



Energy Market Upheaval: The Shale Revolution

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“New Energy Recovery Technologies: Midwest and Global Industry Impacts”

**Federal Reserve Bank of Chicago, Detroit Branch
Monday, April 8, 2013**

Outline

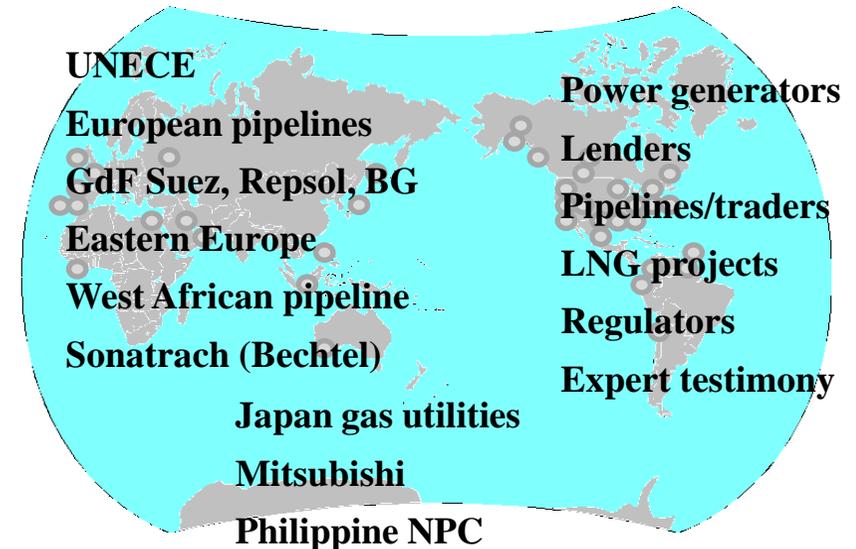
- ◆ Introduction
- ◆ Gas supply: shale gas (and shale oil)
- ◆ Gas demand in crisis
- ◆ Coal substitution, other new markets
- ◆ Global gas markets
- ◆ Conclusions.

BSA – 29 years of gas and energy advisory services.

Expertise

- ◆ Economics, pipeline tariffs, contracting, price risks.
 - Research & training
 - Negotiation of gas contracts
 - Due diligence – Review for lenders in financing of LNG, power plants, gas storage
 - Expert in courts & arbitrations, testified in 16 jurisdictions.
- ◆ 600+ assignments
- ◆ 27 countries.

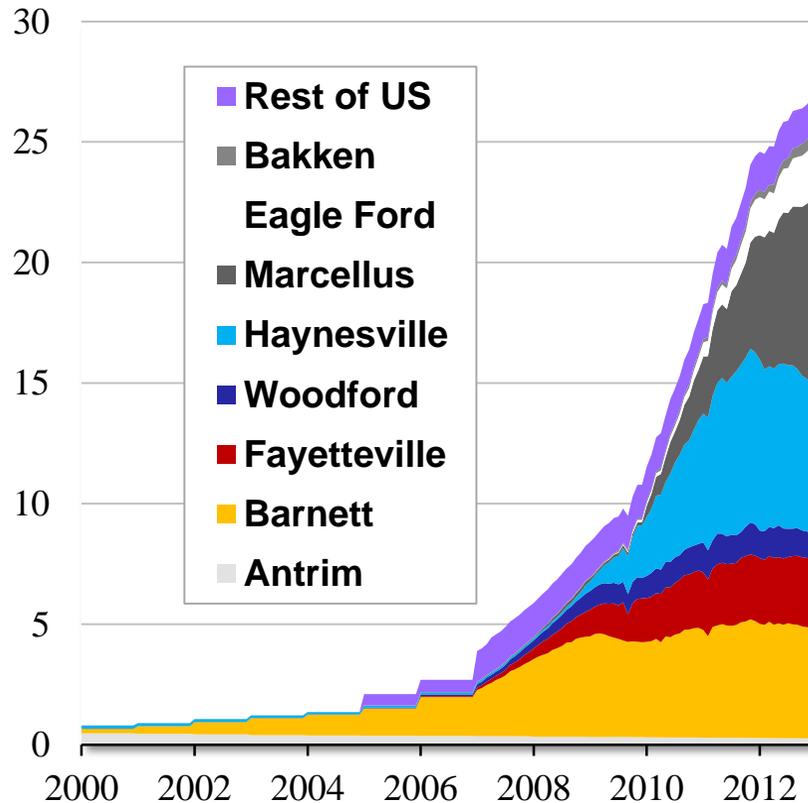
Major Assignments



lients: Energy buyers & sellers, electricity and heating plants, gas and oil pipelines, banks, governments, universities.

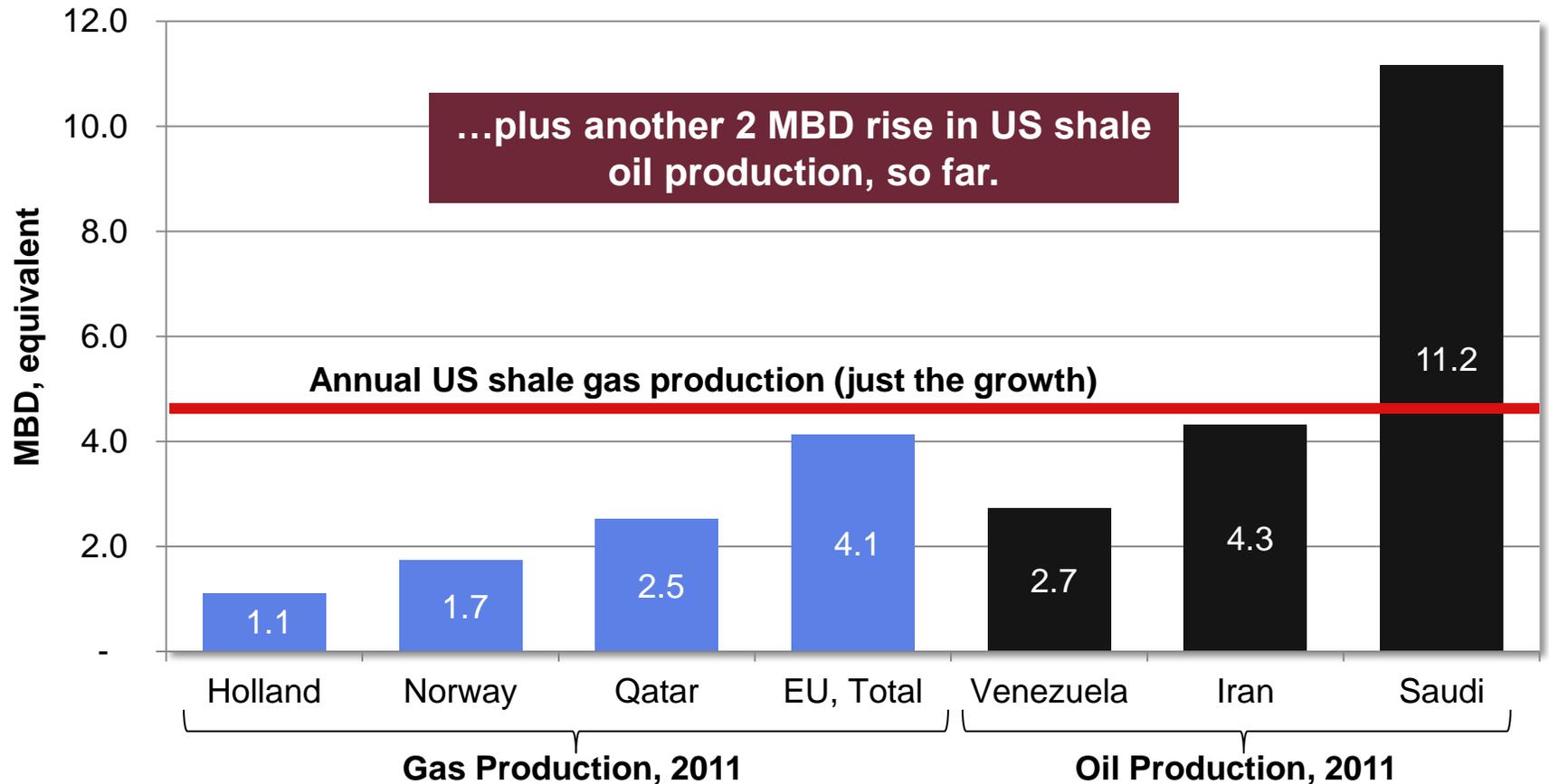
Despite all the words and numbers, people still don't really grasp this.

Estm. US Shale Gas Production, Bcf/day

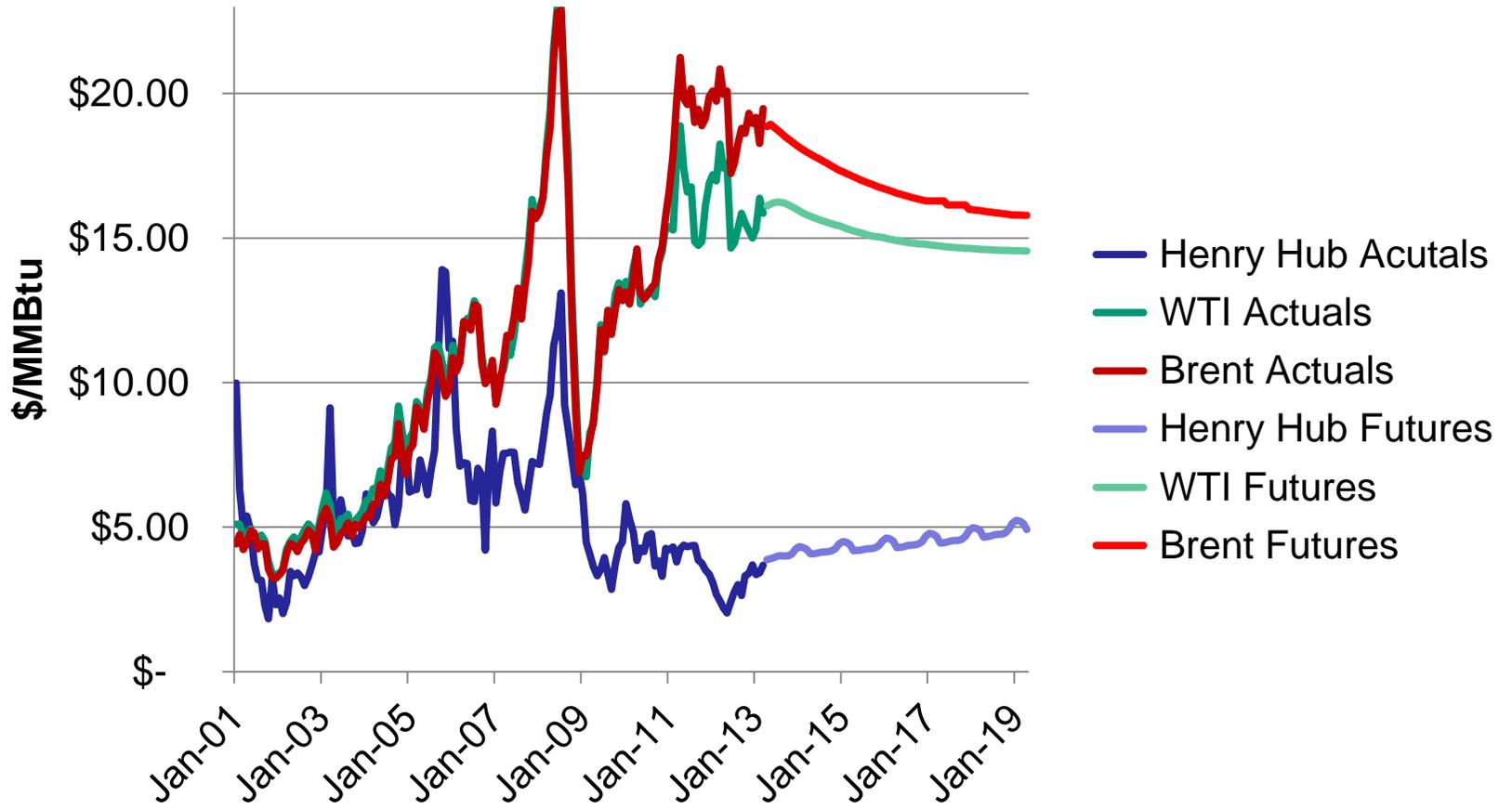


- ◆ The ship arrives.
- ◆ Were it a country, US shale would be the world's 3rd largest gas producer.
- ◆ Most US policy, economic, academic and environmental studies are totally outdated, e.g., from Internet/Google.
- ◆ Shale 'debate' is lost on most people.

US has added 4.6 MBD equivalent of shale gas production since 2001.

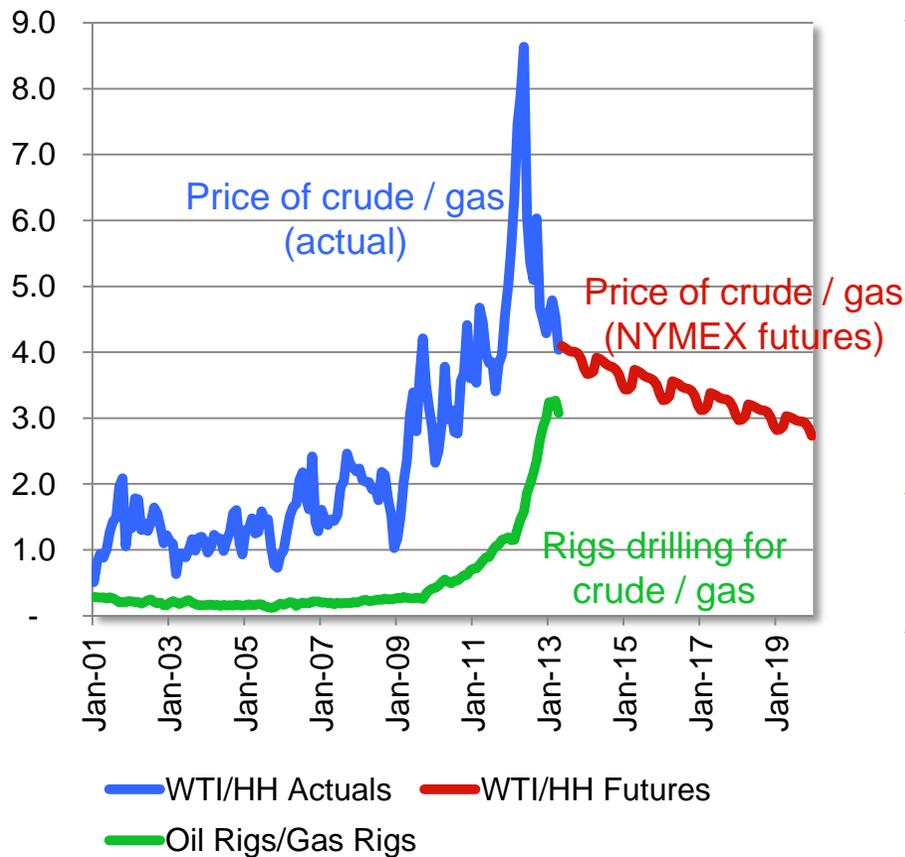


How long will North America's big hydrocarbons price gap persist?



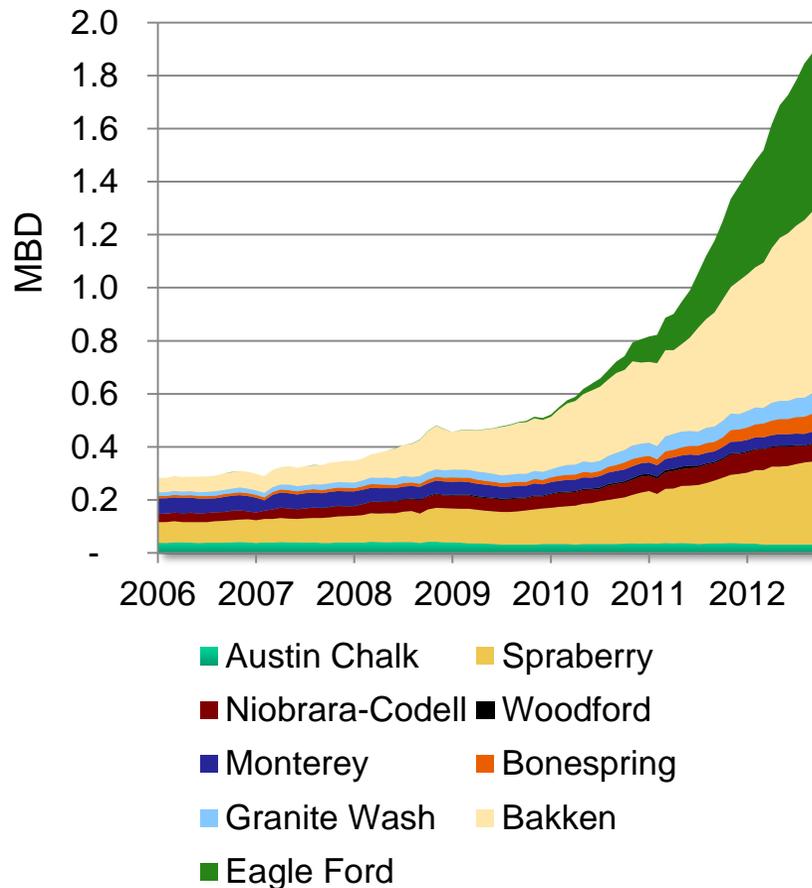
High crude oil prices (relative to gas) mean drillers will continue to seek tight oil.

Oil-to-Gas Ratio



- ◆ Past: Crude prices rose while gas prices fell, until crude prices averaged 6x gas price in 2012 – drillers moved off to oily shales:
 - Eagle Ford, Texas
 - Bakken, North Dakota
 - Utica, Ohio
- ◆ Today: \$96 crude oil is 4x gas (\$16.55/MMBtu versus \$4.10).
- ◆ Outlook: Oil prices and oil drilling rigs both at 3-to-one over natural gas, until gas production falls and its price rises.

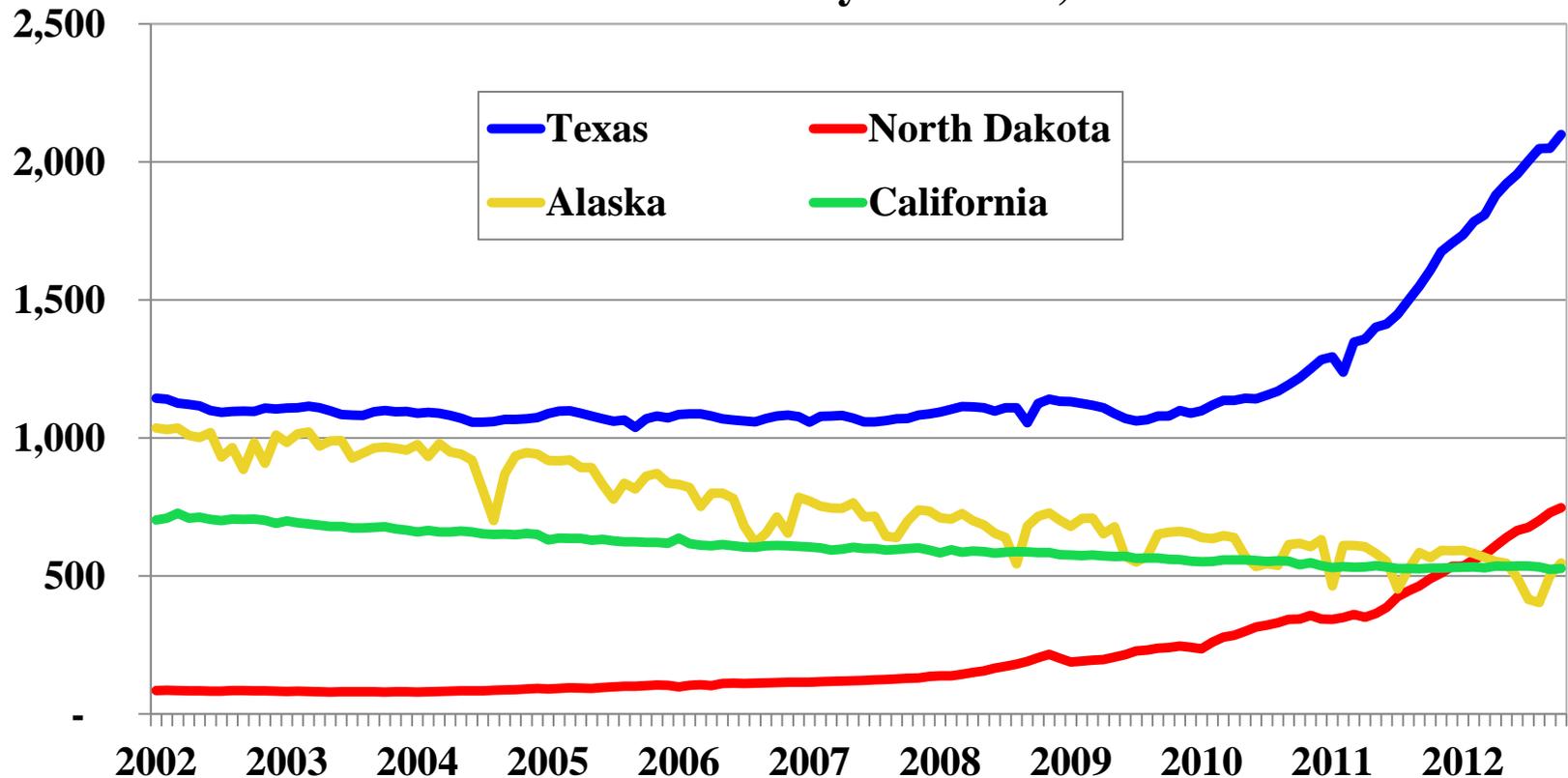
US production of tight oil and NGLs is now rising as dramatically as natural gas did.



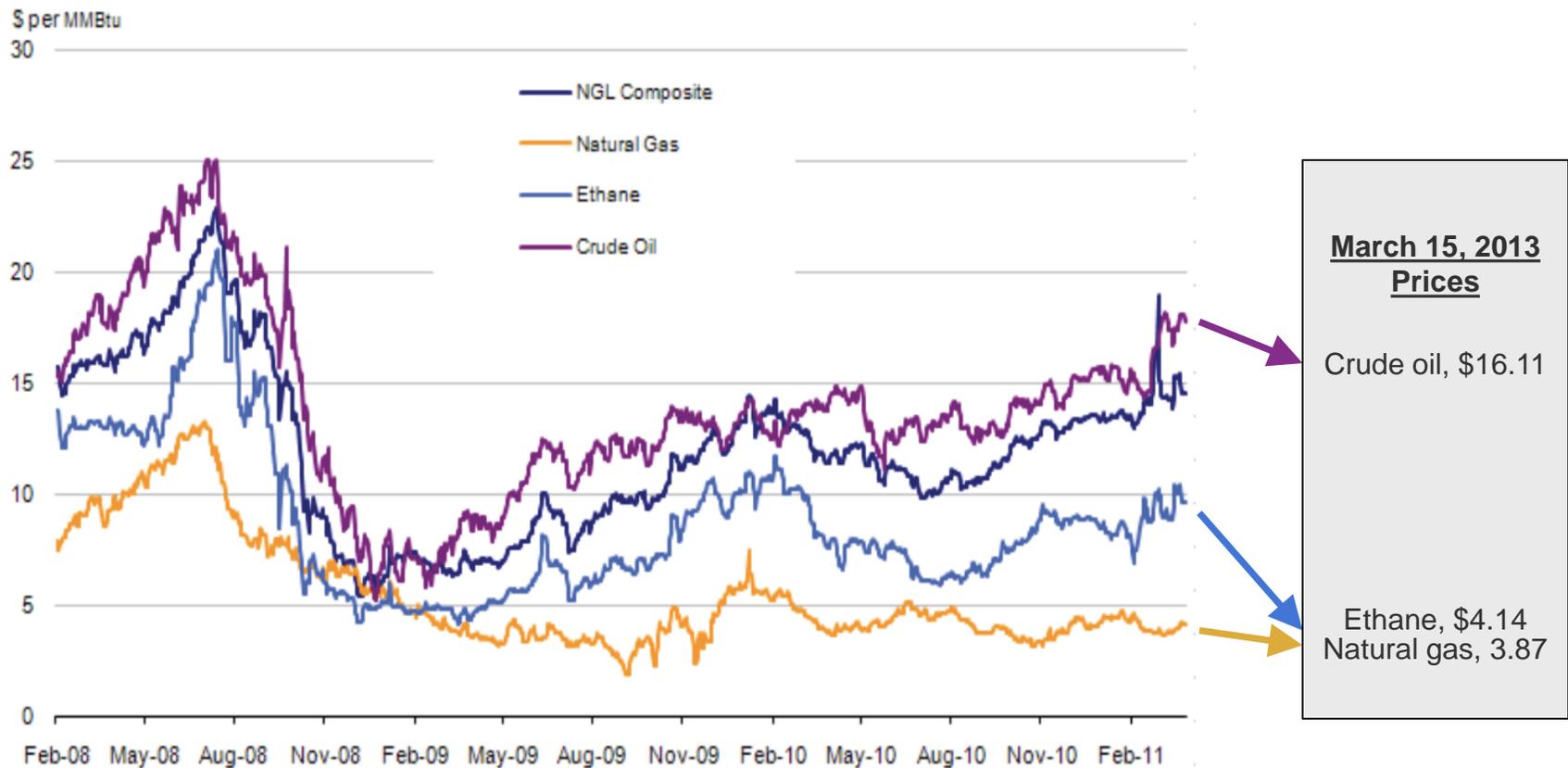
- ◆ Emerging shale plays are forcing new technologies:
 - Multi-well/multi-stage
 - Recycling of return waters
 - New tech (dry fracking, CO₂).
- ◆ Major challenges:
 - Low gas and NGL prices (tends to self-correct)
 - Pipeline bottlenecks, both gas and oil (flaring)
 - High cost of rail
 - Environmental issues?
 - Skilled labor shortages.

North Dakota's oil production will double Alaska's before 2020.

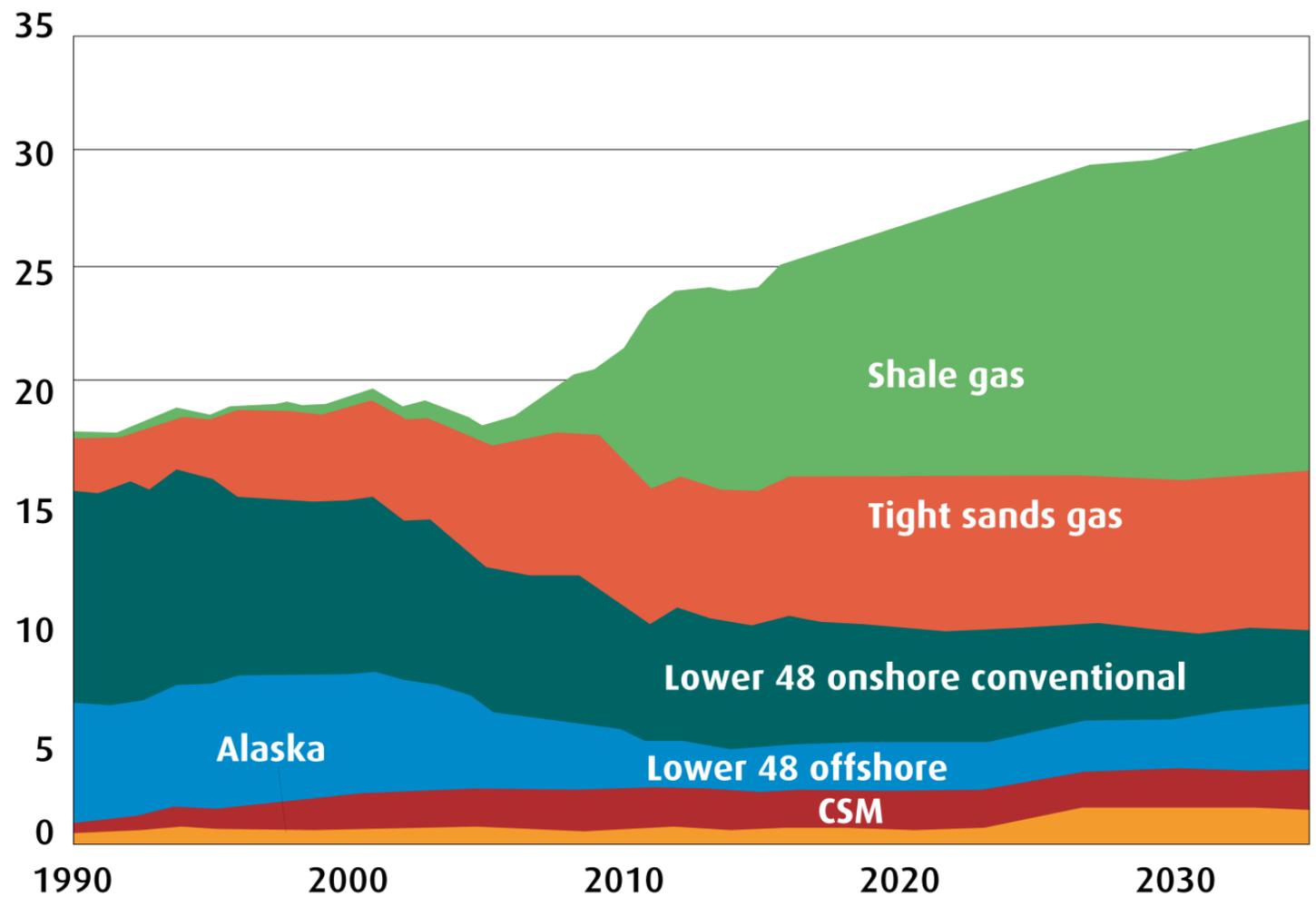
Production of Crude Oil by US State, thousands of b/d



The resulting NGL “waterfall” has driven down prices, esp. ethane.



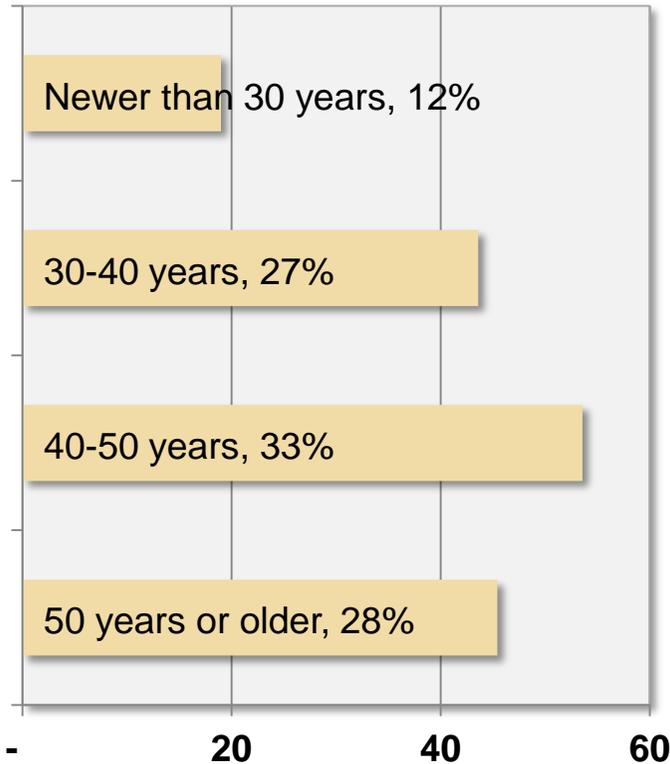
EIA's US Gas Production to 2035



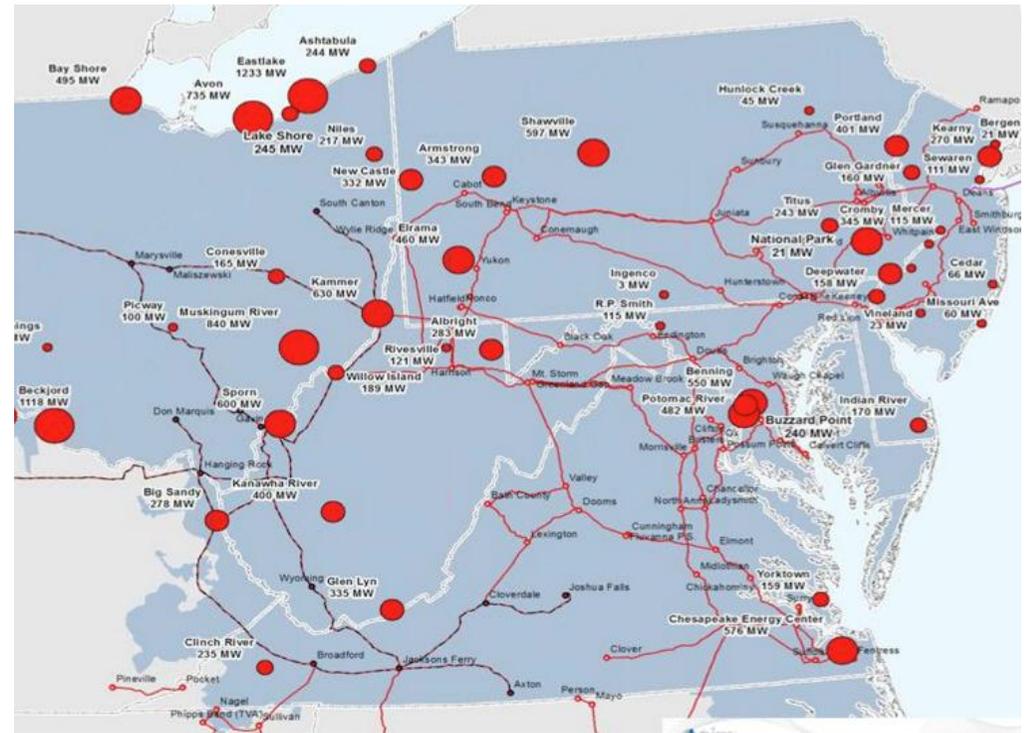
Source: EIA, AEO 2013 Early Release, Reference Case, December 5, 2012.

Most near-term surplus gas will be spent replacing coal in aging power plants.

Coal-Fired Plants, MW



Retiring Coal-Fired Plants



The good news: Replacing old coal with new gas reduces CO₂ emissions by 63-72%.

	Average Age of Plants at Retirement	No. of Plants Retired in Each Year	Total Net Summer Capacity, GW	CO ₂ 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%
2013	55	14	2.1	71.7%
2014	57	34	4.7	64.4%
2015	57	61	9.9	63.1%

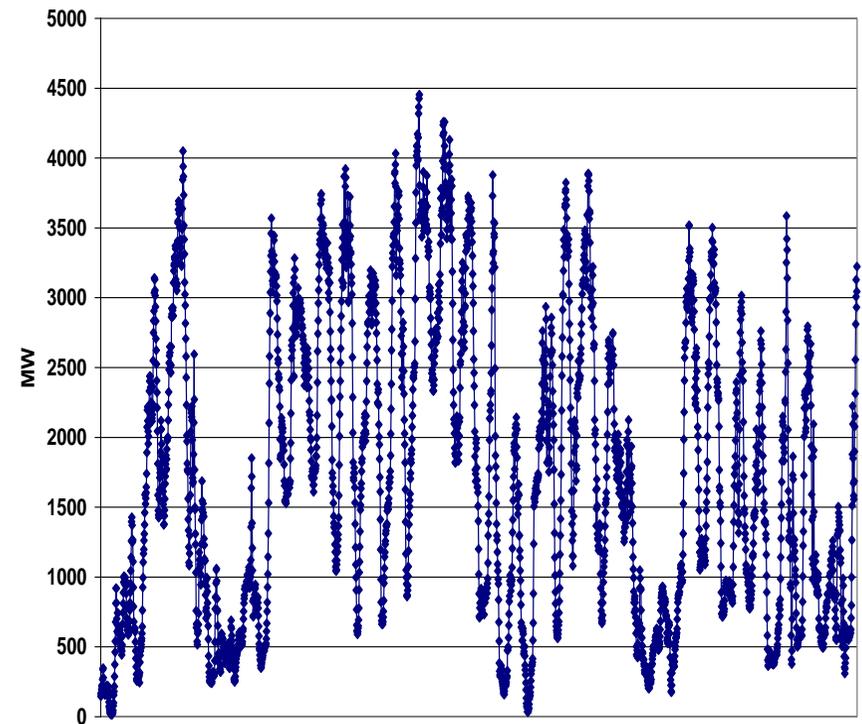
- ◆ GHG reduction due to:
 - Chemical advantage: Gas burning emits 46% less CO₂ than coal.
 - Efficiency advantage of new gas CCGTs versus old coal boilers: 55-60% vs. 31-33%.
 - Carbon emissions savings from fuel cycle as well.
- ◆ Other criteria air emissions reduced/prevented, especially sulfur, particulates, oxidants.
- ◆ But the “low-hanging fruit” might all be picked by 2020.

LNG is uniquely able to offset variable generation, e.g., Spanish CCCTs.

LNG Regas in Spain



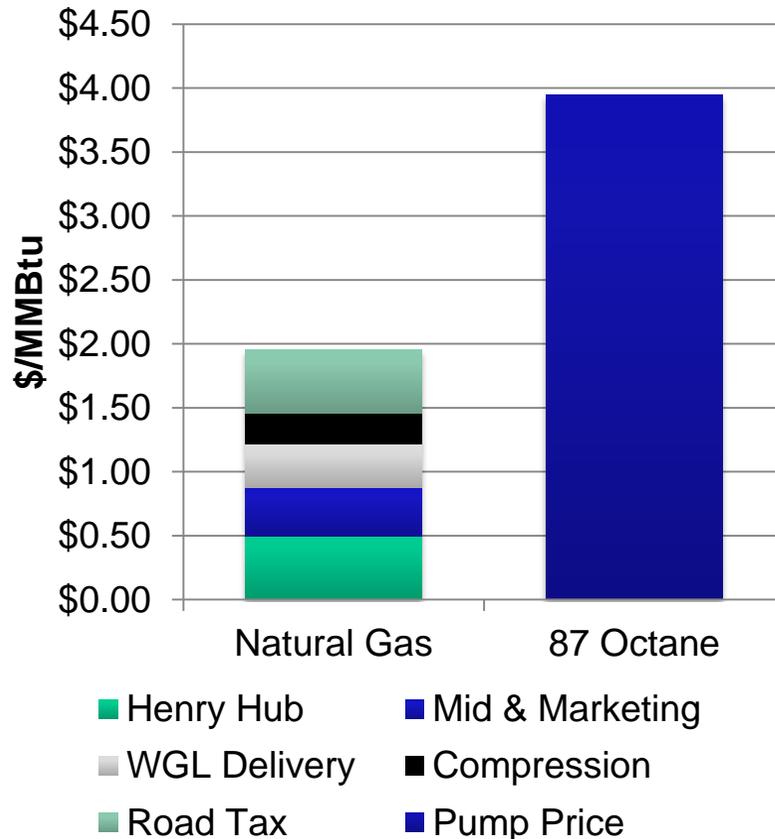
Hourly Wind Production, MW



*Other key new gas markets will take longer
– NGVs, petrochemicals, LNG exports.*



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



- ◆ Favorable economics since 1980s!
- ◆ Natural gas is best used in large vehicles, high-mileage fleets:
 - Municipal trucks, buses
 - UPS, Dulles Flyer
 - Forklifts, compressors
- ◆ Lower mileage personal vehicles headed toward electricity:
 - \$4 natural gas vs. \$32 gasoline (per MMBtu)
 - 61% efficient CCCTs vs. 26% efficient piston engines
 - No wonder electricity = 79 c/gal!

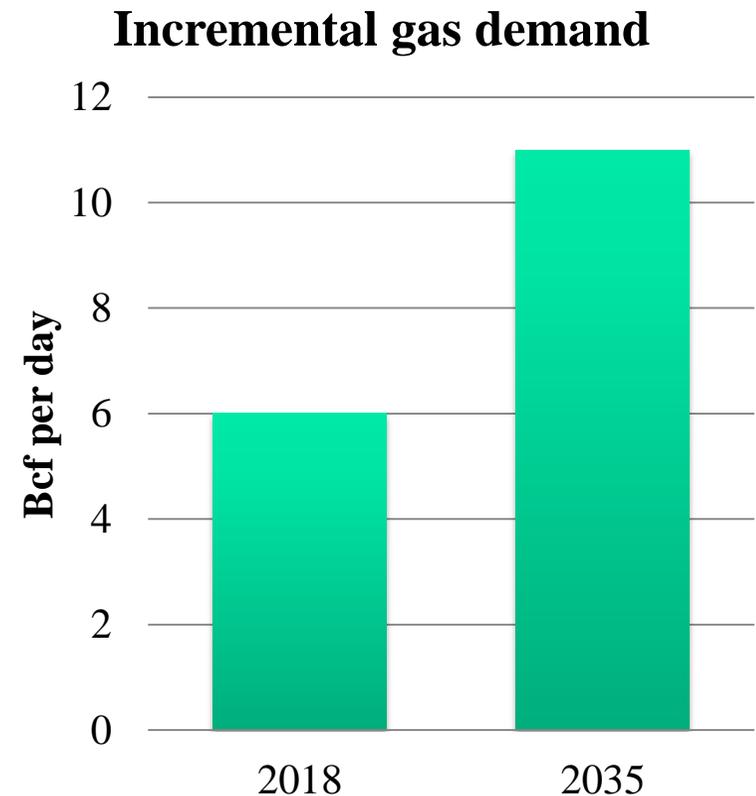
*In some regions, battery EVs are, in effect,
just very high-efficiency NGVs.*



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

Global firms plan to spend \$80 billion on new US gas-based industries.

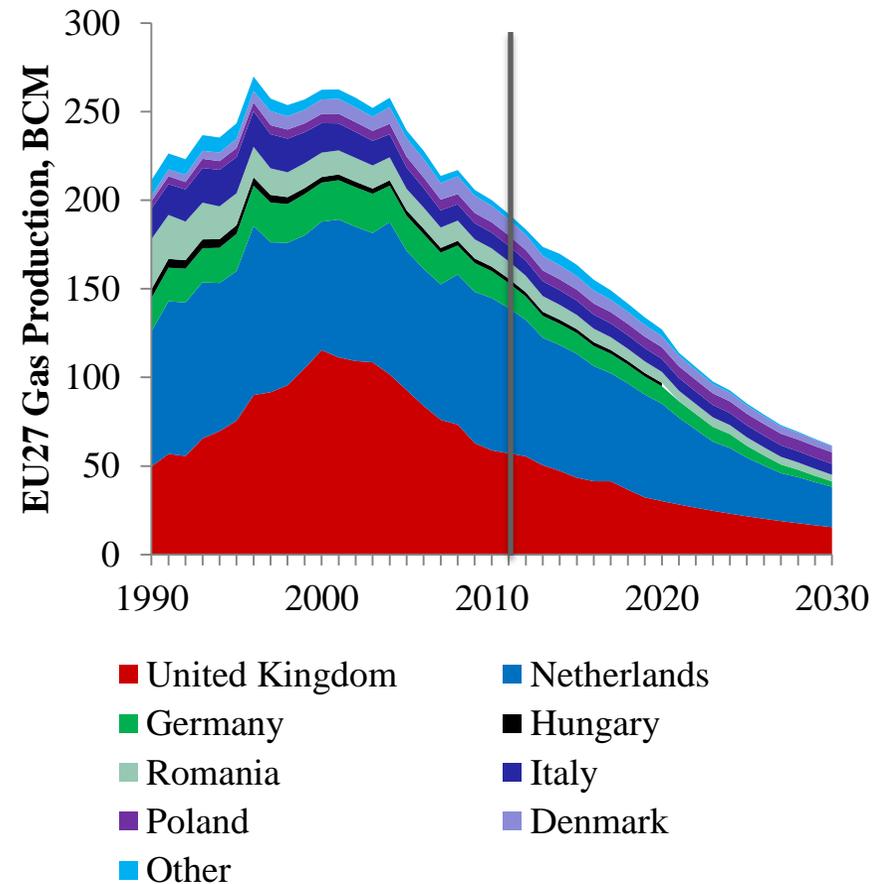
- ◆ About 100 new manufacturing plants in development:
 - Chemicals & petrochemicals
 - Fertilizers
 - Steel & aluminum
 - Tires, plastics
 - Gas to liquids
- ◆ Most sited near the Gulf Coast.
- ◆ If all proceed, added gas demand will reach 11 Bcf/day by 2035.



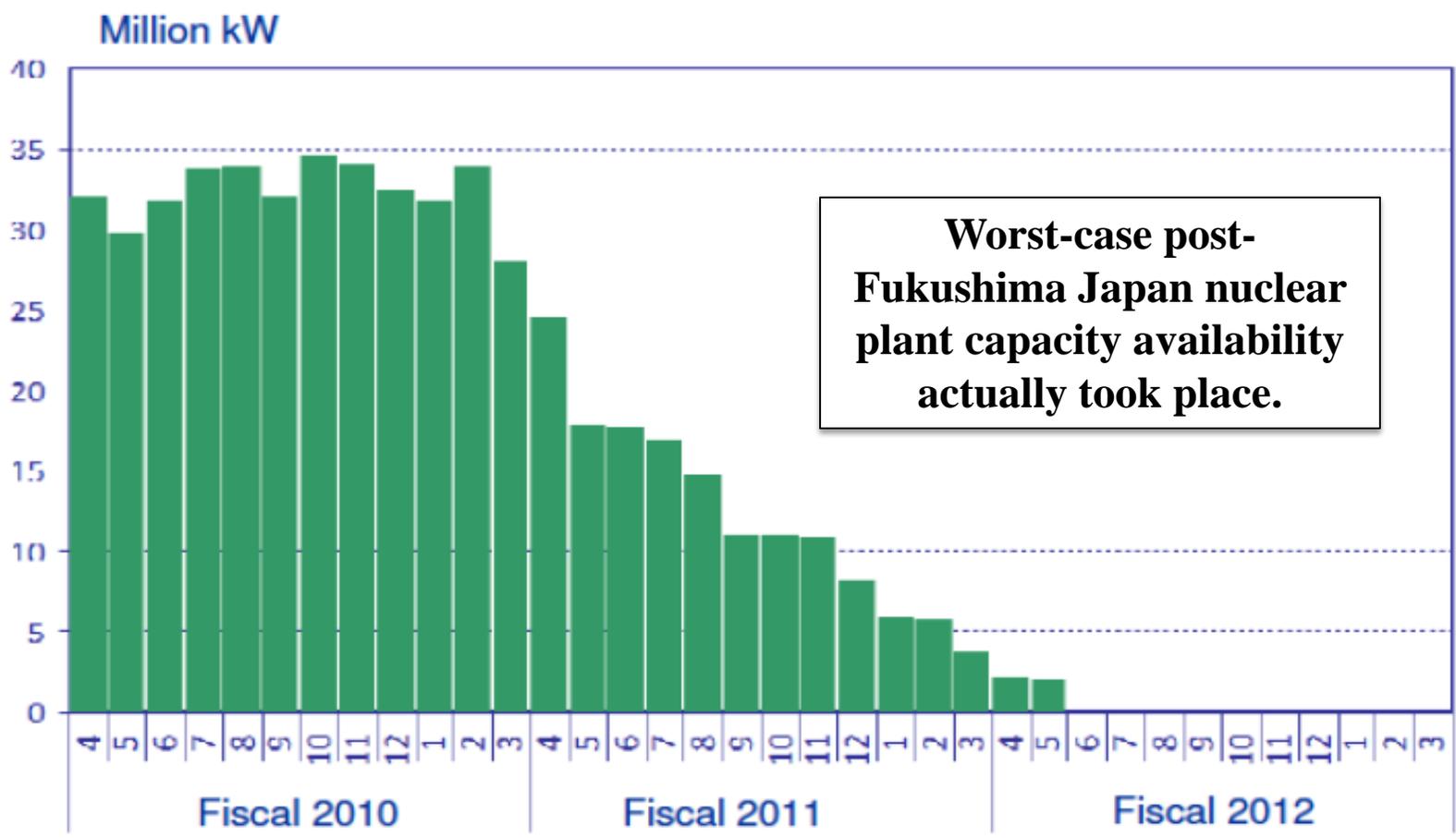
LNG Exports: Linking the US to Global Gas Markets

European demand for gas imports is rising with supply & nuclear issues.

- ◆ Plunging European gas production is intensifying winter supply crises.
- ◆ In less than a decade, the UK has transformed from exporter to LNG importer on scale exceeding Spain.
- ◆ The high cost of marginal Russian gas supplies offers little relief, buyers seek LNG.
- ◆ European gas demand is flat.



Fukushima and economic growth have each strengthened Asian gas demand.

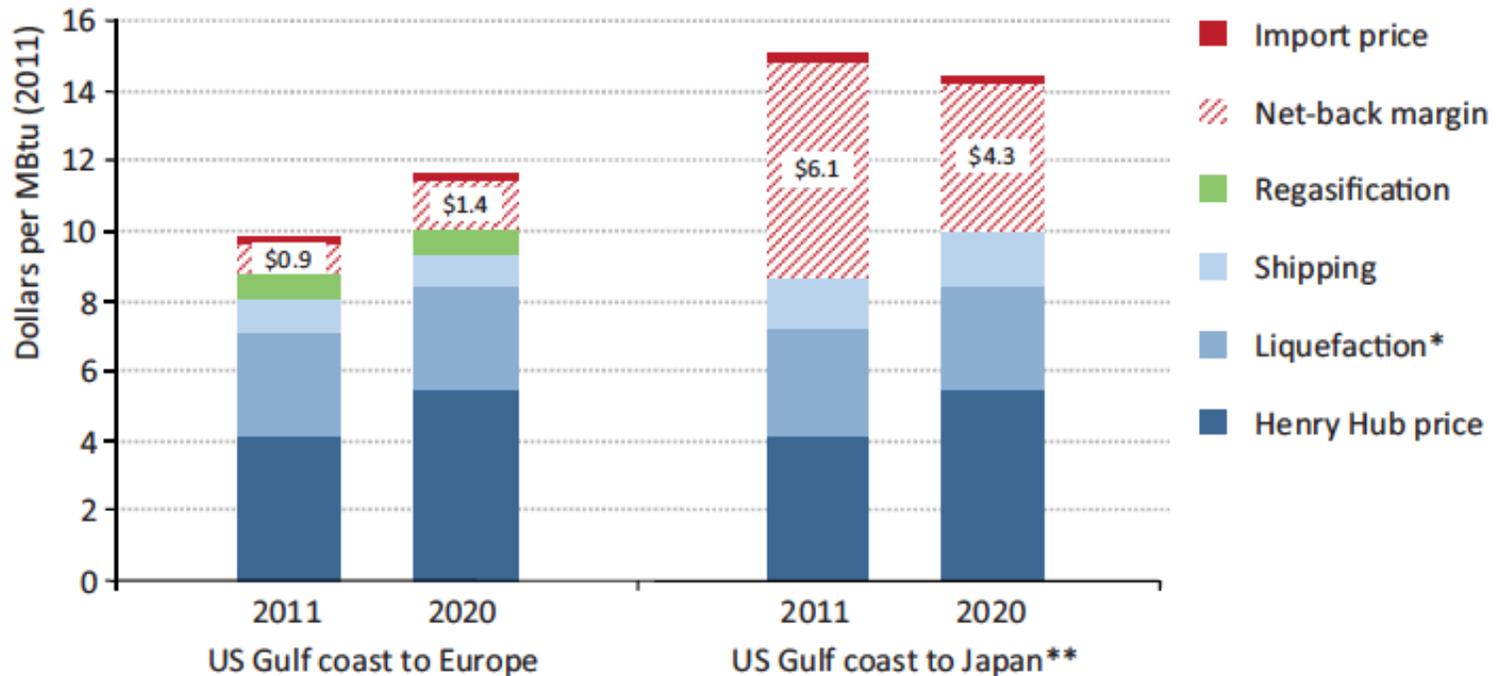


Source: Forecast by M. Toyoda, Institute of Energy Economics-Japan, October 2011.

Gas prices among markets differ greatly from one another.



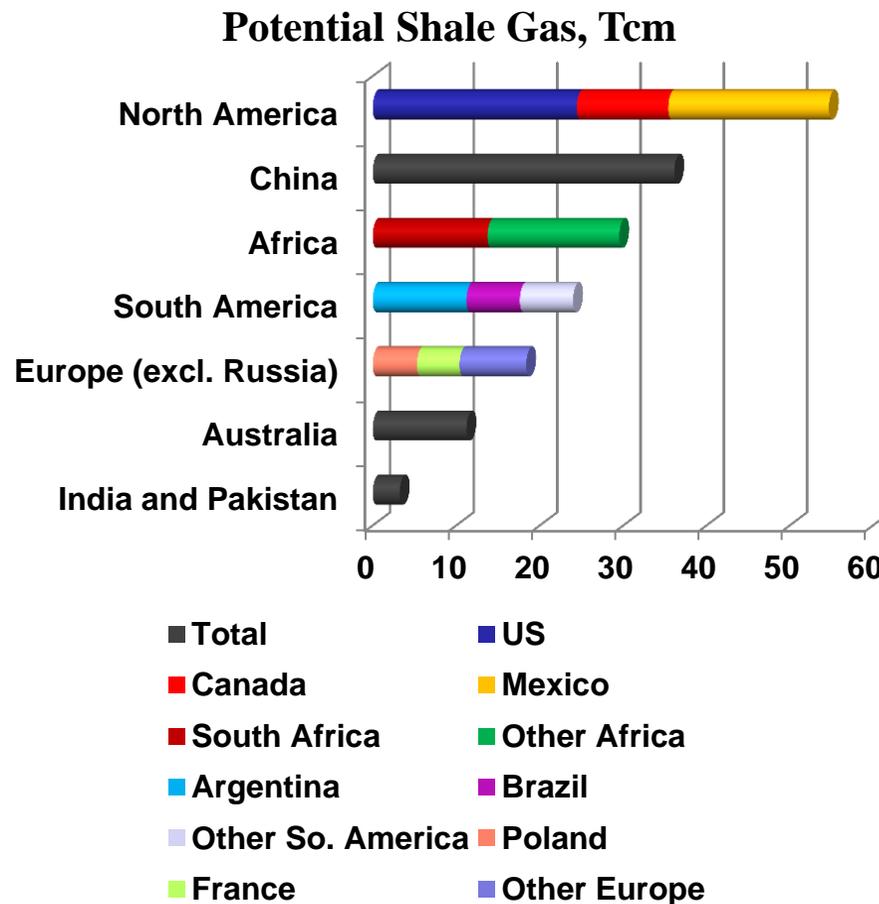
LNG exports from the US are sought after for strategic and economic reasons.



* Includes cost of pipeline transport to export terminal. ** Widening of the Panama Canal, due to be completed in 2014, will allow for more LNG tanker traffic.

Notes: LNG costs are levelised assuming asset life of 30 years and a 10% discount rate. The Japanese import price is for liquefied gas, so it does not include regasification.

Global shale gas is unlikely to threaten US LNG exports for years.



- ◆ Most foreign gas markets are dominated by long-term contracts tied to fuel oil.
- ◆ European, Asian and Russian shale gas resources may remain in place absent:
 - Vibrant independent producing sector
 - Technical expertise
 - Institutional reform/TPA
 - Education.



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