

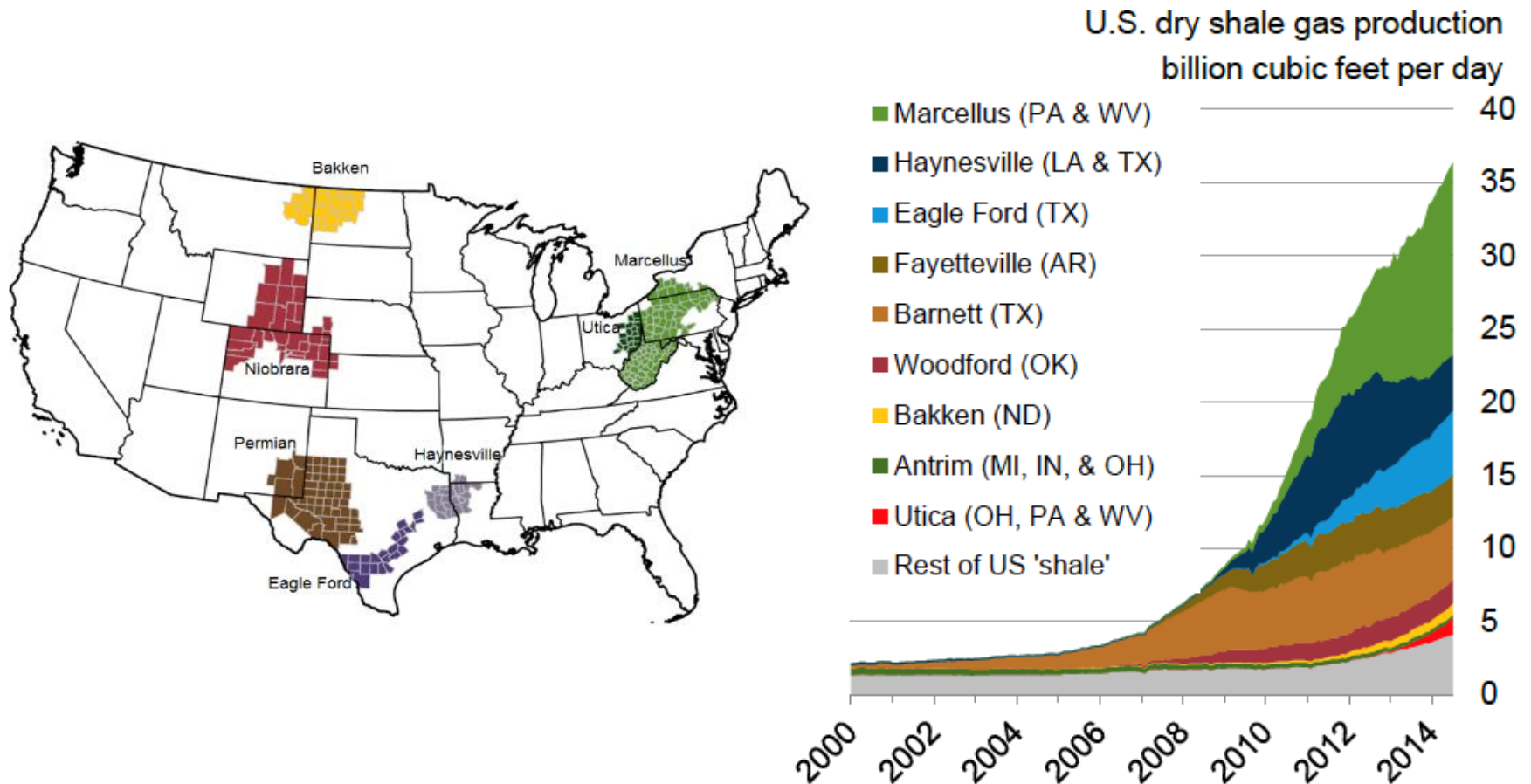


# ***Update on U.S. Natural Gas Markets and Industry: January 2015***

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**UNECE Committee on Sustainable Energy  
Group of Experts on Natural Gas  
2<sup>nd</sup> Session, Palais des Nations, Geneva – 20 January 2015**

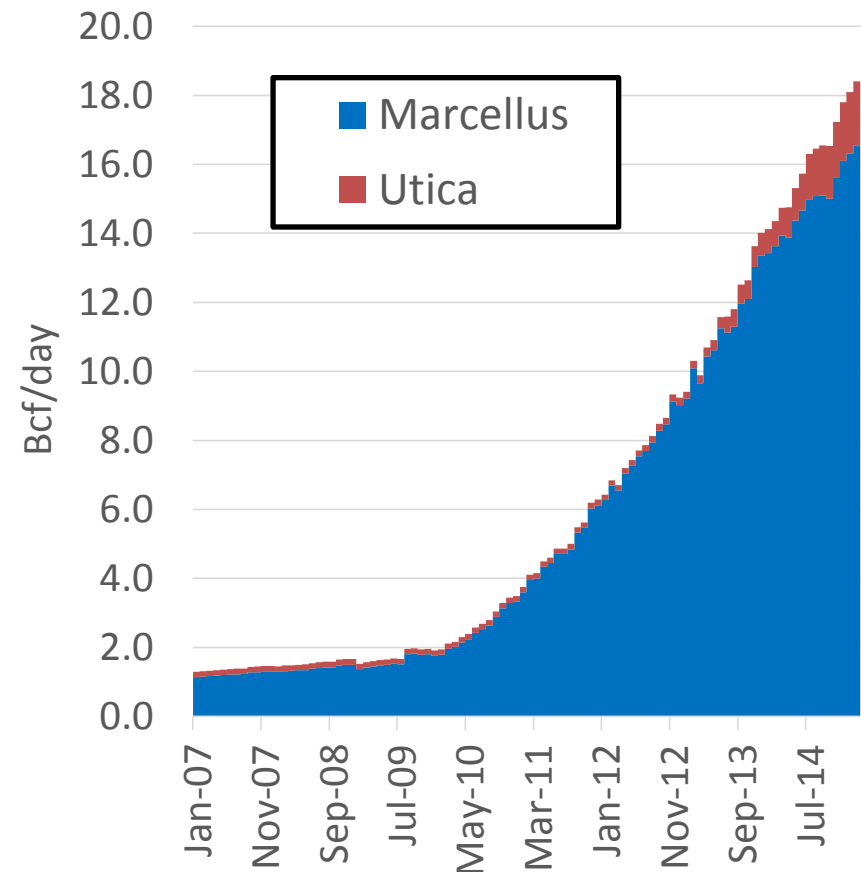
# *Shale gas production has increased quickly in North America, changing pipeline flows.*



Source: EIA Administrator Adam Sieminski, 9/22/2014; from state administrative data collected by DrillingInfo Inc. Data are through July 2014 and represent EIA's official tight oil & shale gas estimates, but are not survey data. State abbreviations indicate primary state(s).

# *Increasingly productive Marcellus/Utica shales are now supplying 24% US market.*

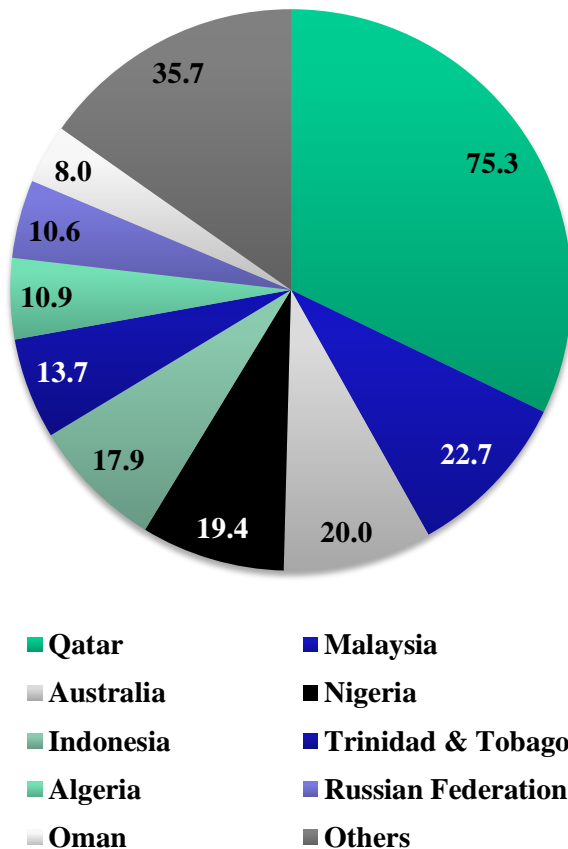
Natural Gas Supplies (Dry)	Potential Production, Bcm	Est. Recoverable, Tcm
Yamal	310-350	16.7
Bovanenkovo (alone)	220	4.9
Marcellus/Utica	190 (February 2015)	12.8
Qatar	159 (2013)	25.1



Source: EIA, Drilling Productivity Report, January 12, 2015; resource data from <http://www.eia.gov/analysis/studies/usshalegas/> (Northeast excl. Antrim); Yamal data from Gazprom, <http://www.gazprom.com/about/production/projects/mega-yamal/>, incl. explored and provisionally estimated; Qatar data from EIA, BP statistical review.

# *US Energy Dept. has approved 85 mtpa of LNG exports.*

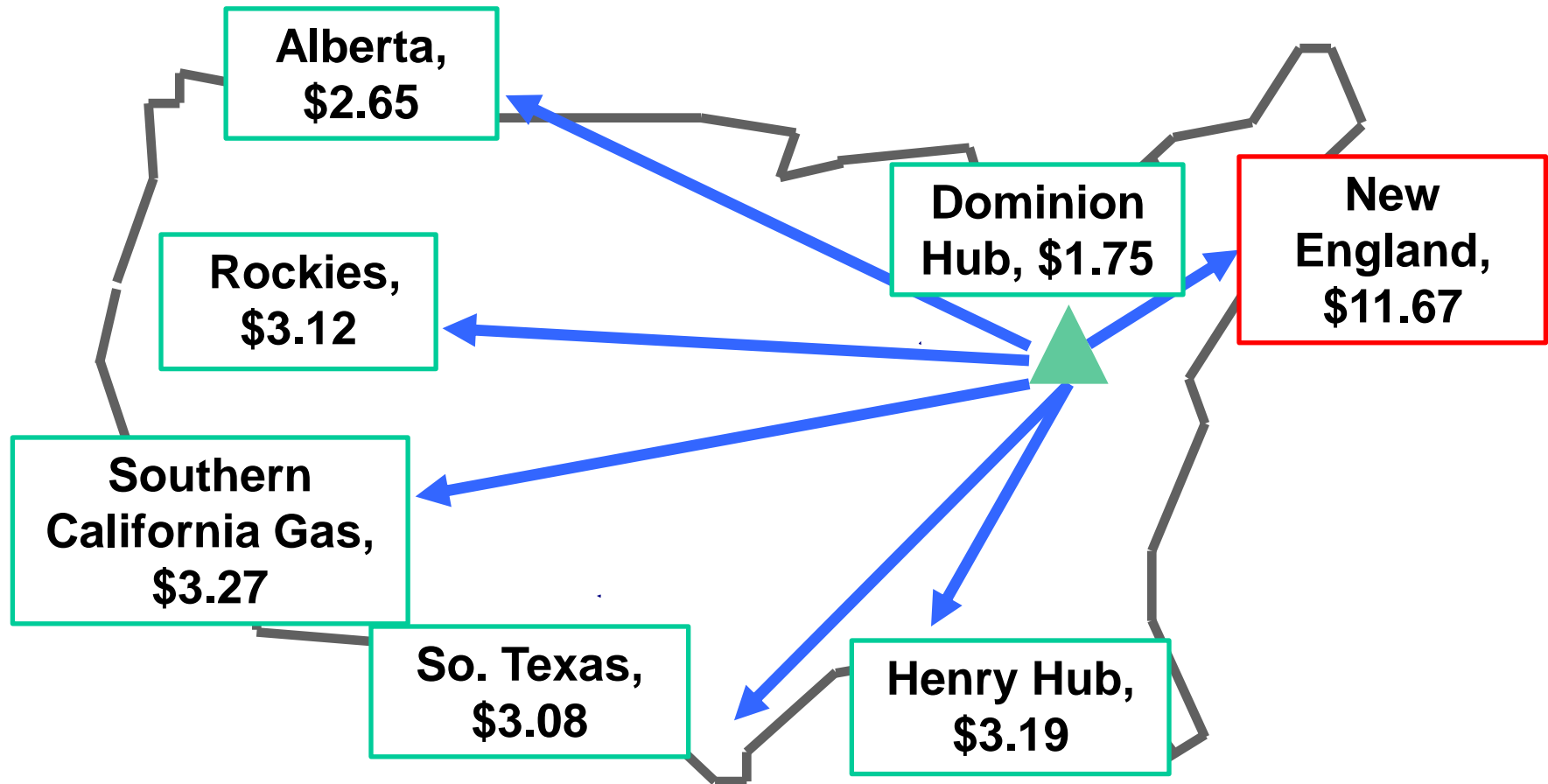
2013 LNG Exports, Mtpa



Issue: How much LNG will the US actually export?

- DOE has now approved about 85 mtpa of exports to non-FTA countries and South Korea.
- Deprived of grounds for rejection by its own studies, DOE recently announced suspension of further LNG export approvals to projects that have not been granted facilities certification from the FERC.
- FERC is likely to approve environmentally acceptable projects for which bone fide sponsors will assume commercial risk.
- *The market, not the regulators, will decide:* Global markets, with low oil-indexed prices, may reduce US LNG exports well below approved levels.

# *Shale gas production has reduced spot gas prices at most North American hubs.*



Source: BSA 2015, January 2015 hub prices from Platts Inside FERC's Gas Market Report; note: Dominion refers to Dominion Appalachia (South Point), New England refers to Tennessee Gas Pipeline, Zone 6..

## *Recent Items of Interest*

- ◆ January 2014 – US Environmental Protection Agency (EPA) released final rule requiring “green completions” in and other measures to prevent methane emissions in shale production (gas transmission standards forthcoming later in 2015), see <http://www.epa.gov/airquality/oilandgas/implement.html>
- ◆ January 2014 – Pennsylvania Department of Environmental (DEP) issues findings from two-year study, concluding “there is little potential for harm to workers or the public from radiation exposure due to oil and gas development.” See [http://www.portal.state.pa.us/portal/server.pt/community/oil\\_gas\\_related\\_topics/20349/radiation\\_protection/986697](http://www.portal.state.pa.us/portal/server.pt/community/oil_gas_related_topics/20349/radiation_protection/986697)
- ◆ October 25-28, 2015, Pittsburgh, Pennsylvania – 33<sup>rd</sup> USAEE-IAEE North American Conference will take up shale gas development, issues, economics and carbon/environmental effects. See <http://www.usaee.org/usaee2015/>



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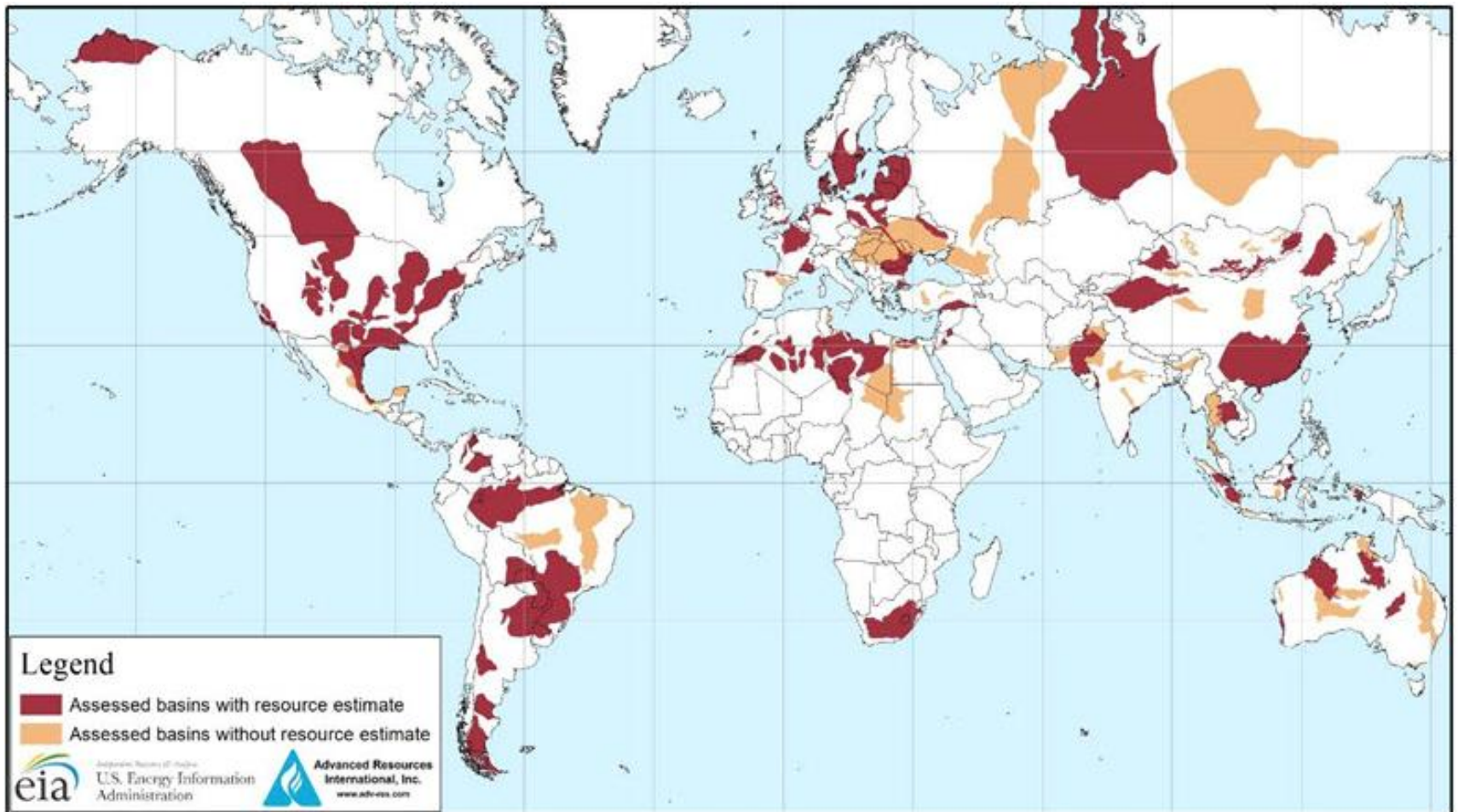
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# *Extra Slides*



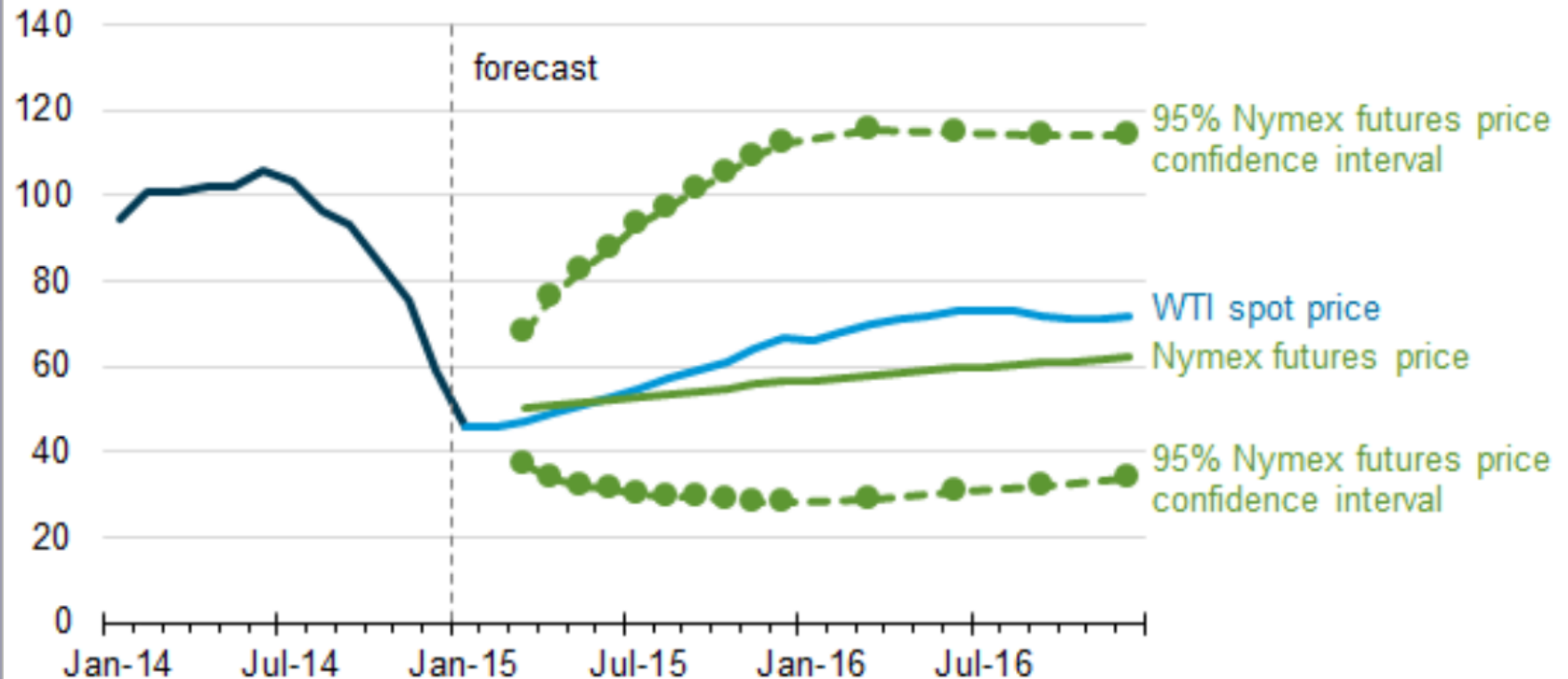
# *Global shale gas development potential is estimated to exceed 200 Tcm.*



Source: United States basins from U.S. Energy Information Administration and United States Geological Survey; other basins from ARI based on data from various published studies

# *Market expectations of oil price uncertainty have increased in recent months.*

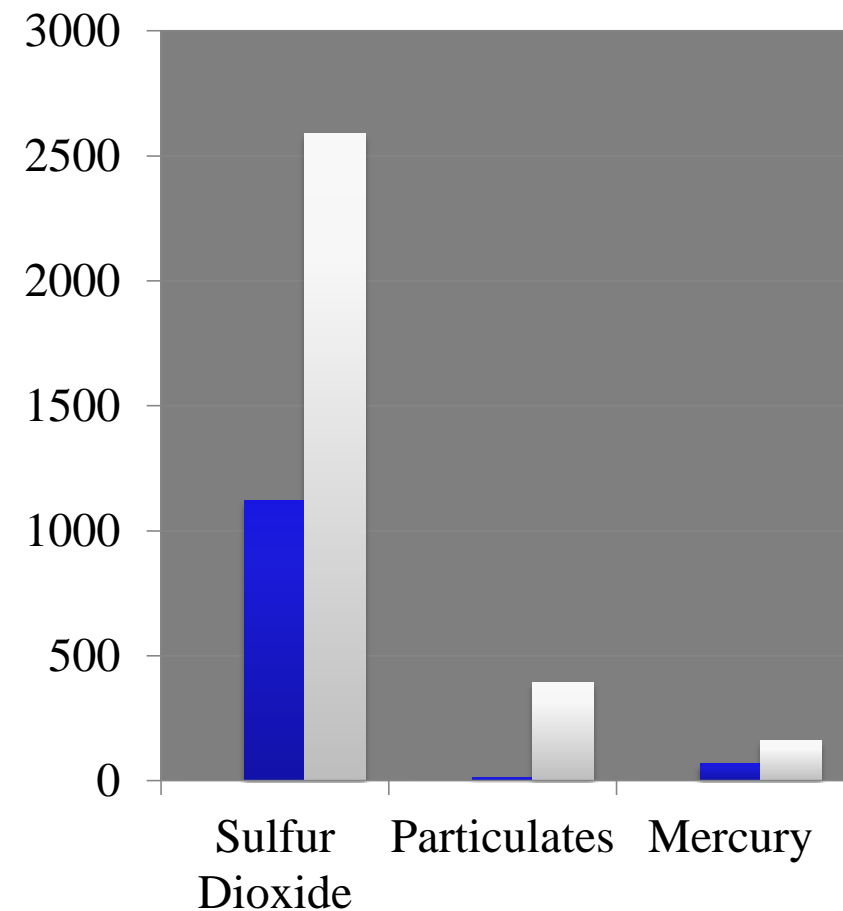
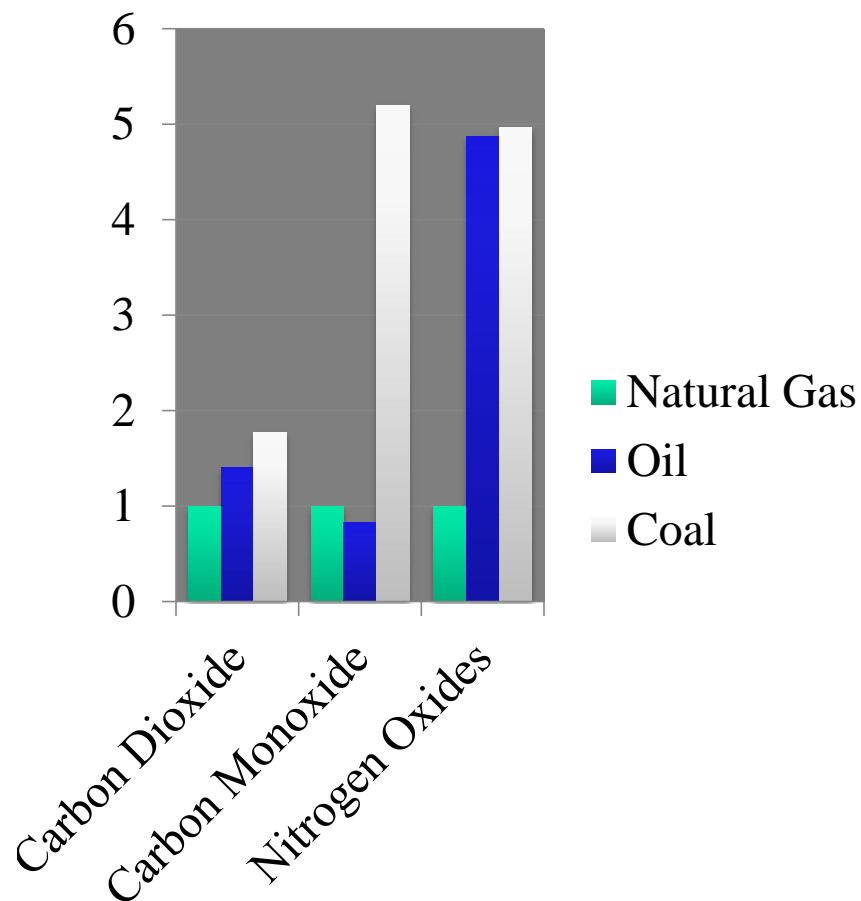
West Texas Intermediate (WTI) crude oil price  
dollars per barrel



Source: U.S. Energy Information Administration, *Short-Term Energy Outlook*, January 2015

Note: Confidence interval derived from options market information for the five trading days ending Jan. 8, 2015. Intervals not calculated for months with sparse trading in near-the-money options contracts.

*Natural gas burns 2x up to 2,590x cleaner than coal, and cleaner than oil as well.*



## *Over 500 drillers report fluids on Frac-Focus, as required by all top producing states.*

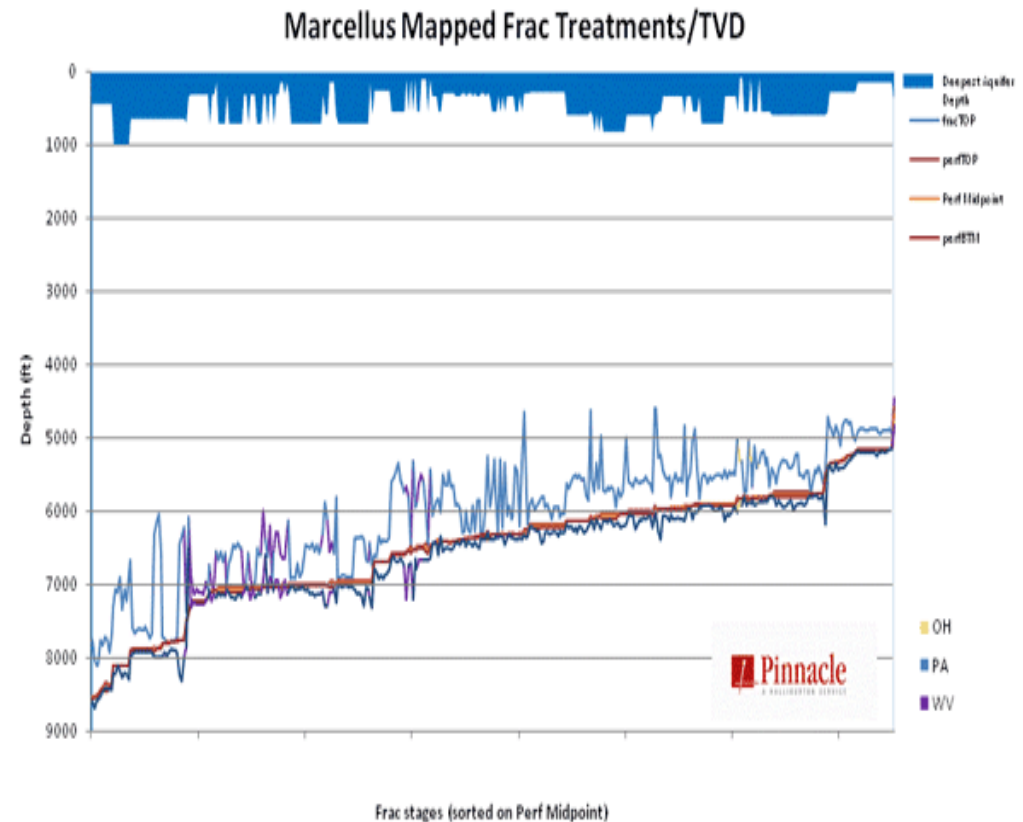


Hydraulic Fracturing Job Circa 1950

- ◆ First hydraulic fracturing in the 1940s.
- ◆ Since then, the process has become routine, used on **over 1 million producing wells**.
- ◆ As the technology continues to develop and improve, operators now fracture as many as 35,000 wells of all types (vertical and horizontal, oil and natural gas) each year.
- ◆ 55,978 well sites report fluid contents to FracFocus.

# *EPA investigations show nearly all ground-water contamination pre-exists fracking.*

- ◆ Shale seams co-located with conventional gas, but lie far below groundwater tables.
- ◆ Shell, Range Resources and other drillers are recycling return waters in TX, PA.
- ◆ Drillers in arid regions are increasingly using waterless and air fracking systems.
- ◆ State environmental laws and the CWA prevent dumping of return wastes.
- ◆ What pathways are left?  
Operator error! Well bores?





# *Methane leakage from shale ops can be minimized through “green completions.”*

- ◆ EDF completed in 2014 the first of 16 methane leakage investigations.
- ◆ UT, WVU, CSM, NOAA staff, and others are involved in this series.
- ◆ Initial findings of high methane leakage rates (from over-flights) were found to be greatly overstated.
- ◆ Obama Administration and producing states are adopting regulations based on EDF’s work.
- ◆ Gas producers, pipelines, distributors and users can and are tightening methane handling to minimize leakage.





# *The good news: Replacing old coal with new gas reduces CO<sub>2</sub> emissions by 63-72%.*

	Average Age of Plants at Retire- ment	No. of Plants Retired in Each Year	Total Net Summer Capacity, GW	CO2 Reduction Replacing Bituminous Coal with Gas
2009	50	12	0.5	67.7%
2010	54	35	1.5	69.4%
2011	62	31	2.5	63.3%
2012	56	57	8.9	63.9%
<b>2013</b>	<b>55</b>	<b>14</b>	<b>2.1</b>	<b>71.7%</b>
2014	57	34	4.7	64.4%
2015	57	61	9.9	63.1%

- ◆ GHG reduction due to:
  - Chemical advantage: Gas burning emits 46% less CO<sub>2</sub> than coal.
  - Efficiency advantage of new gas CCGTs versus old coal boilers: 55-60% vs. 31-33%.
  - Carbon emissions savings from fuel cycle as well.
- ◆ Other criteria air emissions reduced/prevented, especially sulfur, particulates, oxidants.
- ◆ But the “low-hanging fruit” might all be picked by 2020.

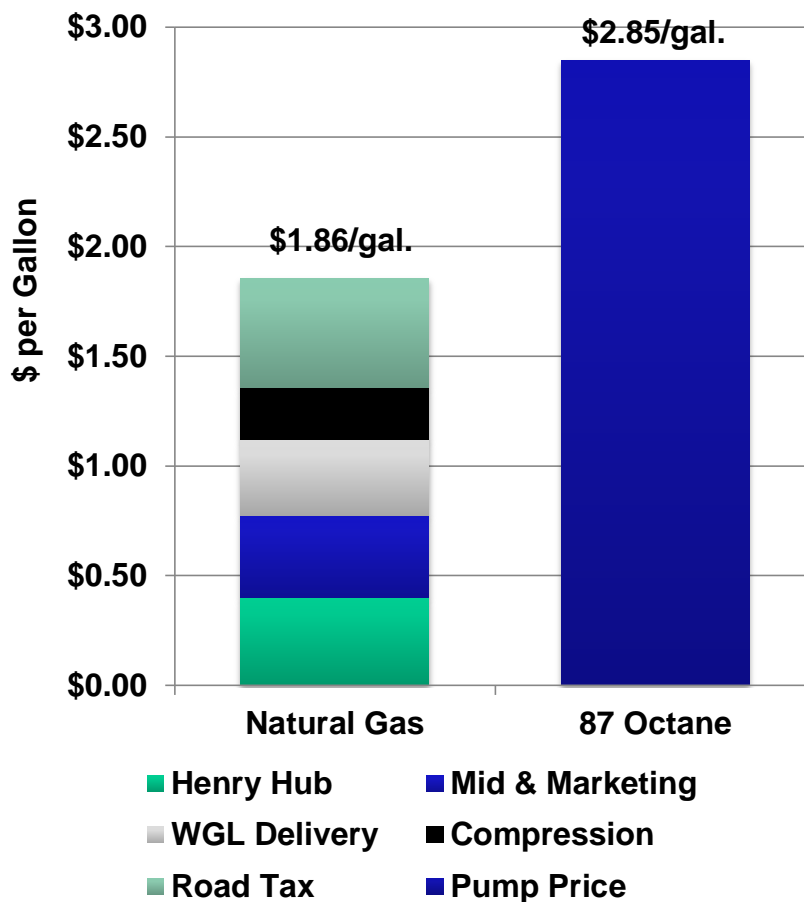


*Natural gas (CNG and LNG) has begun to find markets trucking, rail and ships.*



*But natural gas demand in vehicles will take decades to evolve in the US.*

## *Issue: Why doesn't America have 20 million NGVs by now?*



- ◆ Economics have been highly favorable for 3 decades!
- ◆ Natural gas is best used in large vehicles, high-mileage fleets:
  - Municipal trucks, buses
  - UPS, Dulles Flyer
  - Forklifts, compressors
- ◆ Lower mileage personal vehicles are headed toward electricity:
  - \$4 pipeline gas vs. \$26 gasoline, both per MMBtu
  - 61% efficient CCCTs vs. 26% efficient piston engines
  - No wonder electricity = 79 c/gal!

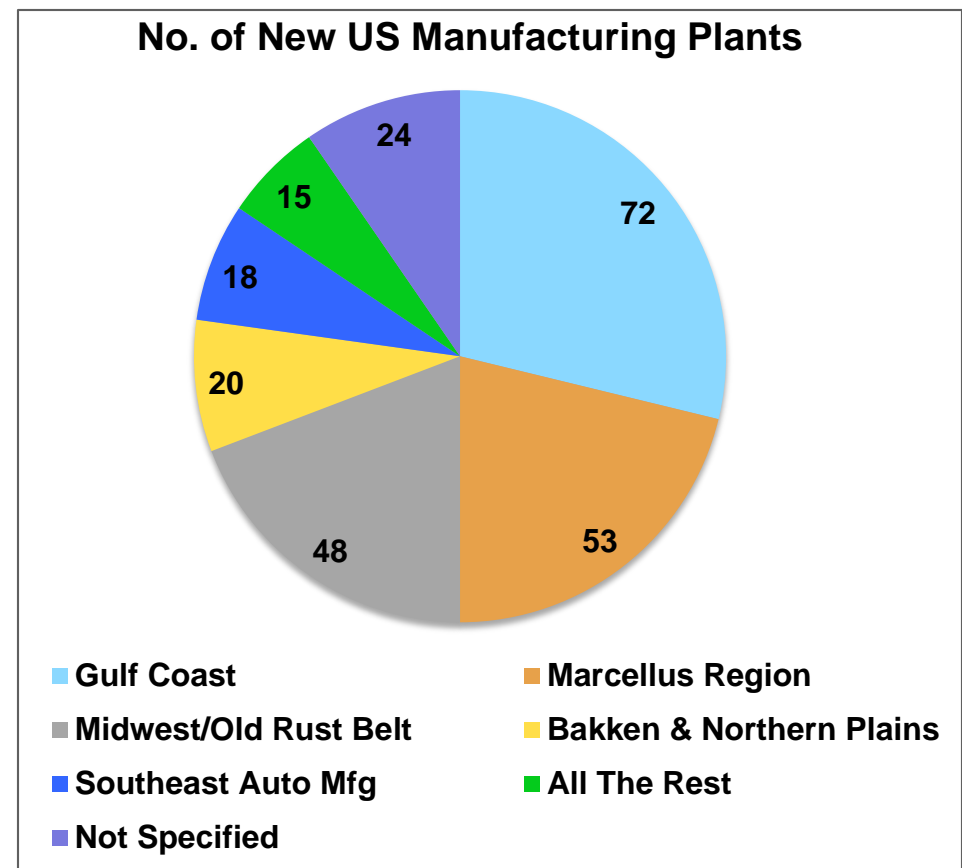
*Gas-fired electricity means battery EVs are, in effect, just very high-efficiency NGVs.*



- ◆ Production of methanol and gasoline from natural gas (GTL) will also become options, as price differentials remains favorable.

# *Global firms plan to spend more than \$110 billion on new US gas-based industries.*

- ◆ 175 new manufacturing plants in development:
  - Chemicals & petrochemicals
  - Fertilizers
  - Steel & aluminum
  - Tires, plastics
  - Gas to liquids
- ◆ Most sited near shales (see count of # plants at right).
- ◆ Increased gas demand will range from 2.1-3.2 Bcf/day by 2025.





# *Newer LNG delivery concepts can deliver surplus shale gas to under-served areas.*



## Moored Buoy System with pipeline to shore

- Special ships moor to buoy
- Regasification done on board the ship
- Ship departs once LNG regasified

## Floating Storage and Regasification Unit

- Terminal is a specially designed moored vessel
- LNG storage and regasification done on board
- Natural gas piped to shore



## Gravity Based Structure

- Terminal is submerged concrete structure
- LNG storage and regasification done on terminal
  - Natural gas piped to shore