"UNCONVENTIONAL OIL AND GAS RESERVOIRS"

PETE 612
FALL 2016

Lecture 1

"Introduction"

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The objectives of this course are to familiarize students with unconventional gas and oil reservoirs, including their (1) economic significance (2) geologic occurrences and unique reservoir properties, (3) controls on production rates, (4) drilling and completion practices, (5) reservoir management, and (6) history and present activity.

Unconventional Oil and Gas Reservoirs – An Introduction

Outline

- Definition of Unconventional Reservoirs and Resources
- World and U.S. Oil and Gas Production and Reserves
- Resource Triangle Concept and Historic Estimates of World Unconventional Gas Resources
- U.S. Unconventional Gas and Oil Resources and Activity
- Effects of Commodity Price and Technology on Unconventional Resource Development
- Conclusions

Lecture Topics
- Depositional Systems Review
- Shale oil and Gas Reservoirs
- Coalbed Gas
- Tight Sands
- Gas Hydrates
- Heavy Oil

Definition

Unconventional Hydrocarbon Resources:
Those hydrocarbon resources that, owing to low reservoir ***permeability*** or ***fluid properties*** (e.g., heavy oil, gas hydrates), cannot be produced at economic flow rates or in economic volumes unless the well is stimulated by a large hydraulic fracture treatment, drilled horizontally, steam flooded, etc.

(TAMU Unconventional Gas Research Group)

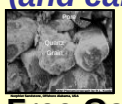
Unconventional Reservoir Types and Hydrocarbon Fluids

What are: roles of natural fractures? fluid contacts? storage mechanisms?

1. Reservoir Control – Tight Reservoirs

Migrated HC; Free Gas/Oil Stored in Pores:

- **Tight (low-permeability) sands (*and carbonates*)**
  - **Tight gas**
  - **(Tight oil)**



Free gas stored in pores

Self-Sourced HC; Sorbed and Free Gas & Oil:

- **Coal beds**
- **Shales (some carbonates)**
  - **Shale gas**
  - **Shale Oil (Tight Oil)**
  - **Oil Shale**

http://ostseis.anl.gov/guide/photos/index.cfm

2. Fluid Control – Usually **High-Permeability Reservoirs**

- **Gas Hydrate Deposits (sandstone reservoirs)**
- **Heavy Oil (sandstone or carbonate reservoirs**
- **Tar Sands**

Focus of this Unconventional Reservoir Class:
Self-Sourced Reservoirs and Tight Sands

1. Reservoir Control – Tight Reservoirs

Migrated HC; Free Gas/Oil Stored in Pores:

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  - **Tight gas**
  - **(Tight oil)**

Free gas stored in pores

Self-Sourced HC; Sorbed and Free Gas & Oil:

- **Coal beds**
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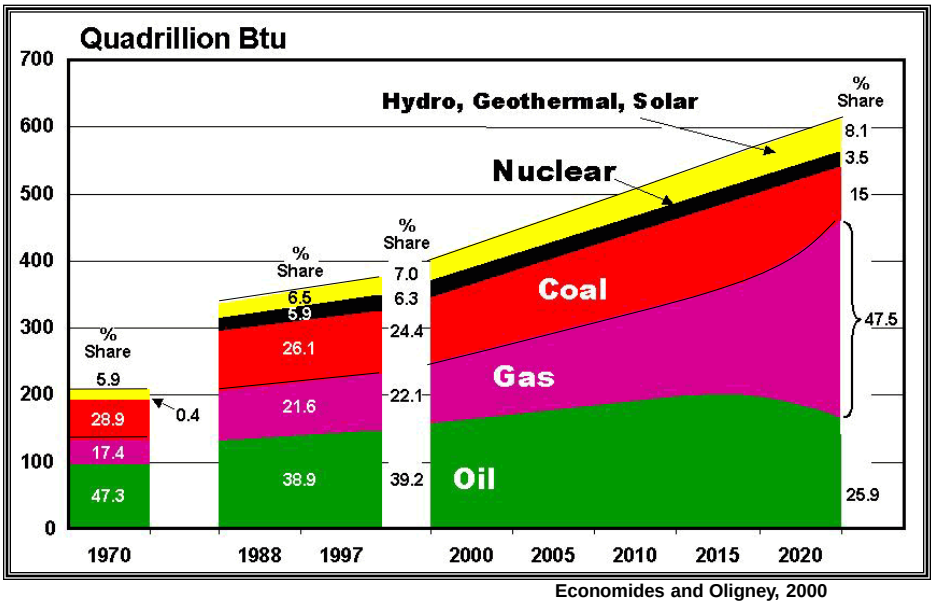
  - **Shale Oil (Tight Oil)**
  - **Oil Shale**

http://lostseis.anl.gov/guide/photos/index.cfm

Why Emphasis on Tight Reservoirs in this Class?

- **Present industry activity/focus and future impact**
- **Abundance of papers and rapid technology development**
- **Reservoir and fluid variability within and between basins**
- **Job opportunities**

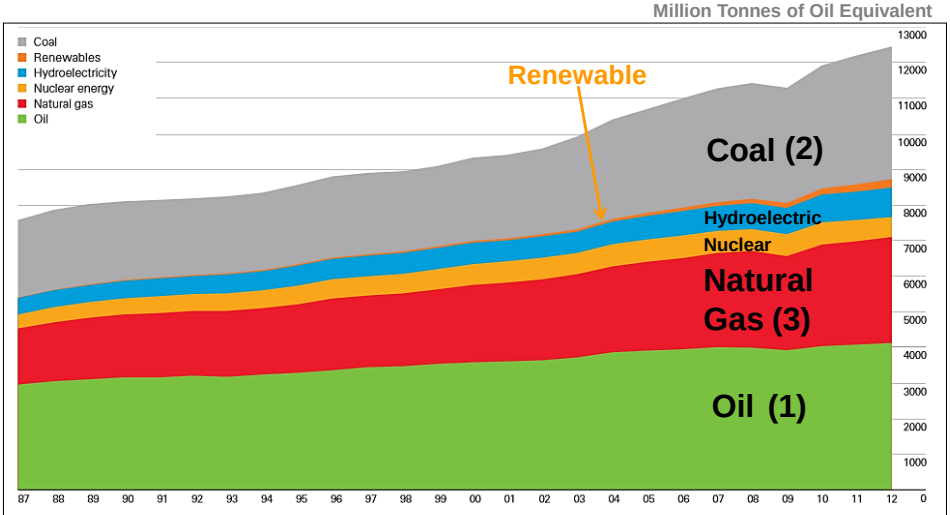
GLOBAL ENERGY DEMAND, TO 2020



Economides and Oligney, 2000

World Energy Consumption, by Type

Million Tonnes of Oil Equivalent



World primary energy consumption grew by a below-average 1.8% in 2012. Growth was below average in all regions except Africa. Oil remains the world's leading fuel, accounting for 33.1% of global energy consumption, but this figure is the lowest share on record and oil has lost market share for 13 years in a row. Hydroelectric output and other renewables in power generation both reached record shares of global primary energy consumption (6.7% and 1.9%, respectively).

BP 2013

World Oil Reserves by Country as of January 1, 2011 (billion barrels)

Top 20 = 95%

Country	Oil reserves	Percent of world total
Saudi Arabia	260.1	17.68
Venezuela	211.2	14.35
Canada	175.2	11.91
Iran	137.0	9.31
Iraq	115.0	7.82
Kuwait	101.5	6.90
United Arab Emirates	97.8	6.65
Russia	60.0	4.08
Libya	46.4	3.16
Nigeria	37.2	2.53
Kazakhstan	30.0	2.04
Qatar	25.4	1.73
United States	20.7	1.41
China	20.4	1.38
Brazil	12.9	0.87
Algeria	12.2	0.83
Mexico	10.4	0.71
Angola	9.5	0.65
Azerbaijan	7.0	0.48
Ecuador	6.5	0.44
Rest of world	74.9	5.09
World total	1,471.2	100.00

Top 10 84.4%

Source: *Oil & Gas Journal*.

EIA 2011

World Natural Gas Reserves by Country as of January 1, 2011

Top 20 = 91%

Country	Reserves (trillion cubic feet)	Percent of world total
World	6,675	100.0
Top 20 countries	6,067	90.9
Russia	1,680	25.2
Iran	1,046	15.7
Qatar	896	13.4
Saudi Arabia	275	4.1
United States	273	4.1
Turkmenistan	265	4.0
United Arab Emirates	228	3.4
Nigeria	187	2.8
Venezuela	179	2.7
Algeria	159	2.4
Iraq	112	1.7
Australia	110	1.6
China	107	1.6
Indonesia	106	1.6
Kazakhstan	85	1.3
Malaysia	83	1.2
Egypt	77	1.2
Norway	72	1.1
Uzbekistan	65	1.0
Kuwait	63	0.9
Rest of world	608	9.1

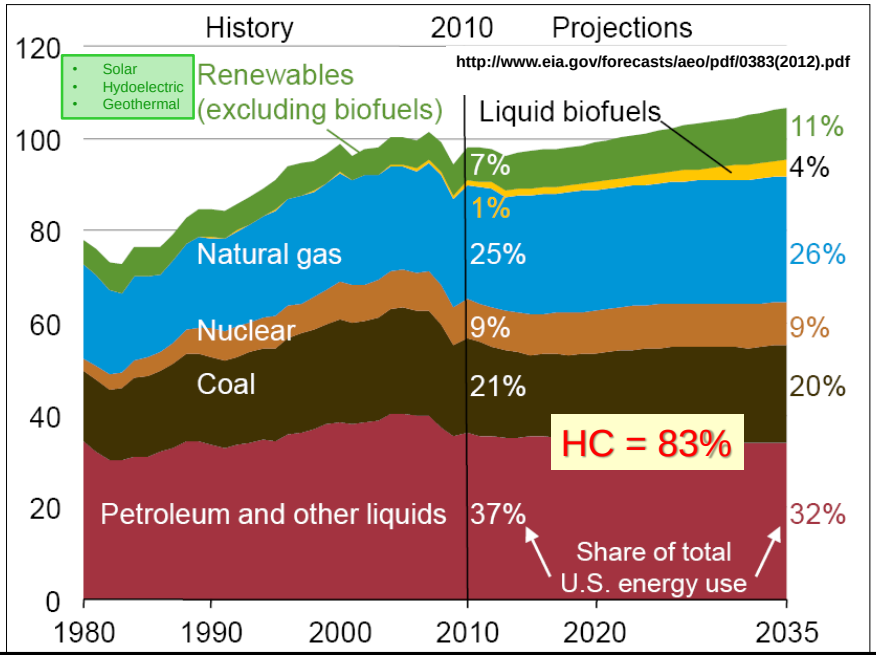
Top 10 77.8%

Sources: *Oil & Gas Journal* and EIA.

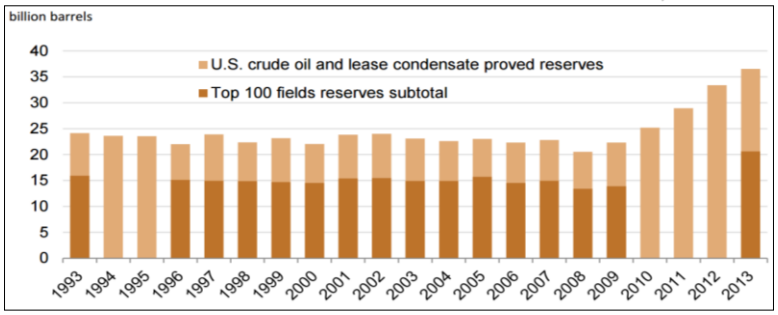
EIA 2011

© 2012 Anadarko Mozambique Area 1

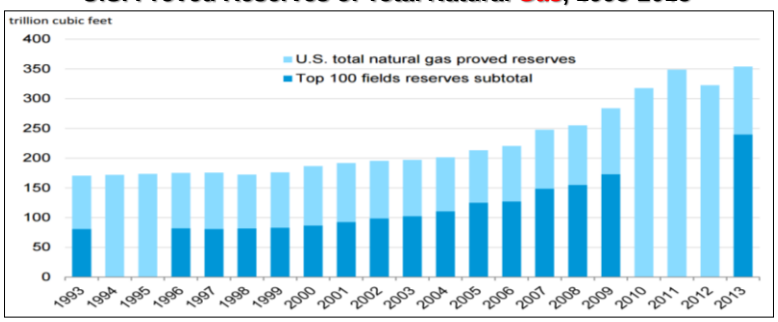
U.S. Primary Energy Use by Fuel, 1980-2035 (quadrillion Btu)



U.S. Proved Reserves of Crude Oil and Lease Condensate, 1993-2013

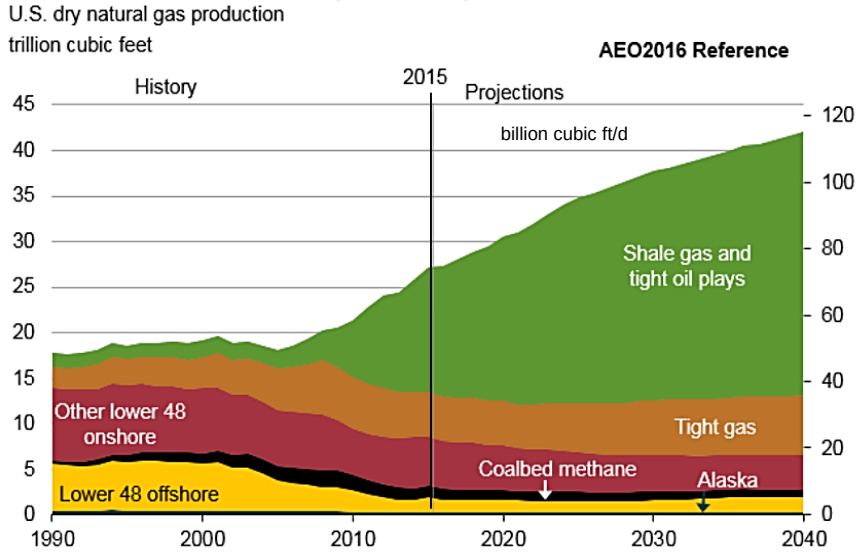


U.S. Proved Reserves of Total Natural Gas, 1993-2013



http://www.eia.gov/naturalgas/crudeoilreserves/top100/pdf/top100.pdf

U.S. Natural Gas Production by Source, 1990-2040 (Tcf/Year)



Source: EIA, Annual Energy Outlook 2016

http://www.eia.gov/forecasts/aeo/er/pdf/0383er(2016).pdf

Top 10 Gas Fields in the U.S. in 2007 - All but Hugoton and Prudhoe Bay Produce from Unconventional Reservoirs

2007 Rank	Field Name	Location (State)	2007 Estimated Production (Bcf & %)	Discovery Year
1	San Juan Basin Gas Area	CO & NM	1,320.7	1927
2	Newark East (Barnett Shale)	TX	1,110.3	1981
3	Powder River Basin (Coalbed)	MT & WY	442.0	1992
4	Jonah (Tight Sand)	WY	366.3	1977
5	Hugoton Gas Area	KS,OK & TX	357.8	1922
6	Pinedale (Tight Sand)	WY	313.4	1955
7	Carthage (Tight Sand)	TX	231.7	1936
8	Natural Buttes	UT	170.4	1940
9	Wattenberg	CO & NM	169.0	1970
10	Prudhoe Bay	AK	168.7	1967
	Top 10 Volume		**4,650.3**	
	Top 10 Percentage of U.S. Total		**22.90%**	

(Data from EIA 2009)

Top 10 Gas Fields in the U.S. in 2009 - All but Hugoton and Prudhoe Bay Produce from Unconventional Reservoirs

2009 Rank	Field Name	Location (State)	2009 Estimated Production (Bcf & %)	Discovery Year
1	NEWARK EAST (Barnett Sh)	TX	1794.6	1981
2	SAN JUAN BASIN (CBM)	CO & NM	1295.2	1927
3	PINEDALE (Tight Sand)	WY	487.8	1955
4	HAYNESVILLE SHALE	LA	203.7	2008
5	B-43 (FAYETTEVILLE) (Shale)	AR	516.8	2004
6	PRUDHOE BAY	AK	166.7	1967
7	JONAH (Tight Sand)	WY	391.1	1977
8	NATURAL BUTTES	UT	224.4	1940
9	HUGOTON GAS AREA	KS & OK & TX	328.1	1922
10	WATTENBERG	CO	195.3	1970
	Top 10 Volume		**5,603.7**	
	Top 10 Percentage of U.S. Total		**24.86 %**	

(Data from EIA 2013)

Top 10 U.S. Oil and Gas Fields, in Order of 2015 (?) Reserves, but showing 2013 Production

Top 10 Oil Fields

1. Eagle Ford (TX) – 238 million barrels
2. Spraberry (TX) – 99 million barrels
3. Prudhoe Bay (AK) – 79 million barrels
4. Wattenberg (CO) – 47 million barrels
5. Briscoe Ranch (TX) **(??)** – 62 million barrels
6. Kuparuk River (AK) – 29 million barrels
7. Mississippi Canyon (Fed Gulf) – 15 million barrels
8. Wasson (TX) – 19 million barrels
9. Belridge South (CA) – 23 million barrels
10. Green Canyon (Fed Gulf) – 27 million barrels

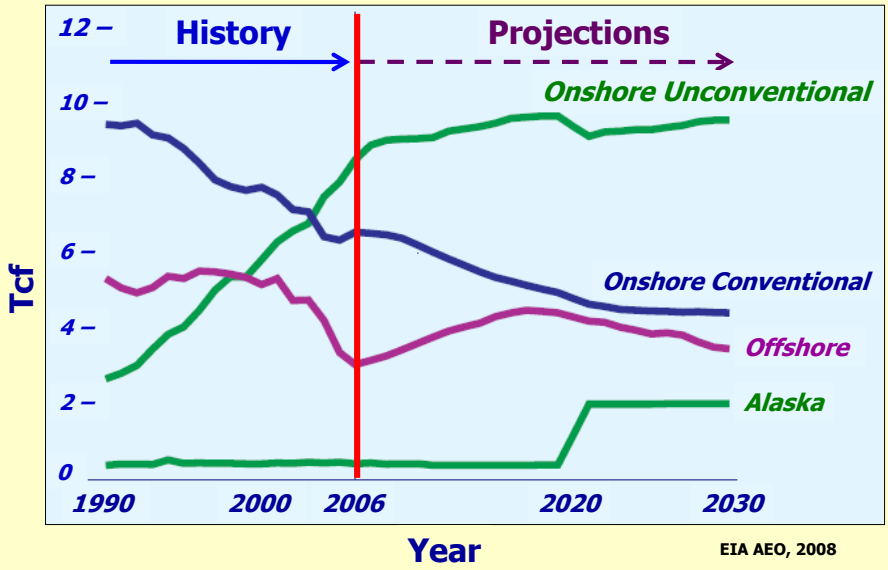
Top 10 Natural Gas Fields

1. Marcellus Shale (PA & WV) – 2,836 billion cubic feet
2. Newark East (TX) – 1,951 billion cubic feet
3. B-43 Area (Fayette.) (AR) – 1,025 billion cubic feet
4. San Juan Basin (CO & NM) – 1,024 billion cubic feet
5. Haynesville Shale (LA) – 1,425 billion cubic feet
6. Pinedale (WY) – 568 billion cubic feet
7. Carthage (TX) – 653 billion cubic feet
8. Jonah (WY) – 239 billion cubic feet
9. Wattenberg (CO) – 304 billion cubic feet
10. Prudhoe Bay (AK) – 147 billion cubic feet

In **2009**, the Marcellus Shale - which spans Pennsylvania, Ohio, West Virginia, and New York – barely received a mention. In the 2015 edition, the Marcellus is by far the largest natural gas region in the country. The **Marcellus' 2.8 trillion cubic feet in natural gas production in 2013 was 45 percent higher than the second largest field on the list, the Newark East (part of the Barnett Shale)**. Detailed lists below (ranked in order of reserves, but EIA only provided 2013 production figures):

http://oilprice.com/Energy/Energy-General/The-Top-10-Largest-Oil-And-Gas-Fields-In-The-United-States.html

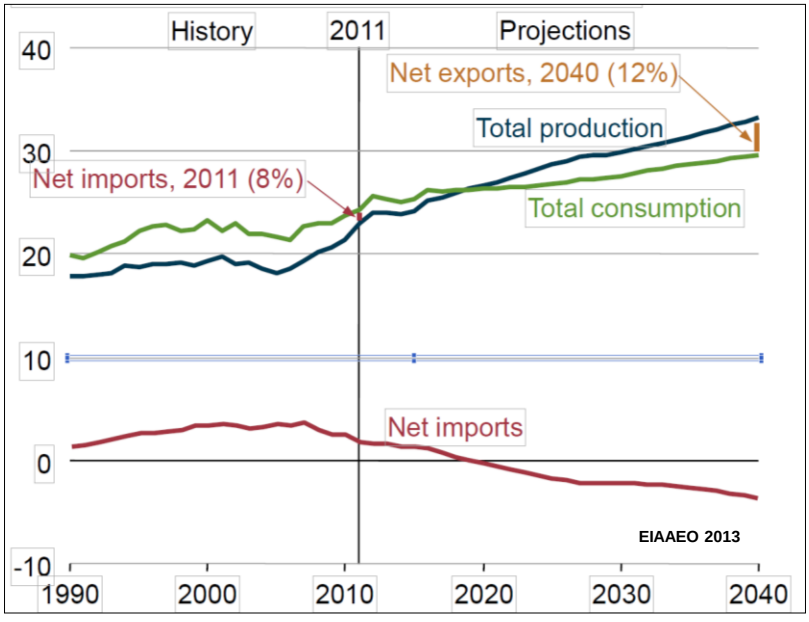
Onshore Unconventional Gas Production is The Only Growing Component of The U.S. Gas Supply



EIA AEO, 2008

Unconventional gas reservoirs account for +55% of U.S. Gas production

Total U.S. Natural Gas Production, Consumption, and Net Imports, 1990-2040 (trillion cubic feet)



World Unconventional Gas Resources

Region	Coalbed Methane (Tcf)	Shale Gas (Tcf)	Tight-Sand Gas (Tcf)	Total (Tcf)
North America	3,017	3,842	1,371	8,228
Latin America	39	2,117	1,293	3,448
Western Europe	157	510	353	1,019
Central and Eastern Europe	118	39	78	235
Former Soviet Union	3,957	627	901	5,485
Middle East and North Africa	0	2,548	823	3,370
Sub-Saharan Africa	39	274	784	1,097
Centrally planned Asia and China	1,215	3,528	353	5,094
Pacific (Organization for Economic Cooperation and Development)	470	2,313	705	3,487
Other Asia Pacific	0	314	549	862
South Asia	39	0	196	235
World	*9,051*	*16,112*	*7,406*	*32,560*

From Rogner, 1997

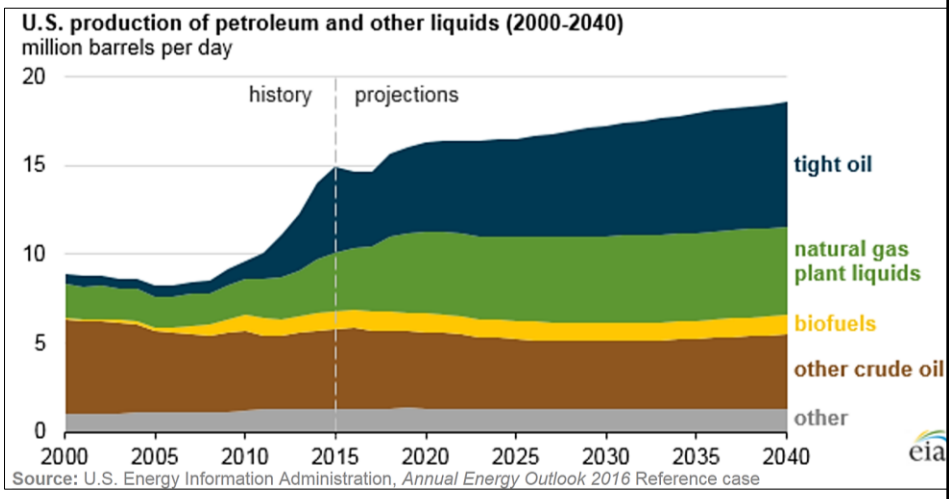
COMPARISON OF REGION-LEVEL UNCONVENTIONAL OGIP ASSESSMENTS (Tcf)

TABLE 14—COMPARISON OF REGION-LEVEL UNCONVENTIONAL OGIP ASSESSMENTS, IN TCF

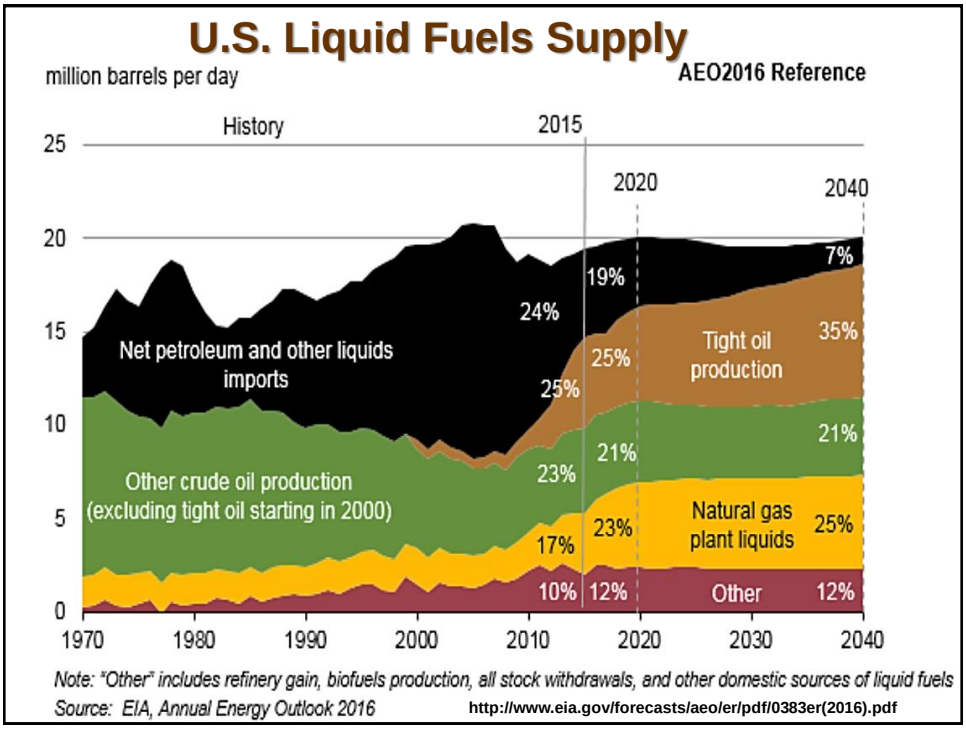
Region	Rogner (1997)				This study			
	Tight gas	Coalbed methane	Shale gas	Total	Tight gas (P50)	Coalbed methane (P50)	Shale gas (P50)	Total (P50)
AAO	1,802	1,724	6,151	9,677	6,253	1,348	2,690	10,291
NAM	1,371	3,017	3,840	8,228	10,784	1,629	5,905	18,318
CIS	901	3,957	627	5,485	28,604	859	15,880	45,343
LAM	1,293	39	2,116	3,448	3,366	13	3,742	7,122
MET	823	0	2,547	3,369	15,447	9	15,416	30,872
EUP	431	274	549	1,254	3,525	176	2,194	5,895
AFR	784	39	274	1,097	4,000	18	3,882	7,901
World	7,405	9,051	16,103	32,559	71,981	4,052	49,709	125,742

Dong et al. 2011, SPE 148365

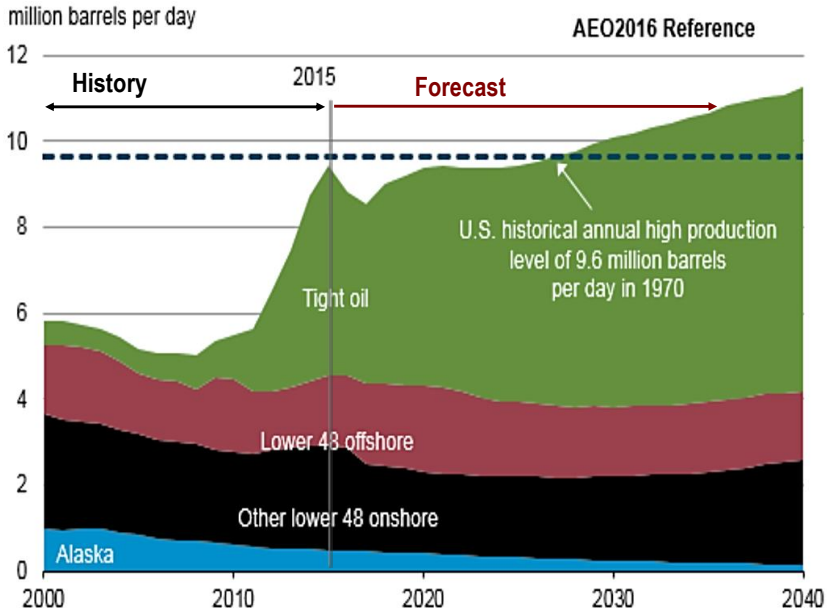
CSUG Canadian Society for Unconventional Gas


U.S. production of petroleum and other liquids (2000-2040)
million barrels per day
20
15
10
5
0
history
projections
tight oil
natural gas plant liquids
biofuels
other crude oil
other
2000
2005
2010
2015
2020
2025
2030
2035
2040
eia
Source: U.S. Energy Information Administration, Annual Energy Outlook 2016 Reference case

EIA 2016


U.S. Liquid Fuels Supply
million barrels per day
AEO2016 Reference
History
2015
2020
2040
25
20
15
10
5
0
Net petroleum and other liquids imports
Other crude oil production (excluding tight oil starting in 2000)
Tight oil production
Natural gas plant liquids
Other
24%
19%
7%
25%
25%
35%
23%
21%
21%
17%
23%
25%
10%
12%
12%
1970
1980
1990
2000
2010
2020
2030
2040
Note: "Other" includes refinery gain, biofuels production, all stock withdrawals, and other domestic sources of liquid fuels
Source: EIA, Annual Energy Outlook 2016
http://www.eia.gov/forecasts/aeo/er/pdf/0383er(2016).pdf

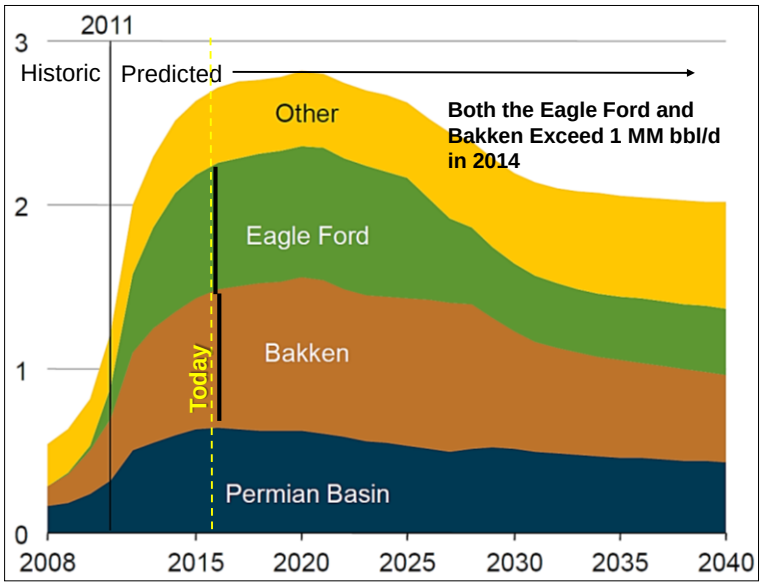
U.S. Crude Oil Production



Source: EIA, Annual Energy Outlook 2016

http://www.eia.gov/forecasts/aeo/er/pdf/0383er(2016).pdf

Total U.S. Tight Oil Production by Geologic Formation, 2008-2040 (million barrels per day)



EIAAEO 2013

Top 10 Oil Fields in the U.S. in 2013 – Many Produce from Unconventional Reservoirs

Top producing oil fields in the United States, 2013

Rank	Field	State	Discovery Year	Million Bbl/Year
1	Eagle Ford Formation	Texas	1962	308.3
2	Bakken formation	North Dakota and Montana	1953	123.8
3	Sprayberry Trend	Texas	1949	99.8
4	Prudhoe Bay Oil Field	Alaska	1967	79.1
5	Wattenberg Gas Field	Colorado	1970	47.3
6	Shenzi	Federal Gulf of Mexico	2002	35.3
7	Kuparuk River oil field	Alaska	1969	29.5
8	Midway-Sunset Oil Field	California	1901	28.8
9	Atlantis Oil Field	Federal Gulf of Mexico	1998	27.3
10	Sugarkane	Texas	2009	25.8

Annual production 2013. Source:[13]

https://en.wikipedia.org/wiki/Petroleum_in_the_United_States

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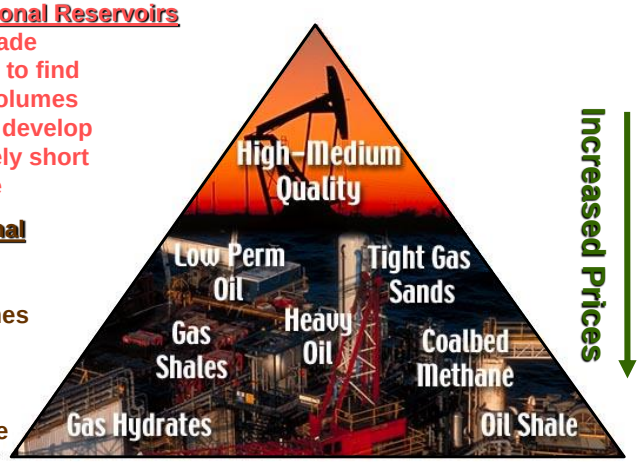
The Resource Triangle

Conventional Reservoirs
- High-grade
- Difficult to find
- Small volumes
- Easy to develop
- Relatively short well life

Unconventional
- Low-grade
- Easy to find
- Large volumes
- Difficult to develop
- Relatively long well life



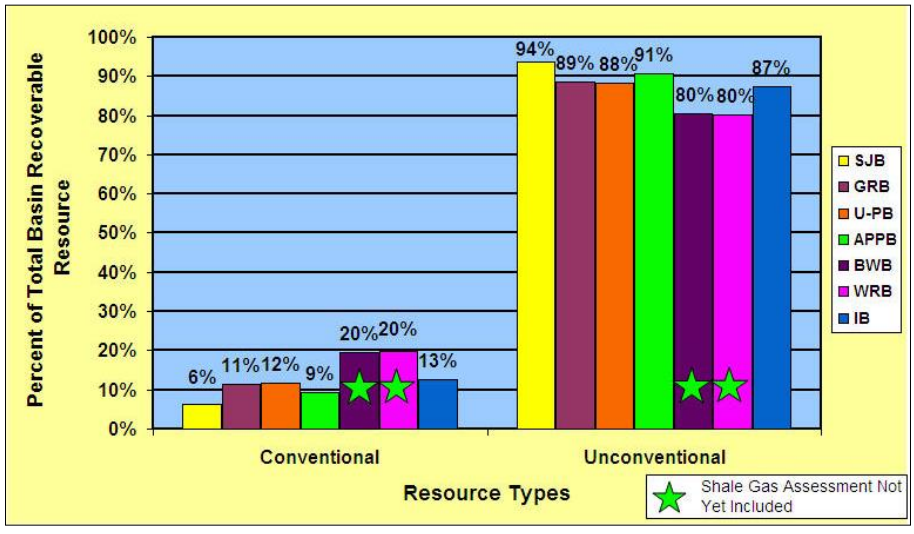
Increased Prices

Improved Technology

- Natural resources are log-normally distributed – gold, silver, oil, gas, etc.
- High-grade deposits (apex) are difficult to find but easy to extract
- Low-grade deposits (deeper in the resource triangle) are easier to find but economic production requires higher resource prices and improved technology

(from Holditch, 2006; after Masters, 1979; Gray, 1977)

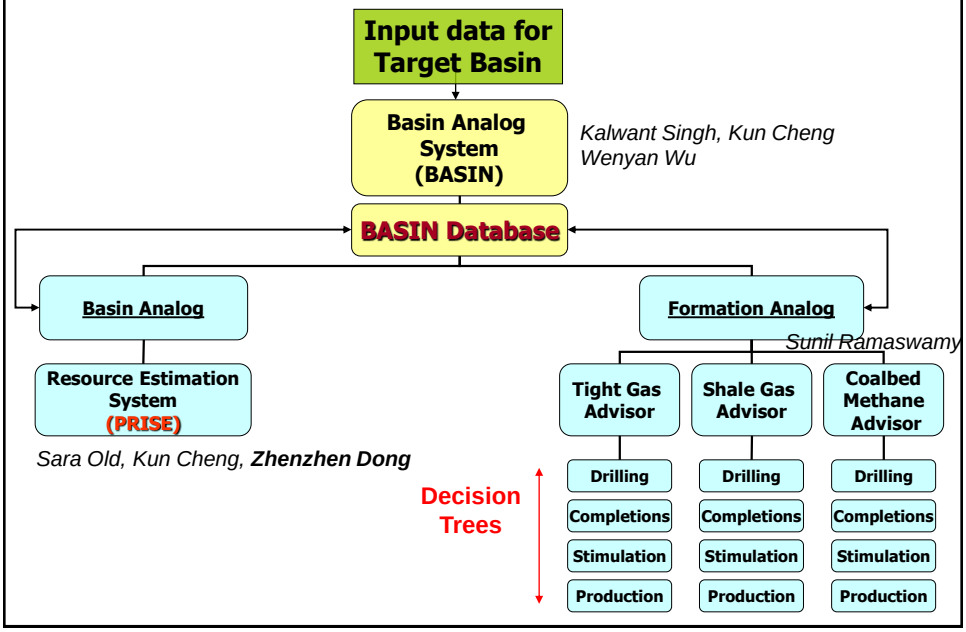
Technically Recoverable Gas Resources by Basin, Conventional vs. Unconventional



SJB – San Juan Basin
GRB – Green River Basin
APPB – Appalachian Basin
UPB – Uinta-Piceance Basin
IB – Illinois Basin
BWB – Black Warrior Basin
WRB – Wind River Basin

From Old, 2008

UGA Group Work Flow



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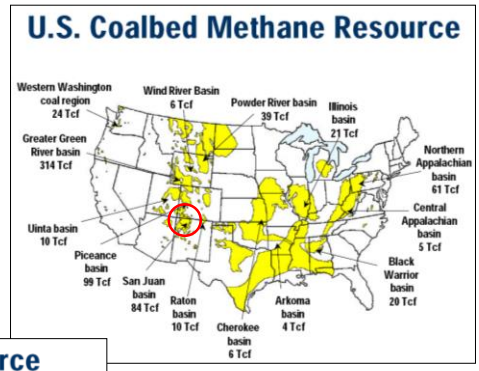
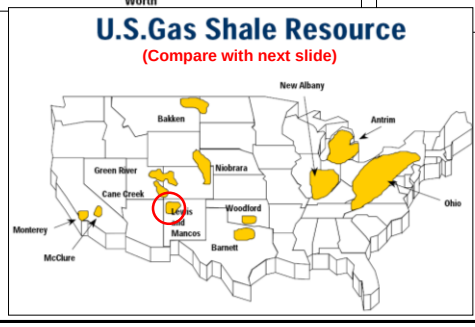
U.S. Unconventional Gas Resource Basins





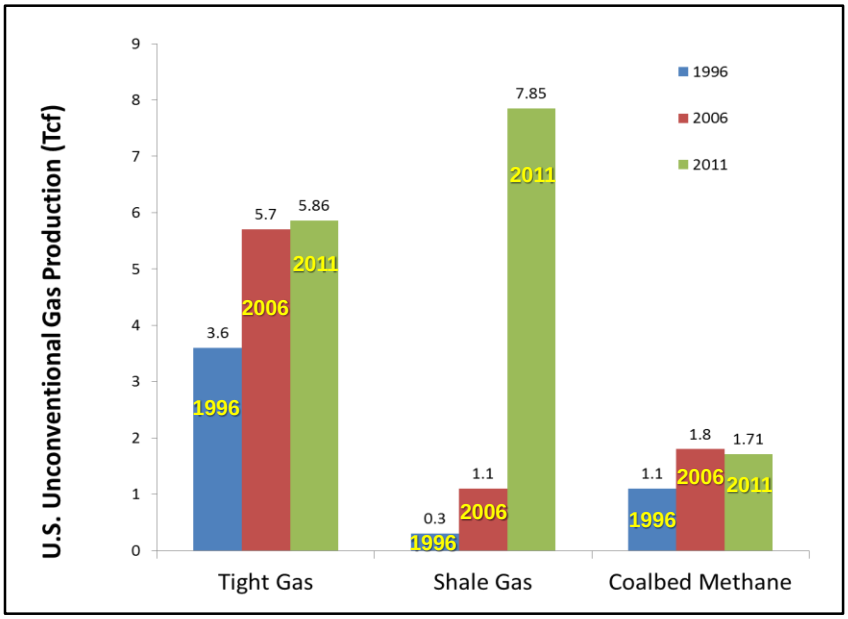
Holditch 2001, after GTI 2001

No significant shale oil until 2008

N.A. Shale Gas and Oil Plays (as of May 2011)

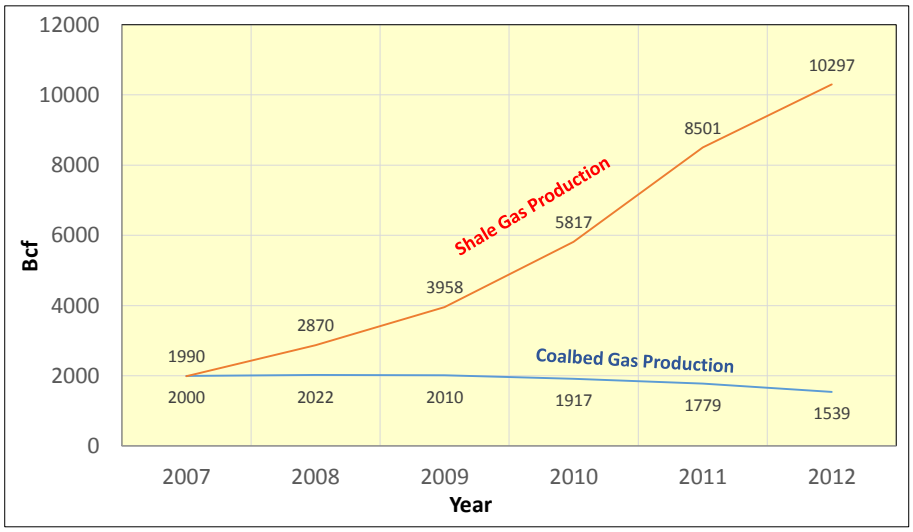
http://c1wsolutions.files.wordpress.com/2012/09/shale2.png

All 3 Unconventional Gas Resource Types Have Had Production Growth



(Data from EIA & Advanced Resources International data base)

Comparison of Shale and Coalbed Gas Annual Production, 2007 - 2012



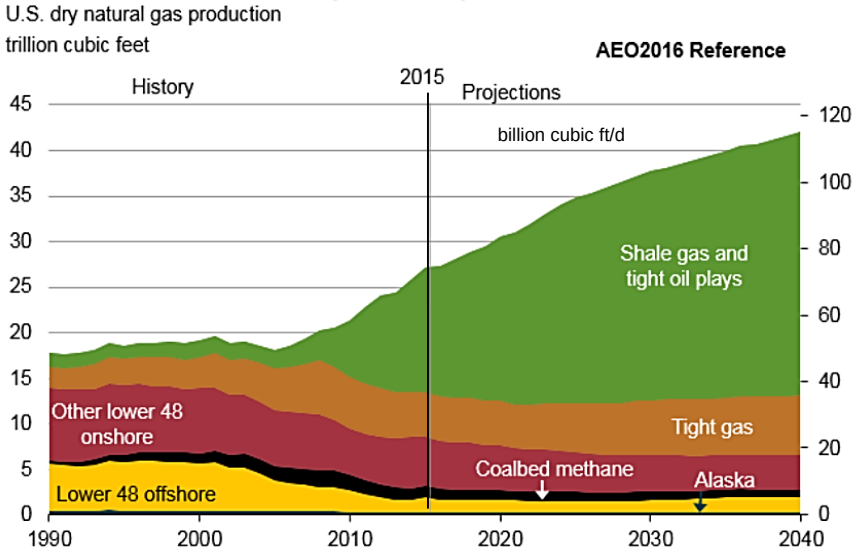
Data from DOE-EIA 2014

U.S. Lower 48 Onshore Unconventional Gas Production

	2011		2040 (Projection)	
	Production (TCF)	% of Total	Production (TCF)	% of Total
Total Dry Gas	**23.00**	**--**	**33.14**	--
Shale Gas	7.85	34.13%	16.70	50.39%
Tight Gas	5.86	25.48%	7.34	22.15%
CBM	1.71	7.43%	2.11	6.37%
Unconven. Subtotal	**15.42**	**67.04%**	**26.15**	**78.91%**

Data from EIA-AEO2013/Table A14

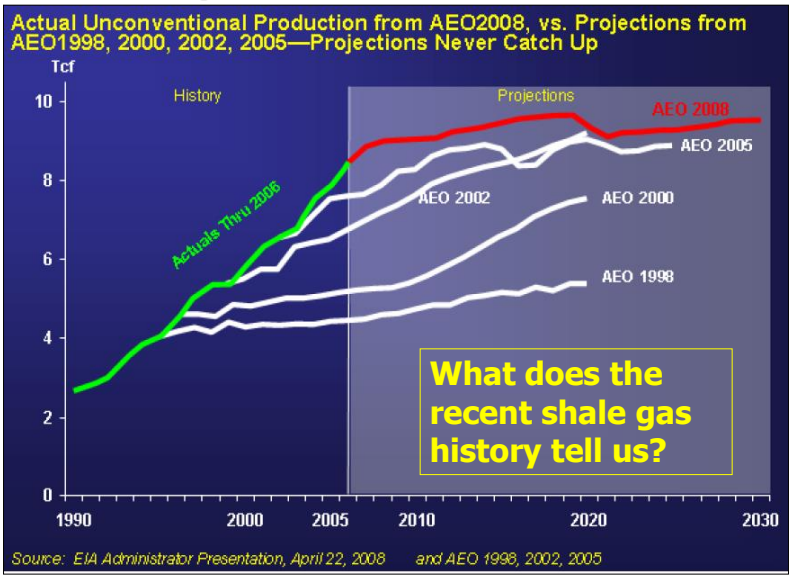
U.S. Natural Gas Production by Source, 1990-2040 (Tcf/Year)



Source: EIA, Annual Energy Outlook 2016

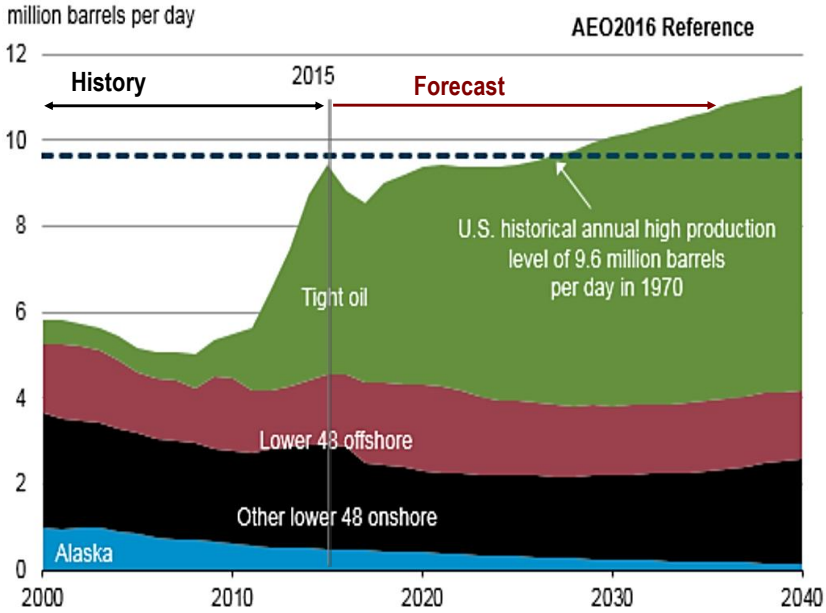
http://www.eia.gov/forecasts/aeo/er/pdf/0383er(2016).pdf

EIA-AEO Unconventional Gas Production Forecasts Consistently Under-Estimated Actual Production



(Navigant, 2008)

U.S. Crude Oil Production



Source: EIA, Annual Energy Outlook 2016

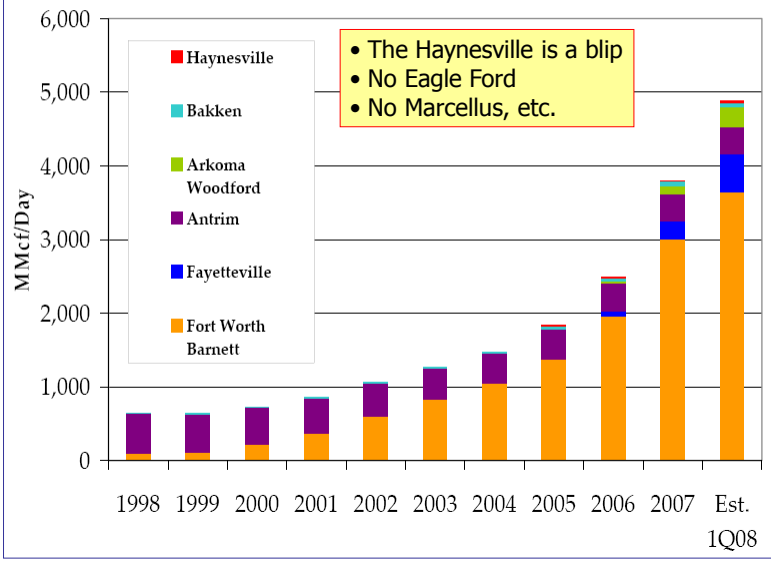
http://www.eia.gov/forecasts/aeo/er/pdf/0383er(2016).pdf

N.A. Shale Gas and Oil Plays (as of May 2011)

http://c1wsolutions.files.wordpress.com/2012/09/shale2.png

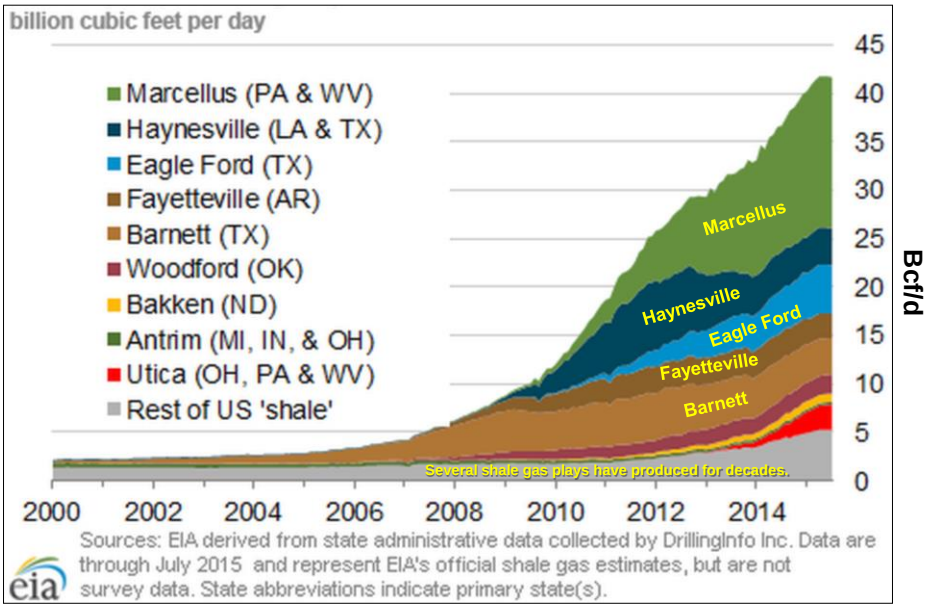
U.S. Shale Gas Production* (MMcf/day)

(Many recent shale gas plays were still ramping up)



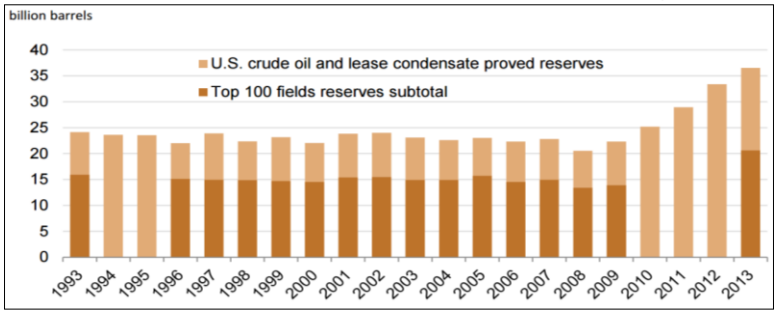
Modified from Navigant Consulting, Inc., 2008

U.S. Monthly Dry Shale Gas Production

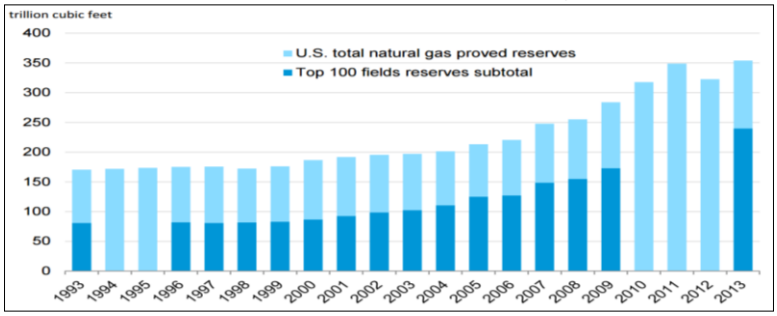


http://www.eia.gov/naturalgas/weekly/

U.S. Proved Reserves of Crude Oil and Lease Condensate, 1993-2013



U.S. Proved Reserves of Total Natural Gas, 1993-2013



http://www.eia.gov/naturalgas/crudeoilreserves/top100/pdf/top100.pdf

High gas prices renew interest in natural gas vehicles in Congress, Detroit.

On the front page of its Business section, the Washington Post (**8/26/08**, D1, Weissmann) reports that "as drivers reel from the shock of high gasoline prices, natural gas vehicles are attracting renewed interest both on Capitol Hill and in Detroit." These vehicles "run on a normal internal combustion engine but have a special, high-pressure fuel tank that is cheap to fill. In April, the equivalent of a gallon of **compressed natural gas** averaged **$2.04**, compared with **$3.53** for gasoline." U.S. Rep. Rahm Emanuel (D-Ill.) and Sen. James M. Inhofe (R-Okla.) "have introduced legislation that would help increase the number of natural gas pumps at fueling stations and boost the number of natural gas vehicles on the road." And in Detroit, General Motors' Larry Burns, vice president of research and development, "created buzz with a recent blog post saying his company was 'taking a serious look at natural gas in the U.S.'" However, with few of the vehicles on the road, some service station owners may balk at the **$150,000 expense of installing a natural gas pump**.

Unconventional Oil and Gas Reservoirs – An Introduction

Outline

- **Definition of Unconventional Reservoirs and Resources**
- **World Oil and Gas Production and Reserves**
- **Resource Triangle Concept and Historic Estimates of World Unconventional Gas Resources**
- **U.S. Unconventional Gas and Oil Resources and Activity**
- **Effects of Commodity Price and Technology on Unconventional Resource Development**
- **Conclusions**

Development History, Barnett Shale Gas, Ft. Worth Basin, Texas – Effects of Price and Technology

Gas Price +$9/Mcf

Horizontal wells

Modified from Givens and Zhao 2007, Republic Energy

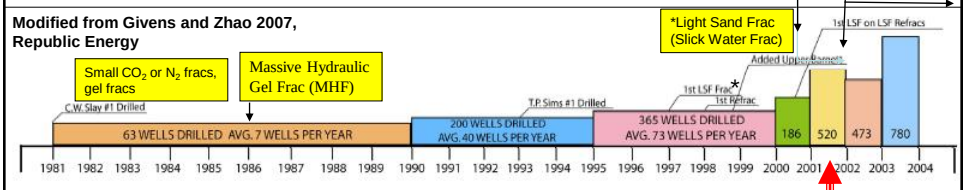
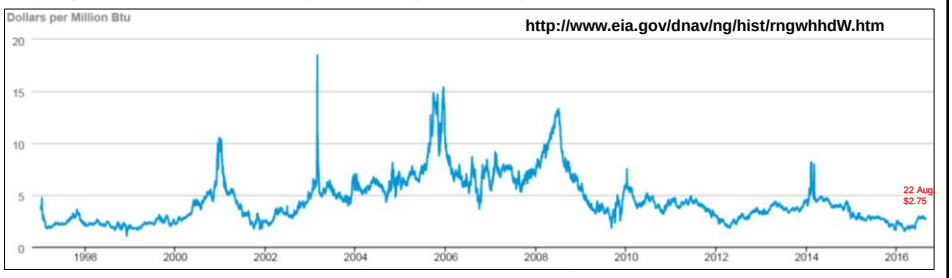


Figure 4 Timeline of wells drilled and major fracture technique breakthroughs.

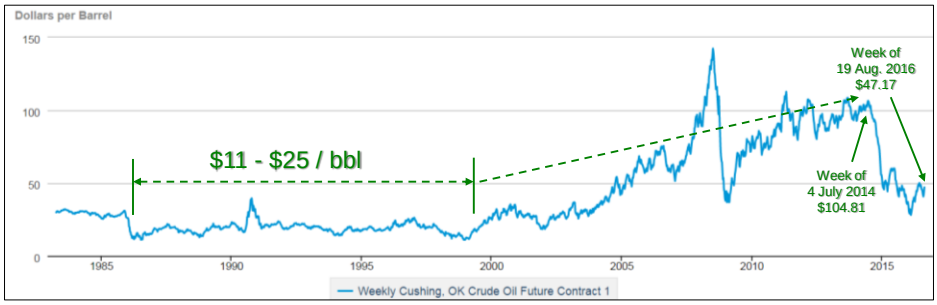
August 2001
Devon Agrees to Acquire Mitchell Energy for $3.1 Billion Cash and Stocks, and Assume $400 Million Debt

West Texas Intermediate Crude Oil Price ($/bbl)

Henry Hub Natural Gas Spot Price ($/MMBtu)

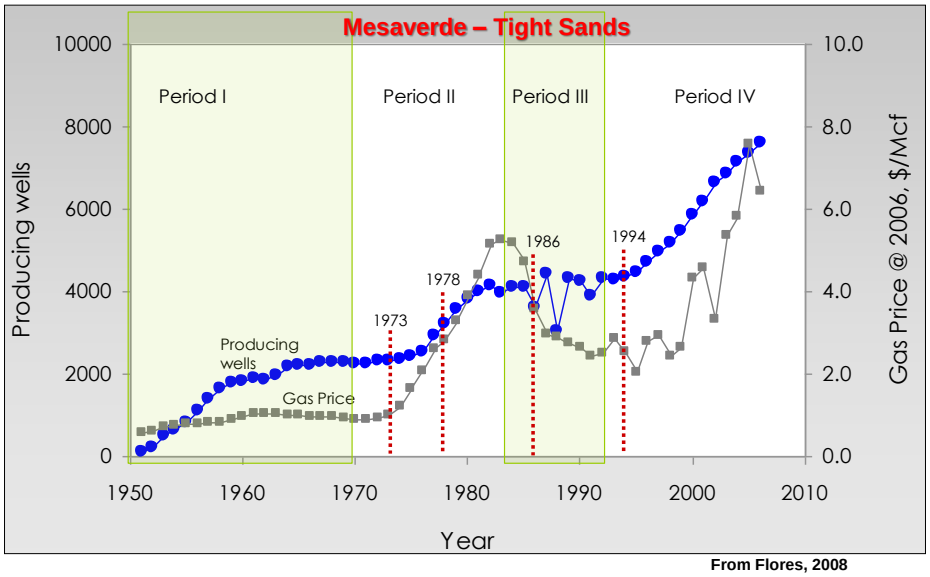


Weekly Price of Cushing, OK Crude Oil Future Contract 1



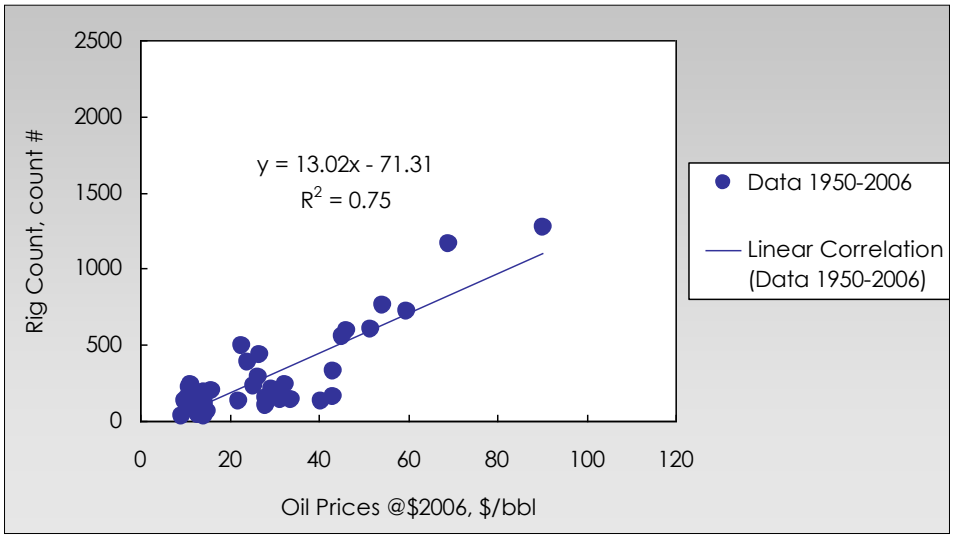
http://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=pet&s=rclc1&f=w

Number of Producing Wells and Gas Price vs. Time, Mesaverde Formation (1951-2006)

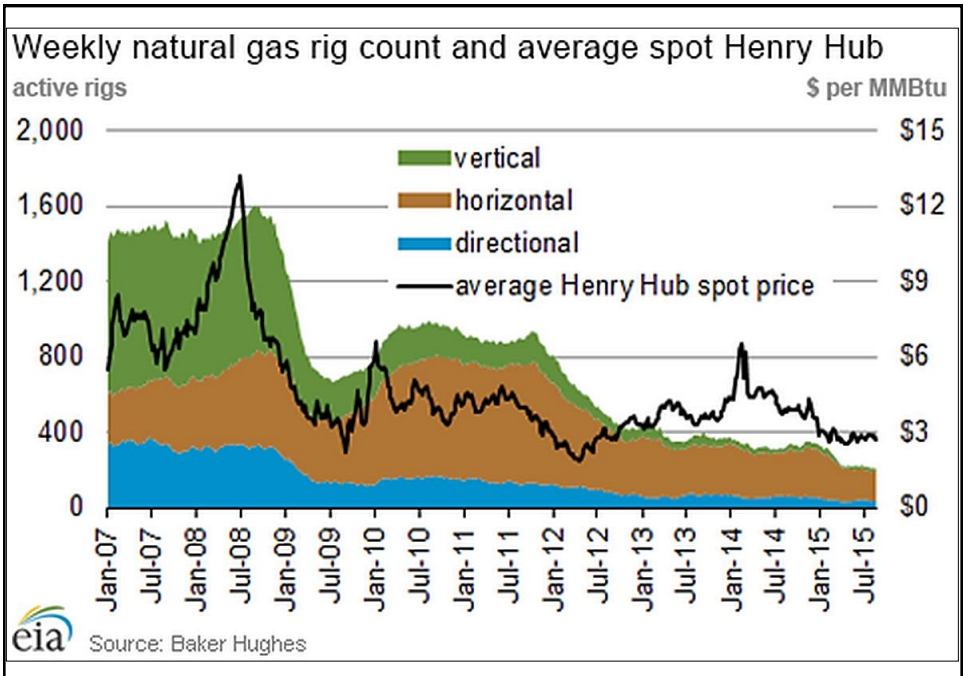


From Flores, 2008

Rig Count vs. Oil Price, Austin Chalk Formation (1950 – 2006)

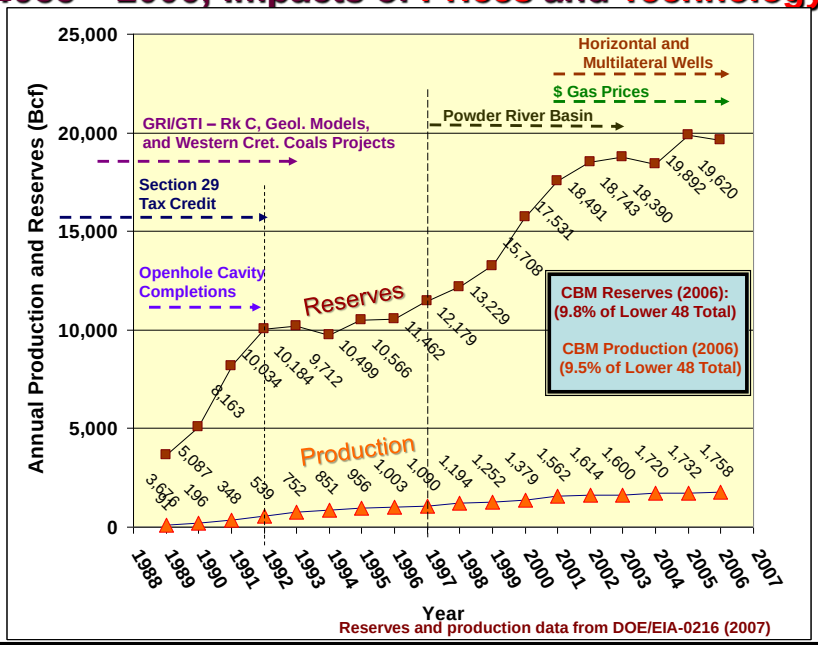


From Flores, 2008



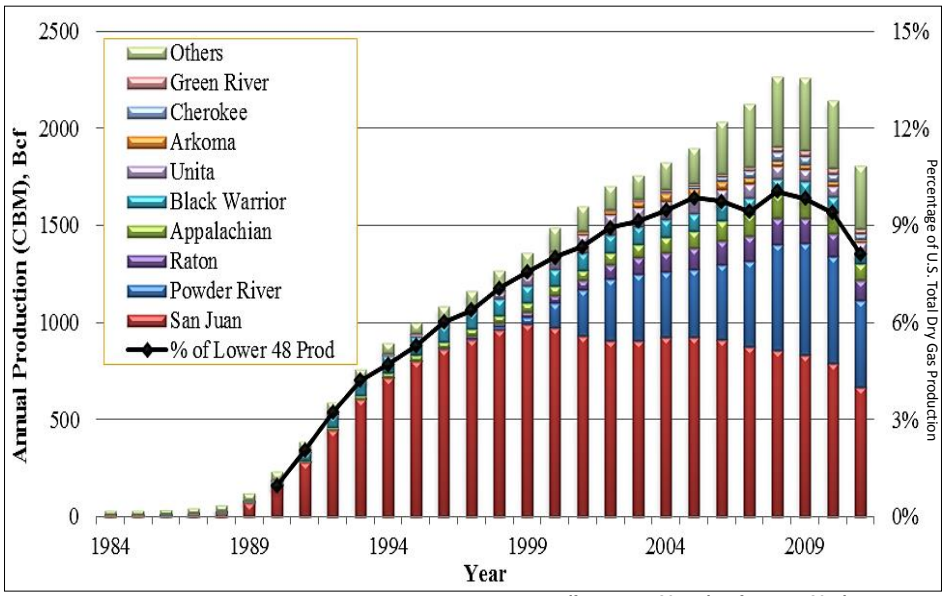
http://www.eia.gov/naturalgas/weekly/

U.S. Coalbed Methane - Reserves and Production, 1988 – 2006; Impacts of Prices and Technology



Reserves and production data from DOE/EIA-0216 (2007)

U.S. Annual CBM Production, by Basin



(from Dong 2011, data from EIA 2011)

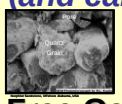
Unconventional Reservoir Types and Hydrocarbon Fluids

What are: roles of natural fractures? fluid contacts? storage mechanisms?

1. Reservoir Control – Tight Reservoirs

Migrated HC; Free Gas/Oil Stored in Pores:

- **Tight (low-permeability) sands *(and carbonates)***
  - **Tight gas**
  - **(Tight oil)**



Free gas stored in pores

Self-Sourced HC; Sorbed and Free Gas & Oil:

- **Coal beds**
- **Shales (some carbonates)**
  - **Shale gas**
  - **Shale Oil (Tight Oil)**
  - **Oil Shale**

http://lostseis.anl.gov/guide/photos/index.cfm

2. Why Emphasis on Tight Reservoirs?

- **Present industry activity/focus and future impact**
- **Abundance of papers and data**
- **Reservoir and fluid variability within and between basins**
- **Job opportunities**

Oil Prices to Slide as OPEC Pressures Grow

May 28, 2007: WTI = $63/bbl; HH Gas = $7.73/Mcf
May 23, 2008: WTI = $131/bbl; HH Gas = $11.77/Mcf
May 29, 2009: WTI = $66/bbl; HH Gas = $4.02/Mcf
May 28, 2010: WTI = $74/bbl; HH Gas = $4.35 Mcf
May 30, 2011: WTI = $103/bbl; HH Gas =$4.64/Mcf
May 25, 2012: WTI = $91/bbl; HH Gas = $2.57/Mcf
June 4, 2013: WTI = $94/bbl; HH Gas = $4.02/Mcf
May 28, 2014: WTI = $104/bbl; HH Gas = $4.58/Mcf
Aug. 28, 2015: WTI = $45/bbl; HH Gas = $2.75/Mcf
Aug. 25, 2016: WTI = $47/bbl; HH Gas = $2.75/Mcf

9/3/03
By Leia Parker

NEW YORK (Dow Jones) - The Organization of Petroleum Exporting Countries is likely to struggle to sustain oil prices next year within its $22-$28 targeted range as Iraqi oil exports and non-OPEC supplies increase, the **World Bank** said Wednesday.

Oil prices are seen **declining** from **$26.50** a barrel this year to **$22 a barrel in 2004** because of increased competition and below-normal demand growth, and **to fall below $20 a barrel by mid-decade**, the World Bank said in its Global Economic Prospects report.

The World Bank **cites rising capacity within OPEC**, the desire of members such as Algeria and Nigeria for higher production quotas and the return of Iraq's oil exports as straining OPEC's efforts to support higher prices. "Difficulties for OPEC could deepen in 2004 when Iraq's exports are anticipated to reach prewar levels," the World Bank said.

"By 2006-2007, **significant new supplies** from West Africa, the Caspian, Russia, deepwater areas of the Atlantic basin and elsewhere are expected to come on stream and, coupled with rising capacity within OPEC, ***exert severe downward pressure on prices***."

The World Bank acknowledged that OPEC could keep prices at $25 a barrel if it manages to maintain strong production discipline, but said the group would have to surrender market share to do so.

That would increase the pressure on world demand and competing supplies, but prices would still probably fall **below $20 a barrel** within a few years because non-OPEC producers would have greater incentive to bring more supplies to market, the World Bank said.

OPEC's price is derived from a basket of seven reference crudes. The OPEC basket price averaged $27.52 a barrel Tuesday, dropping from $28.62 a barrel the previous day, according to OPEC, on Wednesday.

It was first time in 10 days that the basket price had fallen within the group's $22-$28 target range.

With the exception of a slump after the Sept. 11 terrorist attacks on the U.S., oil prices have averaged about $27 a barrel since late 1999.

Oil prices from 1986-1999, when OPEC was primarily concerned with regaining market share, averaged $17.60 a barrel, the World Bank said. © 2003 Dow Jones Newswires.

Conclusions – 1

- Natural resources are log-normally distributed
- Most of the world is still developing conventional oil and gas reservoirs
- Conventional oil and gas production are declining in the U.S. and soon will decline, worldwide
- The gap between demand and supply can be partially filled with HC from unconventional reservoirs
- Unconventional reservoirs have been developed in N.A. for 3 decades, driven by prices and new technology
- Tight oil resources are poorly defined in the U.S. and globally

Conclusions – 2

- Development and expansion of the unconventional O&G resources were driven by tax incentives and gas prices that encouraged technology development
- Technology developed in N.A. is being exported worldwide
- U.S. and Global unconventional gas and oil resources are large, but many of their development requires favorable prices and improved technology
- If unconventional resources are to help meet future global energy needs, new ideas, technologies, and increased prices will be needed to increase reserves

Useful Conversions and Abbreviations

Conversions, Terminology

- 1 **bbl** oil = 5,800,000 Btu (British thermal units)
- **STB** = stock tank barrel = 42 gallons
- 1,000 ft^3 = 1 **Mcf**
- 1 ft^3 gas = 1,000 Btu; 1 Mcf ~1,000,000 Btu
- 6,000 cubic feet (6 Mcf) of typical natural gas has heating value approximately equivalent to 1 bbl oil (boe or BOE)
- 1,000,000 ft^3 = 1 million cubic ft = 1 **MMcf**
- 1,000,000,000 ft^3 = 1 billion cubic ft = **1Bcf**
- 1,000,000,000,000 ft^3 = 1 trillion cubic ft = **1Tcf**

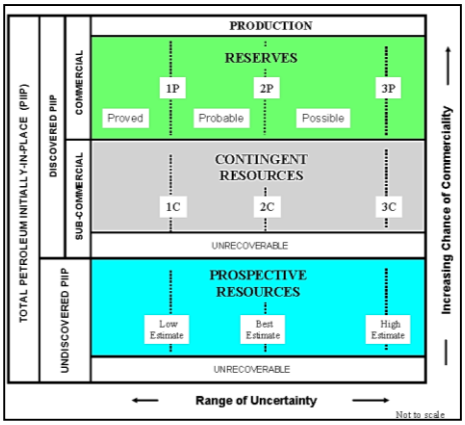
- Well spacing (acres): 320; 160; 80; 40; etc.

Abbreviation/ Acronym	Full Text
Bbbl	Billion Barrels
bbl	Barrel
BBO	Billion Barrels of Oil
BBOE	Billion Barrels of Oil Equivalent
Bcf	Billion Cubic Feet
Bcfe	Billion Cubic Feet of Equivalent
BOE	Barrels of Oil Equivalent
DOE	Department of Energy
EIA	Energy Information Administration
EUR	Estimated Ultimate Recovery
MBOE	Thousand Barrels of Oil Equivalent
MMBOE	Million Barrels of Oil Equivalent
Tcf	Trillion Cubic Feet
Tcfe	Trillion Cubic Feet Equivalent
TRR	Technically Recoverable Resources
USGS	United States Geological Survey

EIA 2011

Hydrocarbon Resources Classifications

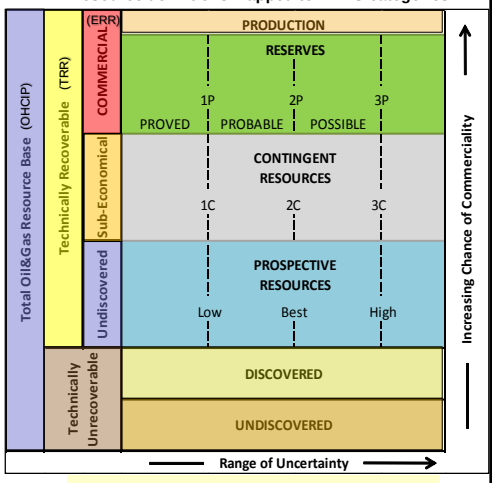
PRMS Hydrocarbon Resources Classification Framework



http://www.spe.org/industry/docs/PRMS_Guidelines_Nov2011.pdf

http://www.spe.org/industry/reserves.php

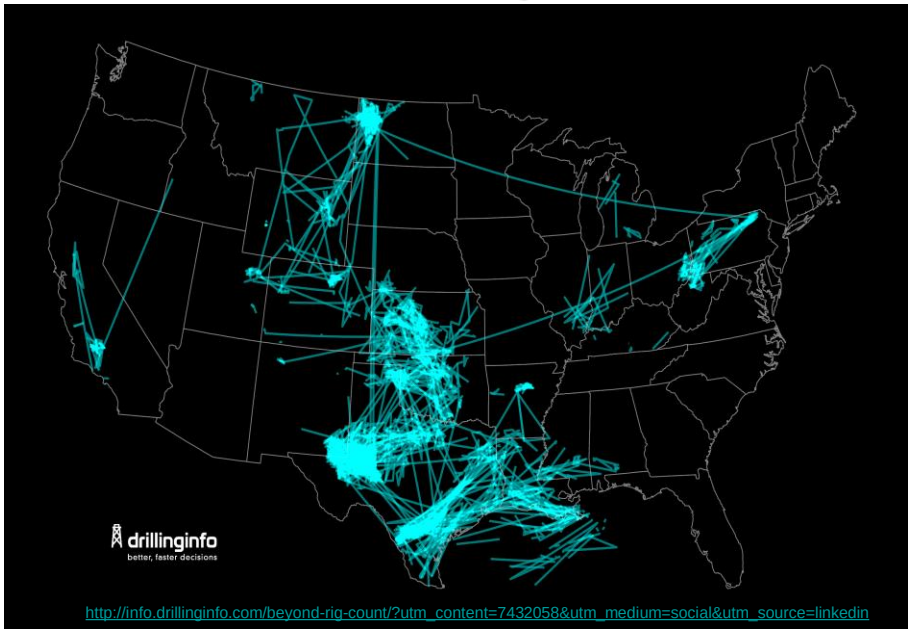
EIA Resource definitions mapped to PRMS categories



www.eia.gov/forecasts/aeo/pdf/0383(2012).pdf

Added Abbreviations:
PRMS = Petroleum Resources Management System
ERR = Economically Recoverable Resource
TRR = Technically Recoverable Resource
OHCIP = Original Hydrocarbons in Place

Time Lapse of Drilling Rig Movements, March 1, 2014 to August 6, 2014



http://info.drillinginfo.com/beyond-rig-count/?utm_content=7432058&utm_medium=social&utm_source=linkedin