Unconventional Oil & Natural Gas: Overview of Resources, Economics & Policy Issues

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Center for Energy Studies

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

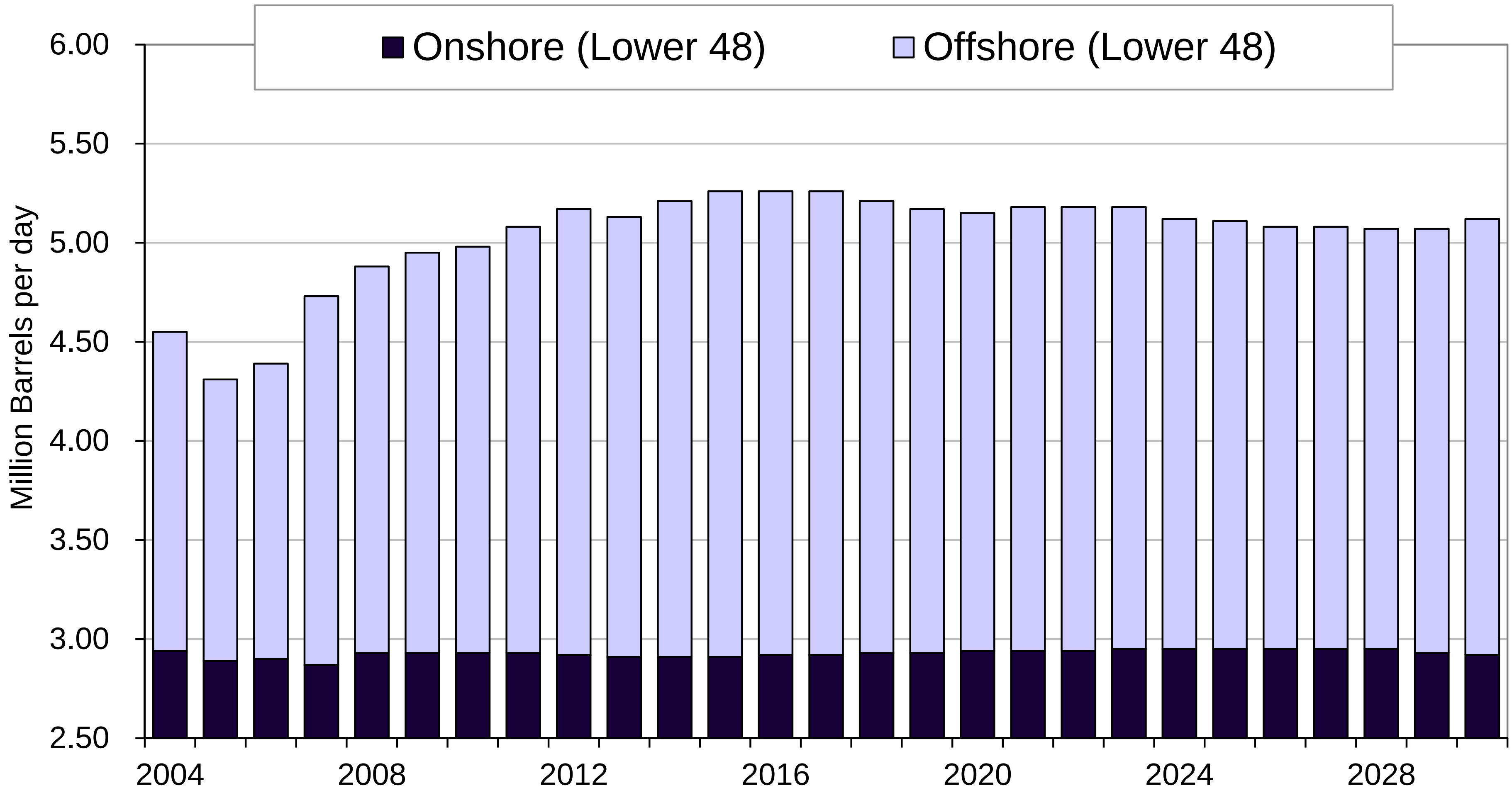
Summary and Take Away

- **New natural gas supply** availability is having considerable impacts on all energy markets today as well as on a longer term, forward-looking basis.
- Shale revolution is **now migrating into liquids** and crude oil production. **Facilitating additional natural gas production** despite low prices and some "dry" gas well shut-ins and decreased natural gas well drilling.
- Considerable **economic development** opportunities are starting to arise leading to a burst in considerable capital investment.
- There are fuel/resource **diversity concerns** and continued natural gas **resource development/environmental concerns and opposition.**

Reminder – The Way Things Were

Long Term US Crude Oil Production Forecast (2006)

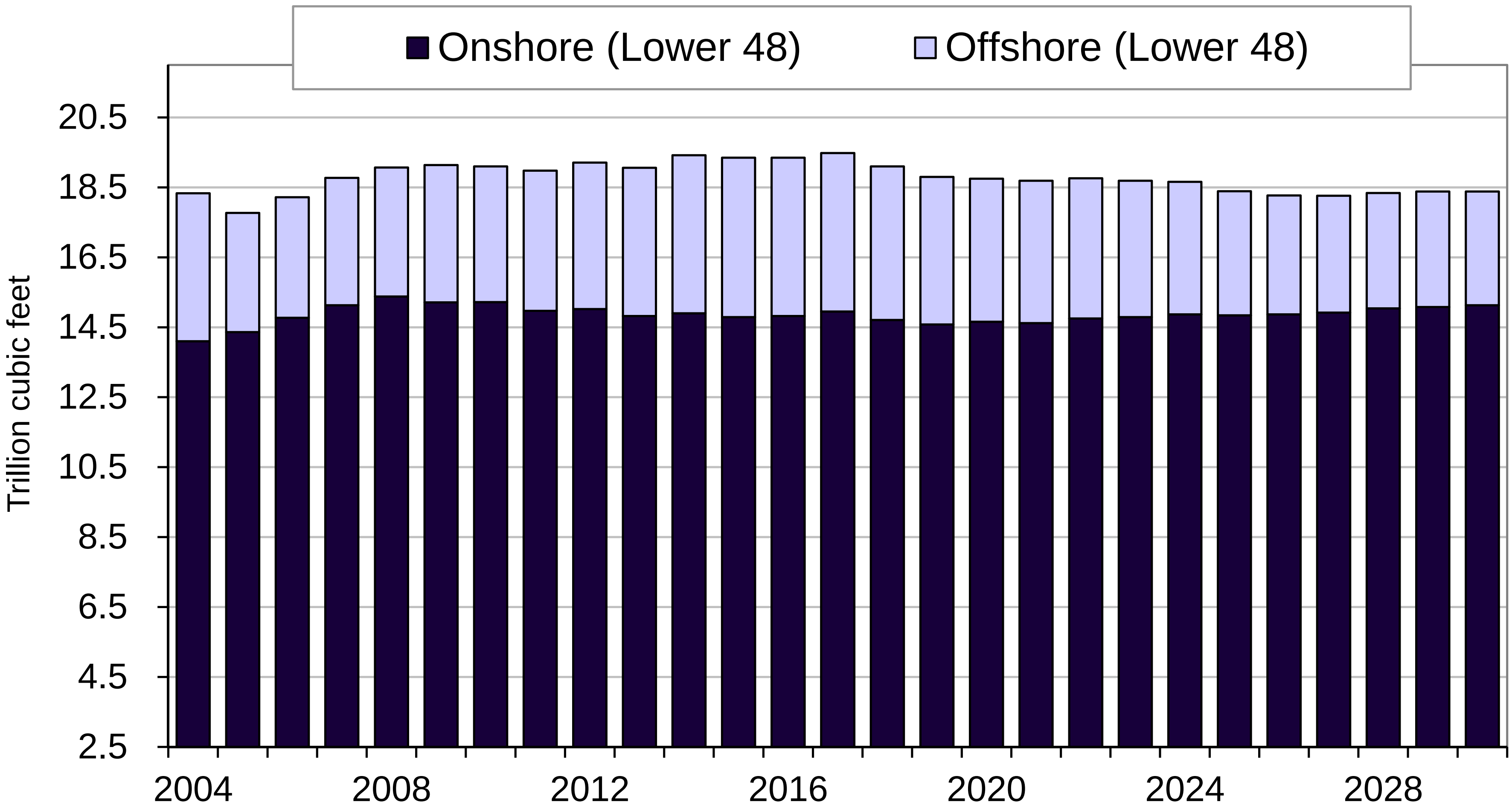
Relatively uninspiring U.S. crude oil production forecast.



Source: USDOE/EIA, Annual Energy Outlook, 2006

Long Term US Natural Gas Production Forecast (2006)

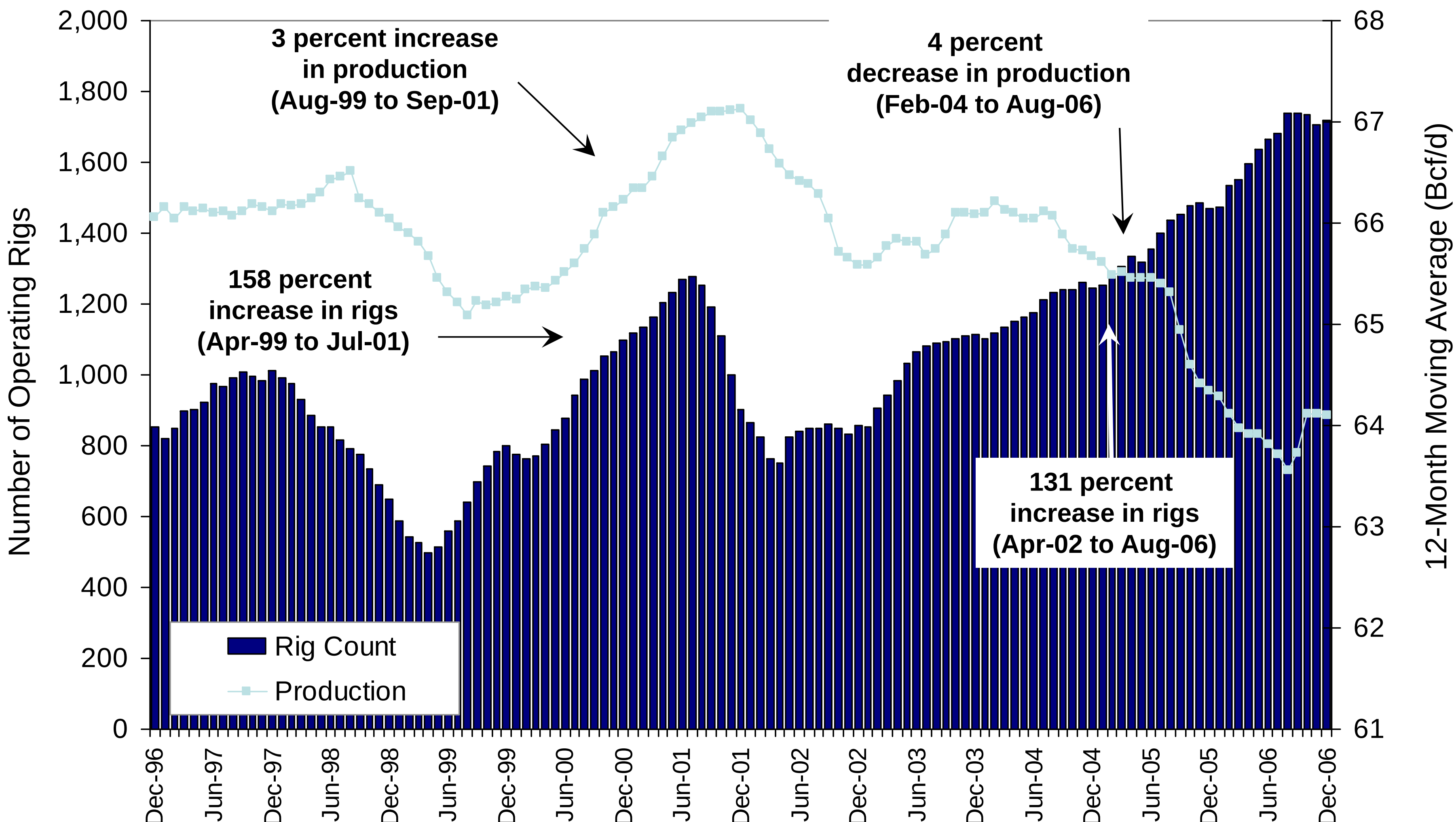
Natural gas production forecasted to decrease starting in 2016.



Source: USDOE/EIA, Annual Energy Outlook, 2006

Historic Monthly Rig Counts and Gas Production (1997-2006)

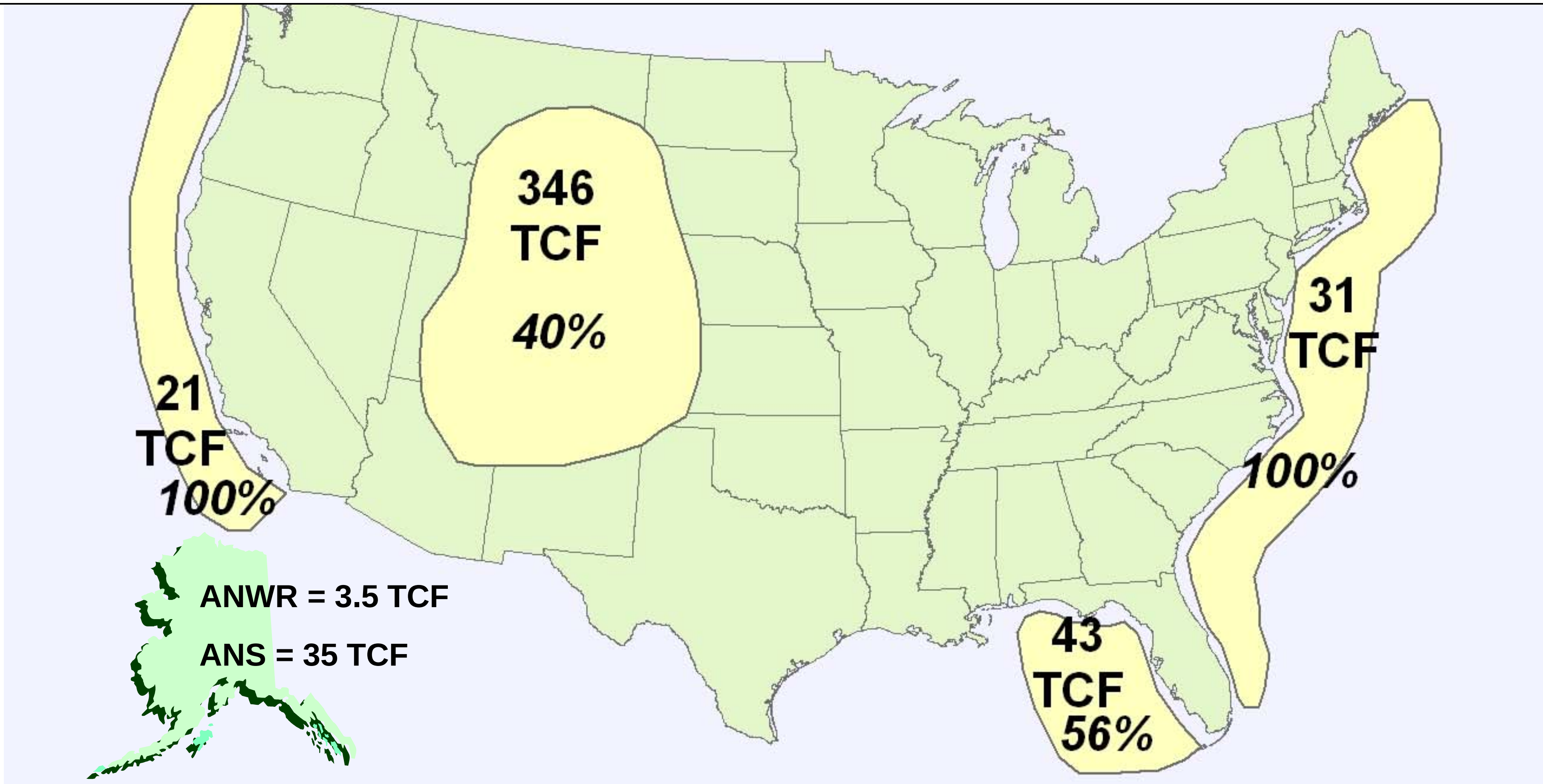
The maturing nature of US basins reflected in drilling productivity.



Source: Energy Information Administration, Department of Energy; and Baker-Hughes Inc.

Resource Estimates: Restricted Areas (Percent Restricted)

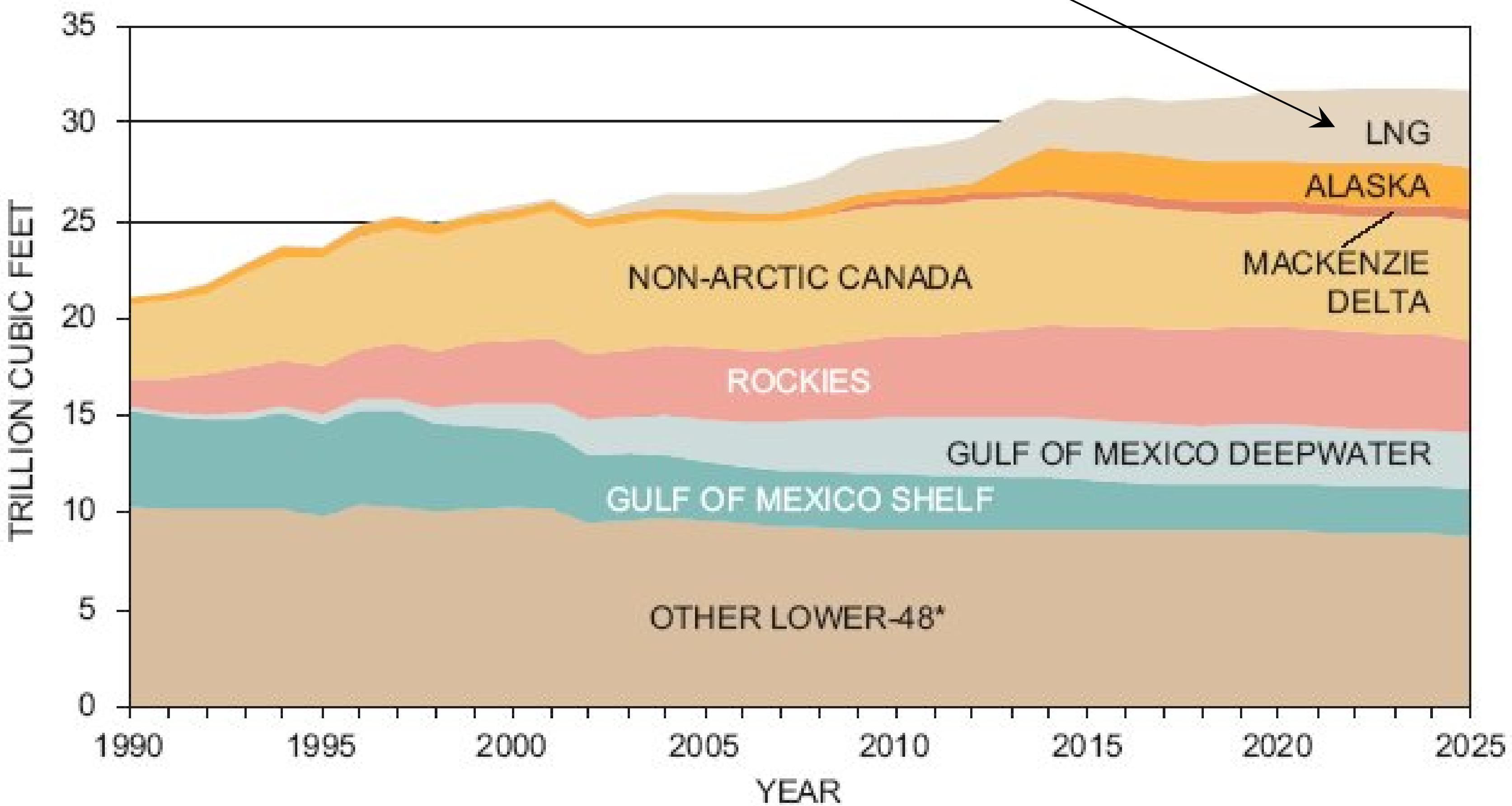
Policy advocacy focused on restricted areas as a potential solution to the resource constraint problem.



Source: Natural Gas: Can We Produce Enough?" Independent Petroleum Association of America, website: http://www.ipaa.org/govtrelations/factsheets/NaturalGasProdEnough.asp.

NPC Forecast North American Supply Disposition

LNG provides 14% of the U.S. supply of natural gas by 2025.

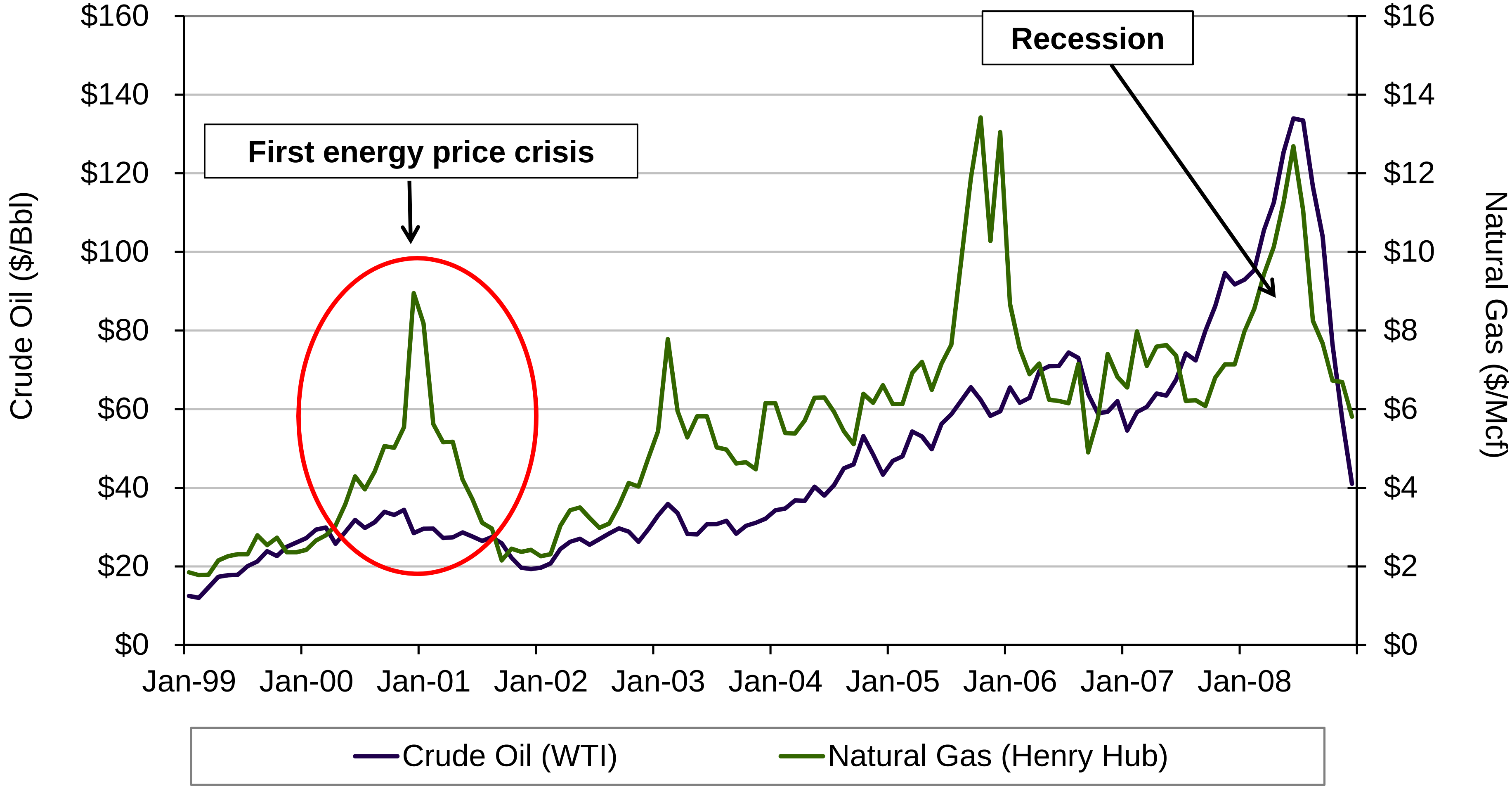


* Includes lower-48 production, ethane rejection, and supplemental gas.

Source: National Petroleum Council

Crude Oil and Natural Gas Prices

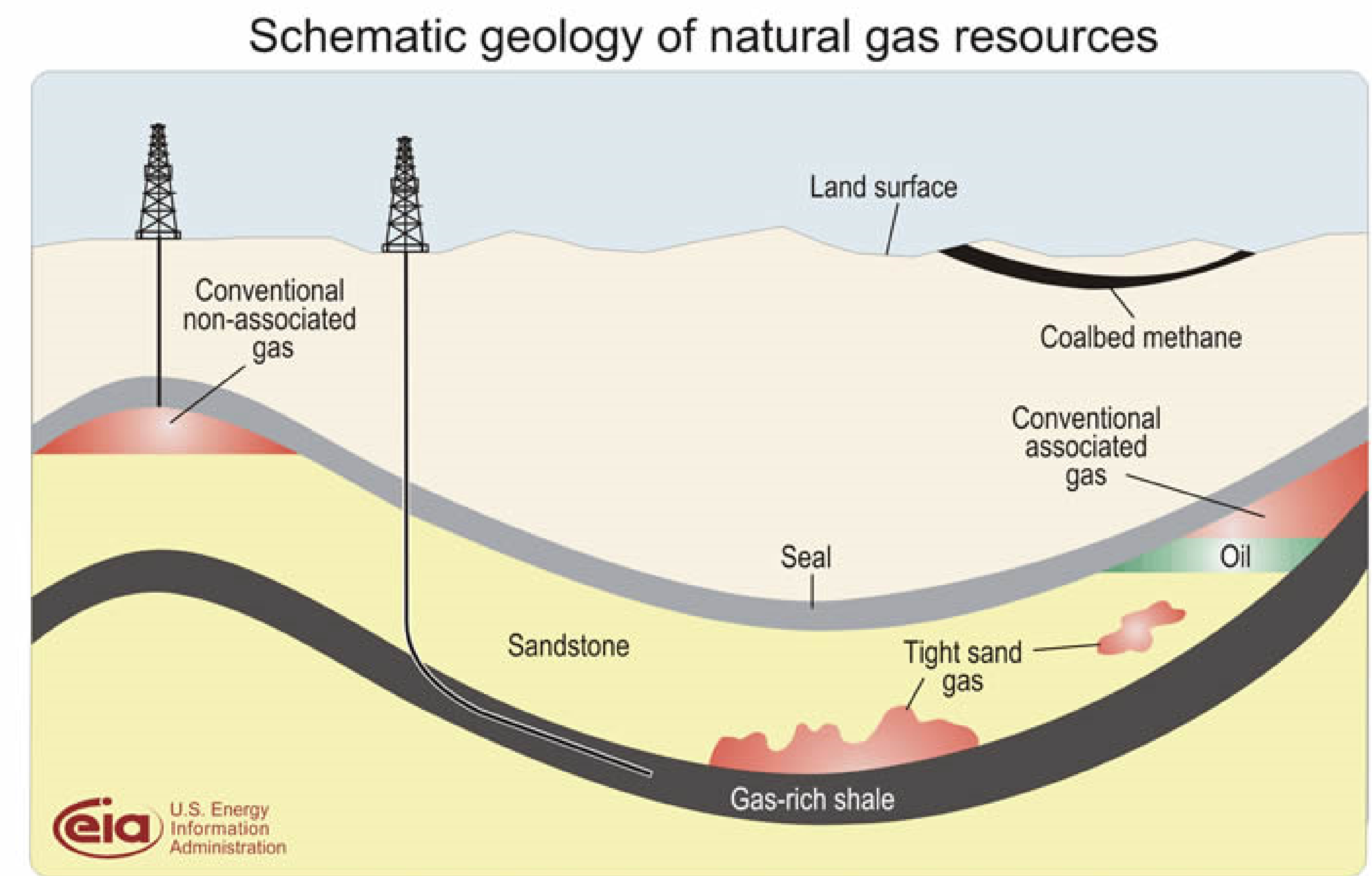
Prices reflected the state of, and outlook for, energy markets.



Source: Federal Reserve Bank

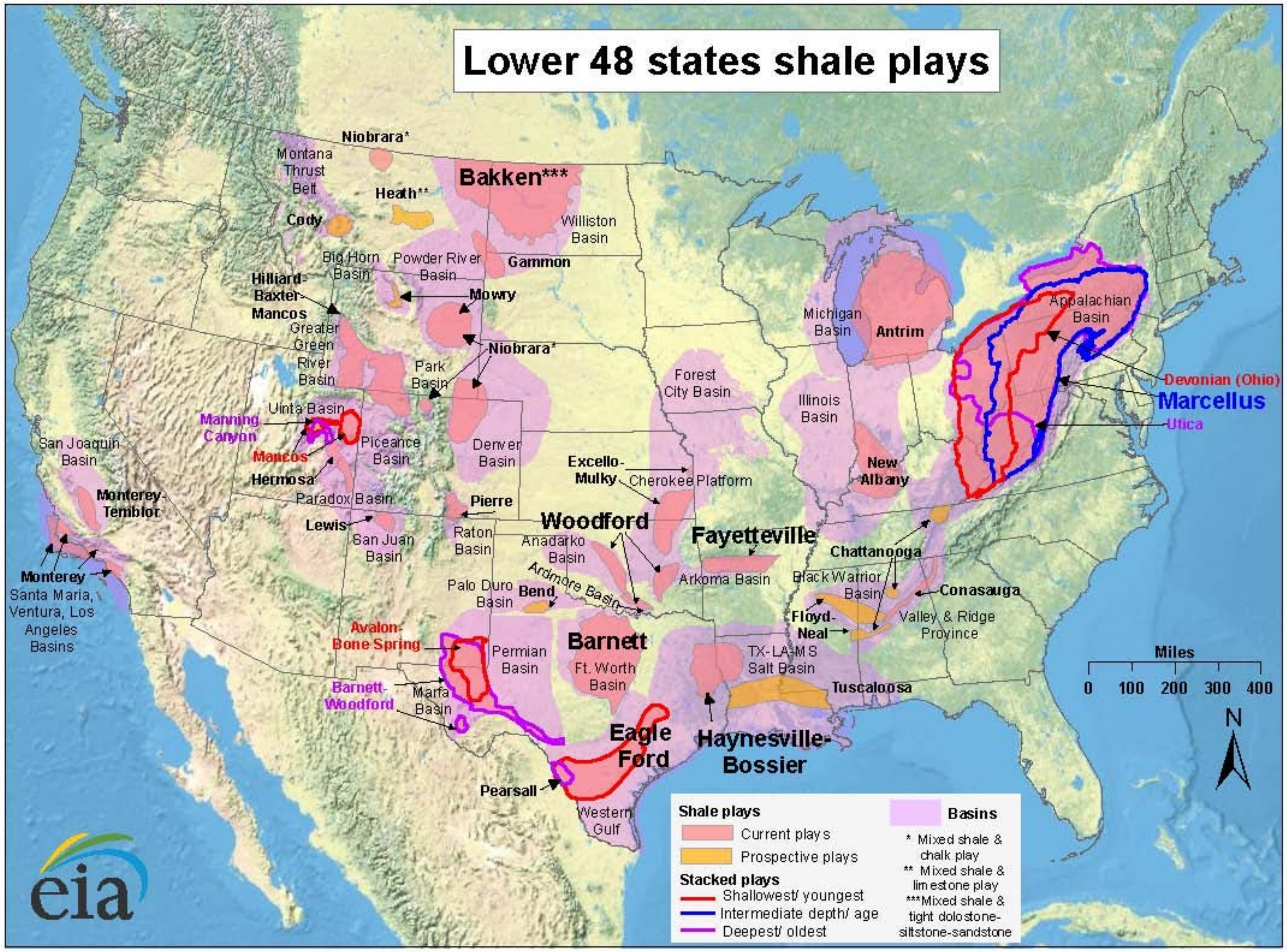
What Changed? The Way Things Are

Unconventional vs. Conventional Geological Formations



Domestic Shale Gas Basins and Plays

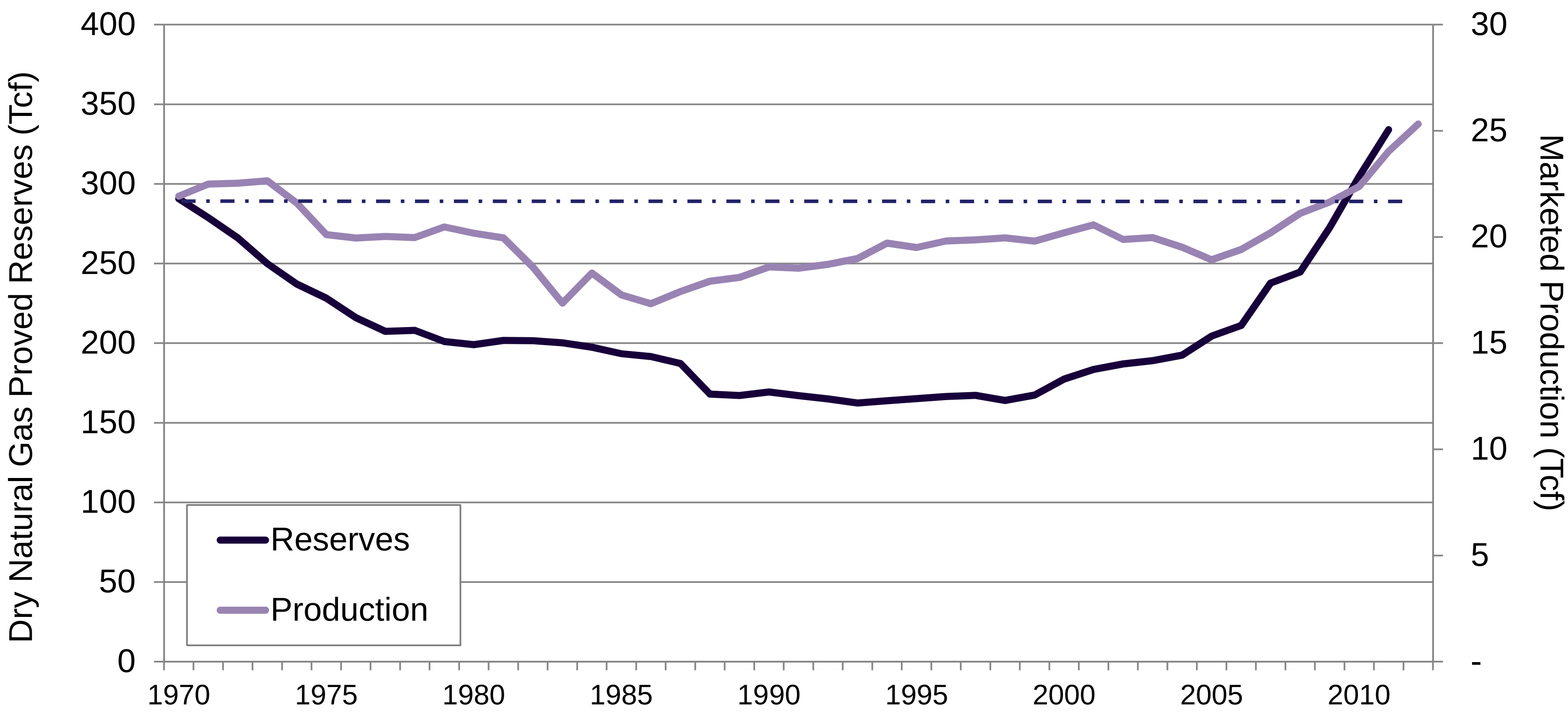
Unlike conventional resources, shale plays (natural gas, liquids, and crudes) are located almost ubiquitously throughout the U.S. and are the primary reason for the decrease in overall and regional natural gas prices.



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

Natural Gas Proved Reserves and Production

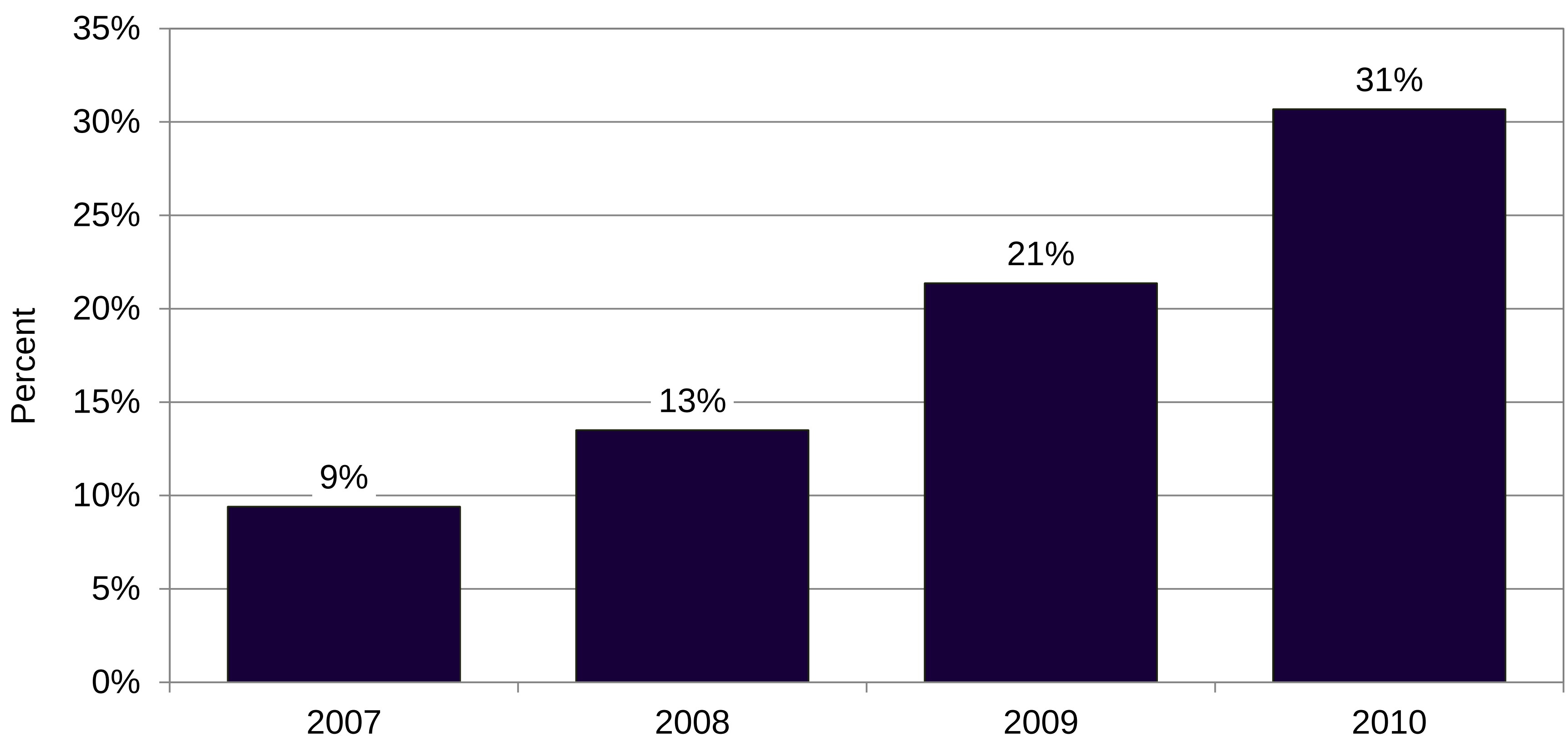
Current U.S. natural gas reserves are approaching record levels not seen since 1970. Natural gas production is at levels that surpass historic peaks.



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

Shale's Share of Natural Gas Reserves

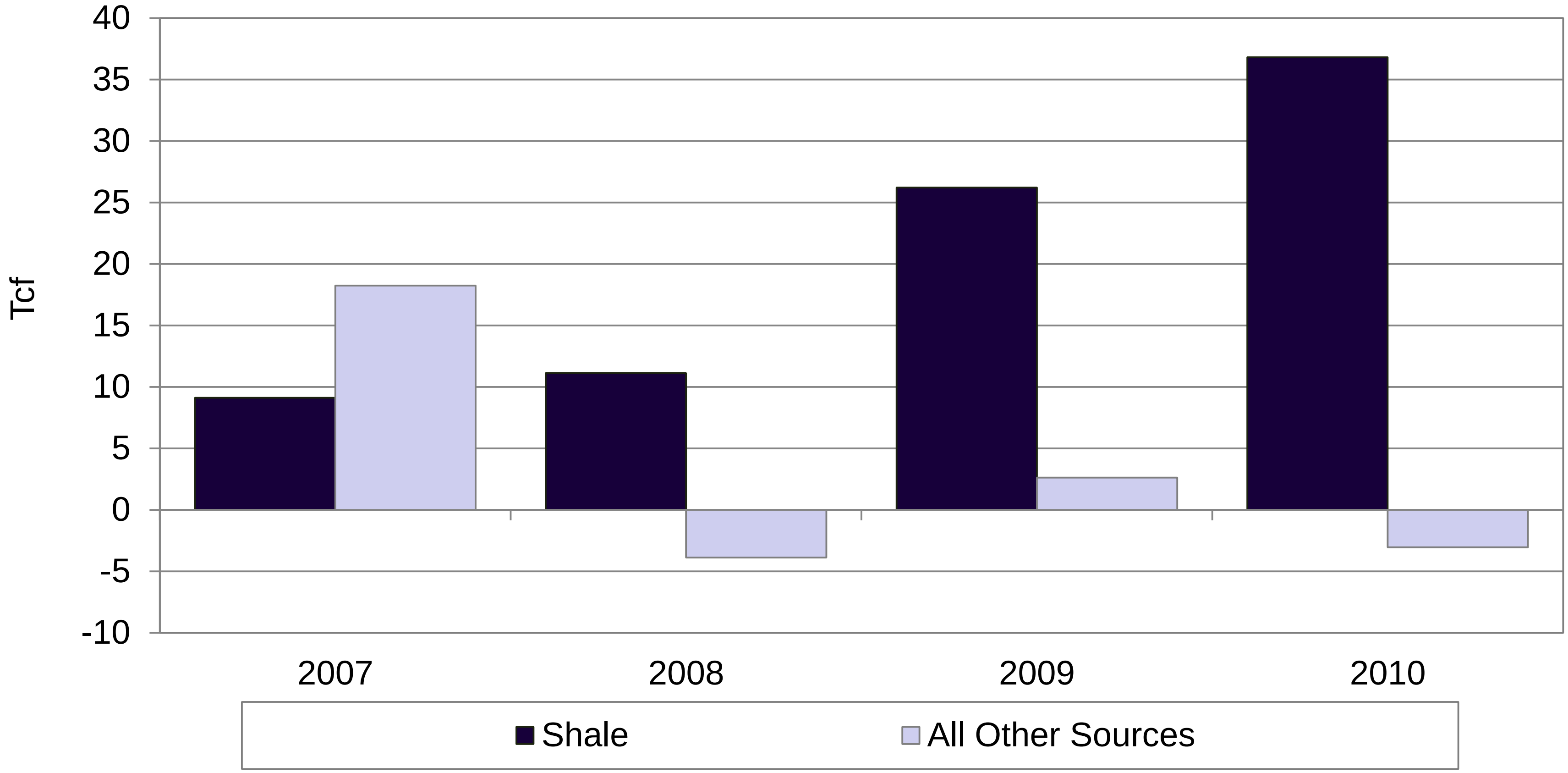
The share of shale gas relative to total U.S. natural gas proved reserves has been increasing significantly, from less than 10 percent in 2007 to over 30 percent in 2010.



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

U.S. Dry Natural Gas Reserve Adjustments

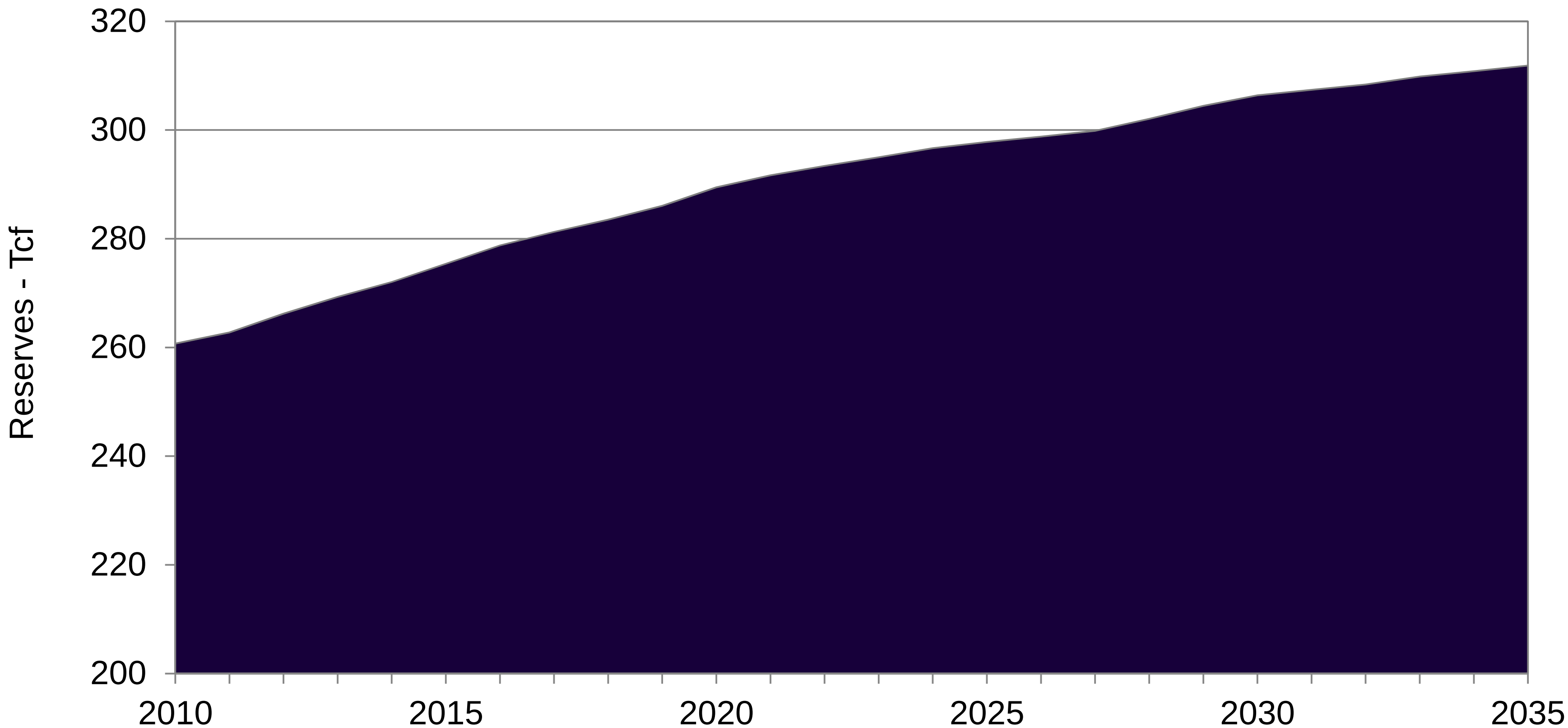
U.S. shale gas reserves are increasing, enough to more than offset the decrease in net reserves from all other sources in both 2008 and 2010.



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

Annual Energy Outlook, Natural Gas Reserves

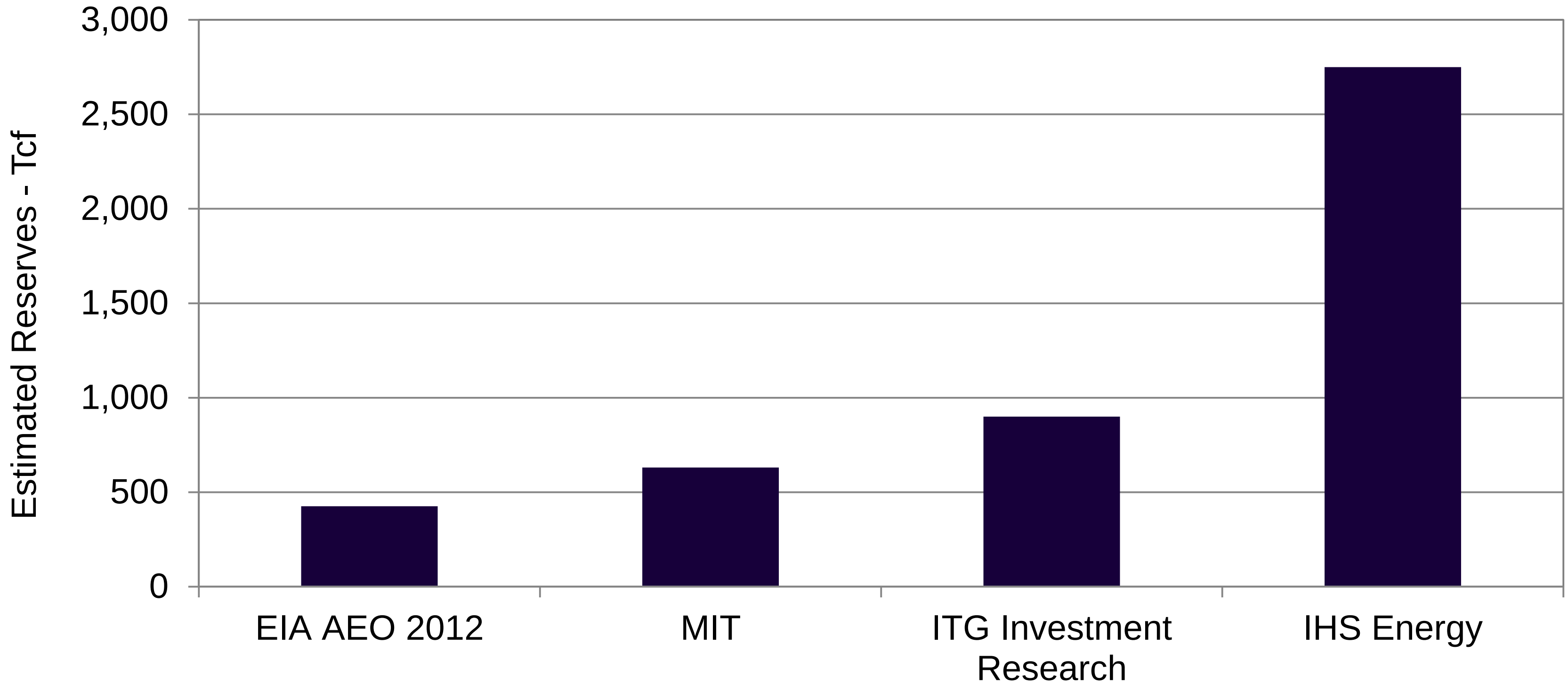
Unconventional resources are not a "flash in the pan" and are anticipated to continue to increase over the next two decades or more.



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

Alternative Natural Gas Reserve Forecasts

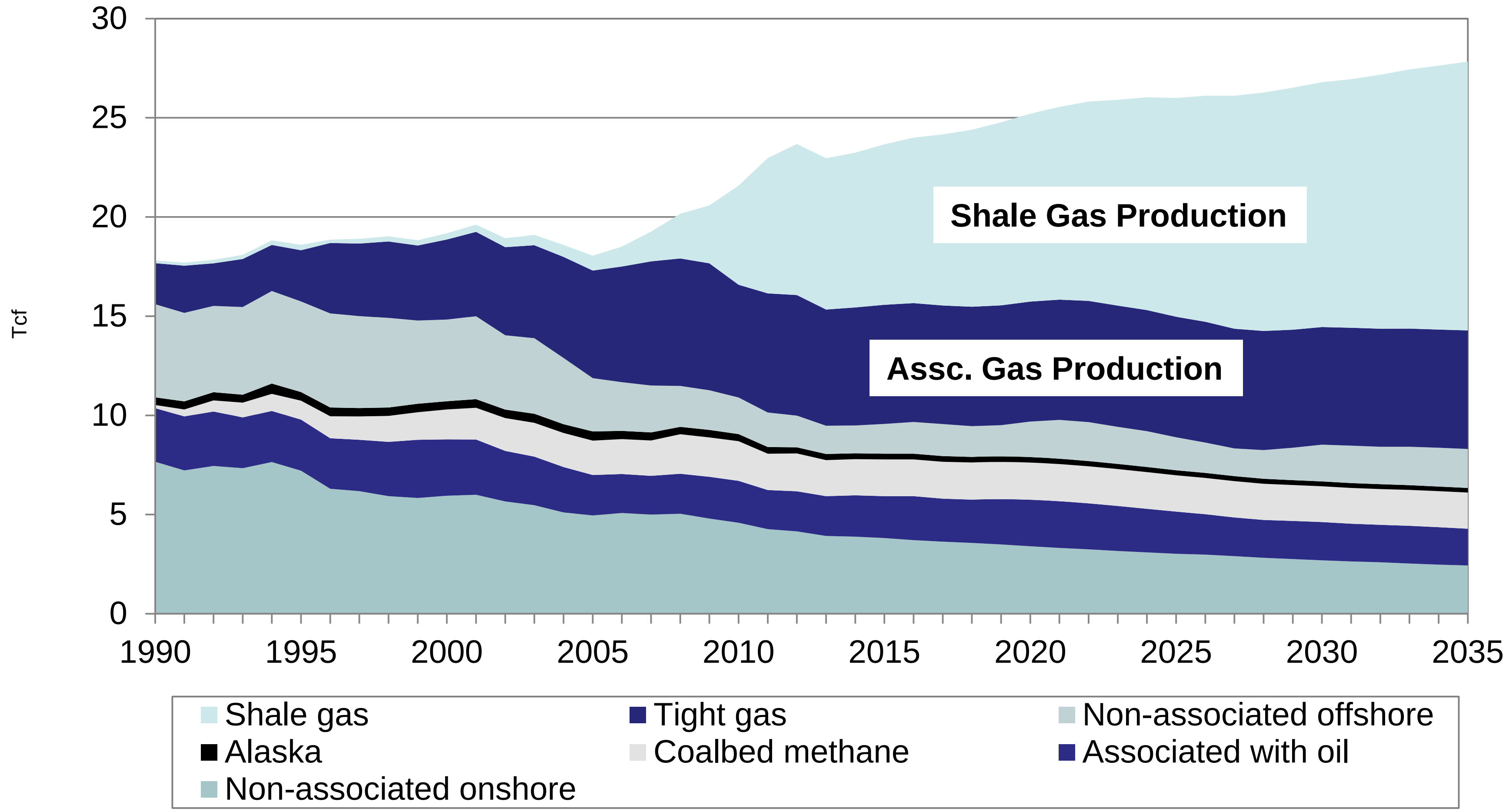
There are a wide range of unconventional shale gas reserve estimates that are as low as 436 Tcf to as high as 2,750 Tcf. This represents a range of between 18 years and over 100 years of available natural gas resources based upon current consumption levels.*



Note: *Assumes an annual consumption level of 24.3 Tcf.
The MIT study reached a mean estimate of technically recoverable resources of 631 Tcf with an 80 percent confidence interval of 418 to 871 Tcf. The ITG estimates of recoverable resources is for 10 overlapping plays, totaling 900 Tcf. These are the same 10 plays as estimated by the EIA's AEO (resulting in 426 Tcf). IHS Energy estimates show that total recoverable shale in the U.S. could be as high as 2,750 Tcf, significantly higher than their estimate of 1,268 in 2010.

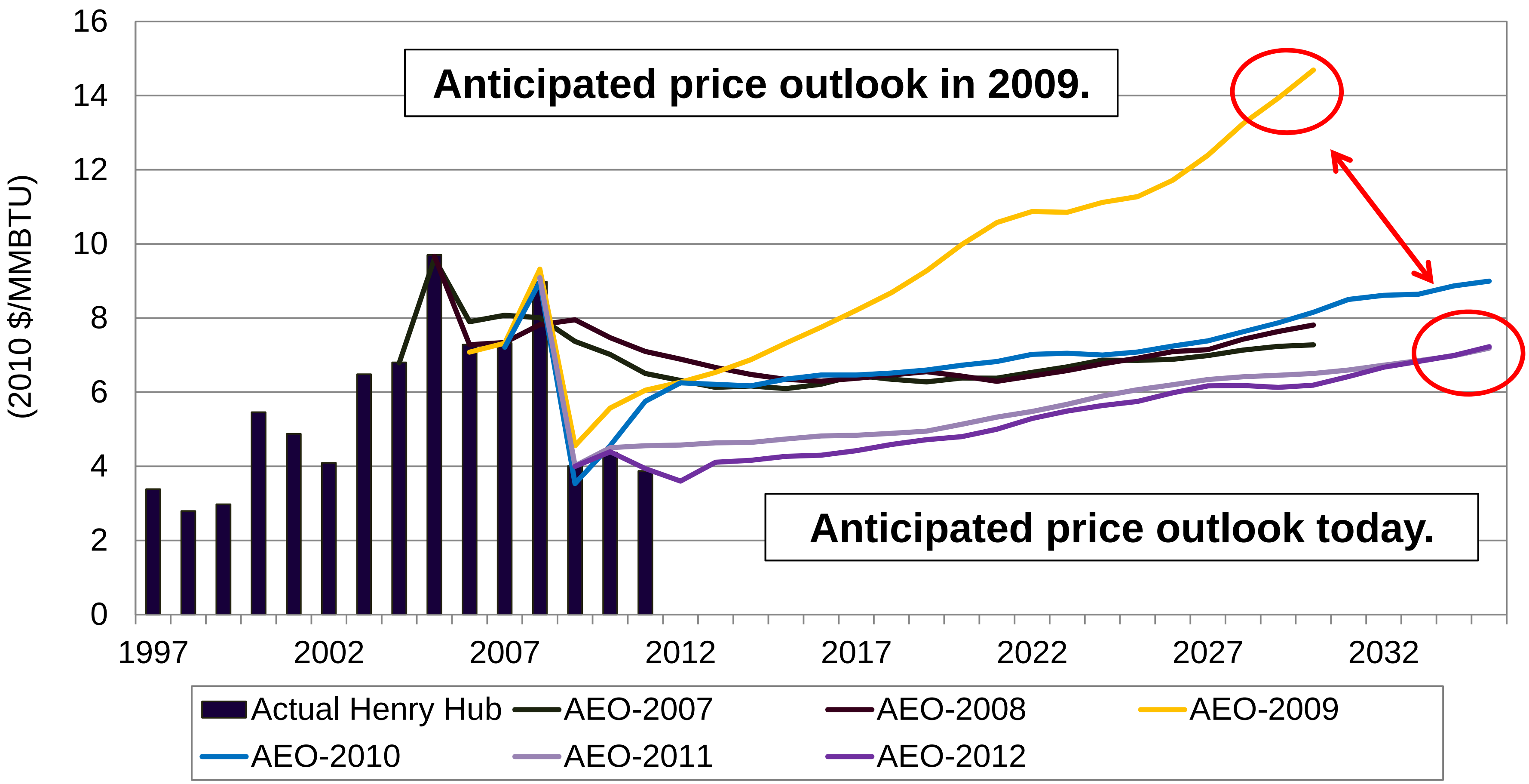
Forecast U.S. Natural Gas Production

Shale availability will drive U.S. natural gas supply.



Changes in AEO Natural Gas Price Forecasts

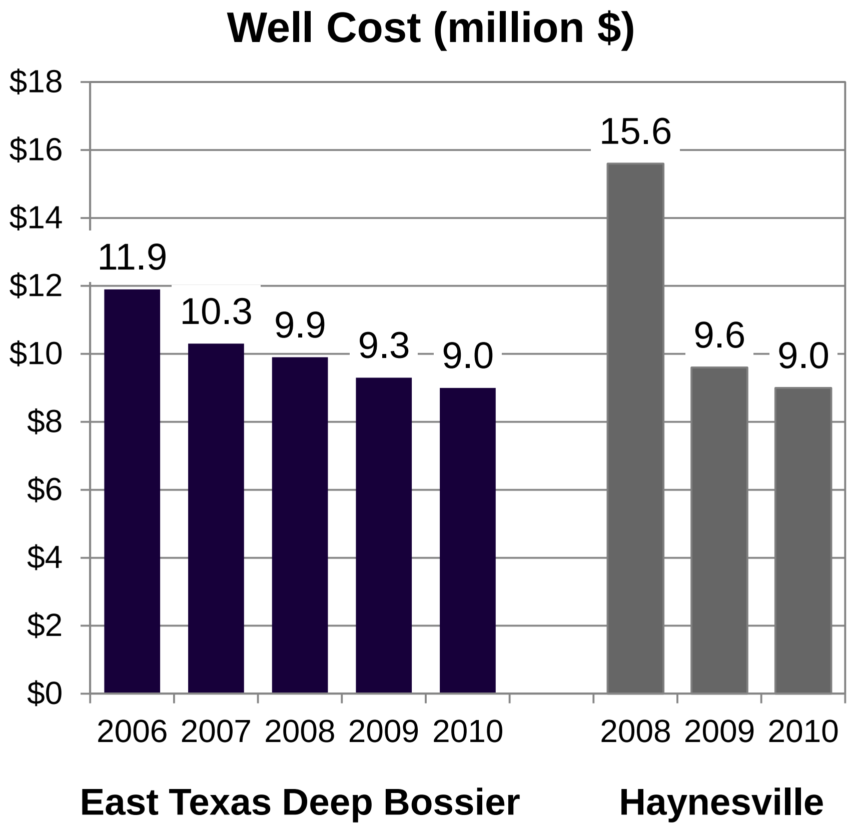
Shale availability has significant impact on future price outlook.

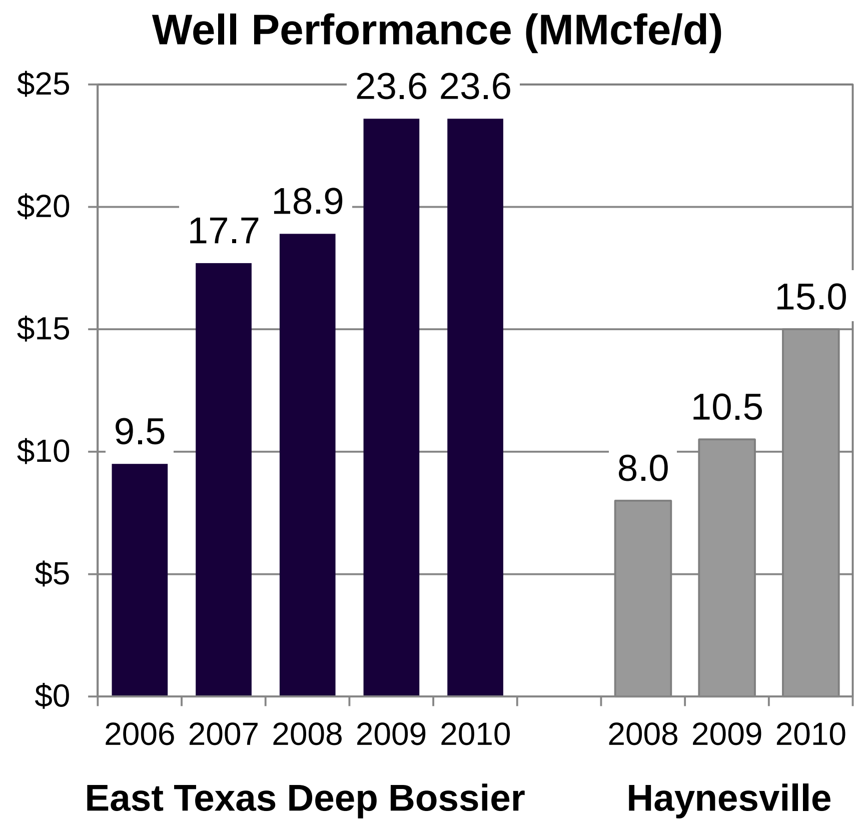


Source: Energy Information Administration, U.S. Department of Energy

Changes in Well Costs and Productivity

Encana reports a reduction in well costs of 15-30% through use of multi-pad drilling, improved rig efficiencies, and lower hydraulic fracturing costs. The use of higher water volumes, increased frac stages, and enhanced pay selection have resulted in 100-150% increases IP rates.



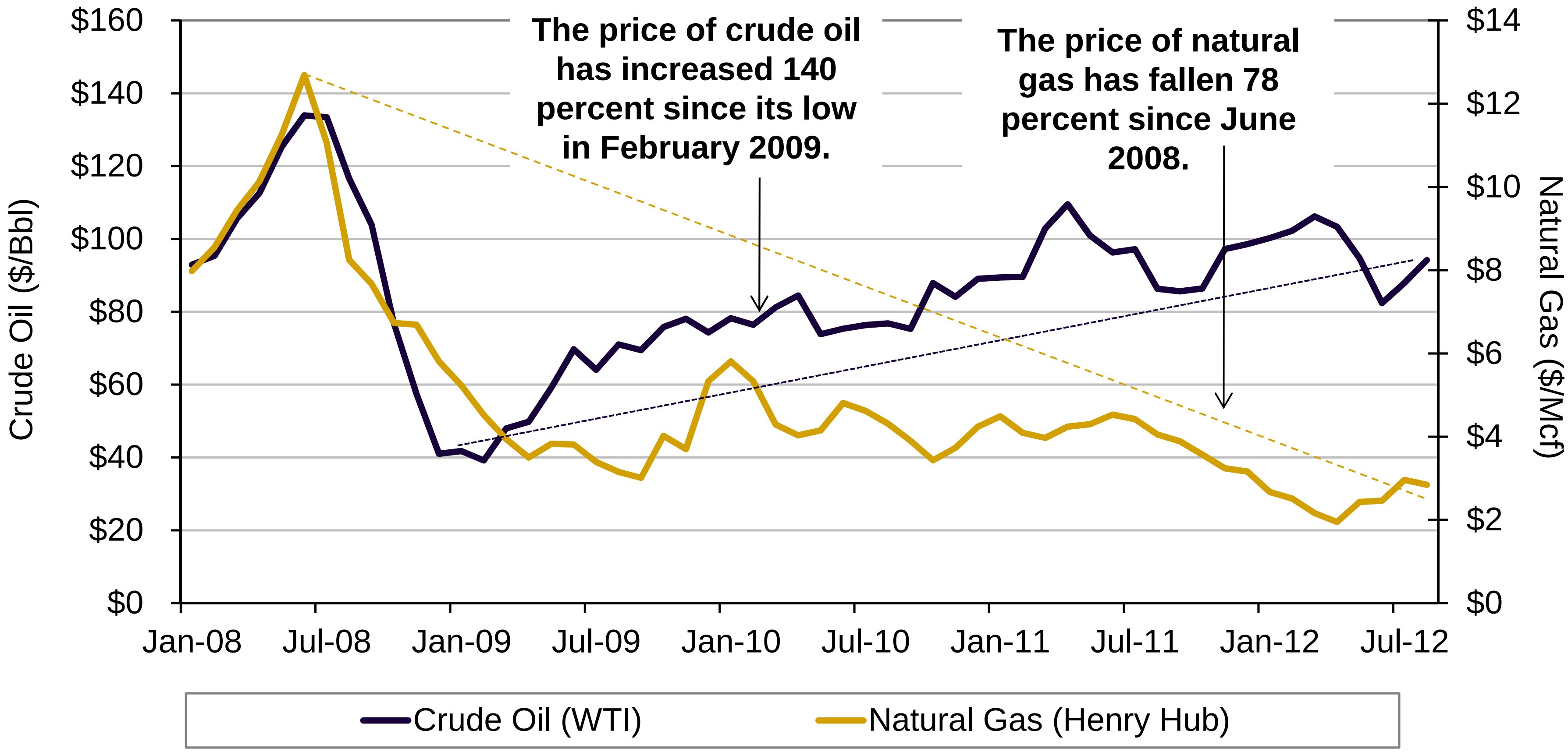


Source: U.S. Natural Gas Resources and Productive Capacity: Mid-2012, Prepared for Cheniere Energy, Advanced Resources International, Inc. August 23, 2012.

Unconventional Crude Oil and Liquids

Crude Oil and Natural Gas Price Decoupling

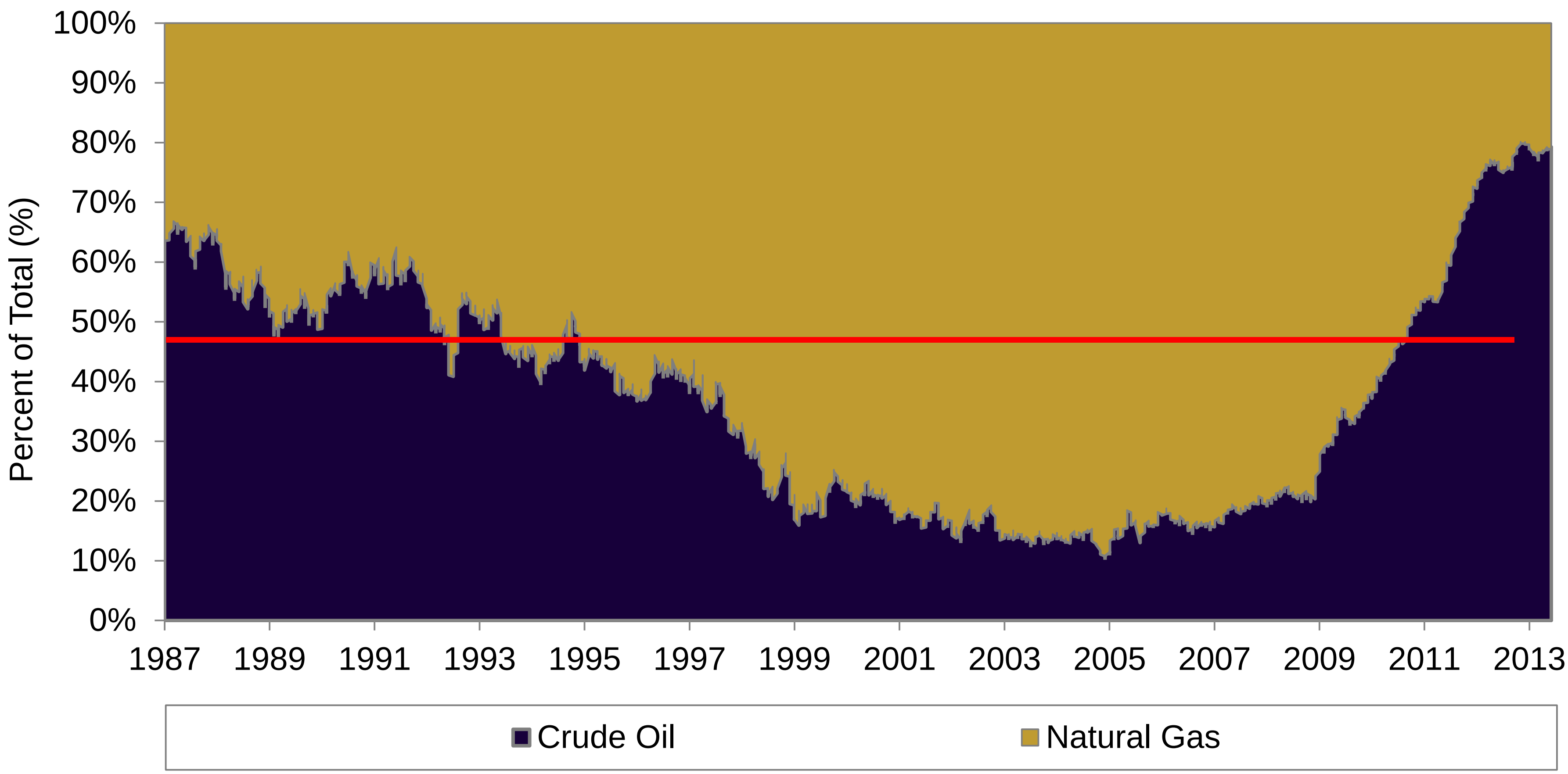
Crude oil prices have doubled in the aftermath of the recession but natural gas prices have remained stable.



Source: Federal Reserve Bank of St. Louis.

U.S. Oil/Gas Rig Split

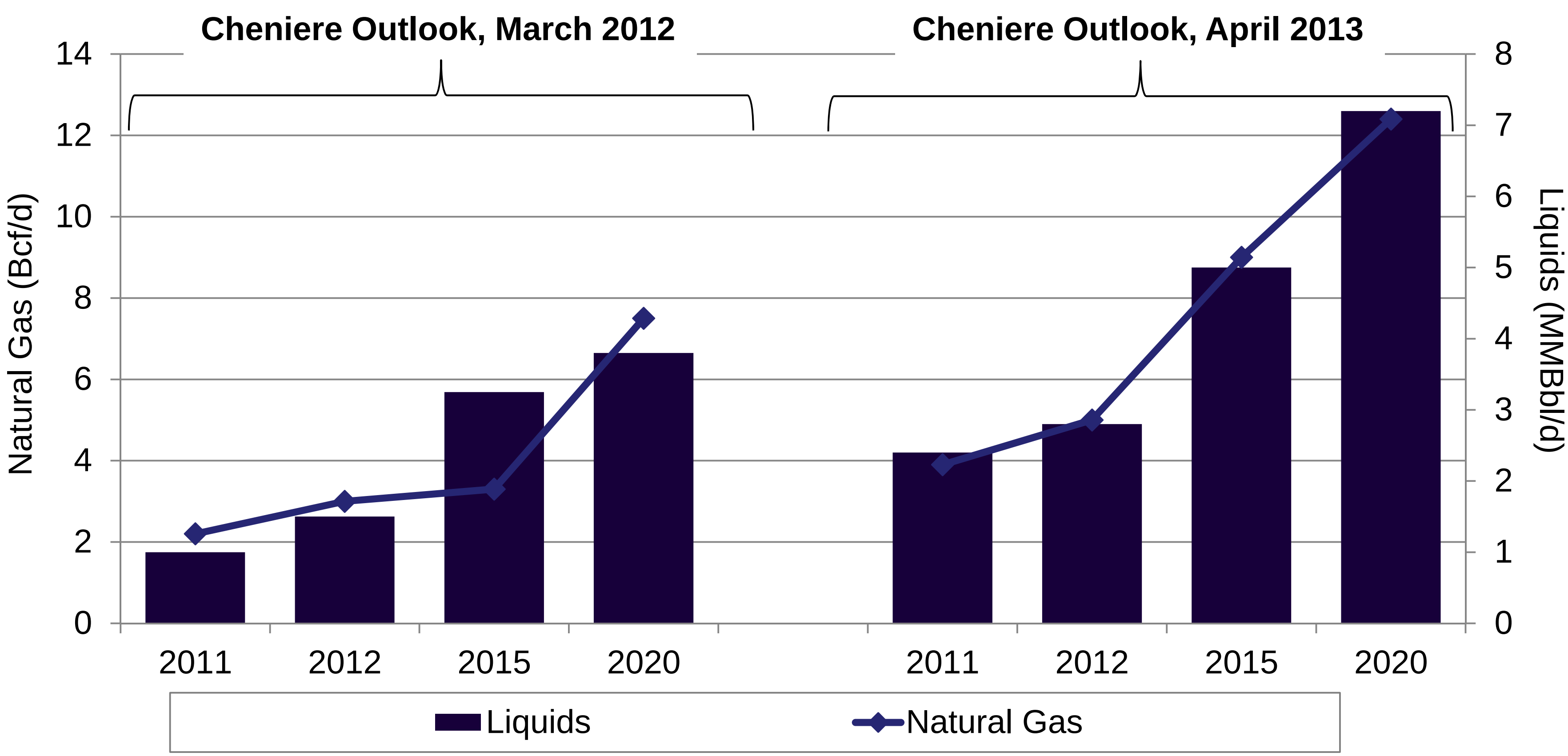
Natural gas drilling emphasis over the past 20 years has shifted to crude oil drilling emphasis over the past two years.



Source: Baker Hughes

Annual Production from Unconventional Reservoirs

In just one year, Cheniere has revised its forecasted natural gas production in 2020 from slightly less than 8 Bcf per day to more than 12 Bcf per day; and liquids production from 6 MMBbls per day to 7 MMBbls per day.

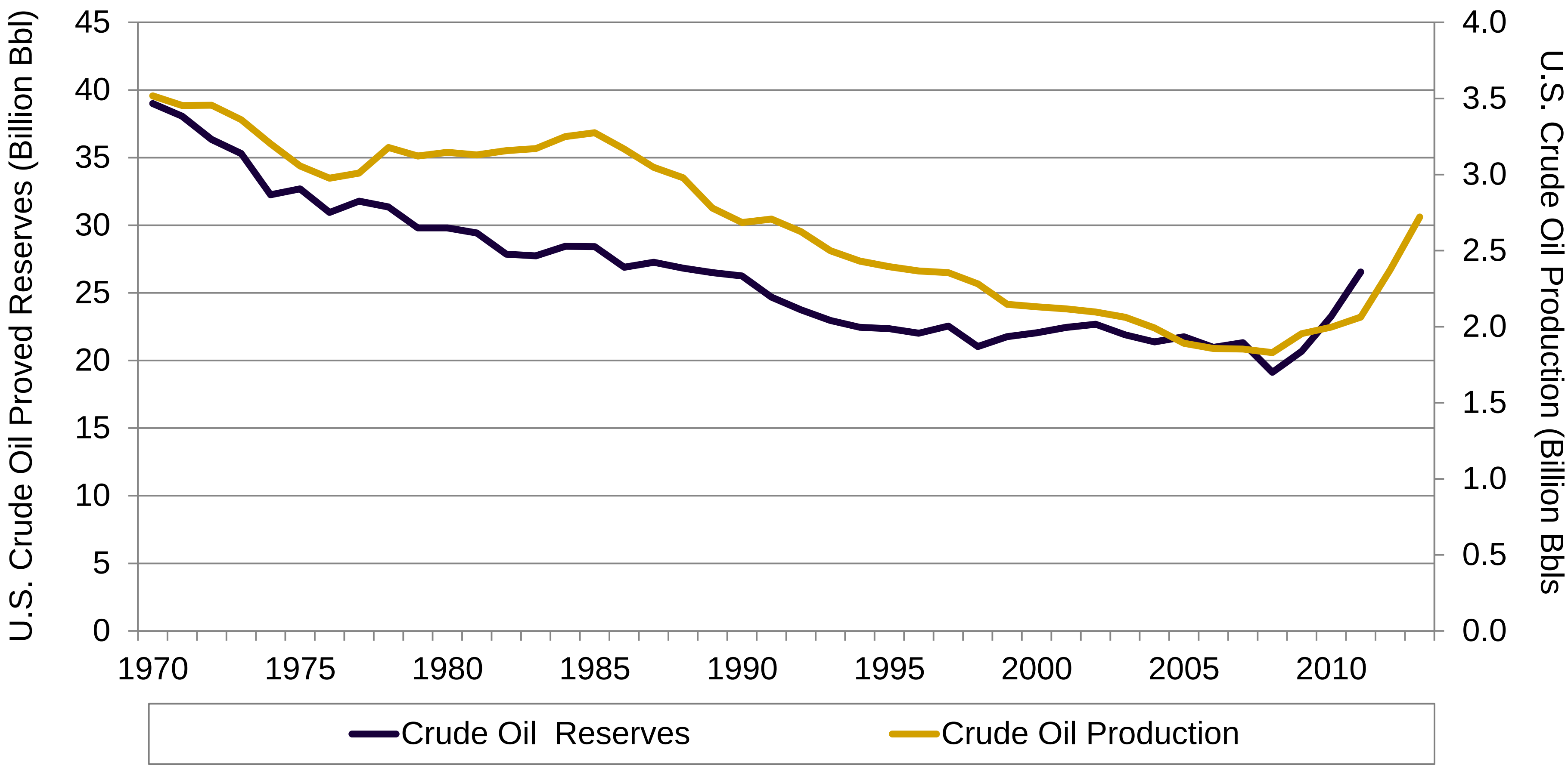


Source: Cheniere Energy Inc,, Corporate Presentations. Available at: http://phx.corporate-ir.net/phoenix.zhtml?c=101667&p=irol-presentations.

Natural Gas and Economic Development: Moving from "Revolution" to "Renaissance"

Changes in Crude Oil Reserves and Production

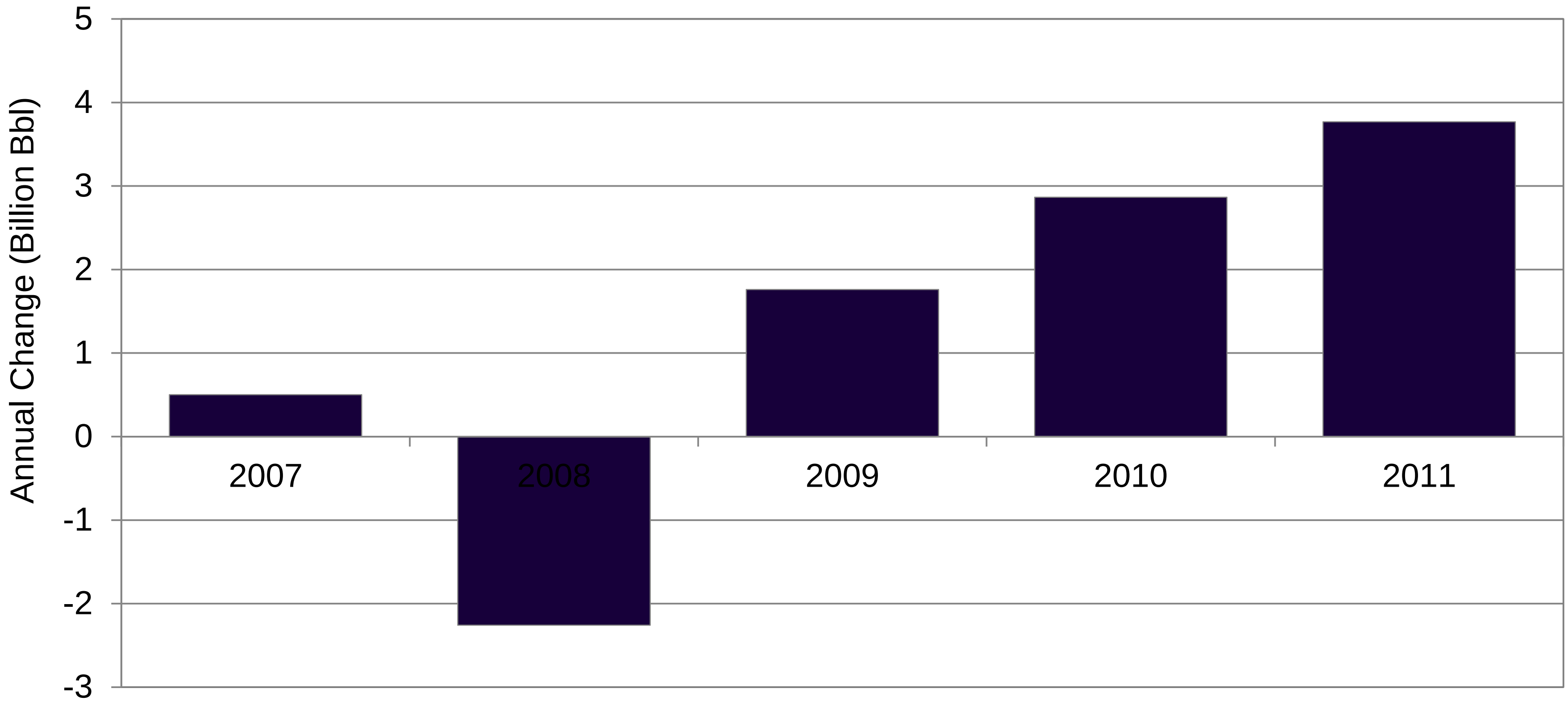
Crude oil production and reserves are climbing back to levels not seen since the 1980s.



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

Annual Changes in U.S. Crude Oil Proved Reserves (Shale and Other)

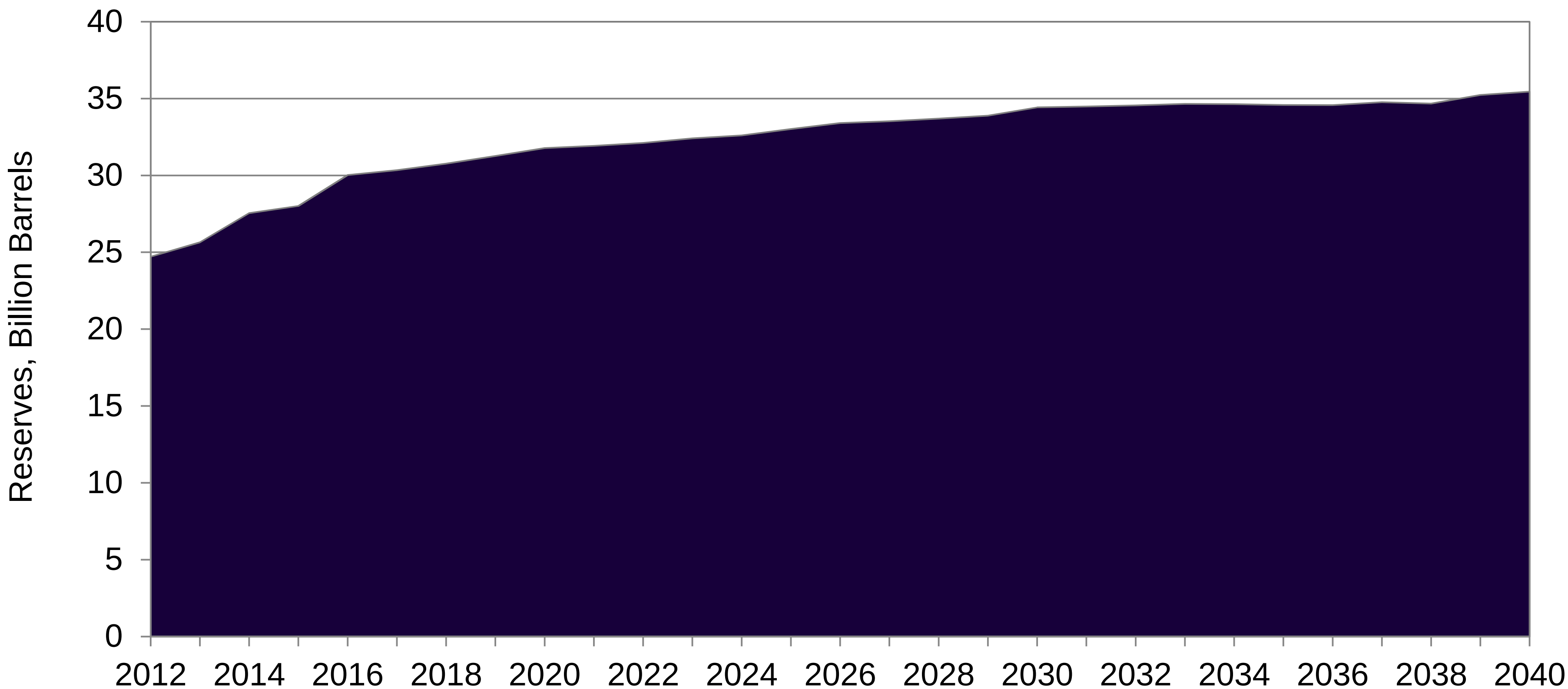
Changes in crude oil reserves have also been positive and increasing over the past several years.



Note: Includes crude oil and lease condensate.
Source: Energy Information Administration, U.S. Department of Energy.

Annual Energy Outlook, Crude Oil Reserves

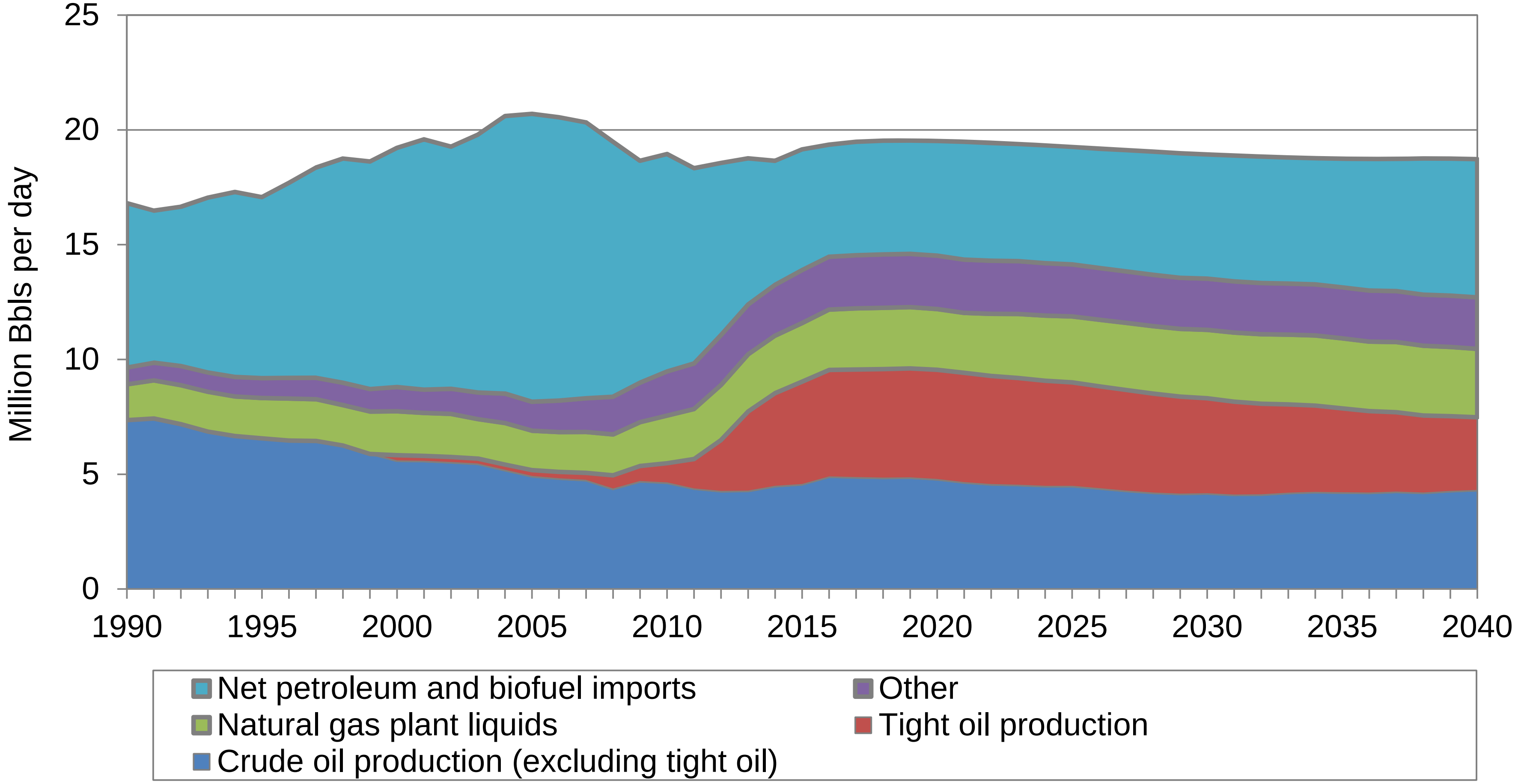
Crude oil reserves are expected to increase over 20 percent by 2016 and then gradually increase by 18 percent another to 2040.



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

Forecast U.S. Crude Oil Production

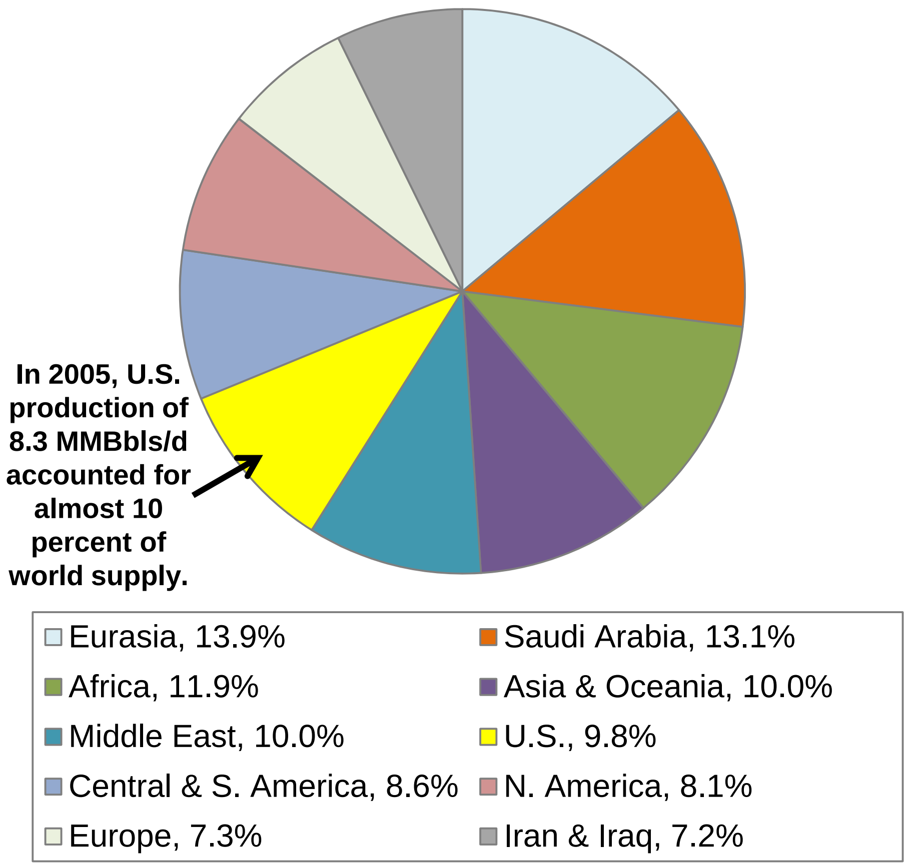
U.S. production of crude oil is expected to increase at an average annual rate of four percent through 2016. Tight oil production increases from 1.31 million barrels per day in 2011 to 4.8 million barrels per day in 2020, an increase of 266 percent.

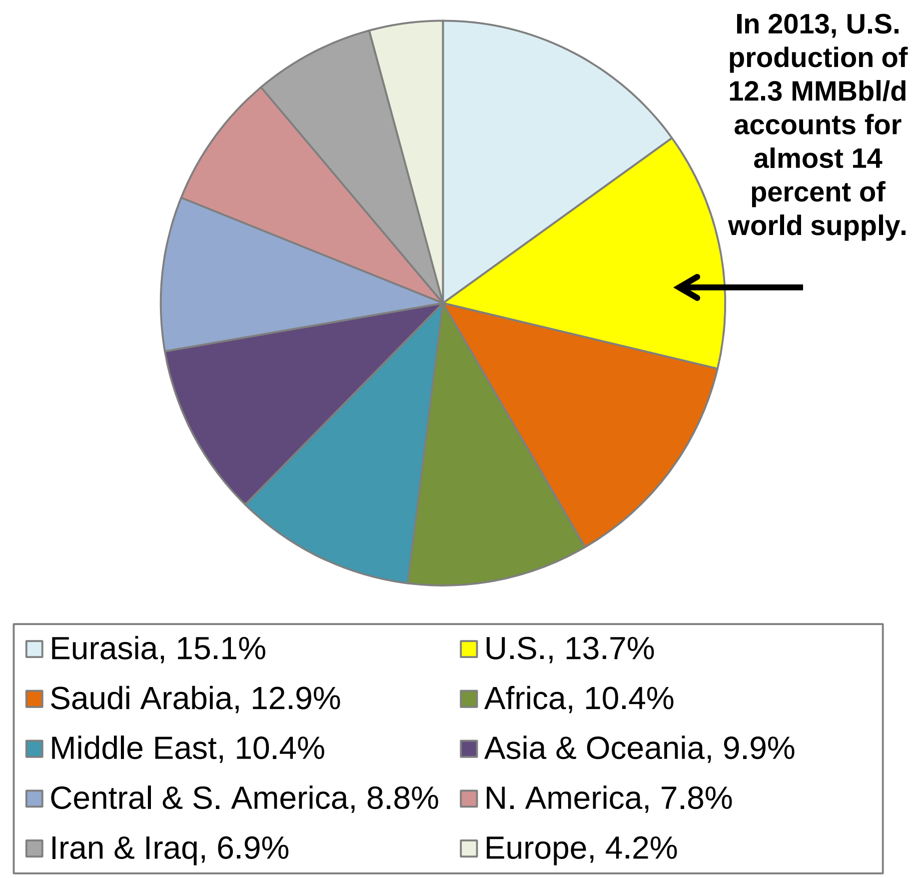


Source: Energy Information Administration, U.S. Department of Energy

International Oil Supply, 2005 and 2013

U.S. oil production has increased since 2005 surpassing Saudi Arabia, Africa and the rest of the Middle East.

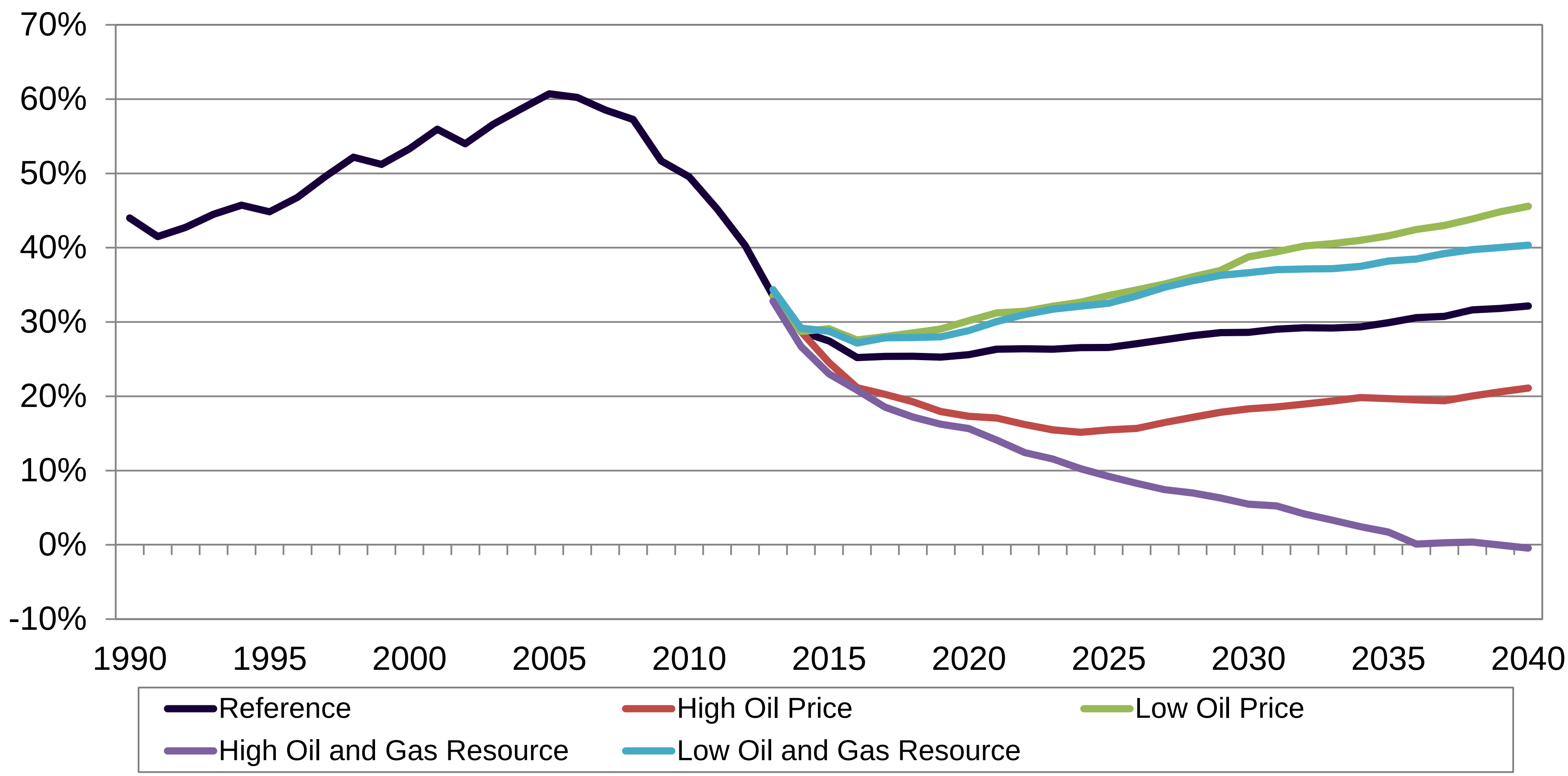




Source: Energy Information Administration, U.S. Department of Energy.

Net Import Share of U.S. Petroleum and Liquid Fuels, 1990 – 2040

The share of U.S. net crude oil and product imports has been falling since 2005. The EIA expects the net import share to decrease to 26 percent in 2023. If however, high prices encourage U.S. development, the share of net imports could drop to zero by 2036.



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

Overview: Why Future Economic Development Will Not be Uniformly Distributed

While the nature of manufacturing has admittedly changed given the **"out-sourcing" prior to the 2008-2009 financial meltdown**, the U.S. economy is beginning to emerge as a **new manufacturing powerhouse**.

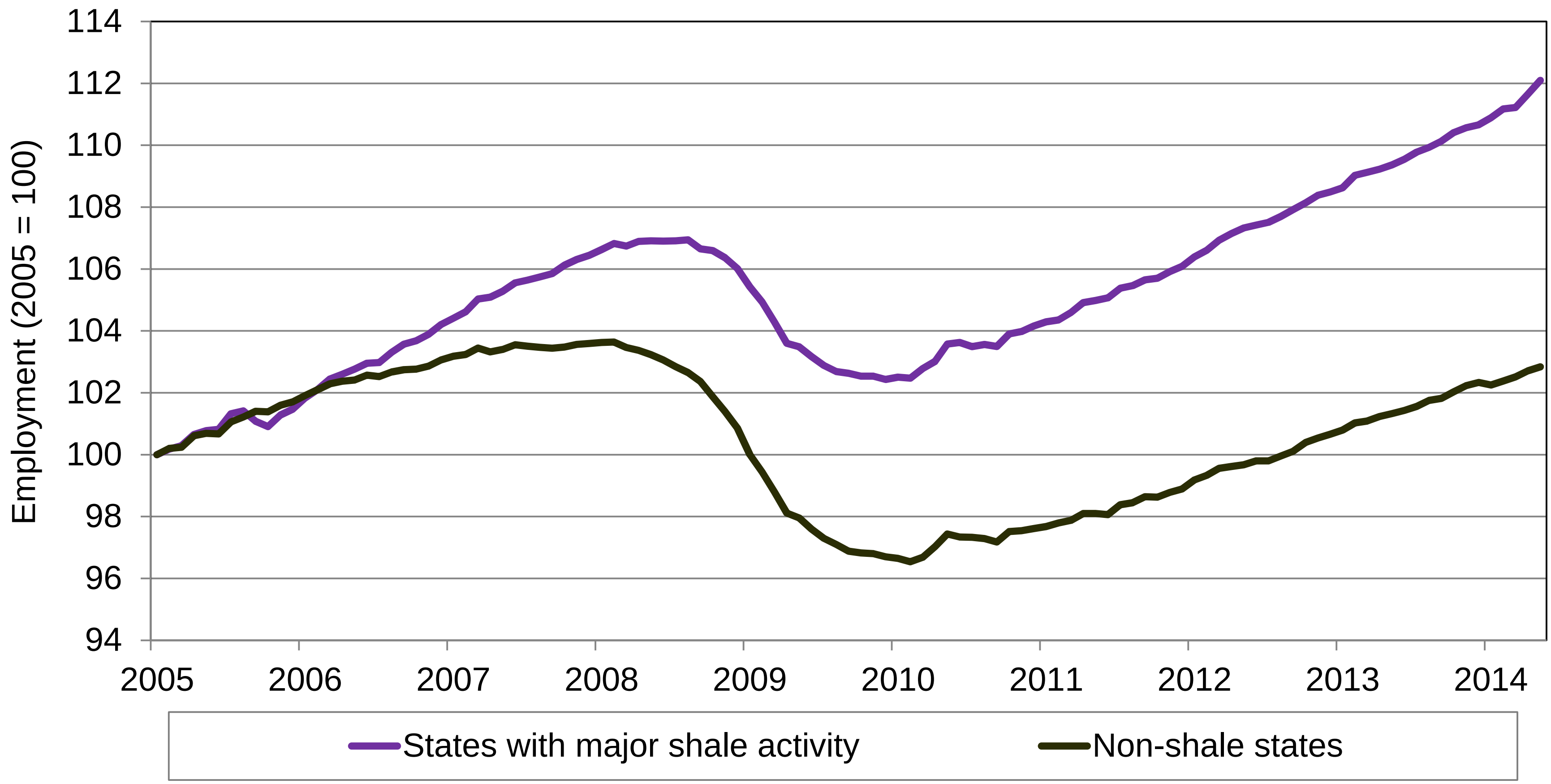
However, the U.S. economic recovery, and regional economic development opportunities over the next decade will likely be concentrated in a few states and regions. **What determines the "winners" and "losers" in this economic resurgence?**

The **"winners" will be those areas with access to low-cost energy supplies** and transportation infrastructure that can move those supplies to rapidly emerging economic development opportunities in manufacturing that were unimaginable as recently as five years ago.

Other important factors influencing manufacturing siting locations includes the presence of a **skilled labor force, competitive wage levels, supportive tax policies, as well as fair and stable regulations and regulatory practices.**.

Relative Employment Changes, Shale vs. Non-Shale States (2005=100)

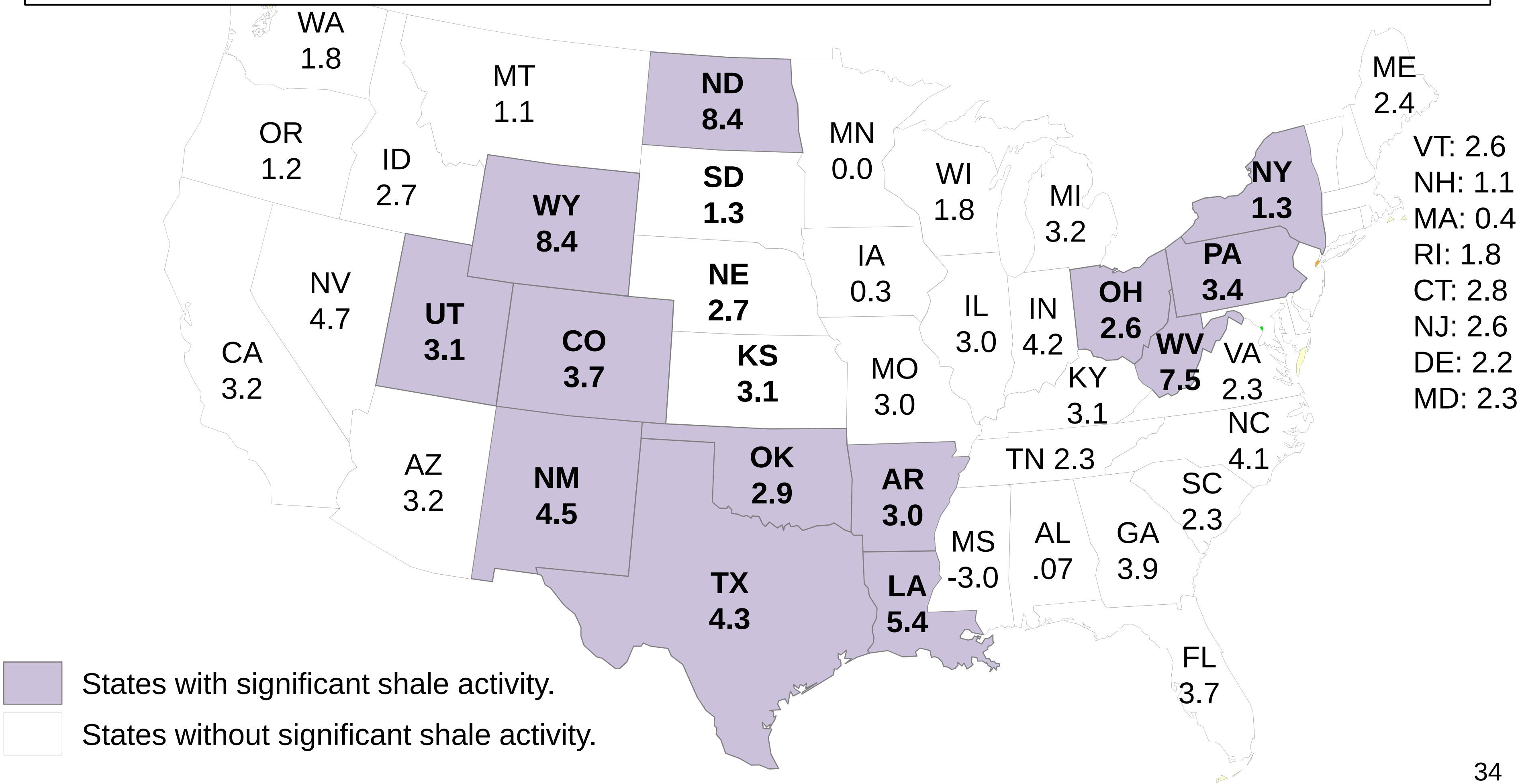
Total employment and employment growth has been faster in unconventional shale-based states than in those without these unconventional resources.



Note: Shale states include Arkansas, Colorado, Louisiana, North Dakota, Pennsylvania, Utah and Texas
Source: Bureau of Labor Statistics

Percent Change in Real Quarterly GDP by State, 2013:III TO 2013:IV

Many of the states with significant shale activity have the highest growth in quarterly GDP. North Dakota, Wyoming and West Virginia have the highest rates (8.4 percent, 8.4 percent and 7.5 percent, respectively). Louisiana is the third highest at 5.4 percent.



Overview: Why Energy-Based Manufacturing

What is **"energy-based manufacturing?"**

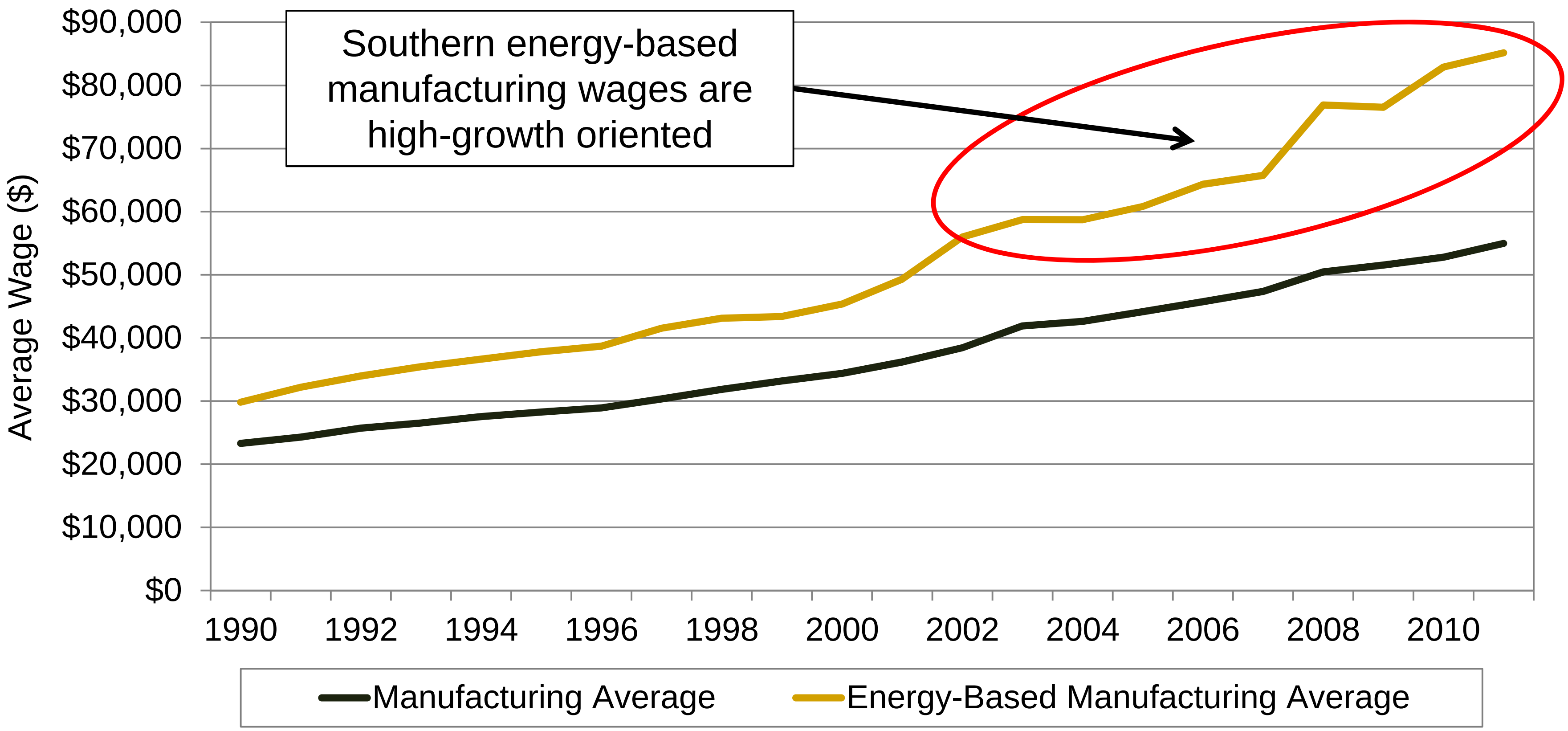
Energy-based manufacturing is comprised of industries that focus or rely heavily on **energy as the primary inpu**t to make their respective products.

Energy is typically a **"feedstock" for these industries** which use energy to make a number of different products much like a baker uses a common input (flour) to make a variety of different products (biscuits, baguettes, pizza dough).

These **energy-based manufacturing industries are large, capital-intensive, and compete globally**. Energy-based manufacturing wages are even higher than the already-above average manufacturing wage levels.

Southern Manufacturing Wages vs. Southern Energy-Based Manufacturing Wages

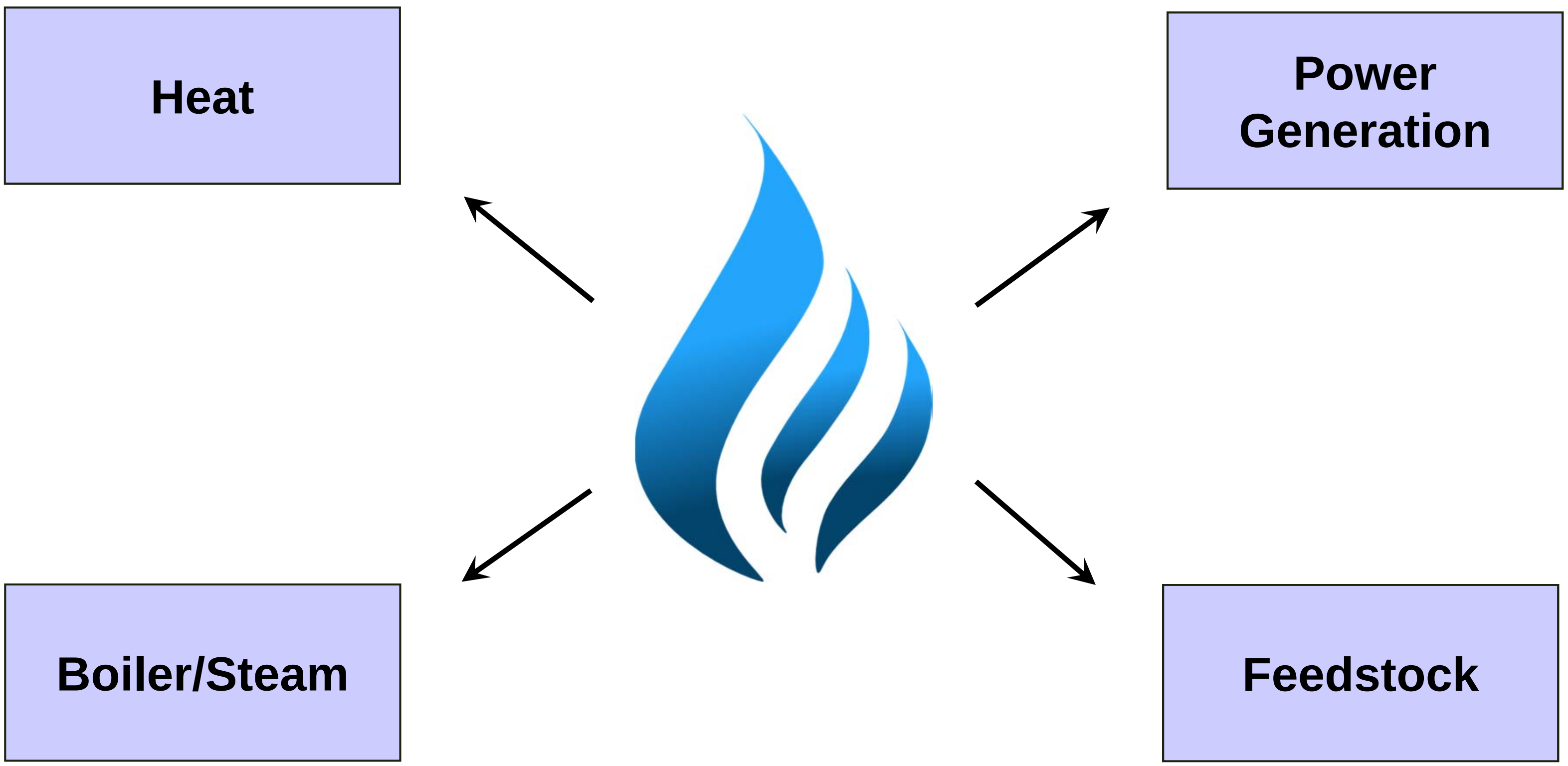
Energy-based manufacturing wages in the South are higher than the average manufacturing wage. In 2012, the average energy-based manufacturing wage was 1.5 times that of the average manufacturing wage growing at average annual rate of 5.2 percent (compared to the manufacturing average of 4.2 percent)



Note: Energy-based manufacturing includes: petroleum and coal products; chemical; and plastics and rubber products manufacturing.
Source: Bureau of Economic Analysis, U.S. Department of Commerce.

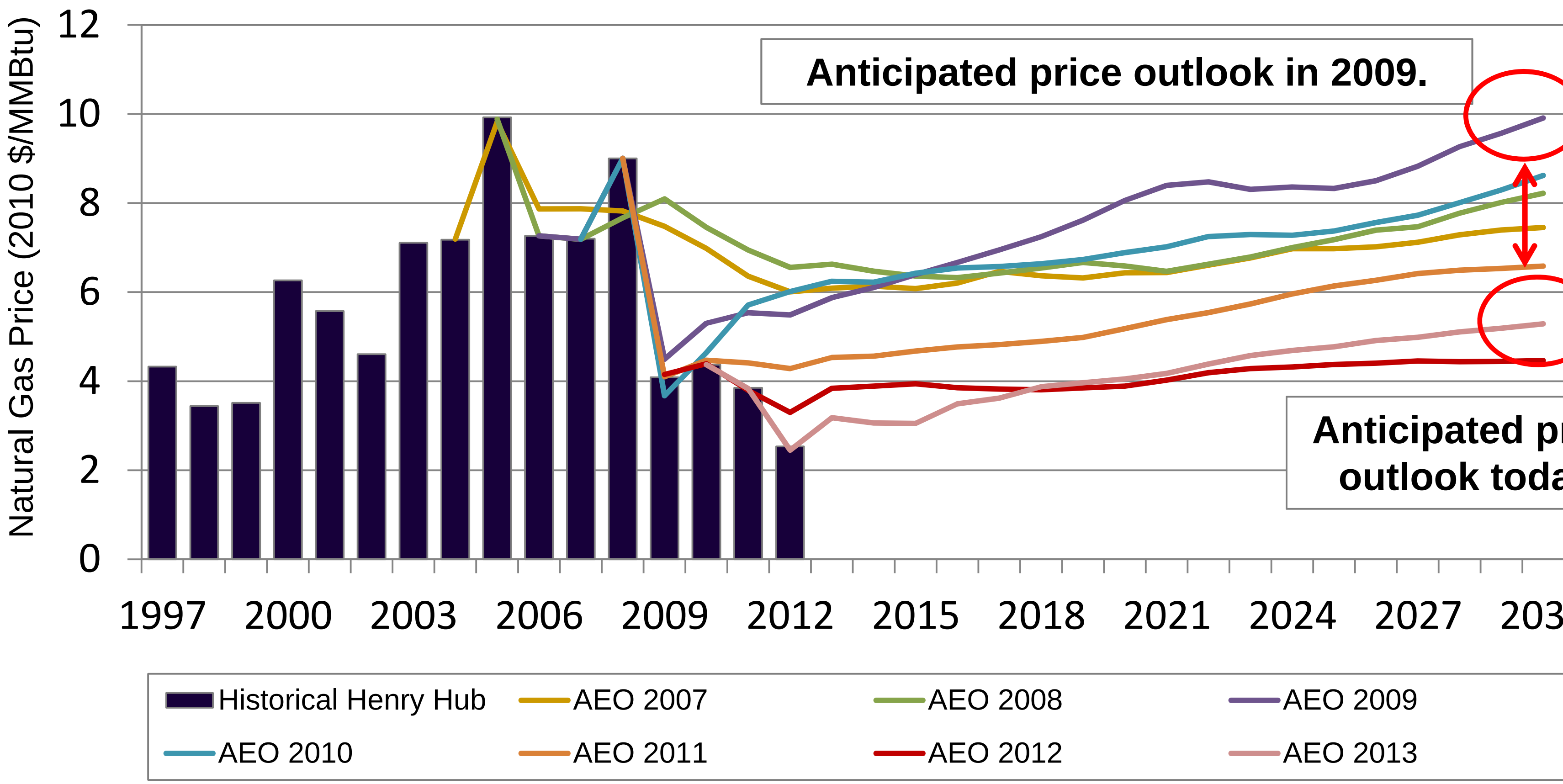
Industrial Natural Gas Usage

Manufacturing industries use natural gas in a range of applications that include the generation of heat, steam, and power. Feedstock uses are equally important and are the building blocks of modern petrochemical manufacturing.



Natural Gas Price Outlook – Annual Energy Outlook ("AEO")

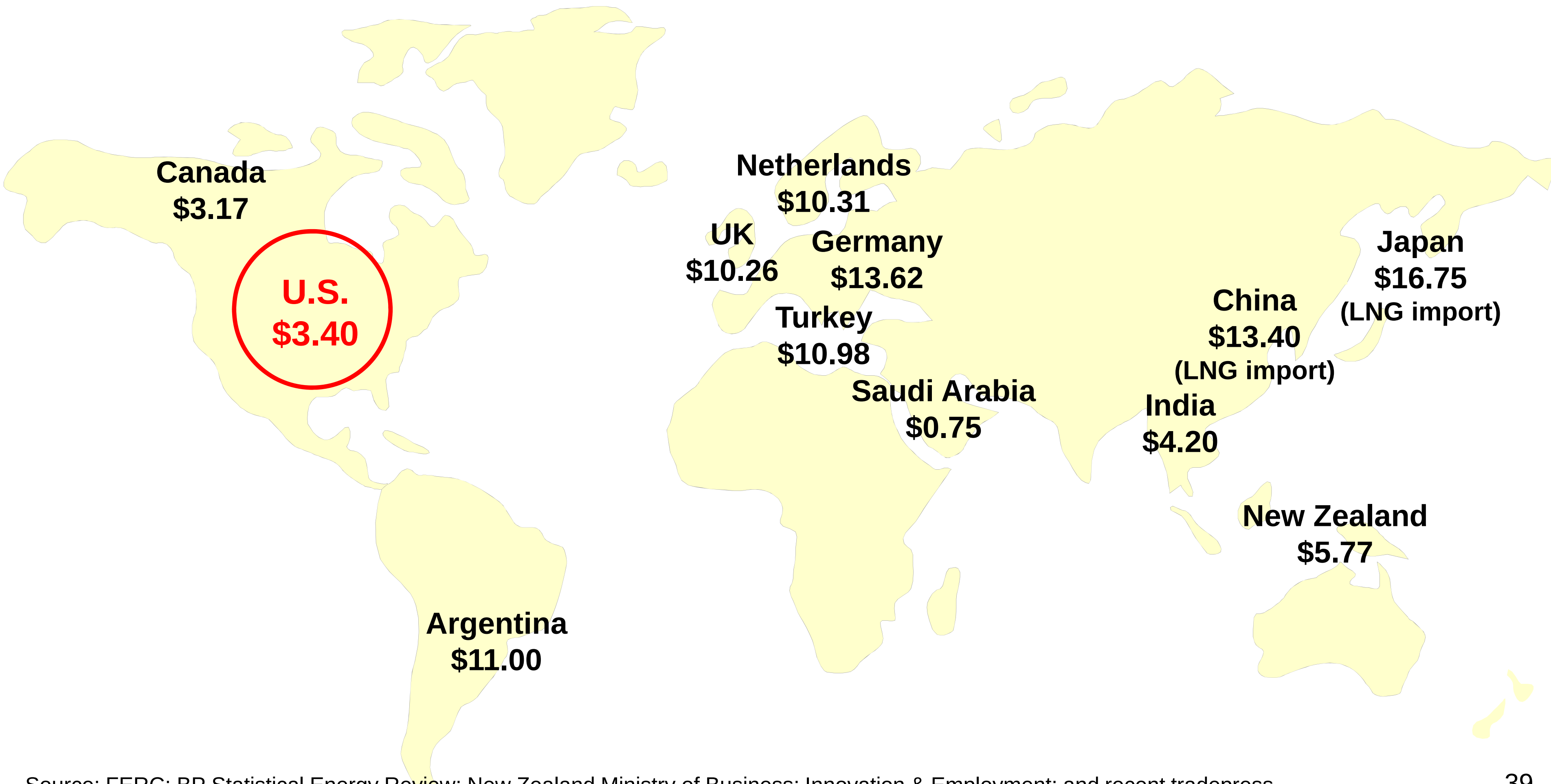
Shale reserves have a significant impact on future price outlook. Abundant supplies should keep prices stable. The current AEO forecasts natural gas prices in 2030 at $5.29/Mcf (47 percent less than the 2009 AEO forecast).



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

World Natural Gas Prices for Industry ($/MMBtu), 2012

U.S. natural gas prices are becoming increasingly competitive with other places around the globe that compete for new energy-based manufacturing investment.



Source: FERC; BP Statistical Energy Review; New Zealand Ministry of Business; Innovation & Employment; and recent tradepress.

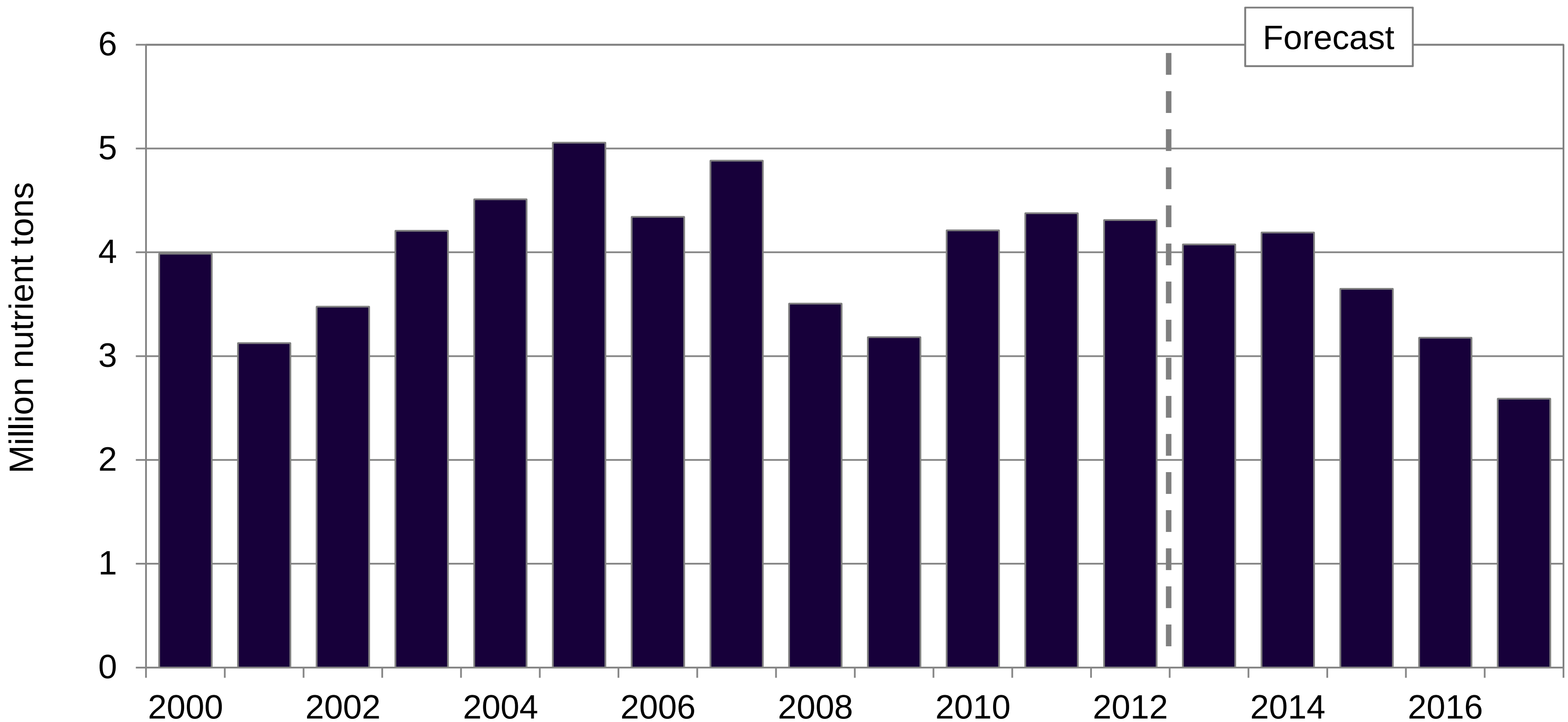
What the Strategic Factors Driving this Renewed Interest?

The factors driving renewed U.S. manufacturing, particularly chemical manufacturing include:

- Low natural gas price
- Increasing U.S. competitiveness
- (Relative) regulatory certainty
- Agricultural and other final chemical output price stability
- Product affordability
- Strong global demand for chemicals
- U.S. import displacement opportunities

Forecasted U.S. Imports

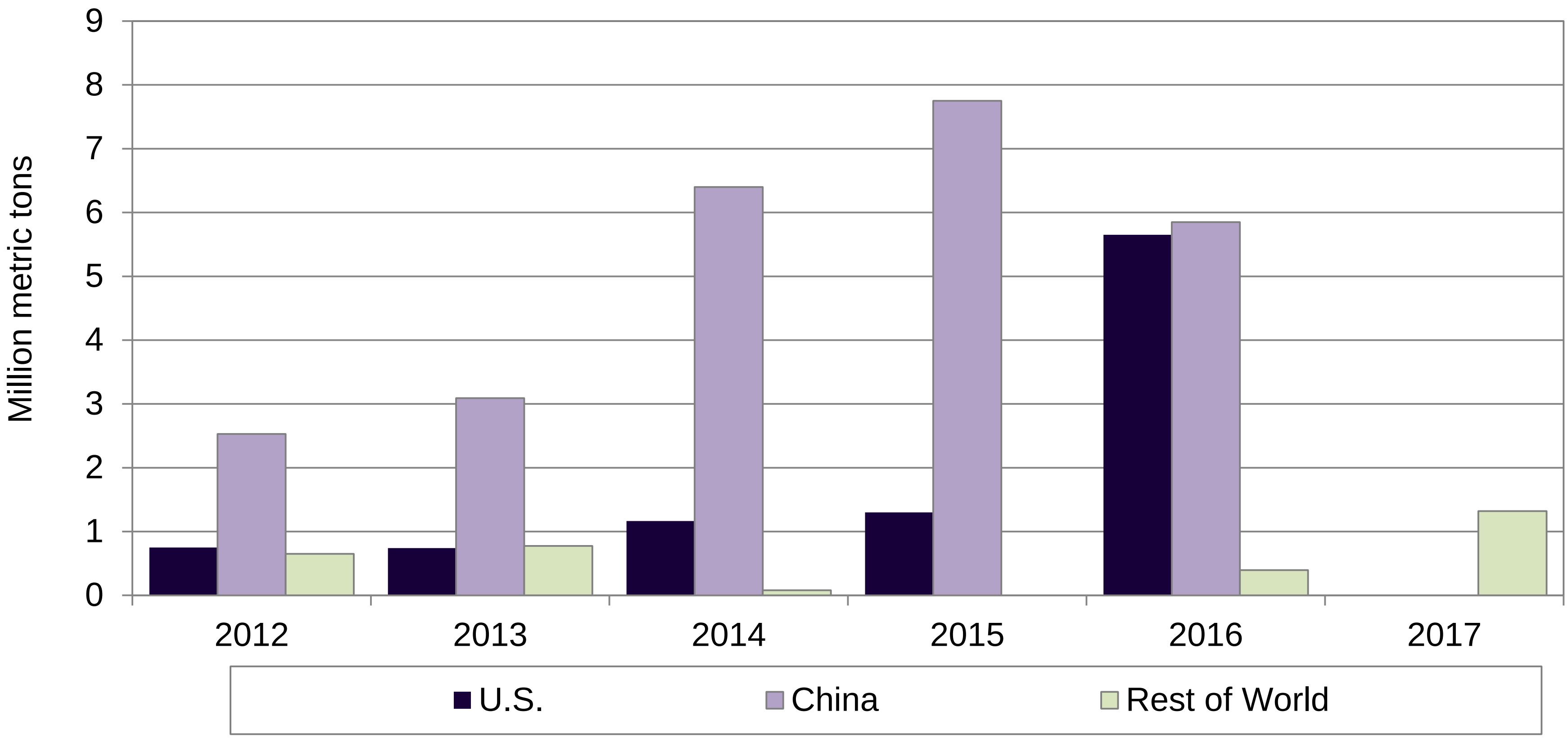
U.S. imports are expected to drop by as much as 12 to 18 percent in 2016 and 2017 when new capacity comes online.



Note: Forecasts based on various industry sources.
Source: International Fertilizer Industry Association; Food and Agriculture Organization of the United Nations; and CF Industries.

Existing U.S. Proposals as a Share of World

While U.S. based projects plan to add an impressive amount of methanol capacity, proposed projects in China will add almost three times as much, totaling 25 to 30 million metric tons. Projects in New Zealand, Brazil, Russia, Azerbaijan and India total 3.2 million metric tons. Still, U.S. projects account for 33 percent of worldwide projects.



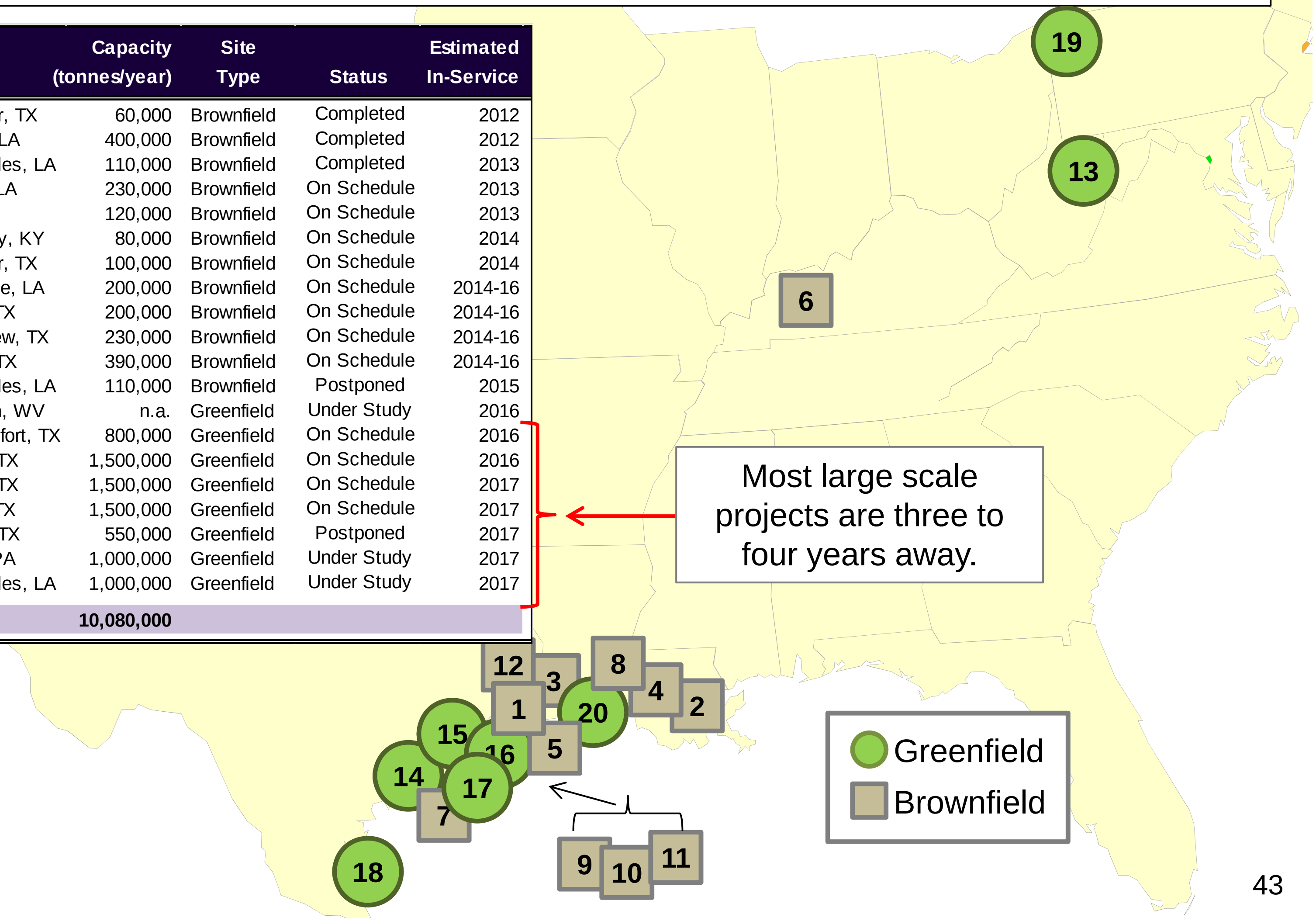
Source: American Oil & Gas Reporter; Oil and Gas Journal.

Recent and Proposed U.S. Ethylene Cracking Capacity Expansions

Over 10 million tons of ethylene cracking capacity is either under construction or has been proposed. This represents more than 35 percent of current ethylene capacity.

	Owner/Operator	Location	Capacity (tonnes/year)	Site Type	Status	Estimated In-Service
1.	BASF-Total	Port Arthur, TX	60,000	Brownfield	Completed	2012
2.	Dow Chemical	Hahnville, LA	400,000	Brownfield	Completed	2012
3.	Westlake Chemical	Lake Charles, LA	110,000	Brownfield	Completed	2013
4.	Williams	Geismar, LA	230,000	Brownfield	On Schedule	2013
5.	Ineos	Alvin, Tx	120,000	Brownfield	On Schedule	2013
6.	Westlake Chemical	Calvert City, KY	80,000	Brownfield	On Schedule	2014
7.	BASF-Total	Port Arthur, TX	100,000	Brownfield	On Schedule	2014
8.	Dow Chemical	Plaquemine, LA	200,000	Brownfield	On Schedule	2014-16
9.	Dow Chemical	Freeport, TX	200,000	Brownfield	On Schedule	2014-16
10.	LyondellBasell	Channelview, TX	230,000	Brownfield	On Schedule	2014-16
11.	LyondellBasell	La Porte, TX	390,000	Brownfield	On Schedule	2014-16
12.	Westlake Chemical	Lake Charles, LA	110,000	Brownfield	Postponed	2015
13.	Aither Chemical	Charleston, WV	n.a.	Greenfield	Under Study	2016
14.	Formosa Plastics	Point Comfort, TX	800,000	Greenfield	On Schedule	2016
15.	ExxonMobil Chemical	Baytown, TX	1,500,000	Greenfield	On Schedule	2016
16.	Chevron Phillips	Baytown, TX	1,500,000	Greenfield	On Schedule	2017
17.	Dow Chemical	Freeport, TX	1,500,000	Greenfield	On Schedule	2017
18.	OxyChem/Mexichem	Ingleside, TX	550,000	Greenfield	Postponed	2017
19.	Shell Chemical	Monaca, PA	1,000,000	Greenfield	Under Study	2017
20.	Sasol	Lake Charles, LA	1,000,000	Greenfield	Under Study	2017
	Total		**10,080,000**			

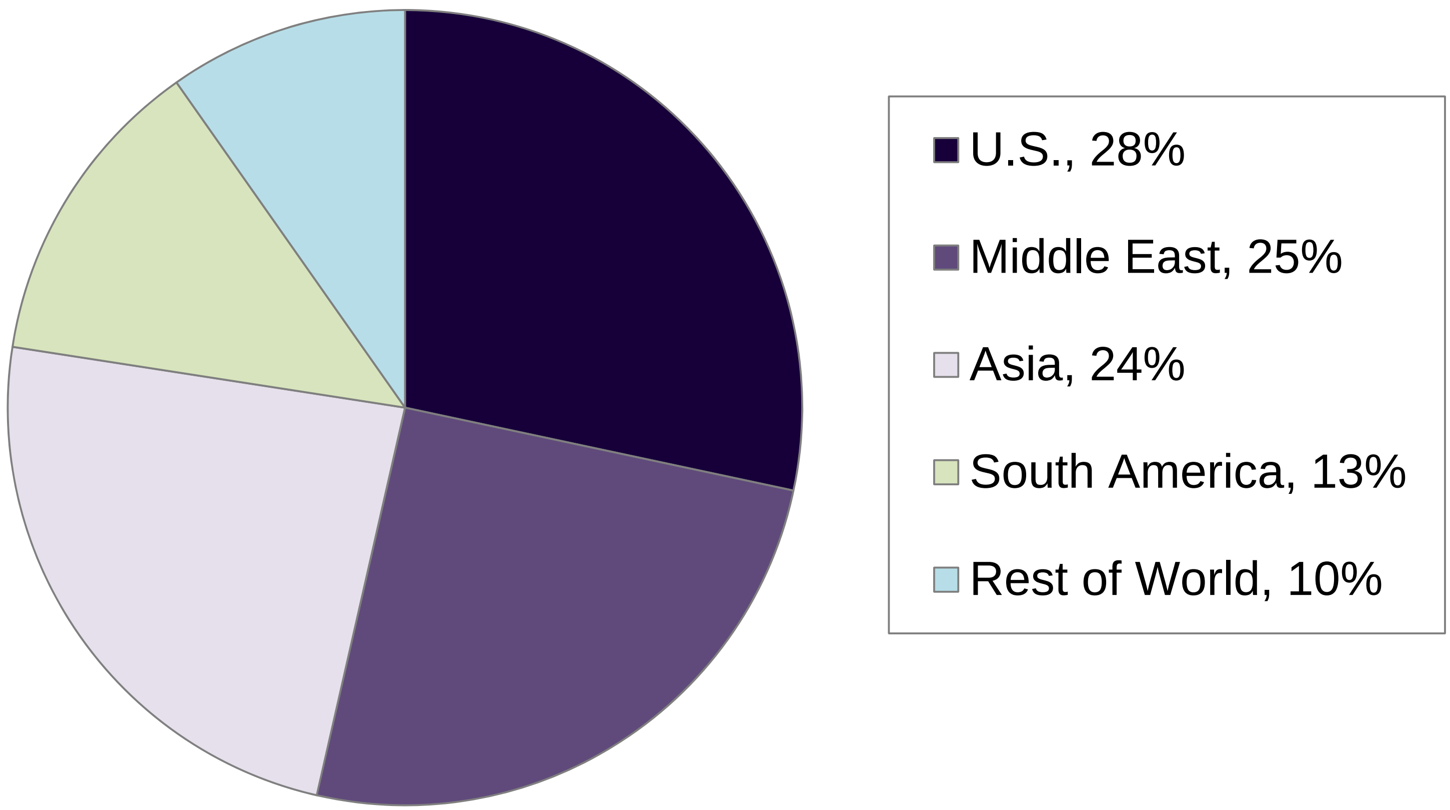
Most large scale projects are three to four years away.



Source: Platts, January 2013.

U.S. Proposals as a Share of World

Ethylene projects in the U.S. account for almost 30 percent of projects worldwide.



Source: Platts, 2013; Oil and Gas Journal; Company websites; and recent tradepress.

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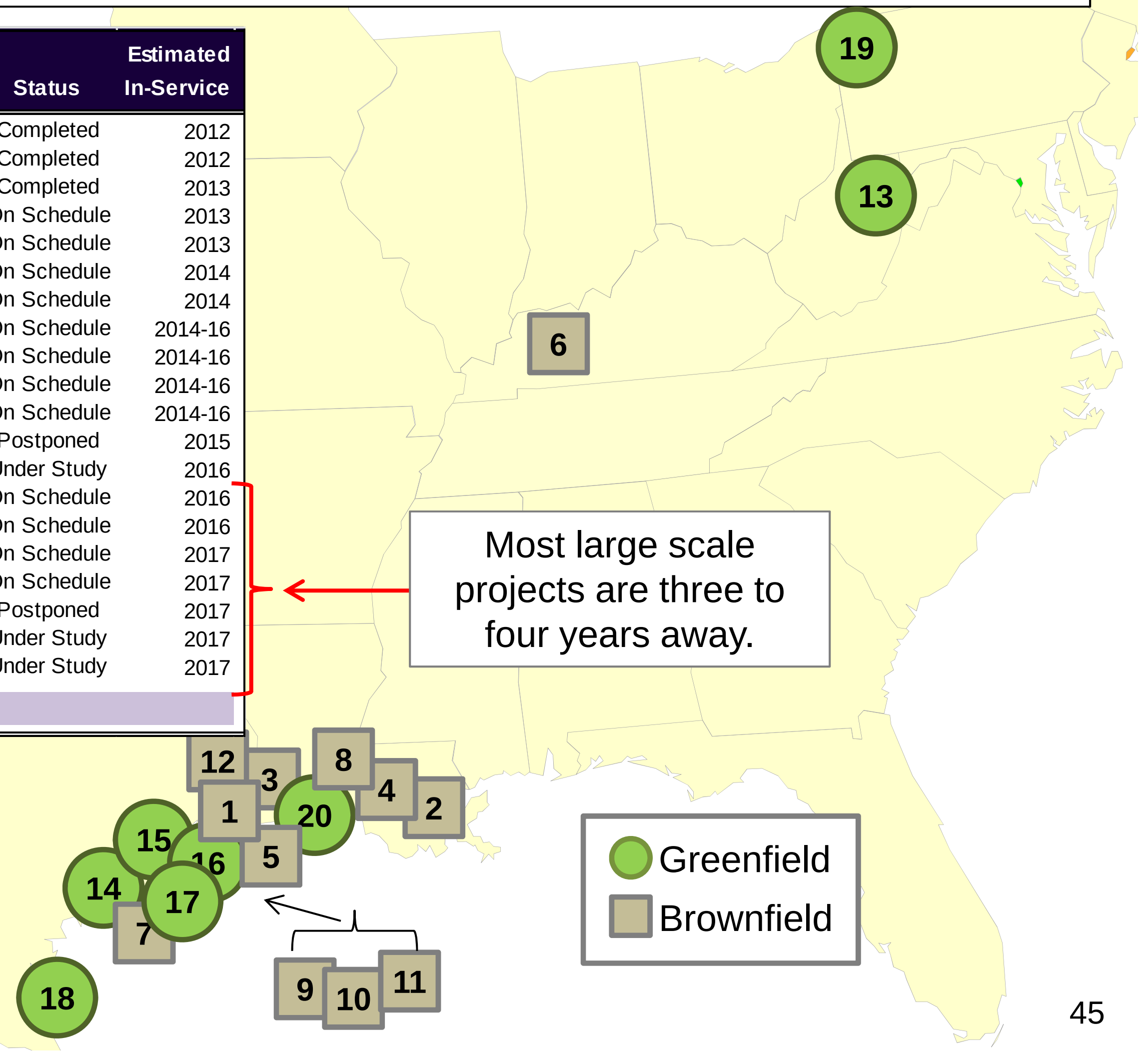
	Total		**10,080,000**			

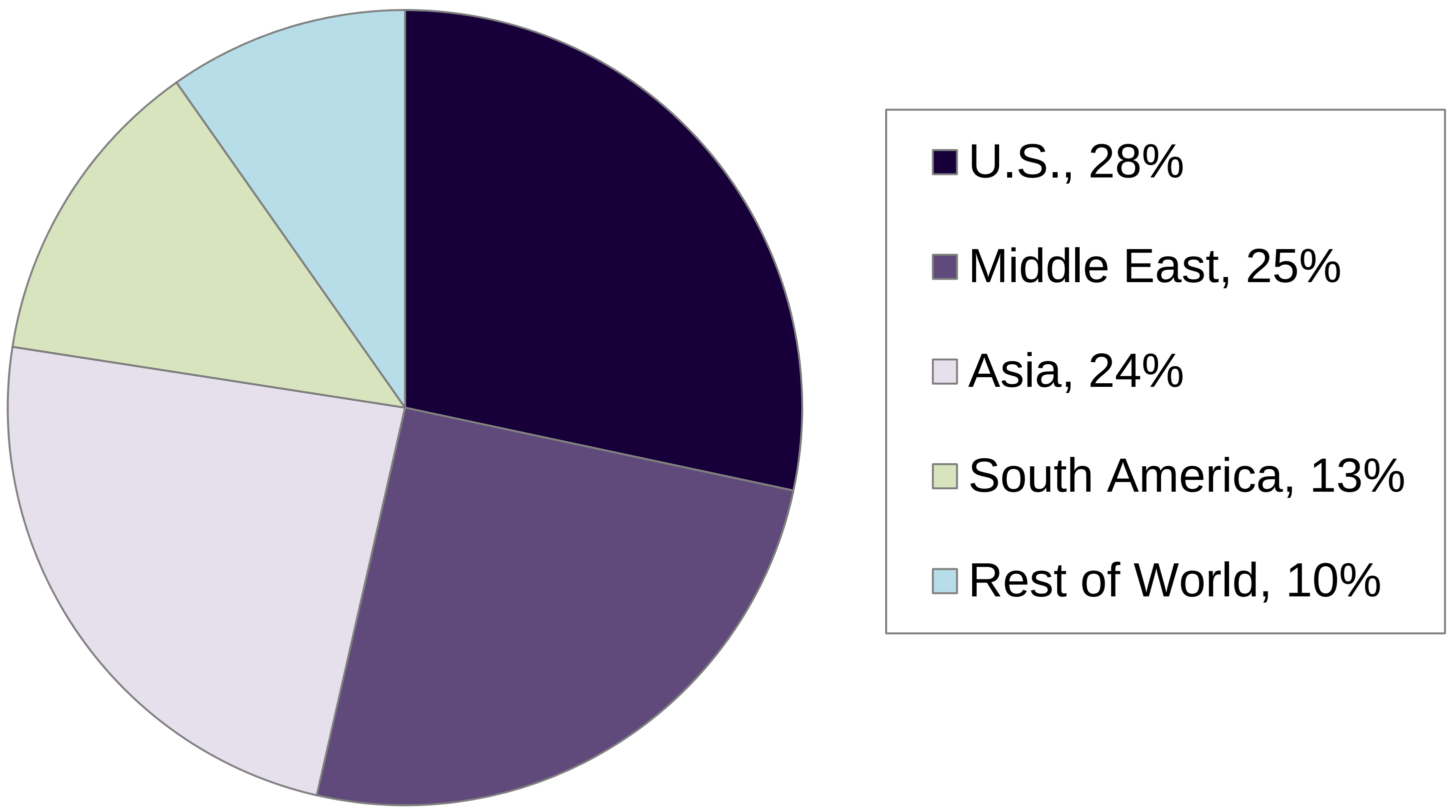
Most large scale projects are three to four years away.



Source: Platts, January 2013.

U.S. Proposals as a Share of World

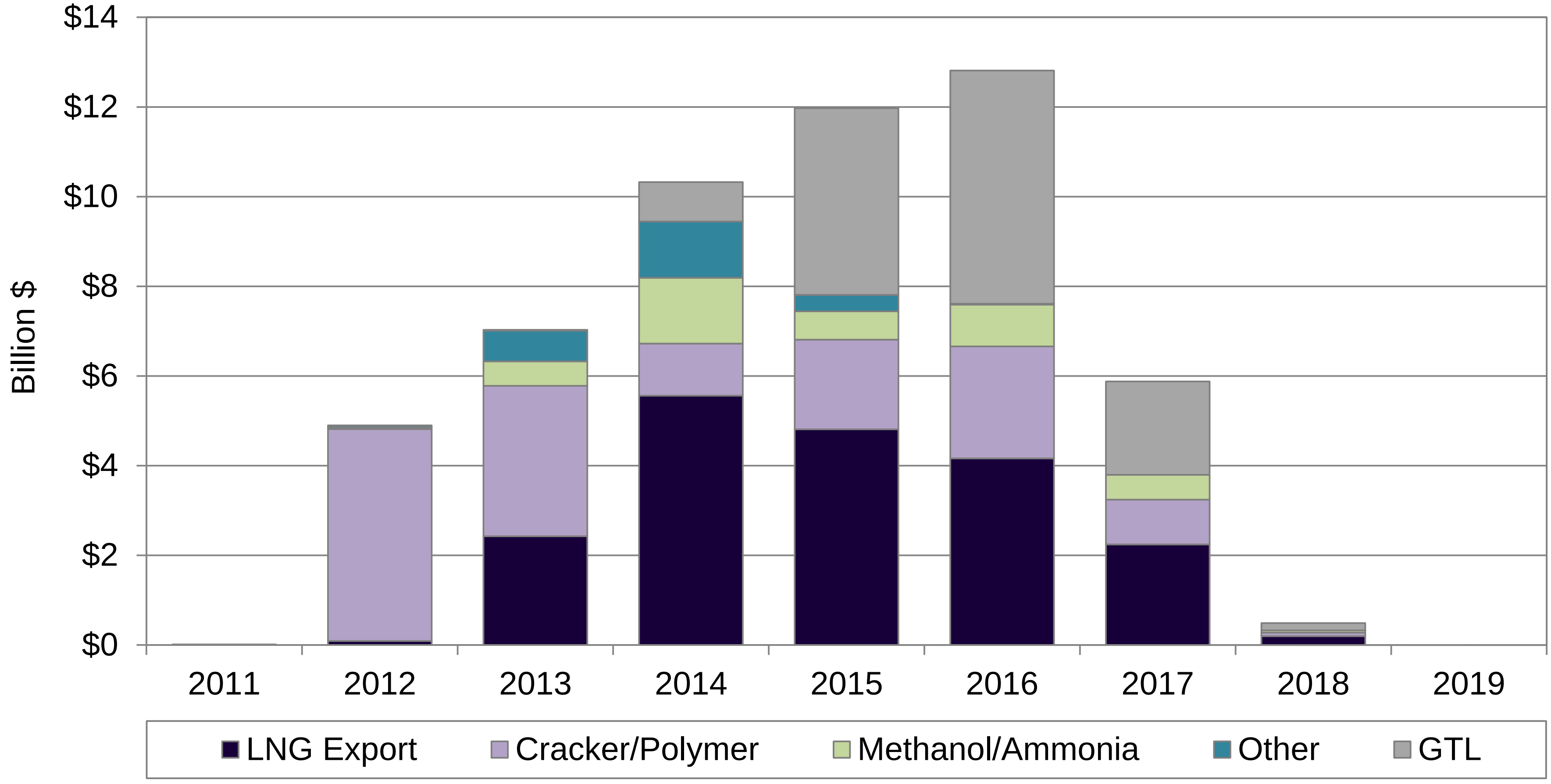
Ethylene projects in the U.S. account for almost 30 percent of projects worldwide.



Source: Platts, 2013; Oil and Gas Journal; Company websites; and recent tradepress.

LSU-CES Study (2013): Louisiana Total Capital Expenditures by Sector

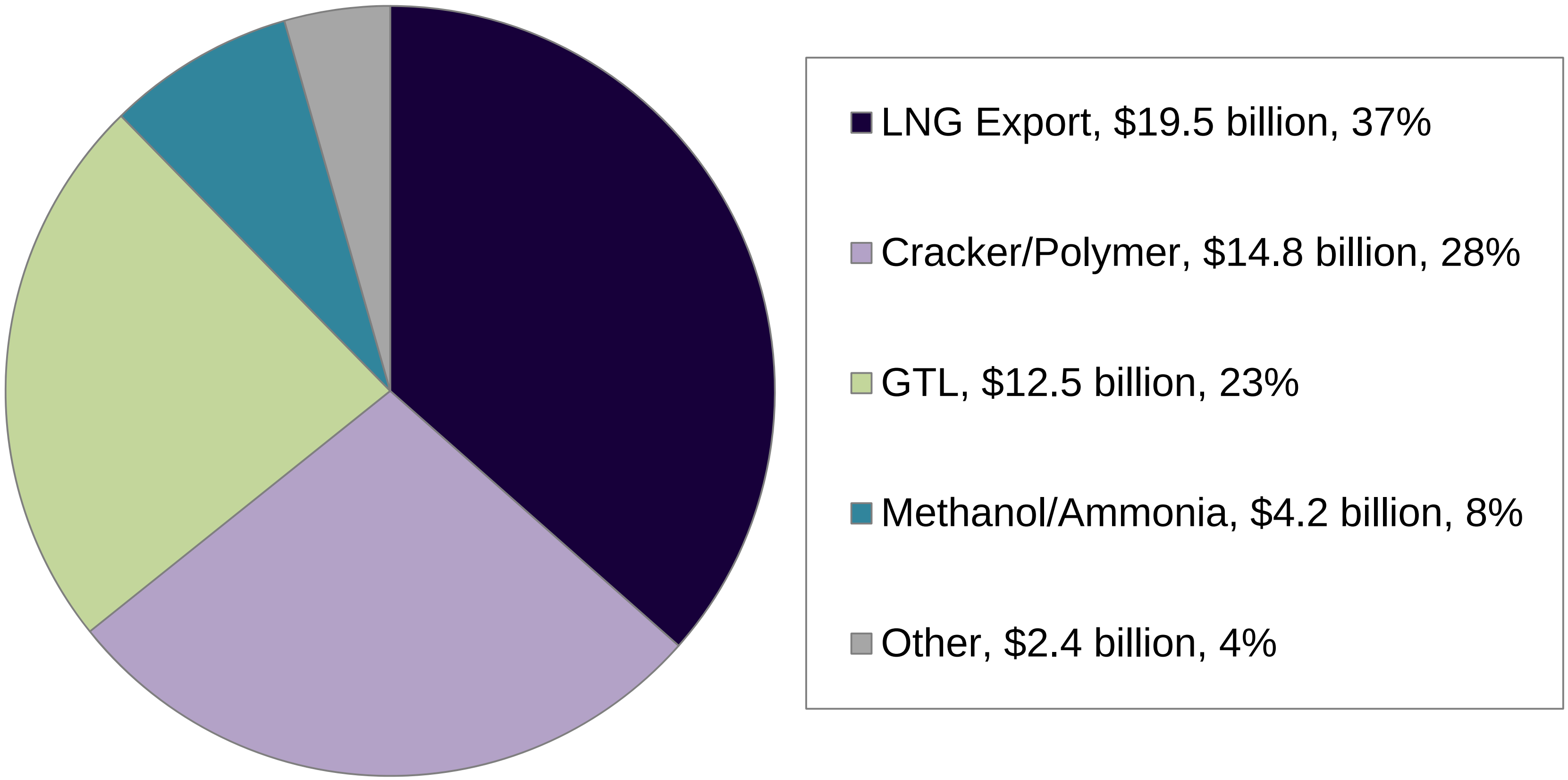
The LSU Center for Energy Studies (CES) reports an estimated $53.4 billion in new energy-based manufacturing development, most of which is anticipated to occur between 2014 and 2019.



Source: David E. Dismukes (2013). *Unconventional Resources and Louisiana's Manufacturing Development Renaissance*. Baton Rouge, LA: Louisiana State University, Center for Energy Studies.

Manufacturing Renaissance

The LSU-CES study identified gas-to-liquids and LNG export as the majority of proposed capital spending.



Source: David E. Dismukes (2013). *Unconventional Resources and Louisiana's Manufacturing Development Renaissance*. Baton Rouge, LA: Louisiana State University, Center for Energy Studies.

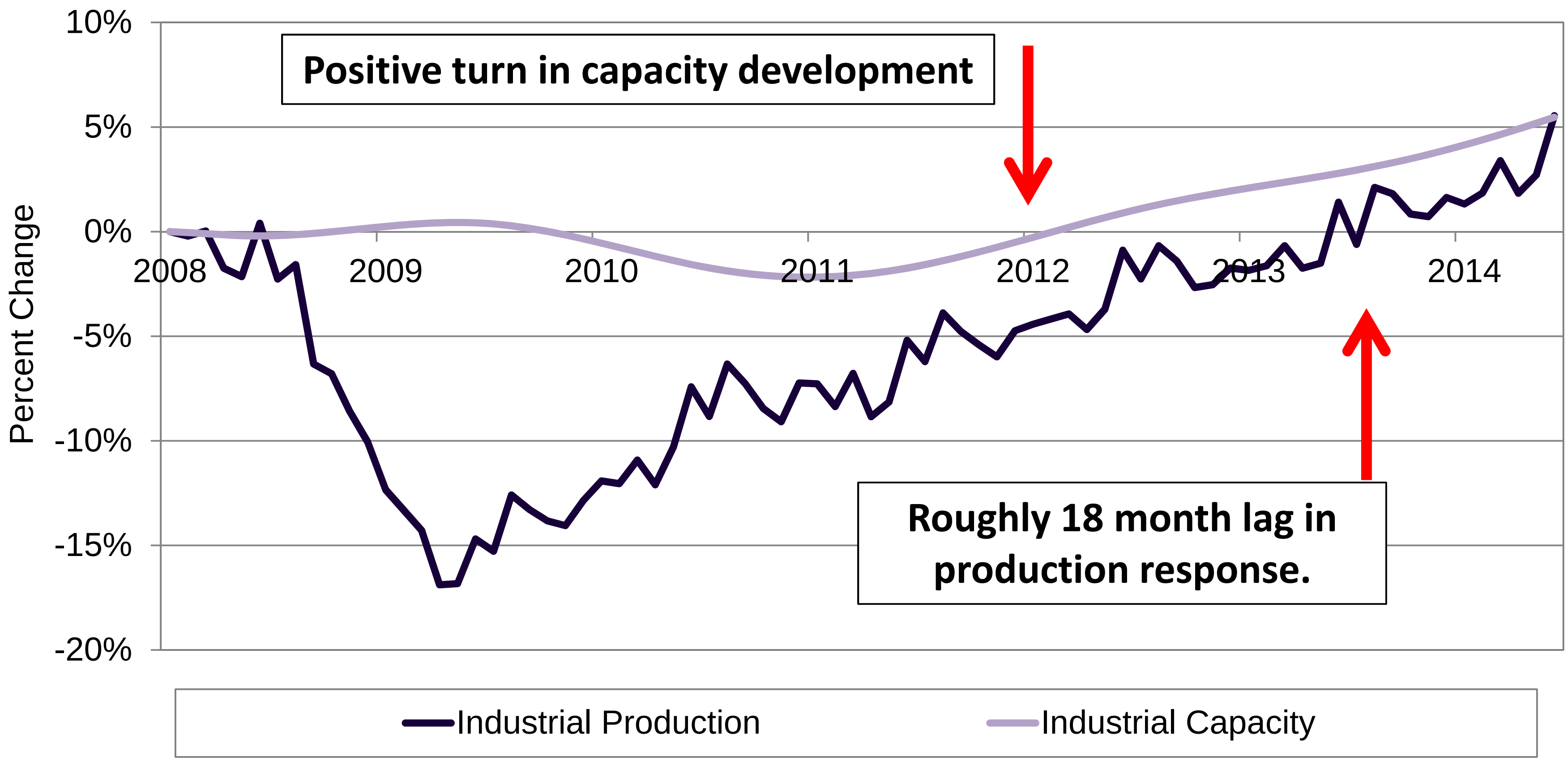
Potential Economic Impacts/Benefit: Construction, State

Not quiet as clear will be the additional power/gas requirements for all the new residential and commercial activities supporting development/operation. Should elevate regional usage trends relative to national averages.

	Construction Impacts									
	Total	2011	2012	2013	2014	2015	2016	2017	2018	2019
Output (million $)										
Direct	$ 17,727.7	$ 4.4	$ 1,715.4	$ 2,458.1	$ 3,538.2	$ 3,872.0	$ 4,091.7	$ 1,890.0	$ 157.9	$ -
Indirect	$ 2,846.2	$ 0.7	$ 275.4	$ 394.6	$ 568.1	$ 621.6	$ 656.9	$ 303.4	$ 25.4	$ -
Induced	$ 5,516.8	$ 1.4	$ 533.8	$ 765.0	$ 1,101.1	$ 1,204.9	$ 1,273.3	$ 588.2	$ 49.1	$ -
Total	**$ 26,090.6**	**$ 6.4**	**$ 2,524.6**	**$ 3,617.7**	**$ 5,207.3**	**$ 5,698.5**	**$ 6,021.9**	**$ 2,781.6**	**$ 232.4**	**$ -**
Employment (jobs)										
Direct	120,114	30	11,623	16,655	23,973	26,234	27,723	12,806	1,070	-
Indirect	19,201	5	1,858	2,662	3,832	4,194	4,432	2,047	171	-
Induced	49,032	12	4,745	6,799	9,786	10,709	11,317	5,227	437	-
Total	**188,347**	**47**	**18,225**	**26,116**	**37,591**	**41,138**	**43,472**	**20,080**	**1,678**	**-**
Wages (million $)										
Direct	$ 5,777.7	$ 1.4	$ 559.1	$ 801.1	$ 1,153.1	$ 1,261.9	$ 1,333.5	$ 616.0	$ 51.5	$ -
Indirect	$ 835.2	$ 0.2	$ 80.8	$ 115.8	$ 166.7	$ 182.4	$ 192.8	$ 89.0	$ 7.4	$ -
Induced	$ 1,549.7	$ 0.4	$ 150.0	$ 214.9	$ 309.3	$ 338.5	$ 357.7	$ 165.2	$ 13.8	$ -
Total	**$ 8,162.6**	**$ 2.0**	**$ 789.8**	**$ 1,131.8**	**$ 1,629.1**	**$ 1,782.8**	**$ 1,884.0**	**$ 870.2**	**$ 72.7**	**$ -**

Industrial Production and Capacity Indices

Industrial capacity development "leads" later production (and employment trends). Recent development announcements suggest a strong steady opportunity for U.S. manufacturing output and employment growth.



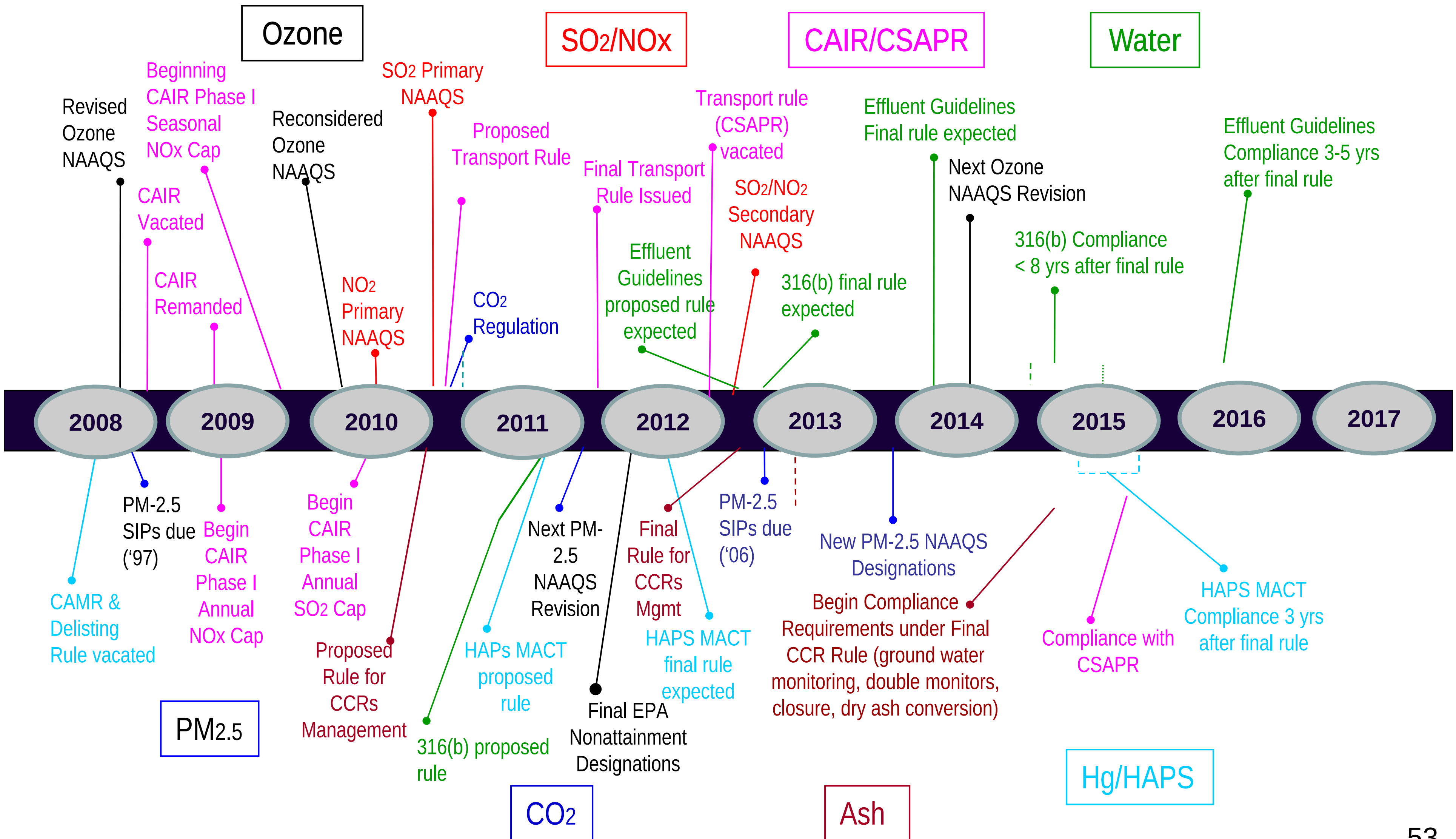
Source: Federal Reserve Bank.

Changes in Power Generation

New Natural Gas End Uses & Fuel Diversity Concerns

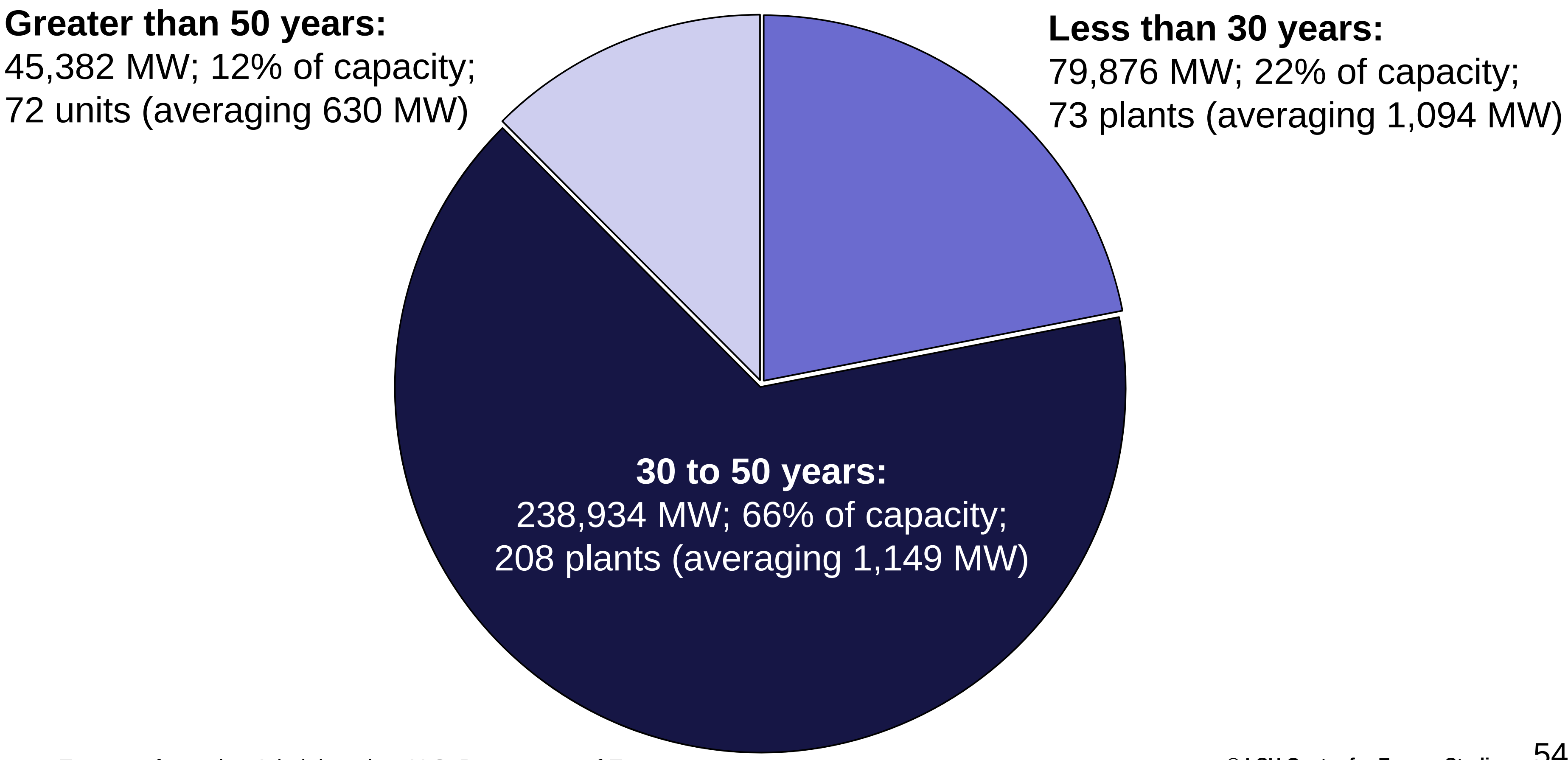
- As noted earlier, **the industrial "renaissance"** is likely to lead to the first increase in industrial natural gas demand in decades. The extent and degree of this is indeterminate. Consider that **a new GTL plant** or a new LNG facility, use roughly 2/Bcfd alone at full capacity (730 Bcf of annual load each).
- However, **power generation** has been – and will continue to be – **a significant natural gas end use**.
- **Environmental regulations** are having a considerable impact on developers' capacity development decisions.
- The low cost of natural gas is clearly provides a **preference to new gas over new coal.**

Electric Industry Environmental Regulations Create Uncertainty for Coal



Coal-Fired Capacity Share by Age Category

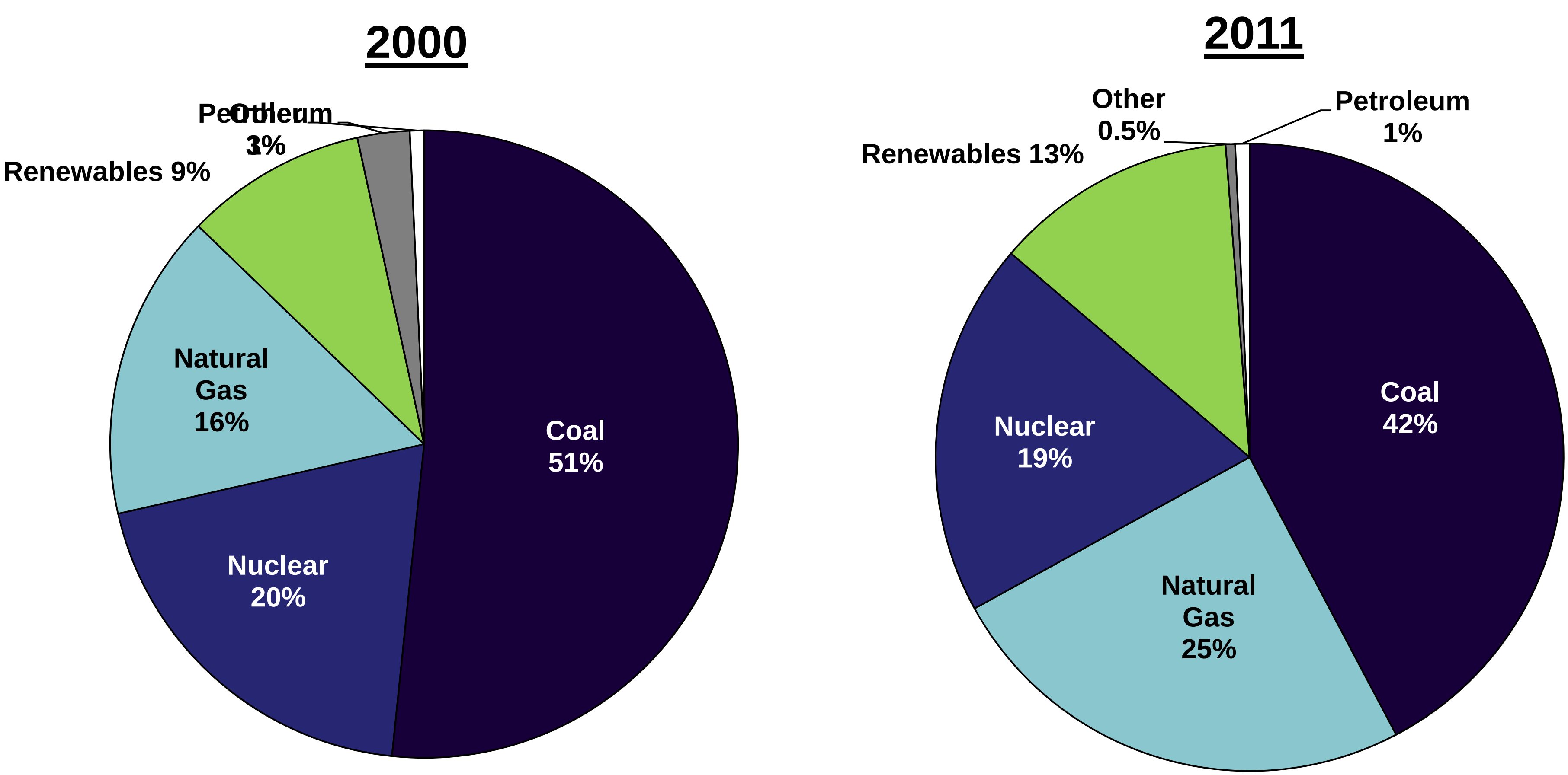
There is a considerable amount of legacy coal capacity (45 GWs) that is relatively old, and in some instances, has few to little controls to meet anticipated standards.



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

U.S. Power Generation – Fuel Mix

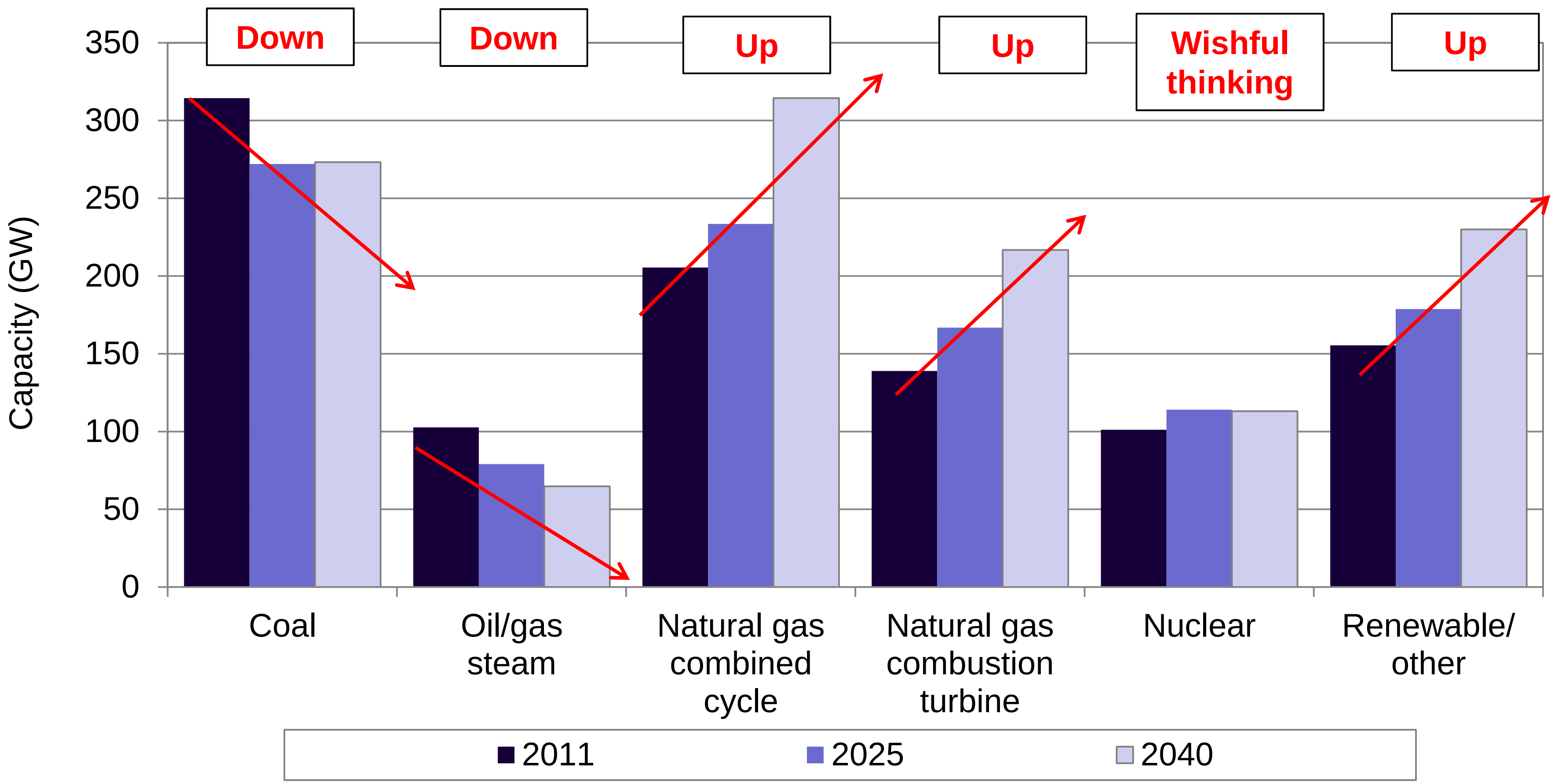
Over 250,000 MWs of natural gas power generation capacity has been added over the past decade at the expense of coal and nuclear.



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

U.S. Generation Capacity by Fuel Type: 2011, 2025 and 2040

EIA estimates the growth in new generation to come primarily from natural gas (~170 GWs) and renewables (~75 GWs).



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

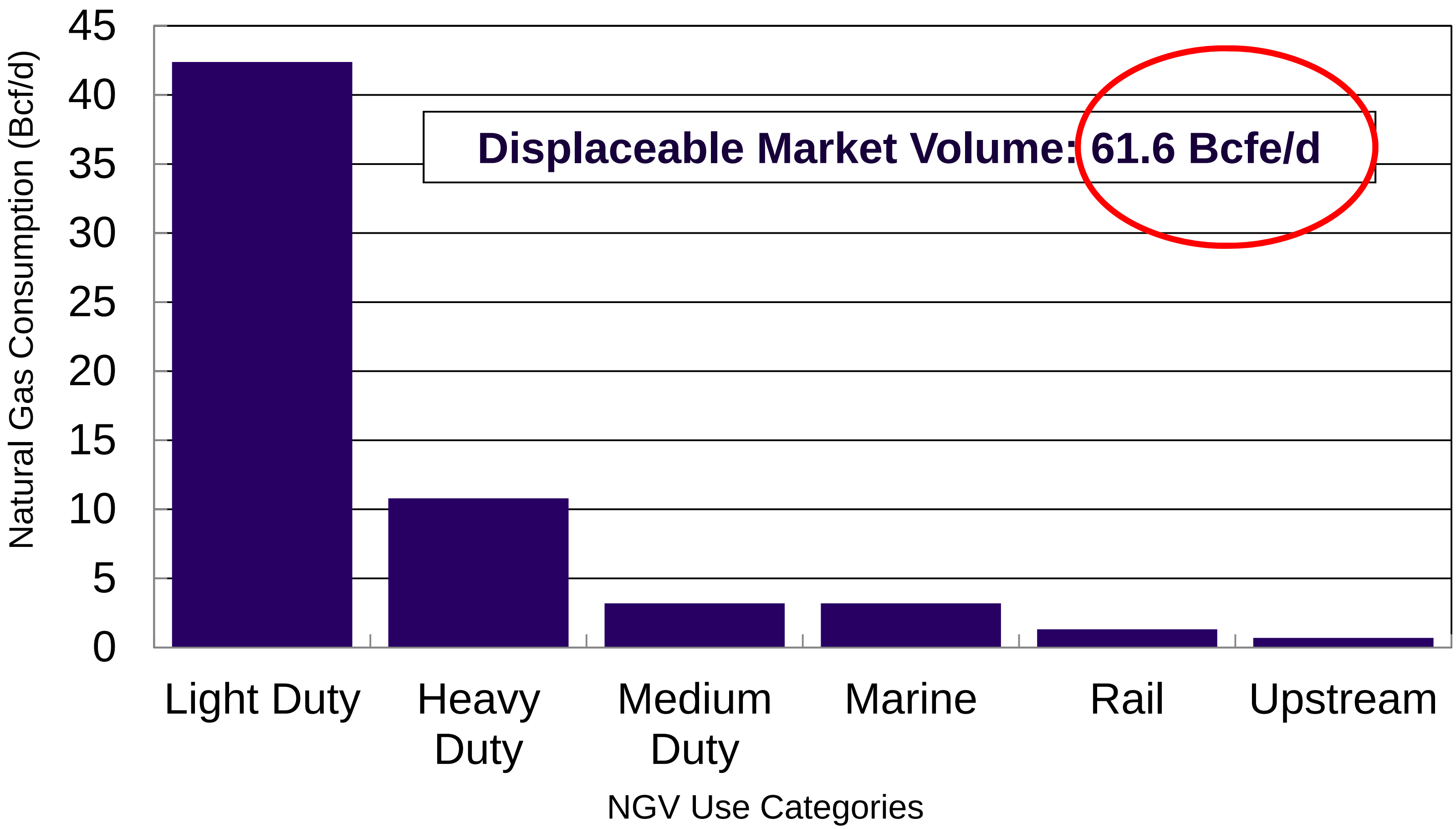
Growth Opportunities or Fly in the Ointment?
New Natural Gas Uses

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.**

Potential NGV Usage

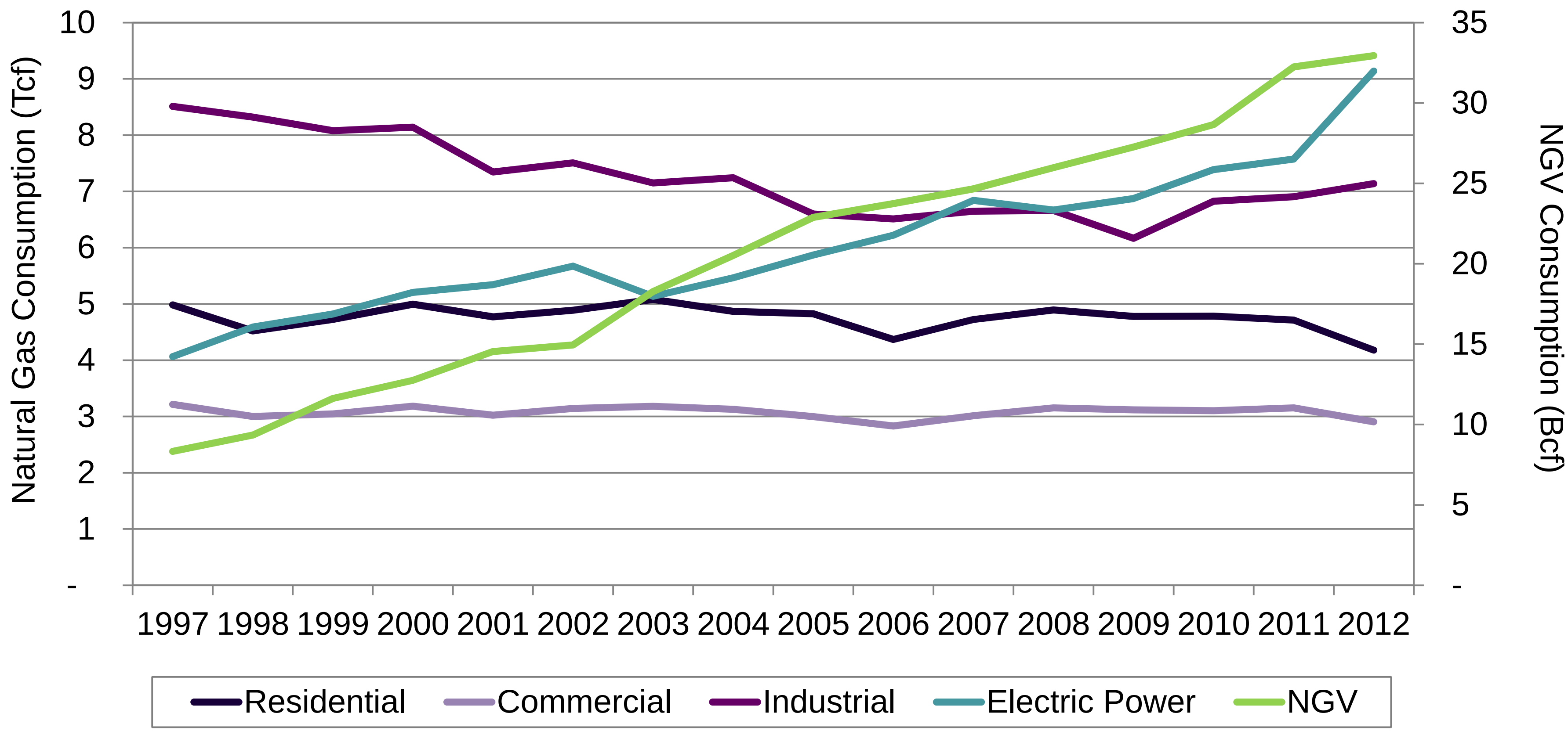
The large potential size of NGV market has a number of competing end-use categories (i.e., chemicals, manufacturing) concerned.



Source: Data and forecast from EIA, Encana, 2010
Displacement opportunities exclude Air, International Shipping, Military, Pipeline Fuel.

Natural Gas Consumption by Sector

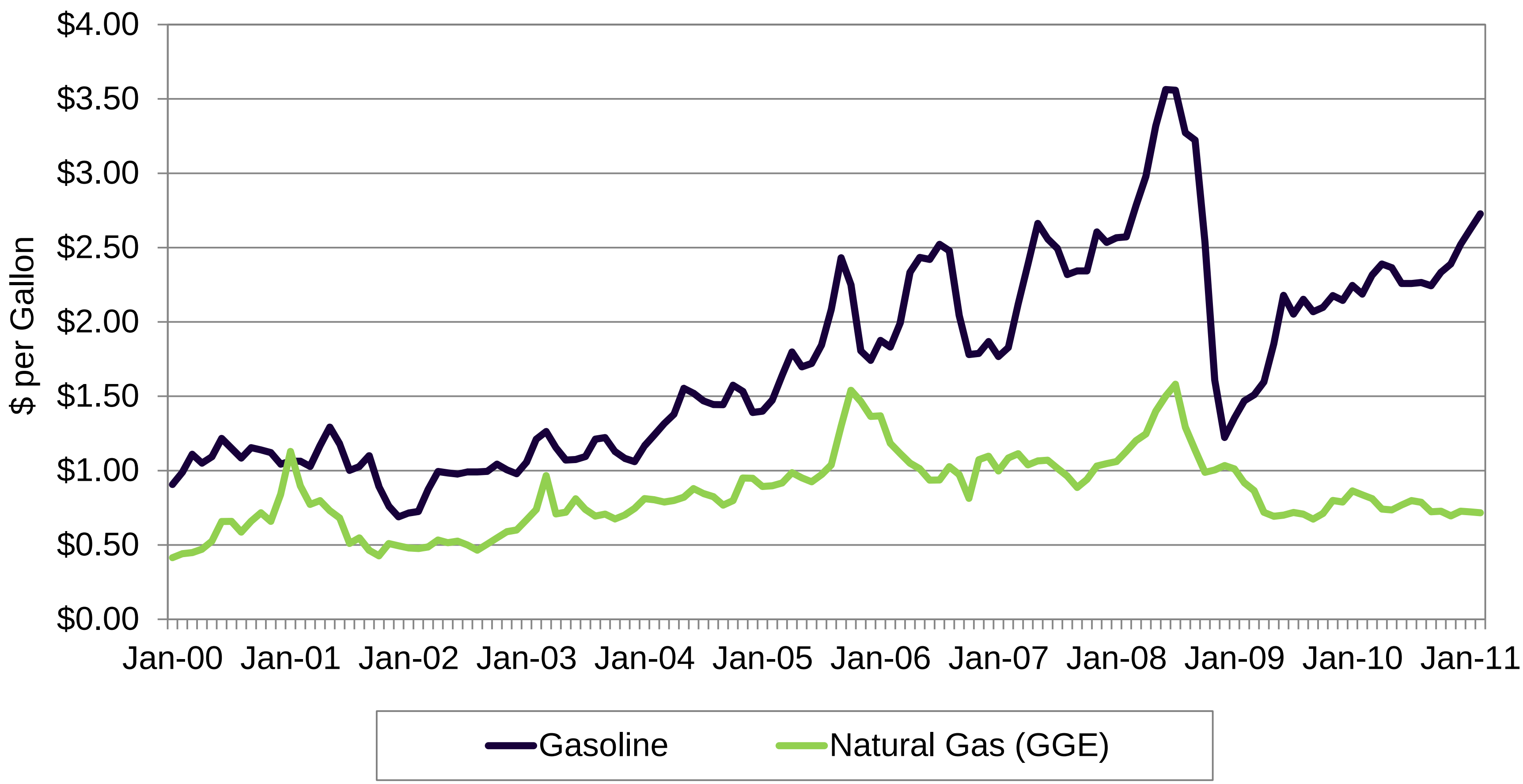
Currently, NGVs account for less than 0.18 percent of U.S. natural gas consumption, but the rate of growth in consumption (158 percent) over the past decade has surpassed all other end-uses.



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

Retail Gasoline Prices and Natural Gas GGE

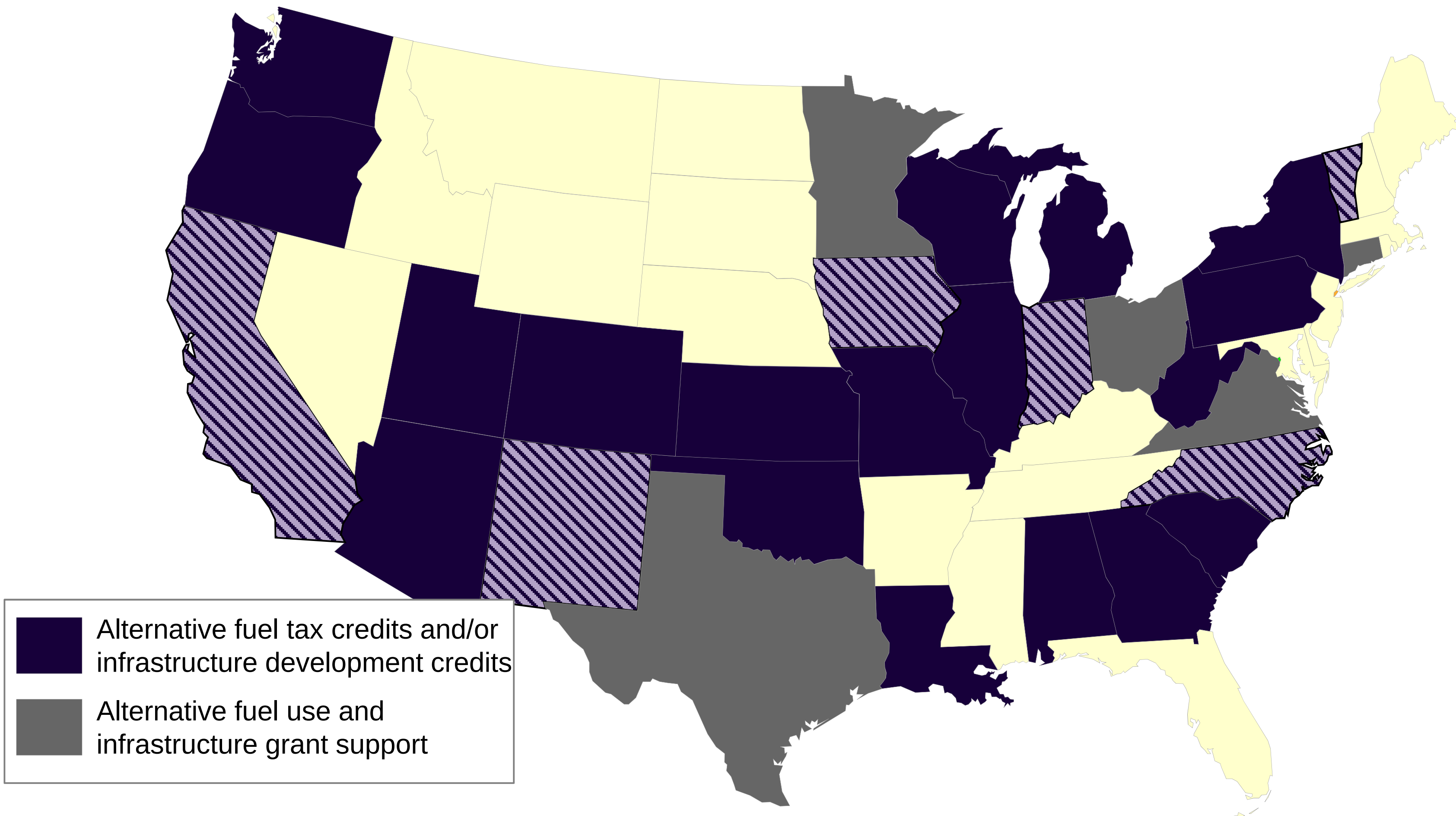
Basic economics, primarily lower relative prices, have played an important role in driving recent increases in natural gas vehicle use.



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

Leading States in NGV Preferences

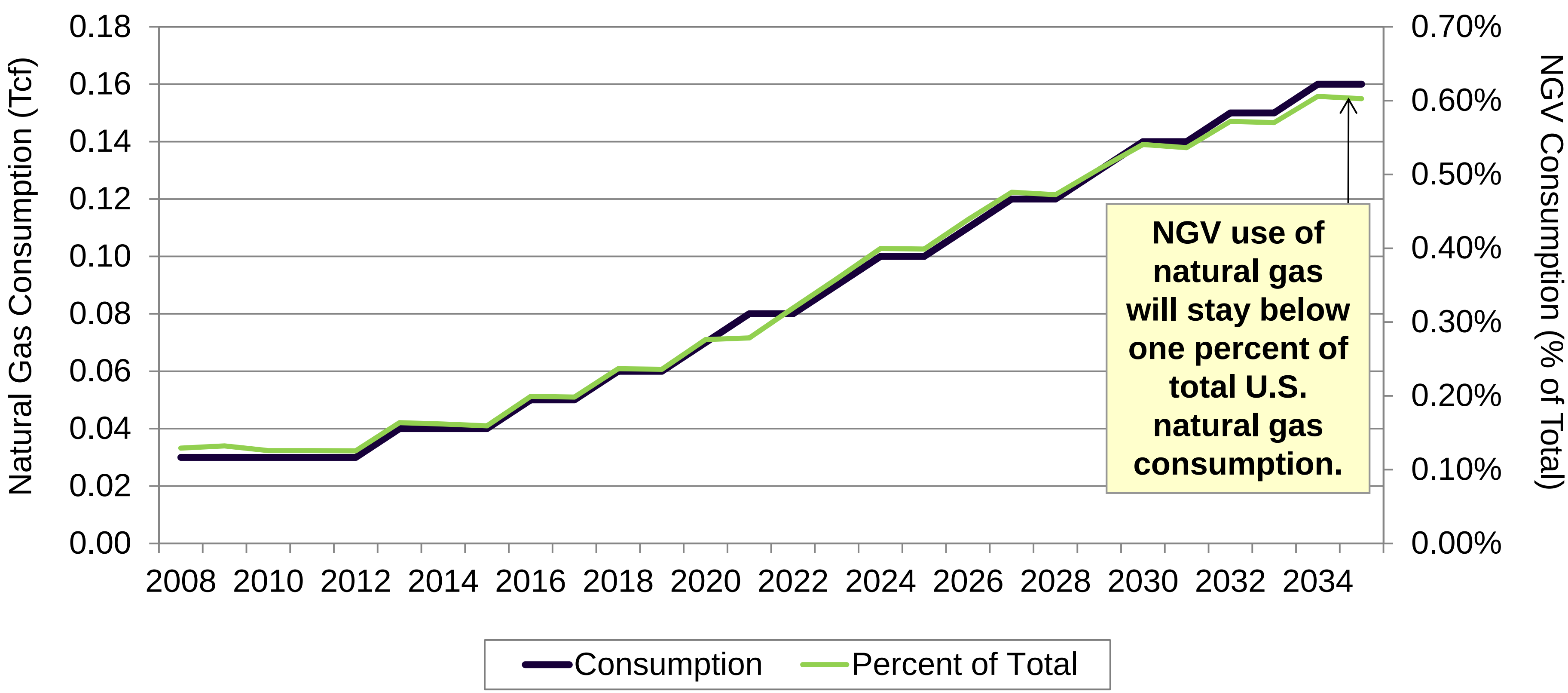
Many states have generous incentive programs that range from additional tax incentives, to infrastructure grant support. Federal benefits include alternative fuel infrastructure tax credit, an excise alternative fuel tax credit and an alternative fuel tax exemption.



Source: U.S. Department of Energy.

Potential Natural Gas Consumption – NGV

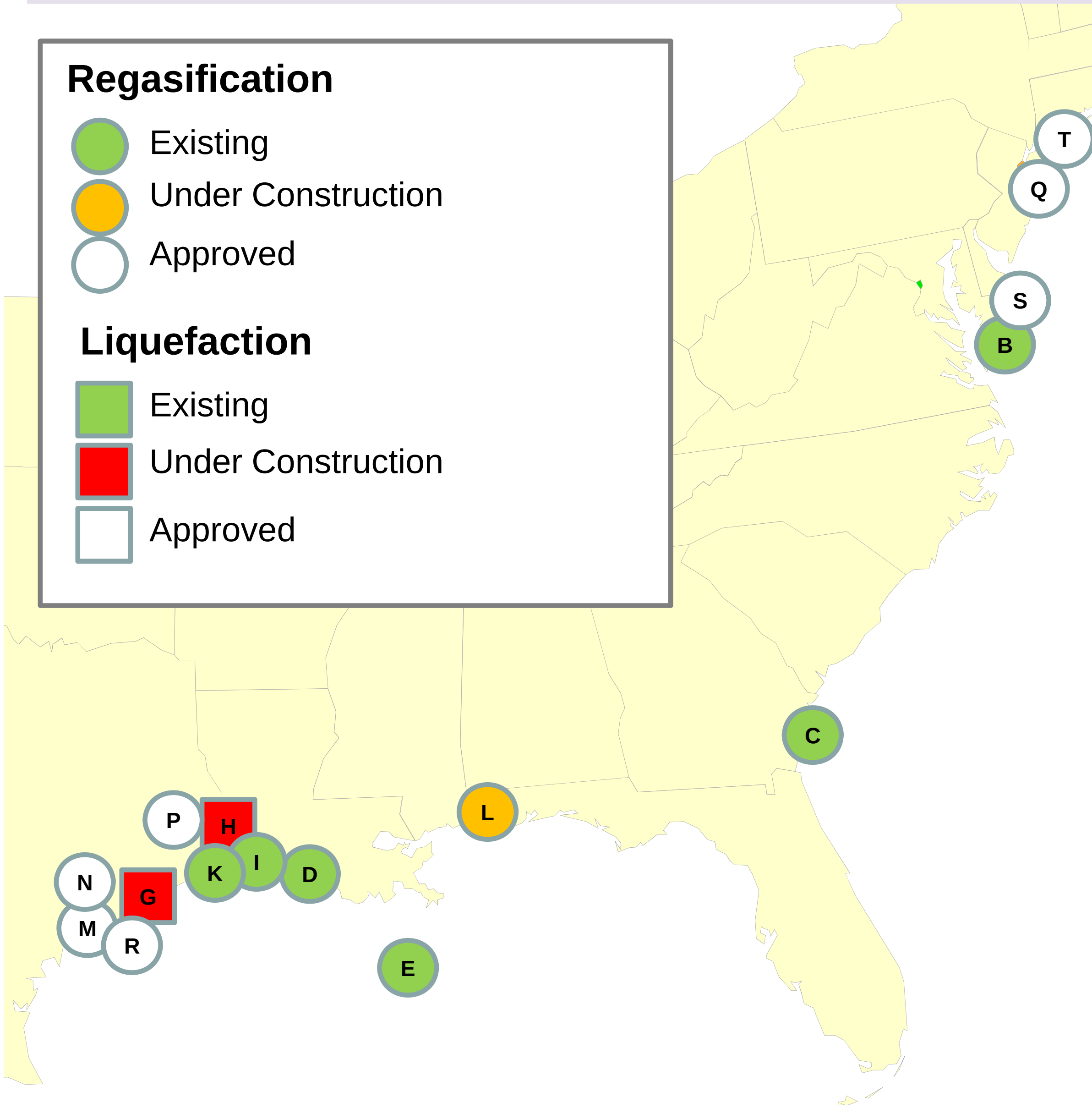
NGV consumption of natural gas is estimated to increase at an average annual rate of 7 percent through 2035, less than 1 Tcf.



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

What About 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

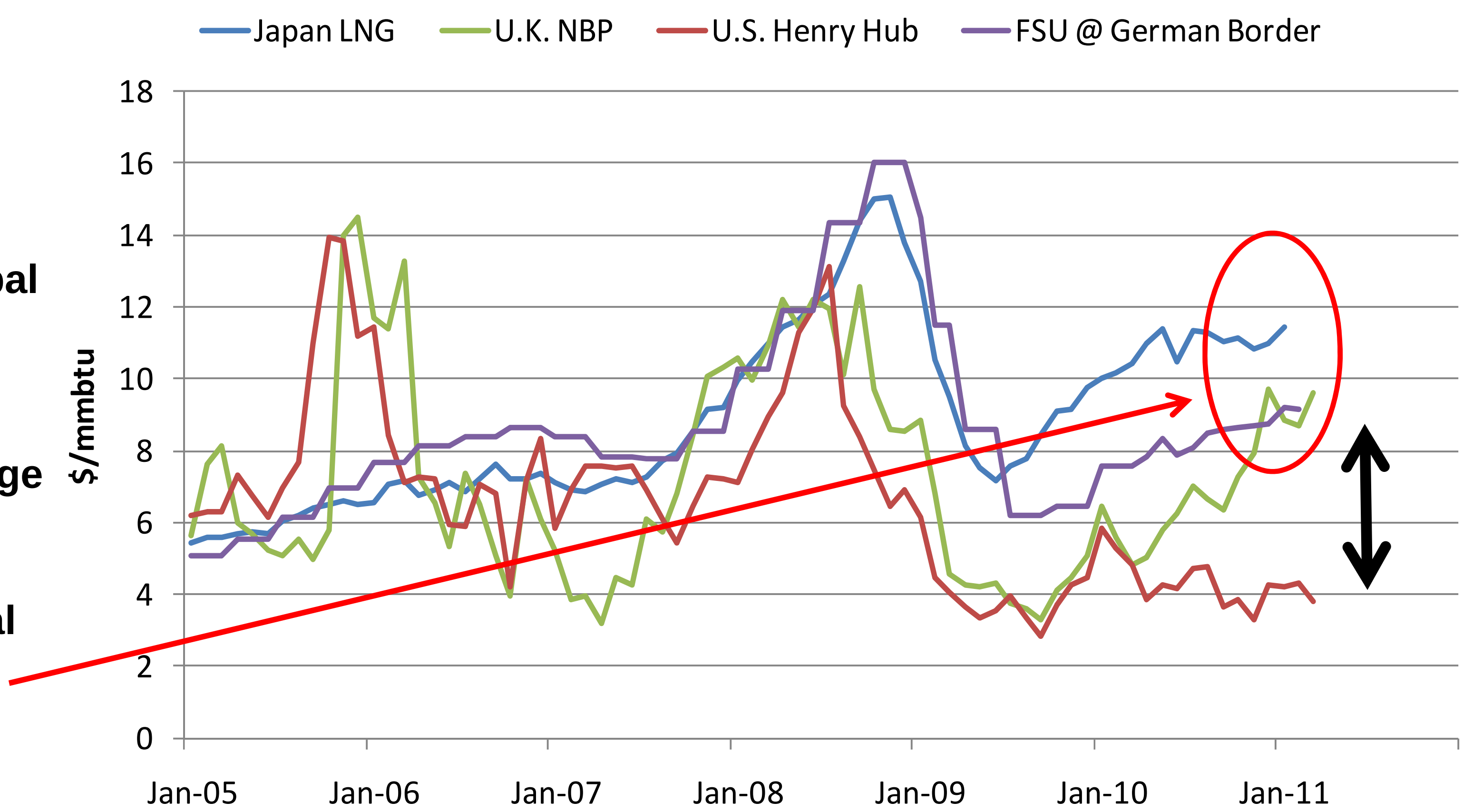
Feedstock (production) costs will be critical in determining the location of basin-specific production along the global LNG supply curve.

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

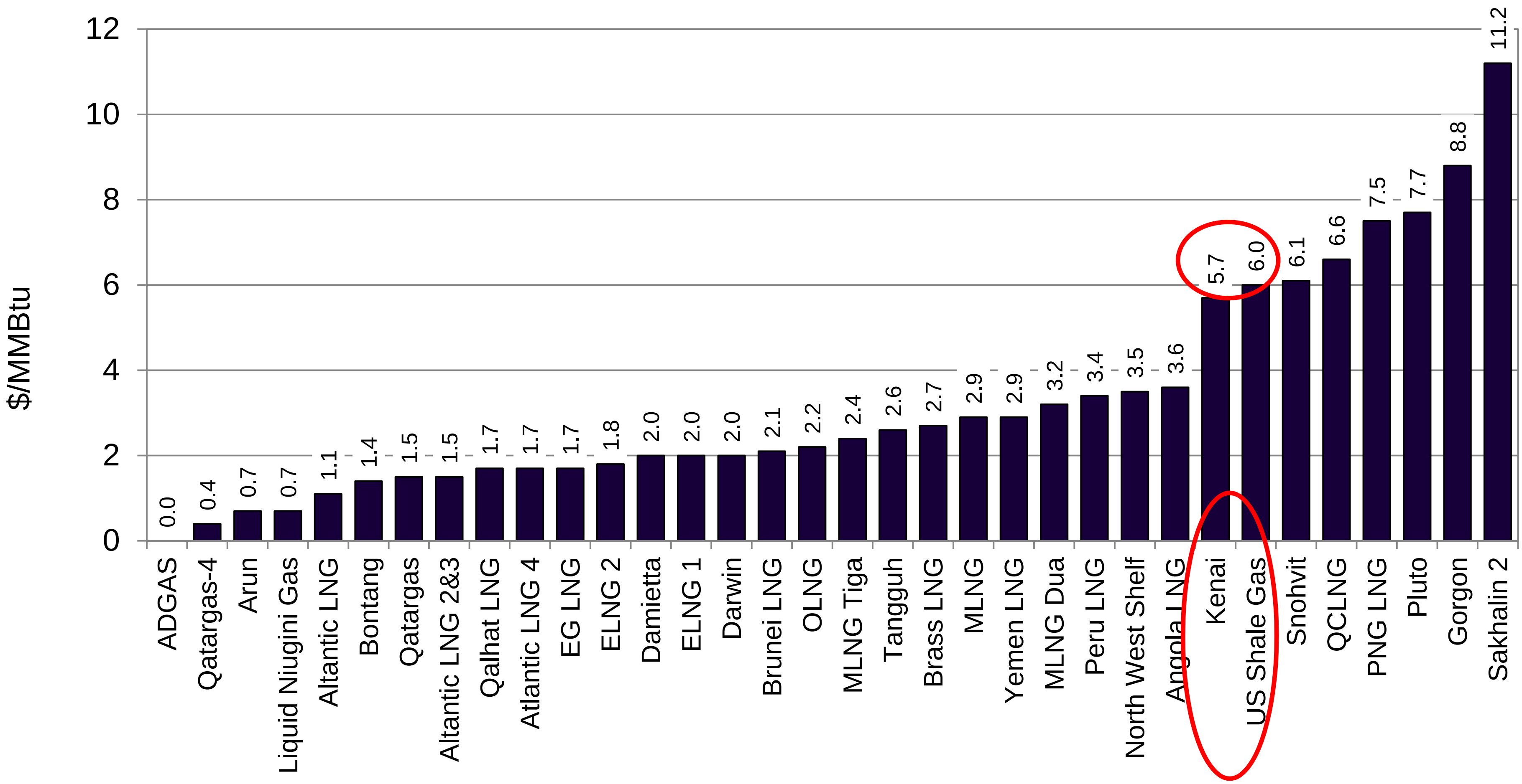
- **Excess U.S. shale production.**
- **Growing global energy demand.**
- **Climate change issues.**
- **Global natural gas price differentials.**



Source: Marathon.

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

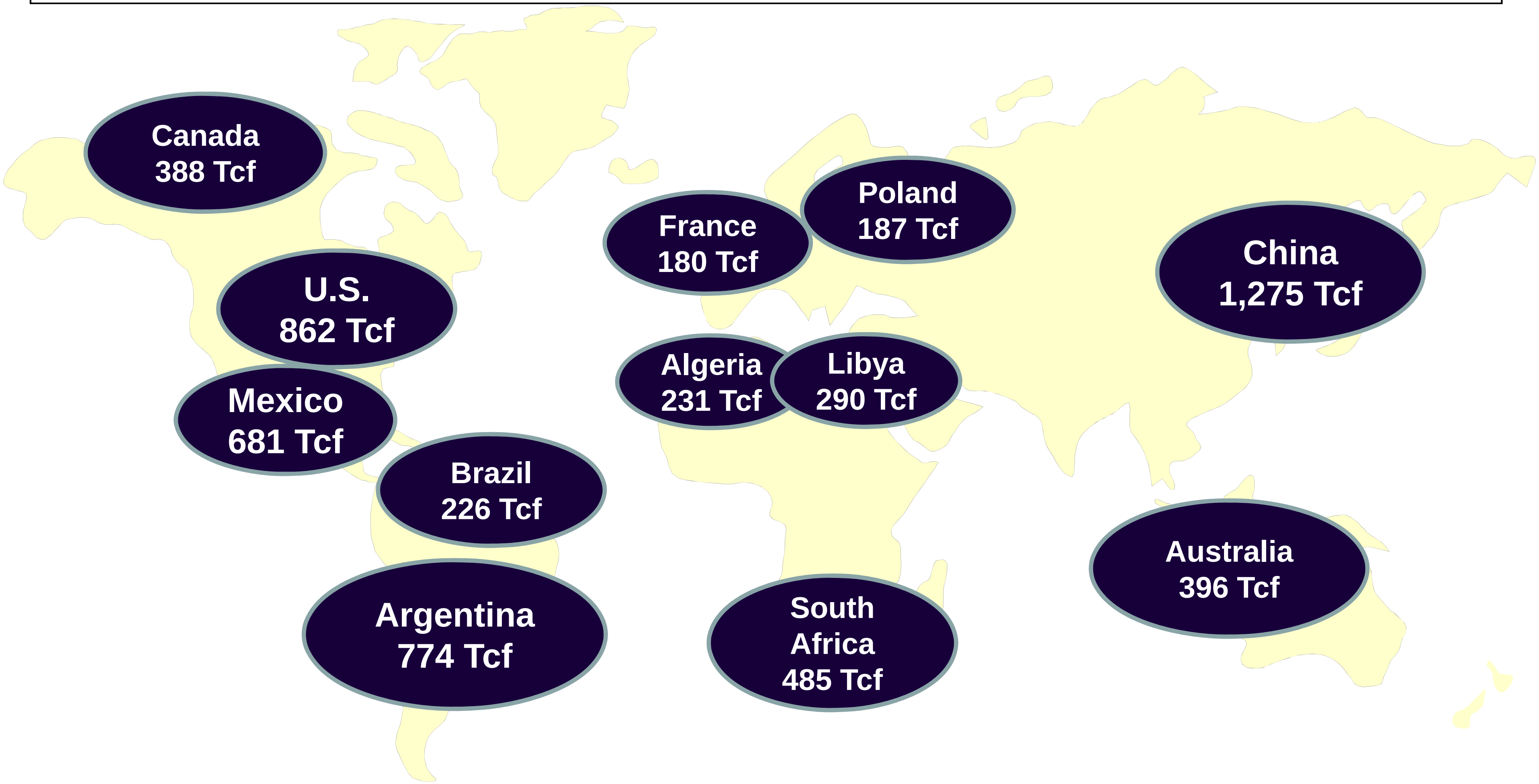
U.S. is likely to be at the upper end of the global LNG supply curve.



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.

Conclusions

Conclusions – Natural Gas Markets

- Natural gas markets continue to be **resilient, affordable and less volatile.**
- Natural gas supply growth **increasingly driven by "associated" natural gas** – a byproduct of increasing production coming from higher hydrocarbon-based production (Marcellus, Eagle Ford, Bakken).
- **New end uses are a blessing** (new manufacturing, more efficient/cleaner power generation) but need to be watched for unanticipated consequences.
- Continued **resource development is policy dependent**. Changes in **economic and environmental policy** can impact the trajectory of unconventional resource development.

Questions, Comments and Discussion

dismukes@lsu.edu

www.enrg.lsu.edu