

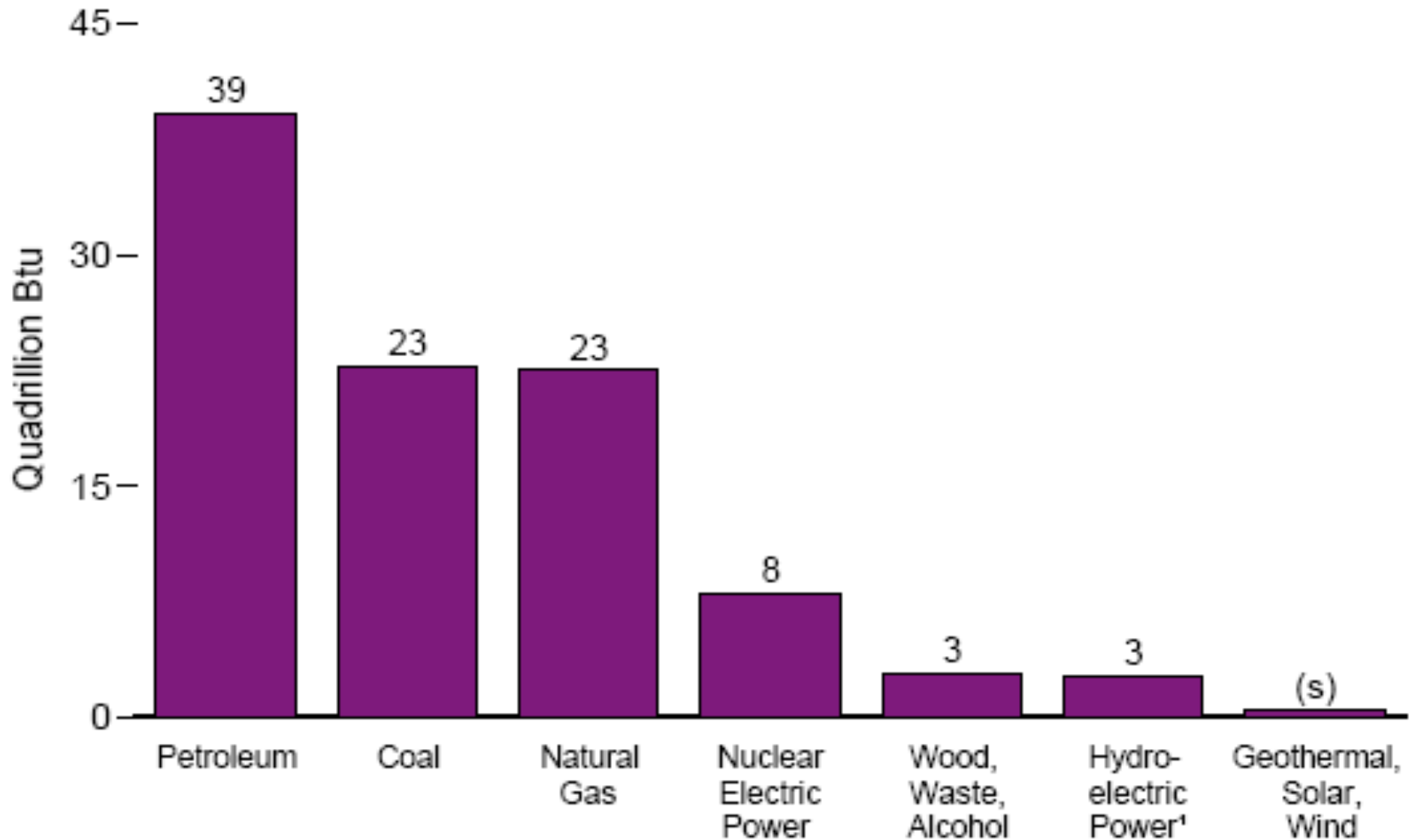
# **Moving Forward**

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**March 7, 2006**

# U.S. Sources of Energy



<sup>1</sup> Conventional and pumped-storage hydroelectric power.  
(s)= Less than 0.5 quadrillion Btu.

# Energy Supply Difficulties

- **Coal**
  - Carbon dioxide releases and global climate change
- **Natural gas**
  - Limited supply
  - Large price variability over time
- **Nuclear power**
  - Disposition of spent fuel
  - High capital cost
  - Internationally proliferation: mask nuclear weapons
- **Hydropower**
  - Limited supply
- **Other renewables**
  - High cost
  - Quantities to replace fossil fuel are huge

# Four Issues Encourage Reduction of Oil Use

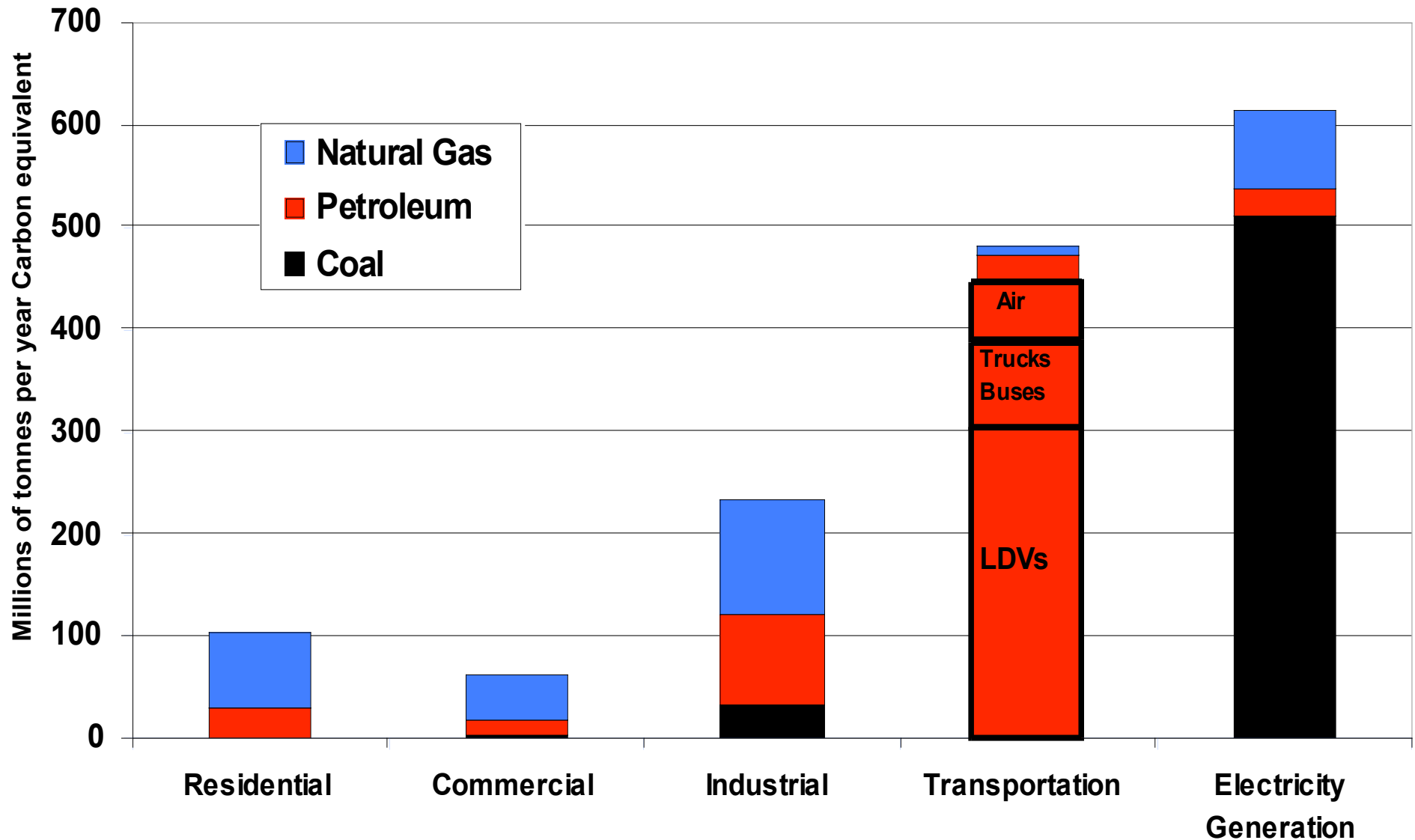
- **Environmental**
  - Carbon dioxide releases and resulting global climate change
  - Oil spills (relatively rare)
- **International security**
  - Possible supply disruptions
  - Linked to international terrorism
  - Limits on US foreign policy
- **High cost**
- **Future conventional oil supply decline, at least from non-OPEC nations (The End of Oil?)**

**Environmental**

# Fossil fuels account for

- ) **98% of the US carbon dioxide net releases into the atmosphere**
- ) **82% of the releases of greenhouse gases, measured on a carbon equivalent basis.**

# U.S. CO<sub>2</sub> Emissions by Sector and Fuels 2003



Source: U.S. EPA Inventory of Greenhouse Gas Emissions, April 2005

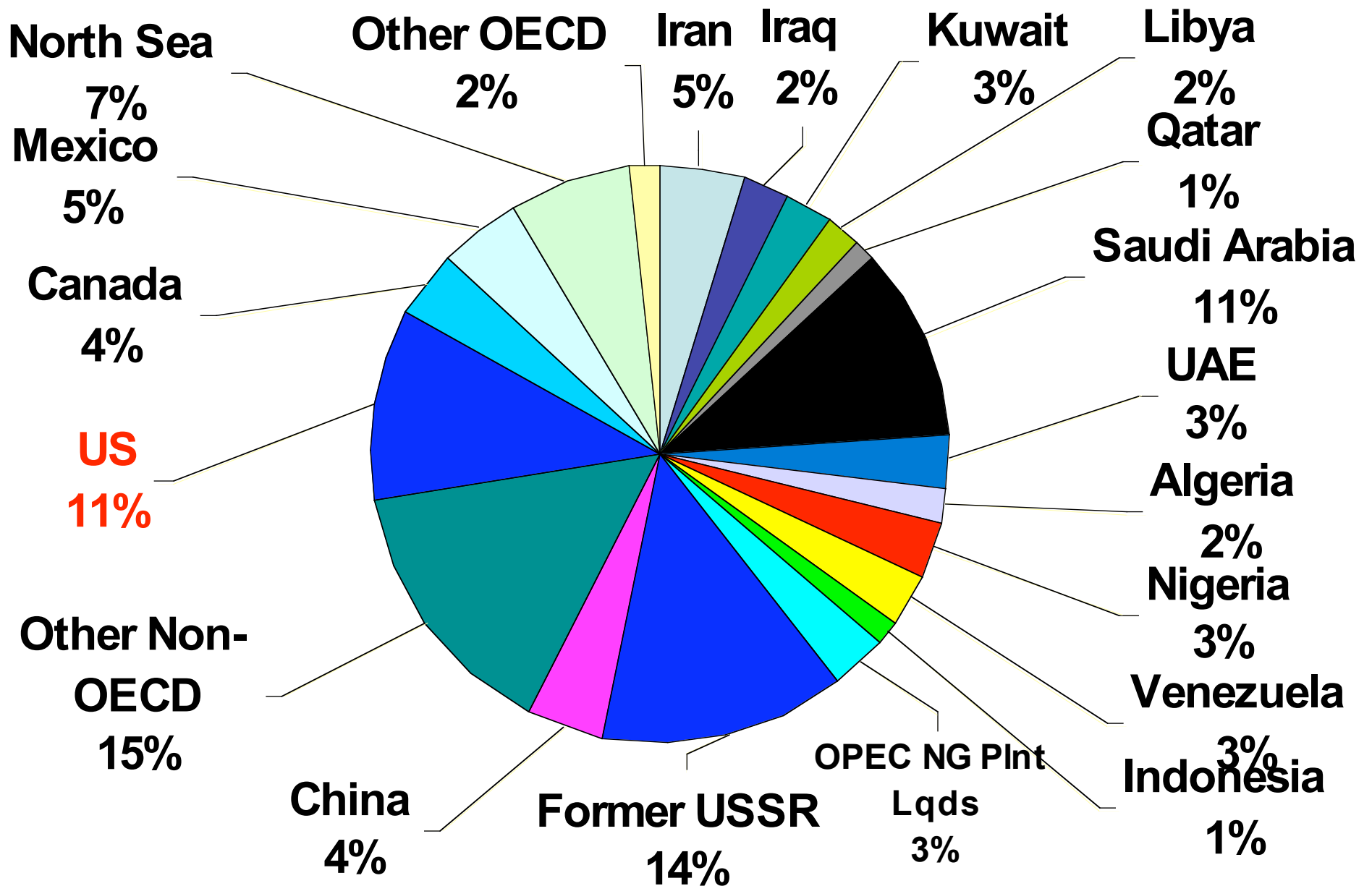
# **Three Strategies to Reduce CO<sub>2</sub> emissions in transportation and electricity generation**

- **Reduce the sector-specific activity**
  - **Less driving**
  - **Less electricity used**
- **Increase energy efficiency**
  - **Greater fuel economy of vehicles**
  - **Higher electricity conversion efficiency**
- **Change primary energy source**
  - **Renewables for electricity**
  - **Biomass or hydrogen for transportation**



# Security Issues

# World Oil Supply, 2004, Total: 83 mmb/d



# Oil and Gas Reserves, Billion Barrels Oil Equivalent

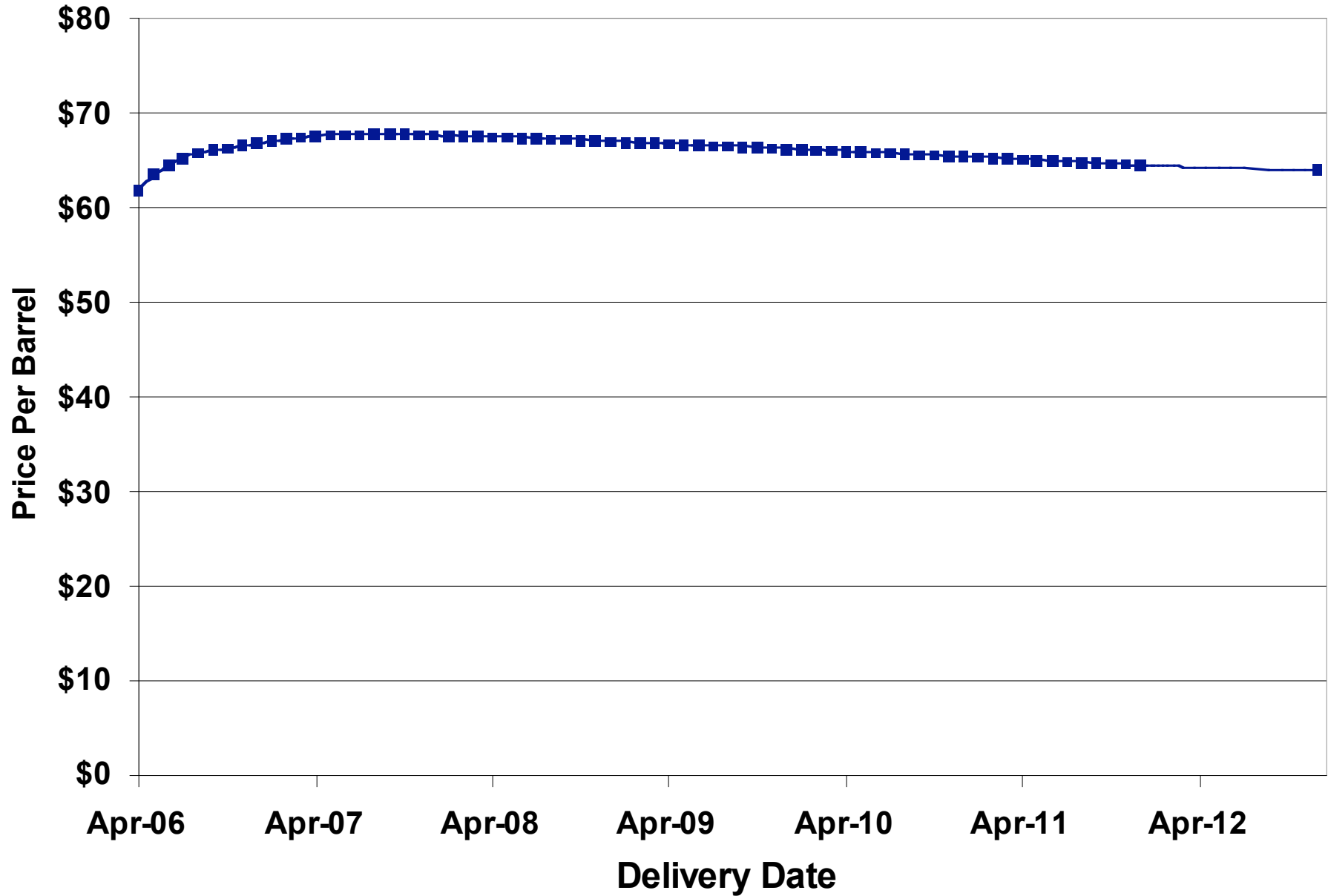
Saudi Aramco (Saudi Arabia)	302	ExxonMobil	23
National Iranian Oil Co	302	Pertamina (Indonesia)	22
Gazprom (Russia)	198	Lukoil (Russia)	21
Iraqi National Oil Co	136	BP	19
Qatar Petroleum	133	Pemex (Mexico)	19
Kuwait Petroleum Co	109	PetroChina	19
Petroleos de Venezuela	105	Shell	16
Adnoc (Abu Dhabi)	80	Yukos (Russia)	13
Nigerian Natnl Petroleum Co	41	Chevron	12
Sonatrach (Algeria)	38	Petrobras (Brazil)	12
Libya NOC	31	Total (France)	11
Rosneft (Russia)	28	Surgutneftgas (Russia)	9
Petronas (Malaysia)	26		

State Owned/Controlling Interest.

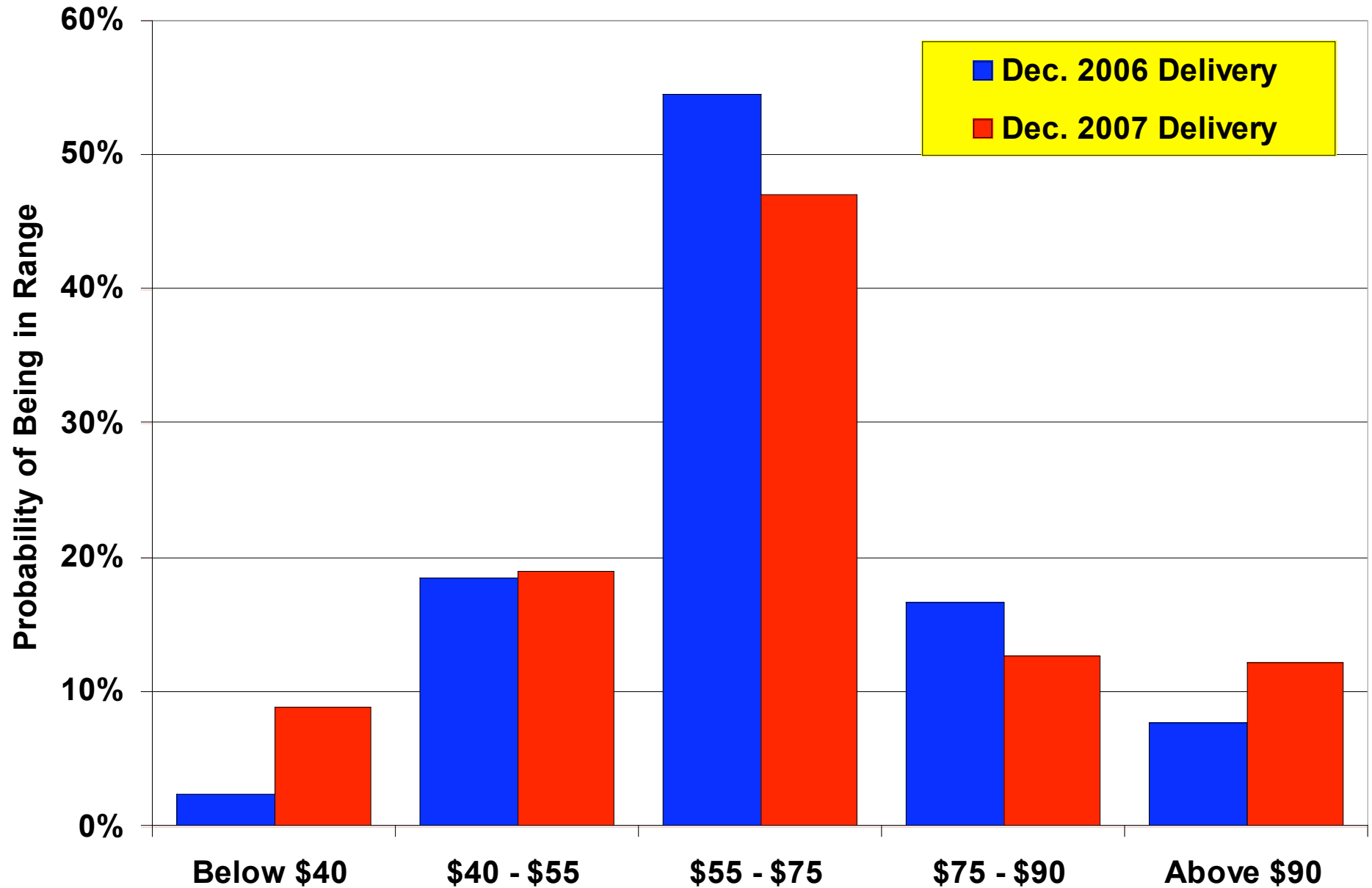
Private Sector

# Oil Prices

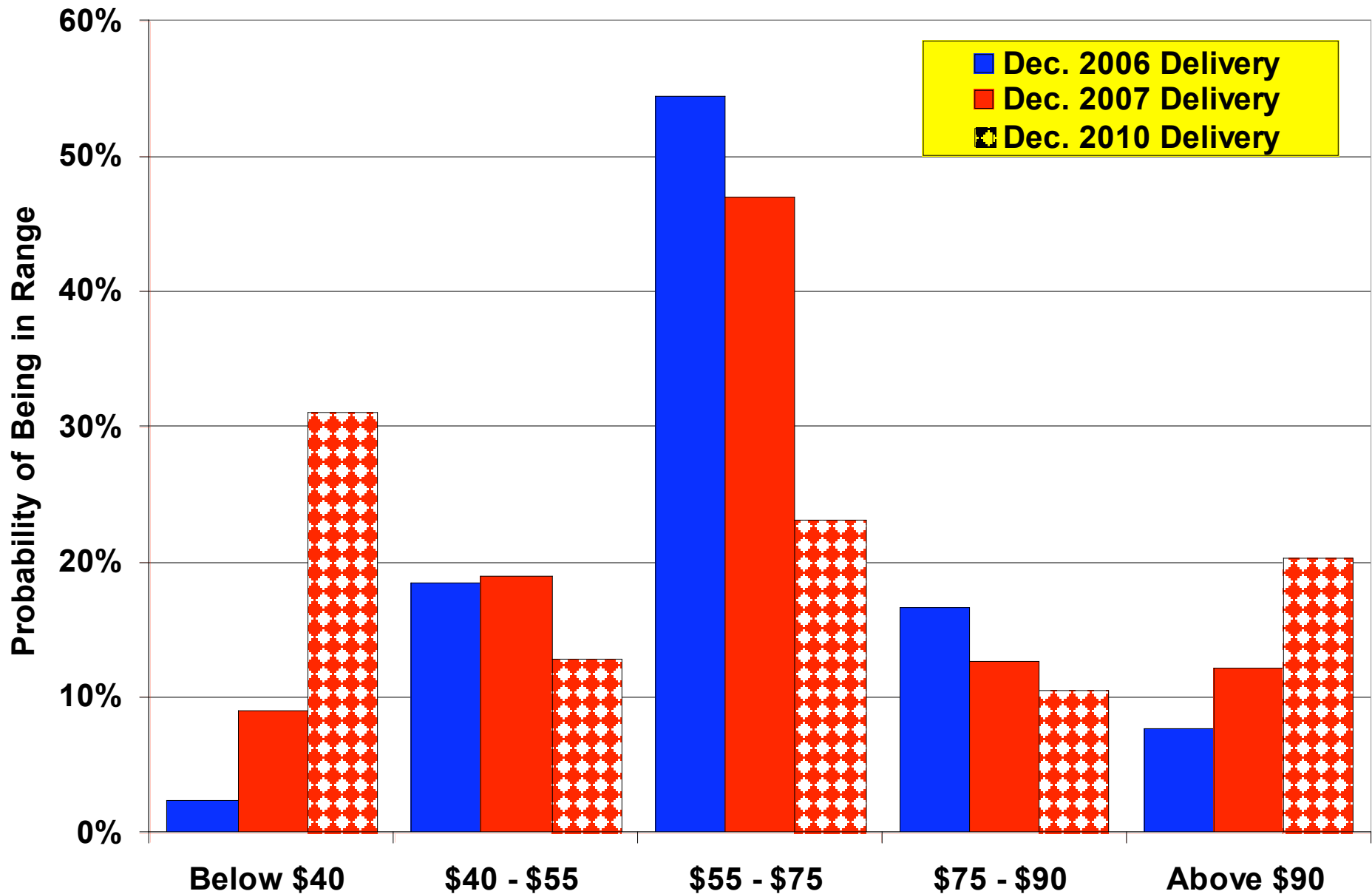
# Crude Oil Futures Prices (as of 3/1/2006)



# Oil Price Uncertainty (From Options Prices)



# Oil Price Uncertainty (From Options Prices)

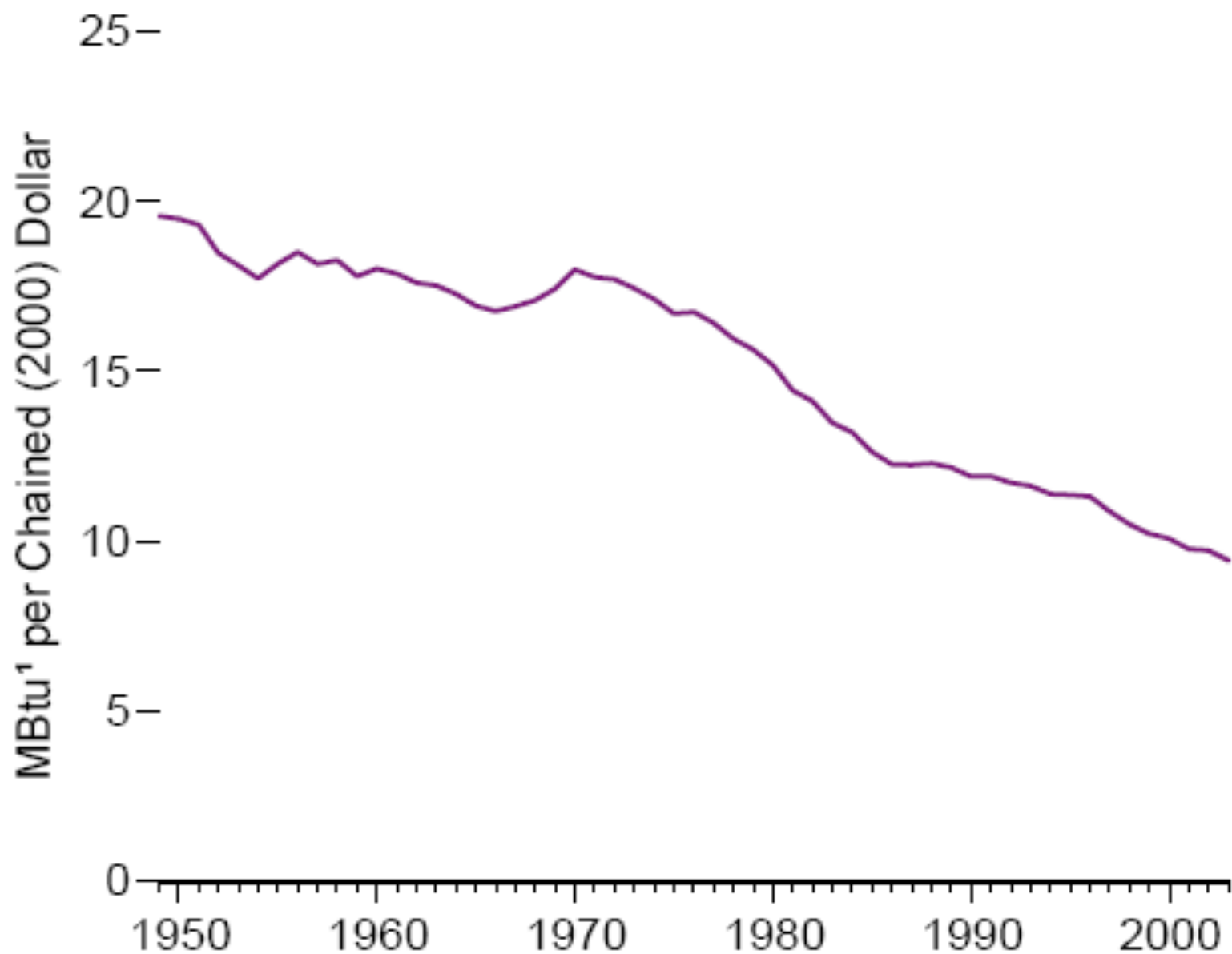


# Solution Strategies

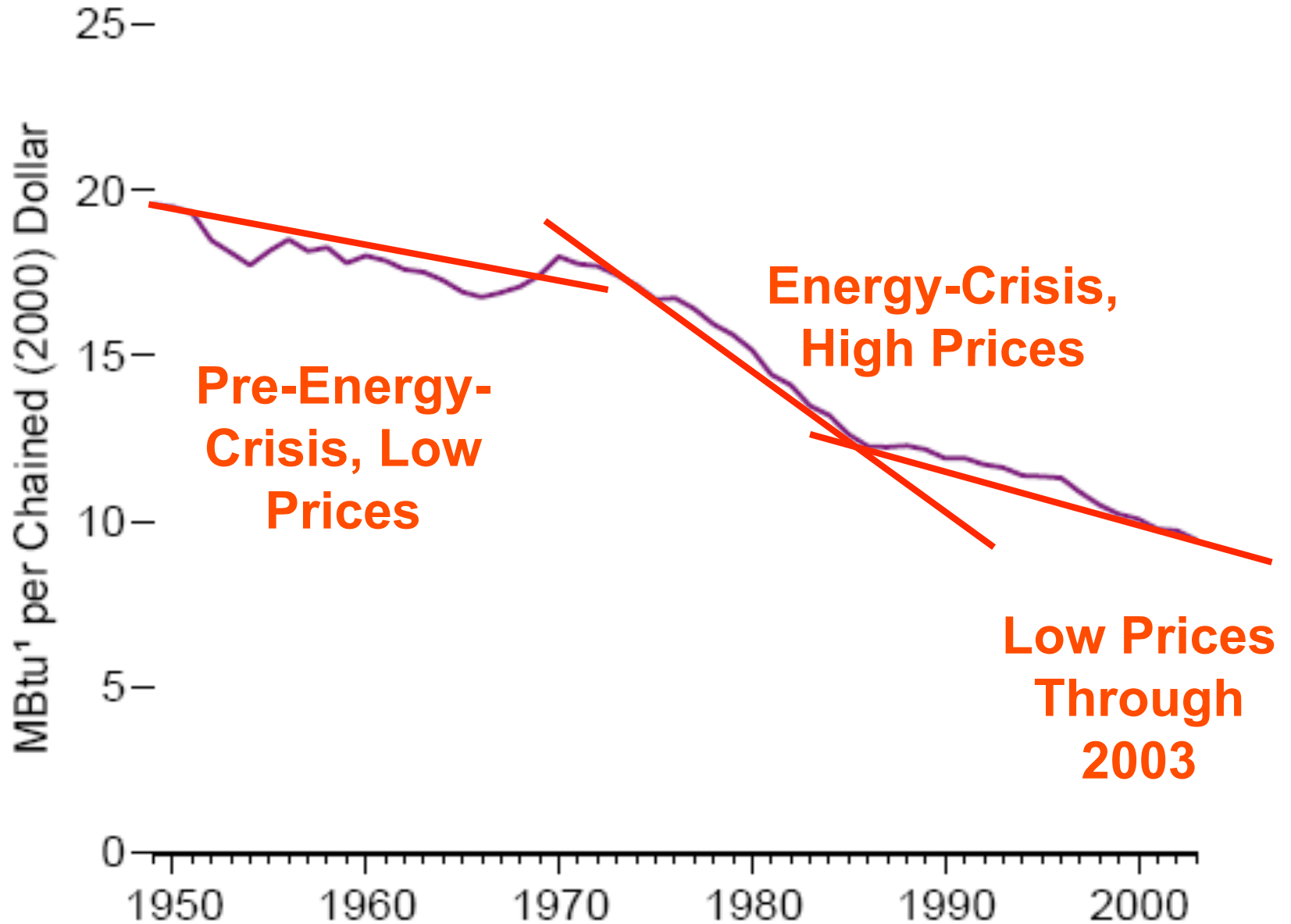
- **Energy Efficiency**
- **Energy Conservation**
- **Substitutes for oil**
  - **Fuel switching**
  - **New technologies**
- **Increases in oil supply**
  - **U.S. production of oil and gas**
  - **Production in secure, friendly areas of the world**
  - **Reduction in demand for oil**



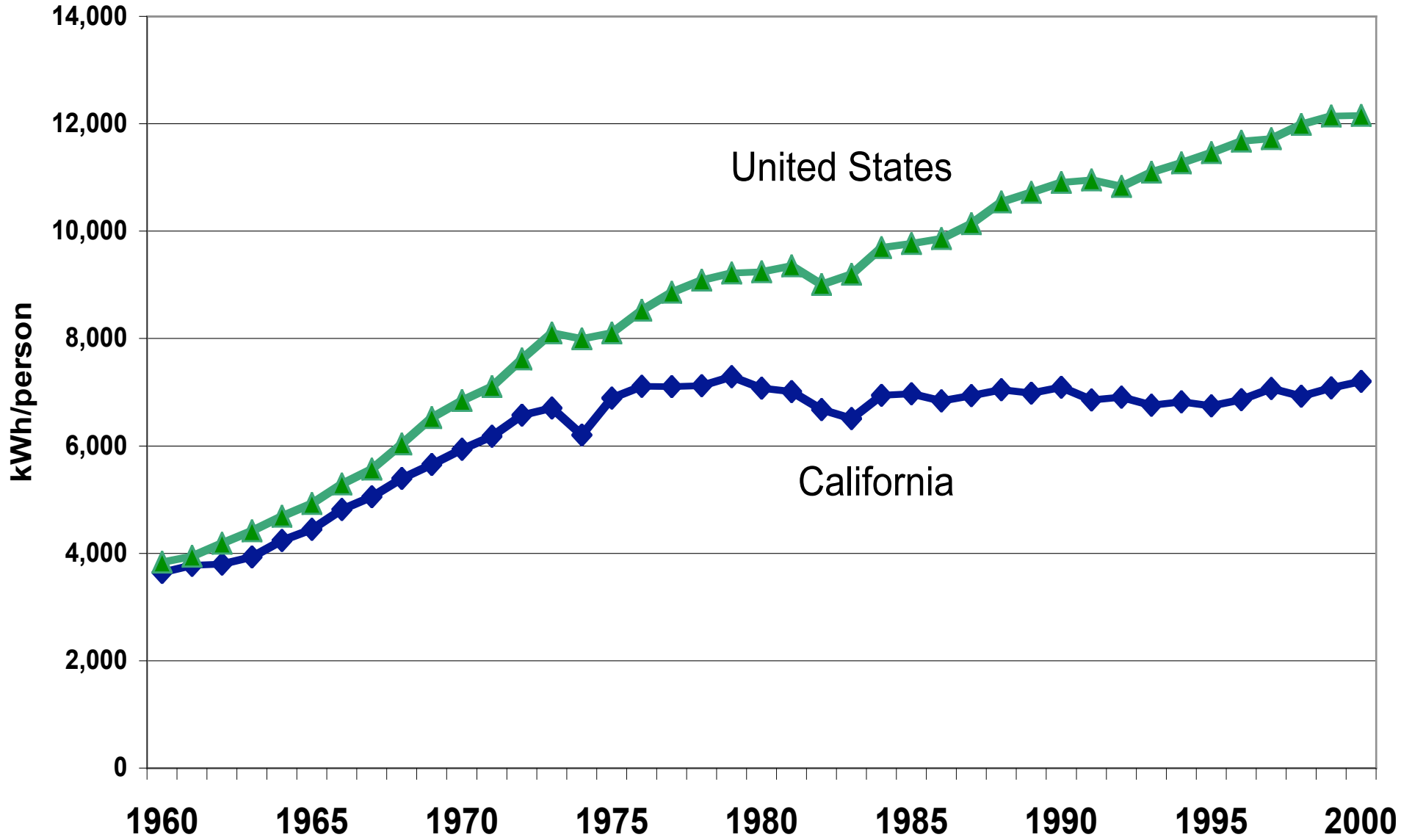
## Energy Consumption per Dollar of Gross Domestic Product, 1949-2003



# Energy Consumption per Dollar of Gross Domestic Product, 1949-2003



# *Per Capita Electricity Consumption*



# **Policy Agenda**

# Get Prices Right

- **Oil**
  - **The world oil price is passed through to drivers**
  - **International security externality not included**
  - **CO<sub>2</sub> externality not included**
  - **Other travel externalities not included**
    - **Congestion**
    - **Highway/Road mortality/injury**
    - **Criteria pollutants**
  - **Thus price we pay for gasoline is too low**

# Get Prices Right

- **US oil price should include an international security externality premium/tax/fee**
  - **Gasoline tax**
  - **Higher CAFE standards on light duty vehicles**
- **Prices for oil substitutes should not be kept artificially high**
  - **Import tax on ethanol -- \$.54 per gallon -- should be eliminated**
    - **Import Ethanol from Brazil instead of subsidizing it in the U.S.**

# Get Prices Right

- **CO<sub>2</sub>**
  - **Need US national carbon dioxide cap-and-trade system**
    - **The United States could implement a cap and trade system even if we do not ratify Kyoto protocol**
  - **System can be implemented**
    - **The nations that have ratified the Kyoto protocol now are operating such a system**
    - **Currently states are beginning to implement such systems, but a national system would be preferable**
    - **We have experience in cap-and-trade**
      - **Acid Rain SOx trading**
      - **RECLAIM program for criteria pollutants**
      - **Chicago Climate Exchange**

# Encourage Technology Development

- **President Bush state of the Union speech**
  - **Call for more research and development**
  - **Primarily supply technologies**
- **Equally important – if not more important – energy efficiency technologies**
  - **Rapid change possible through more efficient vehicles**
    - **Hybrid electric vehicles**
    - **Possibly plug-in hybrids**
    - **Possibly all electric vehicles**
    - **Longer run: Possibly hydrogen vehicles**
  - **Buildings:**
    - **Lighting: light emitting diodes**
    - **Building design, technologies, operating processes**



# Encourage Technology Development

- **Governmental R&D**
  - **Federal**
  - **States (California Public Interest Energy Research Program)**
- **R&D incentives**
  - **In energy bill**
- **Technology competitions**
- **Green labeling**

# Encourage Entrepreneurial Efforts

- **May look like no policy at all.**
- **Encourage technical and market experimentations**
  - **Some will ultimately make it big; others will not.**
  - **But the genius of Silicon Valley involves entrepreneurial efforts, risk-taking, pioneering efforts.**
  - **Some of these will be failures, some successes.**
  - **Successes will live on, grow to become the household names.**
    - **will spawn more entrepreneurial challenges**
    - **The failures will typically lead to different attempts, some successes, some failures.**
  - **Ahead of time impossible to know which will disappear and which will be the next Google.**
  - **Lighting, vehicles are poised for fundamental change.**
  - **Examples**

# Manage Risk

- **National oil companies have incentive to increase uncertainty of oil prices**
  - **Uncertainty reduces investment in capital intensive energy supply alternatives**
- **Need short run shock absorbers, such as strategic petroleum reserve, to mitigate impacts of supply disruptions**
- **Consider variable gasoline tax to assure automakers and drivers that price of gasoline will remain high and therefore to encourage purchase of more fuel-efficient vehicles**

# **Adopt Sector-Specific policies**

- **Autos**
  - Higher CAFE standards
- **Electricity**
  - Renewable Portfolio Standards; Carbon Dioxide Adders
- **Buildings**
  - Building Efficiency Standards
- **Appliances**
  - Appliance efficiency standards; Energy Star labeling
- **Transportation Fuels**
  - Biomass required percentage
- **Solar**
  - Tax credits; Subsidies (Million Solar Roofs Initiative)