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Global Climate Change: Coal Use in China and Other Asian Developing Countries

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ABSTRACT

China leads the world in coal use and CO_2 emissions from coal. Coal use in China and other Asian developing countries is expected to increase significantly over the next 20 years. The 1997 Kyoto Agreement on global climate change imposes binding reductions in emissions of CO_2 and other major "greenhouse gases" on developed nations, but not on China and other developing nations. With China's CO_2 increases projected to surpass U.S. emissions by 2020, the Clinton Administration says it will not send the agreement to the Senate for advice and consent without "meaningful participation" by developing countries. This report discusses the factors behind China's planned reliance on coal for future energy growth and provides statistics on coal use and CO_2 emissions in Asia.

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Summary

Under the international global climate change agreement negotiated in December 1997 in Kyoto, Japan, the United States would be required to reduce emissions of carbon dioxide (CO_2) and other "greenhouse gases" by 7% from their 1990 or 1995 levels (depending on the gas). However, the Kyoto Protocol places no binding greenhouse gas restrictions on developing countries such as China and India — whose CO_2 emissions are projected to grow dramatically.

Concerns have arisen in the United States that without a binding agreement from China, India, and other developing countries, the responsibility for realizing worldwide greenhouse gas reduction goals would fall entirely on industrialized countries, while developing countries continue to increase their emissions. Before completion of the Kyoto Protocol, the U.S. Senate passed a resolution (S.Res. 98) urging that the United States not become a party to the treaty if it did not include specified commitments by developing countries to limit or reduce their greenhouse gas emissions. The Clinton Administration has stated it will not send the protocol to the Senate for consideration until "meaningful participation" by developing countries is achieved. Developing countries are being encouraged to make voluntary commitments to limit greenhouse gas emissions.

Economists anticipate many Asian developing countries will continue to experience rapid economic growth in the years ahead that will increase their demand for electric power, with coal likely to be a major energy source to support that growth. Forecasts show world coal demand growing nearly 70% between 1995 and 2020, with China and India accounting for 85% of that increase. Coal is a major source of CO_2 emissions. China, one of the world's fastest growing economies, is on track to become the world leader in CO_2 emissions within 20 years and is already the world leader in CO_2 emissions from coal. However, to date, China and India have not made any voluntary commitments to limit CO_2 emissions.

China is expected to rely on coal to power much of its future development because of its abundant domestic reserves and low cost, and because the nation's infrastructure is better developed at this time for coal than for other energy sources. China stresses its right to pursue this course of development.

Fostering economic growth while curtailing CO_2 emissions from fossil fuels is one of the greatest dilemmas facing attempts to encourage third-world participation in greenhouse gas reduction efforts. Until this is addressed, the extent of U.S. participation remains unclear.

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Introduction

Coal use in Asia is on a rapid upward trend, particularly in China.[1] This trend has special relevance to issues related to global climate change, because the burning of coal currently accounts for some one-third of all carbon dioxide (CO_2) emissions worldwide, and CO_2 accounts for 85% of all "greenhouse gas" emissions. Increasing concentrations of greenhouse gases in the atmosphere may affect global climate systems.[2]

To address the global climate change issue, the third Conference of the Parties (COP-3) of the United Nations Framework Convention on Climate Change (UNFCCC) convened in December 1997 in Kyoto, Japan. Parties to the resulting protocol agreed to legally binding reductions in emissions of the six major greenhouse gases[3] for the developed countries (listed in Annex I of the UNFCCC and referred to as "Annex I countries"). Each Annex I country negotiated a specific emissions-reduction commitment (listed in Annex B), to be met as an average over a "commitment period" between 2008 and 2012.[4] If the United States ratifies the treaty, it would be committed to a reduction of 7% cumulatively for the six gases — below 1990 emissions levels for CO_2, CH_4, and N_2O, and below 1995 levels for the remaining three gases during this commitment period.[5]

The Kyoto Protocol's lack of corresponding commitments for China and other developing countries has been a key point of contention. Before completion of the Kyoto Protocol, the U.S. Senate passed a resolution (S.Res. 98) urging that the United States not sign the treaty if it did not require developing countries to take on

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[1]In the statistics cited in this report, "Developing Asia" includes all countries in Asia except for Japan, the Middle East, and the Former Soviet Union.

[2]For a discussion of global climate change issues, see CRS Issue Brief 89005, *Global Climate Change*, and the *CRS Global Climate Change Electronic Briefing Book*, at [http://www.congress.gov/brbk/html/ebgcctop.html].

[3]The Kyoto Protocol is an international agreement that outlines binding emission reductions for developed countries for the following greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydro fluorocarbons (HFCs), per fluorocarbons (PFCs) and sulfur hexafluoride (SF6).

[4]For a summary and discussion of the Kyoto Protocol, see CRS Report 98-2, *Global Climate Change Treaty: Summary of the Kyoto Protocol*.

[5]For a further discussion, see CRS Report 98-235 ENR, *Global Climate Change: Reducing Greenhouse Gases — How Much From What Baseline?*

binding commitments to limit or reduce their greenhouse gas emissions. Ongoing negotiations and discussions are dealing with this issue; the Clinton Administration has signed the Kyoto Protocol but has stated it will not submit the agreement to the Senate until "meaningful participation" by developing countries has been achieved.[6]

One major difficulty in engaging developing countries in limiting greenhouse gas emissions is the dependence of these countries on fossil fuels, especially coal, for their economic development. China's energy future is particularly important to greenhouse gas emissions. Vast reserves of coal constitute China's primary energy resource — a resource that the Chinese government has said it plans to exploit as part of the huge nation's future development. China has the third-largest proved reserves in the world (see Table 1).

Table 1. Proven Coal Resources for Selected Countries 1996
(estimated in million short tons)

Rank	Country	Total Proved Reserves
1	**United States**	**271,877**
2	**Russian Federation**	**173,074**
3	**China**	**126,214**
4	**Australia**	**99,649**
5	**Germany**	**73,855**
6	**South Africa**	**60,994**
	All Others	**279,243**
	World Total	**1,084,906**

Source: National Mining Association, International Coal, 1998.

As shown in Table 2, China's coal consumption currently is more than 50% greater than that of the United States and is projected to reach nearly 130% of the U.S. level by 2010. As a result, China by 2010 is projected to account for nearly 40% of the world's carbon emissions from coal (statistics typically include only the carbon content of CO_2). China's projected increase in annual coal-based carbon emissions by 2010 — 530 million metric tons — compares to the 551 million metric tons of carbon per year that would constitute the total CO_2 reductions the 1997 Kyoto agreement would impose on the United States under current trends.[7]

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[6]White House Task Force on Climate Change, *The Kyoto Protocol and the President's Policies to Address Climate Change: Administration Economic Analysis*, July 1998, p. 37.

[7]DOE/EIA, 1998, p. 142.

Table 2. Coal Consumption and CO_2 Emissions for 1996 and 2010

	Coal Consumption 1996	Coal Consumption 2010	Coal Carbon Emissions 1996	Coal Carbon Emissions 2010
	(millions of short tons)		(millions of metric tons)	
China	1,500	2,666	682	1,212
United States	983	1,162	524	616
World Total	5,167	6,827	2,345	3,110

Source: DOE/EIA, 1998, reference case

Factors in Asian Coal Use Trends

Coal plays a crucial role in energy demand and supply in the developing countries of Asia. China accounts for 73% of coal consumption in developing Asia now and could increase its share to 82% by 2020. China and India together already make up nearly 90% of developing Asia's coal consumption.

Developing countries such as China and India expect their use of coal for electricity generation to increase tremendously to support rapid economic growth (see Table 3). Electric power transmission projects in the region, designed to alleviate power shortages that hinder economic development, have been funded by the World Bank over the past several years.[8] In 1998, the World Bank Group provided $550 million towards power transmission projects totaling about $1.6 billion and $63 million of a total $151 million for energy efficiency projects. Much of the energy development will rely on private sector financing and primarily on coal as the least cost energy source.

Asian and World Energy Demand

Generally, economic growth assumptions of countries throughout developing Asia indicate there will likely be an enormous increase in the consumption of coal, natural gas and oil. According to one estimate, coal would grow between 2.2% to 4.7% each year and nuclear would grow as much as 4.9% annually through 2020.[9] Natural gas growth in Asia may be anywhere between 6.1% to 8.4% annually. Oil consumption could grow at an annual rate between 2.5% to 4.8% (see Figure 1). Despite these large projected total increases, energy consumption per capita will likely

[8]The World Bank Group, Annual Reports, 1989-1998, Washington D.C.

[9]DOE/EIA, 1998

remain relatively low because of the region's current low level of economic development and large population.

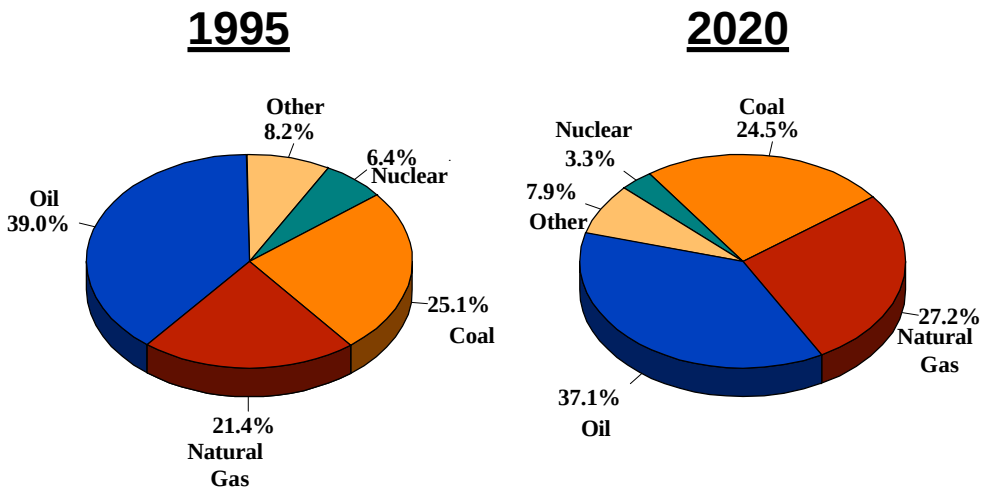
Table 3. Electricity and Economic Growth Rates for Asia: 1996 and Projections for 2020

Country	Electricity Consumption 1996 (billion kwh)	Electricity Consumption 2020 (billion kwh)	Annual Electricity Growth Rate	Annual Economic Growth Rate
China	925	3,486	5.7`	6.7
India	378	1,192	4.9	(see below)
Other Developing Asia	519	1,056	3.0	4.6[a]
Total Developing Asia	2,002	6,122	4.8	4.8

Source: Standard and Poors, 1998, p. 91, and EIA/IEO 1999, p. 102

[a] This figure includes India.

Figure 1. World Total Energy Consumption



Source: Base Case (IEO) 1998

Coal use in China and India together will grow at a slower rate than natural gas, oil, nuclear, and renewables between 1995 and 2020. Expected rapid growth in the transportation sector largely drives the projected increase in oil's share of the energy market. The annual growth rate for natural gas consumption outpaces coal consumption in China and India because natural gas starts off at a such a low level. As a result, coal consumption falls from 53% of total energy consumption in developing Asia in 1995 to 48% in 2020 while natural gas rises from 7% of total energy consumption to 15% over the same period. The small amount of nuclear capacity in the developing Asian/Pacific region is expected to double between 1995 and 2020 but declines as a percent of the total energy share.

World coal demand is expected to increase by nearly 70% from 1995 to 2020.[10] If current trends continue, China and India are expected to account for 85% of that increase. During that same period, coal's share of total energy consumption falls only 1 percentage point, from 25% to 24% (see Figure 2), and holds steady at 36% of fuels used for electricity generation.[11] The world annual energy consumption growth rate is predicted to be 4% for coal, 8.6% for natural gas, and 6% for oil over the same 25-year period.

China's percentage of world coal consumption has risen from 17% in 1980 to 29% in 1995, and is forecasted to climb to 37% by 2020, according to the Energy Information Administration (EIA).[12] China is banking on its huge coal reserves to help power its future economic growth, even though the projected rapid rise in coal demand will require enormous amounts of infrastructure to deliver energy to end-users. China is relying heavily on foreign investors for much of this needed capital.[13]

Electric power generation accounts for most of the projected increase in Asian coal consumption over the next 20 years. The power generation sector increases its share of total Asian coal use from 41% in 1995 to 54% in 2020, according to current projections.[14]

With the world's largest population — 1.2 billion — China has one of the lowest electrification rates in the world but is expected to increase electricity generation from 925 billion kwh 1996 to 2,030 billion kwh in 2010, and reach 3,486 billion kwh by 2020 (see Table 3).[15] China is projected to increase its consumption of coal for electricity generation at an annual rate of 5.3%. This would imply nearly a fourfold increase in coal use over the next two decades.[16]

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[10]International Energy Outlook (EIA), DOE/EIA-0484 (98) April 1998, p. 69.

[11]DOE/EIA, p. 69

[12]DOE/EIA, p. 70

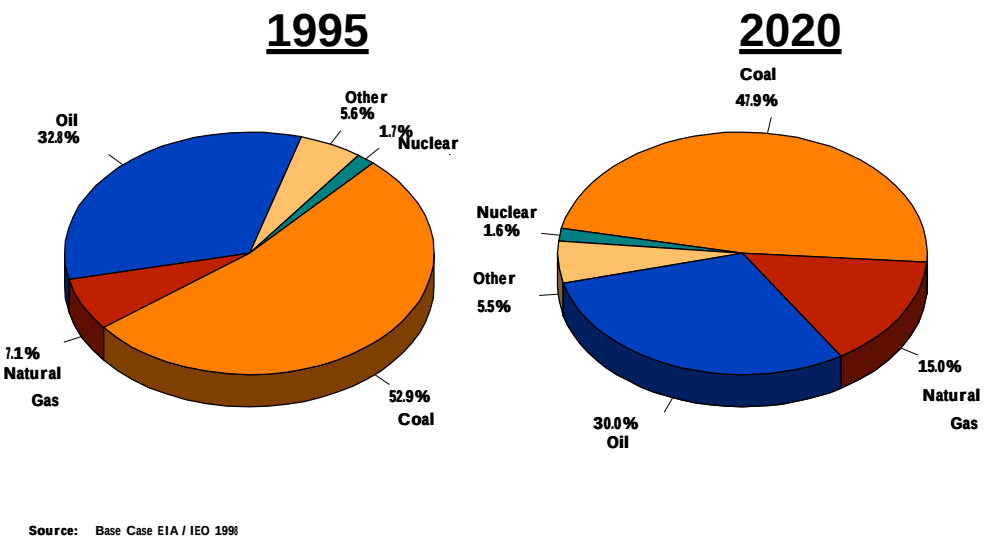
[13]DOE/EIA, p. 117

[14]Standard and Poor's DRI World Energy Service, McGraw Hill, 1998, p. 76.

[15]World Energy Service, World Outlook, Standard and Poor's DRI, McGraw-Hill Companies, 1998, p. 91-93.

[16]DOE/EIA, p. 74.

Figure 2. Developing Asia's Energy Consumption



According to a Resources for the Future (RFF) discussion paper,[17] China's electric generating capacity will need to grow by 23.5 gigawatts annually until 2010 to reach its target of 525 gigawatts. The infrastructure will come at a high cost. As much as $14 billion is required just to meet its year 2000 capacity needs. U.S. firms have already invested heavily in China's power facilities by investing in a significant share of 16 coal-fired power plants. The director of China's State Power Corporation recently made the point that "China's rapid economic growth is creating a huge demand for energy which provides great opportunities for foreign investors."

However, the terms of foreign direct investment in China are fluid. For example, a policy of guaranteed returns for foreign investors was recently terminated, which means that new investments in China will be more risky.[18] Additionally, China places a wide variety of restrictions on foreign investment, including limited ownership.

Asian Coal and World Markets

According to Standard and Poor's DRI World Energy Service, growth in Asia's coal imports (including those of Japan) will average nearly 13% annually between 1995-2020 — the fastest rate in the world. Much of this import growth will occur outside of China, because of China's huge production capacity and reserves that are

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[17]Blackman, Allen and Xun Wu, "Foreign Direct Investment in China's Power Sector: Trends, Benefits and Barriers," Discussion Paper 98-50, Resources for the Future, September 1998.

[18]Bangsberg, P.T., "China Ends Guaranteed Returns for Foreign Investors in the Energy Sector," *Journal of Commerce*, April 19, 1999.

available to meet its demand.[19] Under a base-case scenario prepared by the Energy Information Administration (EIA), Asian coal imports would almost double from 257 million short tons to 442 million short tons. Excluding Japan, coal imports into Asia would be expected easily to more than double, from 119 million short tons to 271 million short tons, between 1995 and 2020. India, which currently imports little coal for a country its size, is believed to have substantial potential for import growth.[20]

Under EIA's base-case scenario, forecasts for metallurgical coal trade (coal used in steel) are flat from 1996 to 2020. Some regions will decline and others will rise in trade but the net effect is flat. In contrast, trade in steam coal (coal burned for energy) almost doubles from 305 million short tons in 1996 to 540 million short tons in 2020.[21]

The biggest exporters will continue to be Australia, the United States, and South Africa over the period 1996-2020. Most of the U.S. and South African exports will go to Europe. Australia's exports will go to Asia. Coal exports from South America and Australia are growing at the fastest rate annually, at 3.6% and 2.0% respectively. South Africa's coal exports increase 1.8% annually and those of the United States 1.4% under the EIA base case.

CO_2 Emissions Trends

The Kyoto agreement requires the United States to cut back greenhouse gas emissions from all sources by about 7% from their 1990 or 1995 levels, depending on the gas. CO_2 represents 82% of the U.S. emissions inventory. If CO_2 emissions were reduced in the same proportion as other greenhouse gases, annual U.S. carbon emissions would fall to 1,252 million metric tons (mmt) by 2010 under the Kyoto agreement, according to EIA. If U.S. emissions continued to increase at current trends, they would reach 1,803 mmt in 2010 and 1,956 by 2020. China, on the other hand, would produce 1,481 mmt of carbon emissions by 2010 and 2,340 mmt by 2020. China is therefore projected to surpass U.S. emissions by 2020 even if the United States pursues a "business as usual" policy and does not reduce its emissions.[22]

The amount of carbon dioxide produced by developing countries in Asia is expected to outpace CO_2 emissions in developed countries even with no Kyoto cutbacks in the developed world. China, already the world leader in CO_2 emissions from coal, is on track to lead the world in total CO_2 emissions. In developing Asia, India is projected to remain a distant second in CO_2 emissions. All the developing countries of Asia are projected to produce about 38% of world CO_2 emissions by

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[19]Ibid., p. 82.

[20]DOE/EIA, 1998, p. 81-82.

[21]DOE/EIA, 1998, p. 81.

[22]DOE/ EIA, 1998, p.142.

2020, nearly catching up to projected business-as-usual emissions from the industrialized nations.[23]

China intends for coal to power its future development (see Tables 1 and 2) because of its abundance and low cost, and because the nation's infrastructure is better developed for coal than for other energy sources. Fostering economic growth while curtailing CO_2 emissions from fossil fuels is one of the greatest dilemmas facing developed countries' attempts to encourage third-world participation in greenhouse gas reduction efforts.

According to a "White Paper on Environment" issued by the People's Republic of China (PRC) in 1996, China attaches equal importance to energy conservation and the growth of the energy industry. China has already enacted many laws on environmental protection, including the Law on the Prevention of Air Pollution. Under the National Environmental Protection Agency, China has established three major policies for environmental protection: (1) putting prevention first, and combining control technology with prevention; (2) making the polluter responsible for treatment of pollution, and (3) intensifying environmental management.[24] However, it is unclear as to what extent these laws are enforced and whether those policies will have a significant effect on China's projected CO_2 emissions from coal.

According to a United Nations Development Program (UNDP) report, one view is that China is substantially improving its energy efficiency and has already cut its energy consumption per unit of output in half with improved technology since 1980. Also noted was that China's emissions growth rate was well below its per capita gross national product (GNP) growth rate (see Table 4), a statistic considered by some to indicate that China is "already participating meaningfully" in reducing its greenhouse gas emissions from previous trends.[25] In other words, China is well below where it would have been had no energy efficiency measures been put in place, according to this view.

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[23] *ibid.*

[24] White Paper on Environment issued by the Information Office of the State Council in Beijing, June 4, 1996.

[25] "Mythical Monster, Fred Pearce slays the myth of the Chinese Carbon Dragon," *New Scientist*, January 9, 1999, p. 44.

Table 4. Per Capita Trends for China and the United States[26]

	GNP per capita (current U.S. $)		Coal Use per capita (short tons)		CO_2 per capita (metric tons)		CO_2 per dollar GNP (current U.S.$)	
	1990	2020	1990	2020	1990	2020	1990	2020
China	1,401	7,571	0.9	3.0	0.5	1.7	0.99 lbs	0.45 lbs.
United States	26,510	34,675	3.6	3.9	5.4	6.0	0.56 lbs.	0.38 lbs.

Source: Census data, CRS calculations (see footnote).

Table 4 shows projections for China to cut its CO_2 per unit of GNP by more than 50% by the year 2020, meaning that the economy continues to grow faster than energy consumption and possibly grow more efficiently. Also, the relative size of CO_2 emissions to the size of the economy shows China approaching the United States. The table also illustrates that CO_2 per capita in China would remain far below that of the United States during the same period that the total amount of CO_2 will greatly exceed that of the United States. However, even though China's emissions of CO_2 grow at a slower rate than its GNP, overall its total CO_2 emissions would be the highest in the world by 2020 under various growth scenarios.

Potential strategies for addressing the CO_2 problem in developing countries include technology research and development, technology transfer, and emissions trading schemes. These are growing areas of interest by the U.S. Government and the World Bank that are addressed in separate CRS reports.[27]

Projected Energy Supply and Emissions From Other Sources

Although China's economic development plans rely primarily on coal, other energy sources are also projected to increase, as noted above. A number of natural gas projects are currently underway in China. According to the president of China National Petroleum Corp., China should double its annual gas production capacity to 30 billion cubic meters by 2005.[28] However, that amount would still be only about 5% of current U.S. production.

Nuclear power could become more prominent in China's power supply mix. Three reactors are currently operating, and four more are currently under construction and scheduled to begin operation by 2003. Two additional plants may be in the

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[26]U.S. and China GNP and population data for 1990 was obtained from the *Statistical Abstract of the United States*, U.S. Department of Commerce, Bureau of the Census, 1998. GNP projections for the U.S. were calculated based on an annual growth rate of 2.5 percent. GNP projections for China are based on an average annual growth rate of 7 percent.

[27]See CRS Report 98-408, *Global Climate Change: R&D Provisions in the President's Climate Change Technology Initiative* and CRS Report 98-235, *Global Climate Change: Reducing Greenhouse Gases--How Much From What Baseline?*

[28]*Journal of Commerce*, November 6, 1998. p. 11A.

works.[29] Forecasts show that nuclear power could provide 2% of China's energy in the year 2020.[30] Under China's most aggressive nuclear scenario, nuclear power capacity would increase from 12 billion kwh in 1995 to 125 billion kwh in 2020, an average annual increase of nearly 10%.[31] Hydropower development of the Three Gorges Dam in China is expected to be completed by 2010 and provide 85 billion kwh of electricity per year and produce no CO_2 emissions.[32]

In China, carbon emissions from natural gas are projected to grow from 1.2% to 2.3% of total carbon emissions during the period 1996-2020.[33] Worldwide, carbon emissions from natural gas remain at between 15%-20% of total carbon emissions.[34] Carbon emissions from petroleum increase at a pace of 5% each year in China and remain at about 15% of total carbon emissions during the 1996-2020 time frame. There are no direct carbon emissions from nuclear power or hydropower.

Conclusions

Asian developing countries' use of coal, especially China's, should continue to rise substantially because of the current electric generating capacity designed for coal, a huge reserve base, and coal production capacity already in place. Natural gas rises at a faster rate than coal but has a much lower starting point. Only in the very long term will natural gas begin to make a dent in the energy supply picture and CO_2 emissions, because of the hundreds of billions of dollars of infrastructure projects needed.

Estimates of worldwide carbon emissions show most of the emissions growth is taking place in China and India, largely because of the projected growth in coal consumption. Without the Kyoto Protocol in place, the developing world as a whole will emit about the same amount of carbon as the developed world by the year 2010. Carbon emissions from developing countries should surpass those from the industrialized world by the year 2020.

The Asian coal outlook raises questions about global climate change policy. If the emissions issue is not sufficiently addressed in developing Asia, especially China and India, Senate ratification of the Kyoto Protocol appears doubtful. But given developing Asia's current plans for economic growth based largely on coal and other fossil fuels, gaining the region's acceptance of Kyoto-style CO_2 limits is likely to face many challenges. The search for strategies that will satisfy both the industrialized and

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[29]"World List of Nuclear Power Plants." *Nuclear News.* March 1999. p. 35.

[30]DOE/IEA p. 163.

[31]DOE/EIA, 1998, p.153

[32]DOE/EIA, 1998 p. 117, and S&P/DRI, p. 100.

[33]DOE/EIA, 1998.

[34]Based on reference case projections by EIA, 1998, p. 18

developing world will undoubtedly continue to be a major focus of the global climate change debate.