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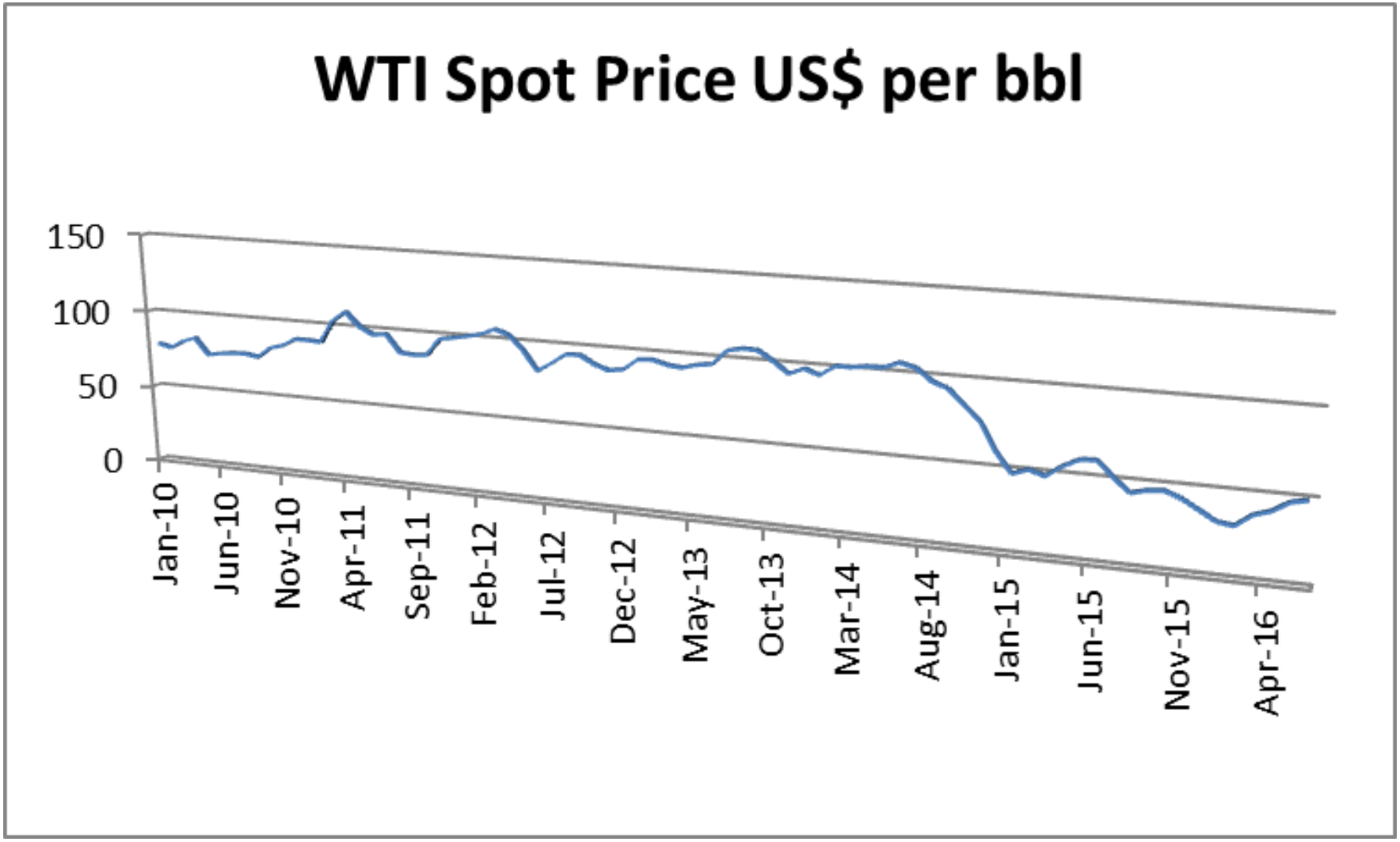
After the Revolution?

Scott Stewart -August 2016

Outline

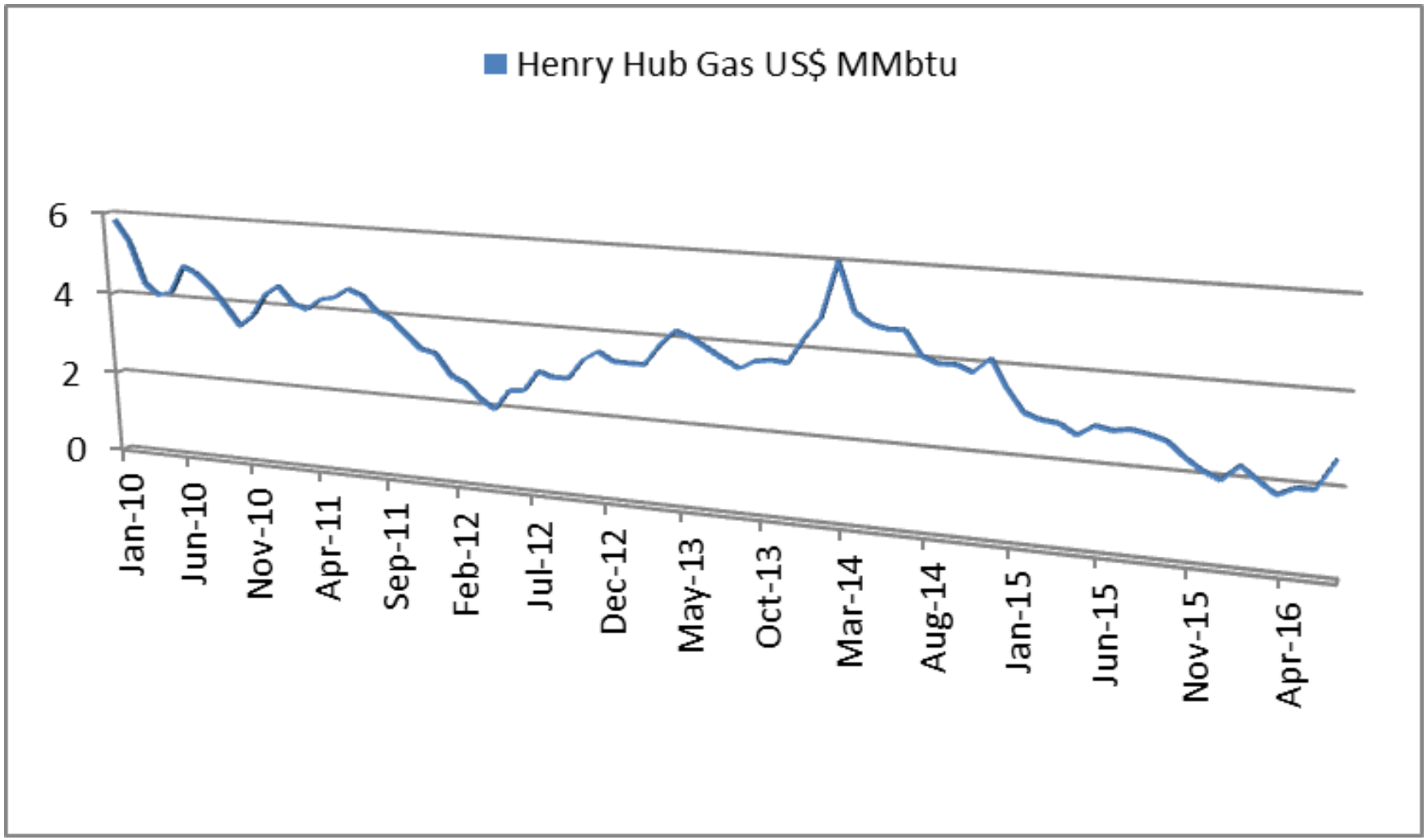
- US Prices, Rigs, Production, Usage 2010 -2016
- Conventional & Unconventional Production
- How are Operators Adapting?
- US and world unconventional play overview
- Commercial impact
- Look to future
- Conclusions

Oil Prices WTI 2010 -2016

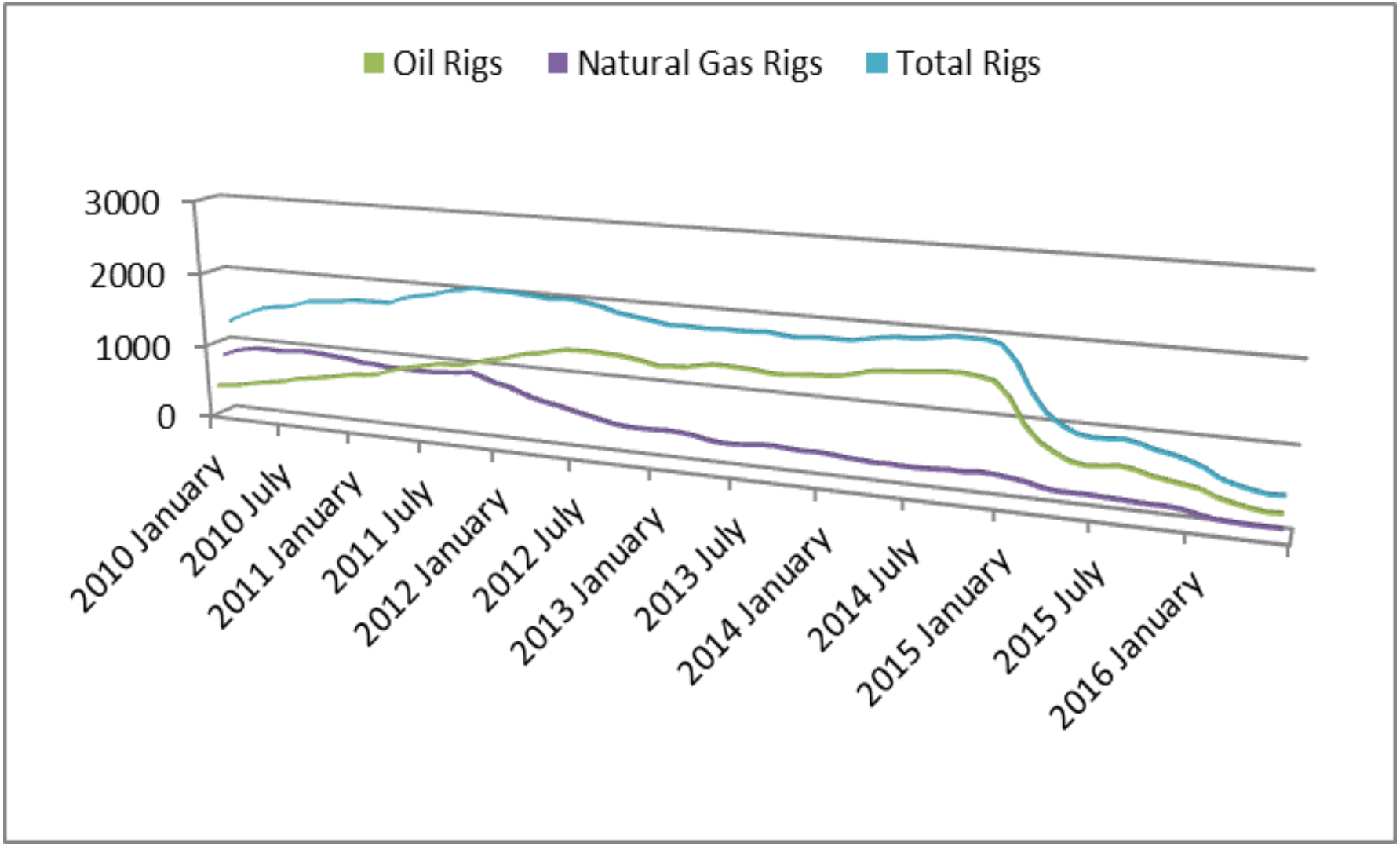


DrillingInfo/EIA 2016

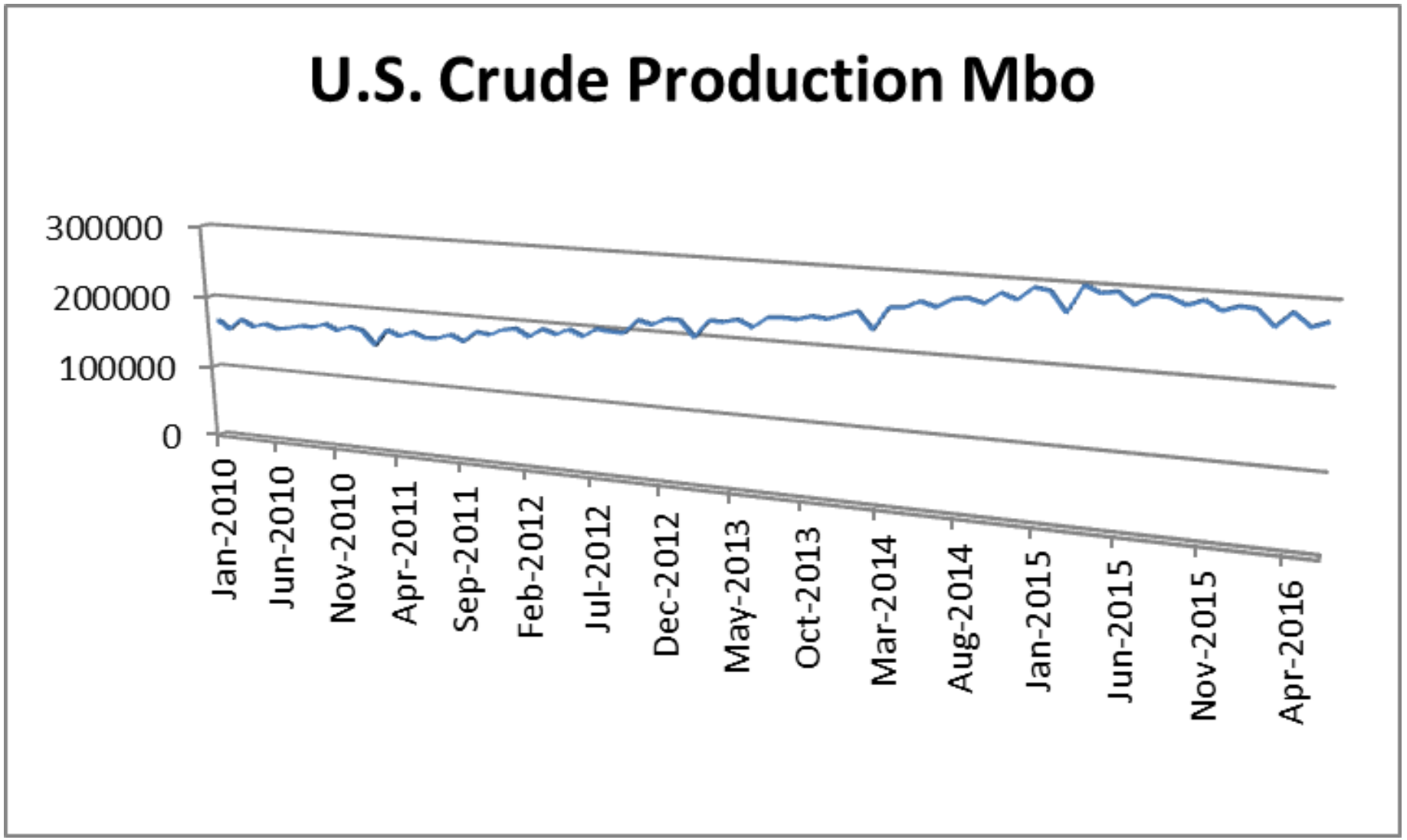
Henry Hub natural gas price 2010 -2016



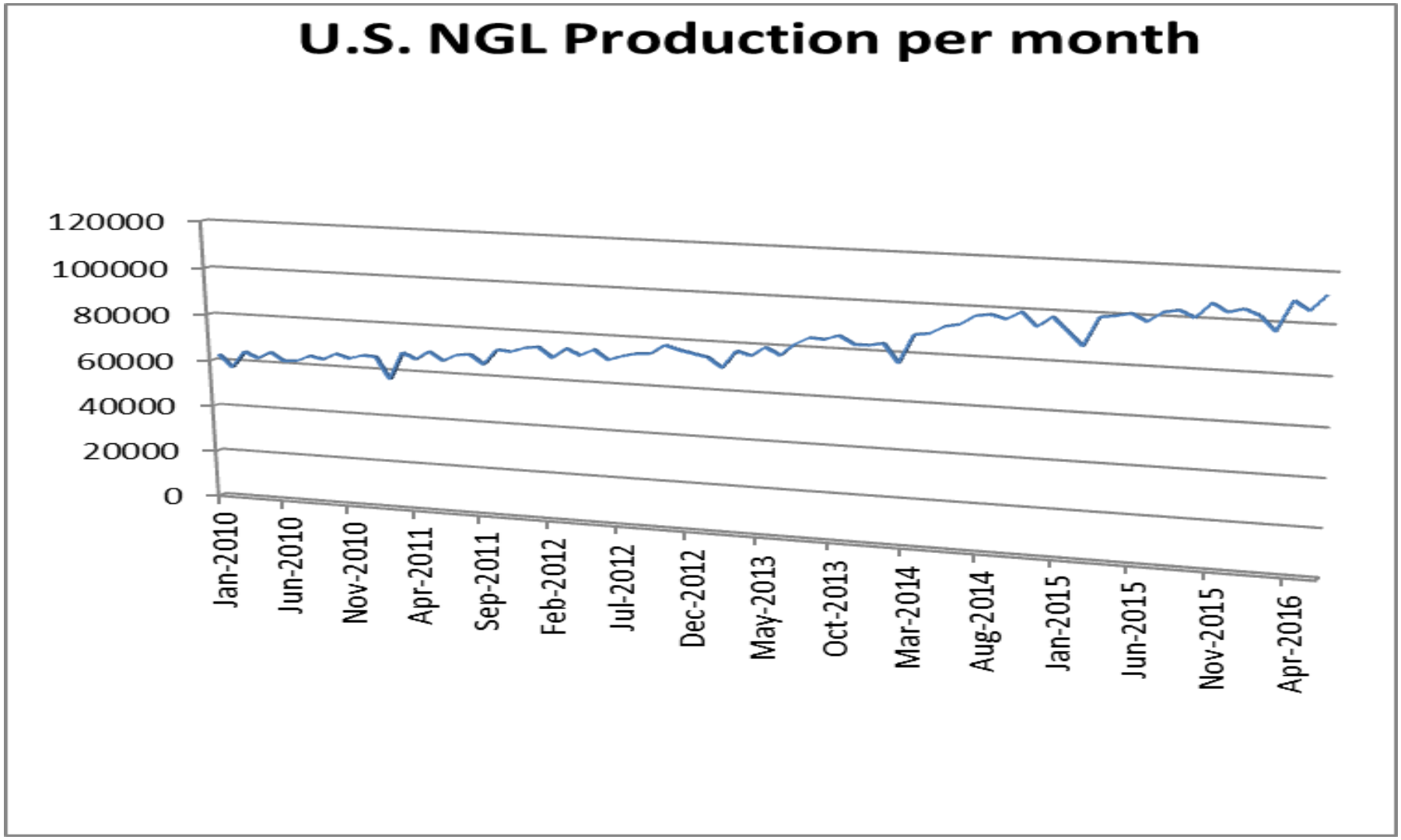
US Rig count 2010 -2016



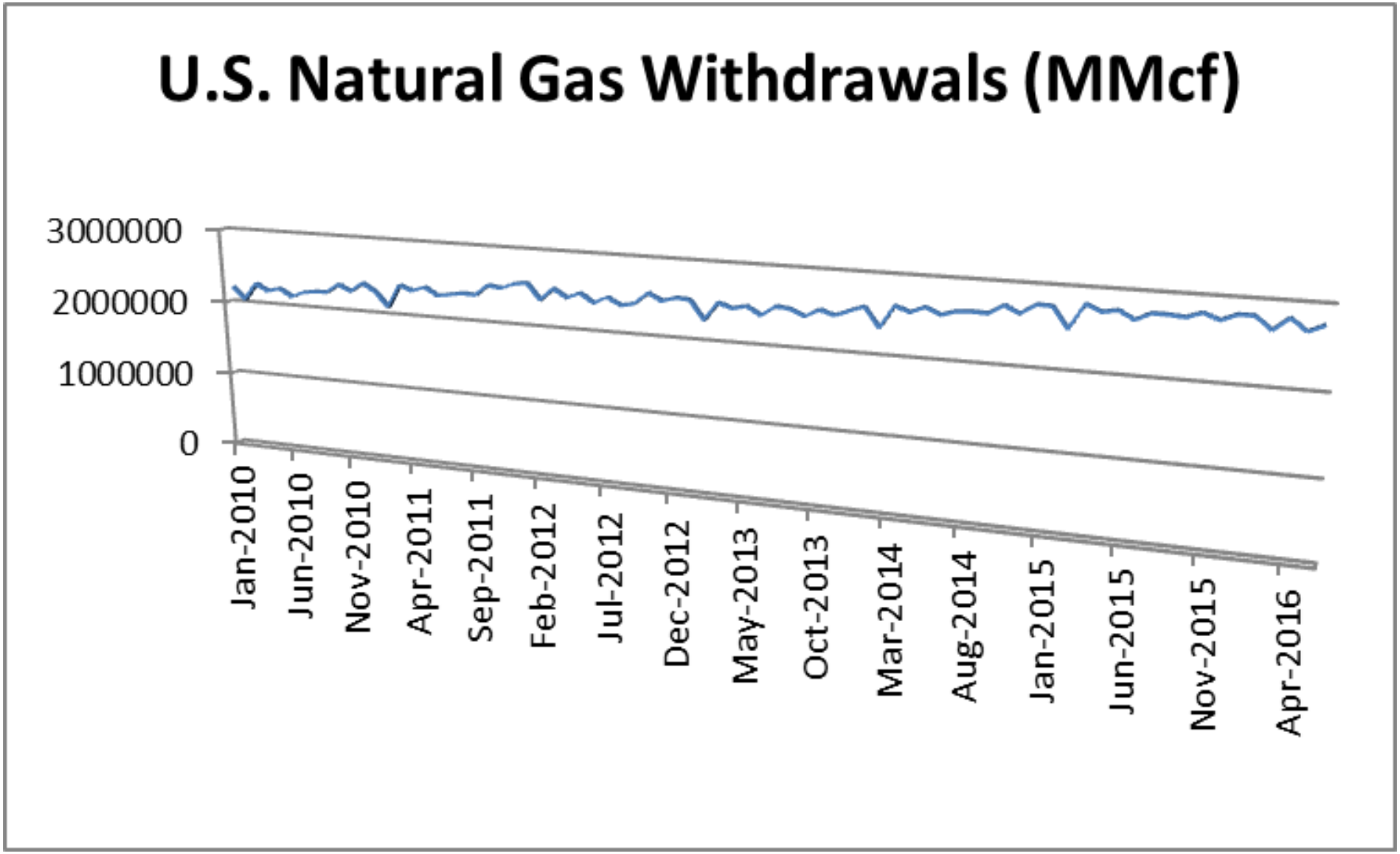
US Crude Production 2010 -2016



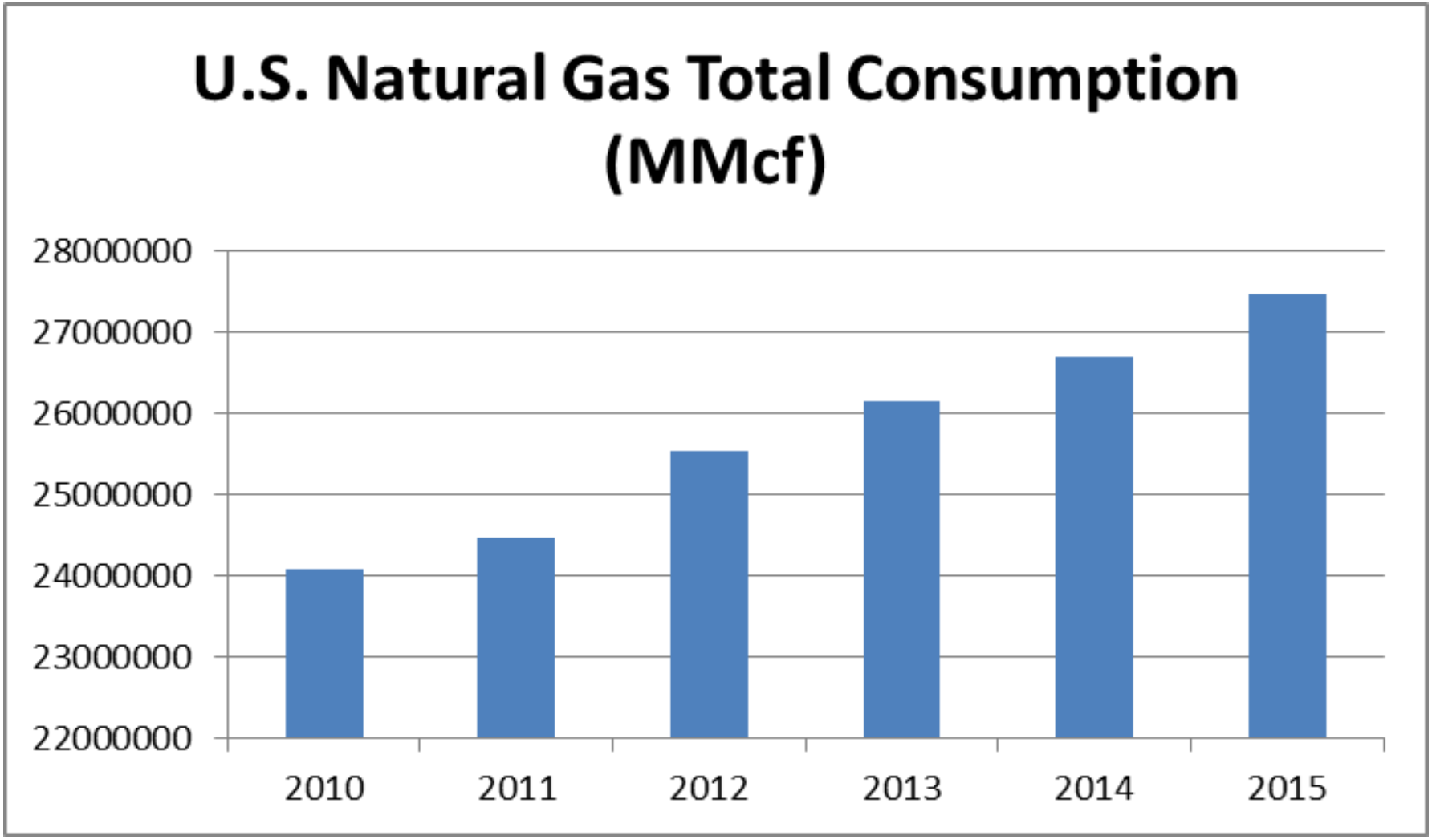
US NGL Production 2010 -2016 Mbo



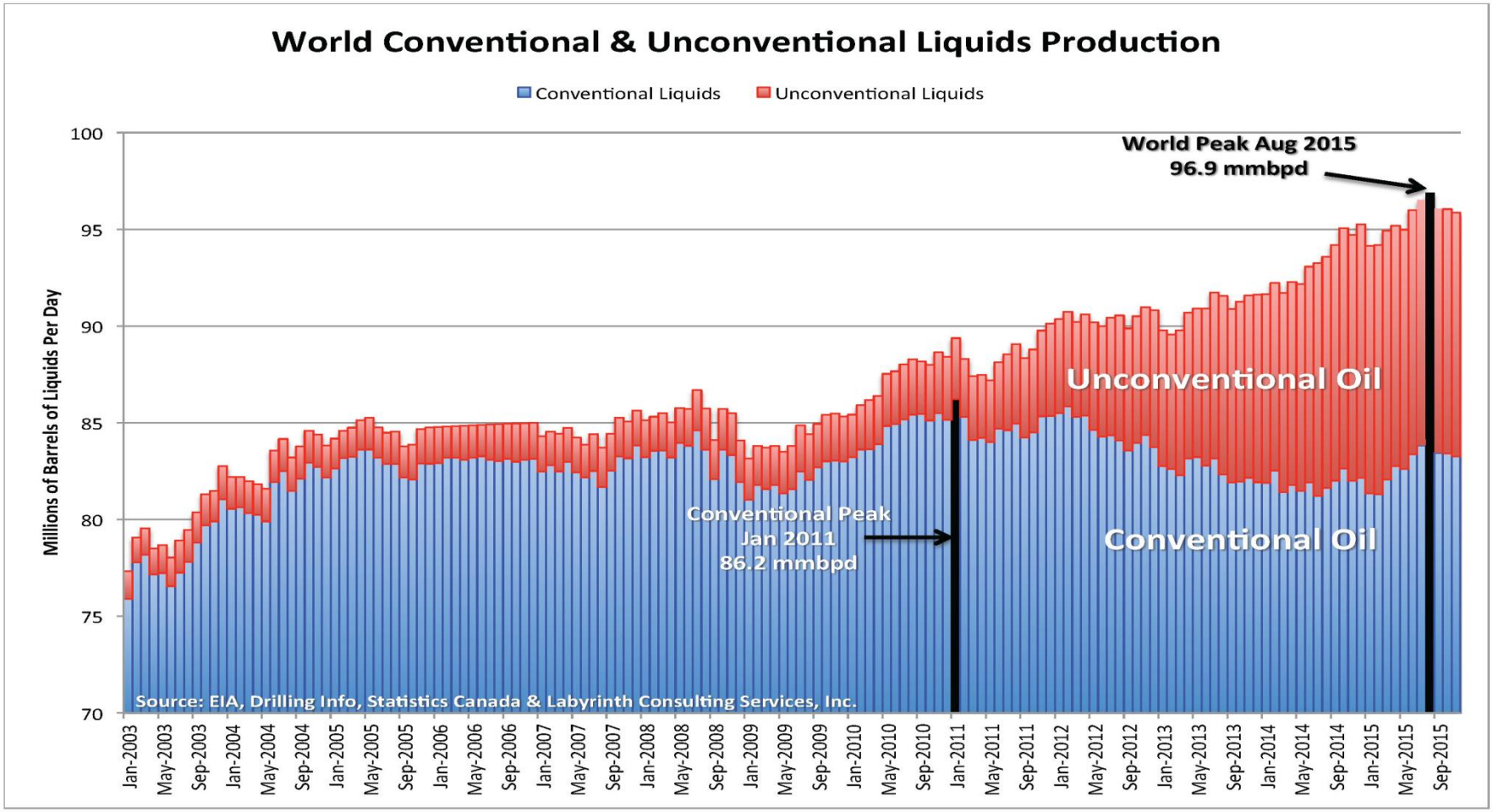
US Gas Production/Withdrawals Monthly 2010 -2016 MMcf



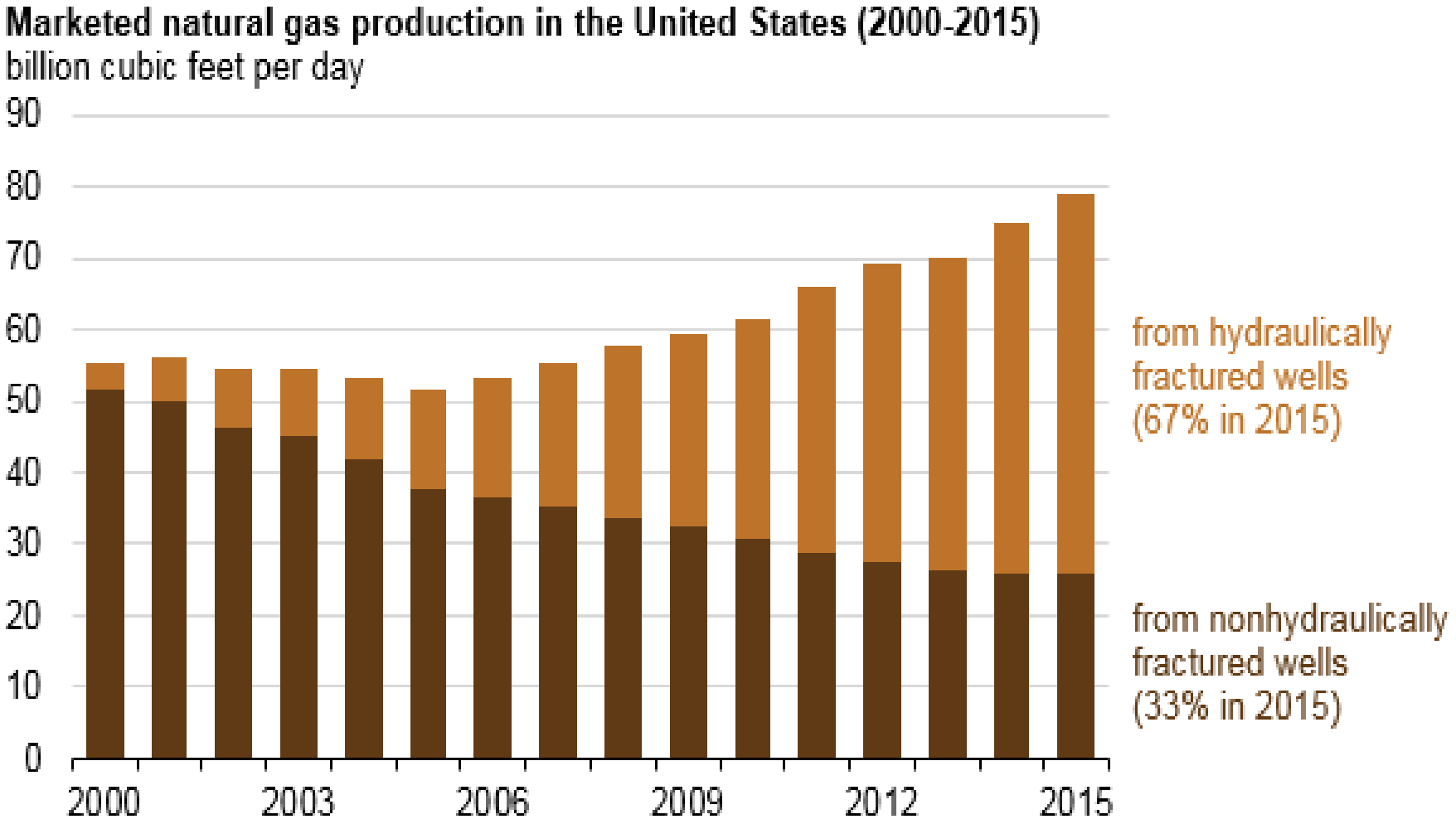
US Gas Consumption
2010 -2015 MMcf



World Liquids Production
Conventional vs Unconventional



US Gas Production
Fractured vs Conventional wells



DrillingInfo/EIA 2016

US UNCONVENTIONAL PRODUCTION

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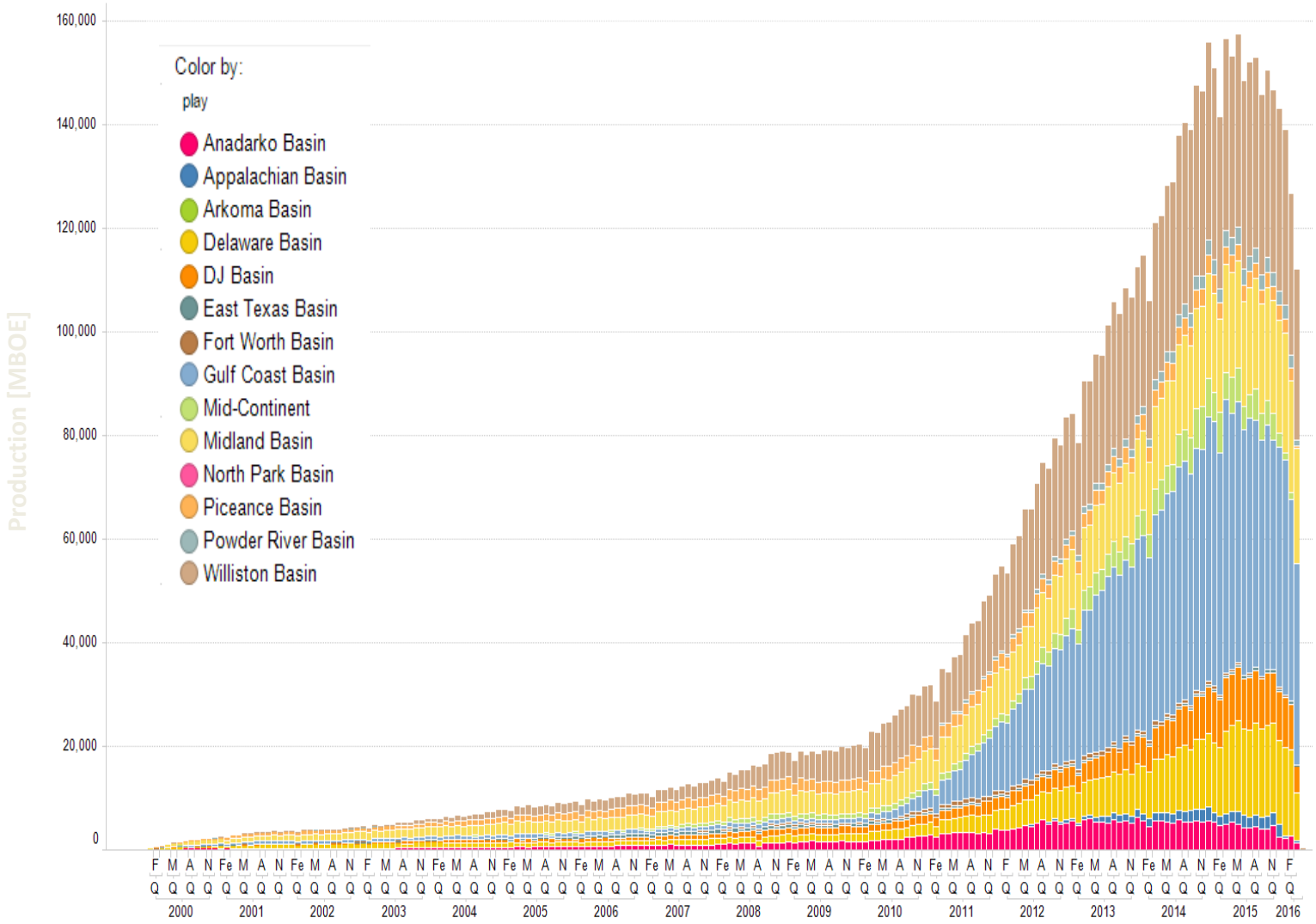

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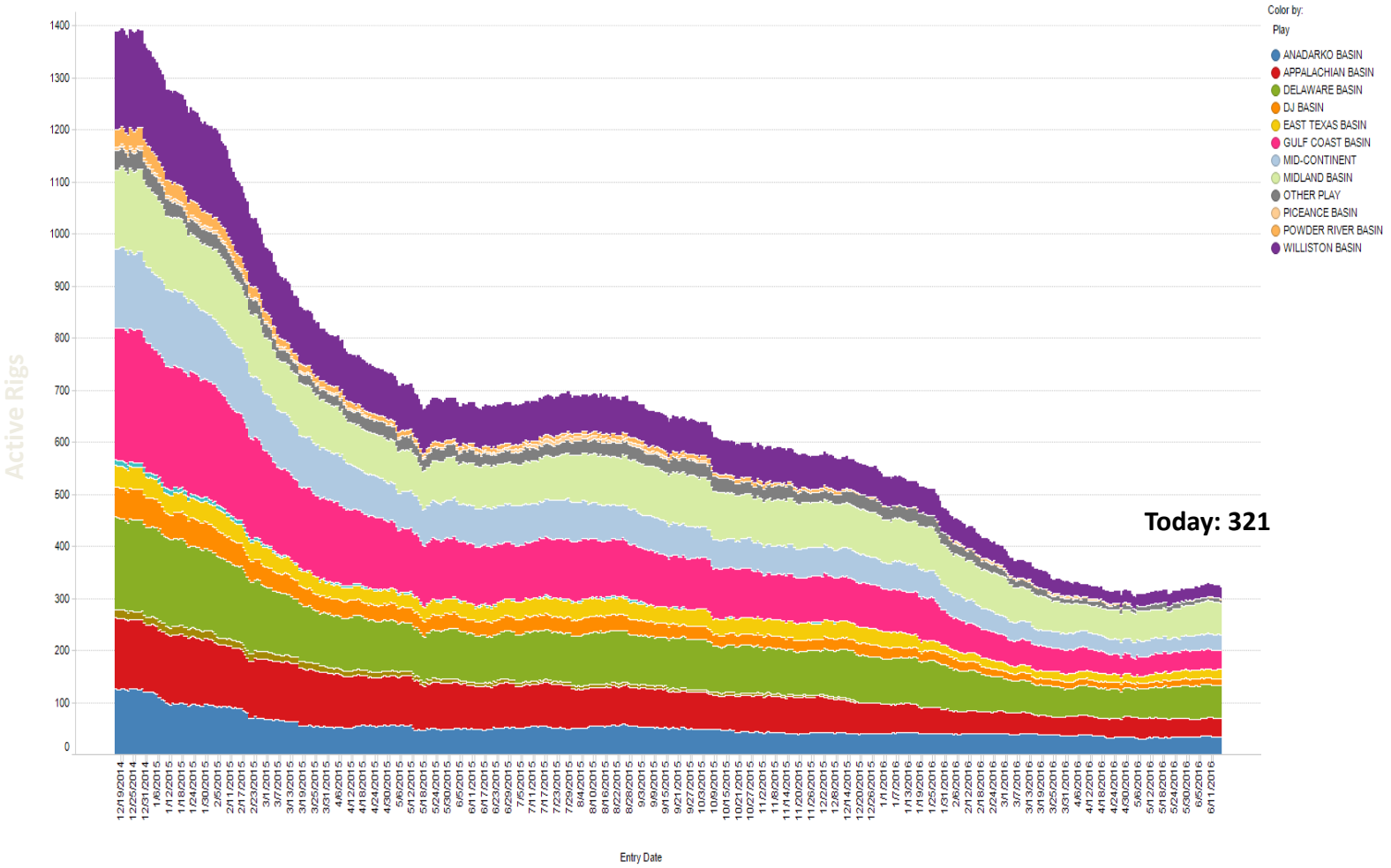
US HZ ONSHORE DRILLING (18 MO.)



Data retrieved from DI Analytics on 5/3/2016; horizontal wells only.

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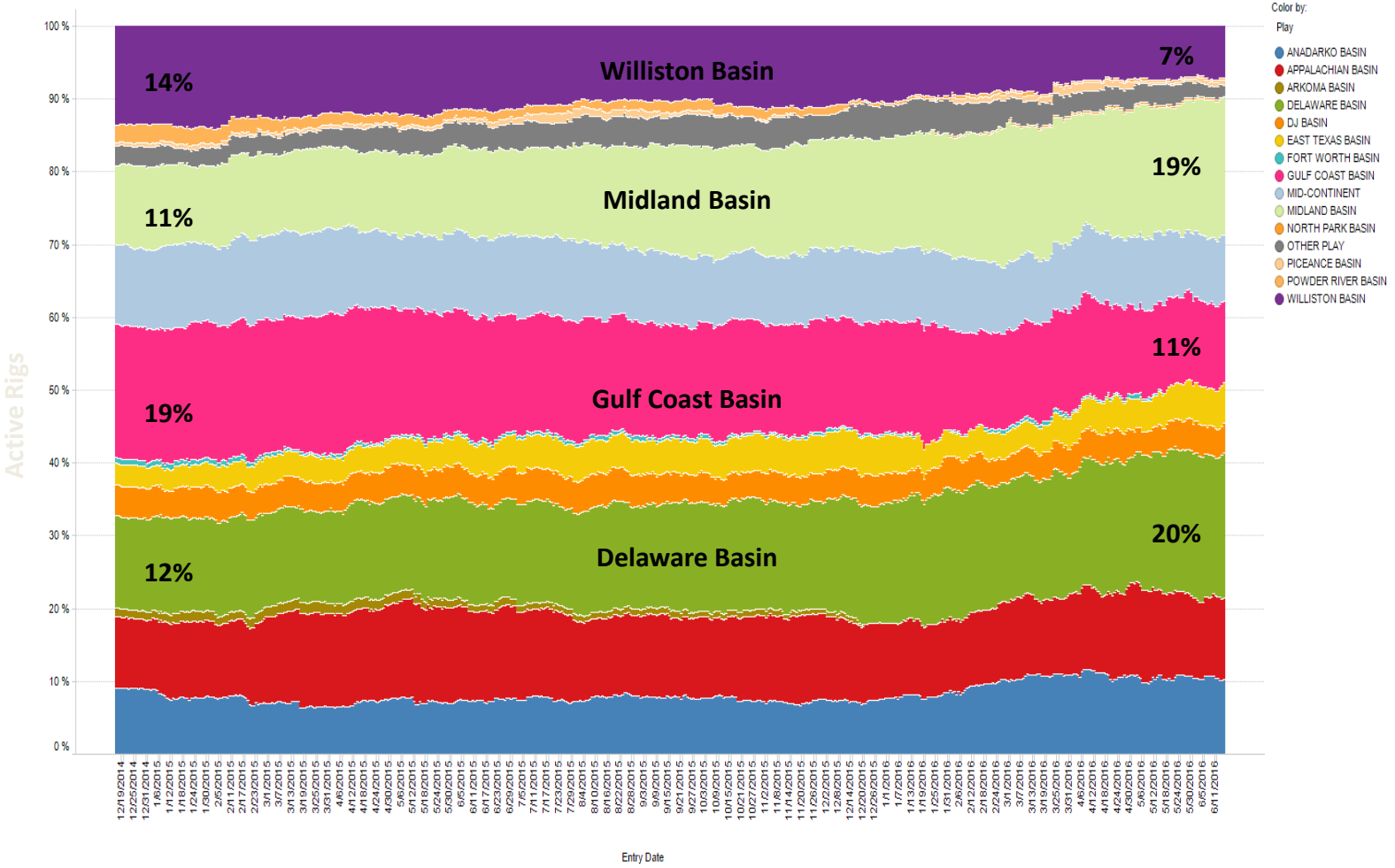

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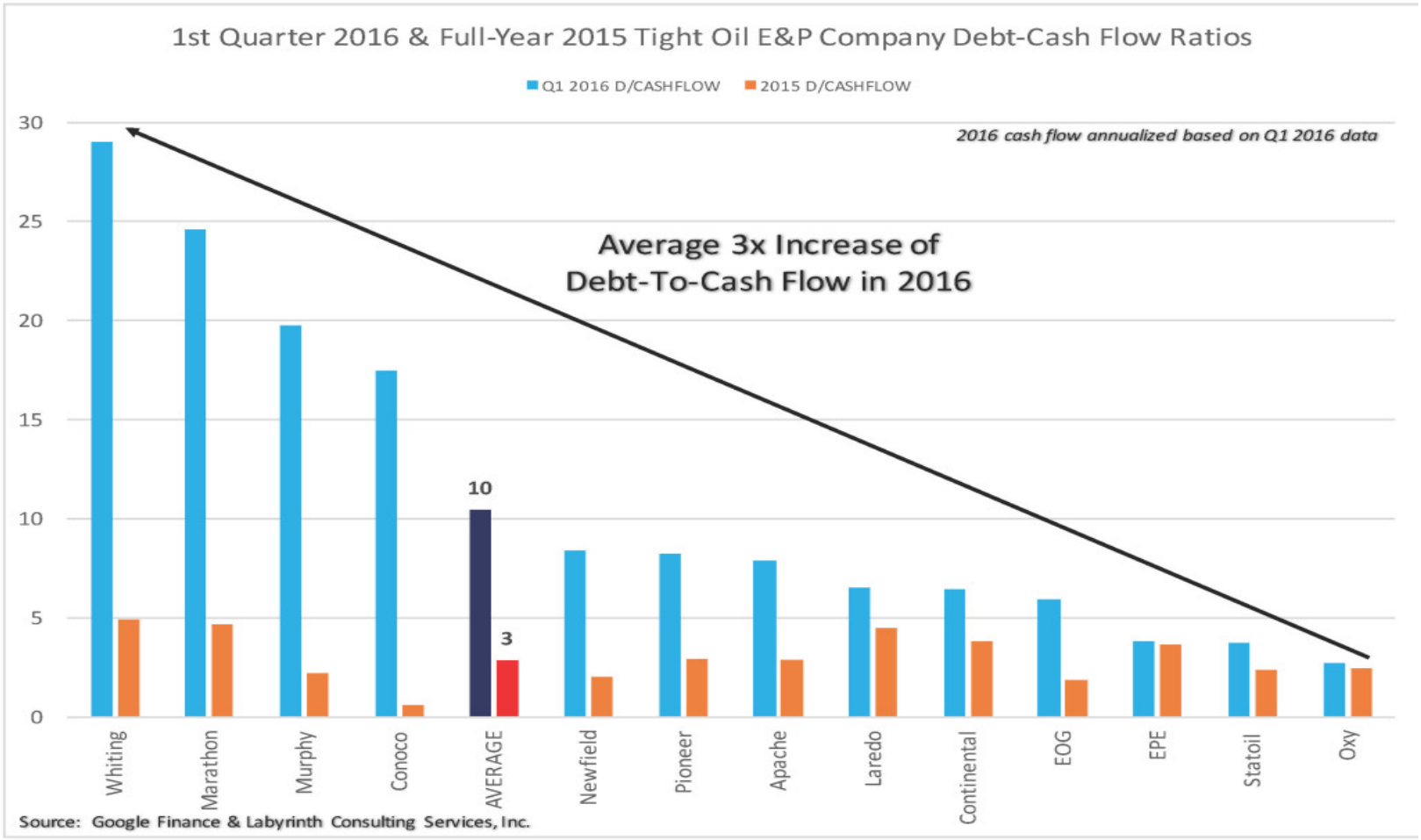
OPERATOR ADAPTATION
HOW ARE THEY MAKING IT?



Operator Adaptation Bankruptcies

- Linn Energy – 10 billion debt
- SandRidge Energy - 4 billion debt
- 64 companies bankrupt from Jan 2015 to May 2016
- 175 E&P companies at high risk in 2016
- 160 others at risk for cash flow constraints
- E&P junk bonds 27% default may reach 35% end 2016
- Piling up debt when oil was US$ 100 per bbl
- Is a capital crisis looming?

Operator Adaptation
Evolving Well Costs

- Total well costs US$ 4.9 - 8.3 million
- Completion 55-70% of well costs
- Completion costs 2.9 -5.6 million
- Due to complex completions on horizontal wellbores
- Drilling – 1.8 -2.6 million
- Facilities just 2-8% well cost
- Costs per well hit a high point in 2012
- Down 25 to 30% since then late 2015

Operator Adaptation
Drilled Uncompleted Wells DUC's

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Advantages

- Can wait until price recovery
- Avoid flooding saturated market
- Cost reduction in hard times
- Avoid breaking rig contracts
- Can bring future production online quickly

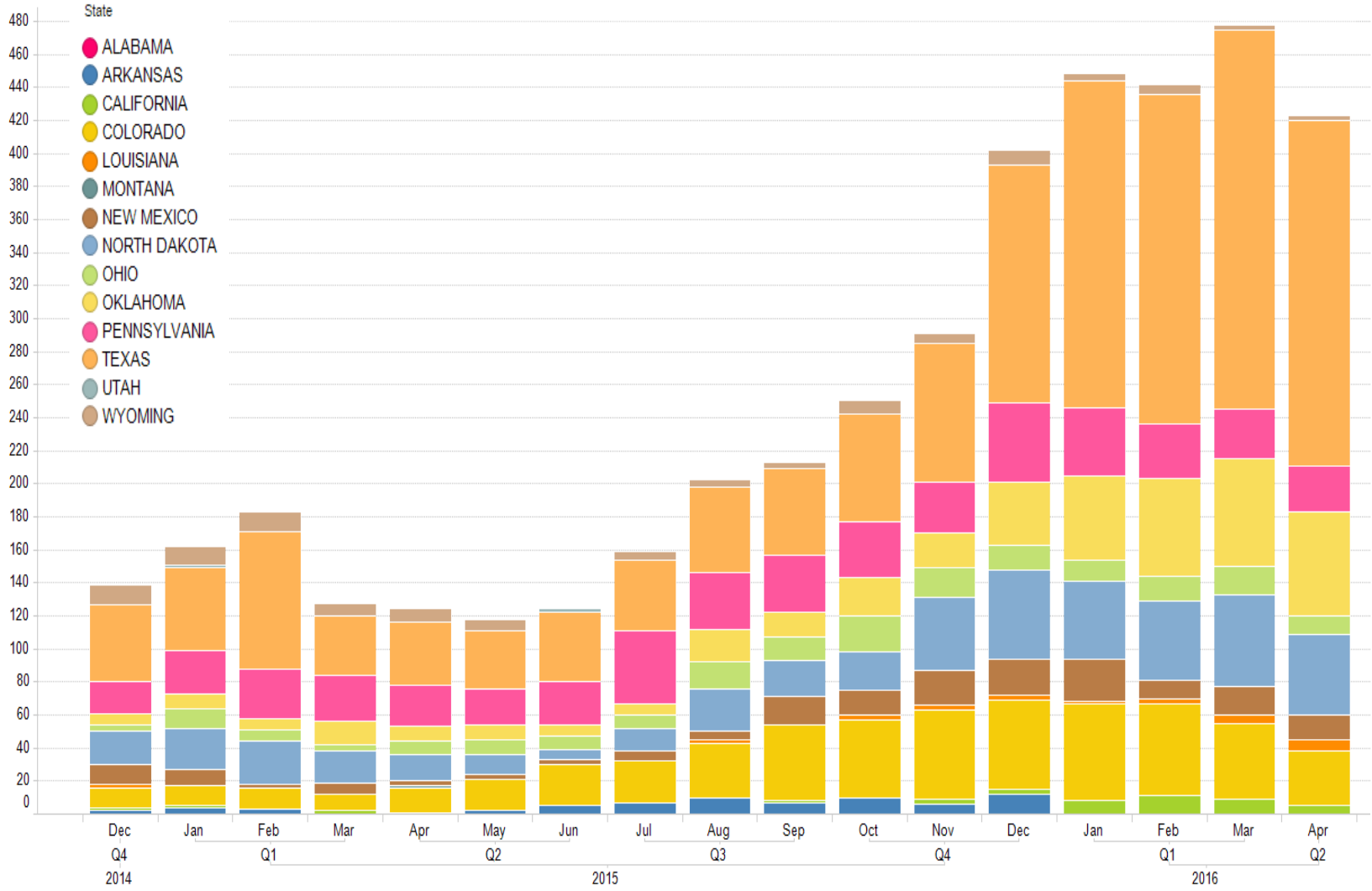
- **Number of DUC's falling**
  - 1300 to 3900
  - Lower rig count
  - Some operators completing DUC's in 2016

Disadvantages

- Time limits to complete wells
- Can inhibit a price rebound
- Operational discontinuity

- **DUC's can slow production decline**
  - But won't compensate for new drilling
  - Expected to contribute 4-5% to production in second half 2017
  - Stabilizing force for both production & price increases

DRILLED BUT UNCOMPLETED (DUC)



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DRILLED BUT UNCOMPLETED (DUC)

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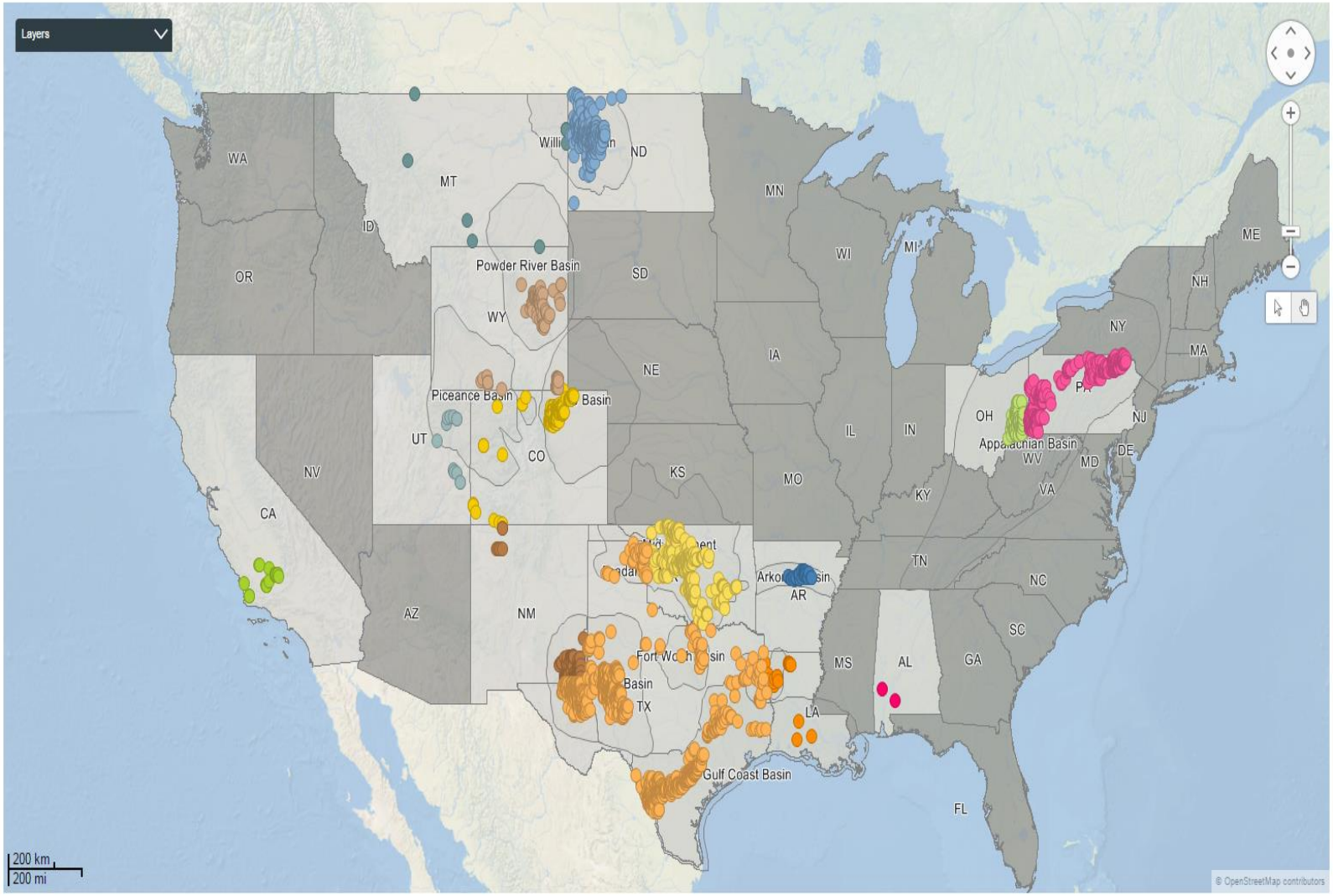

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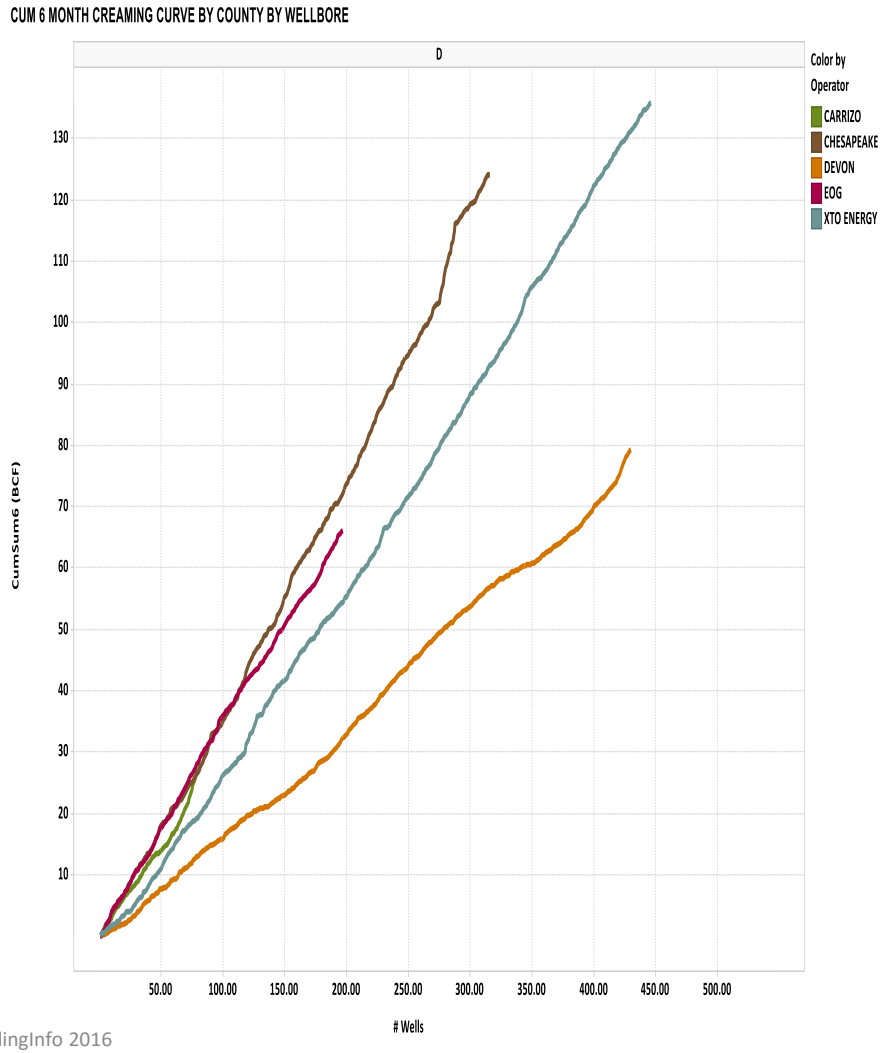
Data is Critical in US Unconventional E&P

- All operators are **NOT** equal.
- All rocks in the resource play are **NOT** created equal.
- All stimulation techniques are **NOT** equally applicable



Frack Improvements

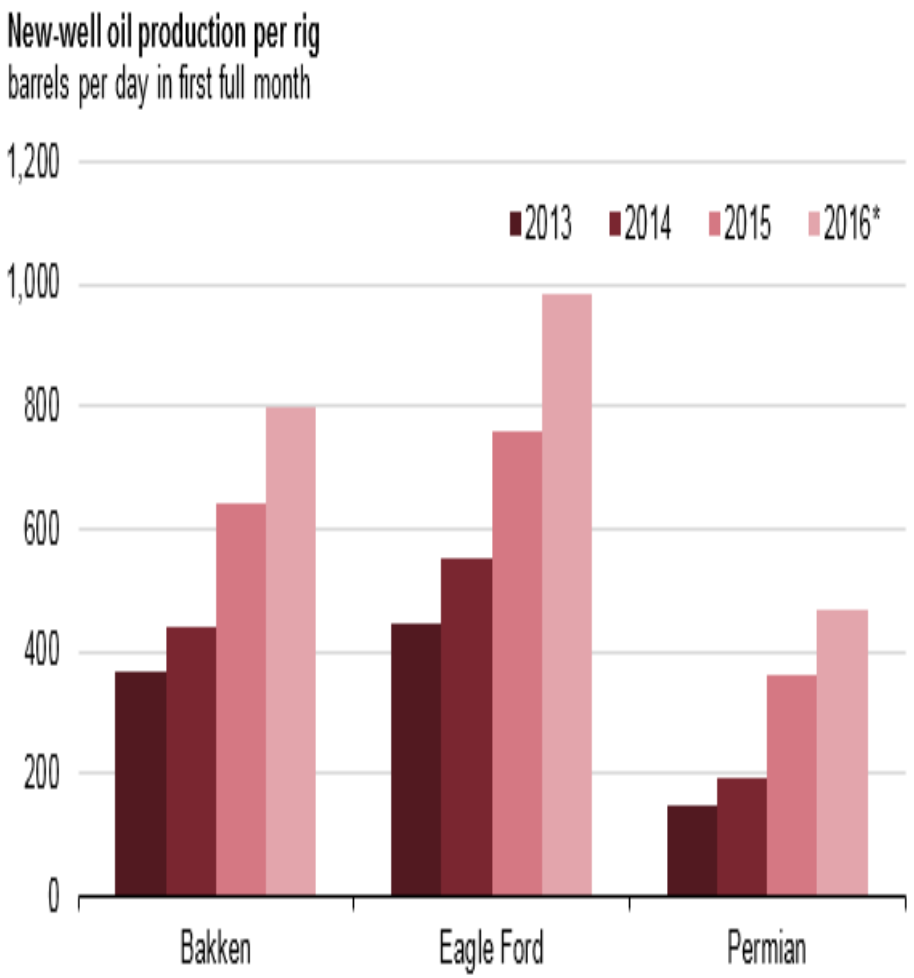
- Emphasis shifted away from factory drilling to reservoir analysis
- Average new well more productive than previous years for nine years in a row
- Frack only gets 10% at most of oil in a zone
- Re-fracking improves well performance by 33 to 50%
- One third the cost of a new well
- Diverters – temporarily block the flow from existing fractures
- Allow fractures to propagate in other parts of the matrix
- Use of CO2 rather than water - experimental

Finding the Sweet Spots

- Combination of TOC and brittleness
- High TOC is more ductile
- Needs to be brittle enough for frack to be effective
- Use of microseismic
- Dual mapping for reservoir and completion quality
- Coring – expensive & real time cuttings analysis used
- Improved tools LWD and Geosteering
- Raman spectroscopy tested by Shell used in CBM

Average production per rig improving

- New well oil prod per rig
- Bo/d first prod month
- EagleFord – 983 bo/d + 226
- Bakken – 796 bo/d + 155
- Permian – 470 bo/d + 111
- Forecast – production will decline for rest of 2016
- Will level off first half 2017 & then increase slowly
- WTI $47 in 3rd qtr 2016 increases to $50 2nd qtr 2017

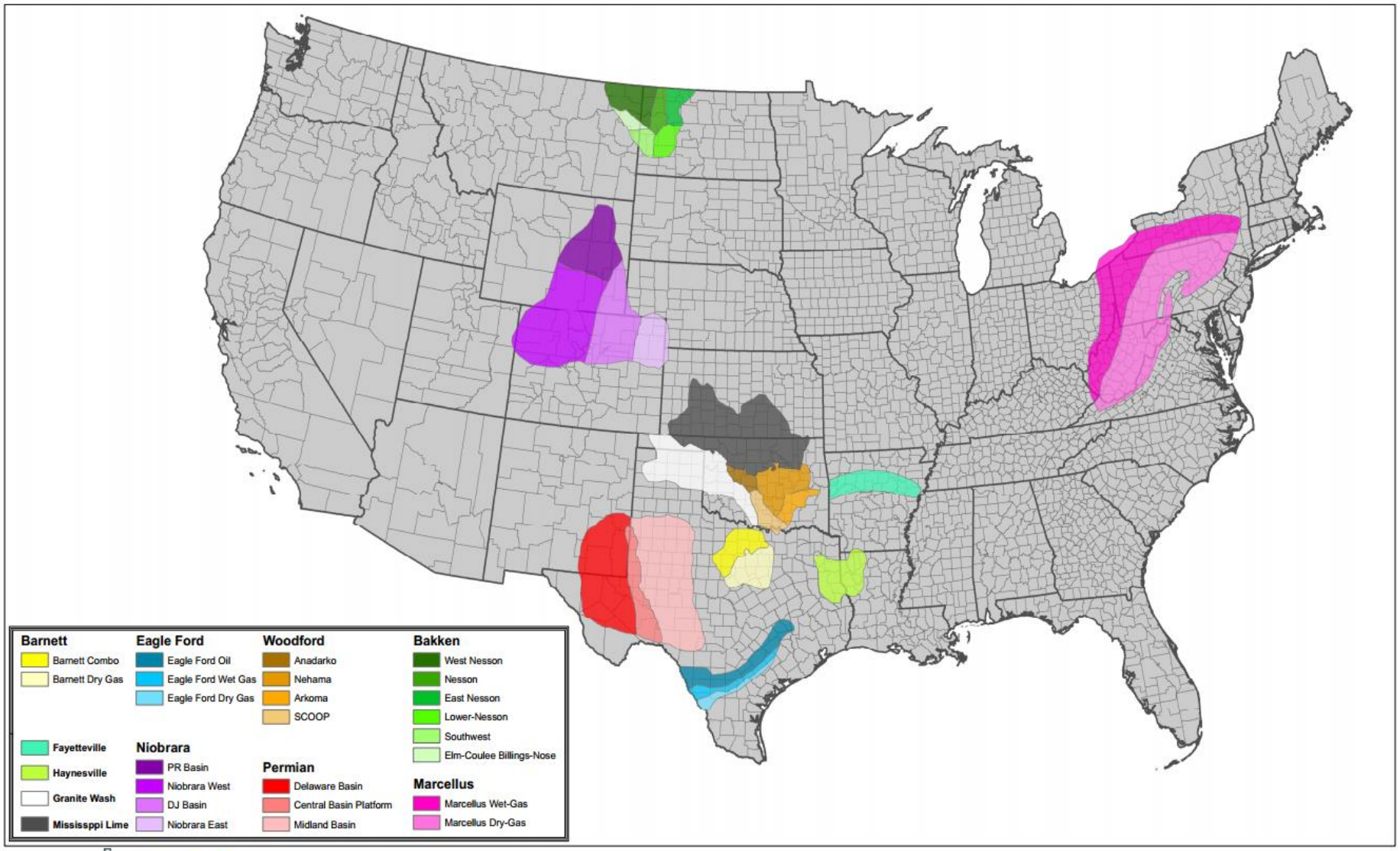


DrillingInfo 2016/EIA/Goldman Sachs

Evolving Shale Economics

- US Shale oil break even in 2014 - $80
- Current Break even price - $55
- 2018 projection - $50
- Well productivity improving by 3-10% per year
- US$ 650 billion in capital at risk/projects over 55/bbl
- Average Bakken & EagleFord wells double digit improvement in 2015
- Partly due to high grading & lower activity but still estimated at 6% without this

US Unconventional Play Map



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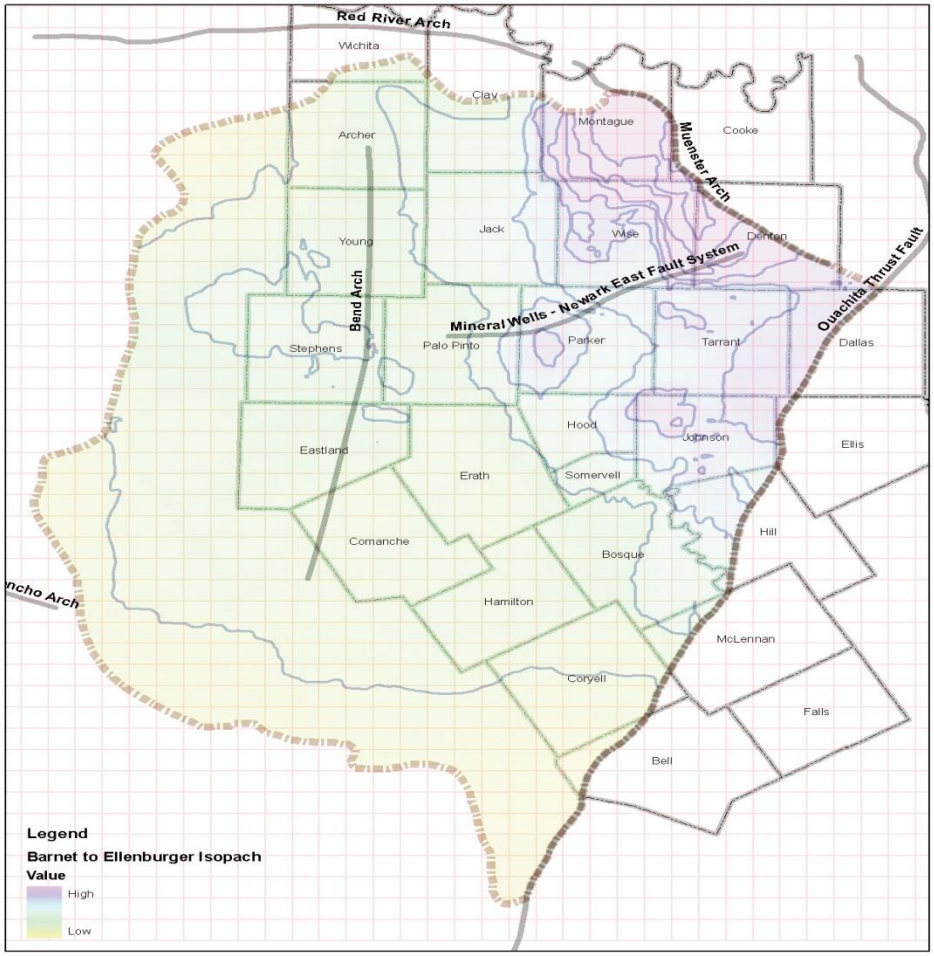
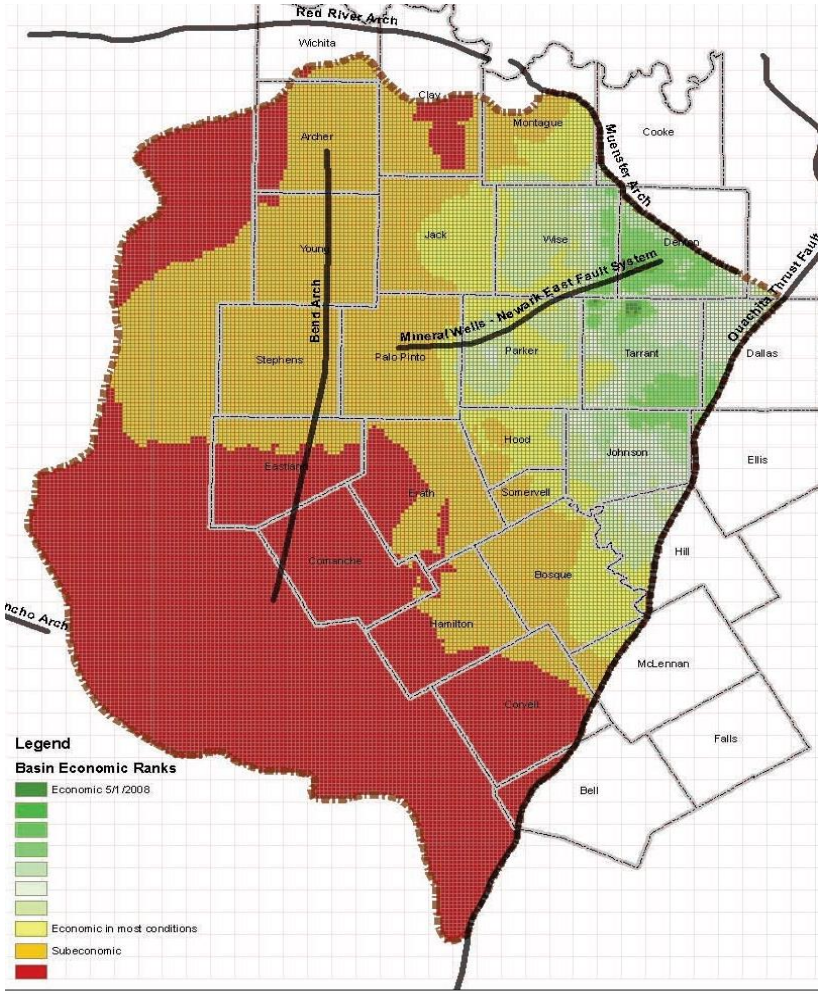
Plays/Play Areas

Unconventional Play Overview
Barnett Shale



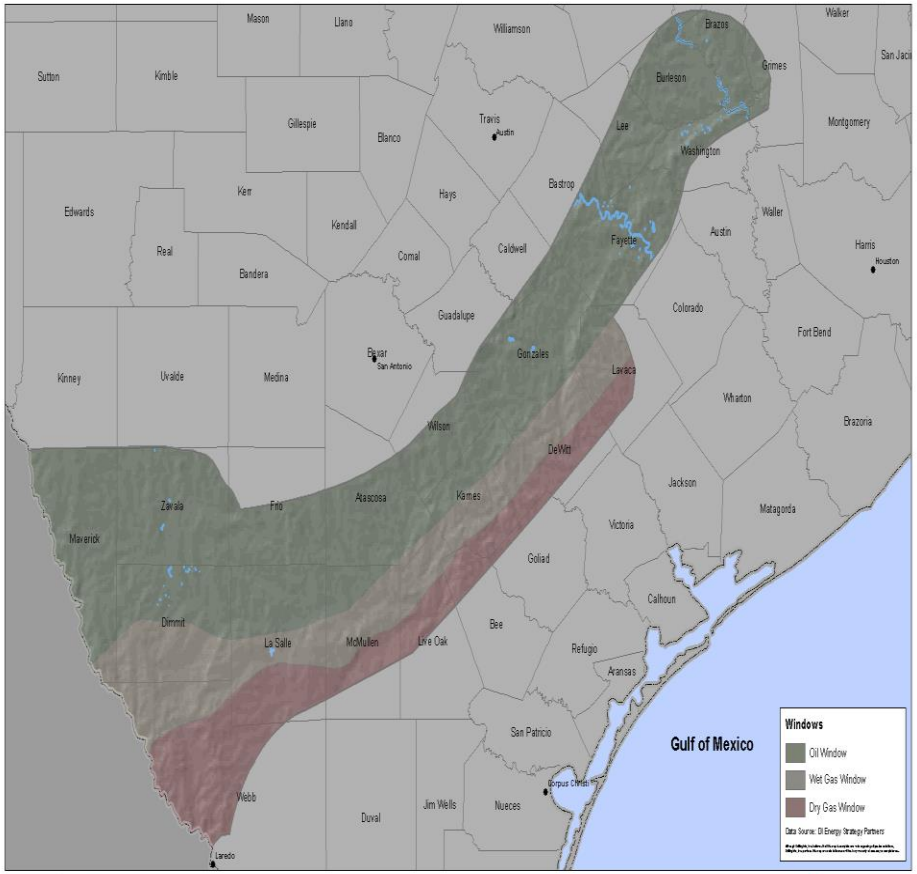
- Fort Worth Basin, Texas, first major unconventional play.
- Mississippian age, porosity .5 to 6%
- First horizontal wells 2001, standard by 2003
- EOG typical well – 300 Mboe
- Year-end 2007 - 3.5 Bcfg/d from 7,000 wells
- Horizontal wells – Max IP 1.36 MMcfg/d, almost 2X verticals
- Prod decline – 60% yr 1, 30% yr 2, 15% yr 3
- Oldest unconventional play – 200 rigs working in 2006 – zero in April 2016

Data Example – Productive Acreage Grading Barnett Shale



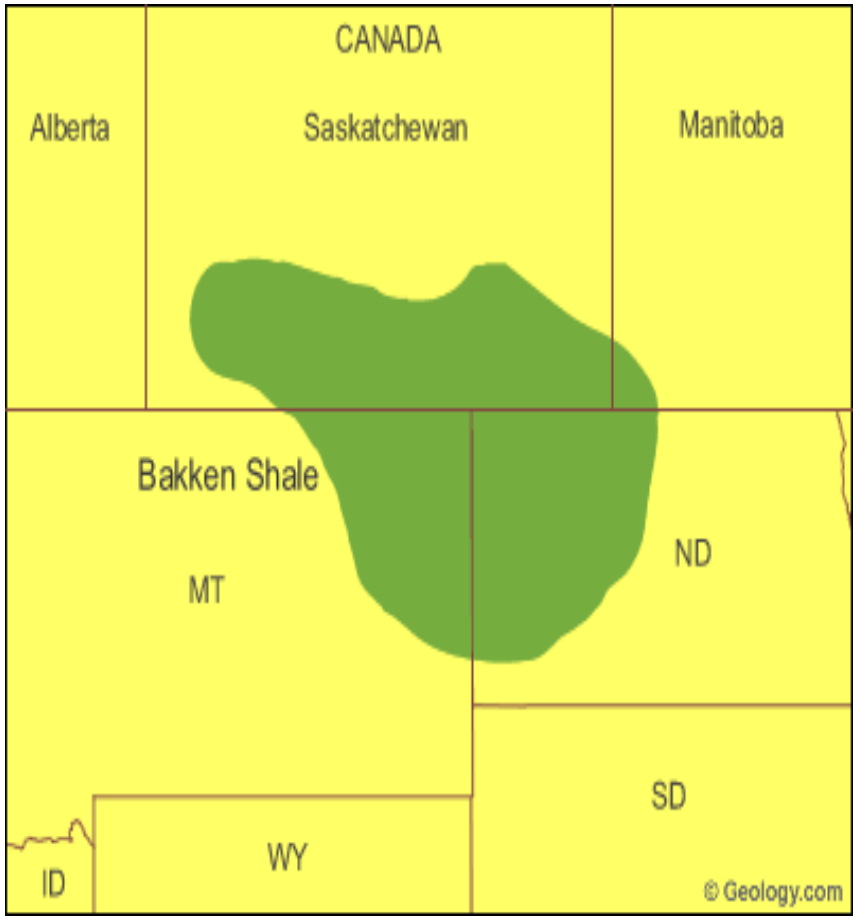
GPA	Acres in Play	%	Cumulative %	Nominal Max Gas/Section	Nominal Min Gas/Section	Nominal Gas In Place	Cumulative NGIP
A	14,080	0.08%	0.08%	83	74.7	1,826	1,826
B	27,520	0.16%	0.25%	74.7	66.4	3,212	5,038
C	91,520	0.55%	0.79%	66.4	58.1	9,495	14,533
D	303,360	1.81%	2.60%	58.1	49.8	27,539	42,073
D_hl	5,760	0.03%	2.63%	58.1	49.8	523	42,596
D_ml	46,080	0.27%	2.91%	58.1	49.8	4,183	46,779
E	418,560	2.49%	5.40%	49.8	41.5	32,569	79,348
E_hl	46,080	0.27%	5.68%	49.8	41.5	3,586	82,934
E_ml	39,040	0.23%	5.91%	49.8	41.5	3,038	85,971
F	632,320	3.77%	9.68%	41.5	33.2	41,002	126,973
F_hl	16,640	0.10%	9.78%	41.5	33.2	1,079	128,052
F_ml	14,720	0.09%	9.86%	41.5	33.2	955	129,007
G	660,480	3.94%	13.80%	33.2	24.9	34,262	163,269
G_hl	126,080	0.75%	14.55%	33.2	24.9	6,540	169,810
G_ml	134,400	0.80%	15.35%	33.2	24.9	6,972	176,782
H	1,054,080	6.28%	21.63%	24.9	16.6	41,010	217,792
H_hl	225,280	1.34%	22.97%	24.9	16.6	8,765	226,557
H_ml	301,440	1.80%	24.77%	24.9	16.6	11,728	238,285
I	1,189,760	7.09%	31.86%	16.6	8.3	30,859	269,144
I_hl	1,227,520	7.31%	39.17%	16.6	8.3	31,839	300,983
I_ml	3,008,640	17.93%	57.10%	16.6	8.3	78,037	379,020
J	97,280	0.58%	57.68%	8.3	0	1,262	380,281
J_hl	6,204,800	36.97%	94.65%	8.3	0	80,469	460,750
J_ml	898,560	5.35%	100.00%	8.3	0	11,653	472,403
Basin Total	16784000	1					

Unconventional Play Overview
Eagle Ford



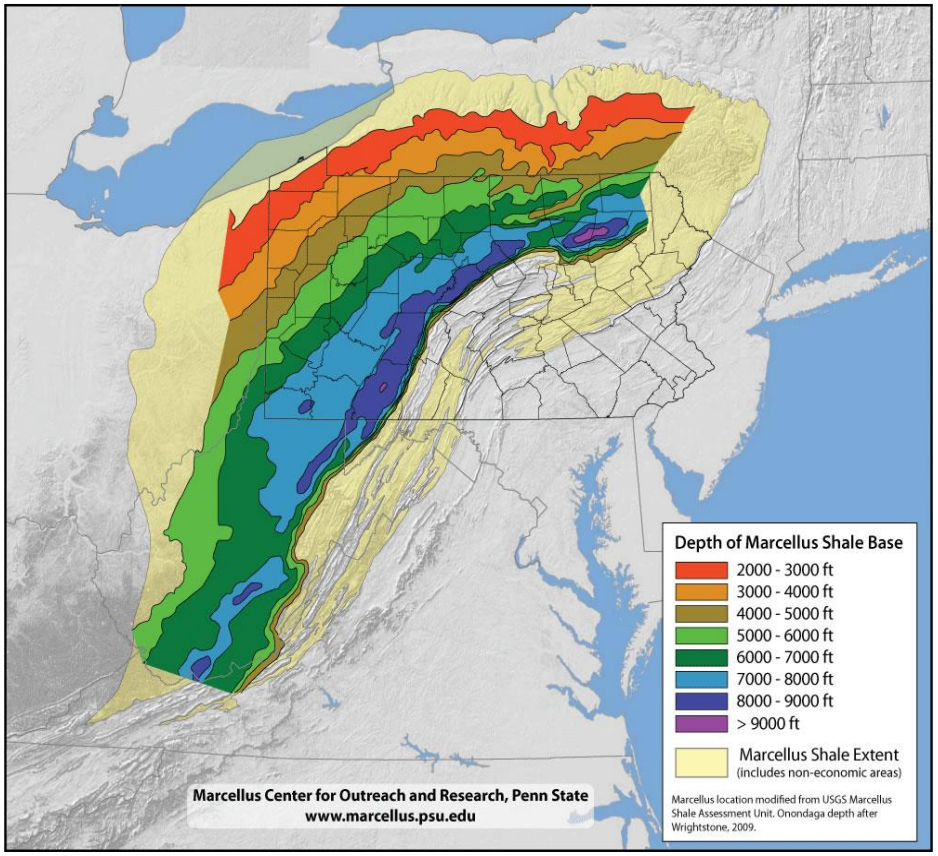
- First production 2006 but main focus initially Austin Chalk
- First true Eagle Ford well by Petrohawk in Hawkville Field, Oct 2008.
- Upper Cretaceous, 30 to 100m thick, good for frack, up to 70% calcite
- Lower transgressive layers oil prone, upper regressive layers gas prone
- Activity focused on liquids not gas
- Simulfrac good practice for oil (50%) & gas (12%) higher.
- Production hit 6 Bcfg/d and 1.5 MMbo but has declined slightly
- Operating expense 9.00 -24.50 per boe

Unconventional Play Overview
Bakken



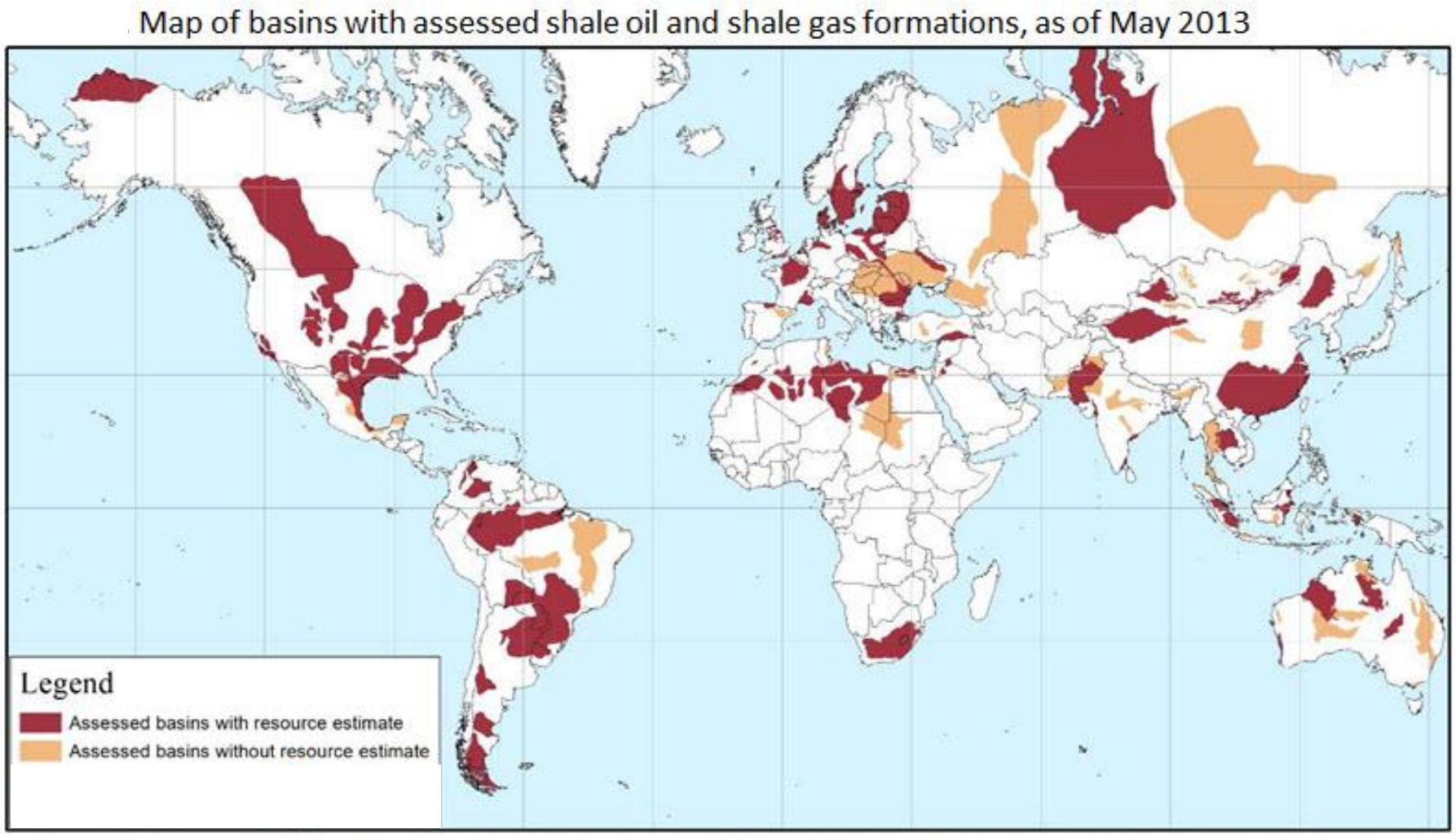
- Mississippian – Devonian, includes Upper, Middle, Lower Bakken & Sanish
- Middle Bakken most important, higher perm & porosity between high TOCs
- Middle Bakken overpressured, natural vertical fractures
- Mostly liquids play, first well 1953, serious production starts 2003-2004
- Peak leasing 2007-2009
- Well costs 7.5 to 8.1 million
- Operating cost – 15 to 37.50 per Boe

Unconventional Play Overview
Marcellus



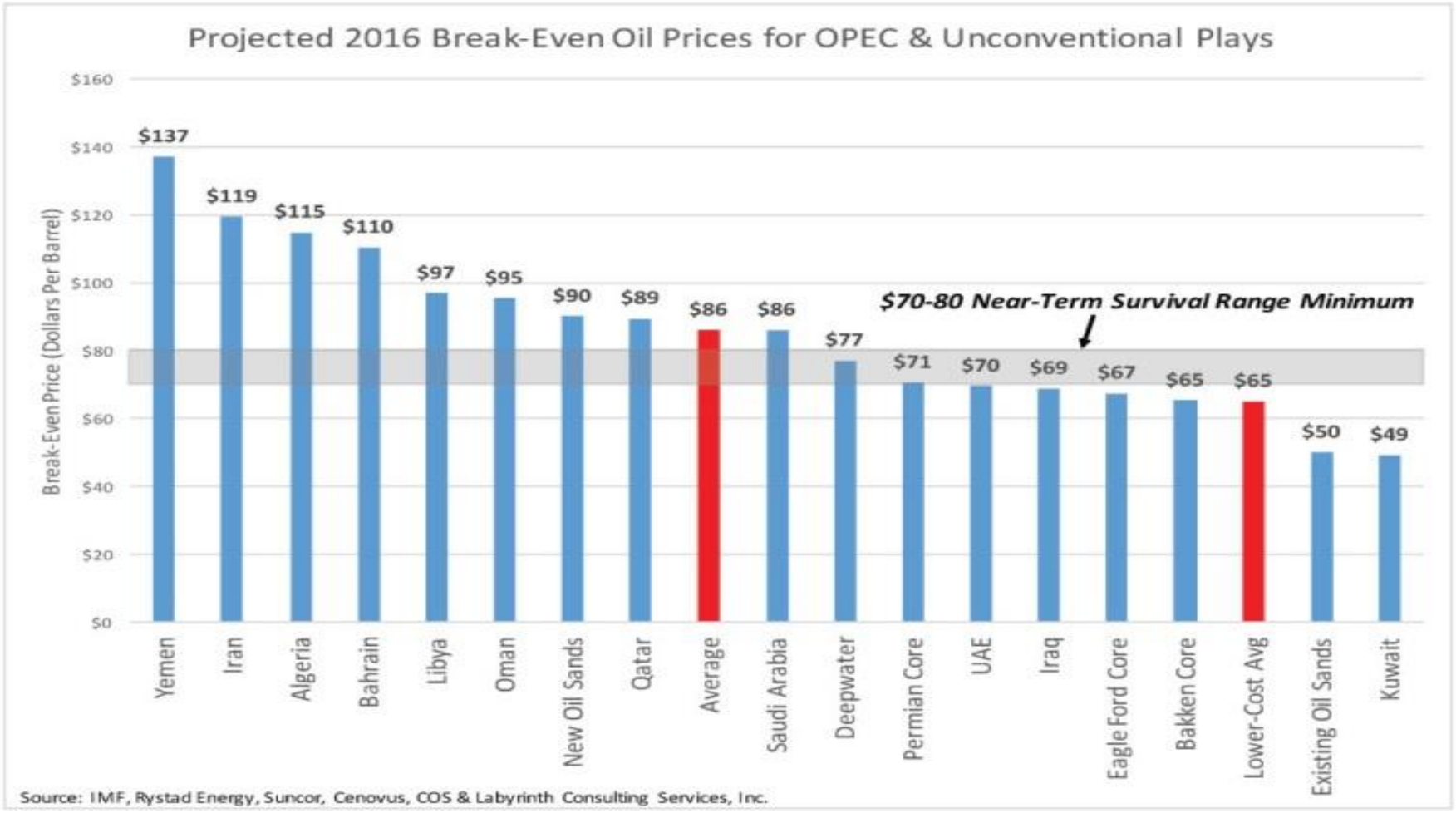
- Middle Devonian low-density black shale, play also includes Huron
- Thickness, thermal maturity, Rome trough, underlying frac barrier
- Average number of frack stages 32
- Drilling rate 800 ft/day
- Proppant – about 1650 lbs ft of lateral
- By 2018 will increase to 38 frack stages, 1000 ft day & 2000 lbs/ft proppant
- Average wells cost US$ 4.9 – 7.9 million
- Operating costs 12.36 to 29.60

World Unconventional Play Map



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.

Profitability by play & location



Commercial Impact Shale Gas Changes

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- Power generation – shift away from coal
- New power plant development in the US
- Coal – 0, Wind 6.8 GW, Solar 9.5 GW, Gas 8.0 GW
- US coal companies - 2011 44.6 billion, 2016 45 million
- New gas turbine technology – h & f class cheap & efficient
- Reduced pollution & greenhouse gas, low prices
- New legislation allows US to export hydrocarbons
- Synthetic fuel from CO2 – 2$ gallon

Looking to the Future

- Real dollars 1970 to 2013 – Oil prices rose 900%
- Mineral and metals prices rose 68% by comparison
- Shale gas technology will spread to other countries
- By 2035 they will exploit unconventionals at same level
- Additional 20 MMbo/d production
- Applying unconventional technology to old conventional fields could result in an additional 20 MMbo/d
- EIA projection 2035 – world will need 20 MMbo/d additional supply
- Resulting in continued downward pressure on prices

Thoughts and Conclusions

- OPEC countries also fighting hard for market share
- Result is a strong downward consistent pressure on prices
- Long term prices 2035 at $40 to $60 per bbl
- Cheap oil & gas will push coal further out of the market
- Will also slow the development of renewables
- The revolution doesn't always work out as expected

Questions?

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