

# China:



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## Energy and Carbon Emissions Outlook to 2020

CIA | OTI | IR-99-058  
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ES

June 1999

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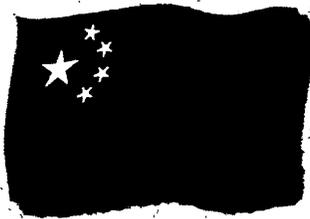


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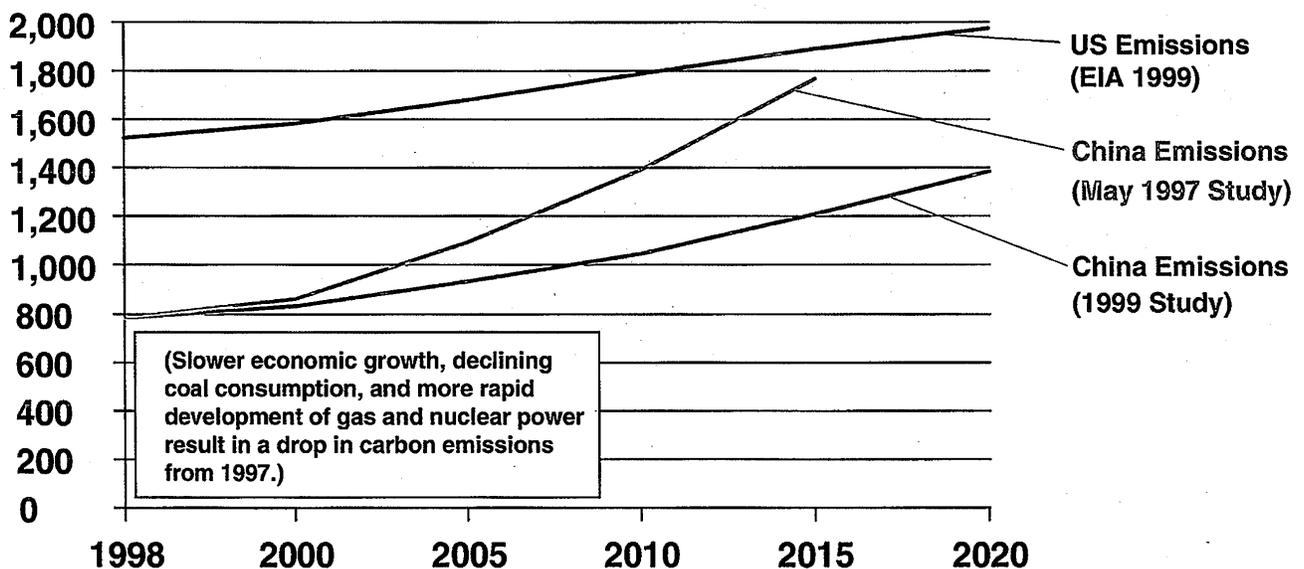
**Energy and Carbon Emissions  
Outlook to 2020**

**June 1999**



## China's Carbon Emissions: The 1997 and 1999 Studies

Million tons carbon



Source: The Energy Information Administration Annual  
Energy Outlook 1999

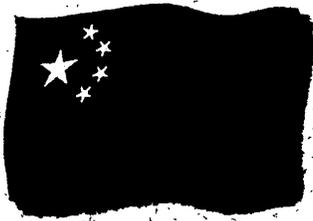
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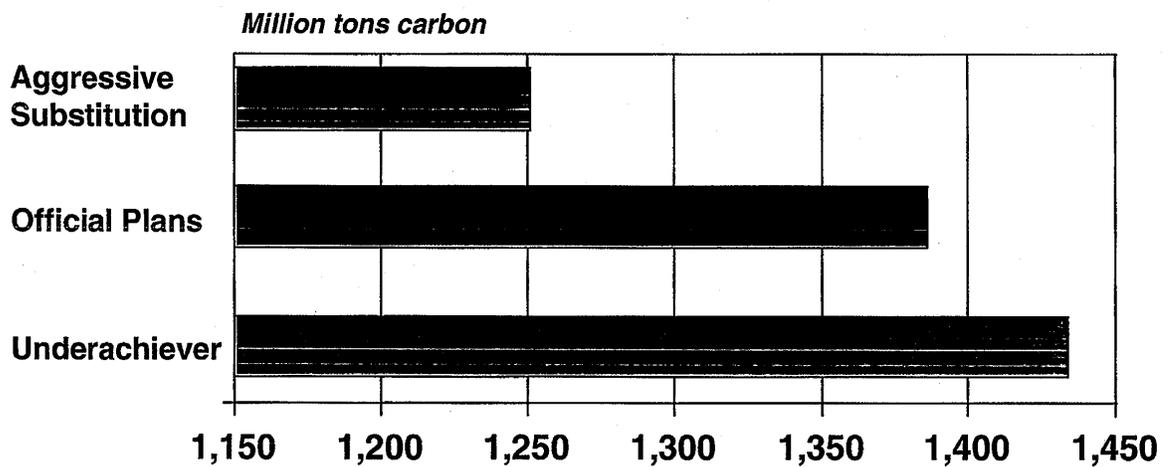


## **New Carbon Emission Projection: Growth Rates Key Factor**

- **A new CIA study of China's energy outlook projects that carbon emissions output—a major cause of greenhouse gases—will reach 1,390 million tons per year by 2020. This is far lower than projected US output levels of 1,975 million tons in 2020 as estimated by the Energy Information Administration (EIA).**
  - **Previous studies by CIA, DOE, and others had projected Chinese carbon emission levels would match US levels around 2015, but this may not occur until 2035, according to the new CIA study.**
- **The lower carbon emission projection derives from the new study's lower economic growth assumptions—average annual rate of 5.5 versus 7.0 percent in the earlier study. Chinese emission levels could reach US levels in 2020, if GDP growth averaged 7.5 percent annually.**
  - **Lower emissions also result from treating coal as a residual fuel to meet primary energy demand rather than using official targets, which appear high given declining production and consumption in the past few years (Appendix A).**



# Carbon Emissions in 2020 Under Three Development Cases

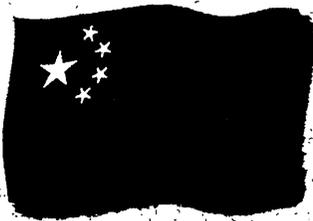




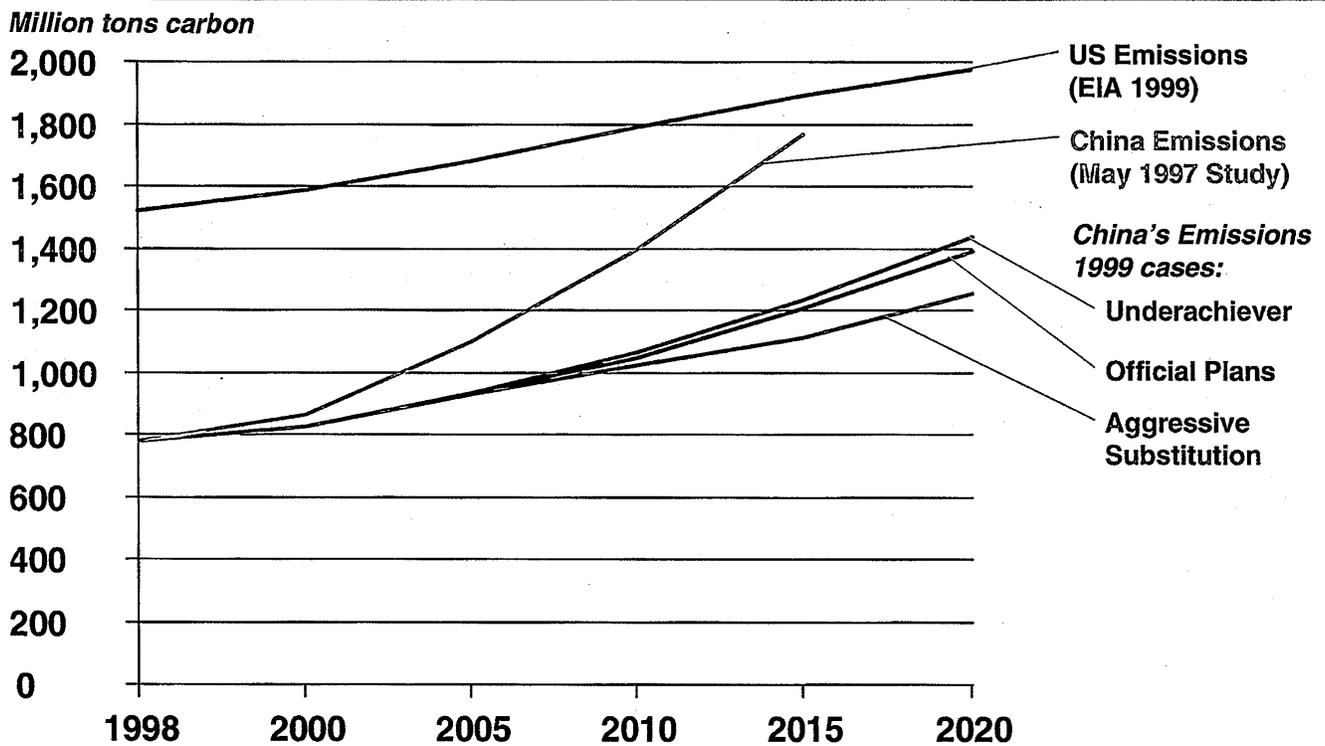
## **Alternative Fuel Development Less Important**

- **China's development of alternative fuels does not substantially alter emissions projections and will be costly. The study considered three development cases for gas, nuclear, hydropower, and renewables—bracketing China's official targets for those fuels.**
  - **Underachiever case assumes a slow rate of alternative fuels development—often the low end of official Chinese targets.**
  - **Official Plans case assumes a moderate rate of alternative fuel development—in line with midrange targets by Chinese officials.**
  - **Aggressive Substitution case assumes China has reached its highest targeted levels for alternative fuel development.<sup>a</sup>**

<sup>a</sup> Where target levels for fuels have not been announced, CIA has extrapolated development levels.

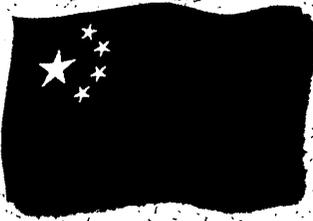


# Carbon Emissions Under Three Development Cases



Source: EIA Annual Energy Outlook 1999

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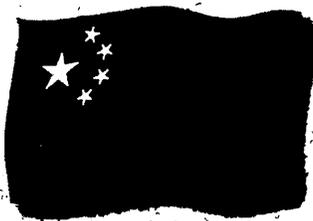
## Cumulative Energy Infrastructure Costs, 1999-2020

- Under the Aggressive Substitution case, carbon emissions decline by 10 percent, or 135 million tons, but the associated costs—not including indirect infrastructure—total \$122 billion.

	Underachiever	Official Plans	Aggressive Substitution
<b>Costs (Billion \$)</b>			
Power plant costs	386	399	484
Partial natural gas Infrastructure	17	23	56
Total infrastructure <sup>a</sup>	403	422	540
<b>Emissions (Million tons carbon)</b>			
Carbon emissions	1,434	1,386	1,251

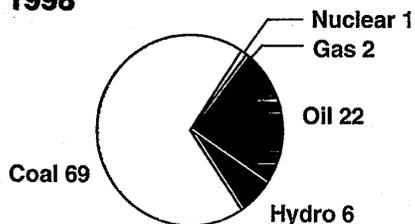
(See Appendix B for electric plant capital costs.)

<sup>a</sup> Note: "Total infrastructure" cost estimates above include only power plants, import pipelines, and liquefied natural gas (LNG) plants, and exclude associated infrastructure costs for domestic gas transmissions and distribution networks, other industrial end users (for example, fertilizer and petrochemical plants), and oil and gas exploration and development.

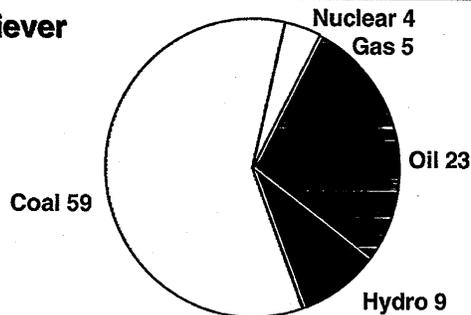


# Comparison of Primary Fuel Mix

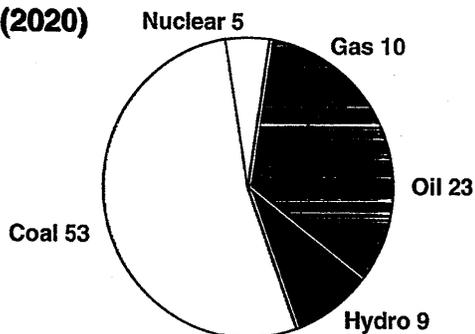
Percent **1998**



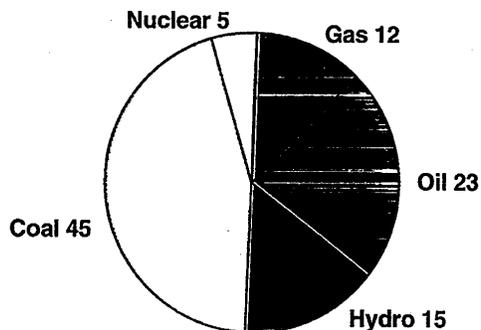
**Underachiever (2020)**



**Official Plans (2020)**



**Aggressive Substitution (2020)**



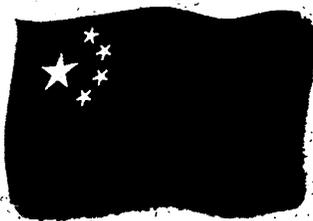
Source: Press

China's primary energy consumption for 1998 and 2020 is 18.8 and 37.7 million barrels of oil equivalent per day, respectively.



## **China Reassessing Energy Policy**

- **Slower economic growth, reduced energy demand, and growing pollution problems are on the minds of Chinese officials as they prepare the Tenth Five-Year Plan (2001-05). Addressing acid rain and airborne ash particles will take precedence over carbon emissions, but efforts to deal with acid rain also may reduce emissions.**
  - **Beijing is emphasizing greater energy efficiency in the industrial and energy sectors through its restructuring of state-owned enterprises and closure of some of the more inefficient and polluting coal-fired plants.**
  - **Embassy and press reports on leadership preferences and recent trends in energy investment suggest the Chinese will seek to develop further their hydropower, nuclear, and natural gas assets.**



## Consumption Outlook For Natural Gas, Coal and Oil

	2000	2005	2010	2015	2020
<b>Natural Gas</b> ( <i>Billion cubic meters per year</i> )					
Underachiever	25	40	65	85	110
Official Plans	25	40	120	160	200
Aggressive Substitution	25	60	115	170	235
<b>Coal</b> ( <i>Million tons per year</i> )					
Underachiever	1,360	1,500	1,670	1,910	2,220
Official Plans	1,360	1,500	1,560	1,770	2,010
Aggressive Substitution	1,360	1,460	1,520	1,550	1,680
<b>Oil</b> ( <i>Million barrels per day</i> )					
All Cases <sup>a</sup>	4.5	5.4	6.4	7.5	8.7

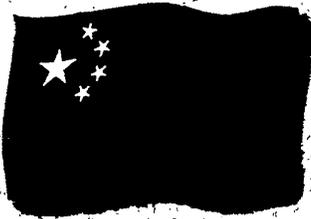
<sup>a</sup> Appendix C—oil elasticity section.

Source: Press



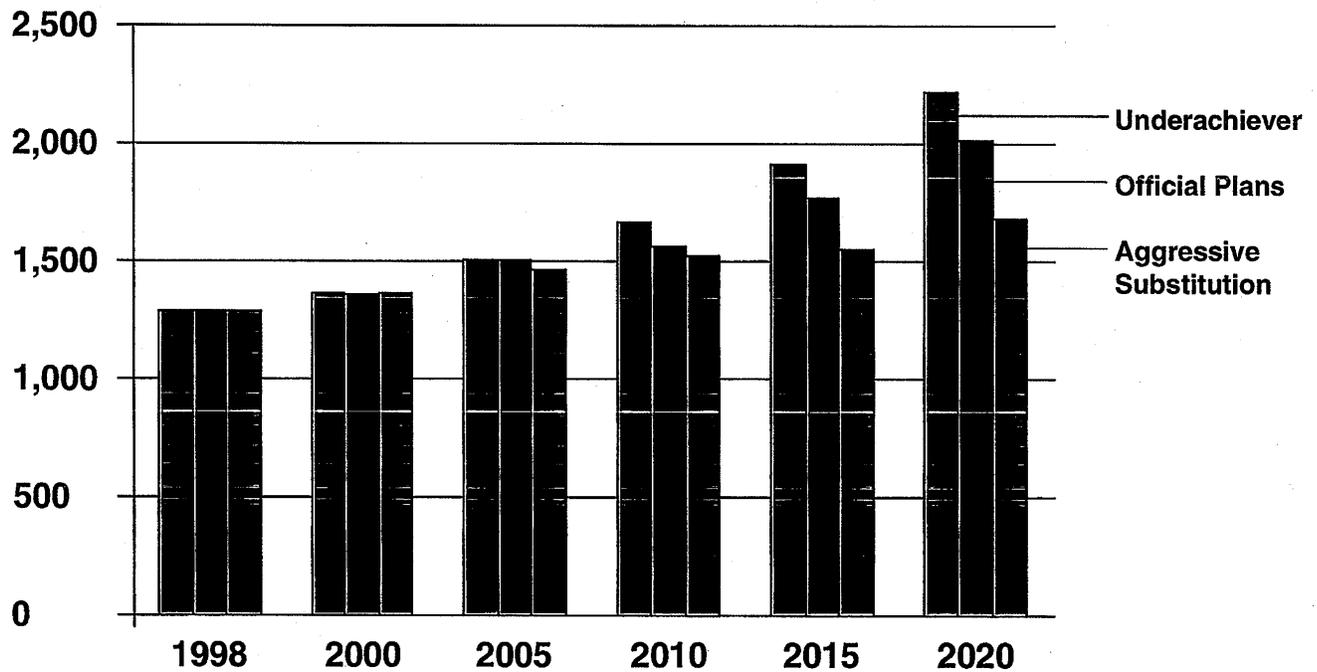
## **Natural Gas: Growing, But Limited, Potential**

- **Chinese officials have announced consumption targets as high as 200 billion cubic meters (bcm) for 2020, nearly ten times China's 1998 production or about one-third current US gas use.**
  - **Even with substantial investment, CIA projects that consumption in 2020 is unlikely to exceed 135 bcm.**
- **Gas use is constrained by the dearth of long-distance transit pipelines.**
- **Proved reserves—CIA estimates about 1,000 bcm—are inadequate for sustained production of much more than 40 bcm without large new discoveries or substantial reserve growth.**
  - **Recent exploration results have been modest to disappointing.**
- **Import pipeline and LNG projects are in their early stages. Financing and project economics are problematic, and the petrochemical sector will remain an important gas consumer.**



## Coal Consumption Outlook by Case, 1998-2020

Million tons of coal



Source: Press

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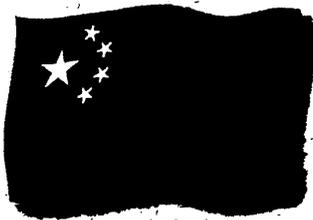
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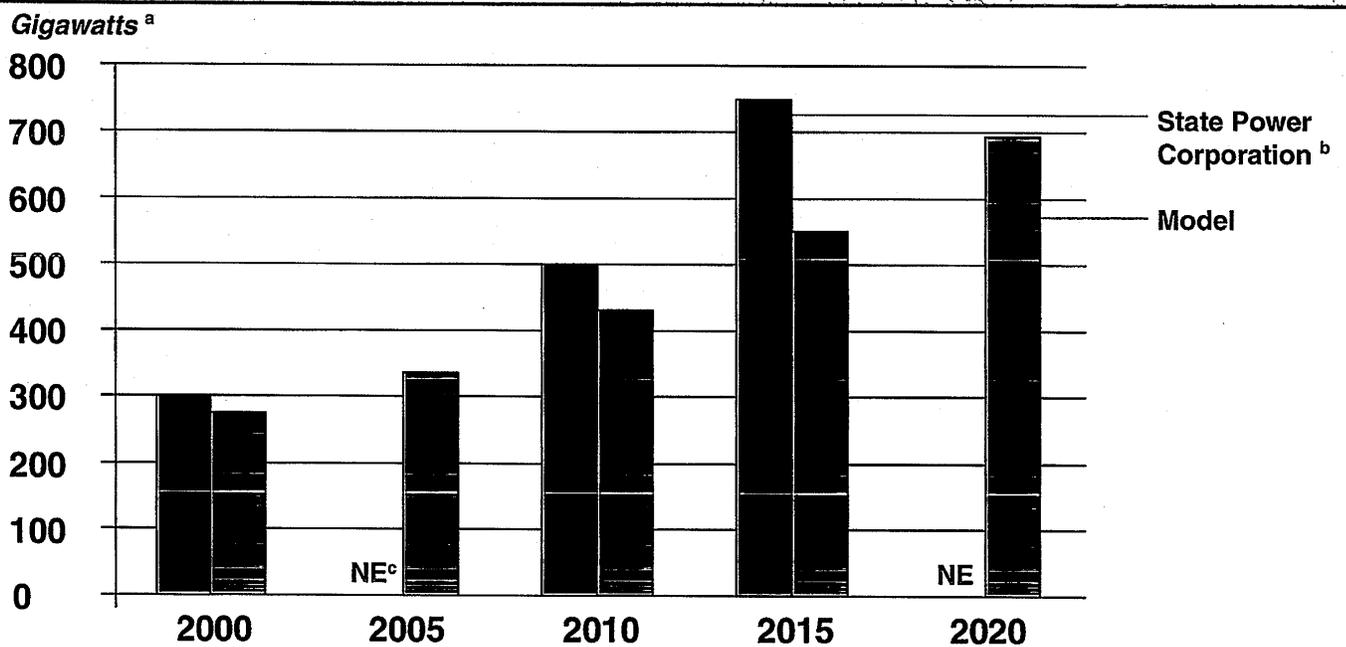


## **Coal's Changing Role in China's Primary Fuel Mix**

- The study projects coal consumption—driven in part by power sector demand—will be 1.7- 2.2 billion tons in 2020.
- Coal output peaked in 1996 at 1.39 billion tons and has since declined annually by about 100 million tons. Coal stocks remain high, forcing China to close 25,000 unlicensed mines and make even greater output cuts this year of 250 million tons, an output target of less than 1.1 billion tons.
  - Beijing is likely to abandon the Ninth Five-Year Plan's official production target of 1.5 billion tons for the year 2000, as slower economic growth, high levels of coal stocks, service sector growth, and greater reliance on alternative fuels depresses demand.
  - If the slump in coal consumption continues for a few years, then our projections for China's emissions in each case will be high.



# Installed Power Generation Capacity, 2000-20



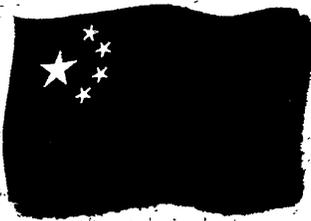
<sup>a</sup>One thousand megawatts or  $10^9$  watts.  
<sup>b</sup>Installed capacity targets under review.  
<sup>c</sup>No estimate.

Source: Press

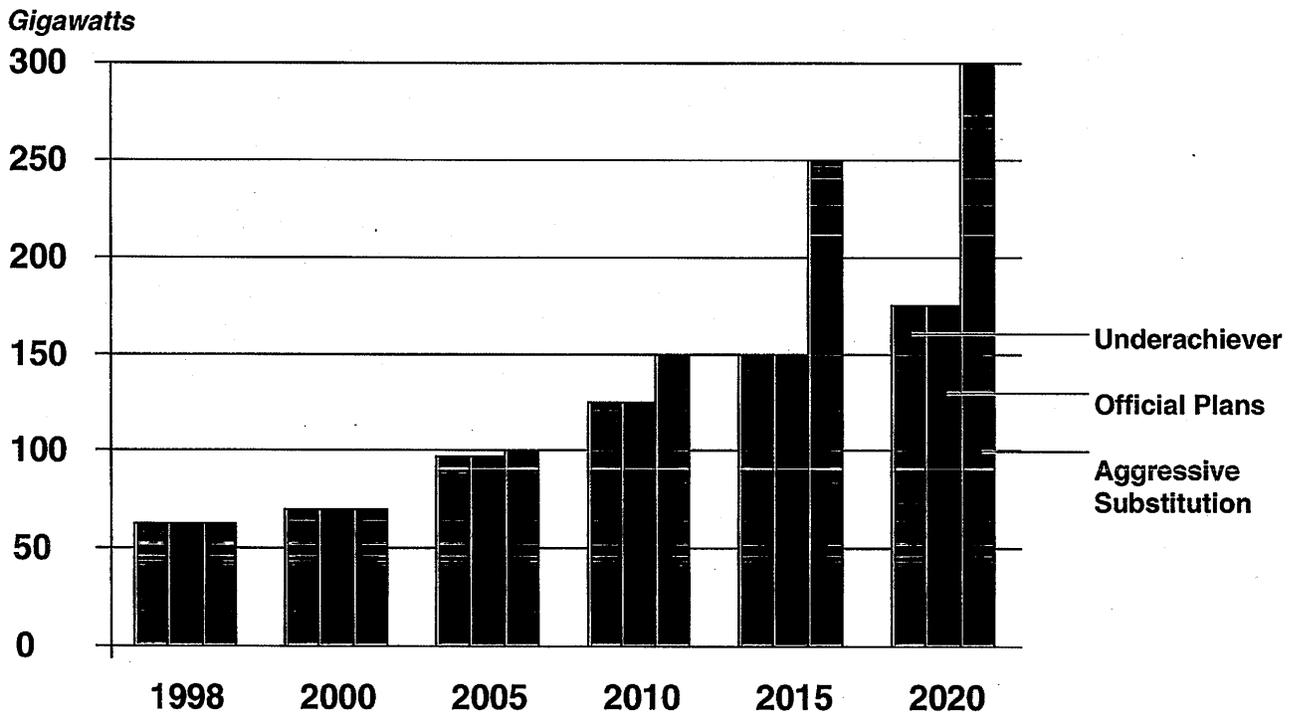


## **Power Sector Demand Driving Coal Consumption Growth**

- **The power sector consumed 35 percent of China's coal in 1998, but our study projects that by 2020 this will rise to 45-51 percent as the demand for electric power increases in the economy. Under the study's 5.5-percent average annual growth rate, China's installed capacity will total 691 GW by 2020—an average annual increase of 21 GW, with coal making up 6 to 12 GW.**
- **State Power officials had planned to add an average of 25 GW annually through 2015, but now say new capacity additions will slow for the next three to five years (Appendix D).**
  - **China is experiencing surplus capacity from depressed demand for electricity in many regions because of slower economic growth, state enterprise reform, and the reduced demand from heavy industry. Over the past decade, new power capacity additions averaged 15 GW annually.**



# Hydropower Capacity Outlook by Case, 1998-2020



Source: Press

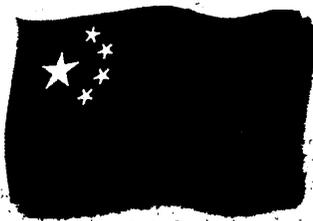
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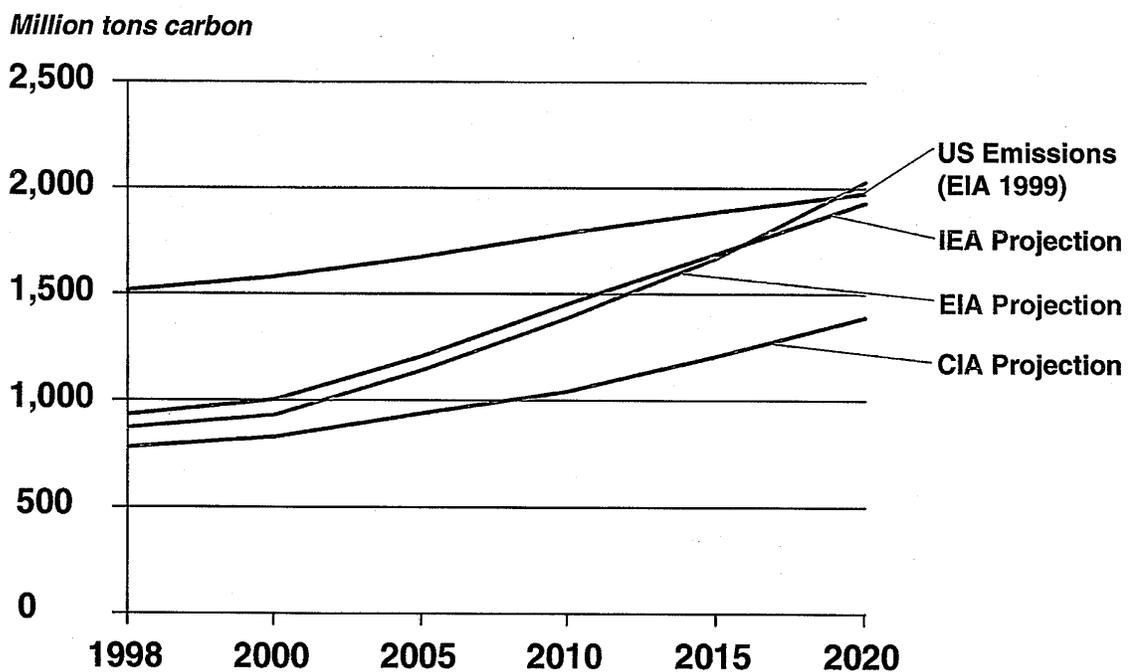


## **Hydropower Development Likely To Remain Strong**

- **Beijing has 14 large dams under construction and plans to rapidly develop hydropower by adding 5 GW annually to 2010. In 1998, China reached an installed hydroelectric capacity of 60 GW, or 16 percent of its total 380 GW hydropower resources.**
  - **Most hydroelectric projects are in isolated rural areas and are critical to rural development and electrification. The high domestic content of hydropower projects also stimulates the economy and creates jobs.**
- **Our projection for hydropower development could be overstated—especially under the Aggressive Substitution case—if China cannot obtain sufficient financing or if extensive corruption is uncovered that leads to a reevaluation of major projects.**
  - **Three Gorges dam—China’s largest at 18 GW—so far remains on schedule to be completed in 2009, despite press reports of insufficient funding, shoddy construction, and graft.**



## Other Studies of China's Carbon Emissions

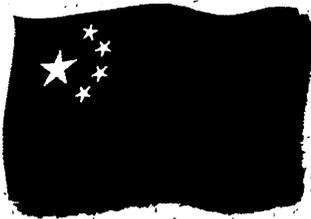


Source: EIA Annual Energy Outlook 1999



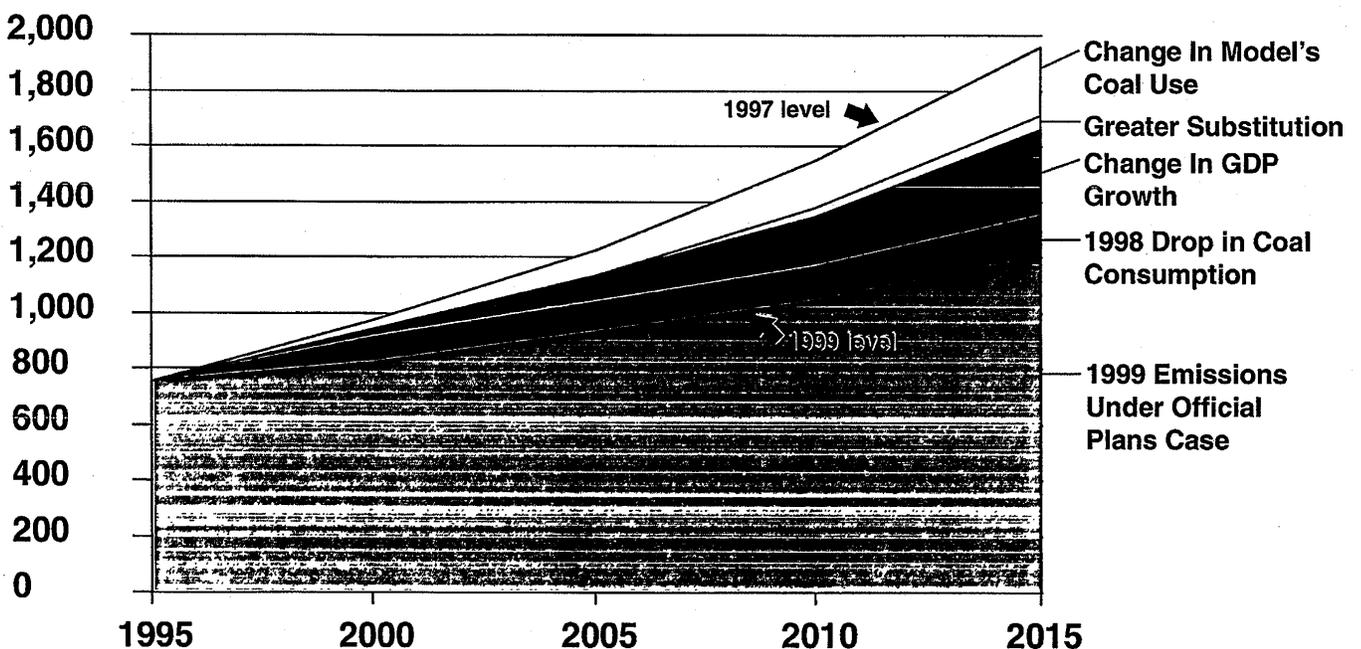
## **IEA and DOE Studies**

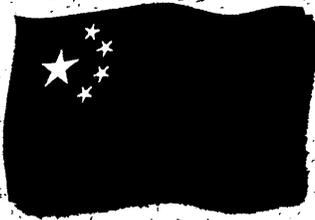
- **A 1998 International Energy Agency (IEA) study is consistent with the 1999 CIA study's conclusion that China's carbon emissions could be lower than US emissions in 2020.**
  - **IEA's study used the same 5.5-percent average annual growth rate for GDP but used higher energy demand elasticities and assumed less natural gas development.**
- **A 1999 study by Energy Information Administration (EIA) of the Department of Energy projects China's emissions will slightly exceed US emission by 2020.**
  - **The EIA study uses a higher level of emissions for their base year and assumes a 6.5-percent average annual GDP growth rate.**



## Appendix A: Factors Underlying Lower Carbon Emissions in 2015

Million tons carbon





## **Appendix A: 1999 Official Plans Versus 1997 Study Assumptions**

- **Slower GDP growth—an average annual rate of 5.5 percent versus 7 percent—accounted for just over 40 percent of the drop in emissions.**
- **Making coal a residual fuel rather than using official targets accounted for a third of the drop in emissions. Under the new study, coal consumption is 1.8 billion tons in 2015, down from 3.4 billion tons. Another 20 percent of the decline in emissions is due to the drop in coal consumption in 1997 and 1998.**
- **Greater development of alternative fuels accounted for only 7 percent of the drop in carbon emissions. Under the new study by 2015 gas consumption in primary energy increases to 160 bcm versus 44 bcm in the earlier study. Alternative fuel use also increased in the power sector.**
  - **Coal-fired capacity declines to 324 GW versus 570 GW, while nuclear power capacity doubles to 30 GW, gas-fired plant capacity increases by 50 percent to 24 GW and hydropower capacity increases by 25 to 150 GW.**

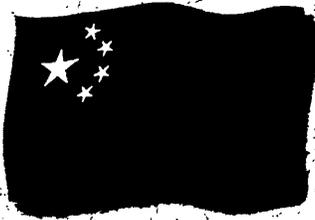


## Appendix B: Capital Costs for Electric Power Plants

Fuel	Cost per Kilowatt Capacity
Coal	\$ 600/kW
Oil	\$ 525/kW
Natural gas	\$ 450/kW
Hydroelectric	\$ 1,000/kW
Nuclear	\$ 1,350/kW
Renewables	\$ 1,000/kW

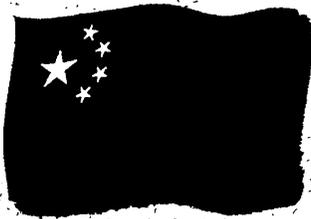
Note: Costs represent the lower end of a range and could understate total capital costs.

Source: Press



## Appendix C: Model Elasticities

- **China's historical income elasticity of primary energy demand—roughly 0.5—is markedly low when compared to other developing nations. The 1999 CIA study assumes that this elasticity will rise to 0.8 by 2020.**
  - **China's low elasticity implies either extreme energy efficiency or faulty GDP statistics; elasticities for India, Taiwan, and the United States are 0.9, 0.9, and 0.7, respectively.**
- **Under the 1999 CIA study China's income elasticity of oil demand rises from a 0.6 historical average to 0.7 in 2020. Even higher elasticities could occur—India and Taiwan have elasticities of 1.0 and 0.9, respectively.**
  - **If China's car ownership trend imitates South Korea's or Taiwan's, oil consumption could increase by 4-6 million barrels per day adding 155-233 million tons more in carbon emissions by 2020.**
- **China's income elasticity of electricity demand averaged 0.8 through 1997, which is low compared with other developing nations. Under the 1999 CIA study, the elasticity increases to 1.2 by 2020, on par with India and Taiwan.**



## Appendix D: Installed Capacity by Fuel Mix Under Three Cases

<i>Gigawatts</i>	2000	2010	2020
State Power's Targets	290	500	NE <sup>a</sup>
Study's Projected Totals	266	431	691
<b>Coal</b>			
Underachiever	173	252	417
Official Plans	172	249	393
Aggressive Substitution	173	231	292
<b>Gas</b>			
Underachiever	1	14	36
Official Plans	1	16	45
Aggressive Substitution	1	16	50
<b>Hydropower</b>			
Underachiever	70	125	175
Official Plans	70	125	175
Aggressive Substitution	70	150	300
<b>Nuclear</b>			
Underachiever	2	19	40
Official Plans	2	19	50
Aggressive Substitution	2	20	60
<b>Renewables</b>			
Underachiever	0.18	2	4
Official Plans	1.25	3.4	8.4
Aggressive Substitution	0.18	3.5	10

<sup>a</sup> No estimate.