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Overview

• World energy situation: recent significant changes
• The long view: U.S. historical trends and forecasts
• Changing role of energy use in the economy—challenges and opportunities
• Energy policy context:
  – Economy: U.S. economic growth and energy use
  – Environment: environmental implications — especially air quality and climate change, and increasingly water
  – Security: national security implications — international and more recently homeland security
• Existing and potential role(s) for the National Research Council
World Energy Situation:
Some Significant Changes In Recent Decades

• Accelerated economic globalization and economic structural change
• Asian economic growth, especially China
• Increased sense of urgency about climate change, at least among OECD countries
• Dramatic performance of energy efficiency improvements in the U.S.
• Middle East developments – Iraq War, Iran, Palestinian conflict and implications for oil supply
• The increased role of natural gas in many countries
Historical World Energy Consumption by Source

Source: IEA, 2004
Total Energy Use Projections for Selected Countries

Source: International Energy Outlook, EIA, 2006
The Growing Role of China

• China’s total energy consumption may equal that of the U.S. by 2027 leading to, among other implications, increasing pressure on world oil markets.

• Most of China’s growth will include substantial increases in fossil fuel consumption, both oil and coal, exacerbating climate change concerns.

“A Thousand new cars per day in Beijing”

Source: H. Gruenspecht, EIA and EIA/OECD, 2006
World Oil Production Looking Forward (million barrels per day)

2004
- OPEC: 30.9%
- United States: 10.2%
- Other Mature Economies: 17.2%
- Emerging Non-OPEC: 14.4%
- Transitional Economies: 4.1%
- U.S.: -0.3%

Total = 82.5

2030
- OPEC: 36.4%
- United States: 7.6%
- Other Mature Economies: 9.9%
- Emerging Non-OPEC: 5.5%
- Transitional Economies: 16.3%
- U.S.: 1.3%
- Canada: 3.0%
- Other: 4.0%

Total = 117.8

Source: EIA, 2006
World Oil Consumption Looking Forward
(million barrels per day)

2004

Total = 82.5

2030

Total = 117.8

Source: EIA, 2006
Selected Dimensions of the U.S. Situation

• The persistent age of fossil fuels: 1900-?
• Long term U.S. energy trends
• Economic growth and structural change, energy prices and energy efficiency
• Energy (oil and now gas) import and now infrastructure vulnerability
• Climate Change
Historical U.S. Energy Use: The Long View Back

Source: Annual Energy Review, Energy Information Administration (EIA), 2006
U.S. Energy Use: The Less Long View Back and Projections to 2025

Source: Annual Energy Review and Annual Energy Outlook, EIA, 2006
Historical U.S. Energy Trends: Total Consumption, Domestic Production, Imports and Exports

Source: EIA, 2006
U.S. Sources and Uses of Energy (quadrillions of Btus)

Net Primary Resource Consumption ~97 Quads

Source: Production and end-use data from Energy Information Administration, Annual Energy Review 2002.
*Net fossil-fuel electrical imports.
**Biomass/other includes wood, waste, alcohol, geothermal, solar, and wind.
Changing Energy Structure of the U.S. Economy

• Eroding energy intensive U.S. industry base being replaced by services – accounts for about a 1/3 of drop in total energy intensity

• Price coupled with regulation-induced energy efficiency improvements – accounts for about 2/3 of drop in total energy intensity
Energy Intensity of the U.S. Economy* Relative to 1970 levels

Energy Intensity* (1970=1)

- Electricity
- Total Energy
- Oil

*Energy consumed per dollar GDP (2000 constant dollars)

Source: Based on EIA, 2006
U.S. Trends in Oil Use

• Oil consumption: then and now
• U.S. oil imports increasing steadily
• Now potential for sustained high prices
• High prices leading to increased utilization of unconventional sources and increasing domestic production
• Increased potential for alternative fuels, such as ethanol
THEN: 1991 U.S. Oil Consumption Projection to 2020 with Options for Change*

*Options include fuel economy improvements, alternative fuels, and new production from Alaska; Source: Gibbons and Blair, *Physics Today*, July 1991
NOW: 2006 U.S. Oil Consumption Projection

Source: EIA, 2006
Historical U.S. Gasoline Prices

Year 2000 constant dollars

Events:
- Price controls
- Arab oil embargo
- Iranian revolution
- Persian Gulf War
- OPEC cuts
- OPEC quota increase
- Asian economic crisis
- Iran/Iraq war
- 9/11
- Iraq War
- Asian growth
U.S. Oil Use, Domestic Supply and Imports
(millions of barrels per day)

Source: EIA, 2006
World Oil Reserves: 1980 and 2005

1980
- Middle East 54.32%
- Euraisia 14.75%
- S&C America 4%
- Africa 7.99%
- Asia Pacific 5.07%
- N. America 13.87%
Total=667 billion barrels

2005
- Middle East 61.86%
- Euraisia 11.7%
- S&C America 8.62%
- Africa 9.52%
- Asia Pacific 3.35%
- N. America 4.96%
Total=1,201 billion barrels
U.S. Trends in Electricity

• Changes in economic structure changing role of electricity in our economy
  • Quality of power
  • Accelerating peak demands

• Demand growth being moderated by efficiency improvements, but substantial new supply needed.

• Environmental issues and now fuel supply issues affecting the mix of fuels for generation

• New energy infrastructure concerns since 9/11
The Historical “NERC Fan”

U.S. Electricity Peak Demand Forecasts: 1973-1983

U.S. Electric Demand 1950-2004
(summer peak demand)
U.S. Electric Generating Capability: 2004

By Source, 2004

- Coal: 313 Million Kilowatts
- Natural Gas: 223 Million Kilowatts
- Dual Fired: 175 Million Kilowatts
- Nuclear Electric Power: 100 Million Kilowatts
- Hydroelectric Power: 99 Million Kilowatts
- Petroleum: 37 Million Kilowatts
- Wind: 6 Million Kilowatts
- Wood: 6 Million Kilowatts
- Waste: 4 Million Kilowatts
- Geothermal: 2 Million Kilowatts
- Solar: (s) Million Kilowatts
- Other: 3 Million Kilowatts
Projected U.S. Electric Generating Capacity
(gigawatts of installed capacity)

Source: EIA, 2006
Energy Policy

- Historical experiences
- Changing focus and priorities
- Why have energy policy initiatives failed?
- New forces at work
- Potential role(s) for the National Academies

**Roosevelt, Franklin D., 1933-45:** 1939 presidentially appointed National Resources Planning Board recommended support of research to promote "efficiency, economy, and shifts in demand to low-grade fuels" and that a “national energy resources policy” should be prepared that to look beyond policy directed at specific fuels.”

**Truman, Harry, 1945-53.** 1950-52 presidentially appointed Materials Policy Commission (known as the Paley Commission after its Chairman William S. Paley) concluded that the U.S. did not possess all material and mineral resources necessary and called for an assessment and scientific plan for utilization of natural resources.

**Eisenhower, Dwight, 1953-61.** 1955 Report from the Cabinet Advisory Committee on Energy Supplies and Resources Policy.

**Kennedy, John F., 1961-63.** 1961 National Fuels and Energy Study (commissioned by the U.S. Senate).

**Johnson, Lyndon, 1963-69.** 1964 “Resources Policies for a Great Society Report to the President by the Task Force on Natural Resources.”
Post Oil Embargo National Energy Policies


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Changing focus of energy policy

Energy policy is largely a derivative policy with its roots in economic, national security, and environmental policies with shifting priorities among those policies.
Changing priorities of energy policy

Energy policy is largely a derivative policy with its roots in economic, national security, and environmental policies with shifting priorities among those policies:

- 1960s: Economic, Environment, Security
- 1970s: Environment, Economic, Security
- 1980s: Economic, Security, Environment,
- 1990s: Environment, Security, Economic
- Current (?): Security, Economic, Environment
Why have U.S. energy policy initiatives been frustrated?

- **Competing values.** Honest differences over the role of energy in society.
- **Short time horizon.** Both political and economic systems focus on short time horizons.
- **Energy choices heavily influenced by price.** Even though many costs of energy use are not reflected in market prices, price and uncertainty about price dominate decisions.
- **Poor public awareness of energy issues.** Example: 1991 Gallup poll found 45% of public unaware that U.S. imports oil at all!
- **Disagreement about role of government.** Activist government in 1970s, to laissez-faire in the 1980s, to modest intervention in 1990s.
- **U.S. political system inertia.** Favors status quo and renders change difficult with many competing values and interests.
- **Weak political parties.** In energy, many splintered coalitions: regional and other interests transcend traditional political parties.
New Forces and Shifting Priorities

• Re-emerging international security concerns about the geo-politics of oil supply, nuclear technology, and increasingly natural gas supply as well as energy infrastructure concerns.

• Increasing urgency over climate change—fossil fuel usage and energy growth in the developing world.

• Improving energy efficiency from high and uncertain prices and technological maturity for many efficiency options.
Selected Current Energy Resource and Technology Constraints and Opportunities

- Potential for energy efficiency improvement remains substantial in essentially all sectors of the economy.
- Increasing concentration of oil reserves in the Middle East is increasingly problematic.
- “Betting the farm” on natural gas has proved problematic.
- Sequestration of carbon in continuing use of fossil fuels is a major challenge.
- High oil prices creating opportunities for alternative fuels and oil production from unconventional sources.
- So many problems, so little time.
An Energy Efficiency Example: 
The Remarkable Wal-Mart Energy Efficiency Program 
(4-year goal of 30% reduction in energy use)

Current program:
- Daylight “harvesting” and real-time lighting control
- Aggressive and centrally controlled energy management
- High-efficiency HVAC and heat reclamation
- “Cool” Roofing
- “Market moving” truck fleet fuel efficiency

Starting this year:
- Interior LED Lighting
- Variable Speed HVAC Fans/Motors
- “Market moving” Advanced Refrigeration technologies
- Geothermal and wind where applicable
An Energy Efficiency Example: Active Lighting Control at Wal-Mart
Role of the National Academies?

• **Strength**: Adding clarity, authority, accountability to science and technology opportunities

• **Strength**: Building credible scenarios for alternative energy futures

• **Less Strong**: Supporting and informing the debate on policy when many value tradeoffs are involved, especially attempting to decide the best overall policy course—instead, better to articulate realistic options to be compared by policymakers.
Some Recent and Current Academy Activities

• Prospective Benefits of Energy R&D
• Nuclear Power R&D
• Vulnerability of the Electric Power System
• Trends in Global Oil Supply and Demand
• Novel Approaches to Carbon Management
• Options for replacing the Indian Point Nuclear Power Station
• Continuing work on the FreedomCar and Fuel Partnership
Some Logical New Questions for Academy Involvement

- Building and maintaining a robust national energy technology innovation capability.
- Identifying the problems and prospects of additional energy efficiency, alternative fuels, nuclear power, carbon sequestration, “clean coal” and renewable technologies, hydrogen, and other S&T avenues.
- Defining realistic future energy technology-based scenarios for the U.S.
Some Logical Questions for Academy Involvement (Continued)

• Analyzing the relative effectiveness of public policy tools for accelerating new energy technology development.

• Analyzing the effectiveness of government R&D programs.

• ……