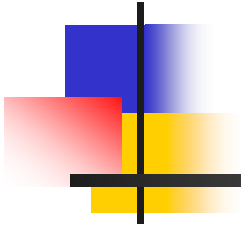


Electric Power Industry in China

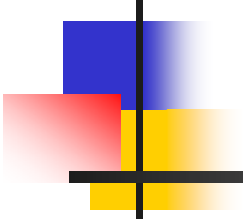


Hui Ren

University of Wisconsin-Madison

North China Electric Power
University

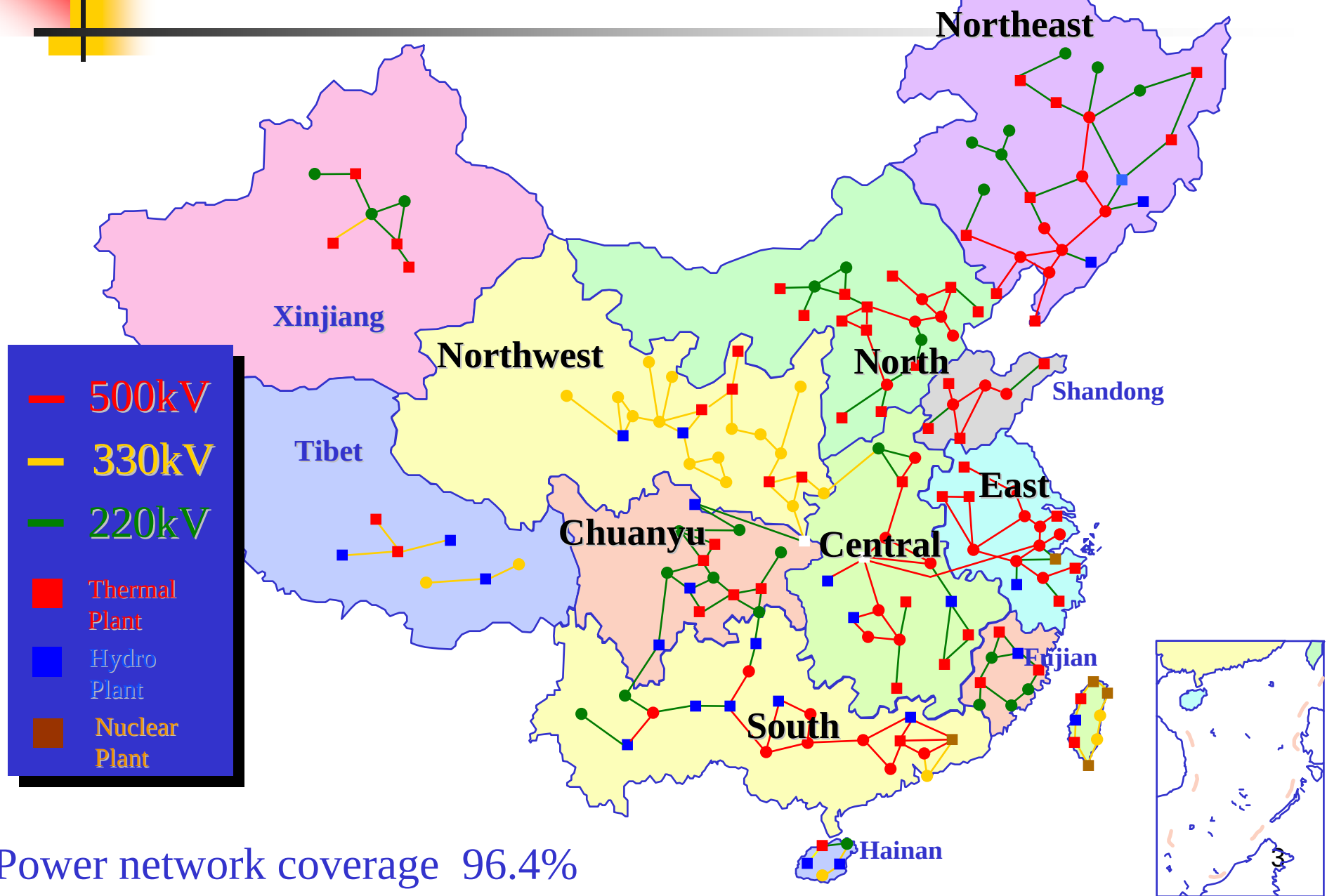
PSERC Tele-Seminar, Feb. 6, 2007



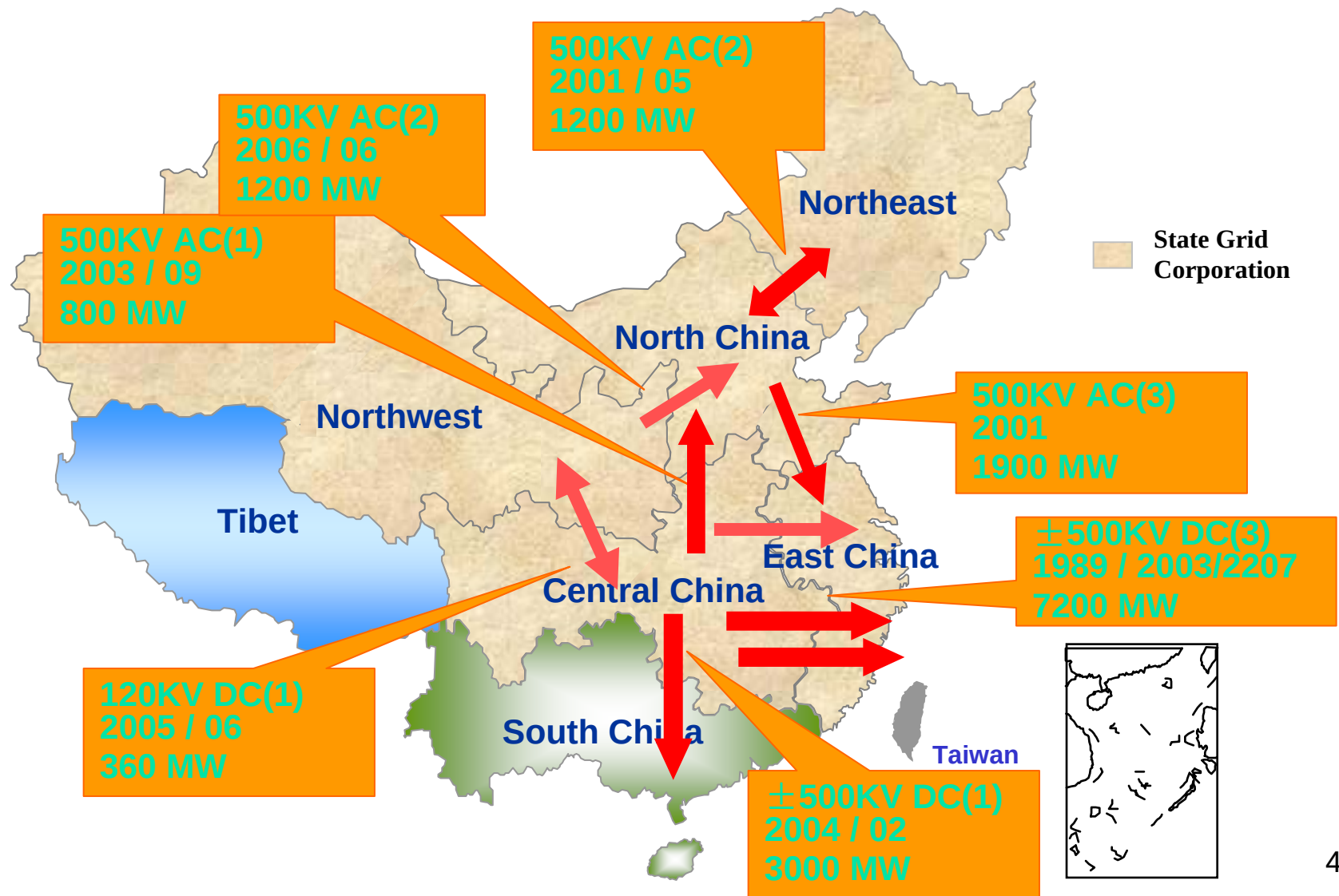
Contents

- Power network in China
- Power supply and demand
- Causes of 2002-2005 power shortage
- Future power development plan and challenges
- Power industry reform

Power network in China



Grid interconnection



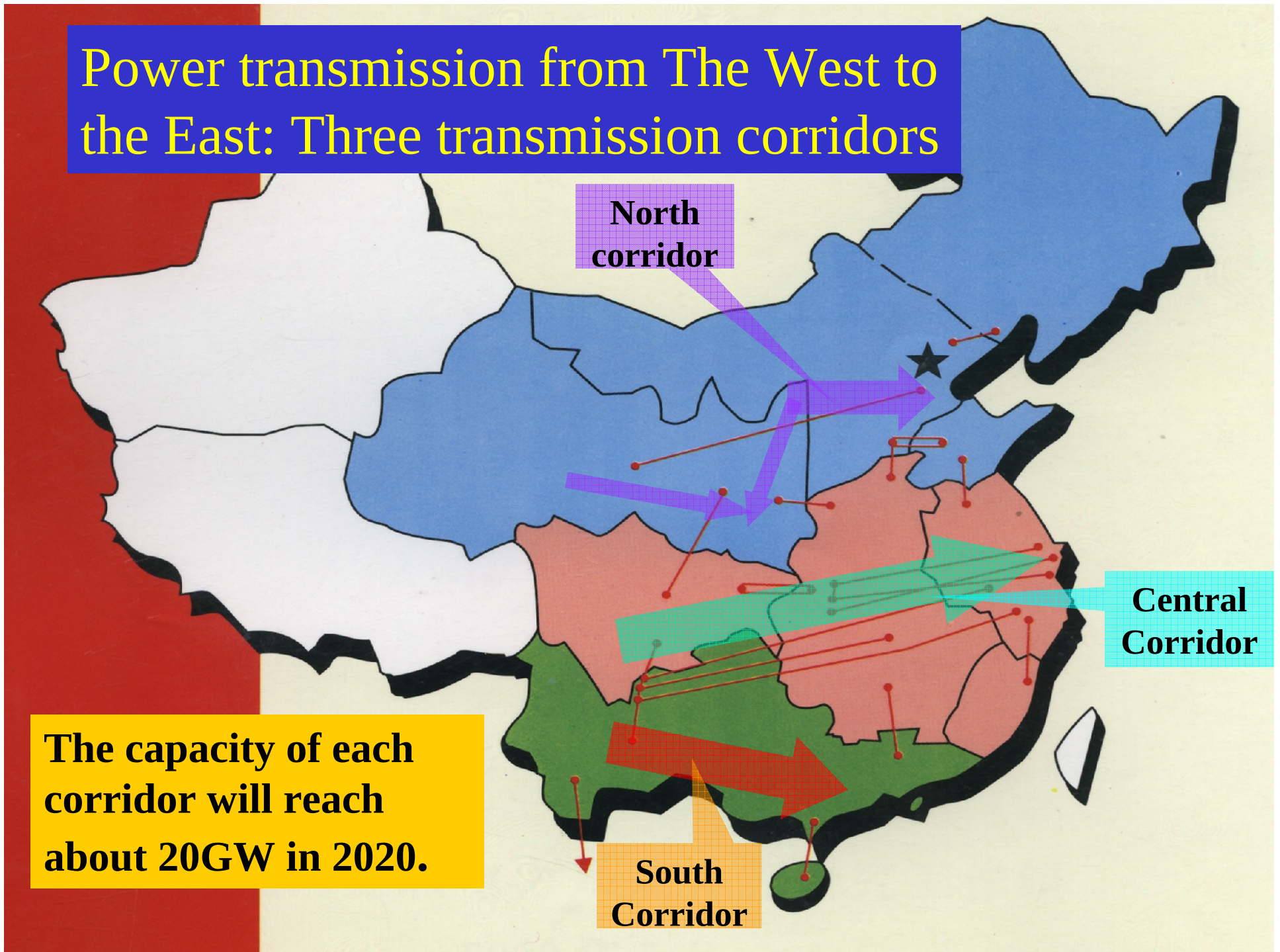
Power transmission from The West to the East: Three transmission corridors

North
corridor

Central
Corridor

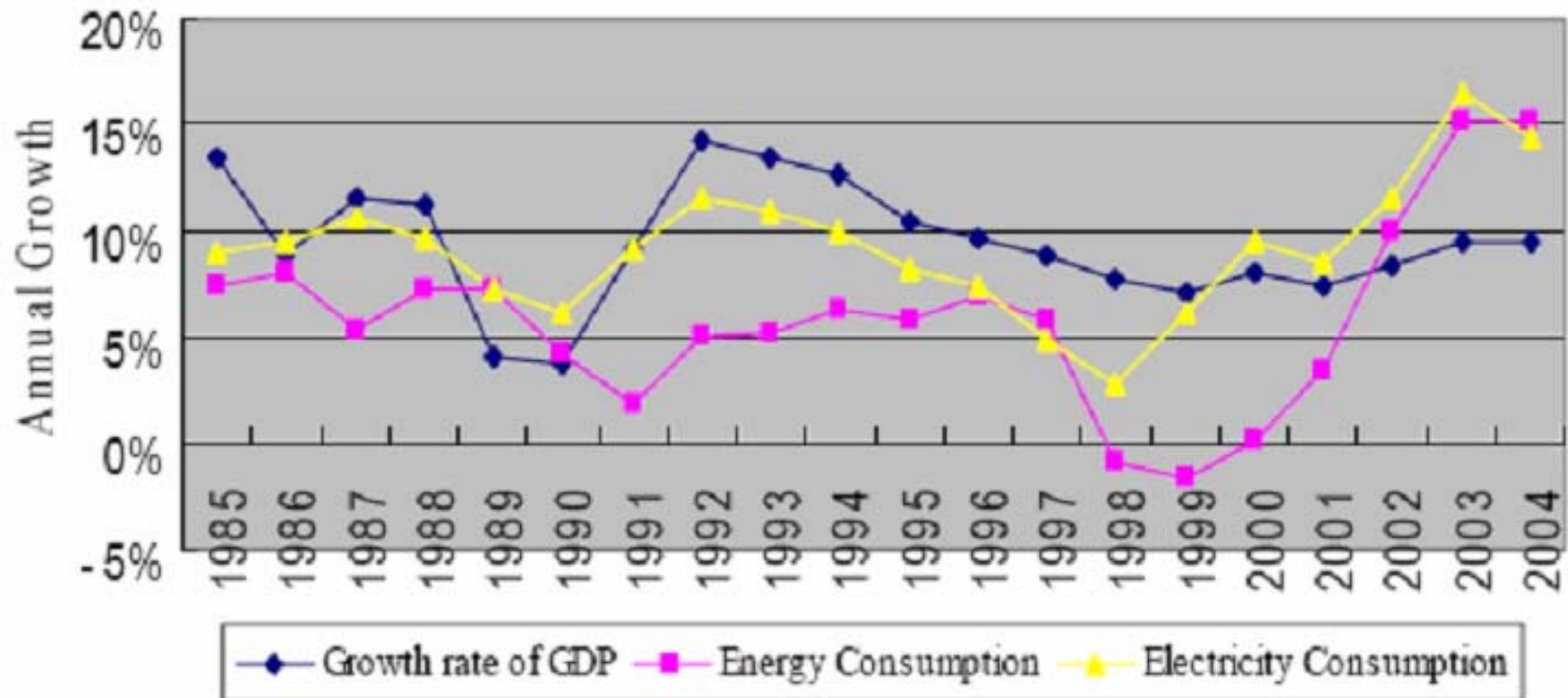
South
Corridor

The capacity of each
corridor will reach
about 20GW in 2020.



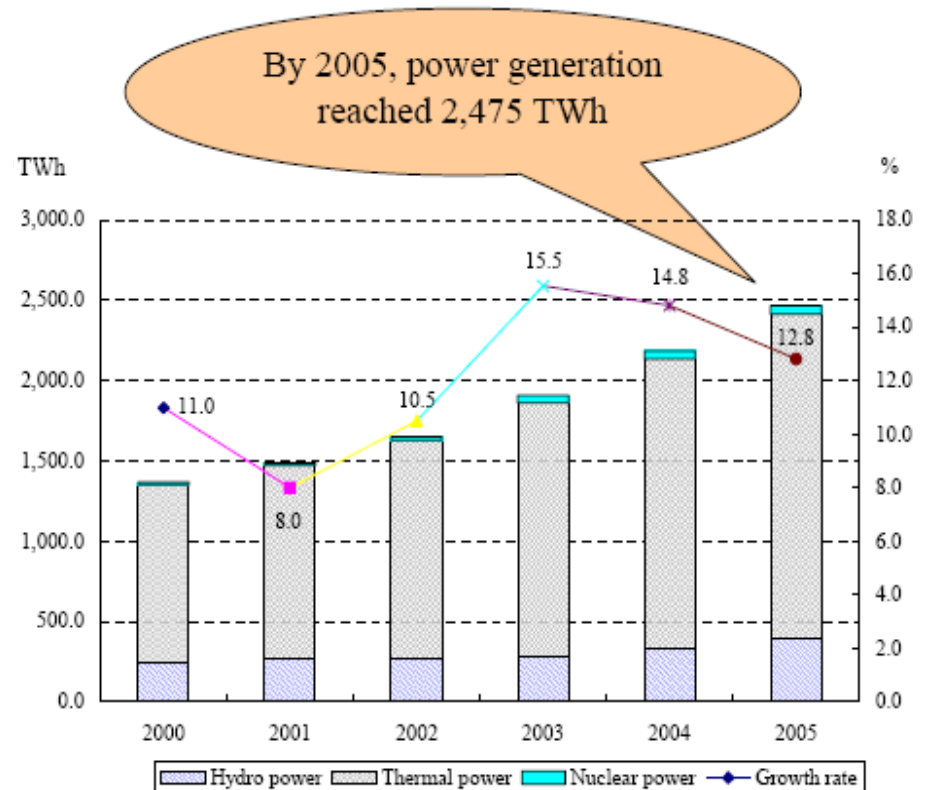
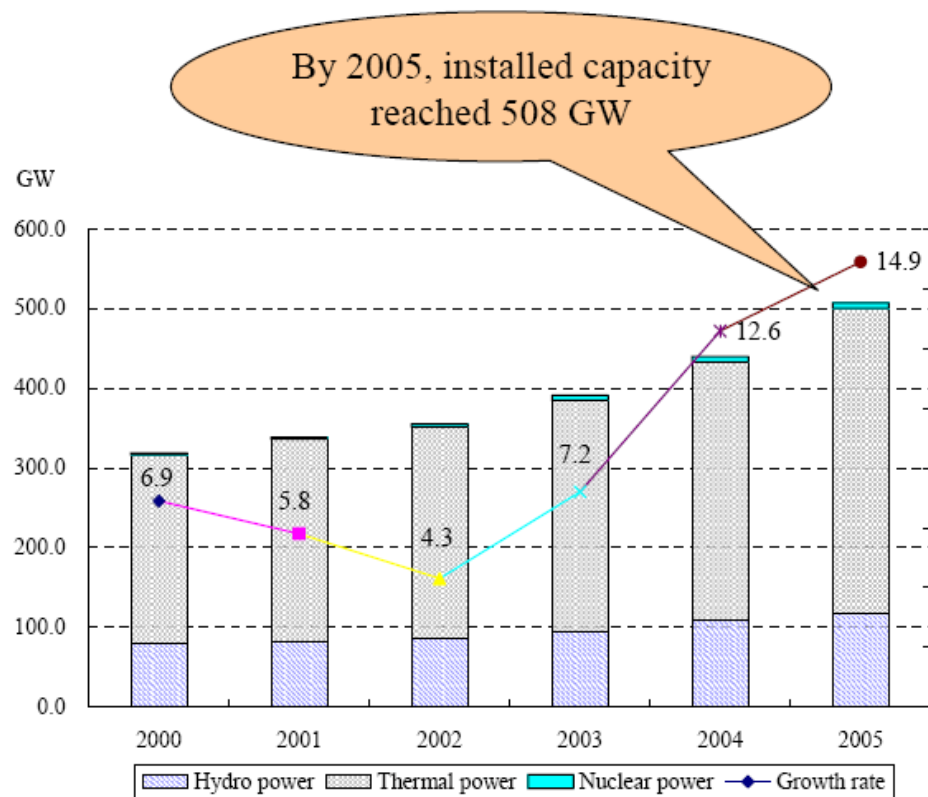
Power supply and demand

Growth of GDP, energy and electricity use



Power supply and demand

- China's installed capacity and power generation output are second largest in the world's electricity industry following the United States



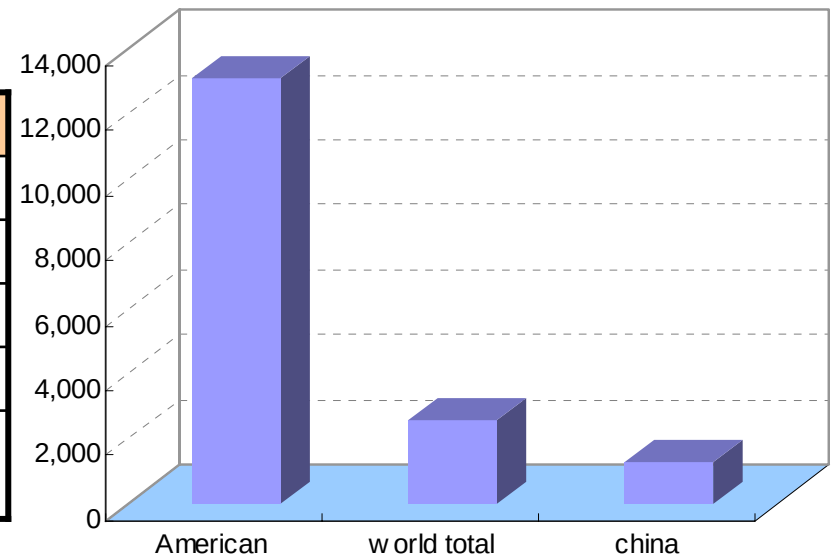
Source: China Electricity Council (<http://www.cec.org.cn/cec-en/index.htm>)

Power supply and demand

- Electricity intensity per capita is 1/10 that of U.S. and less than half of the world's average.

	China	U.S.	World total
Installed capacity (GW)	356.6	979.6	3,372.8
(% of world total)	(9.6%)	(26.4%)	(100%)
Power generation (TWh)	1,654.2	3,858.5	15,614.1
(% of world total)	(10.6%)	(24.7%)	(100%)
Power generation per capita (KWh/person)	1,288	13,120	2,578

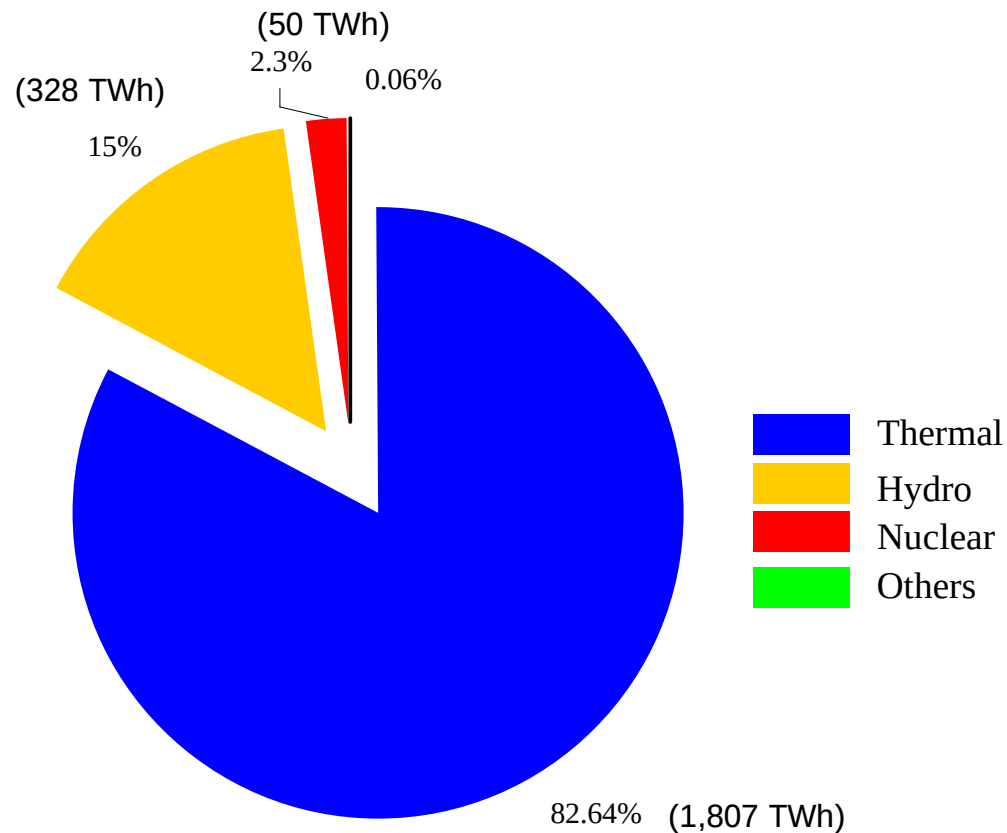
2002 Data



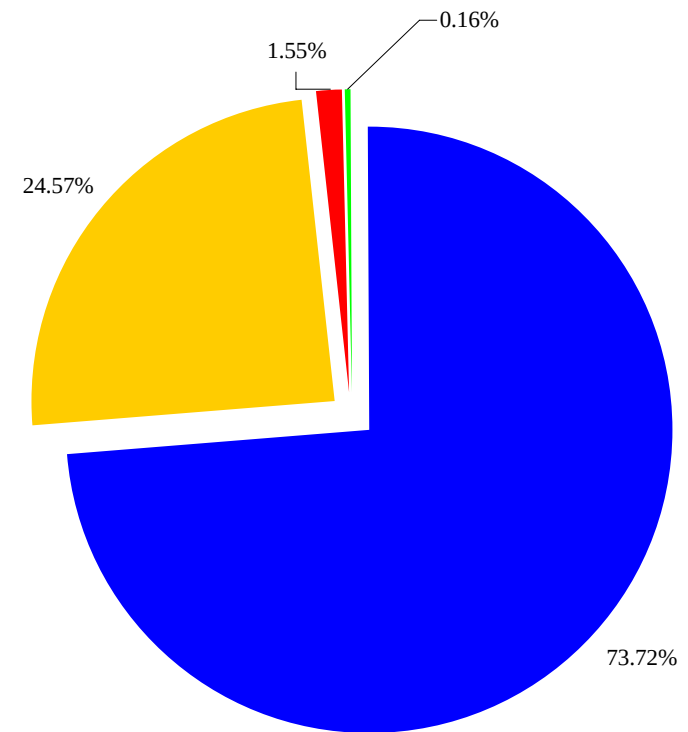
**2002 Per Capita
Generation in
KWh per person**

Power supply and demand

- Coal is the major generation supply fuel.

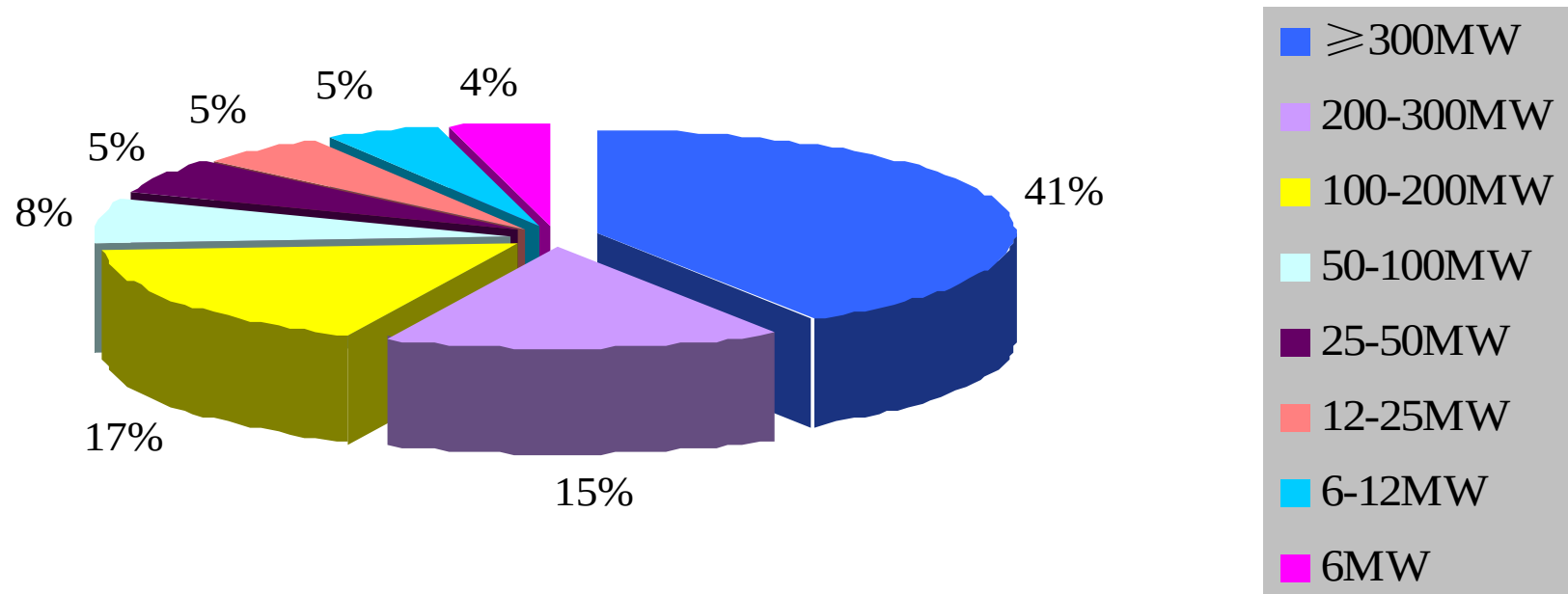


Power generation in 2004



Installed capacity in 2004

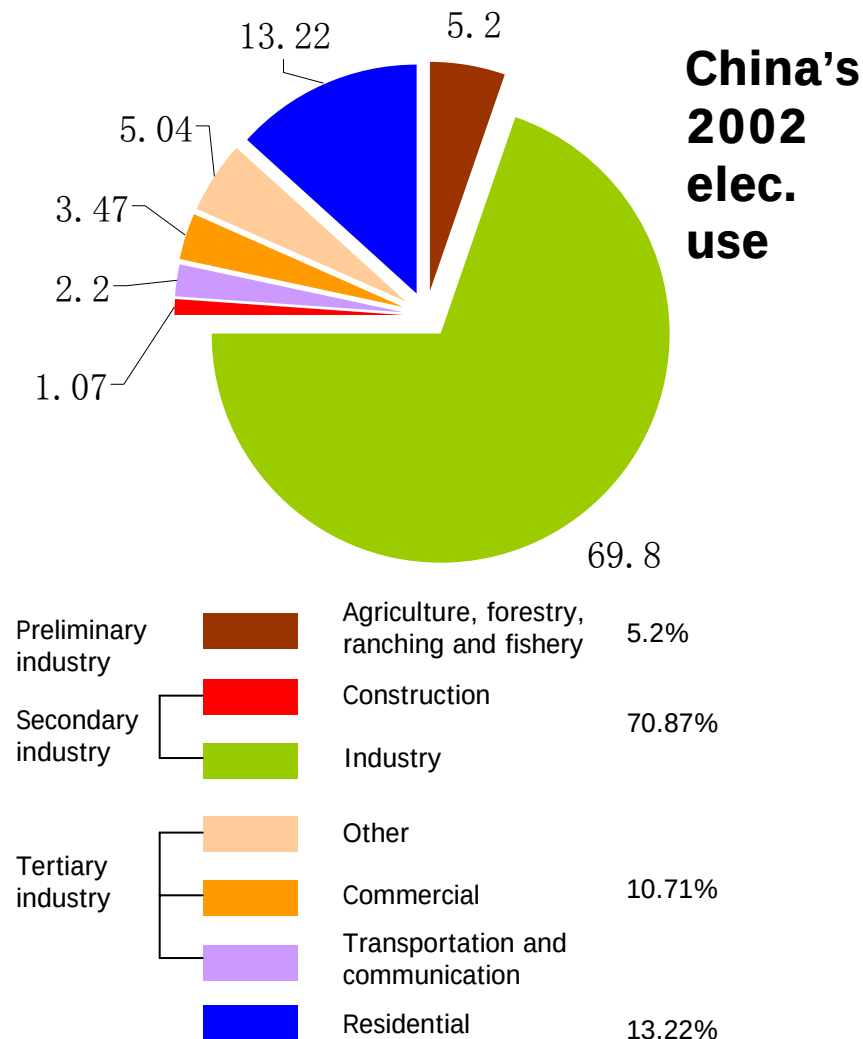
Power supply and demand



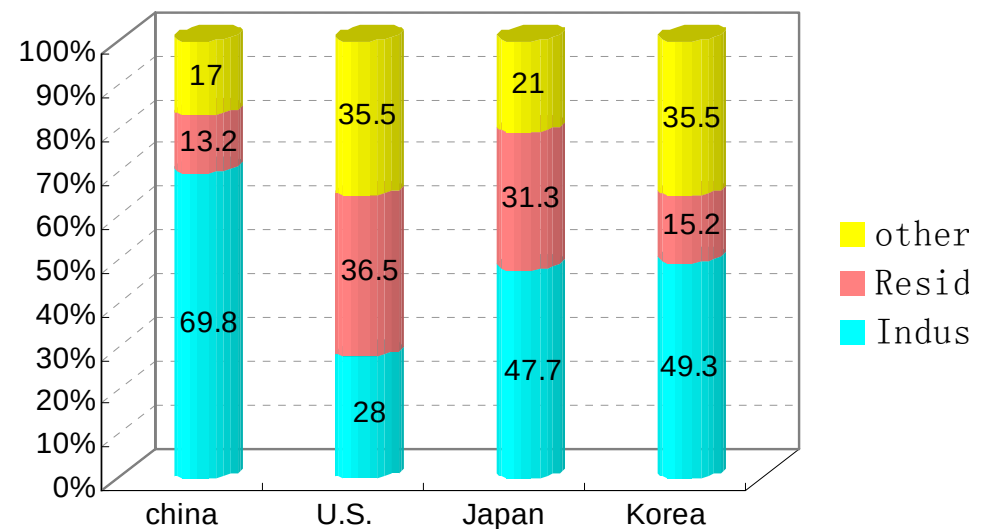
Coal-fueled installed capacity mix in 2003 by unit size. The total installed capacity is 289,770MW

Power supply and demand

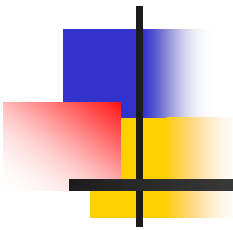
- Industry electricity use dominates other sectors



Share of total 2002 electricity use by sector in 4 countries



Source: China Statistical Annual and China Energy Resource Statistical Annual, and China Electric Power Information Center. 2002 data.



Power supply and demand

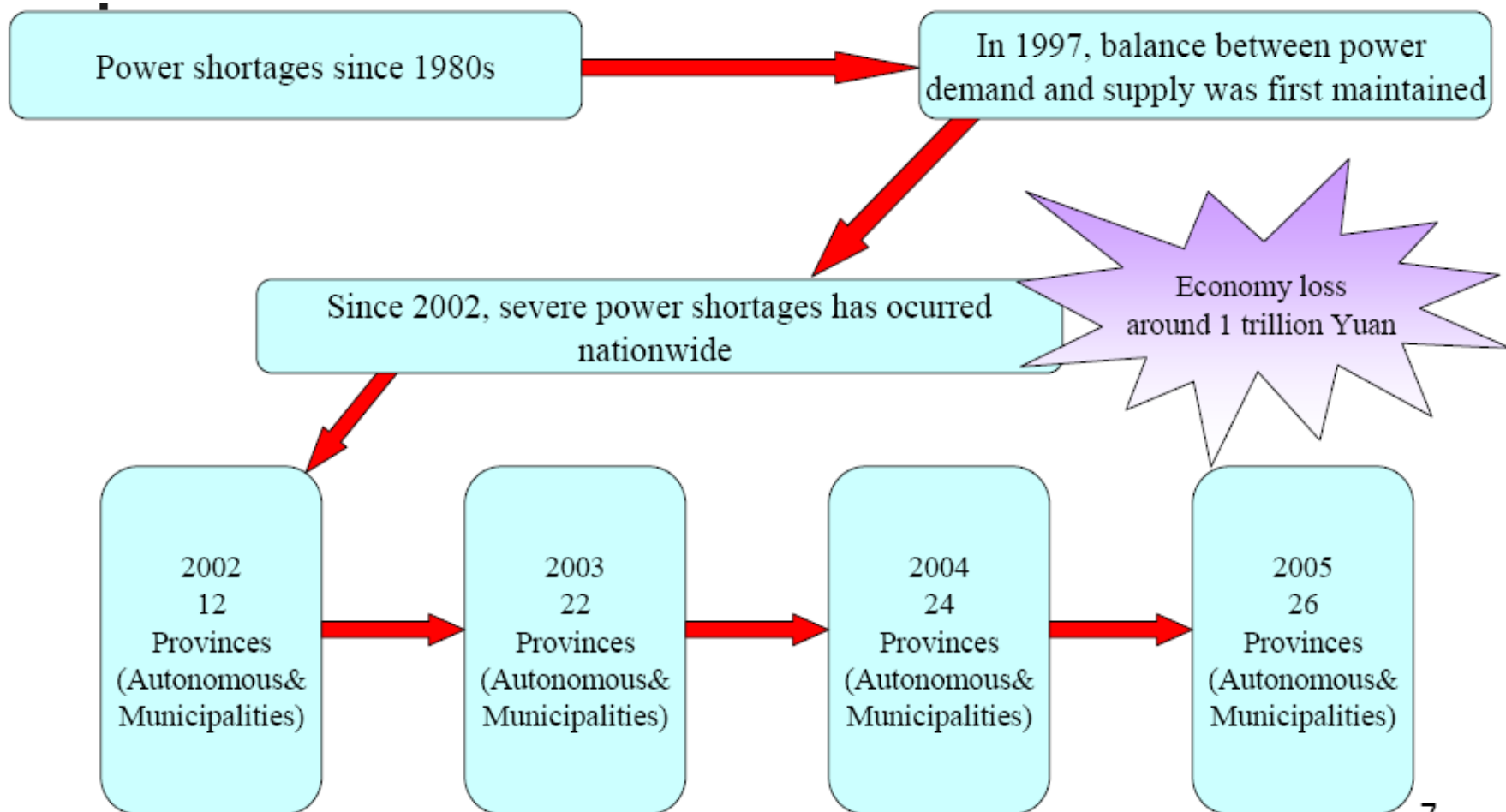
Business consumption growth dominates total growth

Year	Total	Agriculture, forestry, ranching and fishery	Industry and construction	Transportation, communication, commercial and others	Residential	Rate of increase relative to the previous year
2002	14,979	780	10,619	1,600	1,980	10.4%
		5.2%	70.87%	10.71%	13.22%	
2003	18,633	559	13751.2	2,422.2	1,900.8	24.4%
		3%	73.8%	13%	10.2%	
2004	21,762	687.5	16,301	2,329.5	2,444	16.3%
		3.16%	74.9%	10.7%	11.24%	
2005	24,690	740	18,480	2,630	2,840	13.5%
		3%	74.85%	10.65%	11.5%	
'02-'05 annual growth	18 %	-2 %	20 %	18 %	13 %	

Electricity consumption (2002-2005)

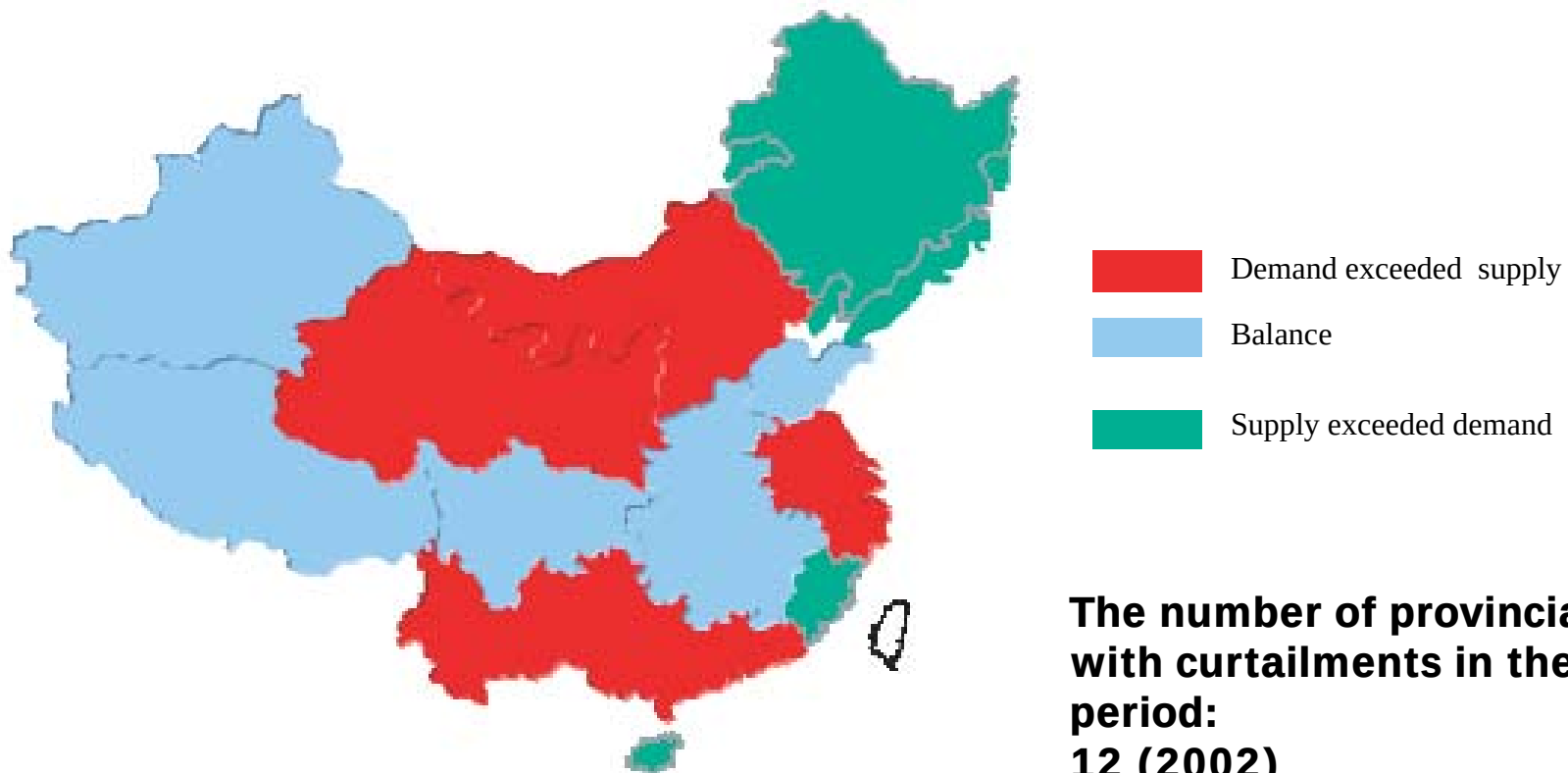
Power supply and demand

- Power shortages were being caused by need for more generation capacity (Trillion Yuan = \$130B)



Power supply and demand

- Power shortages occurred in three major regions.



Demand and supply condition by region (2005)

The number of provincial grids with curtailments in the peak period:

12 (2002)

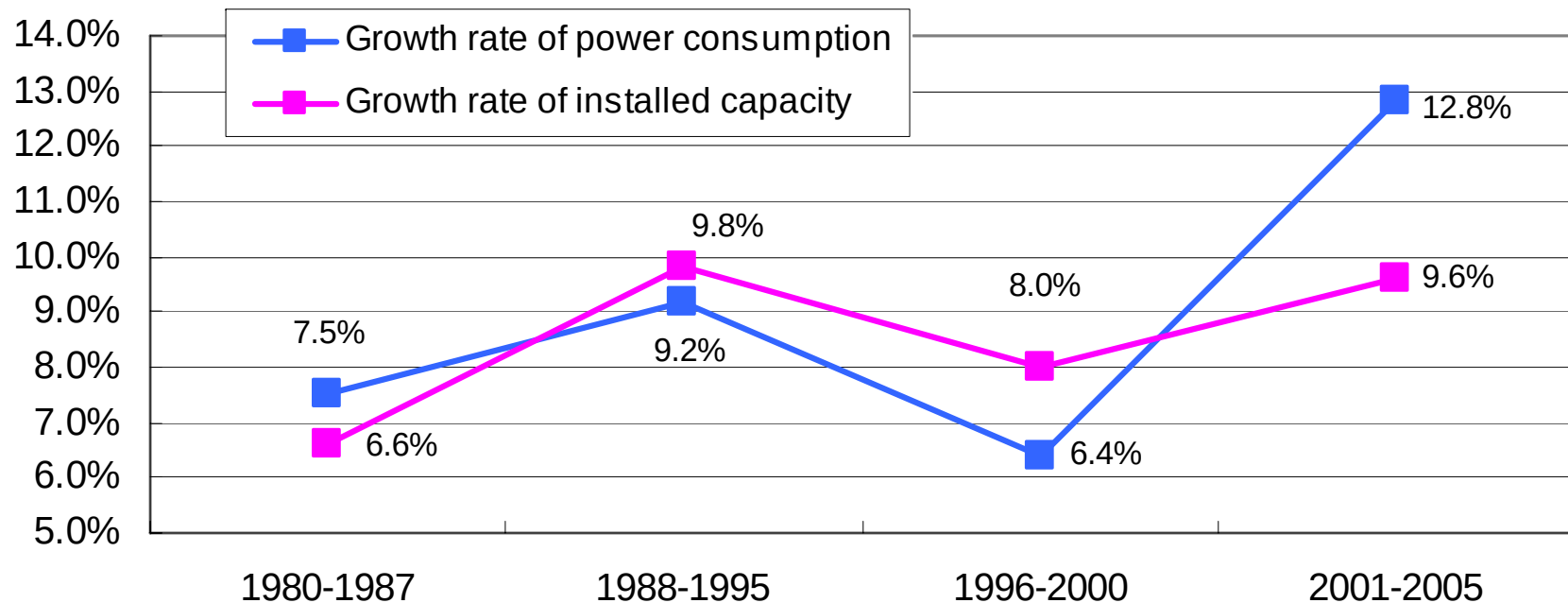
22 (2003)

24 (2004)

26 (2005)

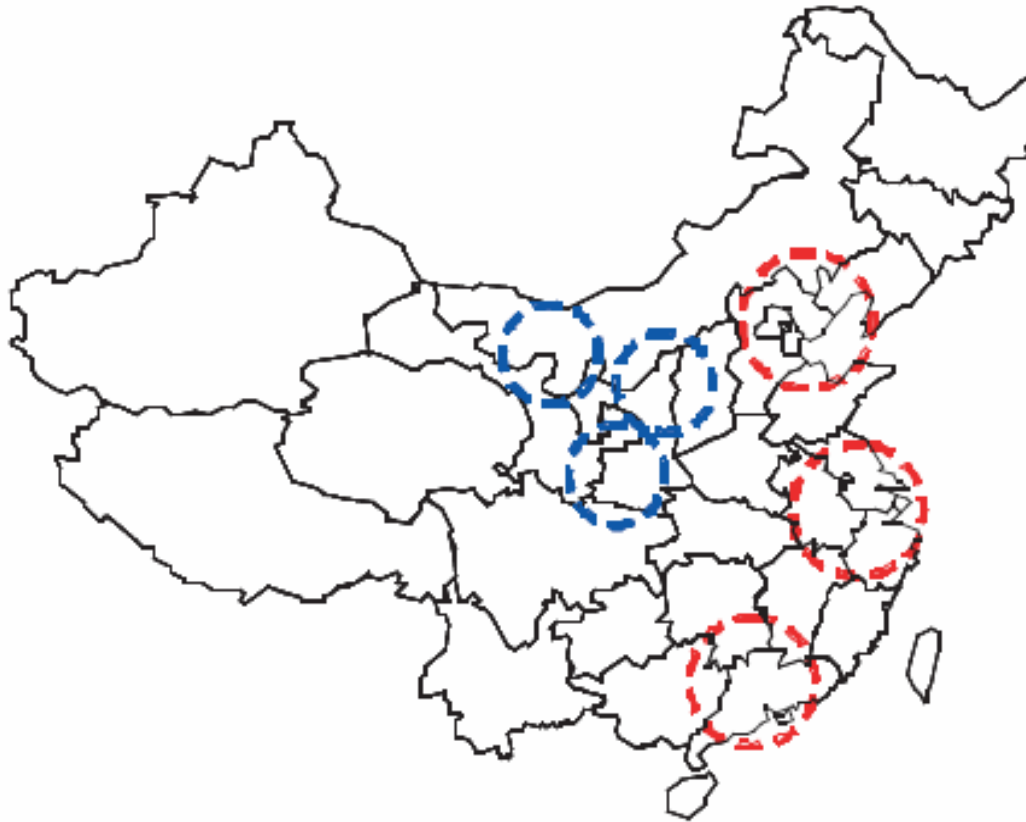
Causes of power shortages

- Climatic variability (droughts and heat waves)
- Economy, and therefore energy use, is growing faster than electric generation capacity can be built.

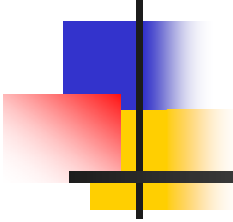


Causes of power shortages

- Coal supply shortages and transport bottle-necks
- Escalating coal prices and decreased energy content of coal. Differences in price trends of “regulated power prices” and “unregulated coal prices”.



Blue indicates supply sources and red indicates major load centers

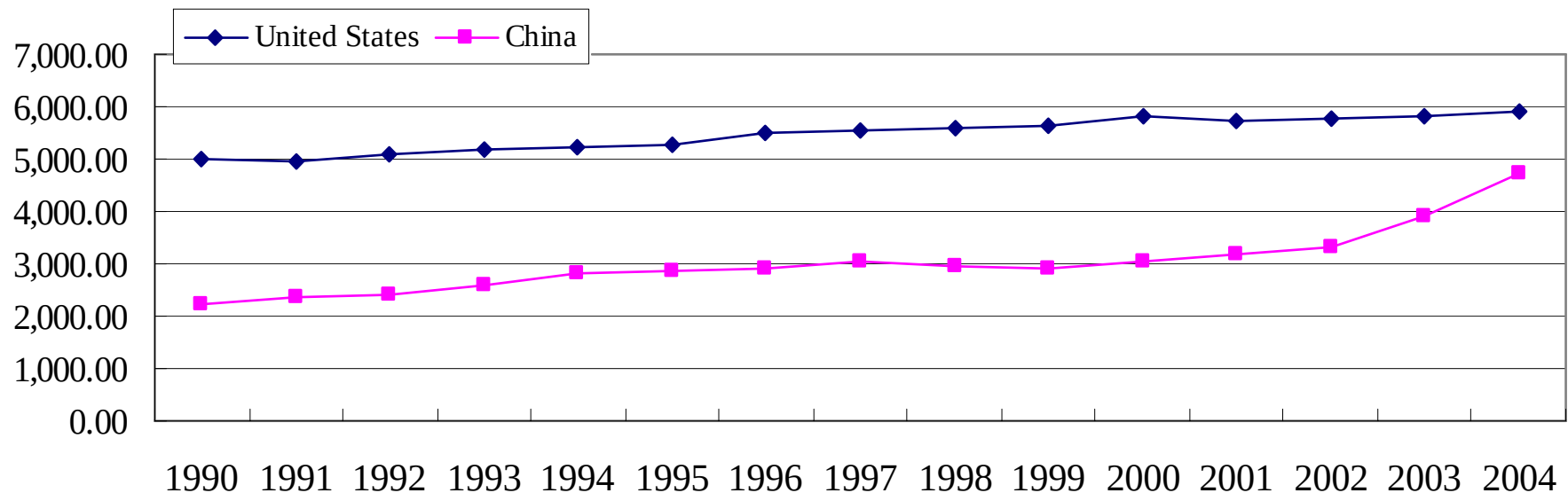


Addressing power supply shortages

- Generation sector
 - Developing coal-fired generation – high boiler pressure, high capacity, and environmentally friendly – is the direction.
 - Accelerating development of hydropower, nuclear power, and gas-fired power generation.
 - Introducing renewable energy (solar, wind,...)
- Network sector
 - Strengthening the grid.
- Intensifying energy conservation efforts and improving energy efficiency.

Environmental challenges

- China's carbon dioxide emissions from consumption of fossil fuels are expected to increase from 3,000 million tons in 2000 to 5,700 million tons in 2020.



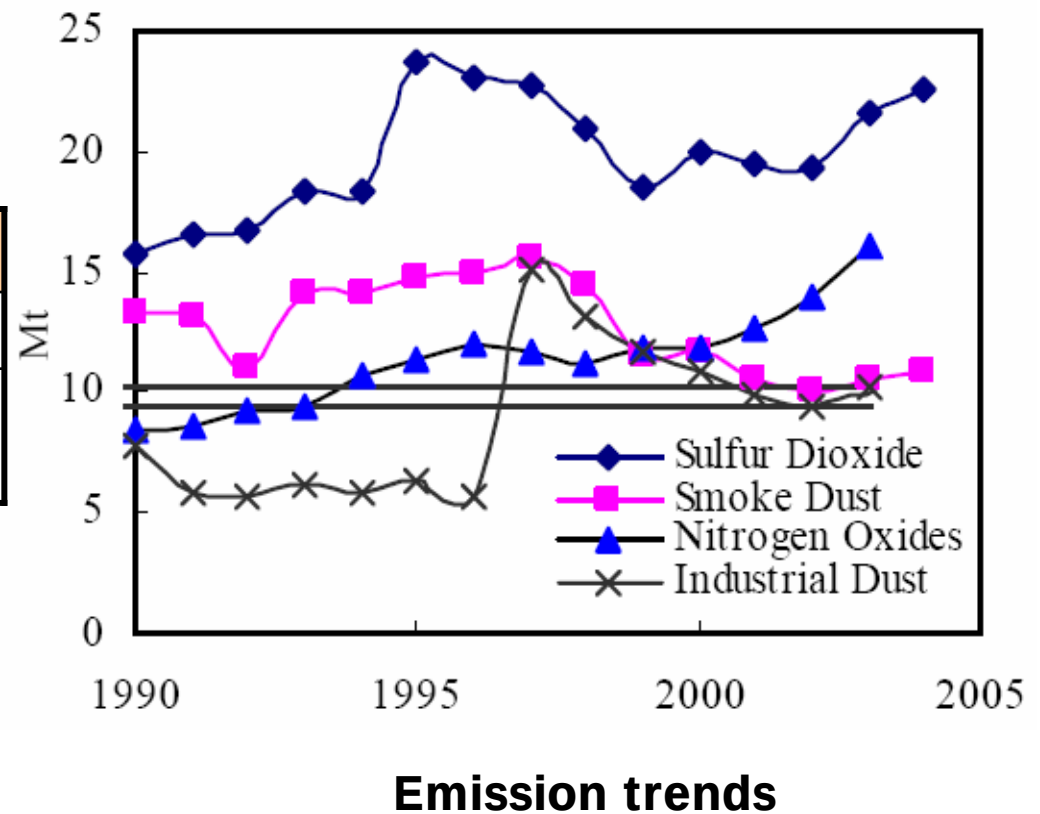
Source: International Energy Association 2004

Environmental challenges

- China is experiencing rising SO₂ and NO_x.

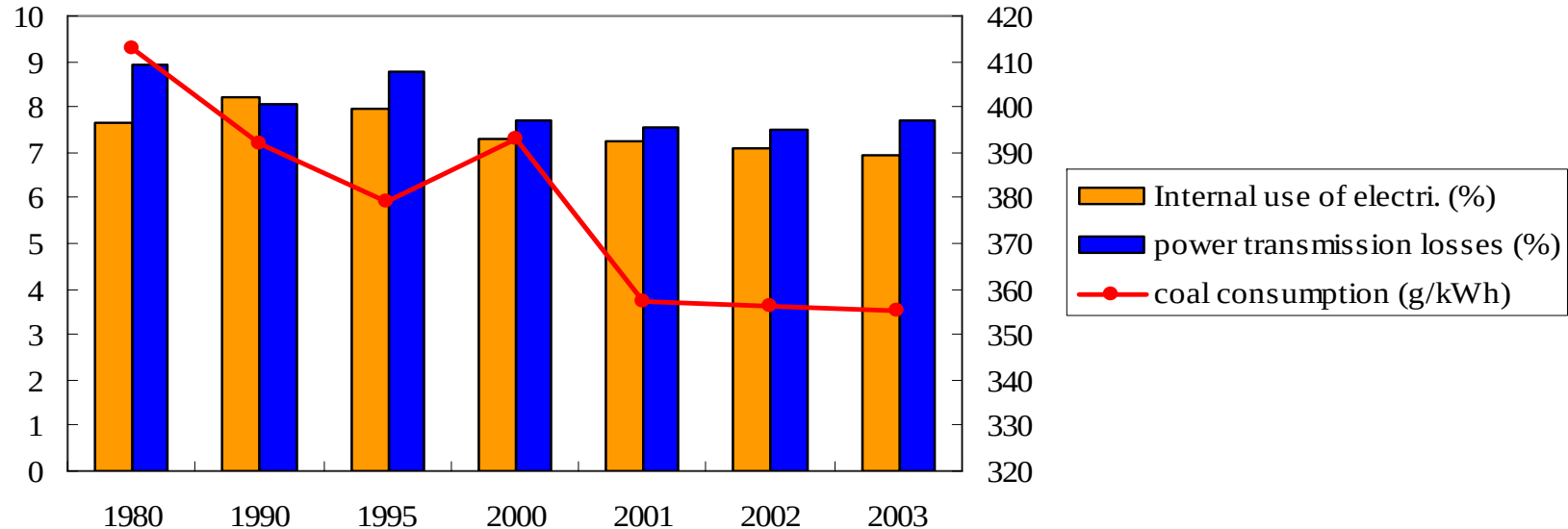
	emission	removal	efficiency
SO ₂	8.01Mt	0.97Mt	10.8%
Smoke dust	3.13Mt	120.8Mt	97.5%

**Efficiency of SO₂ and
smoke dust emission
reduction systems(2003)**

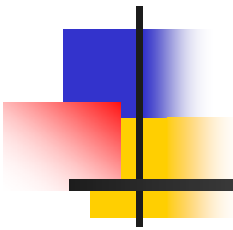


Improving generation and delivery efficiency

- Greater generation and delivery efficiency is reducing rates of internal use of electricity, transmission losses, and coal consumption.



	Internal use of electricity %	Power transmission losses %	Coal consumption (g/kWh)
2005	5.82	7.18	374
2020	5.1	6.2	320



Strategies for overcoming coal supply and delivery challenges

- *Alliances between coal mining companies and power generation companies*
- *Mine-mouth power plants substituting electric transmission for coal transportation*



Shenhua model: simultaneous stock holding and building of power stations

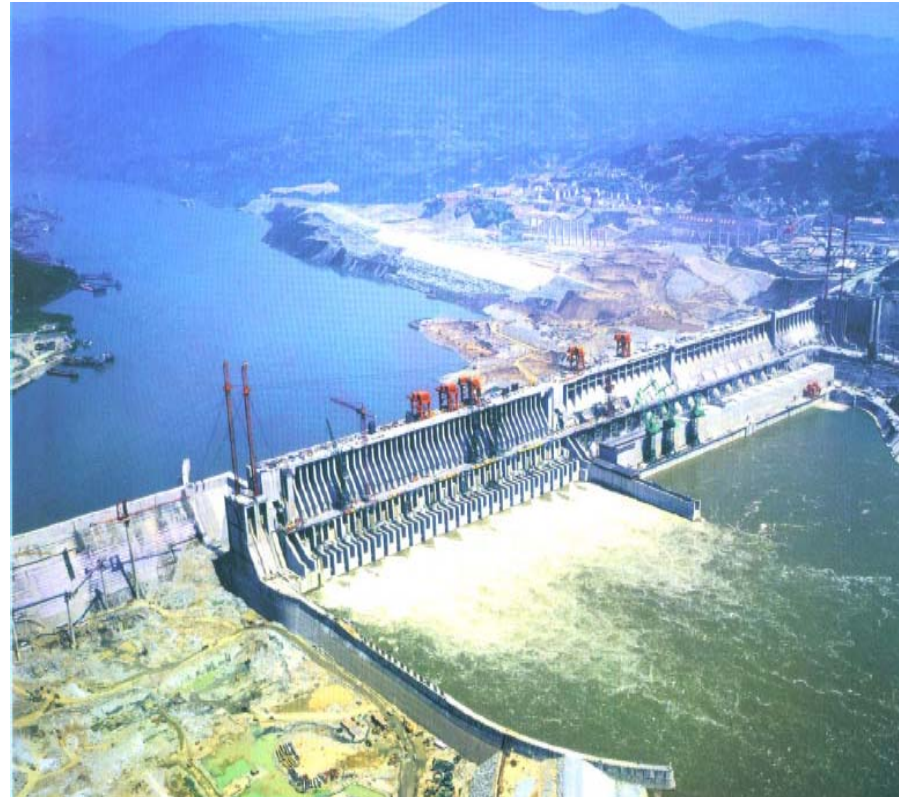
Shanxi coking coal co. model: building of power station by coal mines

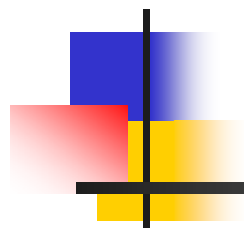
Luneng model: building of coal mines by power enterprises

Huainan model: joint venture to establish the new coal mines and power stations

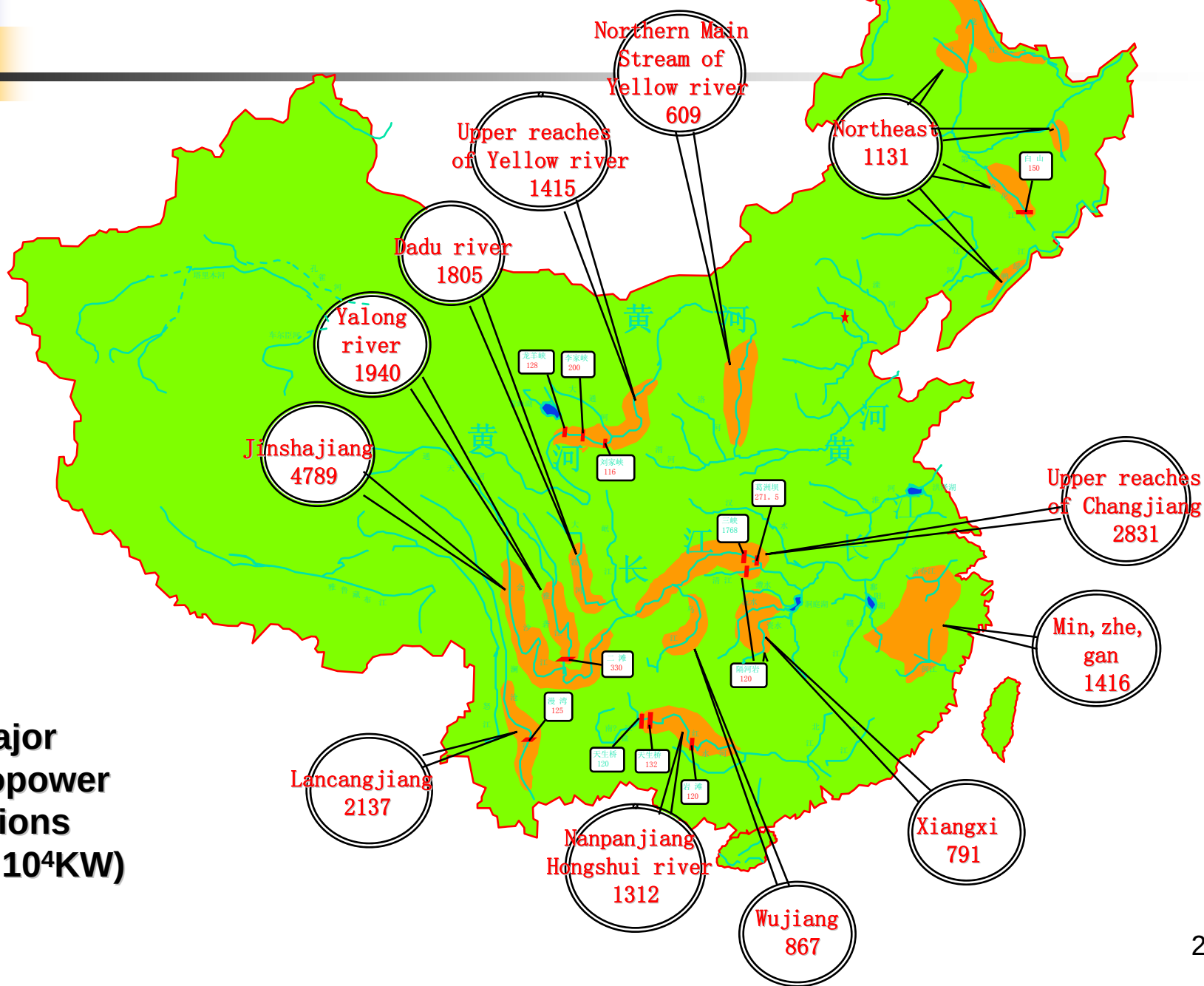
Hydro-power development

- Hydro
 - Resources: 500GW
 - By the year 2005:
 - Installed capacity 120GW (including 34.1GW from small hydro plants).
 - 395TWH, 15% of the total annual generation.

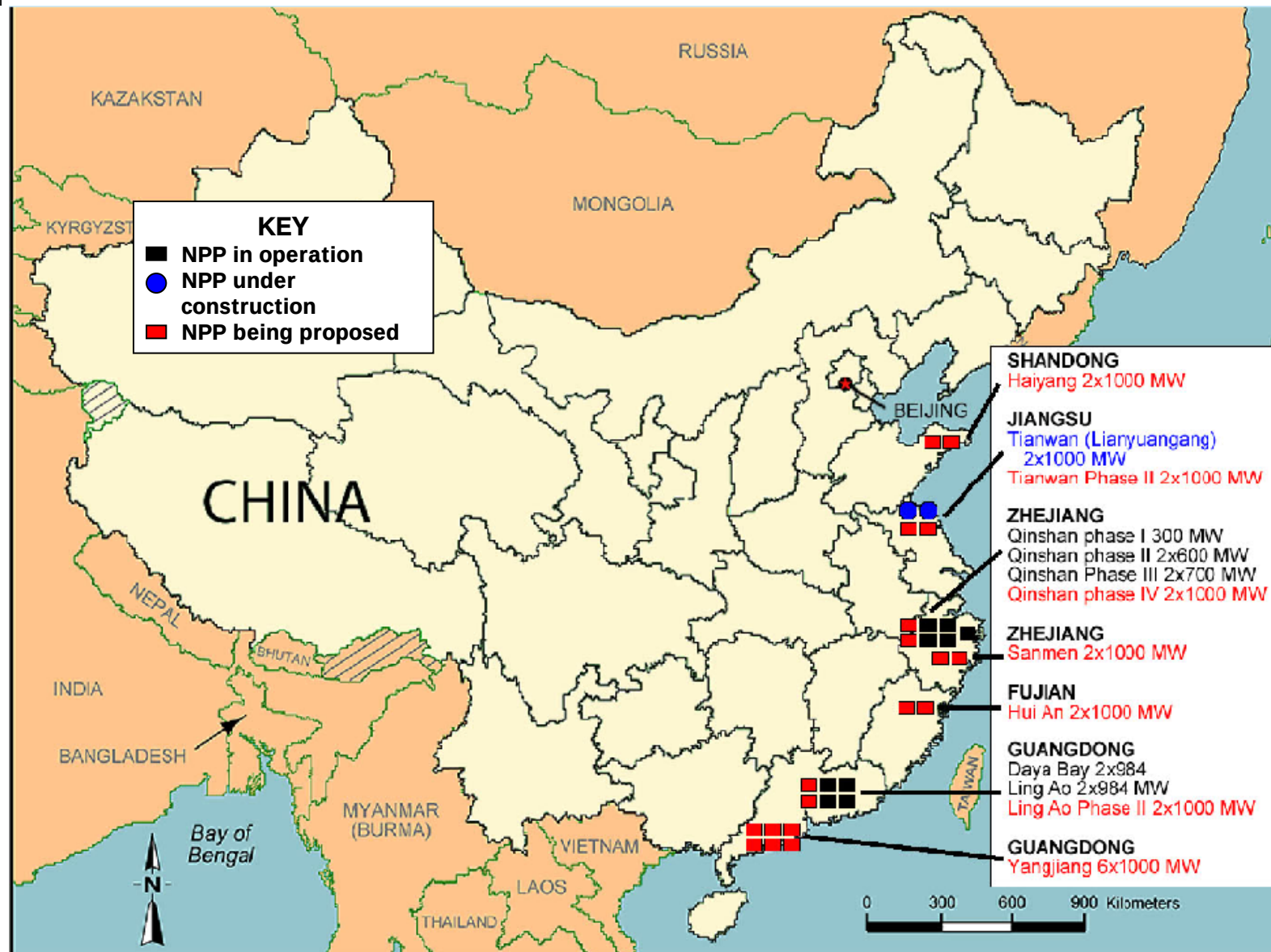


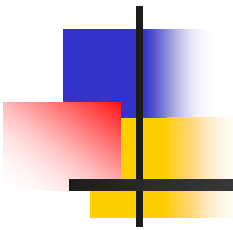


**12 Major
Hydropower
Locations
(unit: 10^4 KW)**

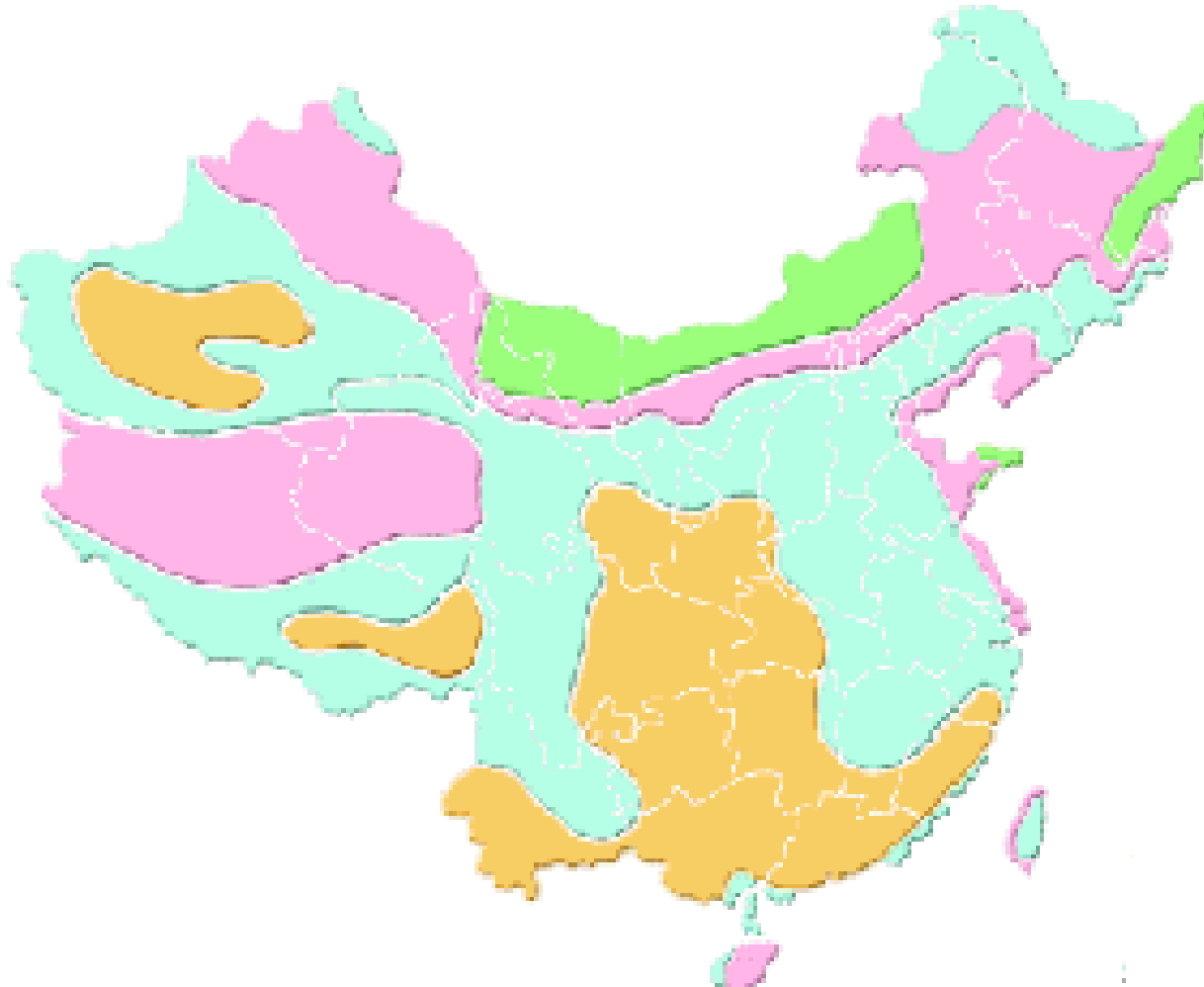


Nuclear power





Potential wind power resource > 3000 GW



**green=great, pink=good, blue=ok, yellow=poor
(offshore & coastal potential not shown)**

Wind power

- By the year 2005:
 - 59 wind power plants, with total installed capacity of 1266MW.
 - 200,000 small wind units, located in rural areas, with total installed capacity of 30MW.
 - Mass production of 750KW (and below) units; units at MW level is still in the trial phase.
 - Key technology dependent on imports. However, design expertise growing in China.
- By the year 2020 – 40GW

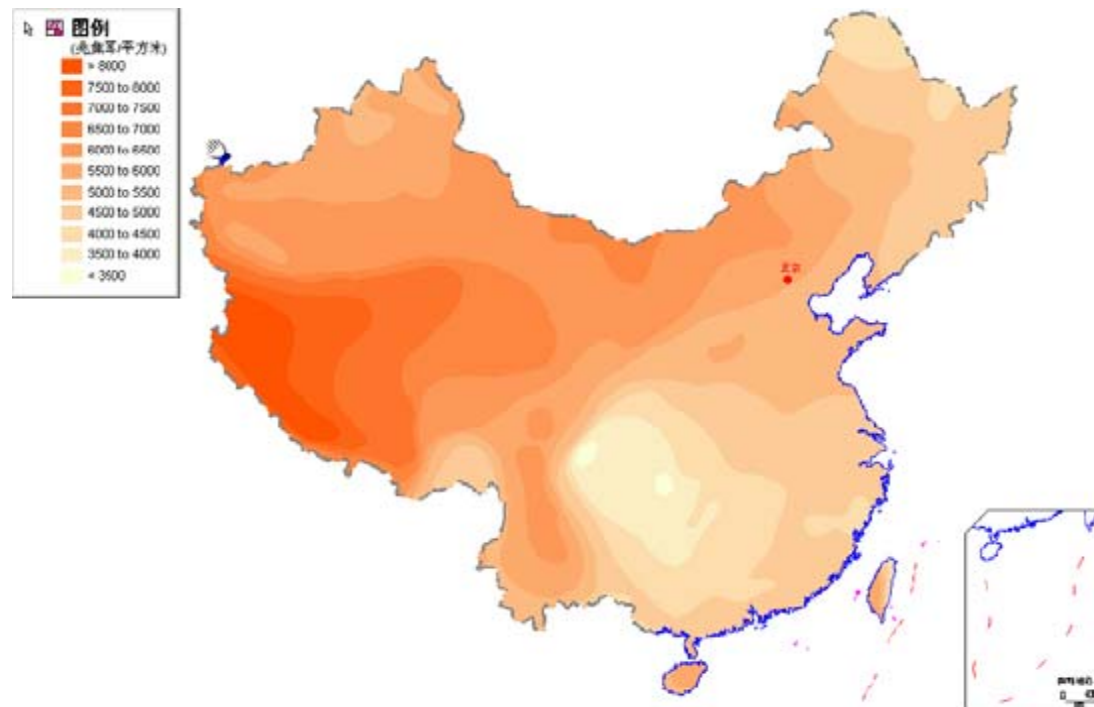
Wind farm under-construction



Dan Nan wind farm in Nan'ao

Solar power resource

- Theoretically 1.7 trillion ton coal equivalent/year
- 2/3 of the land with daylight hours surpassing 2,200 hours/year, equaling 5,000mega joule/m²
- Most abundant in western regions



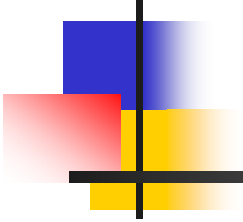
Solar power

■ PV

- Installed capacity: 70 MW, mainly in the rural areas. (including “sending electricity to townships” project: 17MW).
- On-grid ceiling PV: Shenzhen 1MW project.
- Industrial capacity: 300MW units/year, but silicon materials depend on import.

■ Solar water heaters

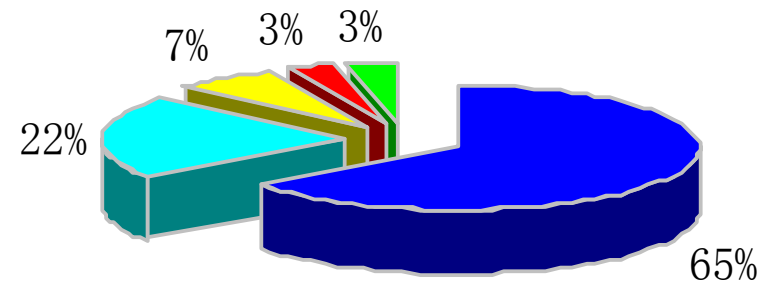
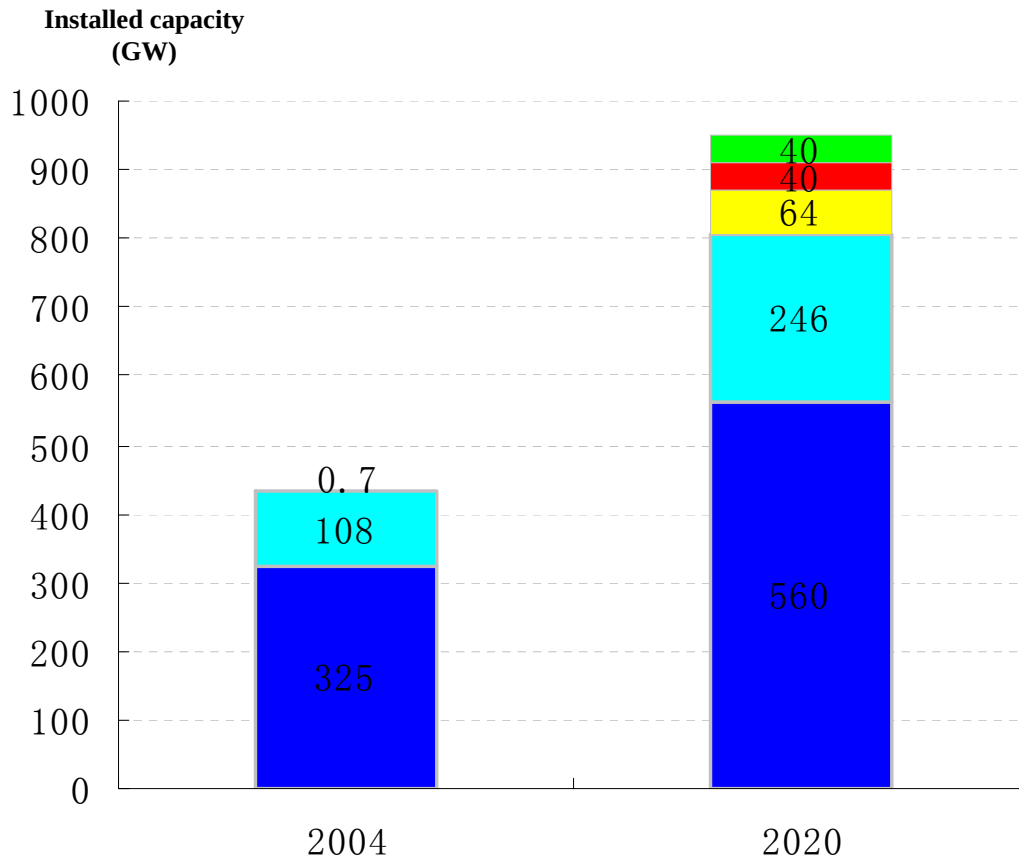




Renewable energy policy

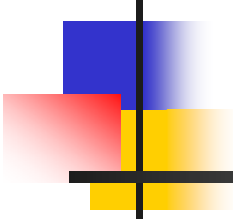
- ***Renewable Energy Law of China*** -- effective from January 2006.
 - Establishing national targets
 - Grid connection priorities
 - Classifying tariffs for RE electricity
 - Sharing cost at national level
 - Special fund for renewable energy
 - Favorable credit and favorable tax treatment

Long-term target generation mix



■ coal ■ hydro ■ gas ■ nuclear ■ new

Target generation mix in 2020



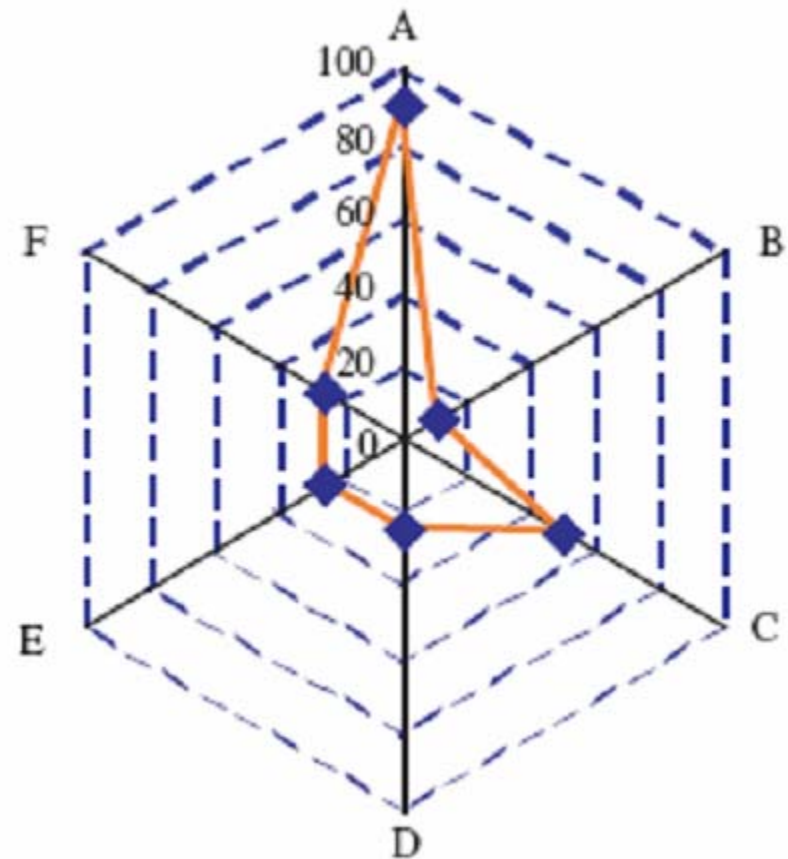
Power industry reform objectives

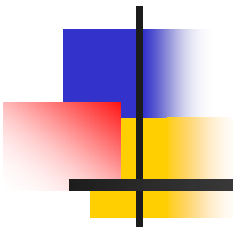
- To establish a power market system that will introduce competitive incentives, improve efficiency, lower cost, improve power pricing, optimize resource allocation, promote electric power development, and advance nationwide grid construction.
- This market system should encompass fair competition, orderly transition, and efficient development using separation of government functions from enterprise functions.

Reform goals

Goals of “Article Five” during the “10th Five-year Plan”

- A: Separation of generation from grid (completed)
- B: Corporate separation of non-core functions (such as planning, designing, construction, etc.)
- C: Direct access to market by large users
- D: Formulation of competitive regional power market
- E: Bidding for access to grids
- F: Make retail tariffs more market-driven





Power industry reform history

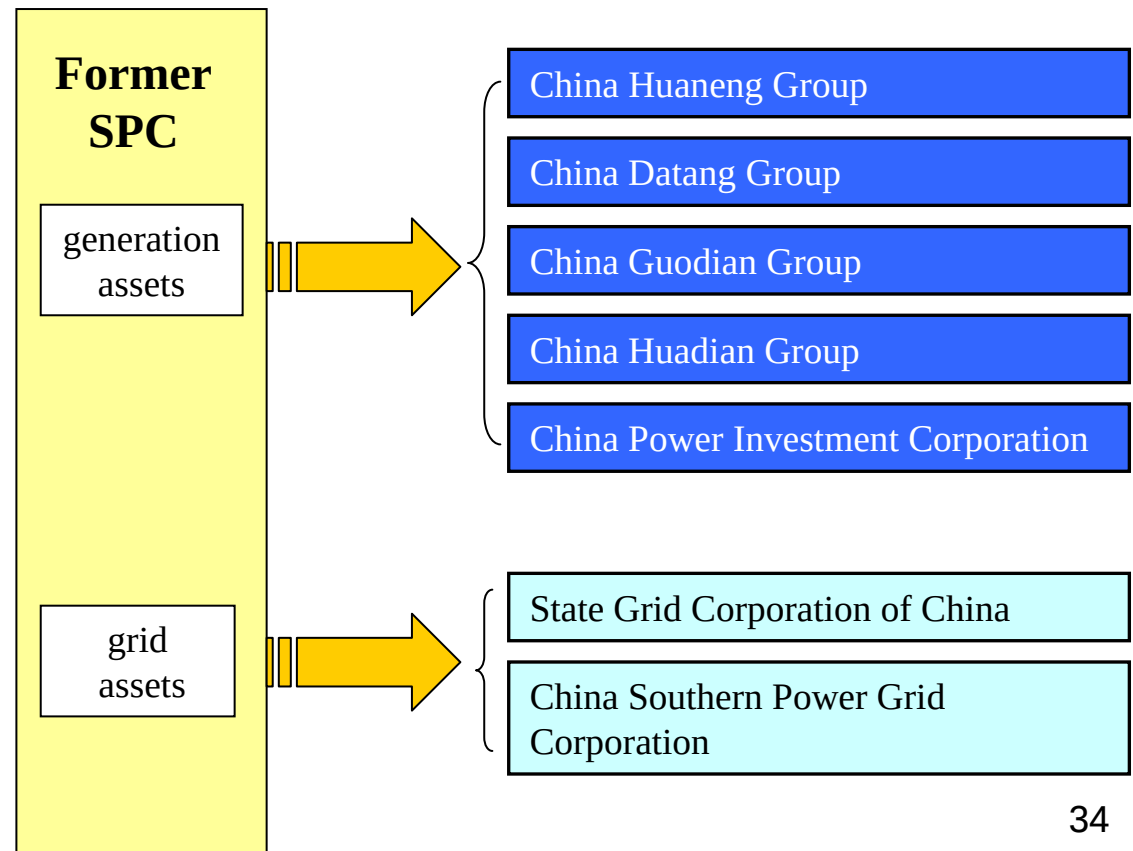
1997	1998	2002	2002	2002	2004	2004	
State Power Corp. (SPC) established	Dissolved Ministry of Electricity	Power Regime Reform formally approved by the State Council	State Elec. Regul. Commission (SERC) created (October 2002)	SPC restructured	Separation of gen. assets from transmission assets	East China starts pilot regional power market operation.	

Power industry reform

- To “ *introduce competition and break the market monopoly* ” generation and grid sectors were separated.

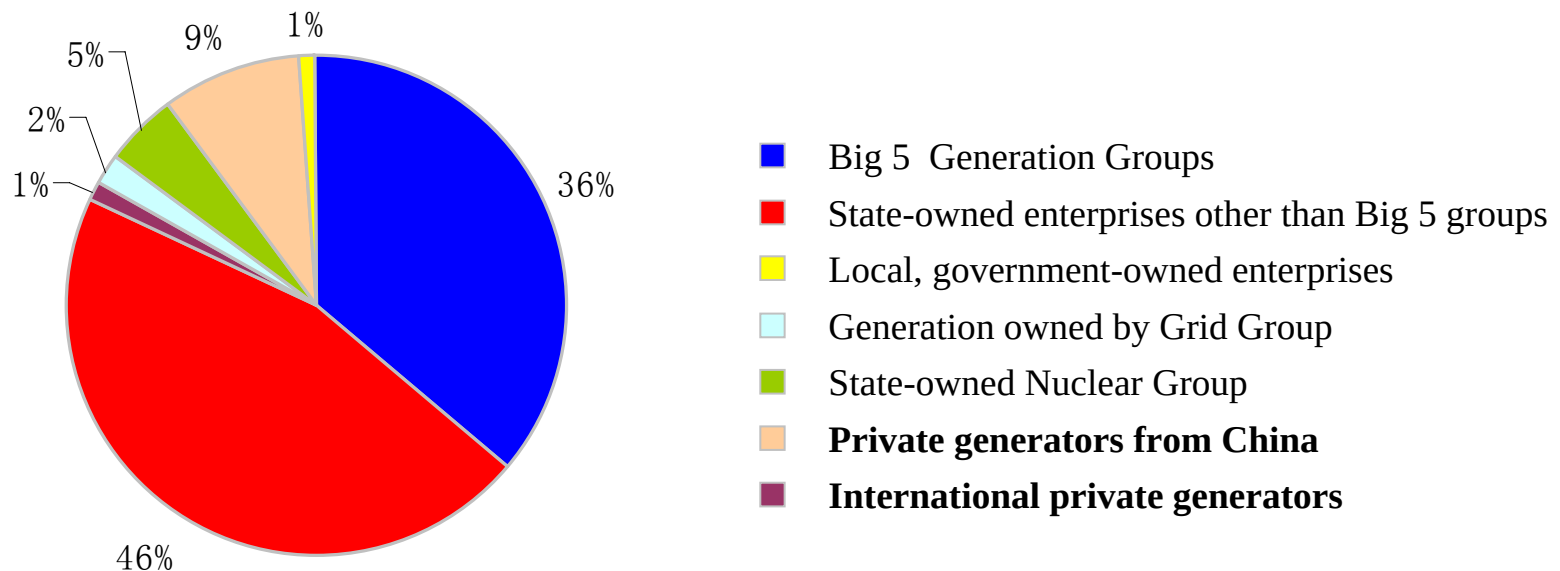
Restructuring of the State Power Corporation of China

December 2002

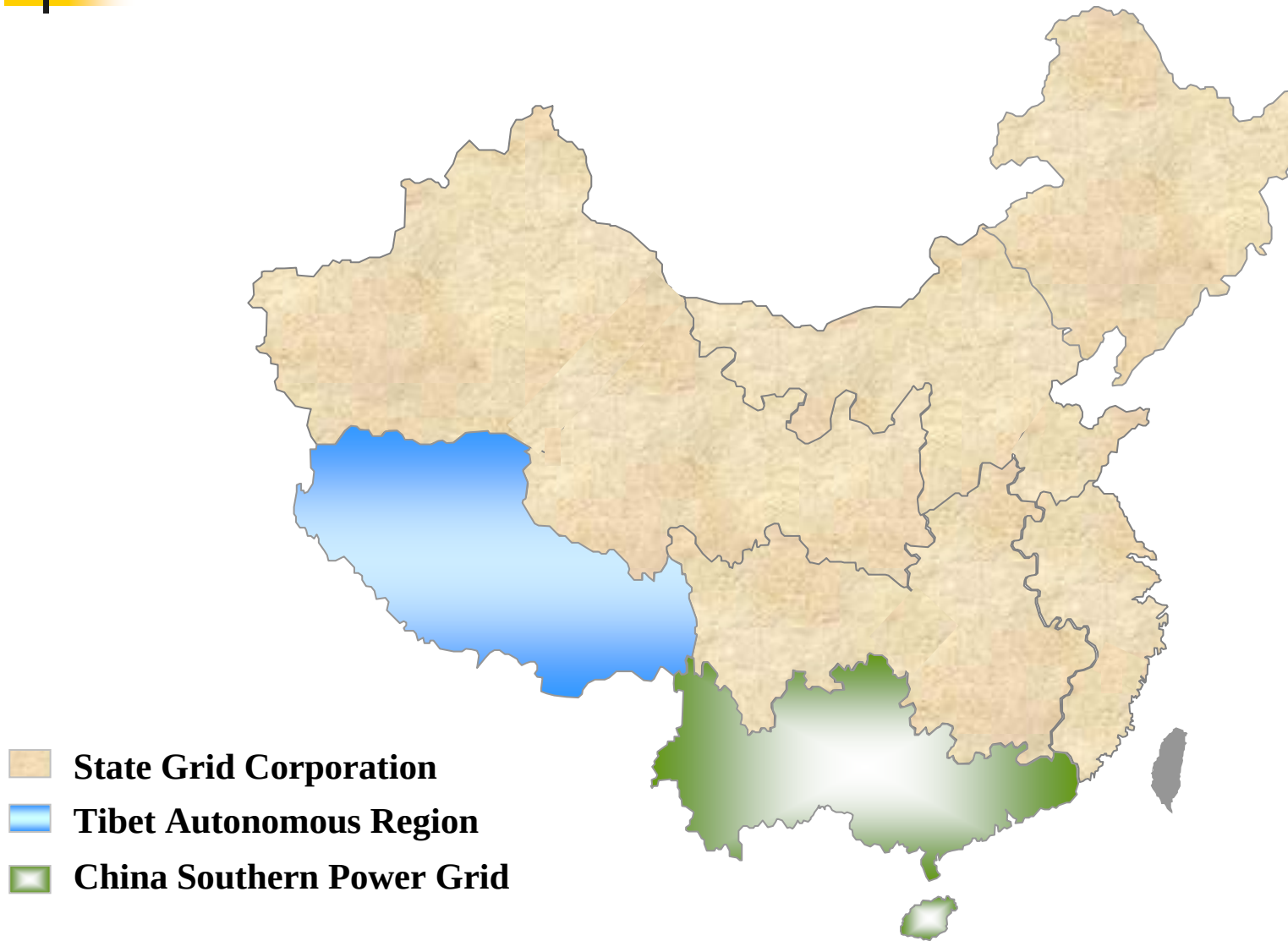


Power industry reform

Comparison of the installed capacity of different types of players (2004)

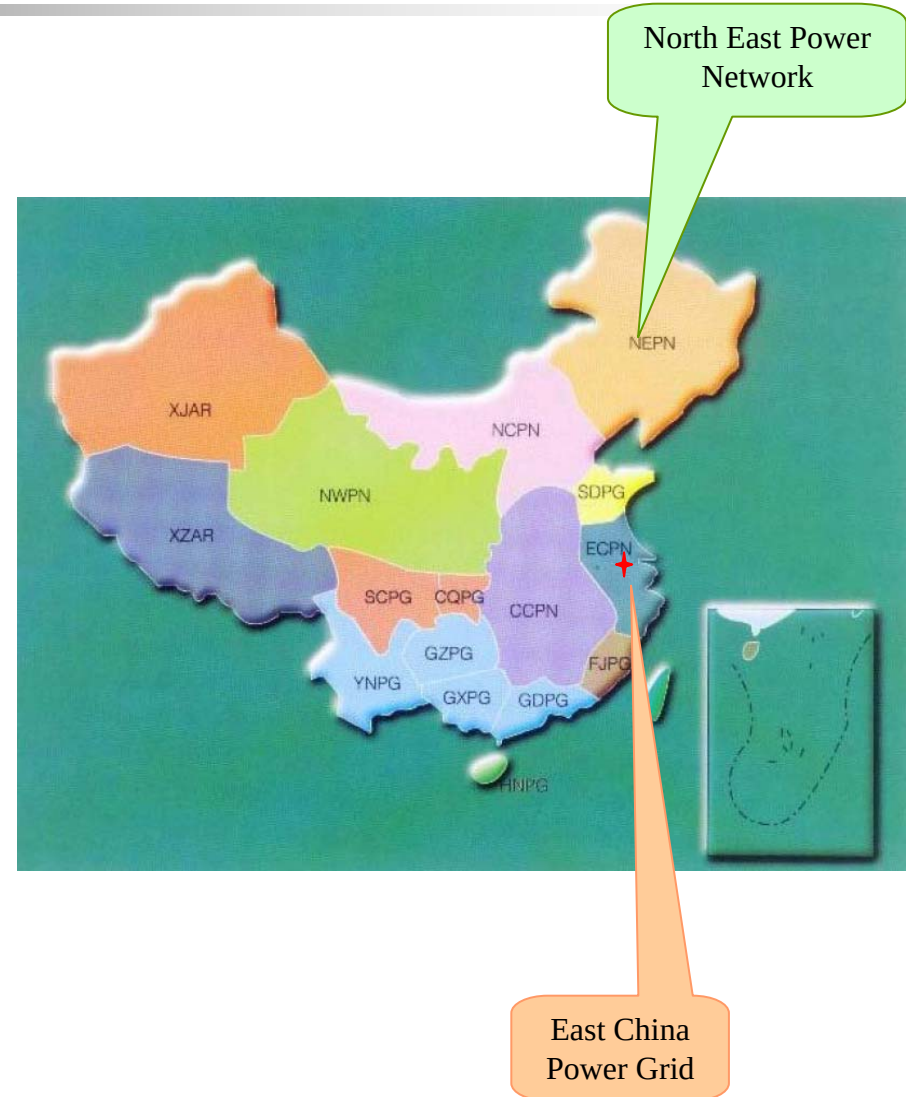


Power industry reform – grid sector

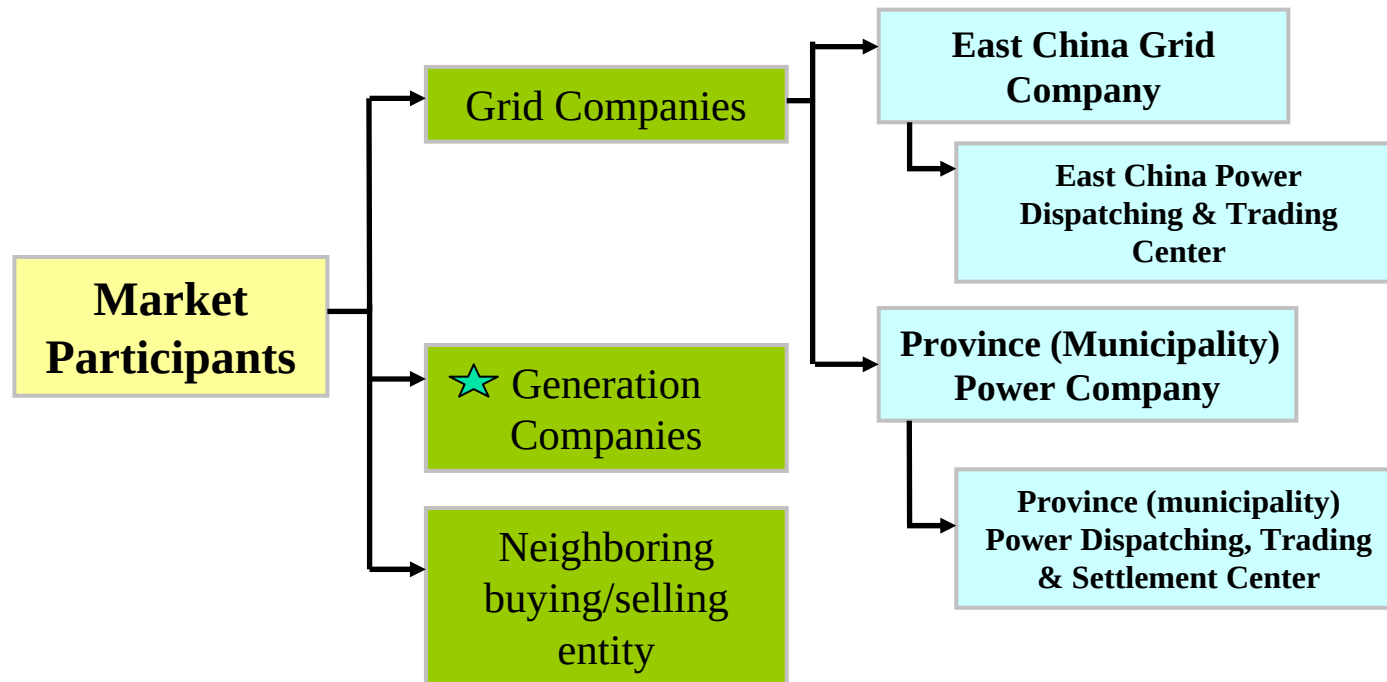


Restructuring pilot program

- East China: the most developed area; electricity consumption ranks first; installed capacity $\geq 100,000\text{MW}$ in 2005.
- One of two pilot regional power markets in China.
- May 18, 2004: East China's first simulated bidding process for the next month.
- October 2005: simulated operation of China's first day-ahead power market.
- April 2006: trial operation of day-ahead power market.



Restructuring pilot program



Generation units in East China: ★

Category A: coal-fired units with capacity over 100MW (216 units registered by the end of 2005, generation capacity $\geq 58,818\text{MW}$ = 56.7% of total generation capacity in East China area). Participation Required.

Category B: gas-fuel units, oil-fuel units, hydro units, nuclear power units, etc. Participation Not Required

Trading modes:

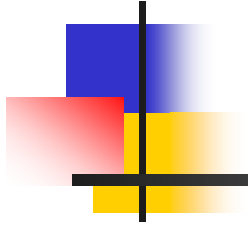
Bilateral Transactions (between neighboring provinces and municipality)

Yearly Generation Contract

Monthly Contract Bidding

Day-ahead Market

Real-time Balance Market



Thanks !