

## **Years Not Decades: Proven Reserves and the Shale Revolution**

### ***The Apparent End of The Beautiful Story***

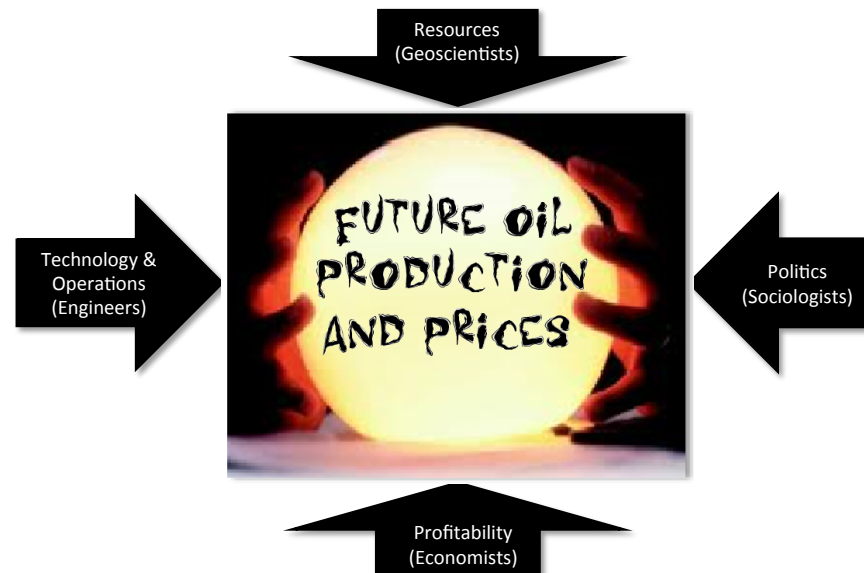
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Houston, Texas  
February 23, 2015**

## The Reality of Years, Not Decades, of Shale Gas and Tight Oil

- Shale plays have added years, not decades, to domestic oil and gas supply.
- Oil and gas from shale is called unconventional, a euphemism for expensive: neither is commercial at current prices.
- There is no revolution: it is a final, desperate effort to squeeze the last remaining petroleum from the worst possible rock.
- 8 years of shale gas proven plus proven-undeveloped reserves.
- 3 years of tight oil proven plus proven-undeveloped reserves.
- Both will peak in the next 10 years.
- Current policy favors export of both oil and gas based on a belief in abundance.
- This will both hasten and accentuate the difficult energy and economic circumstances of the next decade.



## The Beautiful Story: Energy Independence & American Global Dominance

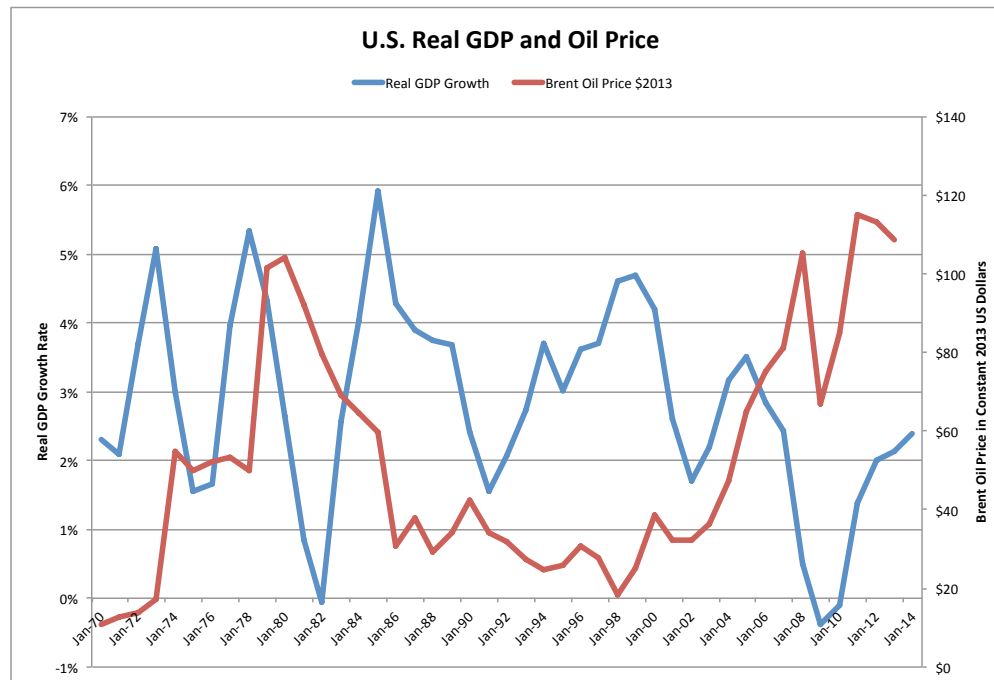
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- Production from shale is a revolution that has changed everything.
- The U.S. is now the largest producer of natural gas and petroleum liquids in the world.
- There are at least 100 years of natural gas supply and decades of tight oil supply.
- The U.S. will use its endless oil and gas resources to re-assert dominance in the world.
- It will challenge Russian power and aggression by exporting natural gas to Europe and Ukraine, and export natural gas to Asia.
- U.S. tight oil production has transformed the U.S. economy and makes us less dependent on Saudi Arabia and other Middle Eastern countries.
- Discussions with Iran may alienate other allies in the region but, since we no longer need their oil, it doesn't matter.
- Shale gas has re-invigorated American manufacturing and petrochemical production.



# A Framework for U.S. Shale Gas and Tight Oil & The Current Oil Price Crisis

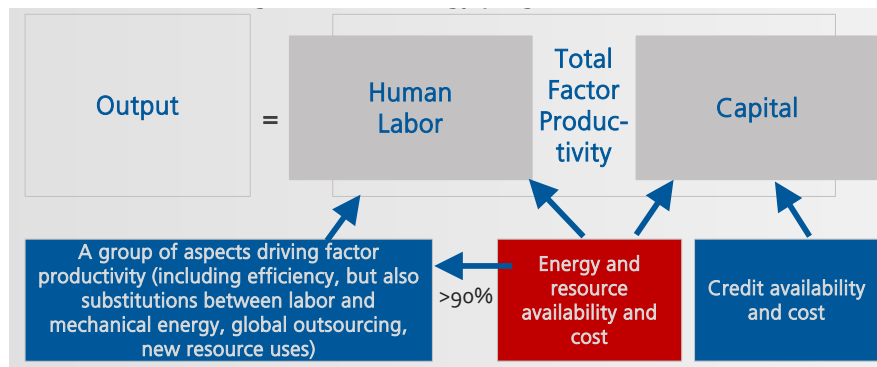
- Energy *is* the economy.
- Currency is a call on work-energy.
- Energy resources are the capital account behind currency.
- The economy can grow as long as there is surplus energy in that account.
- The economy will stop growing when there is only enough energy to meet basic needs.



Source: EIA, mtpl.com

# A Framework for U.S. Shale Gas and Tight Oil & The Current Oil Price Crisis

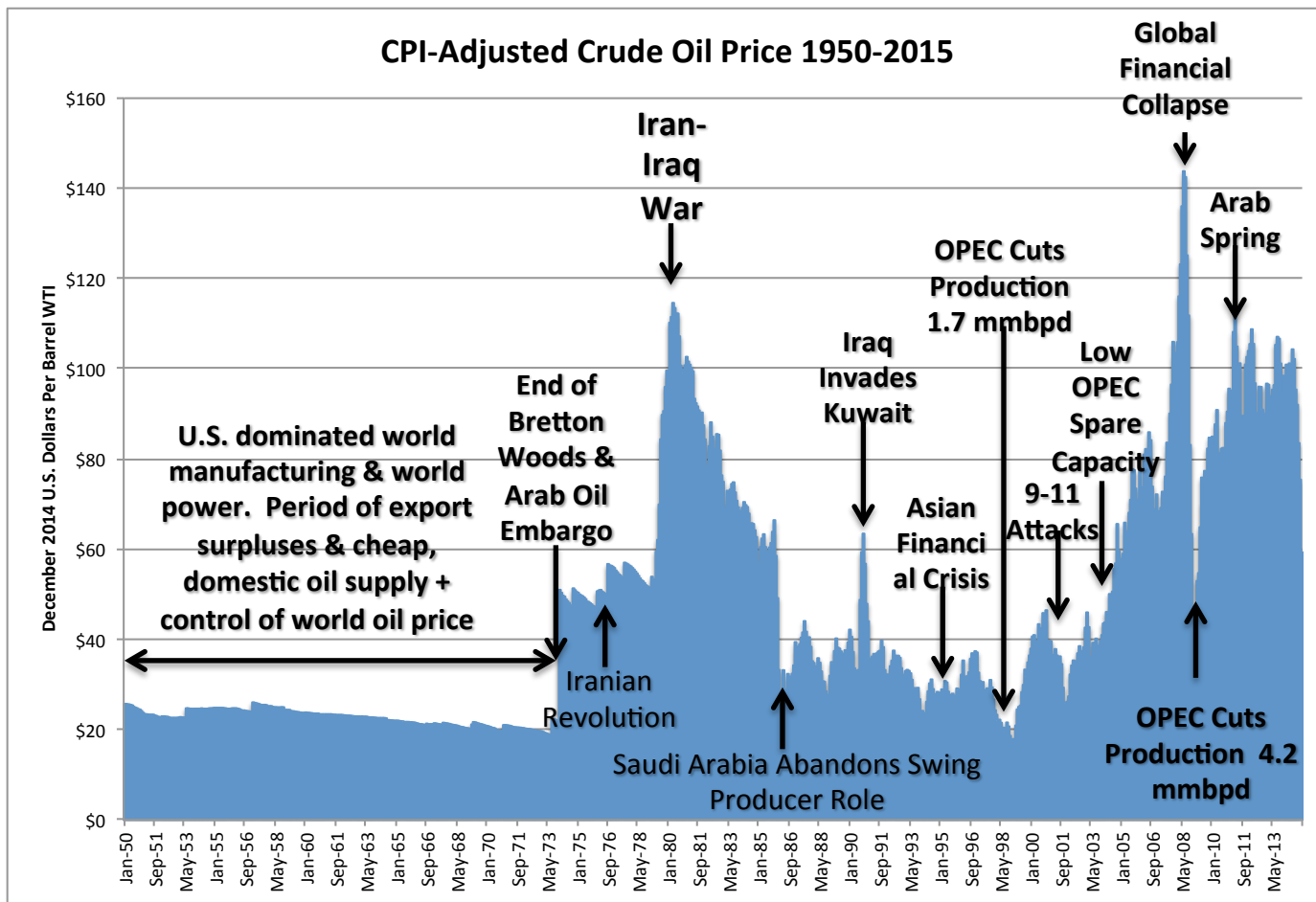
- The American success story is based on a unique period from 1945-1970:
  - After WWII, the U.S. had no rivals for manufacturing and world export,
  - The U.S. dominated world power, naval and air transport,
  - The U.S. was energy self-sufficient with spare production capacity and controlled world oil price through the Texas Railroad Commission's system of allowable production.
- By the mid-1960s, Germany and Japan recovered and challenged U.S. manufacturing.
- U.S. oil production peaked in 1970 and price control was ceded to OPEC.
- In 1971, Nixon took the U.S. off of the gold standard by abrogating the Bretton Woods Accord. The rest of the members of the Accord followed and a massive devaluation of global currency increased oil prices 2.5 x in one year and 5.5 x in 5 years.
- The world and its economy would never be the same.



Source: IIER



## The End of Normal: 1970



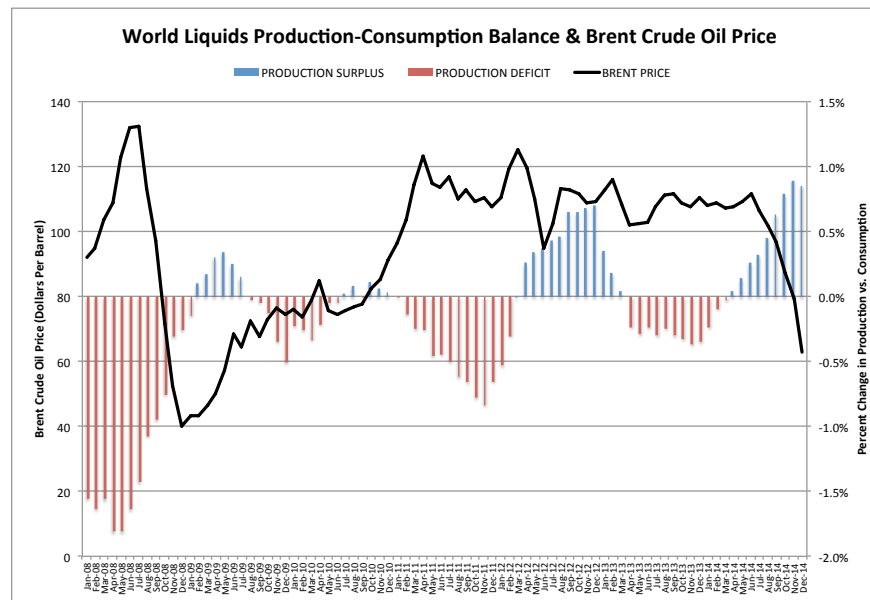
Source: EIA, Dow Jones, Inflationdata.com

1974: Credit Alert.

1979: Credit Downgrade.

2008: Bankruptcy Proceedings Began.

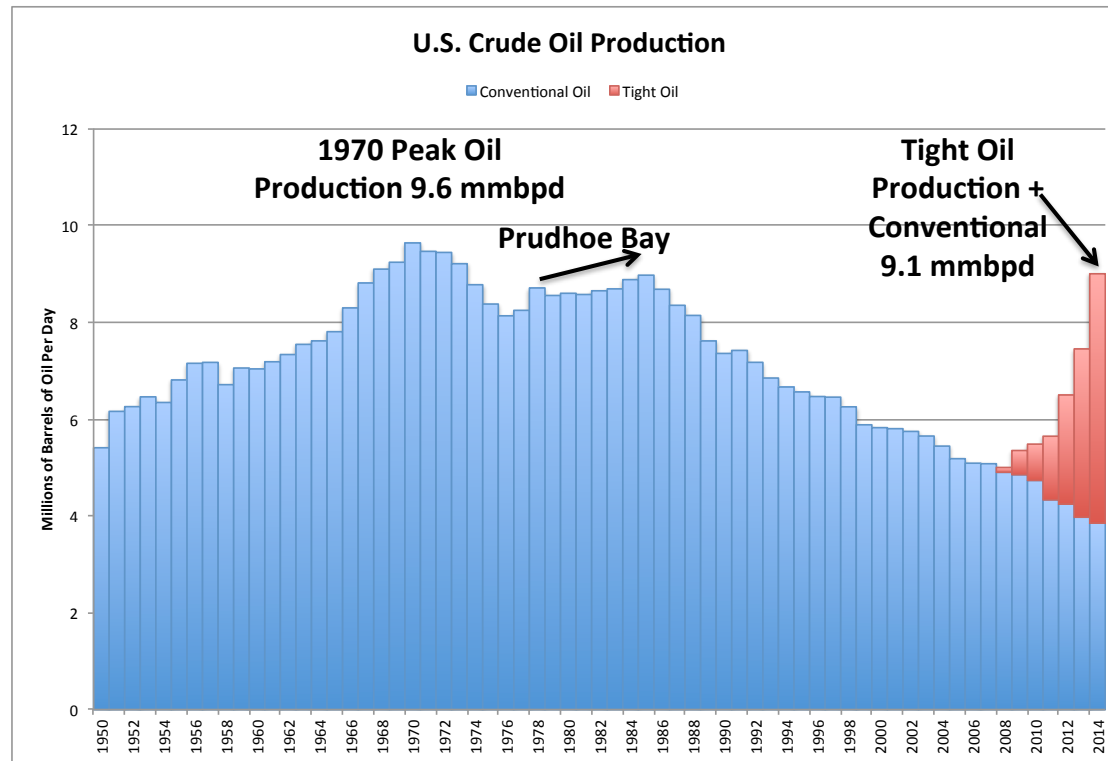
## The Choke-Chain: Net Energy Scarcity Characterized by ~ 12-Month Cycling



Source: EIA

- Supply Deficit → Price increase to demand limit → Incentive to over-produce → Demand destruction → Production surplus → Price drop → Producers cut back → Supply deficit → Price Increase.
- Chronic scarcity:
  - resource costs become significant and doubts about price cycling limit investment spending,
  - Net scarcity persists once established because of uncertainty.
- Service costs increase faster than product price during high-price cycles.
- The choke chain is why neither price or technology is a solution to more energy: high price and the cost of technology trigger the choke chain.

## The End of Peak Oil?

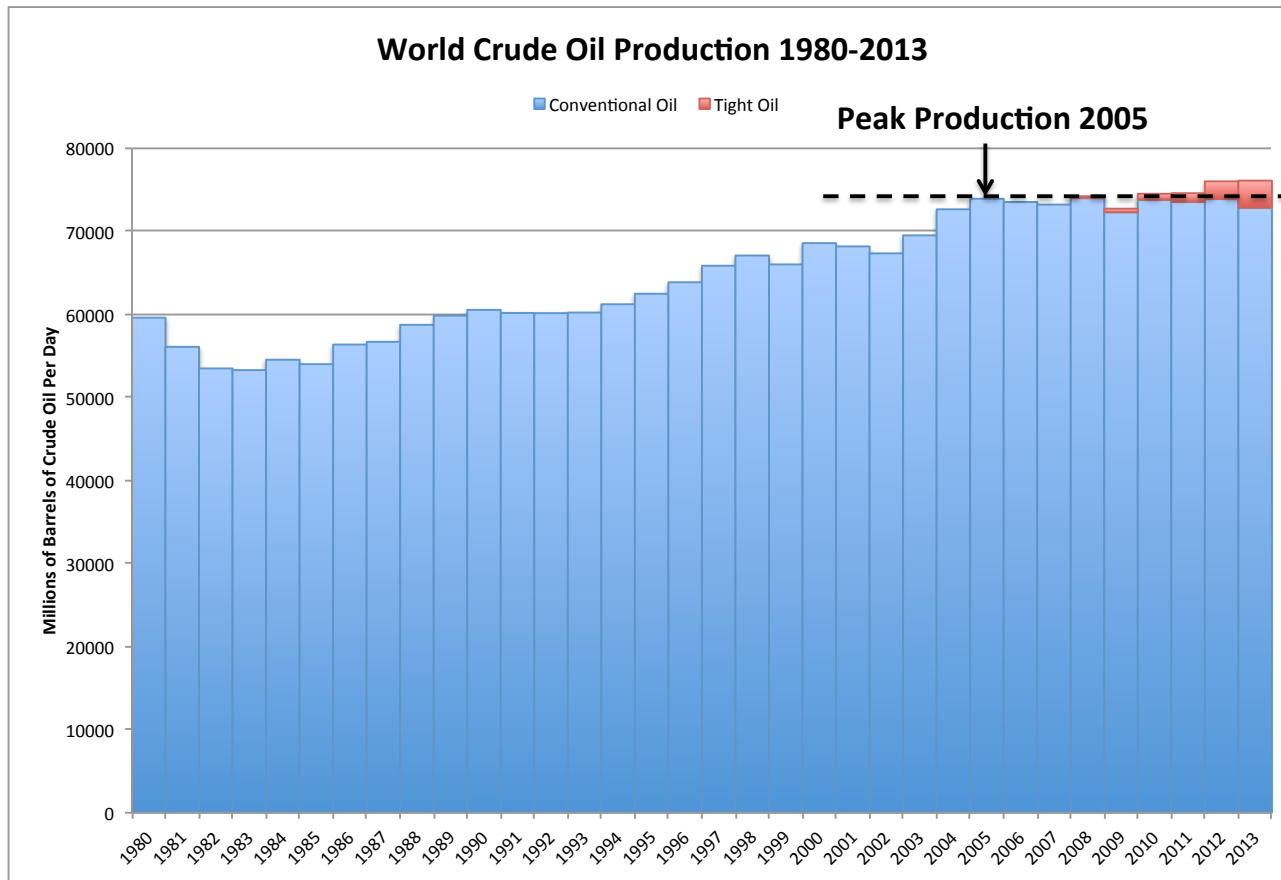


Source: EIA

- The observation of Peak Oil: once conventional production peaks, supply will become increasingly dependent on more expensive, lower quality sources of oil.
- ...Like shale, deep-water, and tar sands.
- It looks like Peak Oil is batting 1000!



## The End of Peak Oil?



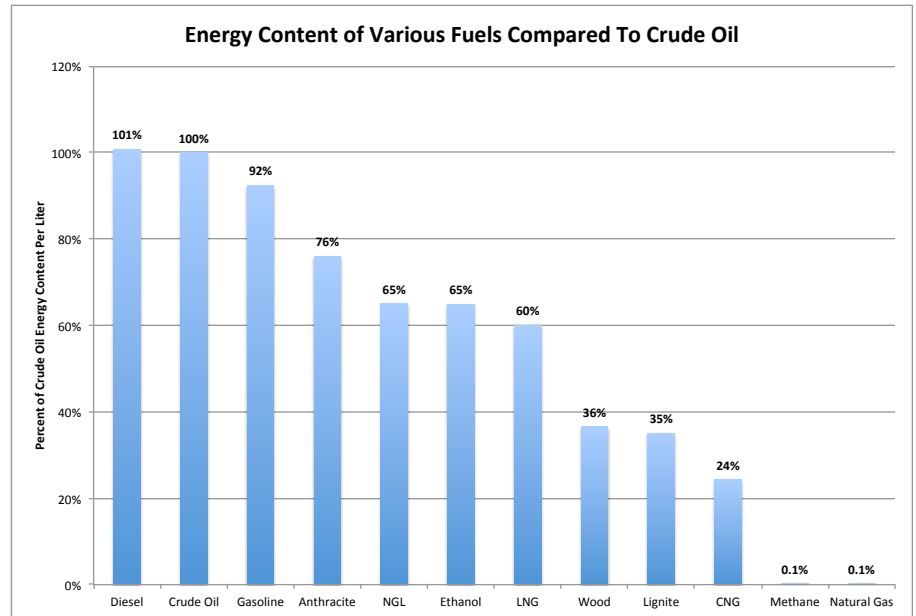
Source: EIA

- World production probably peaked in 2005.
- Tight oil and deep-water production will continue for another decade.

## Not All Energy Is Equal

	Net Energy
Oil (Saudi Arabia)	100:1
Coal	50:1
Hydroelectric	30:1
Oil (Global Average)	30:1
Wind	18:1
Wave	15:1
Natural Gas	10:1
Nuclear	10:1
Geothermal	8:1
Solar PV	7:1
Oil Sands	6:1
Shale Gas & Tight Oil	5:1
Biofuels	3:1
Solar Thermal	2:1

Source: Heinberg and Barnatt



Source: EIA

- Net energy from shale gas and tight oil is less than from solar PV.
- Net energy content of natural gas liquids is <65% of crude oil or gasoline.
- Net energy content of natural gas is <1% of crude oil or gasoline on a volume basis and only 24% as CNG and 60% as LNG.

## Shale Gas and Tight Oil Proven Reserves

SHALE GAS						
TCF GAS	PDP	PDP YRS	PUD	PUD YRS	PDP + PUD	PDP + PUD YRS
<b>TOTAL SHALE GAS</b>	<b>164</b>	<b>6.3</b>	<b>69</b>	<b>2.7</b>	<b>234</b>	<b>9.0</b>
MARCELLUS	65	2.5	29	1.1	94	3.6
BARNETT	26	1.0	6	0.2	32	1.2
EAGLE FORD	17	0.7	9	0.3	26	1.0
HAYNESVILLE	16	0.6	7	0.3	24	0.9
WOODFORD	13	0.5	10	0.4	22	0.9
FAYETTEVILLE	12	0.5	5	0.2	17	0.7
BAKKEN	5	0.2	4	0.1	9	0.3
OTHER	10	0.4	?	?	10	0.4
TIGHT OIL						
MMBO & CONDENSATE	PDP	PDP YRS	PUD	PUD YRS	PDP + PUD	PDP + PUD YRS
<b>TOTAL TIGHT OIL</b>	<b>9,560</b>	<b>1.7</b>	<b>7,976</b>	<b>1.4</b>	<b>18,019</b>	<b>3.3</b>
BAKKEN	4,844	0.9	3,382	0.6	8,226	1.5
EAGLE FORD	4,177	0.8	2,680	0.5	6,857	1.2
PERMIAN	335	0.1	1,819	0.3	2,154	0.4
MARCELLUS	129	0.0	51	0.0	180	0.0
BARNETT	58	0.0	44	0.0	102	0.0
NIOBRARA	17	0.0	?	?	17	0.0
OTHER	483		?	?	483	0.1

Source: EIA

- How can these volumes and years of supply be reconciled with the expectations promoted by the oil and gas industry, politicians and press?
- Reserves are volumes at a certain price—oil reserves will fall in 2015.

## New Reserve Additions For Shale Gas & Tight Oil Were Insignificant in 2013

2013 SHALE GAS PROVEN RESERVES	BCF
<b>New Field Discoveries</b>	<b>16</b>
Marcellus-Utica (KY-TN-OH)	16
<b>New Reservoir Discoveries in Old Fields</b>	<b>1113</b>
Woodford	424
Marcellus-Utica	312
Permian	4
Barnett	338
Eagle Ford	29
Bakken	3
Niobrara	3

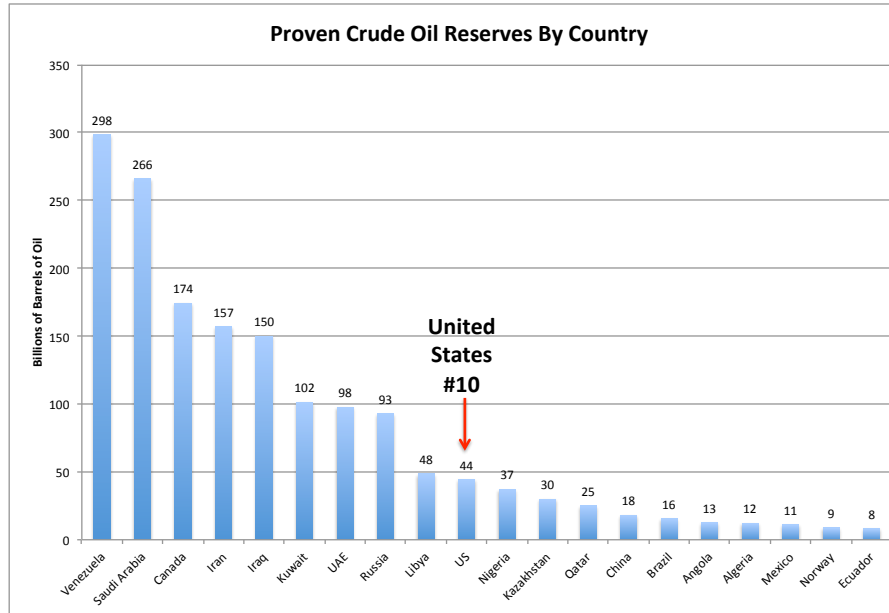
Source: EIA

2013 TIGHT OIL PROVEN RESERVES	Mmbo
<b>New Field Discoveries</b>	<b>9</b>
Bakken	4
Eagle Ford	3
Niobrara-Mancos	1
Woodford	1
<b>New Reservoir Discoveries in Old Fields</b>	<b>170</b>
Permian	75
Woodford	34
Eagle Ford	26
Niobrara-Mancos	18
Bakken	13
Marcellus-Utica	3
Barnett	1

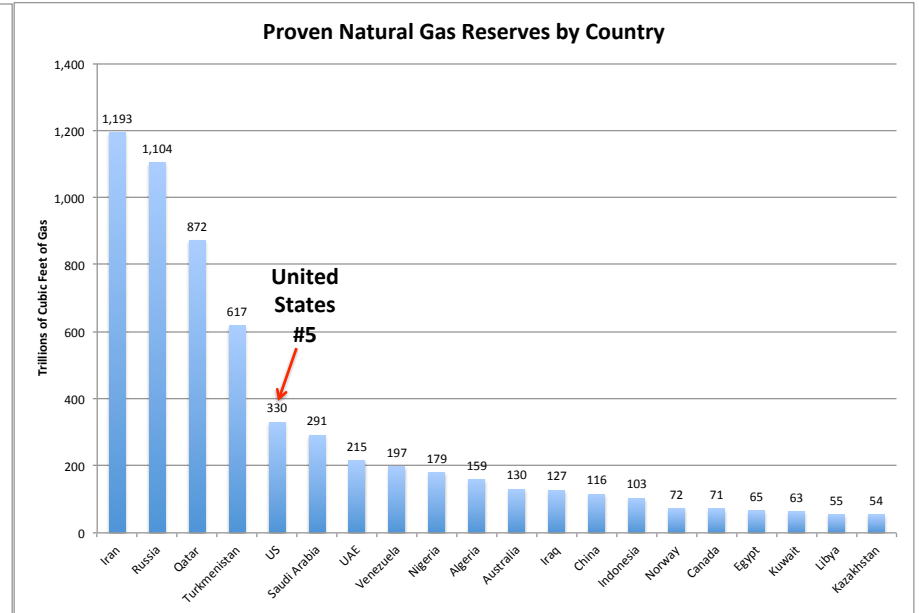
Source: EIA

- All changes for natural gas reserves were because of higher price only.

# The United States is Not an Oil or Gas Super Power



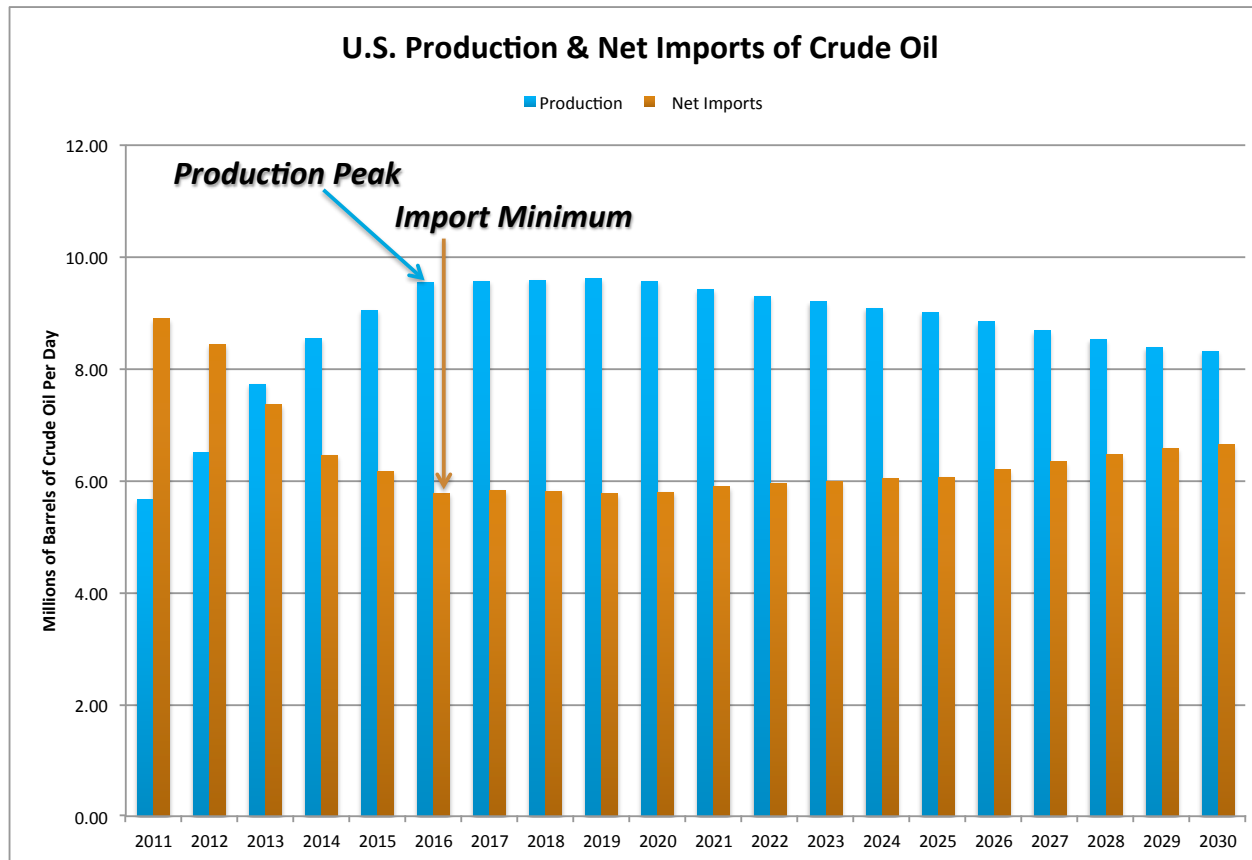
Source: BP



Source: BP

- The U.S. is 10<sup>th</sup> in oil reserves including tight oil.
- It may produce more oil than Saudi Arabia for awhile but reserves are only 17%.
- It is a long 5<sup>th</sup> in natural gas.
- U.S. gas reserves are 53% of #4 Turkmenistan & 38% of #3 Qatar.

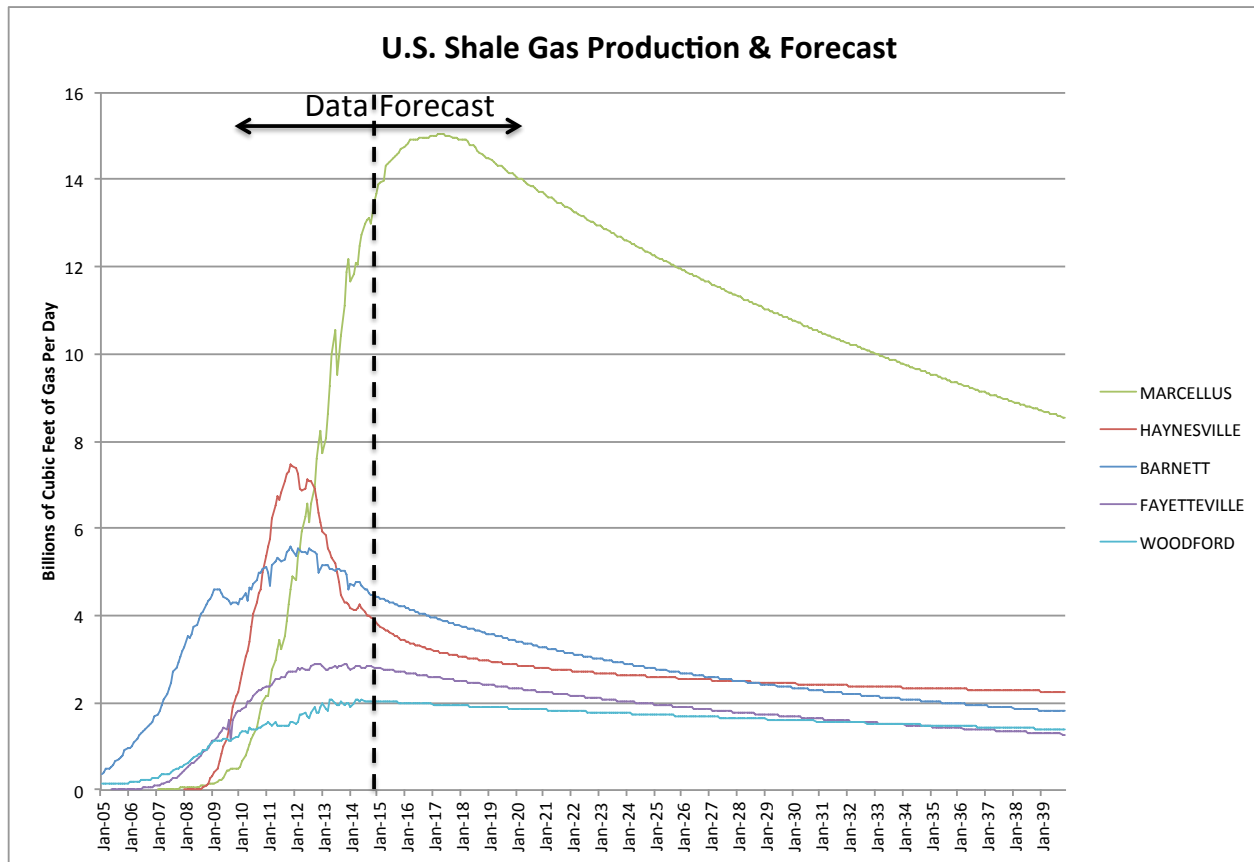
## U.S. Oil Production Will Peak Soon and Imports Will Increase.



Source: EIA

- According to EIA, U.S. oil production will peak in 2016 and decline thereafter.
- 2016 will also be the lowest point for U.S. imports that will increase in later years.

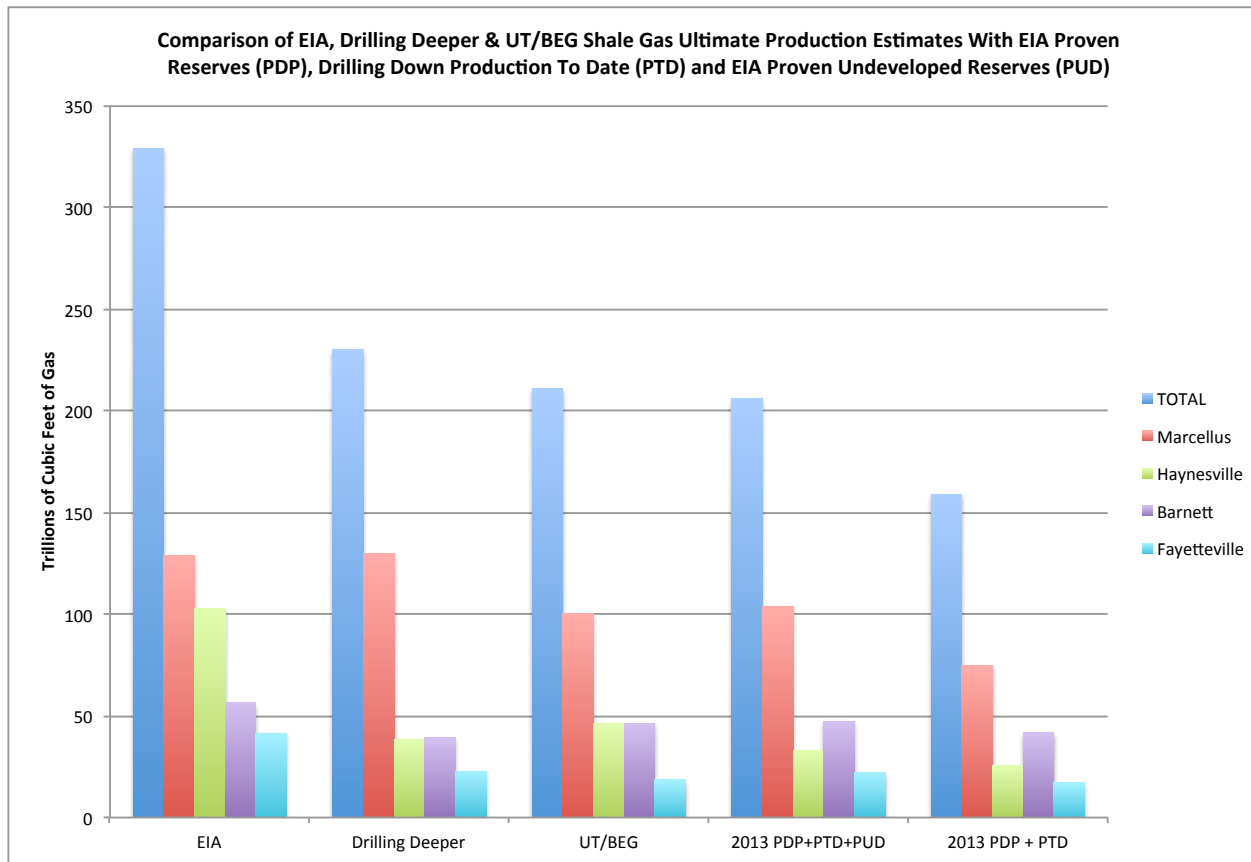
## Most Shale Gas in Decline



Source: Labyrinth Consulting Services, Inc.

- All shale gas plays except the Marcellus are in decline already.
- The future of U.S. gas supply is a single bet on the Marcellus Shale.
- Credible 3<sup>rd</sup> party forecasts predict a Marcellus peak around 2020.

## The Fracking Fallacy Debate Casts Doubt on the EIA Natural Gas Forecast

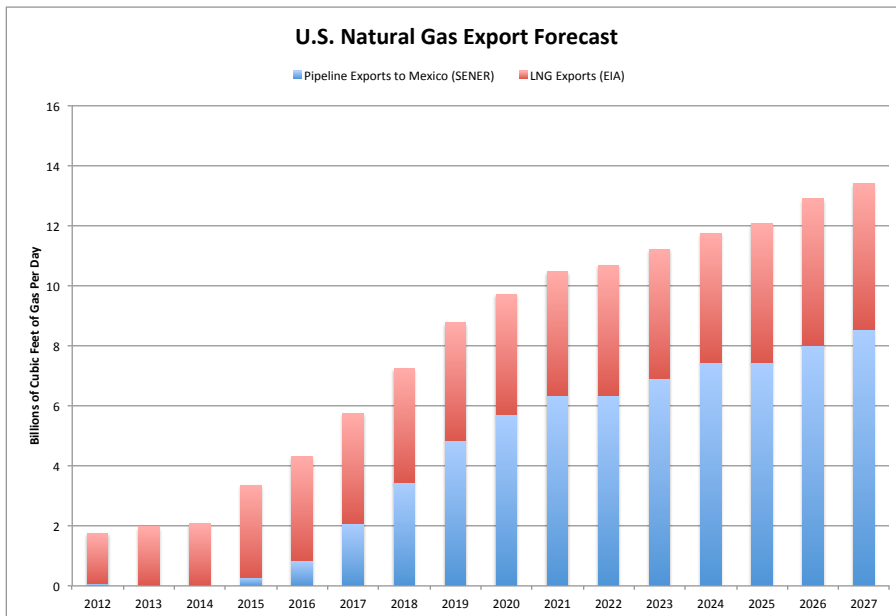


Source: EIA, Drilling Deeper & BEG

- Bureau of Economic Geology and David Hughes (Drilling Deeper) forecast total U.S. natural gas peaking in the early 2020s.



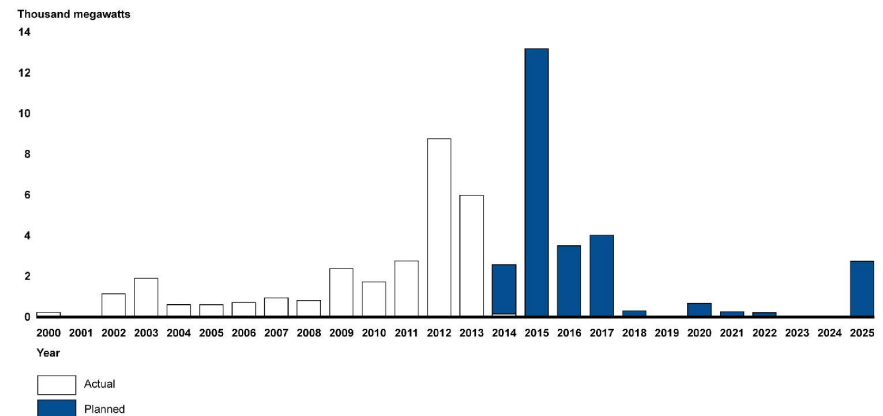
# Natural Gas Exports and Increased Demand From Coal Plant Retirements



Source: EIA & SENER

- More than 10 Bcf/d of pipeline and LNG exports are sanctioned by 2020.
- EPA regulations will reduce coal's percent of electric power generation beginning this year.
- Long-term natural gas demand from coal-plant retirements will increase by 4-5 Bcf/d.

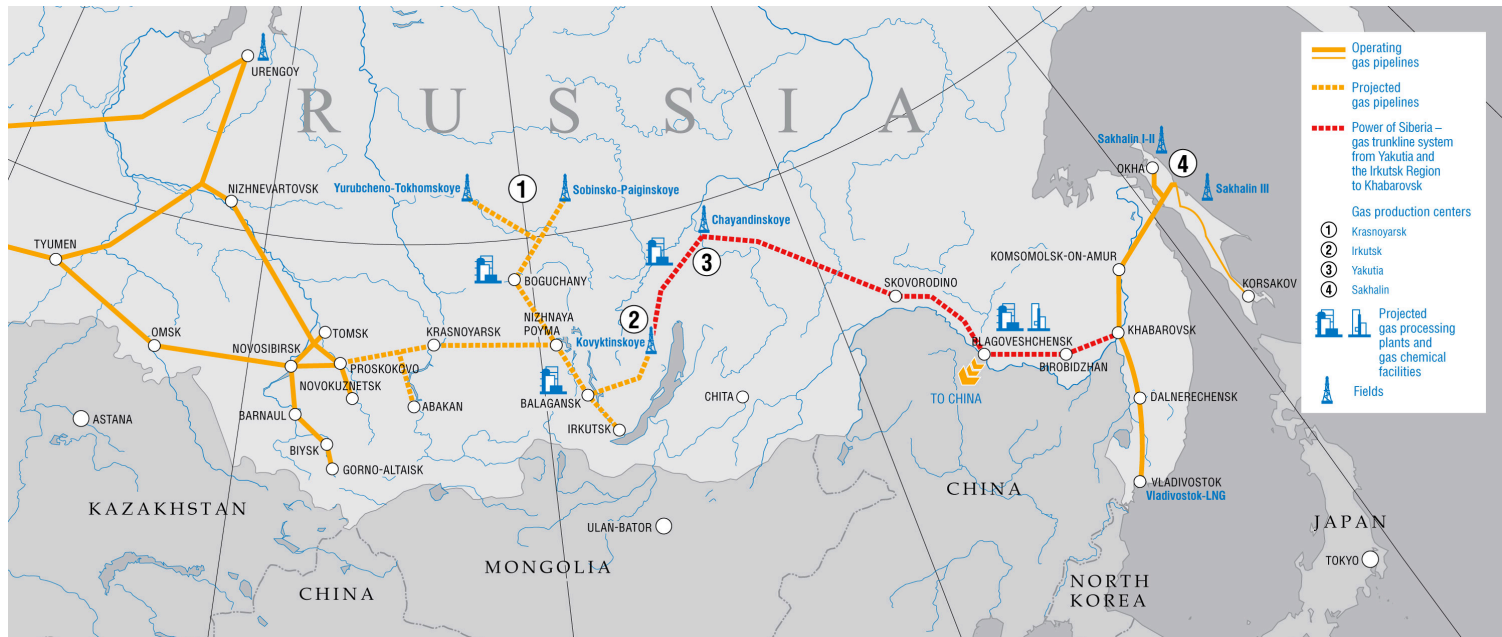
Figure 1: Net Summer Generating Capacity of Actual and Planned Retirements of Coal-Fueled Electricity Generating Units, 2000-2025



Source: GAO analysis of SNL Financial data. | GAO-14-672

Source: GAO

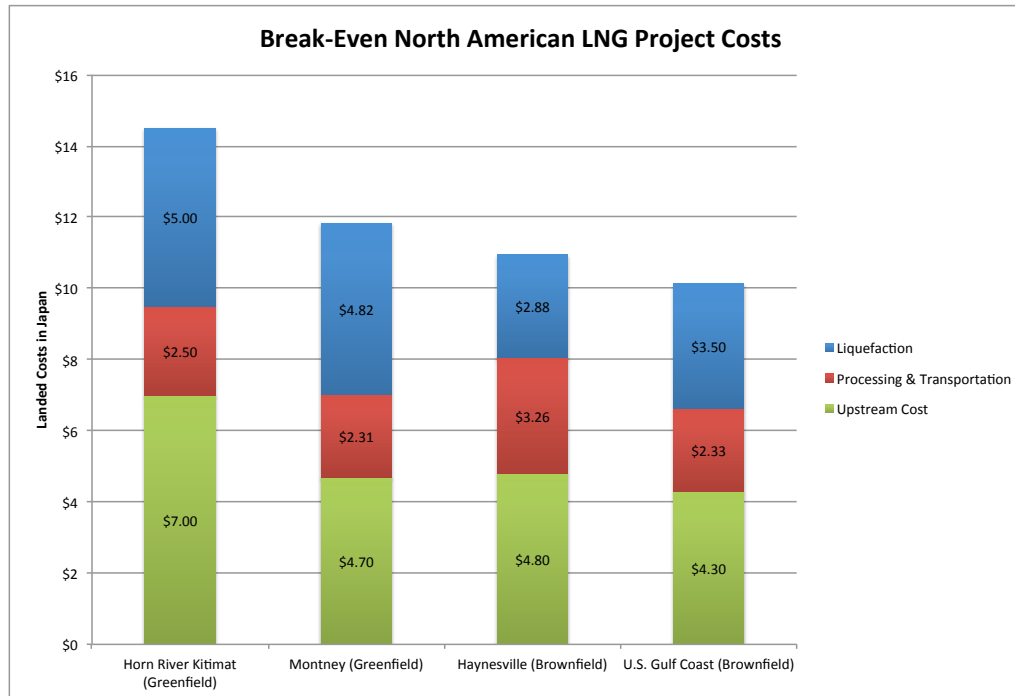
# The Power Of Siberia Pipeline Changes Everything



Source: Gazprom

- Russia's gas deal with China is largest in history: 1.4 Tcf over 30 years for \$400 billion.
- Sets a \$10/MMBtu benchmark price for Asia without oil linkage.
- Gas agreement has far-reaching implications for global LNG markets.
- Russia plans to be the leading supplier to Asian gas markets.
- Russia's East Siberia proven reserves: 196 Tcf & 7 billion barrels of oil, 3-times Canadian reserves and more than U.S. shale gas resources.
- This is only the beginning: pipelines to Korea & Japan are planned.

# LNG Exports Will Follow the Ill-Conceived History of LNG Import in the U.S.



Source: RBC

- Lowest break-even price for Gulf Coast brownfield projects will struggle to compete with Russian price threshold.
- When natural gas prices increase as production peaks in the next 5 years, LNG export will seem like a bad idea because of higher margin from domestic sales.
- Ironically, LNG import beginning in the 2020s is likely.

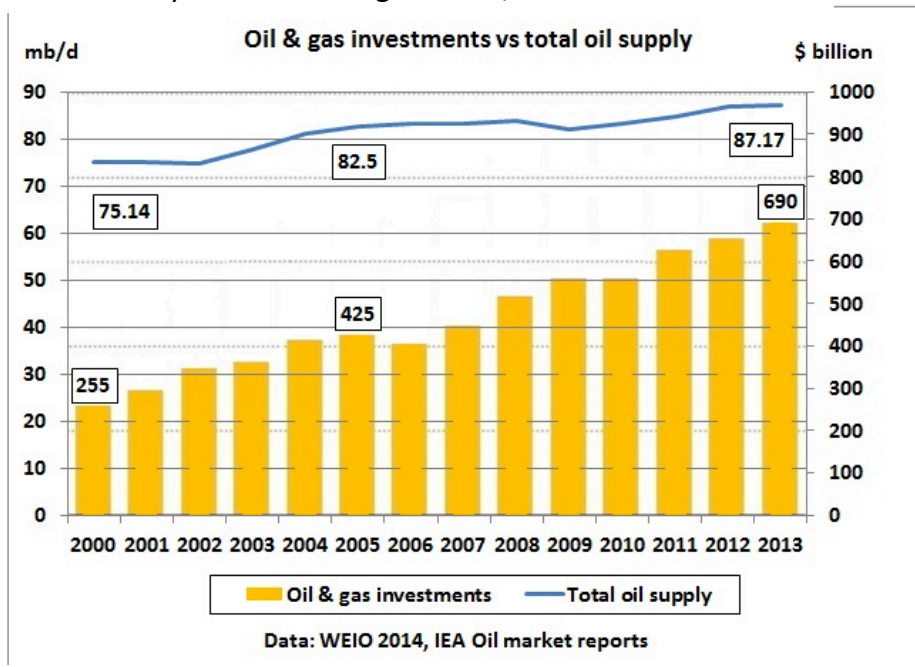


# Tight Oil and Shale Gas Plays Funded by Debt, Bonds, Stock Offerings & Asset Sales

## SAMPLED E&P FREE CASH FLOW & DEBT COMPARISON (2014 FCF ANNUALIZED)

	2014 FCF	2013 FCF	FCF DIFFERENCE	2014 DEBT	2013 DEBT	DEBT DIFFERENCE
<b>GAS-WEIGHTED</b>	<b>-6,637</b>	<b>-7,901</b>	<b>1,264</b>	<b>84,748</b>	<b>81,403</b>	<b>3,345</b>
<b>OIL-WEIGHTED</b>	<b>-7,619</b>	<b>-5,621</b>	<b>-1,999</b>	<b>87,786</b>	<b>83,407</b>	<b>4,378</b>
<b>ALL</b>	<b>-14,257</b>	<b>-13,522</b>	<b>-735</b>	<b>172,534</b>	<b>164,810</b>	<b>7,724</b>

Source: Labyrinth Consulting Services, Inc.



Source: crudeoilpeak.info

- Companies are chronically cash-flow negative.
- Unmanageable debt that can never be paid from cash flow.
- Debt must be continually re-financed on increasingly poorer terms.
- Diminishing returns on investment.
- The E&P business has become financialized—the only measure is production-reserve growth.
- The appeal is the relatively short-term basis compared with deep-water, etc.

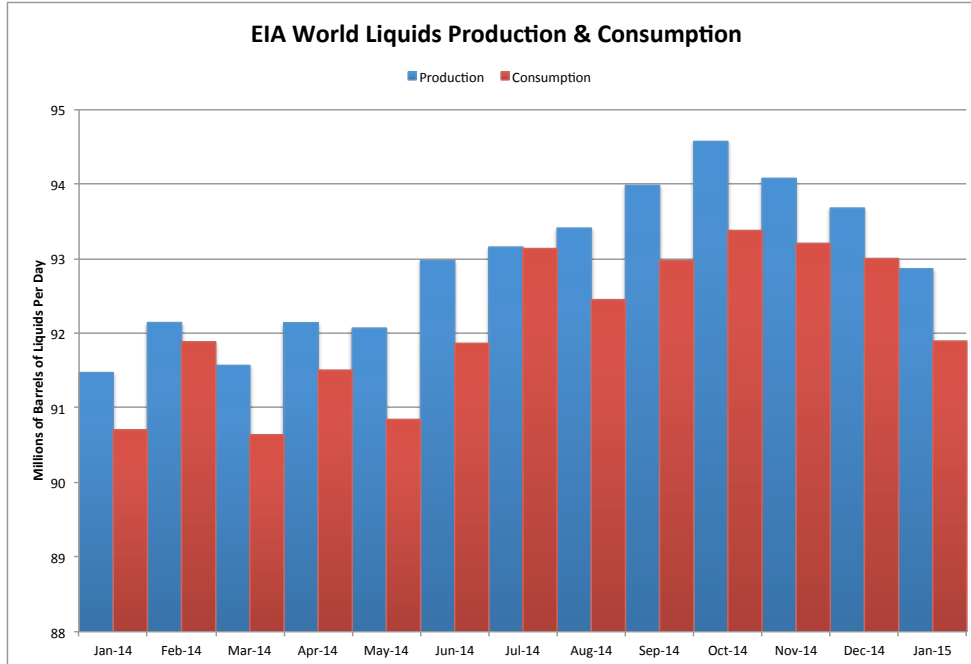
# The Current Oil Price Crisis

	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14
<b>Supply</b>	91.79	91.56	91.01	91.22	91.65	91.51	91.47	92.14	91.57	92.14	92.07	92.98
<b>Demand</b>	92.39	91.98	91.51	92.14	92.82	92.08	90.70	91.88	90.64	91.51	90.85	91.87
<b>Supply Surplus</b>	-0.61	-0.42	-0.50	-0.92	-1.17	-0.57	0.77	0.26	0.93	0.64	1.22	1.11
<b>Brent Price</b>	\$107.93	\$111.28	\$111.60	\$109.08	\$107.79	\$110.76	\$108.12	\$108.90	\$107.48	\$107.76	\$109.54	\$111.80

	Jul-14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14	Jan-15
<b>Supply</b>	93.15	93.41	93.98	94.57	94.08	93.68	92.86
<b>Demand</b>	93.14	92.45	92.98	93.38	93.20	93.00	91.90
<b>Supply Surplus</b>	0.02	0.96	1.01	1.19	0.87	0.68	0.97
<b>Brent Price</b>	106.77	101.61	97.09	87.43	79.44	62.34	47.76

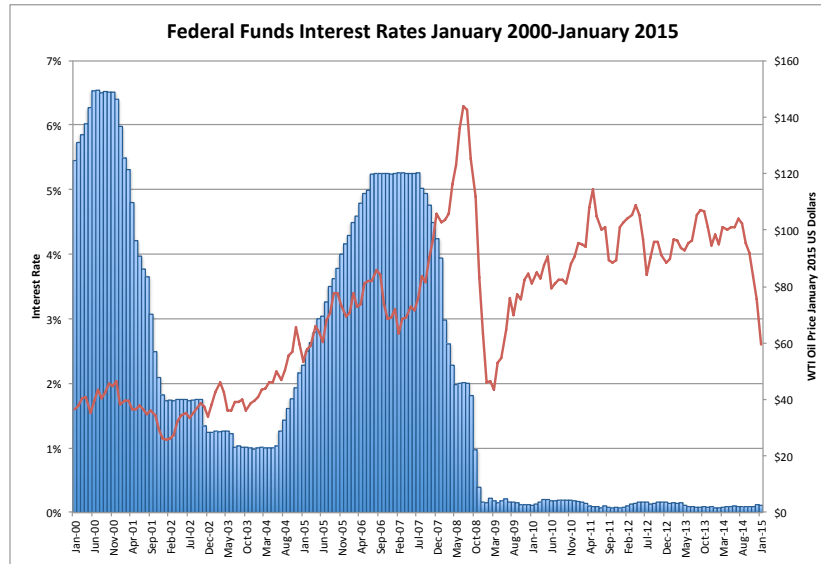
Source: EIA



Source: EIA

- The current oil price crisis really began in January 2014 when world supply went into a surplus.
- The price signal lagged ~6 months.
- The supply surplus is approximately 1-1.5 mmbpd.

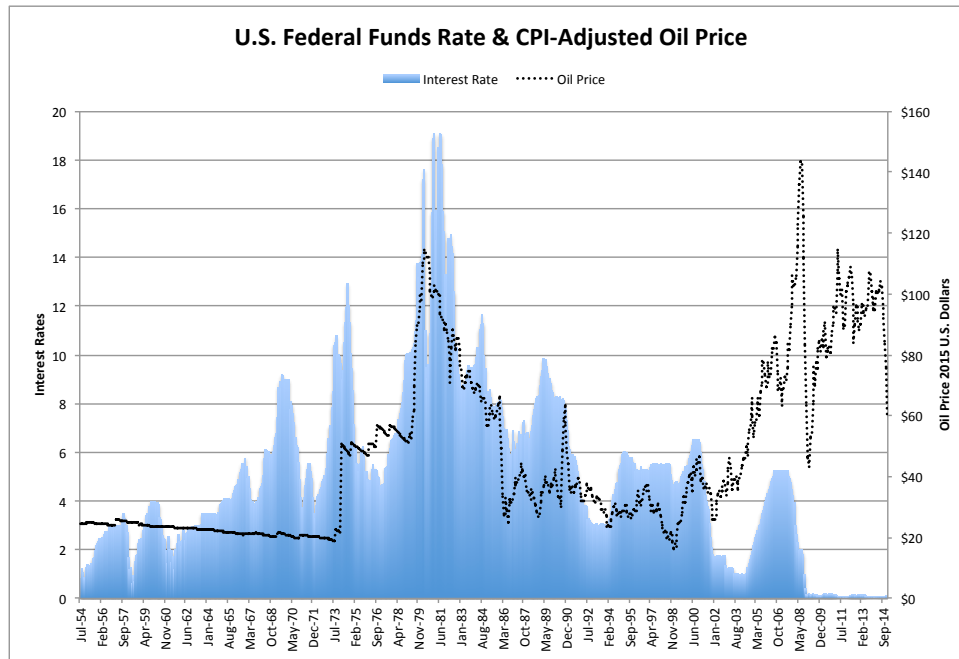
# The Financialization of the Exploration & Production Business



Source: EIA and Federal Reserve Board

- In a zero-interest world, where could reasonably secure yields be found?
- Investment banks identified the U.S. E&P business as the solution.
- Yields for corporate junk bonds, preferred stock and other capital instruments in the range of 6-10% interest.
- In the United States and “backed” by a hard asset in the ground.
- E&P companies became the sub-prime derivative of the post-Financial Crisis period.
- Shale gas and later, tight oil companies had access to almost infinite capital with no performance requirement other than to avoid debt covenants.

## Concluding Observations



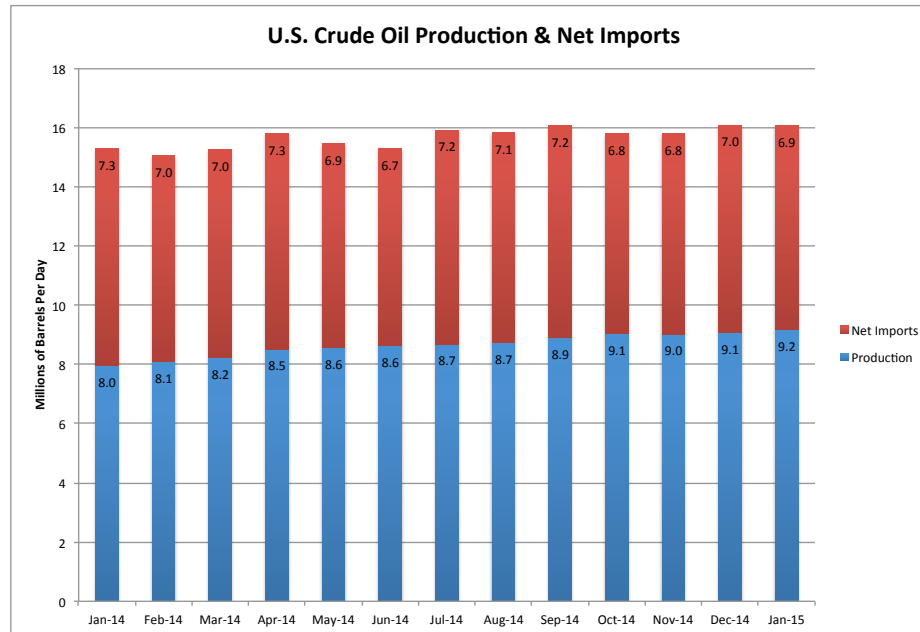
Source: EIA and Federal Reserve Board

- The beautiful story of shale plays was the inevitable result of increasing resource scarcity and a monetary policy that permitted the distortion of zero interest rates since 2008.
- The financialization of the U.S. E&P business created a boom in production and economic activity with no reference or calibration to its lack of commercial substance.
- Energy is the economy and just as energy prices reacted to the artificial low oil price until 1974, energy prices are now reacting to the artificially low cost of capital since 2008.

- The beautiful story of shale plays was part truth and part fiction as any story must be to be believed.
- The reserves added were important but not revolutionary & added years and not decades to supply.
- The United States is major oil and gas producer but not a reserve heavyweight.
- Neither crude oil or natural gas exports make good sense from a resource security perspective.
- The current oil-price crisis is normal from the standpoint of supply surplus and is part of a predictable pattern of price cycling that comes from resource scarcity.
- Its severity and duration are uncertain because it represents the culmination of almost a decade of monetary meddling and unprecedented capital availability.

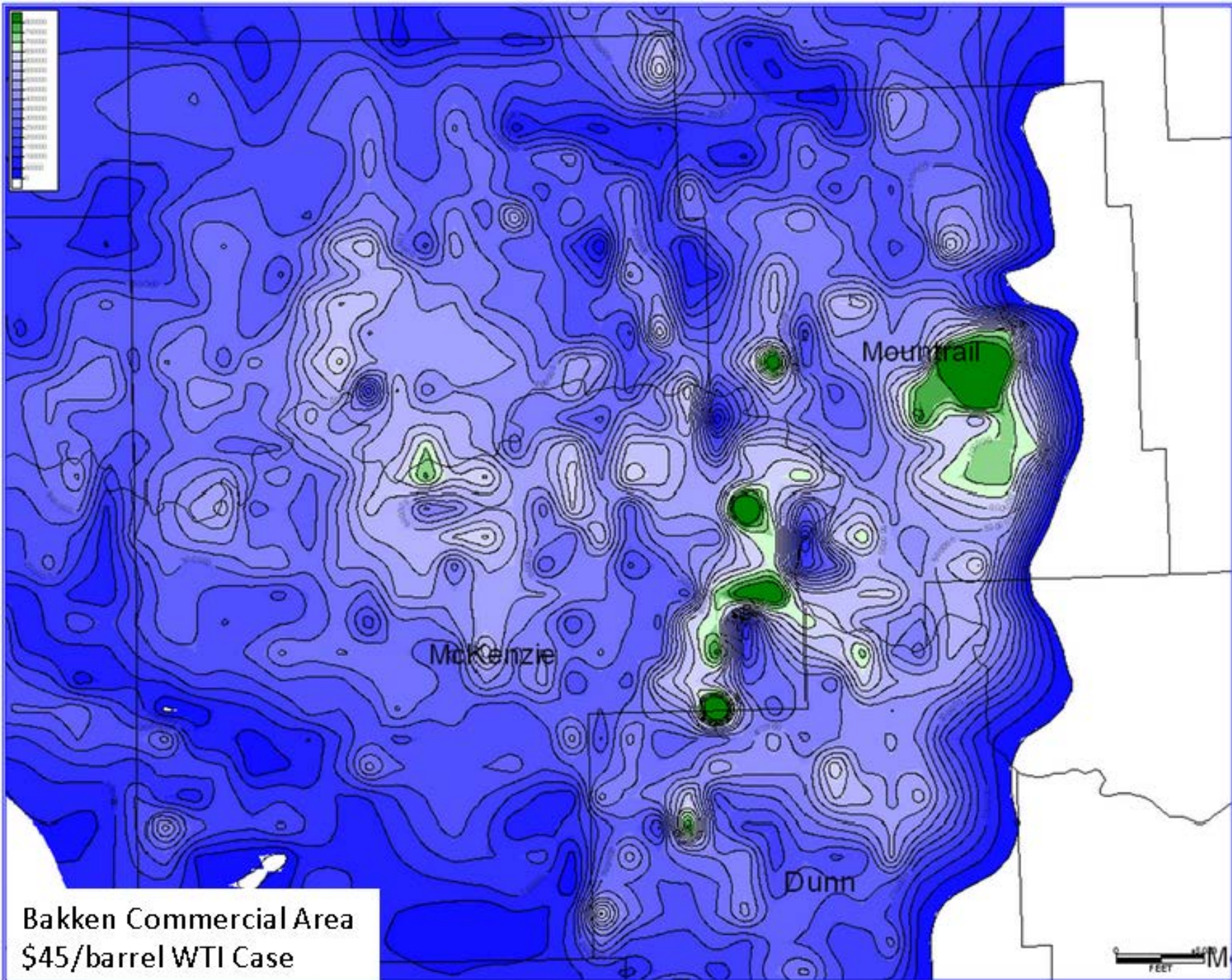


# The Anthem of Energy Independence is Not Supported by Facts

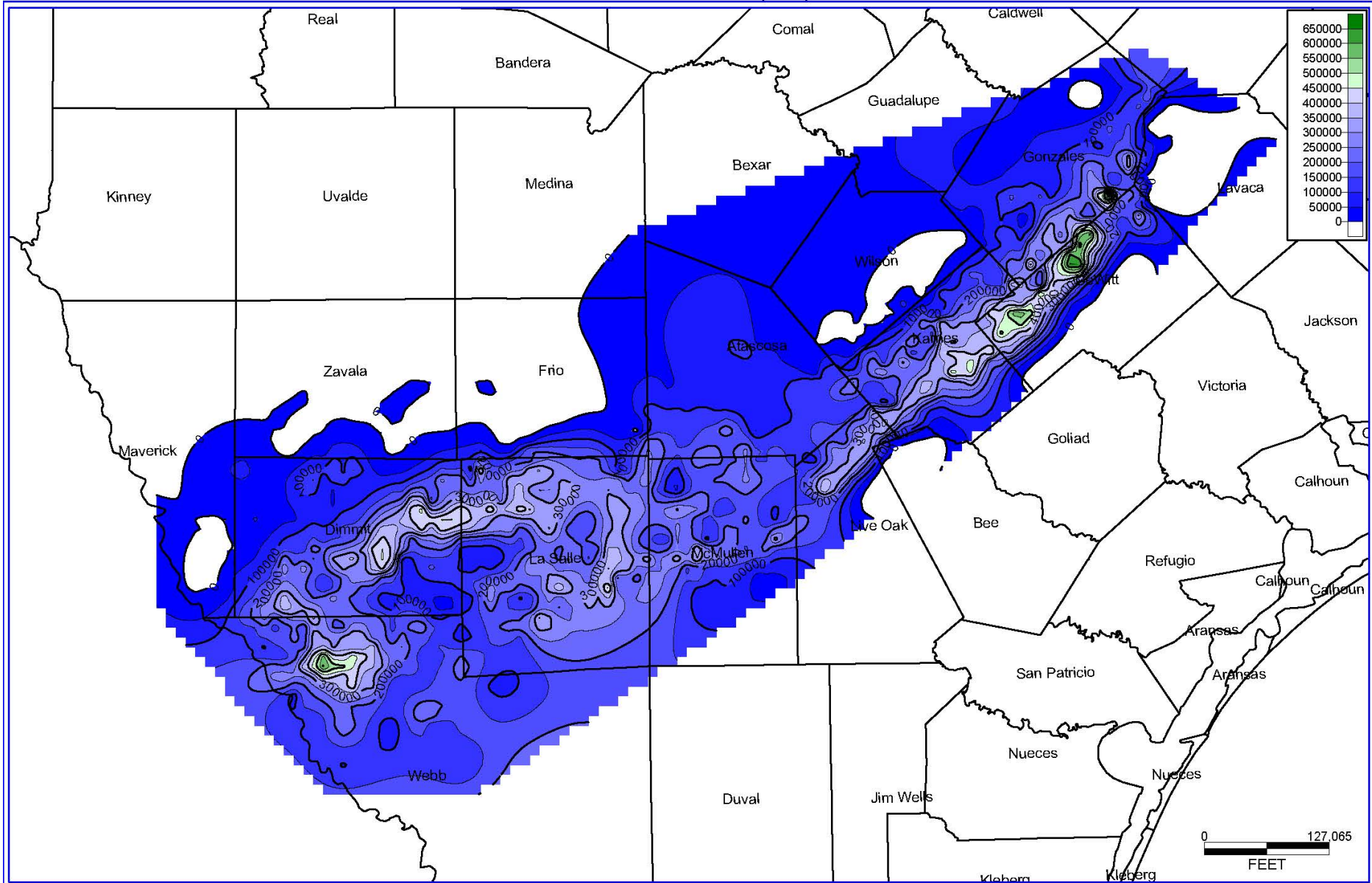


Source: EIA

- U.S. net imports of 7 mmbpd out of 16 mmbpd of total consumption.
- Michael Levi's Questions:
  - If the U.S. were importing 44% of its workers, would that represent abundance?
  - If the U.S. were importing cars, painting them green and exporting them for sale, would that represent a growing car manufacturing industry?



EAGLE FORD WELL - EUR [AEB] - EUR



Eagle Ford Shale EUR Map: green areas are commercial at \$45/barrel WTI oil price