

The U.S. Shale Revolution: Certainty in an Uncertain World

Presentation to:
CO2 & ROZ Conference
Midland, TX

By:
John Harpole

(Oil and Gas are Not Scarce Resources Anymore ... and some people/countries
JUST DON'T SEEM TO GET IT.)



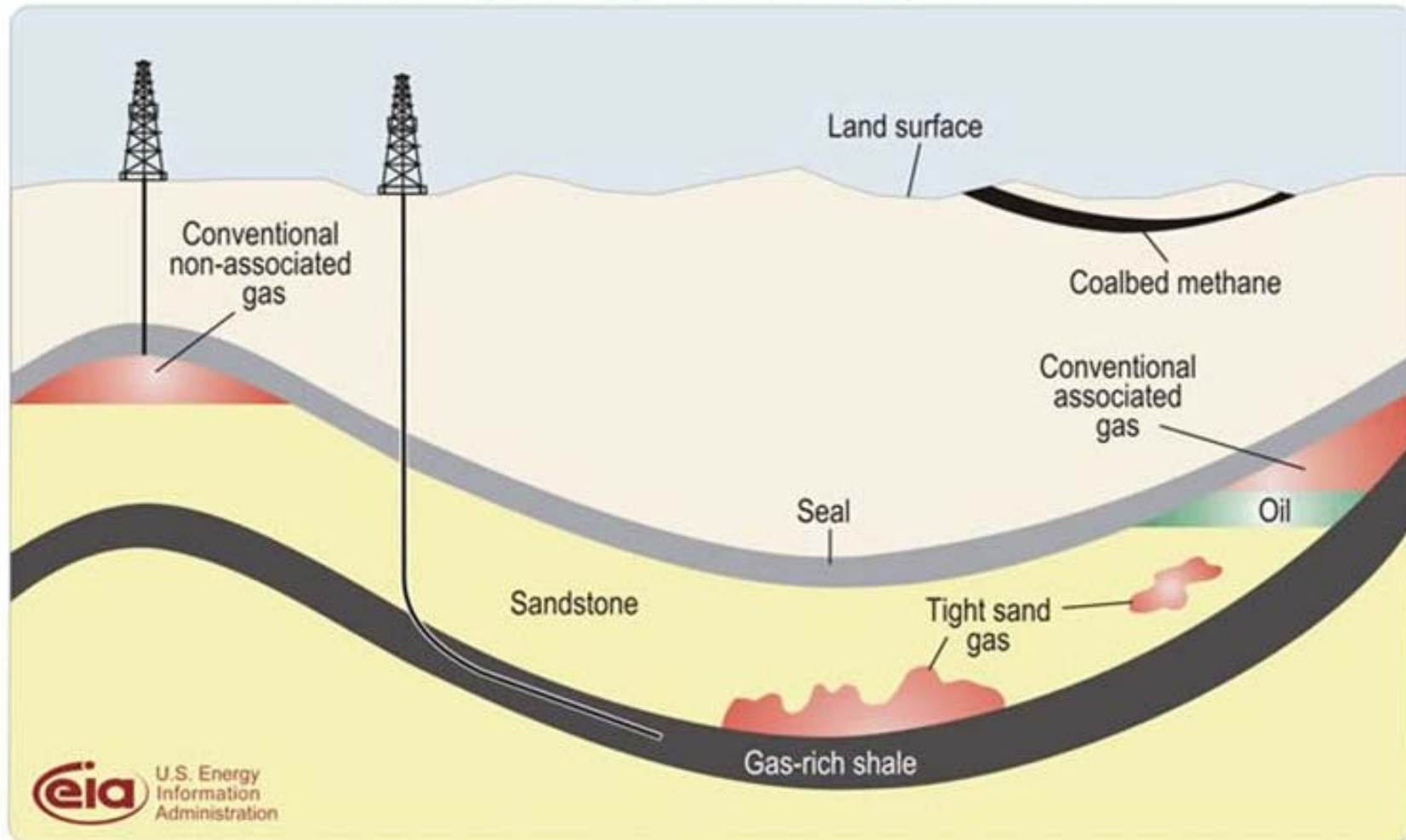
December 6, 2017

The New “Metaphor” by Maytag



It is not a scarce resource anymore

Schematic geology of natural gas resources



Source: US Energy Information Administration

Circa 2007

Russia's Energy Muscle

- Energy Used Over 55 times Against Former Soviet Nations Since 1990



Circa 2007

Gazprom's Current Near-Monopoly Supply Position

% of Supply from Gazprom/Russia

Slovakia	100%
Macedonia	100%
Finland	99%
Bulgaria	97%
Serbia & Montenegro	87%
Lithuania*	84%
Hungary	80%
Czech Republic	79%
Greece	76%

*Remember



Source: "Domestic Consumption" EIA International Energy Annual, 2007; "Exports 2006 and 2007" Gazexport as cited by Energy Intelligence, March 2008

Circa 2007

Gazprom's Current Near-Monopoly Supply Position

(cont'd)

% of Supply from Gazprom/Russia

Austria	74%
Slovenia	64%
Poland	62%
Turkey	60%
Germany	40%
Croatia	37%
Italy	30%
Romania	28%
France	25%



Source: "Domestic Consumption" EIA International Energy Annual, 2007; "Exports 2006 and 2007" Gazexport as cited by Energy Intelligence, March 2008

10/21/2008 in Tehran, Iran

Russia, Iran and Qatar form natural gas cartel



Qatar's Deputy Premier and
Minister of Energy and Industry,
Abdullah bin Hamad Al-Attiya

Iranian Oil Minister,
Gholam Hossein Nozari

Alexei Miller, Chief of
Russia's state gas
monopoly - Gazprom

Circa 2007

U.S. Shale Gas Development Could be Slowed by LNG Imports

- “Importing LNG to the U.S. would be economical at an average gas price as low as \$3.50/MMBtu.”
- “Whereas shale gas requires an average gas price of at least \$6.50/MMBtu to be economical.”

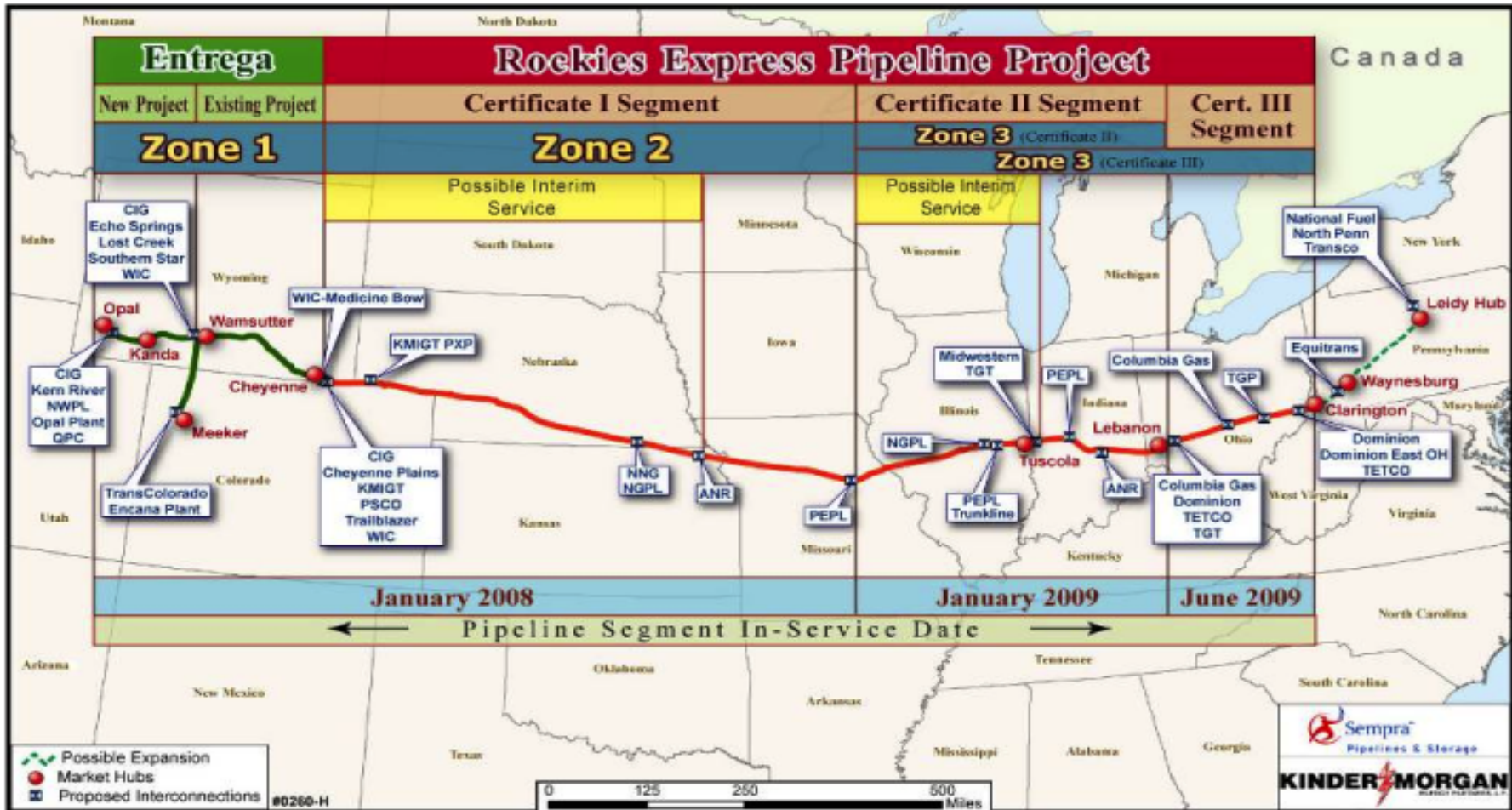
Source: Scott Thetford, VP of Pace Global Energy Services, LLC

Wrong!



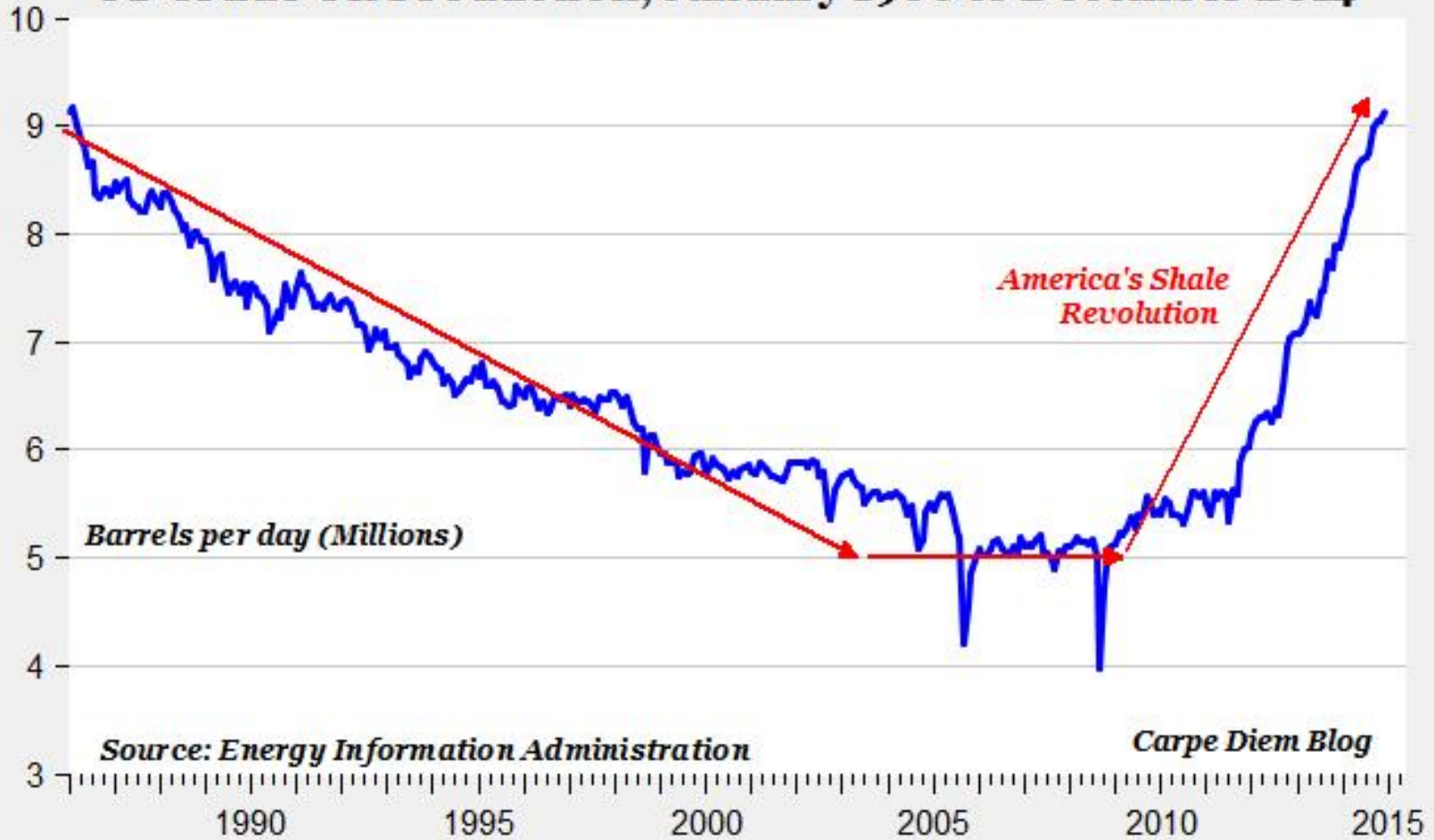
... and then the U.S. Shale Revolution happened... and the world will never be the same again.

The Reversal

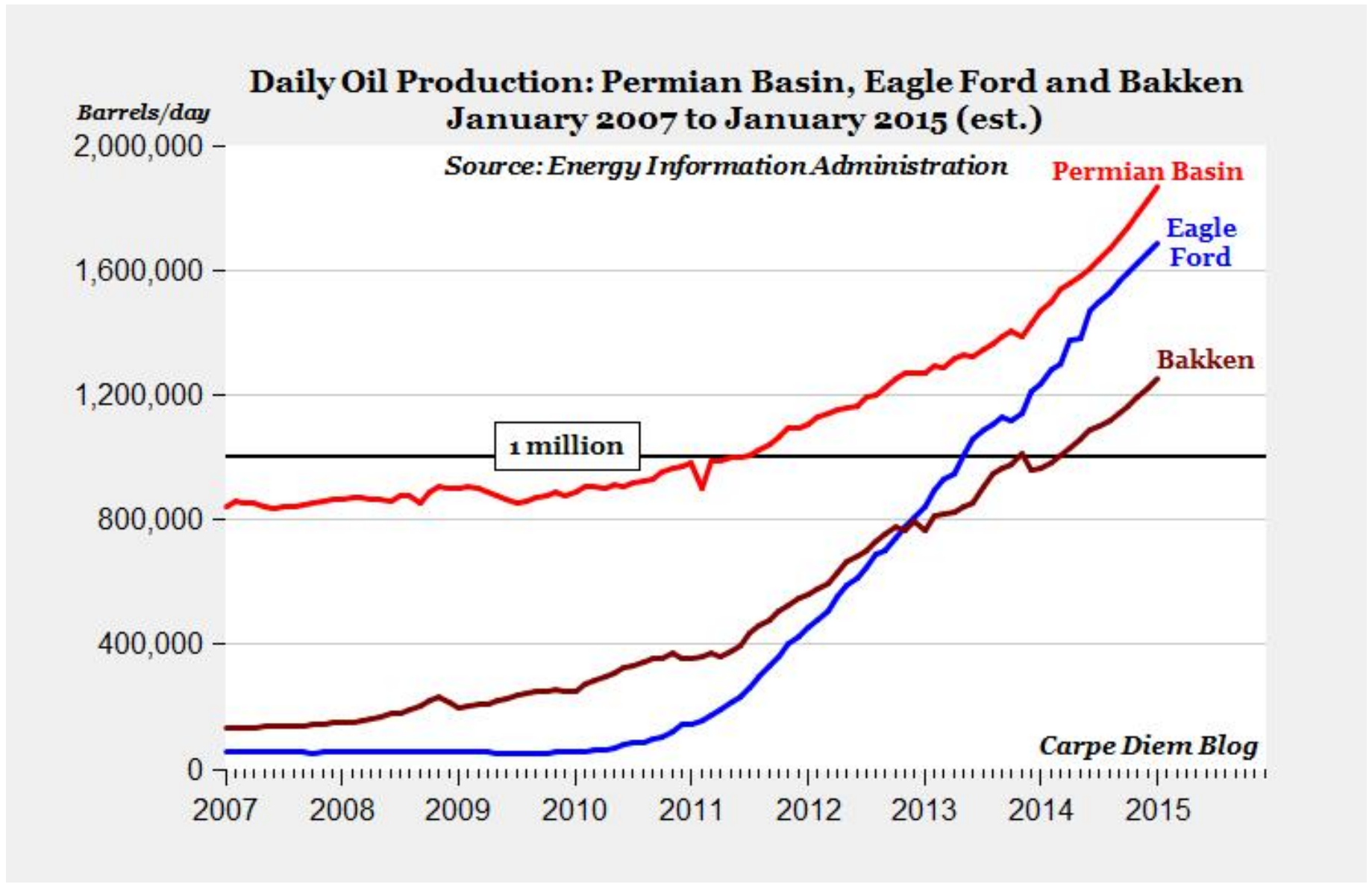


- Prediction 2007: 4 BCF/d of anticipated demand in Northeast U.S.
- Reality 2017: 12 BCF/d of new supply

US Crude Oil Production, January 1986 to December 2014

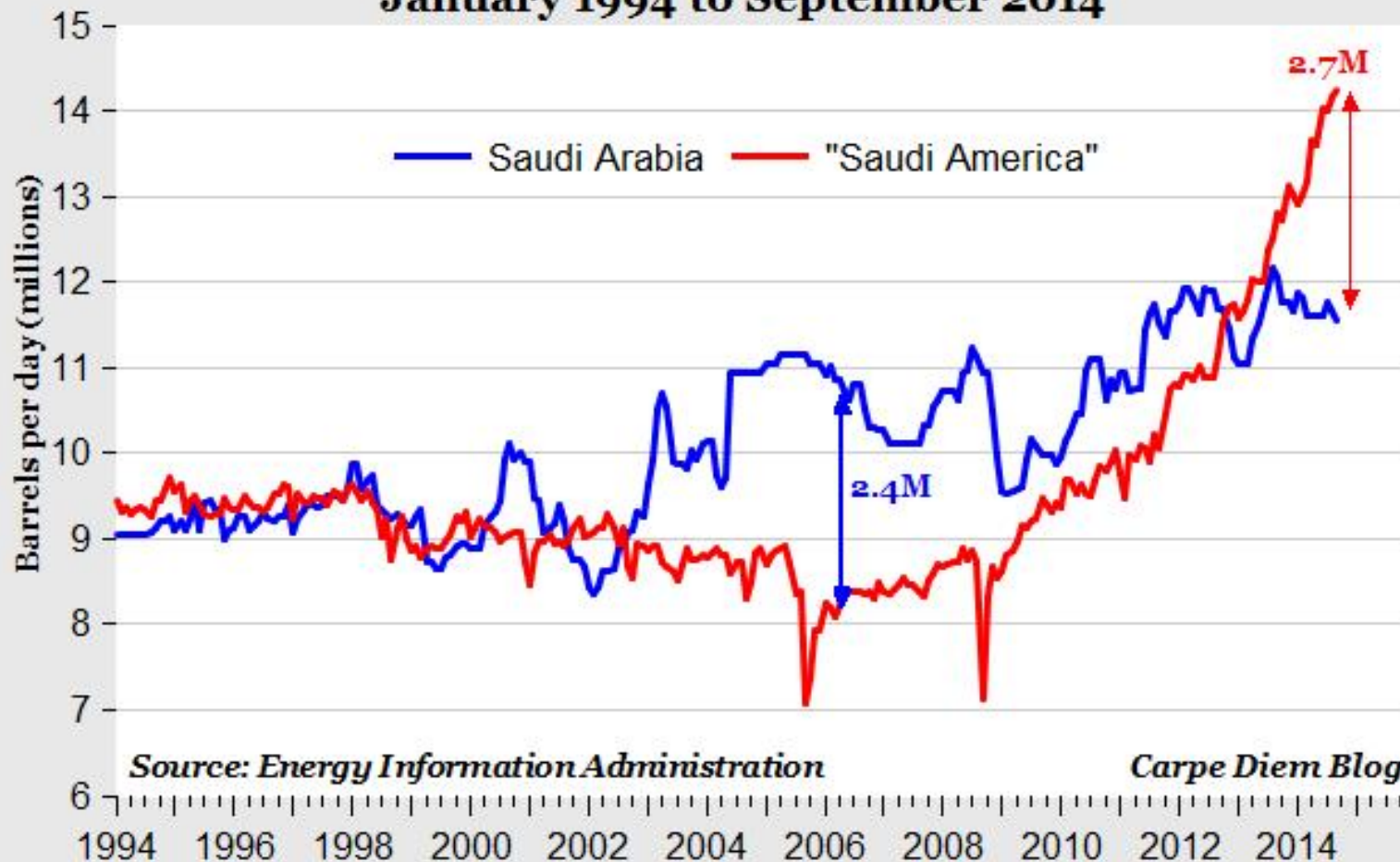


Source: My top ten energy charts of the year for 2014, Mark J. Perry, American Enterprise Institute, January 5, 2015



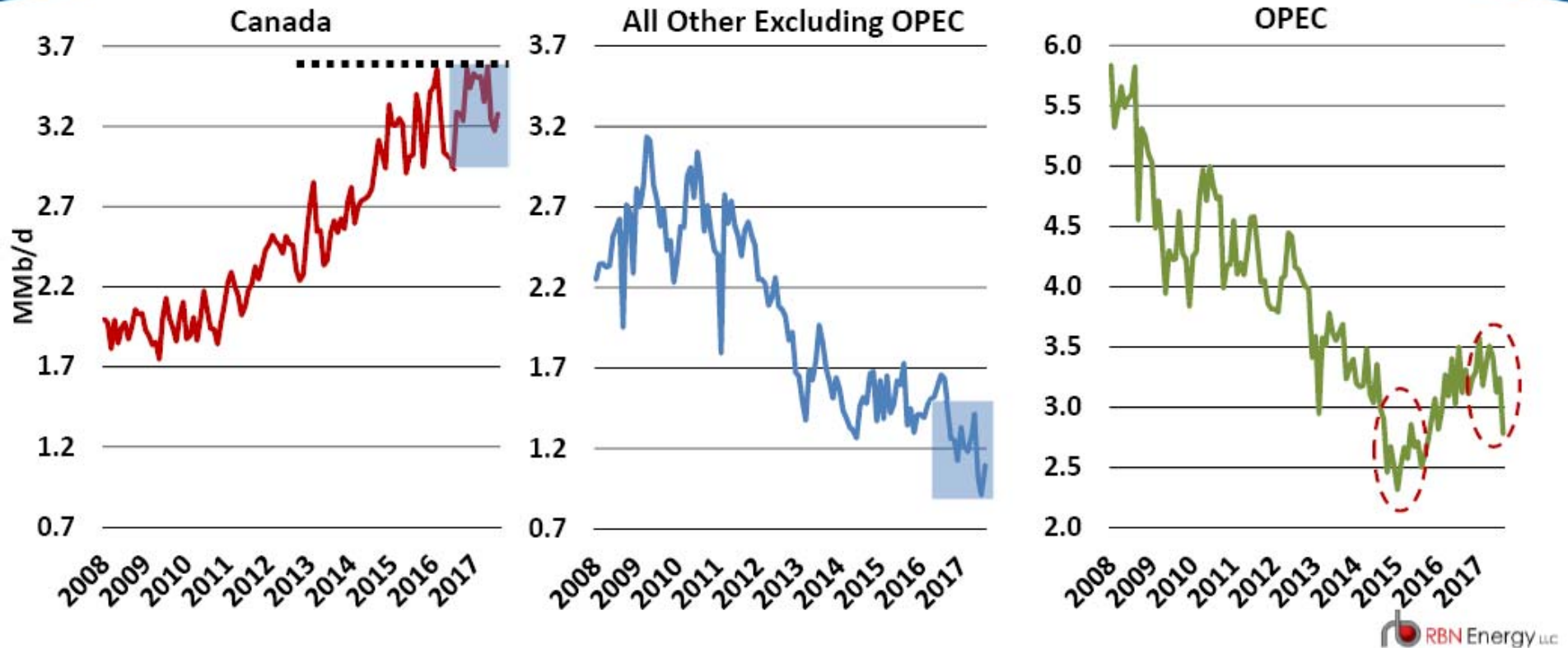
Source: My top ten energy charts of the year for 2014, Mark J. Perry, American Enterprise Institute, January 5, 2015

Total Petroleum Production: Saudi Arabia vs. US January 1994 to September 2014



Source: My top ten energy charts of the year for 2014, Mark J. Perry, American Enterprise Institute, January 5, 2015

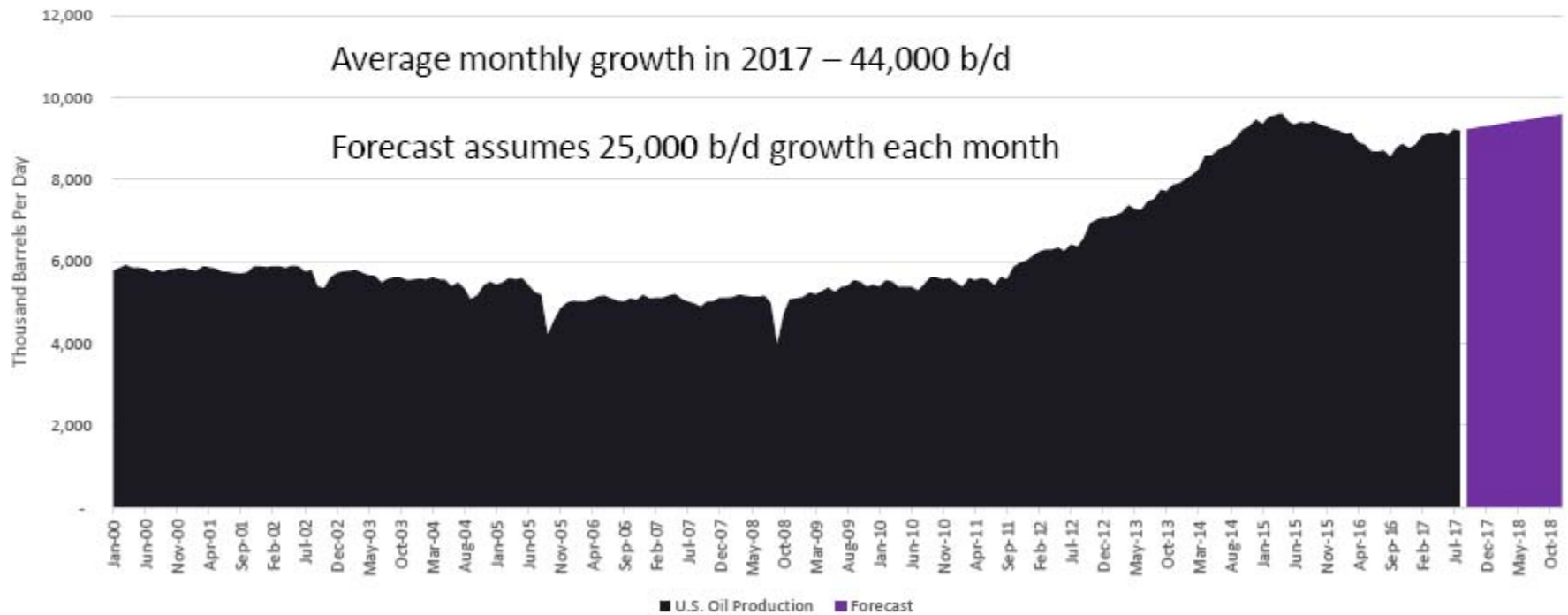
U.S. Crude Oil Imports



Source: *Midstream to Markets: Oil Markets: Out of the Woods?*, RBN Energy, The Energy Summit, August 23, 2017



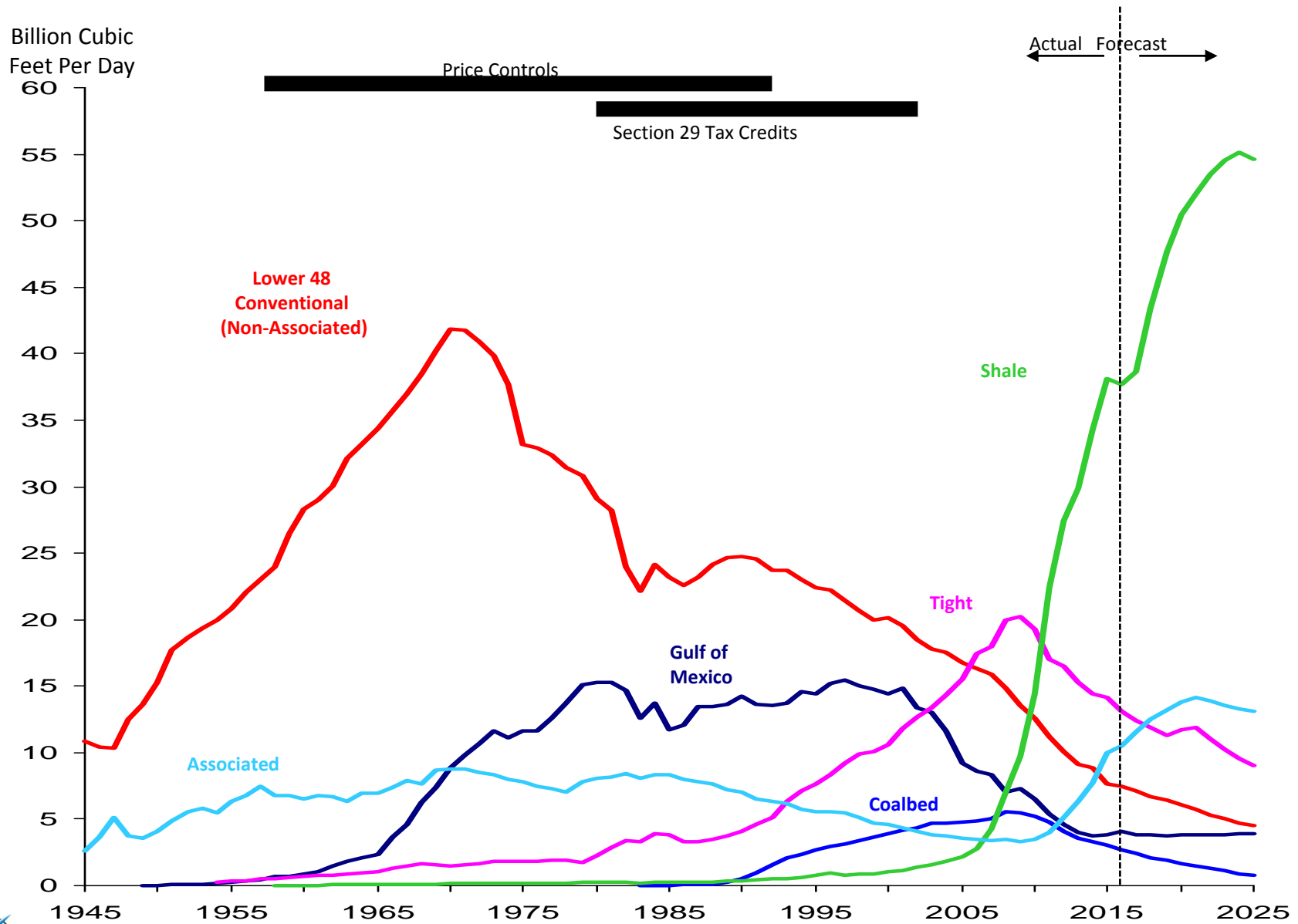
Conservative Forecasting – US Exits 2018 at 9.6 mbd



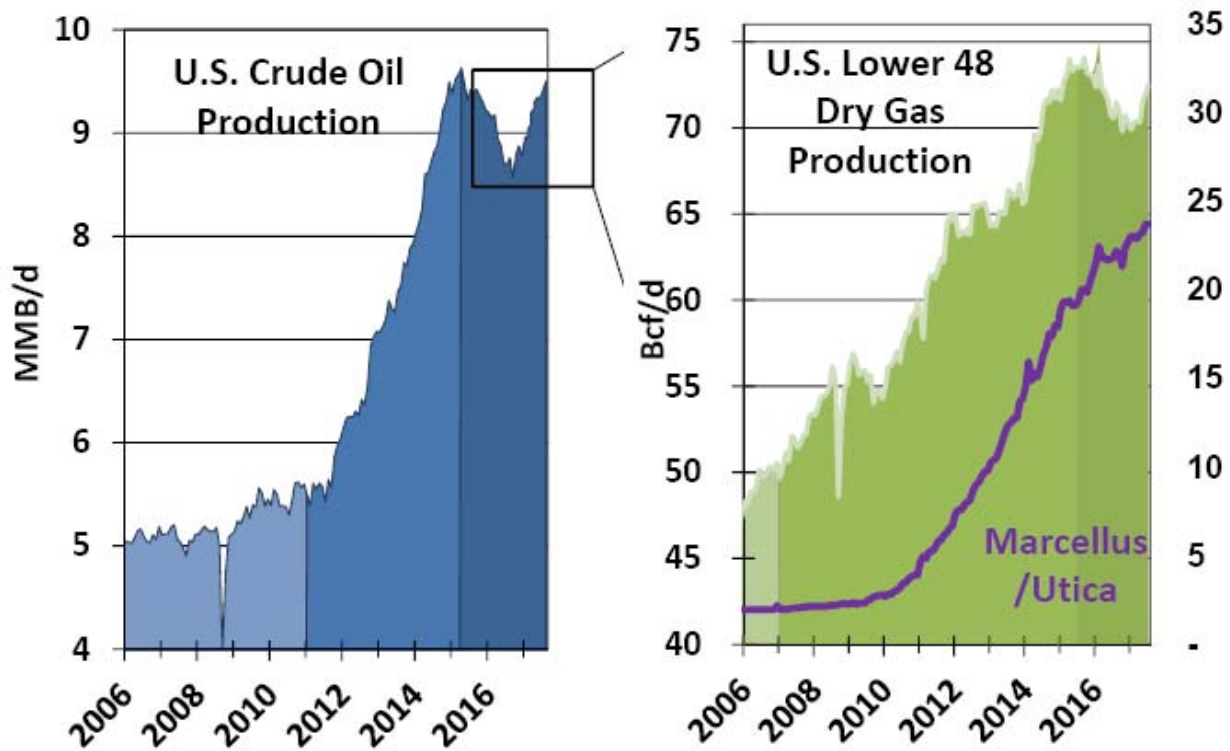
Source: PetroNerds, EIA

Source: *US Shalers – Beating the Bears*, Trisha Curtis, PetroNerds, presentation to The Oxford Institute for Energy Studies, November 2017

FIGURE 3
UNITED STATES NATURAL GAS PRODUCTION

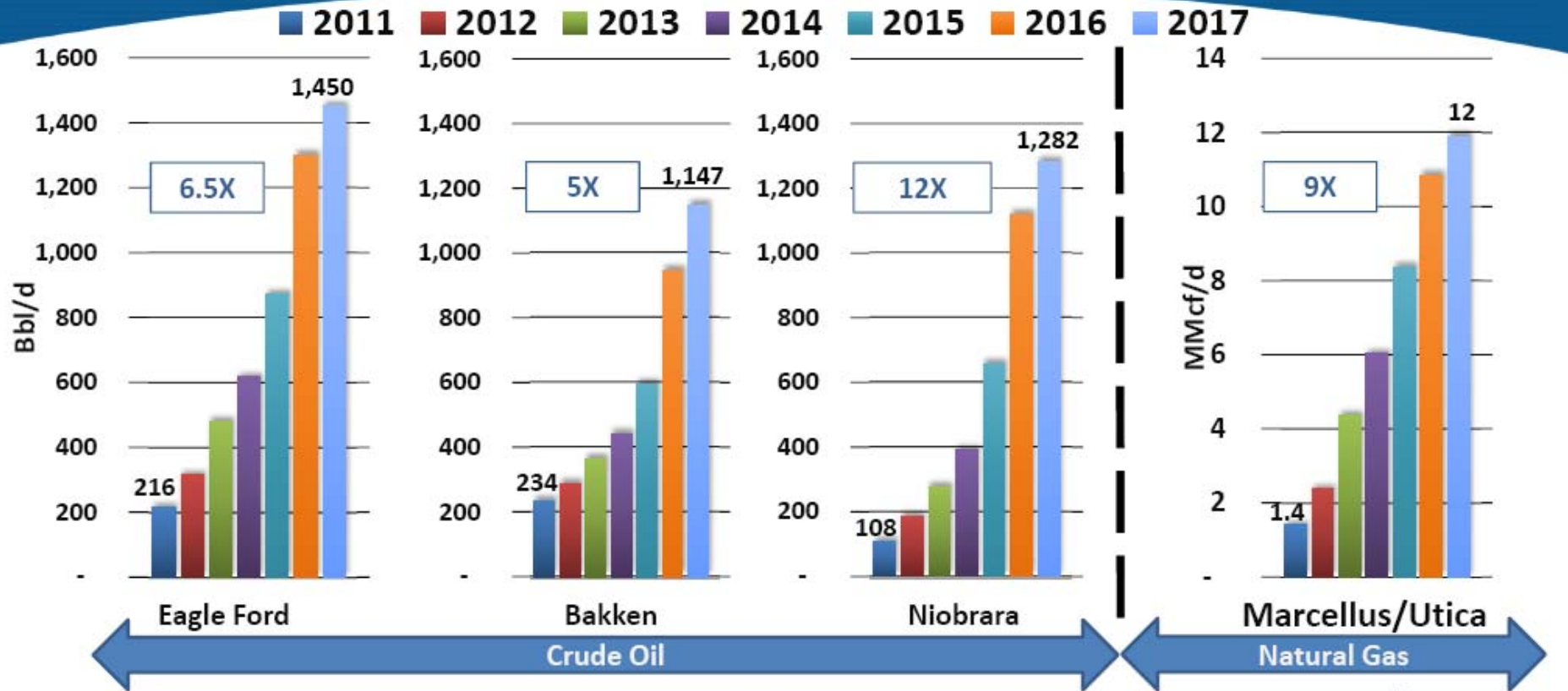


Production of Crude Oil and Natural Gas



Source: *Midstream to Markets: Oil Markets: Out of the Woods?*, RBN Energy, The Energy Summit, August 23, 2017

Oil and Gas Production Added Per Rig



RBN Energy LLC

Source: *Midstream to Markets: Oil Markets: Out of the Woods?*, RBN Energy, The Energy Summit, August 23, 2017

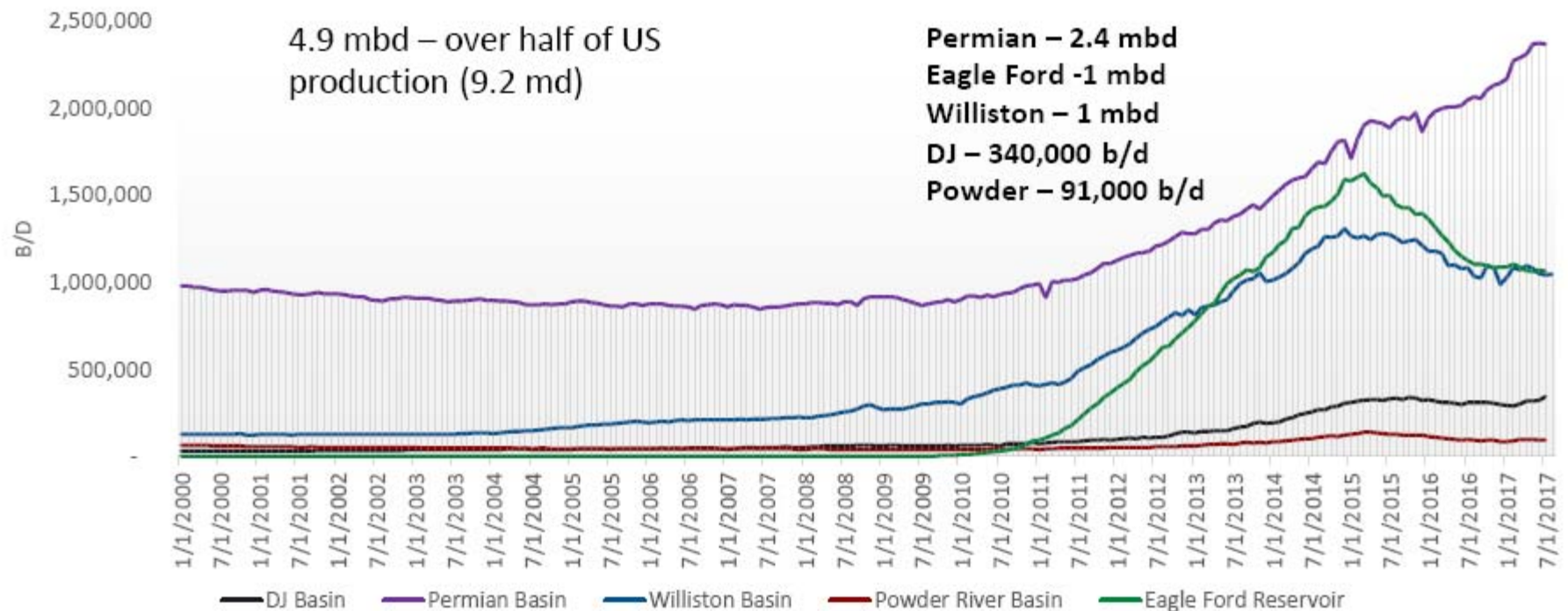
Spud to Total Depth in Less than Three Days



Extraction rig, September 2017

Source: *US Shalers – Beating the Bears*, Trisha Curtis, PetroNerds, presentation to The Oxford Institute for Energy Studies, November 2017

Shale Oil Play Production

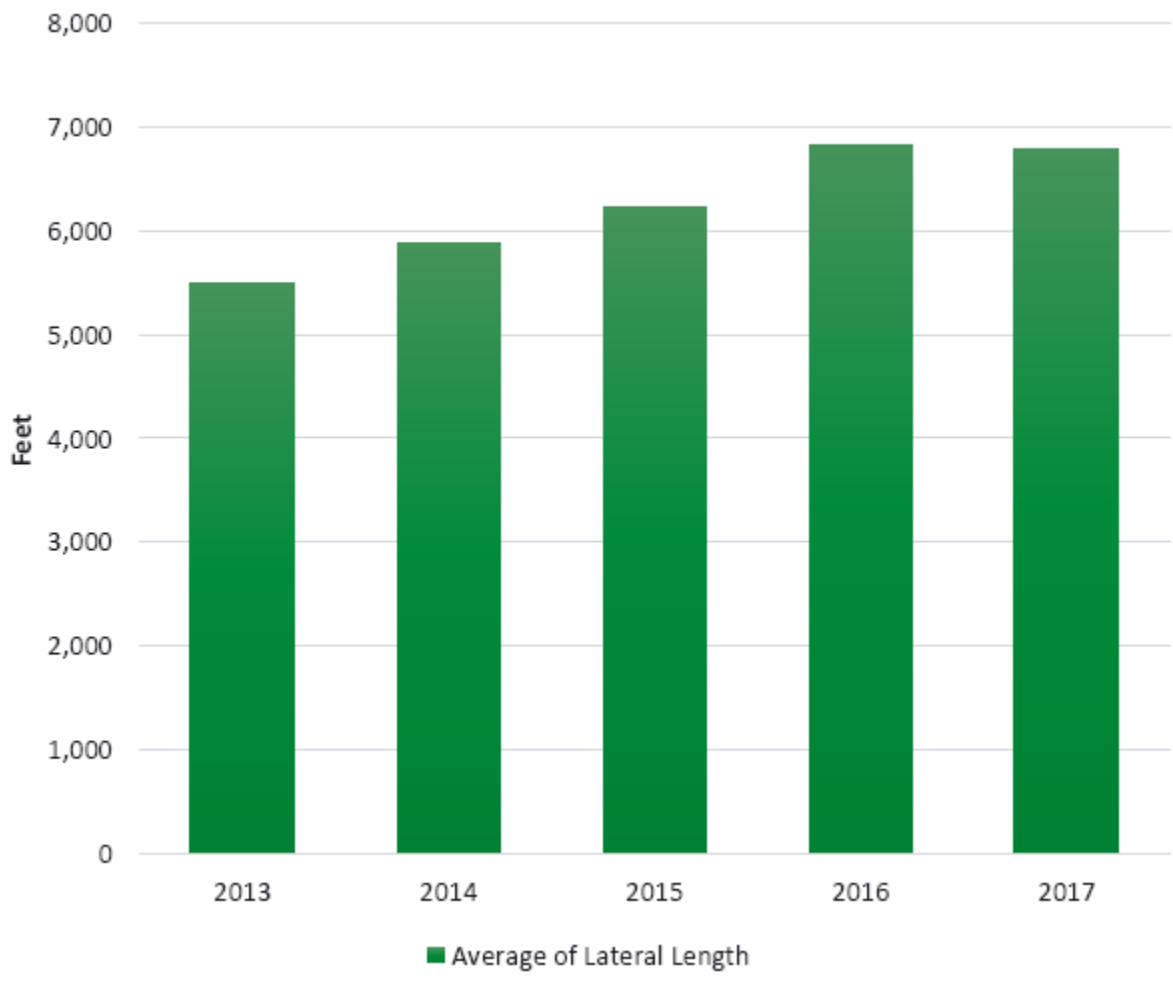


Source: PetroNerds, DrillingInfo

Source: *US Shalers – Beating the Bears*, Trisha Curtis, PetroNerds, presentation to The Oxford Institute for Energy Studies, November 2017



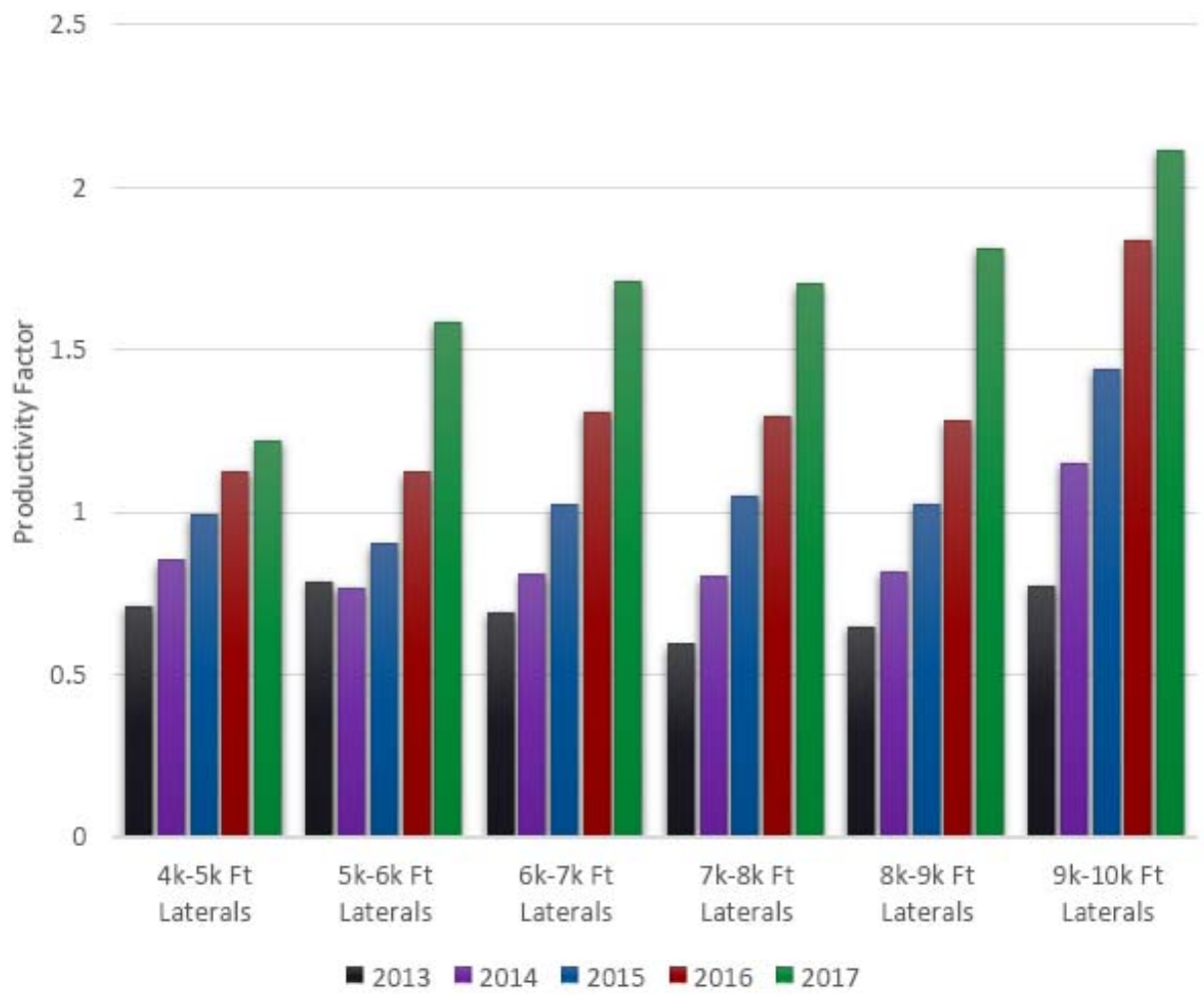
Permian Basin Productivity by Average Lateral Length



Source: *US Shalers – Beating the Bears*, Trisha Curtis, PetroNerds, presentation to The Oxford Institute for Energy Studies, November 2017



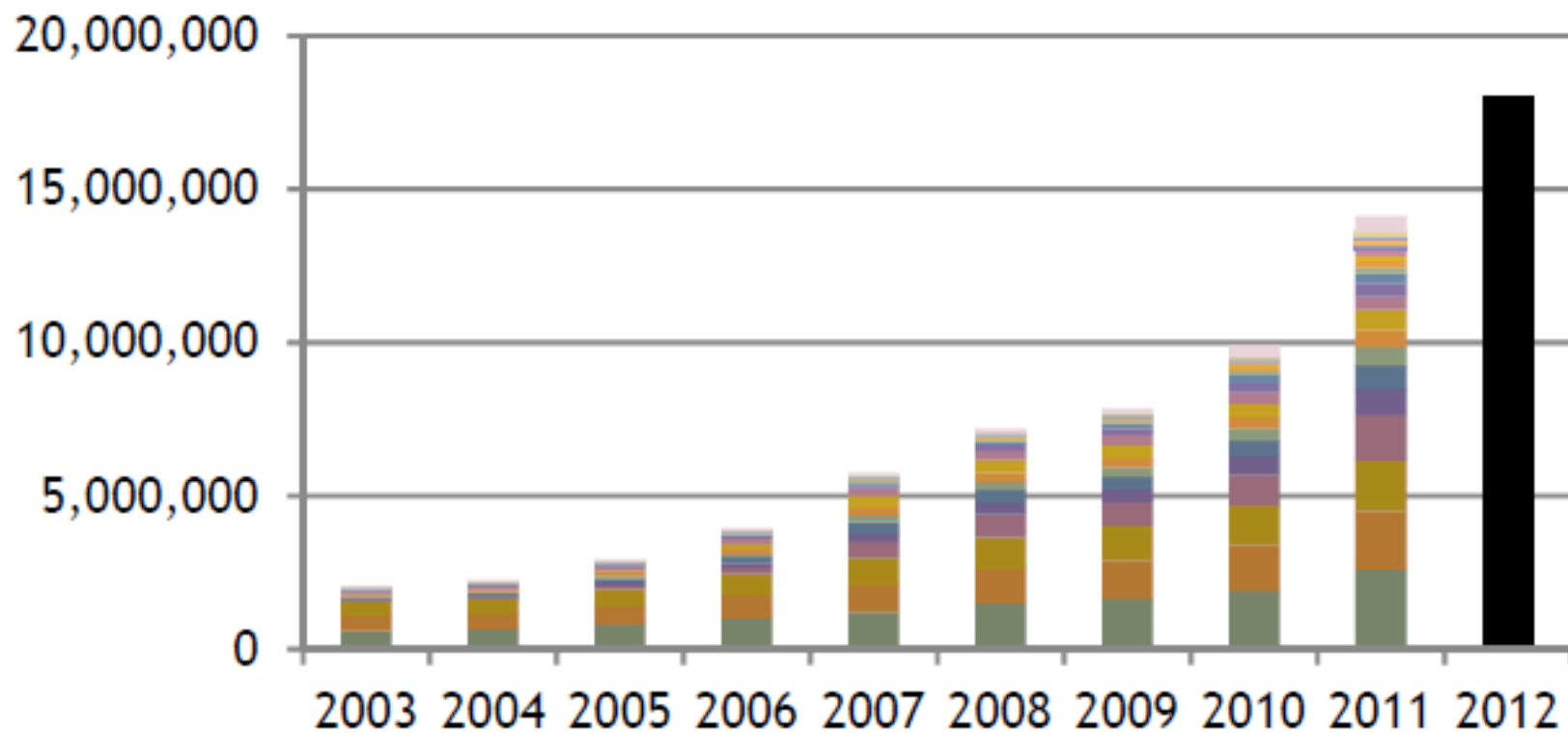
Permian Basin Productivity by Average Lateral Length



Source: *US Shalers – Beating the Bears*, Trisha Curtis, PetroNerds, presentation to The Oxford Institute for Energy Studies, November 2017

Fracturing Application Exploded

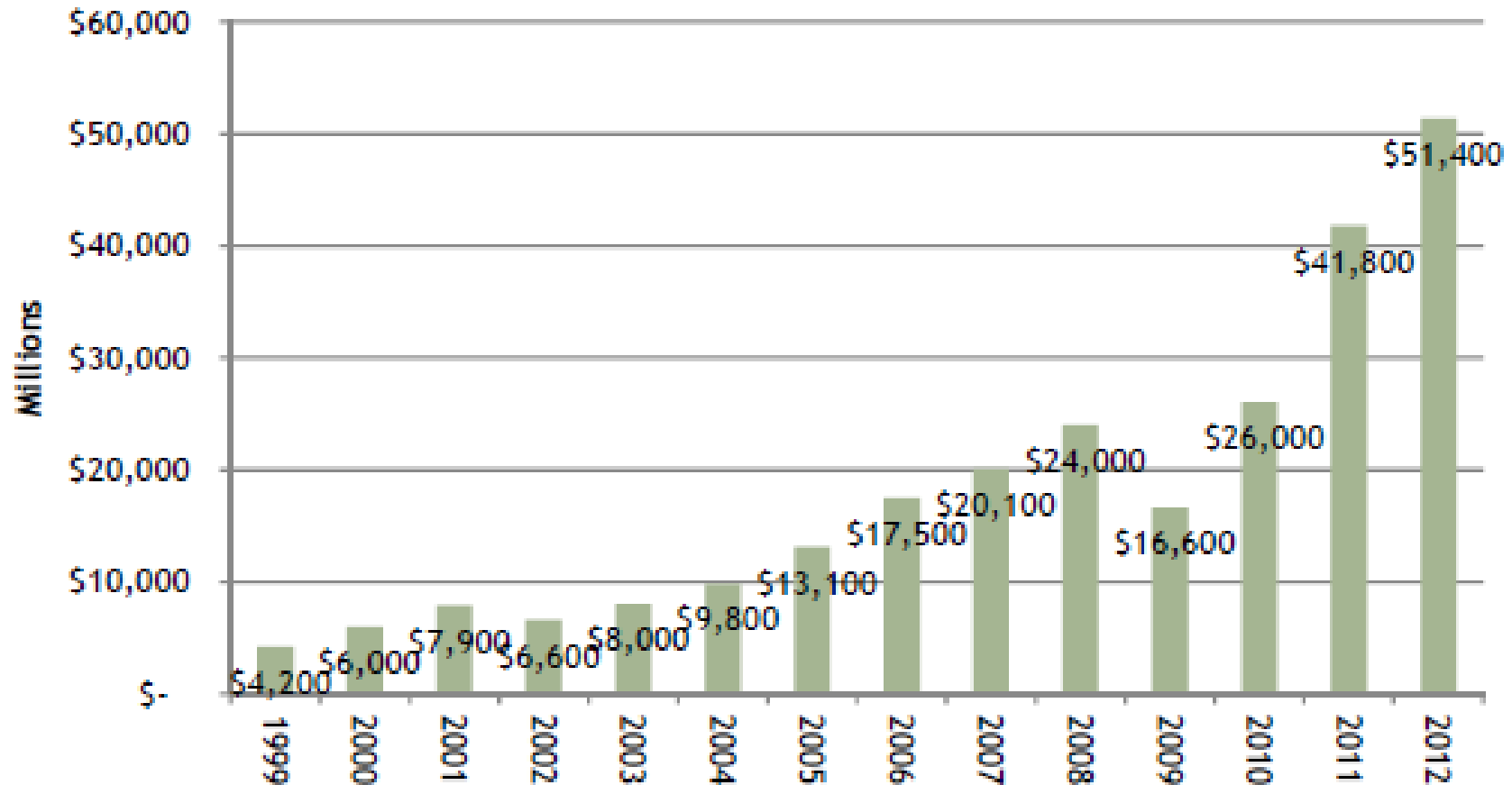
North American Frac Horsepower



Source: Chris Wright, Liberty Resources Tuesday Lunch Club Presentation, 3/5/13

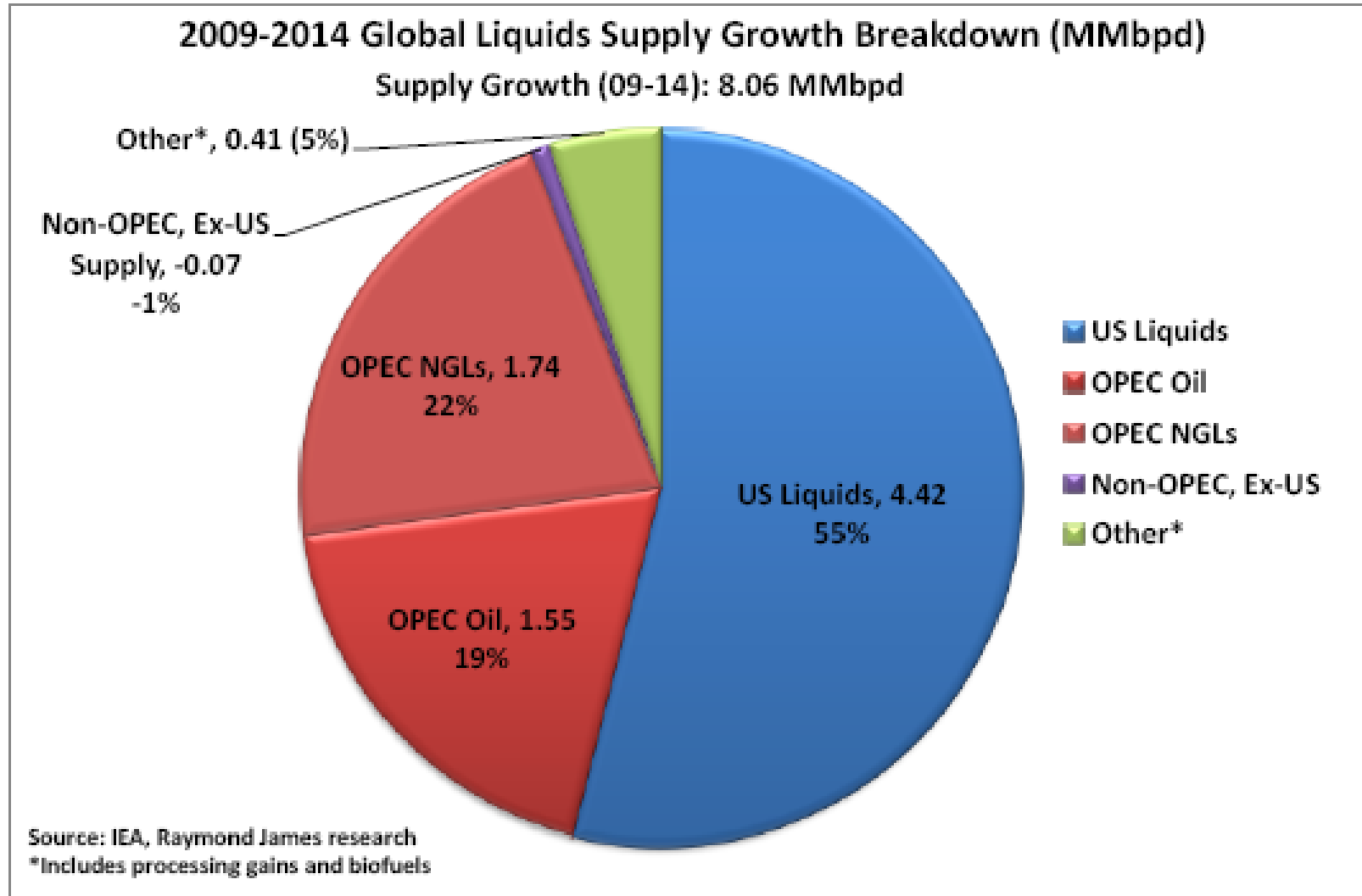
10-fold growth in 10 years

Pressure Pumping Services



Source: Chris Wright, Liberty Resources Tuesday Lunch Club Presentation, 3/5/13

The House of Saud's Motivation



Source: Raymond James U.S. Research Energy Report, January 12, 2015

Prince Alwaleed bin Talal

Saudi Prince: \$100-a-barrel oil 'never' again



Saudi Crown Prince
Abdullah bin Abdul Aziz

Saudi Foreign Minister
Prince Saud al-Faisal (C)

Saudi billionaire Prince
Alwaleed bin Talal



Source: *The Fabulous Life of Prince Alwaleed Bin Talal Alsaud*, Forbes and Maria Bartiromo for USA Today, January 11, 2015

2014 Quote

OPEC's Strategy?

“In 2016, when OPEC *completes this objective of cleaning up the American marginal market*, the oil price will start growing again,” said Fedun, who’s made a fortune of more than \$4 billion in the oil business, according to data compiled by Bloomberg. *“The shale boom is on a par with the dot-com boom. The strong players will remain, the weak ones will vanish.”*”

- Leonid Fedun, VP and Board Member at OAO Lukoil (LKOD)



Source: *OPEC Policy Ensures U.S. Shale Crash, Russian Tycoon Says*, Asst Natl Dir Melony B. DeFord, Tea Party Command Center, November 28, 2014

2014 Quote

Oil at \$65 Until Mid-2015: Kuwait Official

“The reason, according to Iranian Oil Minister, Bijan Namdar Zanganeh, was to keep prices low enough and long enough to threaten the U.S. shale oil industry and restore OPEC’s market share in America. Shale extraction requires expensive methods such as fracking and horizontal drilling, and many observers say it isn’t profitable if the price of oil drops below \$65 per barrel.”

Source: Real Money, The Street Ratings, By: Oilprice.com, December 11, 2014

OPEC Secretary Urging US Shalers to Slow it Down – Oct 9, 2017















Source: *US Shalers – Beating the Bears*, Trisha Curtis, PetroNerds, presentation to The Oxford Institute for Energy Studies, November 2017

OPEC Secretary Urging US Shalers to Slow it Down – Oct 9, 2017

“We urge our friends, in the shale basins of North America to take this shared responsibility with all seriousness it deserves, as one of the key lessons learnt from the current unique supply-driven cycle,” said Barkindo.

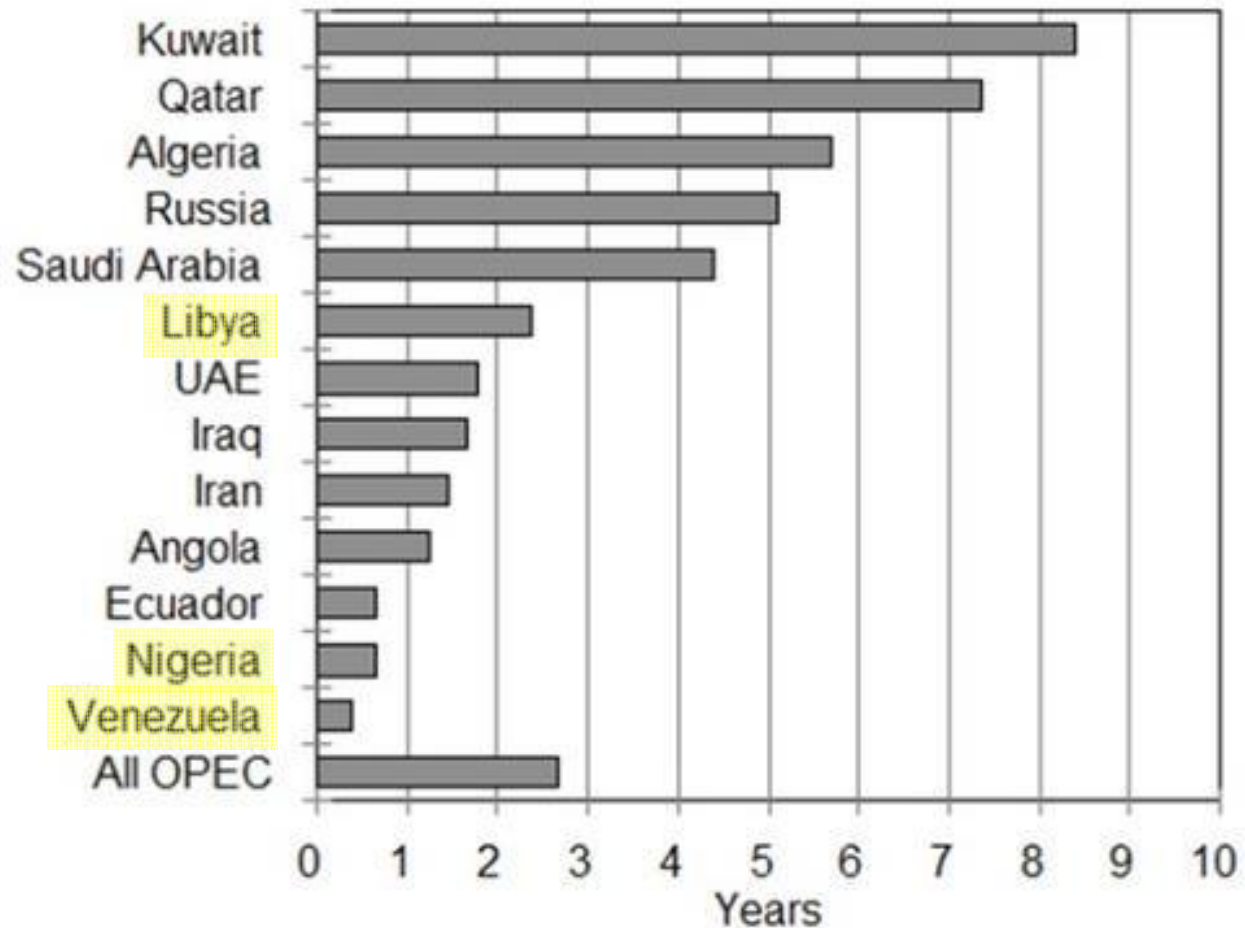
Source: *US Shalers – Beating the Bears*, Trisha Curtis, PetroNerds, presentation to The Oxford Institute for Energy Studies, November 2017

OPEC Member States

Country	Region	Joined OPEC ^[1]	Population (July 2008) ^[2]	Area (km ²) ^[3]
 Algeria	Africa	1969	33,779,668	2,381,740
 Angola	Africa	2007	12,531,357	1,246,700
 Ecuador	South America	2007 ^[A 1]	13,927,650	283,560
 Iran	Middle East	1960 ^[A 2]	75,875,224	1,648,000
 Iraq	Middle East	1960 ^[A 2]	28,221,180	437,072
 Kuwait	Middle East	1960 ^[A 2]	2,596,799	17,820
 Libya	Africa	1962	6,173,579	1,759,540
 Nigeria	Africa	1971	146,255,300	923,768
 Qatar	Middle East	1961	824,789	11,437
 Saudi Arabia	Middle East	1960 ^[A 2]	28,146,656	2,149,690
 United Arab Emirates	Middle East	1967	4,621,399	83,600
 Venezuela	South America	1960 ^[A 2]	26,414,816	912,050
Total			369,368,429	11,854,977 km²

Survival of the Fittest?

DURATION OF FOREIGN RESERVES @ \$50/BBL DEFICIT



*Circa 2014: Saudis have staying power; \$750 billion in foreign country reserves



Source: Oilprice.com, *The Saudi Arabian Oil Conspiracy and What it Might Mean for Your Portfolio*, The Motley Fool, Adam Galas, January 18, 2015

A Game of Chicken?

Nation	Oil price per barrel required to break even or balance budget
US producers	\$38-\$77
Qatar	\$58
Kuwait	\$59
UAE	\$90
Saudi Arabia	\$92
Angola	\$94
Russia	\$101
Iraq	\$116
Venezuela	\$117
Algeria	\$119
Ecuador	\$122
Nigeria	\$124
Iran	\$136

According to data compiled by Bloomberg, “prices have dropped below the level needed by at least 9 OPEC member states to balance their budgets.”

Source: Reuters, *The Saudi Arabian Oil Conspiracy and What it Might Mean for Your Portfolio*, The Motley Fool, Adam Galas, January 18, 2015

Survival of fittest as oil tumbles below \$65, Bloomberg News, December 1, 2014



Saudi Arabia's 5-Star Prison

The Riyadh Ritz Carlton

- 200 people accused of corruption and money laundering (11 princes)
- 1,900 Saudi bank accounts are frozen totaling \$800 billion
- “Officials said 4% of the accused say they will take their cases to court, but 95% are willing to make a deal, which would most likely result in large sums of money exchanged for freedom.”

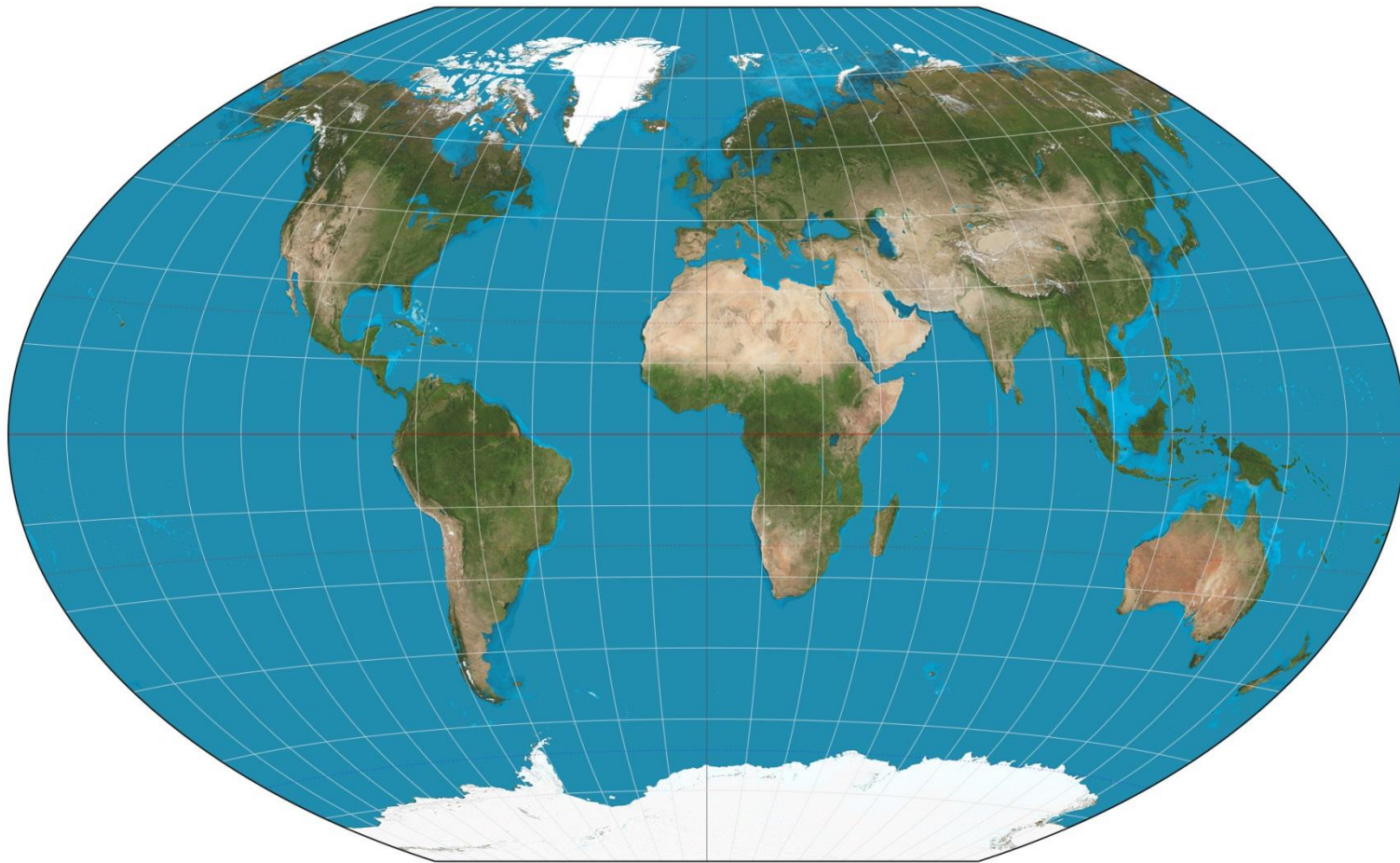
Source: “What life is like inside Saudi Arabia’s ‘5-star prison’ – the Ritz-Carlton where some of the kingdom’s richest and most powerful elites are being held,” Business Insider, Ben Brimelow, November 27, 2017

Time Magazine's 2017 Person of the Year: Saudi Crown Prince Mohammed bin Salman



- 32-year-old heir apparent
- Widely known as MbS
- Has consolidated power in Saudi Arabia

Uncertainty: An Assessment of the Geopolitical Backdrop



North Korea

An unavoidable war?



North Korea

KOGAS – One of the largest U.S. LNG Buyers

- 10% of South Korea's total demand will be met by LNG from Cheniere Energy's Sabine Pass Liquefaction facility in Louisiana.
- 20 year Sales and Purchase Agreement (SPA) officially commenced June 1, 2017
- 3.5 million tonnes of LNG per year (roughly 50 BCF per year)



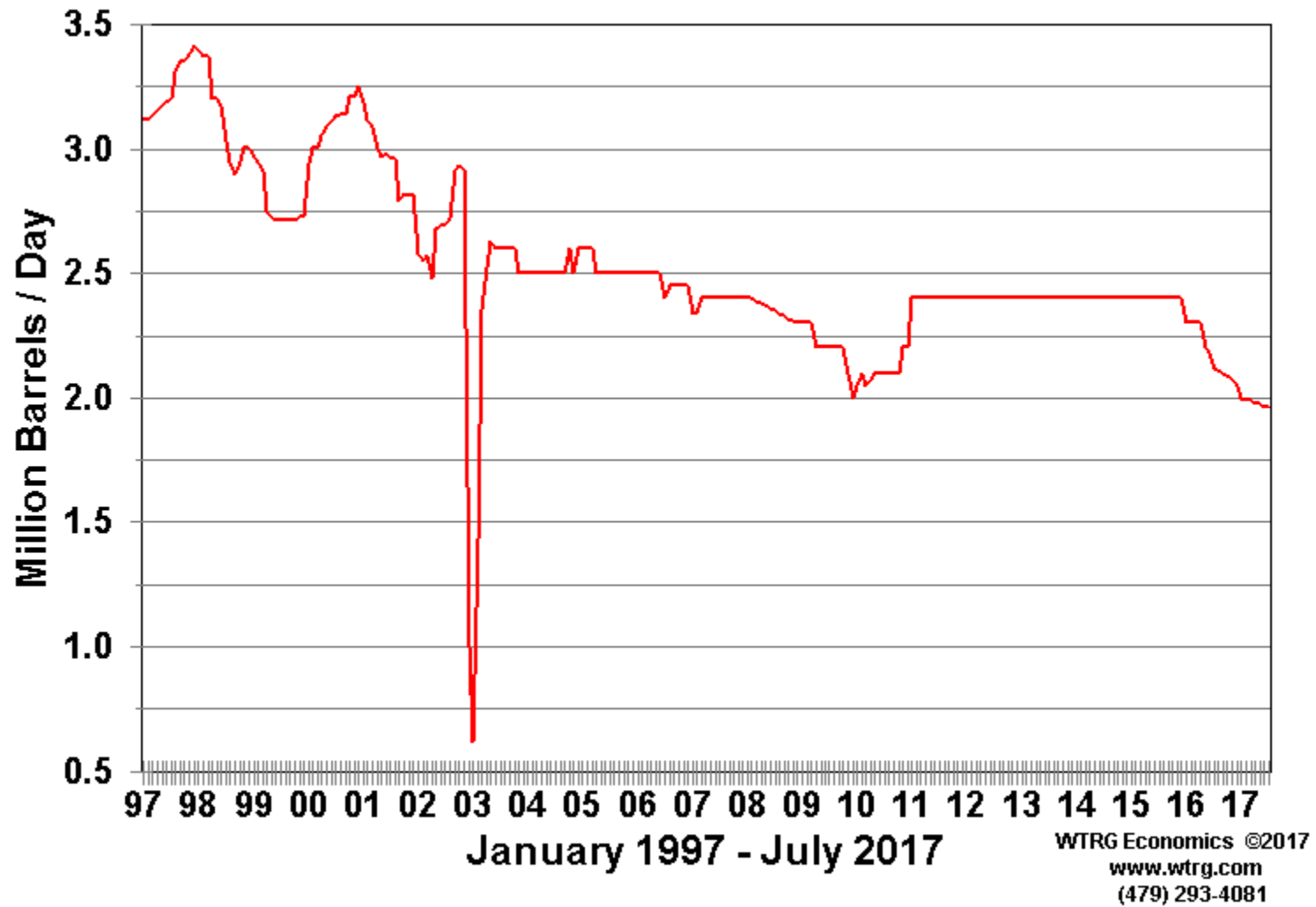
Venezuela



- Population of 30 million people
- China is subsidizing them as a challenge to the U.S.

Venezuela

Crude Oil Production



Venezuela

Caught in a squeeze of their own making

- Venezuela, due to its quality of crude, is a price taker as foreign refiners control them
- Refiners are gradually walking the price down



SOURCE: TRADINGECONOMICS.COM | ORGANIZATION OF THE PETROLEUM EXPORTING COUNTRIES

Venezuela

200,000 March Against President Maduro

(May 20, 2017)



Venezuela

Trump: U.S. will not 'rule out military option' in Venezuela

“Venezuela is not very far away... people are suffering and dying” President Trump, August 11, 2017



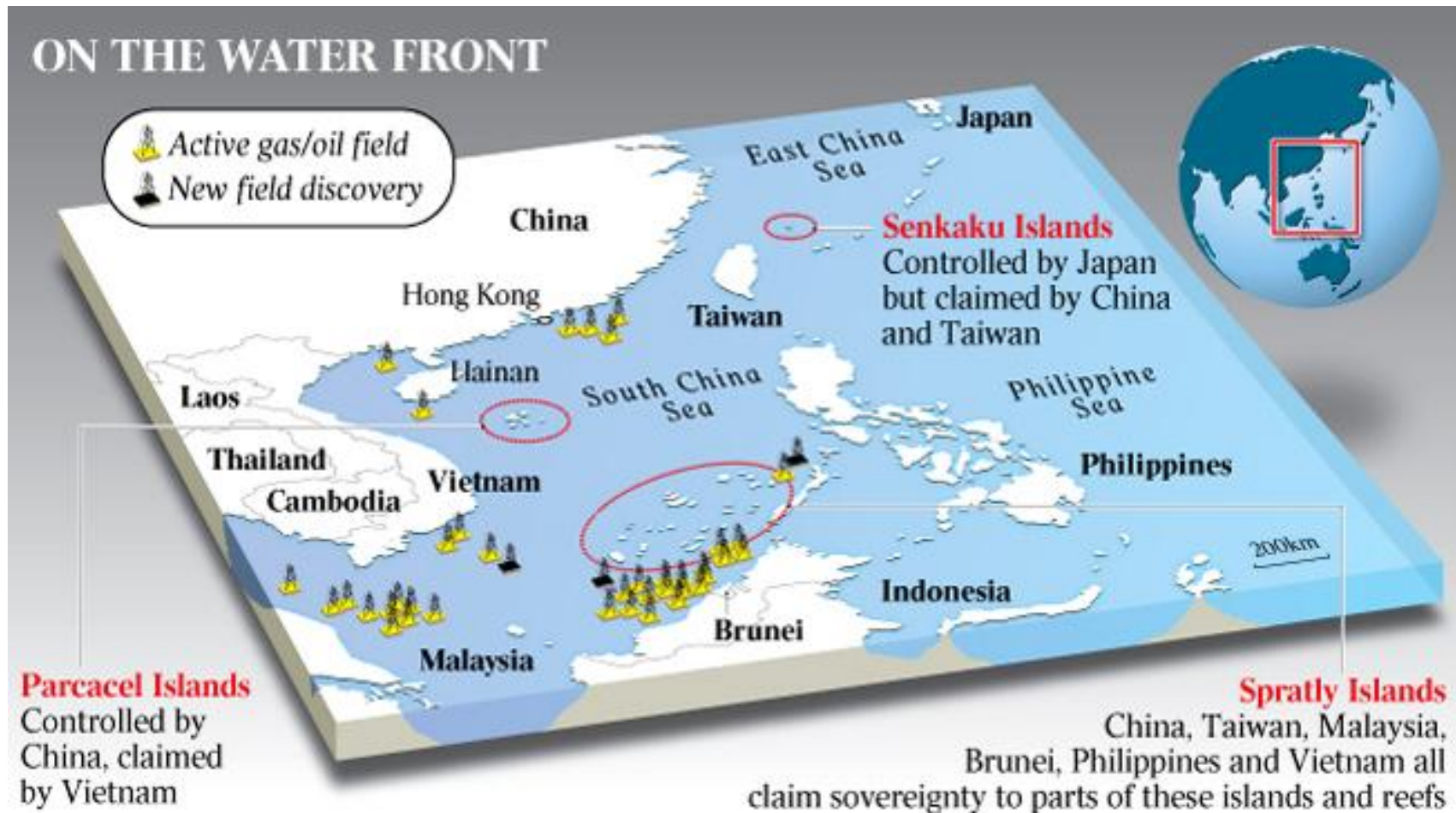
China

Man made islands are a game changer



China

What's at stake?



China's claim encompasses roughly 90% of the South China Sea and all the resources that may exist within it.

China

What's at stake?

“The South China Sea is one of the most important energy trade routes in the world” with “almost a third of global crude oil and over half of global liquefied natural gas (LNG)” passing through it each year.

- US Energy Information Authority (EIA), 2013

Source: *South China Sea headbutting of nations is about energy security*, South China Morning Post, April 5, 2016

China

A Sign of Energy Insecurity?

Two-fold motivation

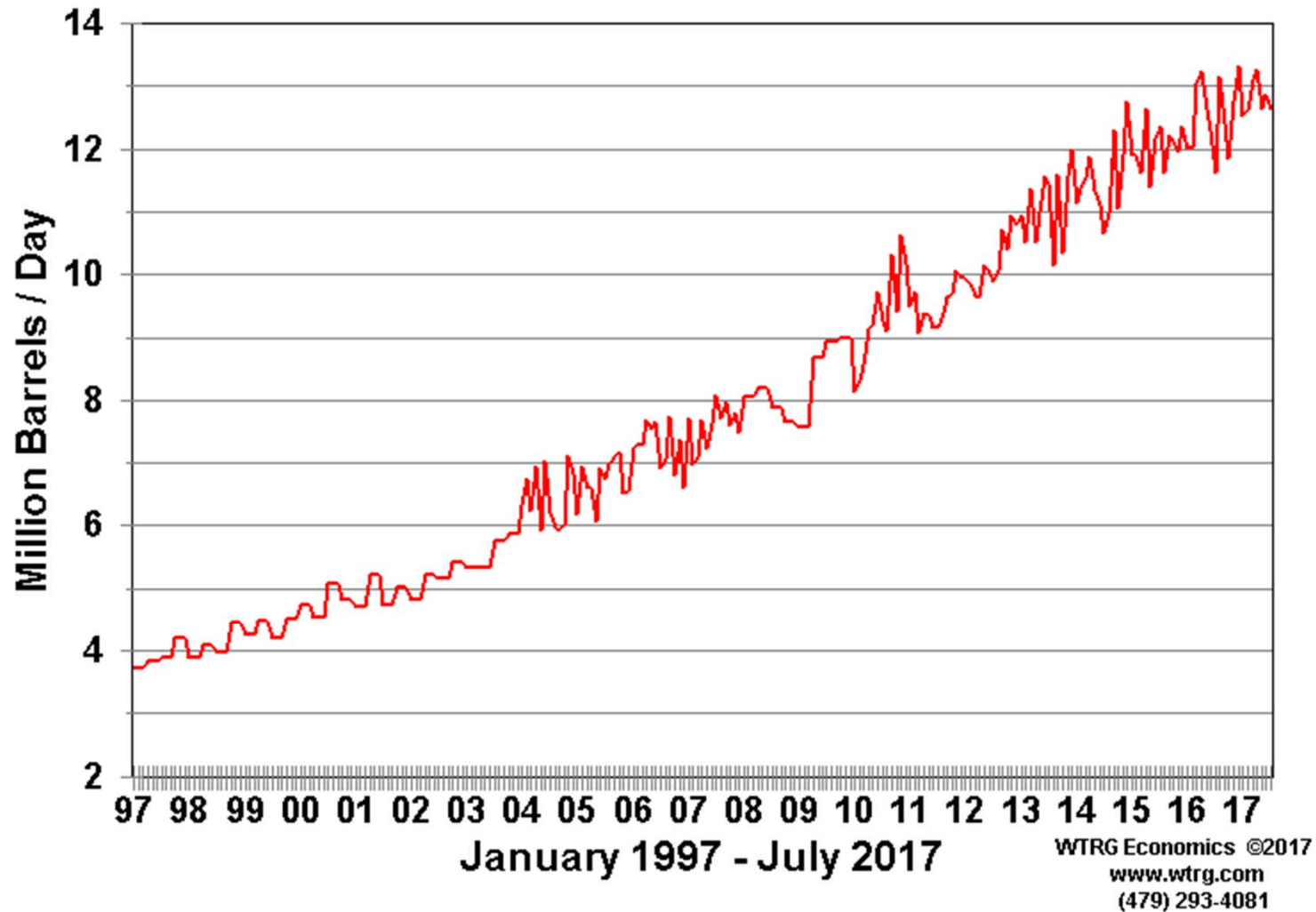
- The South China Sea is believed to have 11 billion proved or probable barrels of oil in reserves and about 190 TCF of natural gas.
- China is the world's largest importer of crude; importing approximately 7.5 million barrels per day or 2.7 billion barrels per year.
- 82% of China's oil imports pass through the South China Sea.

Source: *What's at stake in China's claims to the South China Sea?*, The Conversation, July 14, 2016; *China Morning and China's Energy Insecurity Glaring In South China Sea Dispute*, Forbes, September 2, 2016



China

Petroleum Consumption



Middle East Arab Spring

Hope for democracy was wrong and misplaced



Middle East

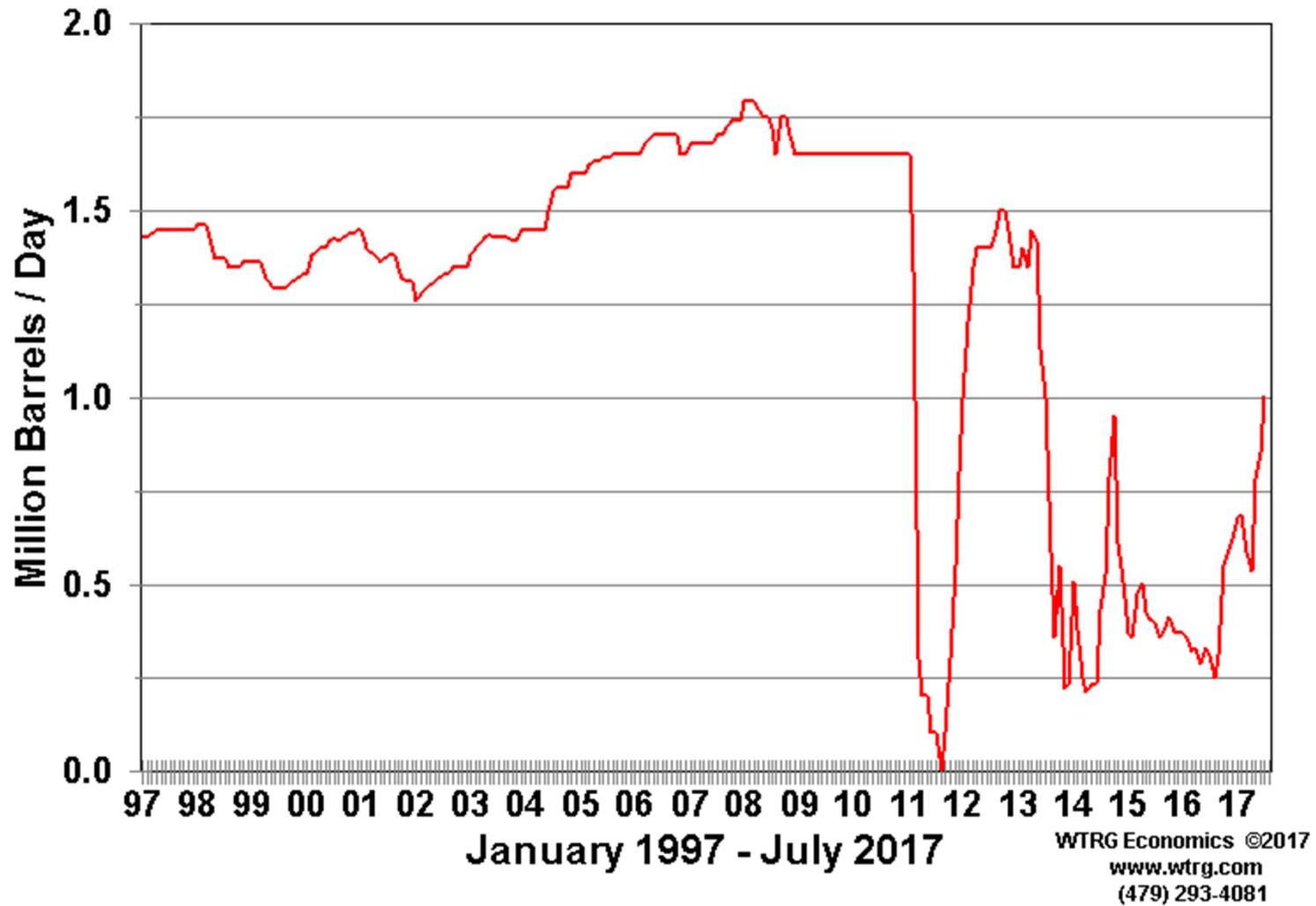
Arab Spring Aftermath?

- 3 failed states: Syria, Yemen, Libya
- No orderly transition resulting in a “Cold War” type standoff between Iran and Saudi Arabia



Libya

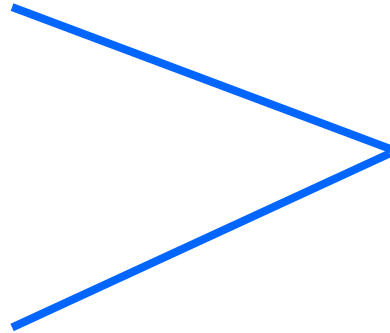
Crude Oil Production



Source: <http://www.energyeconomist.com/a6257783p/world/worldoverview.html>, James L. Williams

The Problem?

Iran
China
Russia



Are playing
for the
long-term



The Answer?

- The short cycle U.S. shale business model is something that OPEC countries don't understand and apparently can't compete with.
- They would have to understand Capitalism and fee ownership of minerals to get it.
- Try explaining George Mitchell and his persistence to someone in the Middle East.

US crude oil exports hit all-time high as production also closes in on record

- Exports hit 2.13 million barrels a day – November 2017



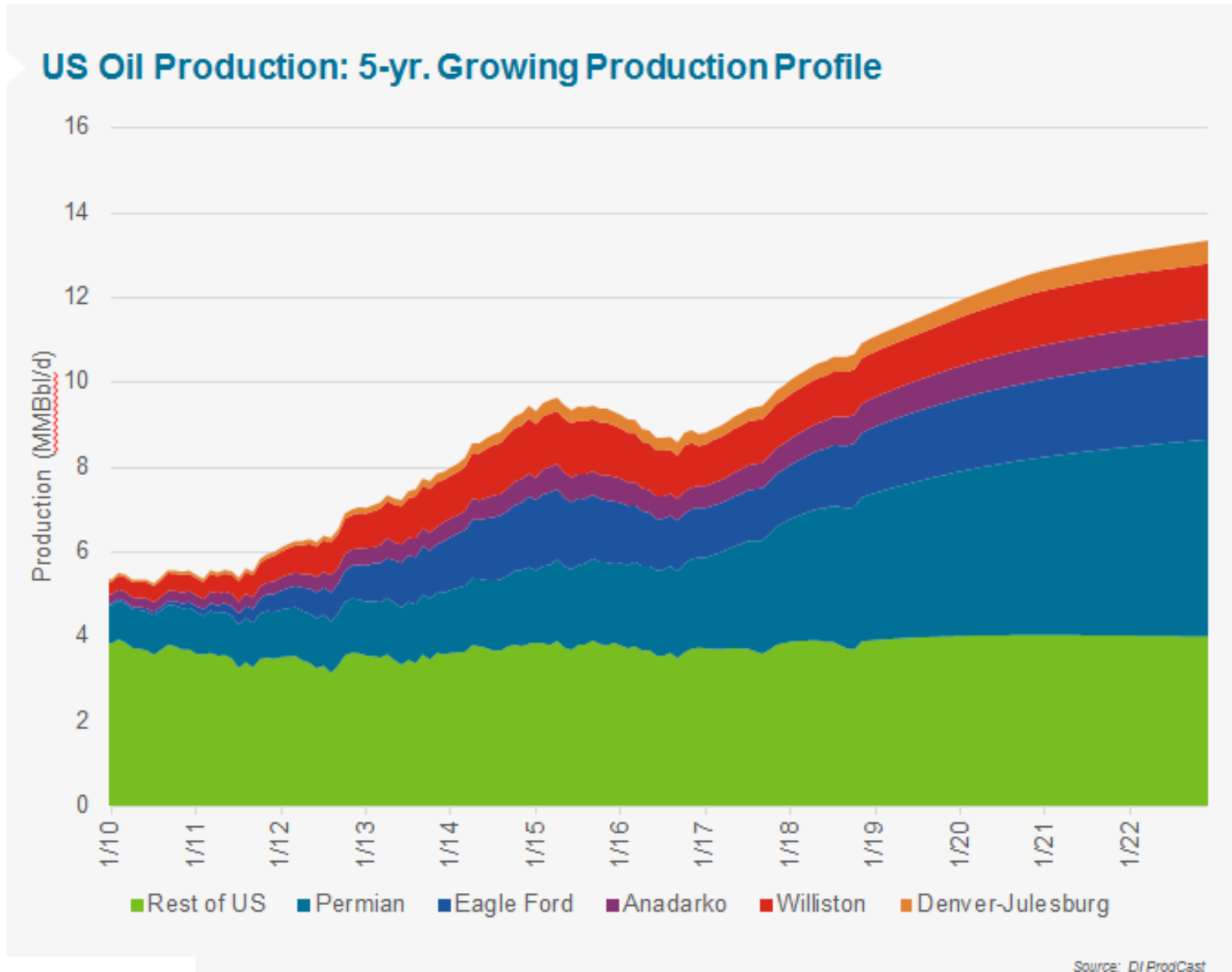
Global gas prices push record US LNG exports

- “In November [2017] exports from Cheniere Energy’s Sabine Pass liquefaction terminal totaled nearly 80 BCF, falling just shy of the facility’s nameplate capacity and setting a monthly record for shipped volumes.”
- Platts assessed the benchmark price for delivered spot-market LNG in East Asia at \$9.90 per MMBtu on November 30, 2017, its highest in nearly 3 years



PHOTO COURTESY OF WWW.LNGNEWORLD.COM

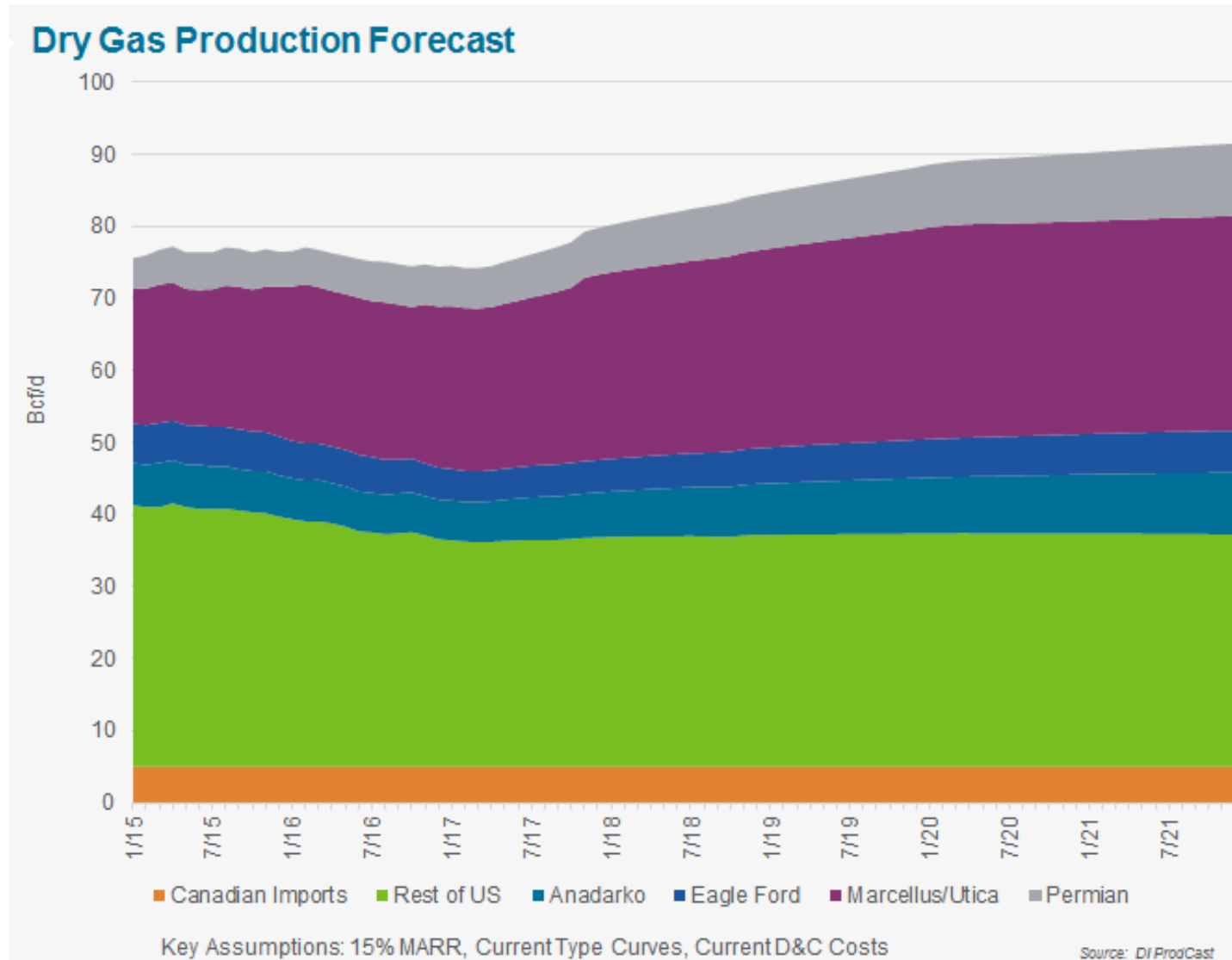
US Oil Production: 5-yr. Growing Production Profile



Source: DI ProdCast

Source: *The New Normal(ization): Market Intelligence: FundamentalEdge Outlook*, Bernadette Johnson, August 2017

Dry Gas Production 5-Year Outlook



The Crystal Ball Price Forecast

YEAR	WTI (\$/Bbl)	HH (\$/MMBtu)
2017	\$52	\$3.25
2018	\$52	\$3.15
2019	\$60	\$3.00
2020+	\$60	\$2.85

Source: *The New Normal(ization): Market Intelligence: FundamentalEdge Outlook*, Bernadette Johnson, August 2017



What is Driving These Gains?

Better drilling and completions designs are leading to productivity gains across the board.

Pump twice or three times as much sand down the well using slickwater (instead of a gel or hybrid fluid) as you did in 2014, layer in a better understanding of your reservoir, increase the horsepower and rate you are pumping, and add more perforations along your lateral and boom – you often have a better well than you did in years past.

And of course, extend the length of your lateral, where you can.

Source: *US Shalers – Beating the Bears*, Trisha Curtis, PetroNerds, presentation to The Oxford Institute for Energy Studies, November 2017



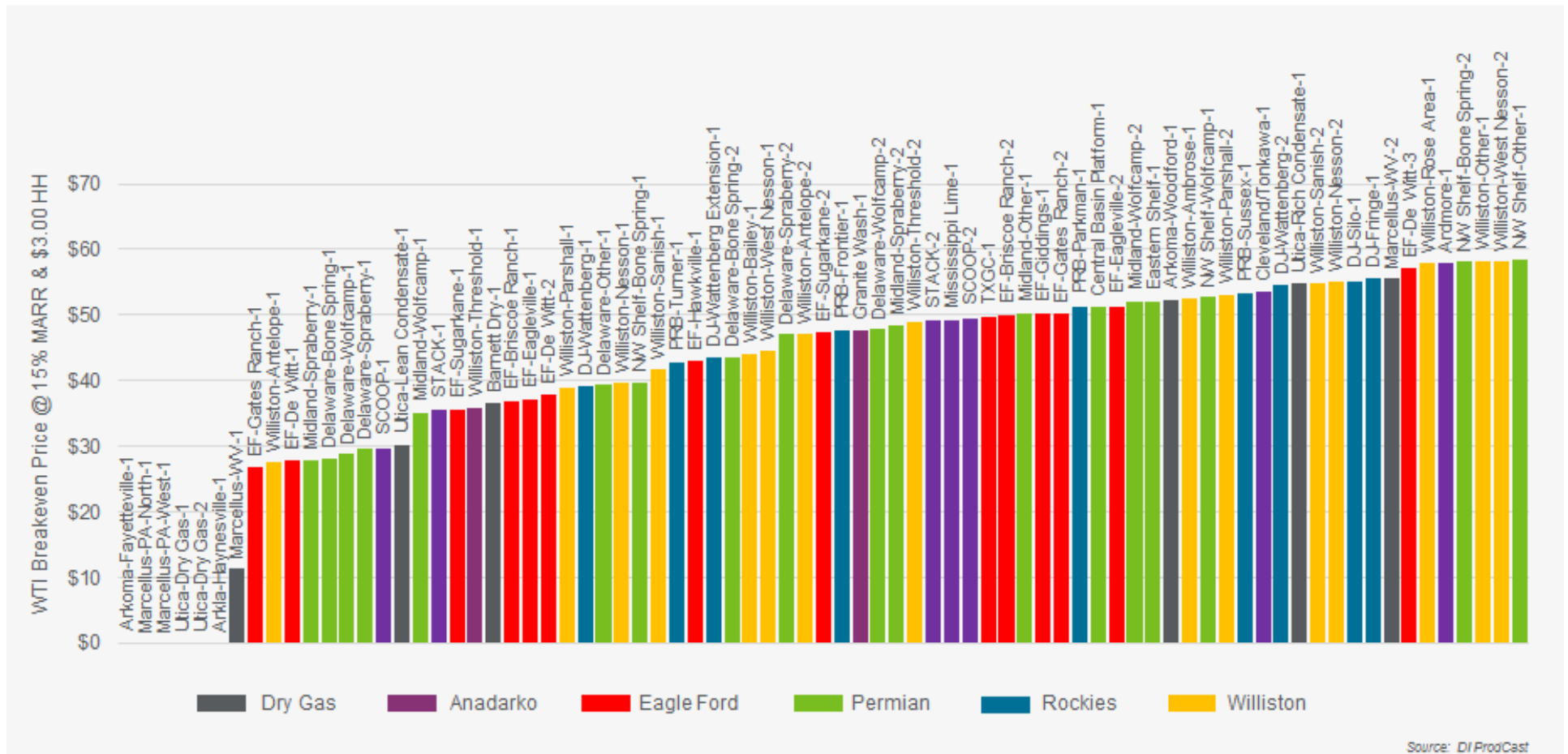
Intensity and Complexity

“High intensity completions” “upsized completions,”
“enhanced completions,” “version 3.0 completion,”
“generation x frac,” and “high density fracs”

1. Massively increased quantities of proppant - sand
2. Massively increased quantities of fluid – mainly slickwater
3. Placement of more fractures along the wellbore

Source: *US Shalers – Beating the Bears*, Trisha Curtis, PetroNerds, presentation to The Oxford Institute for Energy Studies, November 2017

US Production: Economics Support Increased Activity



Conclusions: Crude Oil

- OPEC's compliance has **continued to exceed market expectations** although compliance has posted troubling declines in the recent months. **Saudi Arabia still remains the driving force** behind the compliance and their commitment to the success of the quotas is driven by their impending IPO.
- Collective OPEC production has increased by 841 Mbbbl/d since March, primarily due to increasing production from Nigeria & Libya. These increased are **undermining** OPEC 11's goal of inventory normalization. Inventory normalization to level prior to the price crash are necessary **before any sustained price increased can materialize.**

Conclusions: Crude Oil (cont'd)

- Non-OPEC compliance to-date **has fallen short of promises**. Although compliance has increased steadily, Equatorial Guinea becoming a part of OPEC means that the non-OPEC production remains consistently above promised quotas. Russia and Kazakhstan's overproduction are note-worthy.
- Favorable US production economics, even at current price levels, have generated a steep increase in rig counts since last May. While **nearly 50% of the rig additions were in the Permian**, there are economic sweet spots in many basins. These world-class economics continue to keep a lid on price runs as the US has become the swing producer.

Conclusions: Crude Oil (cont'd)

- **Efficiencies** will continue to play a large role in the declining breakeven costs of the most prolific basins like the Anadarko & Permian. **Efficiencies** will not only lead to production forecasts possibly getting revised higher, but also in offsetting the impact of possible service cost inflation. Takeaway capacity & other infrastructure bottlenecks may lead to times where regional differentials blow out and production may get curtailed during these times.

Conclusions: Natural Gas

- US natural gas supply **is growing again**. Dry gas production in June 2017 was **1.1 Bcf/d higher** than December levels. June 2017 also marked the first month of production above 2016 levels. **However, year-to-date production remains below 2016 levels.** DI expects the largest gains in production during 4Q2017 as pipeline takeaway capacity becomes available. This will allow a year-on-year growth of 0.5 Bcf/d.

Conclusions: Natural Gas (cont'd)

- Pipeline flows across the country **have already changed dramatically** as a result of the Marcellus/Utica growth.
 - A **de-bottlenecking in the Northeast** should finally occur in 4Q2017. Expect Northeast basis to tighten starting this winter
 - **Bottlenecks in the Permian and Anadarko are emerging**. In the Permian, gas needs to move East in order to reach growing LNG demand while in the Anadarko, the constraints are intra-basin and to interstate pipelines.
- Over the next 5 years, **significant natural gas production growth is expected in the Permian, Anadarko and Marcellus/Utica**. Significant demand growth is also expected, led by LNG exports.

Final Conclusion

- The U.S. is poised to meet any decline in worldwide production for oil or gas for the foreseeable future.

Final Question

- How important is the U.S. Shale Revolution to the U.S. and to the free world?

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NYMEX Henry Hub Gas Futures Contract Open Interest Position

