

Energy Efficiency in China: Glorious History, Uncertain Future

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The China Energy Group at LBNE



中国能源与环境研究室



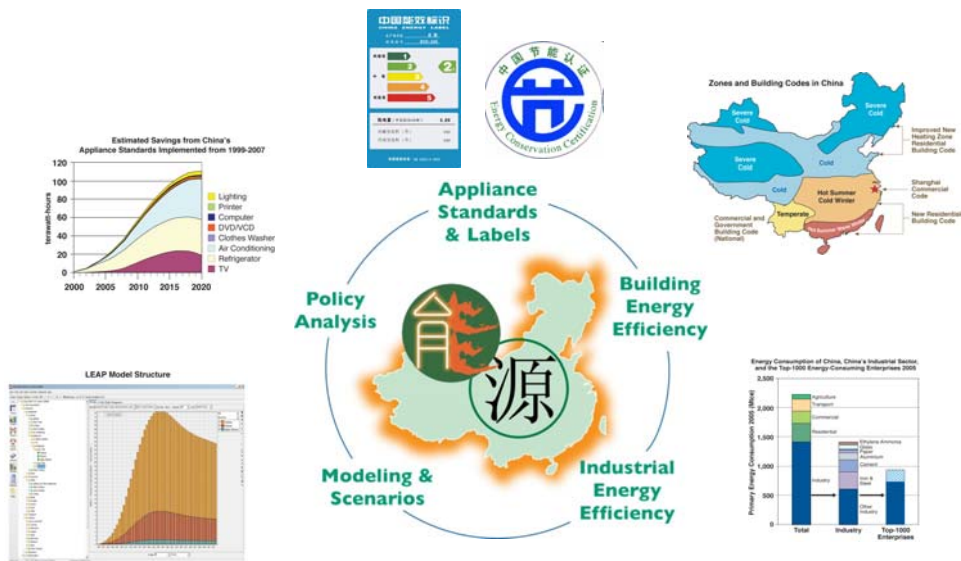
The China Energy Group works collaboratively with groups in China and elsewhere:

- to promote energy efficiency in China,
- to enhance the capabilities of Chinese institutions that promote energy efficiency, and
- to understand the dynamics of energy use in China.

China Energy Group

Founded in 1988

Focused on End-Use Energy Efficiency



~ 40 Current Projects in China

Collaborations with ~50 Institutions in China

China Energy Group



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Queena Qian
Visiting Researcher

Three Major Achievements



- **Appliance Efficiency Standards**
- **Industrial Energy Efficiency Policy**
- **Instrumental in creating two major institutions**
 - **China Sustainable Energy Program of the Energy Foundation**
 - **Beijing Energy Efficiency Center**

Part I: Glorious History

preceded in good dialectical fashion by an inglorious
earlier history

Part II: Energy Crisis in China: 2001 to present

repeat of much earlier “inglorious history”??

Part III: The Future:

What might happen? What is to be done to end the crisis?



Executive Summary (Part I)

- Things were bad in energy (for 3 decades)
- Deng Xiaoping came to power
 - A group of academics suggested a new approach to energy
 - Deng listened!
- Things were much better (for 2 decades)
- The market became king
 - Energy went off track again
- There are solutions
 - The Chinese government and Communist party are responding, somewhat in the manner of Deng

Part I: China's Recent Energy History in Three Acts

“Soviet Style” Energy Policy (1949-1980)

Deng's Initial Reforms (1981-1992)

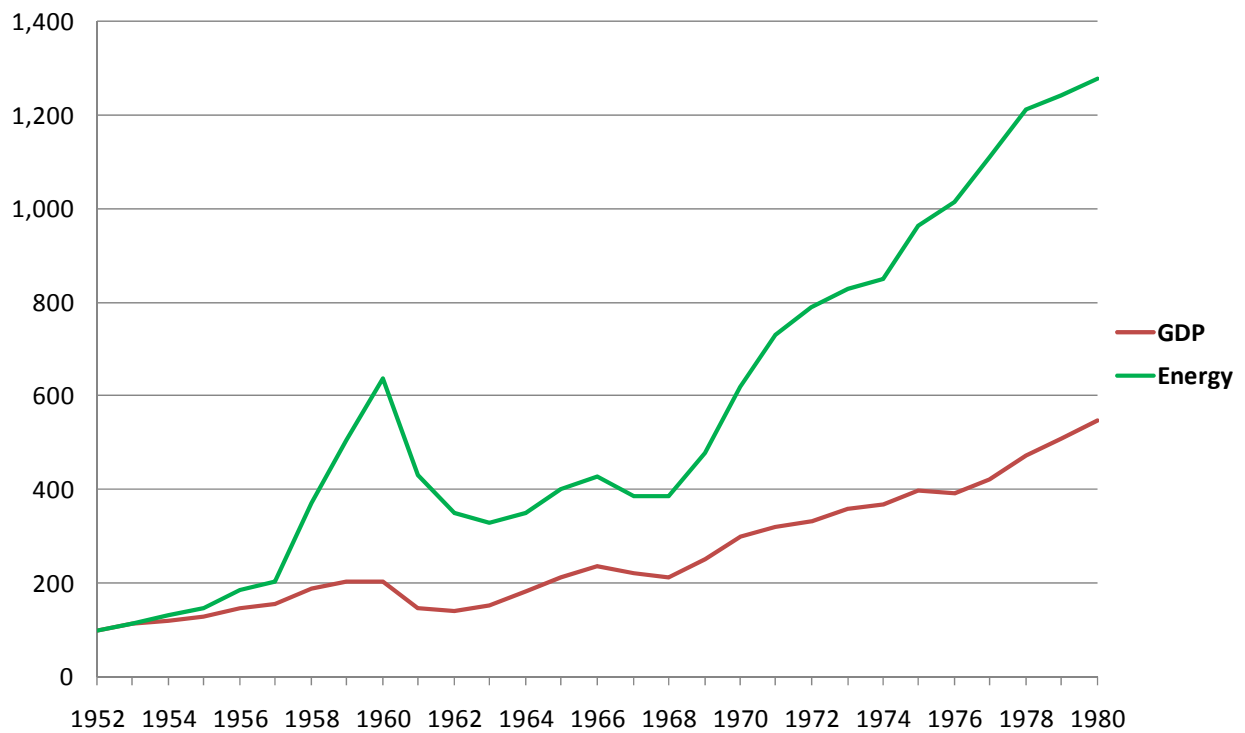
Transition Period (1993 to 2001), then Crises

“Soviet Style” Energy Policy (1949-1979)

- Single objective was rapid energy supply growth
- Energy prices greatly subsidized
- Central allocation system provided energy primarily to heavy industry
- No attention to environment
- **Result:** one of the world’s least efficient (and fastest growing) energy systems



Primary Energy Use vs GDP Index, 1952=100 1952-1980



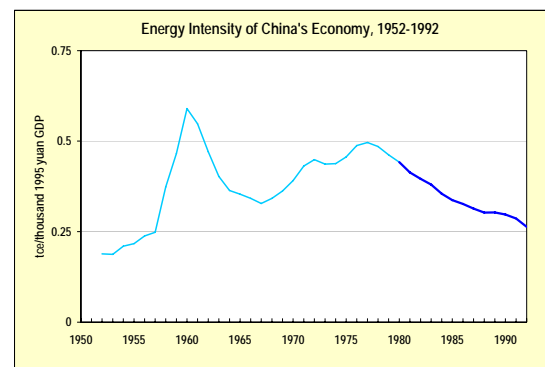
LAWRENCE BERKELEY NATIONAL LABORATORY

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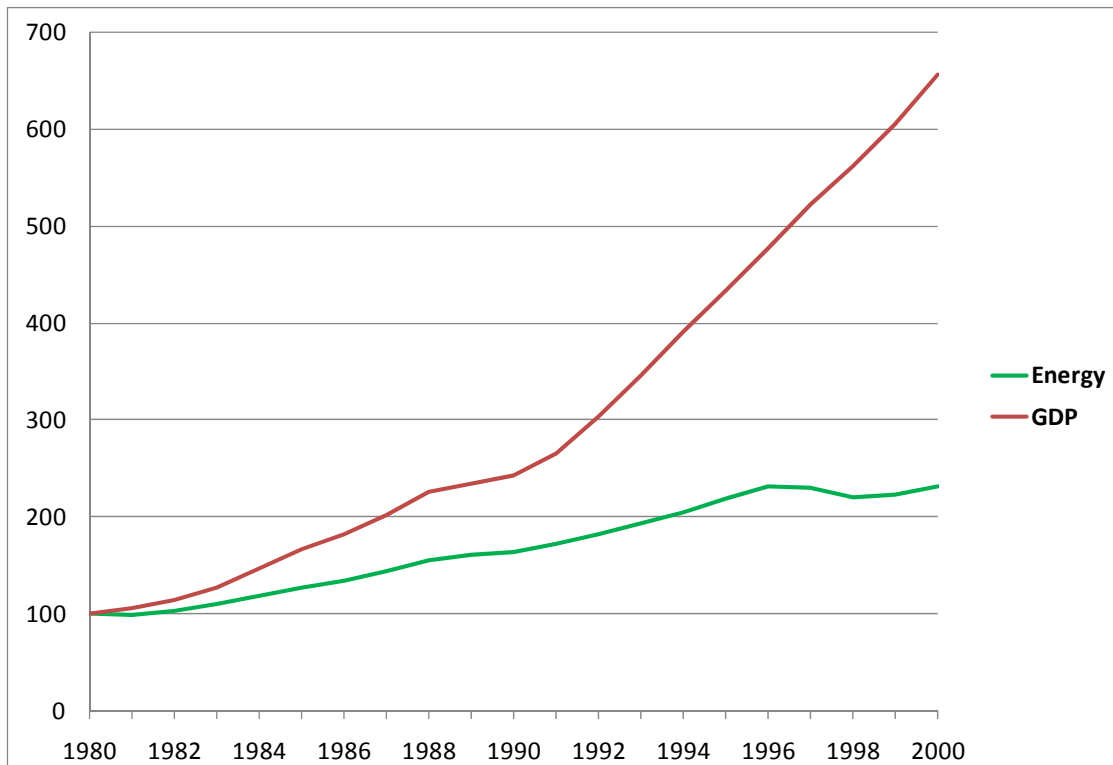


Deng's Initial Reforms (1980-1992)

- Key meetings among more than 100 academic energy experts in 1979 and 1980 stated:
 - China energy policy in crisis
 - need for radical reform
 - major changes identified:
 - (1) energy price reform, and
 - (2) serious attention to energy efficiency
- Government quickly implemented reforms in Sixth Five-Year Plan (1981-1985)



Primary Energy Use vs GDP Index, 1980=100 1980-2000



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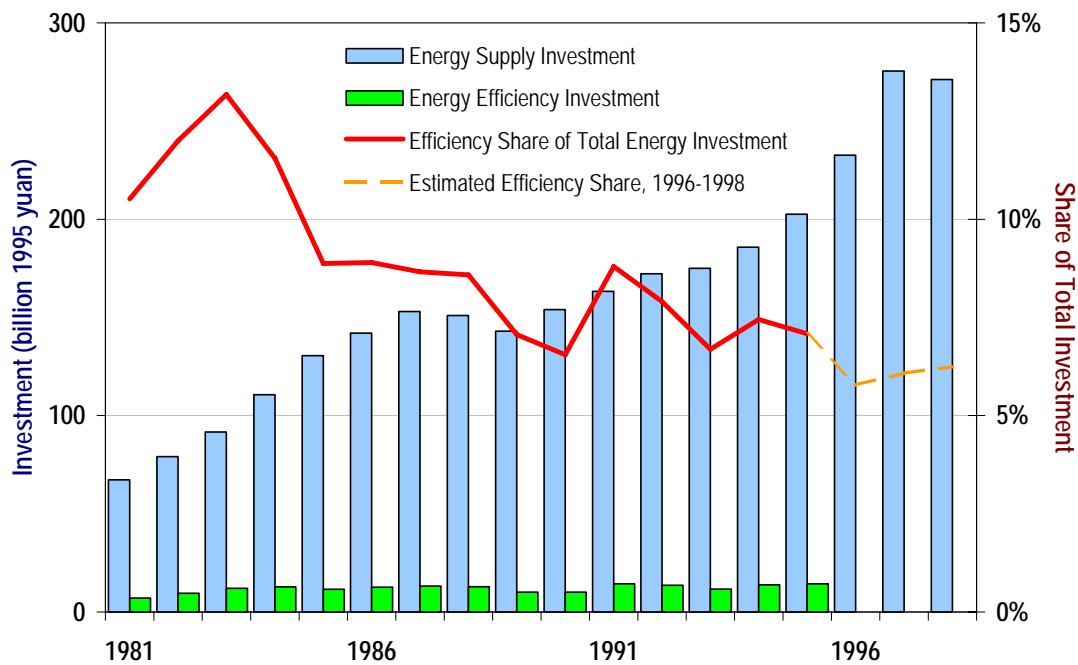
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Energy-conservation policies & measures in Phase II

- **Energy Management**
 - factory energy consumption quotas
 - factory energy conservation monitoring
 - efficient technology promotion
 - close inefficient facilities
 - controls on oil use
- **Financial Incentives**
 - low interest rates for efficiency project loans
 - reduced taxes on efficient product purchases
 - incentives to develop new efficient products
 - monetary awards to efficient enterprises
- **R D & D**
 - funded strategic technology development
 - funded demonstration projects
- **Information Services**
 - national information network
 - national, local, and sectoral efficiency technical service centers
- **Education & Training**
 - national, local, and sectoral efficiency training centers
 - Energy Conservation Week
 - school curricula

Energy efficiency investment is stable, but declining as share of total investment

Energy Supply and Energy Efficiency Investment, 1981-1998



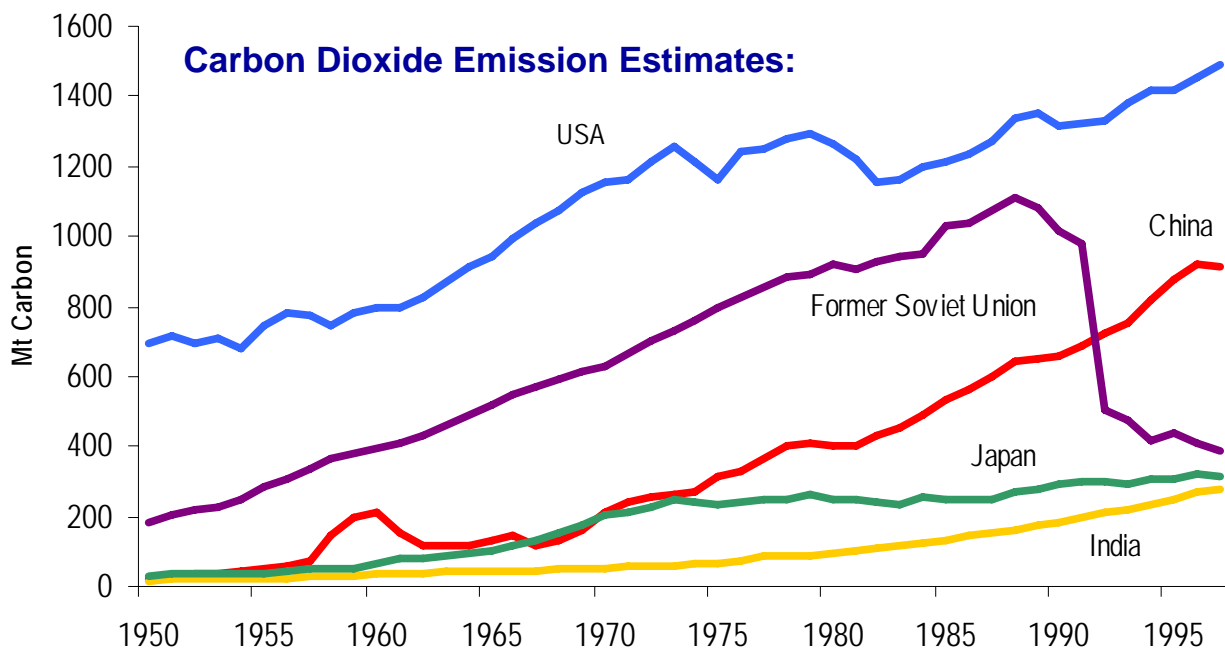
N.B. Only partial data on energy efficiency investments after 1995 are available. These partial data informed the estimates presented here of efficiency's shares of total energy sector investment for 1996-1998. All investment data are for state-owned units only.

Source: NBS, SPC

14



China's CO₂ emissions would have surpassed the US before 1990 if energy intensity had not declined



Source: ORNL

15



Transition period (1993 to 2002)

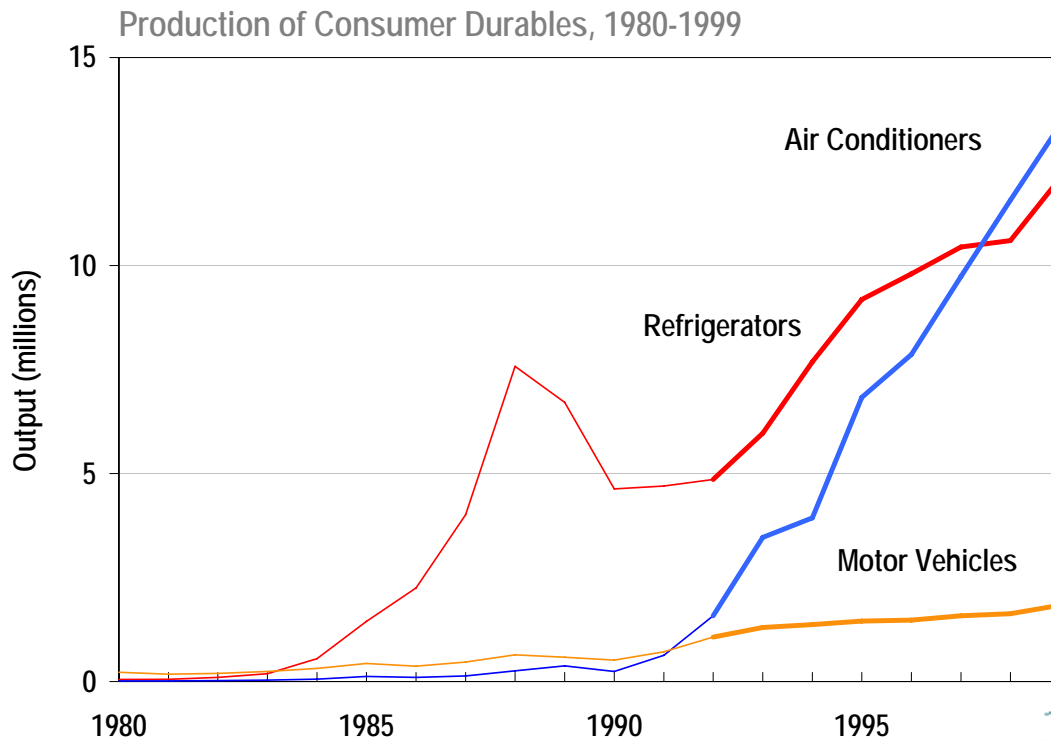
Rapid movement towards market-based system...

- Dramatic energy price reforms (raised all energy prices to consumers)
- Enterprise reforms increased price sensitivity

...but past successes in improving energy efficiency were based on mechanisms that were disappearing...

- Elimination of energy quotas
- Low incentives for monitoring in industry
- Difficulty in continuing energy efficiency loan subsidies
- New tax code (1994) eliminated tax breaks for efficiency

Take-off of consumer goods highlights the need for efficiency standards

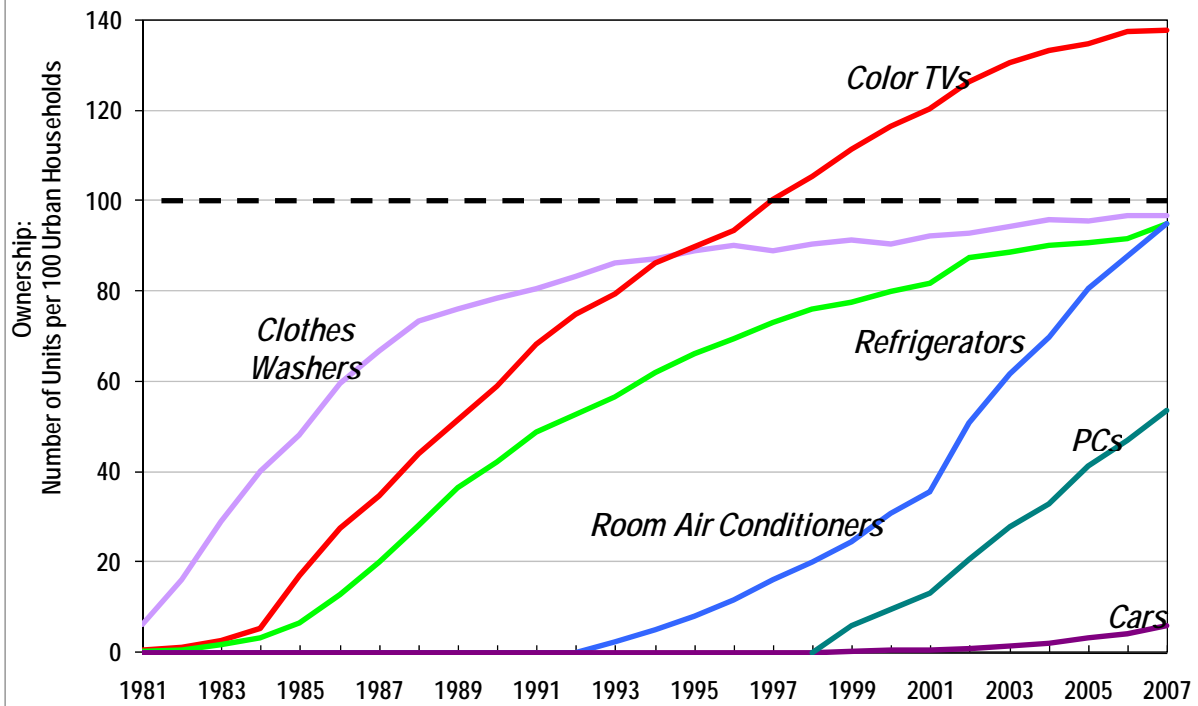


Source: NBS

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Appliance Saturation



Rural households lag urban households by 10-20 years

Part II: Energy Crisis in China: 2002 to present

**repeat of much earlier “inglorious
history”??**



Executive Summary (Part II)

- China faced a serious **new energy crisis**
 - Through 2005, most Chinese saw the **energy shortage** as the crisis
 - The real crisis was in **energy policy and much too-rapid energy demand growth** (just as in 1979)
- A key issue: how does China reduce energy demand growth and still meet requirements for energy services?
- Unless this problem is solved, China's economic goals will be placed in jeopardy and the **environmental consequences** of energy policy failure are truly frightening

Energy crisis: 2002-2005 and beyond

- **Energy demand growing** very, very fast
- **Widespread power shortage; extraordinary pace of construction of power plants**
- **Soaring coal prices**
- **Transportation bottlenecks** for coal
- **“Surge” in oil imports especially as oil is used in place of coal**

China Adds 2 power plants per week

- 101 GW added in 2006
 - 92 GW coal-fired
- Comparable additions in 2007 and 2008
- Annual additions ~ the combined capacity of UK and Thailand
- or twice California's capacity



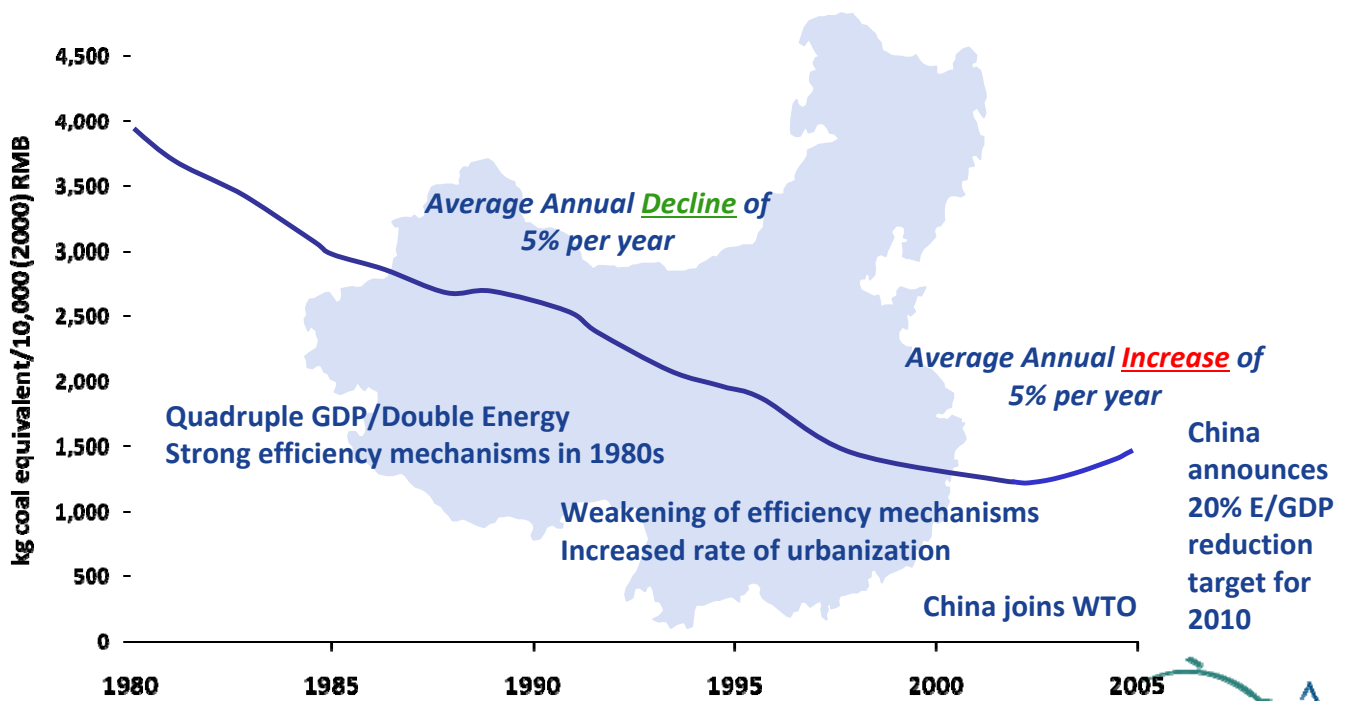
China's Energy and Development Goals for 2020

Goals (compared with 2000)

- GDP -- Quadrupling
- Urbanization -- 65% vs 35% now
- Energy Use -- Doubling

By 2005, it was already clear that the goal could not be realized.

Overview: Energy Intensity Trends and Policy Background



Source: National Bureau of Statistics, *China Statistical Abstract*, various years.

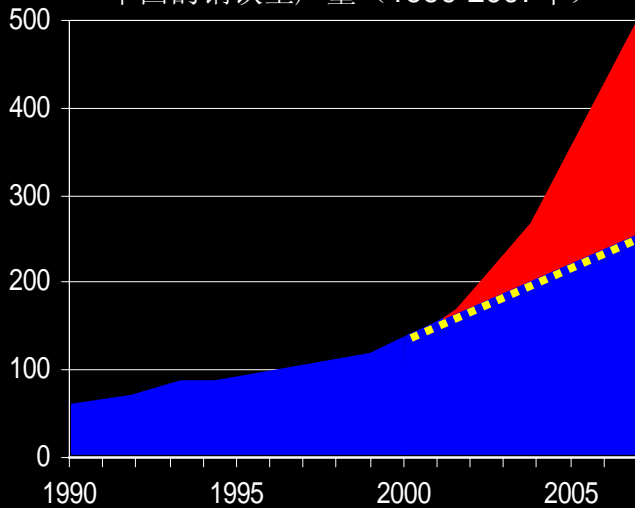


Coal Use & Energy-Related CO₂

煤炭消费与能源相关二氧化碳排放

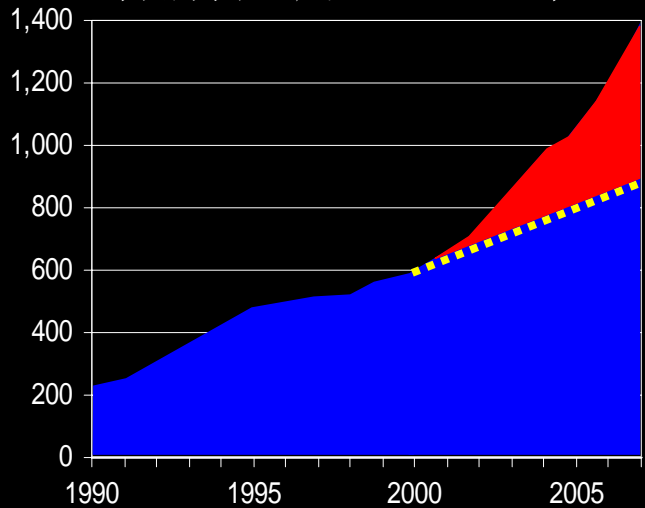
China's Steel Production 1990 – 2007

中国的钢铁生产量（1990-2007年）



China's Cement Production 1990 – 2007

中国的水泥生产量（1990-2007年）



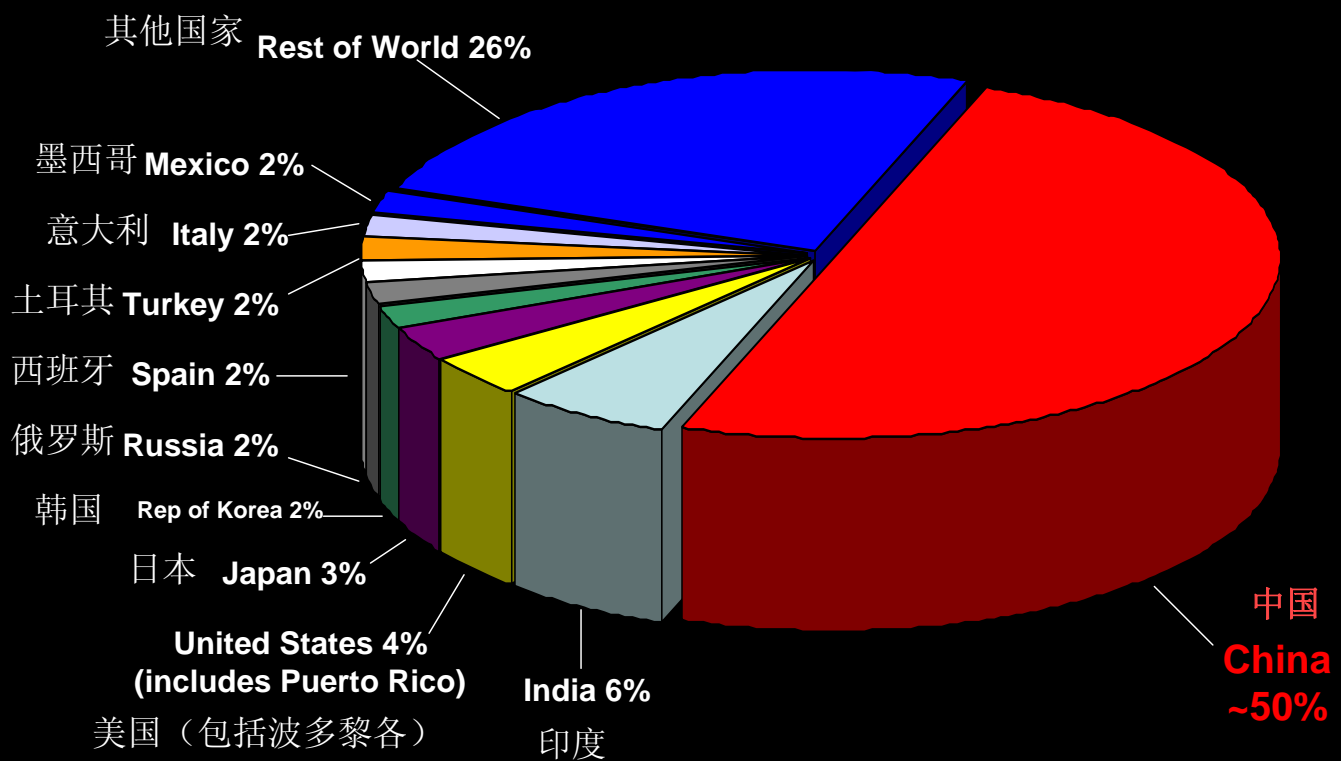
Million Metric Tons 百万吨

Source: China Iron and Steel Association; Institute of Technical Information for the Building Materials Industry; U.S. Geological Survey

数据来源：中国钢铁协会；建筑材料工业技术情报研究所；美国国家地质调查局

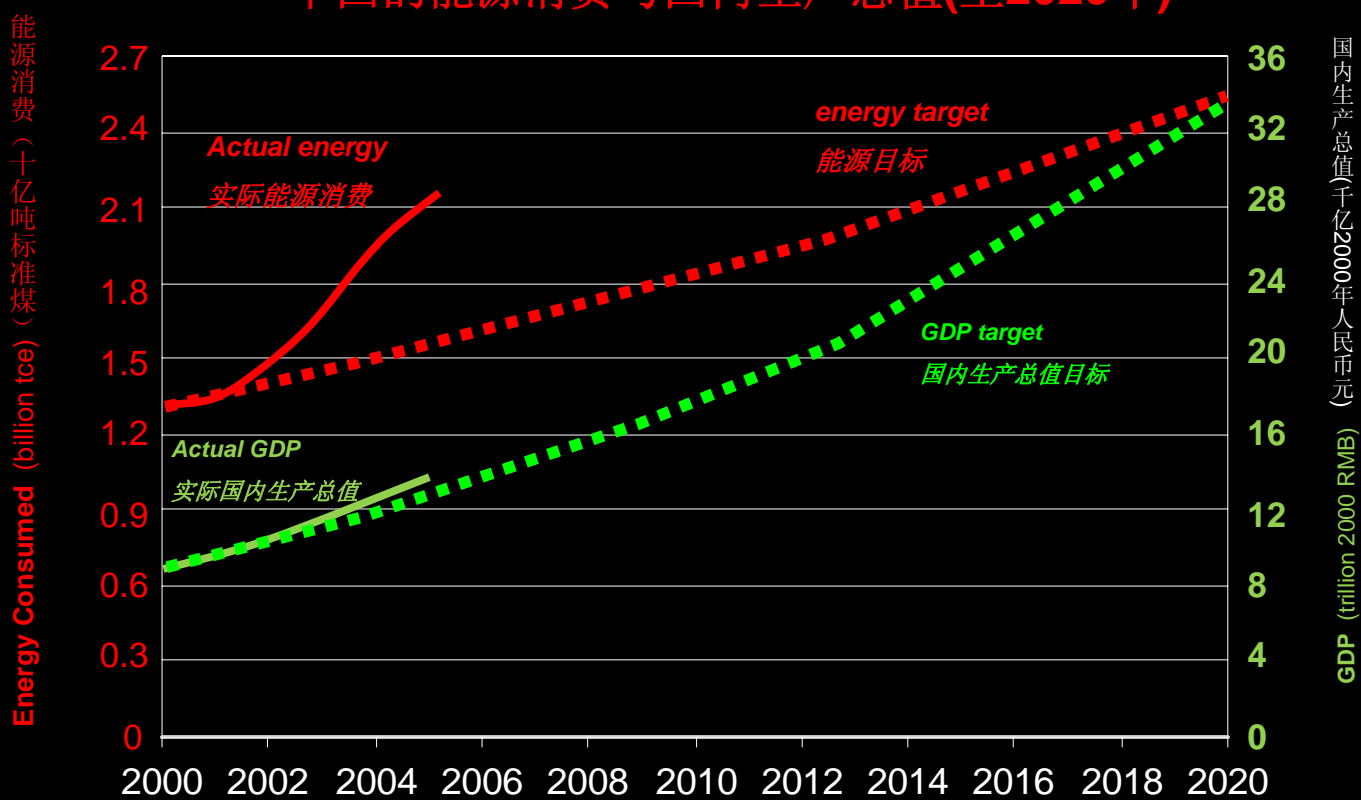
Cement Production Worldwide: 2007

世界水泥生产量2007



Source: U.S. Geological Survey 2008. Mineral Commodity Summaries: Cement; China National Bureau of Statistics, 2008
资料来源：美国地质调查局2008年。矿产品摘要：水泥；中国国家统计局2008年数据。

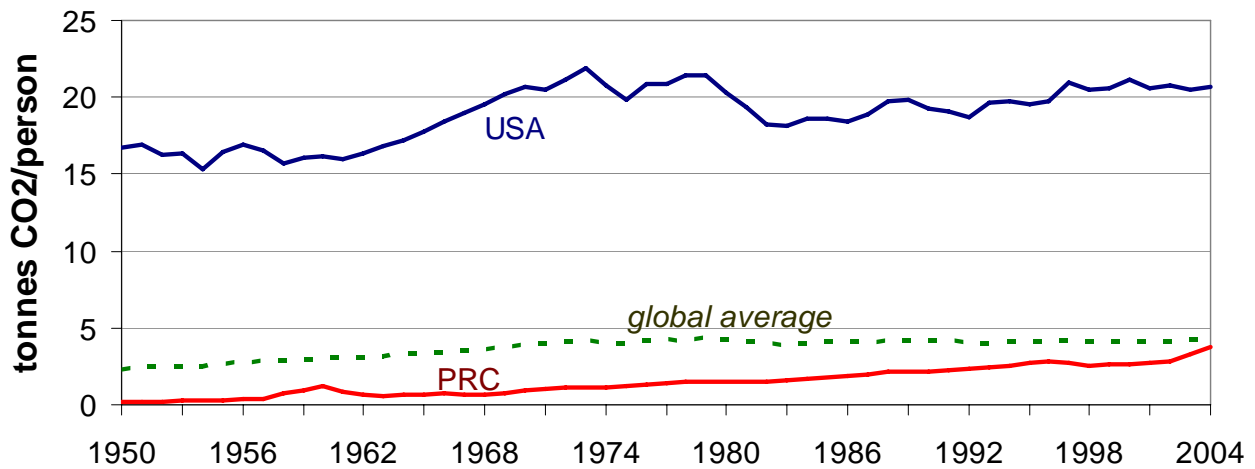
Energy and GDP, Path to 2020 中国的能源消费与国内生产总值(至2020年)



Source: NBS, China Statistical Yearbook, various years; China Statistical Abstract 2005; growth estimates extrapolated from mid-year production data for 2005; targets announced by NDRC

数据来源：中国国家统计局，中国统计年鉴（各年）；中国统计摘要（2005）；2005年增长数据是基于2005年年中生产数据通过插值方法得到的；目标基于国家发展与改革委员会公布的数据

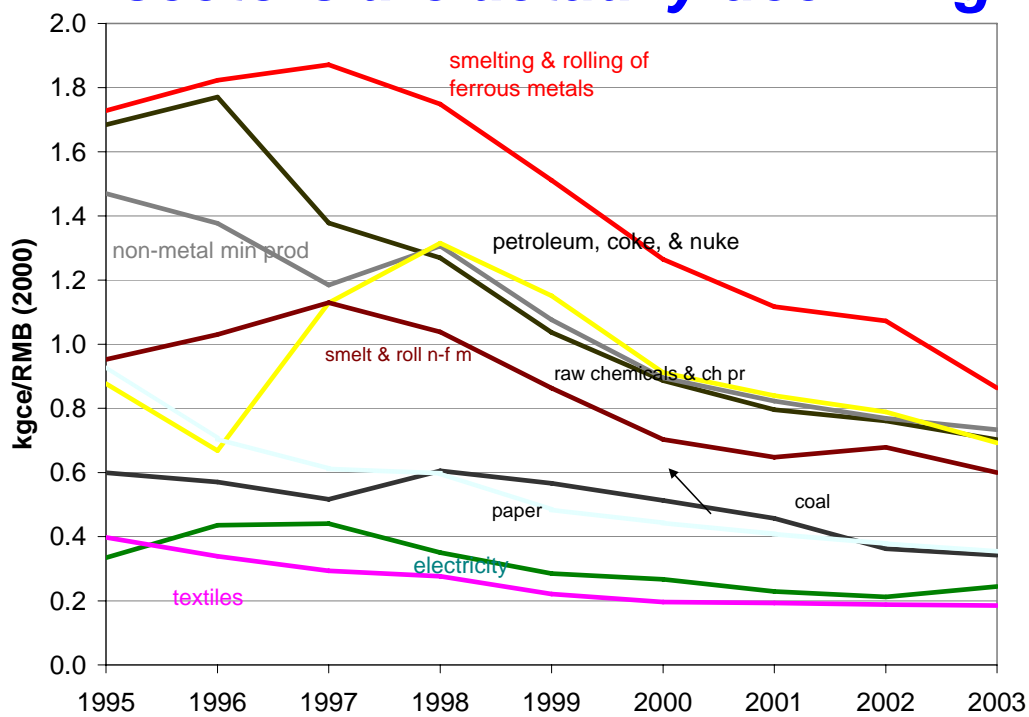
Figure 3: Global, Chinese, and American Per-capita Energy-Related CO₂ Emissions, 1950-2004



Source: China emissions are derived from revised total energy consumption data published in the 2007 China Statistical Yearbook using revised 1996 IPCC carbon emission coefficients by LBNL; China population data from NBS and US Census (for 1950-51); global and American emissions data from Oak Ridge National Laboratory, Carbon Dioxide Information Analysis Center; global and American population data from US Census.



Energy intensities within industrial sub-sectors are actually declining



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Part III: The Period after 2005



Executive Summary (Part III)

- **Things could get worse**
 - Actually they can't, but they could continue on the present path for some time
- **Things could get better**
 - There is some chance!!
- **Update: things are getting better**

China's Policies to Reduce Energy Use and Greenhouse Gas Emissions

Major policy initiatives were introduced in 2005 to reverse the trends in energy demand growth experienced from 2002 to 2005

In 2005, China Adopted an Energy Intensity Reduction Target

- November 2005: Premier Wen Jiabao at the Plenary of the Communist Party: “Energy use per unit of GDP must be reduced by 20% from 2006 to 2010”
- March 2006: Statement reiterated by the National Peoples Congress
- China’s 11th Five Year Plan (2006-2010): outlined goal of reducing energy consumption per unit of GDP by 20% between 2006 and 2010

Responsibility for Achieving 20% E/GDP Reduction Target

- Varying targets have been assigned to all the provinces, cities and counties in China to achieve the national energy conservation target
- Each province signed an agreement with China's State Council outlining their specific targets for energy conservation (both for the Five Year Plan and annually)
- Lower level governments in turn signed agreements with provincial governments

Responsibility for Achieving 20% E/GDP Reduction Target

State Council established a personnel evaluation system to enforce the achievement of the target:

- Officials from that do not meet energy conservation reduction targets cannot participate in annual rewards programs or receive honorary titles
- Officials will not be promoted if their jurisdiction fails to meet energy conservation targets (one-vote veto)
- Leaders in state-owned or state-controlled companies will not enjoy the benefits of annual evaluation award programs
- Provincial governments and companies are subject to the evaluation jurisdiction's high energy-consumption projects followed by an investigation by administrative bodies
- Deception in the reporting of results can lead to criminal charges

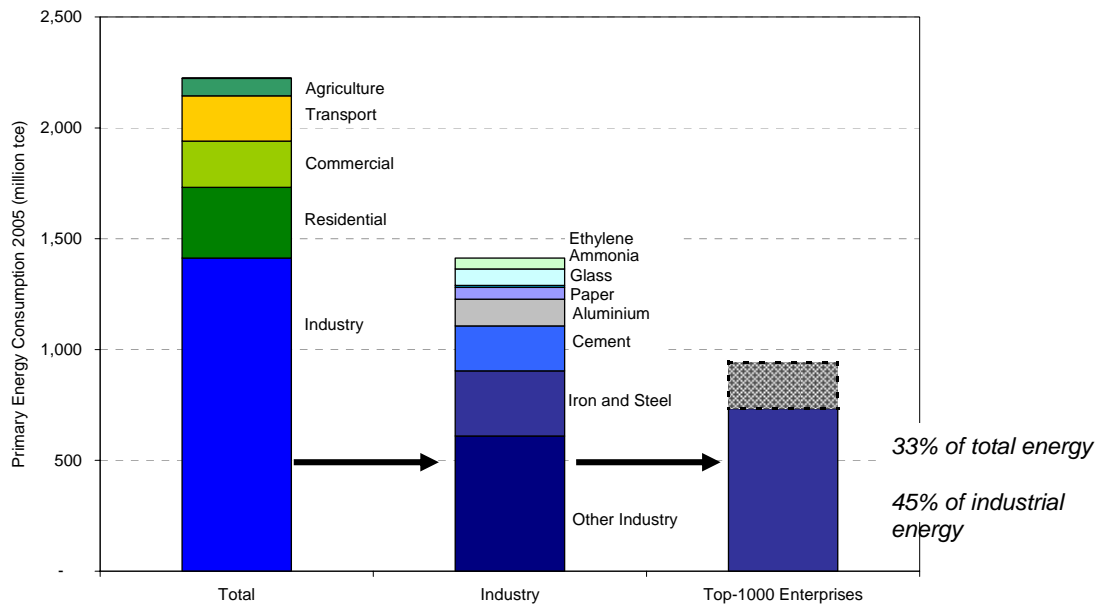
Reducing Energy Use in the Industrial Sector

- China's national-level government established the Top-1000 Energy-Consuming Enterprises Program
- Provincial and local governments signed agreements with about 100,000 smaller companies
- All companies using more than a certain threshold level of energy annually agreed to develop energy conservation targets and action plans



Top-1000 Enterprises Represent a Significant Share of China's Energy Use

Total energy savings goal for all Top-1000 enterprises is 100 Mtce (2.8 Quads) from their expected 2010 energy consumption.



Note: Top-1000 program energy consumption is typically reported in final energy units (dark blue box). The shaded area provides the Mtce equivalent of electricity generation, transmission, and distribution losses so that the Top-1000 program can be compared in primary energy terms with the other two bars. Industry sub-sector breakdown based on LBNL LEAP model, not Chinese statistics.

37 Note: Mtce >> EJ = 0.0293; EJ >> Quads = 0.9478



Rapid growth China's energy efficiency investment

- Feb. 18, 2010: The gross output of China's energy efficiency services industry **increased 40.8% year** on year to **RMB 58.8 billion** (\$8.8 B) last year (2009), according to statistics released by the China Energy Conservation Association.
- Last year, the government's comprehensive energy-saving investment was **RMB 36.0 billion** (\$5.3B), **up 42.3%** from RMB 25.3 billion (\$3.7 B) in the previous year.
- The government incentives drew forth **100 B RMB** (\$14.7 B) investment from industry
- Investment in energy performance contracting in China surged 67.4% year on year to **RMB 19.5 billion** (\$2.9 B) last year

http://www.chinaknowledge.com/Newsires/News_Detail.aspx?type=1&NewsID=31392



Comparison with Wind and Nuclear Investments

Very rough estimates of investment in wind and nuclear:

Wind: 10 GW/yr x RMB 4 billion/GW = **RMB 40 billion/yr**

Nuclear 7 GW/yr x RMB 14 billion/GW = **RMB 100 billion/yr**

Energy efficiency is presently **>RMB 150 billion (\$22B)/year** and growing rapidly!



Electric Power Sector Policies

China has adopted a number of innovative policies that aren't found in most countries

- “Differential pricing” sets electricity prices for energy-intensive sectors based on energy efficiency and has resulted in thousands of inefficient plants being closed
- “Environmental dispatch” means low carbon and clean plants are dispatched first
- Energy Efficiency Power Plants (EPPs) are virtual power plants made of energy efficiency projects – China has EPP pilots in 5 provinces
- Grid-connected renewable energy with preferential feed-in tariffs (60% higher than that for coal-fueled power generation)

Low Carbon Energy Sources

- Renewable Energy
 - Renewable Energy Law enacted in 2006
 - National targets: 10% of total primary energy in 2010 will be from renewable energy, increasing to 15% by 2020
 - Wires charge for Renewable Energy fund doubled to 0.03 cents/kWh
 - More than 170 GW of hydro power has been commissioned; expected growth of about 300 GW by 2020, and 400 GW by 2030
 - Largest producer and user of solar water heaters in the world with over 120 million square meters of solar heat collectors in use, saving 20 million tons of coal per year
 - Largest producer of PV cells for the world
 - Aggressive new solar PV incentives announced in April 2009
- Ambitious nuclear power development plan
 - More than 60 GW new nuclear power plants will be constructed and commissioned by 2020
 - Advanced nuclear power technology being introduced



Recent Achievements in China

With these strong policies and programs, China has been able to reverse the increase of energy use per unit of GDP and has made remarkable progress in improving the country's energy efficiency, reducing energy-related GHG emissions at the same time



Current Situation

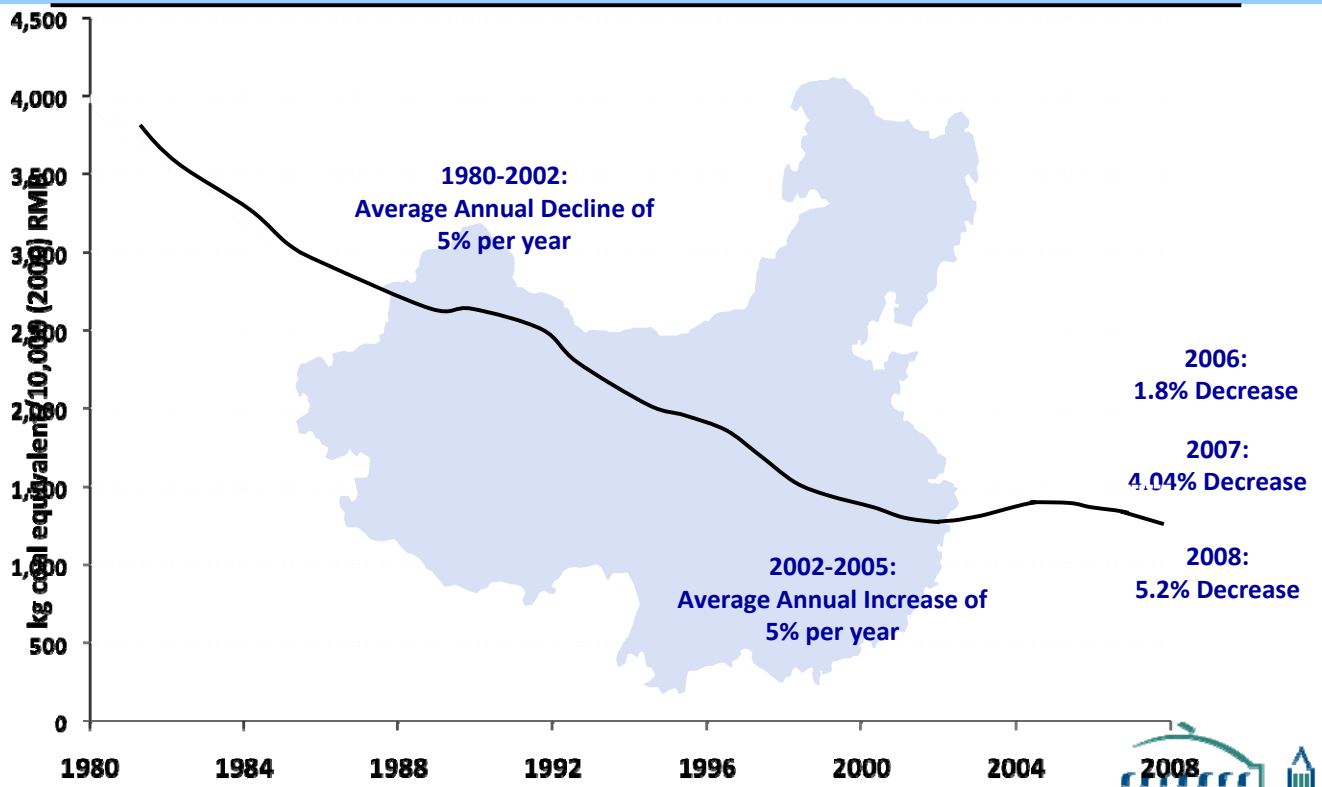
Energy Efficiency Programs - 11th Five Year Plan

- **Top-1000 Program**
 - Goal: savings of 100 Mtce in 2010
 - 2009: program has reached goal of 100 Mtce savings (~ 250 MtCO₂)
- **Ten Key Projects**
 - Boiler retrofits, CHP, waste heat recovery, motor systems, green lights, government procurement, etc.
 - Goal: savings of 250 Mtce in 2010
- **Buildings Energy Efficiency**
 - Minimum efficiency standards, efficiency retrofits, heating system reform, energy management
 - Goal: savings of 100 Mtce in 2010
- **Appliance Standards and Labels**
 - ~ 30 minimum efficiency standards, plus energy efficiency labels
 - 80 Mtce savings will be realized during 11th FYP
- **Small Plant Closures**
 - 13 industrial sectors
 - Goal: savings of 118 Mtce by 2010

Recent Achievements in China

- Economic growth and energy consumption decoupled
- Energy intensity decreases
 - 1.69% in 2006
 - 3.66% in 2007
 - 4.59% in 2008
- 20% energy/GDP target will be difficult to meet because of increase in heavy industry in 2009; however, China is likely to achieve 17%-19% reduction

Current Situation



The story will be continued, as China pursues all avenues to meet its demand for energy services while continuing its policy of aggressively promoting energy efficiency



Myths and Realities about Energy and Energy-Related CO₂ Emissions in China



Motivation for Discussion of Myths 关中国 的

- **Co-operation between the U.S. and China on reducing CO₂ emissions is essential**
- 中美 的 CO₂排放是至关 要的
- **This requires trust between the two countries**
- 要中美 的
- **Mistrust of China in the United States on the topic of climate change is fueled by rampant misinformation**
- 大量的 中美 化 的
- **Thus, dispelling these myths is of high importance**
- , 是 要的

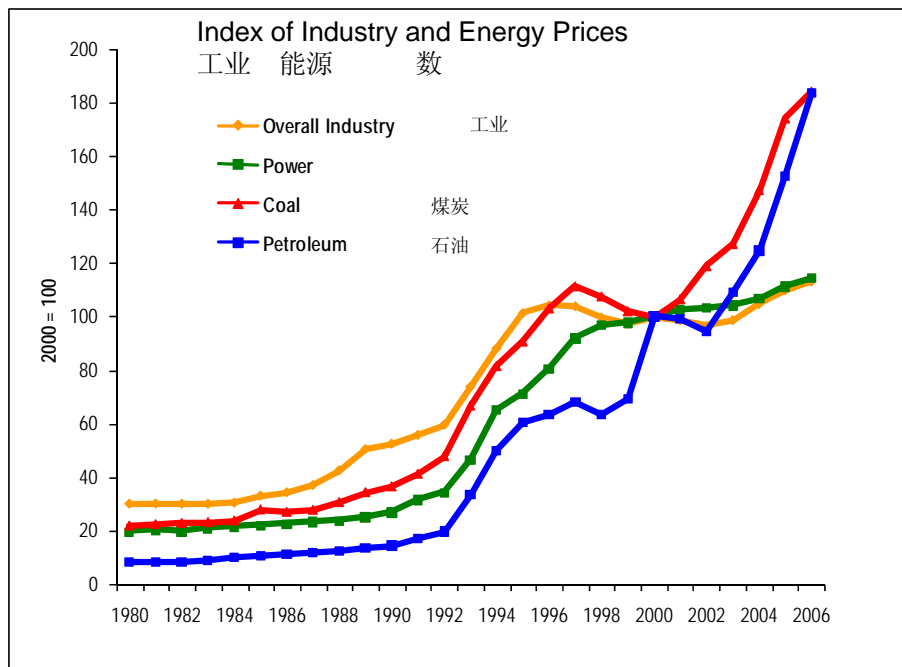


Myth: China's subsidized energy prices give firms a competitive edge

: 中国能源的公

Reality: China's energy prices are mostly at international levels or higher

: 中国的能源于国际水



Residents of Guangzhou pay more (\$0.16/kWh) for electricity than residents of San Francisco (the US) (0.16美元/度)

Natural gas prices in Shanghai are the same as in San Francisco (\$10/mcf) (与美国的相 (\$10美元/1000方))

Coal prices in China (\$147/t) are now higher than in the US (中国的煤炭 (\$147美元/吨) 美国的)

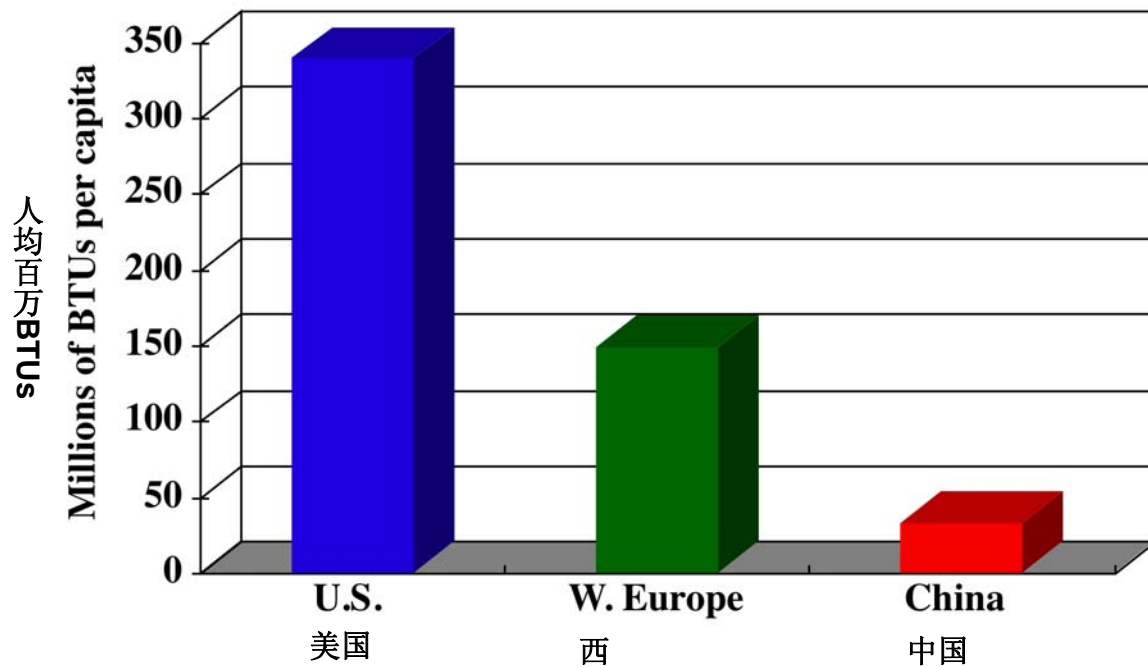


Myth: China is profligate in its use of energy and becoming more so

: 中国地能源得费

Reality: Per capita energy use in China is only 1/8 U.S. & 1/4 EU

: 中国的人均能耗量 美国的1/8, 的1/4

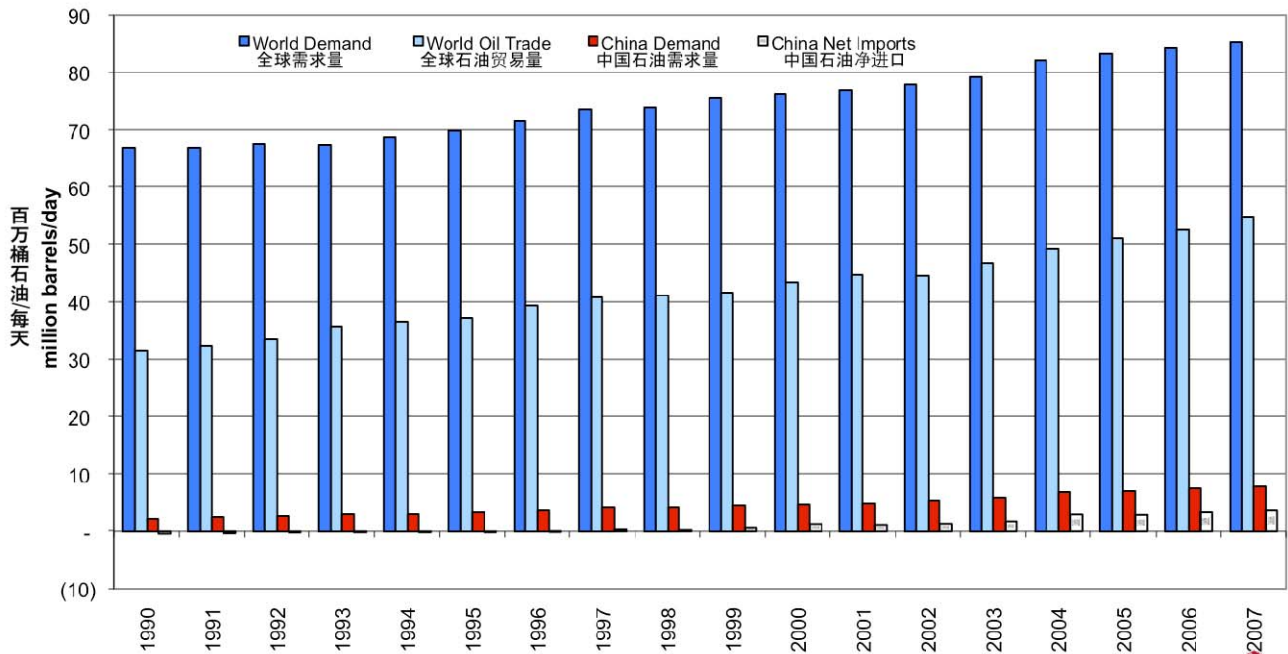


Myth: China is hogging the world's oil imports

: 中国 世界的石油 源

Reality: China's imports, while growing, remain a very small part of traded oil on world markets

: 中国的石油 , 增长, 世界石油 的

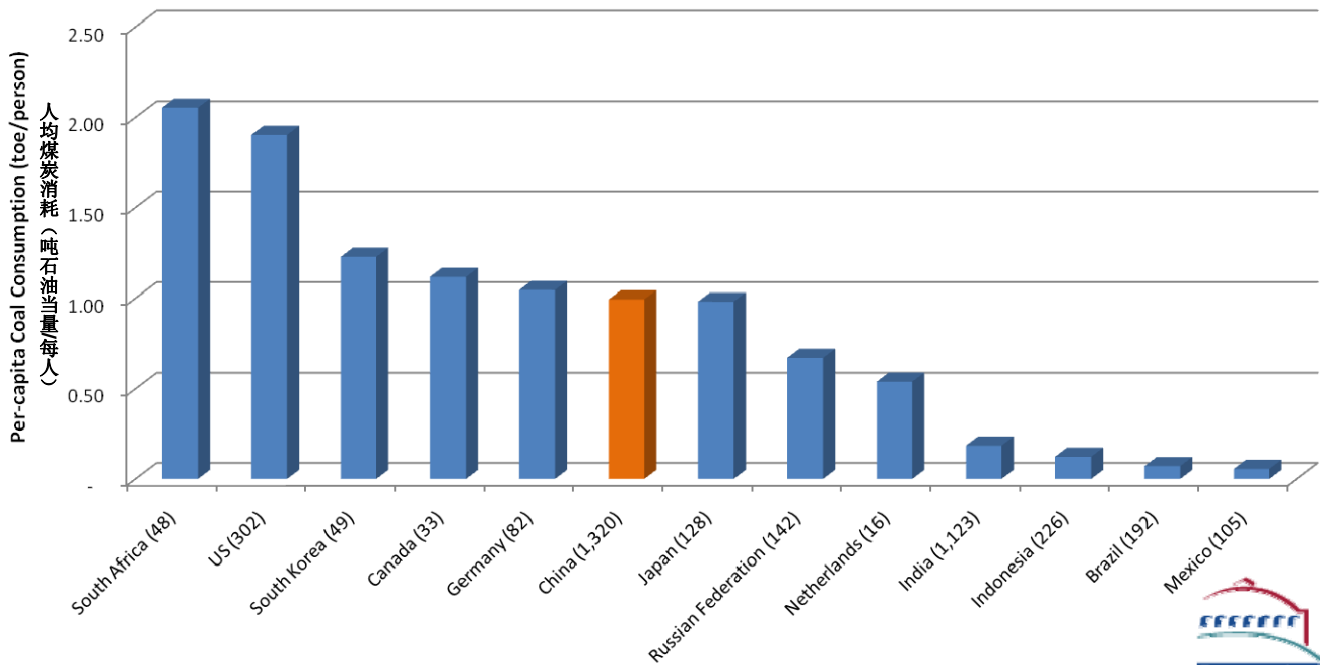


Myth: China's vast consumption of coal dwarfs any global attempt to address climate change emissions

: 中国大量的消耗煤炭 得 化的 大大

Reality: On a per capita basis, China consumes just slightly more than half as much coal as the U.S.!

: 人均水 ， 中国消耗的煤炭 美国水 的 多



Source: BP Statistical Review of World Energy 2008; World Bank, World Development Indicators database 2008.



THE END

(almost)



The Reason for My Optimism: Skills Only Found in China

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