Changing Energy Markets and Policy

Louisiana Department of Natural Resources Annual Conference

Oil & Gas: From Sonris to Sunset
August 29, 2011

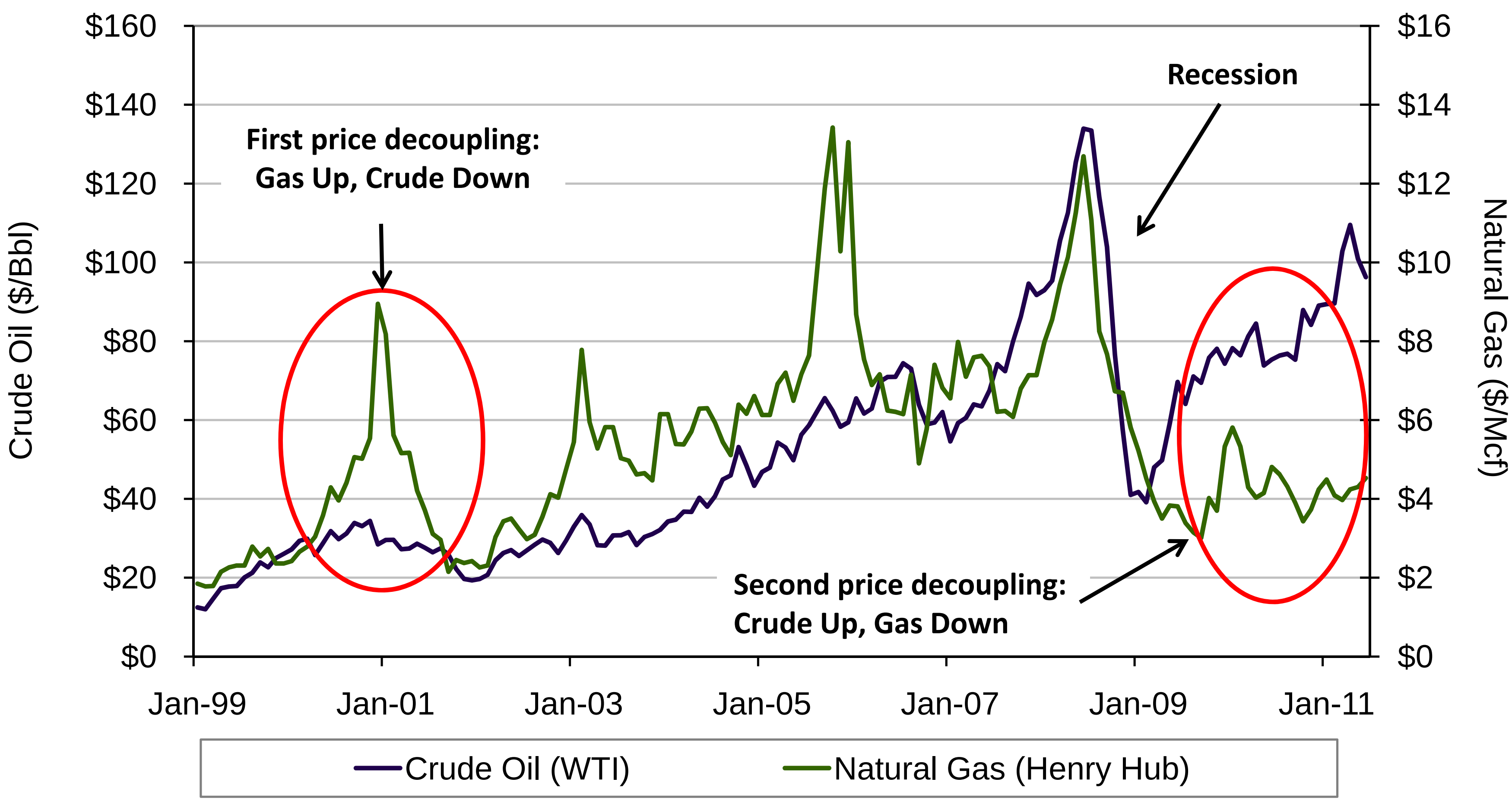
Center for Energy Studies

David E. Dismukes, Ph.D.
Center for Energy Studies
Louisiana State University

Pricing Trends: A Series of Different "Decouplings"

Crude Oil and Natural Gas Prices

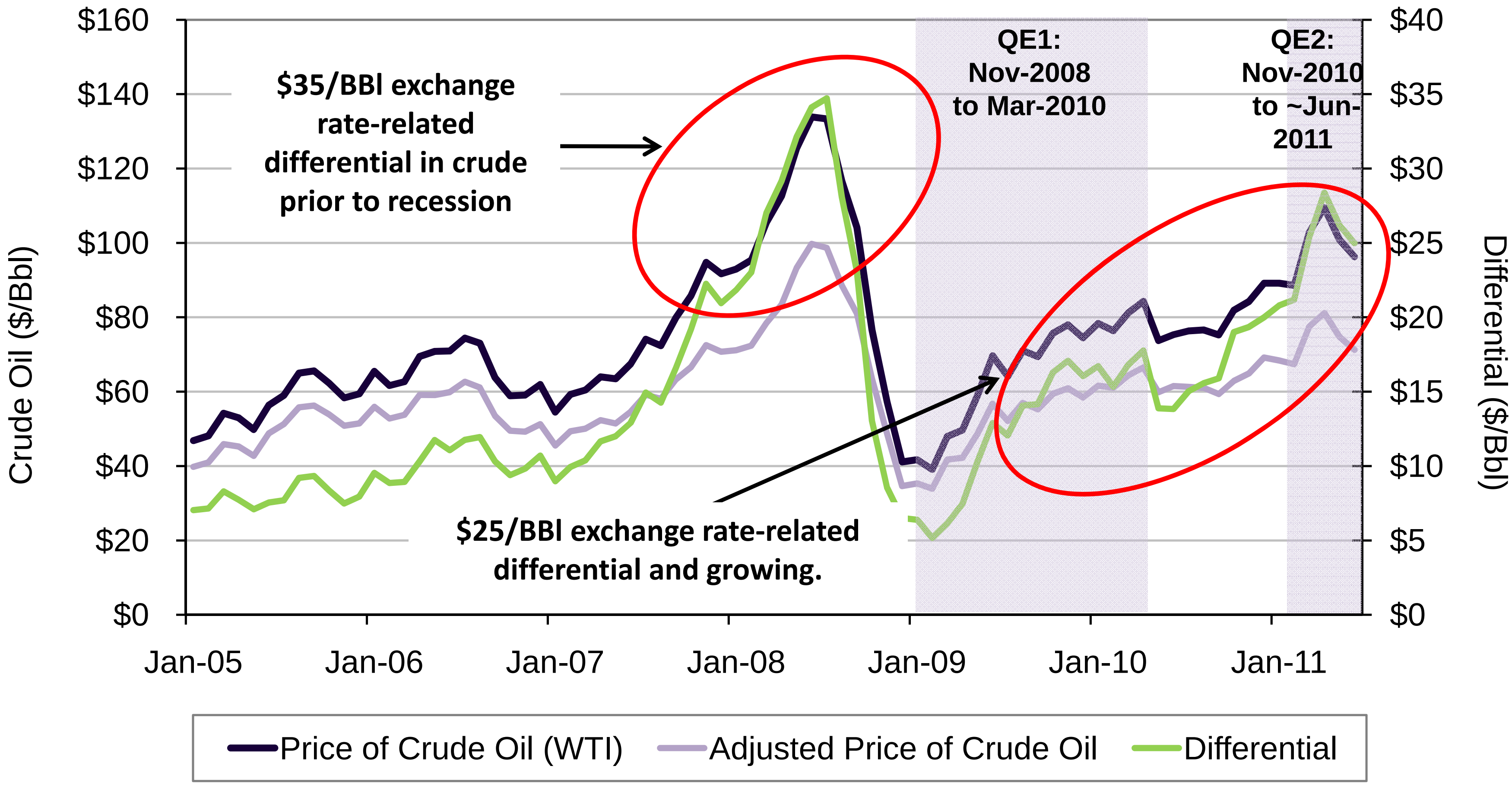
Prices say a lot about what has been going on in energy markets over the past decade. Two significant breaks (decoupling) of natural gas and crude oil prices.



Source: Federal Reserve Bank

Trade Weighted Value of Crude Oil

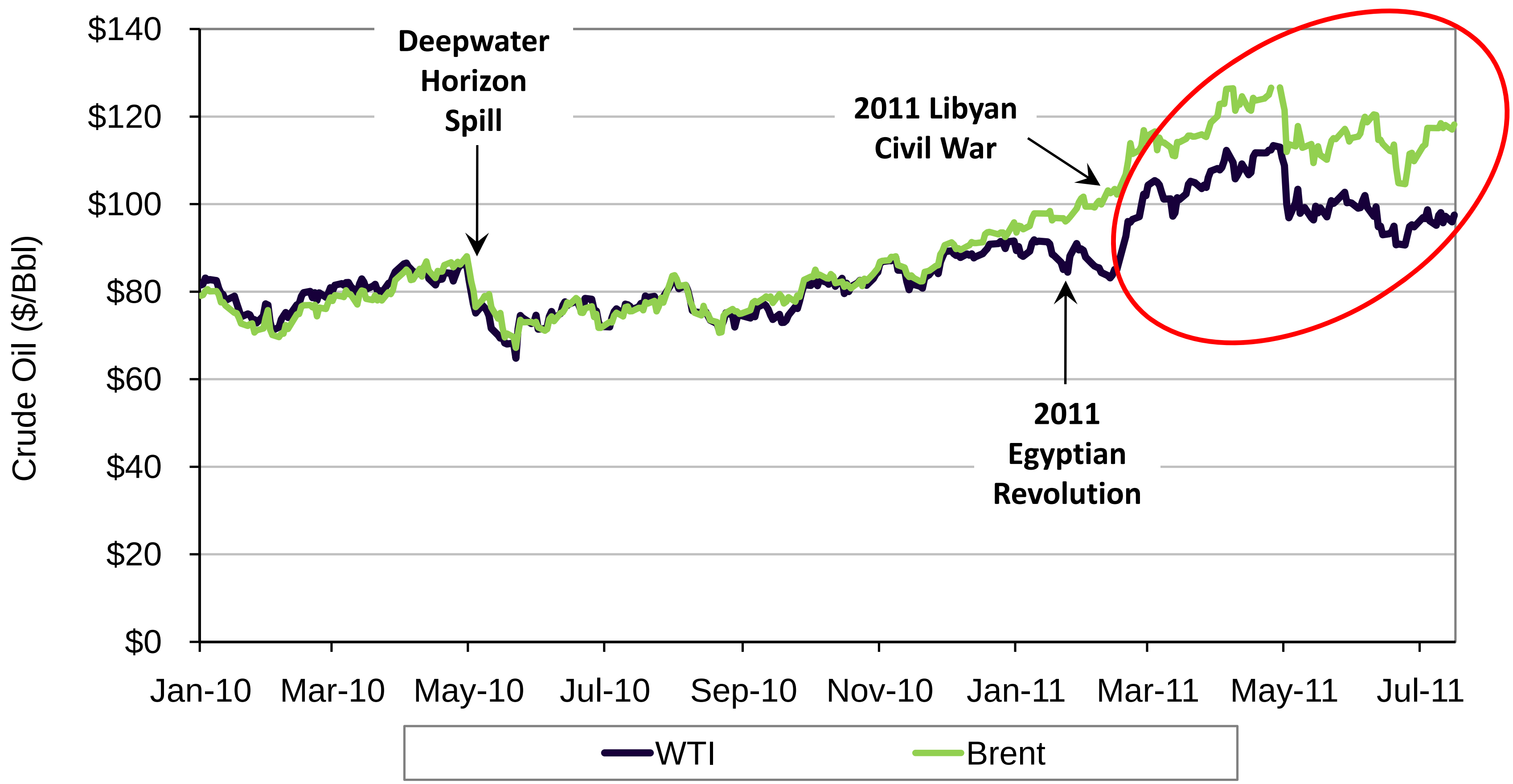
Second decoupling has been associated with the exchange-weighted differences in crude oil prices.



Note: The adjusted price of crude oil is the nominal WTI adjusted by the Federal Reserve Bank's Broad Index. The Broad Index is a weighted average of the foreign exchange values of the U.S. dollar against the currencies of a large group of major U.S. trading partners. Base year is 2002.
Source: Federal Reserve Bank.

Crude Oil Prices – Domestic (WTI) and International (Brent)

Additional decoupling has materialized between domestic crude (WTI) and international priced crude (Brent).

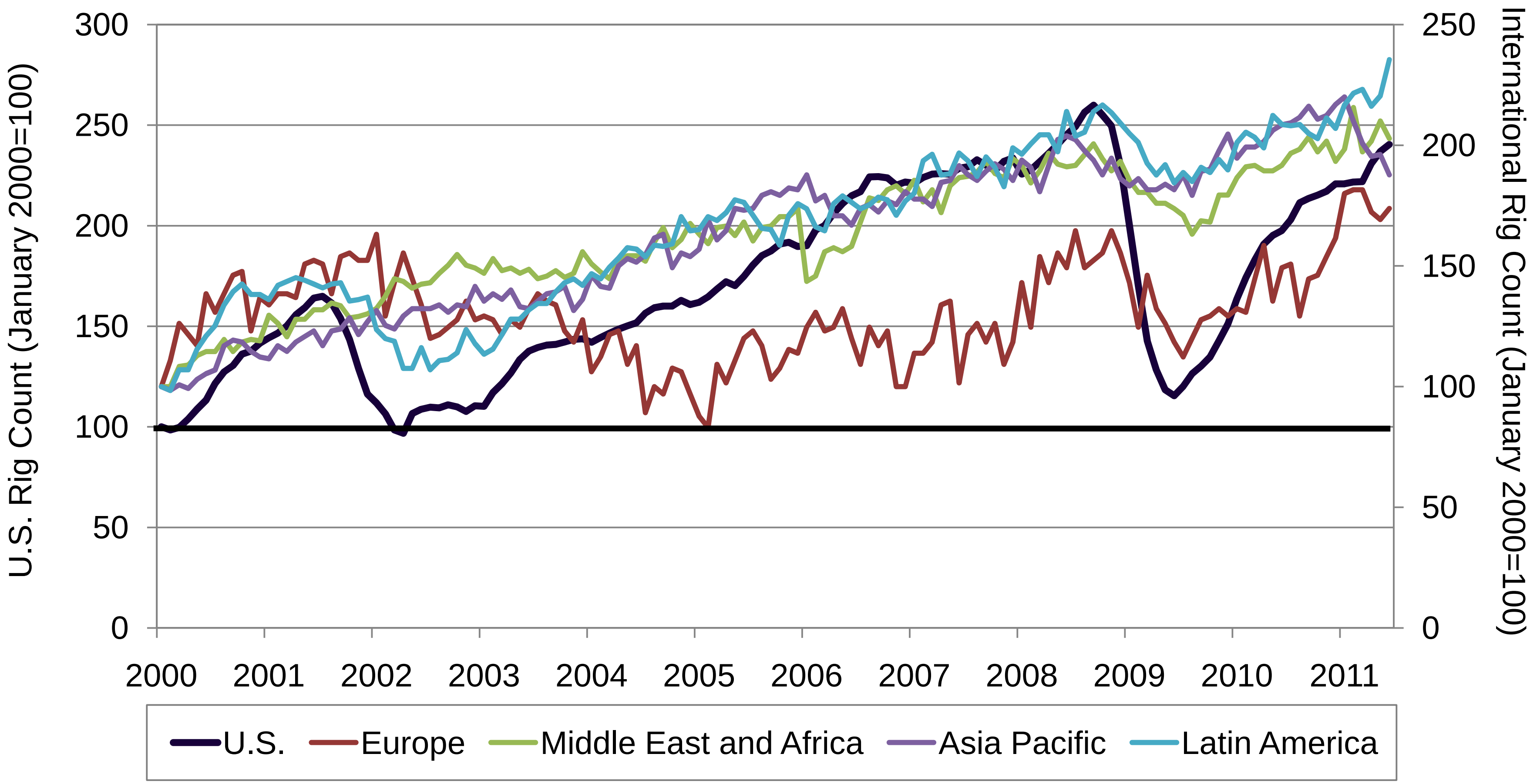


Source: Energy Information Administration, U.S. Department of Energy

Rig Movements

Domestic and International Rig Counts

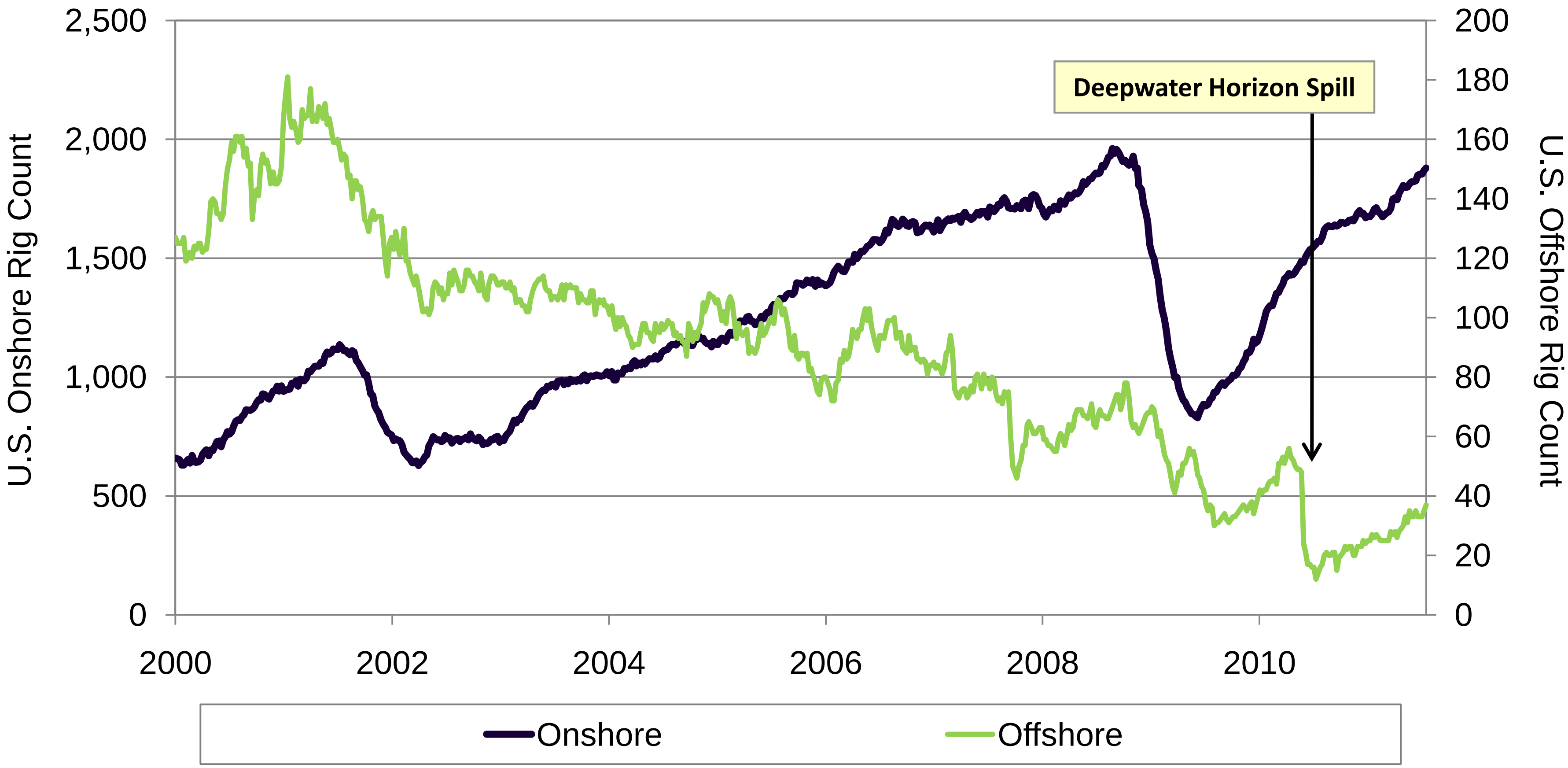
Recent changes in crude oil prices are leading to a rebound in overall U.S. rig count from 2008-2009 recession.



Source: Baker Hughes.

Domestic Rig Counts – Onshore vs. Offshore

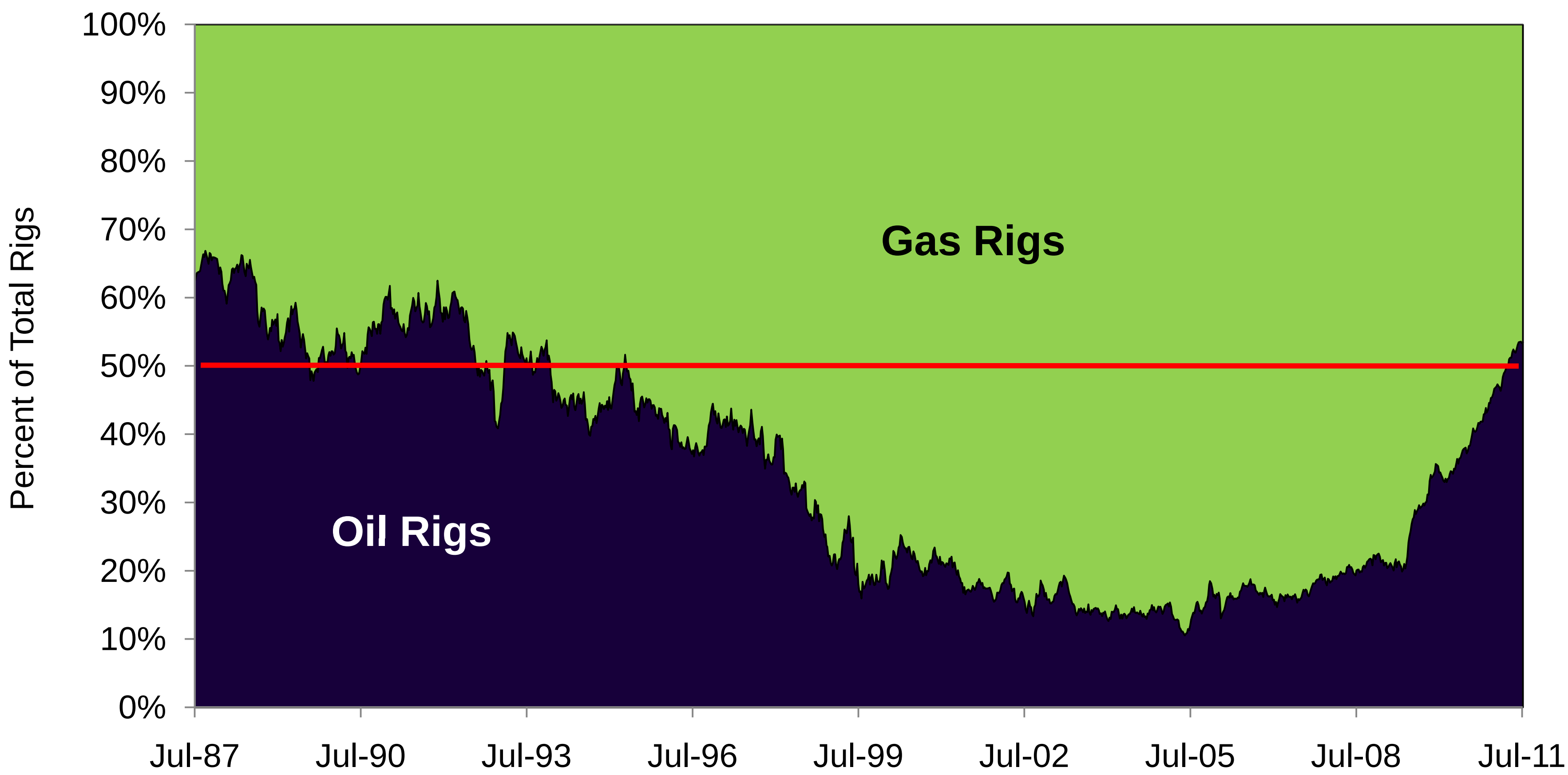
Onshore rig counts are moving close to their pre-recession levels, primarily motivated by increased crude oil drilling, not natural gas.



Source: Baker Hughes.

Domestic Rig Count – Crude Oil vs. Natural Gas

However, for the first time in 16 years, the number of oil rigs is equivalent to gas rigs.

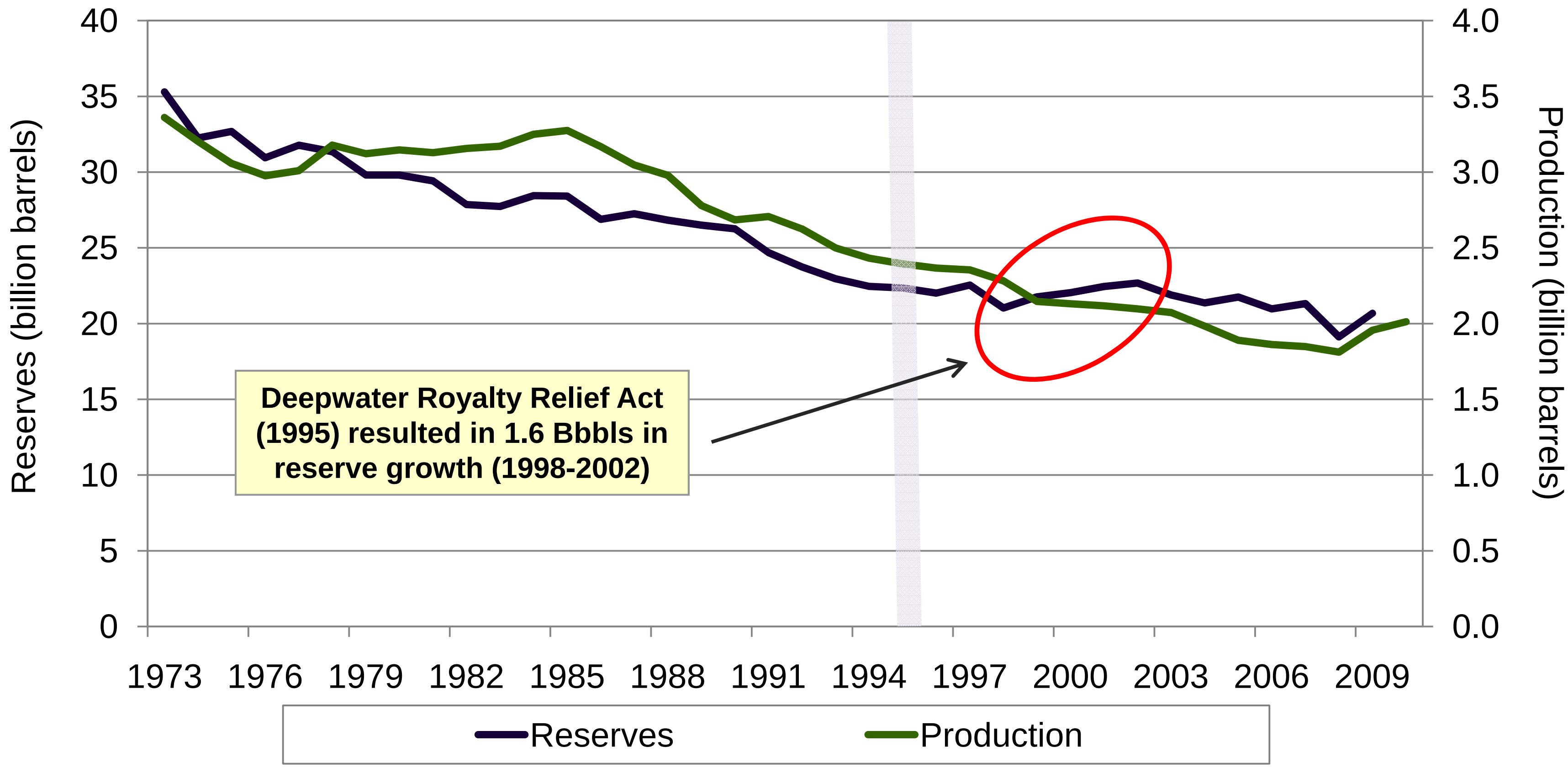


Source: Baker Hughes.

Supply Implications

U.S. Crude Oil Proved Reserves and Production

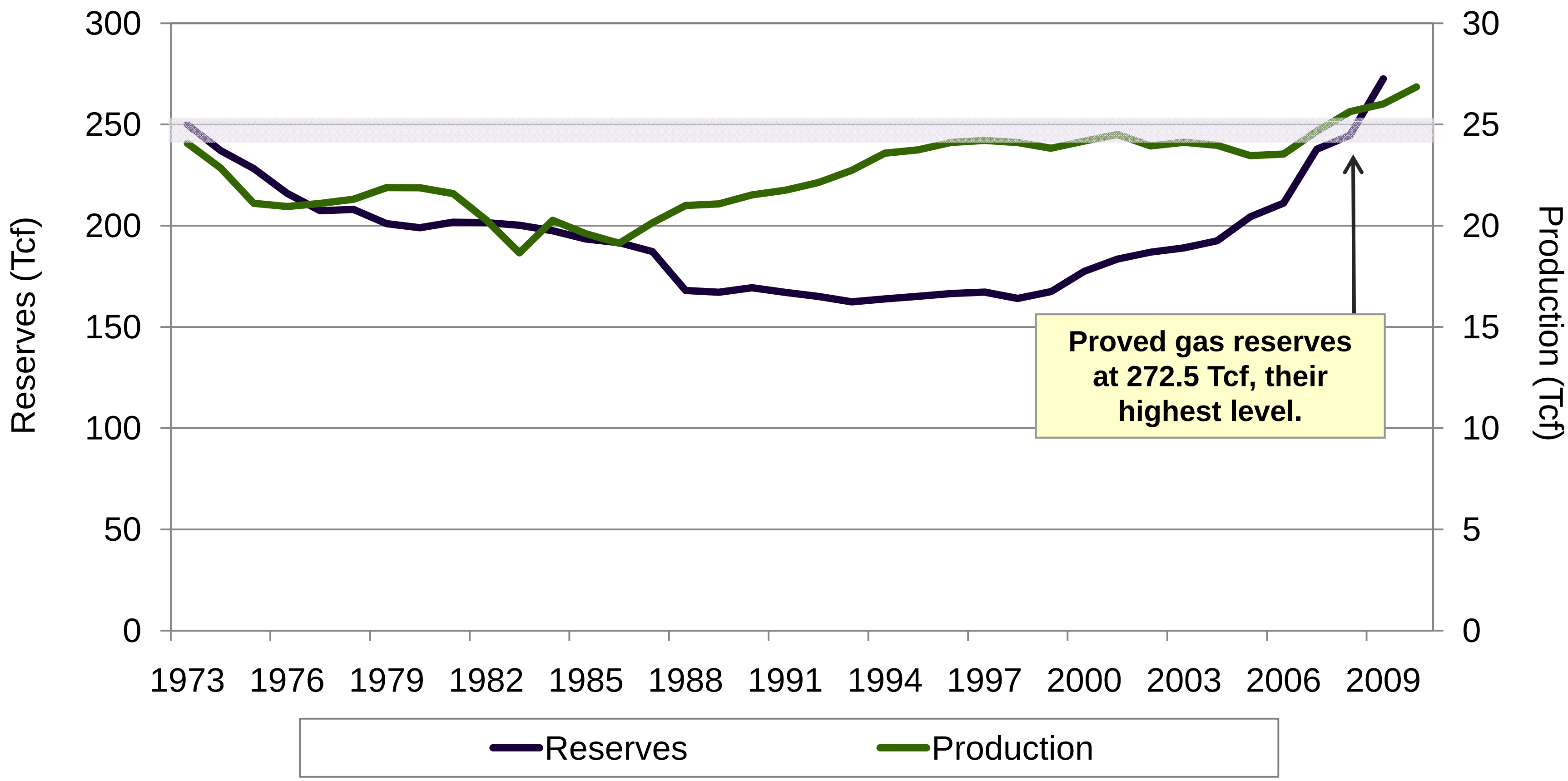
Crude oil reserves holding steady between 22 to 20 BBbls since 1995.
DWRRA (1995) helped reverse a deteriorating trend in GOM reserve declines.



Source: Energy Information Administration, U.S. Department of Energy

U.S. Natural Gas Production and Proved Reserves, January 2007 to Present

2006-2007 reserves growth is the largest in over 30 years. On average, natural gas reserves have been increasing by 5 percent per year since 2000 (except 2004-2005 tropical season, 2 percent).

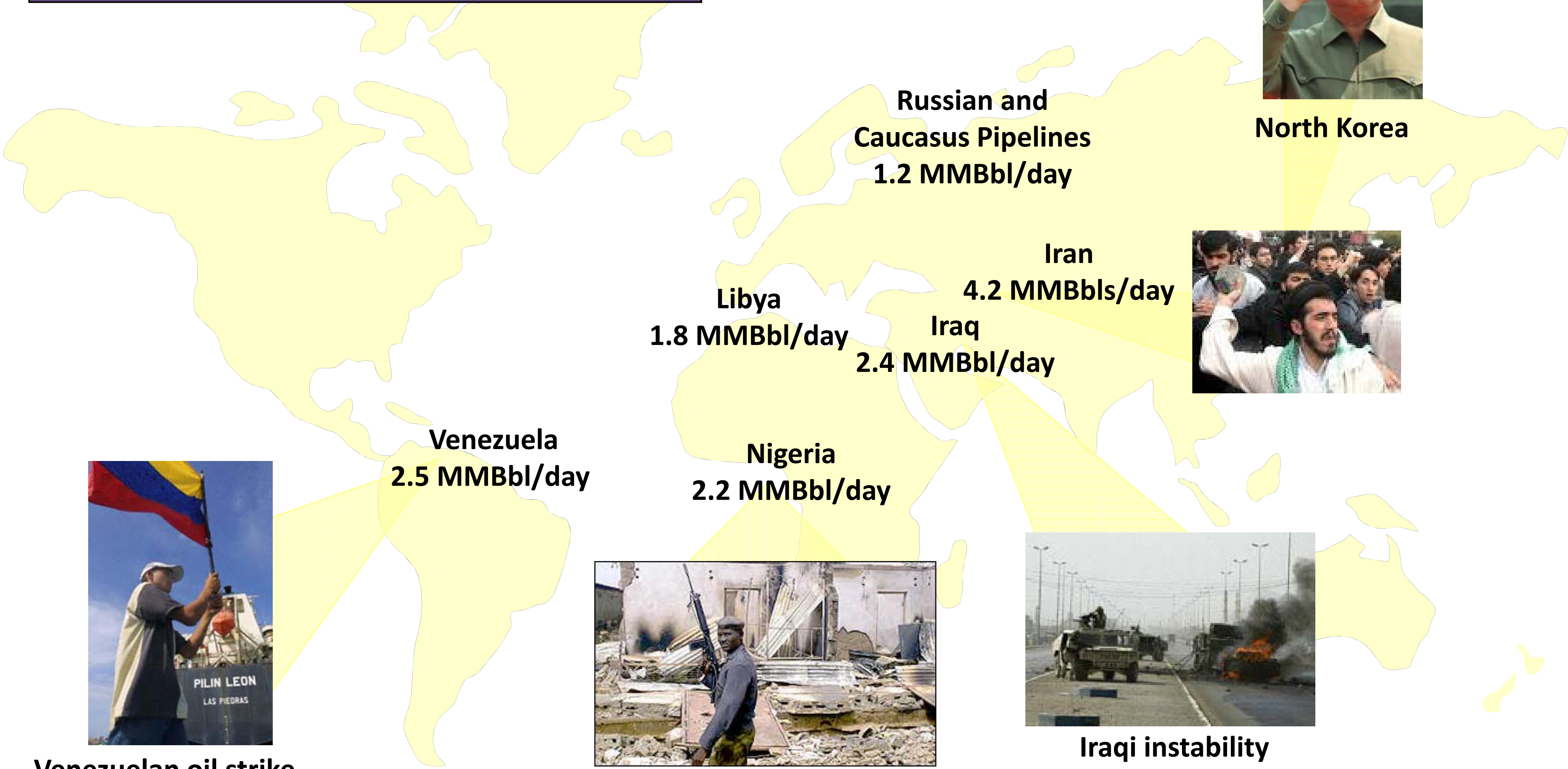


Source: Energy Information Administration, U.S. Department of Energy.

Global Energy Markets

Worldwide Trouble Spots – Potential Impact on Production

Production in Trouble Spots: 14.6 MMBbl/d
Forecast World Growth (2015): 1.5 MMBbl/d
Forecast World Growth (2020): 4.8 MMBbl/d



Venezuelan oil strike

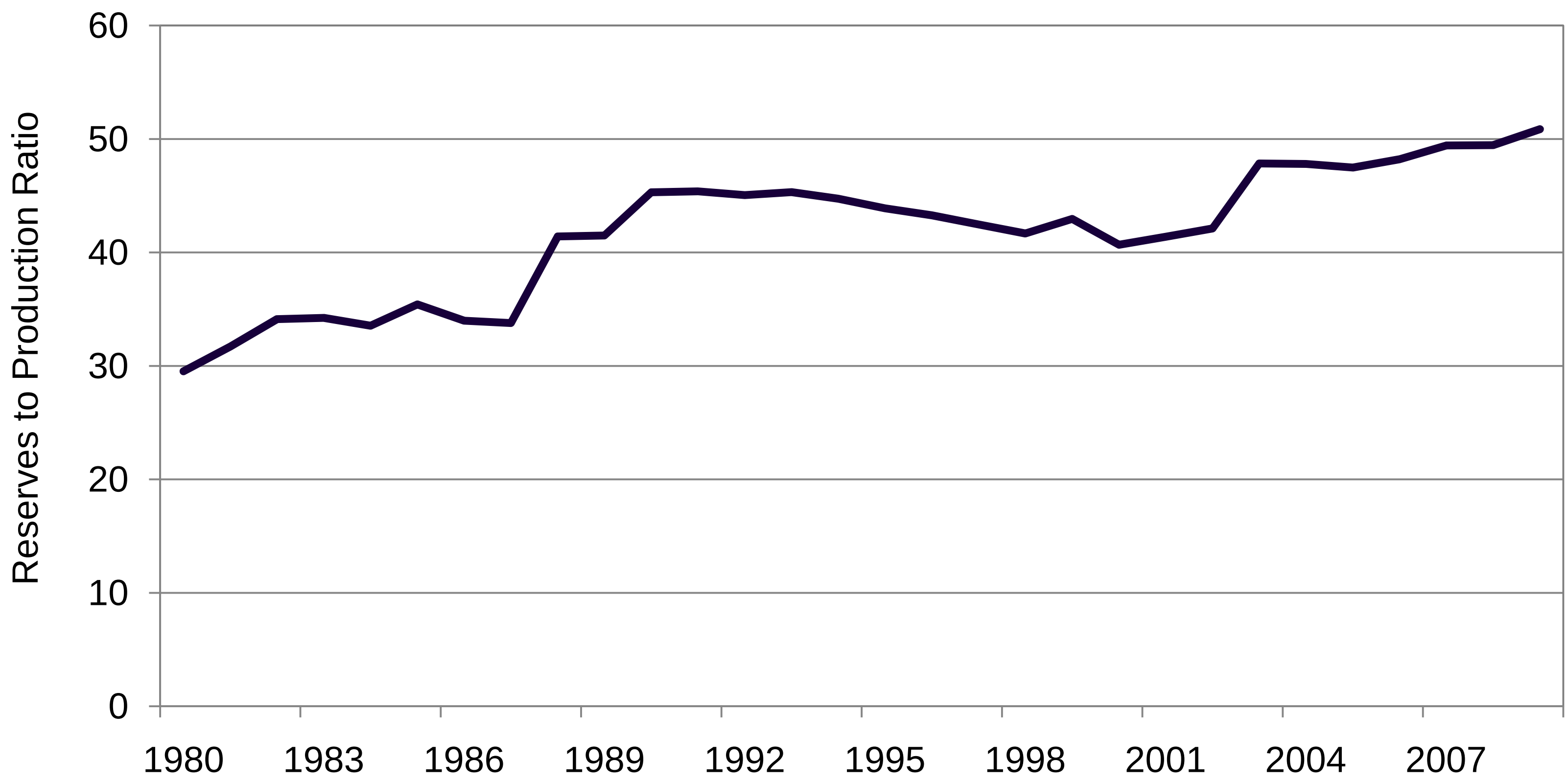
Nigerian civil strife

Iraqi instability

Source: Energy Information Administration, U.S. Department of Energy

World Crude Oil Production to Reserve Ratio

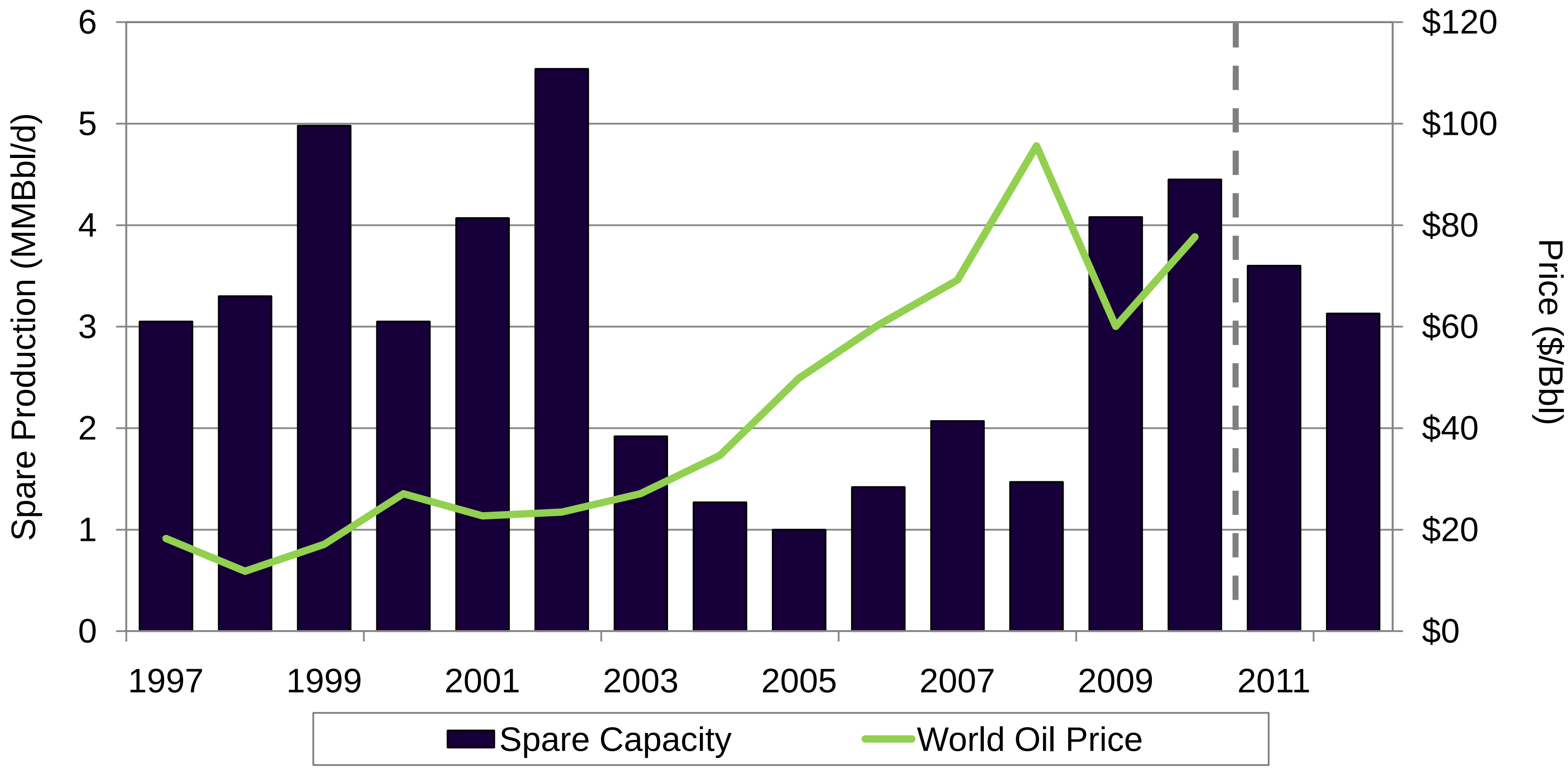
Reserves to production ratios continue to remain strong, and in fact, have actually grown over the past several years.



Source: Energy Information Administration, U.S. Department of Energy

World Surplus Crude Oil Production Capacity

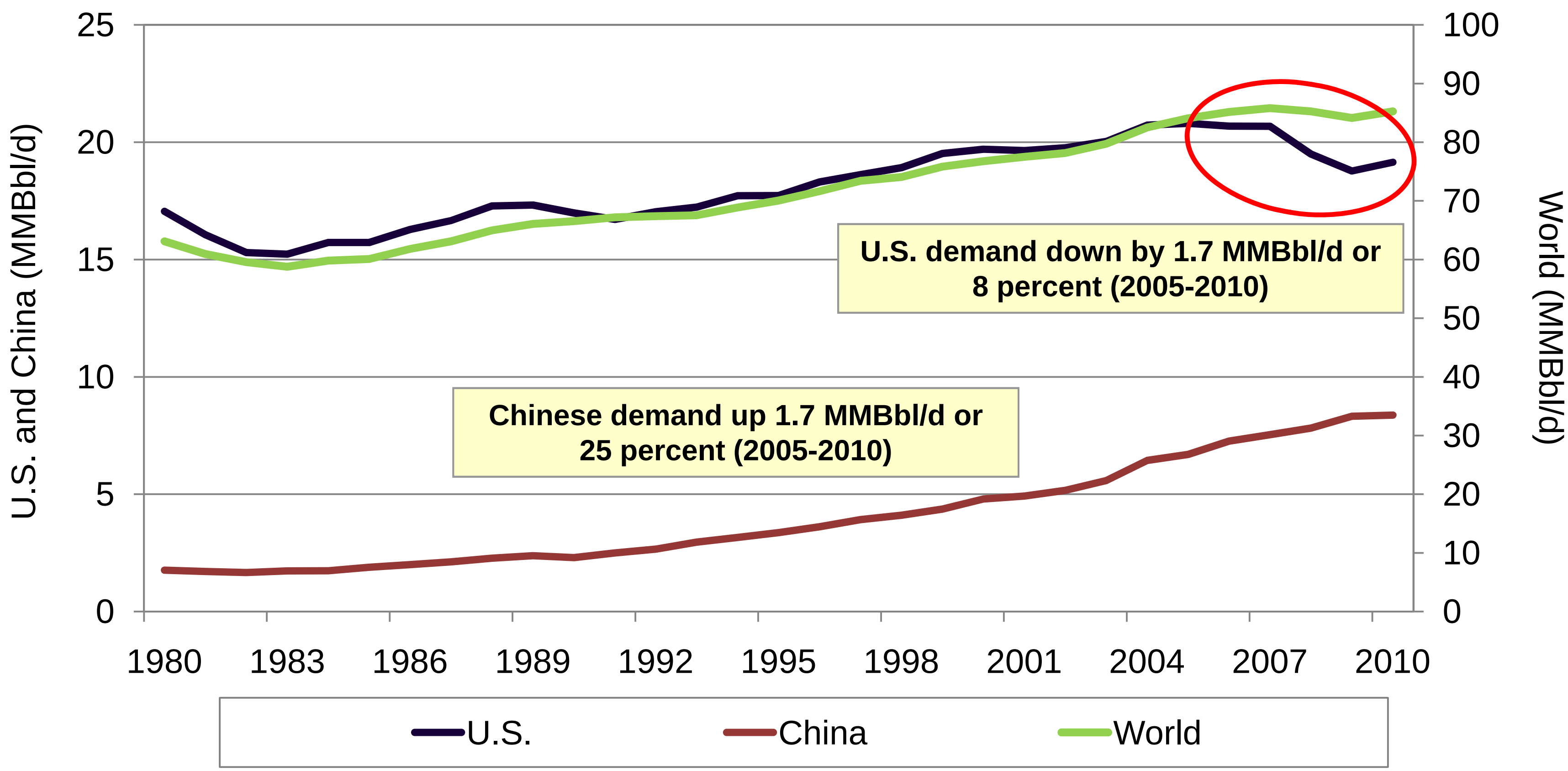
Global spare production capacity has also been growing, even prior to the most recent recession. Forecasted capacity is anticipated to remain strong.



Note: Data is for OPEC Countries only (Algeria, Angola, Ecuador, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, the United Arab Emirates, Venezuela).
Source: Energy Information Administration, U.S. Department of Energy

Petroleum Demand – World, U.S. and China

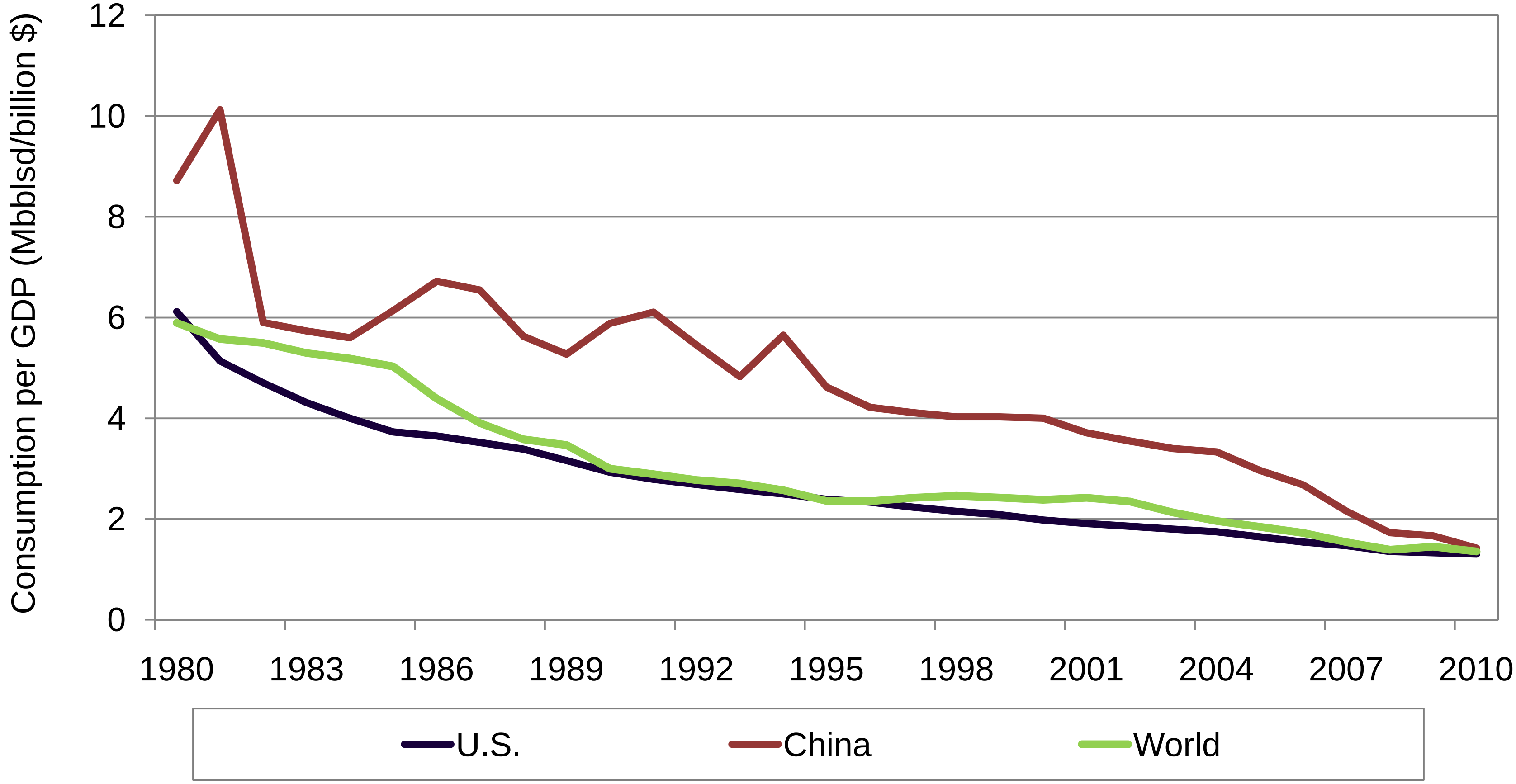
Major concern is anticipated Chinese demand for energy. US demand has been decreasing even prior to the recent recession.



Source: Energy Information Administration, U.S. Department of Energy

Crude Oil Consumption per GDP – World, U.S. and China

While Chinese demand has been growing, efficiency improvements have been considerable over the past two decades.

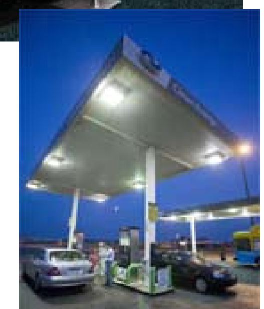


Source: Energy Information Administration, U.S. Department of Energy; and International Monetary Fund.

Policy Issue 1:
Natural Gas Uses

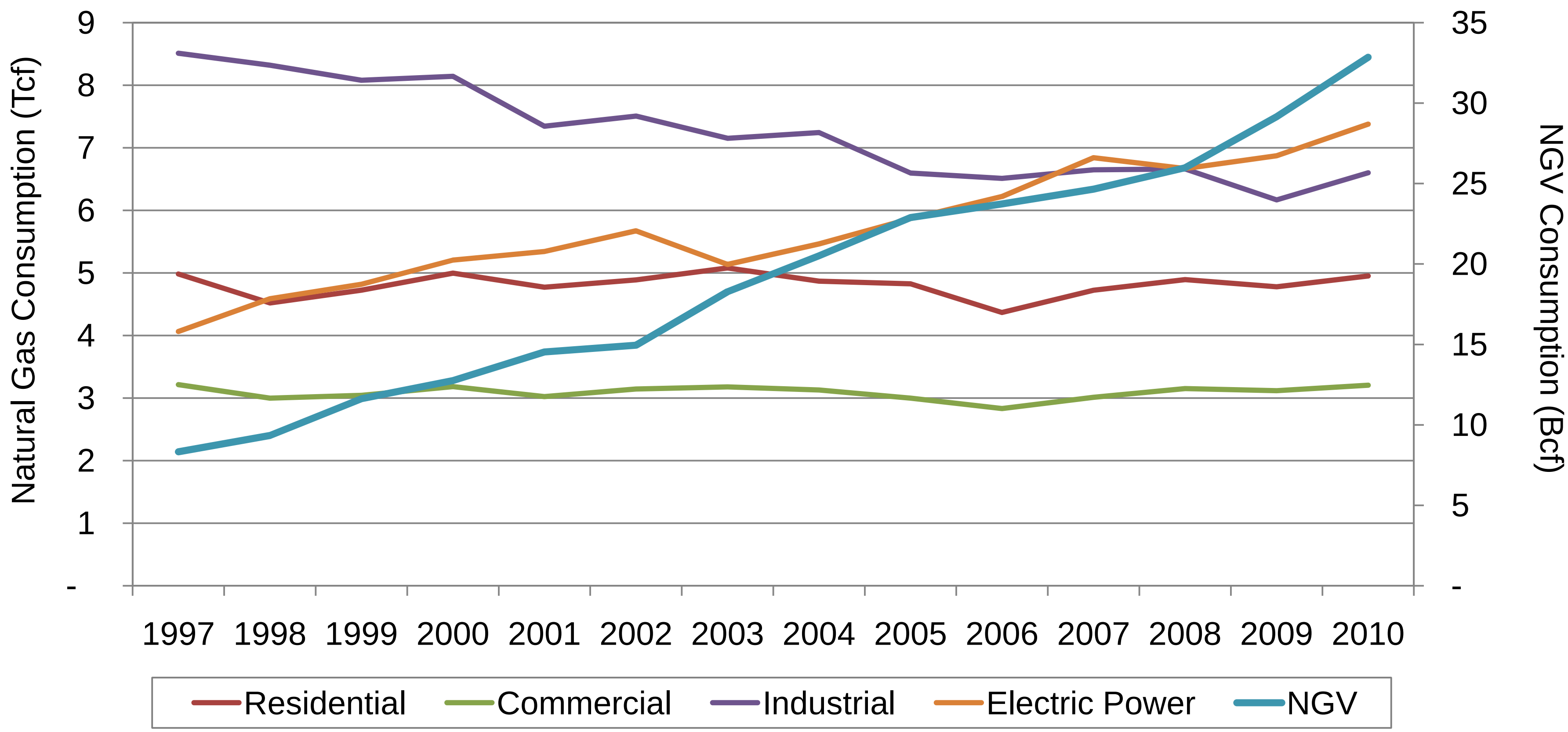
Natural Gas Vehicles

- A natural gas vehicle ("NGV") uses compressed natural gas ("CNG") or, less commonly, liquefied natural gas ("LNG") as a clean alternative to other automobile fuels.
- CNG produces nearly 40 percent less CO2 than refined products.
- In 2008, NGVs used 215 million gasoline gallon equivalent ("GGE"). To compare, total gasoline usage in 2008 was 55 million gallons per day, or a total of 20 billion gallons.
- Currently in the U.S., about 12 to 15 percent of public transit buses in run on natural gas (either CNG or LNG).
- States with the highest consumption of natural gas for transportation are California, New York, Texas, Georgia, Massachusetts and D.C.
- One major limitation is that CNG vehicles require a greater amount of space for fuel storage.

Natural Gas Consumption by Sector

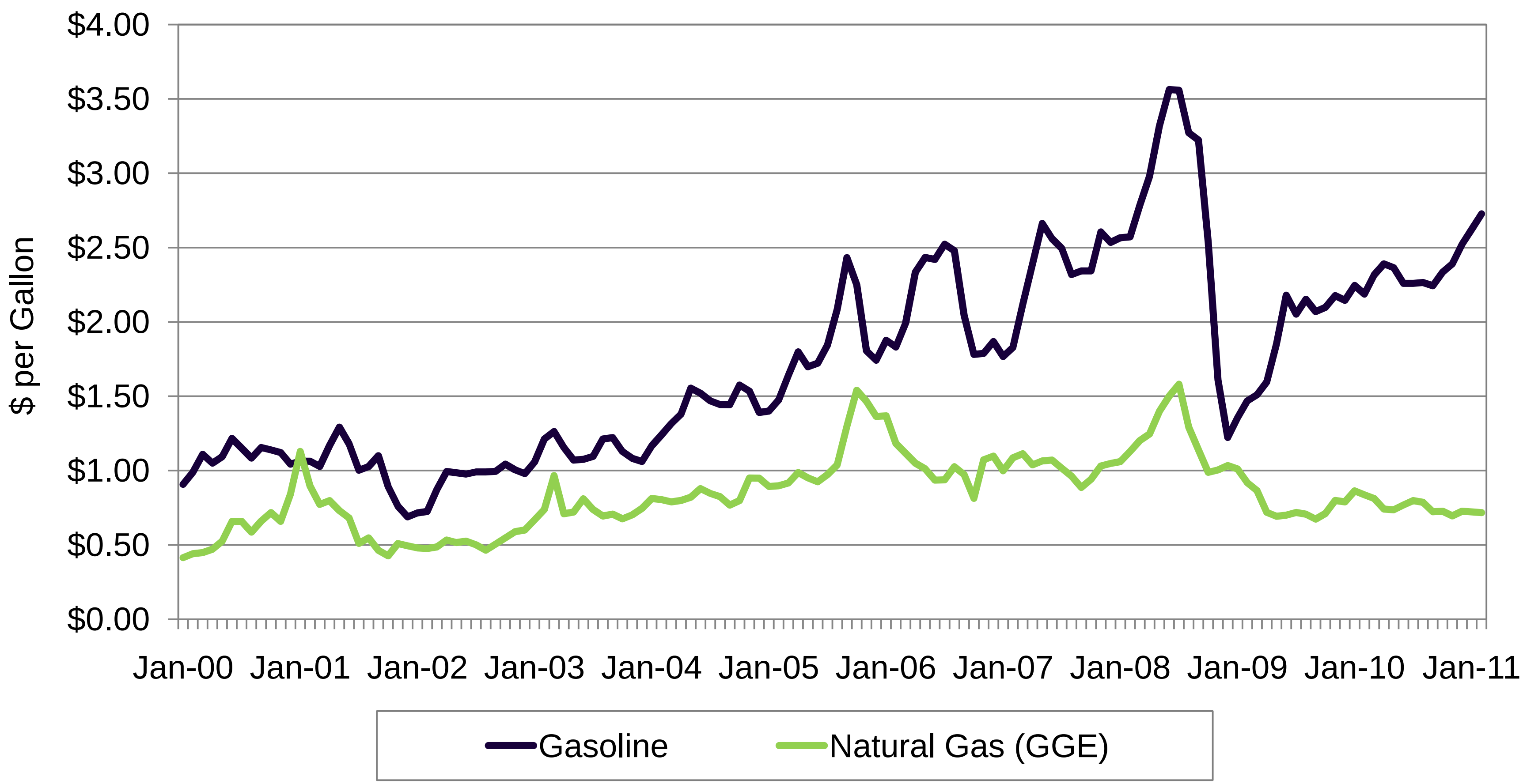
Currently, NGVs account for less than 0.18 percent of U.S. natural gas consumption, but the rate of growth in consumption (158 percent) over the past decade has surpassed all other end-uses.



Source: Energy Information Administration, U.S. Department of Energy

Retail Gasoline Prices and Natural Gas GGE

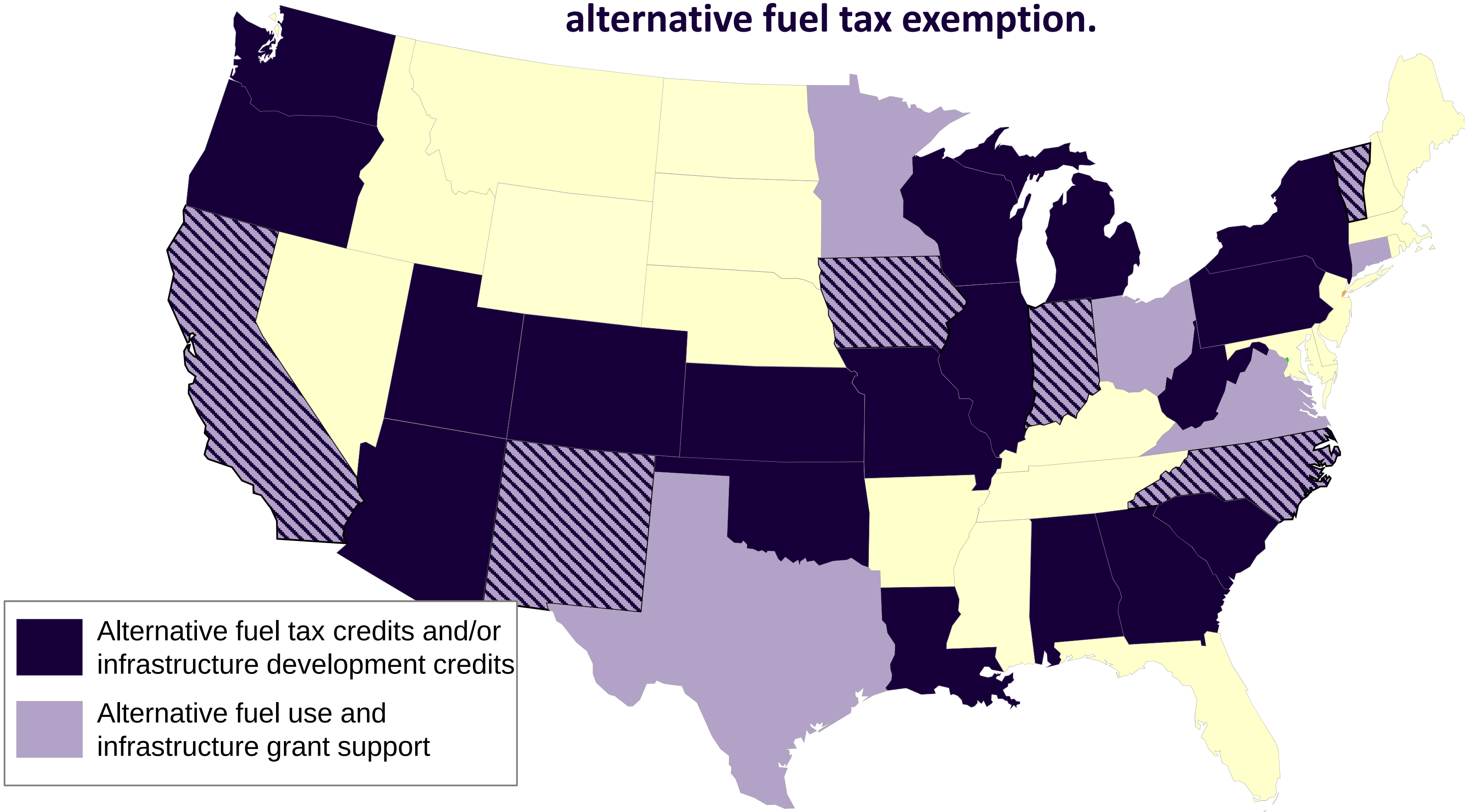
Basic economics, primarily lower relative prices, have played an important role in driving recent increases in natural gas vehicle use.



Source: Energy Information Administration, U.S. Department of Energy

Leading States in NGV Preferences

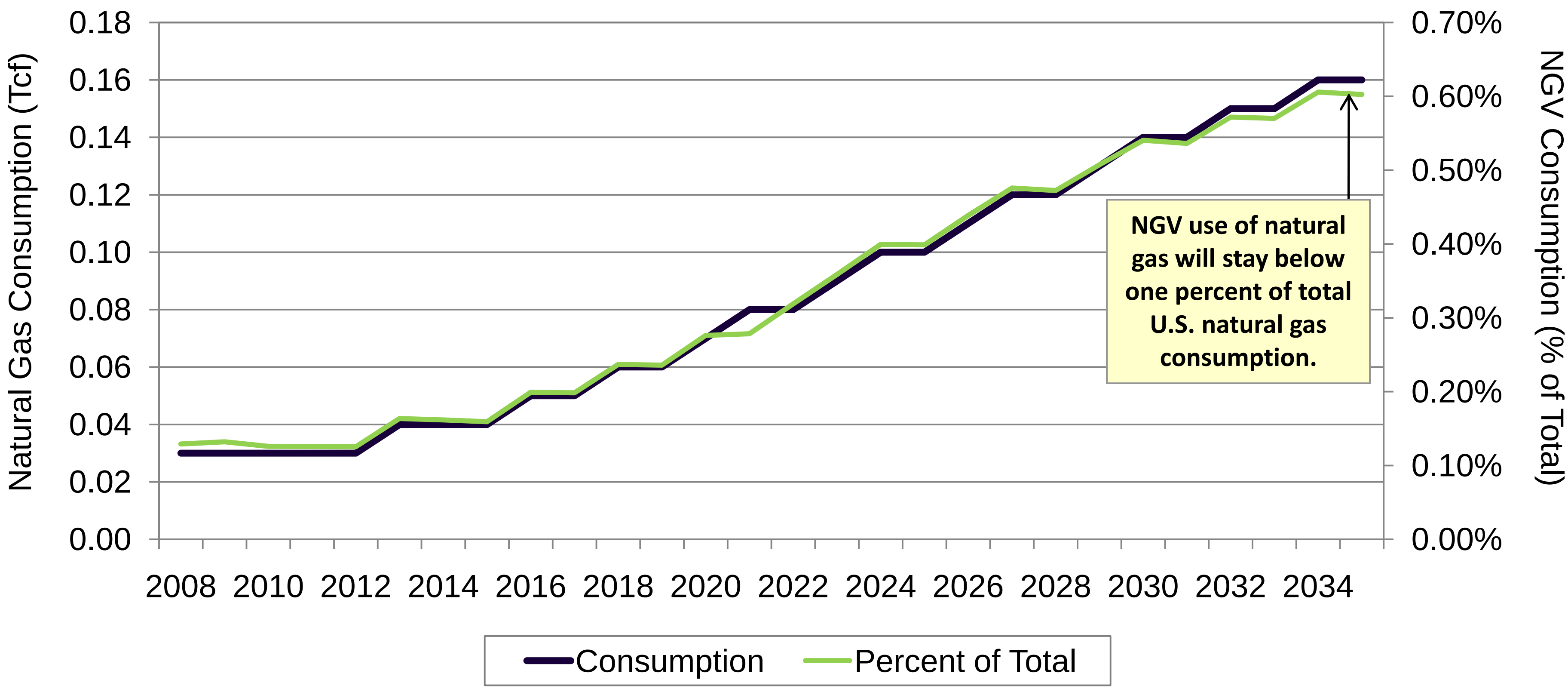
Many of these same states also have generous incentive programs that range from additional tax incentives, to infrastructure grant support. Federal benefits include alternative fuel infrastructure tax credit, an excise alternative fuel tax credit and an alternative fuel tax exemption.



Source: U.S. Department of Energy

Potential Natural Gas Consumption – NGV

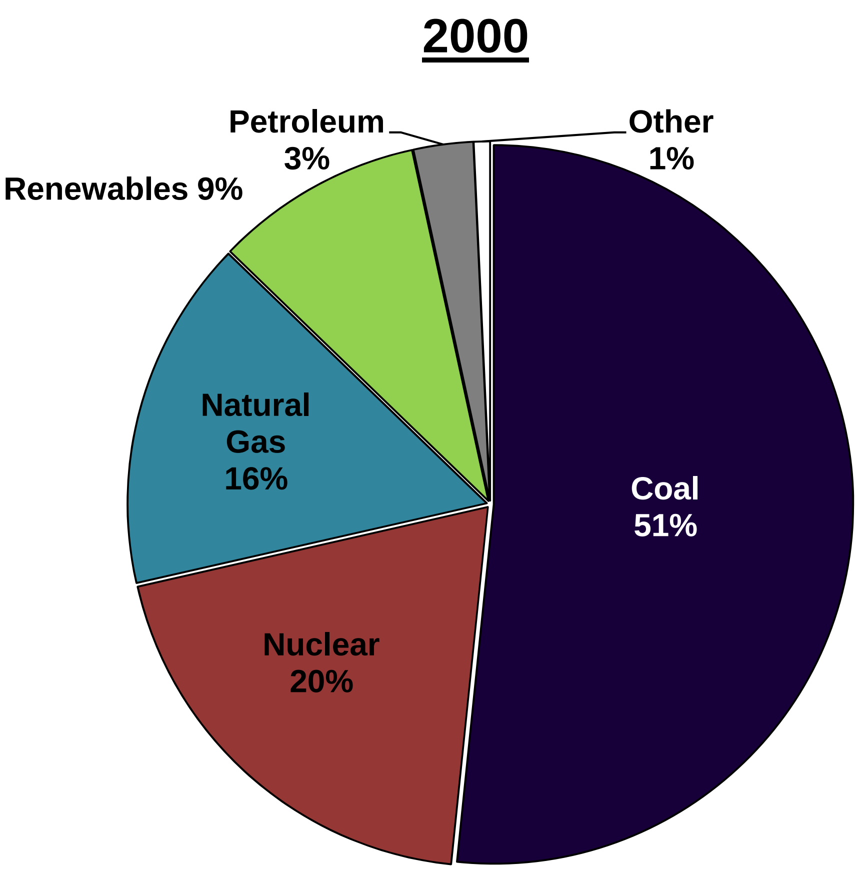
NGV consumption of natural gas is estimated to increase at an average annual rate of 7 percent through 2035. At best, this usage will be considerably less than 1 Tcf and slightly over one-half of one percent of total natural gas market.

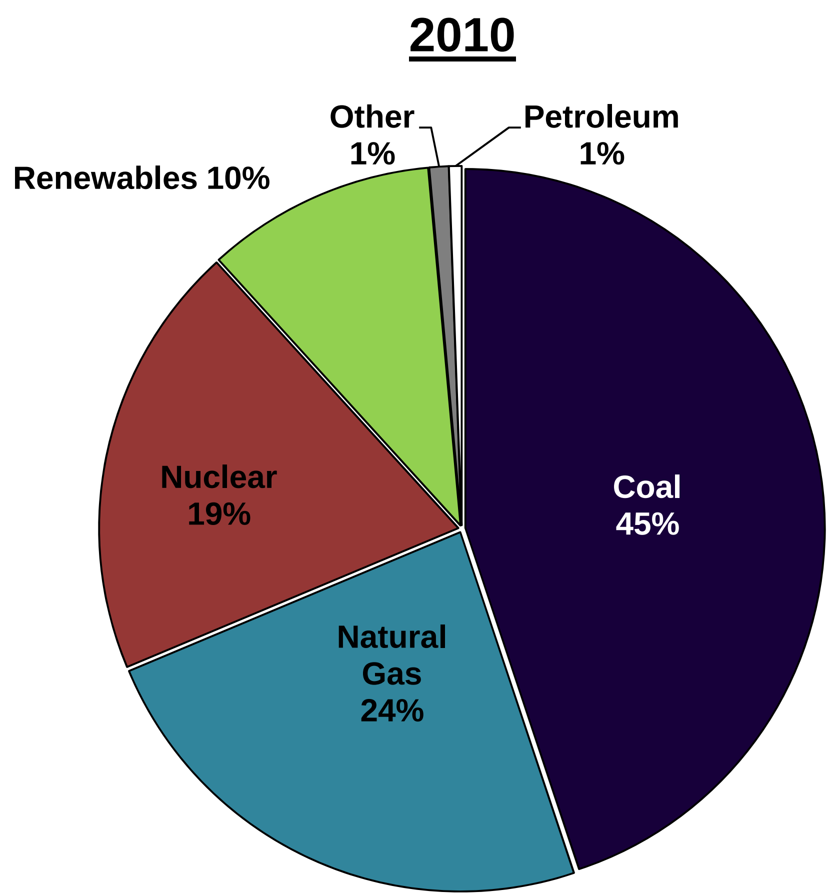


Source: Energy Information Administration, U.S. Department of Energy

U.S. Power Generation – Fuel Mix

Over 250,000 MWs of natural gas power generation capacity has been added over the past decade at the expense of coal and nuclear.





Source: Energy Information Administration, U.S. Department of Energy

Electric Industry Environmental Regulations Create Uncertainty for Coal

National Ambient Air Quality Standards (NAAQS)

- Sets acceptable levels for six criteria pollutants (carbon monoxide, lead, nitrogen dioxide, particulate matter, ozone, sulfur dioxide).
- A network of 4,000 State and Local Air Monitoring Stations is used to determine if geographic areas are meeting or exceeding the NAAQS.

Transport Rule (now CSAPR) [proposed]

- Issued to replace the Clean Air Interstate Rule (CAIR) and its predecessor the Clean Air Transport Rule ("CATR"). Requires 31 states (and D.C.) to improve air quality by reducing power plant emissions (SO2 and NOX) that contribute to ozone and fine particulate pollution in other states (some annual, some on ozone season only).
- By 2014, the rule and other state and EPA actions would reduce power plant SO2 emissions by 80% over 2005 levels. Power plant NOx emissions would drop by 58%.

Utility Maximum Achievable Control Technology (MACT) [to be proposed]

- EPA must set emission limits for hazardous air pollutants. The rule is expected to replace the Clean Air Mercury Rule (CAMR) and add standards for lead, arsenic, acid gases, dioxins and furans.

Coal Combustion Residuals (CCR) [proposed]

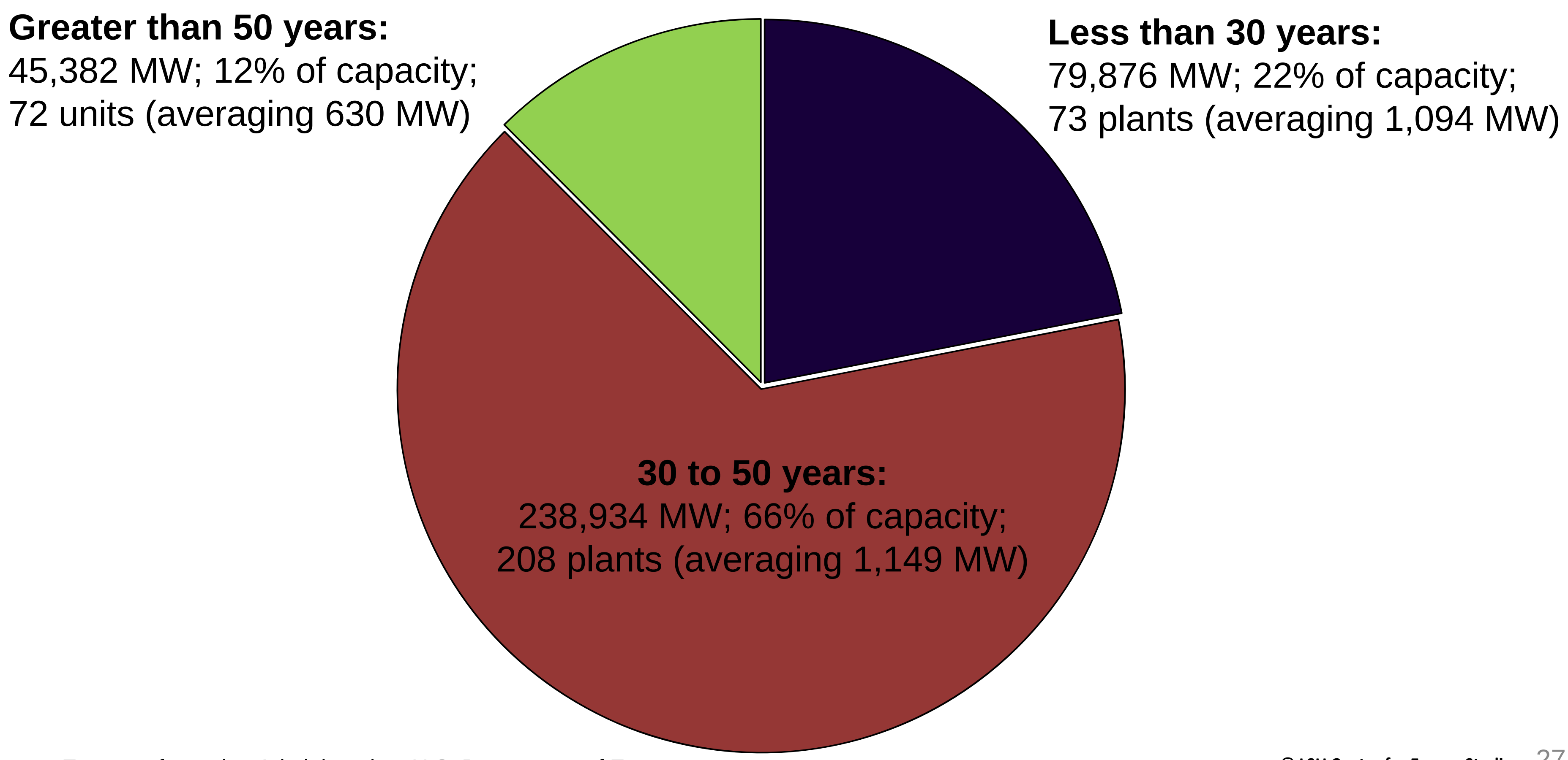
- Would establish, for the first time under the Resource Conservation and Recovery Act (RCRA) requirements for the proper disposal of coal ash generated by coal combustion at electric power plants.

Power Plant Cooling Water Intake Structures Rule

- Section 316(b) of the Clean Water Act is intended to address environmental impacts from cooling water intake to and discharge from power plant cooling systems. Requires that the location, design, construction and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact.

Coal-Fired Capacity Share by Age Category

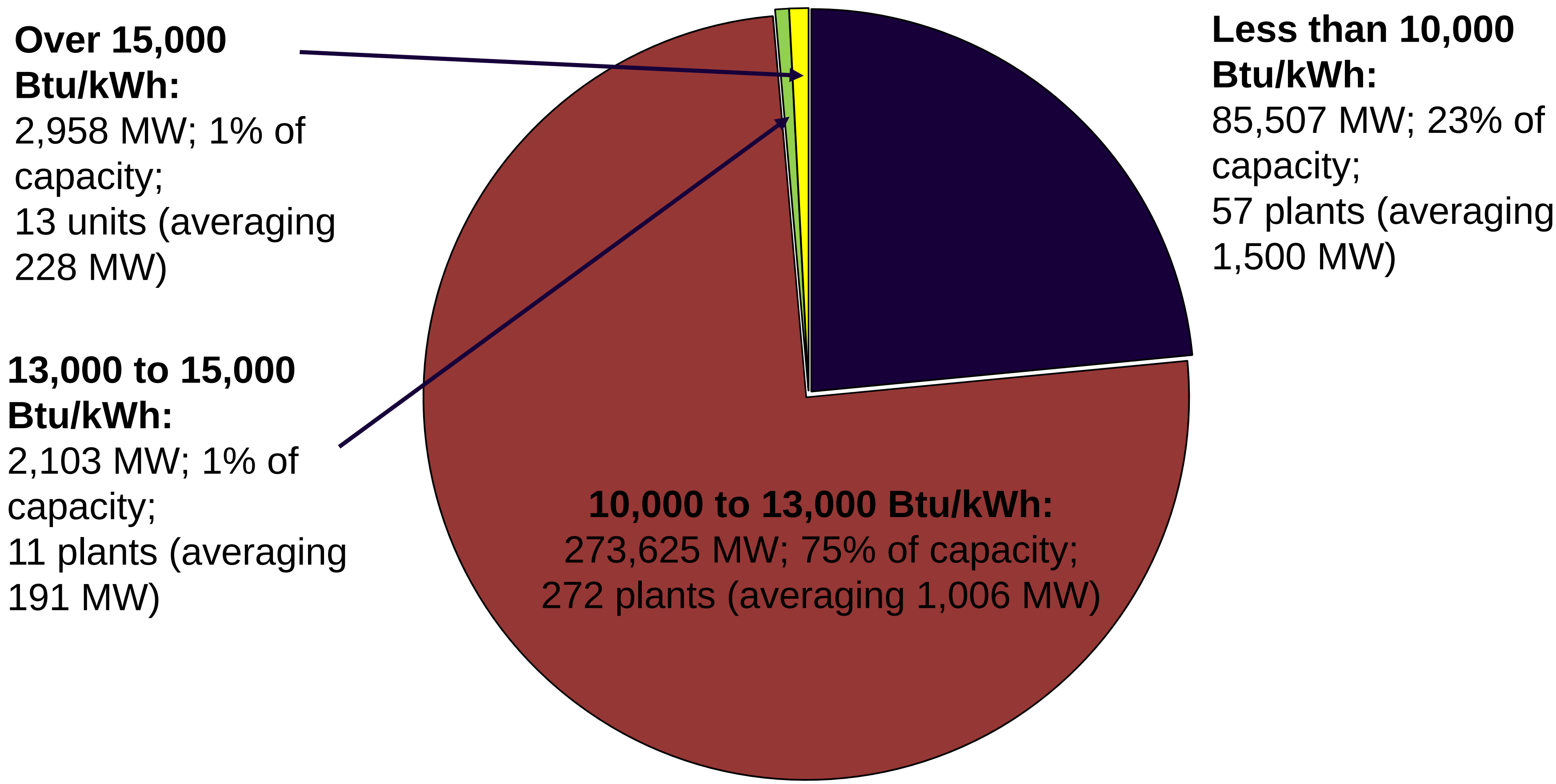
There is a considerable amount of legacy coal capacity (45 GWs) that is relatively old, and in some instances, has few to little controls to meet anticipated standards.



Source: Energy Information Administration, U.S. Department of Energy

Coal-Fired Capacity Share by Heat Rate

Despite the age, many of these assets operate at relatively competitive fuel efficiencies for older steam generators.



Source: Energy Information Administration, U.S. Department of Energy

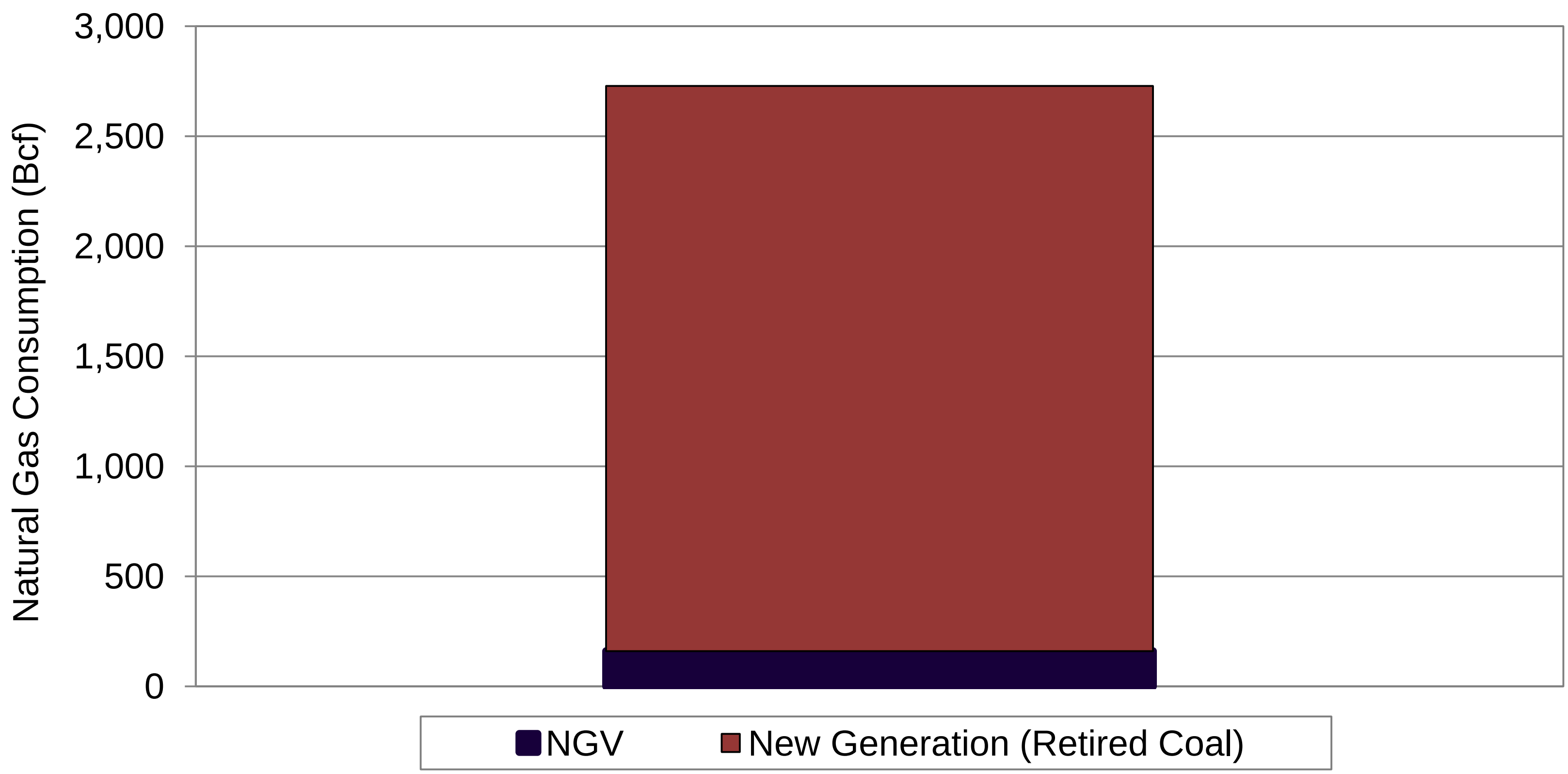
Summary of Retirement Studies Related to EPA Rules

Study	Retired Capacity	Regulation Requirements
NERC (October 2010)	47 to 76 GW by 2018 (total fossil fuel capacity, including oil and gas)	Levelized costs (@2008 CF) after retrofitting each unit for the environmental regulations compared to the cost of a new gas-fired unit. Scenario 1 - Transport Rule Scenario 2 - Transport Rule, MACT Scenario 3 - Transport Rule, MACT, 316(b) Cooling Water, Coal Ash
ICF/IEE (May 2010)	25 to 60 GW by 2015	Cost of retrofitting coal plant compared to cost of new gas CC Scenario 1 - Transport Rule, MACT Scenario 2 - Transport Rule, MACT, CWA 316(b)
Brattle Group (December 2010)	50 to 65 GW by 2020	Regulated Units - 15-year present value of costs > replacement power from a CC or CT. Merchant unit - 15-year present value of cost > revenues from energy and capacity markets. Transport Rule, MACT, 316(b) Cooling Water, Coal Ash
Credit Suisse (September 2010)	60 GW	Size and existing controls Transport Rule, MACT
Charles River Associates (December 2010)	39 GW by 2015	In-house model (NEEMS) optimizing costs of existing capacity and costs of potential new capacity. Transport Rule, MACT
MJ Bradley (August 2010)	30 to 40 GW	Switch to lower sulfur coal, install emission controls, or retire Transport Rule, MACT
Bernstein Research (October 2010)	51 GW	FGS + emissions on all coal fired units by 2015 Transport Rule, MACT

Source: Synapse Energy Economics, Inc., “Public Policy Impacts on Transmission Planning, Prepared for Earthjustice”, December 10, 2010; and “Miller, P. A Primer on Pending Environmental Regulations and their Potential Impacts on Electric System Reliability. Working Draft, JD Northeast States for Coordinated Air Use Management. January 24, 2011.

Potential Natural Gas Consumption – New Generation Use (Retired Coal)

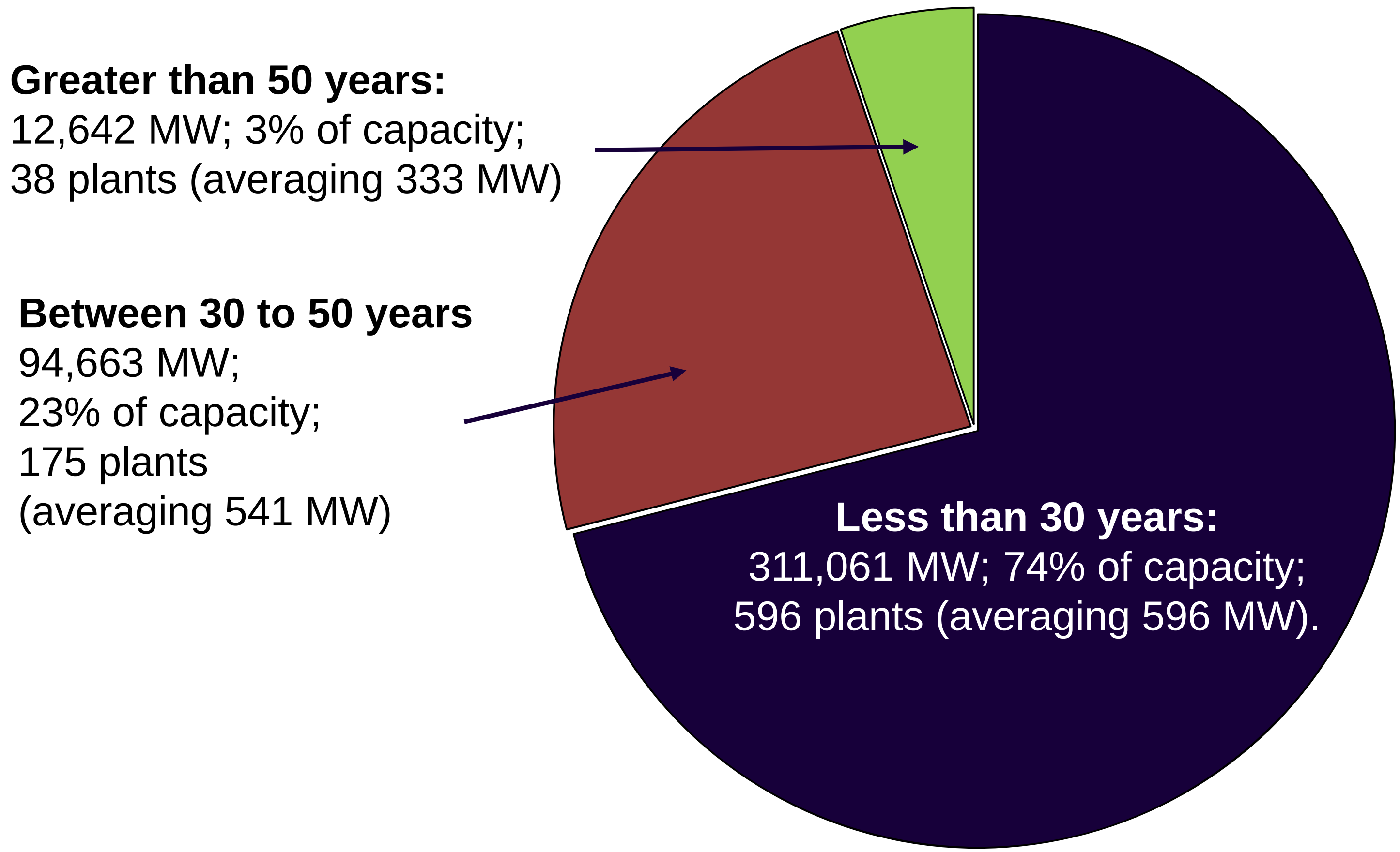
The retirement of 45 gigawatts of capacity would likely still have only a limited impact on overall natural gas usage.



Note: Assumes 160 Bcf of NGV natural gas use. Also assumes retirement of 45 GW of coal-fired capacity, replaced with new natural gas generation with an 85 percent capacity factor and a 7,600 Btu/kWh heat rate.

Natural Gas-Fired Capacity Share by Age Category

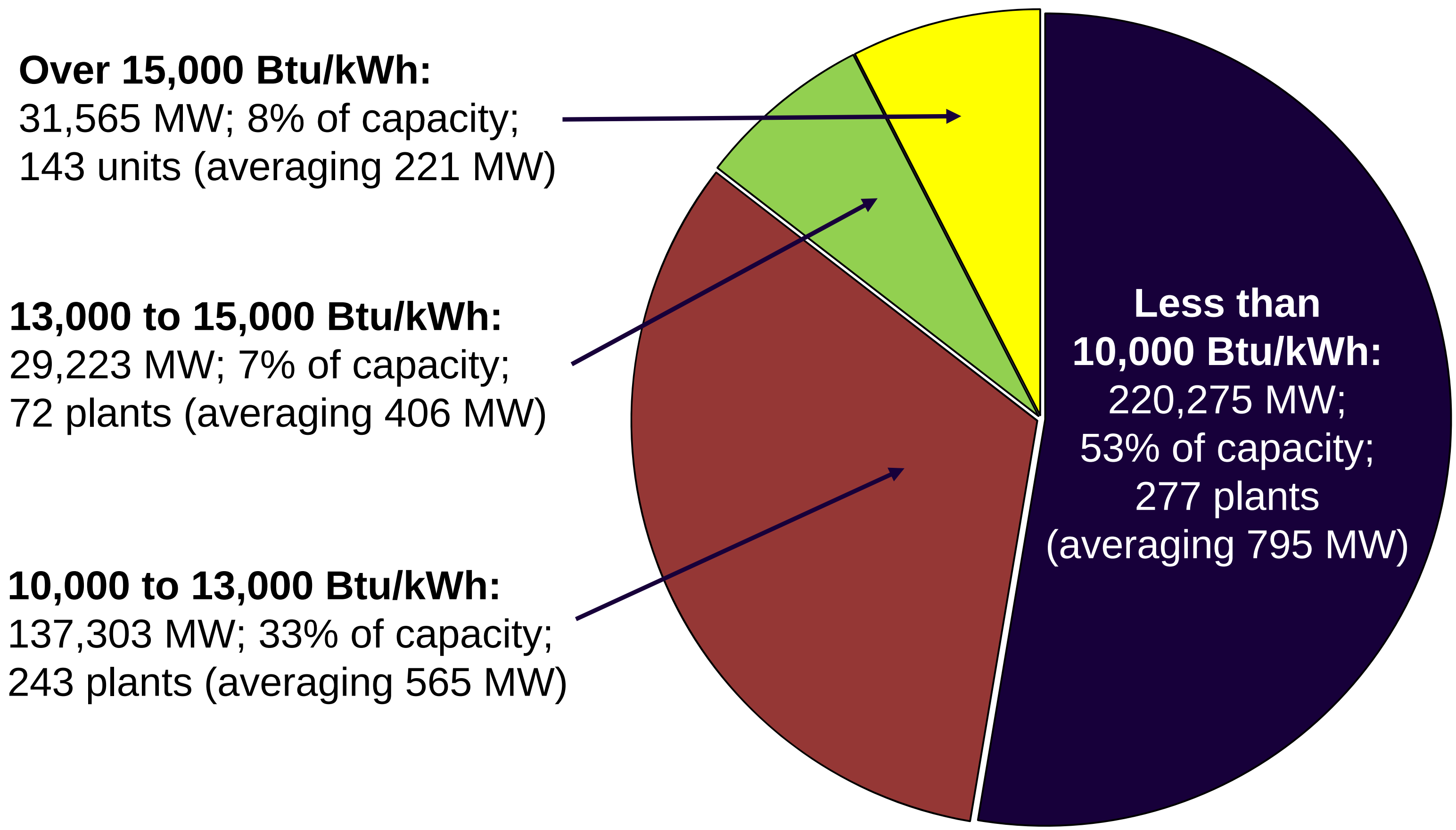
Despite the significant recent investment, there is still a considerable amount of legacy gas (steam) generation.



Source: Energy Information Administration, U.S. Department of Energy

Natural Gas-Fired Capacity Share by Heat Rate

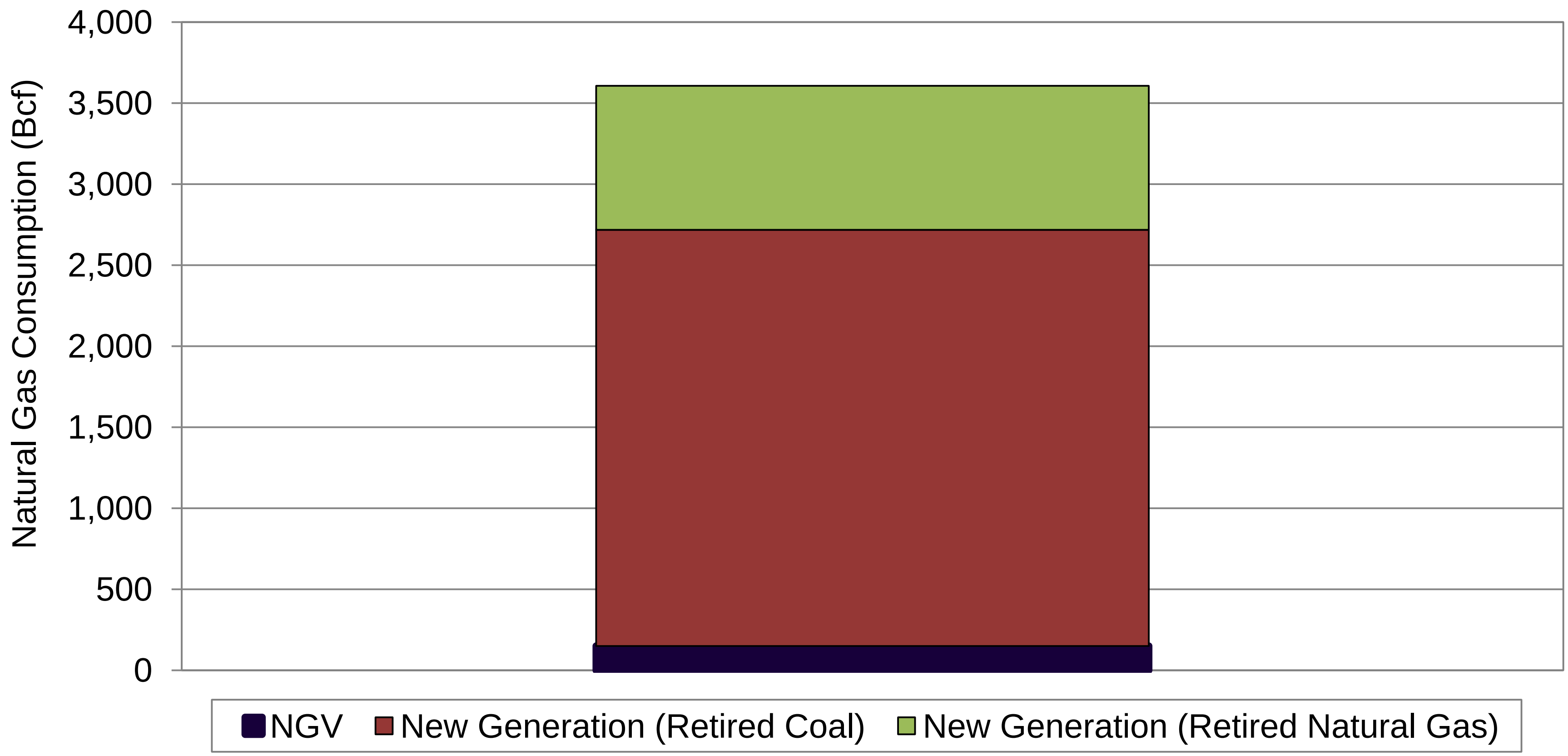
A considerable amount of this legacy generation operates at heat rates considerably higher than newer combined cycle units.



Source: Energy Information Administration, U.S. Department of Energy

Natural Gas-Fired Capacity Share by Prime Mover

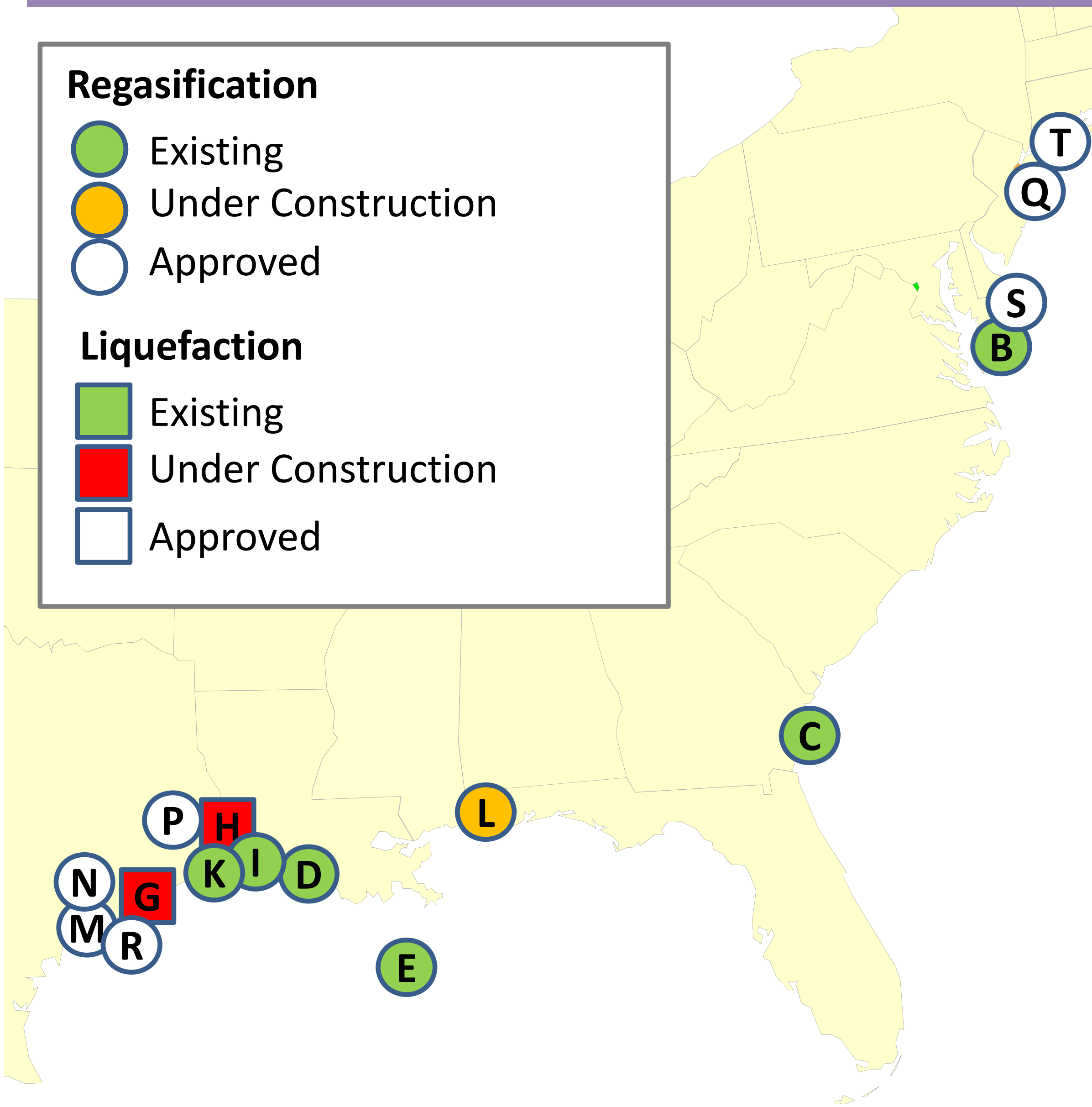
Displacement of legacy gas generation could make a more meaningful contribution to overall natural gas consumption but one still within meaningful levels.



Note: Assumes 160 Bcf of NGV natural gas use. Also assumes retirement of 45 GW of coal-fired capacity, replaced with new natural gas generation with an 85 percent capacity factor and a 7,600 Btu/kWh heat rate. In addition, 17 GW of natural gas-fired capacity is replaced with new generation, with an 85 percent capacity factor and a 7,600 Btu/kWh heat rate.

Policy Issue 2:
LNG and US Natural Gas Exports

Considerable Underutilized LNG Regasification Capacity along GOM



Existing
A. Everett, MA: 1.035 Bcfd
B. Cove Point, MD: 1.8 Bcfd
C. Elba Island, GA: 1.6 Bcfd (+0.5 Expansion)
D. Lake Charles, LA: 2.1 Bcfd
E. Energy Bridge, GOM: 0.5 Bcfd
F. Northeast Gateway, Offshore MA: 0.8 Bcfd
G. Freeport, TX: 1.5 Bcfd (+2.5 Expansion)
H. Sabine, LA: 4.0 Bcfd
I. Hackberry, LA: 1.8 Bcfd (+0.85 Expansion)
J. Neptune, Offshore MA: 0.4 Bcfd
K. Sabine Pass, TX: 1.0 Bcfd (+ 1.0 Expansion)

Under Construction
L. Pascagoula, MS: 1.0 Bcfd

Approved
M. Corpus Christi, TX: 1.0 Bcfd
N. Corpus Christi, TX: 2.6 Bcfd
O. Fall River, MA: 0.8 Bcfd
P. Port Arthur, TX: 3.0 Bcfd
Q. Logan, NJ: 1.2 Bcfd
R. Port Lavaca, TX: 1.0 Bcfd
S. Baltimore, MD: 1.5 Bcfd
T. LI Sound, NY: 1.0 Bcfd

LNG Value Chain

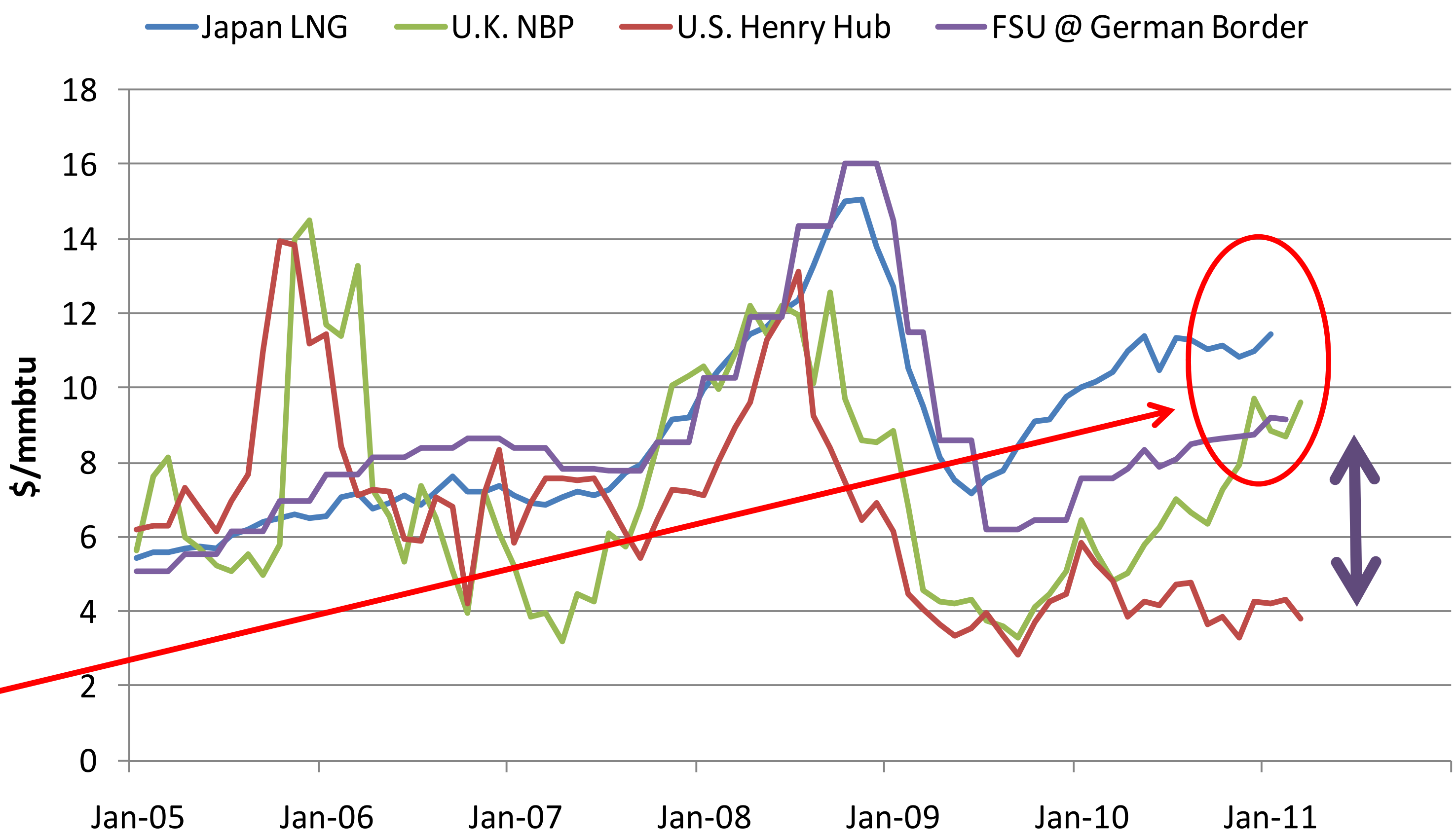
Feedstock (production) costs will be critical in determining the location of basin-specific production along the global LNG supply curve.

Europe:	**Feedgas** **56%** ($/MMBtu)	**Liquefaction** **11%-17%** **($/MMBtu)**	**Shipping & Fuel** **20%-29%** **($/MMBtu)**	**Regas** **4%-7%** **($/MMBtu)**	**Delivered Cost** **($/MMBtu)**	**Equivalent Oil Price*** **($/BOE)**
Low	$4.00	$1.25	$1.40	$0.50	$7.15	$41.47
High	$6.50	$1.25	$1.65	$0.50	$9.90	$57.42
Asia:						
Low	$4.00	$1.25	$2.90	$0.50	$8.95	$51.91
High	$6.50	$1.25	$3.45	$0.50	$11.70	$67.86
					Henry Hub:	**WTI:**
					$4.50	$97.00
					$5.00	$100.00

Note: *uses a BOE conversion of 5.8 Mcf/BOE.
Source: Cheniere.

Motivations for Moving Shale Gas to Global Consuming Areas

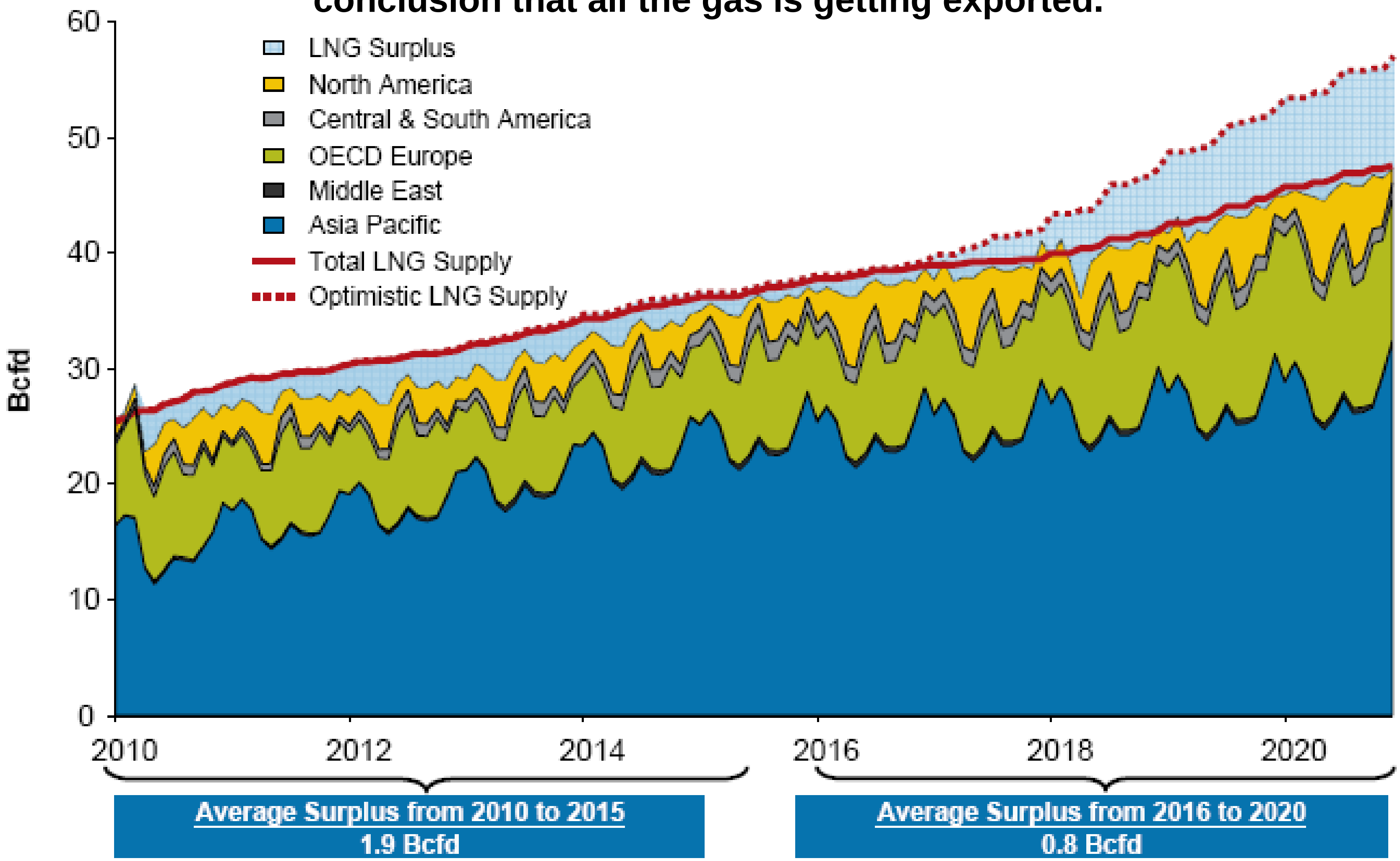
- Excess U.S. shale production.
- Growing global energy demand.
- Climate change issues.
- Global natural gas price differentials.



Source: Marathon

LNG Supply Surpluses Should Continue

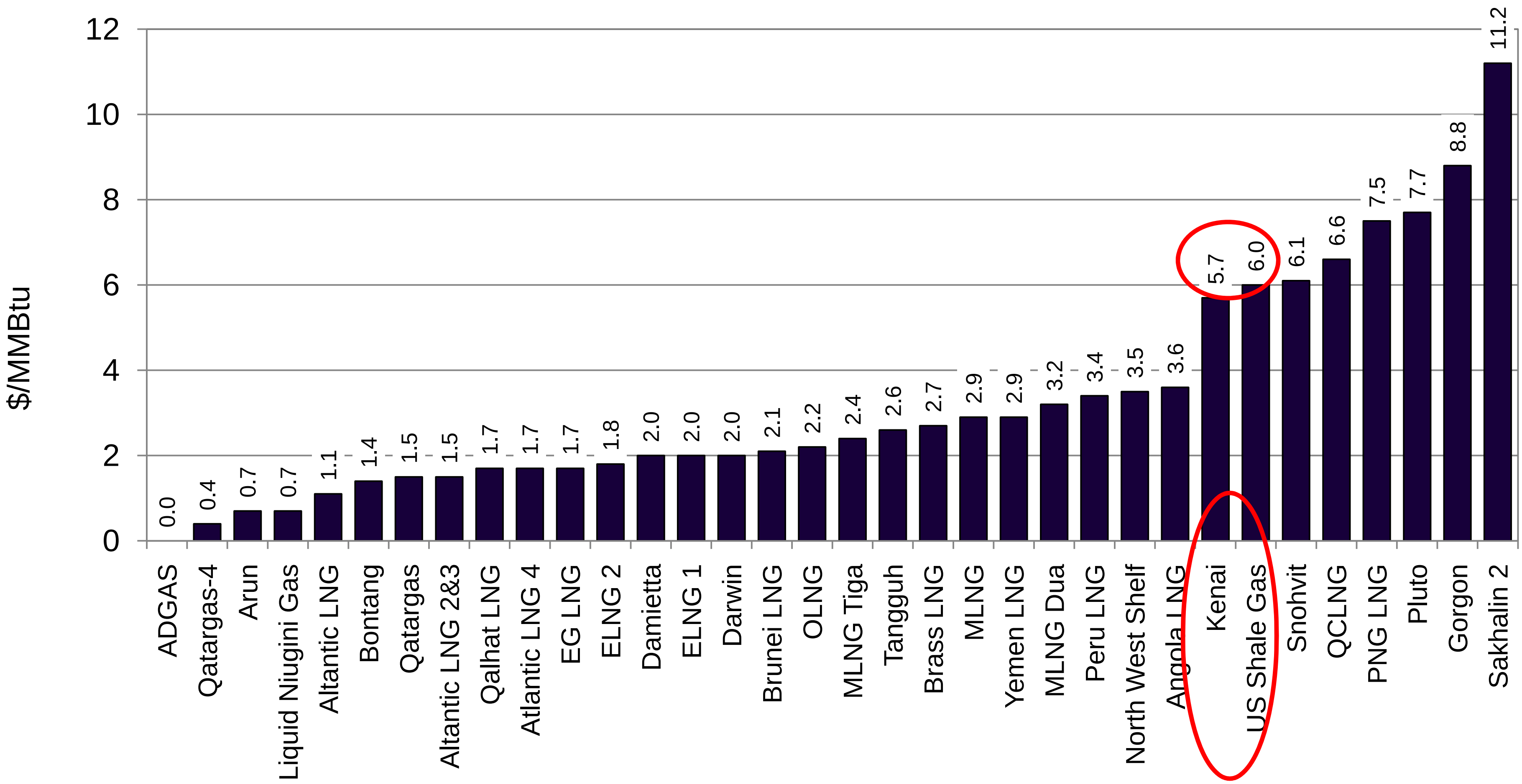
North American shale is going to have to compete in a very tight market. Not a foregone conclusion that all the gas is getting exported.



Source: Charles River Associates.

FOB Gas Price Necessary to Yield 12 Percent Return (Atlantic Delivery)

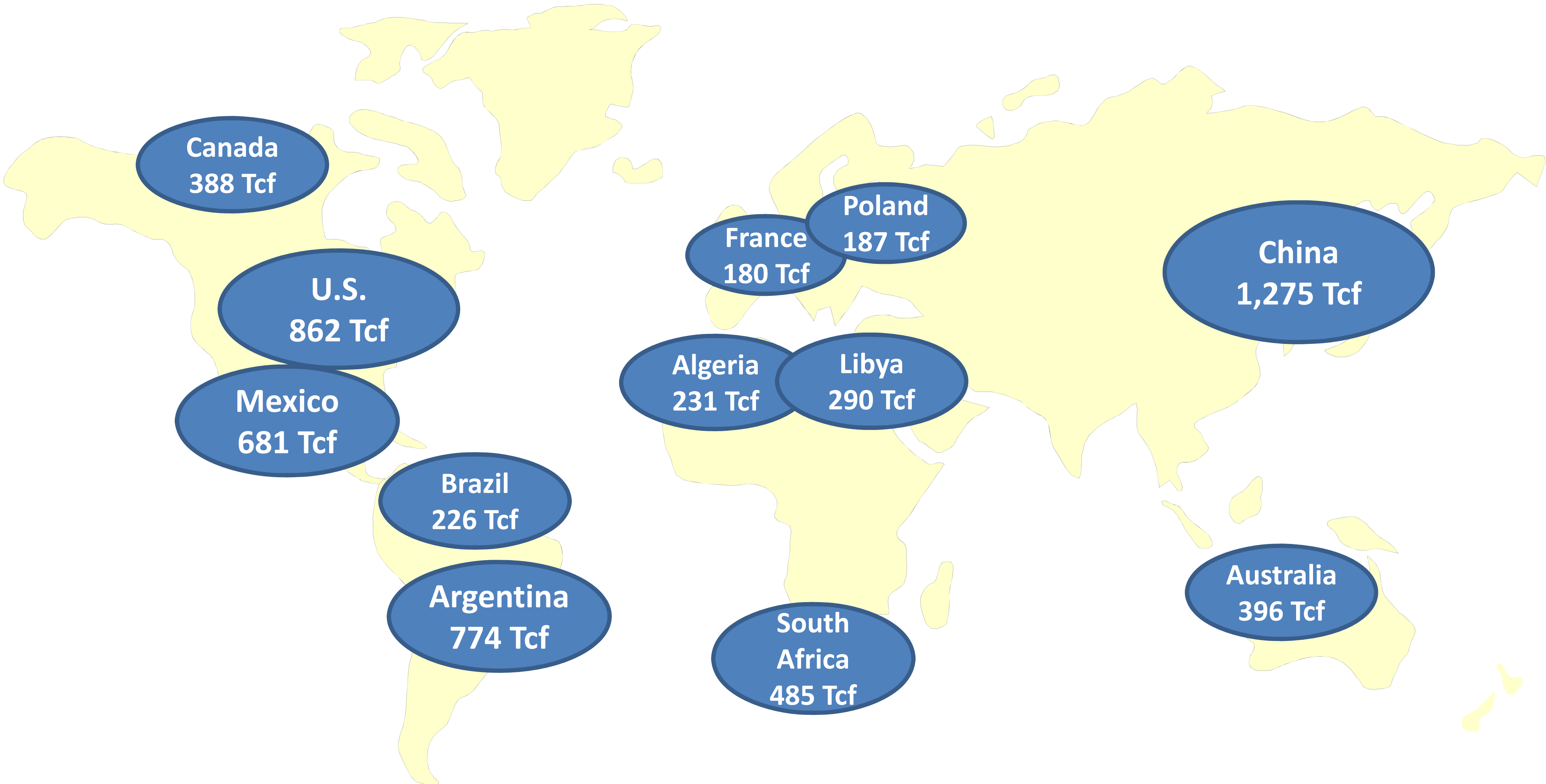
U.S. is likely to be at the upper end of the global LNG supply chain.



Source: Pacific LNG

Basin Competition

Close to 6,000 TCF of shale gas opportunities around the world. Coupled with 9,000 Tcf in conventional suggest a potentially solid resource base for many decades.

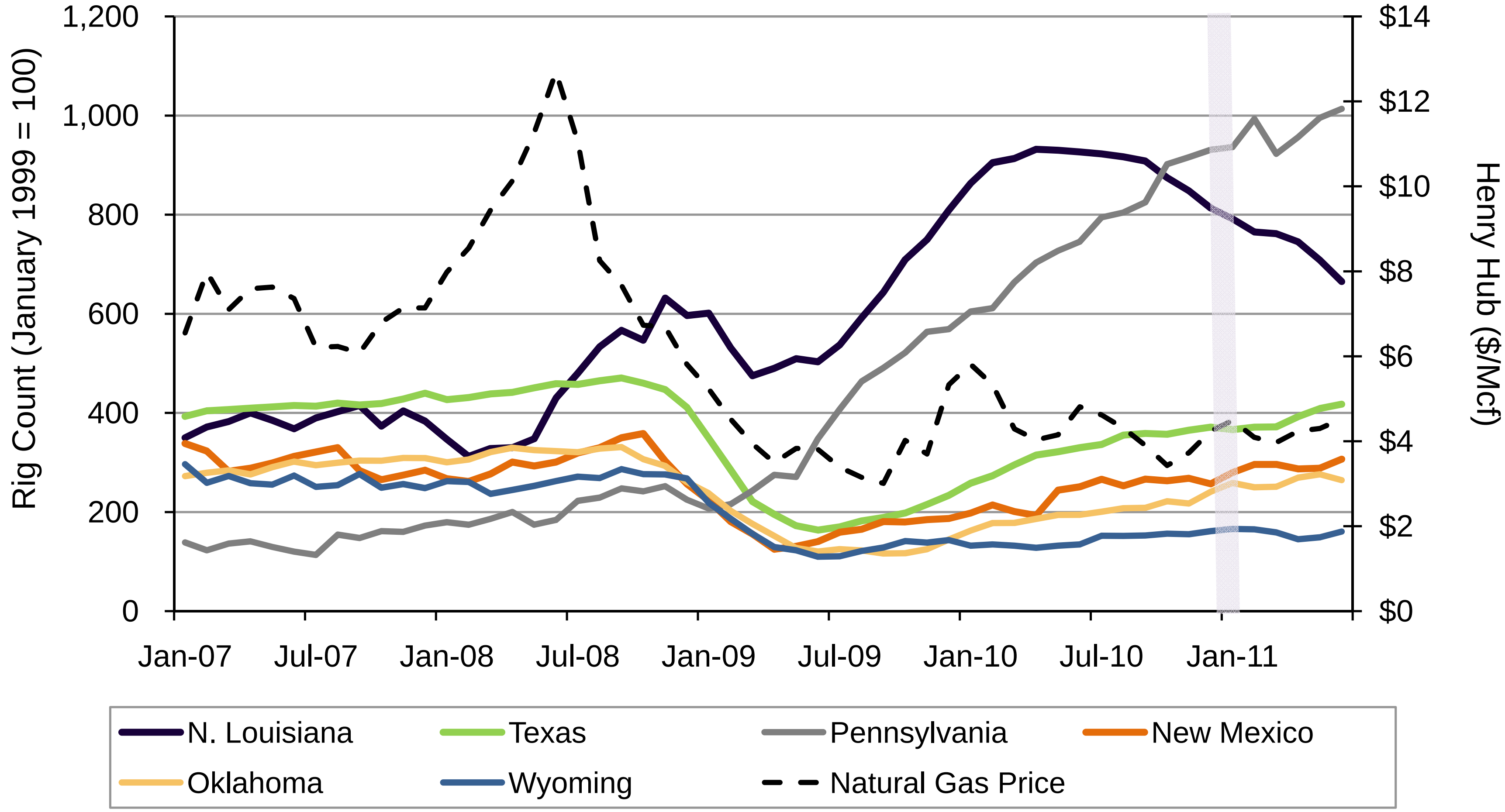


Source: MIT Energy Initiative.

Policy Issue 3: Drilling-Production Challenges & Opportunities

Rig Count and Crude Oil Price, (Each State Measured Relative to 1999 Activity)

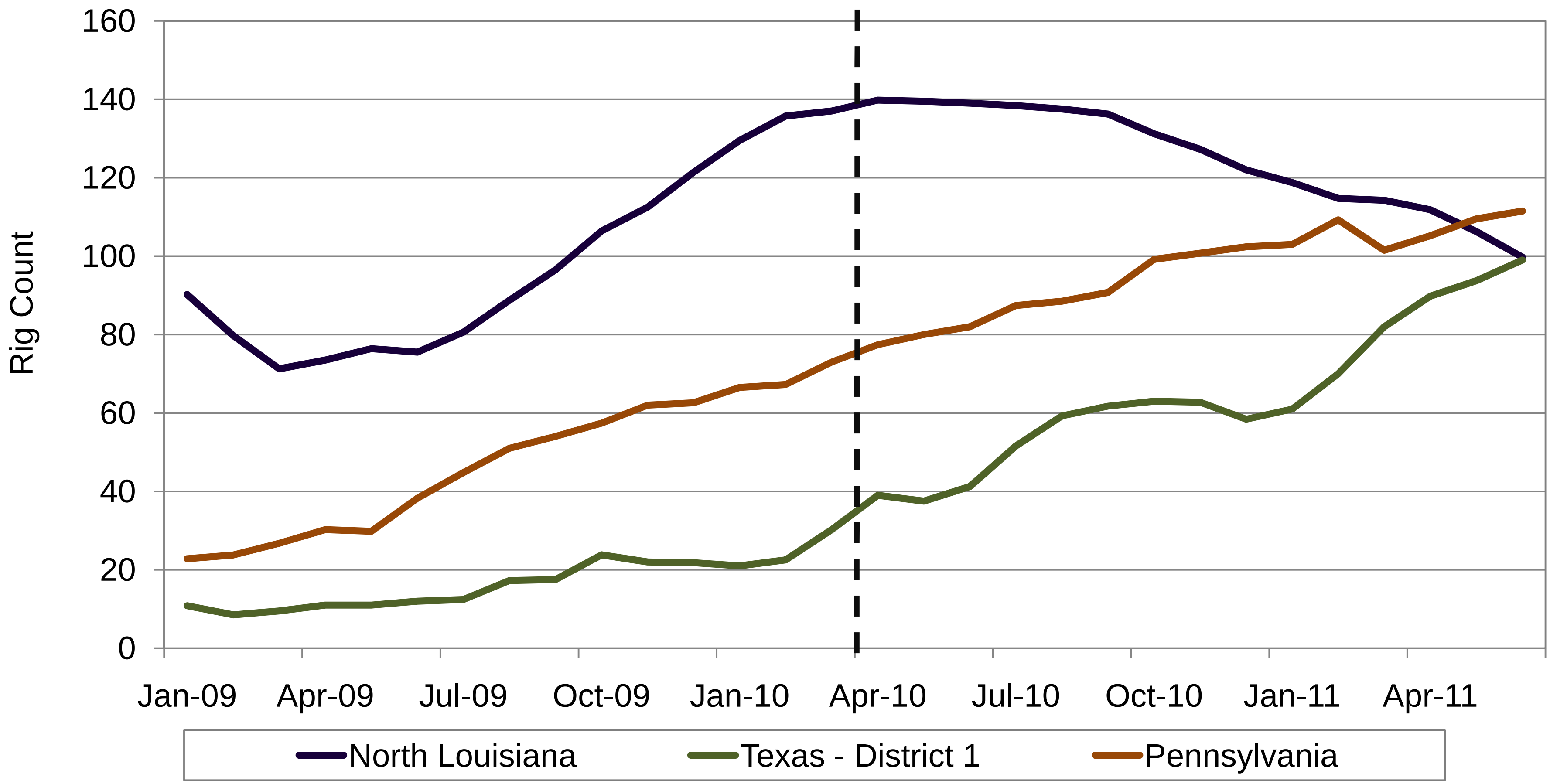
North Louisiana has been the shining opportunity in the industry during the recent price downturn/correction. However, that competitive advantage is starting to deteriorate.



Source: Baker Hughes; and Federal Reserve Bank of St. Louis.

Rig Count, North Louisiana (Haynesville) and Texas District 1 (Eagle Ford)

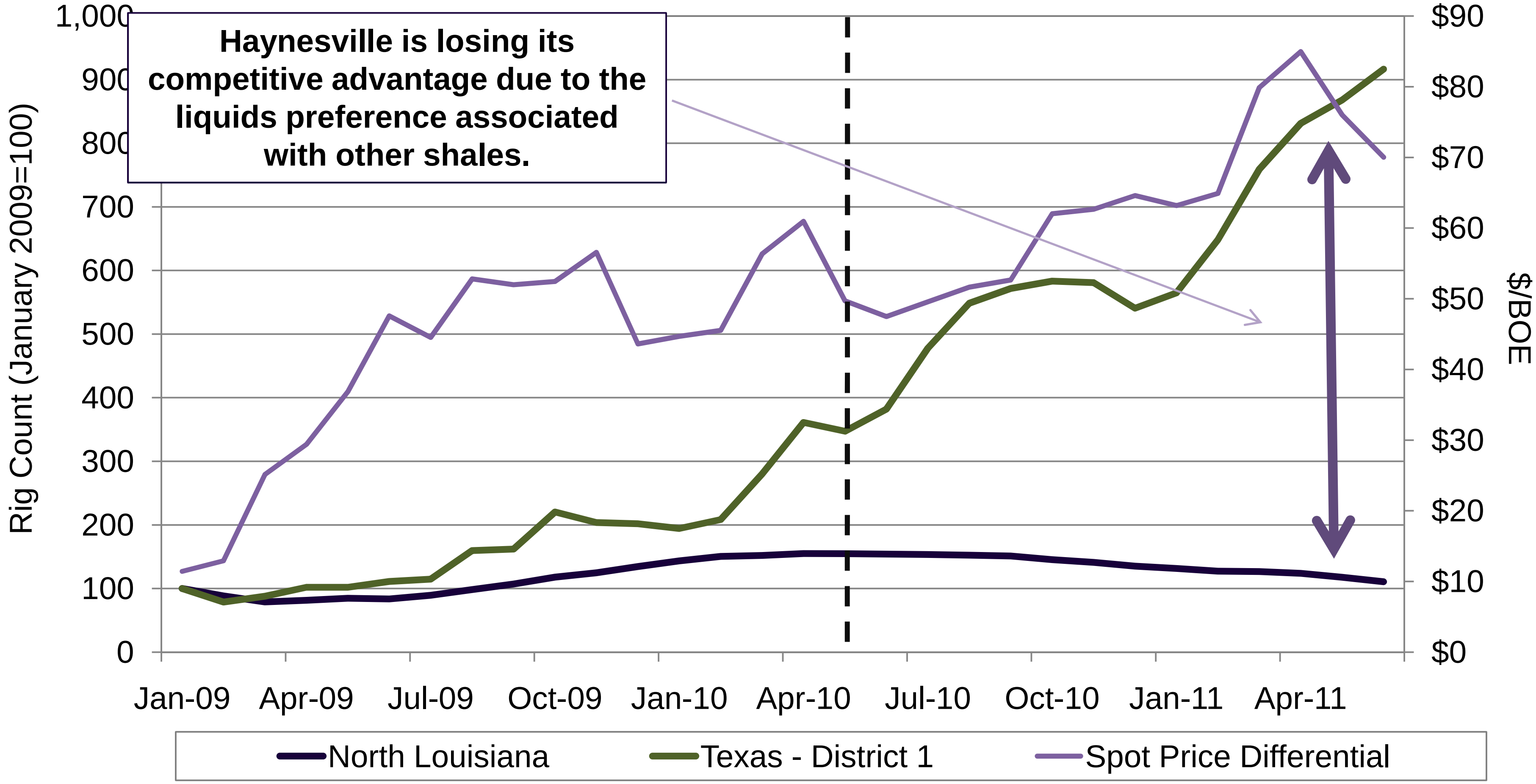
In the past year, the rig count in North Louisiana has fallen 29 percent (40 rigs), while the rig count in the Eagle Ford region has increased 154 percent (60 rigs) and the Marcellus region has increased 44 percent (34 rigs)



Source: Baker Hughes. Rig counts represent the number of active drilling rigs in each reported area.

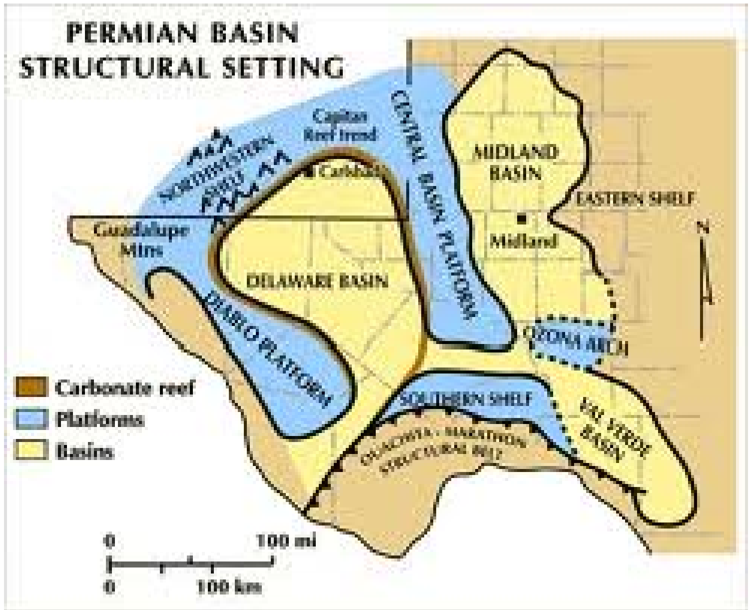
Rig Count, North Louisiana (Haynesville) and Texas District 1 (Eagle Ford)

Indexing the rig change from January 2009 highlights the recent, fast and dramatic shift in basin preference.



Source: Baker Hughes. Rig counts are indexed to the level of active drilling rigs in each reported area as of January 2009.

Return to Conventional Reserves



Permian Basin

- Offers wide range of opportunities (conventional and unconventional) for both crude oil, natural gas, and NGLs.
- Apache Corporation, Petrohawk, Anadarko all active in the area.
- Second most active basin (2010) in acquisitions (second only to Marcellus).

Davy Jones

- In January 2010, McMoRan Exploration announced a discovery on its Davy Jones ultra-deep prospect. Located on South Marsh Island Block 230 in approximately 20 feet of water.
- In June 2011, estimated 192 net feet of potential hydrocarbons in the Tuscaloosa and Lower Cretaceous carbonate sections. Potentially 2-6 Tcf of natural gas.

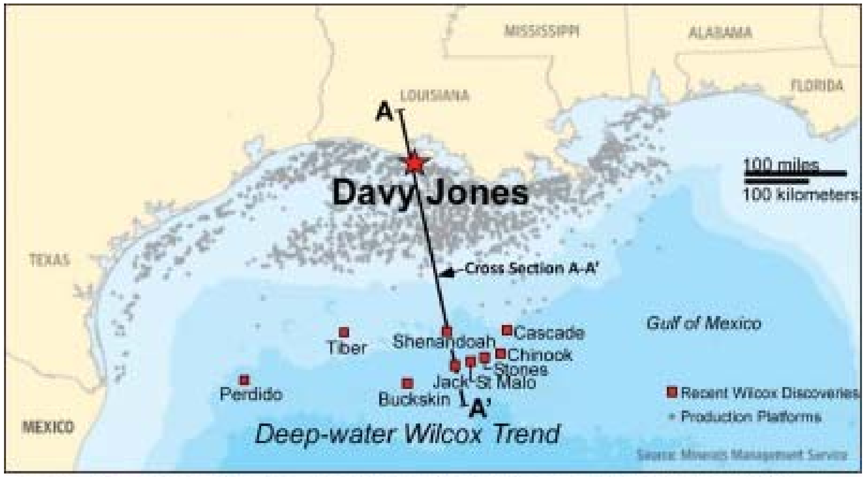
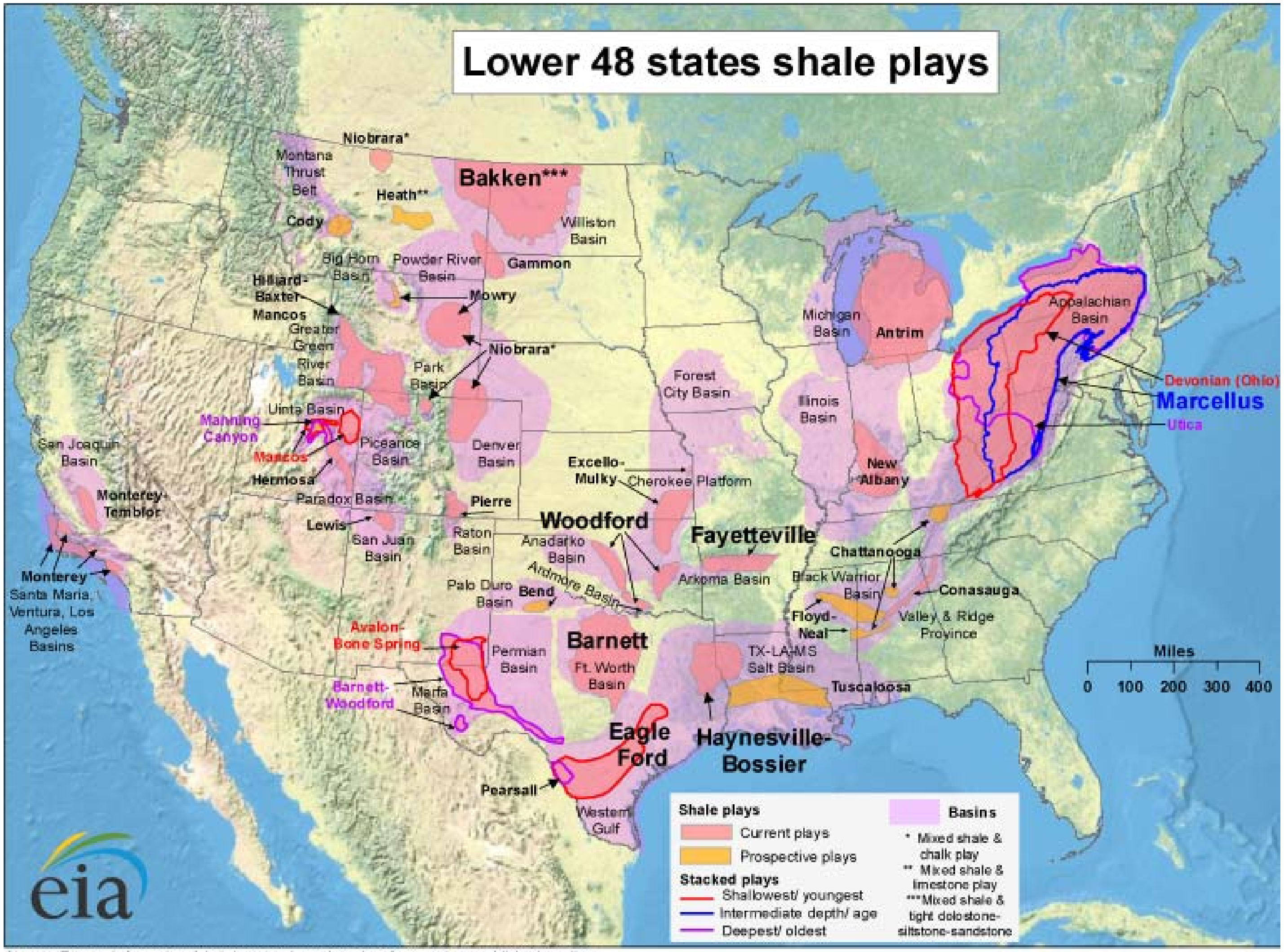


Figure 1. Davy Jones Location Map. Modified from *The Wall Street Journal* (September 3, 2009).

The Next Frontier: Crude Oil Shales

- **Number of emerging crude oil shale plays that could have dynamic impact on industry.**
- **As much as 24 billion barrels in plays such as Monterey (CA), Bakken (ND), Eagle Ford (TX), and Niabrara (CO/NE).**

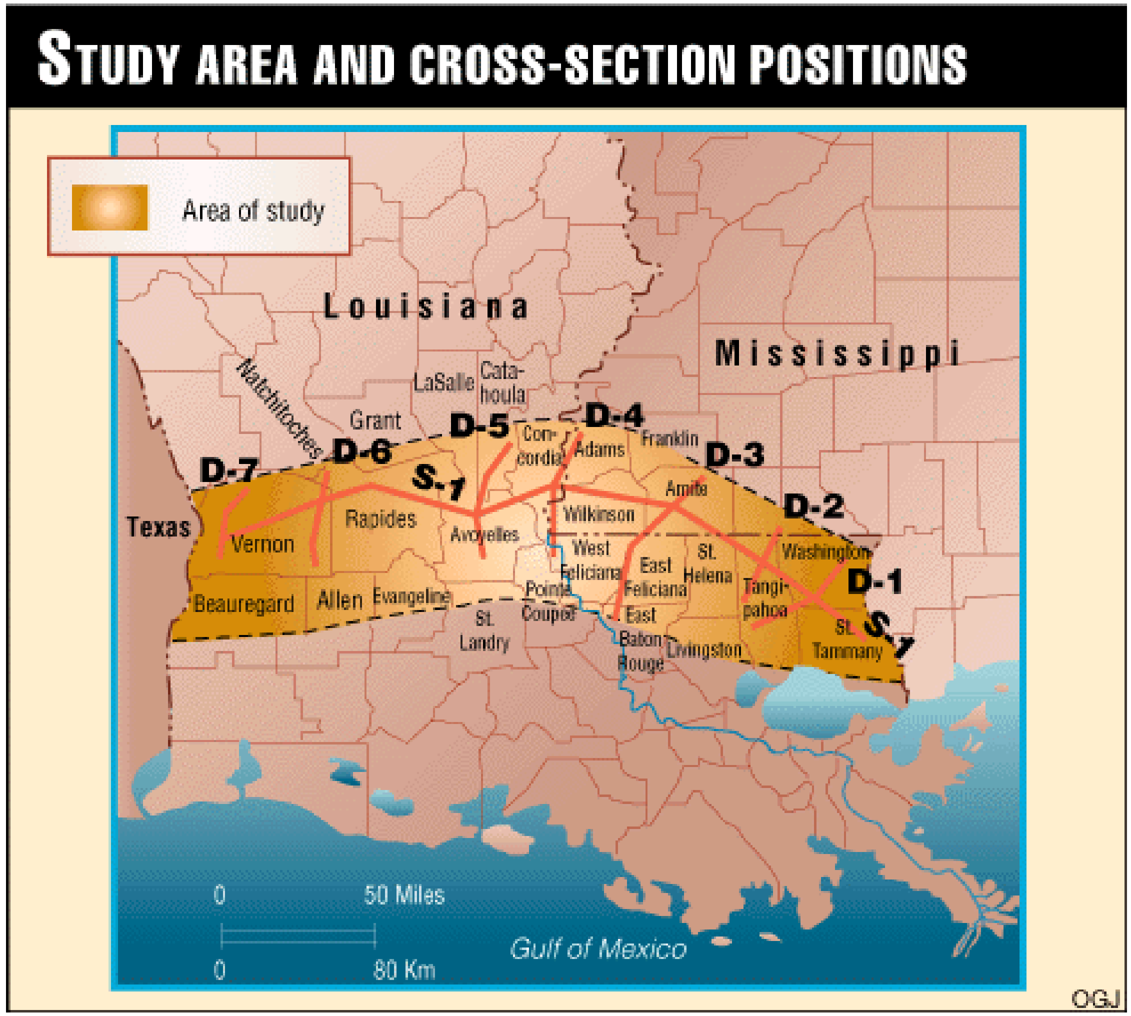


Source: Energy Information Administration based on data from various published studies.
Updated: May 9, 2011

Source: Energy Information Administration.

Crude Oil Shale Opportunities -- Louisiana

- **1998 LGS Study primary publicly-available source of information on the formation.**
- **Lies between sands of the upper and lower Tuscaloosa.**
- **Varies in thickness from 500 feet (MS) to around 800 feet (LA).**
- **Shallowest opportunity around 10,000 feet – mostly between 11,000 to 12,000 – some areas as deep as 16,000 (EBR).**
- **Estimated potential resource of 7 BBbls.**



Source: Oil and Gas Journal and Louisiana Geological Survey.

Continued Shale Development Challenges

Still a number of lingering issues that create challenges for all shale development:

- **Public challenges on true resource size.**
- **Water/aquifer contamination issues.**
- **Water usage issues.**
- **Other environmental issues (geological, emissions)**
- **Regulatory/tax changes**
- **Supporting infrastructure development.**
- **Market demand and price support.**

Conclusions

Conclusions

- **Speculation regarding geo-political supply interruptions and emerging economies (demand) will keep crude prices high and likely maintain the recently observed decoupling with natural gas prices.**
- **Shale continues to display great promise and significant challenges – threat to many vested interests receiving significant subsidies (renewables, energy efficiency).**
- **There are continued opportunities for expanded domestic natural gas use that should not "eat away" at the considerable reserve developments made over the past five years.**
- **The export of US shale production is risky and there are several mitigation remedies for those with concerns (long term contracting, production sharing agreements).**
- **Crude oil shale development stands to be the next big "game changer." Could dramatically impact North American supplies and create a number of interesting "decoupling" dynamics already materializing in NA markets.**

LSU Center for Energy Studies

Questions, Comments and Discussion

dismukes@lsu.edu

www.enrg.lsu.edu