Prudent Development

Realizing the Potential of North America's Abundant Natural Gas and Oil Resources

A Comprehensive Assessment to 2035 with Views through 2050

Environmental NGOs
January 10, 2012

National Petroleum Council (NPC)

Origins	Continuation of WWII government / industry cooperation
Purpose	Sole purpose of NPC is to advise U.S. Secretary of Energy and Executive Branch by conducting studies at their request
Organization	A Federally chartered, self-funded Advisory Committee; Not an advocacy group, does not lobby
Membership	Broad and balanced. Approximately 200 members from all segments of the oil and gas industries and many outside interests
Study Participants	Diverse interests and expertise relating to the topic being addressed
Study Reports	All NPC advice is provided in reports approved by its members and is available to the public. Reports can be viewed and downloaded at no cost from the NPC website – www.npc.org

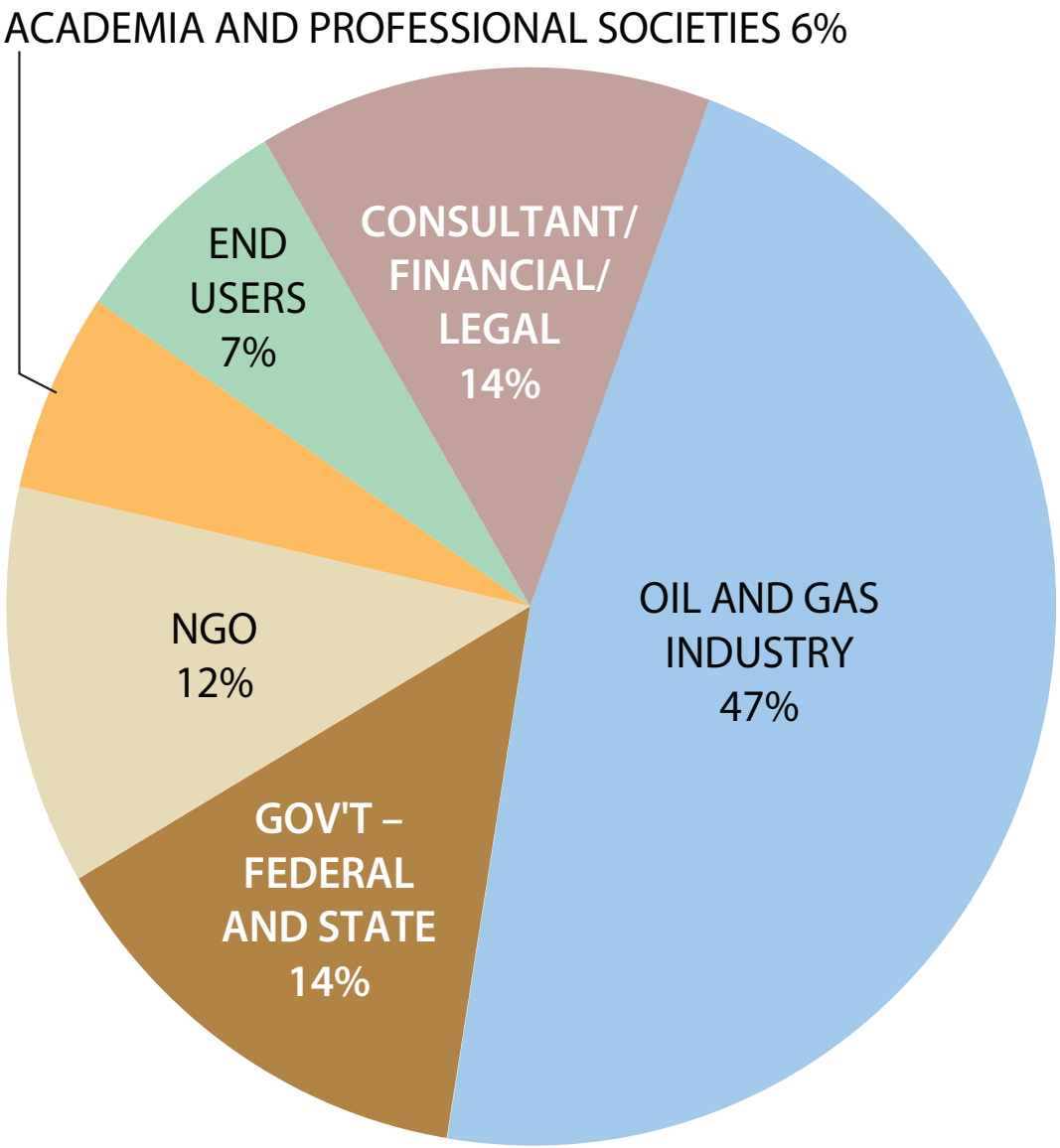
Prudent Development Study Objectives

- **Assess the N. American resource base – natural gas and oil**
  - Conventional
  - Unconventional
- **Describe the role of technology**
  - Environmental
  - Operational
- **Assess N. American supply and demand**
  - Through 2035
  - With a view to 2050
- **Identify the potential role of natural gas to lower emissions**
- **Meet national objectives: economic, environmental, security**

Diverse Study Participation

Study Committee,
CSC,
Task Groups,
Subgroups

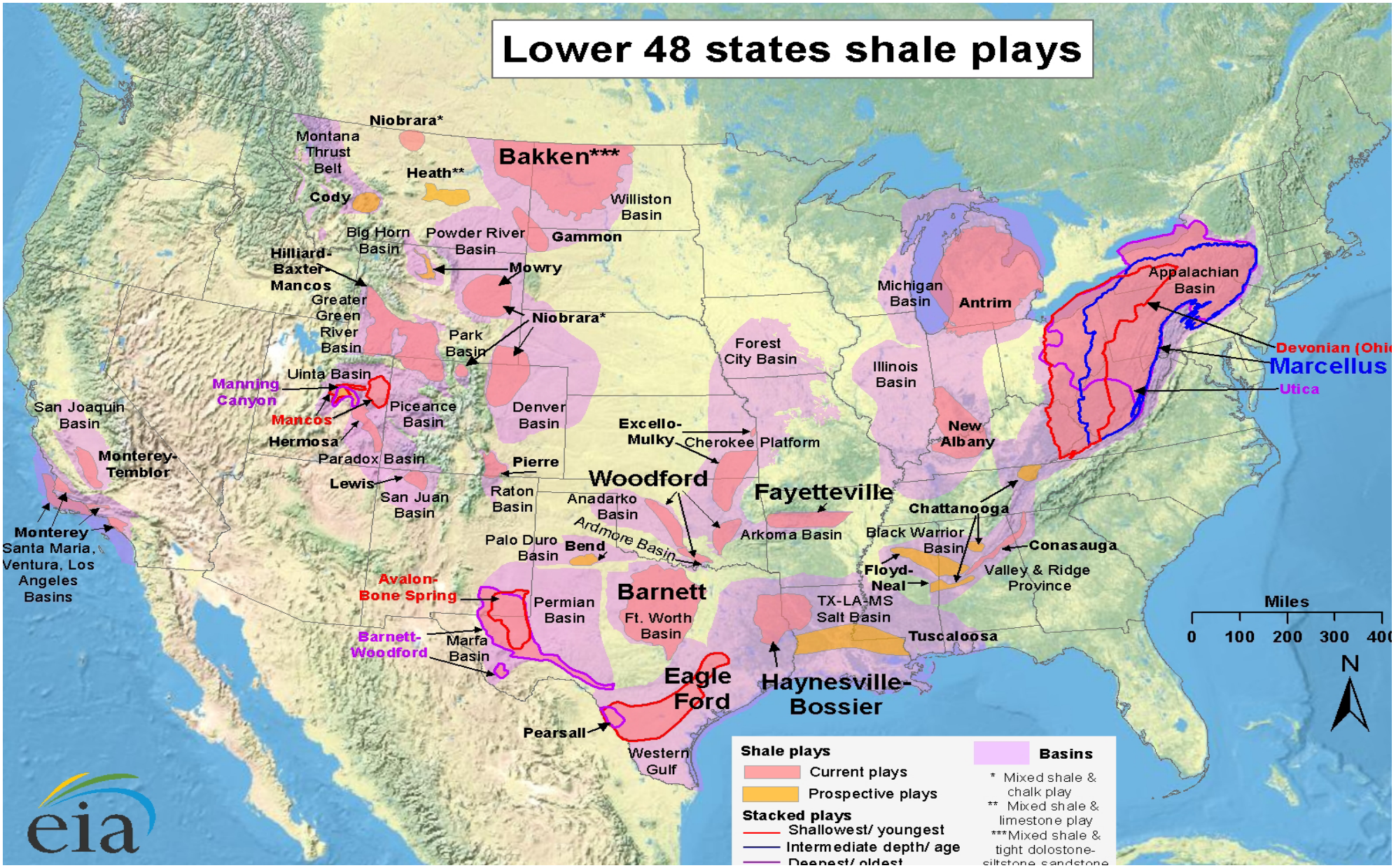
Over
400
Participants



Four Major Findings

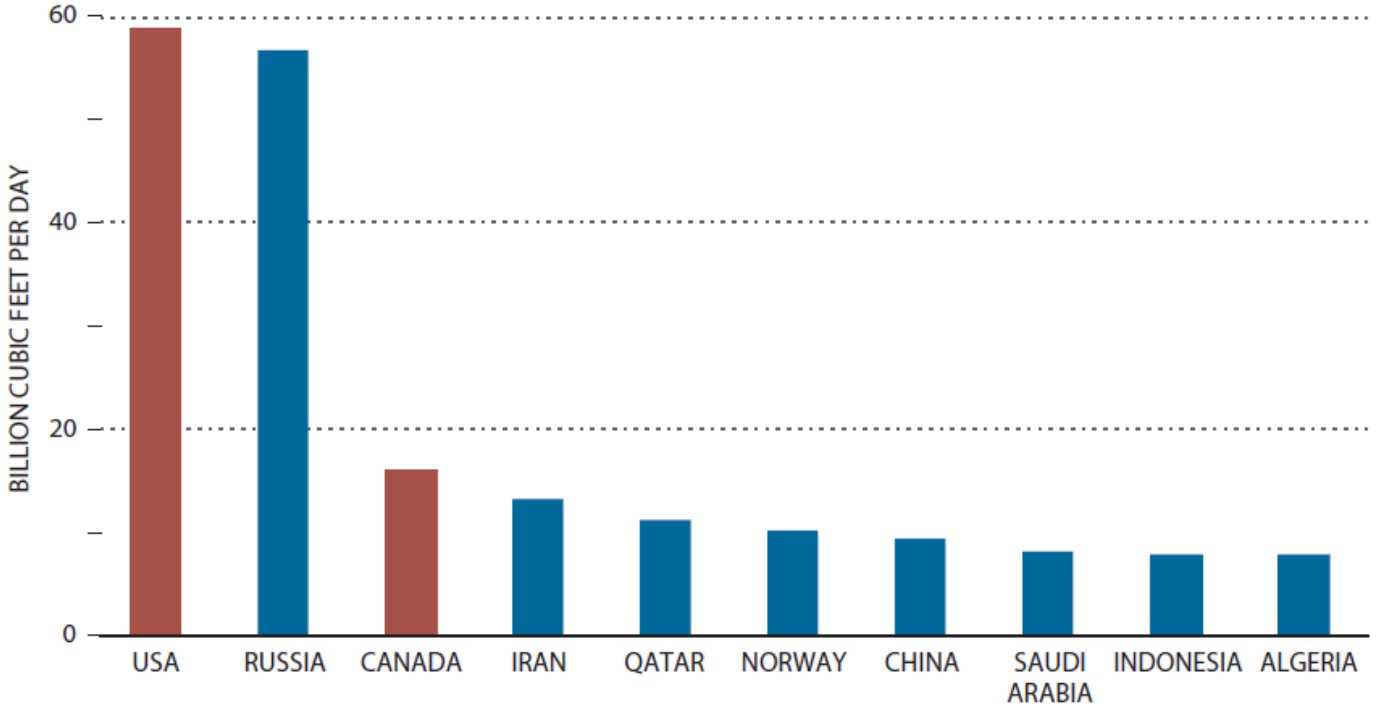
- First, the potential supply of North American natural gas is far bigger than was thought even a few years ago
- Second – and perhaps surprising to many – America's oil resources are also proving to be much larger than previously thought
- Third, we need these natural gas and oil resources even as efficiency reduces energy demand and alternatives become more economically available on a large scale
- Fourth, realizing the benefits of natural gas and oil depends on environmentally responsible development

Benefits of Abundant Resources Require Prudent Development



North American global leadership in natural gas and oil production - a platform for development in natural gas…

Natural Gas Production 2010



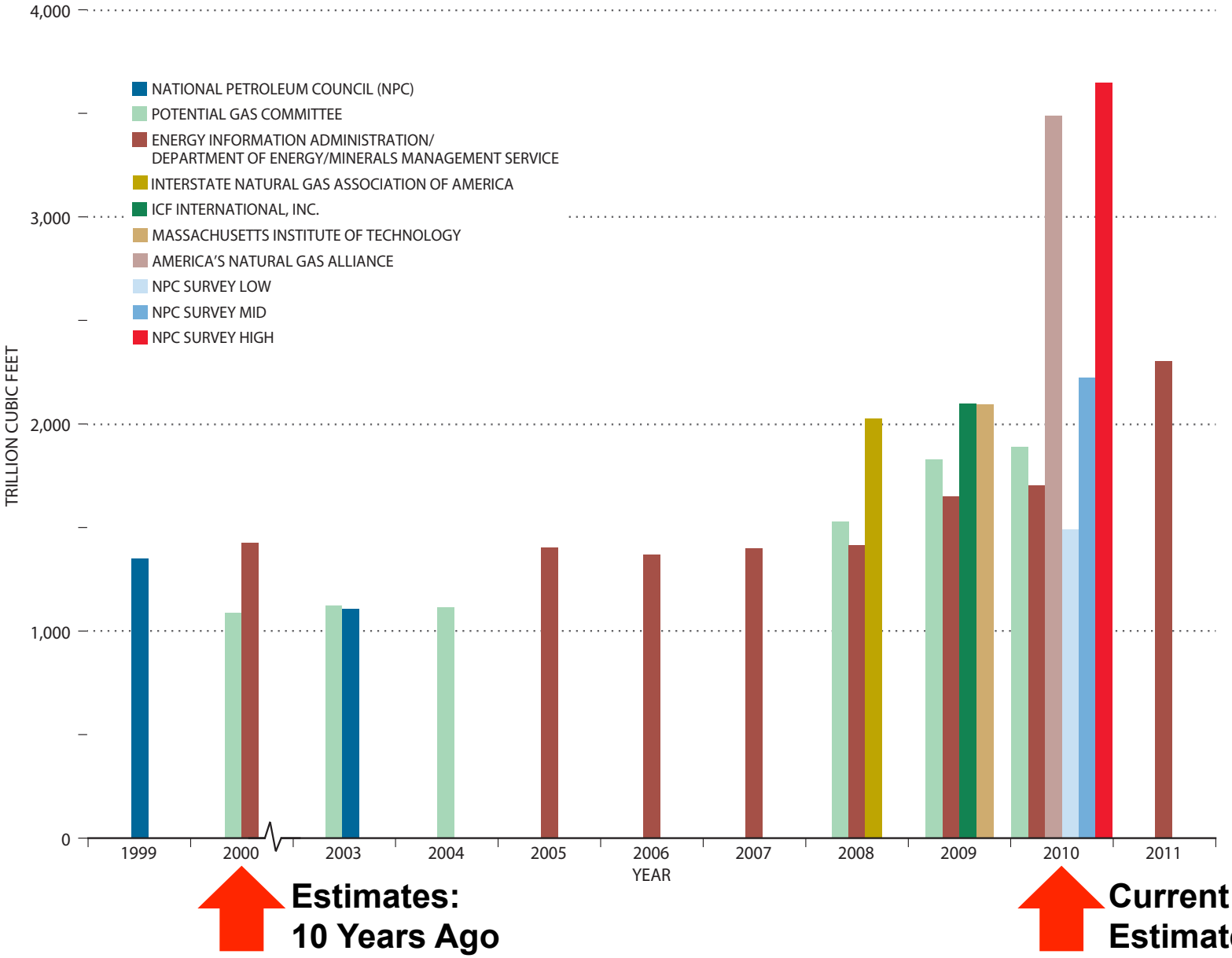
Source: BP Statistical Review of World Energy.

North America has a track record in developing and deploying key technology areas which have led to this position, including for natural gas:

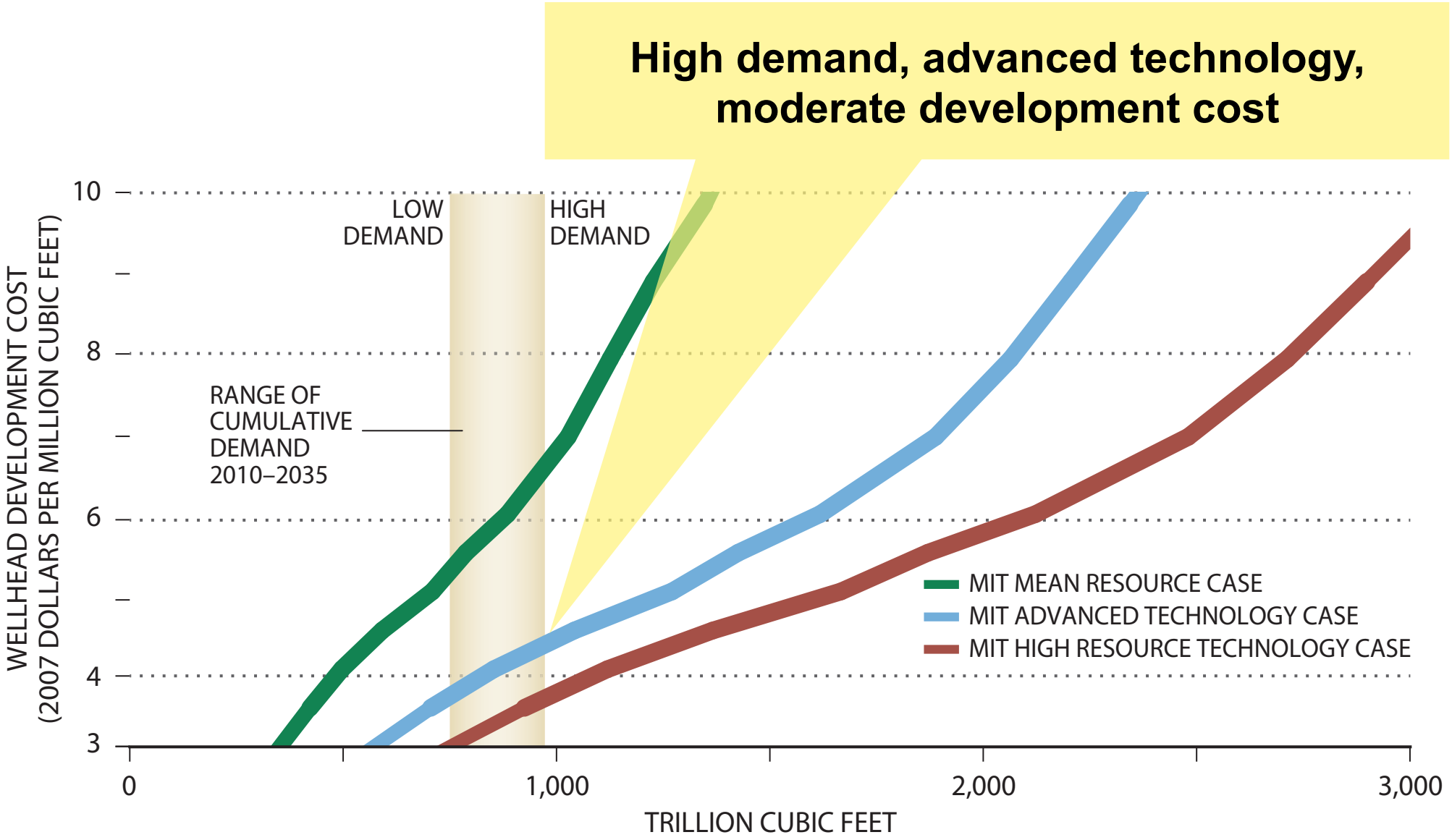
- **offshore drilling, facilities and operations**
- **unconventional gas appraisal, development and production (CBM, tight gas, shale gas)**
- **horizontal drilling and multi-stage fracturing applied to source rock**
- **…**

N.A. Natural Gas Resource Estimates Transform Supply Outlook

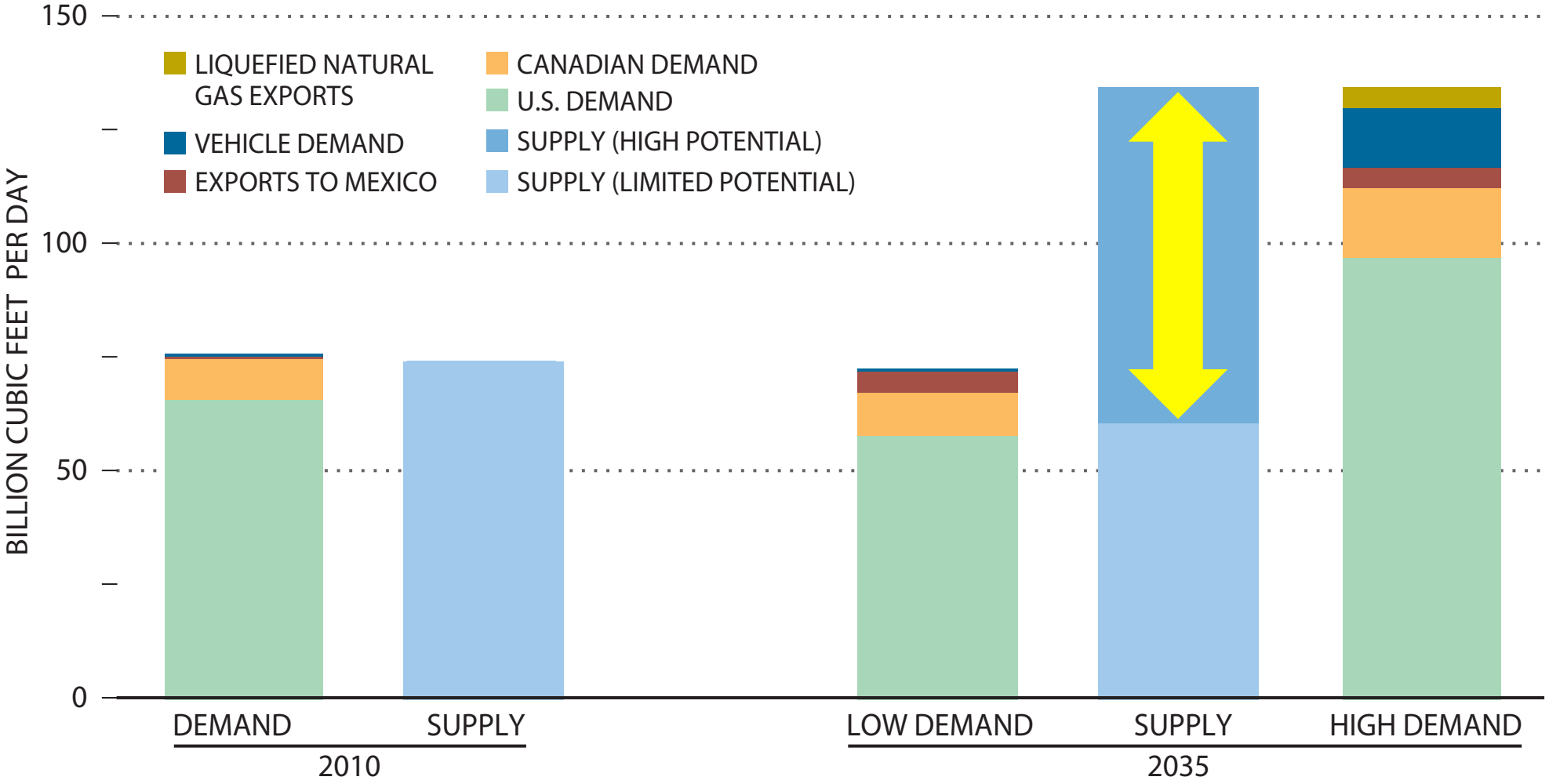
Recent Estimates of Natural Gas Resources



N.A. Gas Resources Have Potential to Supply the Market for Decades

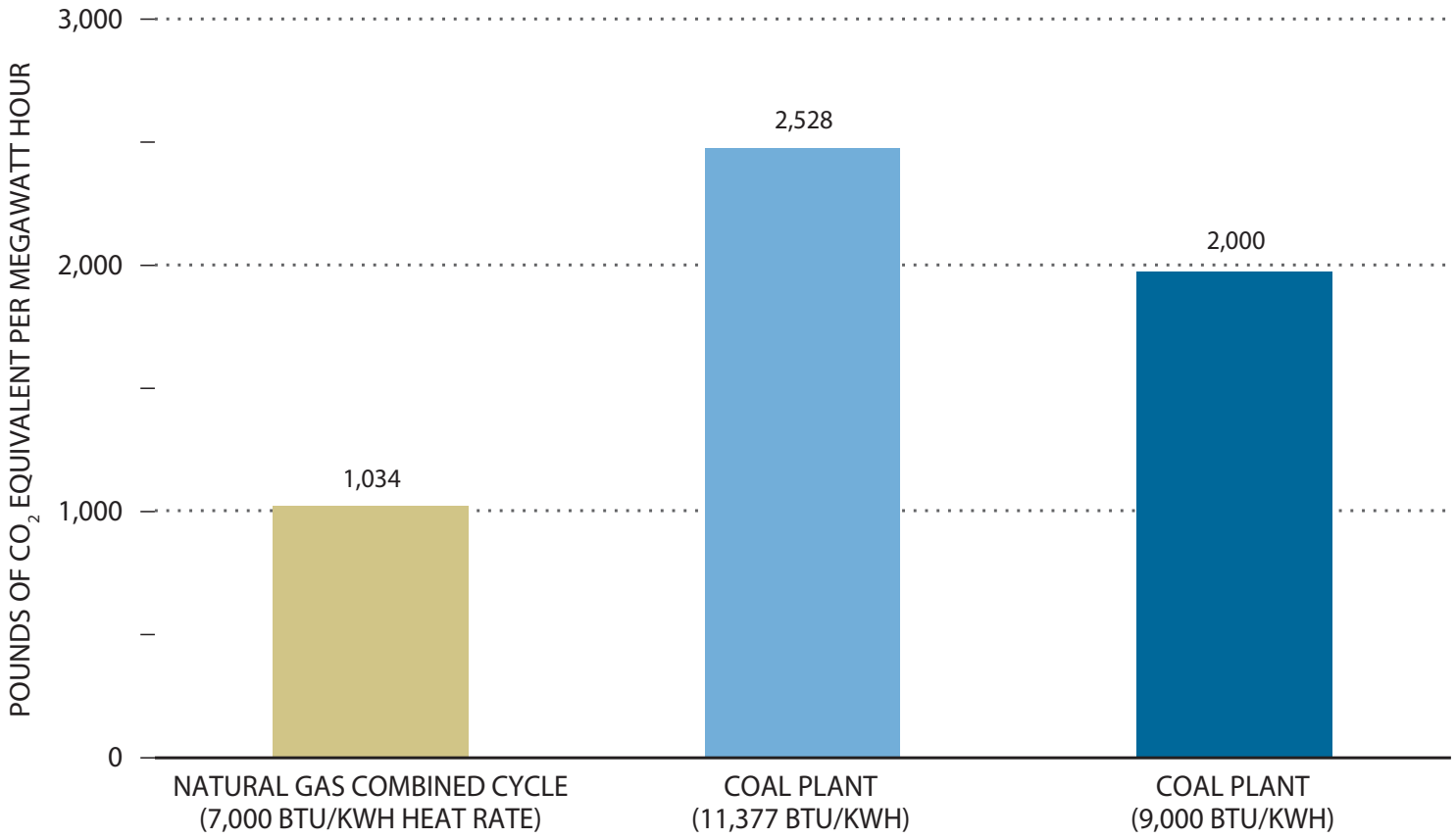


North American Natural Gas Can Meet Even the Highest Potential Demand



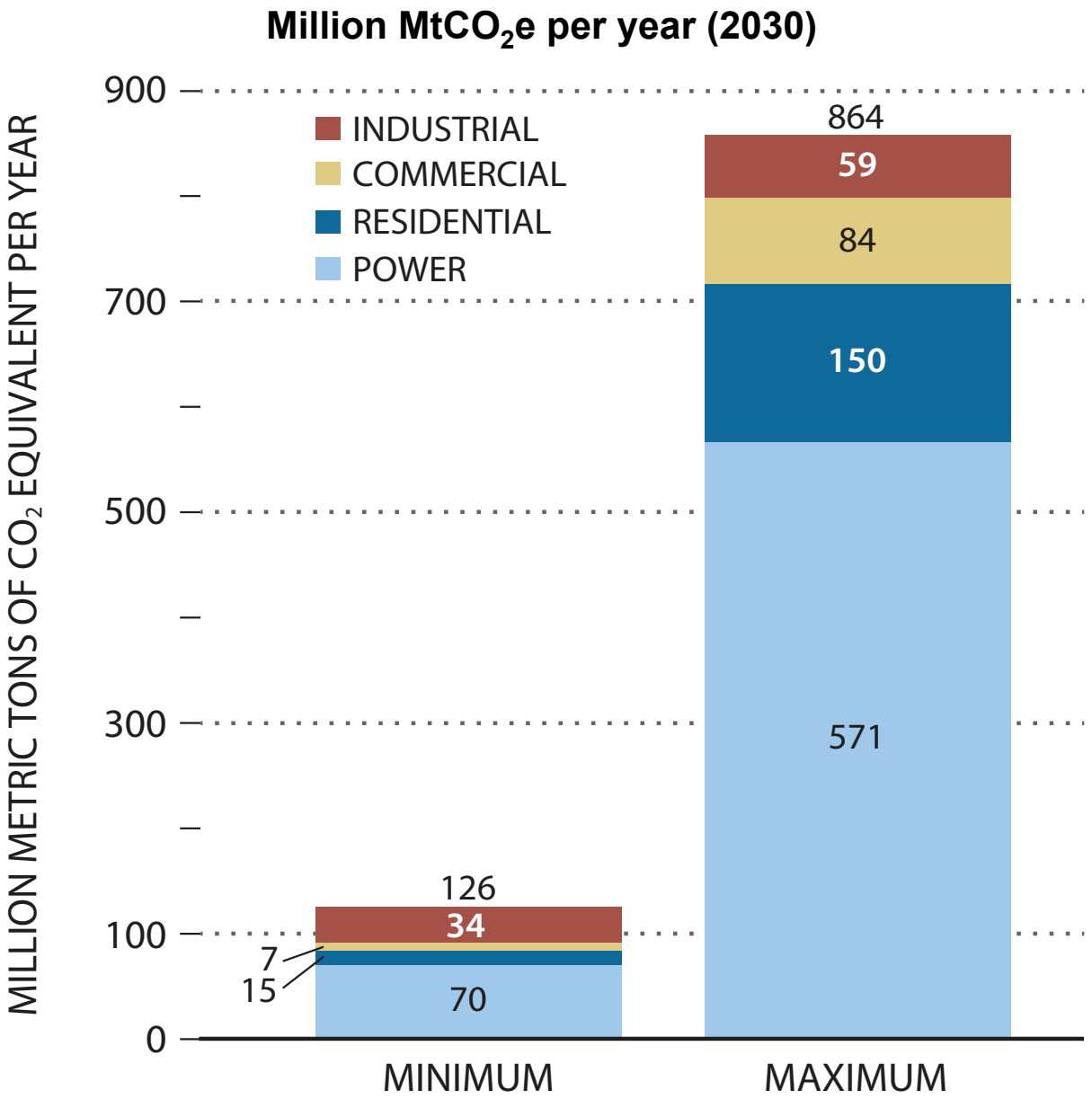
Natural Gas Has Lower GHG Emissions

LCA GHG Emissions from Natural Gas-Fired Plants are 50-60% Lower than Existing Coal-Fired Plants



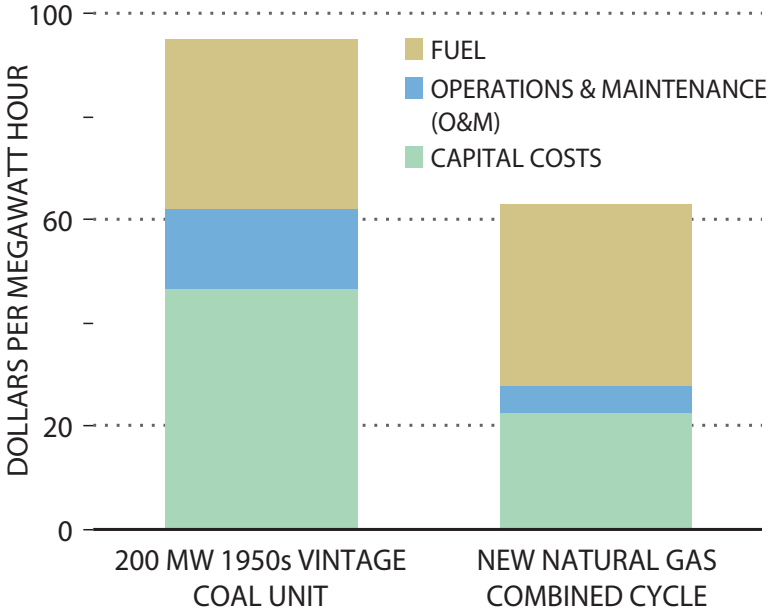
Gas Combined Cycle Plants have 99% Lower SO_2 and Hg Emissions and about 82% Lower NO_x Emissions Relative to Pulverized Coal Units

Range of Potential GHG Emissions Reductions in End-Use Sectors through Natural Gas Technologies



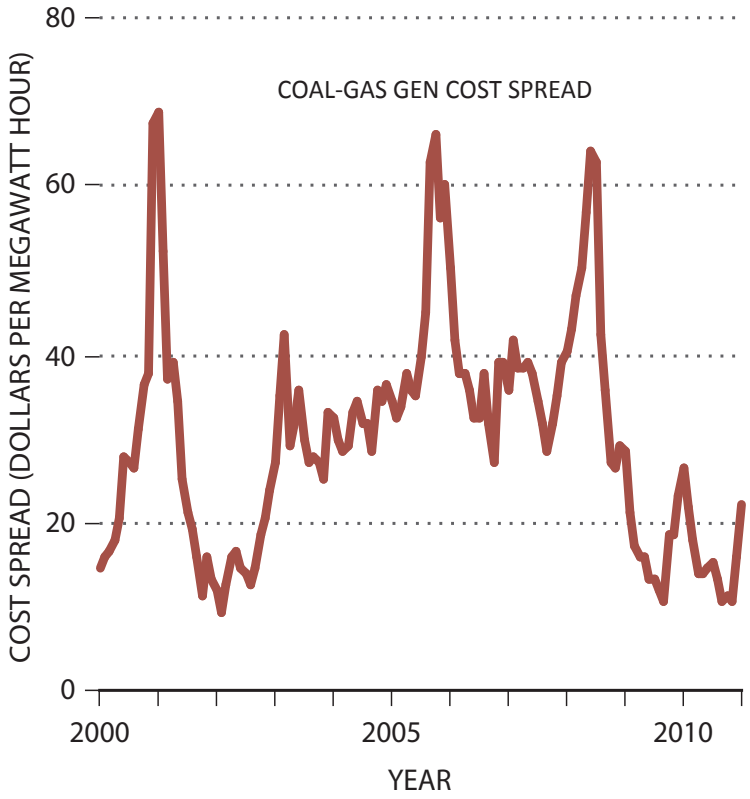
EPA non-GHG Rules – Coal Plant Retirement Decision

The spread between generating electricity from gas and coal has diminished.

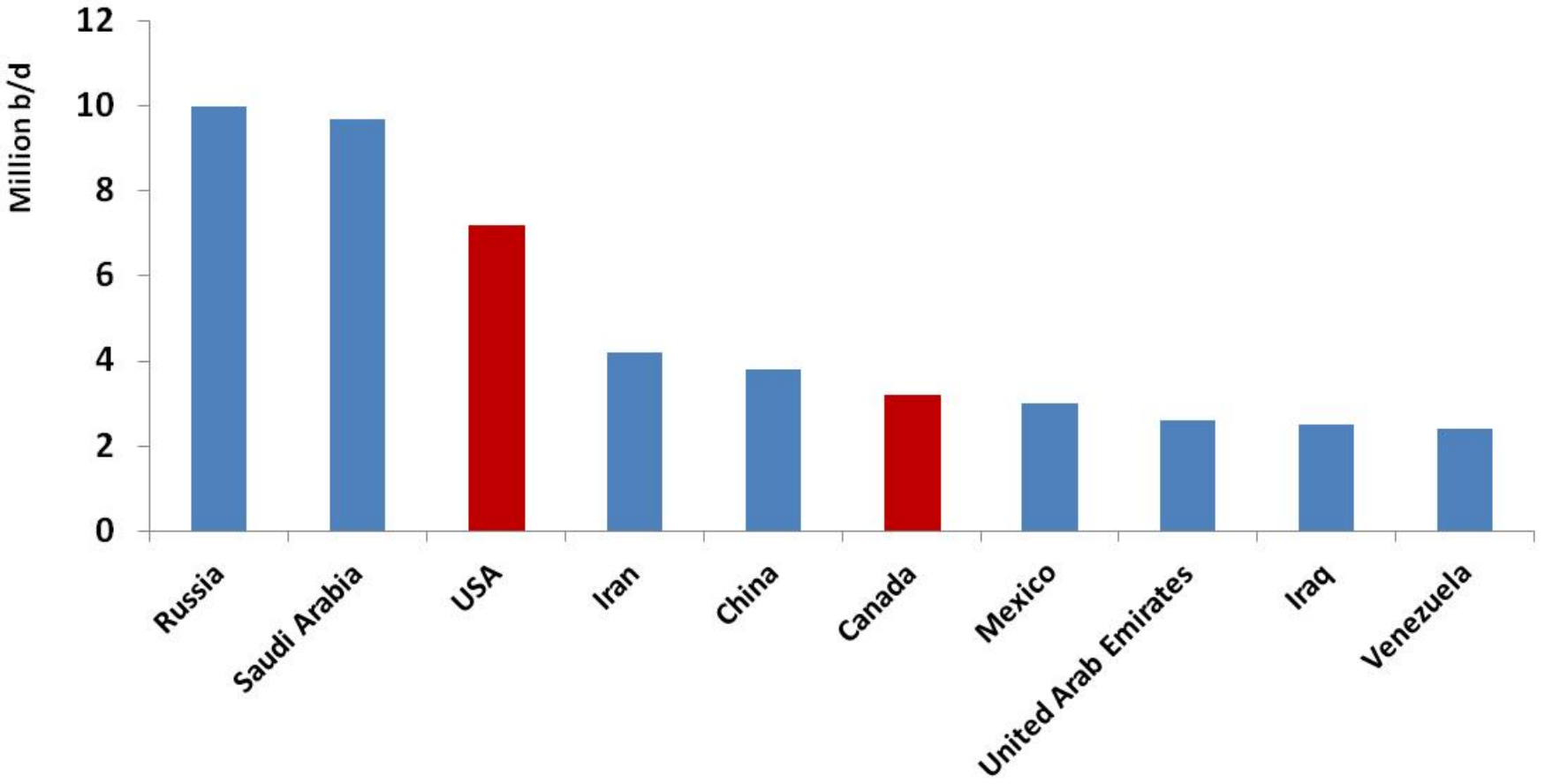


Assumptions:

1. Retrofit and new build capital cost and O&M assumptions are from Environmental Protection Agency estimates.
2. Coal combustion residual (CCR) capital cost is from industry estimates.
3. Uncontrolled coal unit (200 MW) requires flue gas desulfurization (FGD) + selective catalytic reduction (SCR) + CCR: Capital cost – ~$1,450/kW; retrofit life – 15 years; 11,000 Btu/kWh heat rate; $3/million Btu coal price.
4. Natural gas combined cycle: Capital cost – ~$1,000/kW; life – 30 years; 7,000 Btu/kWh heat rate, $5/million Btu gas price.

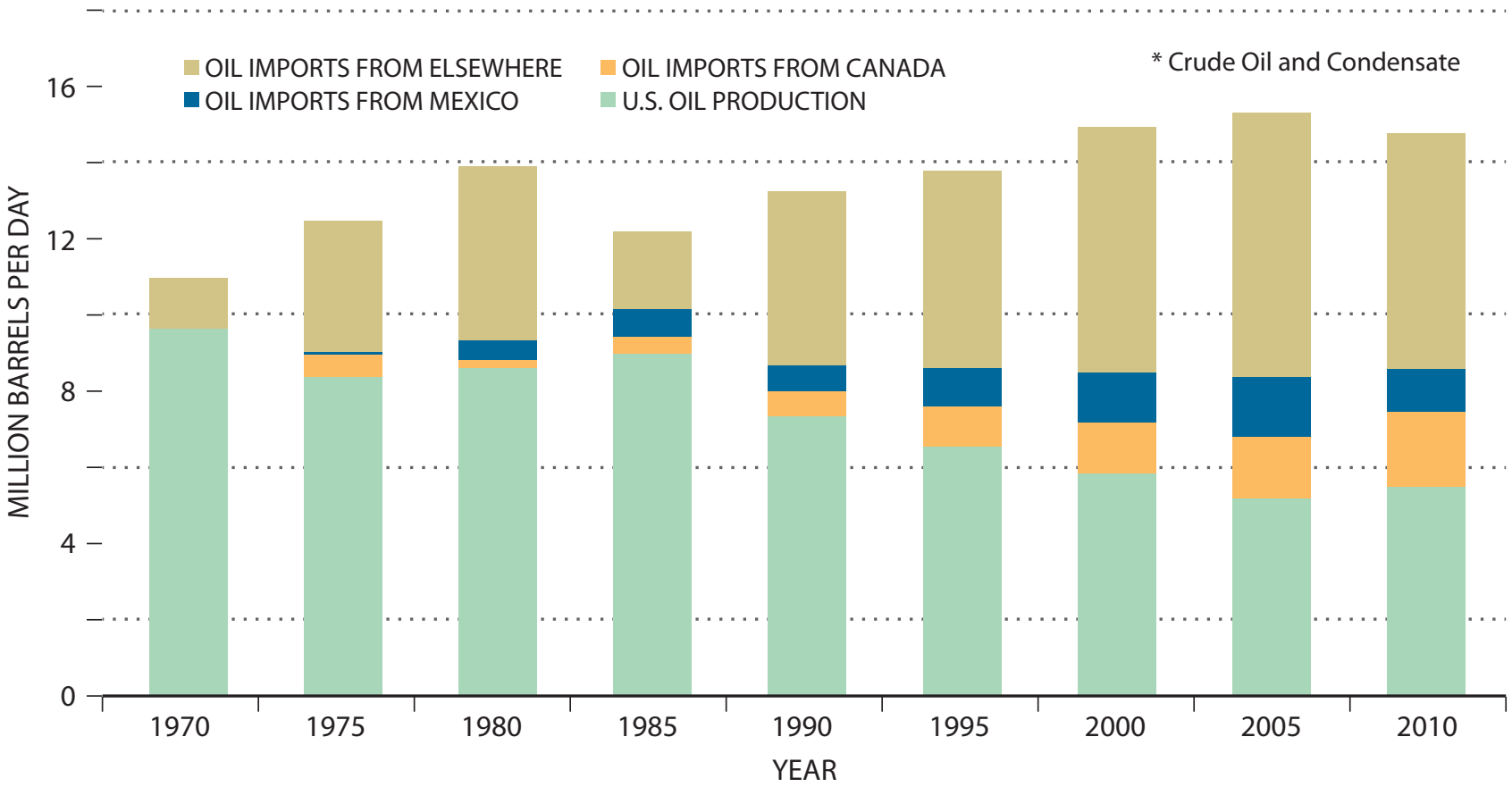


Top 10 Oil Producers



Source: BP Statistical Review of World Energy

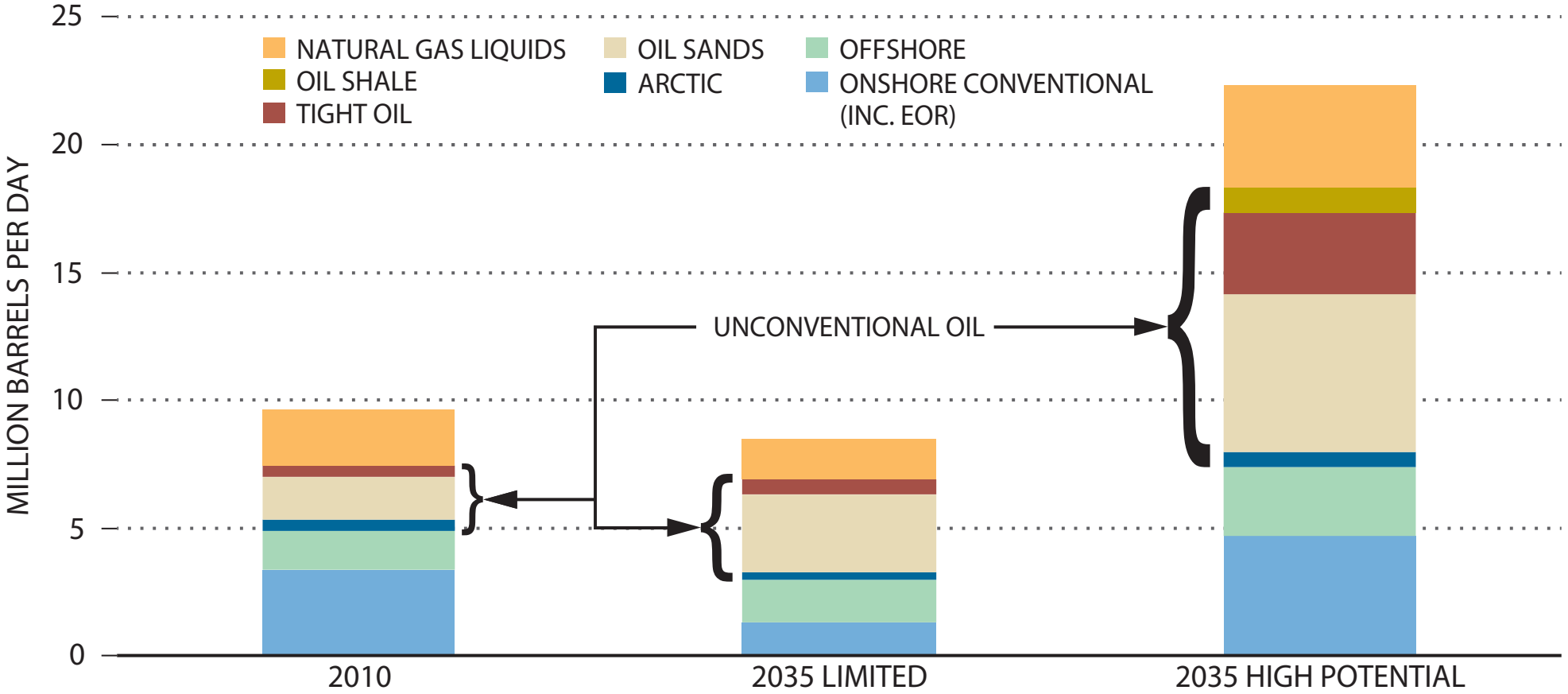
Crude Oil Production's Downward Trend



Source: EIA AEO 2010 & IEO 2009.

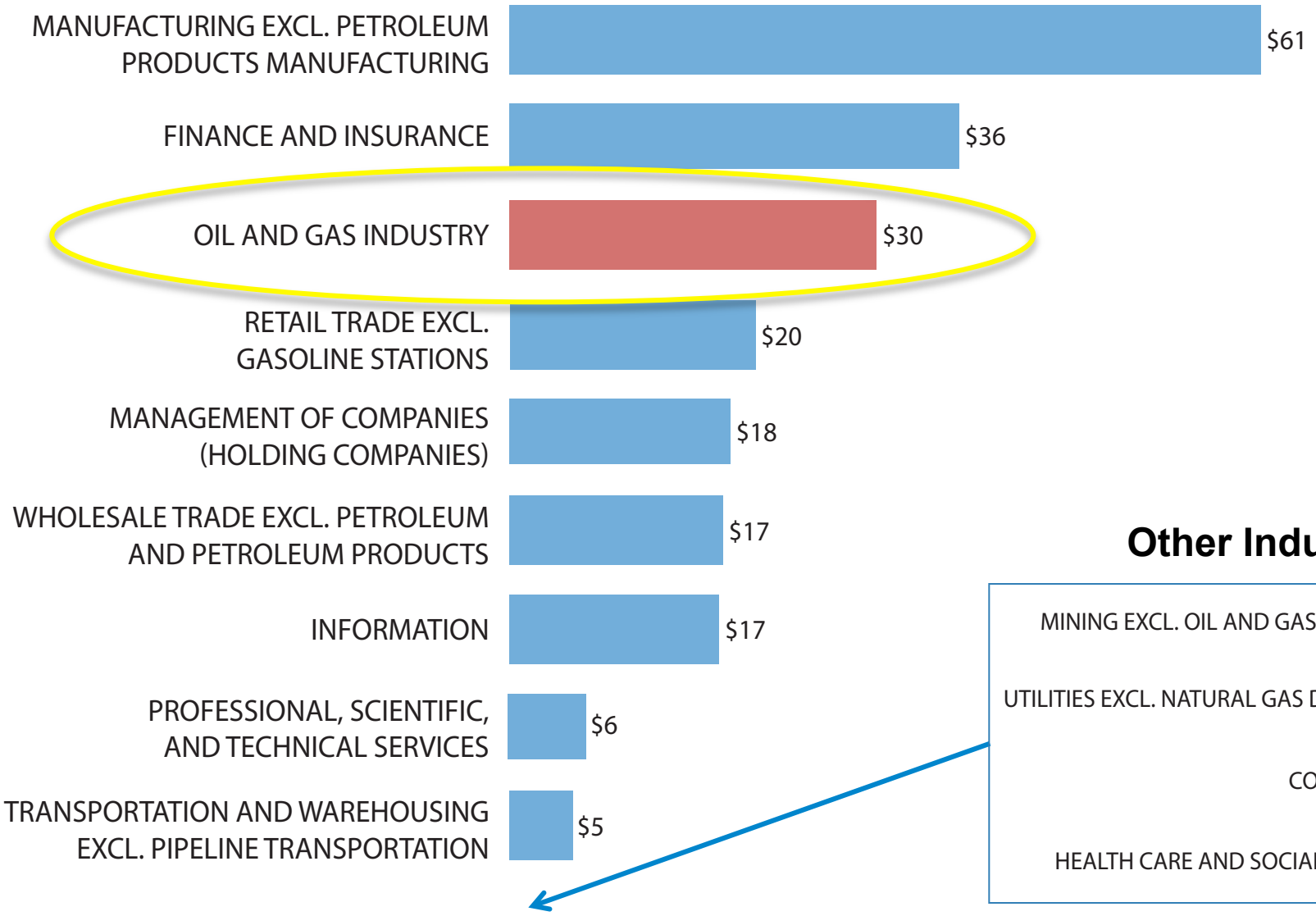
N.A. Oil Supply Has Upside Potential But Risk of Decline

High production opportunities enabled by access frameworks



Other Benefits: Industry Payments of Federal Corporate Income Taxes

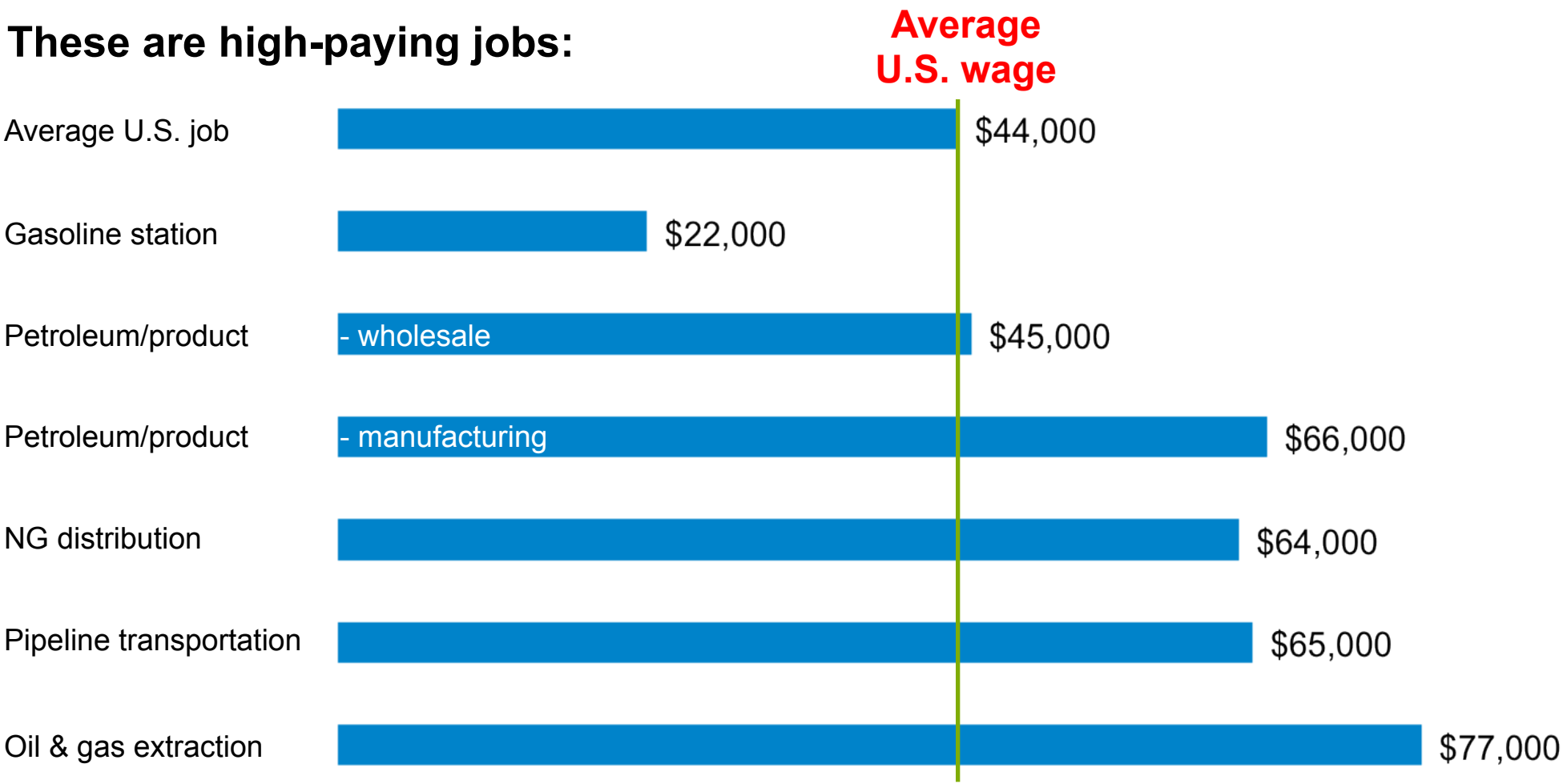
2008 Federal income taxes paid by corporations (IRS) ($Billions)



Economic Benefits Also Flow From More Domestic Gas & Oil Development

- **Direct jobs in the oil & gas industry: 2+ million**
- **Total direct/indirect jobs from oil & gas industry activity: 9+ million**

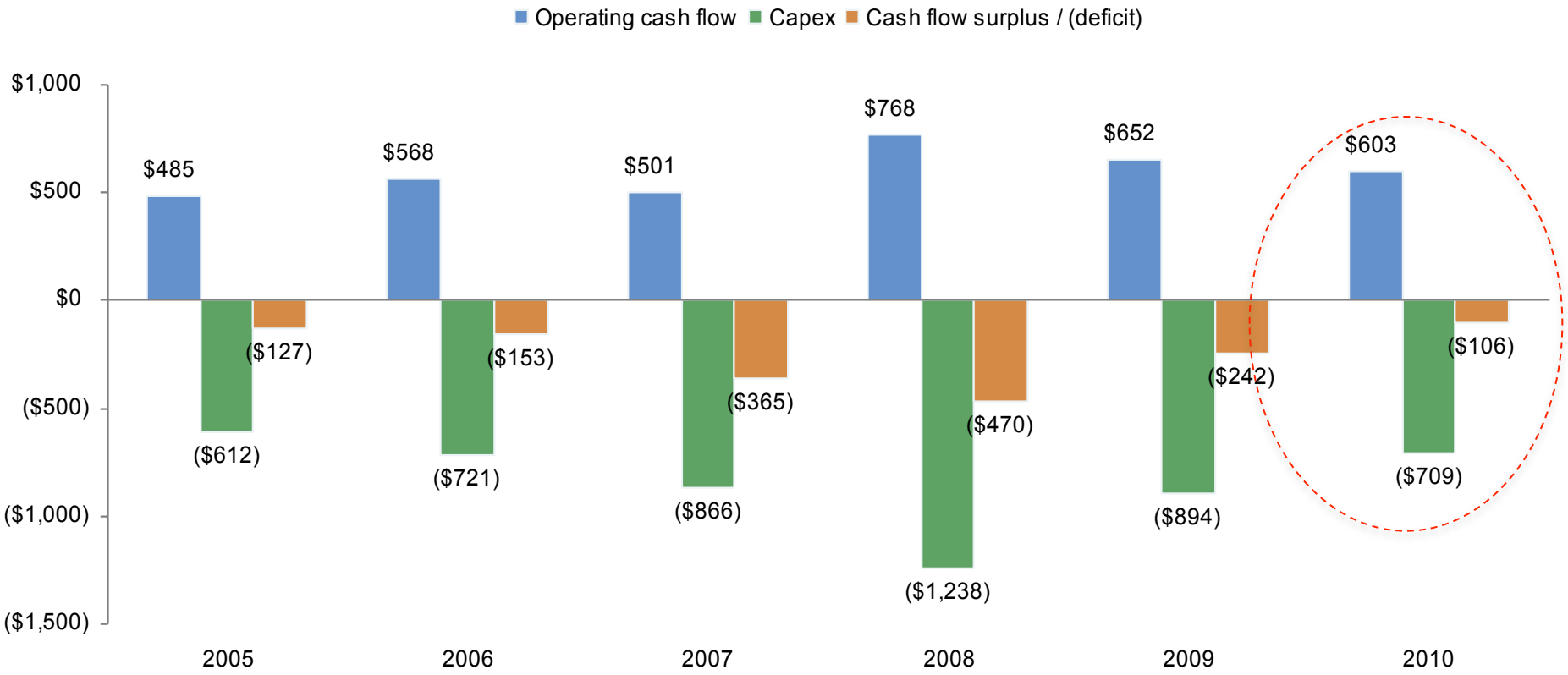
These are high-paying jobs:



Natural Gas And Oil Companies Reinvest Their Cash Flow To Grow Production And Reserves

Average cash flows for U.S. E&P companies with market cap from $1-10 billion

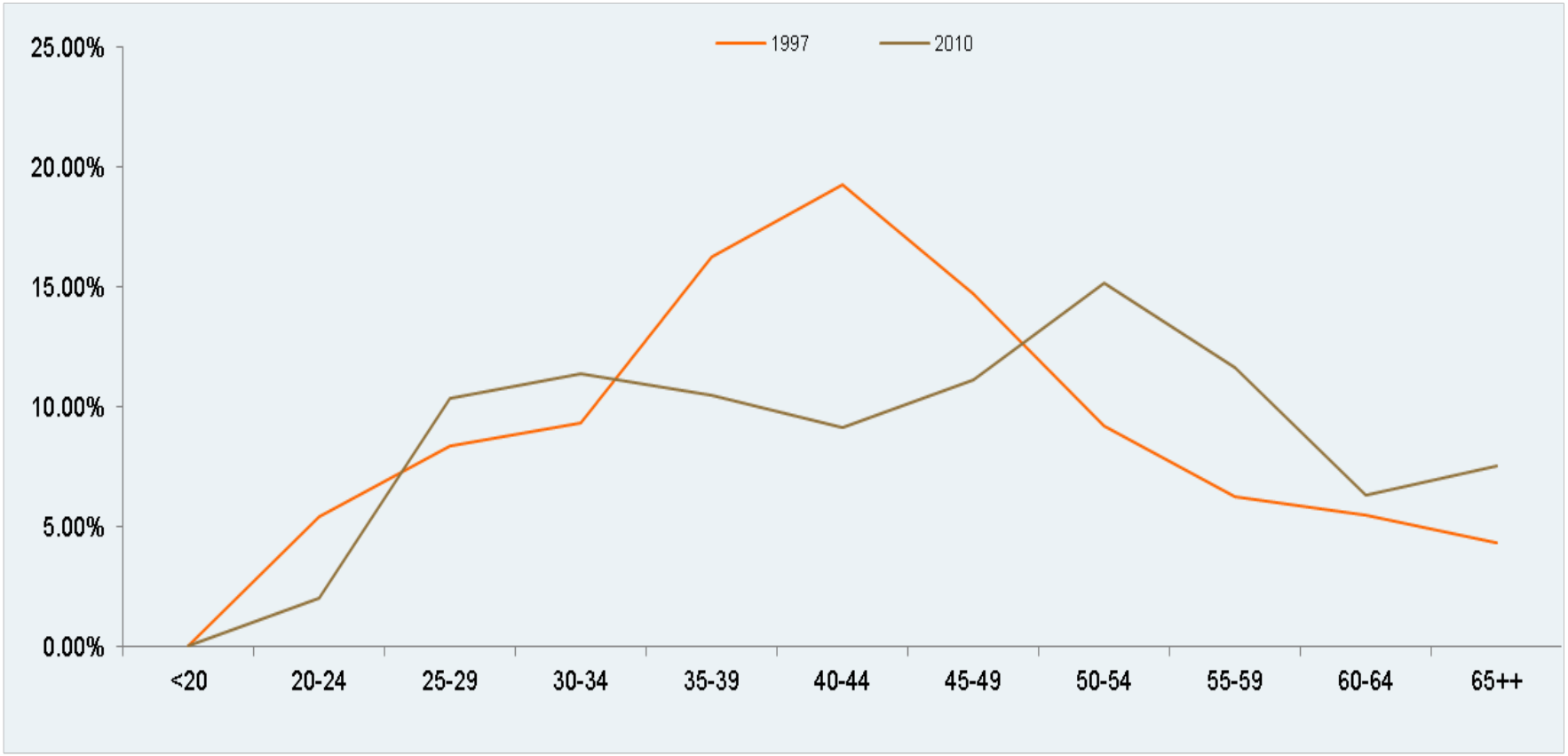
(Amounts in $mm)



Many technical professionals are reaching retirement age

- **The oldest Baby Boomers turn 65 this year, highlighting the demographic change under way in the natural gas and oil industry (and other industries)**

Age distribution of Society of Petroleum Engineers membership



Prudent Development

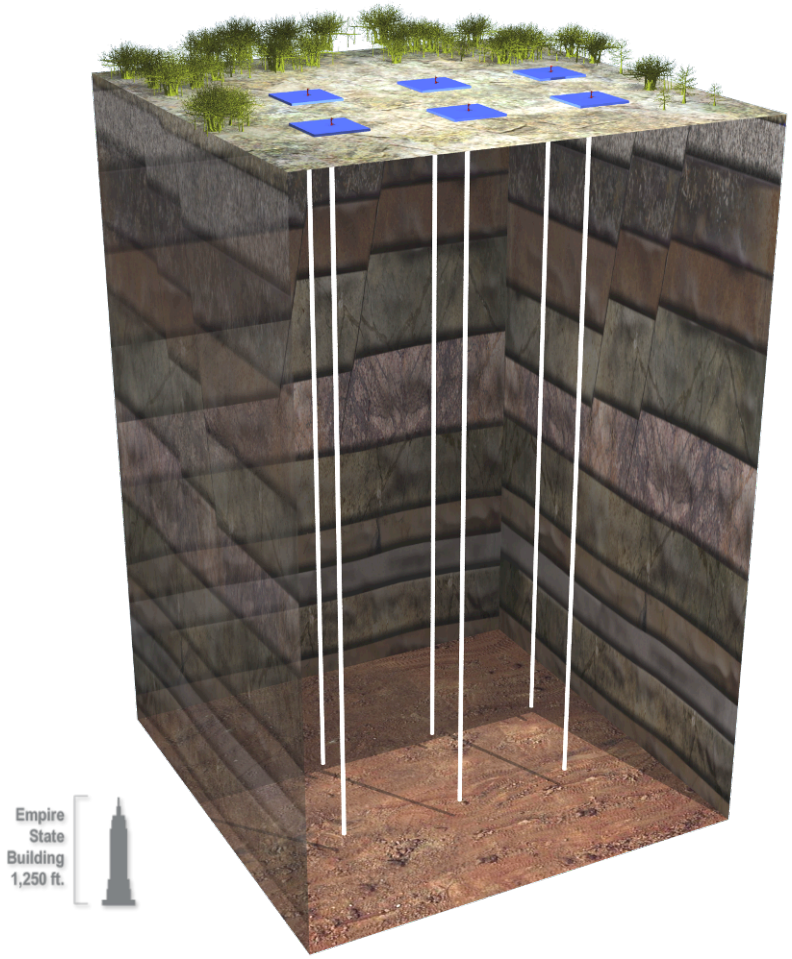
In order for the U.S. to realize the benefits of substantial resource abundance, development must be done prudently.

Prudent development is:

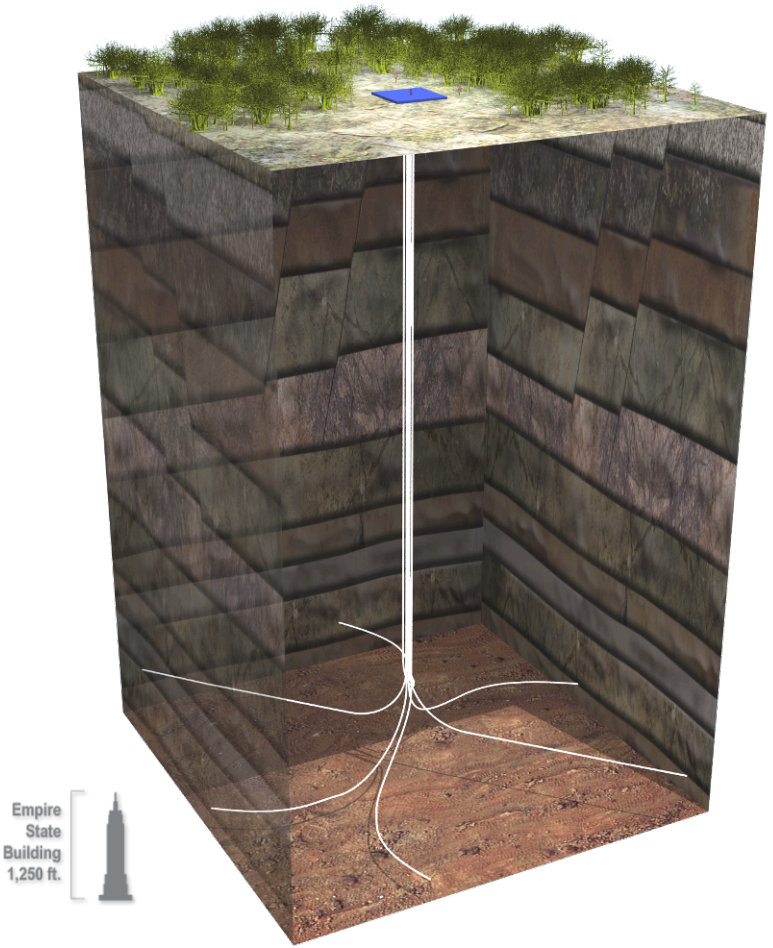
- **Essential for public trust and confidence**
- **Required for continued and expanded access**
- **Fundamental for long term industry success**

Responsible Surface Use

Traditional development with vertical wells requiring one pad site per well

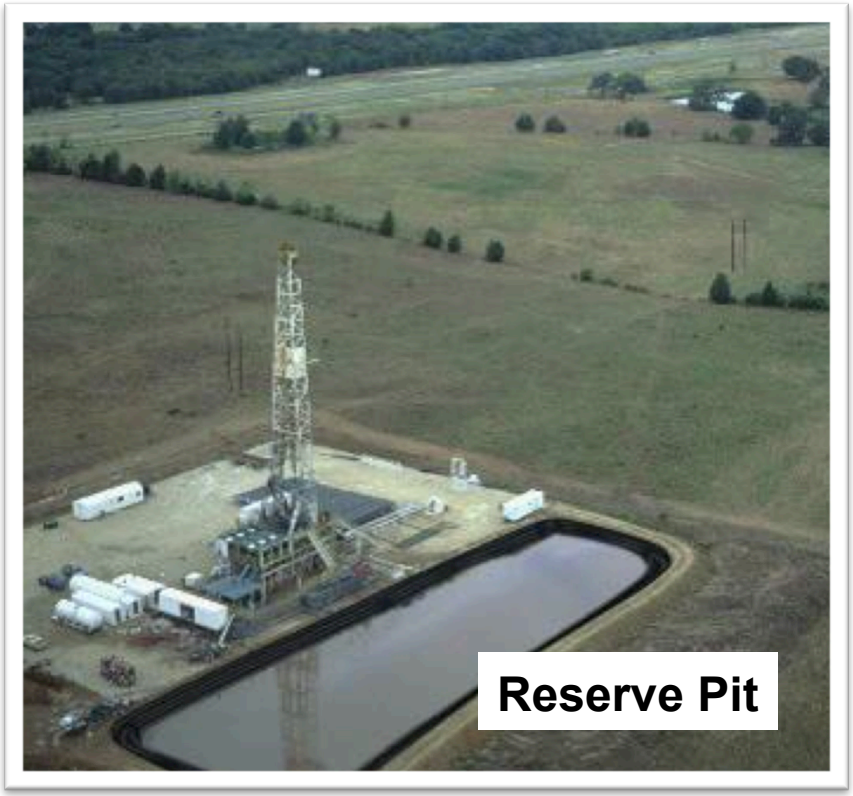


Multi-well development minimizing surface use with 6-12 wells drilled from a single pad site (surface disturbance <2%)



Closed Loop Drilling Fluid System

Open Loop System

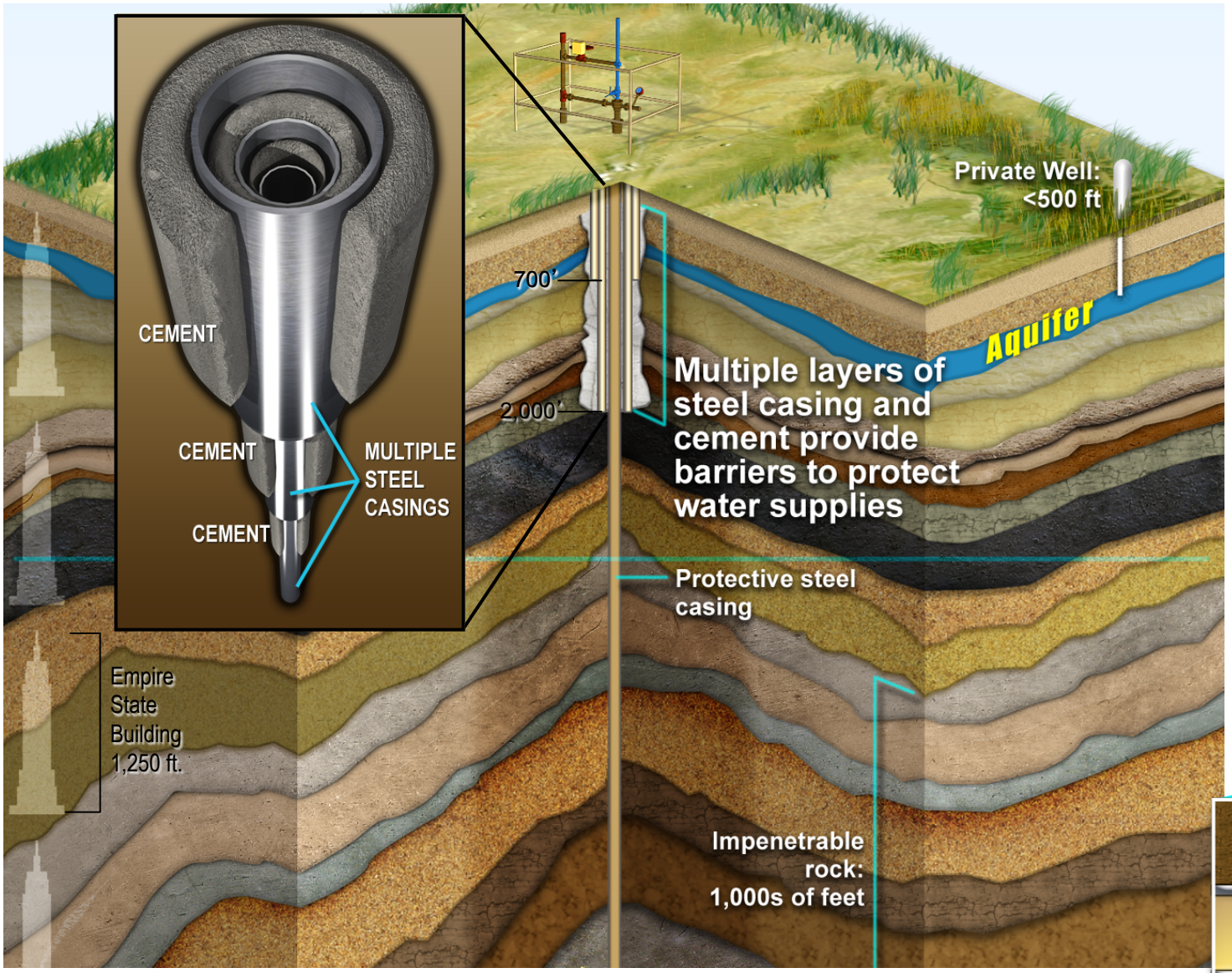


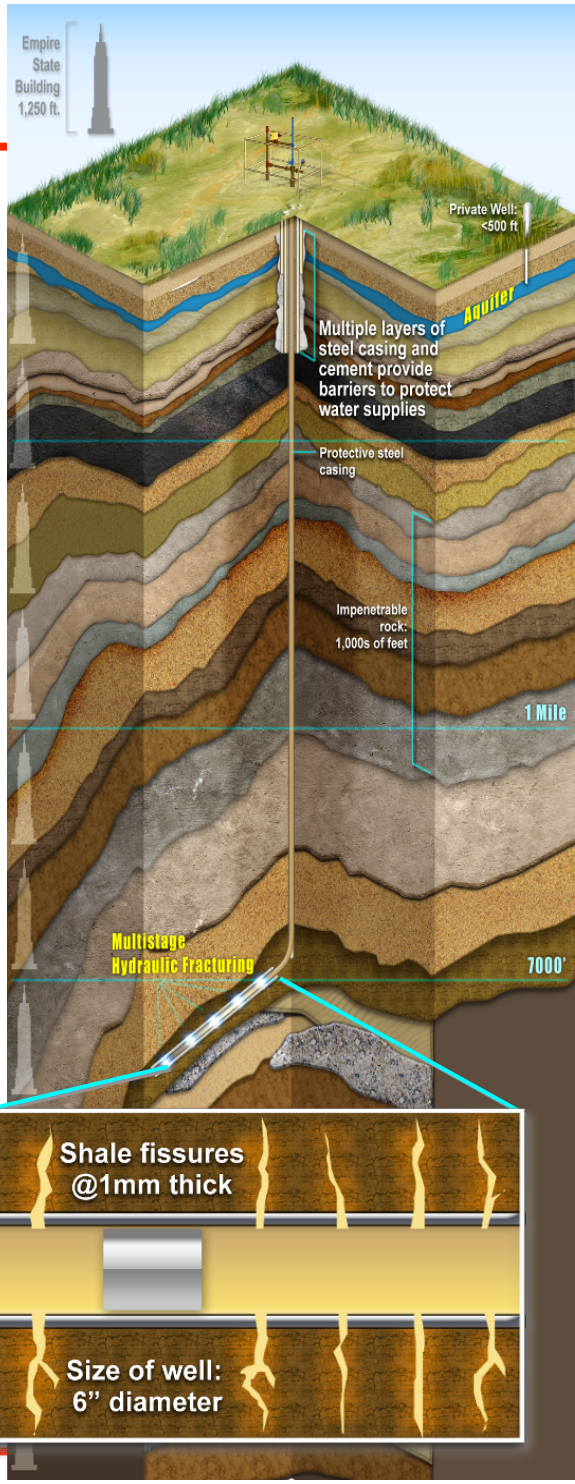
Captures cuttings and stores them in a lined reserve pit.

Closed Loop System

Captures cuttings without the need for a reserve pit. The contained cuttings can be recycled or safely transported to an approved landfill.

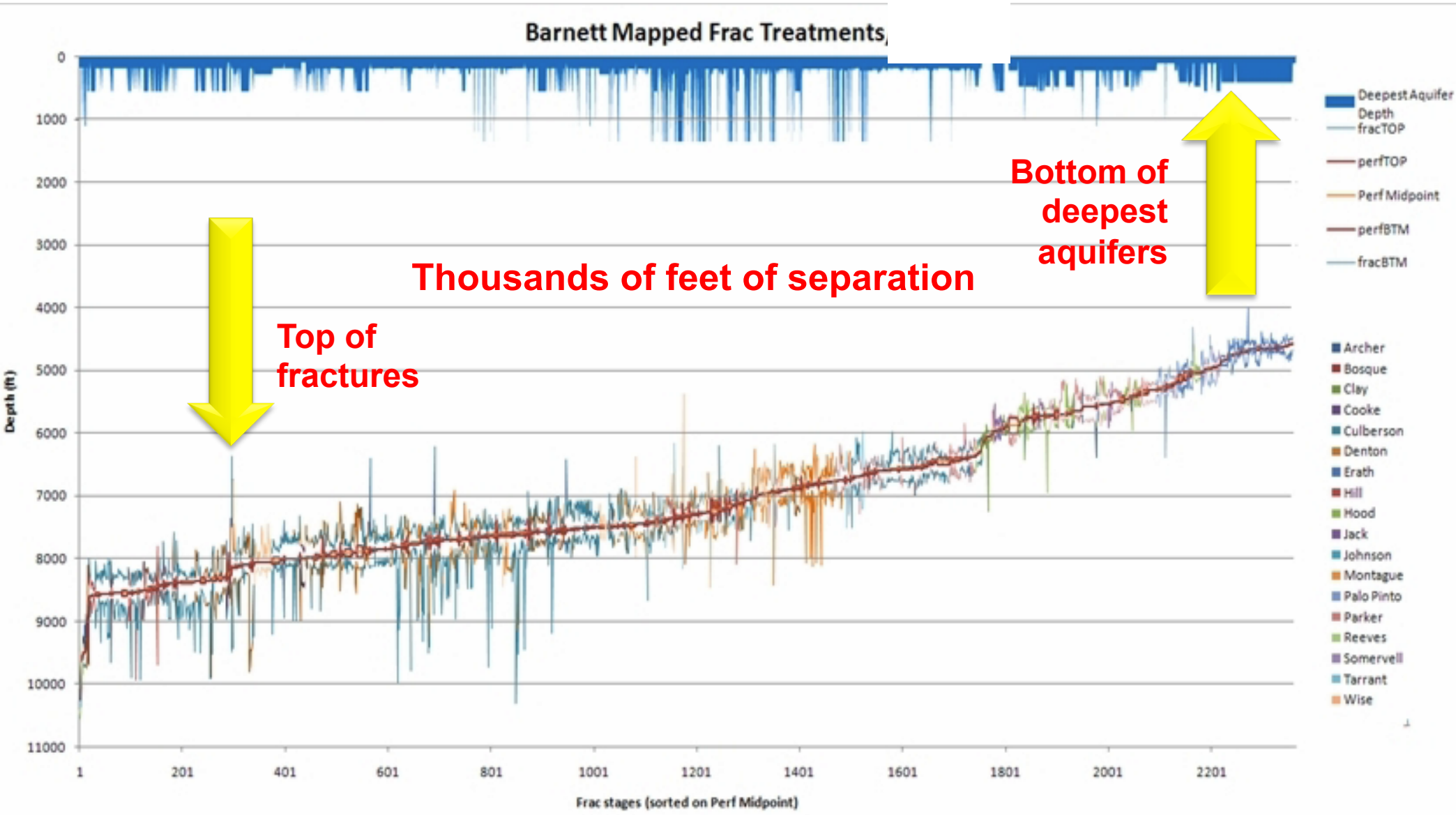
Groundwater Protection





Protection of surface water aquifers is achieved by running two strings of pipe and cementing across the water located above 700'

Technology Improves Understanding of Fracking Impacts



Fracture Height Determination – Microseismic

Key Recommendations:

What is Needed

1. Support Prudent Development

- Establish Regional Councils of Excellence to share effective environmental, health, and safety practices
- Adopt policies for more effective regulation of natural gas and oil production and operations
- Commit to and carry out community engagement
- Measure and reduce methane emissions
- By supporting prudent development, provide access to resources

2. Better Reflect Environmental Impacts in Markets & Choices

- Develop and use tools to better analyze and compare the full environmental impacts of fuels and technologies
- Consider options for internalizing the cost of carbon impacts into fuel prices
- Keep open technology options for reducing GHG emissions from gas in the long run

3. Enhance the Efficient Use of Energy

- **Encourage mechanisms to support greater adoption of energy efficiency in buildings and appliances**
- **Remove barriers to utilities' promotion of efficiency and combined heat and power**

4. Enhance the Regulation of Markets

- **Allow utilities to effectively manage their natural gas price risk**
- **Harmonize interactions between natural gas and power markets**
- **Provide greater certainty in environmental regulations affecting the power sector**

5. Support Needed Talent and Know-How

- **Support intellectual capital and a skilled workforce:**
  - Increase the Number of Qualified Natural Gas and Oil Professionals

Summary

- We have enormous oil and gas resources – of potential value and importance to the nation
- There's enough supply to support national objectives – including our economic, environmental and security interests
- The lynchpin to realizing these benefits is prudent development – We have to do this right.
- And our recommendations help us move toward these outcomes.

Prudent Development

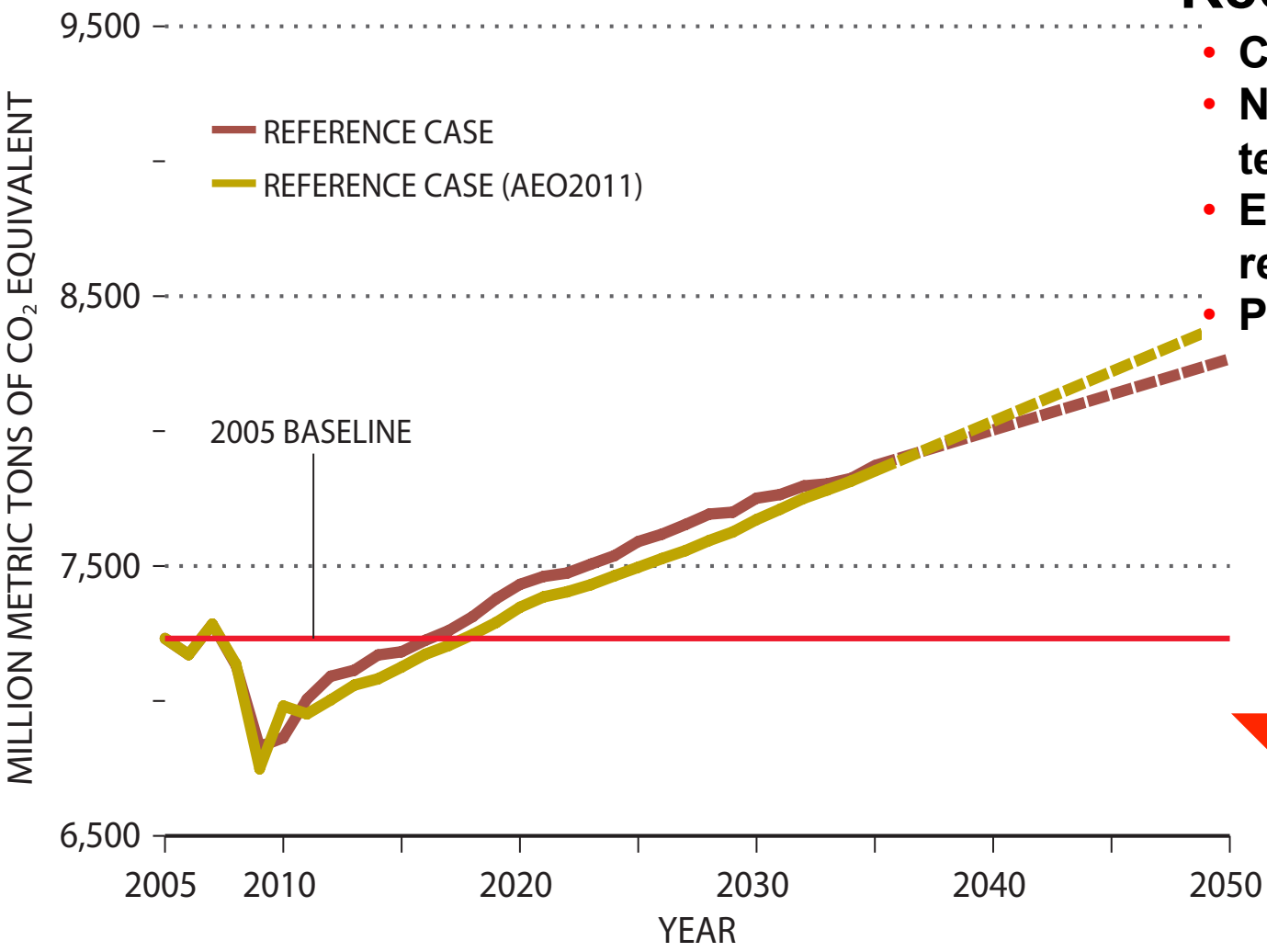
Realizing the Potential of North America's Abundant Natural Gas and Oil Resources

A Comprehensive Assessment to 2035 with Views through 2050

Environmental NGOs
January 10, 2012

Supplemental Slides

Greenhouse Gas Emissions



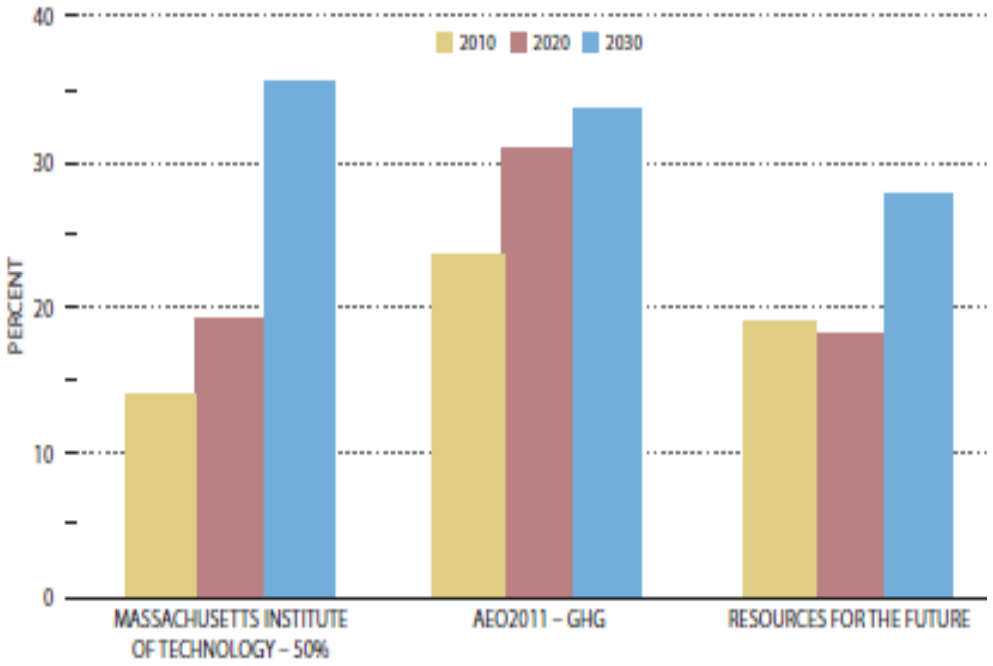
Reduction Pathways

- Coal displacement
- Natural gas end-use technologies
- EPA non-GHG regulations
- Price on carbon

GHG Emissions Are Rising – But Natural Gas Can Be Part of the Solution to Help to Lower GHG Emissions

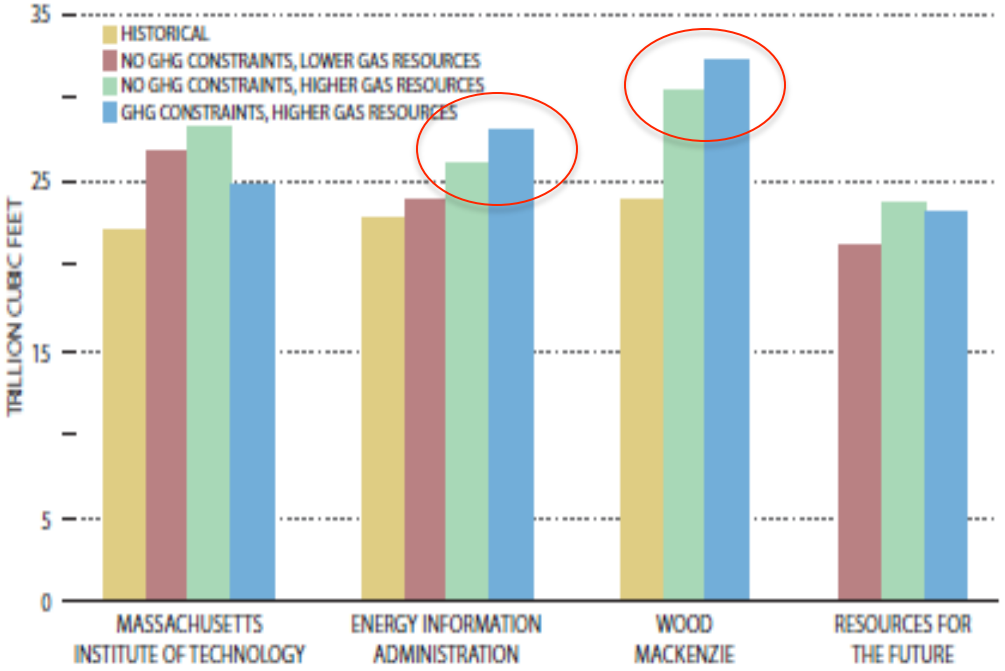
Carbon Constraints & Natural Gas Demand

Natural Gas Generation Intensity in Carbon-Constrained Scenarios



Note: GHG = greenhouse gas.

Total Natural Gas Consumption in 2030



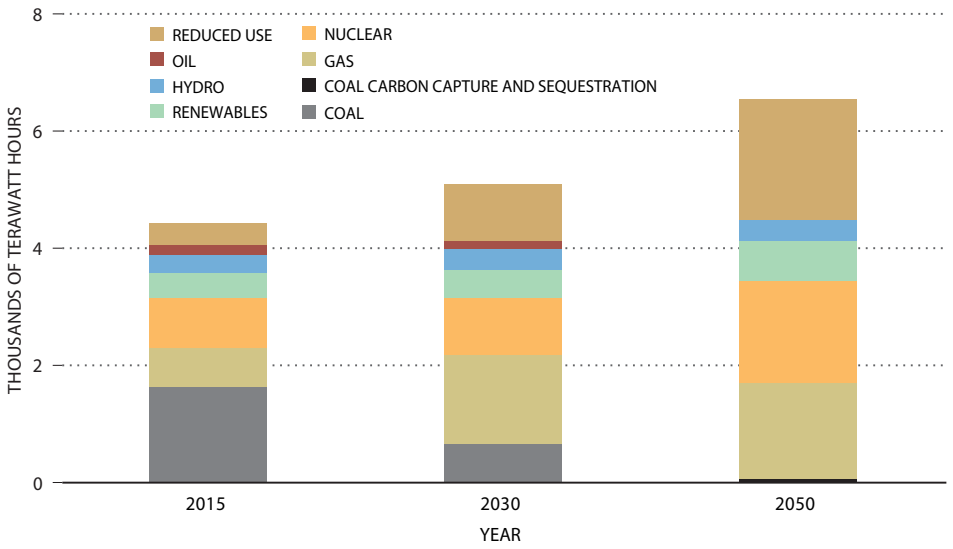
Note: GHG = greenhouse gas.

Carbon Constraints & Resource Mix

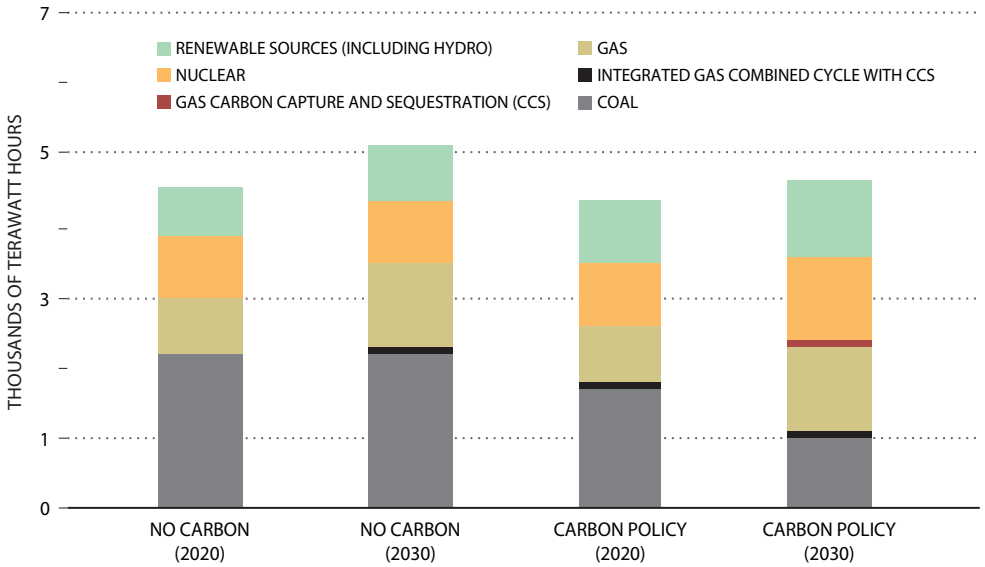
Implications of Increased Natural Gas Supplies and Lower Prices:

- *Viable, Economical Option for 50% GHG Reduction by 2050*
- *More Aggressive (80%) Reductions Will Require Low-to-Zero Emitting Technologies*
- Even with updated resource natural gas resource estimates, the electricity mix in a carbon-constrained economy will be comprised of a diverse mix of low-carbon resources

MIT: Energy Mix Under Carbon Policy – 50% Reduction by 2050



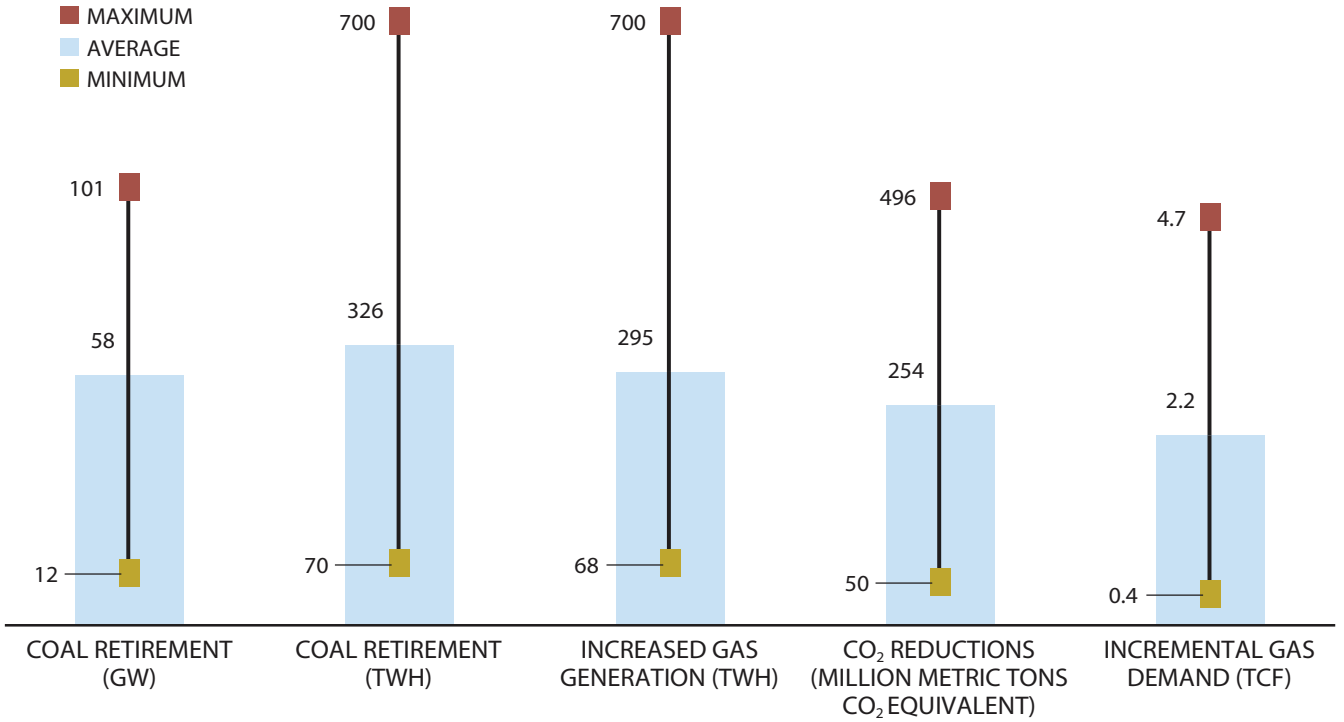
RFF: Energy Mix Under Carbon Policy – 42% Reduction by 2030



Impact of EPA non-GHG Rules

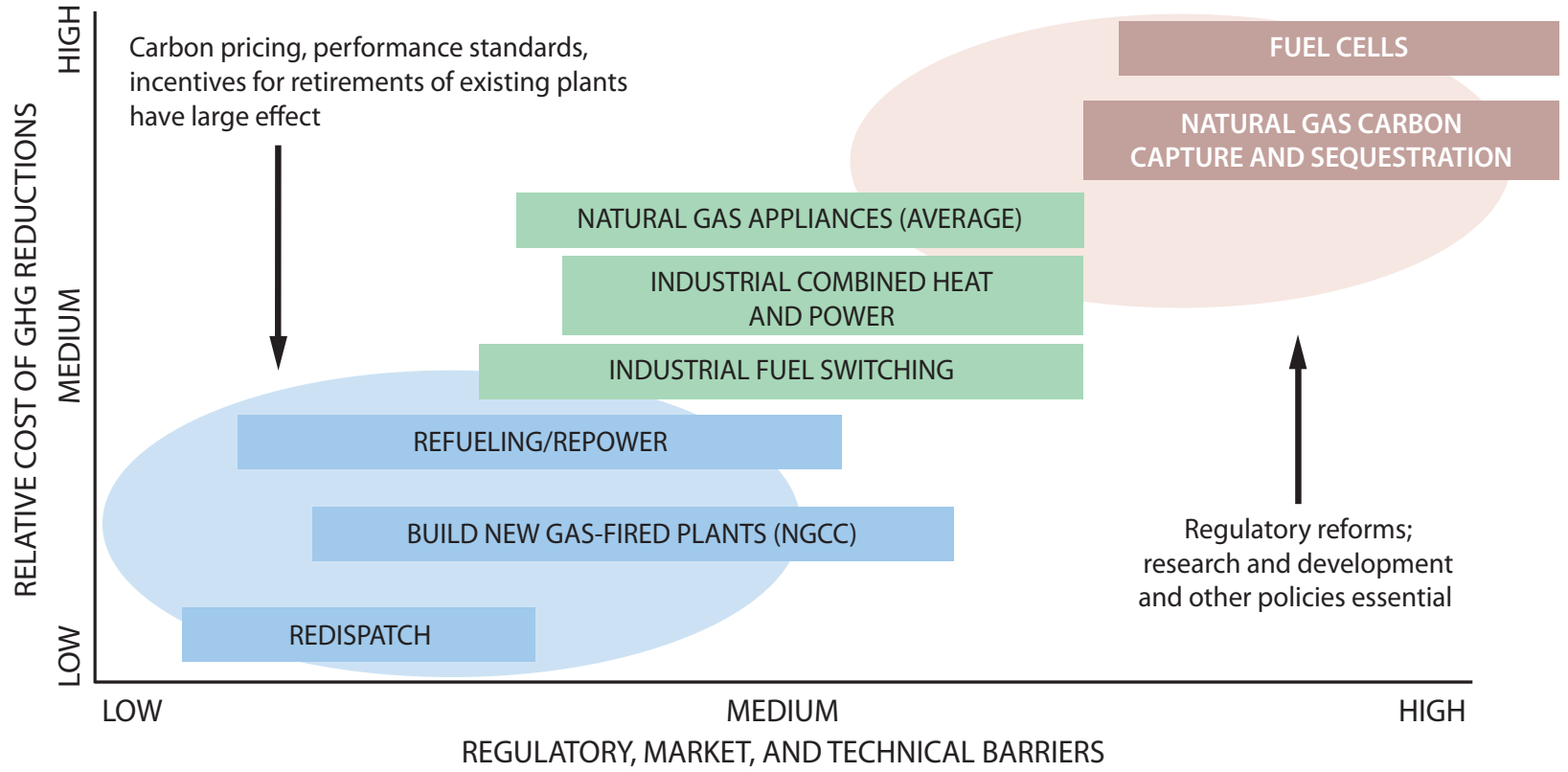
Impact of non-GHG EPA Rules on Coal Plants Averages 58 GW of Retirements (~18% of the 316 GW of Total U.S. Coal-Fired Generation Capacity)

Summary of Results – Average, Maximum, and Minimum Values across All Studies



Favorable fuel prices and pending non-GHG rules may improve natural gas-fired power plants' relative economics and greatly influence a power company's decision to retire or retrofit its coal plants.

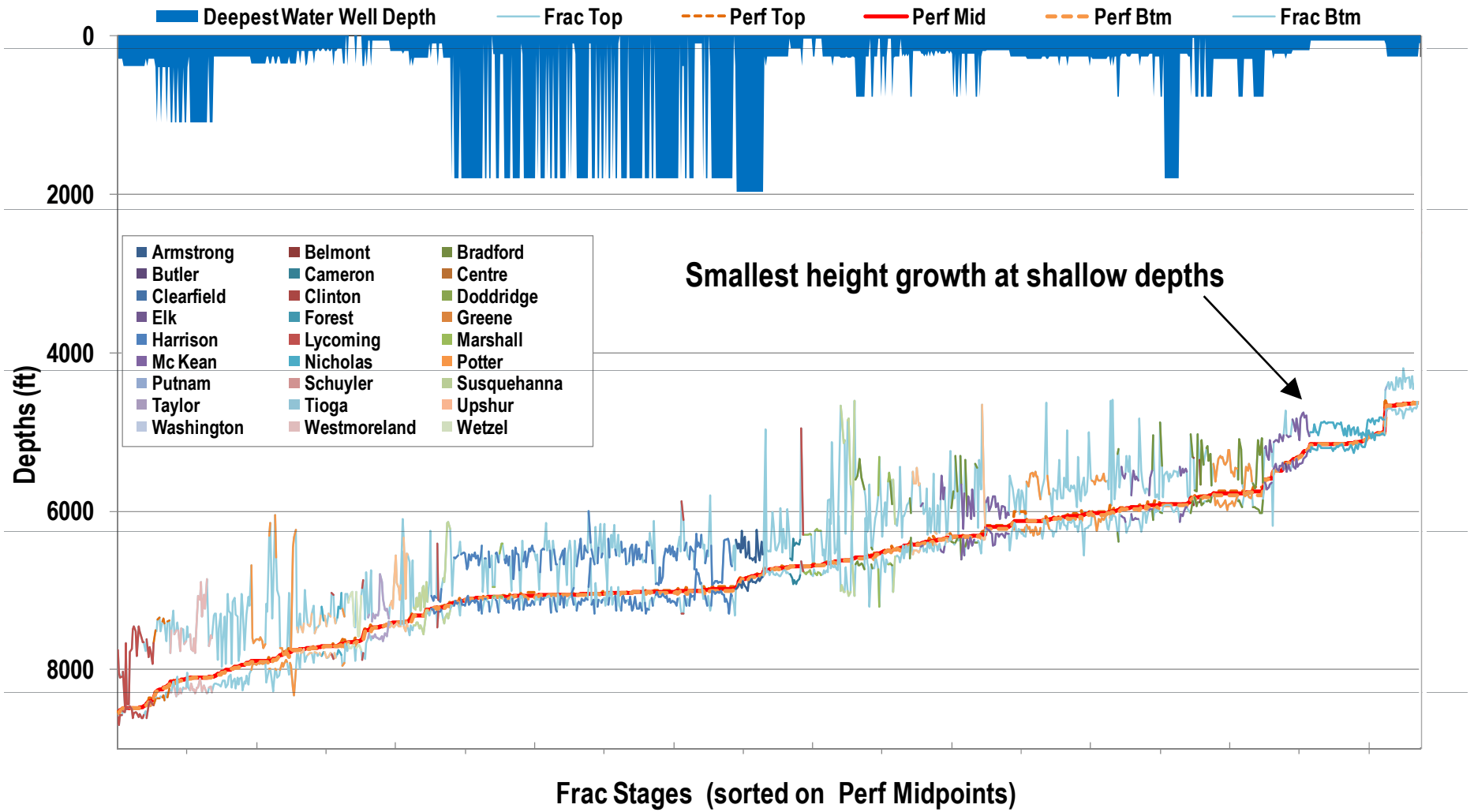
Evaluating Natural Gas End-Use Policy Options to Reduce GHG Emissions



Note: Low relative-cost of GHG reductions means that the technology is at or near competitive with low or zero cost per metric ton CO_2 emission avoided. High relative-cost of GHG reductions means that much larger policy signals – including possibly high costs for CO_2 emissions – would be needed for commercial deployment of the technology.

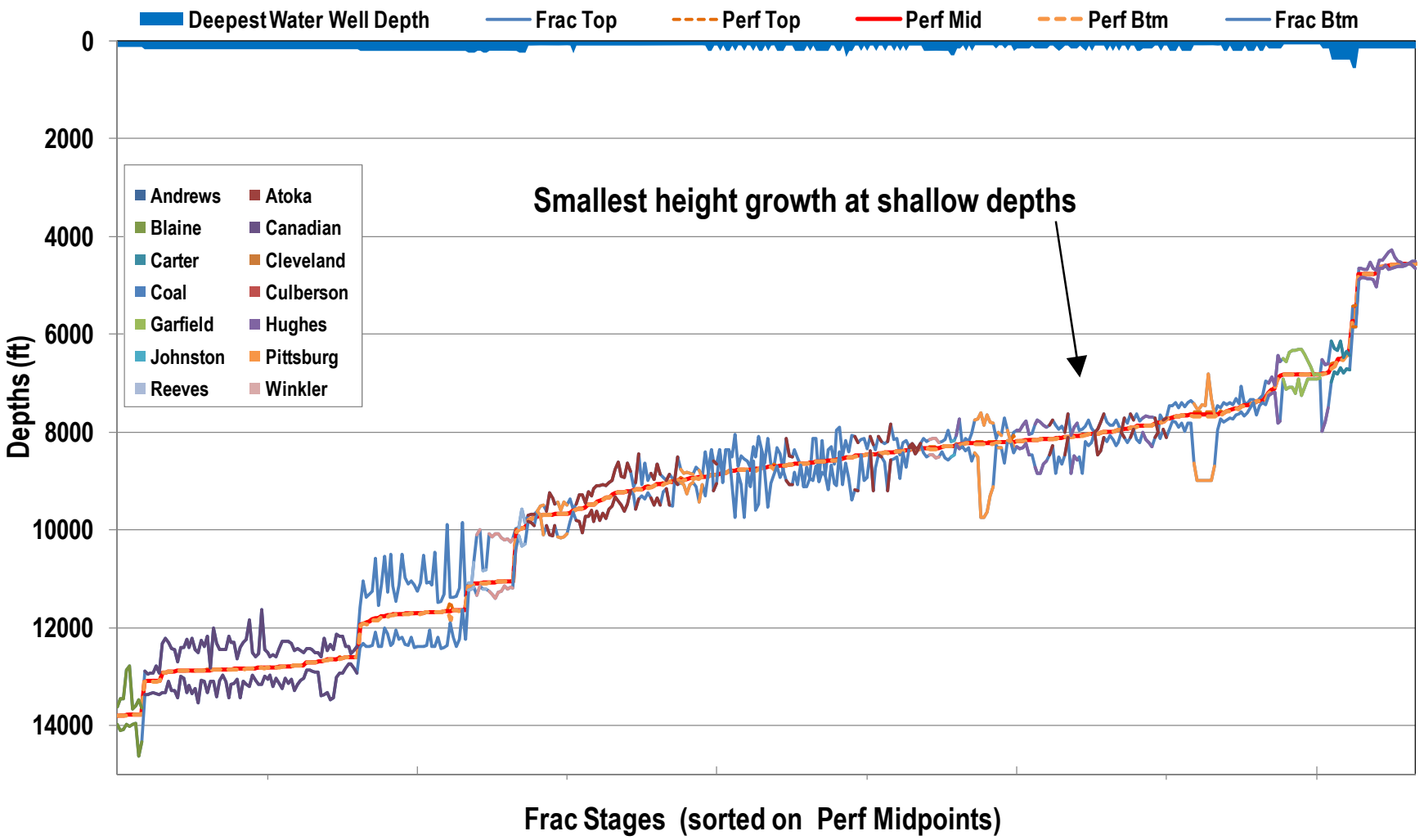
Mapped microseismic height for Marcellus shale

- Top: shallowest microseism; Bottom: deepest microseism
- Aquifers: USGS deepest water wells by county



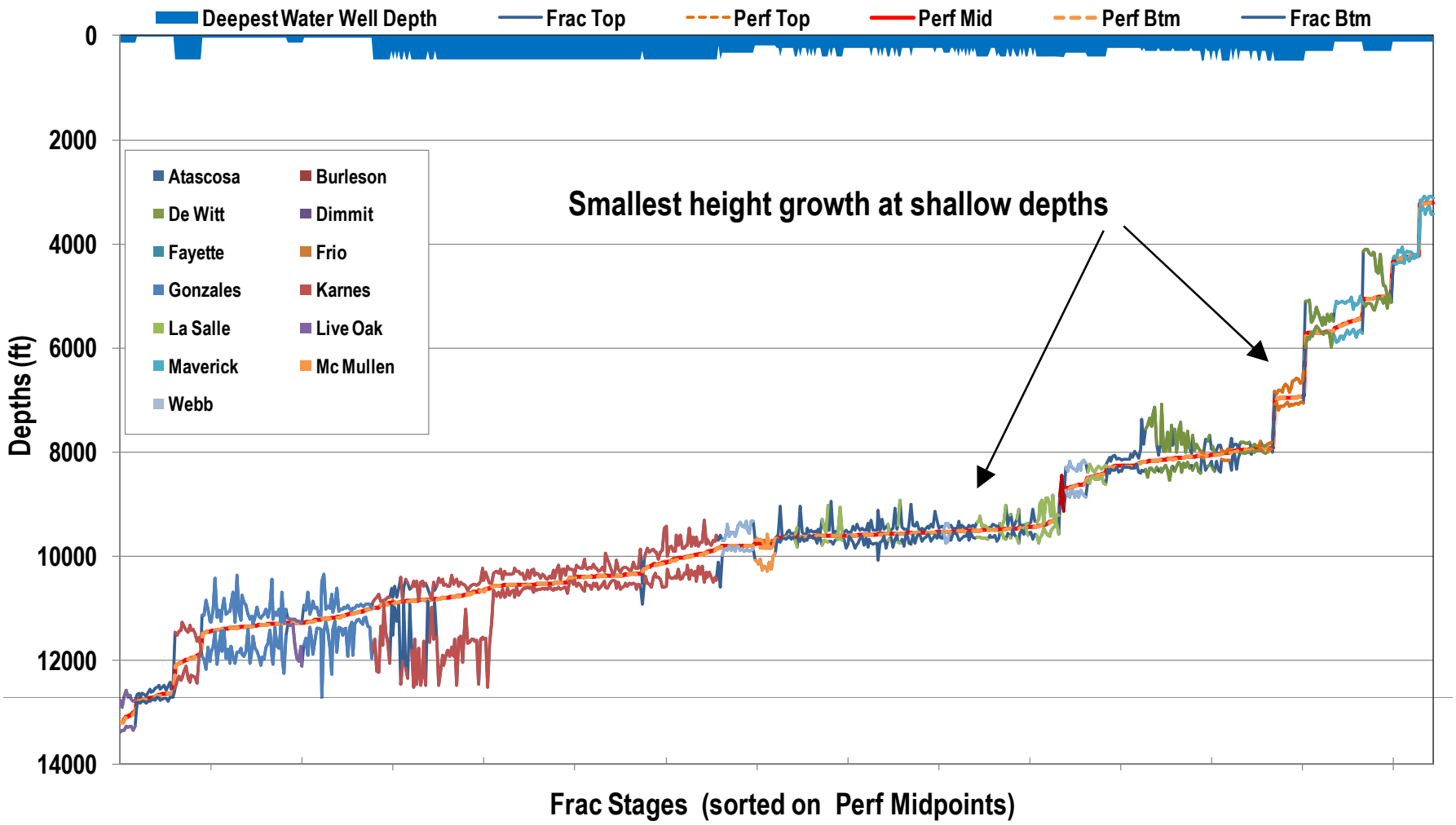
Mapped microseismic height for Woodford shale

- Top: shallowest microseism; Bottom: deepest microseism
- Aquifers: USGS deepest water wells by county

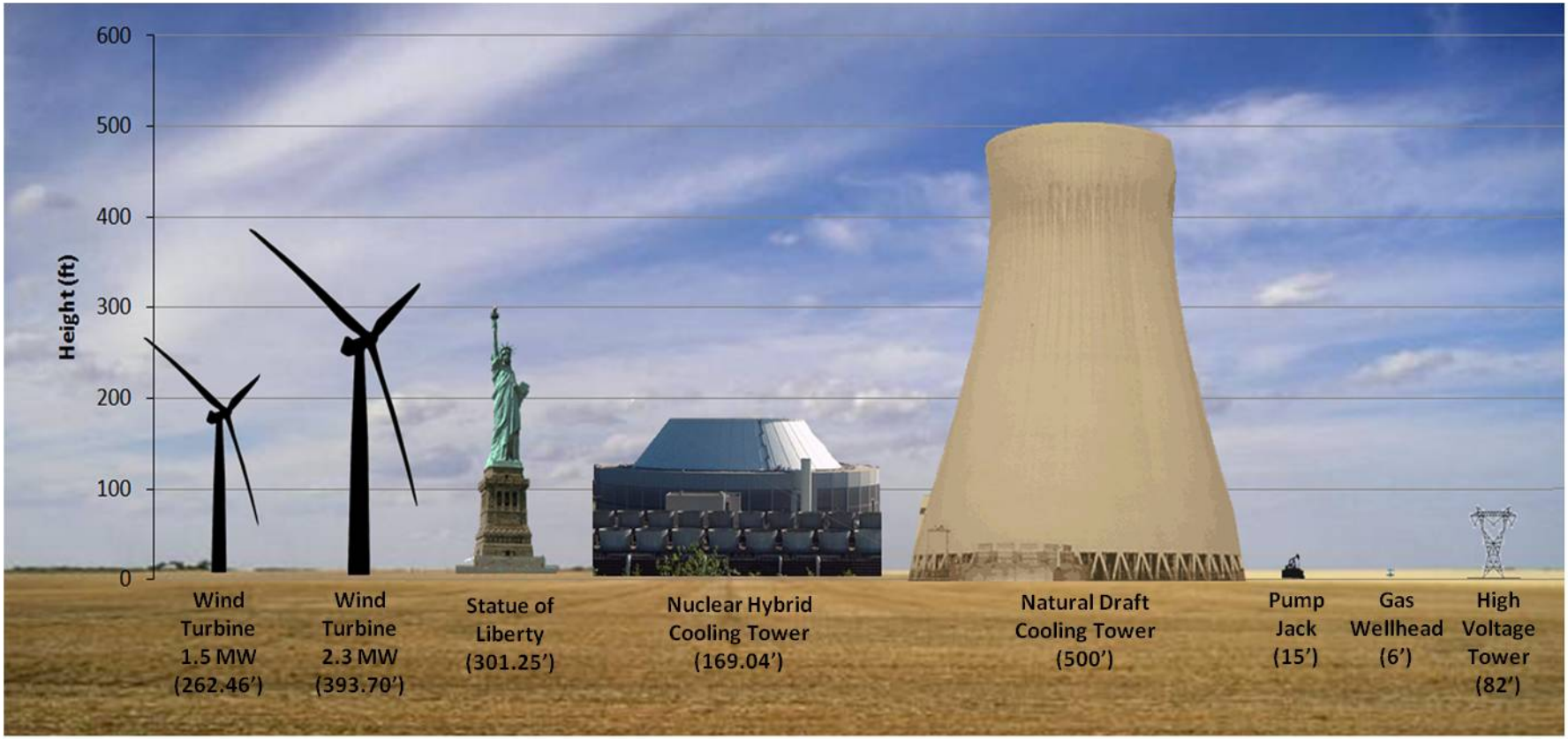


Mapped microseismic height for Eagle Ford shale

- Top: shallowest microseism; Bottom: deepest microseism
- Aquifers: USGS deepest water wells by county



Visual Impact Comparison



Visual impact: the alteration of an aesthetic experience of a viewshed. It is highly subjective; therefore, quantifying visual impacts can be complex.

This study focused on skyline impairment and surface disturbance which allow a degree of scaling.

American Energy and Environmental Research Foundation, The Environmental Cost of Energy, September 2010.