AIChE: Natural Gas Utilization Workshop

Overcoming Hurdles of Technology Implementation

NATIONAL ENERGY TECHNOLOGY LABORATORY

Natural Gas in the United States: An Overview of Resources and Factors Affecting the Market

November 2, 2016

Justin M. Adder, Energy Markets Analysis Team

Solutions for Today | Options for Tomorrow

U.S. DEPARTMENT OF ENERGY

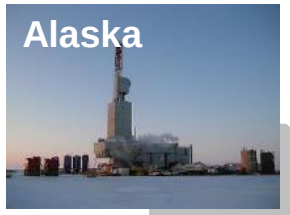
The Fossil Energy Laboratory

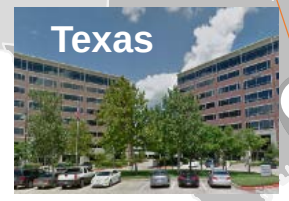
ONE LAB System

- Materials Performance
- Alloy Development/Manufacture
- Geospatial Data Analysis

- Process Systems Engineering
- Decision Science
- Functional Materials
- Environmental Sciences

- Energy Conversion Devices
- Simulation-Based Engineering
- *In-Situ* Materials Characterization
- Supercomputer Infrastructure



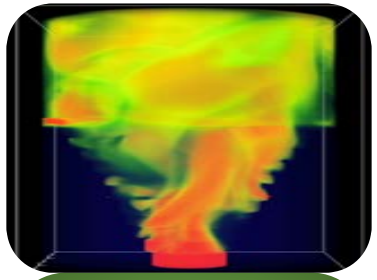


Oil and Gas Strategic Office

Oil and Gas Strategic Office

Core Competencies

NATIONAL ENERGY TECHNOLOGY LABORATORY



Computational Science & Engineering

High Performance Computing

Data Analytics

Materials Engineering & Manufacturing

Structural & Functional

Design, Synthesis & Performance

Geological & Environmental Systems

Air, Water & Geology

Understanding & Mitigation

Energy Conversion Engineering

Component & Device

Design & Validation

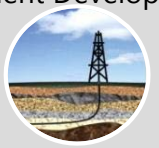
Systems Engineering & Analysis

Process & System

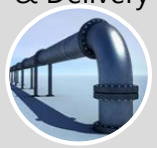
Optimization, Validation & Market Economics

Enhanced Resource Production

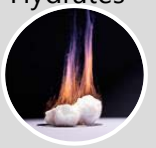
Environmentally Prudent Development



Transmission & Delivery

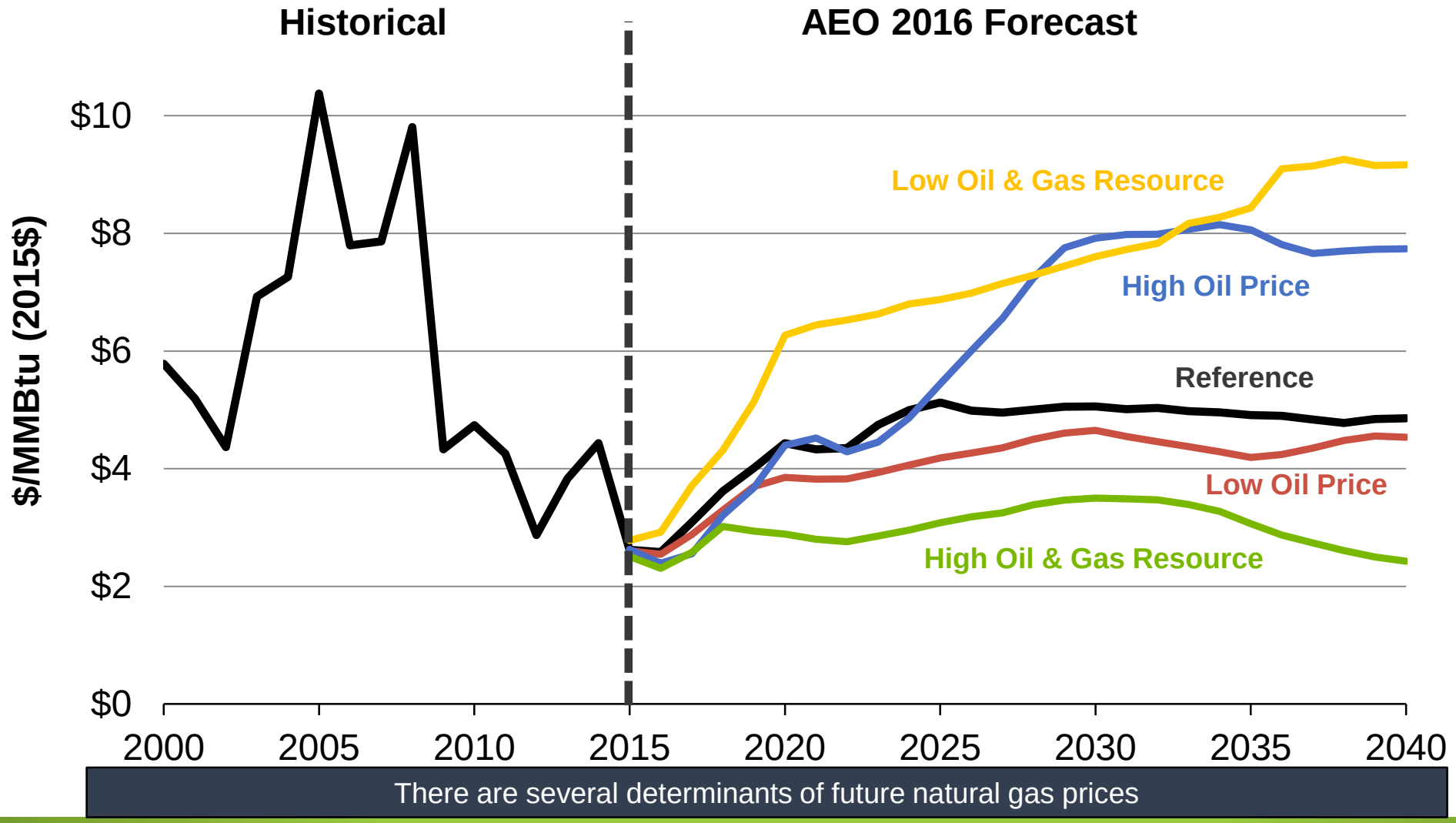


Methane Hydrates



Natural Gas Prices – Various Cases

Henry Hub Spot Prices ($/MMBtu) Under Various EIA Cases



There are several determinants of future natural gas prices

Determinants of Natural Gas Prices

Direct and Indirect Determinants of Natural Gas Prices

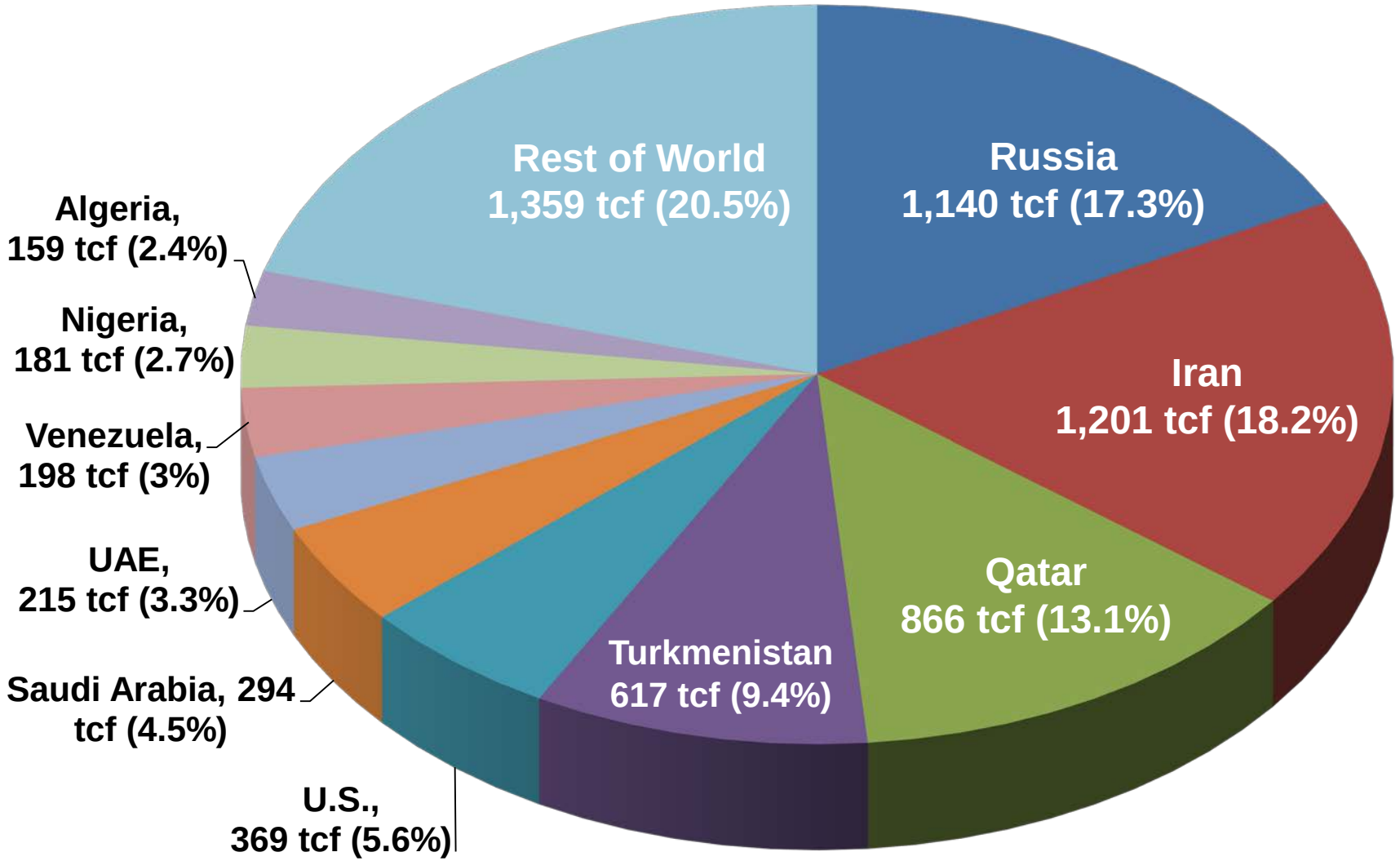
Direct Forces	Time Horizon	Likely Effect
Secular Demand	Long	Rising, thus prices rise; incentive for more supply
Cyclical Investment Behavior	Short to Medium	Pro-cyclical behavior increases amplitude of price fluctuations
Gas Storage	Short to Medium	If well behaved, counter-cyclical effect on price. Issue as to whether there will be enough storage
Pipeline Infrastructure	Medium to Long	Delays in permitting and constructing gathering lines and transmission projects moving gas from high supply areas to high demand areas
LNG Exports	Short to Medium	Foreign markets where natural gas prices are higher; thus putting upward pressure on domestic prices
Access to Resources	Medium to Long	Advanced technology and federal lands could increase supply. Low natural gas prices could hinder production
Indirect Forces		
Industrial Use	Short to Long	Increased manufacturing adds structural element to gas demand
Transportation Use	Short to Long	NG and NGL Vehicles and fleets add structural element to gas demand
Coal Power	Short to Long	Environmental regulations reduce use; structural element added to gas demand
Nuclear Power	Short to Long	Cheapest marginal operating cost, retirements add structural element to gas demand if coal unavailable

World Proved Reserves

World Proved Natural Gas Reserves, 2015

NATIONAL ENERGY TECHNOLOGY LABORATORY

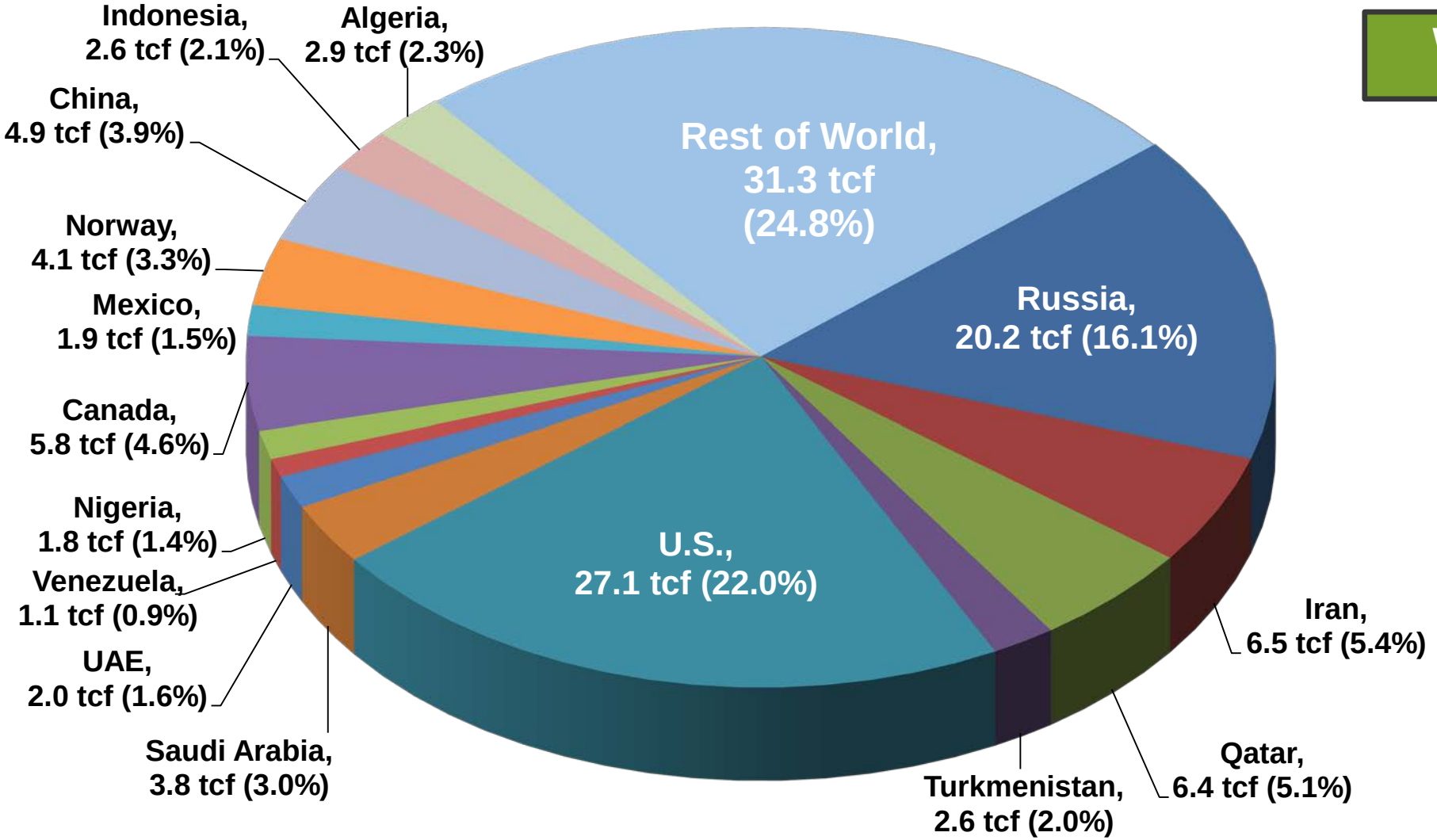
World Total
6,599 tcf



Source: BP Statistical Review of World Energy 2016, http://www.bp.com/ (May not equal 100% due to rounding)

World Production

World Natural Gas Production, 2015

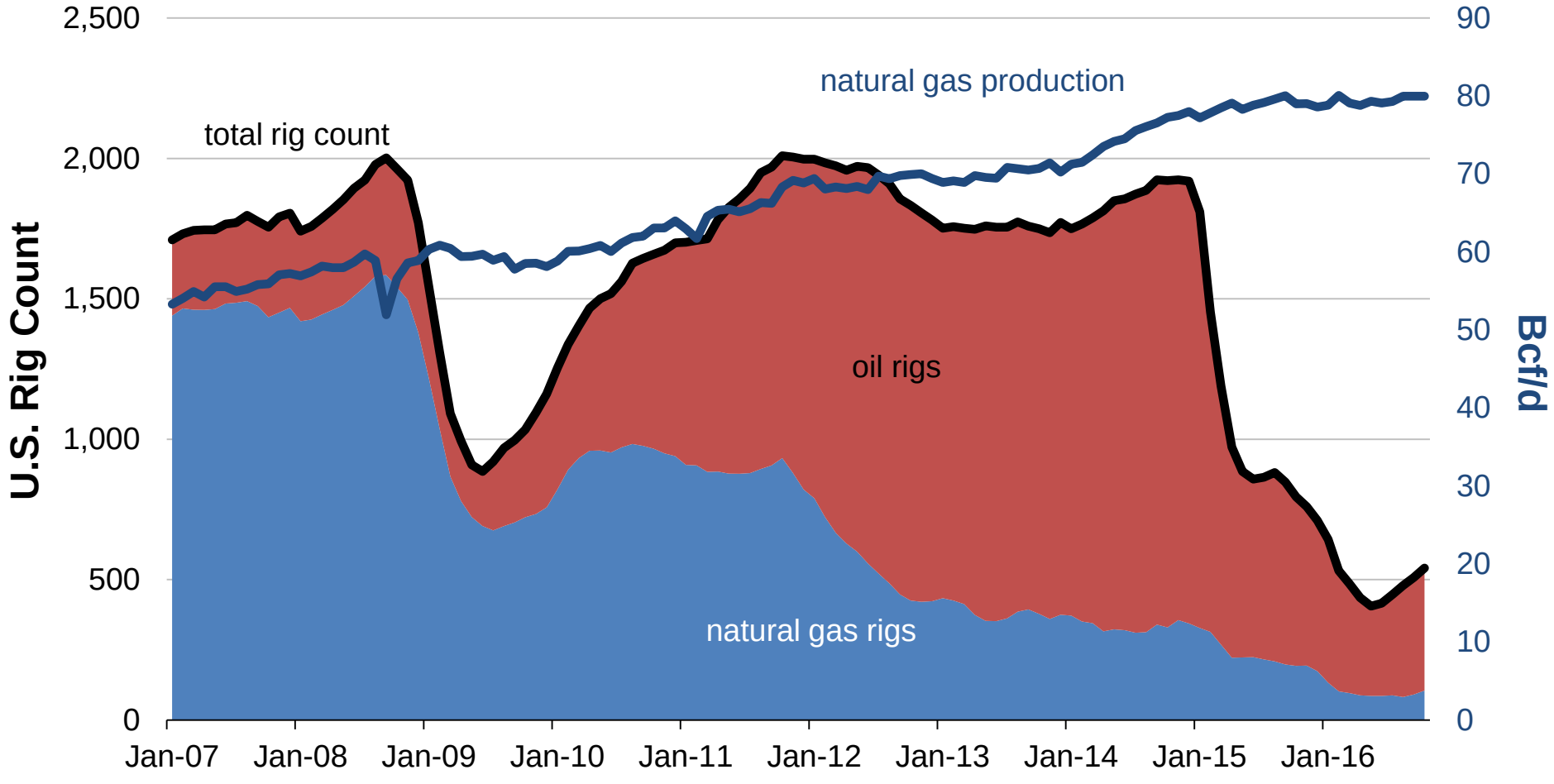


World Total 125 tcf

Source: BP Statistical Review of World Energy 2016, http://www.bp.com/ (May not equal 100% due to rounding)

U.S. Rig Count and Production

Oil and Natural Gas Rig Count and Natural Gas Production

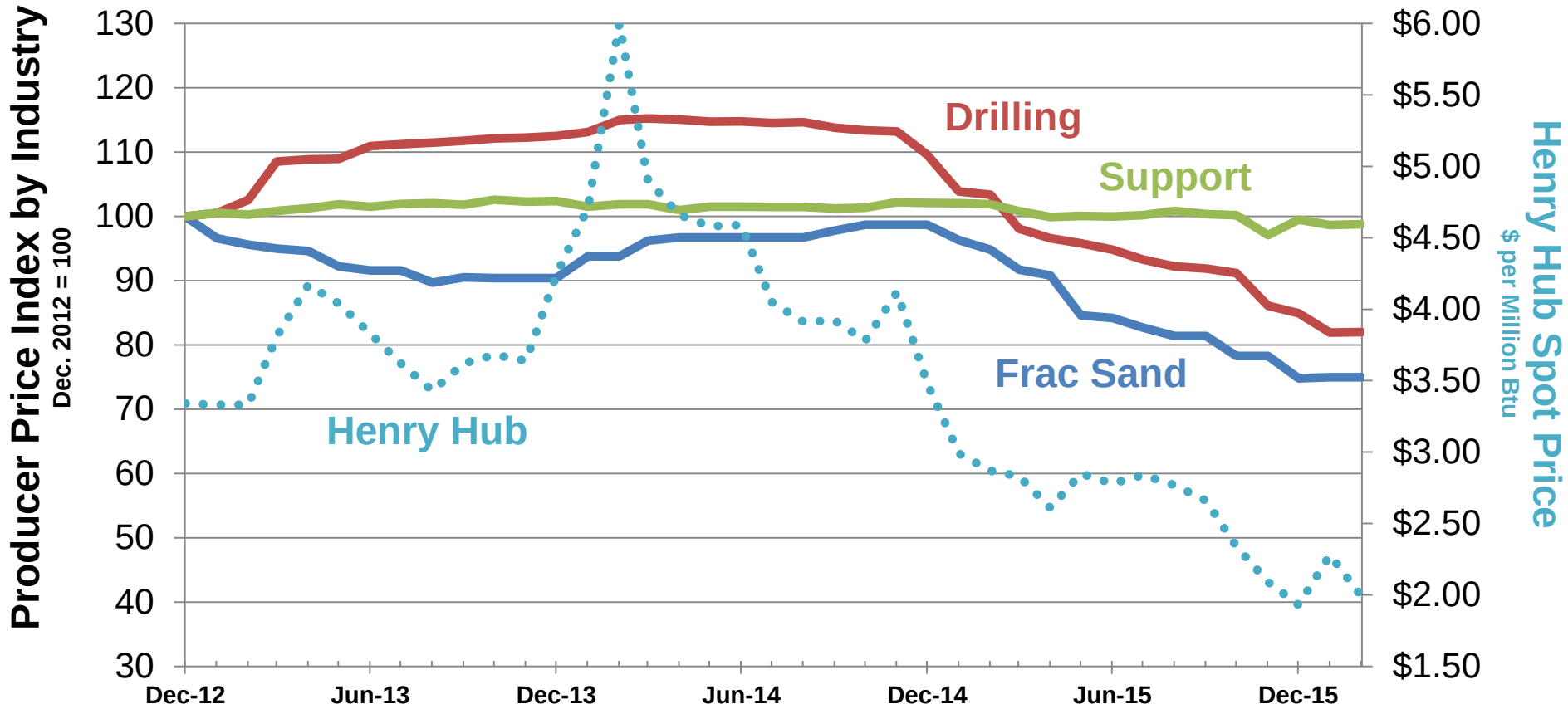


Natural gas production increases despite fall in rig count

Source: Baker Hughes, Inc. rig count, EIA Monthly Total Marketed Production

U.S. Drilling & Completion Costs

U.S. Oil & Natural Gas Drilling & Completion Cost Reductions (indexed to Dec 2012)



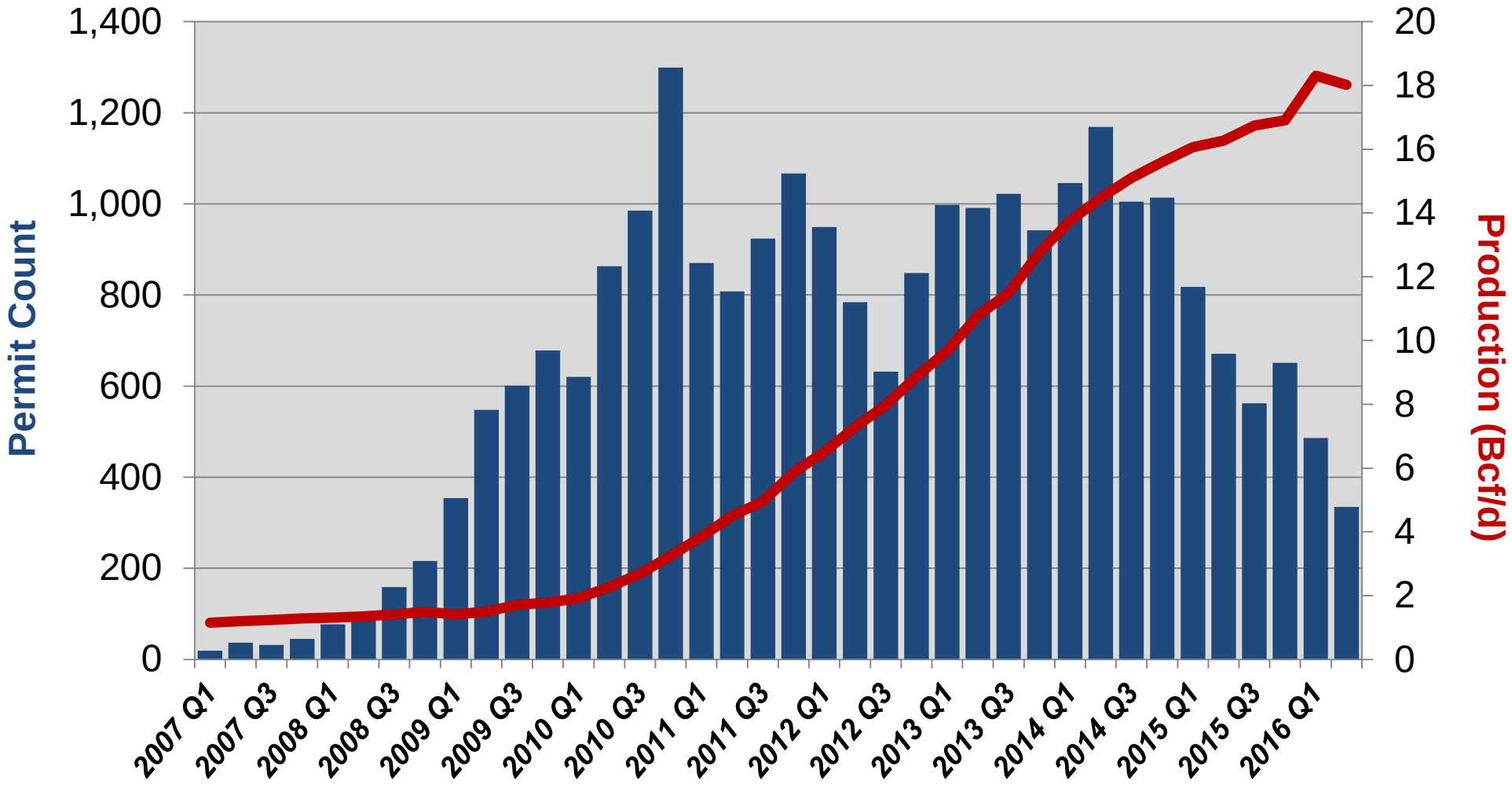
From Feb 2014 to Feb 2016 the PPI by industry classification showed the following changes:

- Rates for drilling activities, which represent fees for contractors to drill oil and gas wells, declined by 28.7%
- Rates for support activities, which include surveying, cementing, casing, and treating wells, declined by 3.1%
- The price of sands primarily used for hydraulic fracturing declined 20.0%

Source: United States Bureau of Labor Statistics, Industry Producer Price Indexes and EIA Henry Hub Spot Price

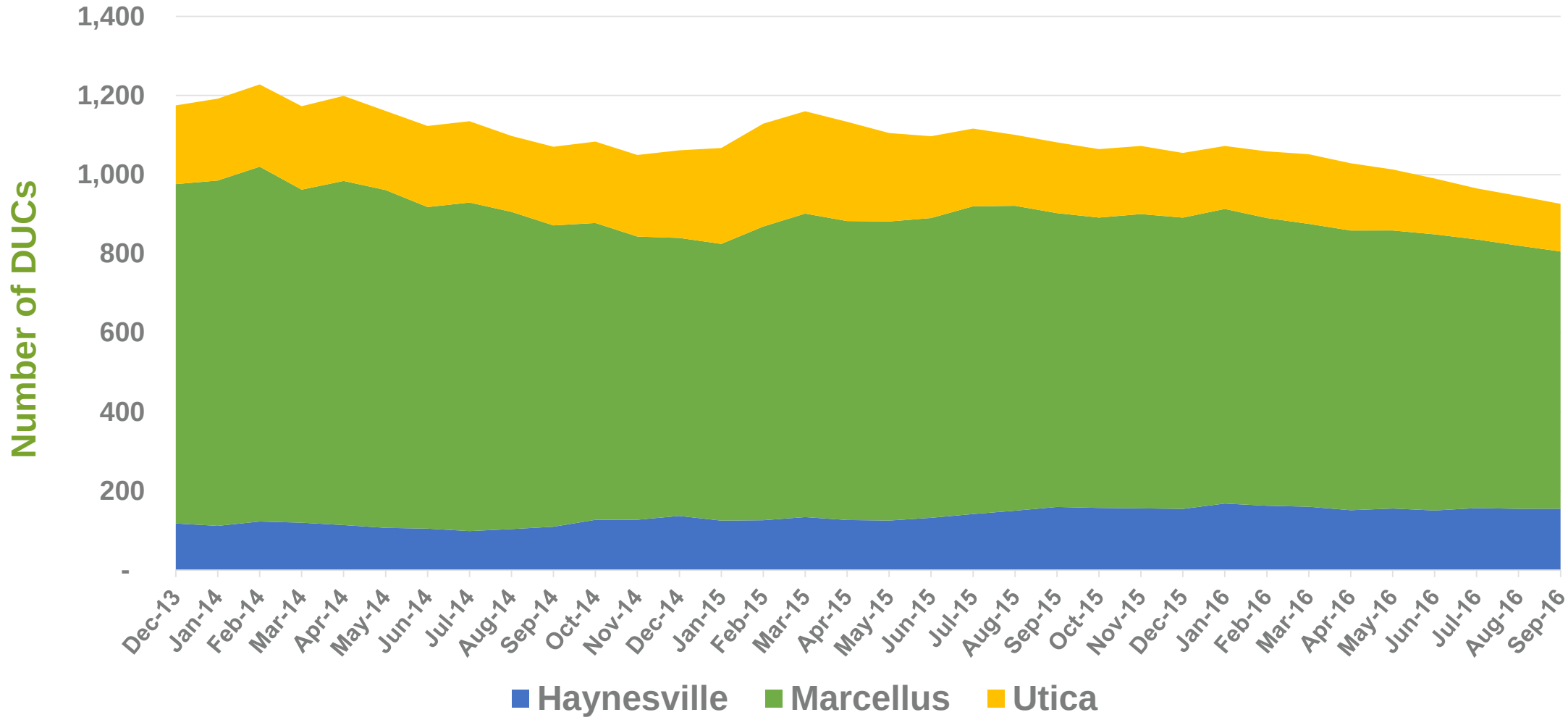
Marcellus Shale Drilling Permits

Drilling Permit Count and Natural Gas Production By Quarter



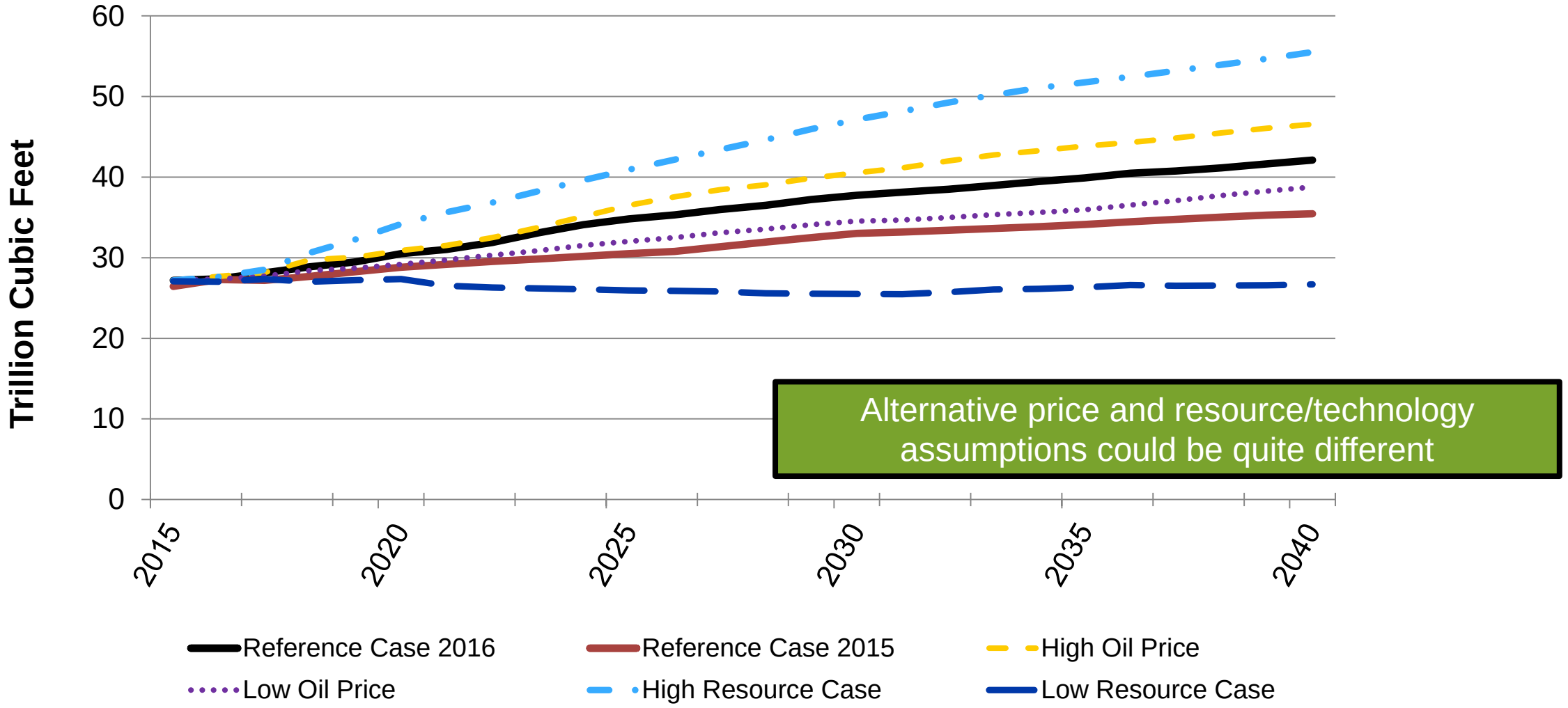
Drilled but Uncompleted Wells

Gas Region DUC Well Inventory



U.S. Natural Gas Production Projections

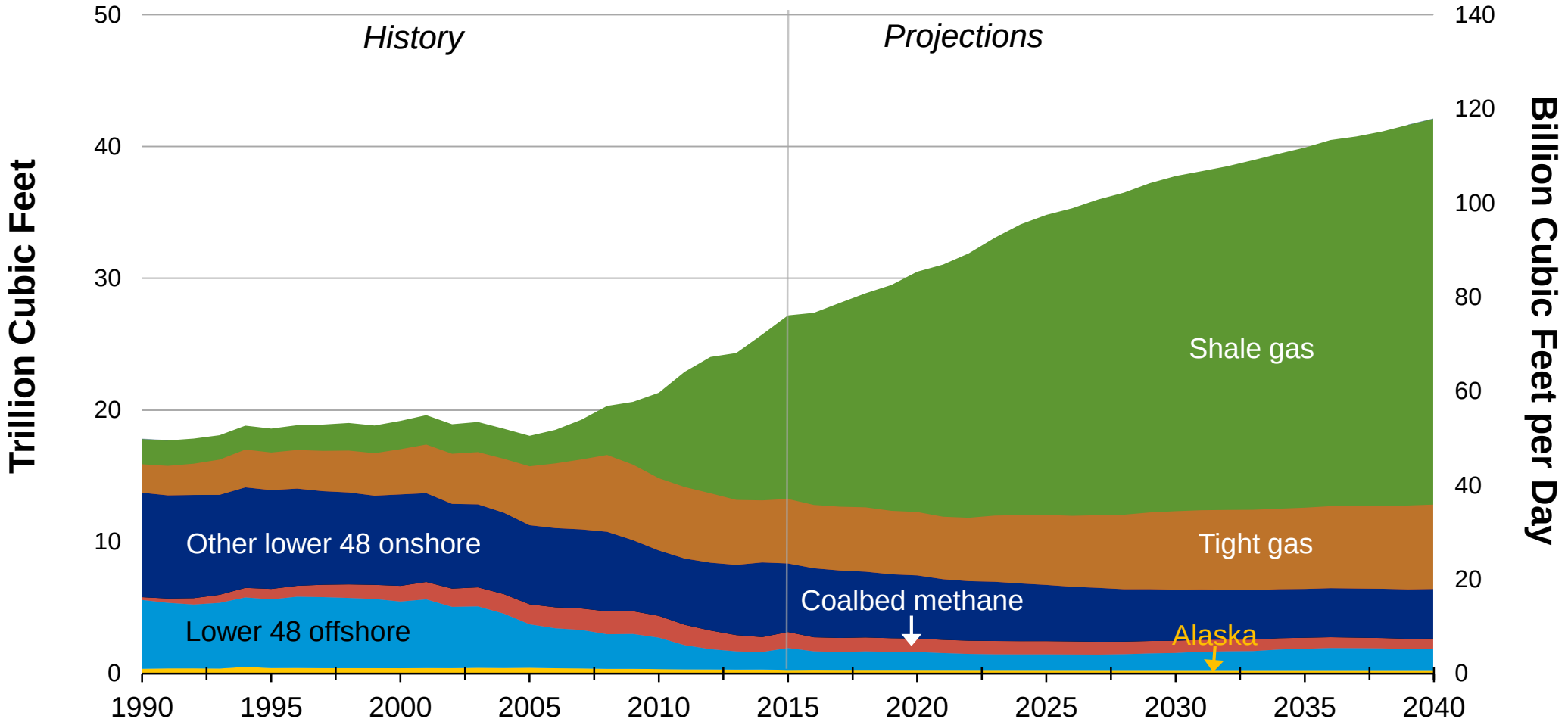
U.S. Natural Gas Production (Tcf) by EIA Case, 2015-2040



Source: U.S. Energy Information Administration, http://www.eia.gov/naturalgas/data.cfm and Annual Energy Outlook 2016

U.S. Natural Gas Supply Sources

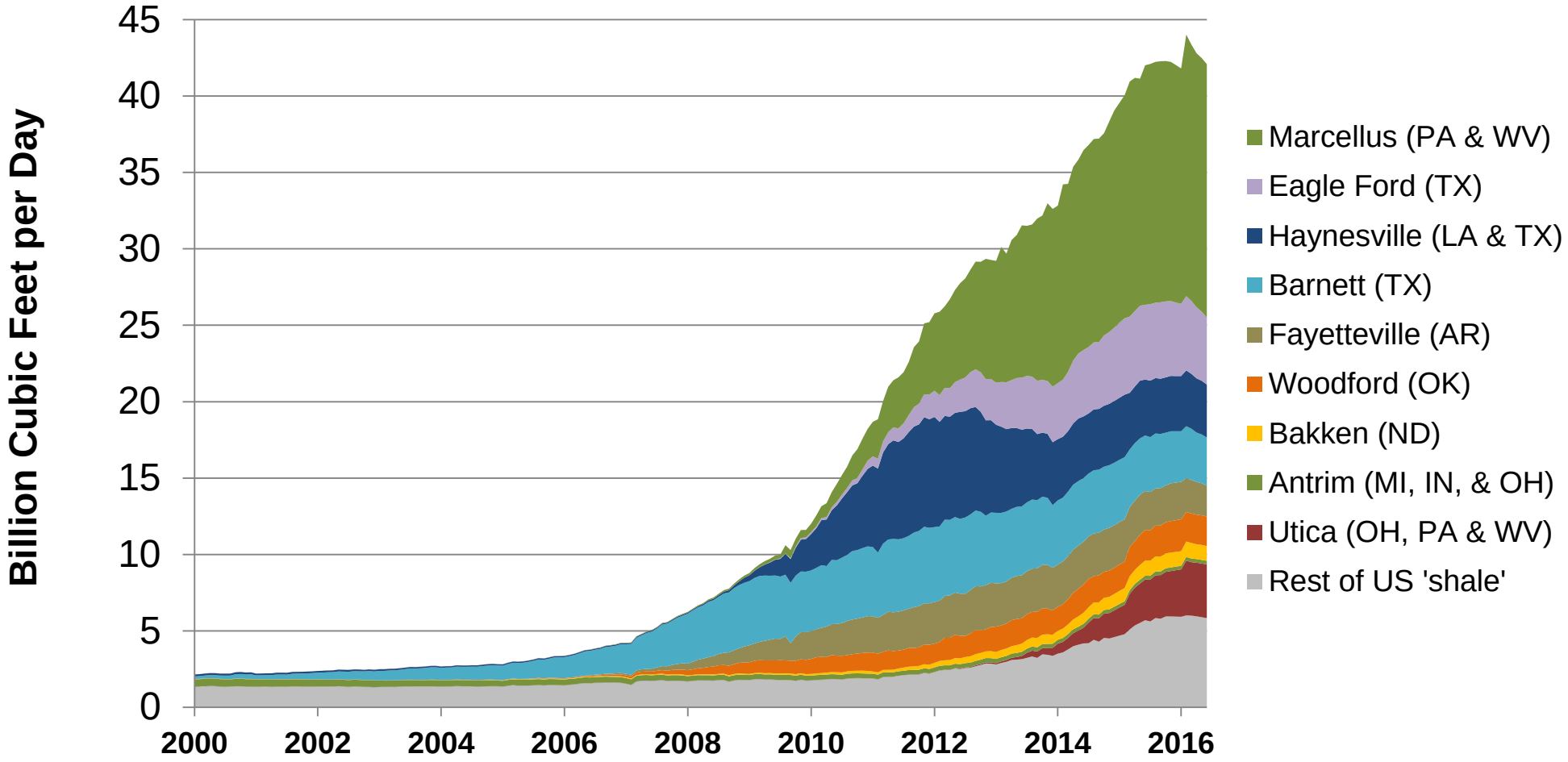
Unconventional Gas: Major Impact on U.S. Gas Supply Sources (Reference Case)



U.S. shale gas grows to 69 percent of total U.S. production by 2040

U.S. Shale Gas Production

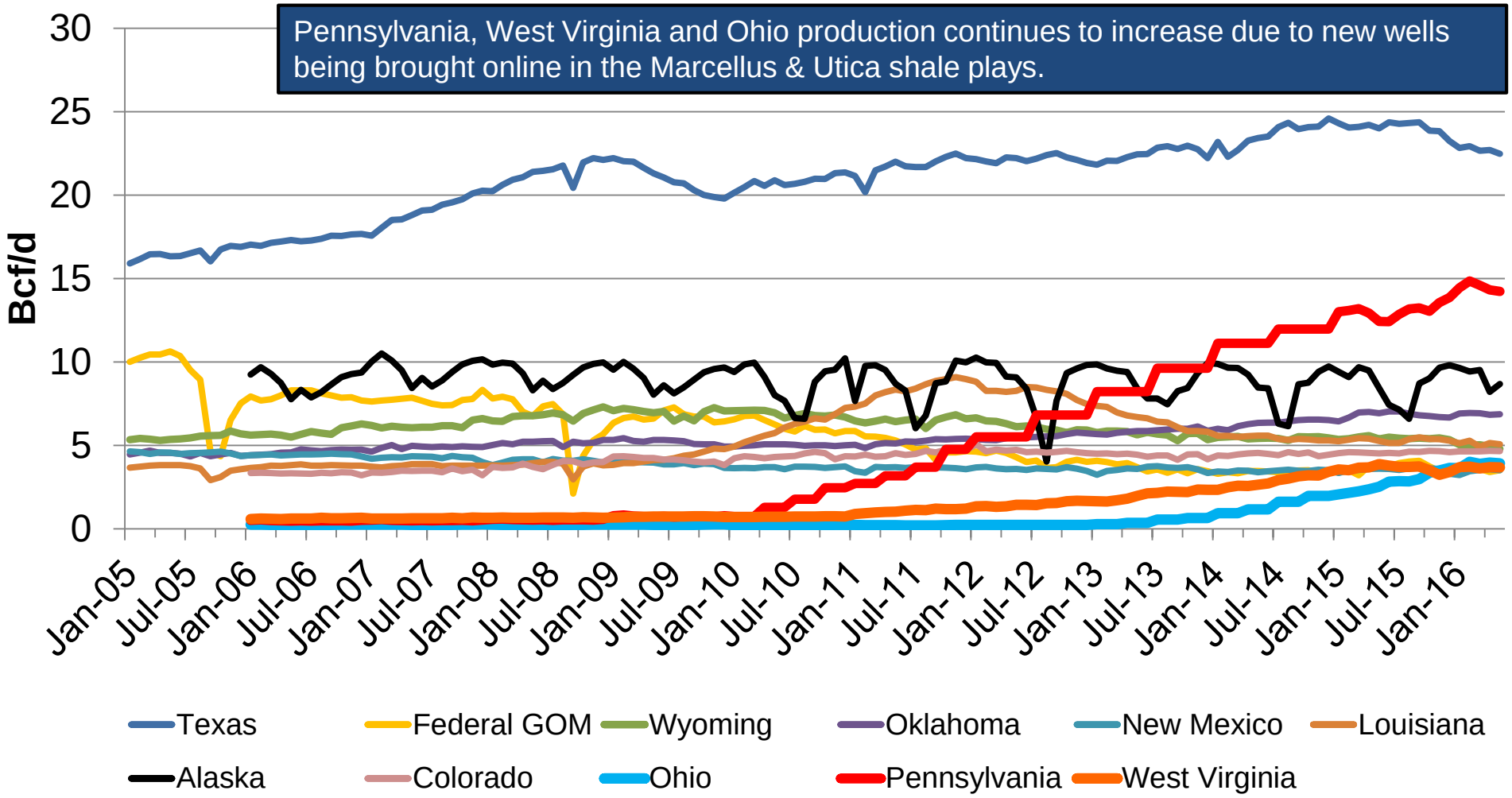
U.S. Dry Shale Gas Production – Through June 2016



Marcellus region provides nearly 40% of total U.S. shale gas production

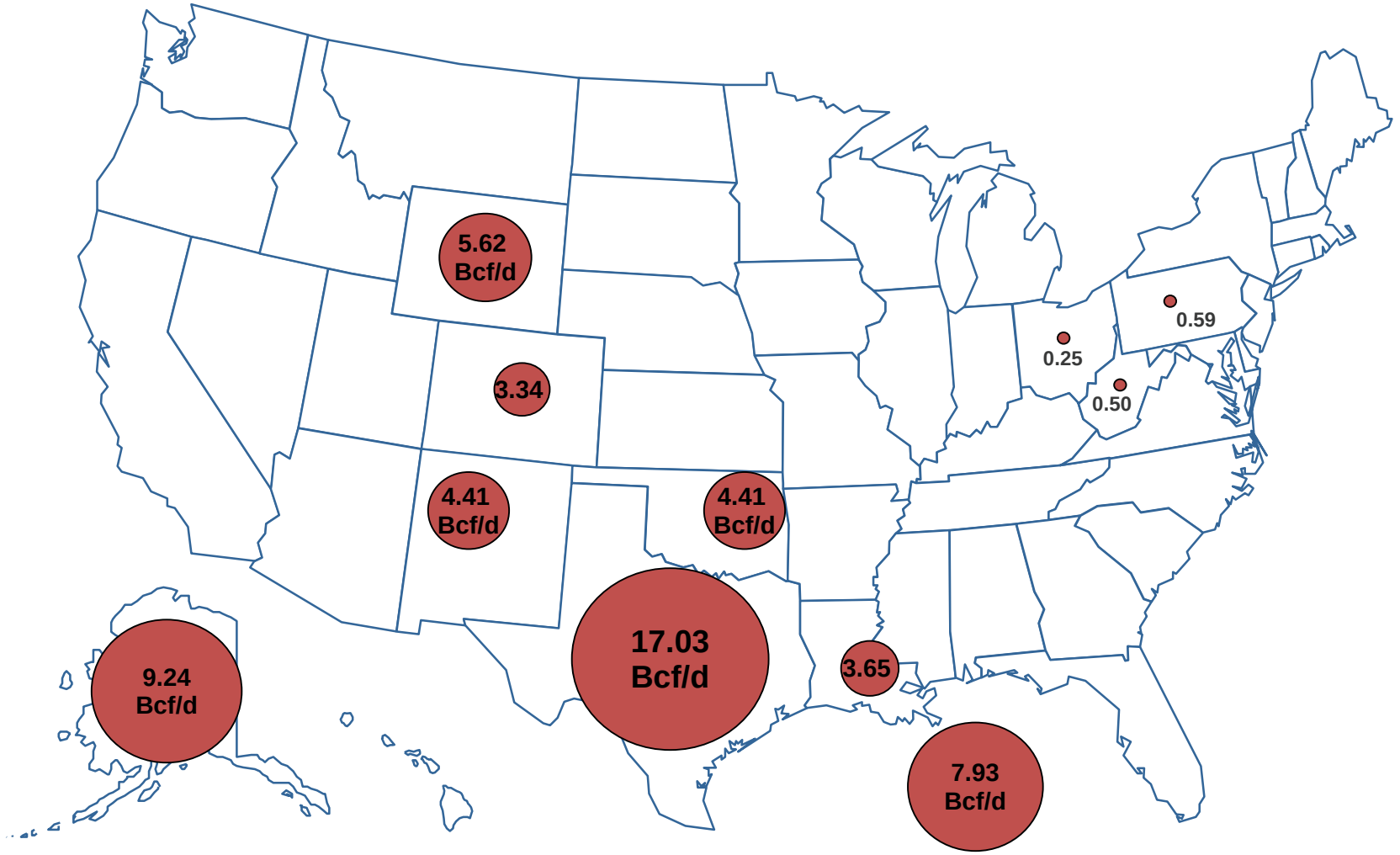
Gross Natural Gas Withdrawals by State

Natural Gas Withdrawals by State, Bcf/d



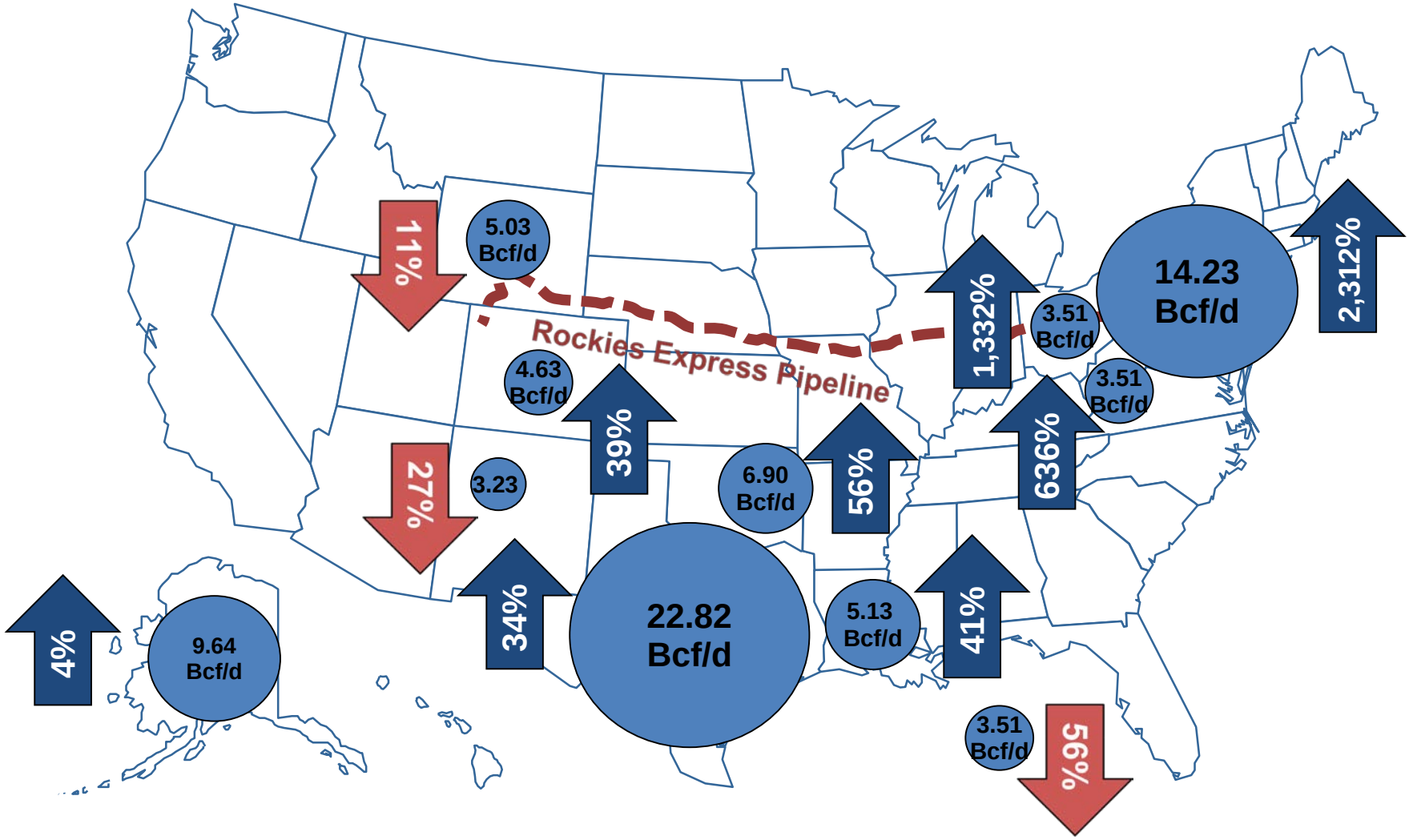
Natural Gas Production Shifts

U.S. Natural Gas Production in Jan. 2006, Bcf/d



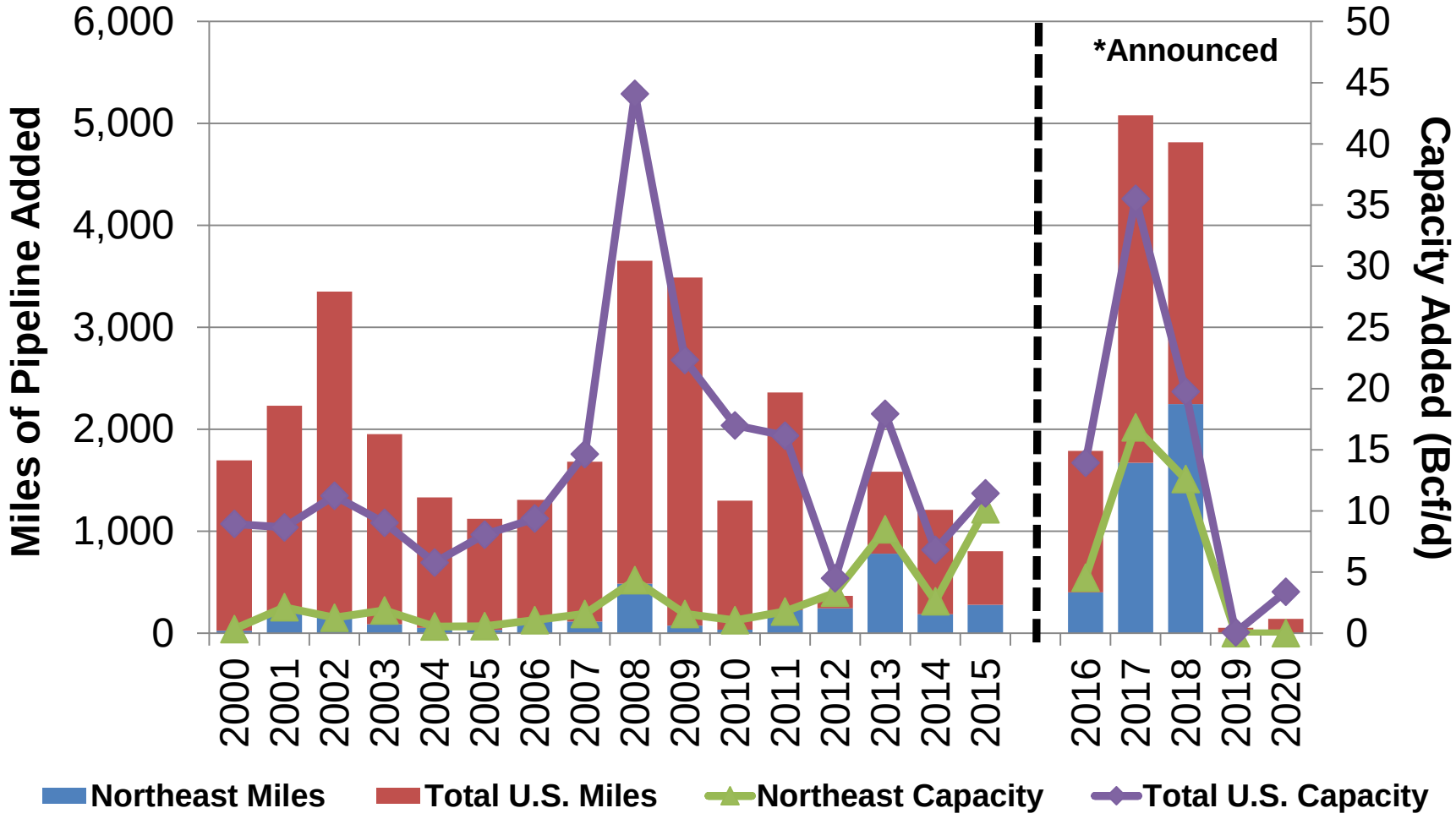
Natural Gas Production Shifts

U.S. Natural Gas Production, Jan. 2006 compared to Jan. 2016, Bcf/d



Natural Gas Pipeline Miles and Capacity

Annual Addition of Natural Gas Pipeline Miles and Capacity, Northeast Region vs. Total U.S. (2000–2020)



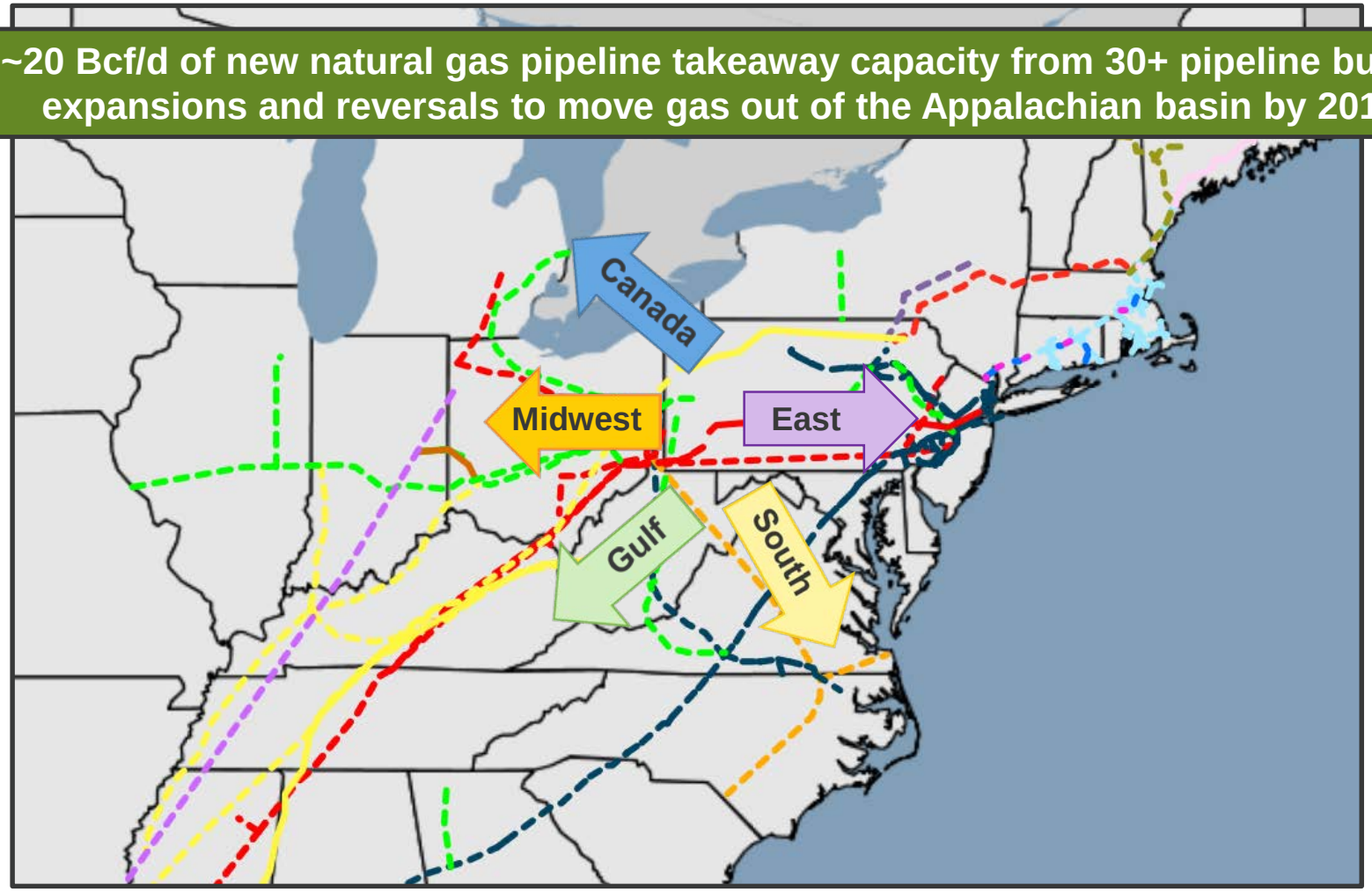
*(Not all announced pipelines will be built)

Source: EIA, http://www.eia.gov/naturalgas/data.cfm#pipelines

Natural Gas Infrastructure Development

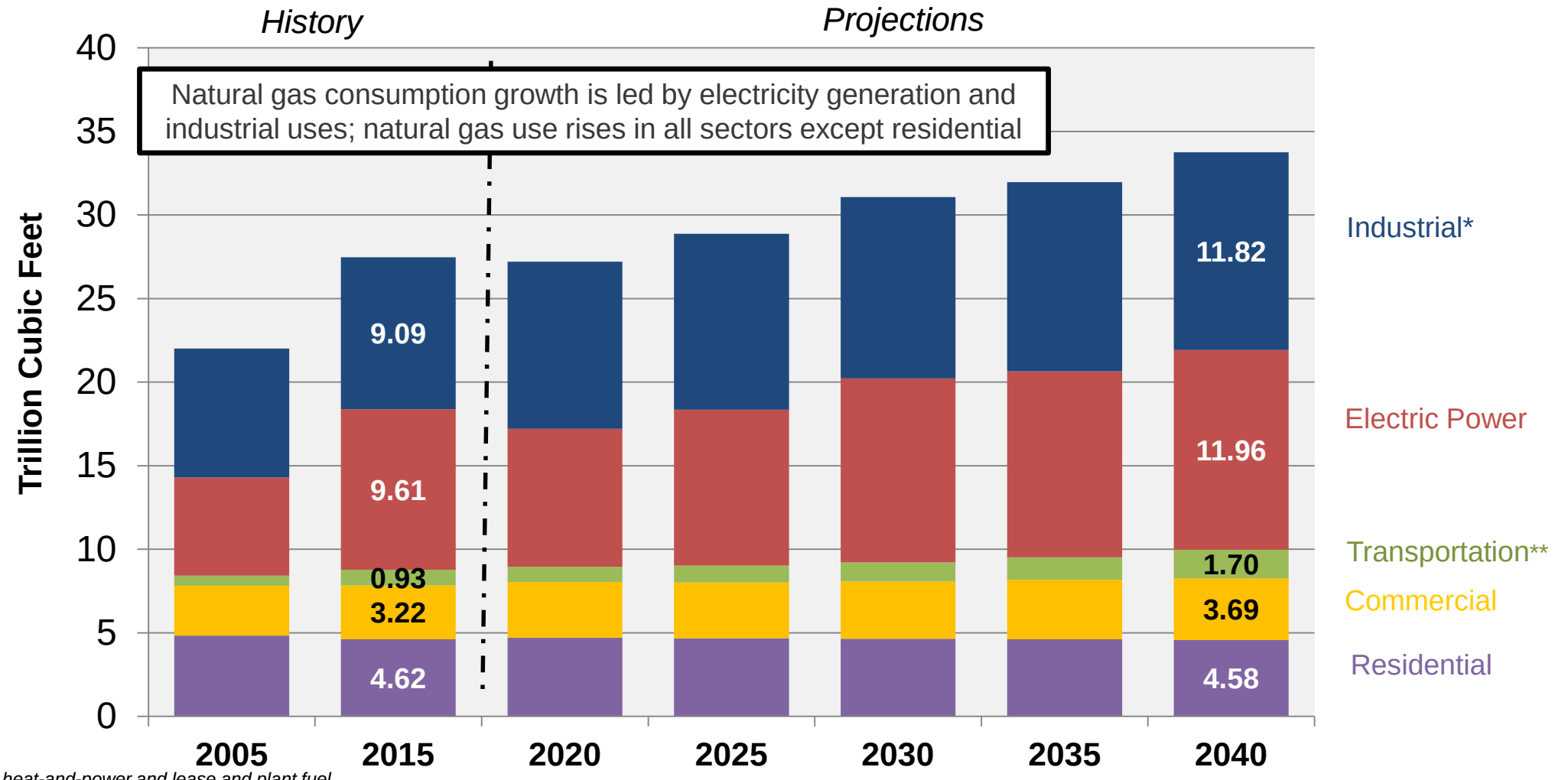
Major Natural Gas Pipeline Capacity Additions in the Northeast

~20 Bcf/d of new natural gas pipeline takeaway capacity from 30+ pipeline builds, expansions and reversals to move gas out of the Appalachian basin by 2019.



Natural Gas Consumption

U.S. Natural Gas Consumption by Sector through 2040 (Reference Case)

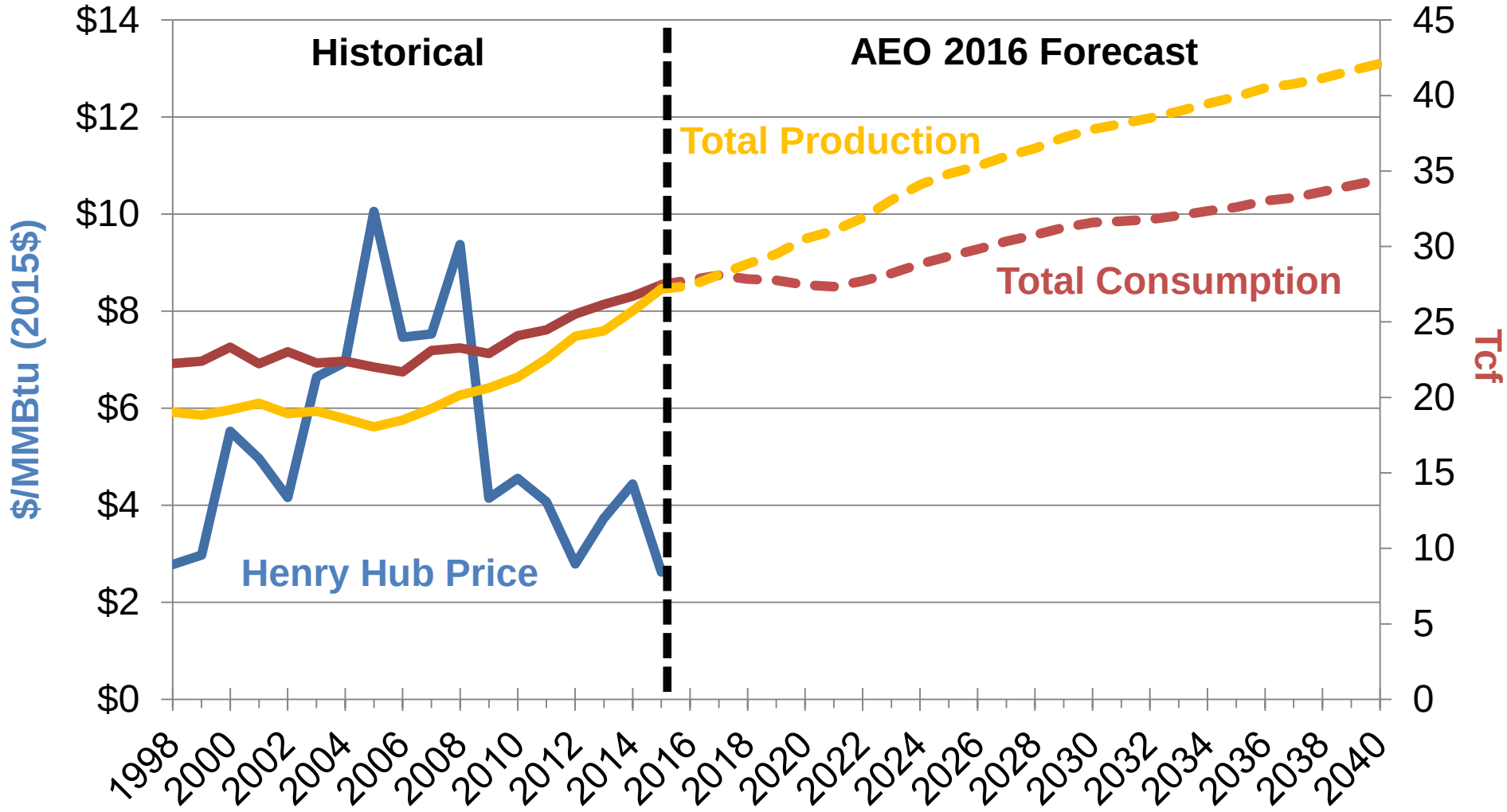


*Includes combined heat-and-power and lease and plant fuel
**Includes pipeline fuel

Source: U.S. Energy Information Administration, http://www.eia.gov/naturalgas/data.cfm and Annual Energy Outlook 2016

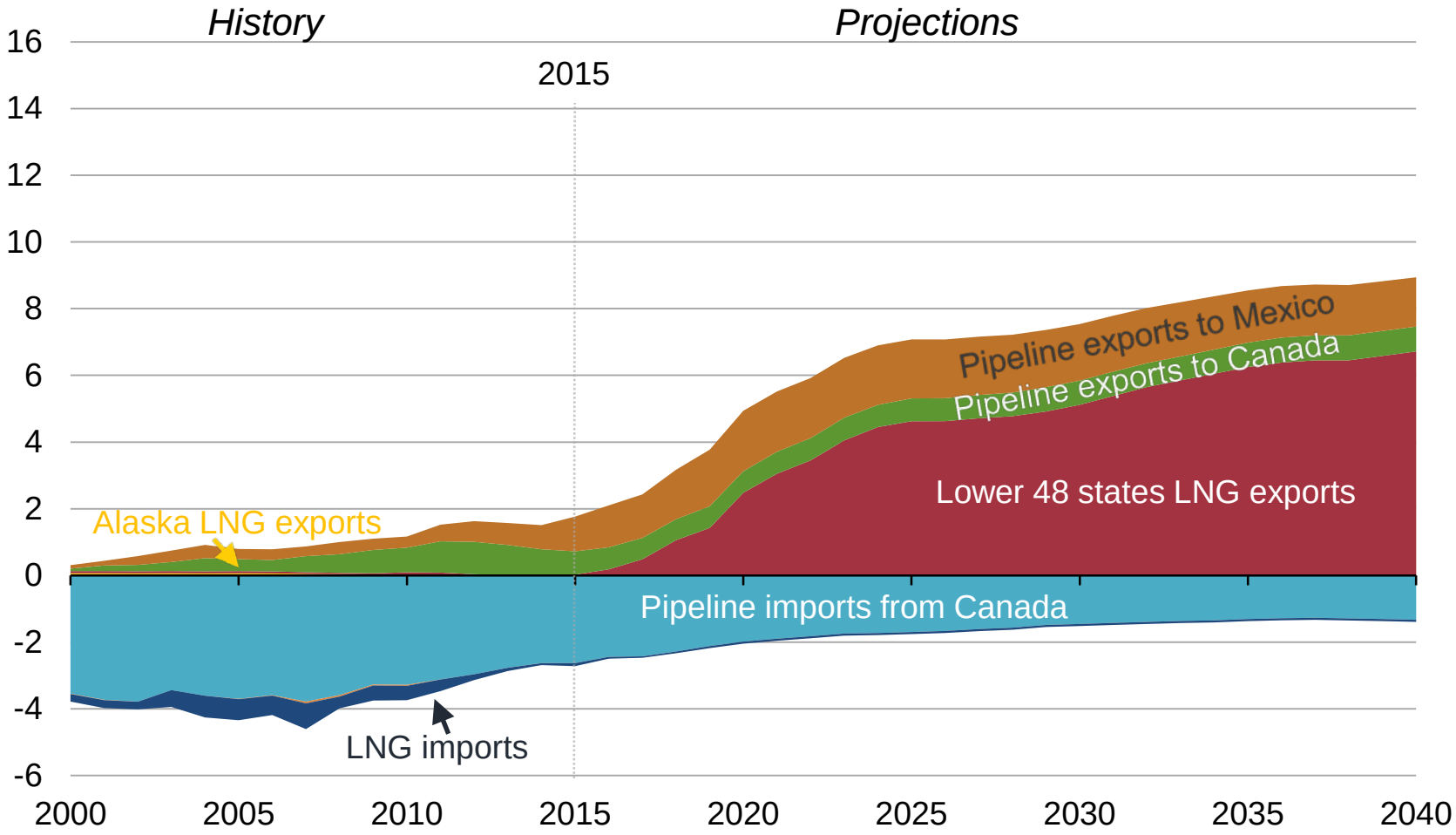
Natural Gas Prices Versus Demand

Henry Hub Spot Prices ($/MMBtu) vs. Total Consumption & Production (Tcf)



U.S. Natural Gas Imports and Exports

U.S. Natural Gas Imports and Exports, (Reference Case) Tcf



U.S. natural gas exports reflect the spread between domestic natural gas prices and world energy prices

Source: EIA, Annual Energy Outlook 2016, Tables 13 and 14

NATIONAL ENERGY TECHNOLOGY LABORATORY