

Providing Options for U.S. Energy Future



*DOE / NSF EPSCoR
Conference 2005*

*June 15, 2005
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Acting Director, NETL*

National Energy Technology Laboratory



Office of Fossil Energy



NETL

- **Only DOE national lab dedicated to fossil energy**
 - Fossil fuels provide 85% of U.S. energy supply
- **One lab, four locations, one management structure**
- **1,100 Federal and support-contractor employees**
- **Research spans fundamental science to technology demonstrations**



Pennsylvania



West Virginia



Alaska



Oklahoma



Office of Fossil Energy Mission

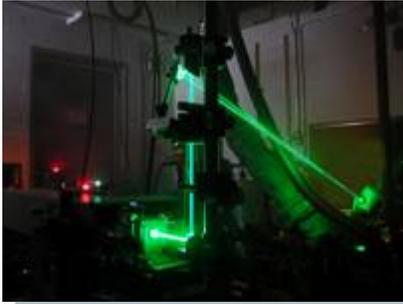
At the core of Fossil Energy's mission are two fundamental objectives:

- To ensure America's readiness to respond to short-term energy supply disruptions
- To provide the nation with the best opportunity to tap the full potential of its abundant fossil energy resources



NETL Conducts Intramural Research

Onsite Focus Areas



Energy System Dynamics

- Fuel Cells / Hybrids
- Gas Combustion
- Carbon Capture
- FutureGen



Geological and Environmental Systems

- Carbon Sequestration
- Clean Air Technology
- Water & Coal Utilization Byproducts



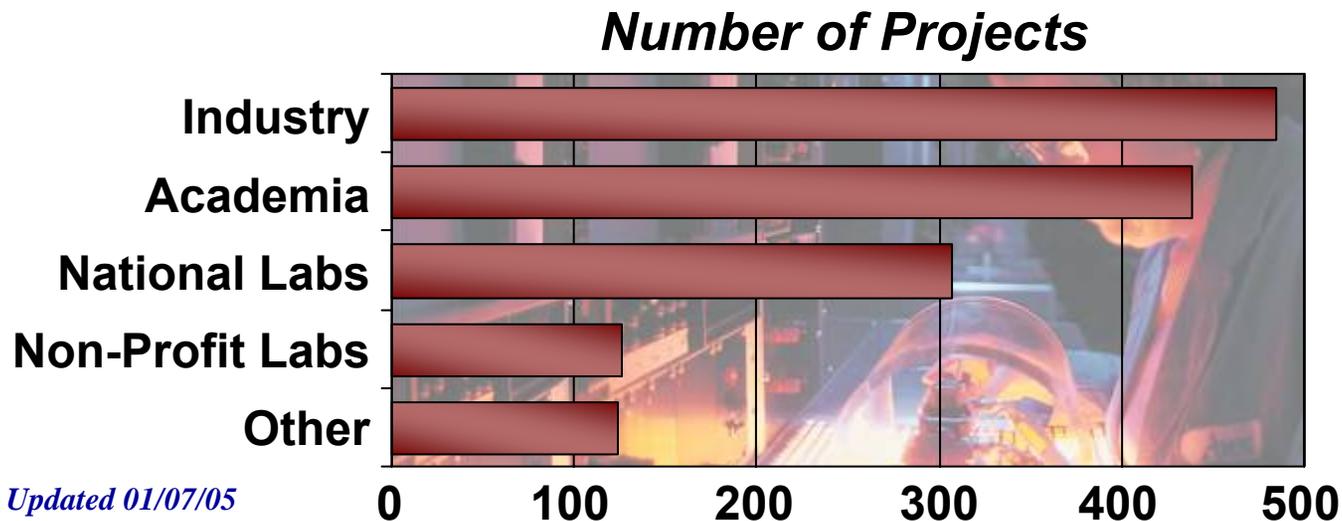
Computational and Basic Sciences

- Computational Chemistry
- Device Simulation
- Advanced Fuel Systems
- Gas Hydrates



NETL Implements and Manages Extramural RD&D

- Over 1,400 research activities in 47 states and more than 40 foreign countries
- Total award value of nearly \$8 billion
- Private sector cost-sharing of almost \$4 billion
 - Leverages DOE funding
 - Ensures relevance
 - Accomplishes mission through commercialization



Updated 01/07/05



Outcomes from NETL Programs

Technology → Assist in providing U.S. acceptable, affordable, and available energy in mid- to longer-term

Policy → Positively impact development of sound energy policies

Competitiveness → Help maintain technology competitiveness of U.S. energy industry

Stability → Appropriately transfer technology to developing countries to improve geopolitical stability / global climate

Workforce → Provide trained energy workforce through university research programs

Region → Regional economic development



Energy Profoundly Impacts Our Quality of Life



Comfort

Warms our homes and provides electricity to wash our clothes and power our televisions



Food

Used to produce food and to deliver clean water to our homes



Productivity
Telecommunications,
banking



Mobility

Unprecedented
mobility

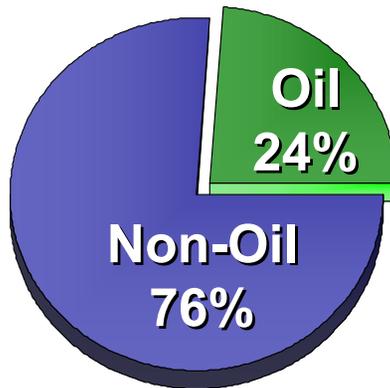


Energy Impacts the Economy

Production and Use



Individual Economy
\$2,300 per person per year spent on energy



International Trade
Petroleum imports account for one-fourth of U.S. trade deficit in goods*

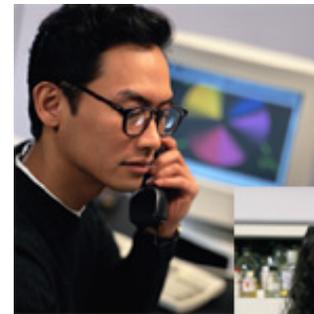
While energy accounts for 7% of GDP, it underlies all economic activity



Burgers ~~\$1.99~~ \$2.09

Prices

Energy prices impact all economic sectors



Employment

No energy – no jobs



* Data for 2000 on Balance of Payments basis

Energy Impacts the Environment

Production and Use



Air Emissions
Emissions down but
continuing pressure
to reduce further



Water
Energy production
and use can impact
water quality

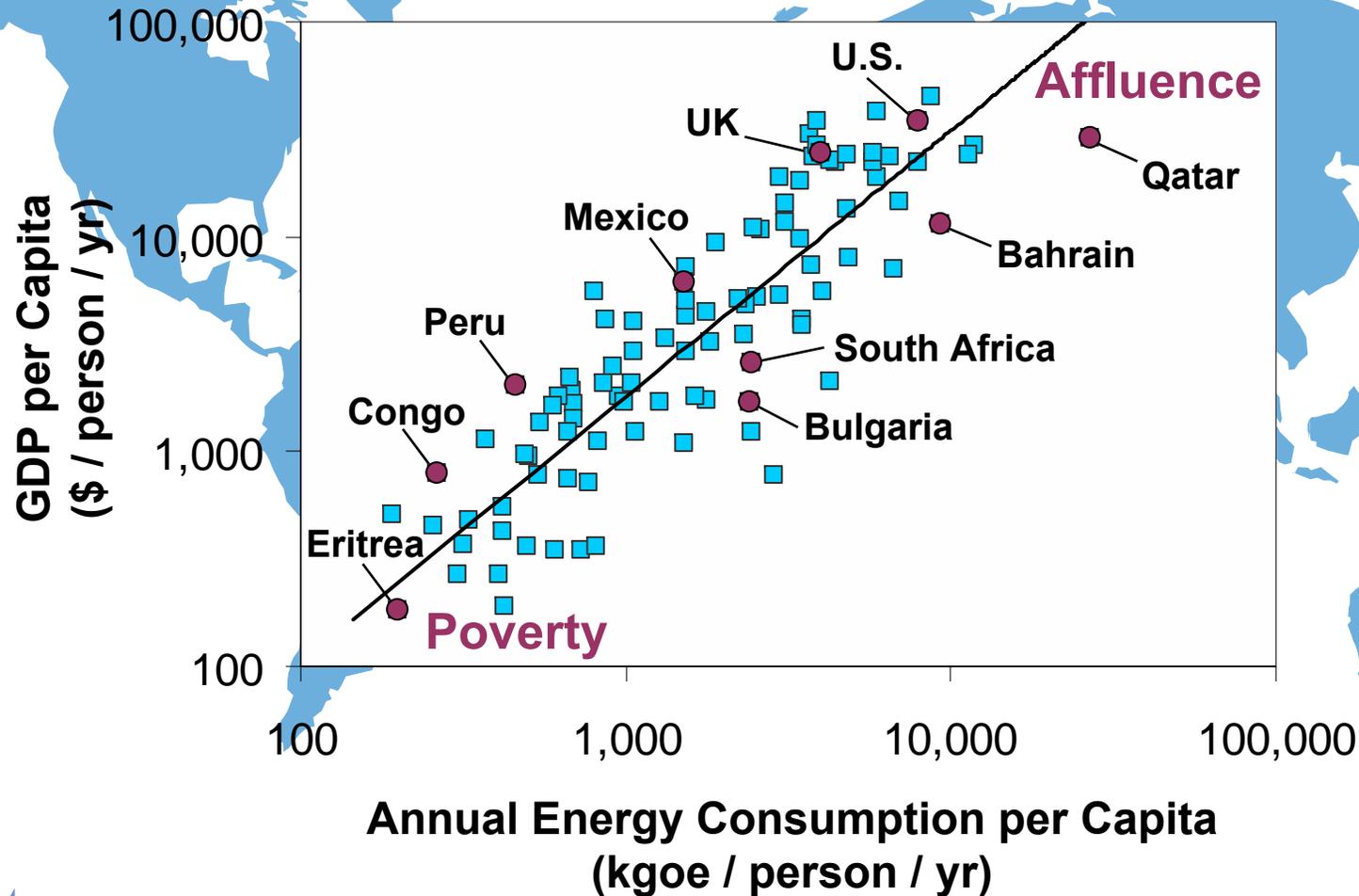


Land Use
Energy is a
major land
user



Energy = Quality of Life

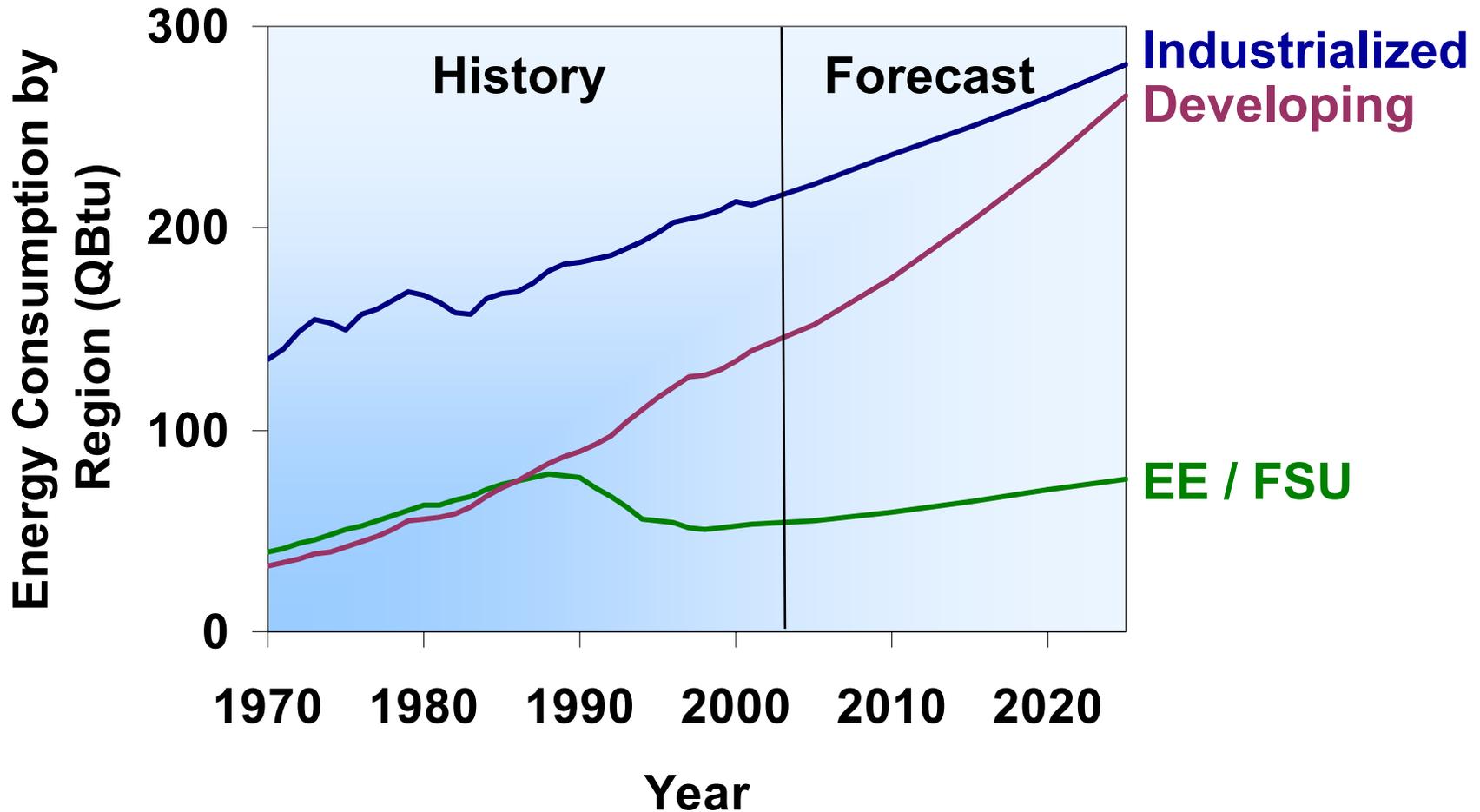
Poverty Reduces Global Security



World Resources Institute Database, accessed June 1, 2005
http://earthtrends.wri.org/searchable_db/

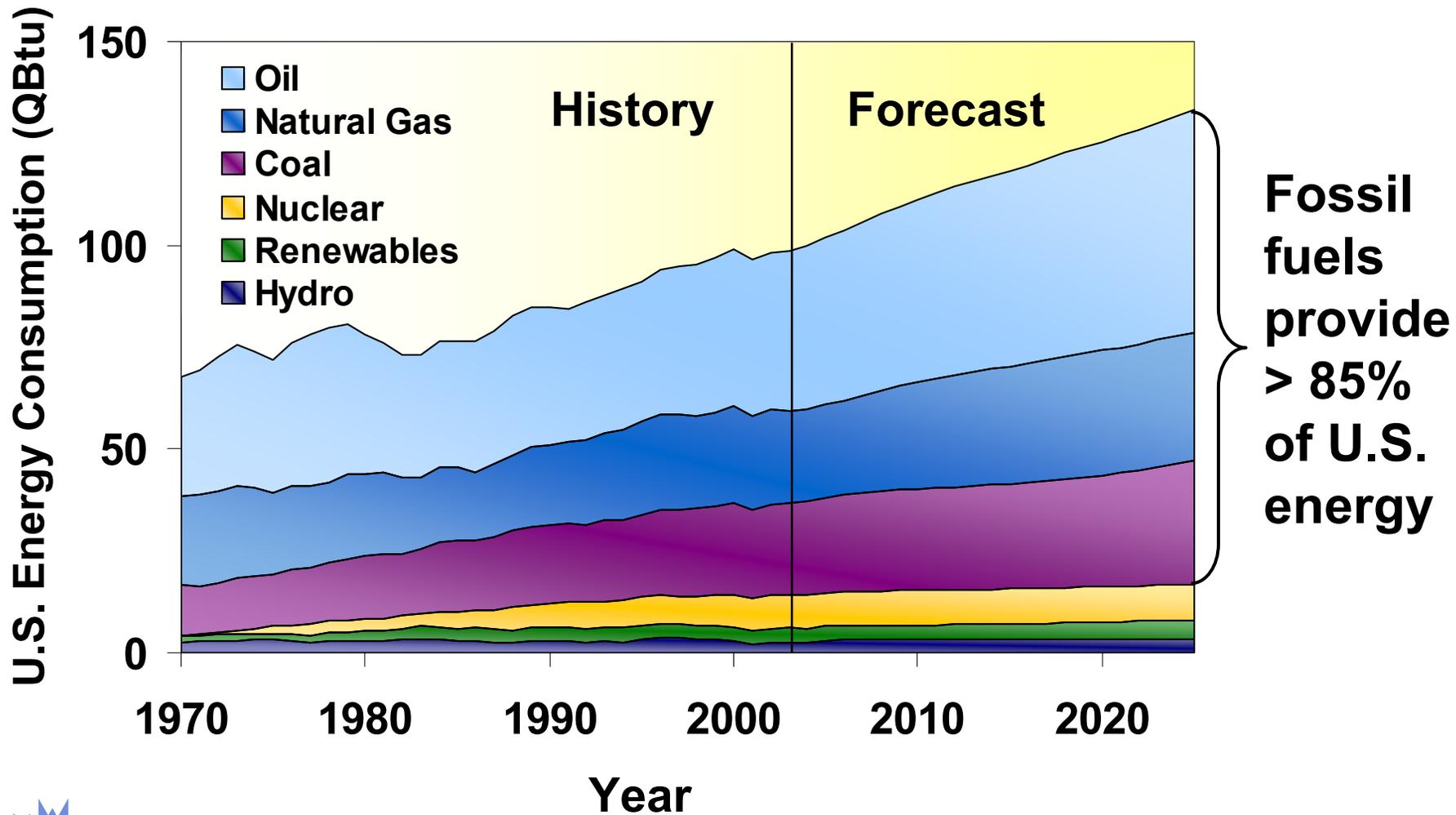
Growing World Energy Demand

Most Energy Growth in Developing Nations



Growing U.S. Energy Demand

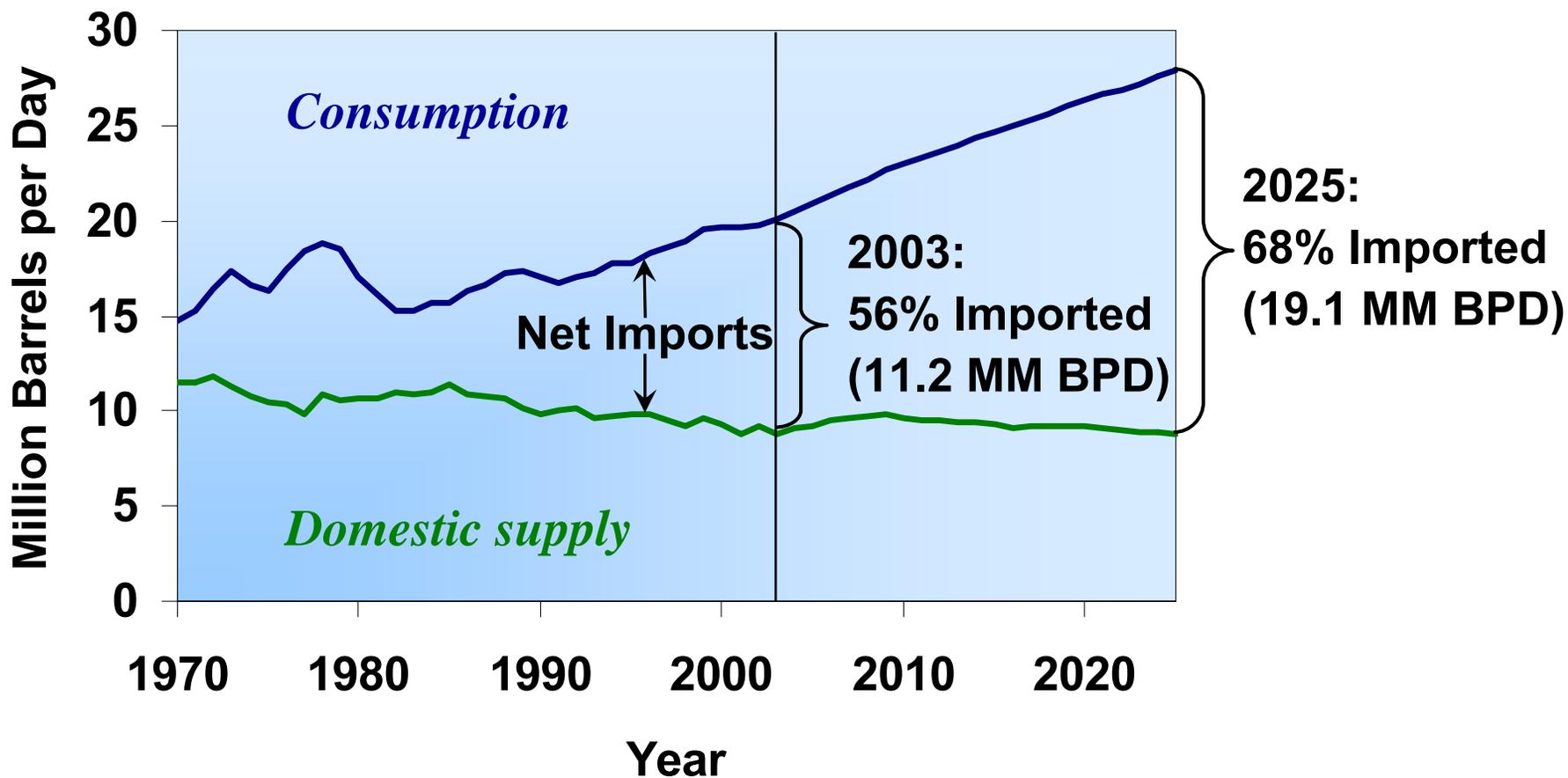
Fossil Fuels Dominate Energy Consumption



Fossil fuels provide > 85% of U.S. energy



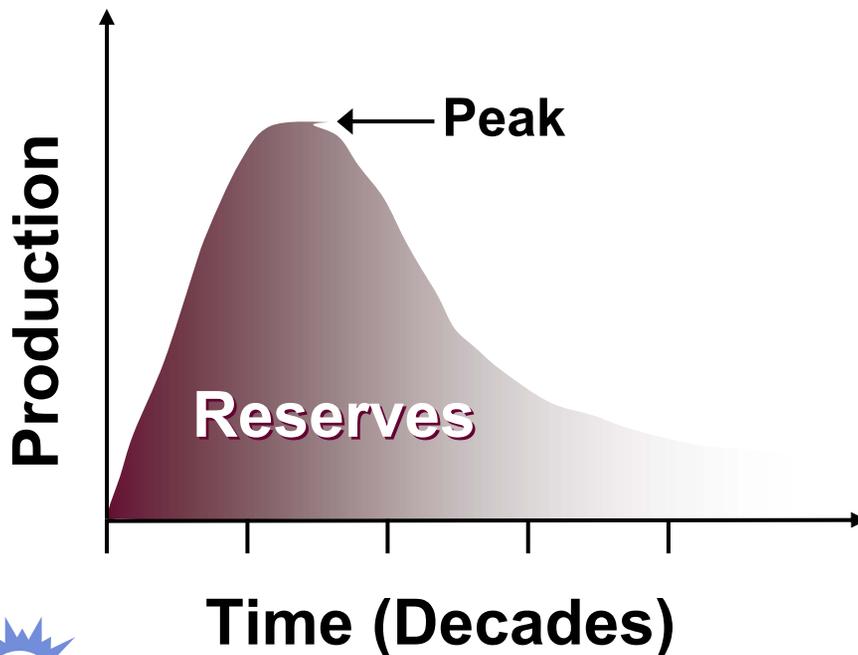
U.S. Oil Production, Consumption, and Imports



No Question World's Conventional Oil Production Will Peak

Production curve from typical oil reservoir thought applicable to total world production

- **Peaking \neq running out**
 - Maximum production
 - \sim Halfway to depletion

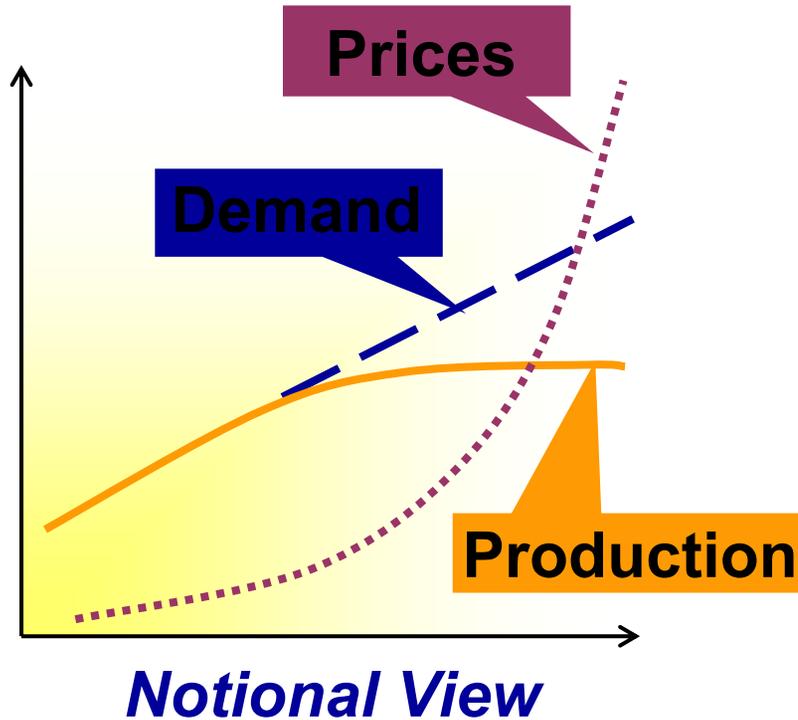


Conventional Oil Found in Discrete “Packets”
Reservoirs of all sizes, depths, & characteristics in limited number of places in world

Trends Around Peaking of World Oil Production

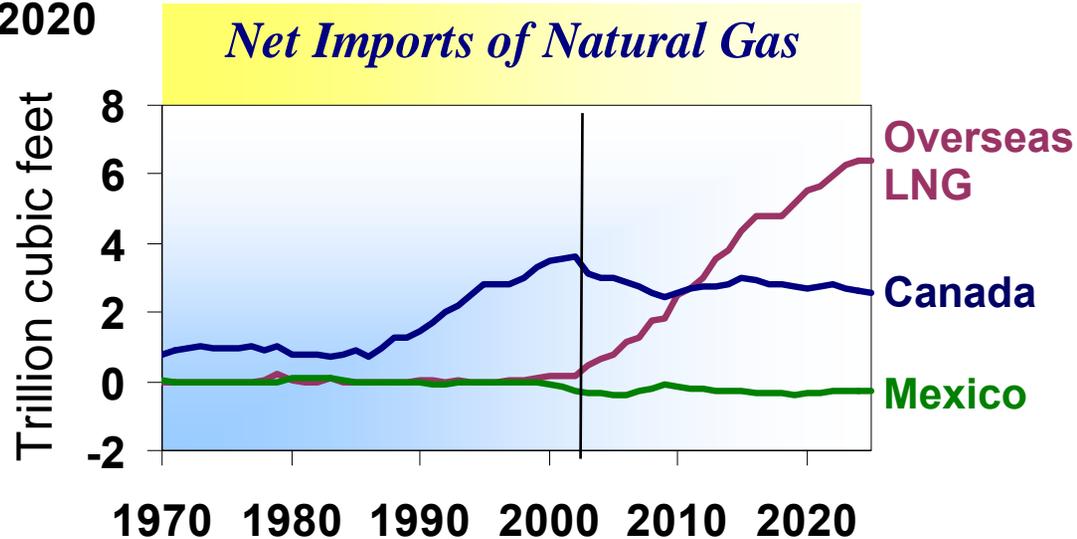
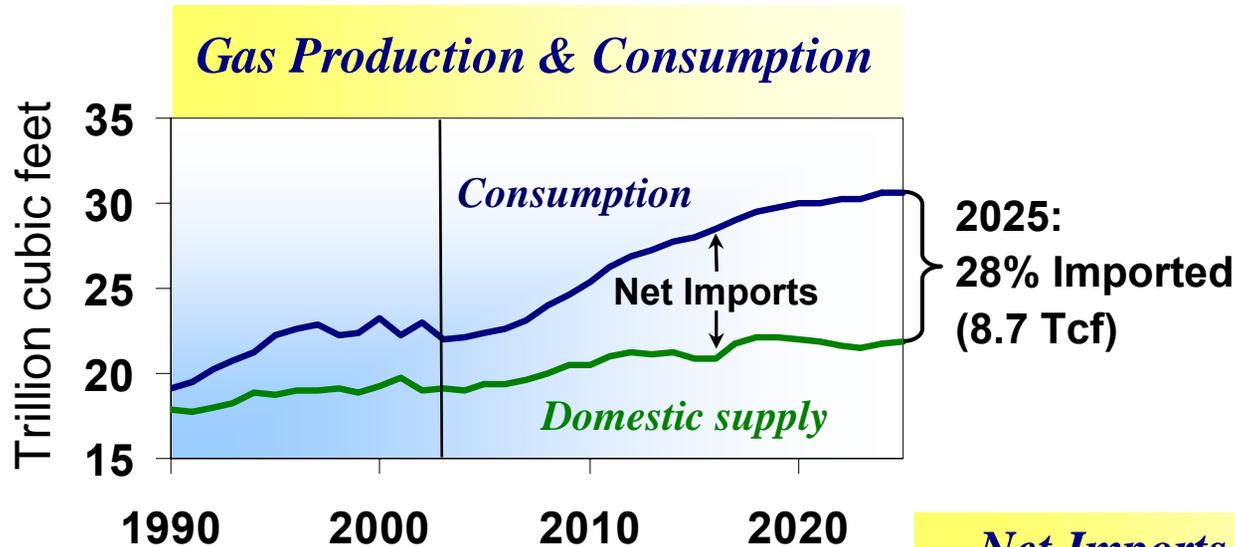
Peaking likely to produce dramatically higher oil prices

- Prices > \$100 / bbl possible
- Analogous to prolonged 1973 embargo



Peaking not business-as-usual energy problem; it's a major threat

U.S. Gas Production, Consumption, and Imports



Annual Energy Review 2003, Table 3.1
Annual Energy Outlook 2005, Table 13 and Figures 82, 83, & 85



Higher Prices Reflect Fundamental Shift in Supply / Demand Balance

- **Traditional North American gas-producing areas**
 - Can only supply 75% of projected demand
 - At best, production remains flat



- **New large-scale resources (LNG, Arctic) could meet 20 – 25% of demand**
 - Have higher cost, long lead times, development barriers

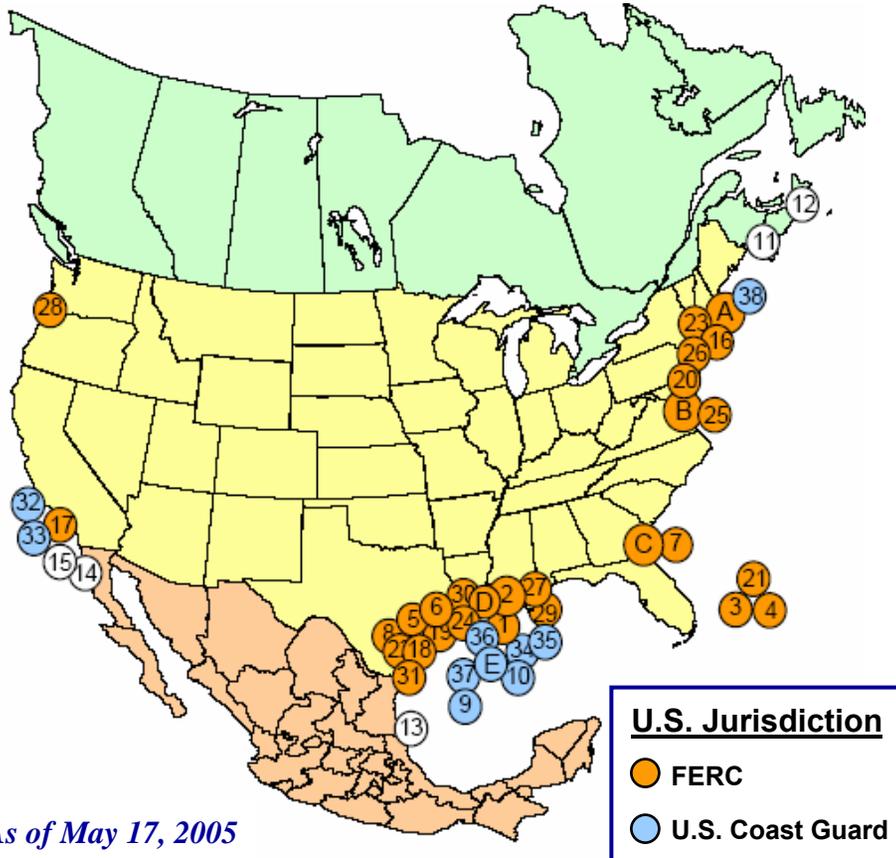
LNG Has Excellent Safety Record

- **40-year history**
- **33,000 tanker voyages**
 - No major accidents
- **January 2004 accident at Algerian LNG plant killed 27**
- **Regasification has fewer complications**
- **General population still has concerns**



Status Of North American LNG Development

Existing and Proposed LNG Terminals



As of May 17, 2005

* U.S. pipeline approved: LNG terminal pending in Bahamas



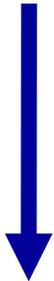
- 5 existing import terminals (including Energy Bridge)
- 15 FERC / Coast Guard / Canadian / Mexican approved sites
- 23 additional proposals
- 8.5 Tcf supply if all approved sites built
 - 18.3 Tcf if all approved and proposed sites built
- EIA forecast for U.S. = 6.4 Tcf by 2025

FERC Office of Energy Projects
<http://www.ferc.gov/industries/lng/indus-act/exist-prop-lng.pdf>

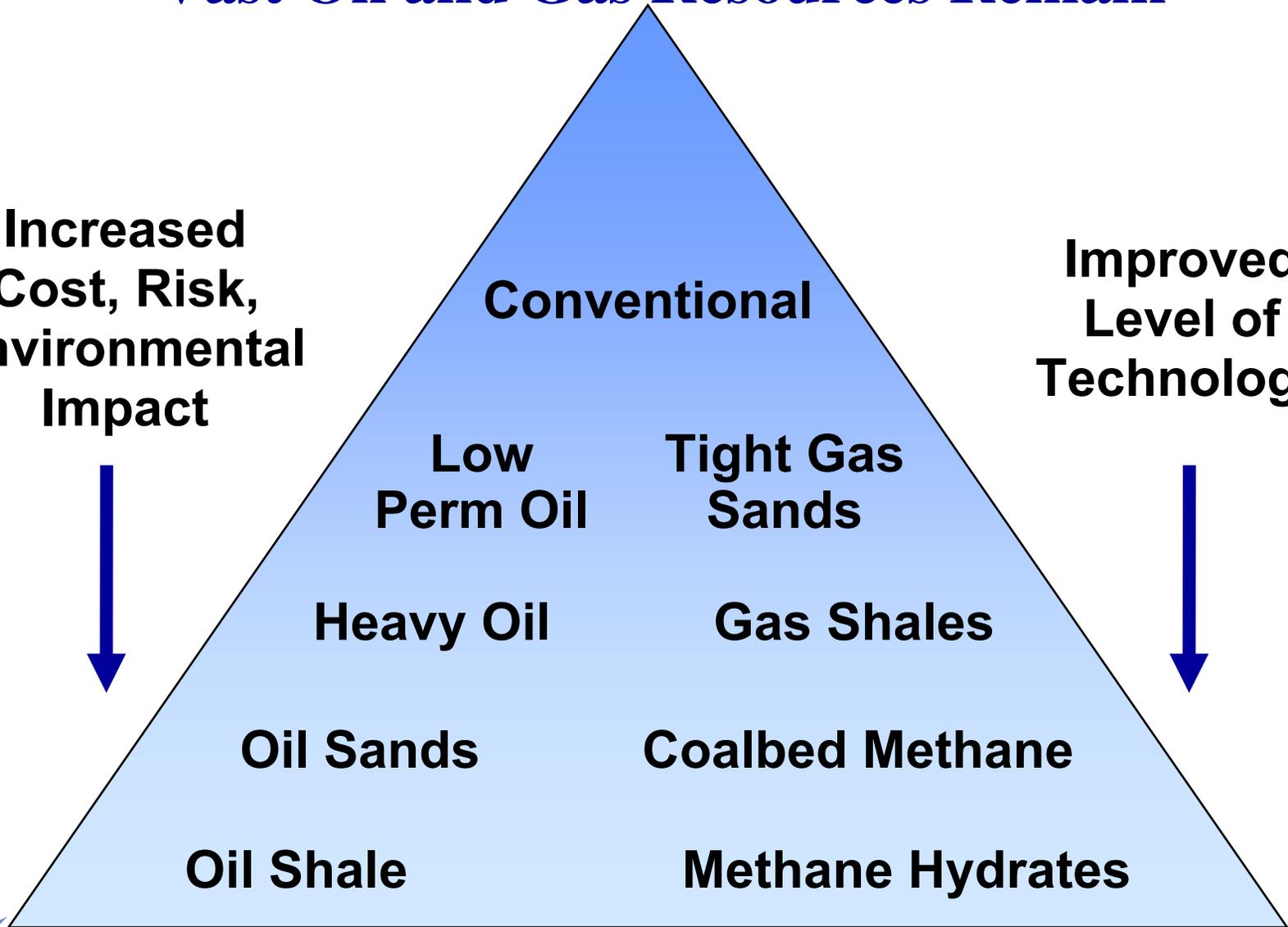
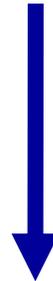
Carl O. Bauer, EPSCor, June 15, 2005

Vast Oil and Gas Resources Remain

Increased
Cost, Risk,
Environmental
Impact



Improved
Level of
Technology



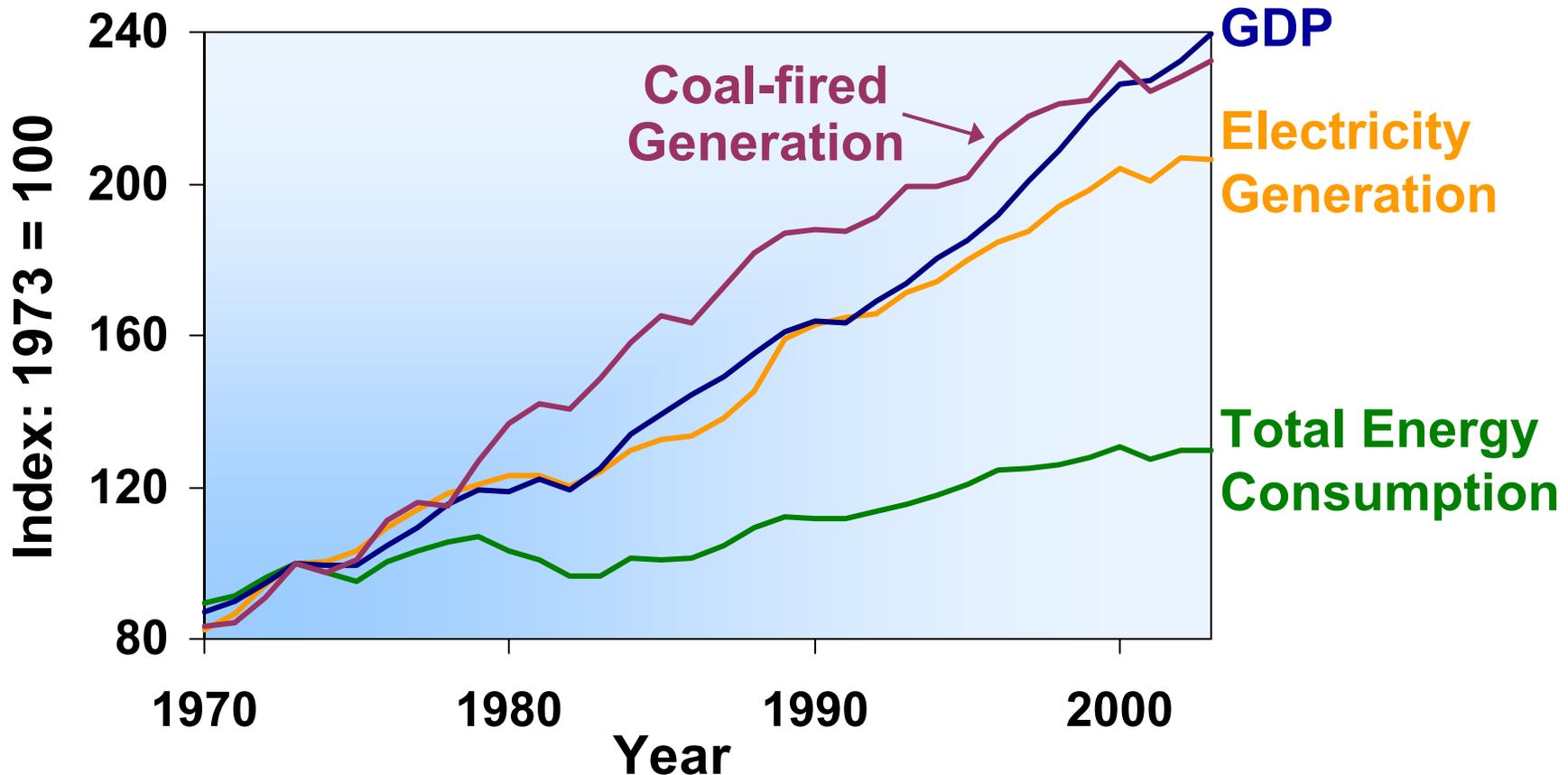
For Longer Term, Methane Hydrates May Be Promising

Mallik Project Mackenzie Delta, Canada

- Three-well project
- First dedicated hydrate production test wells
 - Tested depressurization and thermal methods
 - Final report available summer 2005
- International team



Coal Use Linked to Economic Growth



Coal-fired generation and GDP have grown at nearly the exact same pace over last 30 years

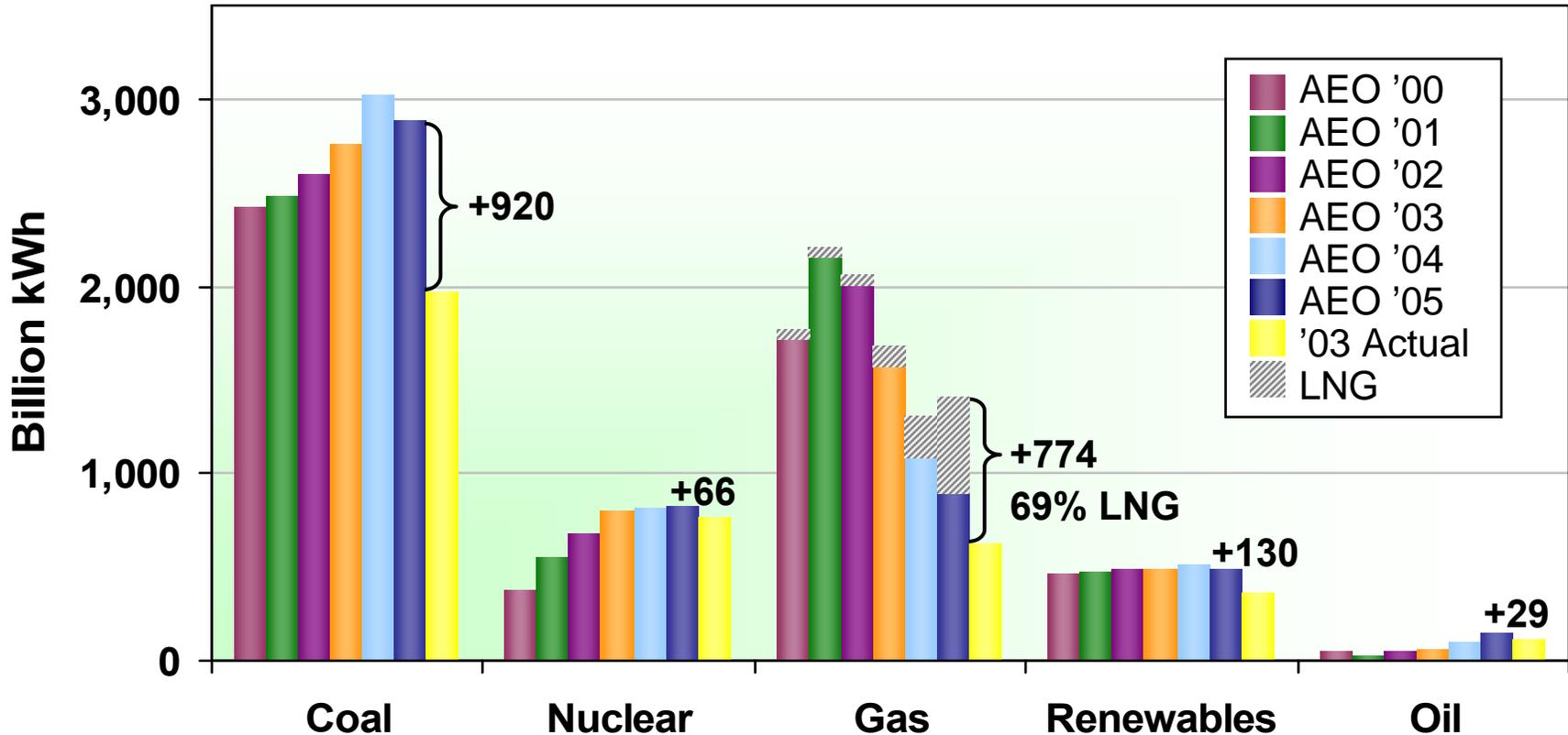


GDP: U.S. DOC, Bureau of Economic Analysis
Energy & Electricity: EIA, Annual Energy Review 2003

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U.S. Electricity Generation by Fuel Source

EIA Estimates for 2025



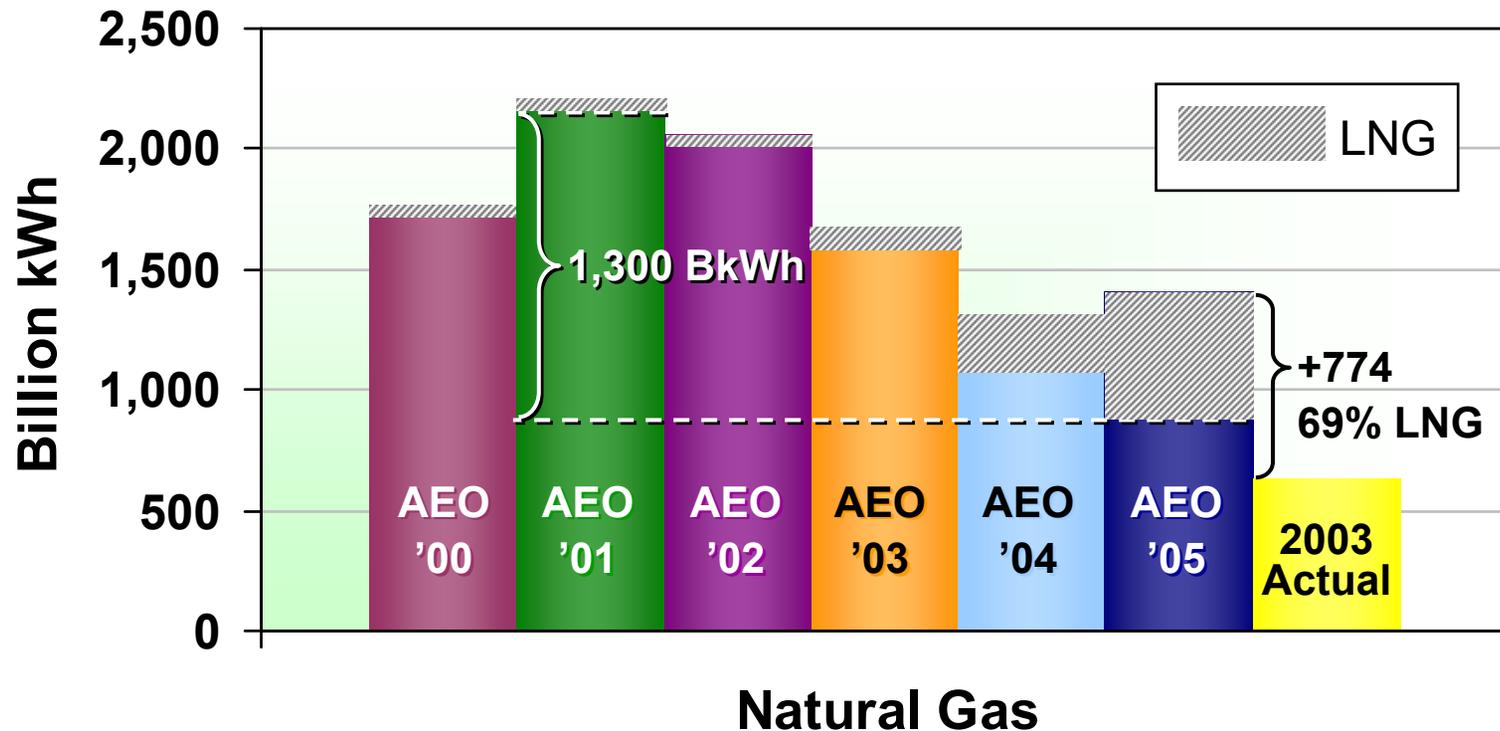
- *Dramatic change in gas-fired generation forecasts*
- *Sudden LNG acceptance begins to displace coal in AEO '05*



EIA, Annual Energy Outlook 2000, 2001, 2002, 2003, 2004 and 2005
 * - AEO 2000, 2001, 2002 trendline extrapolation from 2020 to 2025

U.S. Electricity Generation from Natural Gas

EIA Estimates for 2025



- *Loss of 1,300 BkWh North American gas-fired generation*
- *1,300 BkWh \approx 2 times today's gas-fired generation*

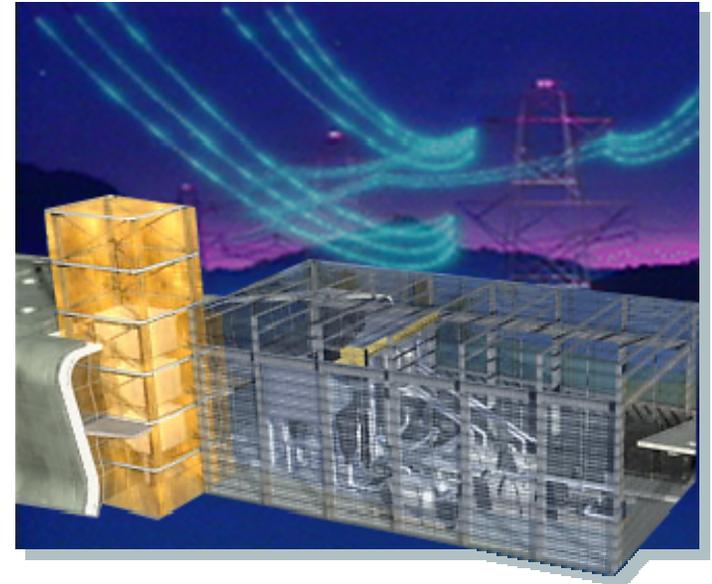


EIA, Annual Energy Outlook 2000, 2001, 2002, 2003, 2004 and 2005
 * - AEO 2000, 2001, 2002 trendline extrapolation from 2020 to 2025
 LNG share of generation assumed equal to share of natural gas growth

FutureGen

**World's first near zero-emission,
coal-based power plant to:**

- **Pioneer advanced hydrogen production from coal**
- **Emit virtually no air pollutants**
- **Capture and permanently sequester carbon dioxide**
- **Integrate operations at full-scale – a key step to proving feasibility**



FutureGen Based on Integrated Gasification Combined Cycle (IGCC) Technology

IGCC Advantages

- Fuel and product flexibility
- High efficiency
- Environmentally superior
- Sequestration capable

Current IGCC Issues

- Capital cost 5 – 20% higher than conventional coal
- Reliability lower

Two Demonstration Plants in U.S.



Industry Group Announced Formation of FutureGen Consortium

- American Electric Power
- CINergy
- PacifiCorp
- Southern Company
- TXU (Texas Utilities)
- CONSOL
- Kennecott Energy
- North American Coal
- Peabody Energy
- RAG American Coal Holding

Charter members represent ~1/3 of coal-fired utilities and ~1/2 of U.S. coal industry



Climate Change May Be Biggest Environmental Problem Yet

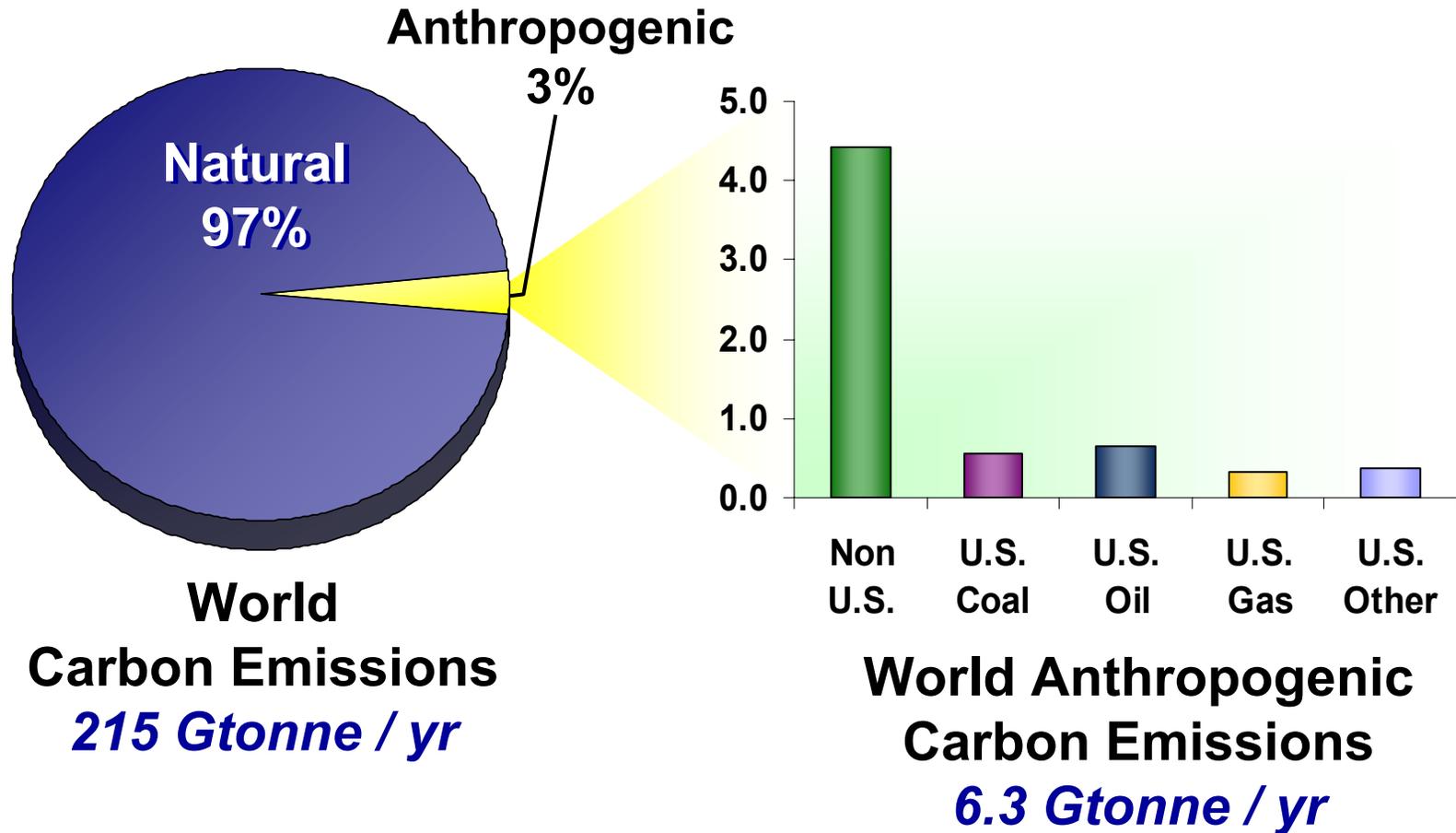
“The scale of this issue is 500 million times more complicated. . . . You’re implicating every business, every family that drives an automobile.”

***– Daniel Esty
Professor of Environmental Law
Yale University***



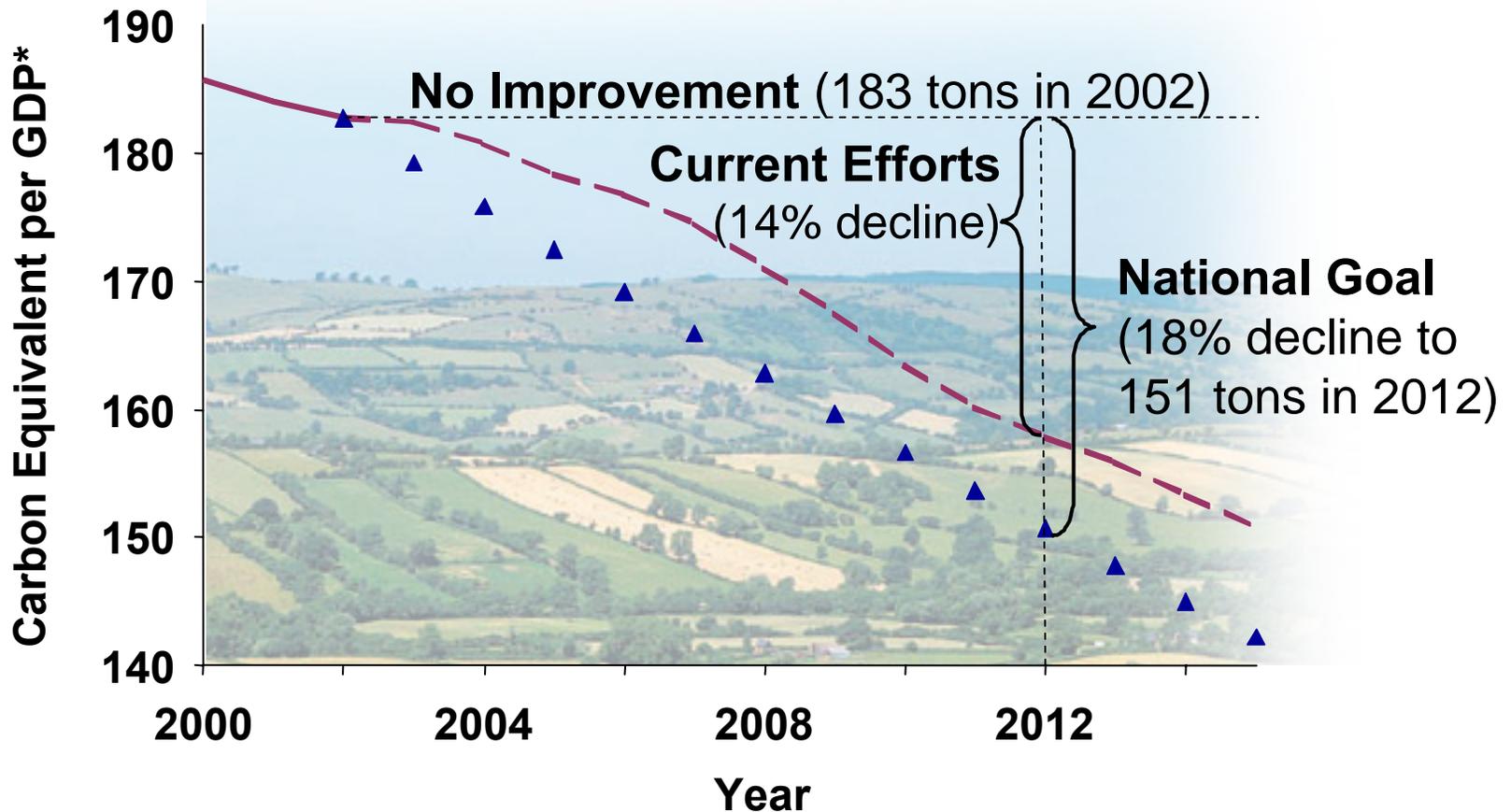
Most Carbon Emissions from Natural Sources

Anthropogenic Emissions “Tip the Scales”



Global Climate Change Initiative

Reduce Greenhouse Gas Intensity 18% by 2012



**Metric Tons Carbon Equivalent per Million \$ GDP, 2001 Dollars*

White House Clear Skies Initiative Factsheet

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Approaches to Sequester Carbon

Capture and Storage



**Unmineable
Coal Seams**



**Deep Ocean
Injection**



**Depleted Oil /
Gas Wells,
Saline Reservoirs**

Enhance Natural Processes



Forestation



**Iron or Nitrogen
Fertilization of
Ocean**



**Enhanced
Photosynthesis**

Conclusion

Energy challenges are daunting

Fossil fuels will continue to play major role for decades

We have used technology to address other major issues facing society

Energy challenges solved easiest with innovative, affordable, low GHG-emitting technologies, especially for electricity and transportation fuels



Visit Office of Fossil Energy & NETL Websites



- > Coal & Natural Gas Power Systems
- > Carbon Sequestration
- > Hydrogen & Other Clean Fuels
- > Oil & Gas Supply & Delivery
- > Natural Gas Regulation
- > Electricity Regulation
- > Petroleum Reserves



Recent Fossil Energy Updates...
Stripper Well Technology
DOE-backed consortium of technologies to extend life



\$760 Million Programs in
DOE's fiscal year billion includes research; increased cells, hydrogen technologies R&D

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Cool Science
ISO14001
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NATIONAL ENERGY TECHNOLOGY LABORATORY
United States Department of Energy

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TOP NEWS STORIES

- DOE-Innovative Technology Shows Promise for Low-Cost Mercury Control**
Close on the heels of the U.S. Environmental Protection Agency's March 15 release of its Clean Air Mercury Rule, the U.S. Department of Energy has issued a license to private industry to commercially develop a promising low-cost, DOE-patented mercury control technology. [Read More!](#)

TECHNOLOGY AREAS

- Strategic Center for Natural Gas & Oil
- Strategic Center for Coal
- Office of Science, Technology & Analysis
- Office of Advanced Initiatives

DOE Celebrates Success of Regional Carbon Sequestration Partnerships

A report released today by the Department of Energy details the success of the Regional Carbon Sequestration Partnerships in laying the groundwork for field testing and verifying carbon sequestration technologies in the near term. [Read More!](#)

DOE-Heavy Oil Potential Key to Alaskan North Slope Oil Future

Alaska's North Slope boasts a massive heavy oil resource that someday could underpin the survival of one of the Nation's most critical oil-producing provinces and research funded by the Department of Energy may provide the key to unlocking this vast but, to date, largely intractable oil resource. [Read More!](#)

[Carbon Capture and Sequestration Systems Analysis Guidelines](#)

<http://fossil.energy.gov/>

www.netl.doe.gov

