Towards a sustainable development of the chinese economy: Accomplishments and challenges in limiting greenhouse gas emissions

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Accomplishments and Challenges in Limiting Greenhouse Gas Emissions[1]

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1. Introduction

The paper of Prof. Ruqiu Ye (Deputy Administer, China's National Environmental Protection Agency), and Profs. Yunhui Jin and Xue Liu (Peking University) (1999) discusses four major issues related to the activities implemented jointly (AIJ). The first issue is about the arguments on AIJ. The second issue is about the disadvantages of AIJ for China. The third issue is about the potential benefits, both direct and indirect, of China's involvement in AIJ. The fourth issue is about the prerequisites of China's participation in AIJ. Reading this very interesting paper suggests five questions or issues to me. The first question is about the subject of the paper. The second question is about China's concerns about clean development mechanism. The third issue is what China has done so far in limiting its carbon emissions. The fourth issue is what can be expected from China at the international climate change negotiations subsequent to Buenos Aires. And the fifth question is whether combating global climate change is in China's interest.

2. The Subject: AIJ or CDM?

Acknowledging the strong opposition to the concept of joint implementation (JI) in the developing world, the first Conference of the Parties (COP) to the UNFCCC in Berlin in April 1995 endorsed a pilot phase of joint implementation, referred to as the AIJ among Annex I Parties and, on a voluntary basis, with non-Annex I Parties. During the AIJ pilot phase, emission reductions achieved are not allowed to be credited to current national commitments of investor countries under the UNFCCC. By the time of the UNFCCC's second synthesis report on AIJ, 95 projects were listed as AIJ projects (UNFCCC, 1998). These projects are located in 24 host countries, with Africa hosting only one certified AIJ project. The uneven geographical representation means that most non-Annex I countries have not experienced an AIJ project within their own countries and thus provides insufficient details to draw conclusions. This leads to the decision 6/CP.4 at the fourth COP to the UNFCCC held in November 1998, Buenos Aires, to continue the AIJ pilot phase (UNFCCC, 1999). Although more countries might gain experience from a new round of AIJ projects, the future of AIJ is likely to be limited. This is partly because of a lack of adequate incentives for the private sector participation in AIJ project financing, and partly because of the adoption of the Buenos Aires Plan of Action, an ambitious two-year work programme intended to make the Kyoto Protocol operative

[1] Invited discussion at the Intergovernmental Panel on Climate Change Working Group III Expert Meeting on the Economic Impacts of Annex I Mitigation Policies on Non-Annex I Countries, The Hague, 27-28 May 1999. The views expressed here are those of the author. The author bears sole responsibility for any errors and omissions that may remain.

(UNFCCC, 1999). According to the Plan, decisions on rules governing cooperative implementation mechanisms are to be made in the year 2000 at the latest. With the work programme in place, attention has since focused on how clean development mechanism (CDM), JI and emissions trading would work, with priority being given to CDM. Therefore, it is generally acknowledged that the interest of potential investors in project-based cooperative mechanisms is likely to focus on CDM and JI rather than AIJ.

The paper of Ye et al. (1999) addresses a variety of concerns regarding to AIJ. However, much of the discussion is related to CDM rather than AIJ. Against the above background, I suggest that the title of the paper should indicate that the subject is CDM. Accordingly, the main text should be adjusted to enrich the policy relevance.

3. China's Concerns about CDM

CDM is an innovative mechanism built into the Kyoto Protocol. While many Annex I countries have put and continue to put pressure on developing countries to take on emissions limitation commitments, CDM so far is the only mechanism with an authentic global reach. If designed appropriately, CDM could prove to be a win-win-win mechanism.

- First, 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 Annex I countries to meet their Kyoto commitments at a lower overall cost than would otherwise have been the case.
- Third, CDM enhances international cooperation in combating global climate change and thus is beneficial to the global environment, as well.

It seems that developing countries prove somewhat more receptive to CDM than to the original concept of joint implementation. However, they have still expressed the fear that:

- They would face possible exploitation due to lack of capacity to negotiate fair contracts with CDM investors from Annex I countries.
- All their low-cost abatement options would be used up, leaving them to face only high-cost options if they would be subsequently required to reduce their own emissions.
- The OECD countries would redefine existing development aid projects as CDM projects, and reduce their aid budgets accordingly. Small developing countries, in Africa in particular, fear that CDM would tend to shift the OECD countries' attention towards those developing countries with large economies and greenhouse gas emissions.
- Developed countries may use CDM to interfere their internal affairs, given that the implementation of CDM projects across national borders would touch on the issue of national sovereignty.

As a developing country, China shares these general views. But, in my view, there are other specific concerns that lead China to have taken a cautious approach to CDM.

First, China and India insist that before CDM commences, the entitlements of both developed and developing countries have to be defined (Sharma, 1998).

Second, CDM could lead to attempts to draw developing countries into unduly early agreeing to something that could be interpreted as new commitments. Closely related to this, there is a particular concern about country-wide baselines that aim to address the leakage problems associated with project baselines, because of their possible links to voluntary or binding commitments. So, in order to protect the longer-term interests of developing countries, it must be absolutely clear from the outset that such baselines, if any, are only for the purpose of reckoning the CDM credits during the agreed periods, without prejudice to future divisions of mitigation responsibilities.

Third, although the sustainable development objective of CDM makes it attractive to developing countries, there is a tendency that CDM would serve the only purpose of assisting Annex I countries in meeting their commitments. Much of the discussion on the CDM to date has focused on technical issues, but its sustainable development objective has not received much attention. This to a large extent explains why CDM does not trigger much more interests from the developing world than what was thought to be the case. If CDM were only beneficial to Annex I countries, CDM could not be sustained.

In order to facilitate the effective developing country participation in the CDM, the sustainable development objective of the CDM must be addressed. Because the CDM will be eventually implemented through projects, this raises a very important question: how can the objective of sustainable development be explicitly incorporated into individual CDM projects?

One possible option is to develop a set of operational criteria or indicators against which social, economic and environmental dimensions of individual CDM projects can be measured. They could differ per type of CDM projects. If sustainable development indicators could be defined in operational terms and be adopted by the parties to the UNFCCC, they provide useful and user-friendly information to guide decisions on whether a proposed CDM project contributes to sustainable development. Another option would be to require the project developers to demonstrate how the CDM project in question is compatible with development priorities of the host country. It is not enough that CDM projects be not harmful because harmless projects that are unrelated to development priorities divert limited resources away from priority activities and thus involve high opportunity cost for the host country. In my view, no matter what an option to measure sustainable development is adopted, host developing countries retain the right to decide whether a proposed CDM project is likely to contribute to sustainable development.

4. What Has China Done so far in Limiting its Carbon Emissions?

The paper of Ye et al. (1999) mentions several times that China should not commit any greenhouse gas abatement obligations that are not commensurate with its capabilities. But it does not spell out what a level of commitment could be acceptable to China. At present, China contributes 13.5% of global CO_2 emissions. Its share in global CO_2 emissions is expected to exceed that of the US by 2020, if the current trend of economic development in China continues (World Bank, 1994). Therefore, it is not surprising that the role of China is a perennial issue at the international climate change negotiations. Before going into elaborate efforts and commitments that can be expected from China, I like to address what China has done so far in terms of limiting its carbon emissions. The reason why I pay attention to this issue is that significant contribution China has made to reducing global CO_2 emissions has been too little appreciated.

With more than 1.2 billion people, China is home to about 21.5% of the world's population (see Table 1) and has a large and rapidly growing economy, making the country an important player on the world's stage. Since launching its open-door policy and economic reform in late 1978, China has experienced spectacular economic growth, with its gross domestic product (GDP) growing at the average annual rate of about 10% over the period 1978-1997. Along with the rapid economic development, energy consumption rose from 571.4 million tons of coal equivalent (Mtce) in 1978 to 1440.0 Mtce in 1997 (State Statistical Bureau, 1998).

Accompanying the growth in fossil fuel use, China's CO_2 emissions have grown rapidly. As shown in Figure 1, the total CO_2 emissions in China rose from 358.60 million tons of carbon (MtC) in 1980 to 847.25 MtC in 1997, with an average annual growth rate of 5.2%. This ranks China as the world's second largest CO_2 emitter only behind the US, according to the World Energy Council (see Table 1). But on a per capita basis, China's CO_2 emissions of 0.685 tC in 1997 were very low, only about half the world average (Zhang, 1999).

Table 1 Shares of Global CO_2 Emissions and World Population, 1996

	Share of global CO_2 emissions (%)	Share of the world population (%)
USA	25.0	4.7
EU-15	14.7	6.5
China	13.5	21.5
CIS Republics	10.2	5.0
Japan	5.6	2.2
India	3.6	16.3
Canada	2.1	0.5
Australia	1.3	0.3

Source: Jefferson (1997).

The breakdown of CO_2 emissions by fuel is shown in Figure 1. Because coal has accounted for about 75% of the total energy consumption over the past years, it is not surprising that coal predominates, accounting for 81.3% of the total emissions in 1997. This share has remained almost unchanged over the past two decades

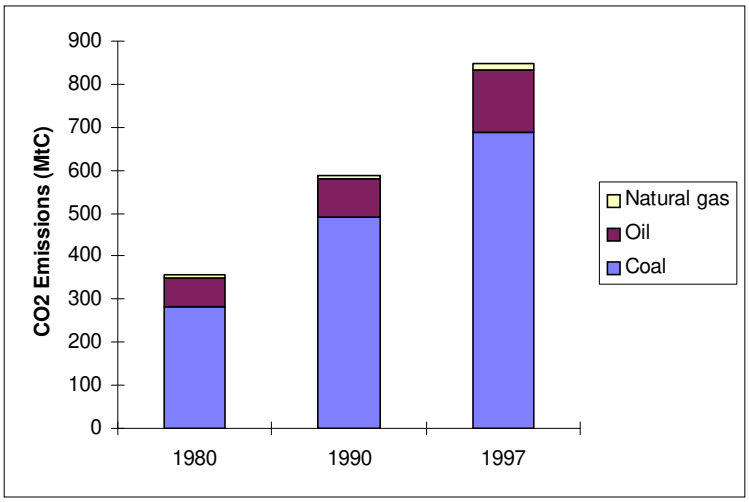

Figure 1 China's CO_2 Emissions by Fuel
Source: Zhang (1999).

Table 2 shows the historical contribution of inter-fuel switching, energy conservation, economic growth, and population expansion to CO_2 emissions in China over the period 1980-1997. The data used to obtain the results in Table 2 are plotted in Figure 2, after normalization to the year 1980. The results in Table 2 and Figure 2 clearly indicate the relative importance of each factor in terms of its contribution to CO_2 emissions growth in China. Given that China has been the most rapidly expanding economy over the past 17 years, it is not surprising that economic growth measured in per capita GDP was overwhelming. This factor alone resulted in an increase of 799.13 MtC. During the corresponding period, through its strict family planning programmes, China experienced a very low rate of population growth in comparison with other countries at China's income level, which in turn contributed to a smaller increase in China's CO_2

emissions than would otherwise have been the case.[2] As a result, population expansion was responsible for an increase of 128.39 MtC, an increase in emissions considered to be modest given its population size. Also, the change in fossil fuel mix contributed to an increase in emissions (3.93 MtC), but its role was very limited because the share of coal use in total commercial energy consumption increased only slightly during the period.

Table 2 Breakdown of the Contributions to CO_2 Emissions Growth in China, 1980-1997 (MtC)[a]

Due to change in fossil fuel carbon intensity	Due to penetration of carbon free fuel	Due to change in energy intensity	Due to economic growth	Due to population expansion	Total change in CO_2 emissions
+3.93	-10.48	-432.32	+799.13	+128.39	+488.65

[a] A positive sign indicates an increase; A negative sign indicates a decline.
Source: Zhang (1999).

By contrast, a reduction in energy intensity tended to push CO_2 emissions down. Since the early 1980s, the Chinese government has been placing great emphasis on energy conservation and has formulated and implemented approximately 30 energy conservation laws concerning the administrative, legislative, economic and technological aspects of energy conservation. After years of preparation, China's Energy Conservation Law was enacted on 1 November 1997 and came into force on 1 January 1998. In order to efficiently use energy, China has significantly reduced subsidies for energy consumption, with coal subsidy rates falling from 61% in 1984 to 37% in 1990 and to 29% in 1995, and petroleum subsidy rates falling from 55% in 1990 to 2% in 1995 (Kosmo, 1987; World Bank, 1997a). Currently, coal prices are largely decided by the market and vary significantly depending on the destination of the coal.[3] Energy pricing reforms may have already proceeded to the point where the bottlenecks to more adoption of efficiency measures have less to do with energy prices than other factors (Sinton et al., 1998). Along with the economic reforms that, among other achievements, have spurred investment in more energy efficient production technologies, the Chinese government has also played a crucial role both in promoting a shift of economic structure towards less energy-intensive services (see Table 3) and a shift of product mix towards high value-added products, and in encouraging imports of energy-intensive products.[4] Furthermore, efforts have been made towards implementing nationwide energy conservation programmes. For example, state capital construction loans for efficiency are at an interest rate of 30% lower than commercial loans, and state technological renovation loans for efficiency are with 50% of the interest subsidized (Sinton et al., 1998). The creation of over 200 energy conservation technology service centers throughout the country, which have worked most closely with the end-users of the efficient technologies, devices and practices that the government sought to promote, has been extremely valuable. In power industry, efforts have been made towards developing large-size coal-fired power plants. In 1987, only 11 power stations had an unit capacity of 1 gigawatt (GW) and above. The combined capacity of these power stations was about 15 GW, accounting for one-seventh of the nation's total. By 1994, there were 34 power stations having an unit capacity of 1 GW and above, with a combined capacity of 43 GW, accounting for 21.4% of the nation's

[2] During the period 1980-1997, the annual average growth rate of population in China was 1.33%. In contrast, the corresponding figure for low-income economies (excluding China) between 1980 and 1995 was 2.35%, and the world average was 1.66% (World Bank, 1997c).
[3] For example, the mine-mouth price of Datong mixed coal was 128 yuan per ton in June 1994. The same coal retailed for 230 yuan per ton in Shanghai, 262 yuan per ton in Nanjing, 280 yuan per ton in Guangzhou, and 340 yuan per ton in Xiamen (SETC, 1996).
[4] About 10% of the total energy savings during the period 1981-1988 were attributed to imports of energy-intensive products (Zhang, 1997).

total (SETC, 1996). In the meantime, the share of generating units having a capacity of 100 MW and above increased from 32.5% in 1984 to 57.2% in 1994 (MOEP, 1985; SETC, 1996). Along with these large units commissioned into operation, the average generation efficiency of thermal power increased from 28.5% in 1984 to 29.7% in 1994. Given the sheer size of the Chinese power industry, even this small efficiency improvements translate into large coal savings when multiplied by tens of GW of capacity installed.

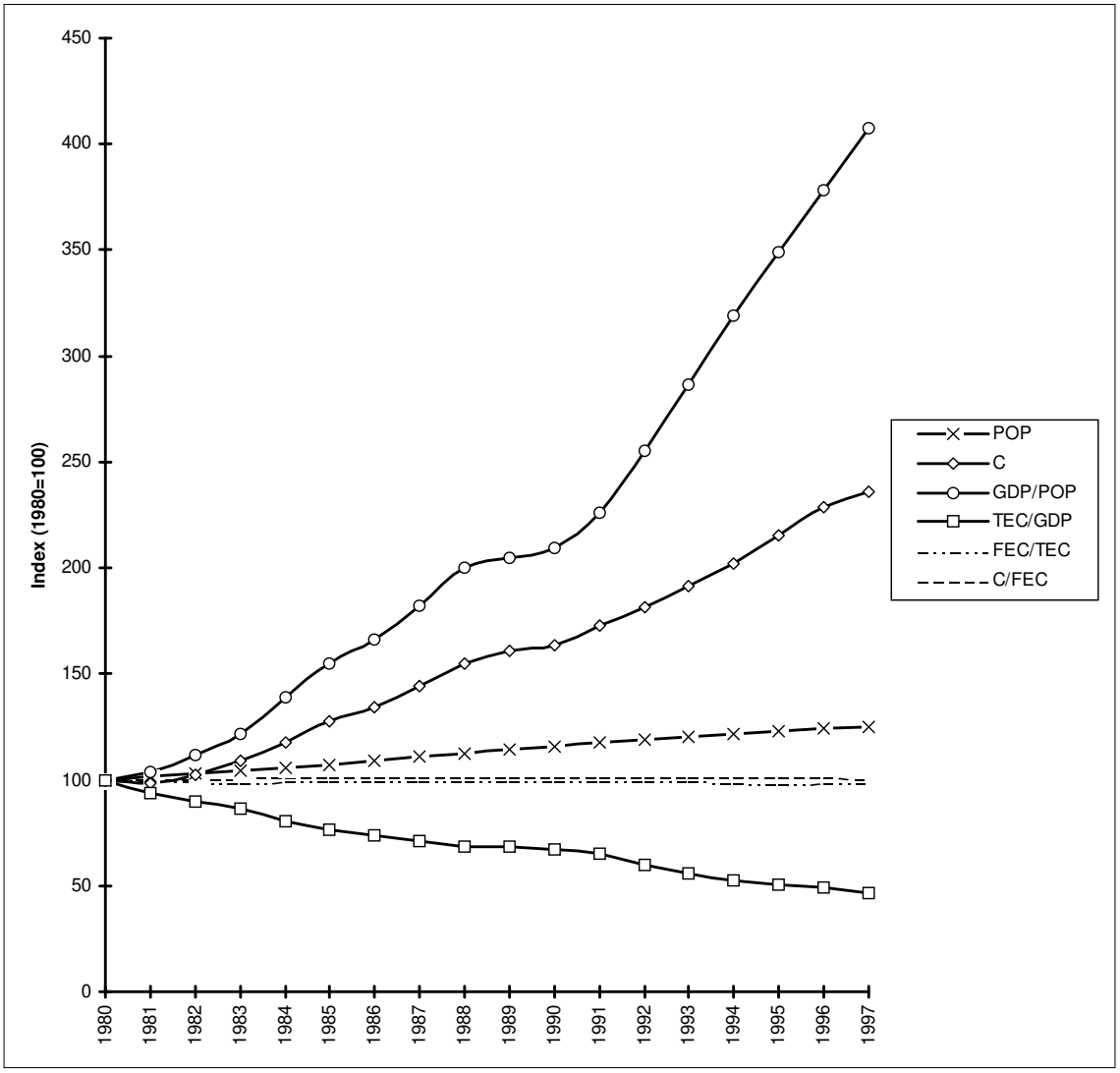

Figure 2 Contribution to CO_2 Emissions in China, 1980-1997[a]

[a] C = The amount of CO_2 emissions; FEC = Total carbon-based fossil fuel consumption; TEC = Total commercial energy consumption; GDP = Gross Domestic Product; and POP = Population.

Source: Zhang (1999).

Table 3 The Composition of GDP in China, Japan and the US (percentage of GDP)

	China			Japan	United States
	1980	1990	1997	1995	1995
Agriculture	30.1	27.1	18.7	2	2
Industry	48.5	41.6	49.2	38	26
Services	21.4	31.3	32.1	60	72

Sources: State Statistical Bureau (1998); World Bank (1997c).

Clearly, it is by implementing these policies and measures that great progress in decoupling China's GDP growth from energy consumption has been made, with an annual growth of 10.06% for the former but only 5.26% for the latter during the period 1980-1997. This achievement corresponds to an income elasticity of energy consumption of 0.52 and to an annual saving rate of 4.37%.[5] Given the fact that most developing countries at China's income level have the income elasticity of energy consumption well above one (see Table 4), this makes China's achievement unique in the developing world.[6] As a result, a reduction of 432.32 MtC was achieved. In other words, without the above policies and measures towards energy conservation, China's CO_2 emissions in 1997 would have been 432.32 MtC higher, or more than 50% higher, than its actual emissions.

Table 4 Growth Rates of GDP and Energy Consumption, and the Income Elasticity of Energy Consumption among Different Economies, 1980-1994

	Annual growth of GDP (%)	Annual growth of energy consumption (%)	Income elasticity of energy consumption
Low-income economies *	2.8	4.7	1.66
China	11.0	4.5	0.41
Upper-middle-income economies	2.5	3.9	1.56
High-income economies	2.8	1.1	0.39

* Excluding China.
Source: Calculated based on data from the World Bank (1996).

In addition to energy conservation, the penetration of carbon-free fuels contributed to a small reduction in CO_2 emissions (-10.48 MtC). This is mainly due to the underdevelopment of hydropower, and partly because the development of nuclear power in China is still at the initial start-up stage.

From the preceding analysis, it follows that China has made significant contribution to reducing global CO_2 emissions, although none of these carbon savings have resulted from domestic climate mitigation policies. Unfortunately, China's contribution has been too little appreciated. While China is making such an impressive achievement, we might ask how the OECD countries perform in this regard. They accounted

[5] The income elasticity of energy consumption is defined as the change in energy consumption divided by the change in economic growth.
[6] As shown in Table 4, the income elasticity of energy consumption in China is quite low by international standards. In addition to energy conservation, there are other two possible explanations for this. First, the growth of energy consumption is underestimated relative to the GDP growth. Second, quantitative restrictions have kept energy consumption from rising as would otherwise have occurred. Drawing on the analysis of rationing by Neary and Roberts (1980), the quantitative restrictions act like an implicit energy tax levied at rates varying with use and fuel. Generally speaking, households face a higher implicit tax than industrial users, and oil and natural gas are taxed at a higher rate than coal.

for 50.3% of global CO_2 emissions in 1996 compared with 49.6% in 1990 (Jefferson, 1997) and promised at the Earth Summit in June 1992 to individually or jointly stabilize emissions of CO_2 and other greenhouse gases at their 1990 levels by 2000. As shown in Table 5, the total CO_2 emissions in the OECD countries rose by 7.8% between 1990 and 1996. On their current trends, CO_2 emissions in the US and EU-15 (the fifteen member countries of the European Union) would be 13% and 8% above the promised targets in 2000 respectively (Jefferson, 1997; Reid and Goldemberg, 1997). Therefore, it is fair to say that, with few exceptions, most of the OECD countries are unlikely to meet their voluntary commitments to stablilizing CO_2 emissions at their 1990 levels by 2000.

Table 5 Changes in CO_2 Emissions from Fossil Fuel among Selected Countries and Regions (%)[a]

	1990-1996	1995-1996
OECD[b]	+7.8	+2.6
EU-15	+0.9	+2.3
Denmark	+41.0	+20.6
Germany	-7.8	+2.1
Netherlands	+10.0	+2.6
United Kingdom	-1.0	+2.9
United States	+8.4	+3.3
Canada	+5.5	+1.6
Japan	+14.3	+1.8
Australia	+9.5	+2.2
New Zealand	+10.7	+4.0
Norway	+14.5	+7.3
CIS and C& E Europe	-31.0	-2.6
Developing countries	+32.0	+5.1
World	+6.4	+2.7

[a] A positive sign indicates an increase; A negative sign indicates a decline.
[b] Excluding Mexico, Korea, Hungary and Poland.
Source: Jefferson (1997).

5. What Can be Expected from China at the Negotiations Subsequent to Buenos Aires?

Of course, the above discussion is not to justify no further action by China. Indeed, faced with both the mounting pressure from the US and the new post-Kyoto negotiating environment, and given the global characteristics of climate change and China's importance as a source of future CO_2 emissions in line with its industrialization and urbanization, China cannot come away without taking due responsibilities.

5.1 The Changed Negotiating Environment

Prior to Kyoto, developing counties' demand for the US 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 US, which leads the world in greenhouse gas emissions. Now the US has made legally binding commitments at Kyoto. The Kyoto target is seen as not enough but yet not unreasonable given that the US economy would not be disrupted unreasonably (King, 1998).[7] Now the ball is kicked off to China's court. The US has made it clear that bringing key developing countries, including China, on board has been and will continue to be its focus of international climate change negotiations. According to some US Senators,

[7] As indicated in Table 5, the US CO_2 emissions in 1996 were already 8.4% above 1990 levels. To meet the Kyoto commitments requires the US to cut its greenhouse gas emissions by up to 30% from its business-as-usual levels during the period 2008-2012. This is not tremendous but not trivial either.

it will be countries like China, India and Mexico that will decide whether the US 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 US Senate and possibly even be blamed for "blowing up" subsequent negotiations aimed at dealing with developing countries' commitments.

While preparing for greater and greater pressure from the US, China should take the following non-US factors into account in developing its post-Kyoto climate negotiation strategies.

First, although the group of 77 and China[8] managed to block the US proposal for allowing a developing country to voluntarily commit to reductions in greenhouse gas emissions at Kyoto, the US had partial success in weakening the position of the group. As might be expected, the US will continue to apply the "divide and rule" tactic by getting at least a few to accept obligations they are not required to undertake and then putting pressure on the rest of the developing countries to do the same, exploiting the fact that such developing countries as Argentina have already determined to take on voluntary commitments.[9] Given the fact that developing countries are a more diverse and heterogeneous group than the Annex I countries, and that their interests in the climate change debate are heterogeneous and occasionally competing, it might be very difficult to prevent some countries in the group -- particularly those countries with a relatively high per capita income and that perceive the greatest potential gain from emissions trading -- from being drawn into making commitments of their own at the negotiations subsequent to Buenos Aires.

Second, after the first commitment period 2008-2012, China will soon surpass the US as the world's largest greenhouse gas emitter, due mainly to its sheer size of population and partly to its rapidly growing economy. While it will still take at least another three decades for cumulative greenhouse gas emissions from China to exceed those of the US, Western media and some US Senators could deliberately misguide the general public's attention and then shift the attack on the US to China.

Third, although in accordance with the principle of common but differentiated responsibilities Annex I countries should take the lead in reducing their greenhouse gas emissions and providing adequate technology transfer and financing to non-Annex I countries, broadening commitments to include all countries in the long term is necessary and unavoidable in order to achieve the UNFCCC's ultimate objective of stabilizing greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.

Under these circumstances, it would be unwise for China just to sit back and let the US define what is "meaningful participation" from developing countries. It would be also unwise for China simply to distance itself from attempts to draw developing countries into agreeing to something that could be interpreted as new commitments at the negotiations subsequent to Buenos Aires. Doing so would only

[8] As has been the case in the international climate change negotiations, the developing countries express their consensus views as the group of 77 and China's positions. Divergent or dissenting views are then expressed separately, representing either individual countries or smaller groups, such as the Alliance of Small Island States (AOSIS).

[9] At the fourth COP to the UNFCCC held in November 1998, Buenos Aires, the host country, Argentina, proposed the inclusion of voluntary commitments from developing countries on the conference agenda. When delegates considered the agenda, a Chinese delegate saw any discussion on the subject of voluntary commitments from developing countries as a means of destroying the unity of the group of 77 and China, while a Brazilian negotiator said it was a means of helping some countries to avoid existing commitments rather than promoting the UNFCCC (Earth Negotiations Bulletin, 16 November 1998). As a result, the host's proposal was rejected by the group of 77 and China. In the end, during the second week of the fourth COP, Argentina and Kazakstan stepped out from the ranks of the group of 77 and China and declared that they would undertake a voluntary commitment to abate their greenhouse gas emissions at the fifth COP to the UNFCCC in 1999.

create negative image and publicity for China, which has been regarded as a "hard liner" at the climate change negotiations. In the meantime, China should keep eyes on the negotiating positions of such developing countries as Argentina, Costa Rica and South Korean and should not let the fate of the whole South be left at the hands of these relatively high-per-capita-income countries.

5.2 China's Strategies at the Climate Change Negotiations Subsequent to Buenos Aires

Faced with a different situation from that at Kyoto, China should ponder deeply over its strategies at the international climate change negotiations subsequent to Buenos Aires. On the one hand, China should take much more efforts towards communicating to the industrialized world the substantial contributions it has already made to limiting greenhouse gas emissions. China has cut its energy consumption per unit of output in half since 1980, indicating that if the energy intensity were the same now as that in 1980, China would consume twice as much energy, and produce twice as much CO_2 emissions as it now does. Unfortunately, this achievement is not widely known or appreciated outside of China: outsiders know that the Chinese economy is booming, but they are not as cognizant of China's very impressive improvement in energy efficiency. Therefore, efforts towards effective communication about what has been achieved in China to the outside world will help to correct the distorted picture that had been painted.

On the other hand, while insisting on its legitimate demand for industrialized countries to provide adequate technology transfer and financing, and demanding that emissions targets beyond the first commitment period be set for Annex I countries at the subsequent negotiations over new additional developing countries' commitments, China could propose and direct negotiations, rather than just react and respond. In proposing its voluntary efforts and commitments, China should bear in mind that demanding for the "equal per capita entitlements" is politically unrealistic for the time span we are considering, although it is perfectly justified on grounds that all human beings are born equal and that the atmosphere is a global common. On the other hand, the US demand for imposing a cap on China's future emissions is absolutely unacceptable for China, at least until its per capita income catches up with the level of middle-developed countries. For these reasons, I put aside the proposal for either "equal per capita entitlements" or an absolute cap on national emissions. I envision the following six proposals that could be put on the table as China's plausible negotiation position, which are each described in the order of their stringentness.

First, China could regard its active participation in CDM as "meaningful participation". If appropriate rules and guidelines for CDM are defined, what then are the potential areas in China's interest? It is usually acknowledged that the success of CDM premises an effective understanding of local (host country) development aspirations and the use of CDM to push ahead with efforts to achieve these aspirations. Thus, in order to enhance their possibility of success, there is the need to make due consideration of local objectives and local conditions in designing the CDM projects. Considering that China is more concerned with local pollutants, such as SO_2, NOx and particulates from coal burning, and regards them as its own environmental priorities, it is expected that the most potential areas of interest to China are related to those activities and options aimed at: (1) improving the efficiency of energy use, particularly at energy-intensive energy sectors (for example, iron and steel industry, chemical industry, building materials industry, and power industry) and devices (for example, industrial boilers); (2) pushing efficient use of coal through increasing proportion of raw coal washed; popularizing domestic use of coal briquette; substitution of direct burning of coal by electricity through development of large-size, high-temperature and high-pressure efficient coal-fired power plants; expanding district heating systems and developing co-generation; increased penetration of town gas into urban households; and through development and diffusion of environmentally sound coal technologies; (3) speeding up the development of hydropower and nuclear power; and (4) developing renewables, in particular wind power.

Second, just as Article 3.2 of the Kyoto Protocol requires Annex I countries to "have 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 go a little further to 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.

China should resort to all means of securing either of the above deals. It could even lobby for support from the EU, and therefore put collective pressure on the US.[10] If all the attempts prove unsuccessful, China might resort to the last three options.

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. Such a commitment would still allow China to grow economically while improving the environment. It reflects a basic element of the UNFCCC, which has recongnized the developing countries' need for further development and economic growth. The industrialized countries, particularly the US, have no reason or right to argue against it. To do so would contradict their claim that asking China's involvement in combating global climate change is not intended to limit its capacity to industrialize, reduce poverty and raise its standards of living. Even if the Chinese government has claimed that China will continue its efforts towards improving energy efficiency and minimizing further degradation of the environment in any event, it would be wise to propose an explicit value for carbon intensity of the Chinese economy as a starting point for negotiations. In this regard, there is a pressing need for comprehensive analysis and quantification of the economic implications of climate change for China. For a long time, the Chinese government has claimed that asking for China to take actions would seriously harm China's economic development. However, until now, inside of China there has been no single comprehensive study indicating the economic effects of possible future carbon limits for China, for example, in terms of foregone national income, although along this line there have been some studies done outside of China (e.g., Zhang (1997, 1998)). Findings that show that China would be the region hardest hit by carbon limits can help to convince the world of the Chinese government's claim. Such information can be used to China's advantage in bargaining a possible targeted carbon intensity with other countries, as well.

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 can not afford to go beyond it until its per capita income catches up with the level of middle-developed countries.

[10] In the run up to Kyoto, the following two points distinguish the EU from the US. In comparison with the US demand for developing countries to agree to cuts in greenhouse gas emissions in the same timeframe as industrialized countries, the EU has made clear that developing countries need not to promise at Kyoto to make cuts, although they should be persuaded to do so at a later date. Moreover, by permitting a 30-40% increase in emissions to Greece and Portugal, the EU proposal for international community burden-sharing accepts that poorer countries should be treated more leniently, whereas the US has been opposed to differentiated emissions targets until it has to give up its opposition at Kyoto. If Greece and Portugal can have this sort of rise, it would be very difficult for the EU to reject the demand from the really poor, that is, developing countries, for a not unreasonable leeway in emissions.

It should be pointed out that before legally binding commitments become applicable to Annex I countries, they have a grace period of 16 years starting from the Earth Summit in June 1992 when Annex I countries promised to individually or jointly stabilize emissions of CO_2 and other greenhouse gases at their 1990 levels by the end of this century to the beginning of the first commitment period in 2008. Therefore, China could demand a grace period before either of the last three commitments becomes legally binding. Even without the precedent for Annex I countries, China's demand is by no means without foundation. For example, the Montreal Protocol on Substances that Deplete the Ozone Layer grants developing countries a grace period of 10 years. Moreover, China could insist that accession of developing countries and burden sharing be based on ability of pay. As such, a country is expected to take on emissions limitation commitments once it exceeds a threshold level of per capita income. On the one hand, this approach would avoid the costly negotiations for accession of developing countries on an individual basis. On the other hand, the approach would bind China and other developing countries, thus giving China more clout in the final bargaining in determining a threshold level.

6. Combating Global Climate Change Is in China's Interest

I fully agree with Ye et al. (1999) that China itself will benefit from international cooperation on combating global climate change. Because economic development remains the priority for China, its climate policy would focus on the so-called win-win strategies. The above efforts and commitments proposed for China reflect that; they do not go beyond the scope of taking no-cost or low-cost "no-regrets" actions. Although the last three commitments are more stringent than the first three, none of them would be likely to severely jeopardize Chinese economic development. Indeed, taking due responsibilities in combating global climate change should be in China's interest on the following grounds.

First, because climate-sensitive sectors such as agriculture still account for a much larger proportion of GDP in China than in the developed countries (see Table 3), China is even more vulnerable to climate change than the developed countries. Therefore, a broad commitment to global efforts towards limiting greenhouse gas emissions would reduce the potential damage from climate change in China itself, since after all it is not only the developed countries whose climate will change if greenhouse gas emissions are not reduced.

Second, China is scarce in energy, with per capita energy endowments far below the world average (see Table 6). Although energy consumption per unit of output in China has been cut in half since 1980, its major industries continue to use energy far more intensively than in industrialized countries (see Table 7). By making the above commitments, China will be pushed for a more efficient use of its scarce energy resources.

Third, driven by the threat of further degradation of the environment[11] and the harmful economic effects of energy shortages, China is already determined to push energy conservation and enhanced energy efficiency in general and more efficient coal usage in particular. Although it is taking such drastic domestic efforts on its own, China badly needs assistance and economic and technical cooperation with the developed countries, because of the huge amounts of capital and technical expertise required. In this regard, CDM, if designed appropriately, could provide an opportunity for China to get increased access to more advanced energy efficiency and pollution control technologies and additional funding.

[11] Existing estimates for the economic costs of China's environmental degradation vary, depending on the comprehensiveness of the estimates. For example, using the measure of willingness to pay, the World Bank (1997b) has estimated that air and water pollution cost China about 8% of its GDP, around $54 billion annually, while Smil (1996) puts China's environmental damages between 5.5% and 9.8% of its GNP.

Table 6 Proved Reserves and Utilization Rates of Fossil Fuels in China, 1997

Resources	Proved reserves	R/P ratio[a] (years)		Per capita proved reserves[b]	
	China	China	World	China	World
Coal	114.5 billion tons	82	219	95	182
% world total	11.1%				
Oil	3.3 billion tons	21	41	3	25
% world total	2.3%				
Natural gas	1.16 trillion cubic meters	52	64	967	25517
% world total	0.8%				

[a] R/P ratio stands for the lifetime of proved reserves at 1997 rates of production.
[b] Measured in tons for coal and oil and in cubic meters for natural gas and based on population in 1995.
Sources: Calculated based on data from the British Petroleum (1998) and World Bank (1997c).

Table 7 A Comparison of Unit Energy Consumption for Selected Energy-Intensive Users

	1980 China	1994 China	Advanced level abroad
Comparable energy consumption per ton of steel (tce/t)	1.30	1.03[a]	0.6 (Italy)
Energy consumption per ton of synthetic ammonia (tce/t)			1.2
Large plants	1.45	1.34[a]	
Small plants	2.90	2.09	
Energy consumption per ton of cement clinker (kgce/t)	206.5	175.3	108.4 (Japan)
Net coal consumption of coal-fired plants (gce/kWh)	448	413	327 (ex-USSR)
Thermal efficiency of industrial boilers (%)		60-70	80-85

[a] In 1990.
Source: Zhang (1997).

From the preceding discussion, it follows that the above efforts and commitments proposed for China, though aimed at limiting greenhouse gas emissions, will contribute to the reductions in local pollutants and thus will be beneficial to a more sustainable development of the Chinese economy as well as to the global climate. At the same time, they would give China more leverage at the international climate change negotiations subsequent to Buenos Aires.

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