FONDAZIONE ENI ENRICO MATTEI

NOTA DI LAVORO

92.2010

Assessing China's Energy Conservation and Carbon Intensity: How Will the Future Differ from the Past?

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SUSTAINABLE DEVELOPMENT Series
Editor: Carlo Carraro

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Summary

As an important step towards building a "harmonious society" through "scientific development", China has incorporated for the first time in its five-year economic plan an energy input indicator as a constraint. While it achieved a quadrupling of its GDP while cutting its energy intensity by about three quarters between 1980 and 2000, China has had limited success in achieving its own 20% energy-saving goal set for 2010 to date. Despite this great challenge at home, just prior to the Copenhagen climate summit, China pledged to cut its carbon intensity by 40-45% by 2020 relative its 2005 levels to help to reach an international climate change agreement at Copenhagen or beyond. This raises the issue of whether such a pledge is ambitious or just represents business as usual. To put China's climate pledge into perspective, this paper examines whether this proposed carbon intensity goal for 2020 is as challenging as the energy-saving goals set in the current 11th five-year economic blueprint, to what extent it drives China's emissions below its projected baseline levels, and whether China will fulfill its part of a coordinated global commitment to stabilize the concentration of greenhouse gas emissions in the atmosphere at the desirable level. Given that China's pledge is in the form of carbon intensity, the paper shows that GDP figures are even more crucial to the impacts on the energy or carbon intensity than are energy consumption and emissions data by examining the revisions of China's GDP figures and energy consumption in recent years. Moreover, the paper emphasizes that China's proposed carbon intensity target not only needs to be seen as ambitious, but more importantly it needs to be credible. Given that China has shifted control over resources and decision making to local governments as the result of the economic reforms during the past three decades, the paper argues the need to carefully examine those objective and subjective factors that lead to the lack of local official's cooperation on the environment, and concludes that their cooperation, and strict implementation and coordination of the policies and measures enacted are of paramount importance to meeting China's existing energy-saving goal in 2010, its proposed carbon intensity target in 2020 and whatever climate commitments beyond 2020 that China may take.

Keywords: Energy Saving, Renewable Energy, Carbon Intensity, Post-Copenhagen Climate Negotiations, Climate Commitments, China

JEL Classification: Q42, Q43, Q48, Q52, Q53, Q54, Q58

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The previous version: May 10, 2010
This version: May 24, 2010

Assessing China's Energy Conservation and Carbon Intensity: How Will the Future Differ from the Past?[1]

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Abstract
As an important step towards building a "harmonious society" through "scientific development", China has incorporated for the first time in its five-year economic plan an energy input indicator as a constraint. While it achieved a quadrupling of its GDP while cutting its energy intensity by about three quarters between 1980 and 2000, China has had limited success in achieving its own 20% energy-saving goal set for 2010 to date. Despite this great challenge at home, just prior to the Copenhagen climate summit, China pledged to cut its carbon intensity by 40-45% by 2020 relative its 2005 levels to help to reach an international climate change agreement at Copenhagen or beyond. This raises the issue of whether such a pledge is ambitious or just represents business as usual. To put China's climate pledge into perspective, this paper examines whether this proposed carbon intensity goal for 2020 is as challenging as the energy-saving goals set in the current 11th five-year economic blueprint, to what extent it drives China's emissions below its projected baseline levels, and whether China will fulfill its part of a coordinated global commitment to stabilize the concentration of greenhouse gas emissions in the atmosphere at the desirable level. Given that China's pledge is in the form of carbon intensity, the paper shows that GDP figures are even more crucial to the impacts on the energy or carbon intensity than are energy consumption and emissions data by examining

[1] Prepared for Ross Garnaut, Jane Golley and Ligang Song (Editors), *China: The Next Twenty Years of Reform and Development*, Australian National University E-Press and Brookings Institution Press. This book is launched at China Update 2010: The Next 20 Years of Reform and Development, Australian National University, Canberra, Australia, July 14, 2010.

the revisions of China's GDP figures and energy consumption in recent years. Moreover, the paper emphasizes that China's proposed carbon intensity target not only needs to be seen as ambitious, but more importantly it needs to be credible. Given that China has shifted control over resources and decision making to local governments as the result of the economic reforms during the past three decades, the paper argues the need to carefully examine those objective and subjective factors that lead to the lack of local official's cooperation on the environment, and concludes that their cooperation, and strict implementation and coordination of the policies and measures enacted are of paramount importance to meeting China's existing energy-saving goal in 2010, its proposed carbon intensity target in 2020 and whatever climate commitments beyond 2020 that China may take.

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1. Introduction

Since launching its open-door policy and economic reforms in late 1978, China has experienced spectacular economic growth and hundreds of millions of Chinese people have been raised out of poverty. During this time, however, China has been heavily dependent on dirty-burning coal to fuel its rapidly growing economy. This has given rise to unprecedented environmental pollution and health risks. On top of these environmental stresses, projected global climate change is expected to pose additional threats to China in the foreseeable future.

As the world's largest carbon emitter, China is facing great pressure both inside and outside international climate negotiations to be more ambitious in combating climate change. China, from its own perspective can not afford to and, from an international perspective, is not allowed to continue on the conventional path of encouraging economic growth at the expense of the environment. Instead, a range of environmental concerns and pressures have sparked China's determination to improve energy efficiency and to increase the use of clean energy in order to help its transition to a low-carbon economy.

China achieved a quadrupling of its GDP with only a doubling of energy consumption between 1980 and 2000 (Zhang, 2003). Following the trends of the 1980s and 1990s, the United States Energy Information Administration (EIA) (2004) estimated that China's CO_2 emissions were not expected to catch up with the world's largest carbon emitter until 2030. However, China's energy use had surged since the turn of this century, almost doubling between 2000 and 2007. Despite similar rates of economic growth, the rate of growth in China's energy use during this period (9.74% per year) was more than twice that of previous two decades (4.25% per year) (National Bureau of Statistics of China, 2009). This change in energy intensity was responsible for an increase of 20 million tons of carbon (MtC) emissions during the period 2001-2007, compared with a reduction of 576 MtC over the period 1980-2000 (Zhang, 2009d). As a result, China became the world's largest carbon emitter in 2007.

To reverse this trend, China has incorporated for the first time in its five-year economic plan an input indicator as a constraint – requiring that energy use per unit of GDP (energy intensity) be cut by 20% during the 11th five-year period running from 2006 to 2010. This is widely considered an important step towards building a "harmonious society" through "scientific development". Just prior to the Copenhagen climate summit, China further pledged to cut its carbon intensity by 40-45% by 2020 relative its 2005 levels in order to help to reach an international climate change agreement at Copenhagen or beyond.

This paper focuses on assessing China's energy conservation to date and its proposed carbon intensity target.[2] It first discusses China's own efforts towards energy saving and pollution cutting, and the widespread use of renewable energy. Next, to put China's proposed carbon intensity target into perspective, the paper examines whether the proposed carbon intensity goal for 2020 is as challenging as the energy-saving goals set

[2] See Zhang (2000 and 2009a,b,c) for detailed discussion on China's climate strategies regarding the format and timeframe that it would take on climate commitments.

in the current 11th five-year economic blueprint, to what extent it drives China's emissions below its projected baseline levels, and whether China will fulfill its part of a coordinated global commitment to stabilize the concentration of greenhouse gas emissions in the atmosphere at the desirable level. No doubt, as long as China's pledges are in the form of carbon intensity, the reliability of both emissions and GDP data matters. The paper then addresses reliability issues concerning China's statistics on energy and GDP. Given that China has shifted control over resources and decision making to local governments during the last three decades, effective environmental protection must be placed in the context of government decentralization. Finally, the paper argues the need to carefully examine those objective and subjective factors that lead to the lack of local official's cooperation on the environment, and concludes that their cooperation, strict implementation and coordination of the policies and measures enacted are of paramount importance to meeting China's existing energy-saving goal in 2010, its proposed carbon intensity target in 2020 and whatever climate commitments beyond 2020 that China may take.

2. Increasing energy efficiency and cutting pollutants

While China has been calling for energy saving since the early 1980s, the country has set, for the first time, the goal of cutting energy intensity 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 1, but since 2002 China has experienced faster energy consumption growth than economic growth, which translates into rising energy intensity, suggesting that achieving this cut in energy intensity will be extremely challenging (Zhang, 2005 and 2007d). Given that industry accounts for 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 the current 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 a surge in energy use in heavy industry, the Chinese government started levying export taxes in November 2006 on energy- and resource-intensive products to discourage their exports and to save scarce energy and resources. This includes a 5% export tax on oil, coal and coke, a 10% tax on non-ferrous metals, some minerals and 27 other iron and steel products, and a 15% tax on copper, nickel, aluminum and other metallurgical products.[3] From July 2007, China eliminated or cut export tax rebates for 2831 exported items. This is considered 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. The export tax rebates on these products were completely eliminated. This policy will help to enhance energy efficiency and rationalize energy and resource-intensive sectors as well as control soaring exports and deflate the ballooning trade surplus (Zhang, 2008).

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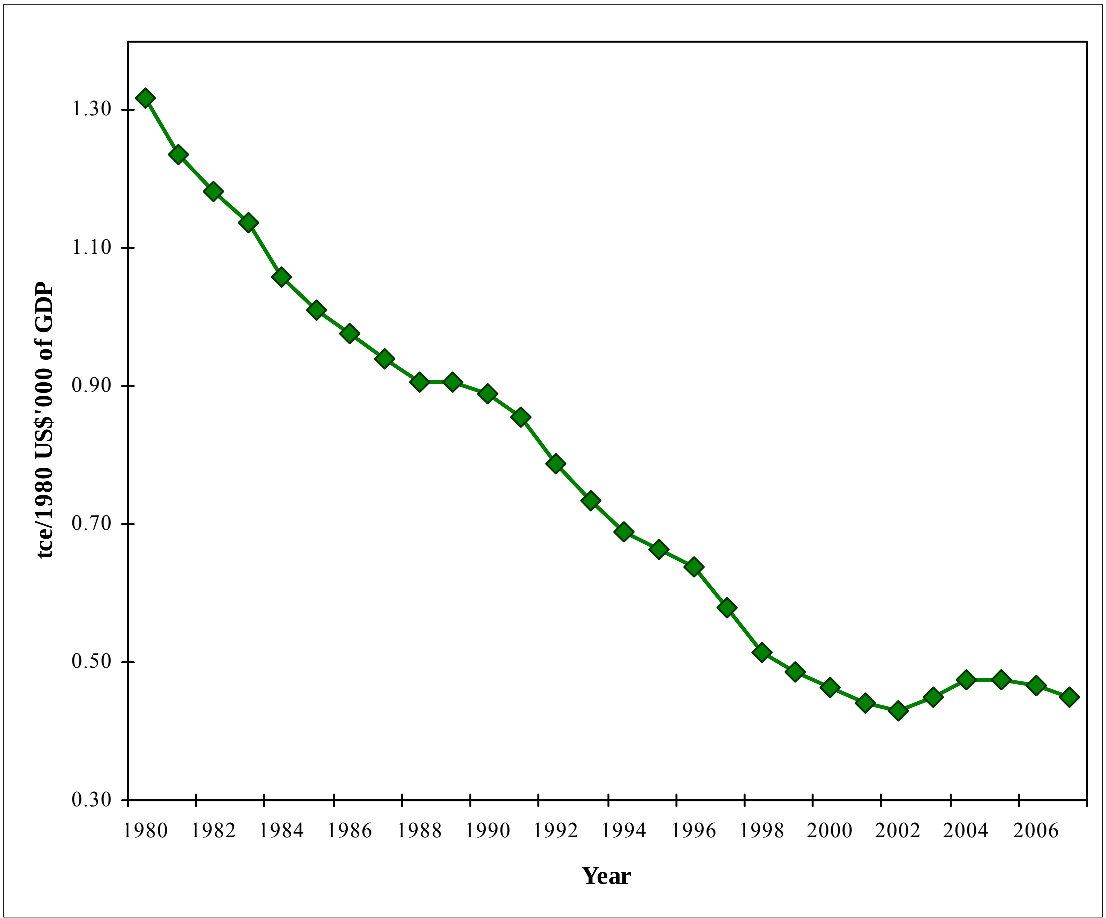
[3] See Zhang (2009c) for discussion on links between China's own export taxes and carbon tariffs proposed in the U.S. congressional climate legislations.

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. These enterprises each 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, 2006a). In May 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 that the goal is met, achieving energy efficiency improvements has become a criteria for job performance evaluations of the heads of these enterprises. The first year's results of the program's implementation are encouraging, with more than 95% of these enterprises appointing energy managers, and the program achieving energy savings of 20 million tce in 2006 (NDRC and NBS, 2007). In 2007, the energy saving of 38.17 million tce was achieved, almost doubling the amount of energy saving in 2006. If savings continue at the 2007 rate, the top-1000 program will exceed its target (NDRC, 2008b).

As the largest coal consumer, power generation currently consume over half of the total coal used in China. This share is expected to rise well above 60% in 2020, given the rapid development of coal-fired power generation. Thus, efficient coal combustion and power generation is of paramount importance to China's endeavor of energy saving and pollution cutting. To that end, China has adopted the policy of accelerating the closure of thousands of small, inefficient coal- and oil-fired power plants. Units facing closure include those below 50 MW, those below 100 MW and having in operation of over 20 years, those below 200 MW and having reached the end of their design life, those with a coal consumption of 10% higher than the provincial average or 15% higher than the national average, and those that fail to meet environmental standards. The total combined capacity that needs to be decommissioned is set at 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, 2008a). By the end of the first half of 2009, the total capacity of decommissioned smaller and older units had increased to 54 GW, meeting the 2010 target one and half years ahead of schedule (Sina Net, 2009).

The Chinese government's policy has concurrently focused on encouraging the construction of larger, more efficient, and cleaner units. By June 30, 2009, 64% of coal-fired units comprised units with capacities of 300 MW or more (Wang and Ye, 2009). Due to higher thermal efficiency and relatively low unit investment costs, China's power industry has listed super critical power generation technology as a key development focus. As a result, an increasing number of newly built plants are more efficient supercritical (SC) or ultra-supercritical (USC) plants. By 2007, the share of SC and USC units in total coal-fired generation capacity was about 12%. In comparison, the corresponding share is about 70% in Japan and 30% in the U.S. However, as all new units of 600 MW and above are required to be SC and half of these will be USC between 2010 and 2020, their share in total coal-fired generation capacity is expected to grow to 15% by 2010 and 30% by 2020 (Huang, 2008; IEA, 2009a).

Figure 1 Energy use per unit of GDP in China, 1990-2007 (tons of coal equivalent per US$ 1000 in 1980 prices).
Source: Drawn based on *China Statistical Yearbook*, various years.



For residential buildings, China has taken 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. Second, China requires that new buildings be 50% more efficient by 2010. Third, the energy-saving goal is to be increased to 65% for new buildings by 2020 (Zhang, 2005 and 2008). Tianjin is the first metropolitan city in China to embark on reform for heat supply and charge. By the end of 2006, 73.49 million m^2 energy-efficient residential buildings were built in this city, accounting for 47.8% of total residential buildings (Zheng and You, 2007). In Beijing, the building sector consumed 28% of 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. All these energy-efficient buildings in Beijing accounted for 65.1% of its total residential buildings. Beijing plans that all new residential buildings will have to meet with the 65% more energy-efficient standards by 2010, one decade ahead of the national schedule (BMCDR, 2006).

In the transport sector, the excise tax for vehicles has been adjusted over time to incentivise the purchases of energy-efficient cars. The excise tax levied at the time of purchase was first introduced in 1994, and the rate increases with the size of the engine, set at 3% for cars with engines of 1.0 litre or less, 8% for cars with engines of more than 4 litres, and 5% for cars with engines in between. These tax rates for cars remain unchanged. The new vehicle excise tax implemented since April 2006 has broadened the tax base from the existing range of 3-8% to 3-20%, and to six categories of engine size. Table 1 demonstrates clearly the large, upward adjustment in the consumption tax on gas-guzzling cars over time, which reflects the Chinese government's determination to use consumption taxation as an important economic instrument to achieve its policy goals on energy conservation and environmental protection. Moreover, China cut the purchase tax rate for cars with engines of 1.6 litres or less from the normal rate of 10% to 5% in 2009 and 7.5% in 2010. While this rate cut is motivated for stimulating the economy in the economic crisis, it practically benefits energy saving and pollution cutting as well.

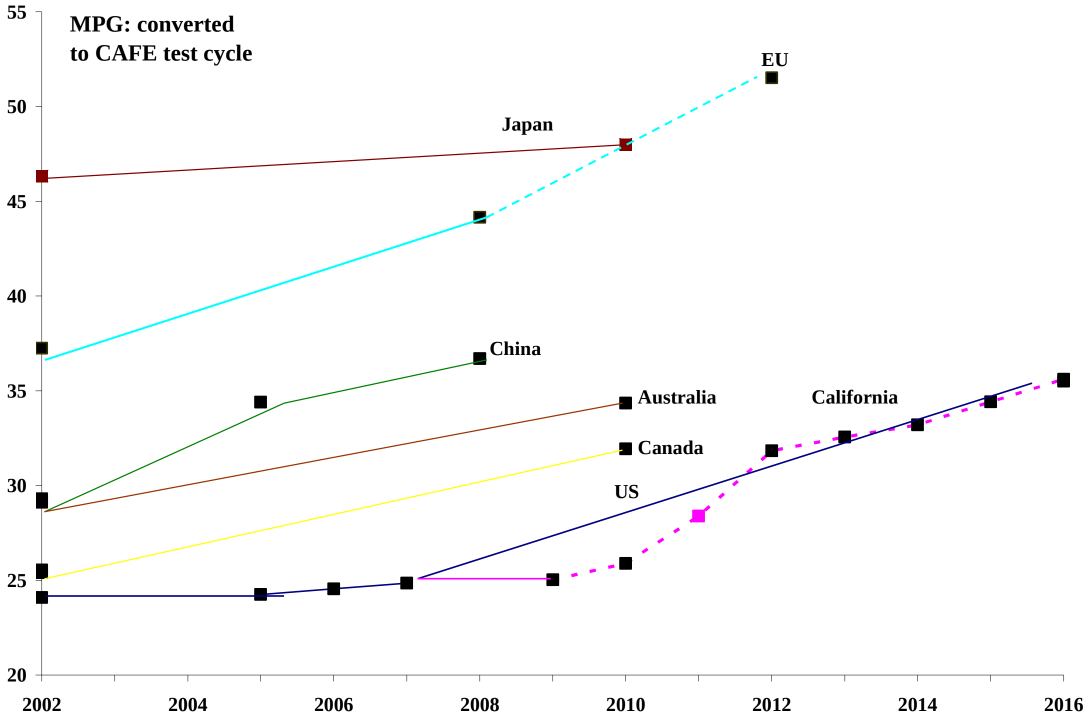
Table 1 Consumption Tax Rates for Cars in China

Engine (litres)	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 (2008).

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 2). Implemented in two phases, the standards classify vehicles into 16 weight classes, covering passenger cars, SUVs and multi-purpose vans. Converted to the U.S. CAFE (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).

Figure 2 Comparison of Fuel Economy Standards for Vehicles
Notes: Dotted lines denote proposed standards; MPG – Miles per gallon.
Source: Adapted from 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 the 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 2). Pollution from State Phase III standards is 30% lower than that from State Phase II standards. Pollution from State Phase IV standards goes down below 60% of that from State Phase II standards (Xinhua Net, 2007). Clearly, vehicle emission standards in China have become increasingly stringent over time. New vehicles that do not comply with the new standards cannot be sold in China. While China is at about the same levels of vehicle emission standards as India and most of ASEAN (Association of Southeast Asian Nations) countries, it is a couple of years ahead of these countries in its time schedules to implement these regulations. Also while China still lags behind the European Union's emissions requirements for new vehicles, its gap with the EU requirements has gradually fallen from about nine years in 2001 to five and a half years in 2010. Clearly, these new standards will help to reduce substantially the environmental stress in China.

Table 2 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 (2008).

3. The use of renewable energy

Concerns about a range of environmental problems and health risks from burning fossil fuels and steeply rising oil consumption have sparked China's plans to pursue alternative energy sources to meet the country's increasing energy needs. China has targeted alternative energy sources to meet up to 15% of the nation's energy requirements by 2020, up from 8.9% in 2008. 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 (GW) for hydropower (including large hydropower), 30 GW for wind power and 30 GW for biopower (power generated from biomass), and to produce 10 million tons of ethanol and 2 million tons of biodiesel by 2020 (Zhang, 2007b).

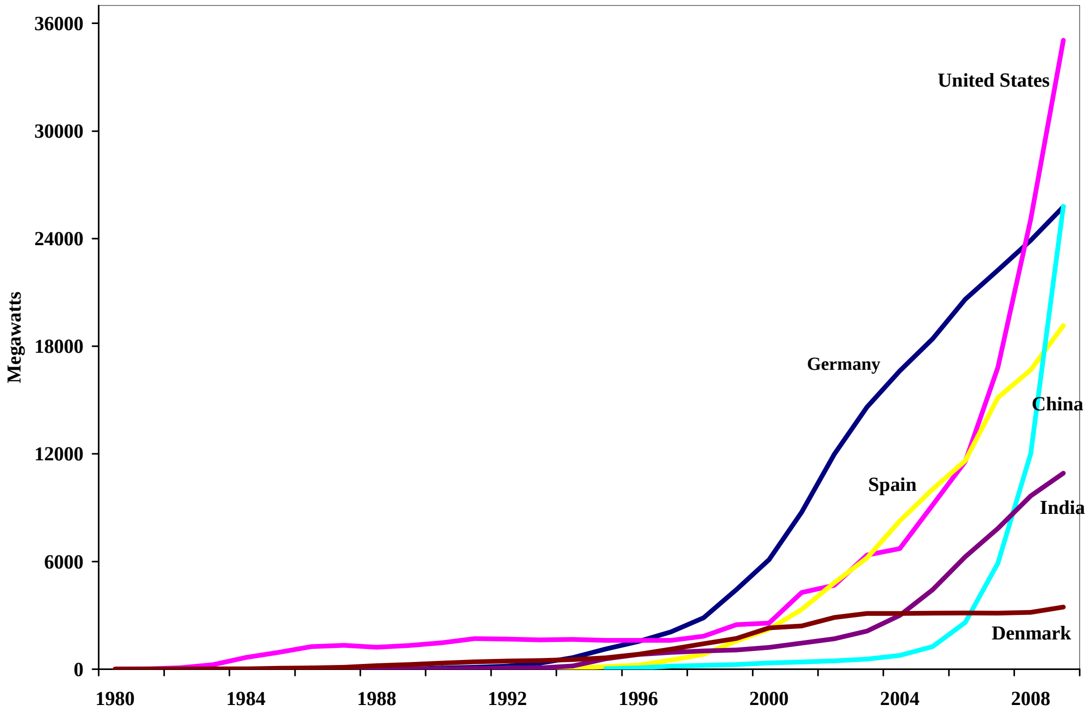
The European Union is widely considered to be the world's leader in renewable energy. The EU aims at renewable energies meeting 12% of its primary energy by 2010 and 20% by 2020 from its current level of 6.5% (European Commission, 2007a,b). At first glance, the EU's goal of tripling the share of renewable 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 of the EU.

Not only is China setting extremely ambitious renewable energy goals, more importantly it is taking dramatic efforts to meet these goals. China invested $34.6 billion in renewable energy in 2009, causing the U.S. to lose the top spot for the first time in five years with a distant second in total investment of $18.6 billion. In terms of renewable energy investment as a percentage of GDP, China with 0.39% invested three times more than the U.S. with 0.13% in 2009. With an installed capacity of 52.5 GW, China ranked second in the world's total renewable energy capacity in 2009, just slightly behind the U.S. with 53.4 GW (Pew Charitable Trusts, 2010).

With wind power identified as a priority for diversifying China's energy mix, this sector has been the primary receipt of renewable energy investment and favourable policies in recent years. In 2003, China had adopted the so-called Wind Power Concession Program as its primary strategy to further promote wind power development. Feed-in tariffs enacted in 2005 took effect on January 1, 2006 in China. This government-run program auctions off development rights for wind power projects of 100 MW or more for a 25 year period, which include a guaranteed tariff for the first 30,000 hours, as well as concession operation agreements. Such on-grid tariff of wind power is decided through a competitive bidding process. If such a tariff is higher than the reference on-grid tariff of desulfurized coal-fired power, then the difference will be shared in the selling price at the provincial and national grid levels. For the remainder of the period (namely, after the first 30,000 hours until the ending of the total concession period of 25 years), the tariff of wind power is set to be equal to the average local on-grid tariff. Other policies have included a halving of the value added tax for wind power from the normal rate of 17% to 8.5%; lower duty rates levied on domestic investment in wind power (6% compared with the normal rate of 23%); and duty free for equipments imported for renewable energy technologies in joint ventures. Some local governments have provided even more favorable policies. For example, in Inner Mongolia, a value-added tax of 6% is levied on 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 Energy Law entering into force in January 2006, the pace of installations 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 five consecutive years (see Figure 3). With total installed capacity of 5.9 GW 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. During this process, local wind turbine makers, such as Sinovel Wind, Goldwind Science and Technology, and Dongfang Electric, accounted for an increasing share of total new installations. Together they now supply over 50% of a market dominated by foreign firms until 2008. Sinovel and Goldwind are now among the world's top five turbine manufacturers.

Figure 3 Cumulative Installed Wind Power Capacity by Country, 1980-2009
Sources: Drawn based on data from Global Wind Energy Council (2010) and Earth Policy Institute (2008).



In its response to the economic crisis, the Chinese government has identified the development of wind power as one of the areas of economic growth. With new installations of 13.8 GW in China, relative to that of 10.0 GW in the U.S., China overtook the U.S. as the top world's wind power market in 2009. With a total installed capacity of 25.8 GW, China slipped past Germany to become the second place in total wind power installations in 2009 by a very narrow margin (Global Wind Energy Council, 2010). While the U.S. continues to have a comfortable lead in terms of total installed capacity, at this growth rate of new capacity installations, China would overtake the U.S. in 2010 to become global leader in installed capacity, and would have met its 2020 target of 30 GW ten years ahead of schedule. Indeed, since 2008 China has been planning and designing the so-called mega wind-power base program, which aims to build a combined wind capacity of 127.5 GW by 2020 in six selected Chinese provinces. Implemented as scheduled, this program is expected to increase China's total installed capacity of wind power to 150 GW or more by 2020, five times the 30 GW target as set as late as September 2007.

With both power demand and new installations of wind power capacity increasing faster than planned, and further deterioration of the environment, China is set to raise its wind power target. The country now aims to have at least 100 GW of wind power capacity in operation by 2020. This revised target is 70 GW more than the current 30 GW target, four times its current total wind power capacity, and more than the Great Britain's entire current power capacity. In addition, the NDRC enacted feed-in tariffs for wind power, which took effect on August 1, 2009. This means the ending of the controversial bidding-based program that had been in place since 2003. According to the quality of wind energy resources and the conditions of engineering construction, four wind energy areas are classified throughout China. Accordingly, on-grid tariffs are set at 0.51, 0.54, 0.58 and 0.61 Yuan/kWh as benchmarks for wind power projects across the nation, respectively (NDRC, 2009). The levels are comparable to the tariffs that the NDRC had approved in the past several years in most regions, and are substantially higher than that set through bidding. By letting investors know the expected rate of return on their projects through announcing on-grid tariffs upfront, the Chinese government aims to encourage the development of wind energy resources of good quality. In the meantime, this will encourage wind power plants to reduce the costs of investment and operation and increase their economic efficiency, thus promoting the healthy development of the whole wind industry in China.

However, it should be emphasised that while China has established a very ambitious wind power target, many local power grids are simply too small to carry all the wind power being generated. Wind turbines often have to wait 4 months or more before they are hooked up with the power grid. Of 5.9 GW of total installed capacity at the end of 2007, only 4 GW were plugged into the grid (Cyranoski, 2009). In the first quarter of 2010, the amount of wind power that was forced not to use because of not being hooked up with the grids reached almost 0.3 TWh. This is a significant amount of generation, given that the total wind power generation only reached 0.5 TWh in the same period (Chen, 2010). Thus, China needs to significantly improve its power grids and to coordinate the development of wind power with the planning and construction of power grids. New transmission lines will have to be constructed simultaneously as more wind power farms are built. Moreover, given the significantly scaled-up wind power capacity planned for 2020, China should now place more emphasis on companies ensuring the actual flow of power to the grid rather than just meeting capacity. In this regard, improving the quality of increasingly-used, domestically-made turbines is seen as crucial for this endeavor. While being less costly, domestic wind turbines in China break down more often and have overall capacity factors of several percentage points lower than foreign models. These few percentage points difference might not seem significant, but could well make a difference between a wind farm that is economically viable and one that is not.

4. China's proposed carbon intensity target: ambitious or business as usual?

Just prior to the Copenhagen climate summit, China pledged to cut its carbon intensity by 40-45% by 2020 relative its 2005 levels. A lot of discussion has since focused on whether such a pledge is ambitious or just represents business as usual (e.g., Qiu, 2009). China considers it very ambitious, whereas Western scholars (e.g., Levi, 2009) view it just business as usual. There are several ways to evaluate this issue.

One way is to see whether this proposed carbon intensity goal for 2020 is as challenging as the energy-saving goals set in the current 11th five-year economic blueprint. This requires first the establishment of why the current 20% energy-saving goal is considered very challenging. As discussed earlier, China sets a goal of cutting energy use per unit of GDP by 20% by 2010 relative to its 2005 levels. 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 1.8% over the entire year. Although this decline is a first since 2003, it was far short of the targeted 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 5.3%, followed by Tianjin, another metropolitan city in China, with the energy intensity reduction of 4.0%, Shanghai by 3.7%, Zhejiang by 3.5% and Jiangsu by 3.5% (NBS et al., 2007).[4] In 2007, despite concerted efforts towards energy saving, the country cut its energy intensity by 4.0% (NBS et al., 2009). Beijing continued to take the lead, cutting its energy intensity by 6%, followed by Tianjin by 4.9% and Shanghai by 4.7% (NBS et al., 2008). This clearly indicated Beijing's commitments to the 2008 Green Olympic Games. In the meantime, however, there were seven provinces whose energy-saving performances were below the national average. 2008 was the first year in which China exceeded the overall annualized target (4.4%) for energy saving, cutting its energy intensity by 4.6% (NBS et al., 2009). This was due partly to the economic crisis that reduced overall demand, in particular the demand for energy-intensive products. Overall, the energy intensity was cut by 10.1% in the first three years of the plan relative to its 2005 levels. This suggests that the country needs to achieve almost the same overall performance in the remaining two years as it did in the first three years in order to meet that national energy intensity target. Moreover, as discussed in the next section, these reductions in China's energy intensity have already factored in the revisions of China's official GDP data from the second nationwide economic census, part of the government's continuing efforts to improve the quality of its statistics, whose accuracy has been questioned by many both inside and outside of China. Such revisions show that China's economy grew faster and shifted more towards services than previously estimated, thus benefiting the energy intensity indicator. Even so, it will not be easy for China to achieve its 20% energy-saving goal. The new carbon intensity target set for 2020 requires an additional 20-25% on top of the existing target. Achieving this will clearly be even more challenging and costly for China.

Another way is to assess how substantially this carbon intensity target drives China's emissions below its projected baseline levels, and whether China does its part as required in order to fulfill a coordinated global commitment to stabilize the concentration of greenhouse gas emissions in the atmosphere at the desirable level. The World Energy Outlook (WEO) 2009 (IEA, 2009b) has incorporated many policies into the baseline projection that were not incorporated in the WEO 2007 (IEA, 2007). This projection puts China's baseline carbon emissions at 9.6 GtCO_2 in 2020. Under the ambitious parts per million (ppm) of CO_2 equivalent scenario, China's CO_2 emissions are projected to be 8.4 GtCO_2 by 2020, 1.2 GtCO_2 less than that in the baseline (IEA, 2009b). Now let us put

[4] See Zhang (2007a,c,d) for detailed discussion on why Beijing recorded the most success in achieving the energy-saving goals.

China's proposed carbon intensity target into perspective. My own calculations show that cutting the carbon intensity by 40-45% over the period 2006-2020 would bring reductions of 0.46-1.2 GtCO_2 in 2020, which are equivalent to a deviation of 4.8-12.7% below the WEO 2009 baseline set for China in 2020. Two key points need to be made. First, even the lower end of that range does not represent business as usual, because it represents a deviation of 4.8% below the WEO 2009 baseline levels. Second, if China would be able to meet its own proposed 45% carbon intensity cut, the country would cut emissions of 1.2 GtCO_2 in 2020 from its baseline levels as is required under the ambitious 450 ppm scenario. That is equivalent to 31.6% of what the world would need to do in 2020 under the 450 ppm scenario, a share higher than China's share of the world's total CO_2 emissions (28% in 2020). Clearly, the high end of China's target, if met, aligns with the specified obligation that China needs to fulfill under the 450 ppm scenario.

Arguably, China will claim to meet its carbon intensity target as long as it cut its carbon intensity by 40% over the period 2006-2020. This raises the stringency issue of this proposed intensity reduction. IEA (2009b) estimates that national policies under consideration in China would bring reductions of about 1 GtCO_2 in 2020. This suggests a carbon intensity reduction of 43.6% in 2020 relative to its 2005 levels, implying that the low end of China's carbon intensity target is conservative. Is there a big deal to emphasize this few percentage differences? It depends really on which country is in question. It may not matter much for a small country, but for China it matters a great deal. Given that China is already the world's largest carbon emitter and its emissions are projected to rise to 28% of the world's total in 2020, that 3.6% difference in reductions for China will translate into an over 10% difference in reductions for the world as a whole in that year.

Is there a room for China to increase its own proposed carbon intensity reduction of 40-45% by 2020? It would be hard, but not impossible. Given that many of policies considered in the WEO 2009 that will cut emissions of 1 GtCO_2 in 2020 from its baseline levels are not particularly climate-motivated, China could accelerate the speed of, and scale up the implementation, of such policies and enact additional policies with explicit considerations of climate mitigation and adaptation. This would bring additional reductions in China's carbon intensity.

What then is the yardstick or bound on the energy or carbon intensity of the Chinese economy in 2020? Assuming that China's economy grows at the annual average rate of 7.6% per year used for the WEO 2009 and that China is able to limit the growth of energy use to half the growth rate of the economy between 2006 and 2020, then China's energy use per unit of GDP would be cut by 42% by 2020, relative to its 2005 levels. This back-of-the-envelope calculation assumes an income elasticity of 0.5 between 2006 and 2020, as it was roughly during the 1980s and 1990s. However, given that China had experienced faster energy consumption growth than economic growth between 2002 and 2005, this is likely to be an underestimate in the future, which will result in higher emissions growth. Thus, a 42% cut in China's energy intensity by 2020 relative to 2005 levels is considered as an upper bound on China's energy intensity target. With carbon-free energy meeting 7.1% of China's total energy needs in 2005 (National Bureau of

Statistics of China, 2009) and that share mandated to be increased to 15%, this 42% cut in energy intensity is equivalent to a 50% cut in carbon intensity between 2006 and 2020, implying that there is a room for China to increase its own proposed carbon intensity reduction of 40-45% by 2020. China should therefore aim for a 46-50% cut in its carbon intensity over the period 2006-2020. IPCC (2007) recommends developing countries as a group to limit their greenhouse gas emissions to 15-30% below their baseline levels by 2020. This 46-50% carbon intensity reduction will lead to China's emissions reductions of 15-21% compared with its baseline levels in 2020. That will put China's absolute emissions reductions very much at the IPCC's recommended level.

5. Meeting China's carbon intensity: reliability issues of China's energy and GDP statistics

Having an ambitious commitment is one thing. Fulfilling that commitment is another issue. While the level of China's commitments is crucial in affecting the level and ambition of commitments from other countries, it is more important to know whether the claimed carbon emissions reductions are real. This raises reliability issues concerning China's statistics on energy and GDP.

China is not known for the reliability of its statistics (e.g., Rawski, 2001). China's refusal to budge on the United States' and other industrialised country's demands for greater transparency and checks at Copenhagen was cited by negotiator after negotiator as a key block to reaching a deal. As long as China's pledges are in the form of carbon intensity, the reliability of both emissions and GDP data matter.

Assuming the fixed CO_2 emissions coefficients that convert consumption of fossil fuels into CO_2 emissions, the reliability of emissions data depends very much on energy consumption data. Unlike the energy data in the industrial product tables in the *China Statistical Yearbook*, the statistics on primary energy production and consumption are usually revised in the year after their first appearance. As would be expected, the adjustments made to production statistics are far smaller than those made to consumption statistics, because it is easier to collect information on the relatively small number of energy producers compared to the large number of energy consumers. Table 3 shows the preliminary and final values for total primary energy consumption and coal consumption in China between 1990 and 2008. Until 1996 revisions of total energy use figures were several times smaller than in the late 1990s and early 2000s. The preliminary figures for total energy use in 1999-2001 were revised upwards by 8-10%. In all three years, these adjustments were driven by upward revisions of 8-13% made to the coal consumption figures to reflect unreported coal production mainly from small, inefficient and highly polluting coal mines. These coal mines were ordered to shut down through a widely-publicized nationwide campaign beginning in 1998, although many had reopened because in many cases local governments had pushed back to preserve local jobs and generate tax revenues as well as personal payoffs. In recent years, preliminary figures for energy use are almost the same as the final reported ones.

Table 3 Preliminary and Final Values for Total Primary Energy Consumption and Coal Consumption in China, 1990-2008

Year	Total primary energy consumption			Total coal consumption		
	Preliminary value (Mtce)	Final value (Mtce)	Adjustment (%)	Preliminary value (Mtce)	Final value (Mtce)	Adjustment (%)
1990	980.00	987.03	0.7	740.88	752.12	1.5
1991	1023.00	1037.83	1.4	777.48	789.79	1.6
1992	1089.00	1091.70	0.2	815.66	826.42	1.3
1993	1117.68	1159.93	3.8	813.67	866.47	6.5
1994	1227.37	1227.37	0.0	920.53	920.53	0.0
1995	1290.00	1311.76	1.7	967.50	978.57	1.1
1996	1388.11	1389.48	0.1	1041.08	1037.94	-0.3
1997	1420.00	1377.98	-3.0	1043.70	988.01	-5.3
1998	1360.00	1322.14	-2.8	973.76	920.21	-5.5
1999	1220.00	1338.31	9.7	818.62	924.77	13.0
2000	1280.00	1385.53	8.2	857.60	939.39	9.5
2001	1320.00	1431.99	8.5	884.40	955.14	8.0
2002	1480.00	1517.97	2.6	978.28	1006.41	2.9
2003	1678.00	1749.90	4.3	1125.94	1196.93	6.3
2004	1970.00	2032.27	3.2	1333.69	1381.94	3.6
2005	2233.19	2246.82	0.6	1538.67	1552.55	0.9
2006	2462.70	2462.70	0.0	1709.11	1709.11	0.0
2007	2655.83	2655.83	0.0	1845.80	1845.80	0.0
2008	2850.00*			1957.95*		

Notes: Mtce (million tons of coal equivalent).
* Data on energy and coal consumption in 2008 are preliminary value.
Source: Based on *China Statistical Yearbook*, various years.

Similarly, China first releases its preliminary GDP figures and then revises them. These revised GDP figures for the years 2005-2008 are further verified based on the second agricultural census released in February 2008 and the second nationwide economic census released in December 2009. With upward revisions of both GDP and the share of services, there is a big variation between the preliminary value for China's energy intensity and the final reported one. As shown in Table 4, such revisions lead to a differential between preliminary and final values as large as 45.5% for the energy intensity in 2006. With the government's continuing efforts to improve the quality of China's statistics, there is a downward trend of such a differential as a result of the revisions.

Table 4 A Reduction in China's Energy Intensity: Preliminary Value versus Final Value[a]

Year	Preliminary value (%)	Revised value (%)	Final value (%)	Differential between preliminary and final values (%)
2006	1.23 (March 2007)	1.33 (12 July 2007)	1.79 (14 July 2008)	**45.5**
2007	3.27 (March 2008)	3.66 (14 July 2008)	4.04 (30 June 2009)	**23.5**
2008	4.59 (30 June 2009)	5.2[b] (25 December 2009)		**13.3**
2009	3.98[c] (March 2010)			

Notes: [a] The dates when the corresponding data were released are in parentheses.
[b] Based on China's revised 2008 GDP from the second nationwide economic census, which raised the growth rate of GDP to 9.6% from the previously reported 9% for that year and the share of services in GDP.
[c] Own calculation based on the National Development and Reform Commission's reporting that China's energy intensity was cut by 14.38% in the first four years of the 11th five-year plan relative to its 2005 levels (Xinhua Net, 2010).

From the preceding discussion, it follows that GDP figures are even more crucial to the impacts on energy or carbon intensity than are energy consumption and emissions data. At Copenhagen, China eventually compromised to agree to open its emissions data to international consultation and analysis. The EU has identified building a robust and transparent emissions and performance accounting framework as a key element of implementing the Copenhagen Accord (European Commission, 2010). How all this will be worked out remains to be seen. China has not agreed to open its GDP figures to international consultation and analysis. As long as China's commitments are in the form of carbon intensity, establishing a robust and transparent emissions and performance accounting framework is helpful, but not enough to remove international concern about the reliability of China's commitments. The aforementioned revisions of China's GDP figures reflect part of the government's continuing efforts to improve the accuracy and reliability of China's statistics on economic activity. They are certainly not being calculated to make the energy intensity indicator look good to the government's advantage, although practically they do benefit this indicator. But such revisions have huge implications for meeting China's existing energy-saving goal in 2010 and its proposed carbon intensity target in 2020.

6. Central-local relations, energy savings and emission reductions

Given China's vast size and diversity, it is impossible for the central government in Beijing to operate single-handedly in pursuing nationwide energy-saving and environmental outcomes. The ability of, and incentives for, lower-level governments to effectively implement energy-saving and pollution-cutting policies are therefore critical, particularly since that the last three decades of economic reforms has witnessed a shift in the control over resources and decision making to local governments and enterprises.

This devolution of decision making to local governments has placed environmental stewardship in the hands of local officials. They are more concerned with economic growth, because under the current evaluation criterion for officials in China, local officials typically have been promoted based on how fast they expand their local economies. This distorted incentive system tempts officials to disregard the environmental costs of growth. Moreover, objectively speaking, the current fiscal system in China plays a part in driving local governments to seek higher GDP growth because that system makes it hard to reconcile the interests of the central and local governments (Zhang, 2007c,d and 2009a). 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 the 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, but its share in the total government expenditure just rose by 2%. By 2008, local governments only accounted for 46.7% of the total government revenue, but their expenditure accounted for 78.7% of the total government expenditure in China. To enable to pay their expenditure for culture and education, supporting agricultural production, social security subsidiary, etc, local governments have little choice but to focus on local development and GDP. That will in turn enable them to enlarge their tax revenue by collecting urban maintenance and development tax, contract tax, arable land occupation tax, urban land use tax, etc.

Another example of the improper tax-sharing scheme in China is related to differentiated tariffs. The NDRC ordered provincial governments to raise power tariffs for eight energy-guzzling industries from October 1, 2006 onwards (see Table 5), but many local governments failed to implement the differentiated tariffs that charge more for companies classified as “eliminated types” or “restrained types” in these industries, with 14 of them even continuing to offer preferential power tariffs for such industries. The reason for this failure is the lack of incentive for local governments to implement this policy, because all the revenue collected from these additional charges goes to the central government. To provide incentives for local governments, these revenues should be assigned to local governments, but the central government requires local governments to use the revenue specifically for industrial upgrading, energy saving and emissions cutting (Zhang, 2007c,d, 2008 and 2009a).

The evidence above suggests the need to carefully examine those objective and subjective factors that lead to the lack of local official’s cooperation on the environment, and to provide right incentives to get their cooperation. One way to ensure local officials realize that they should take their jobs seriously is developing criteria that incorporate energy conservation and environmental performance into the overall evaluation of local officials' performances. As discussed earlier, to ensure the energy-saving goal to be met under the "Top 1000 Enterprises Energy Conservation Action Program", achieving energy efficiency improvements has become a criteria for job performance evaluations of heads of these enterprises. This helps them realize that they should take their jobs seriously because they have a very real stake in meeting energy-saving goals. This should be strengthened, and is extended to have local officials to hold accountable for energy saving and pollution cutting in their regions. Evaluation of local officials should abandon the unique importance of GDP. Instead, evaluation needs to look not only at economic growth of a region, but even more at the model and quality of its development. There is an encouraging sign towards this direction, but is still far short of the needs, given huge challenges that China is facing.

Table 5 Differentiated Tariffs for Eight Energy-guzzling Industries in China

<table>
<tr><th colspan="2"></th><th>Existing Additional Charge (Yuan/kWh)</th><th>Additional Charge since October 1, 2006 (Yuan/kWh)</th><th>Additional Charge since January 1, 2007 (Yuan/kWh)</th><th>Additional Charge since January 1, 2008 (Yuan/kWh)</th></tr>
<tr><td rowspan="2">Eight energy-guzzling industries</td><td>Eliminated types</td><td>0.05</td><td>0.10</td><td>0.15</td><td>0.20</td></tr>
<tr><td>Restrained types</td><td>0.02</td><td>0.03</td><td>0.04</td><td>0.05</td></tr>
</table>

Source: NDRC (2006b).

Alleviating the financial burden of local governments is another avenue to incentivize them not to eye on economic growth alone. Enlarging their tax revenue is the key to helping them cover a disproportional portion of the aforementioned government expenditure. The central government really needs to cultivate steady and sizeable sources of revenues for local governments. Enacting property taxes or real estate taxes for local governments is urgently needed. In the tax-sharing system adopted in 1994, resource taxes on the shore are assigned to local governments, while the central government is collecting revenues from resource taxes off the shore. Currently, resource taxes in China are levied on the basis of extracted volume of resources. Starting in 1984, resource taxes have been levied at Yuan 2-5 per ton of raw coal and Yuan 8 per ton of coking coal, with the weighted average of Yuan 3.5 per ton of coal. For crude oil, the corresponding tax is levied at Yuan 8-30 per ton. While the prices of coal and oil have significantly increased since 1984, the levels of their resource taxes have remained unchanged over the past 25 years. In addition, current resource taxes are only levied on seven types of resources including coal, oil and natural gas. This coverage is too narrow, falling far short of the purposes of both preserving resources and protecting the environment. Thus, broadening the current coverage of resource taxation and significantly increasing the levied level based on revenues rather than volumes also help to increase local government's revenues while conserving resources and preserving the environment.

7. Conclusions

China achieved a quadrupling of its GDP with only a doubling of energy consumption between 1980 and 2000. However, since 2002 the country has experienced faster energy consumption growth than economic growth. To reverse this trend, China has incorporated for the first time in its five-year economic plan an input indicator as a constraint – requiring that energy use per unit of GDP be cut by 20% during the 11th five-year period running from 2006 to 2010. This is widely considered an important step towards building a "harmonious society" through "scientific development". Despite significant efforts towards energy saving, pollution cutting and the widespread use of renewable energy over the past four years, however, China has had limited success in achieving this goal to date.

While facing this great challenge at home and international pressure both inside and outside international climate negotiations to be more ambitious in limiting its greenhouse gas emissions, just prior to the Copenhagen climate summit, China pledged to cut its carbon intensity by 40-45% by 2020 relative its 2005 levels. This unilateral commitment clearly indicates China's determination to further decouple its energy use and carbon emissions from economic growth. The proposed carbon intensity target does certainly not just represent business as usual as some Western scholars have argued, because even the lower end of that target represents a deviation of 4.8% below the WEO 2009 baseline levels, not to mention a deviation of 12.7% below the WEO 2009 baseline levels at the higher end. On the other hand, that target may not be quite as ambitious as China argues, because national policies under consideration in China prior to the announcement of its carbon intensity target would already lead to a carbon intensity reduction of 43.6% in 2020 relative to its 2005 levels. Given that China is already the world's largest carbon emitter and its share in the world's total emissions continues to rise, even a few additional percentage reductions in its carbon intensity translate into a significant amount of global emissions reductions. It is hard, but is not impossible for China to increase its own proposed carbon intensity reduction target. We suggest that China should aim for a 46-50% cut in its carbon intensity over the period 2006-2020. That will put China's absolute emissions reductions very much at the IPCC's recommended level for developing countries.

China's proposed carbon intensity target not only needs to be seen as ambitious, but more importantly it needs to be credible. Ascertaining this credibility involves two issues. One is whether the claimed carbon emissions reductions themselves are real. This raises reliability issues concerning China's statistics on energy and GDP, given that China is not known for the reliability of its statistics. China's compromise at Copenhagen to agree to open its emissions data to international consultation and analysis is a start, although it remains to be seen how this works out in practice. As long as China's commitments are in the form of carbon intensity, establishing a robust and transparent emissions and performance accounting framework is helpful, but not enough to remove international concern about the reliability of China's commitments. The revisions of China's GDP figures and energy consumption in recent years reflect part of the government's continuing efforts to improve the accuracy and reliability of China's statistics on economic activity and energy use. Such revisions show that GDP figures are even more crucial to the impacts on the energy or carbon intensity than are energy consumption and emissions data. Such revisions have huge implications for meeting China's existing energy-saving goal in 2010 and its proposed carbon intensity target in 2020.

Another issue is whether China is really able to achieve its target, given that China has faced and continues to face great difficulty meeting its own set 20% energy-saving goal in 2010. China needs to further strengthen existing policies and measures towards energy saving. China has increased its prices of gasoline and diesel, and cut its total energy subsidies in recent years to provide incentives for efficient fuel use and adoption of clean technologies that reduce emissions at sources. Although this is encouraging, removing such subsidies is but a first step in getting the energy prices right. Further steps include incorporating the cost of resources themselves to reflect their 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. Moreover, given that China has shifted control over resources and decision making to local governments as the result of the economic reforms during the past three decades, it will also be crucial to ensure that local governments act in accordance with centrally-directed policies and have adequate funding to achieve their own policy goals.

Finally, it should be emphasised that enacting the aforementioned policies and measures targeted for meeting China's existing energy-saving goal in 2010 and its proposed carbon intensity target in 2020 signals the goodwill and determination of China's leaders. To actually achieve the desired outcomes, however, requires strict implementation and coordination of these policies and measures as the aforementioned development of wind power and its coordination with the planning and construction of power grids have exemplified. This will be a decisive factor in determining the prospects for whether China will achieve its carbon intensity target. There is no doubt that achieving this target poses a significant challenge for China. The whole world is waiting to see whether China can turn this challenge into a win-win outcome for both China and global climate change.

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(lxxxvi) *This paper was presented at the Conference on "Urban and Regional Economics" organised by the Centre for Economic Policy Research (CEPR) and FEEM, held in Milan on 12-13 October 2009.*

(lxxxvii) *This paper was presented at the Conference on "Economics of Culture, Institutions and Crime" organised by SUS.DIV, FEEM, University of Padua and CEPR, held in Milan on 20-22 January 2010.*

(lxxxviii) *This paper was presented at the International Workshop on "The Social Dimension of Adaptation to Climate Change", jointly organized by the International Center for Climate Governance, Centro Euro-Mediterraneo per i Cambiamenti Climatici and Fondazione Eni Enrico Mattei, held in Venice, 18-19 February 2010.*