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Chinese Transportation Fuels and CO_2 Emission Implications

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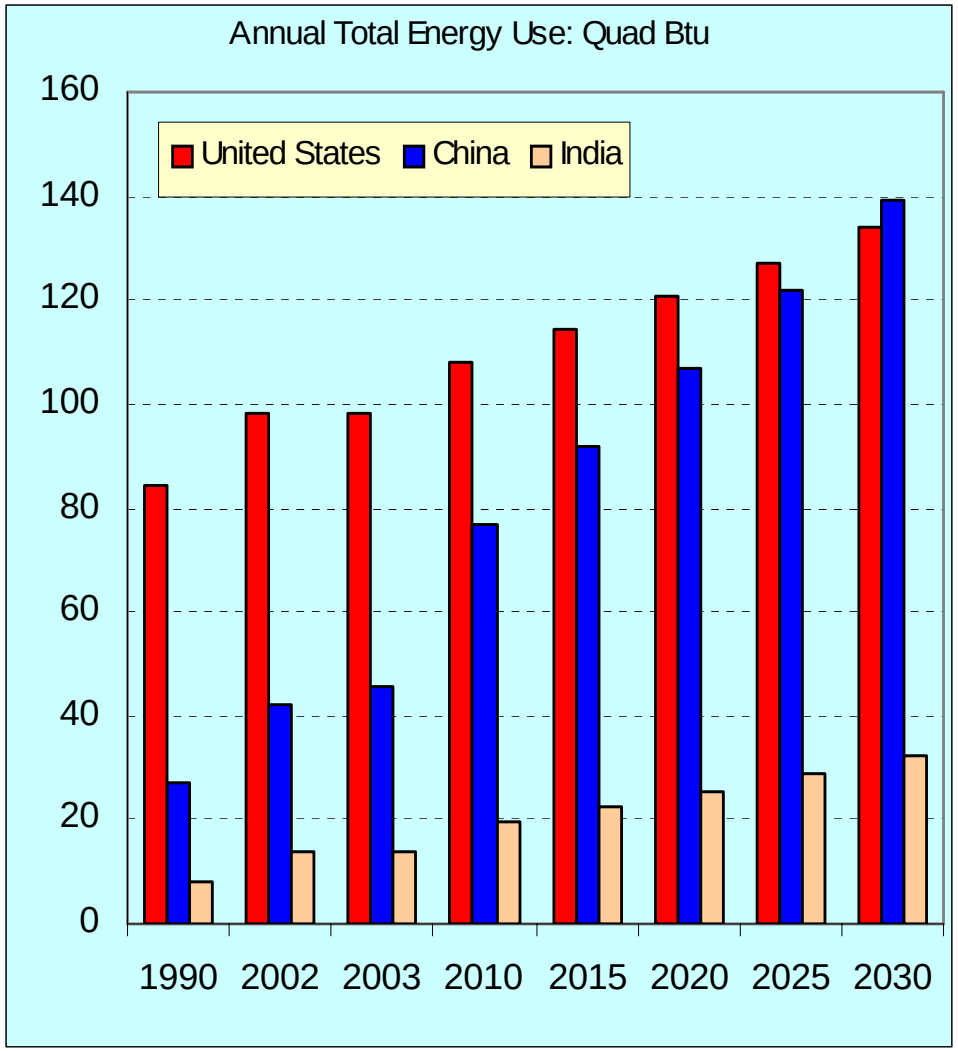
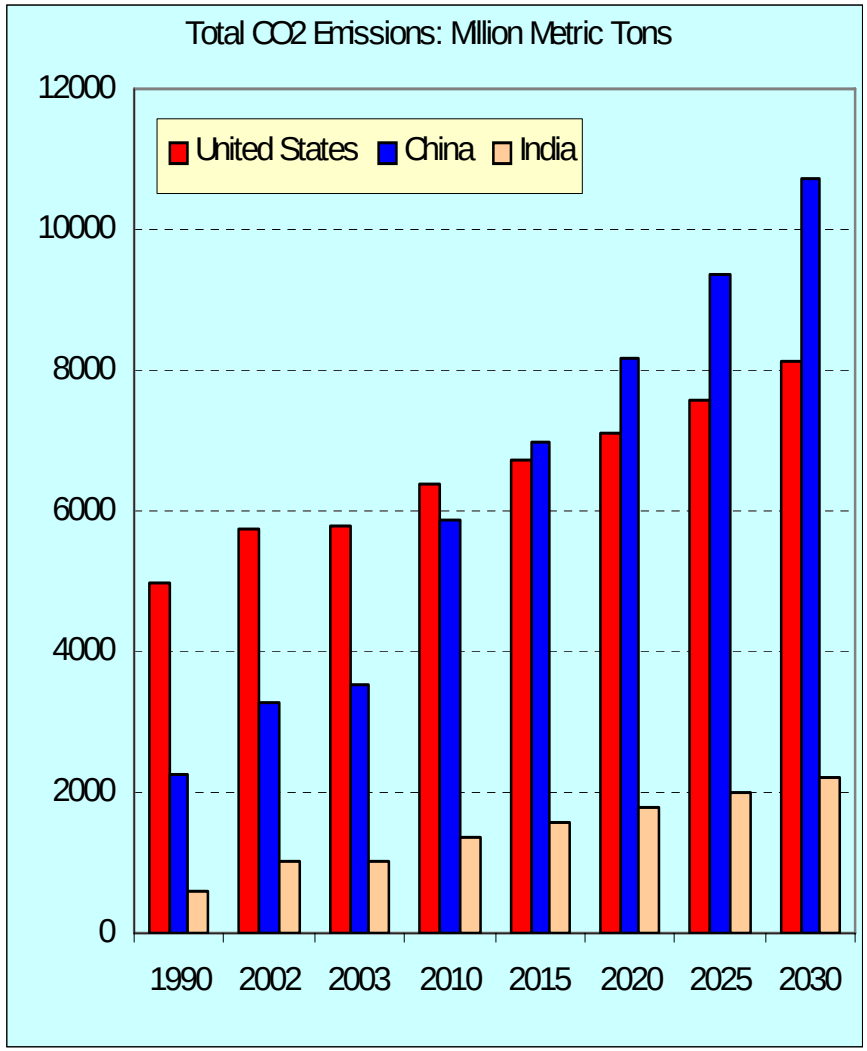
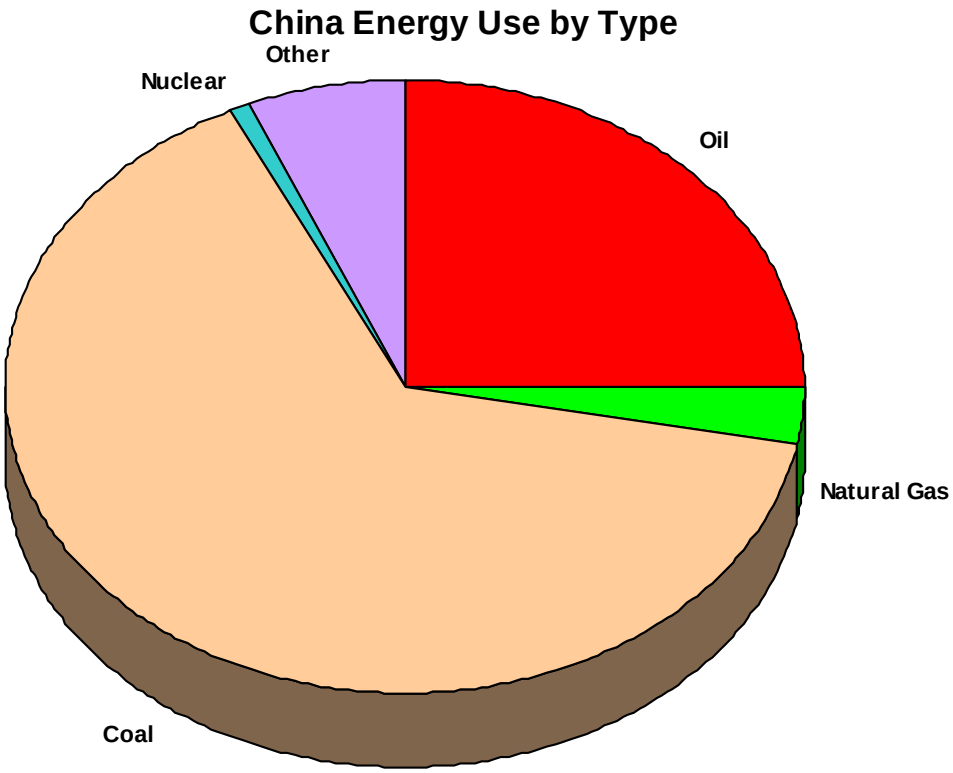
The U.S. and China Will Be the Top Two Energy Users and CO2 Emitters

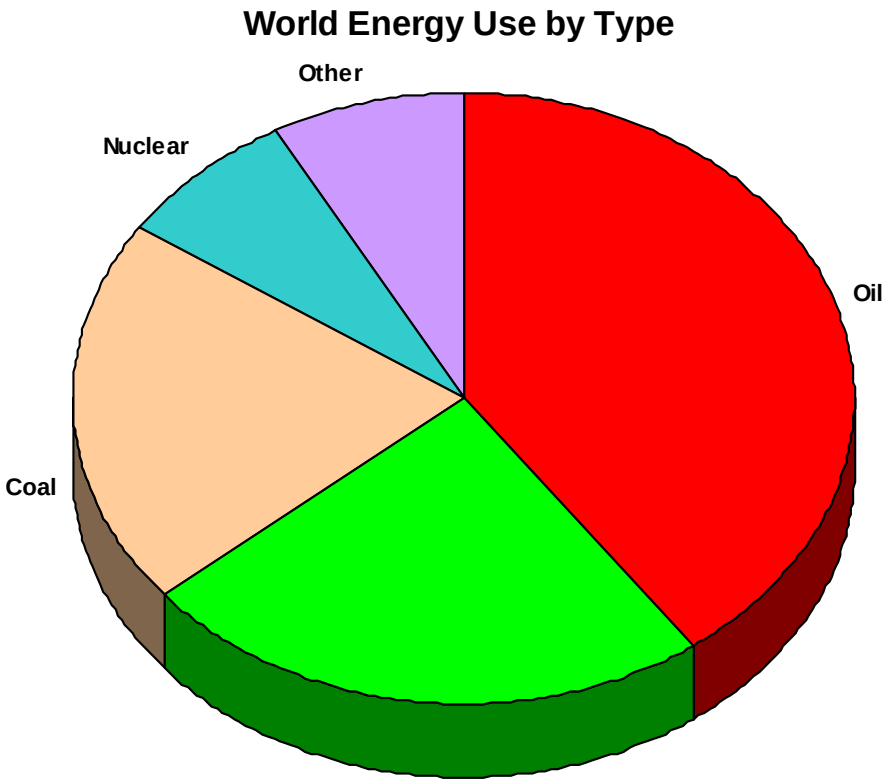




Source: Energy Information Administration 2006

China Depends Heavily On Coal for Its Energy Supply

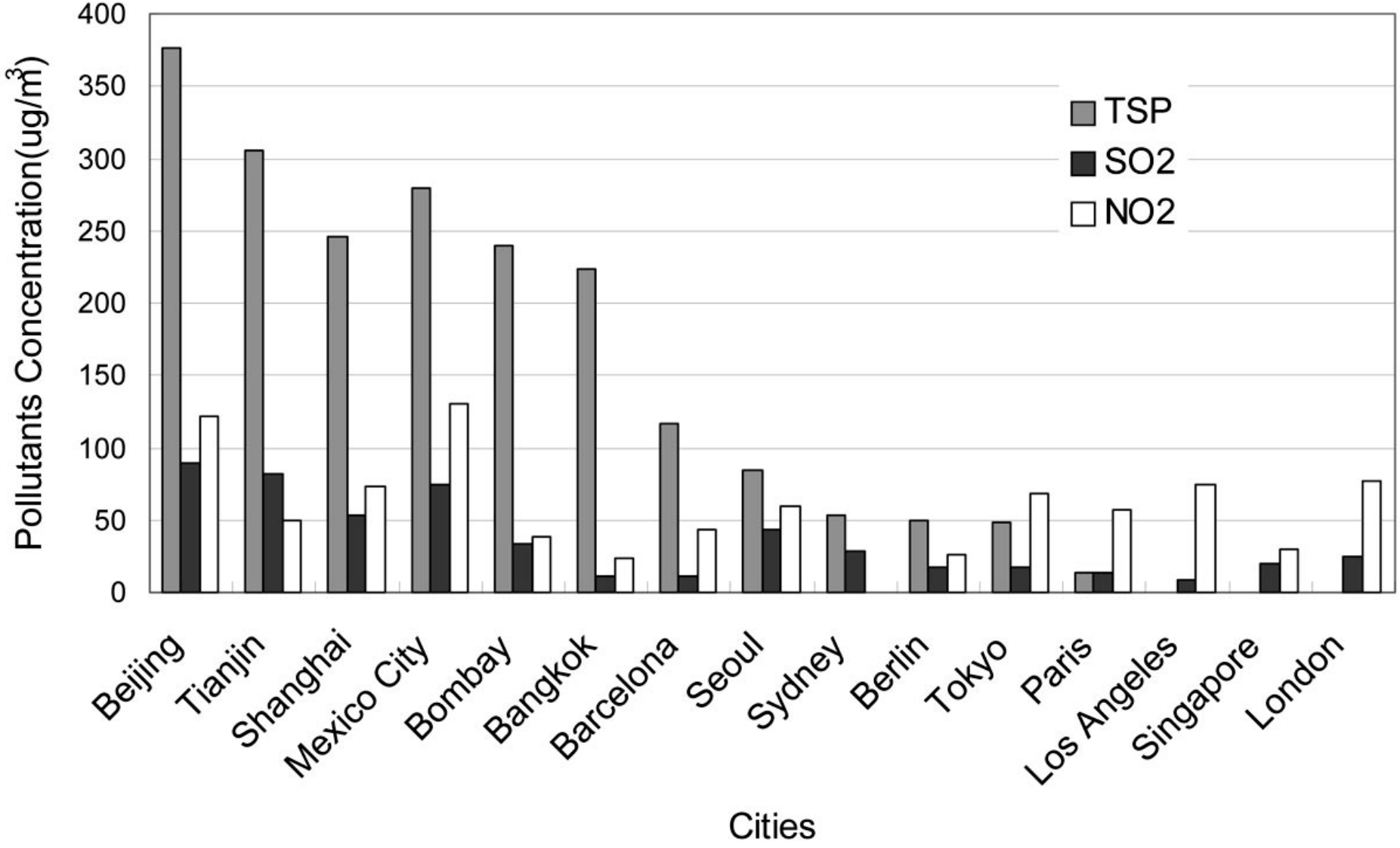




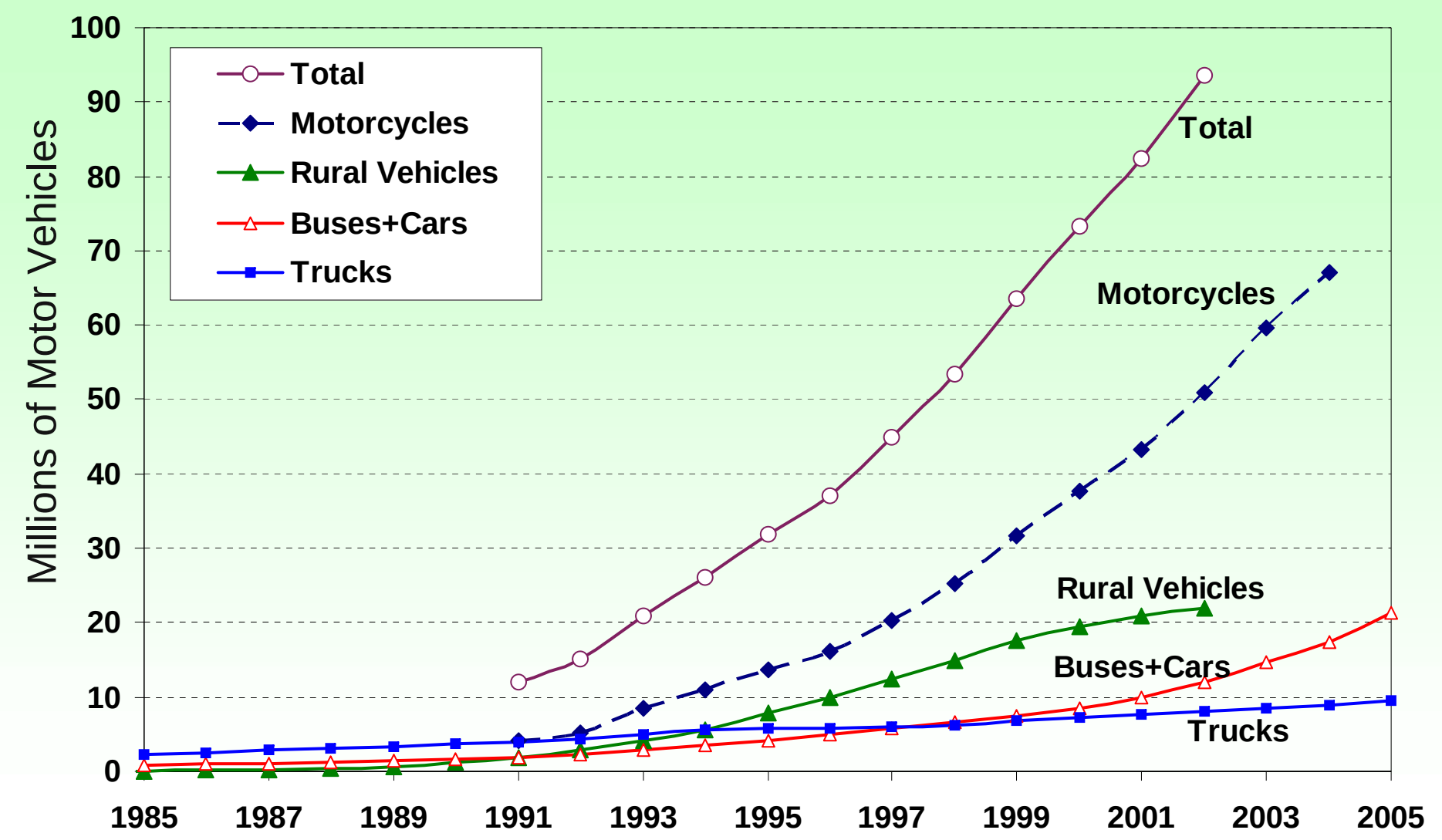
Source: Energy Information Administration 2006

- China is short of oil and natural gas, but rich in coal
- Of the total energy resources available, coal accounts for 87.4%, oil for 2.8%, natural gas for 0.3%, and hydropower for 9.5%
- Of the total energy supply to Chinese economy, coal accounts for 70%, this will be the situation for a foreseeable future

The World's Top Three Polluted Cities Are in China

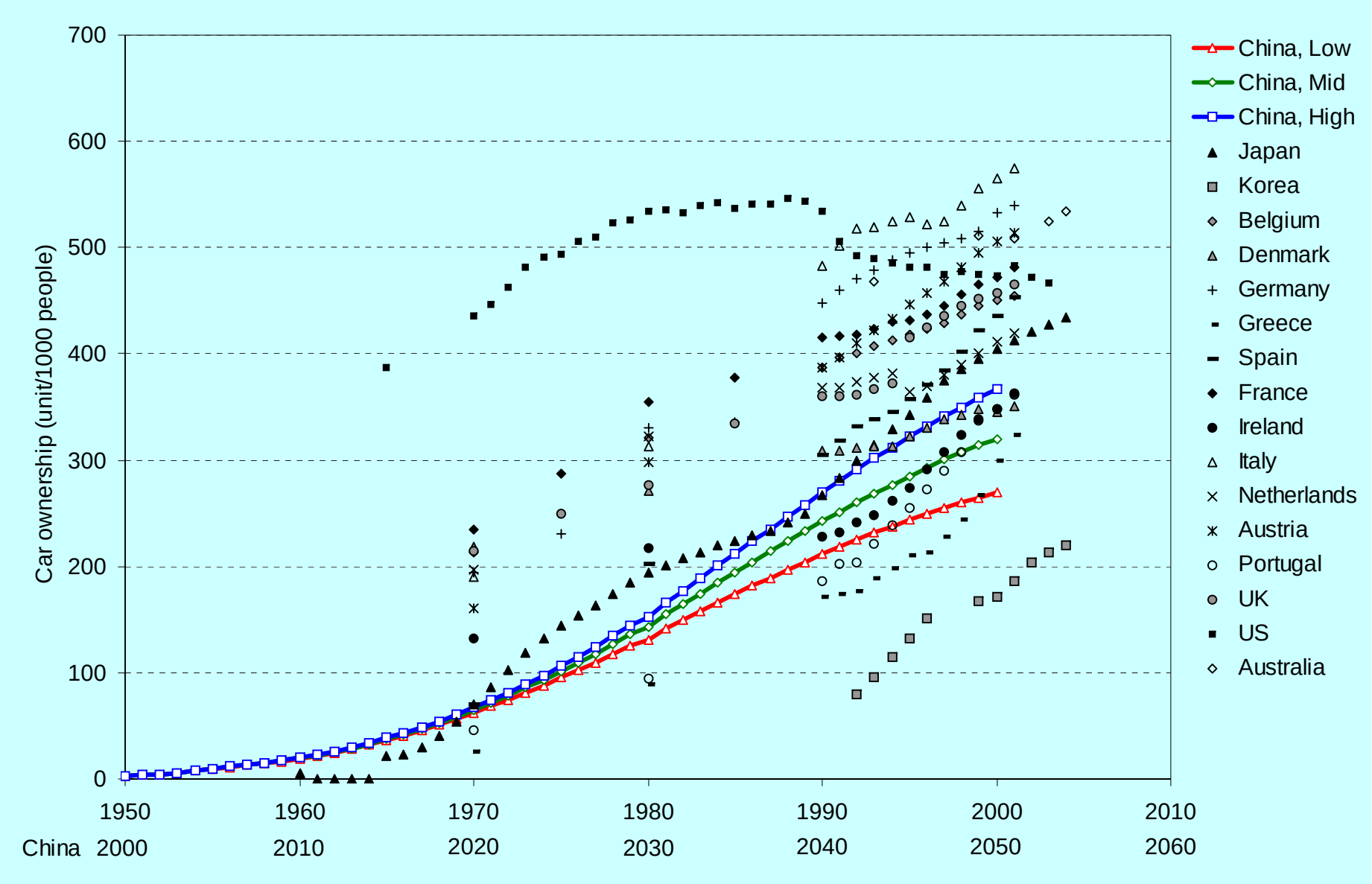


Though Growth in Chinese Motorcycles Has Been Rapid, Growth in Cars Has Begun Recently

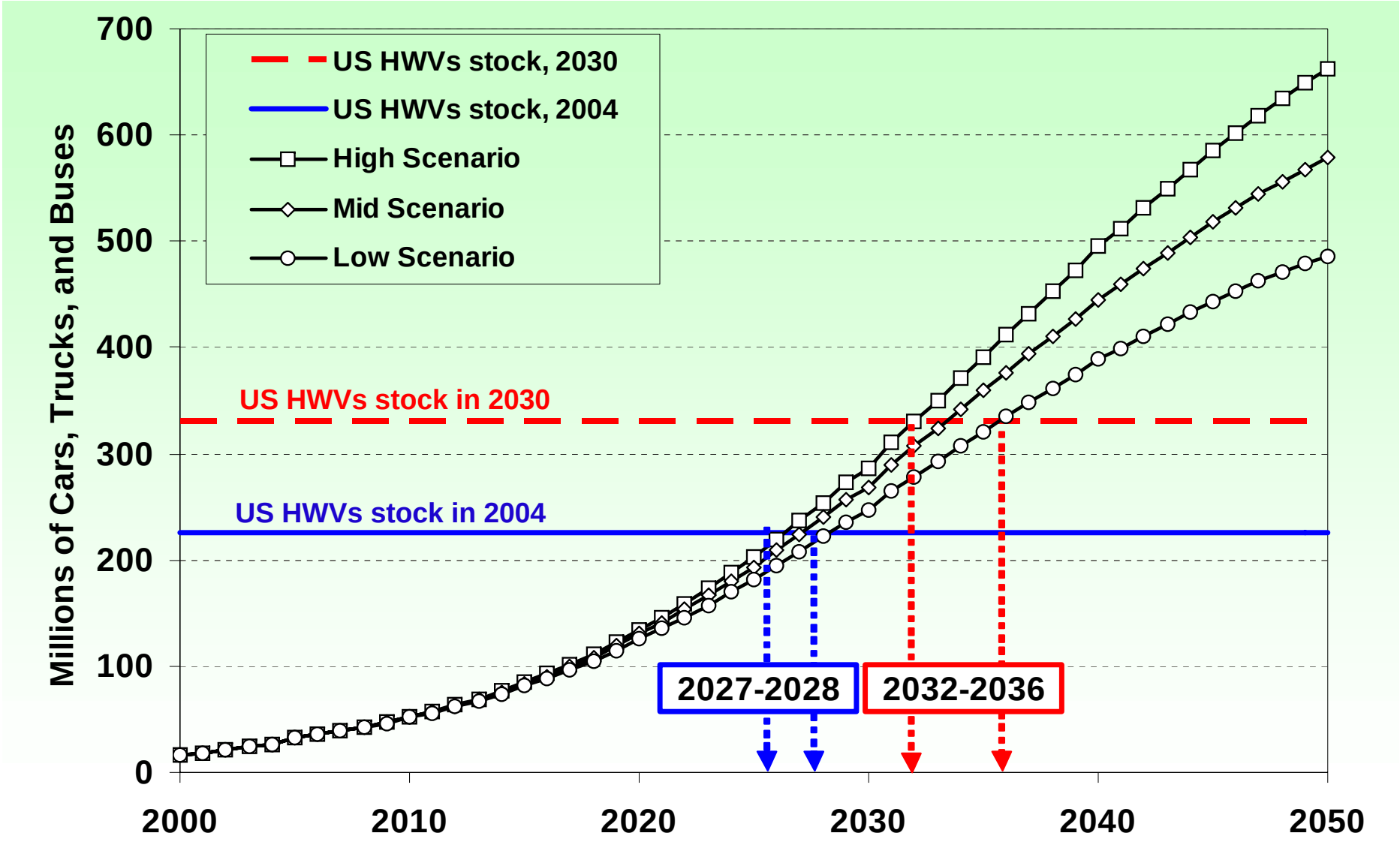


Sources: China Statistics Yearbook 1995-2005; China Statistics Abstract 2006; rural vehicle population was derived from MMIC (1997) and CATARC (2002)

Car Ownership Across Countries Indicates That China Will Experience Rapid Vehicle Growth

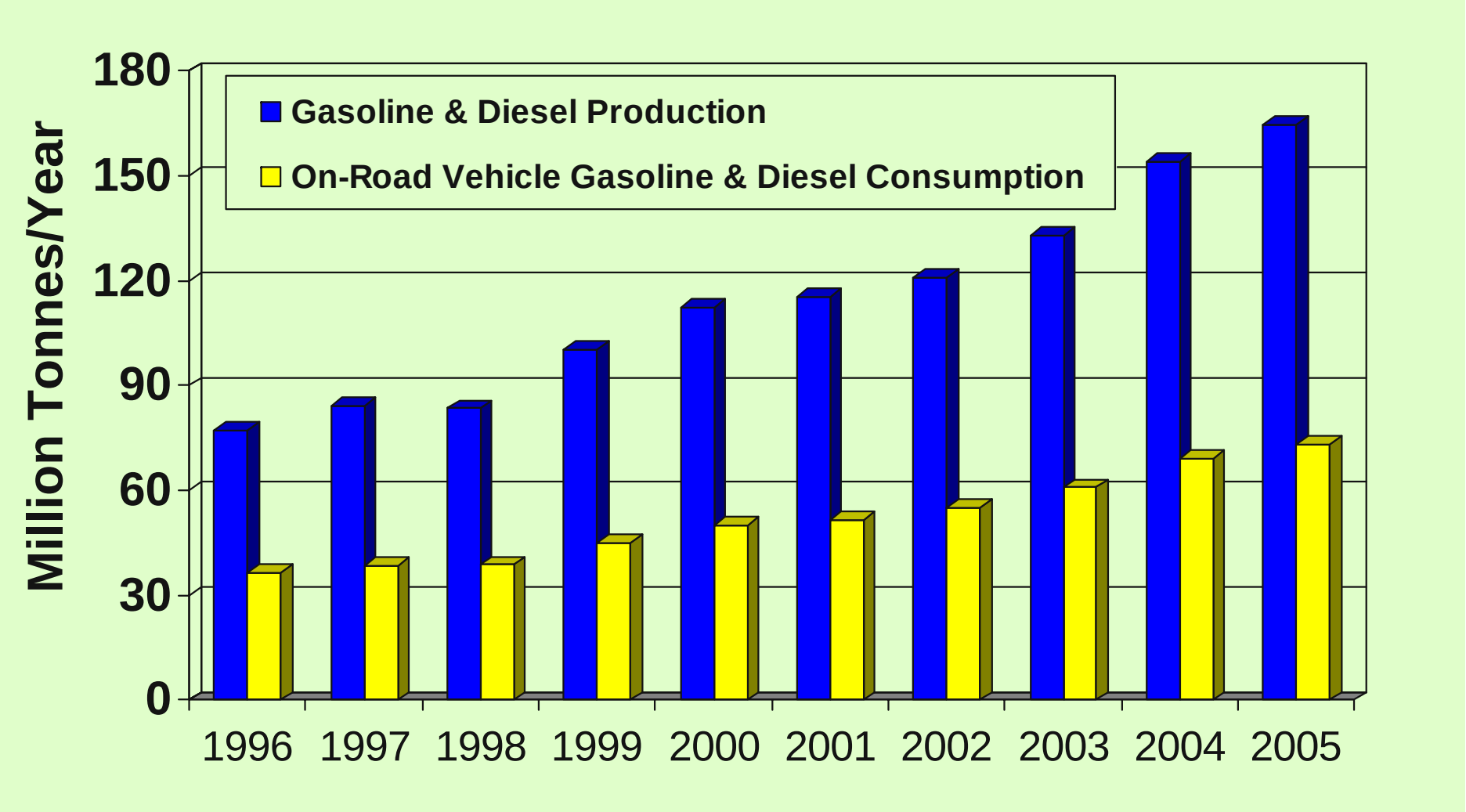


Argonne Projects That Chinese Highway Vehicle Population Could Exceed U.S. Population in 2030s

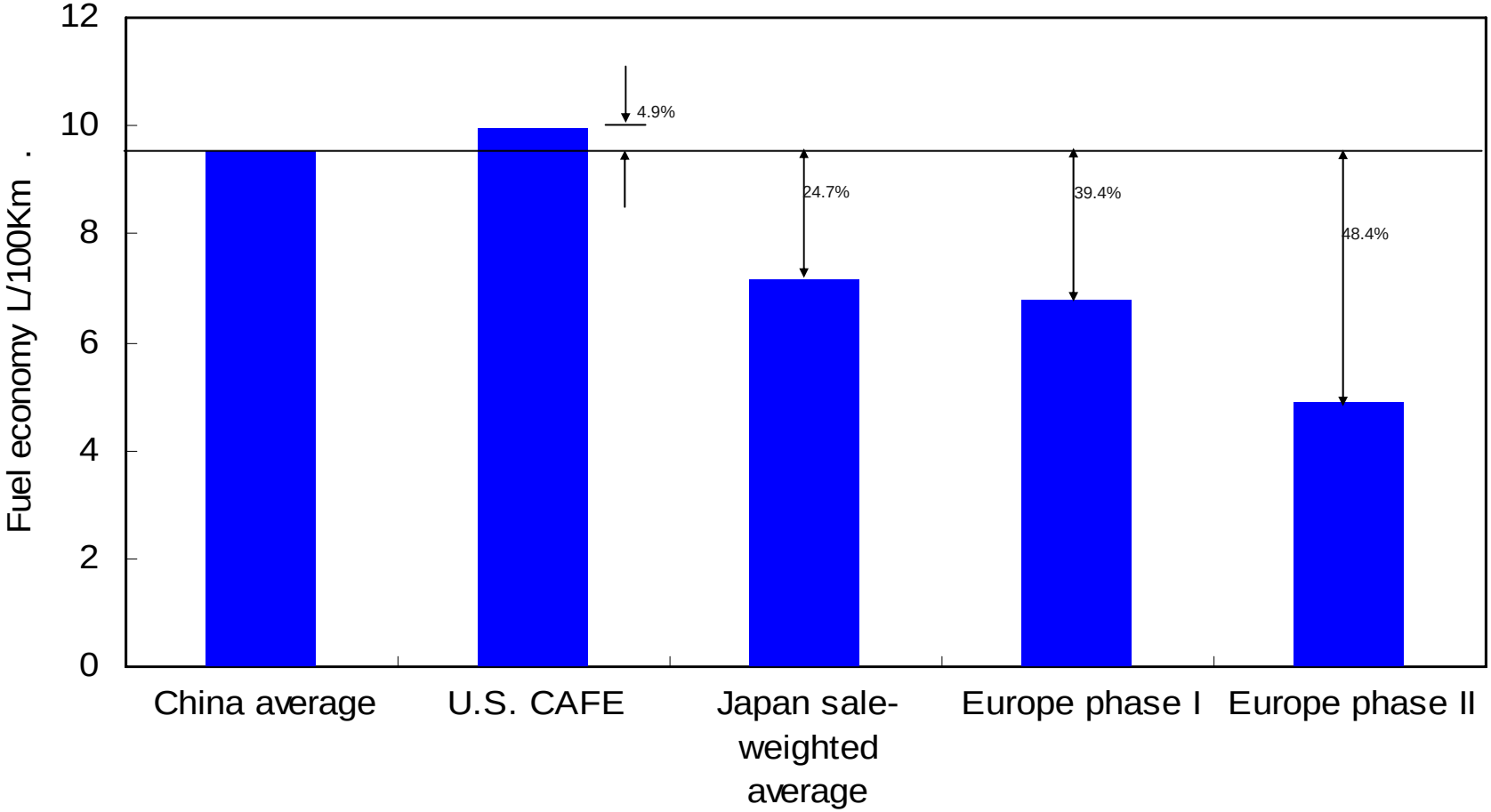


U.S. data sources: Davis et al, 2006; EIA, 2006

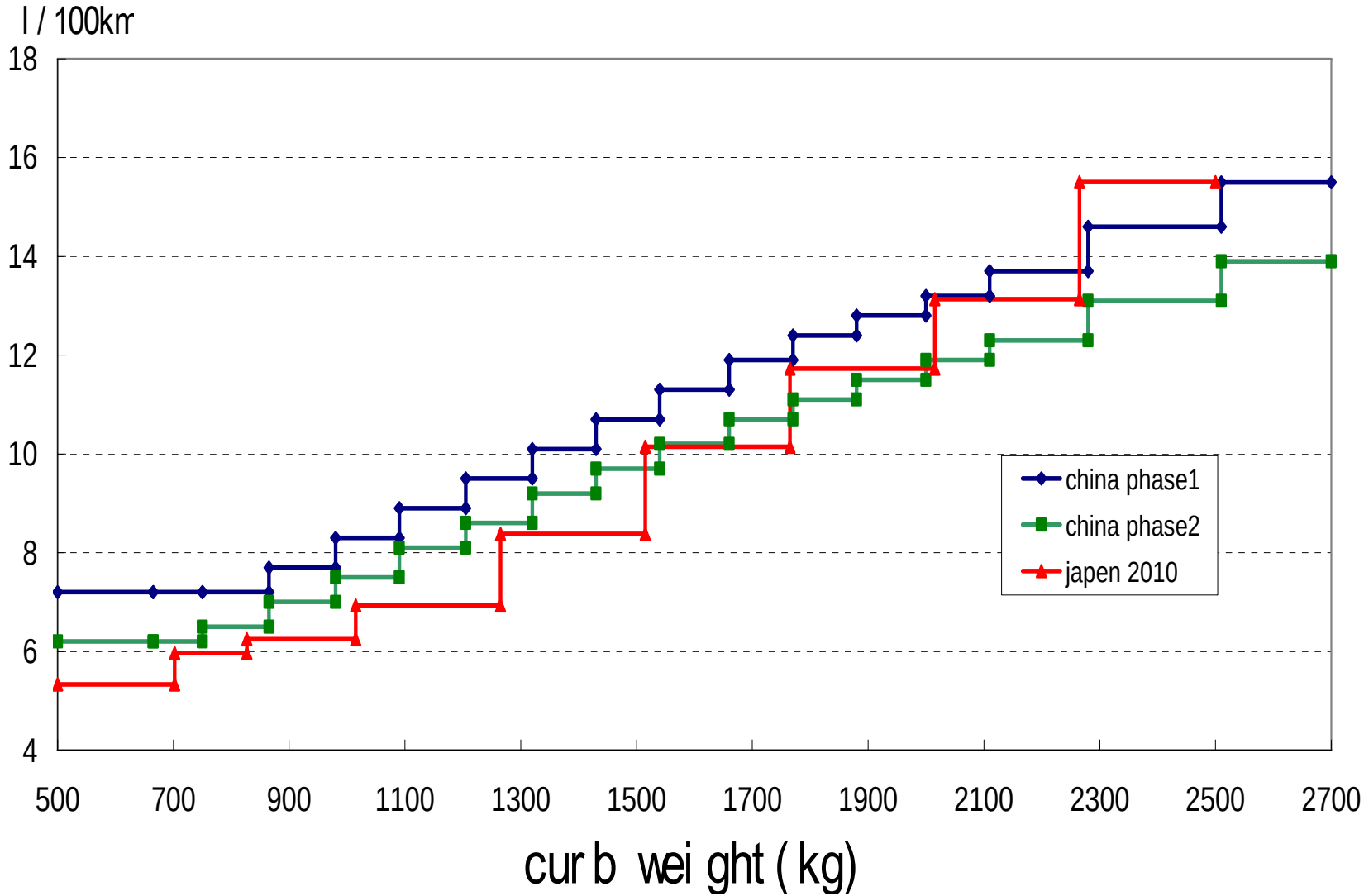
In 2005, Chinese On-Road Fuel Use Was 73 M Tonnes (1.5 M BBL/D) – 44% of Total Fuel Use and 24% of Total Oil Use; In 2020, On-Road Fuel Use Could Be >50% of Total Oil Use



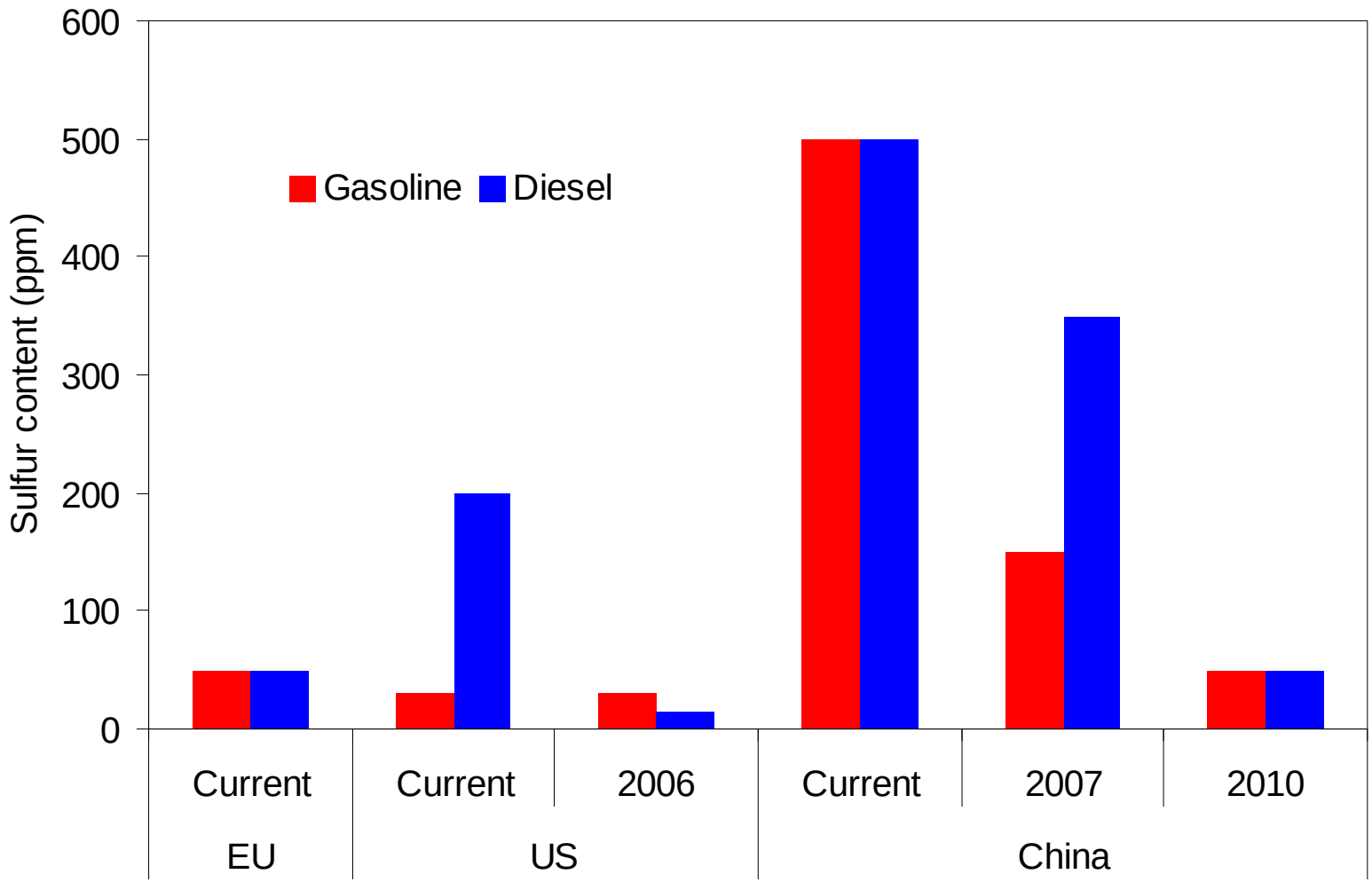
Chinese Vehicle Fuel Consumption Is Higher Than Many Other Countries



China Adopted Phase 1 and Phase 2 Fuel Consumption Standards in 2004

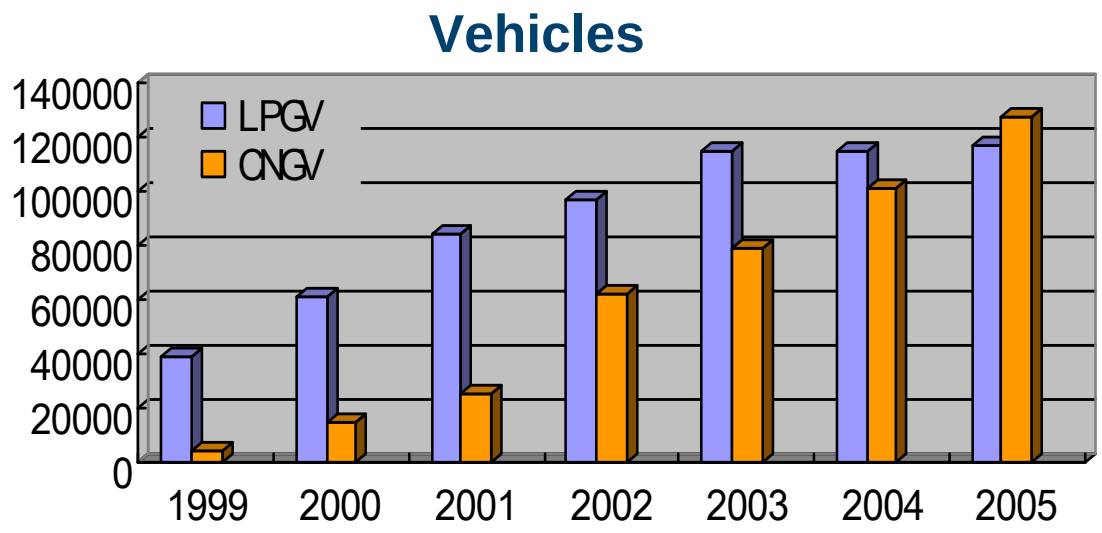


Sulfur Contents in Chinese Gasoline and Diesel Are Much Higher than in the EU or U.S.

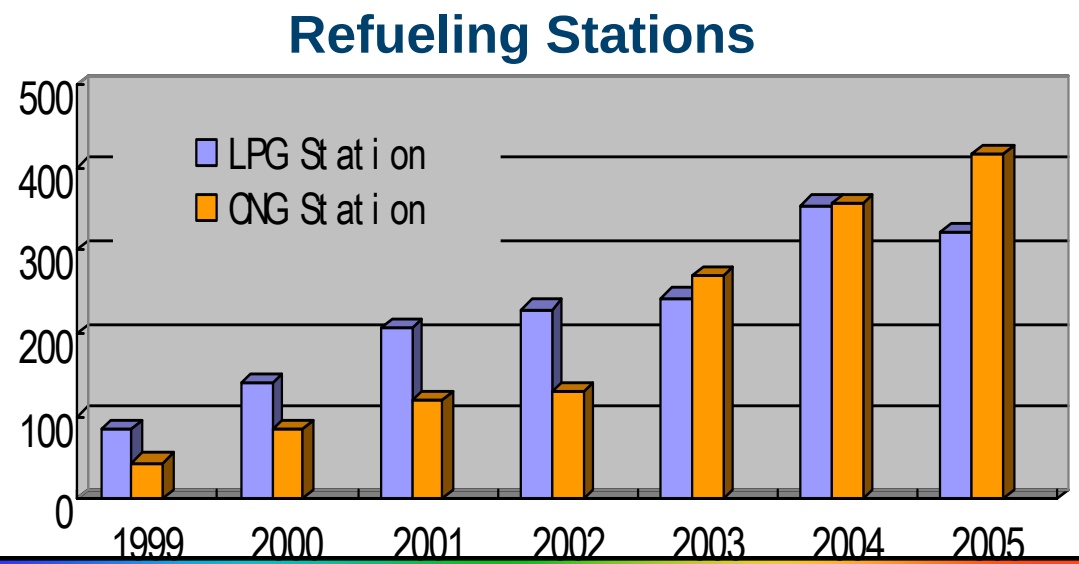


China Has Expanded Use of CNG and LPG Vehicles for Air Pollution Control

In 2005, there were 116,400 LPGVs and 127,000 CNGVs in use



In 2005, there were 320 LPG and 420 CNG refueling stations



China Is The No. 3 Ethanol Consuming Country After the U.S. and Brazil

- **In 2006, the U.S. consumed about 4.9 billion gallons of fuel ethanol**
- **In 2006, China consumed about 340 million gallons of fuel ethanol**

	U.S.	China
Population: millions	300	1,306
Gasoline market: billion gallons	140	16
Diesel market: billion gallons	50	24
Corn ethanol production: billion gallons	4.9	0.34
Corn production: million tons	332	128
Arable land: million hectares	186	130

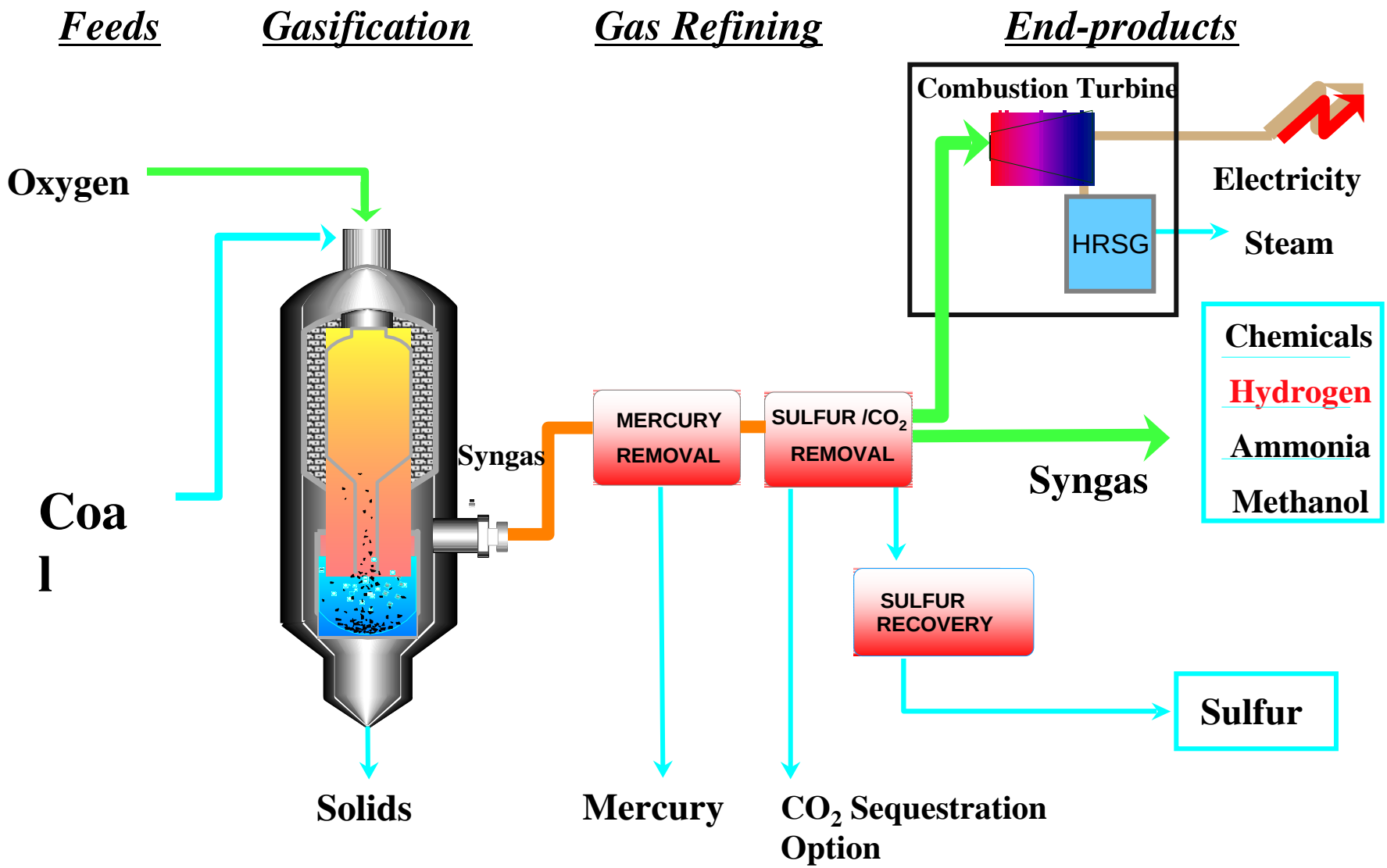
There Is A High Interest in Producing Liquid Fuels from Coal in China

- China's coal availability
  - Reserve of 200 billion tonnes
  - Resource of 600 billion tonnes
  - Ultimate resource of 1,440 billion tonnes
- Liquid fuels can be produced from coal via
  - Direct liquefaction to gasoline and diesel: requiring high-quality coal
  - Indirect liquefaction (gasification) to:
    - *Methanol*
    - *Dimethyl ether*
    - *Fitscher-Tropsch diesel*
    - *Hydrogen*

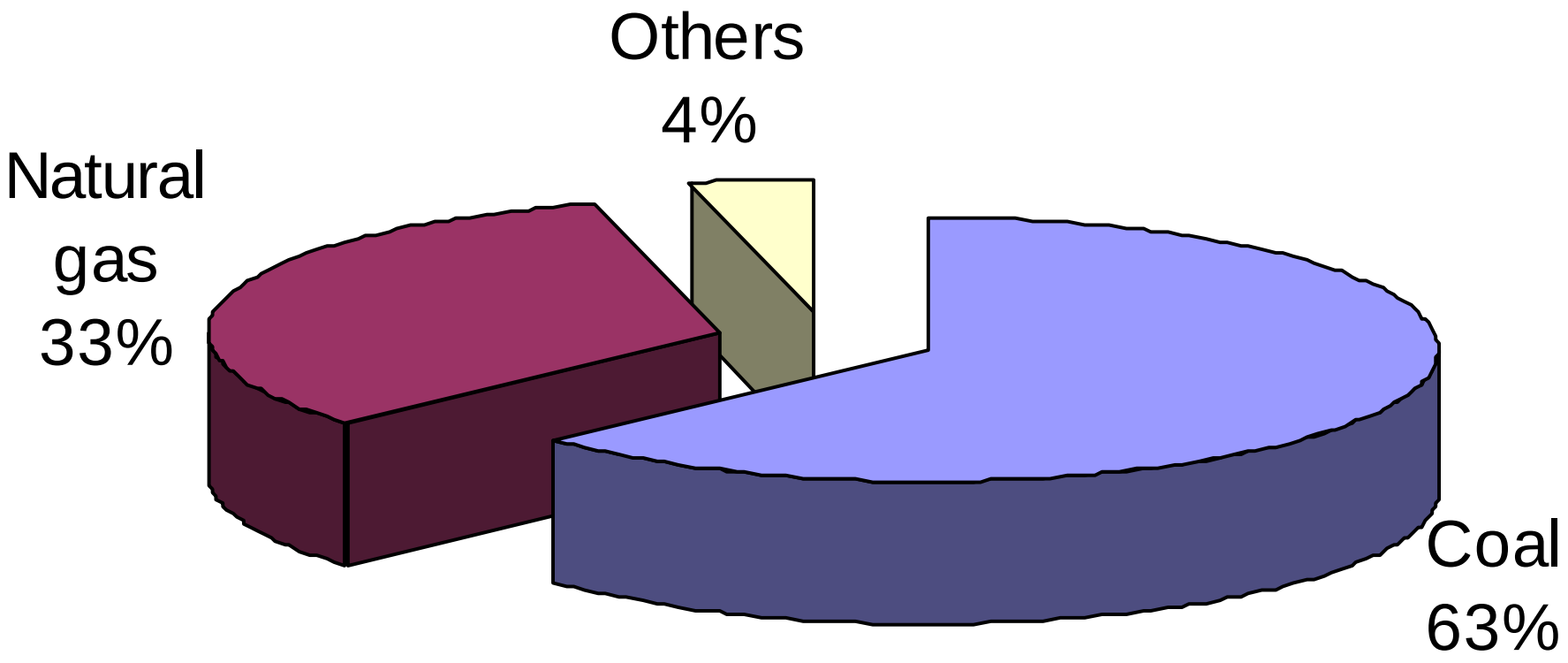
Coal to Liquid Fuels: An Energy Diversification Opportunity But A Carbon Risk

- Status of liquid fuel production from coal in China:
  - Methanol: current production of 5 million tons a year
  - DME: current production 40,000 tons a year
  - Direct liquefaction: a plant of 3.2 million tons of oil a year to be completed in 2007; 10 million tons possible by 2010?
  - Gasification: several projects are under consideration
- Both direct liquefaction and gasification have low conversion efficiencies, resulting in large amounts of carbon emissions during production
  - Direct liquefaction makes carbon capture economically infeasible
  - Gasification makes carbon capture and sequestration feasible
    - *Captured carbon could be used for enhanced oil recovery in Northwest China*
    - *Policy is needed for carbon capture and sequestration*

There Is Government Plan for Integrated Gasification Combined Cycle (IGCC) Demonstration Plants



A Large Share of Methanol Is Produced from Coal in China



Chinese Methanol Production Capacity Is Expanding Fast

Capacity for Methanol Plants with >80k Tonnes/Year

	Capacity (1,000 tonnes/yr)	Coal-Based (including COG), %	NG-Based %
Capacity in 2005	7,680	59	37
Capacity under Construction as of 2005	9,120	83	17
Construction during the 11th 5-Year Plan	23,140	96.7	3.3
Total Capacity by 2010	39,940		

Chinese Coal-Based Fuel Production Is Concentrated in Coal-Rich Provinces

Methanol Vehicles and Refueling Stations in Shanxi Province

Methanol Vehicle Demonstration Fleet

Methanol-Gasoline Blend Refueling Station

A Small Ammonia Plant with Methanol Co-Production

Concluding Remarks

- The Chinese transportation sector will grow rapidly
- Questions remain in
  - How rapid the Chinese growth will be
  - How China, and in fact the world, can support the fast-growing Chinese transportation sector
  - How large the role of alternative fuels will be
    - *Likely to small for the near future*
    - *But the government could make it significant*
  - If the carbon emission challenge of coal-to-liquid fuels could become an opportunity