unfair to criticize China without acknowledging what the country has done.

To point out the direction and focus of future international climate negotiations, the paper discusses how far developing country commitments can go in an immediate post-2012 climate regime. The paper argues that developing country commitments are most unlikely to go beyond the defined polices and measures in this timeframe. On this basis, the paper suggests that, rather than attempting the unrealistic goal, international climate negotiations may instead need to initially frame the post-2012 developing country participation in terms of certain policies and policies as envisioned a decade ago.
As the largest developing country, China has shown no inclination to commit internationally to specific emissions targets in the post-Kyoto climate discussions, at least until the U.S. has taken binding actions. In the meantime, China is anxious not to be cast as a villain. In my view, regardless of what commitments would be agreed on for developing countries in the ongoing post-Kyoto negotiations, the best and most realistic way for China to act as a large and responsible developing country and take due responsibilities is to make credible domestic commitments to energy saving and the use of clean energy. They include but are not limited to continuing to set energy-saving and pollutant control goals in the subsequent national five-year economic blueprints as challenging as the current 11th five-year blueprint does, increasing investment in energy conservation and improving energy efficiency, decommissioning those small, inefficient coal-fired power plants with an unit capacity of 100 MW or less, significantly scaling up the use of renewable energies and other low-carbon technologies, in particular wind power and nuclear power, and providing additional support policies to accomplish its own ambitious energy-saving and clean energy goals.

Given its very low level of GDP per capita, it is not a clear cut whether China has to commit to specific emissions targets until its per capita income reaches the certain level. Attempting to pressure on China on this may be a counterproductive way to engage China. For those who insist on this, perhaps the architect of China's economic reform Deng Xiaoping's well-acclaimed quote that "no matter whether it's a white cat or a black cat. It's a good cat so long as it catches mice" may help to change the way of thinking. Continuing to push along that line irritates China, but does not do any good to combat climate change. After all, the extent to which China cuts its greenhouse gas emissions matters most to climate change, not the way of commitments, be they domestic or international commitments, per se. The best strategy is to encourage China to take on stringent domestic actions to the extent possible and appreciate the Chinese efforts, and at the same time to enable China to do that by providing a package of positive incentives in the form of support for scaling up of technology transfer and deployment, financing and capacity building. That will accelerate China's future development along a more sustainable path. Given coal-dominated energy mix in China, energy saving and the widespread use of renewable energies also mean that larger amount of greenhouse gas emissions will be avoided than would otherwise have been the case. That helps to mitigate global climate change. Clearly, this is the win-win outcomes both for China and global climate change.

The paper focuses on China. However, it should be pointed out that the role of the U.S. is of paramount importance to either effective China-U.S. cooperation or global efforts towards climate control. The U.S. has led several multilateral efforts in this area, but has not taken the lead in global efforts towards combating global climate change. Winston Churchill said that "[you] can always count on the Americans to do the right thing – after exhausting every other alternative.". In my view, the U.S. leading the world in climate control or setting a good example for China may well be remembered as a case where Americans can do the right thing after exhausting at least some of the alternatives (Zhang, 2007c). There is a sign that U.S climate policy in the Obama administration will have dramatic departure from the previous one against mandatory emission cuts. However, whether such a major policy shift is quick and aggressive enough for a new climate treaty by December 2009 remains to be seen.

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Reference
An, F. and A. Sauer (2004), *Comparison of Passenger Vehicle Fuel Economy and GHG Emission Standards around the World*, Pew Center on Global Climate Change, Arlington, United States, December, Available at: http://www.pewclimate.org/docUploads/Fuel%20Economy%20and%20GHG%20Standards_010605_110719.pdf.

Beijing Municipal Commission of Development and Reform (BMCDR, 2006), The 11th Five-Year Development Program for Energy Conservation in the Building Sector of Beijing Municipal, September 8, Available at: http://www.beijing.gov.cn/zfzx/ghxx/sywgh/t662751.htm.

Earth Policy Institute (2008), Global Wind Power Capacity Reaches 100,000 Megawatts, Washington DC, March 4, Available at: http://www.earth-policy.org/Indicators/Wind/2008.htm.

EIA (2003), International Energy Outlook 2003, DOE/EIA0484(2003), U.S. Energy Information Administration (EIA), Washington, DC.

EIA (2006), International Energy Outlook 2006, U.S. Energy Information Administration (EIA), Washington, DC.

EIA (2007), Emissions of Greenhouse Gases in the United States 2006, DOE/EIA-0573(2006), U.S. Energy Information Administration (EIA), Washington, DC, November, Available at: http://www.eia.doe.gov/oiaf/1605/ggrpt/pdf/0573(2006).pdf.

European Commission (2007a), Communication from the Commission to the European Council and the European Parliament: An Energy Policy for Europe, Brussels, COM(2007) 1 Final, January 10, Available at: http://ec.europa.eu/energy/energy_policy/doc/01_energy_policy_for_europe_en.pdf.

European Commission (2007b), Energy for a Changing World: An Energy Policy for Europe - the Need for Action, Brussels, Available at: http://ec.europa.eu/energy/energy_policy/doc/2007_03_02_energy_leaflet_en.pdf.

Global Wind Energy Council (2009), US and China in Race to the Top of Global Wind Industry, Brussels, February 2, Available at: http://www.gwec.net/index.php?id=30&no_cache=1&tx_ttnews[tt_news]=177&tx_ttnews[backPid]=4&cHash=3a1c08c3ac.

IEA (2007a), *Energy Use in the New Millennium - Trends in IEA Countries*, International Energy Agency (IEA), Paris.

IEA (2007b), *World Energy Outlook 2007*, International Energy Agency (IEA), Paris.

Lecocq, F. and K. Capoor (2003), State and Trends of the Carbon Market 2003, Prototype Carbon Fund, The World Bank, Washington, DC, December 1.

National Bureau of Statistics of China (2008), *China Statistical Yearbook 2008*, China Statistics Press, Beijing.

National Bureau of Statistic (NBS), National Development and Reform Commission and National Energy Administration (2008), Bulletin on Energy Use per Unit of GDP and other Indicators by Region, Beijing, July 14, Available at: http://www.stats.gov.cn/tjgb/qttjgb/qgqttjgb/t20080714_402491870.htm.

National Bureau of Statistic (NBS), National Development and Reform Commission and Office of The National Energy Leading Group (2007), Bulletin on Energy Use per Unit of

GDP and other Indicators by Region, Beijing, July 12, Available at: http://hzs.ndrc.gov.cn/newjn/t20070809_152873.htm.

National Development and Reform Commission (NDRC, 2006), The Top 1000 Enterprises Energy Conservation Action Program, NDRC Environment & Resources [2006] No.571, Beijing, April 7, Available at: http://hzs.ndrc.gov.cn/newzwxx/t20060414_66220.htm.

National Development and Reform Commission (NDRC, 2007a), The 11th Five-Year Blueprint for Energy Development, Beijing, April, Available at: http://www.ccchina.gov.cn/WebSite/CCChina/UpFile/File186.pdf.

National Development and Reform Commission (NDRC, 2007b), National Climate Change Program, Beijing, June 4, Available at: http://www.ccchina.gov.cn/WebSite/CCChina/UpFile/File188.pdf.

National Development and Reform Commission (NDRC, 2008a), The State Council Approved the NDRC's New Portfolio and the Corresponding Department Establishments and the Number of Staffs, Beijing, August 21, Available at: http://www.ndrc.gov.cn/xwfb/t20080821_231799.htm.

National Development and Reform Commission (NDRC, 2008b), A Circular on Adjusting Prices of Oil Products, NDRC[2008] No. 205, Beijing, June 19, Available at: http://www.ndrc.gov.cn/zcfb/zcfbtz/2008tongzhi/t20080620_219171.htm.

National Development and Reform Commission (NDRC, 2008c), China Had Decommissioned Fossil Fuel-Fired Small Plants with a Total Capacity of 25.87 GW since January 1, 2006, Beijing, July 14, Available at: http://nyj.ndrc.gov.cn/sdyx/t20080714_224054.htm.

National Development and Reform Commission (NDRC) and National Bureau of Statistic (NBS) (2007), Bulletin on Energy Use of the Top 1000 Enterprises, Beijing, September 18, Available at: http://www.sdpc.gov.cn/zcfb/zcfbgg/2007gonggao/W020071009598162122784.pdf.

Netherlands Environmental Assessment Agency (MNP, 2007), China Now No. 1 in CO_2 Emissions; USA in Second Position, June 19, Available at: http://www.mnp.nl/en/dossiers/Climatechange/moreinfo/ChinanowNo1inCO2emissionsUSAinsecondposition.html.

People Net (2008a), Adjustments for Vehicle Excise Taxes Will Take Place Since September 1, Up for Cars with Large Engines and Down for Small Cars to 1%, August 14, Available at: http://auto.people.com.cn/GB/1049/7663221.html.

People Net (2008b), Prices of Oil Products Go Up, and Drivers Line up in the Night to Fill, October 7, Available at: http://energy.people.com.cn/GB/8135477.html.

Pew Center on Global Climate Change (2008), Summary of the Boxer Substitute Amendment to the Lieberman-Warner Climate Security Act, June 4, Available at: http://www.pewclimate.org/docUploads/L-WFullSummary.pdf.

Point Carbon (2008), Carbon 2008: Post-2012 Is Now, March 11.

Renewable Energy Policy Network for the 21st Century (REN21, 2008), *Renewables 2007 Global Status Report,* Paris.

Sina Net (2006), Special Topic on Paying Close Attention to Adjustments in Consumption Tax Policy, Available at: http://finance.sina.com.cn/focus/gzxfstz/index.shtml.

Sina Net (2008), WTO Rules For the First Time China's Violation of its Trade Provisions, February 14, Available at: http://news.sina.com.cn/c/2008-02-14/165514939341.shtml.

Stewart, R.B and J.B. Wiener (2003), *Reconstructing Climate Policy: Beyond Kyoto*, American Enterprise Press, Washington, DC.

The Economist (2008), China, India and Climate Change: Melting Asia, June 7, pp. 29-32.

The State Council (2008), Work Plan for Energy Saving and Pollution Cutting, Beijing, July 15, Available at: http://www.ccchina.gov.cn/cn/NewsInfo.asp?NewsId=14127.

UNEP Risoe Center (2008), CDM and JI Pipelines by September 1, Denmark, Available at: http://www.cdmpipeline.org/Publications/CDMPipeline.xls.

UNFCCC Secretariat (2007), Report on Analysis of Existing and Potential Investment and Financial Flows Relevant to the Development of an Effective and Appropriate International Response to the Climate Change, Dialogue Working Paper No. 8, Prepared for the Fourth Workshop under the Dialogue on Long-Term Cooperative Action to Address Climate Change by Enhancing Implementation of The Convention, August 27-29, Vienna, Available at: http://unfccc.int/files/cooperation_and_support/financial_mechanism/financial_mechanism_gef/application/pdf/dialogue_working_paper_8.pdf.

Weyant, J.P. (ed., 1999). The Cost of the Kyoto Protocol: A Multi-model Evaluation. *Energy Journal*, Vol. 20, Special Issue on the Cost of the Kyoto Protocol, pp. 1-398.

Xinhua Net (2005), Beijing Starts State Phase III Standards Today, December 30, Available at: http://news.xinhuanet.com/auto/2005-12/30/content_3987678.htm.

Xinhua Net (2007a), Beijing Reaffirms the Implementation of State Phase IV Vehicle Emission Standards as Planned, June 8, Available at: http://news.xinhuanet.com/auto/2007-06/08/content_6213918.htm.

Xinhua Net (2007b), Delays in the Implementation of State Phase III Vehicle Emission Standards, July 7, Available at: http://auto.sina.com.cn/news/2007-07-07/1015290457.shtml.

Xinhua Net (2007c), China Auto Lies in the Turning Point of Being Environmentally-Friendly, and Energy Saving and Pollution Cutting Are Heavy Responsibility and Long Way to Go, June 9, Available at: http://auto.sina.com.cn/news/2007-06-09/0917282702.shtml.

Zhang, Z.X. (1999), Estimating the Size of the Potential Market for all Three Flexibility Mechanisms under the Kyoto Protocol, Prepared for the Asian Development Bank under contract TA-5592-REG, Faculty of Law and Faculty of Economics, University of Groningen, The Netherlands.

Zhang, Z.X. (2000a), Can China Afford to Commit itself an Emissions Cap? An Economic and Political Analysis, *Energy Economics*, Vol. 22, No. 6, pp. 587-614.

Zhang, Z.X. (2000b), Estimating the Size of the Potential Market for the Kyoto Flexibility Mechanisms, *Weltwirtschaftliches Archiv - Review of World Economics*, Vol. 136, No. 3, pp. 491-521.

Zhang, Z.X. (2001), An Assessment of the EU Proposal for Ceilings on the Use of Kyoto Flexibility Mechanisms, *Ecological Economics*, Vol. 37, No. 1, pp. 53-69.

Zhang, Z.X. (2003), Why Did the Energy Intensity Fall in China's Industrial Sector in the 1990s?, The Relative Importance of Structural Change and Intensity Change, *Energy Economics*, Vol. 25, No. 6, pp. 625-638.

Zhang, Z.X. (2004), Meeting the Kyoto Targets: The Importance of Developing Country Participation, *Journal of Policy Modeling*, Vol. 26, No. 1, pp. 3-19.

Zhang, Z.X. (2005), Sustainable Energy Development in China: Challenges Ahead to 2020, The Keynote Address at the International Conference on Staying Ahead of the Energy Scenarios, Bangkok, November 11.

Zhang, Z.X. (2006a), Towards an Effective Implementation of Clean Development Mechanism Projects in China, *Energy Policy*, Vol. 34, pp. 3691-3701.

Zhang, Z.X. (2006b), The World Bank's Prototype Carbon Fund and China, *Journal of Energy and Development*, Vol. 31, No. 2, pp. 157-171.

Zhang, Z.X. (2006c), Cutting Carbon Emissions While Making Money: A Wishful Thinking or A Win-Win Opportunity?, The Keynote Address at the Plenary Session on Making Money from Saving Carbon at the 29th International Association for Energy Economics International Conference, Potsdam, Germany, June 8-10.

Zhang, Z.X. (2007a), China's Reds Embrace Green, *Far Eastern Economic Review*, Vol. 170, No. 5, pp. 33-37.

Zhang, Z.X. (2007b), China Is Moving away the Pattern of "Develop first and then Treat the Pollution", *Energy Policy*, Vol. 35, No. 7, pp. 3547-3549.

Zhang, Z.X. (2007c), China, the United States and Technology Cooperation on Climate Control, *Environmental Science & Policy*, Vol. 10, Nos.7&8, pp. 622-628.

Zhang, Z.X. (2007d), Greening China: Can Hu and Wen Turn a Test of their Leadership into a Legacy?, Presented at the Plenary Session on Sustainable Development at the first-ever Harvard College China-India Development and Relations Symposium, New York City, March 30 – April 2.

Zhang, Z.X. (2007e), Why Has China not Embraced a Global Cap-and-Trade Regime?, *Climate Policy*, Vol. 7, No. 2, pp. 166-170.

Zhang, Z.X. (2007f), Energy and Environmental Policy in Mainland China, The Keynote Address at the Cross-Straits Conference on Energy Economics and Policy, Organized by the Chinese Association for Energy Economics, Taipei, November 7-8.

Zhang, Z.X. (2008a), Asian Energy and Environmental Policy: Promoting Growth While Preserving the Environment, *Energy Policy*, Vol. 36, No. 10, pp. 3905-3924.

Zhang, Z.X. (2008b), Multilateral Trade Measures in a Post-2012 Climate Change Regime?: What Can Be Taken from the Montreal Protocol and the WTO?, Available at: http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1328548.

Zhang, Z.X. (2008c), How Far Can Developing Country Commitments Go in an Immediate Post-2012 Climate Regime?, *Energy Policy*, forthcoming, Available at: doi:10.1016/j.enpol.2009.01.016.

Zheng, X. and S. You (2007), Heat Reform in Tianjin China, Unpublished Manuscript, School of Environmental Engineering, Tianjin University, Tianjin, China.