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Intelligence Report


Office of Transnational Issues

20 October 1997


China's Energy Outlook: Continued Heavy Reliance on Coal Likely



Senior Chinese officials have said that China plans to continue relying on its abundant and cheap coal reserves to supply three-quarters of its fast-growing demand for primary energy. *Beijing faces resource, infrastructure, and technological constraints in substituting other energy sources for coal use that would increase capital costs and dependence on imported fuels while yielding only modest environmental benefits.*

- China has not found sufficient proved reserves of oil or gas to boost their production, and Beijing would have to substantially increase imports to substitute for coal. China already is aggressively exploiting its largest hydroelectric potential, including the Three Gorges Dam, and China is relying heavily on foreign equipment for its few nuclear and renewable energy projects. 

Our analysis of two coal substitution scenarios indicates that although China could decrease its dependence on coal by 2015 to about 55 percent of energy demand, coal use nevertheless would double from 1996 levels, assuming an average annual economic growth of 7 percent. Capital costs for new power plants alone would increase by nearly \$140 billion.

- *Reductions in annual carbon emissions relative to the baseline case would be 9 and 3 percent, respectively, for aggressive substitution and moderate substitution cases.*
- *Carbon emissions in 2015 under either scenario would be about 2.5 times what they were in 1996, and China would surpass the United States in annual carbon emission levels.* 


China's heavy dependence on coal already has caused serious health and environmental problems, and China does not have the technology to reduce coal pollutants.


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- So far, Beijing has done little to combat air pollution problems caused by coal use, and, as a result, respiratory disease from coal pollutants is the leading cause of death in China, according to the World Health Organization.
- China does not have the domestic capability to manufacture clean-coal equipment and has been unwilling to buy foreign pollution-control equipment. 

The higher costs for alternative energy sources and Beijing's reluctance to rely on foreign energy sources probably rule out a change in China's energy plans away from heavy coal use in the near term. Chinese attitudes could change, however, if leadership concerns grow about the economic and health costs associated with extensive coal use. Implementation of even a modest coal-substitution plan would require Beijing to change many of its long-standing energy policies, including removal of subsidies on energy prices, easing of restrictions on foreign imports, and stronger environmental laws combined with strict enforcement. 

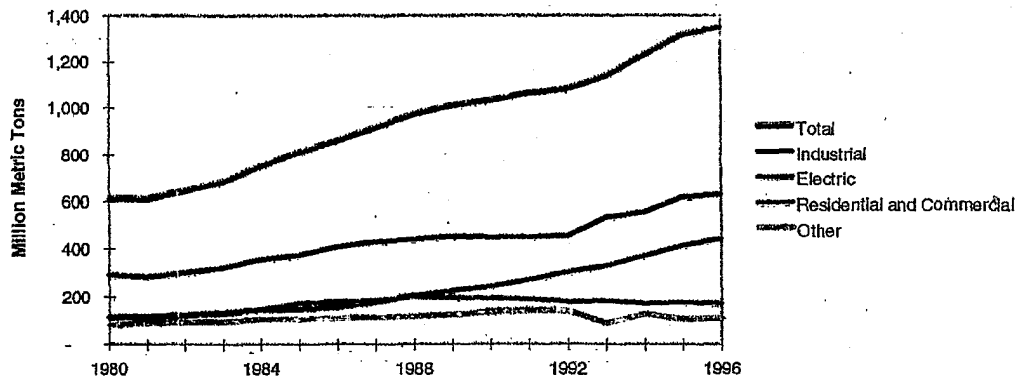
Heavy Reliance on Coal in Energy Sector

China's economic development has been fueled primarily by coal, and the country relies heavily on its abundant and cheap coal reserves to supply its fast-growing demand for primary energy.

China consumed more than 1.3 billion metric tons of coal in 1996, representing about 75 percent of primary energy consumption. Industry uses almost 600 million metric tons of coal per year, followed by the electric power sector, with more than 400 million metric tons annually, and the residential and commercial sectors, with 200 million metric tons (see figure 1).

- China claims to have more than 1 trillion tons of coal reserves—more than 700 years of consumption at current rates.
- Coal costs less than other fossil fuels in world markets, and price subsidies in China keep coal prices below world levels. For example, in the United States, coal generally costs less than half as much as heavy oil, or about \$7.00 per barrel of oil equivalent (boe), according to the US Department of Energy.

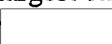
Figure 1. China: Coal Consumption, 1980-1996




Note: Other includes the transportation and nonspecified sectors.





China's heavy dependence on coal has caused serious health and environmental problems.


- Respiratory disease from poor control of coal pollutants, for instance, is the leading cause of death in China, according to the World Health Organization.
- China's annual carbon emissions—estimated at more than 800 million tons—are second only to those of the United States, with nearly 1,500 million tons annually. With an expected growth rate more than four times that of the United States, China will have the world's largest carbon emissions by 2015, according to US Department of Energy  projections.

So far, Beijing has done little to address air pollution problems. It lacks the technology to manufacture clean-coal technologies and has been unwilling to pay for foreign equipment. If China decides to take more concrete steps, it will either have to begin a large-scale program to install clean-coal technologies or promote the substitution of other energy sources. 

Constraints to Coal Substitution

Although there are potential coal substitution options for China, each faces resource, infrastructure, and technological constraints. 

Oil. China has not found sufficient new reserves to boost stagnating oil production that averaged some 3.2 million barrels per day (b/d) last year. 

 Oil currently supplies nearly 20 percent of primary energy.

- Exploration results in the Tarim Basin—believed by many Western and Chinese geologists to have the country's best potential for large, undiscovered oilfields—have been mixed, and most Western oil companies suspended exploration activity there last year citing poor results and bureaucratic problems, according to press reports.
- Production at China's mature fields in the northeast—Daqing, Shengli, and Liaohe—has been stagnant since the late 1980s, and recent press reports indicate that production at Daqing has begun to decline. These fields account for more than 60 percent of the country's total output, or about 2 million b/d.
- Offshore oil production in the East and South China Seas also has been disappointing in the view of many Western industry observers. Output from the South China Sea probably will start to decline in a few years unless new fields are

found [redacted]. Offshore oil production remains small—about 300,000 b/d, or approximately 10 percent of total output [redacted]

Gas. Gas production probably will continue to grow slowly from 1996 levels of some 20 billion cubic meters (bcm). Reported projections of gas consumption to as much as 80 bcm after 2010 almost certainly would require a significant increase in gas imports—by pipeline from the former Soviet Union or as liquefied natural gas (LNG), most likely from Indonesia, Malaysia, or Australia. We estimate that China has some 1,500 bcm of natural gas reserves—in contrast, one Russian gasfield, Urengoi, holds 7,000 bcm of proved reserves. Gas provided about 2 percent of China's primary energy demand in 1996.

- Limited gas reserves, lack of an extensive gas-pipeline infrastructure, and long construction leadtimes hamper gas production and use.
- We have no evidence that China has made any financing arrangements for the numerous gas pipelines and LNG projects that have been reported in the press.

[redacted]

Hydroelectric. According to US Department of Energy studies, China holds large potential hydropower resources—nearly 400 gigawatts (GW)—but most of the country's unexploited resources are far from the country's population centers in the north and east. China's hydroelectric power plants generate about 20 percent of the nation's electricity and provide 6 percent of the country's primary energy.

- China currently has 80,000 hydroelectric power plants, but only one has an installed capacity of more than 2 GW, according to industry statistics. Most of these plants have a capacity of less than 5 megawatts and are not connected to the transmission grid.
- China already is aggressively pursuing its largest hydropower potential, including the 18-GW Three Gorges Dam, which is planned to be on-line by 2010. [redacted]

Nuclear. Beijing's nascent nuclear power program consists of three units at Qinshan and Daya Bay, with a combined generating capacity of 2 GW—less than 1 percent of China's total installed capacity and primary energy use. China plans for nuclear power plants to be the main alternative to coal-fired plants in the long-term, [redacted]

[redacted]—with 40 to 50 GW by 2020; however, it will likely be more than 20 years before nuclear power becomes a significant source of electricity because of the high capital costs of the plants, the lack of indigenous manufacturing capability, and the lengthy construction process.

[Redacted]

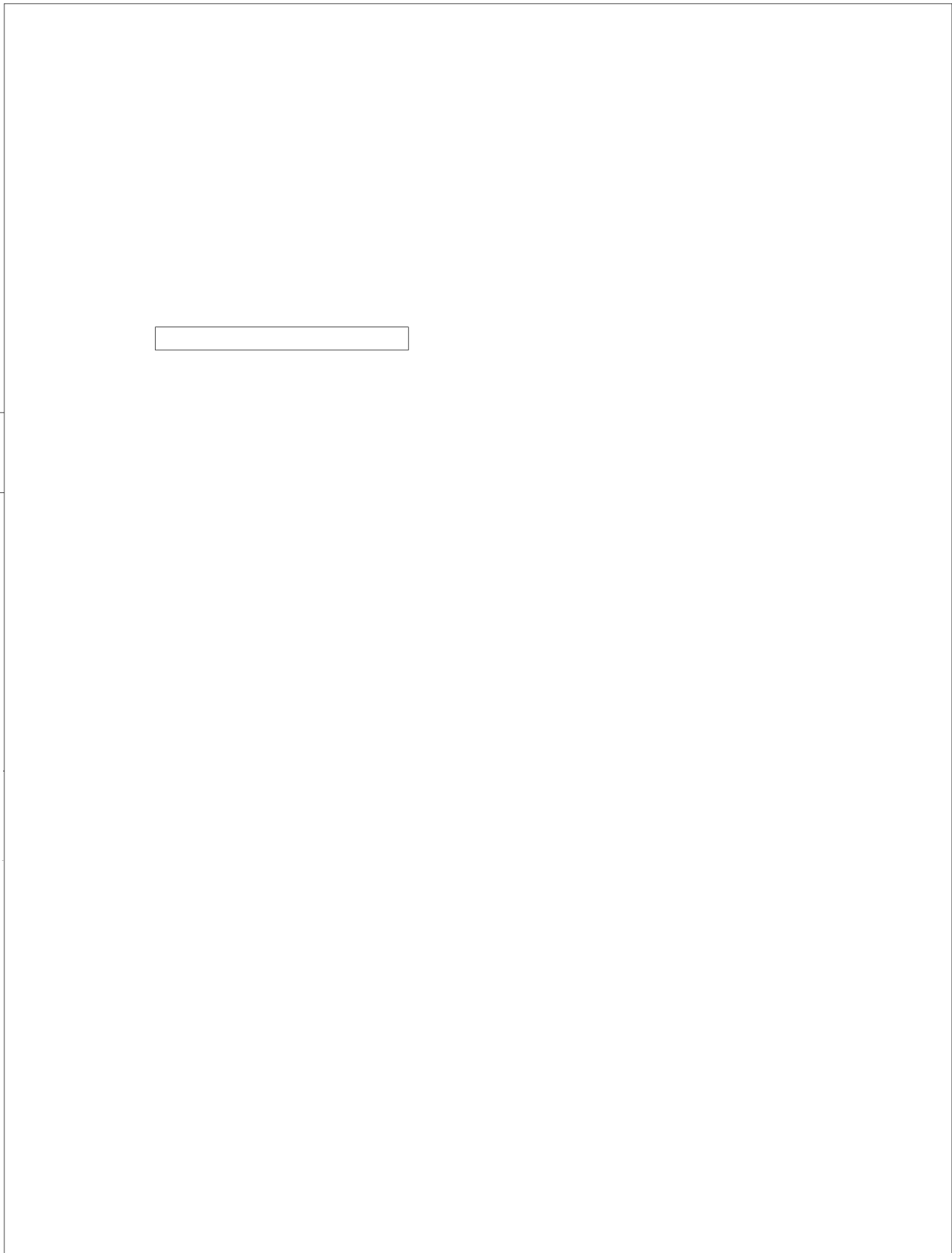
- China's current nuclear power plants were built with expensive foreign equipment, and China does not yet have the technology to manufacture all the critical components to build its own nuclear power plants. [Redacted]
- China's indigenous pressurized-water reactor program is moving slowly, and China is not likely to develop this technology in the next decade. [Redacted]

Renewable Energy. Although China has abundant solar, geothermal, and wind resources, they are located far from demand centers. For example, China's sunny regions are in the far western Himalayan Plateau area, while central China generally is cloud-covered. Geothermal resources are located mainly in the same Himalayan region, while wind resources are in the western desert and the remote northern corridor along Inner Mongolia.

- Electricity generation from renewable energy sources represents less than 1 percent of China's total electricity generation because of their locations and high costs relative to fossil fuels.
- The cost of solar-generated and wind-generated electricity runs about 25 cents and 4 cents per kilowatt hour (kWh), respectively, compared with 1 to 3 cents per kWh for fossil fuels, according to industry sources. [Redacted]

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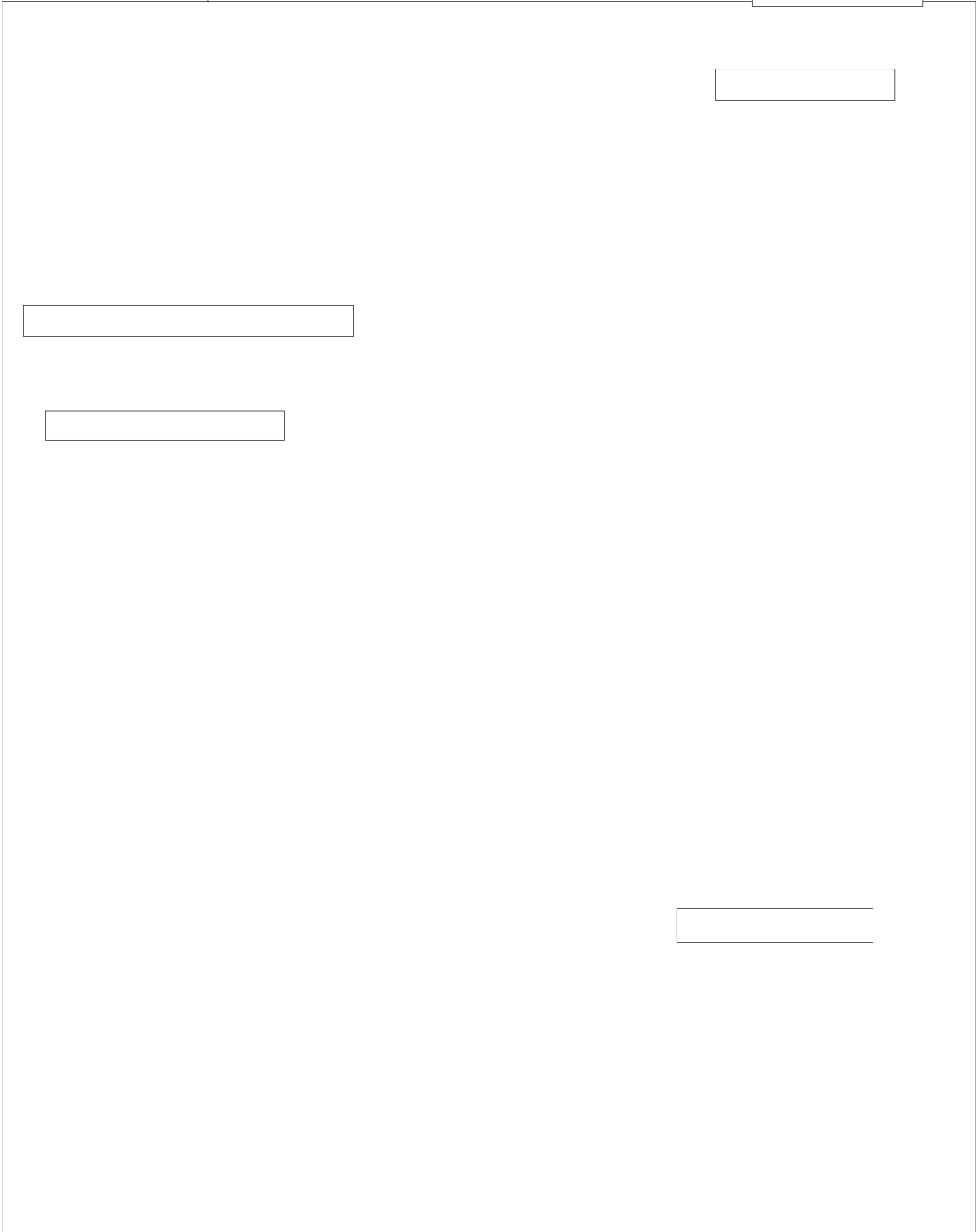
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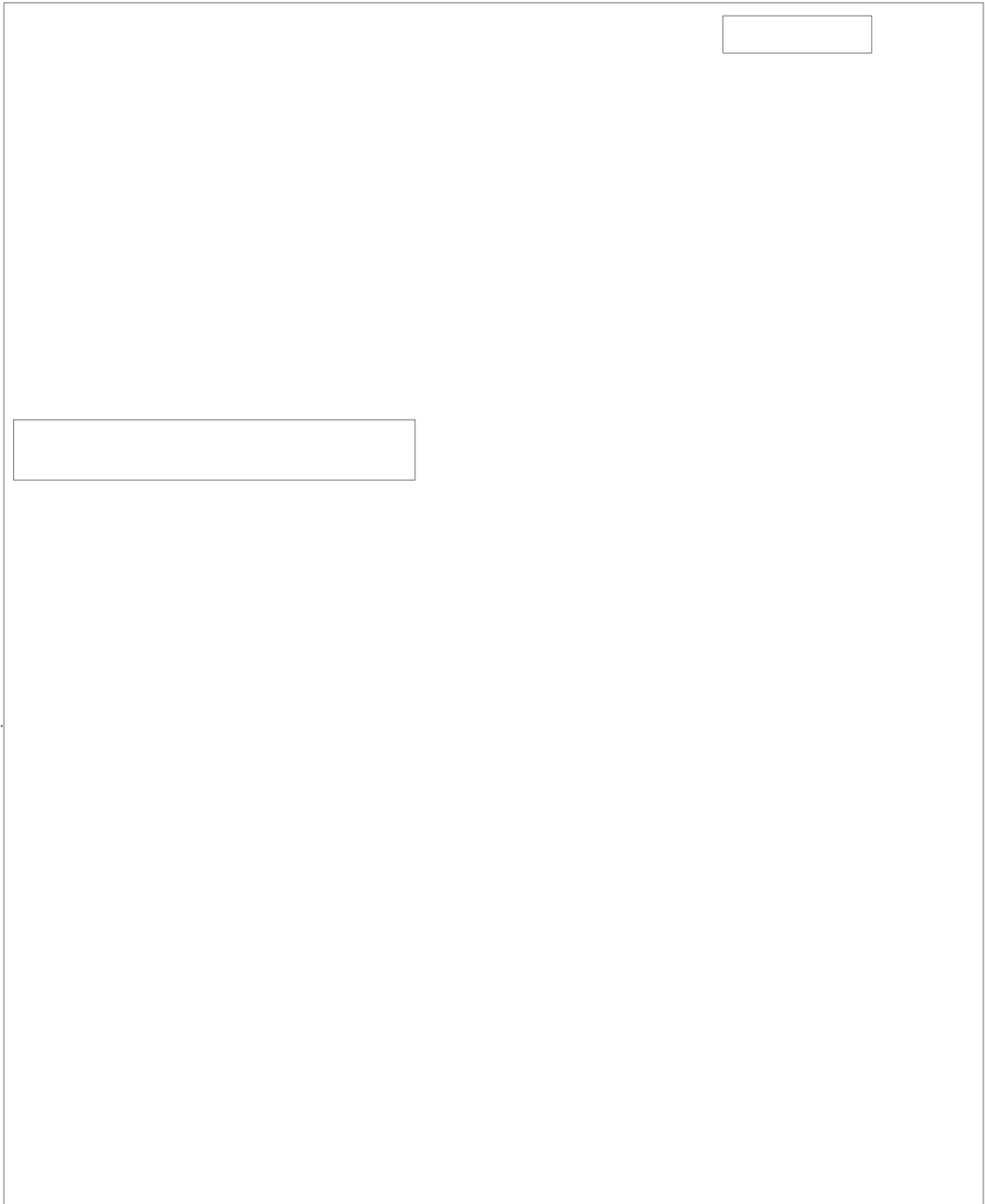
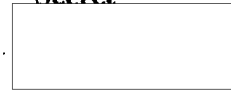


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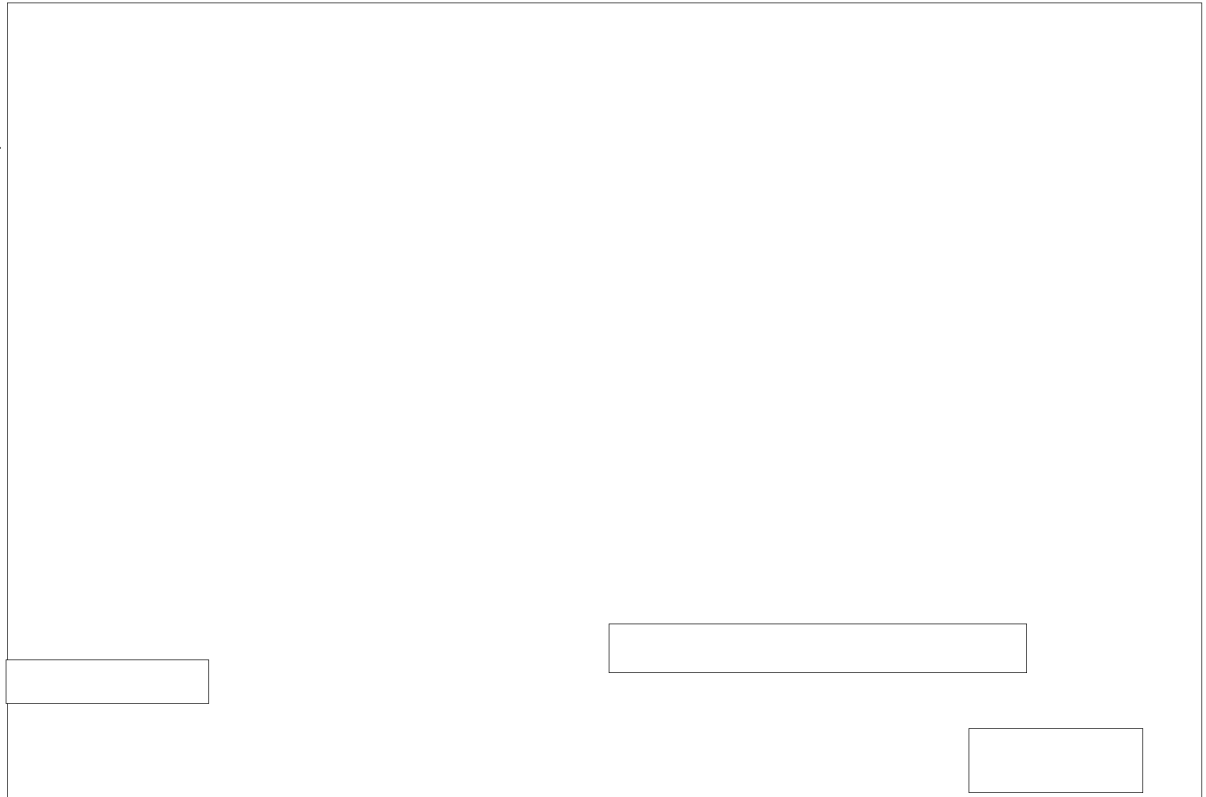
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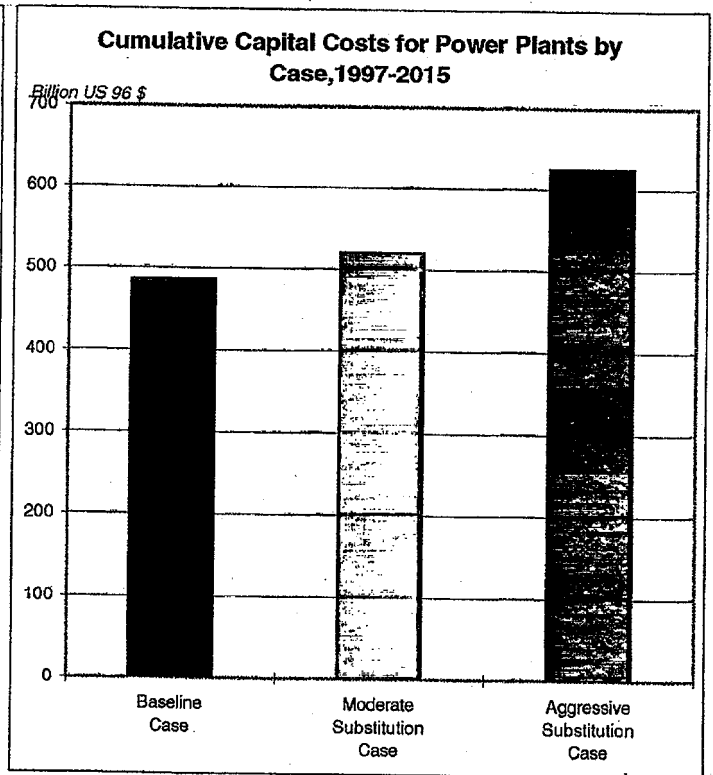
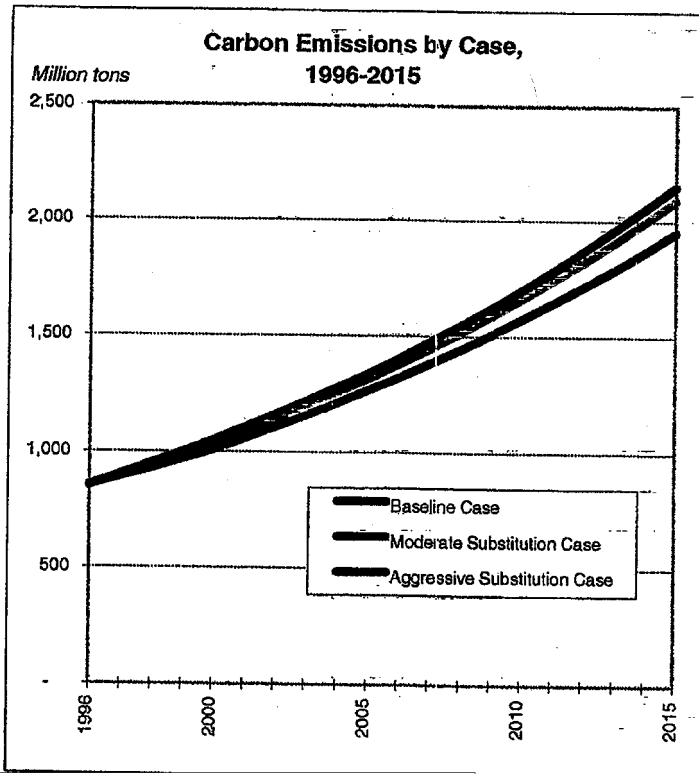
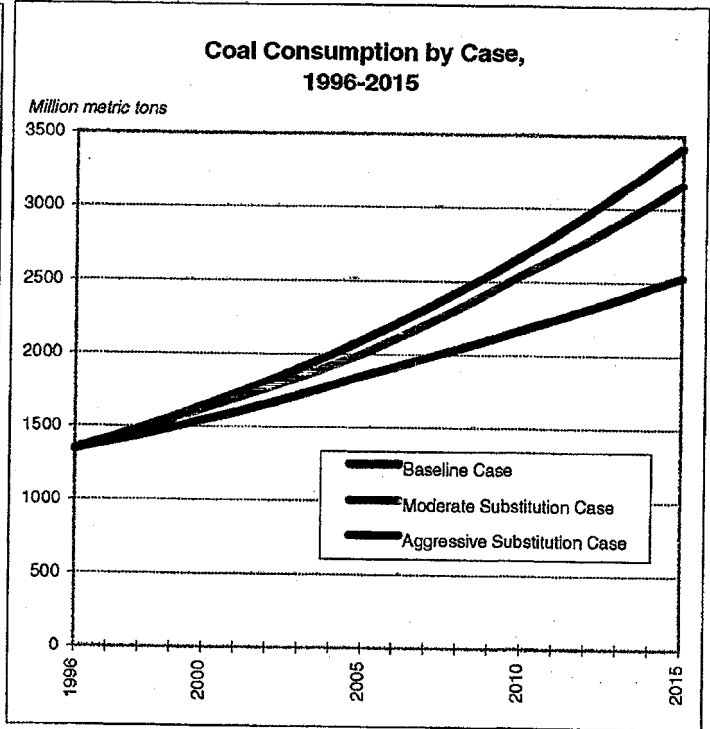
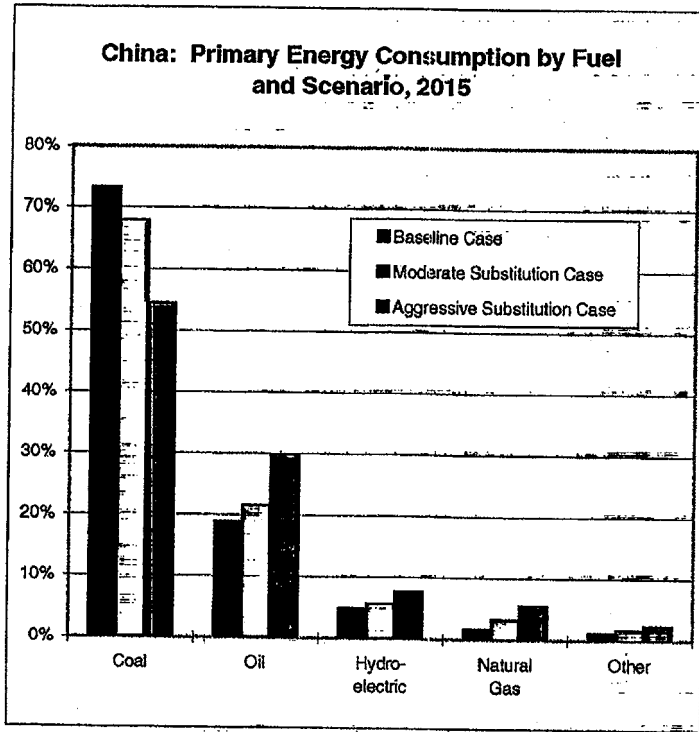


Our analysis indicates that while China could decrease its dependence on coal by about 25 percent by 2015 under the most aggressive substitution case, coal use still would almost double from 1996 levels. Capital costs for new power plants alone would increase by nearly \$140 billion in the aggressive substitution scenario and by more than \$30 billion annually in the moderate substitution case (see figure 4)—an increase of 30 percent and 7 percent, respectively, over the baseline case.

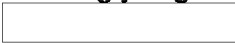
- Reductions in annual carbon emission relative to the baseline case would be 9 and 3 percent, respectively, for the aggressive substitution and moderate substitution cases.
- Even so, carbon emissions in 2015 under either scenario would be nearly 2.5 times what they were in 1996. 

Aggressive Substitution Case. This case results in about a 25-percent decrease in annual coal use by 2015, with a cumulative savings of 6 percent in carbon emissions from 1997-2015. However, capital costs for new electric power plants increase by almost \$140 billion—or about 30-percent higher than in the baseline case—with another \$25 billion annually needed to offset the additional purchases of oil and gas even with decreased coal purchases.


Figure 4
Coal Substitution Model Results





- In this case, China becomes more heavily dependent on oil imports, especially increased reliance on supplies from the Middle East, and will need to build and upgrade additional refineries to handle the crude.
- Expansion of the gas industry costs \$125 billion, mainly for pipelines and other infrastructure construction, and includes funding for domestic exploration and development.
- Hydroelectric capacity increases to more than half of China's exploitable resources, and China turns increasingly to gas and nuclear power to meet its electricity generation needs. 

Moderate Substitution Case. This case results in a 7-percent decrease in annual coal use by 2015 but only a 2-percent cumulative savings in carbon emissions. Capital costs under this scenario increase by more than \$30 billion—about 7 percent higher than in the baseline case—with another \$7 billion annually for increased fuel costs.

- China relies more heavily on oil imports than in the baseline case, again with the Middle East as probably the most important supplier.
- Some \$90 billion is needed for gas industry development, although no international pipelines are built.
- Reliance on nuclear power increases but to a lesser extent than in the aggressive substitution case. 

Chinese Policies Make Coal Substitution Difficult 

The higher costs for alternative energy, Beijing's desire to build its own domestic energy technology, and a reluctance to rely on energy imports would make it difficult for China to exercise even moderate coal substitution in the near term in our judgment. Chinese attitudes could change, however, if leadership concerns grow about the economic and health costs associated with extensive coal use.

- China's energy policy reflects a strong bias toward least-cost energy development using coal, with minimal consideration given to environmental consequences.



- A recent World Bank study put the cost of environmental pollution in China at \$50 billion annually. [redacted]


Implementing even modest coal substitution would require Beijing to change many of its long-standing energy policies. Key policy changes would include:



- *Removal of subsidies on energy prices.* A major obstacle to coal substitution would be removed if energy prices were allowed to rise to market levels. In that case, electric power and industrial plant operators would look to the most efficient and flexible way to produce electricity or steam at the lowest overall cost. With prices for coal and gas at free-market levels, gas would become a more viable option for China—in regions such as coastal areas where imported gas could compete with indigenous coal. For example, gas-fired units require less capital costs, are quicker to build, and come on line faster than coal-fired units.
- *Fewer government controls on imports and the elimination of taxes on imported energy equipment.* Beijing maintains a 15-percent tariff on imported energy equipment and requires foreign suppliers to transfer technology to local manufactures, according to Chinese press reports. Without these market barriers, foreign companies that specialize in energy technologies—including US firms—would be in a better position to encourage alternatives to coal use and gain access to the Chinese market for coal alternatives.
- *Stronger environmental laws with strict enforcement.* Stronger air pollution laws and stricter enforcement would mean that plant operators would become more conscious about the need to reduce emissions and improve efficiency. In that event, China may advocate more strongly the use of noncoal energy sources such as nuclear and natural gas. [redacted]



Clean-Coal Technology Options


Our modeling does not include implementation of clean-coal technology; however, the best opportunity China has to decrease harmful air emissions without using other fuels is to employ clean-coal technologies such as fluidized bed combustion, flue-gas desulfurization, and coal gasification units, according to industry experts—although these technologies do not reduce carbon emissions.²

 China has little indigenous environmental technology development under way and needs to buy such technology from foreign firms. China's domestic environmental technology program is about 40 years behind that of the United States.

- China's main effort to reduce emissions centers on improving plant efficiency by building modern coal-fired plants—300-MW and 600-MW units—and by retrofitting existing, older units. , the majority of capital expenditures related to coal technology are used to increase energy output through efficiency gains—an effort that does reduce carbon emissions. 

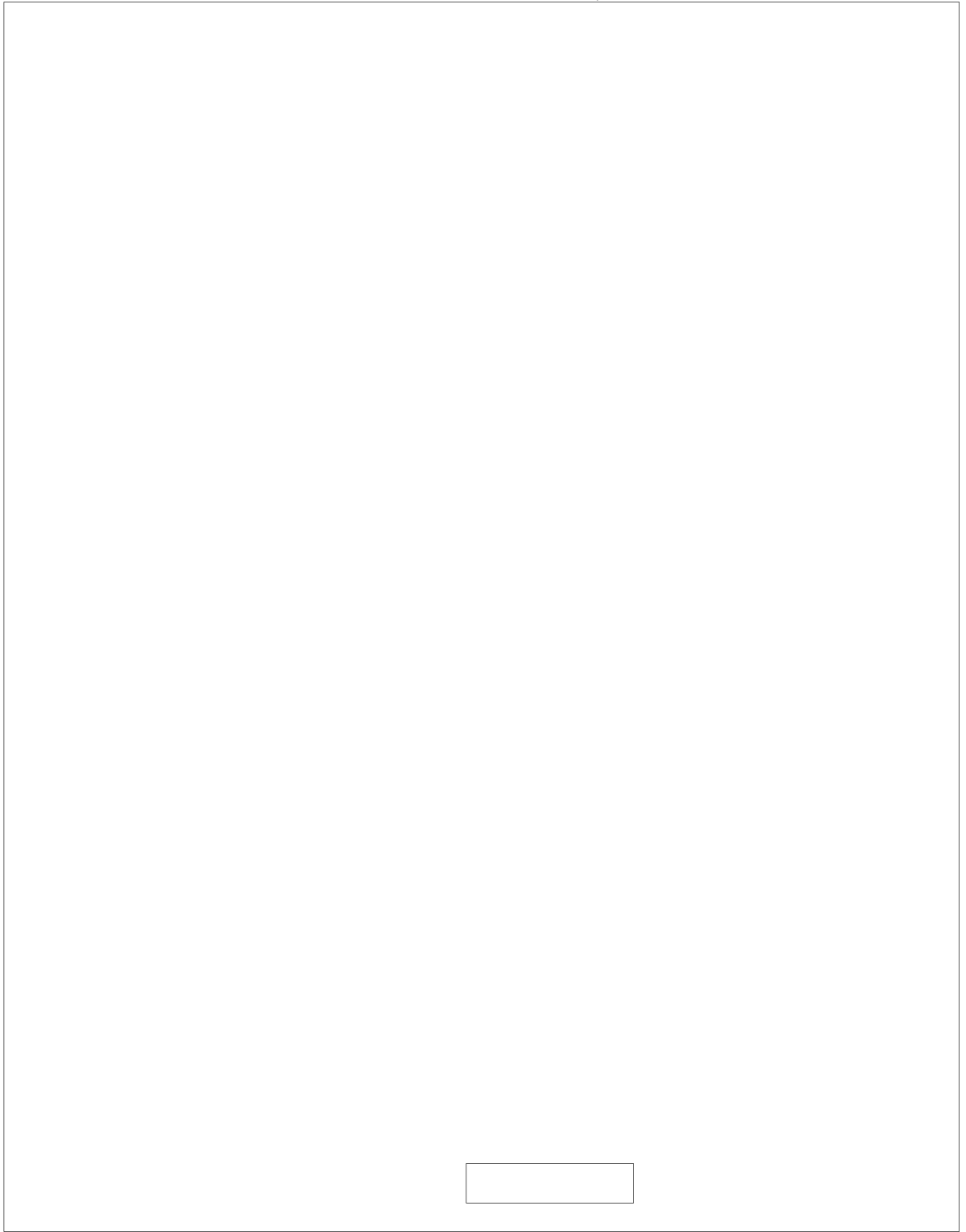
Industry analysis of projections of coal use in China suggest that the country's air pollution problems would intensify even if clean-coal technologies were used.

- Although such technology would reduce emissions per unit of coal burned, the projected large increase in future coal consumption would raise sulfur dioxide emissions from 20 million tons in 1994 to 25-30 million tons in 2020.

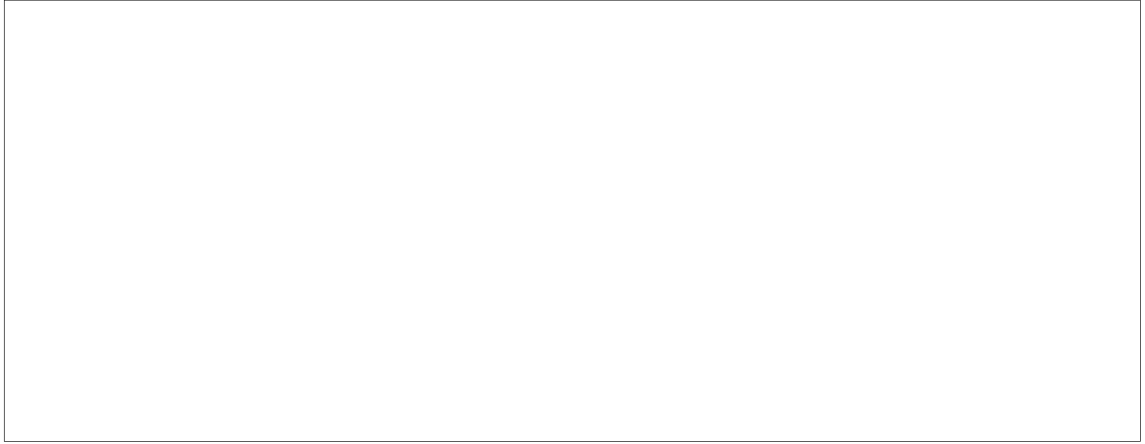
 by 2020, increased coal consumption will push China's carbon emissions to 1,700-1,900 million tons or to 25 percent of the world's total—with China surpassing the United States as the world's largest carbon emitter.



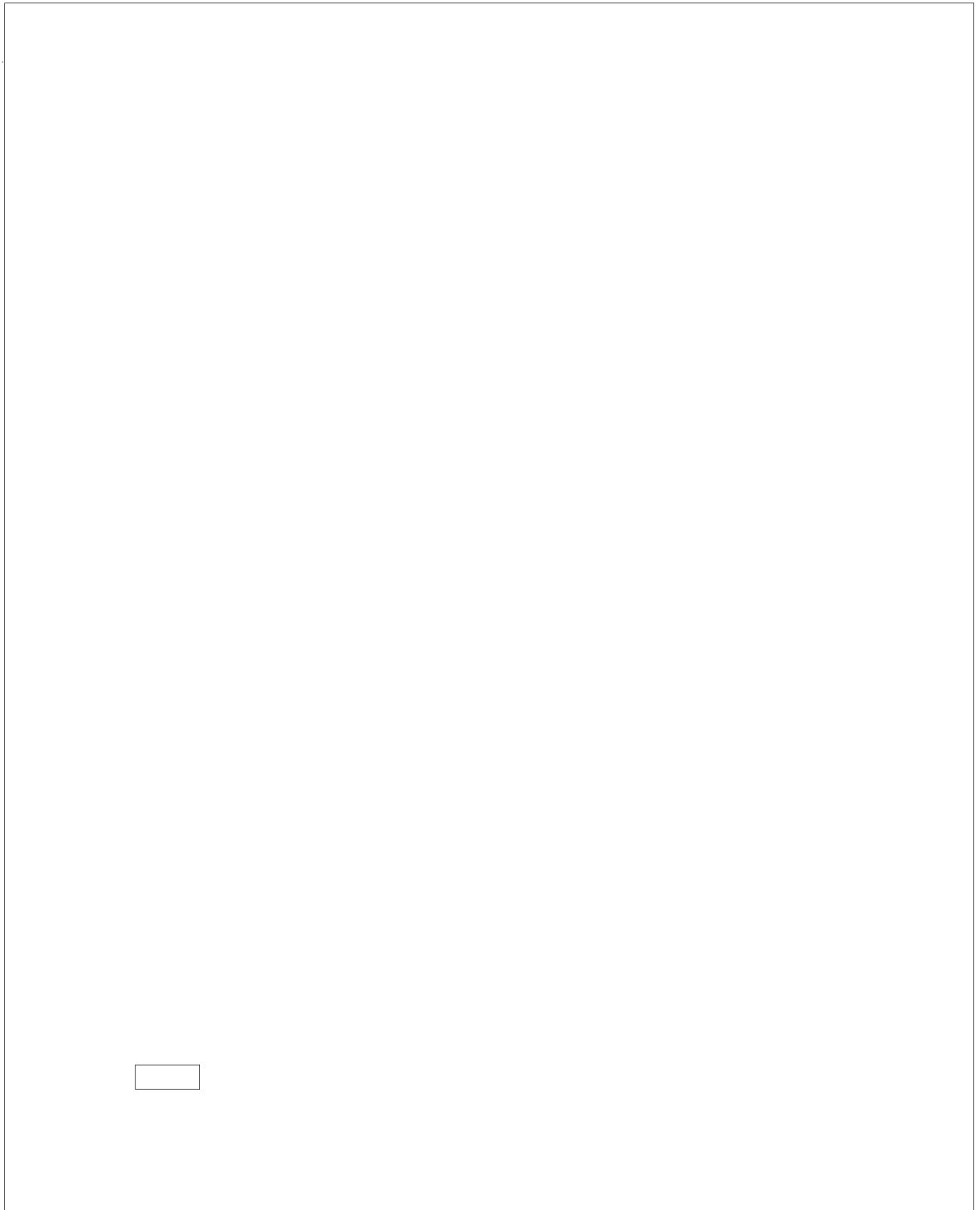
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