Order Code RL34659

CRS Report for Congress

China's Greenhouse Gas Emissions and Mitigation Policies

September 10, 2008

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Summary

China's greenhouse gas (GHG) emissions and policies are frequently invoked in Congressional debates over appropriate climate change policy. This background report describes Chinese GHG emissions and some of its mitigation efforts. It touches briefly on China's international cooperation.

China and the United States are the leading emitters of GHGs, together responsible for about 35% of global emissions. A lack of official and reliable data makes any ranking of country emissions difficult to verify for now. China has released one GHG inventory, for the year 1994. Chinese CO_2 emissions are high due to the country's large population, strong capital investment and urbanization, and heavy reliance on coal, but are constrained by low incomes. Current forecasts are speculative but foresee Chinese emissions to grow rapidly with its economy.

In June 2007, China released its National Climate Change Program, a plan to address climate change. The Program outlines activities both to mitigate GHG emissions and to adapt to the consequences of potential climate change. Within the Program, perhaps most challenging is China's goal to lower energy intensity 20% by 2010. The country fell short of its annual milestones, set in energy policies, in both 2006 and 2007; in July 2008, Premier Wen Jiabao and the State Council warned that meeting its energy intensity and emission reduction goals "remained an arduous task." Related goals include more than doubling renewable energy use by 2020, expansion of nuclear power, closure of inefficient industrial facilities, tightened efficiency standards for buildings and appliances, and forest coverage expanded to 20%. The Chinese, and some international observers, claim that China has been more proactive on climate change than some developed countries, though others are cautious of China's ability to achieve its goals. Meanwhile, Chinese business opportunities in clean and low carbon energy are expanding rapidly.

Chinese negotiators adhere to the principle of "common but differentiated" responsibilities, agreed in the United Nations Framework Convention on Climate Change. They argue that emissions per person in China are low and that raising incomes must be their highest priority, and that industrialized countries bear primary responsibility for the historical buildup of GHGs in the atmosphere and should thus lead in mitigating emissions domestically. Industrialized countries also, they say, should assist developing countries to mitigate emissions and adapt to coming change.

Debate on potential climate change legislation in the United States has been influenced by China's surging GHG emissions, and uncertainty over how and when China might alter that trend. There is concern that strong domestic action taken without Chinese reciprocity would unfairly advantage China in global trade, and fail to slow significantly the growth of atmospheric concentrations of GHGs. The governments of both China and the United States have indicated some closure of their gap on future actions to address climate change. Some observers believe that the next Administration and the 111th Congress will seek more active measures.

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Introduction: China and Climate Change[1]

China stands front and center in the congressional debate on climate change, due to that nation's contribution to global emissions and competitiveness in global trade. With its large population, rapidly expanding economy, and heavy reliance on coal, China now shares the lead in global greenhouse gas (GHG) emissions with the United States. China's GHG emissions are expected to continue growing in the years ahead based on projections of continuing rapid economic growth. Experts generally agree that emissions in all major countries must be abated in order to stabilize growth of atmospheric concentrations of GHG that leads to climate change.

In the United States, critics of mandatory, domestic GHG controls (without reciprocal Chinese action) argue they would increase the costs of U.S. goods relative to those from China, thus harming competitiveness of certain U.S. industries. To the degree that production might decrease here and increase in China as a result, reduced emissions in the United States might be offset by higher emissions there (called "leakage"). This could exacerbate trade tensions between the United States and China, and not appreciably reduce the risk of climate change. So, unless China takes significant simultaneous action with the United States, some analysts contend, it is not in U.S. interests to do so here.

Proponents of U.S. climate leadership, on the other hand, note the need for developed countries to act first due to historical contributions to current GHG concentrations and greater economic capabilities. Only if the United States and other industrialized emitters act first, they argue, can the developing countries be encouraged to do their part; industrialized countries must demonstrate to China and other large developing countries that emissions can be reduced without unacceptable economic losses. This, in their perspective, is the only way to break the standoff that some claim the two nations face.[2]

Between 1979 and 2007, the Chinese economy grew at an average annual rate of 9.8%.[3] Hundreds of millions of Chinese have improved their standards of living.

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[1] Most of the research for this report and the initial draft were prepared by Anna Mackey, Intern in the Resources, Science, and Industry Division of CRS, during the summer of 2008.

[2] See W. Chandler, *Breaking the Suicide Pact: U.S.-China Cooperation on Climate Change*, Carnegie Endowment for International Peace, March 2008.

[3] See CRS Report RL33534, *China's Economic Conditions*, by Wayne M. Morrison.

The country held $1.5 trillion in foreign exchange reserves by the end of 2007[4], leading some to claim that China was no longer a developing country. Despite this progress, a recent World Bank report estimated that up to 200 million people in China lived on less than $1.25 a day in 2005.[5] Eradicating poverty and raising incomes toward the global average remains a high priority for China.

Historically, China has often put economic growth ahead of the environment. Many Chinese policymakers now realize, however, they can no longer afford an unbalanced approach, especially in the wealthier regions of the country. Environmental pollution has become so bad in places that social and political stability are at risk. Officially recognized "public order disturbances" grew from 58,000 in 2003 to 87,000 in 2005, many due to environmental pollution and land-takings stemming from government corruption.[6] The World Bank, working with the Chinese government and other experts, in 2007 estimated that the cost of outdoor air and water pollution to China's economy totalled around US$100 billion annually, or 5.8% of China's GDP.[7] Related to such findings, the Chinese government put environmental protection into its 11th Five Year Plan (2006-2010) as a high priority. Chinese central government officials have over the past decade pursued a combination of measures to control air, water, and soil pollution, and are struggling to build a "recycling" industrialized economy to ease environmental pressures. These efforts have met with mixed success. Even when national officials genuinely want to encourage a better environment, local officials may have different priorities in mind. As will be reflected further in this report, one important question is the degree to which national goals and measures will be achieved.

Controlling local and regional pollutants like oxides of sulfur and nitrogen, particulates, and mercury is difficult because of the different priorities of local and central government officials and insufficient enforcement. Controlling GHG emissions in China is even harder. For traditional pollutants, both mitigation costs and impacts are local or regional; averaged nationally, polluters will pay the cost one way or another. But with GHG emissions, mitigation costs may be local, while climate impacts are global. So, without shared international action, this can lead to a "tragedy of the commons" phenomenon[8] where free riders emit more than they might otherwise.

Over the past five years or so, China has demonstrated an increasing realization that it has ownership in the outcomes of a warming world. As China grows — potentially enormously, it recognizes that it too will bear the potential costs of

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[4] See CRS Report RL34314, *China's Holdings of U.S. Securities: Implications for the U.S. Economy*, by Wayne Morrison and Marc Labonte.

[5] S. Chen and M. Ravallion, "China is Poorer Than We Thought, but No Less Successful in the Fight Against Poverty," Policy Research Working Paper, WPS-4621, World Bank, May 2008, Table 2.

[6] See CRS Report RL33416, *Social Unrest in China*, by Thomas Lum.

[7] World Bank. 2007. *Cost of Pollution in China: Economic Estimates of Physical Damages*. Washington DC.

[8] Garrett Hardin, "The Tragedy of the Commons," *Science* 162:1243-1248, 1968.

increasing storm intensity, rising sea levels, shifting water availability and agricultural productivity, as well as changing disease migration.[9]

Given the act of balancing economic growth with environmental protection, international relations with domestic politics, and equity with the declared need for action, China, apparently like the United States, maintains a "wait and see" climate policy.[10]

This report lays a groundwork for consideration of expectations of China in the context of climate change as a global challenge. It first provides a brief comparison of China's economy and energy sector with those of the United States. The report then assesses the limited information available on GHG emissions in China. Next, it summarizes some of the best described elements of China's strategy to mitigate its GHG emissions. Finally, a brief section identifies key points on China's status in international cooperation.

China in Context

Table 1 provides selected statistics from 2005 to allow comparison between China and the United States. While China's population is approximately four times larger than that of the United States, its economy, as measured using nominal exchange rates,[11] was only about one-sixth as large. Conversion of currencies using purchasing power parities instead of exchange rates (see Text Box, p. 11) results in a Chinese economy about half as large as that of the United States.[12]

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[9] The *National Climate Change Program*, released in 2007, identifies many potential impacts of climate change on China. Additional examples of recent publications outlining such costs include A. Thomson, R. Izaurralde, N. Rosenberg, and X. He, "Climate Change Impacts on Agriculture and Soil Carbon Sequestration Potential in the Huang-Hai Plain of China," *Agriculture Ecosystems & Environment* 114 (2-4): 195-209, 2006; X. Wang, F. Chen, and Z. Dong, "The Relative Role of Climatic and Human Factors in Desertification in Semiarid China," *Global Environmental Change – Human and Policy Dimensions* 16 (1): 48-57, 2006; X. Zhang, and W. Liu, "Simulating Potential Response of Hydrology, Soil Erosion, and Crop Productivity to Climate Change in Changwu Tablel and Region on the Loess Plateau of China," *Agricultural and Forest Meteorology* 131 (3-4): 127-142, 2005.

[10] For more on China's "wait and see" climate policy, see J. Lewis, M. Cummings, and J. Logan, "Understanding the Climate Challenge in China," *Oil, Gas and Energy Law Intelligence*, May 2008, [http://www.gasandoil.com/ogel/samples/toc.asp?key=29].

[11] In mid-2008, the U.S. dollar bought about 6.8 Chinese yuan, also known as the renminbi (RMB). This exchange rate has declined from 8.2 RMB/$ in 2005.

[12] A. Keidel, "China's Economic Rise — Fact and Fiction," Carnegie Endowment for International Peace, July 2008, p. 5-6.

Table 1. Selected Statistics for China and the United States in 2005

	China	United States
Population (millions)	1305	297
Population Growth (annual %)	0.6	1.0
Gross Domestic Product (billions US$)	2, 244	12,398
Gross National Income using Purchasing Power Parities (US$)	5,359	12,359
GNI per capita (US$)	4,110	41,680
GDP growth (%)	10.4	3.2
Energy Consumption per Capita (kg oil equivalent per capita)	1,316	7,893
Electricity Consumption per Capita (kWh per capita)	1,718	13,698
Greenhouse Gas Emissions (metric tons CO_2e)	7,527	7,282
Greenhouse Gas Emissions per Capita (metric tons per capita)	6	25
Greenhouse Gas Emissions per GNI (tons per 1000 US$ GNI, using purchasing power parities)	1.4	0.6

Source: World Bank Group, *Quick Query from World Development Indicators*, data extracted July 30, 2008, [http://ddp-ext.worldbank.org/ext/DDPQQ/member.do?method=getMembers]. For GHG emissions: International Energy Agency, International Energy Agency. 2007. *CO_2 Emissions from Fuel Combustion 1971 - 2005*. Paris: Organisation for Economic Cooperation and Development.

Note: "CO_2e," or "carbon dioxide equivalents," quantifies six greenhouse gases according to their relative, estimated effects on global warming over a 100-year period.

China's Energy Sector. Because energy production and use — and the resulting carbon dioxide emissions — emit the largest share of total greenhouse gases, comparing China's energy sector to the United States' helps to explain many differences between the emissions of the two countries. Chinese energy demand has surged since the start of this decade, often growing at a rate faster than the economy.[13] This growth has made China a near equal to the United States in terms of overall energy demand, even if Chinese per capita consumption remains far lower

[13] For a discussion of China's surging energy use, see D. Rosen and T. Houser, *China Energy: A Guide for the Perplexed*, China Balance Sheet, May 2007, [http://www.iie.com/publications/papers/rosen0507.pdf].

(at 1.3, compared to 7.9, metric tons of oil equivalent per capita in 2005 — see **Table 1**).

In 2007, the United States used petroleum for 40% of its total energy needs, with coal and natural gas each contributing about 25%, and nuclear and hydroelectric contributing another 10%. In China, however, coal provided 70% of total energy, with petroleum contributing 20%, gas 3%, and hydroelectric and nuclear the remaining 7%.[14,15] China now consumes about twice as much coal each year as the United States, even though its total energy demand in 2007 was about 21% less, according to British Petroleum (BP) data. The next biggest differences between China and the United States in energy structure — besides China's greater reliance on coal — are China's limited quantities of domestic natural gas and fewer nuclear power plants.

China's National Greenhouse Gas Emissions

China's greenhouse gas emissions have become a point of polemics in U.S. debate over appropriate domestic climate change policy, especially regarding the "fairness" of whether the United States government should commit legally to greenhouse gas reductions before or simultaneously with the government of China. A variety of perspectives — and supporting data — are put forward in such debates. This section reviews available data and, along with **Table 1**, describes how estimates of GHG in absolute terms, relative to population or economic production, or associated with exports to other countries, may enter into policy consideration. It also assesses arguments that countries' contributions to atmospheric concentrations, or their emissions related to exports to consuming nations, should play a role in deciding equitable shares of global GHG reduction efforts.

By most estimates, China is now, or soon will be, the largest emitter of greenhouse gases (GHG) globally.[16] The most recent — and only — official GHG inventory published by the government of China was for the year 1994.[17,18] At that

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[14] These data are from the *BP Statistical Review of World Energy 2008*, available at [http://www.bp.com].

[15] Estimates of GHG emissions in China are uncertain, in part because of underlying uncertainties in official energy and economic data. Such data issues are more pronounced when considering data over time (for example, regarding changes in coal data over the past decade) or in comparison to other countries, where levels of uncertainty may be less.

[16] The Netherlands Environmental Assessment Agency was the first organization to state that Chinese carbon dioxide emissions, the main greenhouse gas, exceeded those of the United States starting in 2006. Since then, other organizations have made similar statements. See E. Rosenthal, "China Increases Lead as Biggest Carbon Dioxide Emitter," *New York Times*, June 14, 2008.

[17] *The People's Republic of China Initial National Communications on Climate Change*, Office of National Coordination Committee on Climate Change, 2007, available at [http://www.ccchina.gov.cn/en/index.asp].

[18] Like some other developing countries, China has resisted proposals in international (continued...)

time, China estimated its total GHG emissions to be 4,060 million metric tons of carbon dioxide equivalent ($MMTCO_2e$).[19] In 2007, China tentatively estimated its total GHG emissions in 2004 to be about 6,100 $MMTCO_2e$, a growth of 50% in one decade.[20] Of the estimated emissions in 2004, approximately 83% were carbon dioxide (CO_2), 12% were methane (CH_4), and 5% were nitrous oxide (N_2O), with less than 1% of sulfur hexafluouride (SF_6), hydrofluourocarbons (HFC) and perfluourocarbons (PFC).[21] (Together, these constitute the six GHG covered by the Kyoto Protocol.) In lieu of more recent, official GHG estimates, the Chinese National Climate Change Program sometimes cites GHG emissions estimates from the International Energy Agency (IEA).

The IEA has estimated that China's GHG emissions for 2005, including CO_2, CH_4, N_2O, HFC, PFC, and SF_6, were 7,527 $MMTCO_2e$.[22] Of these emissions, about 78% were CO_2, 13% CH_4, 8% N_2O, and 1% or less of each of the three other gases. The shares emitted by different economic sectors are discussed later in this report.

Figure 1 illustrates significant uncertainties regarding China's emissions by comparing estimates by gas from two different data sources: China (for 2004) and the IEA (for 2005). While the estimates are substantially similar, the IEA total for 2005 is 23% greater than the Chinese tentative estimate for 2004. The difference is likely due in part to strong growth in energy use from 2004 to 2005, but it also likely reflects significant differences in the underlying data. Proportionately, CO_2 is a greater share of emissions in the estimate from China (83% compared with 78%), and the Chinese estimate does not include emissions of SF6, PFC or HFC, which together make up 1.6% of the IEA's total.

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[18] (...continued)
negotiations under the United Nations Framework Convention on Climate Change (UNFCCC) that developing countries submit annual GHG inventories to the Conference of the Parties.

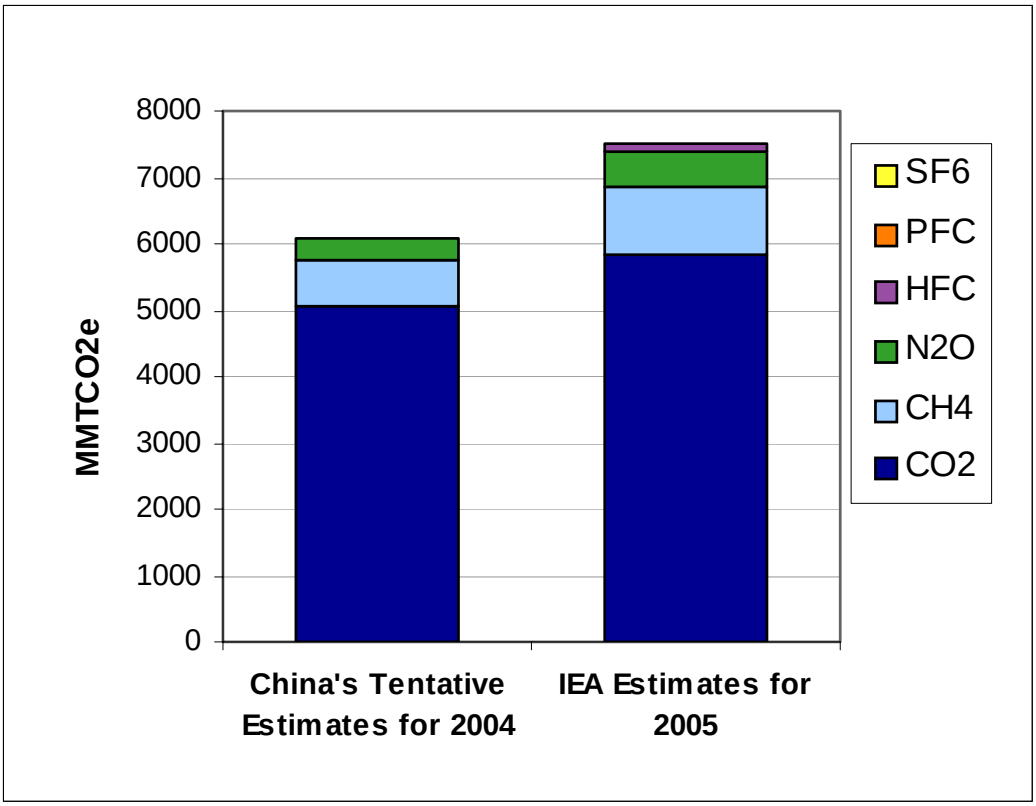
[19] $MMTCO_2e$ means "million metric tons of carbon dioxide equivalent," which is an aggregate of all greenhouse gases with each gas weighted by its effect on climate change compared to CO_2.

[20] "China: Backgrounder: Current GHG Emissions in China, *Xinhua*, June 4, 2007, [http://www.chinaview.cn].

[21] For background information on GHGs, see CRS Report RL34513, *Climate Change: Current Issues and Policy Tools*, by Jane A. Leggett.

[22] *IEA Database on CO2 Emissions from Fuel Combustion, 1971-2005*, IEA, 2007. Contrary to the title, this series of publications contains estimates of all 6 greenhouse gases.

Figure 1. Comparison of Estimations of GHG Emissions in China for 2004 and 2005



Source: CRS figure with estimates from IEA database (extracted January 8, 2008) and Xinhua (June 4, 2008).

According to China's National Climate Change Program,[23] China offset a portion of its GHG emissions with removals (sequestration) by forests: "from 1980 to 2005, a total of 3.06 billion tons of CO_2 were absorbed by afforestation, a total of 1.62 million tons of CO_2 were absorbed by forest management, and 430 million tons of CO_2 from deforestation were saved."[24] Removals of CO_2 from the atmosphere by land use, land use change and forestry are much more uncertain in all countries than emissions by human activities.

According to IEA data, China and the United States are approximately tied as the leading global emitters of GHG emissions, both at more than 7 billion metric tonnes per year.[25] **Figure 2** ranks the world's leading GHG emitters, using data from

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[23] China published this document in June 2007 to outline its plan to address climate change and show its determination to mitigate emissions. The official document is available at [http://english.gov.cn/2007-06/04/content_635624.htm].

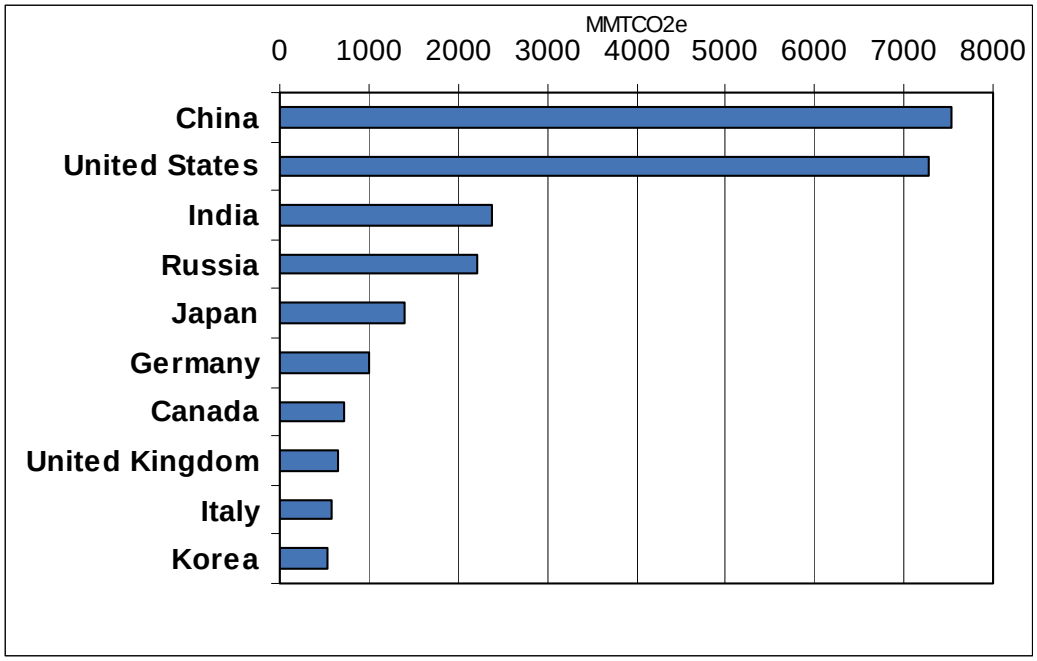
[24] National Development and Reform Commission (NDRC), "China's National Climate Change Program," p. 10.

[25] According to IEA's most recent estimates for 2005, China's emissions were 7,484 $MMTCO_2e$ and the United States' emissions were 7,282 $MMTCO_2e$. All of the other listed

(continued...)

the IEA. According to these data, China and the United States are each responsible for about 17% of global GHG emissions. Uncertainties in the methods and data underlying the IEA estimates make it unsupportable, for now, to definitively rank which country is the largest emitter.[26] The date when China may unarguably become the largest GHG emitter is also unclear, but likely by 2009.

Figure 2. Top GHG Emitters in 2005



Source: CRS graphic from IEA estimates (extracted January 8, 2008).

Together, the United States and China emit approximately 40% of global carbon dioxide emissions, and about 35% of total GHGs. Many people argue that, eventually, both countries would need to play a role in substantially mitigating emissions if the world is to hold atmospheric concentrations of greenhouse gases at a level that is considered safe.[27] The respective abatement to which each country should commit, however, is controversial because of the very different economic conditions in the two countries. These differences become apparent when comparing GHG emissions per capita and per unit of economic production.

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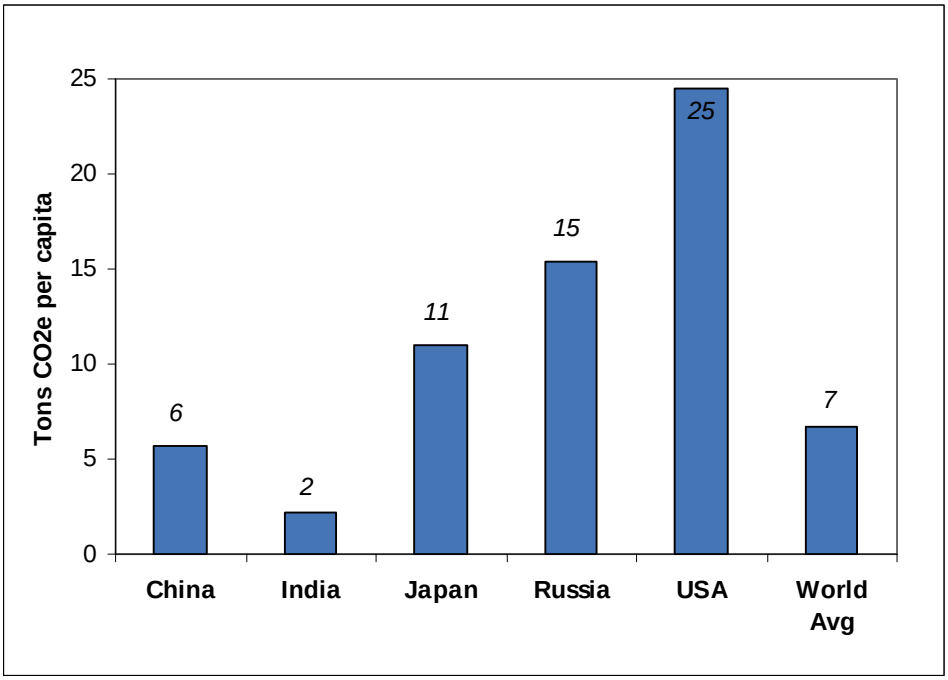
[25] (...continued)
countries emit far less than both China and the United States. For example, India was the third largest emitter at 2,380 $MMTCO_2e$ in 2005.

[26] The IEA report notes that "It is stressed that the uncertainty in the resulting dataset at national level may be substantial, especially for methane and nitrous oxide, and even more so for the F-gases. The uncertainty is caused by the limited accuracy of international activity data used and in particular of emission factors selected for calculating emissions on a country level." IEA, op. cit., p. III.12.

[27] W. Chandler, op. cit.

GHG per capita. Although China is a leading GHG emitter, its GHG emissions per person fall far below those of the United States and other industrialized nations (**Figure 3**). China's population was approximately 1.3 billion people in 2005, almost 20% of global population — a larger share than its GHG emissions. In 2005, Chinese emissions per capita were about 6 tons, compared to the United States at 25 tons, and Russia at 15 tons. China's emissions per capita are also below the world average of 7 tons.

Figure 3. Estimated Per Capita GHG Emissions in 2005



Source: CRS graph from IEA estimates for 2005 (extracted January 8, 2008).

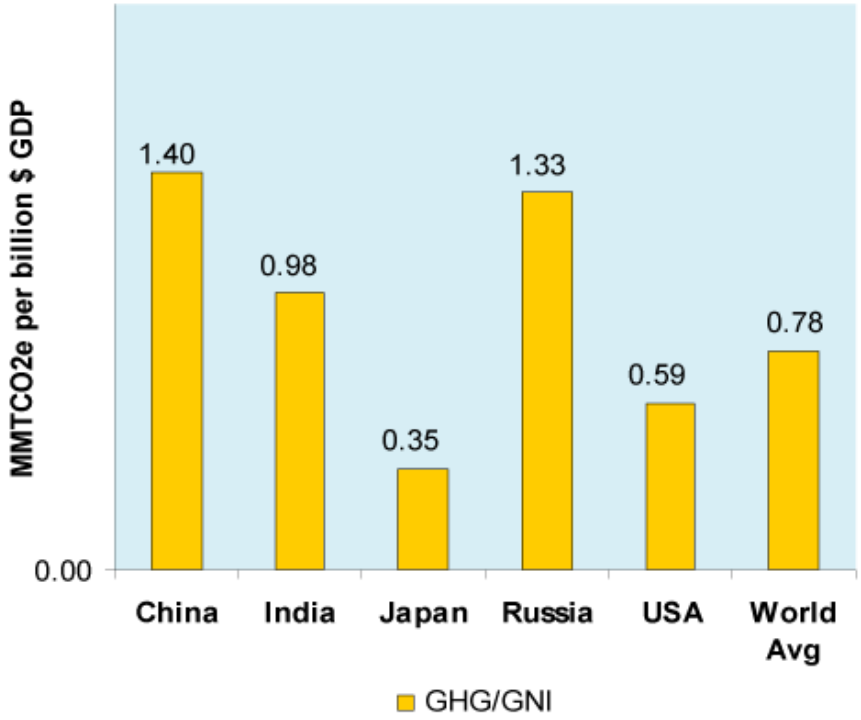
In a policy context, the Chinese government and some observers point to China's low emissions per capita — associated with China's lower-than-average levels of income and consumption — and argue that the country's GHG emissions per capita and in total should be expected — and allowed — to grow as incomes rise. Some contend, in moral terms, that the Chinese should have a "right" to consume per capita a greater share of world resources (in this case, the absorptive capacity of the atmosphere). People who consume a greater than average share of resources, they say, should reduce them to allow for expansion by those who now consume less than average.[28]

GHG Productivity or Intensity. Experts often compare economies by their productivity in use of a particular resource, such as labor or energy. They may also speak about the productivity of an economy (or sector) in terms of the GHG emissions associated with its level of production. This concept may be termed "GHG

[28] There has been substantial literature internationally concerning "contraction and convergence" of emissions per capita. See, for example, [http://www.gci.org.uk/contconv/cc.html].

productivity" or "GHG intensity." The lower a GHG intensity number for an economy, the more efficient that economy is in terms of its GHG emissions per unit of production, typically measured as gross domestic product (GDP) or gross national income (GNI).[29] Some experts — and President George W. Bush — have proposed setting international GHG emission control targets in terms of the rate of improvement of GHG/GDP, also called "GHG intensity targets." They believe that this form of GHG target would not penalize economic growth, among other reasons.

Figure 4. Estimated GHG Intensities in 2005



Source: CRS graph from IEA estimates for 2005 (extracted January 8, 2008) and World Bank economic Gross National Income data (extracted September 10, 2008).

Though China's emissions per capita are lower than most developed nations, China's GHG intensity remains higher than most nations (**Figure 4**) and well above the world average of about 0.78 tons of GHG per billion U.S. dollars of Gross National Income using purchasing power parities (GNI_{ppp}) to convert currencies to US dollars (see **Text Box**). China's emissions are about 1.40 million $MMTCO_2e$ per billion U.S. dollars of GNI_{ppp} — nearly twice the world average. Russia is slightly below China by these estimates at 1.33 $MMTCO_2e$ per billion U.S. dollars of GNI_{ppp}. followed by India at 0.98 $MMTCO_2e$. The United States, like most high income countries with large service sectors has a GHG intensity of about 0.59 $MMTCO_2e/GNI_{ppp}$.

[29] According to the World Bank, "GNI is the sum of value added by all resident producers plus any product taxes (less subsidies) not included in the valuation of output plus net receipts of primary income (compensation of employees and property income) from abroad."

The overall level of economic activity and industrialization are important determinants of GHG emissions. Since China is trying to increase its national income, its emissions are also expected to increase. China and other developing countries give high priority to eradicating poverty and raising the incomes (income per capita) of their populations toward those of industrialized nations. Consequently, these countries contend in GHG negotiations that addressing climate change must be of lesser priority, while wealthier countries take the lead in reducing their GHG emissions.

Some experts argue that economies that are less GHG-efficient (with higher GHG intensity), such as China, must have greater opportunity and responsibility to improve those efficiencies. Some of these experts may argue that advancing growth of developing economies would naturally lead to less GHG emissions (based on some, but disputed, analysis that emission intensities of economies naturally decline as incomes rise). Others have found that rapidly advancing technologies in use may improve GHG intensity but result in greater GHG emissions overall because of the macroeconomic expansion and consumption they could stimulate.[30]

Though total GHG emissions have grown in China, its GHG emissions intensity has substantially fallen in recent decades, though not consistently. In the last few years, aggressive energy efficiency policies have contributed to this decline, and will be discussed further in the domestic policy section. Using IEA's GHG emission estimates and the World Bank's World Development Indicators, China's GHG intensity fell more than two-thirds from 1990 to 2005 (whether calculated by GDP using exchange rates or GNI using purchasing power parities). For the same period, the world average emissions intensity dropped 43%, while the United States' GHG intensity declined by 48%.[31] As a measure of the progress of its national policy, the National Bureau of Statistics, the National Development and Reform Commission (NDRC), and the National Energy Administration said in a statement that the energy consumption for every 10,000 yuan of GDP for 2007 was 1.6 tons of coal equivalent, falling by 3.7% from the year 2006.[32]

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[30] Fisher-Vanden, Karen, and Mun S. Ho. 2006. Technology, Development, and the Environment, *under review*, [http://www.dartmouth.edu/~kfv/Paperspub.htm].

[31] CRS estimates using IEA and World Bank data.

[32] Some view Chinese energy and economic statistics with caution. "Energy Consumption per Unit of GDP Continues to Fall," *Xinhua*, July 15, 2008.

Measurement of Economic Activity Affects Cross-Country Comparisons

How economic activity is measured influences the comparison of GHG intensities across countries. The exchange rate between the Chinese currency and the U.S. dollar influence how this number is reported, for example. The Chinese RMB has strengthened roughly 20% in comparison to the dollar since it began a "managed float" in July 2005,[a] resulting in a relative increase in China's estimated GDP and therefore lowering of Chinese GHG intensity.[b] Many analysts believe that using purchasing power parity (PPP) — like several estimates in this CRS report — rather than currency exchange rates, is a better way to compare GHG intensities across countries with different economic structures and conditions.

Economists have attempted to factor-in national price differentials by using a purchasing power parity (PPP) measurement. The PPP converts foreign currencies into a common currency (usually the U.S. dollar) on the basis of the actual purchasing power of those currencies (based on surveys of the prices of various goods and services) in each respective country. In other words, the PPP data attempt to determine how much local currency (yuan, for example) would be needed to purchase a comparable level of goods and services in the United States per U.S. dollar.

However, Purchasing Power Parities are estimated as well; a World Bank revision of its PPPs in December 2007 reduced estimates of the size of China's economy by about 40% for 2005.[c] This relative reduction of the size of Chinese economy, while estimates of GHG emissions remained constant, raised CRS' calculation of China's GHG intensity for 2005 from 0.98 to 1.40 — raising it substantially relative to other countries (for which the world average remained the same).

a. B. Naughton, Summer 2008. "The Inflation Battle: Juggling Three Swords," *China Leadership Monitor*, [http://www.hoover.org/publications/clm/issues/20100644.html].

b. CRS Report RS22808, *How Large is China's Economy? Does it Matter?*, by Wayne M. Morrison and Michael F. Martin.

c. [http://www.imf.org/external/pubs/ft/survey/so/2008/RES018A.htm].

China's Contribution to GHG Concentrations. Internationally, 192 countries — including the United States — have joined the 1992 United Nations Framework Convention on Climate Change (UNFCCC) to stabilize "greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system" (Art. 2). In the UNFCCC, governments agreed to a principle of "common but differentiated responsibilities" among countries. This principle is at the core of debate about how to share among countries the challenge of stabilizing GHG concentrations. In the negotiations leading to the Kyoto Protocol, the Brazilian delegation proposed that the effort to reduce GHG emissions might be shared globally, with commitments from developing countries not beginning until their contributions to present or future GHG concentrations in the atmosphere reach those of the historical contributions of industrialized countries ("the Brazil Proposal").

Thus, much analysis and political discussion about appropriate responsibilities among countries for mitigating emissions has revolved around how much each country has contributed to the accumulation of GHG in the atmosphere (i.e., GHG

concentrations). Depending on judgments of how to define such contributions (for example, from which year to begin counting emissions, which types of emissions to count, etc.), the share attributable to a country could vary by as much as 10 percentage points, according to recent analyses. For example, looking only at recent annual emissions, China contributed about 17% to current global GHG emissions (for 2005), including all human-related sources and sinks of CO_2, CH_4, N_2O, SF_6, HFC and PFC. (This is approximately the same as the United States' estimated share in the same year, recognizing the uncertainty in the estimates.)

Considering accumulated historical emissions, **Figure 5** shows the results of an international study to estimate the shares of different countries' contributions to the accumulation of GHG in the atmosphere as current concentrations, under a range of methods, criteria and modeling tools.[33] **Figure 5** represents just four of many alternative cases. The "Reference Case" is based on the accumulations of emissions and net removals of six GHG from 1890 to 2005, taking into account changes in national boundaries (for CO_2 only). The case "RC (excl. LULUCF)" is similar to the Reference Case but does not include emissions or removals of CO_2 from/to the atmosphere due to changes in land use and forestry. The "RC ($t \geq 1990$)" case counts GHG emissions only since 1990 (rather than 1890). The "Art. 4 Joint Contribution ($t > 1990$)" case is a hypothetical case as if industrialized and developing countries were to share equal responsibility for the growth of GHG emissions in developing countries since 1990. While the differences among these cases are illustrative, not precise technically nor agreed politically, the examples demonstrate the effects of alternative ways to consider a country's contribution to climate change now and in the future. The Chinese government often refers to "historic responsibility" for climate change — and China's lower contribution to it than some industrialized countries — by estimates such as these, when discussing the options for future GHG commitments under an international agreement.[34]

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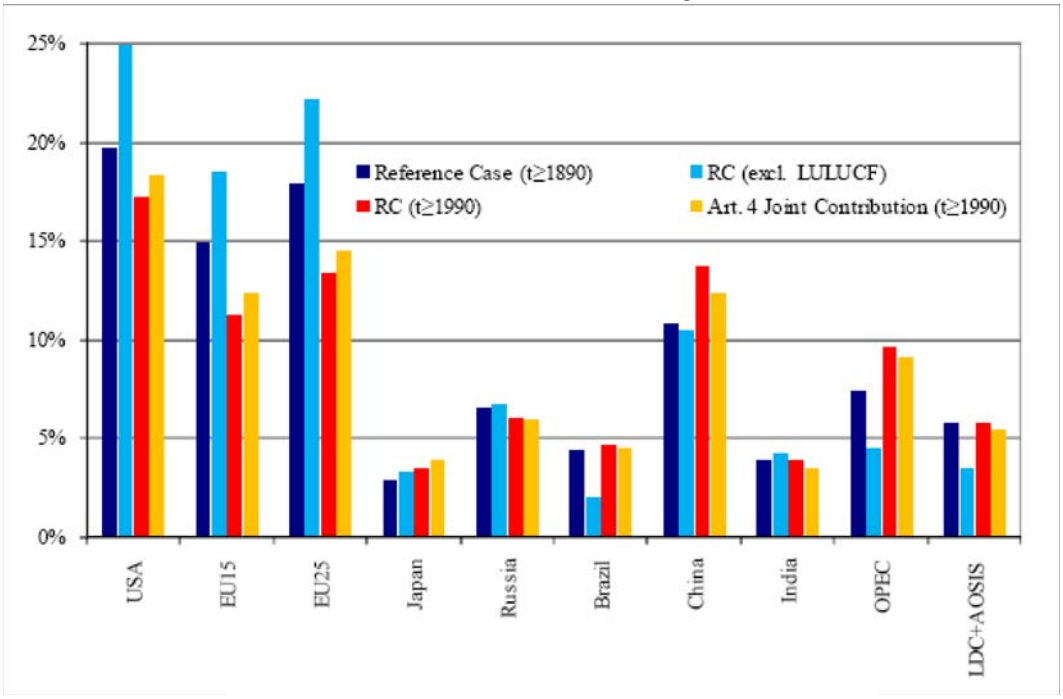
[33] Although **Figure 5** comes from B. Muller, et al., *Differentiating (Historic) Responsibilities for Climate Change — Summary Report* (October 2007), a better reference for the analysis is Den Elzen, Michel. 2007. *Report of the Ad Hoc Group on Modeling and Assessment of Contributions to Climate Change* (MATCH). April 7, 2007, [http://www.match-info.net/].

[34] See CRS Report RL33826, *Climate Change: The Kyoto Protocol, Bali "Action Plan," and International Actions*, by Susan Fletcher and Larry Parker, for further discussion of international negotiations to mitigate GHG.

Figure 5. Relative Contributions to Climate Change in 2000 Under Alternative Assumptions



Source: Muller et al.

GHG Emissions Due to Exports (Embedded Emissions). Periodically, some people propose that, because GHG are driven by people's consumption, allocating the responsibility to reduce emissions should be based on such consumption, not on who produces the emissions. When a country emits GHG while manufacturing products to be exported to a consuming nation, the responsibility for those emissions are implicitly "embedded" in the exports. While there are several options for addressing embedded emissions, one is that the export-related emissions of a country, such as China, be debited from its inventory and credited to those of importing countries, such as the United States. Others would argue that administering such a approach accurately would be infeasible, while others would argue that it would be preferable for the exporting country to pay the cost of reducing the emissions and to pass that cost through in the prices of its exports.

Regardless of the merits of the arguments, the share of China's GHG emissions attributable to its exports could be as much as one-third in 2005 (see **Figure 6** and **Figure 7**).[35] However, "[w]hile Chinese production has several advantages for the global economy, it currently causes greater environmental impacts compared to if the goods were produced in many other regions."[36] This conclusion is founded on the

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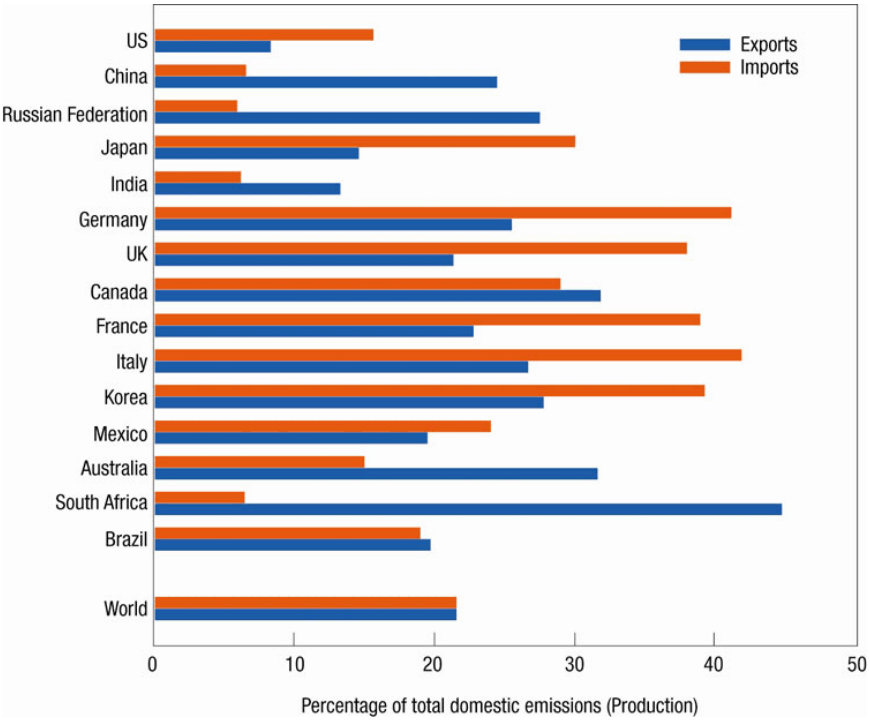
[35] Weber, Christopher L., Glen P. Peters, Dabo Guan, and Klaus Hubacek. "The Contribution of Chinese Exports to Climate Change." *Energy Policy*. doi:10.1016/j.enpol.2008.06.009.

[36] Peters, G.P., C.L. Weber, D. Guan, and K. Hubacek. 2007. "China's Growing CO_2 Emissions — A Race between Increasing Consumption and Efficiency Gains." (continued...)

relatively higher GHG intensity of production in China, as well as its generally higher levels of other types of pollution and resource use per unit of production, compared to many industrialized and developing countries.

Figure 6. One Estimate of CO_2 Emissions Associated with Imported and Exported Products in 2007



Source: Peters, Glen, and Edgar Hertwich. 2008. CO_2 Embodied in International Trade with Implications for Global Climate Policy. Environ. Sci. Technol. 45, no. 2 (January 30): 1401-1407.

Note: As the data for trade and associated emissions, as well as consistency of data across countries, are of mixed quality, these estimates may be viewed as imprecise.

Recent Rates of Growth of China's GHG Emissions. Chinese GHG emissions have grown rapidly this decade, largely due to energy-intensive industrial activity.[37] According to unofficial GHG estimates from China, from 1994 to 2004, China's annual average GHG growth rate was around 4%.[38] In this period, the share of carbon dioxide in total GHG emissions increased from 76% to 83%.[39]

According to IEA estimations of China's GHG emissions, from 1990 to 2005 the total amount of CO_2 increased from 2545 $MMTCO_2$ to 5843 $MMTCO_2$ (almost 144%), while total GHG emissions increased from 3905 $MMTCO_2e$ to 7527

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[36] (...continued)
Environmental Science & Technology 41, no. 17 (September 1): 5939-5944.

[37] D. Rosen and T. Houser, op. cit.

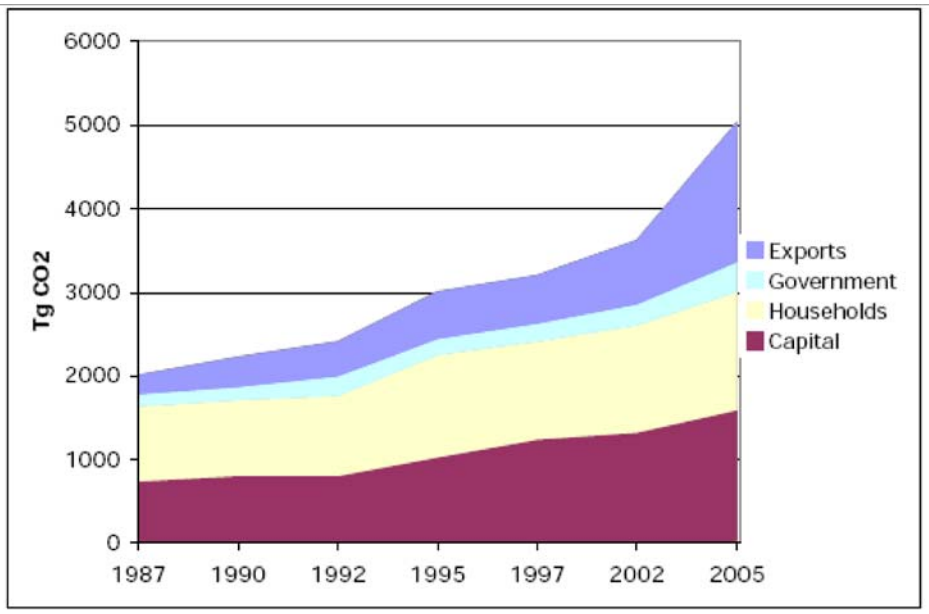
[38] The Climate Change Group, "China Briefing," Issue 1, September 2007.

[39] Xinhua, op. cit., June 4, 2007.

$MMTCO_2e$ (152%).[40] China's increasing carbon dioxide emissions — up 8% from 2006 to 2007 — accounted for two-thirds of the growth in all global CO_2 emissions in 2007.[41]

Figure 7 provides one estimate of the economic activities that have been driving recent growth of Chinese GHG emissions. It concludes that the emissions associated with exports have grown rapidly in the past few years, but most growth has been due to capital investment (construction of buildings, roads, etc.) and increased consumption by growing population and — especially — incomes.[42]

Figure 7. One Estimate of Factors Driving Recent Growth of GHG Emissions in China



China's total domestic CO_2 emissions, divided by driving demand: exports, governmental consumption, household consumption, and capital investment

China exercises strong policies to slow population growth; the growth of population in 2005 was approximately 0.6%, down from an average rate of about 1.1% in the 1990s and 1.4% in the 1980s,[43] helping to diminish the corresponding growth of national GHG emissions. China's population policies are clearly not

[40] International Energy Agency, op. cit., data extracted July 8, 2008.

[41] According to report released by the Netherlands Environmental Assessment Agency, [http://www.mongabay.com].

[42] Weber, Christopher L., Glen P. Peters, Dabo Guan, and Klaus Hubacek. 2008. "The Contribution of Chinese Exports to Climate Change." *Energy Policy*. doi:10.1016/j.enpol.2008.06.009.

[43] Population growth rates taken from United Nations, *World Population Prospects: The 2006 Revision*, 2007; and Central Intelligence Agency, *The World Factbook: China*, July 2008, [https://www.cia.gov/library/publications/the-world-factbook/geos/ch.html].

aimed at mitigating GHG emissions, but observers note that without them emissions would have increased substantially.[44]

China reports that from 1991 to 2005, its real GDP grew at an average annual rate of 10.2% while its annual rate of energy growth was 5.6%.[45] Much of the improvement came from economic restructuring and energy efficiency improvements. China's emissions growth is also driven heavily by increased consumption of electricity generated from coal.

GHG Projections. China's emissions are widely projected to continue rising rapidly for at least the near future. The trajectory of future Chinese emissions depends on many variables, some of which are impossible to predict, including technological breakthroughs, economic growth, and developments in international negotiations. According to the Chinese *Initial National Communication on Climate Change*,[46]

> [t]he principal factors affecting China's future GHG emissions are: population growth and increasing urbanization, the changes in the pattern of economic development and consumption, the expansion in people's daily necessities, the adjustment in economic structure and technological progress, and the changes in forestry and ecological preservation and construction.

While many envision continued strong growth, there is also the possibility that Chinese emissions will decline, perhaps due to social and political upheaval that results in economic slowdown. There are also Chinese officials who envision half or more of China's energy coming from nuclear and renewable energy sources by 2050.[47]

Given "business as usual," the U.S. Energy Information Administration forecasts an average growth rate in Chinese carbon dioxide emissions of 3.3% per year between 2005 and 2030.[48] This trajectory would put Chinese carbon dioxide emissions at just over 12 billion metric tons in 2030, nearly twice the level of the United States that year at 6.9 billion metric tons. Forecasts of Chinese emissions by the IEA are similar, although slightly lower than the EIA's.[49]

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[44] According to Gao Guangsheng of the NDRC, Chinese carbon dioxide emissions would have been 1.3 billion tons higher in 2005 had the country not implemented family planning policies in the 1970s, [http://www.pewclimate.org/docUploads/Gao%20Guangsheng.pdf]. Some people find family planning and other methods of birth control immoral. Regardless of moral viewpoint, slowing population growth is likely to contributing to GHG mitigation.

[45] National Bureau of Statistics, *China Statistical Yearbook 2007*.

[46] People's Republic of China, Initial National Communication on Climate Change, 2004.

[47] China Climate Change Info-Net. 2008. *Low Carbon, High Hopes*. August 11, [http://www.ccchina.gov.cn/en/NewsInfo.asp?NewsId=13798].

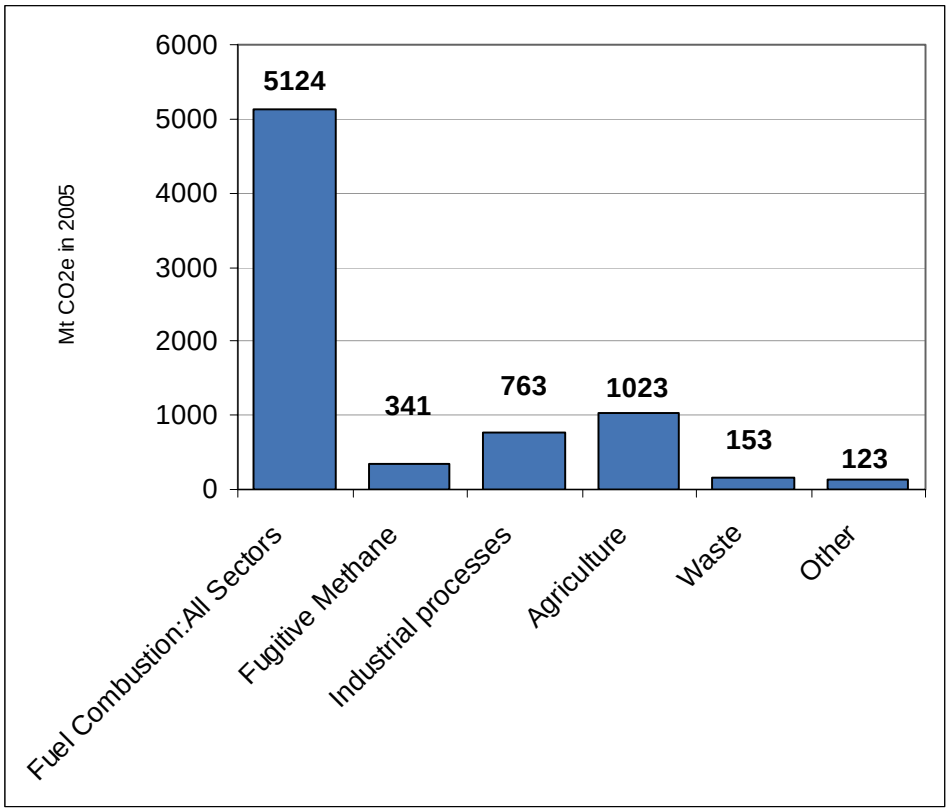
[48] Energy Information Administration, *International Energy Outlook 2008*, Table A.10, U.S. DOE, June 2008.

[49] See IEA, *World Energy Outlook 2007: Focus on China and India*, November 2007.

Sectoral GHG Emissions. Since China has not officially released a GHG inventory since 1994, it is difficult to know how sectors contribute to national emissions. The Pew Center on Global Climate Change estimated that, in 2003, electricity and heat made up 42% of China's GHG emissions, industry made up 21%, agriculture 20%, households and services 9%, transportation 5%, and the remaining 3% was waste.[50]

According to IEA estimates, of China's 2005 GHG emissions, about 68% came from fuel combustion of all sectors (**Figure 8**). About 5% evaporated as methane from energy related systems. Another 10% came from industrial processes, and about 14% came from agriculture. Waste and miscellaneous sources accounted for the remaining 4% of China's GHG emissions that year.

Figure 8. GHG Emissions By Source Types in China in 2005



Source: CRS graph from IEA estimates, extracted July 8, 2008.

China's Domestic Policies to Mitigate GHG Emissions

Due to pressures on China's energy system, health effects of pollution, and climate change policies, the national government has adopted a variety of policies and programs to improve energy efficiency of demand and supply, diversify its energy sources, reduce polluting emissions, and suppress large vehicle demand. In

[50] Pew Center on Global Climate Change, "Climate Change Mitigation Measures in the People's Republic of China," p. 1, April 2007.

June 2007, China released its first national strategy on climate change. The plan, called China's National Climate Change Program, promises to improve energy efficiency and expand low-carbon energy supply, but rejects any mandatory caps on greenhouse gas emissions. The report also states that China is taking a responsible attitude towards climate change, and contends that some measures taken by China are more proactive than those of some developed countries. Many of the policies have been laid out as well by the Renewable Energy Law of 2005; the Energy Conservation Law of 2008; the *Medium- and Long-Term Development Plan for Renewable Energy* issued by the National Development and Reform Commission (NDRC); and by the *Several Opinions Regarding Acceleration of Shutting down Small Thermal Power Generating Units* jointly issued by the NDRC and the State Energy Office, and the *11th Five-Year Program* (2006-2010).

In support of these programs, the government reports that it is raising spending on energy efficiency and greenhouse gas emission reduction programs to US$6.1 billion in 2008, up from US$3.5 billion in 2007.[51]

Enacted Domestic Programs in China. Out of the 52 policies and measures stated in China's National Climate Change Program to address climate change, ten are quantitatively described; these are outlined in **Table A-1** of the Appendix to this CRS report. Some information in the table comes from more recent announcements in China. Brief descriptions of each of the mitigation measures is provided below. (Estimates of GHG emissions reduced, unless otherwise noted, come from Chinese press releases, and the baseline from which the reductions are calculated has not been provided.)

An Economy-Wide Energy Efficiency Target. China has set an economy-wide energy efficiency target that mandates a 20% reduction in energy intensity (energy use per unit of GDP) between 2005 and 2010. This sets up milestones of 4% reductions in each year, against which the Chinese government has been measuring performance. The expected greenhouse gas emissions reduction would be 700 million tons of CO_2 by 2010 compared to the business-as-usual baseline. Progress reports indicate that, in 2006 energy consumption fell 1.23% from 2005 levels, short of the 4% annual goal.[52] In 2007, preliminary results show a roughly 3% decline.[53] Meeting this goal will thus be enormously challenging for China. Reportedly, China raised its electricity tariffs by about 5% in June 2008 and again in July 2008, seemingly in line with China's visible high level attention to its energy challenge.

The Renewable Energy Law. Effective since February 2005, China's Renewable Energy Law (RE Law) has set the world's most aggressive and legally

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[51] Jiang Xufeng. 2008. *China Takes Responsible Attitude to Climate Change and Environmental Protection.* Xinhua, April 13, English edition. Estimate uses currency exchange rates.

[52] The China Sustainable Energy Program, op. cit., [http://www.efchina.org].

[53] R. Shen, "China May Hit Energy Use Target for First Time in 08," *Reuters*, February 25, 2008.

binding target for expanding the use of renewable energy. The law mandates that 16% of all energy is to come from wind, biomass, solar, and hydro-power energy by 2020. When the RE Law was enacted, only 7% of China's energy came from renewable sources.[54] Wind, solar, geothermal, and tidal energy are expected to reduce 60 Mt CO_2 by 2010. Bio-energy is expected to create a 30 Mt CO_2e reduction by 2010, and hydroelectricity development is expected to reduce emissions by 500 Mt CO_2.[55] The Global Wind Energy Council predicts China will become the world's largest wind turbine market by 2010,[56] adding to China's top-standing in solar hot water use, and a rapidly growing photovoltaic sector. Over the longer term, some officials have expressed a vision that, by 2050, nuclear power and renewable energy may exceed half the country's energy production.[57]

Becoming a major producer and exporter of "clean" technology appears to be a component of China's overall strategy of "sustainable development." By 2008, China was the second leading manufacturer of solar photo-voltaic technology, after Japan; by 2009, China is expected to lead in manufacture of wind turbines. China "is also taking the lead in solar water heaters, energy efficient home appliances, and rechargeable batteries."[58] According to a recent report by the Climate Change Group, based in Britain, "it is precisely [China's] ability to manufacture technology in large volumes and at competitive prices that will enable it to dominate the world's renewable technology market."

While investment in "green energy" has become a Chinese government priority and is attracting billions of dollars annually of private capital, some observers have noted substantial challenges to China's plans:

> Although green energy is drawing more and more attention in China, the development of the industry is still faced with many difficulties, for instance, uncompleted policy system, excessive reliance of the enterprise(s) on the government for development and relatively unsophisticated technologies and equipment. To be specific, the difficulties are manifested in the following aspects: 1) there are few professional research institutions under the government and its ability to promote extensive use of green energy in the society is yet to be improved; 2) there are few self-developed technologies, especially high-end technologies and most technologies remain in the simulation stage; 3) the industry is in severe lack of technical professionals and there is urgent need for conservation and training of technical talents; 4) some industry facilities can not meet the needs of the industry, for instance, poor quality and severe lack of

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[54] The China Sustainable Energy Program, "Fact Sheet: China Emerging as New Leader in Clean Energy Policies," [http://www.efchina.org].

[55] NDRC, China's National Climate Change Program, p. 31.

[56] Global Wind Energy Council, *Global Wind 2007 Report*, April 2008, p. 12. Other reports have stated that China may become the world's largest turbine manufacturer by 2009.

[57] China Climate Change Info-Net. August 11, 2008. *Low Carbon, High Hopes*, [http://www.ccchina.gov.cn/en/NewsInfo.asp?NewsId=13798].

[58] Howard, Steve, and Changhua Wu. 2008. *China's Clean Revolution*. The Climate Group.

equipment co-exist. All of these have jointly restricted the development of the green energy industry.[59]

Promoting Nuclear Power. One of China's main concerns is to actively promote the development of nuclear power as part of its national energy strategy. In 2008, the National Energy Administration raised its target to 5% of installed capacity by 2020, a percentage point higher than the goal set in 2007. China intends to construct nuclear power stations in coastal regions, "unify technology approaches," adopt advanced technology, construct large-scale nuclear power stations, advance international cooperation, and promote technology transfer. China's mitigation target is to have installed capacity exceeding 70 GW by 2020, with expectations that nuclear power generation would rise from 2.3% of China's of electricity generation to 16% by 2030. With the former 2007 target, greenhouse gas emissions were expected to be reduced by 50 Mt CO_2 by 2010.[60] Reported progress is that, as of March 2008, China had been expanding nuclear power construction plans faster than earlier planned. The installed power capacity could be 50% above the initial goal by 2020.[61] But China, like other nations, faces economic and financing challenges with nuclear power plant construction.

Improve Power Sector Efficiency. China has ambitious goals to decommission small, inefficient power generators and to accelerate the deployment of very advanced powerplant technology (e.g., "supercritical" and "ultra-supercritical" combustion technology). These measures are expected to reduce greenhouse gas emissions by 110 Mt CO_2 by 2010.[62] In 2007, China reportedly exceeded its target to close 10 GW of small inefficient generators.[63] China has also installed relatively efficient supercritical and ultra-supercritical coal-fired power plants over the past few years.[64] Such technologies, in combination with carbon capture and sequestration (if required or subsidized), could profoundly alter China's future carbon emissions trajectory.[65]

Development of a Coalbed Methane Industry. Capturing methane (CH_4) potentially released during coal production and using it as a fuel both reduces emissions and substitutes for other fuel use and emissions. China's National Climate Change Program states that China wants to vigorously develop the coalbed methane (CBM) industry. Coalbed methane exploration, development, and utilization are to

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[59] [http://www.zero2ipo.com.hk/china_this_week/detail.asp?id=7164].

[60] NDRC, op. cit., p. 32.

[61] Reuters, "China's Nuclear Power Expansion 'Faster Than Planned,'" *Xinhua*, March 8, 2008.

[62] NDRC, China's National Climate Change Program, p. 32.

[63] "China to Shut Coal Power Stations This Year Amid Coal Crisis," *International Mining*, February 6, 2008.

[64] The Power-Technology.com website has more information on this technology in China: [http://www.power-technology.com/projects/yuhuancoal/].

[65] For example, Jianxiong Mao. 2008. "Status and Development of China's Electric Power." Presented at Asia Clean Energy Forum, June 2008. Manila, Philippines.

be adopted as important ways to "expedite the structural optimization of coal industry, reduce accidents of coal production, improve rates of resource utilization, and prevent environmental pollution."[66] Some incentives provided by Chinese policy include adopting preferential tax policies for CBM utilization projects, exempting or partially exempting surface extraction and exploring projects from utilization fees for prospecting and mining rights, applying preferential policies as defined in China's Renewable Energy Law, and ensuring that the CBM price for industrial and residential use is not below the price of natural gas with the same calorific value. With these measures, China's mitigation target is that 10 CBM pipelines be built throughout the nation between 2006 and 2010. These pipelines should be capable of distributing 6.5 billion cubic meters of CBM. Expectations are for 200 Mt CO_2e to be reduced by 2010 as a result of policies.[67] Reported progress indicates that, as of June 2008, China had started construction on the first of 10 coal-bed methane pipeline projects.[68] Meeting the production target of 10 billion cubic meters of CBM production in 2010 will be challenging given relatively low production now.

Top 1,000 Enterprise Efficiency Program. China's industry is dominated by large, state-owned enterprises. These enterprises consume one-third of the country's energy and emit the bulk of China's pollution, including CO_2. The Top 1,000 Enterprise Efficiency Program was established in 2006, and aims to reduce energy use of China's 1,000 most energy-intensive enterprises. About 61 MMTCO_2 are expected to be cut annually by 2010. One of the policies used to try to reach this goal has been to make energy efficiency improvement a criteria for job performance evaluations of local officials and heads of state-owned enterprises.

By the end of 2007, China had shut down 29.4 million tons of outdated iron smelting capacity and 15.21 million tons of outdated steel smelting capacity. In 2008, the Chinese government expects to force closure of inefficient industrial facilities producing 50 million tons of cement, 6 million tons of steel and 14 million tons of iron.[69] As of 2008, the 1,000 Enterprise Efficiency Program was reportedly on or above track to meet its 2010 target.[70]

National Building Codes. The non-military building sector accounts for some 28% of national energy consumption. China announced that new buildings constructed from 2006 to2010 are subject to a design standard that would improve energy conservation by 50%; in major cities (e.g., Beijing), buildings are subject to a 65% energy-saving standard. From 2006 to 2010, large cities are expected to upgrade 25% of established building space with new efficiency measures. Medium-sized cities are expected to improve 15% of building their areas, and small cities are

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[66] NDRC, op. cit., p. 33.

[67] NDRC, op. cit., p. 33.

[68] Xinhua, June 25, 2008.

[69] Jiang Xufeng, op. cit., 2008.

[70] L. Price, X. Wang, and J. Yun, *Reducing Energy Consumption in the 1000 Largest Industrial Enterprises in China*, Lawrence Berkeley National Laboratory, June 2008.

expected to improve 10%.[71] According to the national climate change office, the percentage of new houses meeting the building energy standards rose from 20% in 2004 to 71% last year in 2007. The government also reported that per-unit energy consumption was down 2.9% in the first half of 2008 compared to the same period in 2007.[72] In August 2008, additional building efficiency regulations and measures (such as auditing of public buildings) were adopted, to take effect on October 1, 2008.[73]

As an enforcement measure, 10 provinces, municipalities and autonomous regions (including Beijing, Tianjin, Jiangsu and Inner Mongolia) are beginning to pilot a permitting system for the energy and environmental performance for all capital investment projects. The vice-minister of the National Development and Reform Commission has cited a "lack of leadership" in other regions as one obstacle. He also stated that "some local governments are investing heavily in resource-intensive sectors, ignoring the central government's directive to save energy and reduce emissions." An economist with the Chinese Academy of Social Sciences recommended that "the focus should be designing an accountability system to change the local governments' mindset of blindly speeding up investment."[74]

Appliance Efficiency Standards. China makes more consumer appliances than any other country. In order to cut electricity growth and greenhouse gas emissions, China established energy efficiency standards and labels for lighting, air conditioners, and home appliances. The standards set a target of reducing residential electricity use by 10% by 2010.[75] The Chinese government estimated that in 2010 the standards and labels for refrigerators, air conditioners, clothes washers, and color televisions will save 33.5 terawatt-hours (billions of kilowatt-hours) and reduce greenhouse gas emissions by 11.3 $MMTCO_2$. The program currently appears to be on track.[76]

Fuel Economy Standards and Taxes for Motor Vehicles. In 2004, China set passenger vehicle fuel economy standards in stages that exceeded those of the United States.[77] The average Chinese passenger vehicle is required to meet a 36

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[71] The China Sustainable Energy Program, op. cit., [http://www.efchina.org].

[72] China Climate Change Info-Net. August 12, 2008. *China Issues National Decree on Energy Savings at State-Funded Organizations*, [http://www.ccchina.gov.cn/en/NewsInfo.asp?NewsId=13810].

[73] China Climate Change Info-Net. August 13, 2008. *Energy-Saving Rules Released*, [http://www.ccchina.gov.cn/en/NewsInfo.asp?NewsId=13824].

[74] China Climate Change Info-Net. August 7, 2008. *New Energy Rule in the Works*, [http://www.ccchina.gov.cn/en/NewsInfo.asp?NewsId=13754].

[75] The China Sustainable Energy Program, op. cit., [http://www.efchina.org].

[76] N. Zhou, *Status of China's Energy Efficiency Standards and Labels for Appliances and International Collaboration*, Lawrence Berkeley National Laboratory, March 2008.

[77] F. An and A. Sauer, *Comparison of Passenger Vehicle Fuel Economy and Greenhouse Gas Emission Standards Around the World*, Pew Center on Global Climate Change, (continued...)

mpg requirement in 2008. China is in the process of setting fuel economy standards for trucks and agricultural vehicles as well. When these standards are all implemented, passenger, truck, and agricultural vehicle policies combined should reduce 488 $MMTCO_2$ by 2030 (compared to an unstated baseline). Phase one of fuel economy standard enforcement increased overall passenger vehicle efficiency by about 9% from 26 mpg in 2002 to 28.4 mpg in 2006.[78]

In addition, the Chinese Ministry of Finance adopted a gas-guzzler structure for taxes on new vehicles, effective September 1, 2008 — doubling taxes on large vehicles while reducing them on small vehicles. More specifically, purchasers of cars with engines above 4-liter capacity will pay a tax of 40%. The tax on vehicles with engines between 3 and 4 liters will rise from 15% to 25%. In contrast, the tax on automobiles with engines less than 1-liter capacity will be reduced from 3% to 1%. The Ministry of Finance said that this policy was prompted by the rise of imported oil to 50% of China's total oil consumption, as well as the failure of China in 2007 (and previous years) to meet its annual target of a 4% reduction in energy intensity.

Closing Inefficient Industrial Facilities. In 2006, China announced efforts to decommission hundreds of small, old, industrial plants. Many of the plants were in the cement and steel sectors, but other chemical, refining, and manufacturing facilities were slated for closure as well. The government faces unique challenges in closing some plants given strong demand for their products. Plans called for decommissioning inefficient cement and steel factories with production capacity of 250 million tons and 55 million tons, respectively, by 2010. China claims to have closed cement plants with 87 million tons of production capacity and steel with 37 million tons of capacity, though the timing of these closures is uncertain.[79]

China's Role in International Cooperation to Curtail GHG Emissions

In 1998, China established the Office of the National Coordination Committee on Climate Change to deal with coordination of climate change activities. The Committee is a cross-ministerial body "responsible for deliberation and coordination on climate related policy issues and activities, [and] negotiations with foreign parties."[80] The National Development and Reform Commission takes the lead on most domestic climate change activities, while the Ministry of Foreign Affairs leads on international issues.

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[77] (...continued)
December 2006.

[78] The China Sustainable Energy Program, op. cit., [http://www.efchina.org].

[79] The relationship of this initiative — to close small, inefficient facilities — to the Top 1,000 Enterprise Efficiency Program is unclear, though one covers the 1,000 largest companies while the other is focused on small facilities; there may be overlap between the two programs.

[80] NDRC, op. cit., "Brief Introduction to the Office of the National Coordination Committee on Climate Change," [http://www.ccchina.gov.cn/en/Public_Right.asp?class=25].

China has ratified both the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. As a non-Annex 1 (developing) country, China has no binding emissions limits in the first commitment period (2008-2012) of the Protocol. It also has resisted proposals under the UNFCCC for developing countries — like Annex 1 countries — to submit regular GHG inventories to the Conference of the Parties according to agreed methodological guidelines. China prepared its first and only official GHG inventory for the year 1994, although it sometimes cites IEA estimates or unofficial estimates for more recent years. Its delegation has strongly rebuffed proposals that non-Annex 1 (developing) countries prepare and submit annual national GHG inventories to the Conference of the Parties. China submitted its first complete National Communication to the Conference of the Parties in February 2007.[81] With financing from the World Bank, China is beginning to plan its second national communication to the UNFCCC Conference of the Parties.

China is an active participant in the Clean Development Mechanism (CDM) established under the Protocol. The CDM grants emission credits for verified reductions in developing countries, which can be used by developed countries towards meeting their Kyoto targets. This provides lower-cost reductions for developed countries and generates investment in clean development in developing countries. China is by far the largest source of CDM credits, accounting for over 40% of those generated to date.[82] China's dominance in the market is due in part to its entrepreneurship in developing CDM projects and to its relatively low-risk investment.

In addition, China participates in numerous bilateral and multilateral programs that may facilitate GHG emissions reductions. Among these, China participates in the Asia-Pacific Partnership on Clean Development and Climate, the Climate Technology Partnership, the Strategy for Clean Air and Energy Cooperation, the U.S.-China Oil and Gas Industry Forum, the Carbon Sequestration Leadership Forum, the International Partnership for a Hydrogen Economy, the International Thermonuclear Experimental Reactor (ITER), and a number of additional programs largely sponsored by the U.S. federal government.

China's View: Developed Countries Should Lead. China has long believed that established industrial powers need to act first, because they built their wealth largely by burning fossil fuels and adding to the atmosphere's greenhouse gasses. Ma Kai, former head of China's National Development and Reform Commission (NDRC), said: "Our general stance is that China will not commit to any quantified emissions reduction targets, but that does not mean we will not assume responsibilities in responding to climate change."[83] He also stressed that as a latecomer to industrialization, China has produced only a small fraction of the

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[81] [http://www.ccchina.gov.cn/en/Public_Right.asp?class=18].

[82] More information on comparative CDM projects is available at the "United Nations Environment Program Risoe CDM/JI Pipeline Analysis and Database," [http://www.cdmpipeline.org].

[83] "Experts React to China's Climate Change Plan," *Reuters*, June 4, 2007, [http://www.ccchina.gov.cn/en/NewsInfo.asp?NewsId=7974].

world's greenhouse gases, and that its current per capita emissions equaled a small fraction of the rate in the United States.[84]

An Alternative View: China Must Commit As Well. Some experts argue, however, that the environment cannot afford for China not to take rapid action to slow and then reduce its GHG emissions. Fatih Birol, Chief Economist of the International Energy Agency, warns that if China does not begin curbing its current rate of GHG emissions within 25 years, "China's output of CO_2 emissions could amount to twice the combined emissions of the world's richest nations — including the United States, members of the European Union, and Japan." "said that no plan could succeed without a major role for China and that making distinctions between 'total emissions' and 'per capita emissions' obscured the larger point."[85]

Conclusions

China will play a key role in any effective solution to address the global climate challenge. While China is still considered a developing country, it has grown rapidly enough in recent years for some to begin challenging that label; the old "developed/developing" dichotomy among countries that is embedded in much of the climate change debate may be too simplistic for practical and equitable solutions. China and the United States are now the largest emitters of GHGs annually. China is very likely to become the undisputed leader in annual emissions by 2009, though for now, data uncertainties make that ranking unverifiable. Some analysts concede that measurements of GHG emissions cumulatively over some number of years, rather than annual emissions, would be a more meaningful characterization of contributions, since most gases exist in the atmosphere for decades if not centuries. On that measure, it may be several decades before China surpasses the United States.

China's GHG emissions on a per capita basis were still lower than the world average in 2005, but the intensity of Chinese emissions was relatively high. China's economic development aspirations point to increasing GHG emissions for at least several decades, although this is speculative given the many social, economic, and political challenges the country still faces.

China joins many other developing countries in calling for the industrialized world to lead in GHG mitigation. At the same time, China appears to have taken some progressive steps to make economic development more sustainable, including GHG mitigation. Progress on meeting targets in its National Climate Change Program and other mitigation measures appears to demonstrate that the Chinese government is making an effort to improve the country's environmental reputation. Greater questions arise, however, over the ability of China to meet its goals for 2010 and later, given their ambitiousness and limits to enforcement. It remains to be seen how China's policy might respond to acceptance of a binding emissions commitment by the United States; that could become more evident in the 111th Congress.

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[84] J. Yardley and A. Revkin, "China Issues Plan on Global Warming, Rejecting Mandatory Caps on Greenhouse Gases," *The New York Times*, June 5, 2007, sec. International / Asia Pacific, [http://www.nytimes.com].

[85] J. Yardley and A. Revkin, op. cit.

Appendix. Selected Measures to Mitigate GHG Emissions in China

Table A-1. Mitigation of GHG Emissions in China: Selected Measures and Mitigation Targets, Expected GHG Reductions, and Reported Progress

Mitigation Measure	Mitigation Target	Expected GHG Reductions	Reported Progress
Economy-Wide Energy Efficiency Target	Reduce energy intensity 20% between 2005 and 2010.	700 Mt CO_2 reduction in 2010 compared to baseline; 1,500 MT CO_2 reduction in 2010 compared to no intensity change.	In 2006, energy intensity fell 1.2% from 2005 levels, short of the 4% annual goal. In 2007, the decline was reportedly 3%. China faces serious challenges meeting this goal, although political requirements may demand success.
Renewable Energy Law	16% of all energy is to come from wind, biomass, solar, and hydroelectric energy by 2020.	Wind, solar, geothermal, and tidal energy expected to have a total reduction of 60 Mt CO_2 by 2010. Bio-energy is expected to create a 30 Mt CO_2e reduction by 2010. Hydroelectricity development is expected to reduce emissions by 500 Mt CO_2 by 2010.	In 2008, China was ranked 5th globally in installed wind power capacity, with about 6 gigawatts (GW). Wind capacity is projected to be 20 GW by 2010 and 100 GW by 2020. The Global Wind Energy Council expects China to become the largest wind turbine market in 2010. China is also the world leader in installed solar hot water systems, and expects continued strong growth in photovoltaic production and use.

Mitigation Measure	Mitigation Target	Expected GHG Reductions	Reported Progress
Promote Nuclear Power	Operating power capacity to hit 40 GW by 2020 from 8.6 GW in 2008.	50 Mt CO_2 reduction by 2010	Appears to be on track.
Improve Power Sector Efficiency	Close 50 GW of small, inefficient and dated power plant capacity by 2010 and develop 600 MW or above supercritical (SC) or ultra-supercritical (USC). 70-80%of new installations will be SC/USC units Improve coal to electricity efficiency from 366 to 345 Gt coal equivalent per kWh from 2006 to 2020.	110 Mt CO_2 reduction by 2010	In 2007, China reportedly shut 553 small coal-fired power plants, accounting for 14.4 GW of capacity. This exceeded the official target of shutting down 10 GW of capacity. In 2008, 13.0 GW of small units are to be closed. Challenges remain, however, given shortages of electricity in China through mid-2008. By end-2007, 74% of ordered thermal capacity is SC or USC.
Develop Coalbed Methane Industry	China targets 10 billion cubic meters of gas production by 2010, and 40 BCM by 2020. The 11th Five-Year Plan (2006-2010) also calls for the construction of 10 CBM pipelines.	200 Mt CO_2 e reduction by 2010	In 2005 and 2006, China drilled as many CBM wells as it did from 1990 to 2004, according to Sun Maoyuan, head of China United Coalbed Methane Company. Still, China produced only 200 million cubic meters of CBM in 2006. In June 2008, China started construction on the first of 10 CBM pipeline projects.
Top 1,000 Enterprise Efficiency Program	Cut energy use of the 1,000 most energy-intensive enterprises.	Cut 100 million tons of coal-equivalent energy consumption and 61 million tons of CO_2 emissions annually by 2010.	Many staff of the top 1000 enterprises have taken training in energy savings, and firms have had energy saving audits performed. A preliminary survey reports that the enterprises saved 20 million tons of coal equivalent in 2006, indicating that the program is on or ahead of target to meet its goals.

Mitigation Measure	Mitigation Target	Expected GHG Reductions	Reported Progress
Adopt National Building Codes for Residential and Commercial Buildings	Between 2006-2010, new buildings are subject to the design standard of 50% energy conservation, and major cities (e.g., Beijing and Tianjin) are subject to a 65% energy-saving standard.	Not available.	National building codes have been passed; implementation is underway in 6 cities.
Establish Energy Efficiency Appliance Standards	Reduce residential electricity use by 10% by 2010.	In 2010, 33.5 billion kilowatt-hours and GHG emissions are expected to be reduced by 11.3 Mt of CO_2, as a result of standards and labels for refrigerators, air conditioners, clothes washers, and color televisions.	Largely on track. China has mandatory minimum efficiency standards for most residential and commercial appliances, lighting, and heating/cooling equipment. New standards are under development for other appliances.
Fuel Economy Standards for Vehicles	By 2008, average Chinese passenger vehicles are required to meet 36 mpg requirement. In process of setting fuel economy standards for trucks and agricultural vehicles.	Passenger, truck, and agricultural vehicle policies combined should reduce 488 Mt of CO_2 by 2030.	Phase 1 standards have increased overall passenger vehicle efficiency by about 9%, from 26 mpg in 2002 to 28.4 mpg in 2006. Standards are about 40% more stringent than those of the United States. Taxes have been increased on large vehicles and reduced on small ones.
Closing Inefficient Industrial Facilities	Decommission inefficient cement and steel factories with production capacity of 250 million tons and 55 million tons, respectively, by 2010.	Reduce coal consumption by 60-90 Mt per year by 2010.	China claims to have closed cement plants with 87 million tons of production capacity and steel with 37 million tons of capacity, but the time period for these closures is unclear.