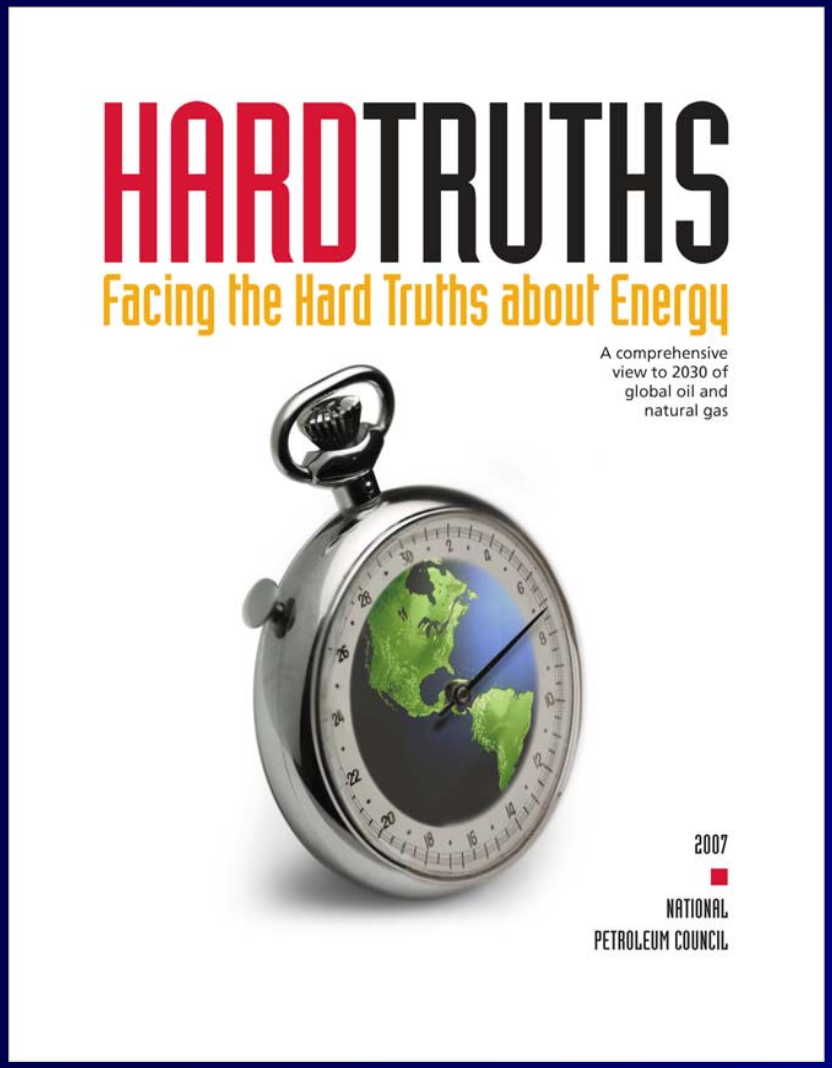


One Year Later

An update
presented to the
National Petroleum Council

September 17, 2008

The 2007 Study Questions

- What does the future hold for global oil and natural gas supply ?
- Can incremental oil and gas supplies be brought on-line, on-time, and at a reasonable price to meet future demand without jeopardizing economic growth ?
- What oil and gas supply strategies and / or demand-side strategies does the Council recommend the U.S. pursue to ensure greater economic stability and prosperity ?

Unprecedented Report Reception

- Over 1.5 million downloads from the website
- Over 8,200 hard copy reports distributed
- Over 180 presentations and briefings
- Executive Summary in seven languages:
  - English
  - Arabic
  - Chinese
  - French
  - Japanese
  - Russian
  - Spanish

Events and Trends in the Last Year

- Oil and gas prices rose sharply and remain volatile
- Higher energy prices are slowing demand growth
- Geopolitical issues are widespread:
  - Middle East
  - Nigeria
  - Russia/Caucasus
  - Venezuela
- Focus on carbon management has increased
- Energy Independence and Security Act enacted
- Energy is a high-profile topic in the political debate

Task Group Updates

- Demand – Jim Burkhard
- Supply – Don Paul
- Geopolitics and Policy – Frank Verrastro
- Technology – Rod Nelson

Key Findings from the 2007 Report Reinforced

- Demand for fuel and power to grow significantly, requiring increases in efficiency, and expansion of all economic energy sources
- Increasing risks to the expansion of conventional liquids supplies
- Significant additions of unconventional liquids supply are projected
- Recent studies report a larger oil and gas resource endowment
- Exploration and production expenditures have increased dramatically
- Growing pressure on cost and availability of project resources is hindering the ability to expand energy production capability
- Pressures to address carbon emissions and energy security are increasing

To meet the accumulating risks, all recommendations of the 2007 Report require implementation with increased urgency

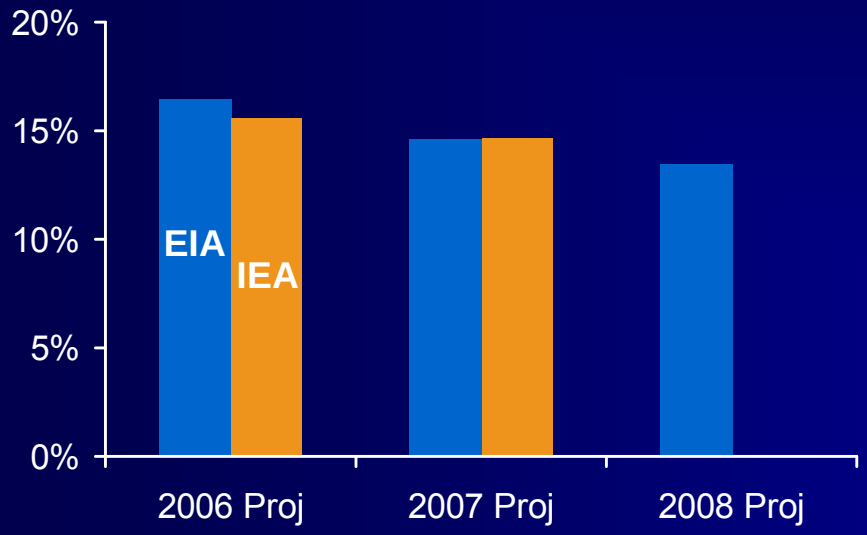
The Hard Truths

Coal, oil, and natural gas will remain indispensable to meeting total projected energy demand growth.

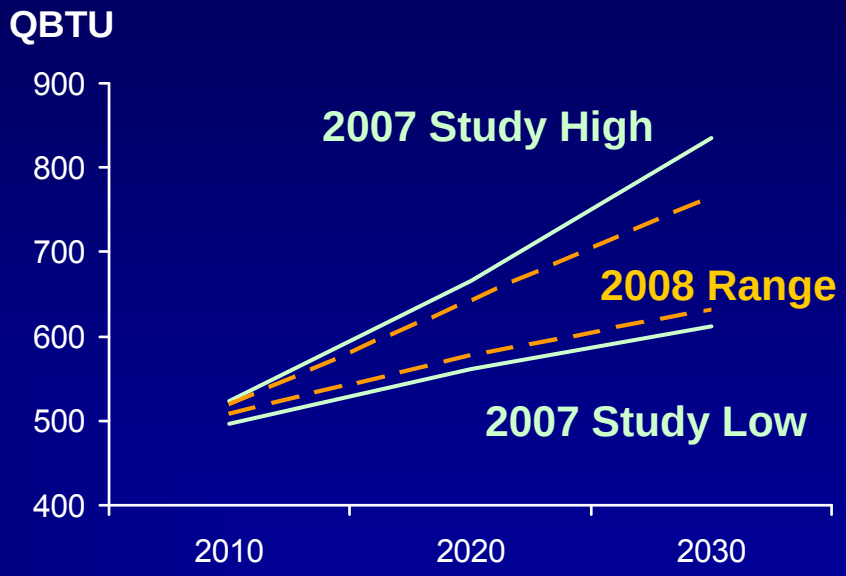
- Growth of economic activity and population in developing world expected to drive increased energy demand
  - Non-OECD demand likely to exceed OECD
  - U.S. and G-8 share of world economy decreasing
- Updates project that coal, oil and gas fossil fuels will supply substantial majority of energy through 2030

Economic and Energy Projections

U.S. Share of 2030 World GDP



World Energy Outlooks

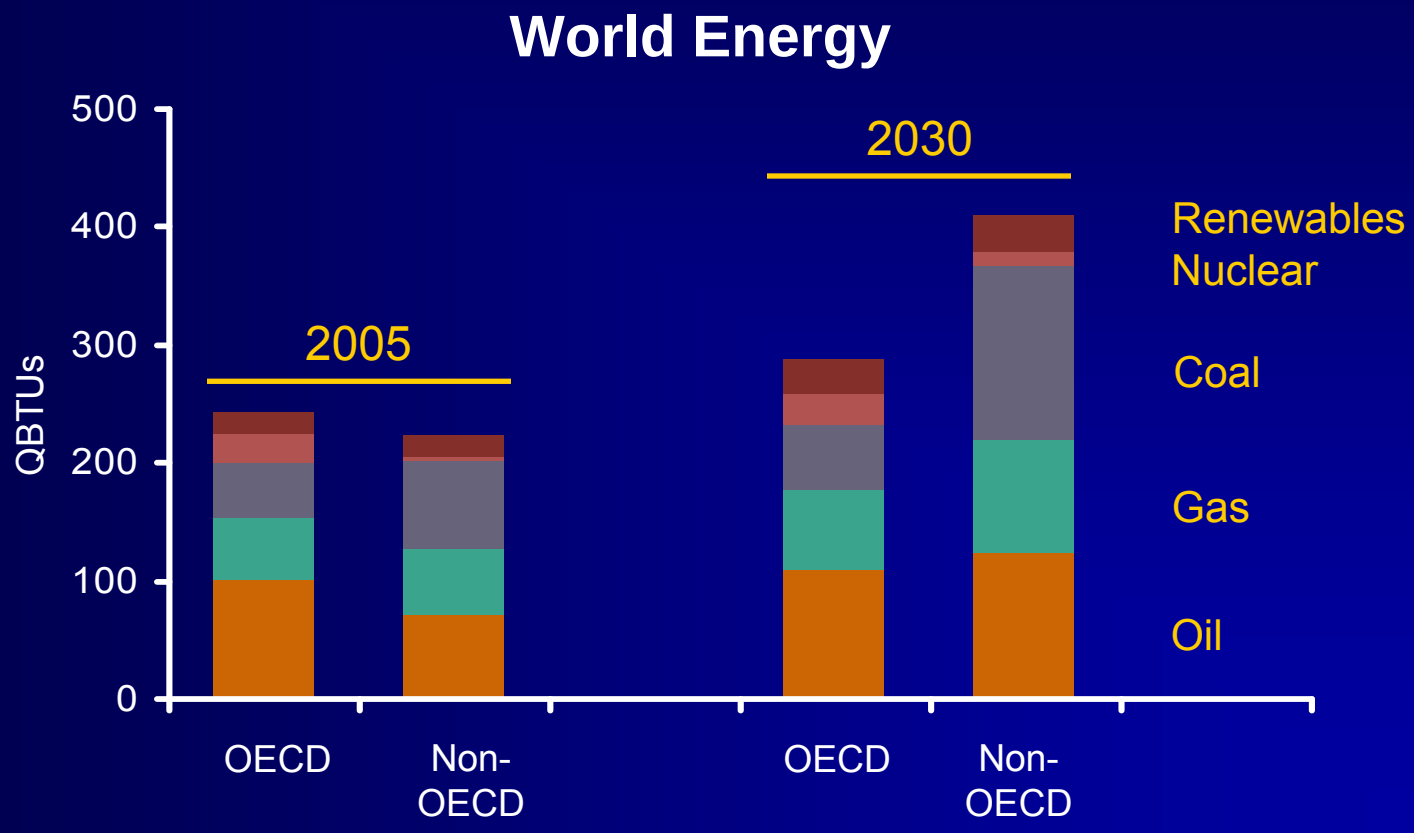


Global GDP estimates are higher, U.S. share decreasing

New outlooks within original Study's range

Projected Demand Increase

- Developing world projected to drive the demand increase
- Coal, oil, and gas continue to supply ~80% of total energy



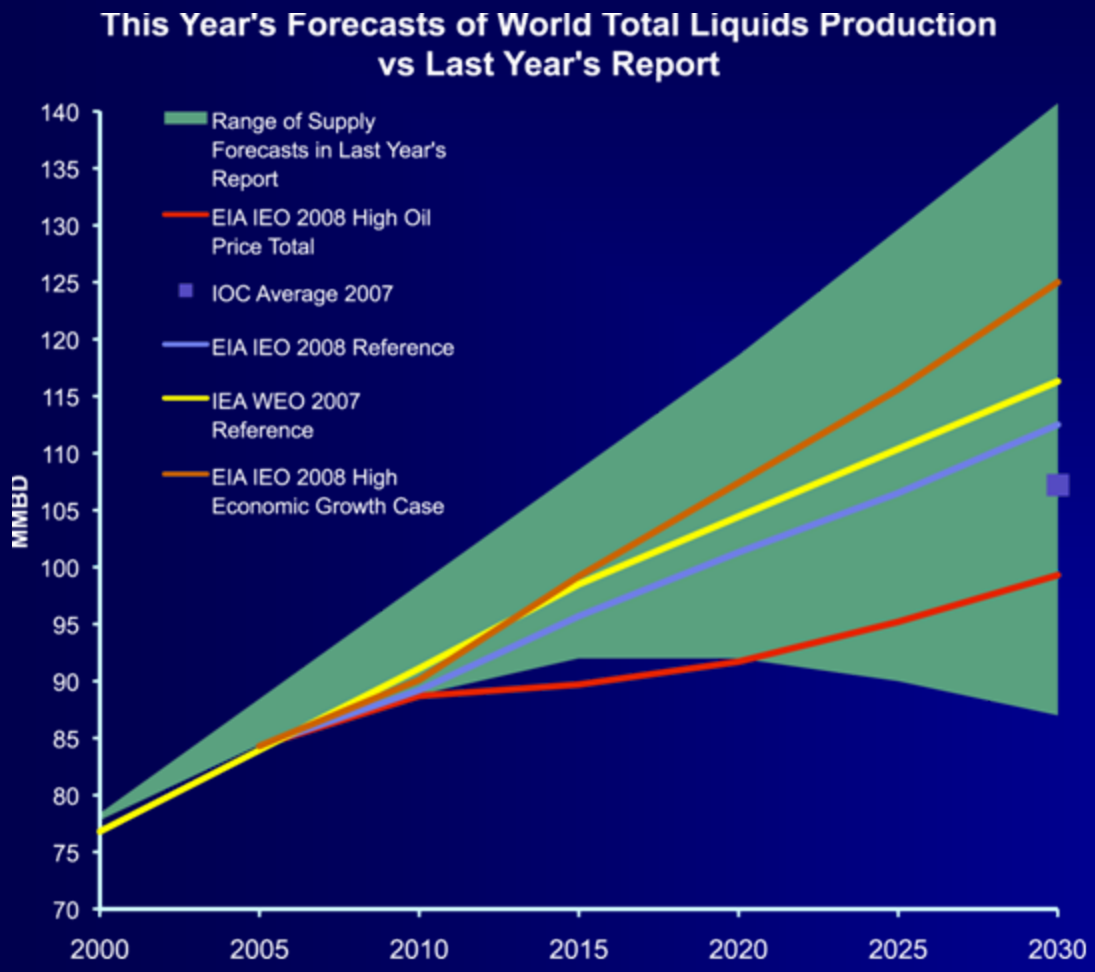
Source: DOE EIA 2008 International Energy Outlook.

The Hard Truths

The world is not running out of energy resources, but there are accumulating risks to continuing expansion of oil and natural gas production from the conventional sources relied upon historically. These risks create significant challenges to meeting projected demand.

- Increasingly apparent accumulation of risks to expansion of conventional liquids
- Resource estimates are growing, but turning resources into supplies is an increasing challenge
- Where resource is accessible, cost and availability of materials and human resources are hindering projects
- Constraints to expansion of first-generation biofuels are more apparent

Liquids Production Projections

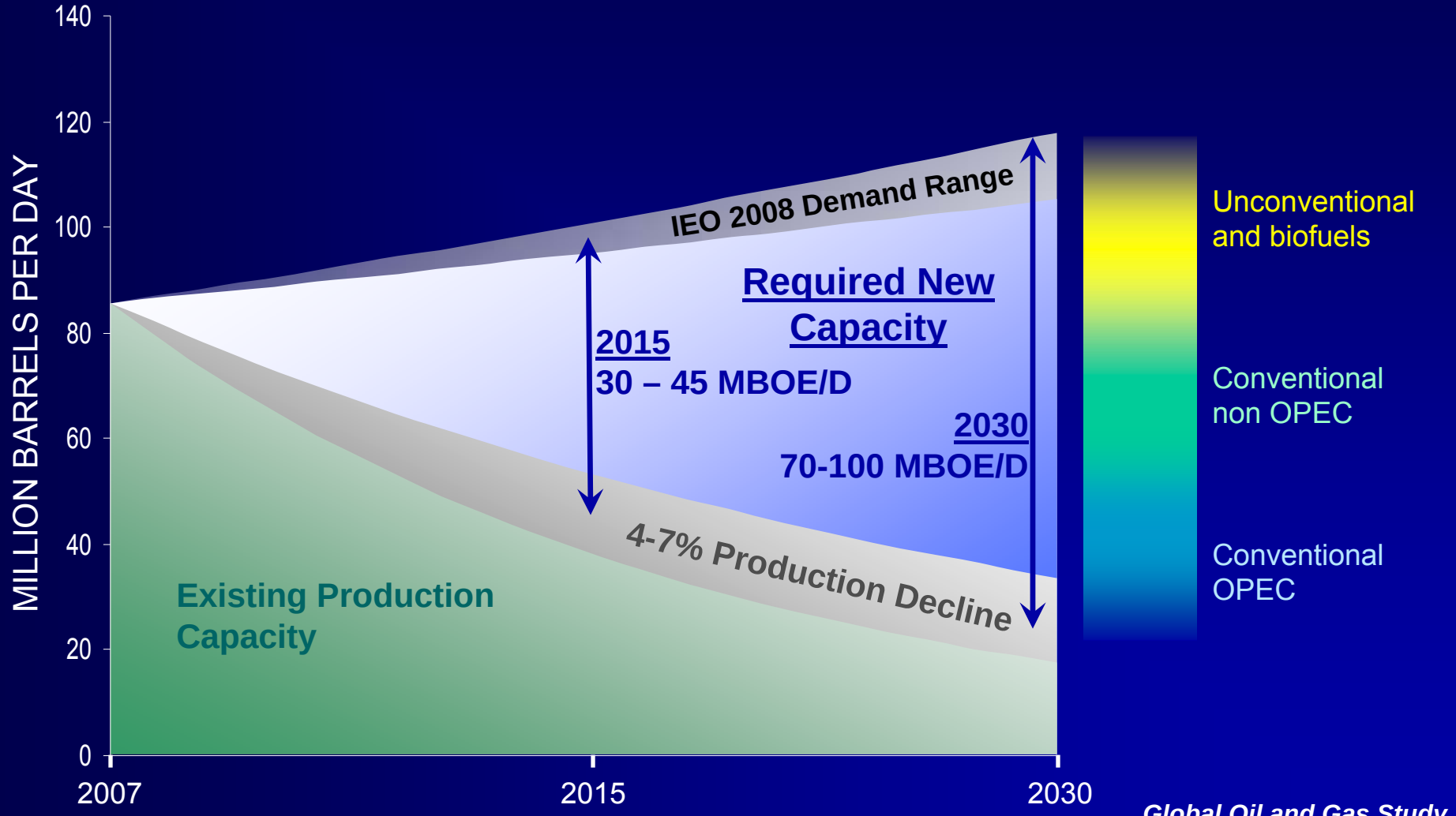


- New projections are mostly within last year's range when normalized
- Lower projections may reflect reduced demand assessment rather than supply limitation
- For petroleum liquids alone, the Shell scenarios show flat-to-declining production after 2020

All data from published sources.

The Growing Liquids Supply Challenge

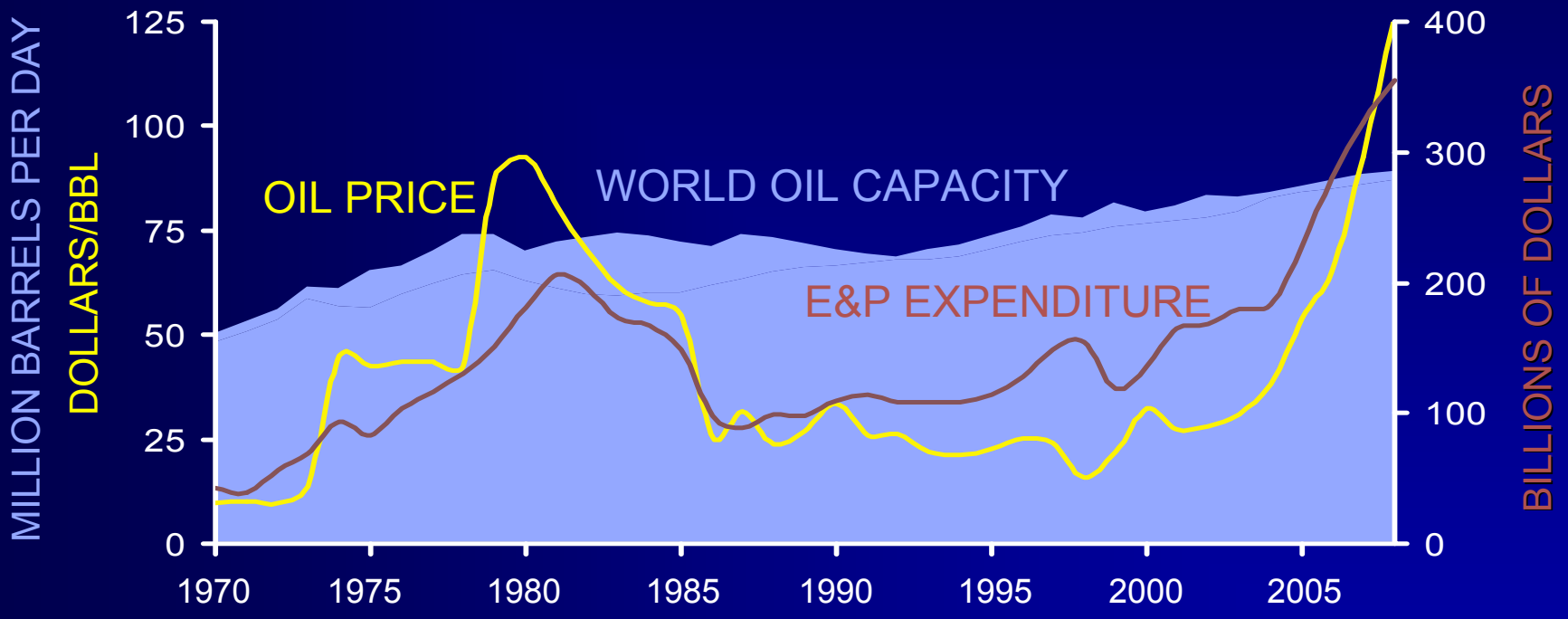
Increasing demand and natural production decline create growing need for significant new production capacity



Investment, Capacity, and Time (2008 dollars)

Investment has dramatically increased ...

... with years required to increase production



Sources: BP Statistical Review, IEA, Citigroup, 2008 dollars.

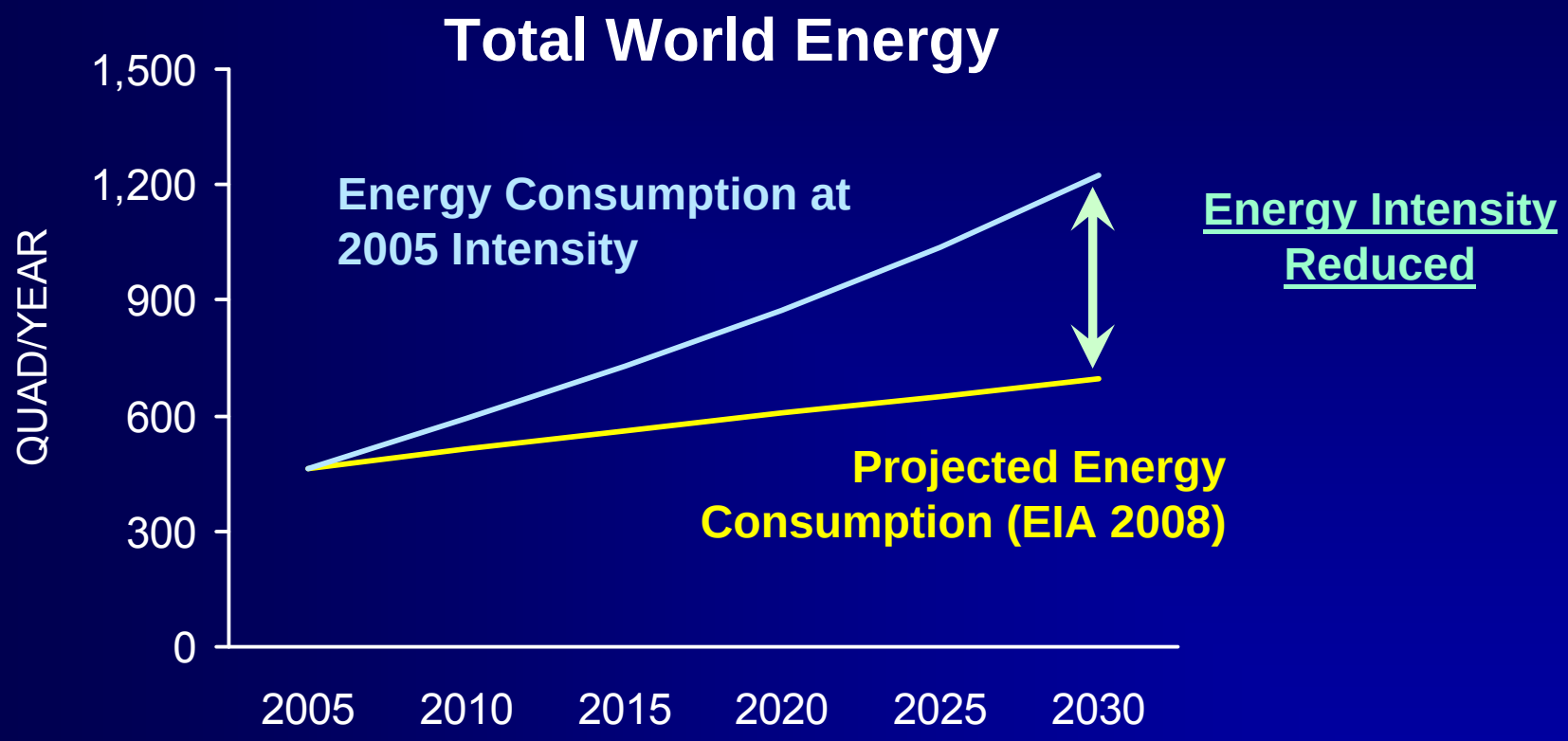
The Hard Truths

To mitigate these risks, expansion of all economic energy sources will be required, including coal, nuclear, biomass, other renewables, and unconventional oil and natural gas. Each of these sources faces significant challenges...

- Continued efficiency improvement increasingly important
- Increased unconventional liquids, biofuels, and unconventional gas necessary
- Access to resources critical to augmenting U.S. supply
- Simultaneous pursuit of multiple energy sources increases pressure on cost and availability of project resources

Energy Efficiency

Without energy efficiency improvement, projected energy use would be substantially higher

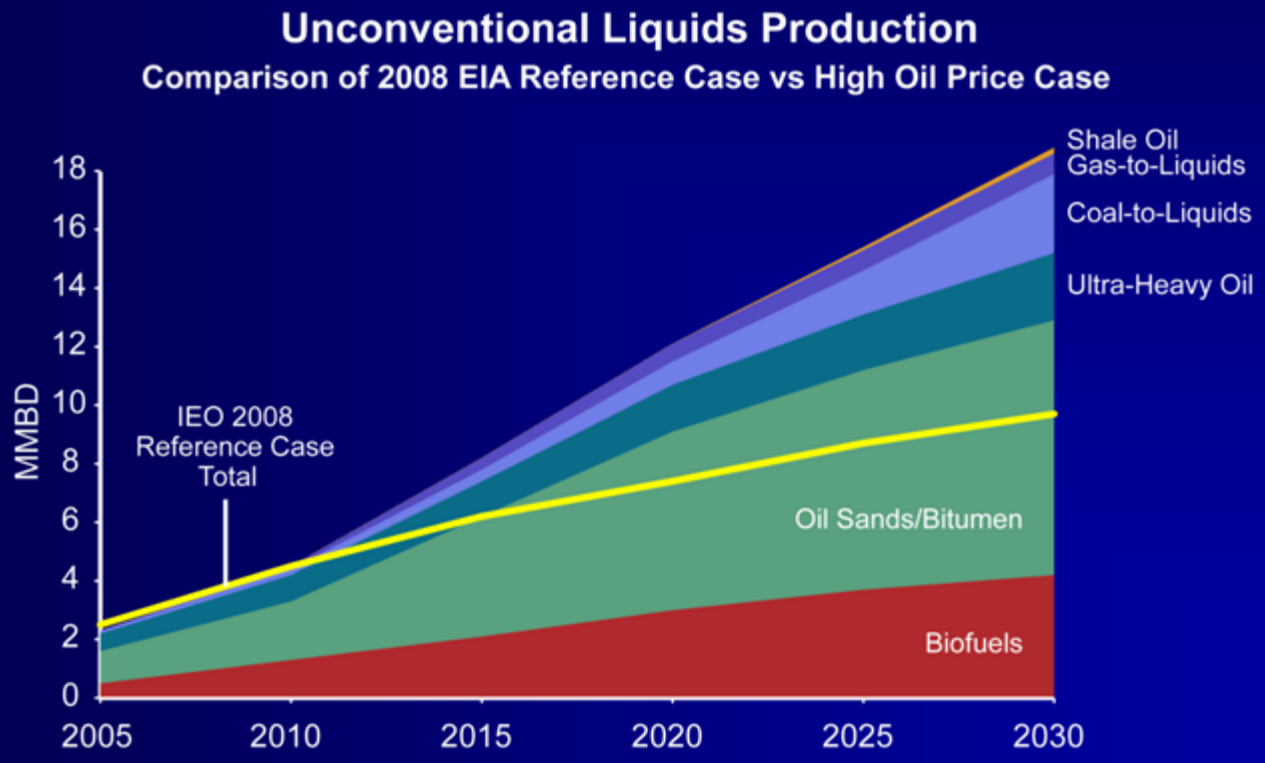


Intensity is unit of energy per unit of economic output
Source: EIA's 2008 International Energy Outlook.

World Unconventional Liquids

Unconventional liquids needed to meet forecast demand in most projections

Development of unconventional sources requires significantly increased investment levels, continued technology advancements, and potentially large carbon management infrastructure

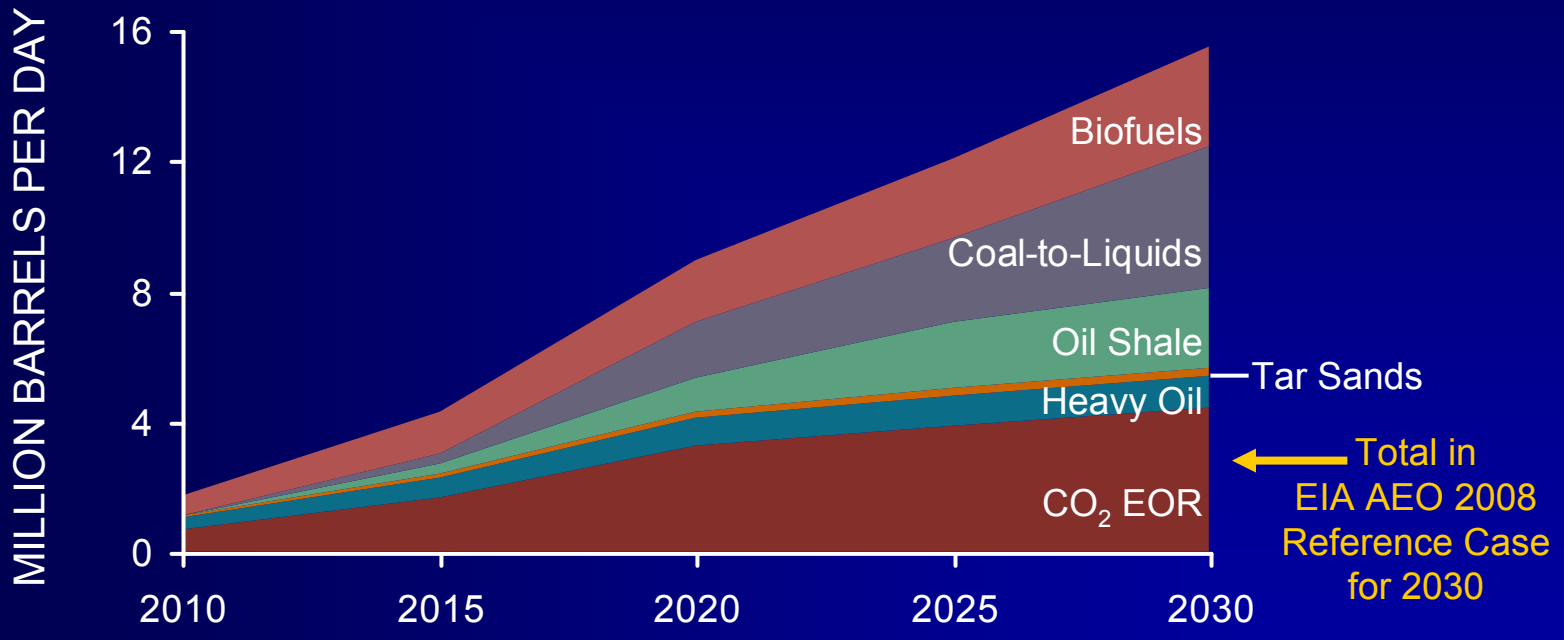


Source: EIA IEO2008 reference case.

U.S. Unconventional Liquids Potential

Aggressive forecasts reflect development of significant unconventional resources

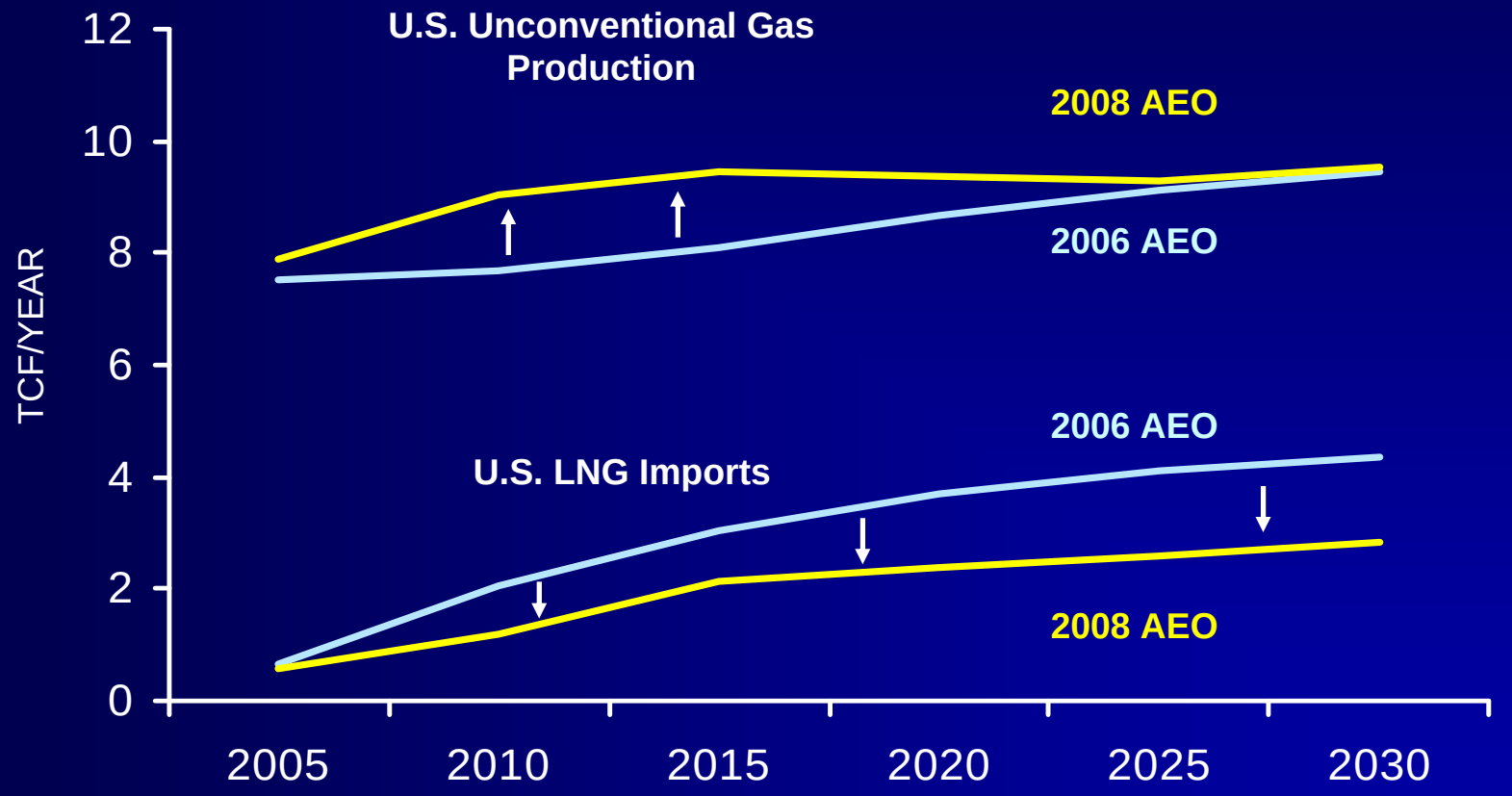
Combination of Aggressive, Unconstrained Forecasts



Sources: Strategic Unconventional Fuels Task Force, DOE and USDA, ARI and other.

U.S. Unconventional Gas

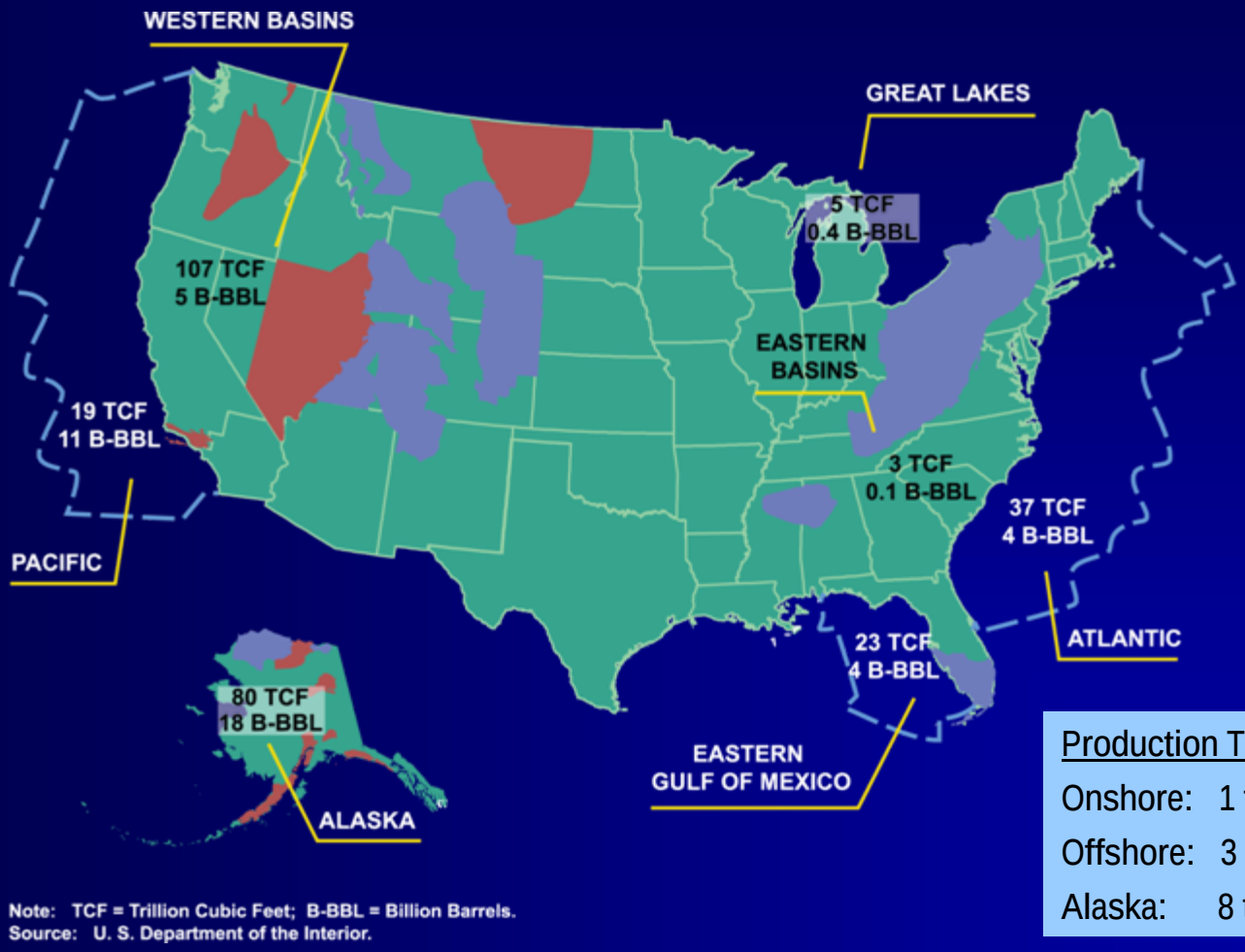
Technology and price have increased unconventional gas drilling and production



Source: EIA's 2006 and 2008 Annual Energy Outlook.

Restricted Resources

Access to significant U.S. oil and gas resources restricted



Note: TCF = Trillion Cubic Feet; B-BBL = Billion Barrels.
Source: U. S. Department of the Interior.

Production Timeline

Onshore: 1 to 8+ years

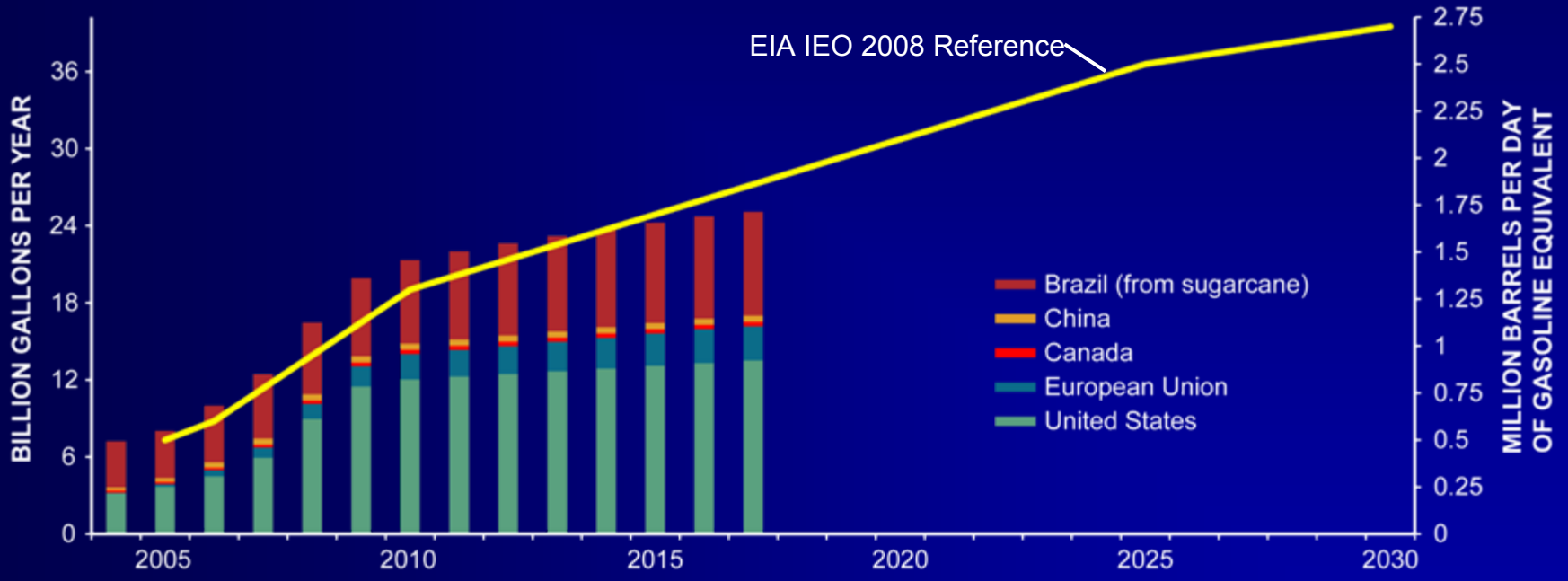
Offshore: 3 to 10+ years

Alaska: 8 to 12+ years

Biofuels Growth To Continue

- 1st generation biofuels have become an integral component of fuel supply
- 2nd generation not yet demonstrated at scale

EIA IEO2008 Reference Case World Biofuel Production with USDA's 2007 Ethanol Production Forecast by Country



Source: USDA Agricultural Projections to 2017 from Global Agricultural Supply and Demand: Factors Contributing to the Recent Increase in Food Commodity Prices July 23, 2008.

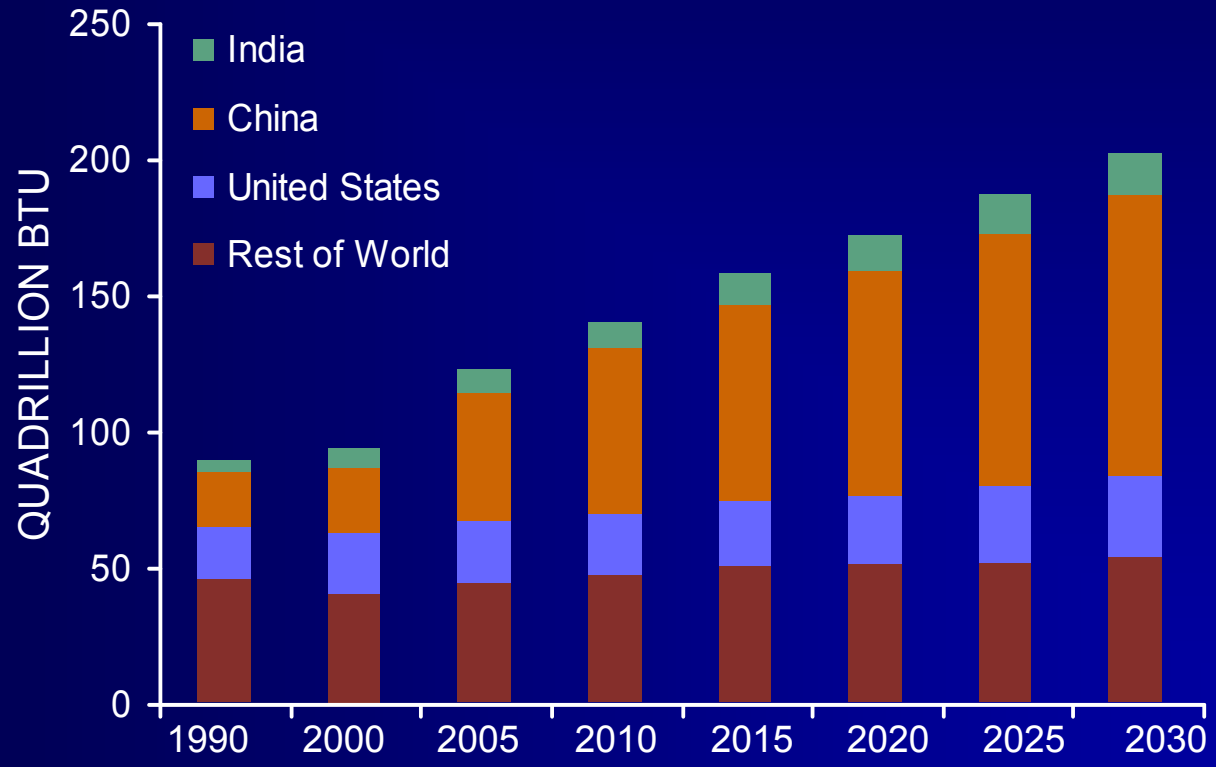
Power Generation Growth

- Wind and solar projected to grow strongly worldwide, contributing 2-3% of U.S. power in 2030
- Geothermal and hydropower grow at lower rates, with U.S. hydro declining slightly
- 34 nuclear power plants are under construction worldwide
- Strong global coal growth forecast ex carbon constraints
  - Growing resistance to new U.S. coal power plants poses a risk to meeting projected demand
  - Carbon constraints will increase power generation costs to consumers

World Coal Consumption

Global and U.S. resources and reserves estimates remain very large relative to production requirements

Strong global growth forecast – will pressure greenhouse gas concerns



Source: EIA, IEO 2008.

Indicators of Increasing Risks to Production Growth

- Limited increases in supply capacity in spite of unprecedented investment rates
- Major development projects suffering increased costs and delays
- Most forecasts project significant increases in unconventional liquids production which require major new investments and technology advances
- First-generation ethanol supply is predicted to flatten by 2015

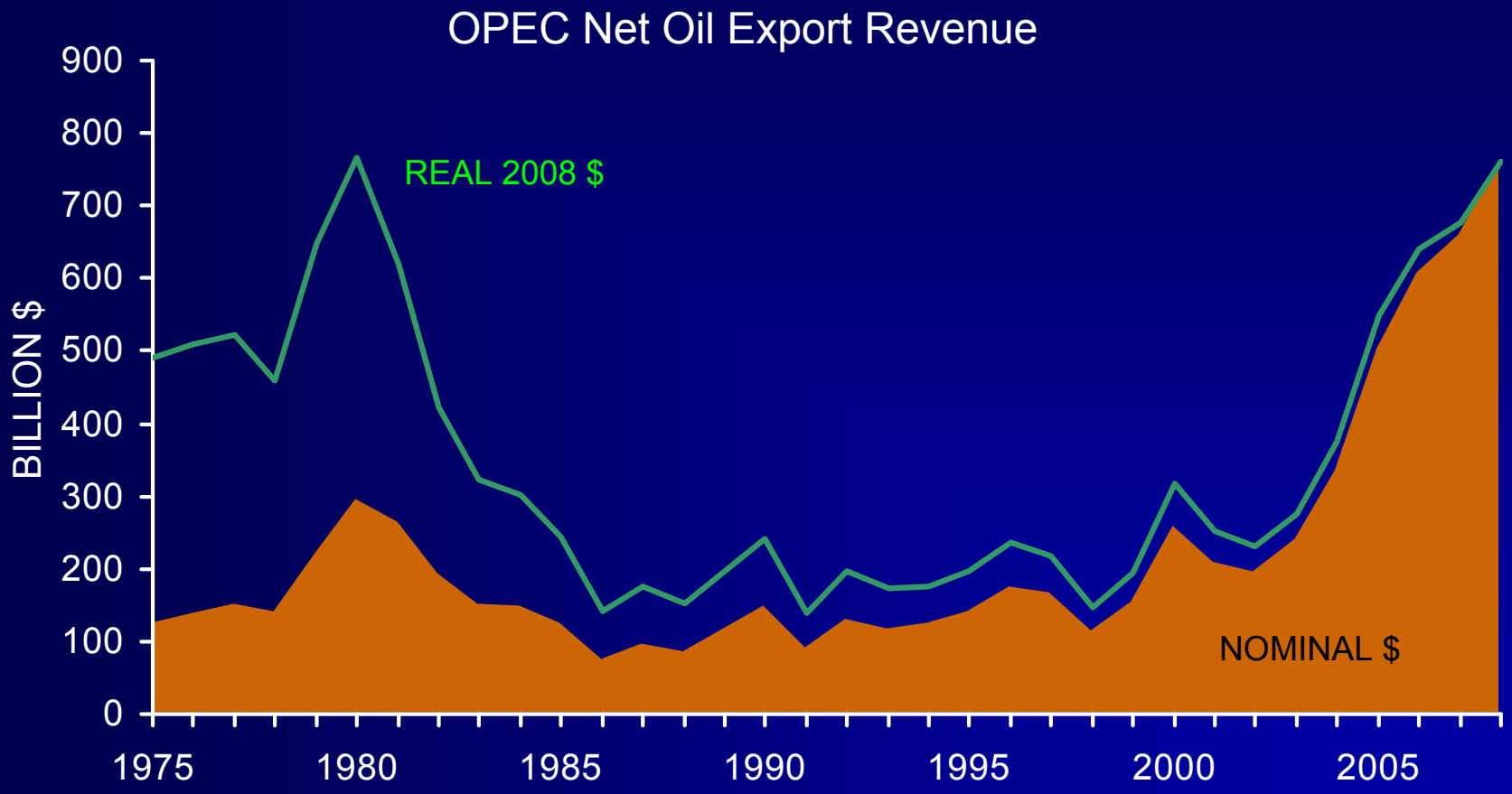
The Hard Truths

"Energy Independence" should not be confused with strengthening energy security. The concept of energy independence is not realistic in the foreseeable future, whereas U.S. energy security can be enhanced by moderating demand, expanding and diversifying domestic energy supplies, and strengthening global energy trade and investment.

- Growing revenues enable resource-owning countries to pursue national interests incompatible with increasing supply
- Subsidies for energy use distorting market and becoming significant political challenges in energy-consuming countries
- Improved understanding of food, fuel, and environmental balance is increasing the complexity of the energy debate
- Heightened sense of accumulating above-ground risks

Increasing Oil Revenue Flows

Wealth transfer enables resource nationalism



Source: EIA.

Heightened and Accumulating Risks

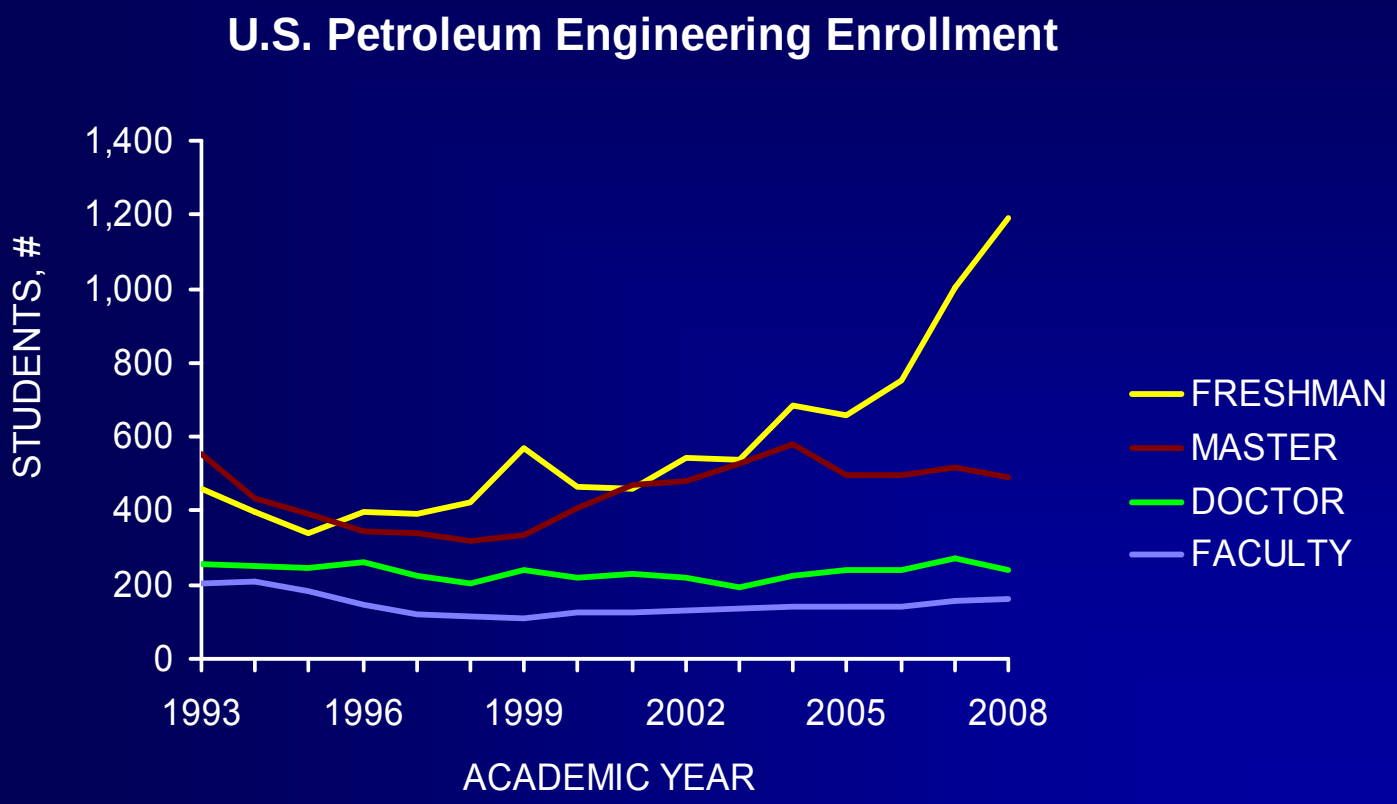
The Hard Truths

A majority of the U.S. energy sector workforce, including skilled scientists and engineers, is eligible to retire within the next decade. The workforce must be replenished and trained.

- Increased awareness of the issue
- Enrollments in petroleum engineering have doubled since 2005
  - Starting salaries are up
  - Academic capacity may be limited by faculty
- Professional societies have increased involvement

U.S. Petroleum Engineering Enrollment

Enrollment is increasing, but faculty could be a limit



The Hard Truths

Policies aimed at curbing carbon dioxide emissions will alter the energy mix, increase energy-related costs, and require reductions in demand growth.

- Discussions of carbon constraints have intensified, yet understanding of scale and cost is superficial
- Policy uncertainty has hindered construction of new U.S. fossil fuel power plants, increasing the risk of a supply gap
- Some progress made on demonstrating CCS, but legal/regulatory and economic frameworks do not exist

Enormous Challenge to Reduce Carbon Emissions

How big is a Gigaton of Carbon?

Technology	Actions that provide 1 Gt/yr of Carbon Mitigation
• Coal-fired power plants	Build 1,000 "zero-emission" 500 MW power plants
• Geologic sequestration	3,700 sequestration sites the size of Norway's Sleipner
• Nuclear	Build 500 new nuclear plants, each 1 GW in size
• Efficiency	Deploy 1 billion new cars at 40 mpg vs. 20 mpg
• Wind energy	Install 650,000 wind turbines
• Solar photovoltaics	Install 6 Million acres of photovoltaics
• Biofuels for transport	Convert an area 20 times that of Iowa to new biomass
• CO_2 storage in forests	Convert to new forest a barren area 9 times that of the state of Washington

Source: DOE Climate Change Technology Program.

Expanding CO_2 Sequestration Plans

Global Oil and Gas Study

The Five Core Strategies

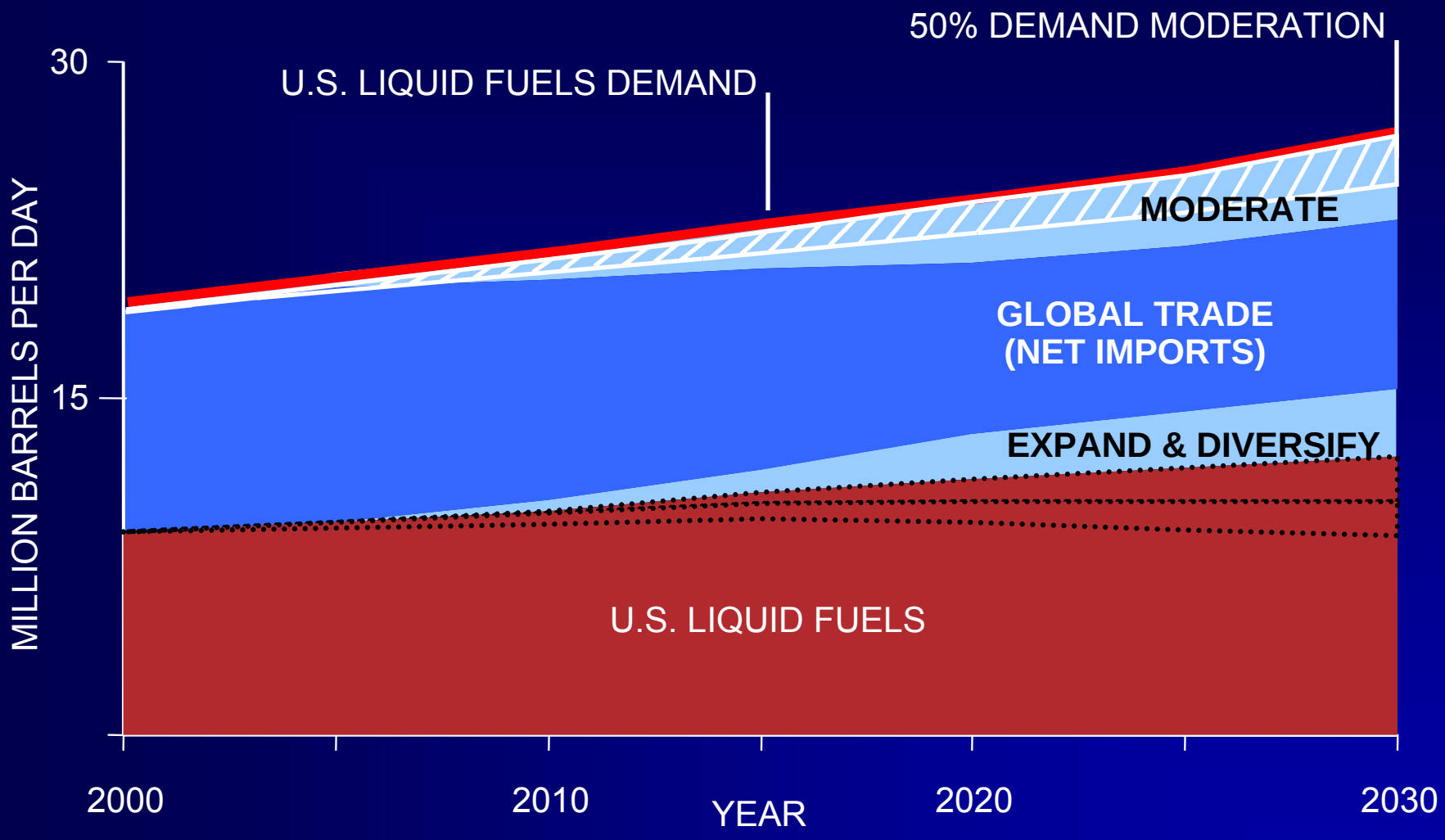
- Moderate growing demand by increasing efficiency of transportation, residential, commercial, and industrial uses
- In the U.S., expand and diversify energy supply, moderate oil and gas production decline, and increase access to new resources
- Strengthen global energy trade and investment
- Enhance science and engineering capabilities
- As CO_2 emissions reductions are considered, promote a global framework for carbon management to establish:
  - Transparent, predictable, economy-wide cost
  - Legal / regulatory structure to enable CCS

All recommendations must be pursued

Progress on the Strategies

- 2007 Energy Independence and Security Act raises CAFE and promotes improved building, industrial, and appliance efficiency
- Increased access for U.S. oil and gas production being debated
- More global discussion on responses to volatile energy prices
- U.S. investment increasing for oil, gas, and renewables

Progress on the Strategies



Source: EIA Reference Case / NPC Global Oil and Gas study survey.

Illustrative View

Summary Conclusions

- Increasing evidence of accumulating risk to adequate supply
  - Growing pressure on cost and availability of project resources hindering ability to develop energy resources
  - Geopolitical risks are widespread
- Technology investments are increasing for energy efficiency, diversification, alternatives, and carbon management
- Clear legal and regulatory framework for carbon management needed
  - Carbon constraints will alter energy mix
  - Energy related costs will increase

Thank you for listening to this presentation on:
"Facing the Hard Truths About Energy"

For information, please refer to the NPC Website for a complete list of available resources:
http://www.npc.org