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CHINA'S REGIONAL ENERGY-INTENSITY ISSUES

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ACKNOWLEDGMENTS

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- ❖ Figures, tables, and photos are mainly from the book *The Technology-Energy-Environment-Health (TEEH) Chain in China*.
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IMPORTANT PHENOMENA IN CHINA

- Continuation of rapid Gross Domestic Product (GDP) increase (9-11% per year)
- In 2004, 17.4% of global carbon dioxide (CO₂) emissions
- Large 67% energy-intensity (energy consumption per unit of GDP) decline from 1978-2004, but . . .
- Largest global consumer of coal, coke, steel, and other energy-intensive products

ENERGY INTENSITY

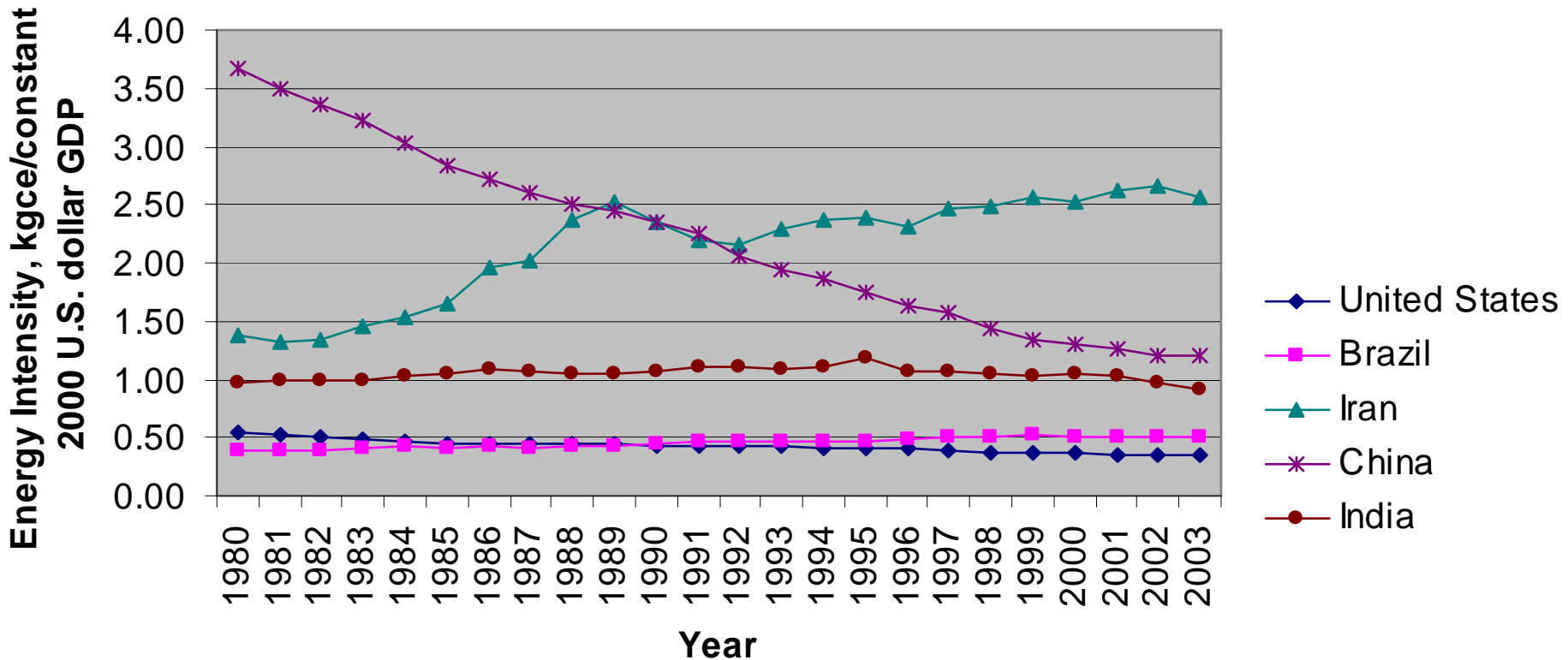
- Energy intensity is defined as energy consumption per yuan of gross domestic product
- China can reduce its CO₂ emissions by reducing the coal consumption, thus mitigating negative climate-change impacts.
- Latest (11th) five-year plan mandates reducing the national energy intensity by 20% by 2010 while maintaining GDP growth.

THREE MEANS TO REDUCE ENERGY INTENSITY

1. Reduce total energy consumption;
2. Switch from high to lower carbon fuels;
3. Introduce new technologies, especially in high energy-intensive sectors, such as power generation, cokemaking, iron and steel plants, thus increasing their energy efficiency.

ENERGY-INTENSITY

SELECTED COUNTRIES, 1980-2003



Notes: (1) GDP = gross domestic product, measured in 2000 US dollars.

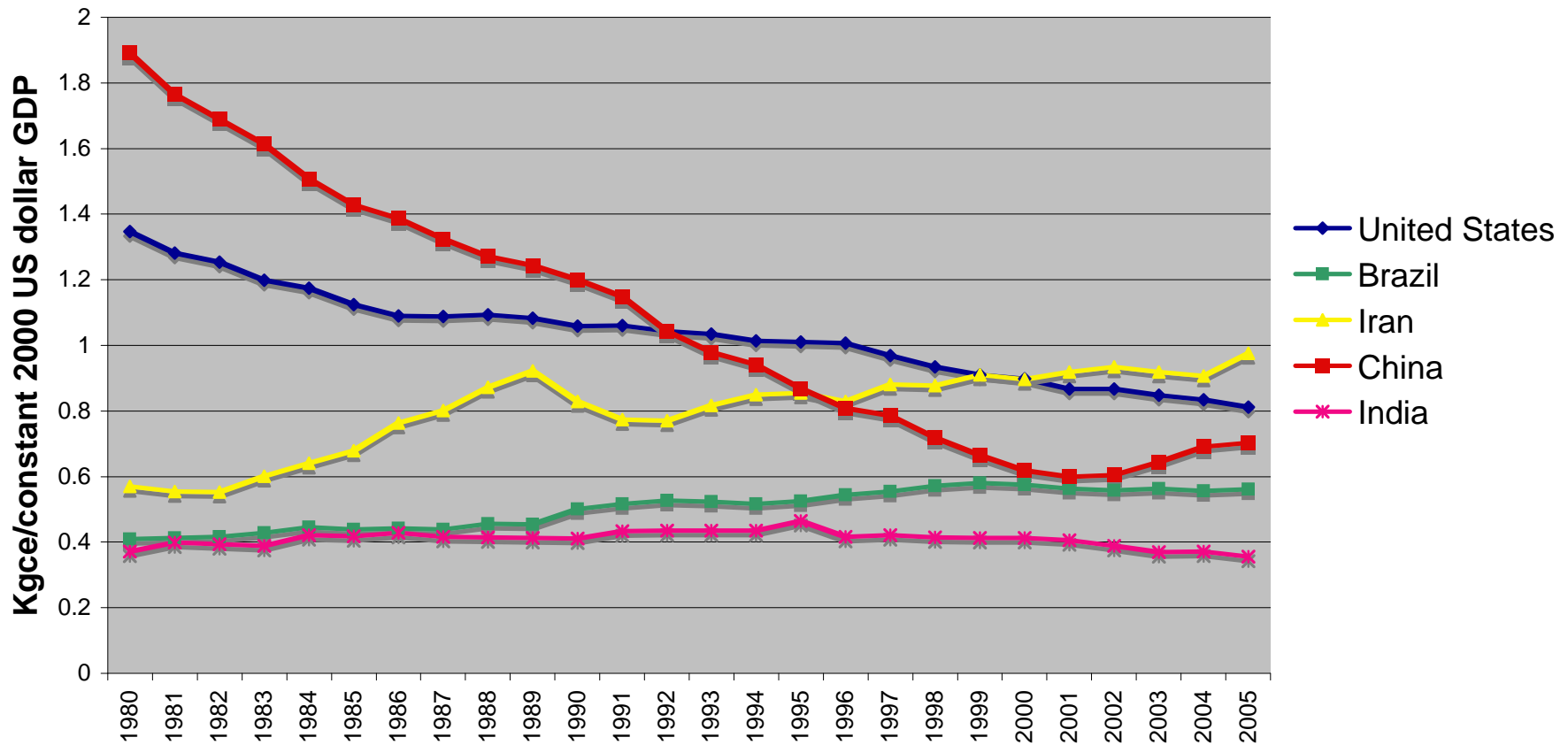
(2) Kgce = Kilograms of coal equivalent.

(3) Units of energy consumption were converted from British thermal units to Kgce (1 million Btu=89 Kgce).

Source: Compiled by the Multiregional Planning Research Team from Energy Information Administration (2005) data.

ENERGY-INTENSITY

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REGIONAL ENERGY-INTENSITY REDUCTION TARGET (2005-2010)

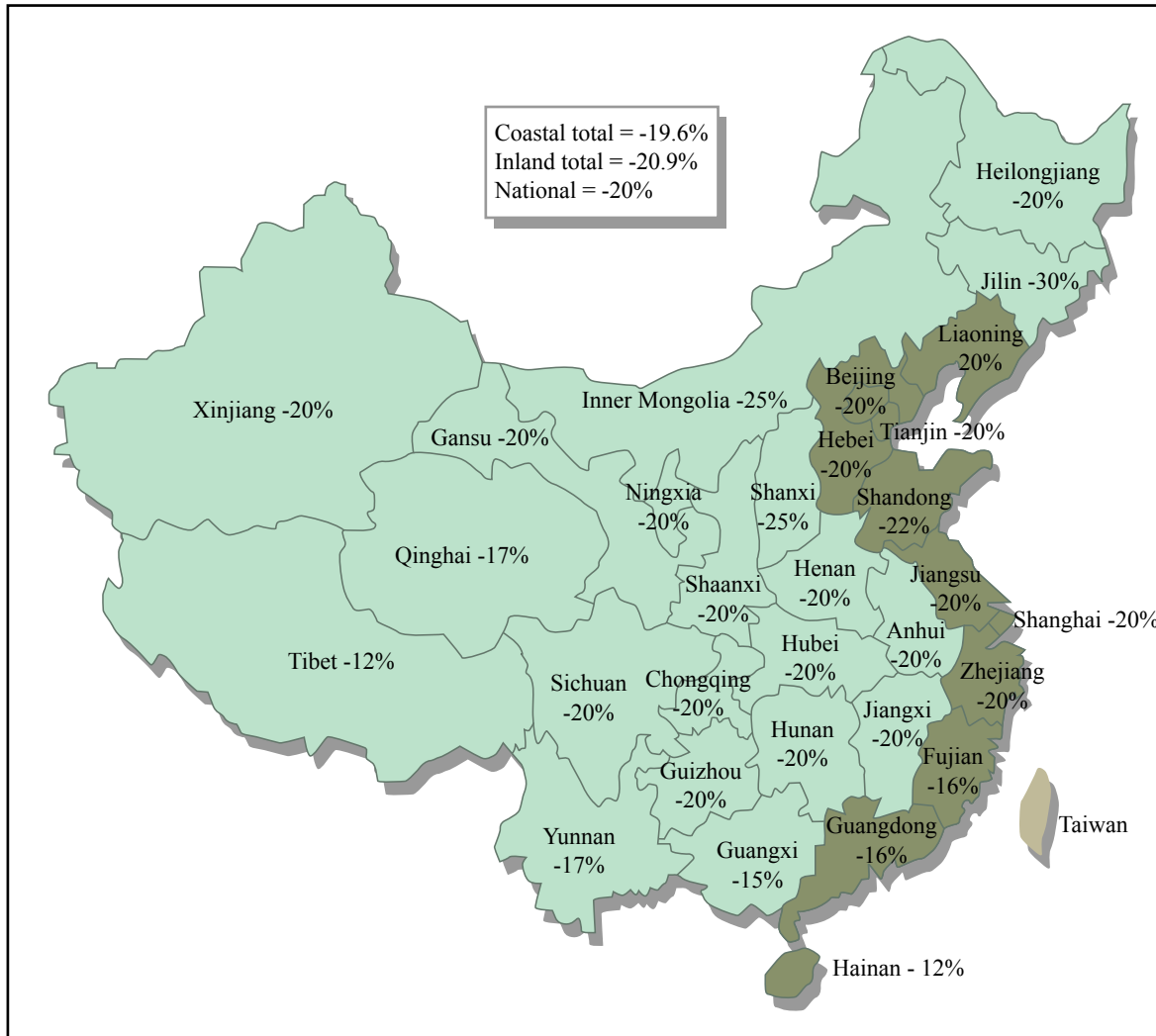
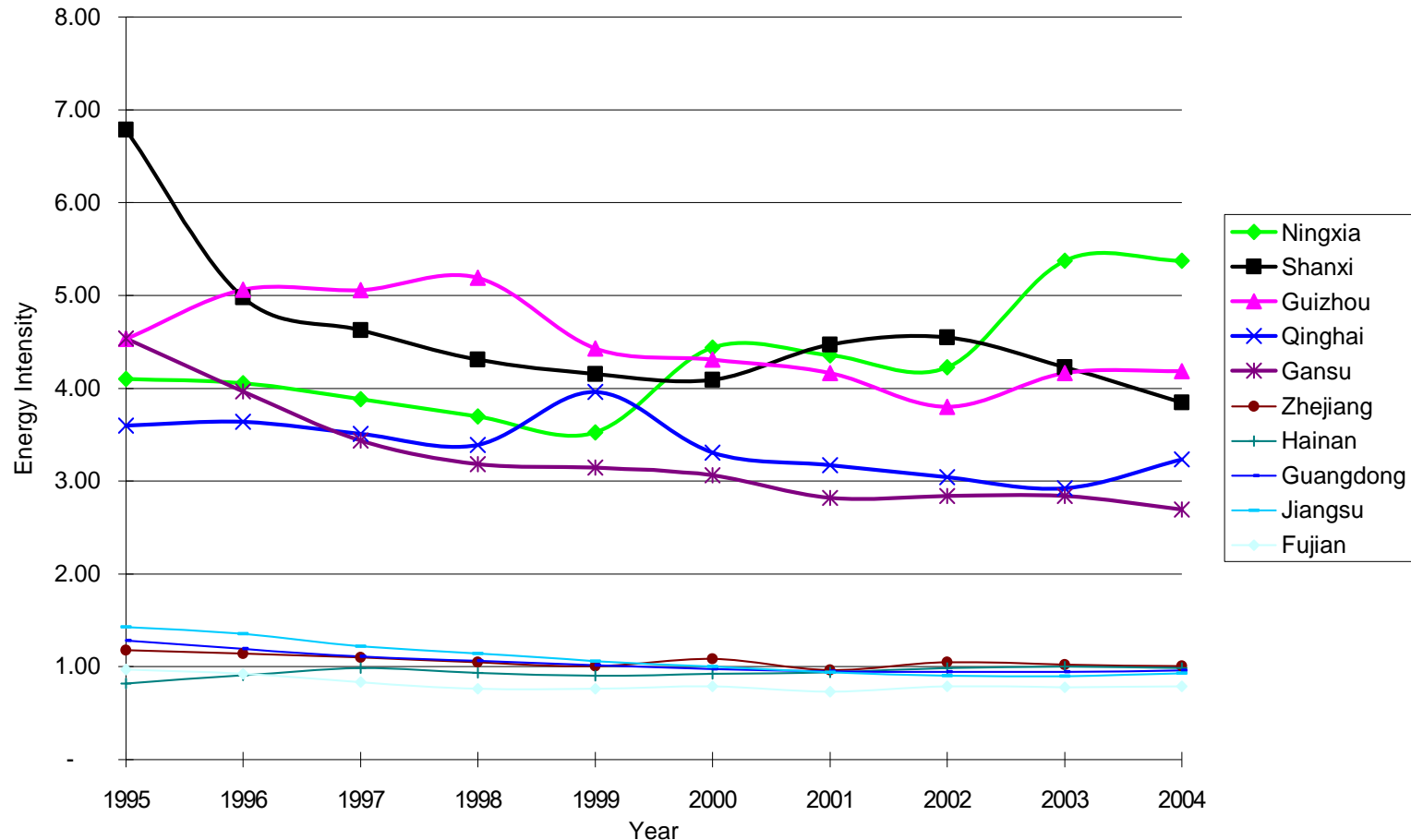


Figure by MIT OpenCourseWare.

THE MOST AND LEAST ENERGY-INTENSIVE REGIONS IN CHINA, 1995-2004

Energy intensity (kilograms of coal equivalent/GDP)

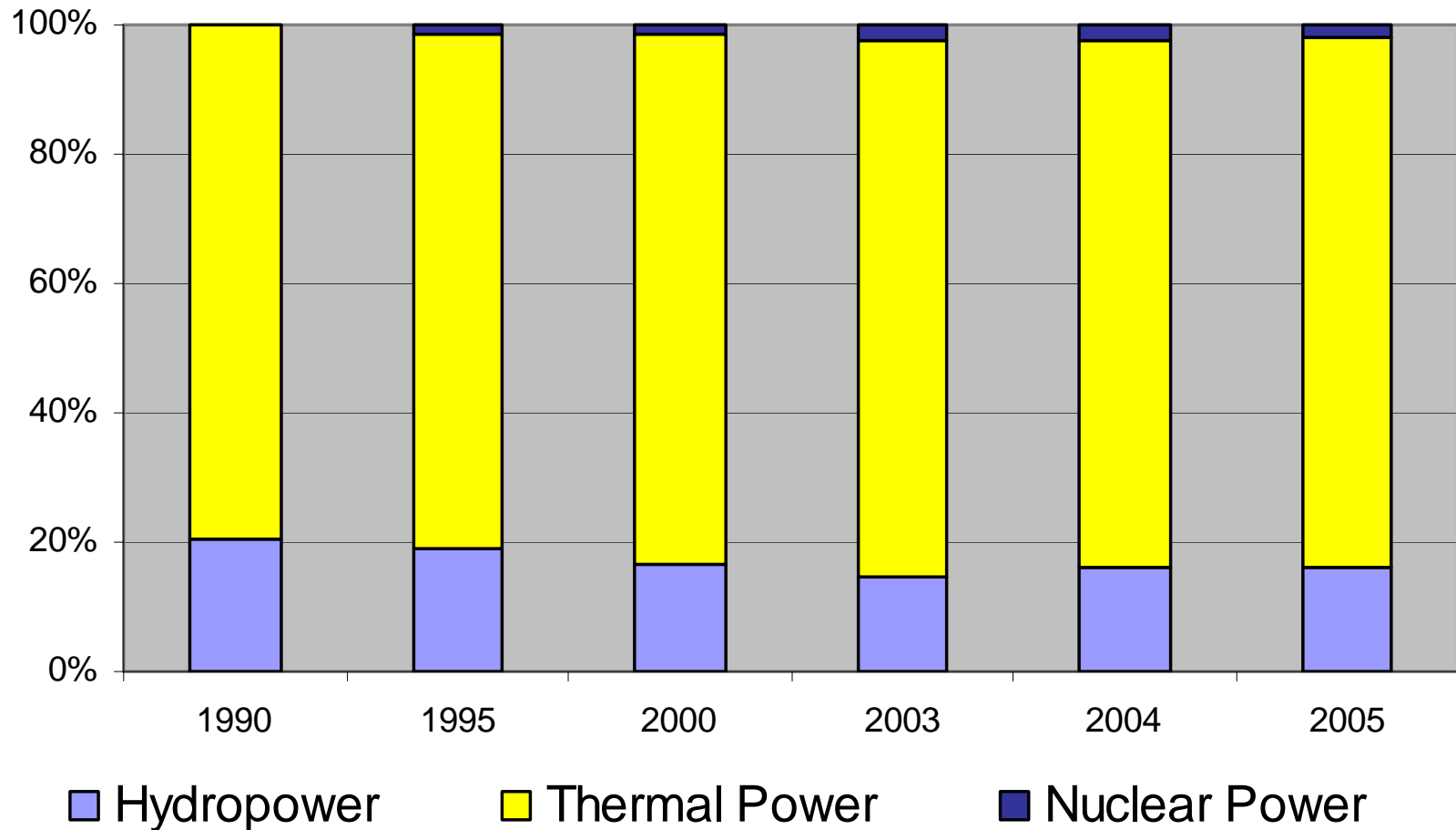


GDP = Gross Domestic Product, measured in thousand of 1995 yuan.

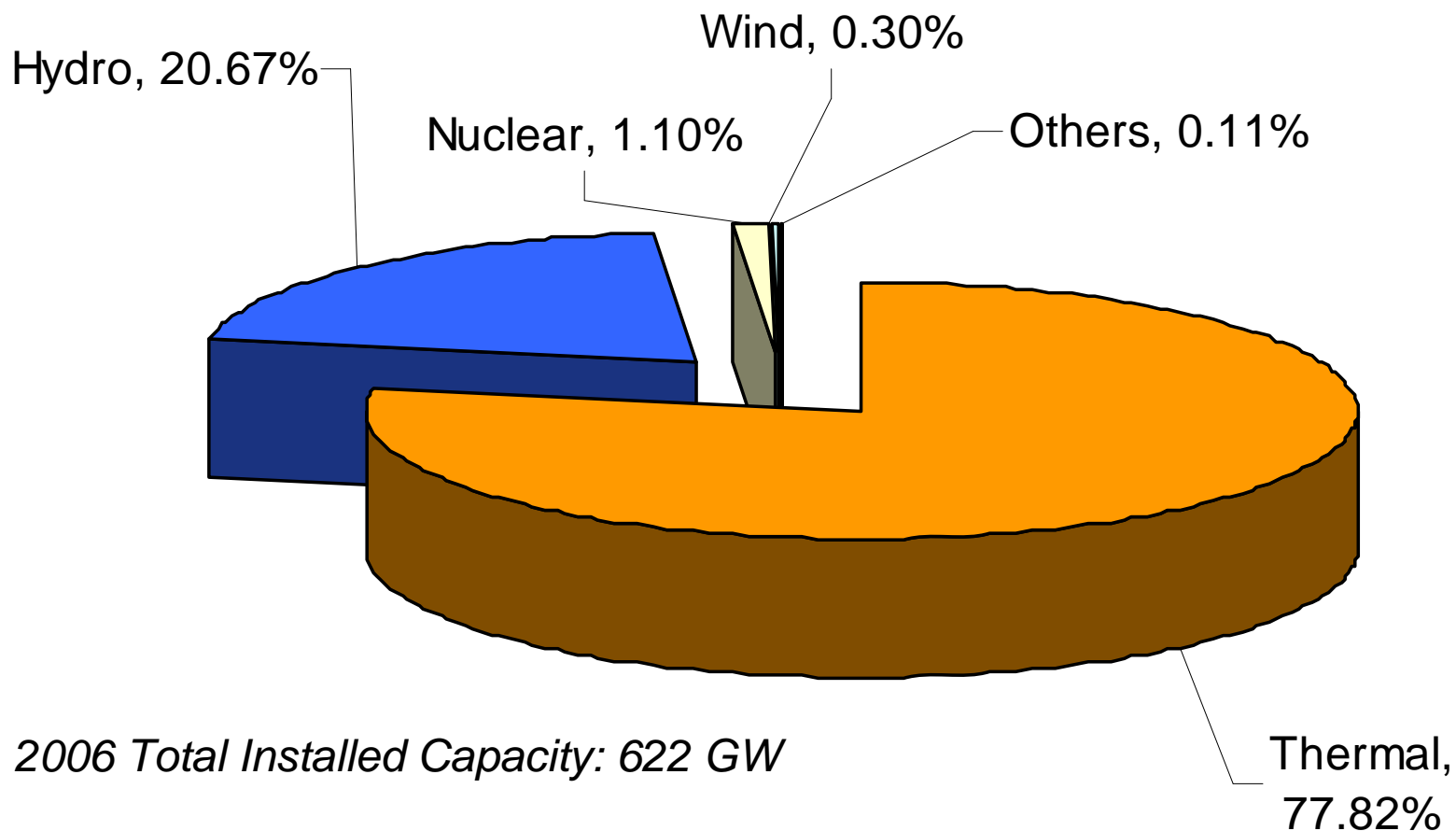
Source: *China Statistical Yearbook (1991-2005)*, *China Energy Statistical Yearbook (1991-2005)*

Multiregional Planning Team, MIT

CHINA ELECTRICITY PRODUCTION



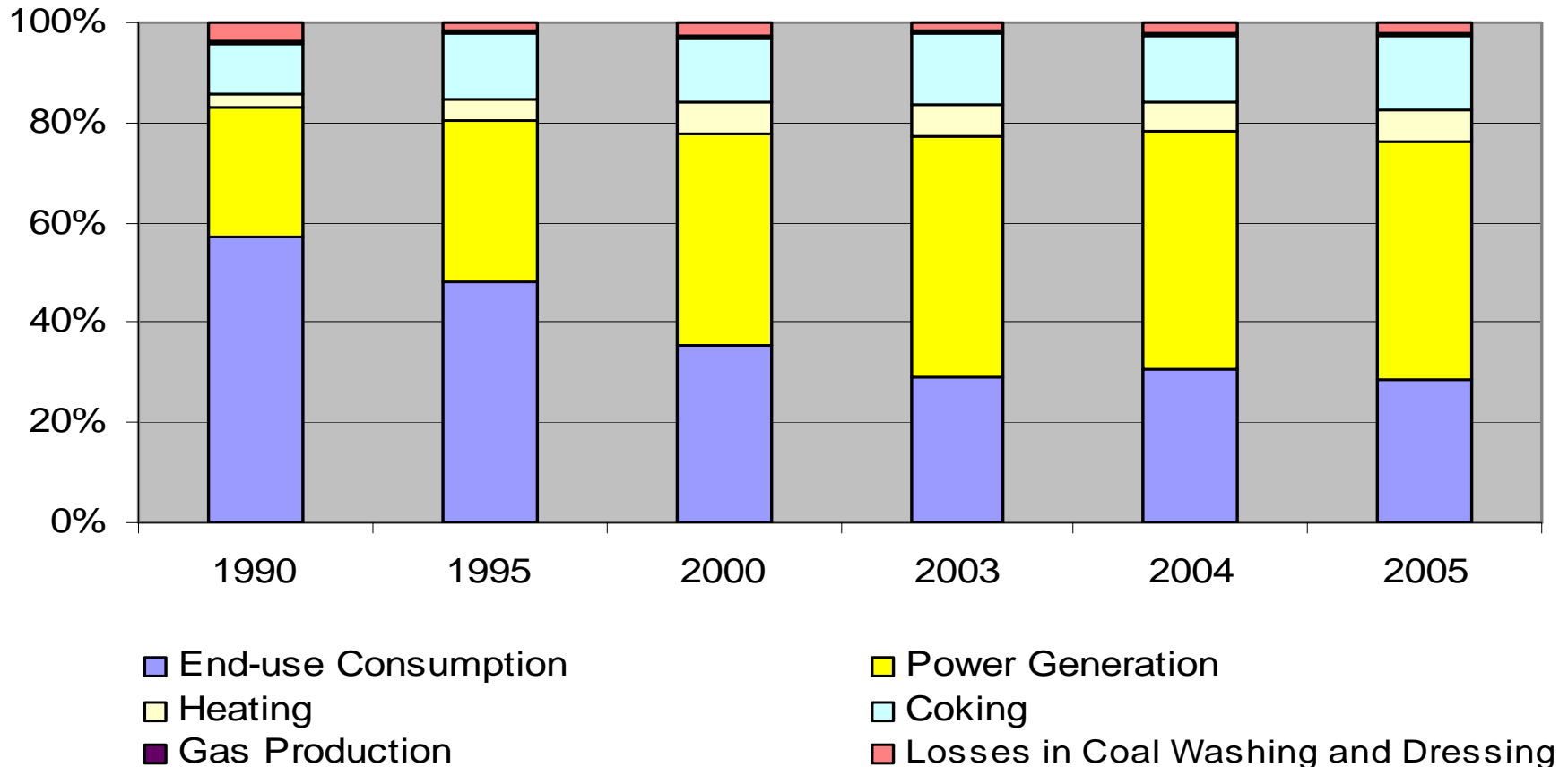
CHINA ELECTRICITY GENERATION, 2006



2006 Total Installed Capacity: 622 GW

Source: SERC Annual Report 2006

CHINA COAL CONSUMPTION



Source: China State Statistical Bureau, 2007

Year 2005: 2.17 billion tonnes

ELECTRICITY REGULATORY STRUCTURE

GENERATION	TRANSMISSION	DISTRIBUTION
Huaneng Group	State Grid	State Grid
Datang Group		
Huadian Group	China Southern Power Grid	China Southern Power Grid
Guodian Group		
Electricity Investment Group		
Electricity Engineering Consulting Group		
Hydro-electricity Engineering Consulting Group		
Gezhouba Group		

State Electricity Regulatory Commission

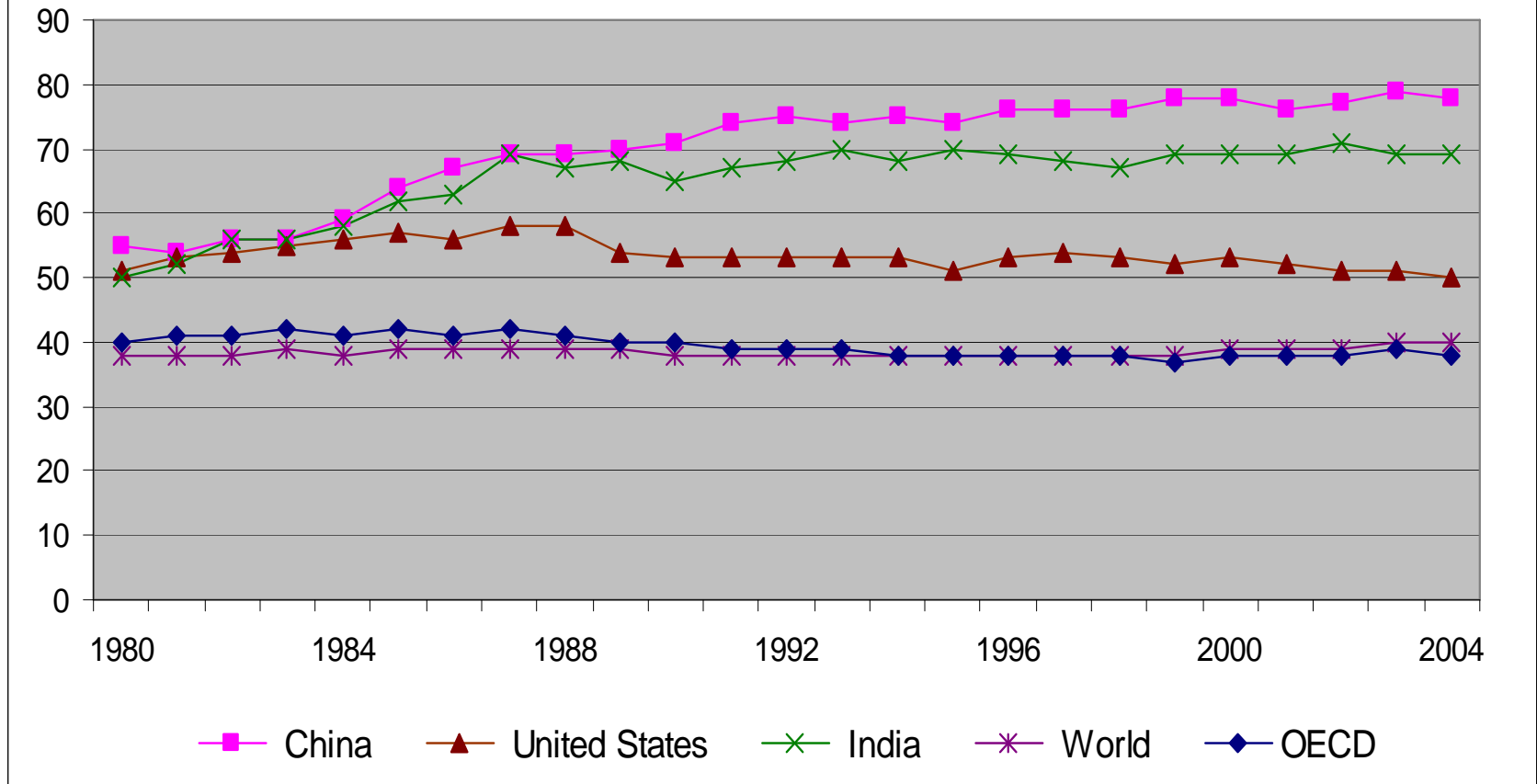
Figure by MIT OpenCourseWare.

OVERVIEW

- Coal is China's most important and abundant fuel, accounting for ~2/3rds of its primary energy supply;
- China's coal output rose from 1.3 billion tonnes in 2000 to 2.2 billion tonnes in 2005, making China the largest global coal producer;
- In 2005, electricity generation accounts for 69% of all coal consumption in China, while cokemaking accounts for 21%;
- Coal currently accounts for ~80% of China's electricity generation, more than 50% of industrial fuel utilization, and ~60% of chemical feedstocks;
- 45% of China's national railway capacity is devoted to the transport of coal.

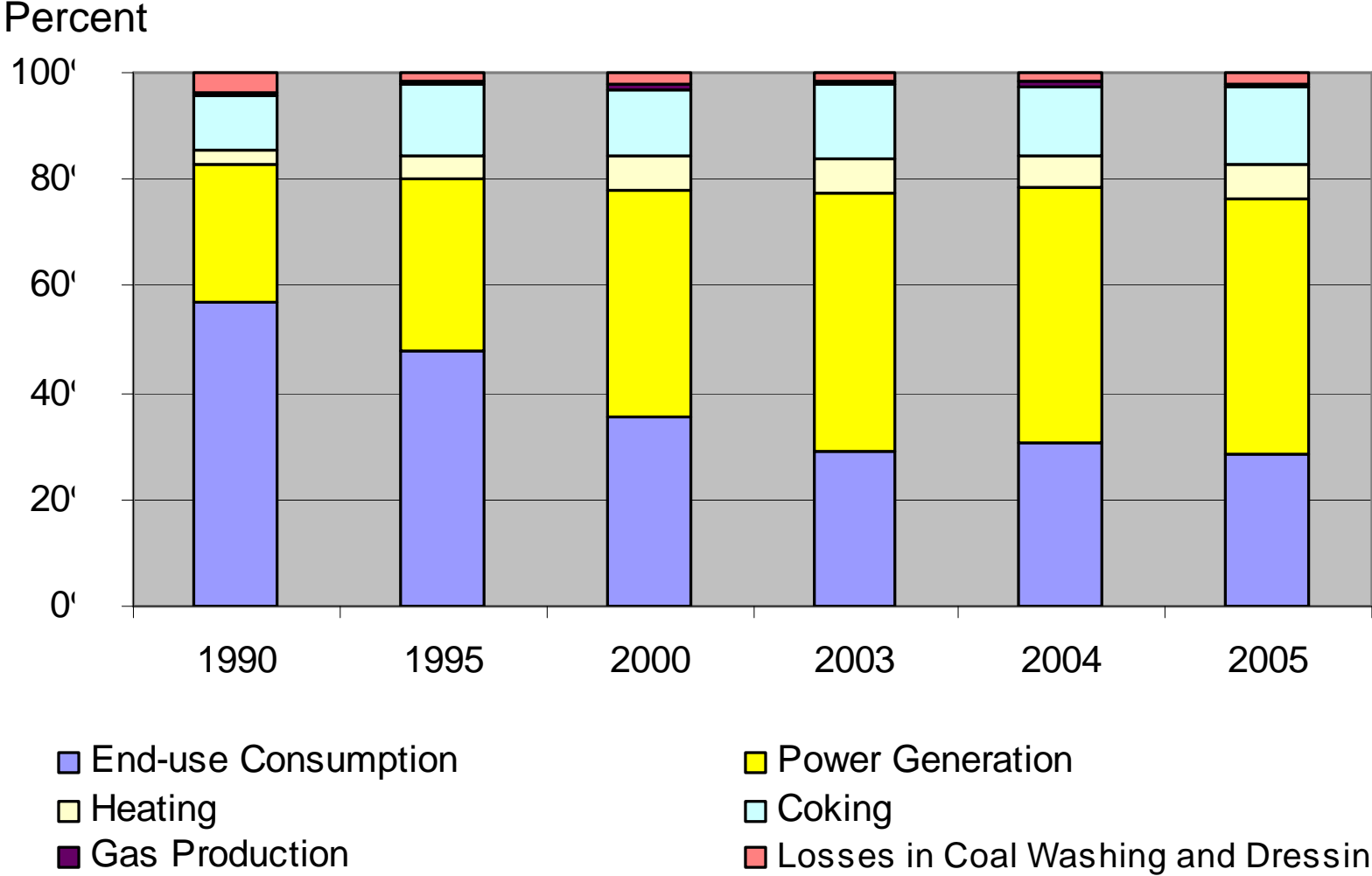
Source: MIT. 2007. *The Future of Coal, An Interdisciplinary MIT Study; China Energy Statistical Yearbook 2006*

WORLD ELECTRICITY PRODUCTION FROM COAL (percent)



Source: Calculated from World Development Indicator Database by the World Bank. URL:
<http://ddp-ext.worldbank.org/ext/DDPQQ/member.do?method=getMembers&userid=1&queryId=6>

CHINA COAL CONSUMPTION, 1990-2005



Source: China State Statistical Bureau, 2007

Year 2005: 2.17 billion tonnes

CHINA'S COAL RESOURCES

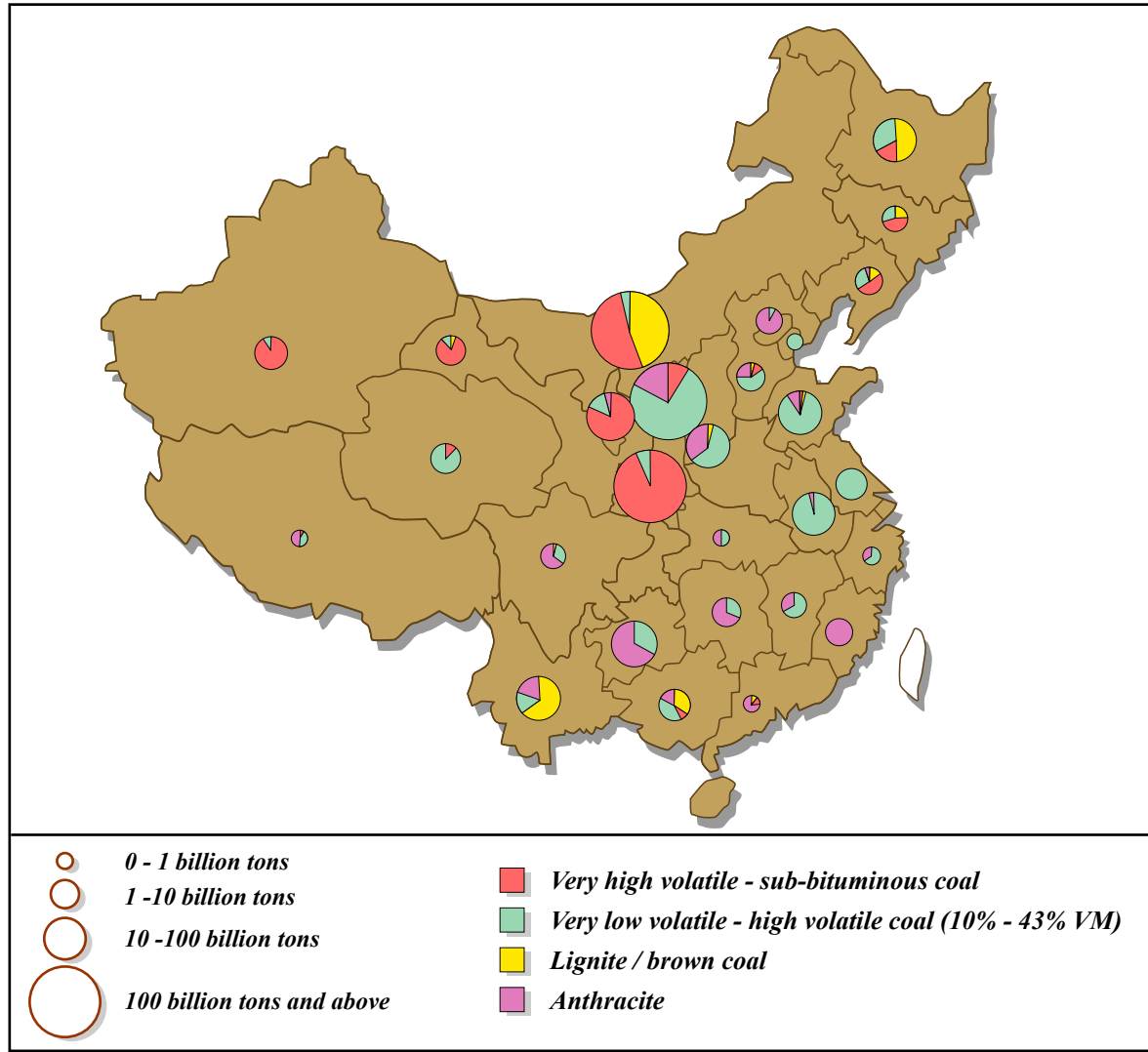


Figure by MIT OpenCourseWare.

Source: Beijing HL consulting (2006)

ESTIMATED COAL RESERVES IN CHINA

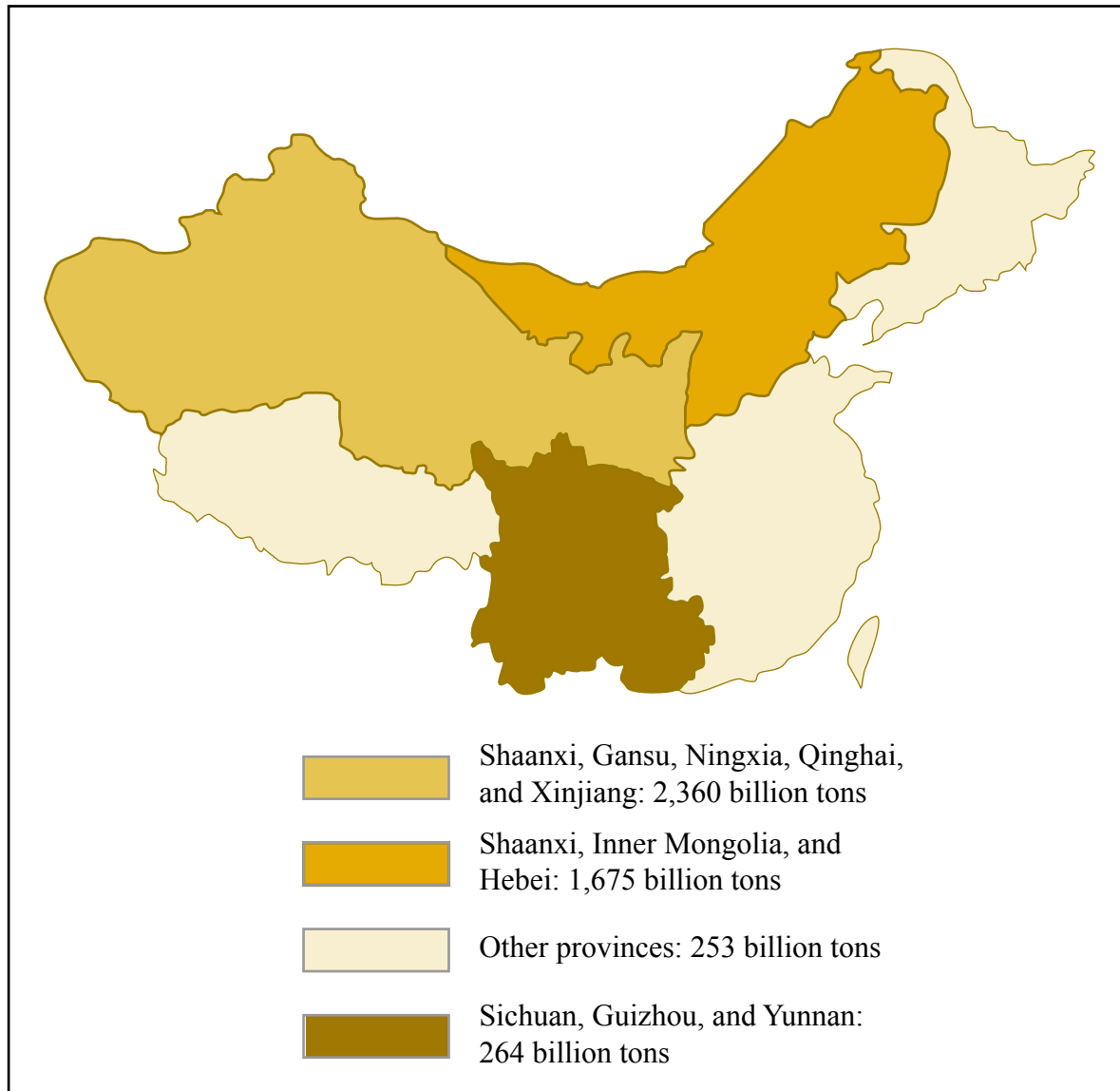


Figure by MIT OpenCourseWare, adapted from Kexi Pan, Fudan University.

POWER PLANTS CARBON INTENSITY IN CHINA, 2007



SPATIAL IMBALANCE COAL AND ELECTRICITY

Regions	Projected coal reserves		Number of power plants		Annual electricity produced, 2007, (TWH)	
	(billion tonnes)	%		%		%
Shanxi, Inner Mongolia, Hebei	1675	37	105	10	276	12
Sichuan, Guizhou, Yunnan	264	6	162	15	249	11
Xinjiang, Gansu, Shaanxi, Ningxia, Qinghai	2360	52	84	8	172	7
Other provinces	253	6	705	67	1595	70
Total	4552	100	1056	100	2292	100

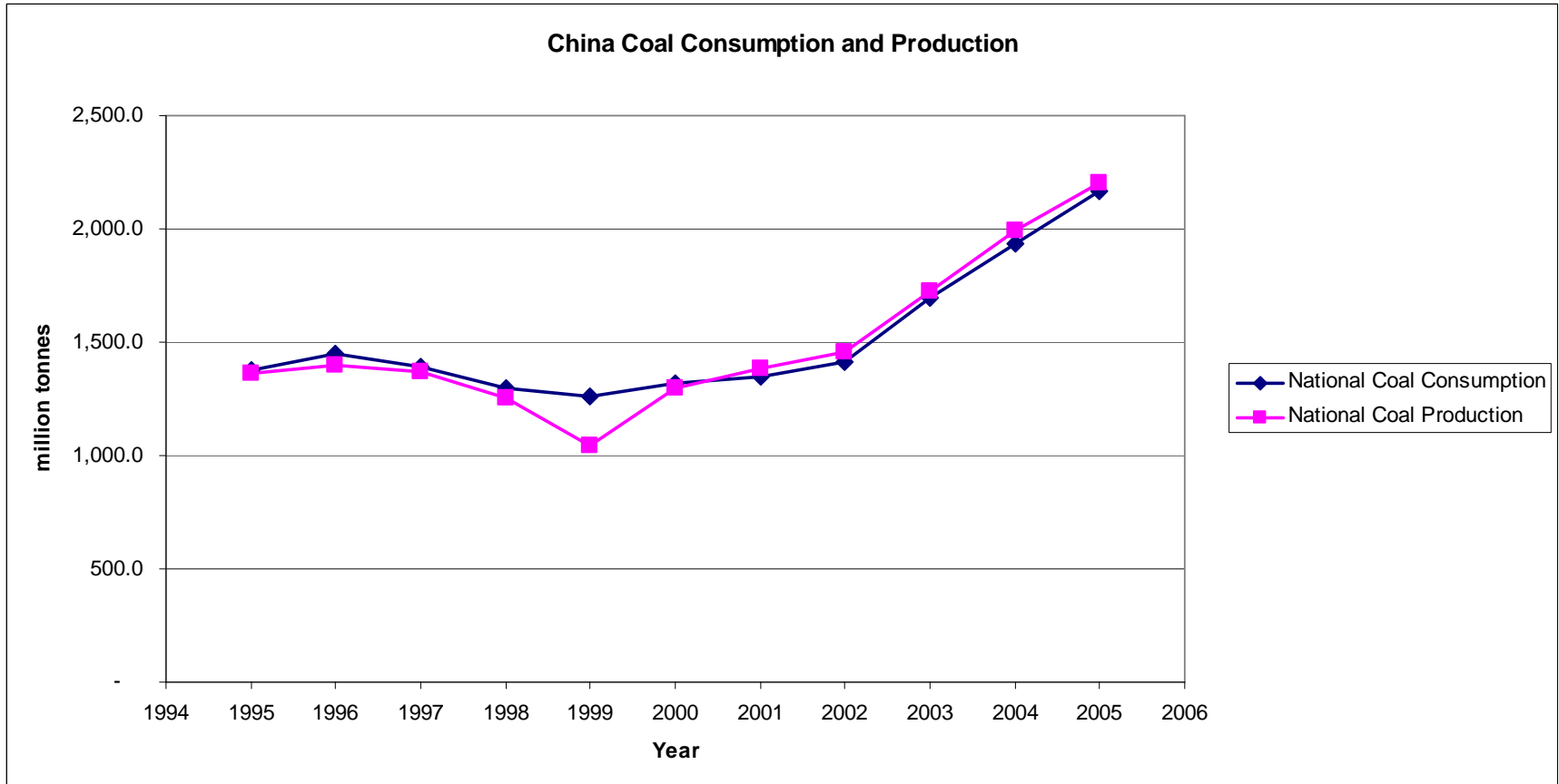
Note: Based on 1056 power plants with geographic coordinates; TWH=Trillion Watt-hour
Multiregional Planning Team, MIT

ENERGY CONSUMPTION BY TYPE IN CHINA, 1978-2005

Year	Energy Consumption (million tonnes SCE)	Percentage of Total Energy Consumption				
		Coal	Crude Oil	Natural Gas	Hydro	Total
1978	571	70.7	22.7	3.2	3.4	100.0
1980	603	72.2	20.7	3.1	4.0	100.0
1985	767	75.8	17.1	2.2	4.9	100.0
1990	987	76.2	16.6	2.1	5.1	100.0
1995	1,312	74.6	17.5	1.8	6.1	100.0
2000	1,386	67.8	23.2	2.4	6.7	100.0
2005	2,233	68.9	21.0	2.9	7.2	100.0

SCE: Standard Coal Equivalent. Source: *China Statistical Yearbook, 2006*.

CHINA COAL CONSUMPTION AND PRODUCTION, 1995-2005



Source: author; *China Energy Statistical Yearbook 1997-1999, 2000-2002, 2006*

The 1999 dip of production results from closing of almost 26,000 Chinese coal mines that year, according to the *Asian Economic News*.

COAL CONSUMPTION AND PRODUCTION BY PROVINCE (2005)

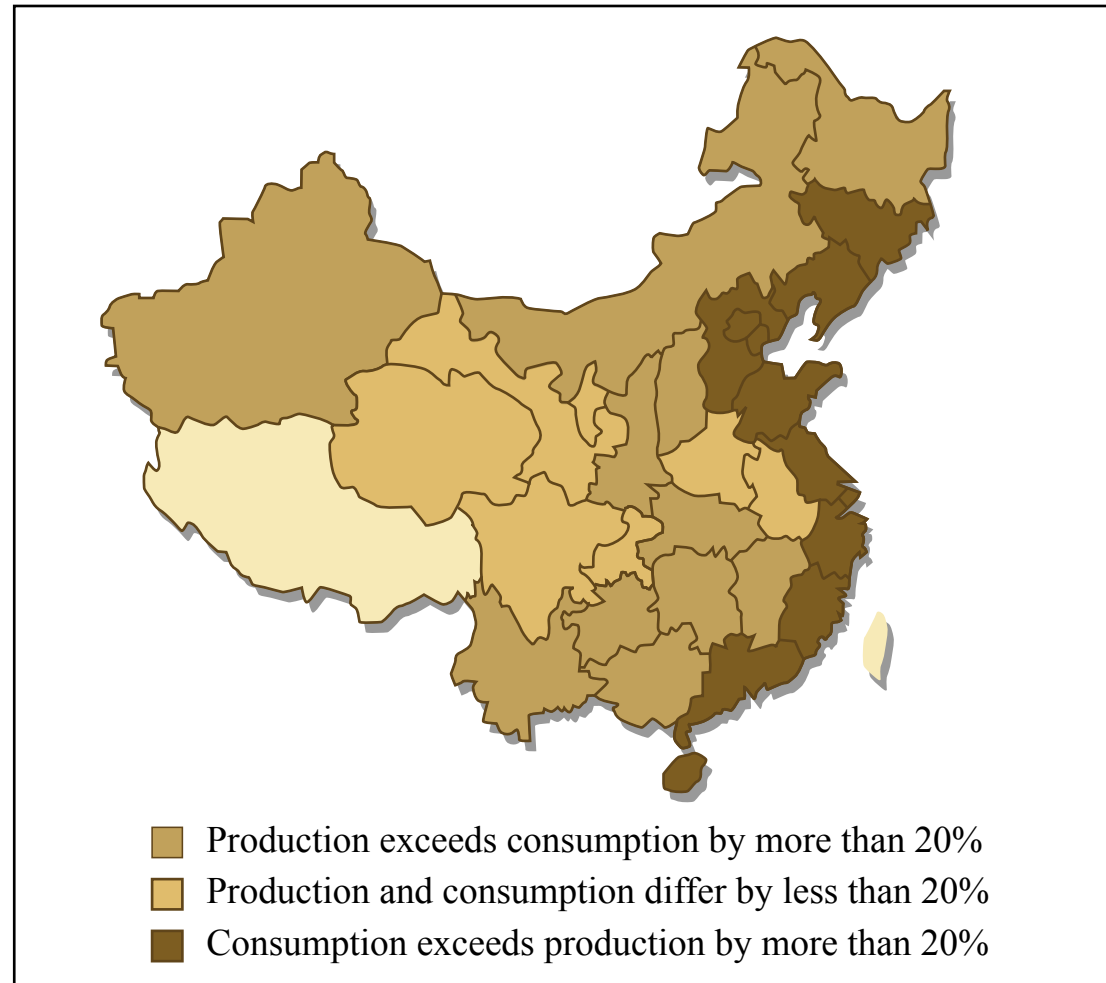
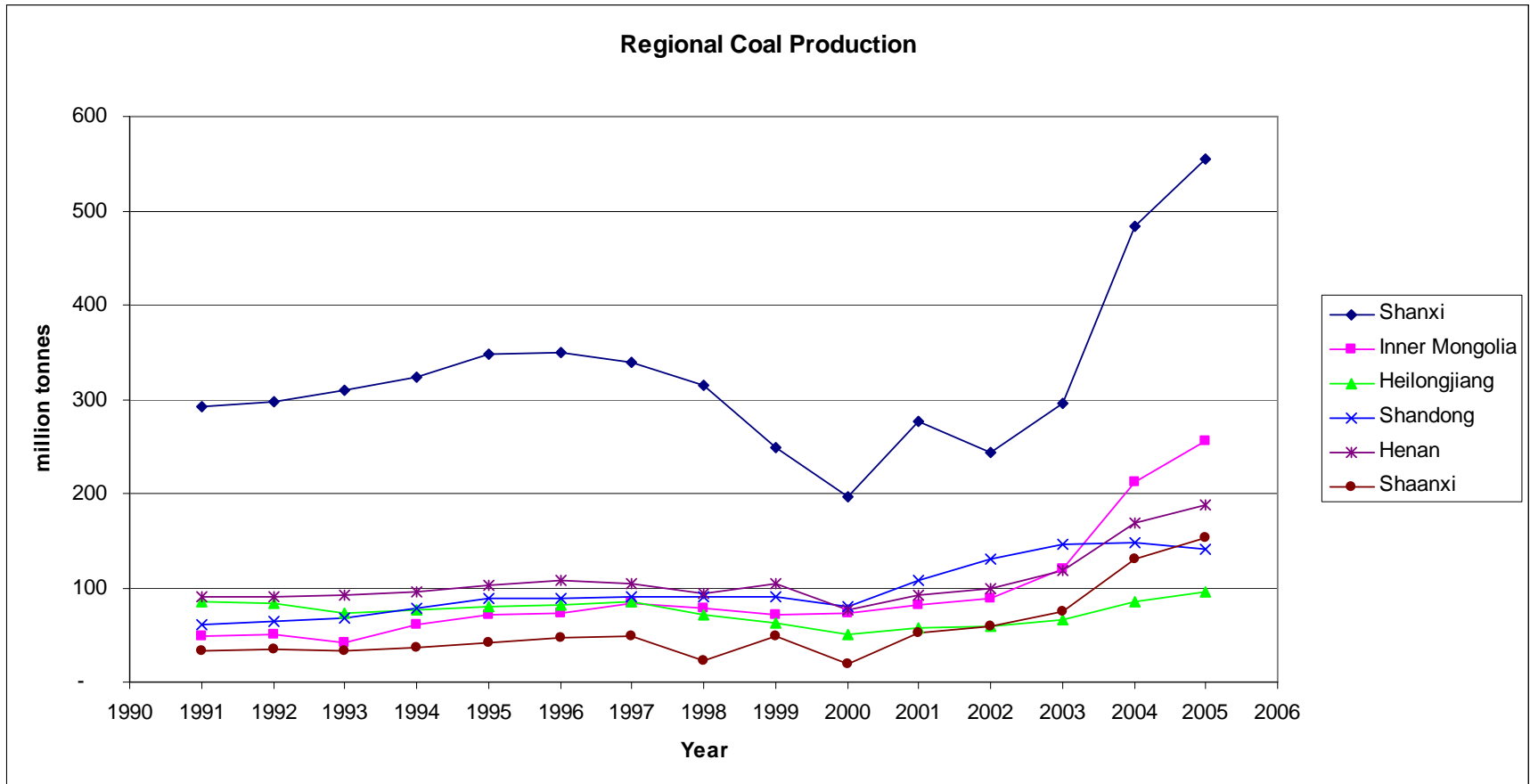


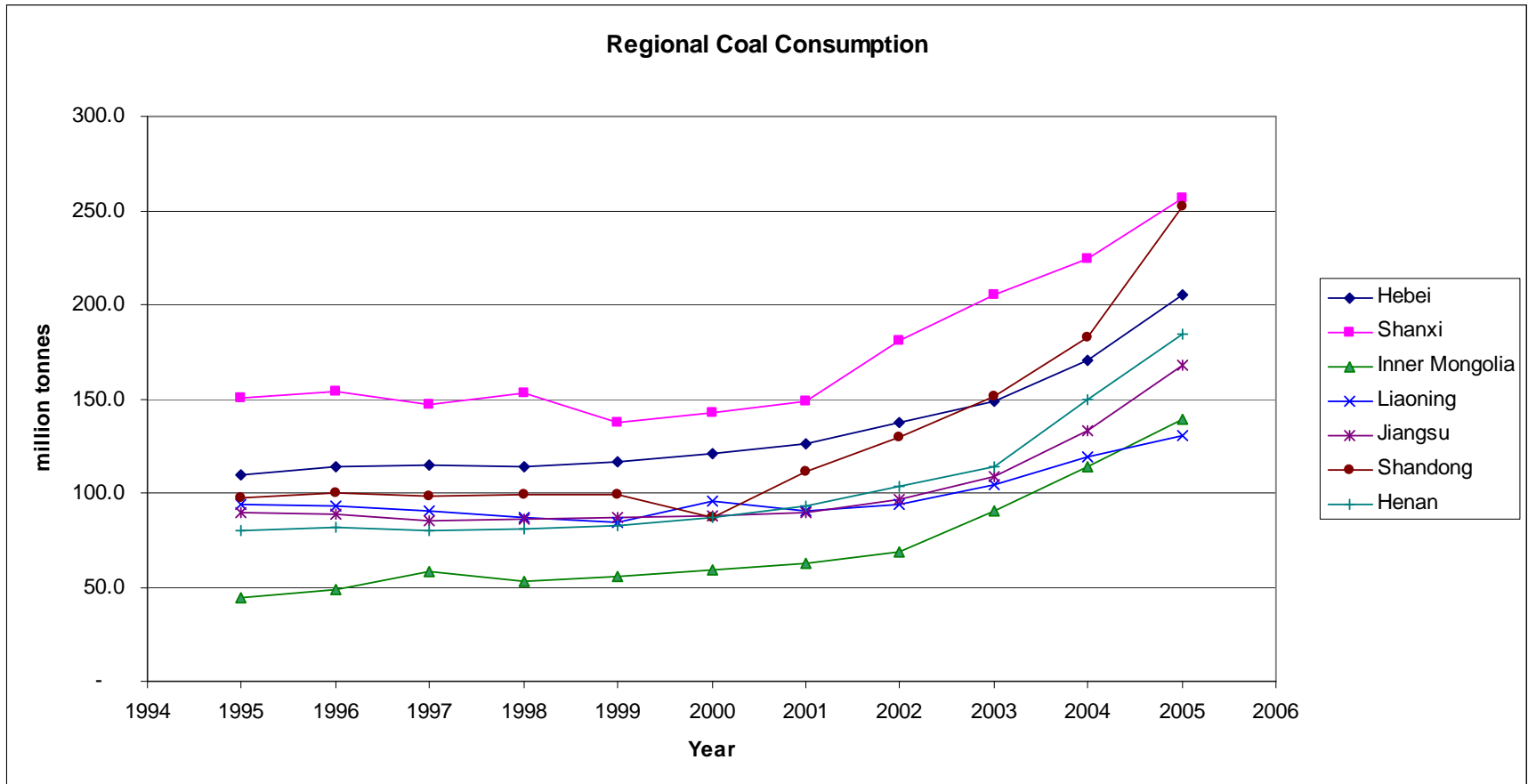
Figure by MIT OpenCourseWare.

REGIONAL COAL PRODUCTION, 1991-2005



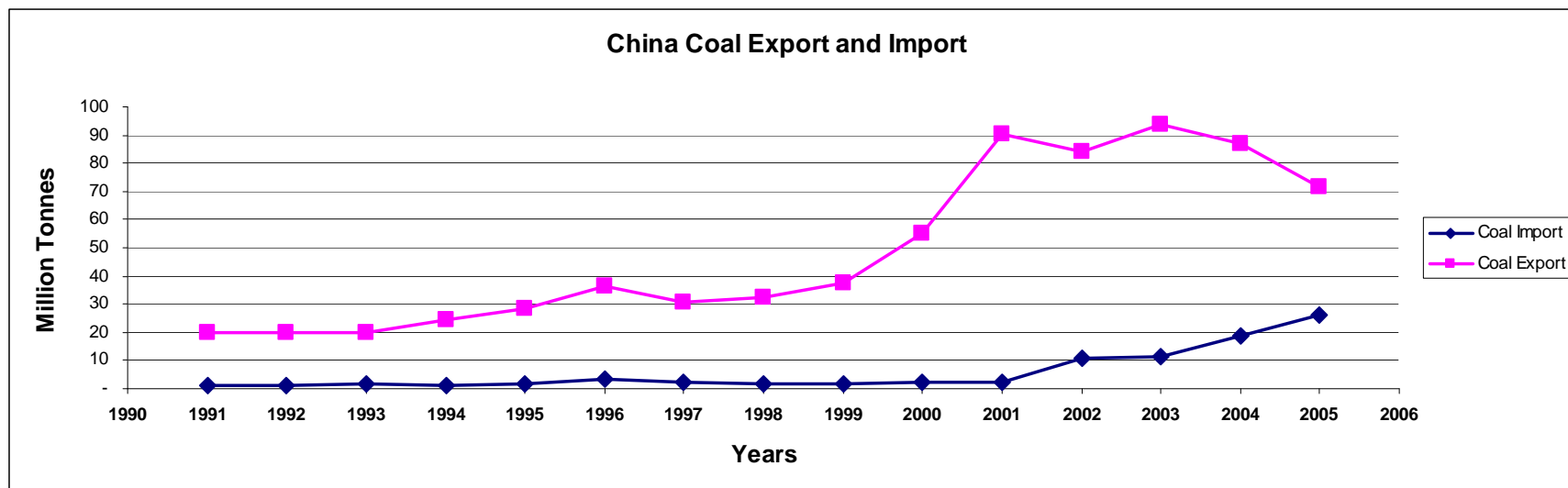
Source: Author; *China Energy Statistical Yearbook 1991-1996, 1997-1999, 2005, 2006*

REGIONAL COAL CONSUMPTION, 1995-2005









Source: author; China Energy Statistical Yearbook 1997-1999, 2000-2002, 2006

CHINA COAL IMPORTS AND EXPORTS, 1991-2005 (I)



Source: Authors; *China Energy Statistical Yearbook 1991-1996, 1997-1999, 2005, 2006*

COAL CONSUMPTION AND GDP WORLD, USA, AND CHINA, 1980-2004

	Coal Consumption <i>Millions of metric tonnes carbon equivalent</i>			Gross Domestic Product <i>Billions of 2000 US dollars</i>		
Year	 China	 USA	 World	 China	 USA	 World
1980	760	775	4,561	183	5,128	17,623
1985	1,004	902	5,388	305	6,011	20,041
1990	1,239	997	5,808	445	7,055	23,956
1995	1,648	1,061	5,638	793	7,973	26,926
2000	1,414	1,195	5,622	1,199	9,765	31,775
2004	2,273	1,221	6,723	1,715	10,764	35,162

DIFFERING PATTERNS OF COAL USE

Coal-Use Projections and Average Rate of Increase (2002-2030)

	2003	2010	2015	2020	2025	2030	AVERAGE % Increase
United States							
Total (Quadrillion Btu)	22.4	25.1	25.7	27.6	30.9	34.5	1.6
% Electric	90	91	91	91	91	89	1.6
China							
Total (Quadrillion Btu)	29.5	48.8	56.6	67.9	77.8	89.4	4.2
% Electric	55	55	57	55	56	56	4.2

Source: MIT. 2007. *The Future of Coal, An Interdisciplinary MIT Study*

ECONOMIC SECTORS RANKED BY COAL INTENSITY, 2000

Rank	Sector Name	Energy Intensity		Consumption Share	
		Coal per tonne of output	Coke per tonne of output	Coal	Coke
1	Production and supply of electric power steam and hot water	37.182	0.024	45.0%	0.4%
2	Coking, gas and petroleum refining	6.096	0.050	6.2	0.6
3	Mining and Quarrying	3.532	0.066	6.5	1.5
4	Building materials and non-metal mineral products	2.817	0.084	8.0	2.9
5	Metal products	2.453	1.575	10.1	77.1
6	Chemical industry	1.502	0.175	7.5	10.4
7	Services	0.598	0.012	7.6	1.8
8	Foodstuff	0.546	0.007	2.1	0.3
9	Others	0.527	0.008	1.7	0.3
10	Transportation, post, and telecommunications	0.371	0.004	0.9	0.1
11	Textile, sewing, leather and furs products	0.293	0.001	1.4	0.1
12	Agriculture	0.180	0.016	1.3	1.4
13	Machinery and equipment	0.159	0.032	1.3	3.0
14	Construction	0.076	0.003	0.4	0.2
	Total			100%	100%

REGIONAL OVERVIEW

CASE OF SHANXI PROVINCE



Image source: http://en.wikipedia.org/wiki/File:China_Shanxi.svg.

- **Shanxi** Province is the largest coal- and coke-producing region in China.
- In 2005, **Shanxi** Province produced 80 million metric tonnes of coke, accounting for about 31% of China's total coke output versus 45% in 1998.
- Of the total 2005 coal consumption of 226.3 million tonnes in **Shanxi**, over 50% was used for cokemaking and only about 30% for electricity generation.
- In 2005, **Shanxi** Province exported 5.96 million metric tonnes of coke, accounting for 47% of China's total 12.76 million tonnes of coke exports.

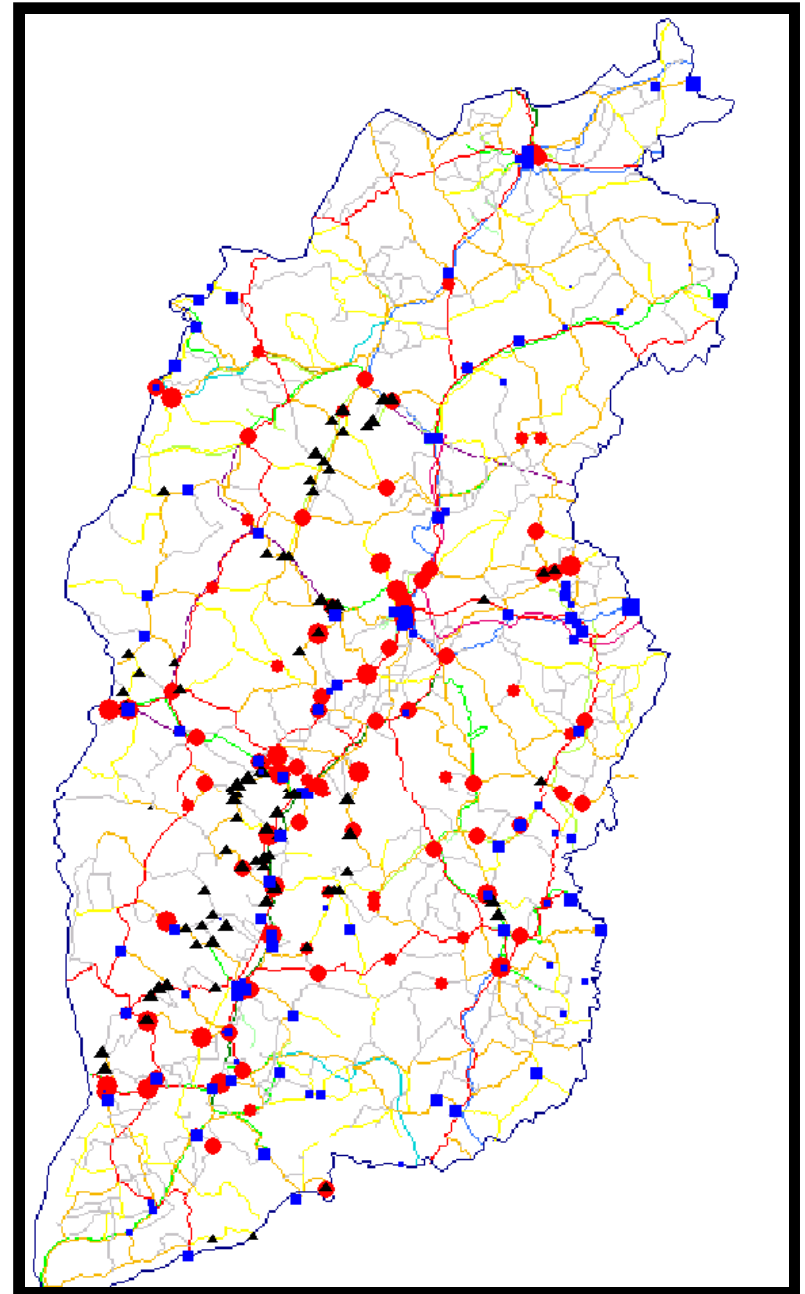
Source: China Energy Statistical Yearbook 2006, Shanxi Statistical Yearbook 2006, book "TEEH Chain in China", Springer, 2006

Coal Mine, Coke-Plant, and Consumer Data

from Shanxi Energy Atlas (1990)

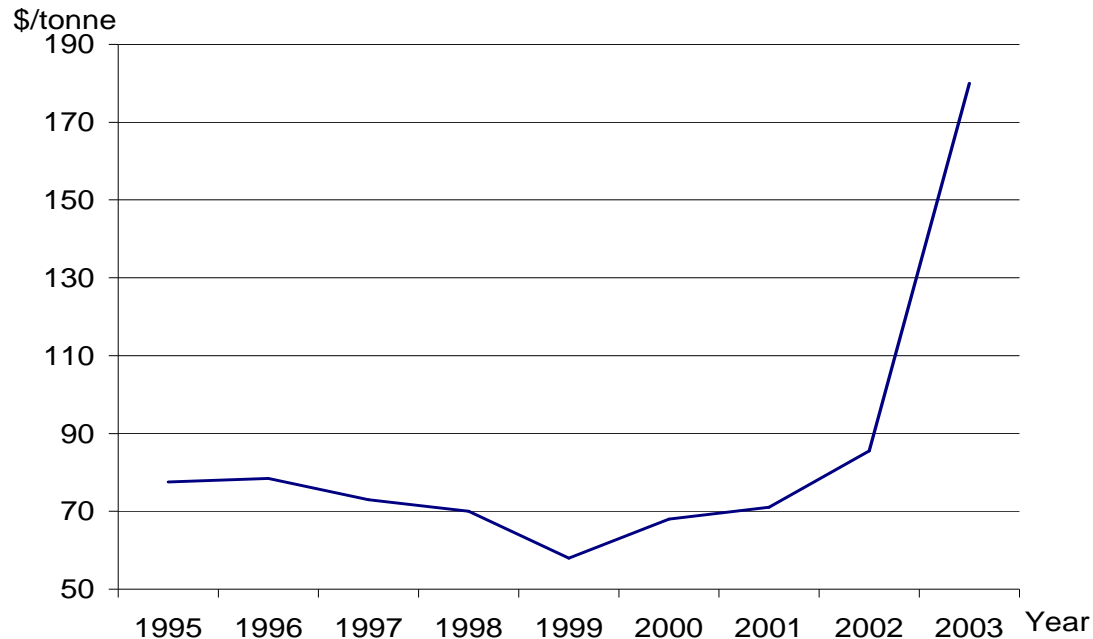
- ▲ Coal Mine
- Cokemaking Plant
- Consumer
(iron and steel plants,
chemical plants, etc.)

Source: Chen Yan's Master's Thesis, MIT 2003



COKE PRICES

China's Coke Prices in World Market, 1995-2003



Source: Patrick Cleary, CRU International, Met Coke World Summit 2003

The future price trend of Chinese coke partially depends on the speed at which the government closes production capacity as well as the iron and steel output growth rates. As of January 1, 2008, the coke export tax was raised to 25% from 15% in China, according to Platts, making the international spot price of Chinese coke with 12.5% ash estimated at about \$400/mt FOB. As of March 2008, the spot price for thermal coal was \$130/tonne and for coking coal was \$330/tonne, according to Peter Freyberg, CEO of Xstrata's coal unit.

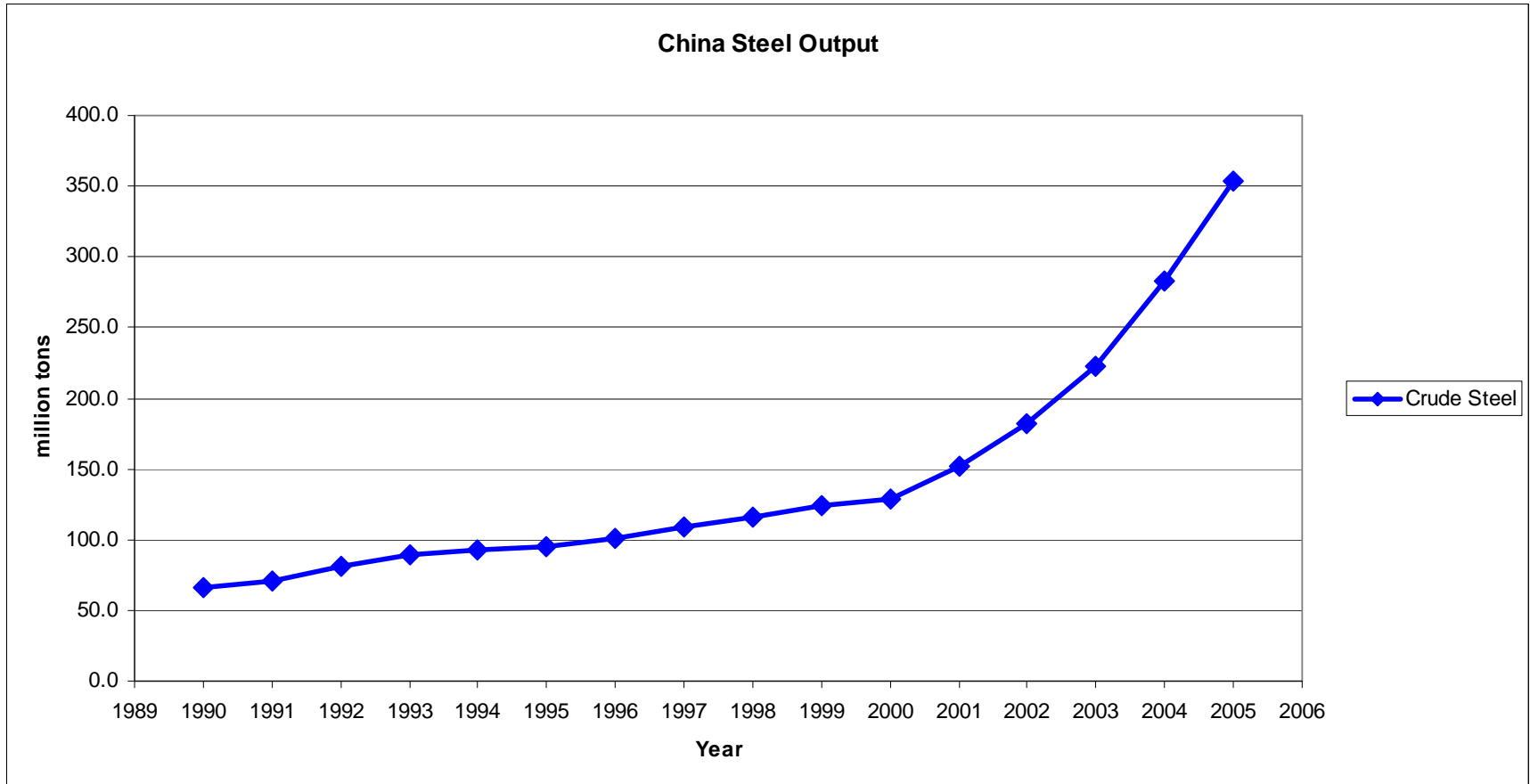
TECHNOLOGY CHANGE IN SHANXI PROVINCE

In 1998, Shanxi Province had 1,872 coke plants; by 2003, they had only 589 plants, with indigenous, modified indigenous, and small machinery ovens being replaced by modern, large-machinery, as well as “clean” coke ovens.

Despite the closure of ~1,200 coke plants in Shanxi Province, during 1998 to 2003, coke production increased from 57 to 68 million tonnes.

Compared with the coke ovens used prior to 1995, the latest ovens possess considerably larger output capacity and are more energy, labor, and environmentally efficient.

CHINA STEEL PRODUCTION



Source: author; *China Statistical Yearbook 2006*

Investment-Policy Implications for China

- To improve energy efficiency, the government should invest in energy-efficient technologies in coal- and coke-intensive sectors.
- Similarly, private companies and research agencies should be encouraged to invest in such technologies.
- If our forecasts are correct, the Chinese government may need to consider the possible coal shortage when investing in coal-consuming industries. For coke-consuming industries, investment in steelmaking and automaking would further increase domestic coke demand and push the domestic and international coke prices higher.

TEEH CHAIN IN CHINA

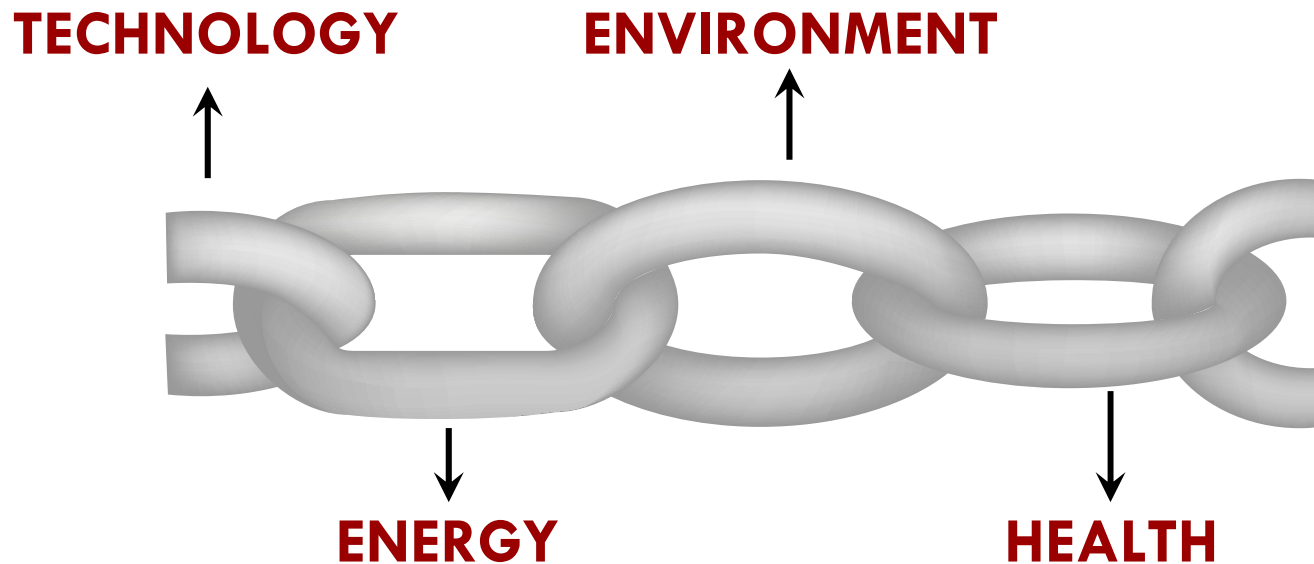


Figure by MIT OpenCourseWare.

The Technology-Energy-Environment-Health Chain in China: a Case Study of Cokemaking in Shanxi Province, edited by Karen R. Polenske. 2006. Springer Publishers (in English) Higher Education Press (in Chinese)

技术-能源-环境-健康链在中国——一个炼焦业的实证研究，2006年，高等教育出版社