TECHNIP CONFERENCE

30th march 2017

SHALE GAS AND SHALE OIL

GAME CHANGERS FOR THE WORLD

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Former head of gas and electricity of TOTAL

Former head of strategy and planning of TOTAL

SHALE OIL AND SHALE GAS:
TWO MAJOR GAME CHANGERS

A FEW SIMPLIFIED FIGURES TO ILLUSTRATE HOW SHALE OIL IS « DIFFERENT » FROM CONVENTIONNAL OIL 1

	2010	2014
USA total oil production	7,5 mb/d	12 mb/d
From which shale oil/LTO	0,5 mb/d	4,5 mb/d
Us oil production as % consum^p	40%	60%
US oil import as % consum^p	60%	40%

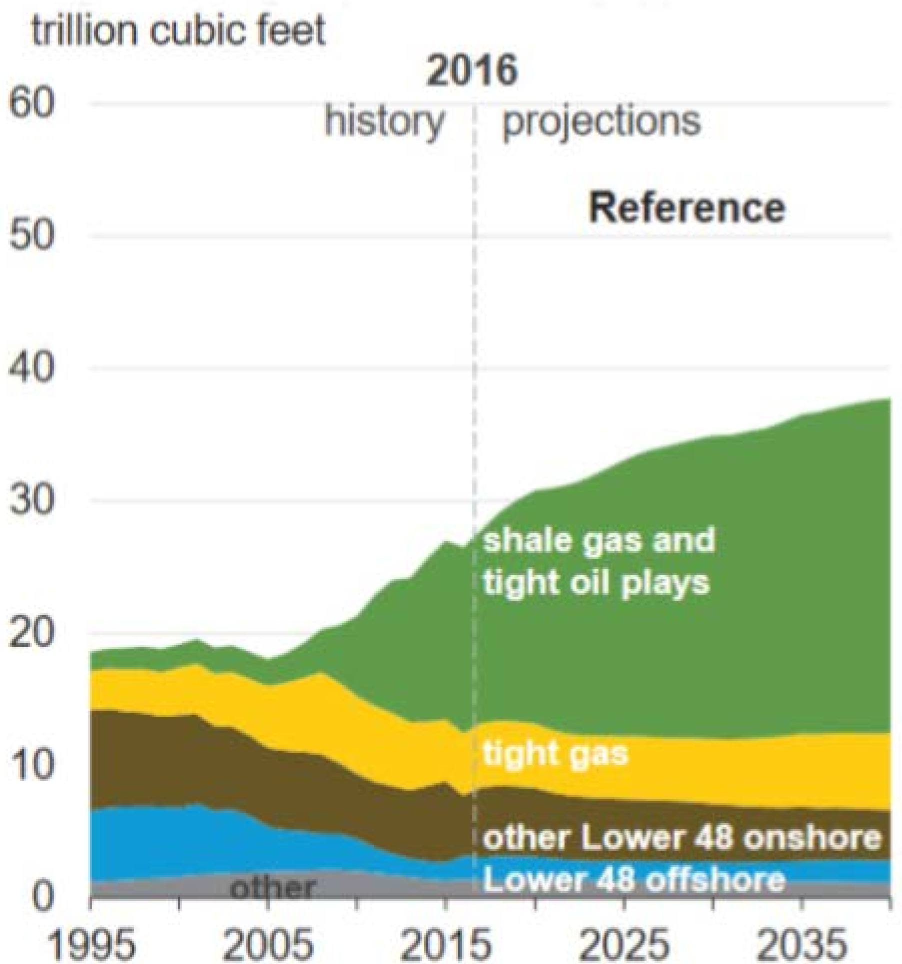
Source: PR Bauquis – 25 Avril 2015

A FEW SIMPLIFIED FIGURES TO ILLUSTRATE HOW SHALE OIL IS « DIFFERENT » FROM CONVENTIONNAL OIL 2

	Annual decline rates	Recovery rates
US conventionnal onshore	**5% / Y**	**50%**
US shale oil / LTO	**50% / Y**	**5%**

Source: PR Bauquis – 25 Avril 2015

NATURAL GAS PRODUCTION IN THE US: SHALE GAS AND TIGHT GAS ALREADY REPRESENT 2/3 OF THE PRODUCTION



Source : EIA, Annual Energy Outlook 2017

A WORLD RESERVE ESTIMATE OF SHALE OIL

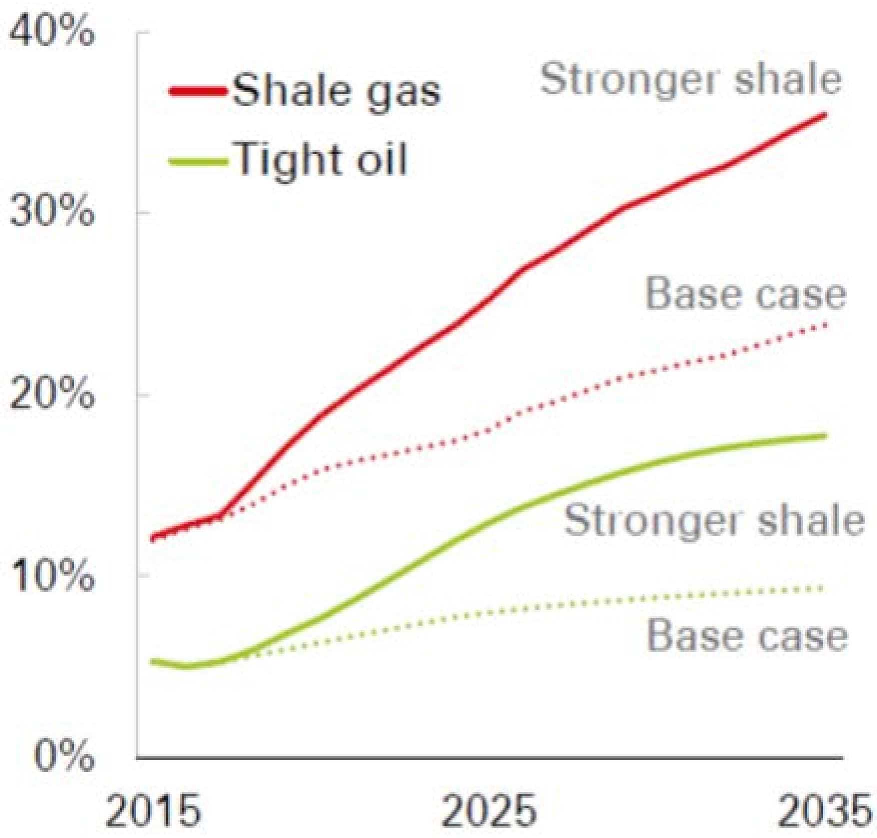
TO BE PRESENTED ON 15 JUNE 2017 AT THE EAGE CONGRESS
BY MARC BLAIZOT

- **Methodology used: PSY (Petroleum System Yield)**
- **Retained accumulation in source rocks estimate: 75. 000 Gbo**
- **Unrisked oil reserves estimate: 10% of « in place » ie: 7.500 Gbo**
- **Reserves estimate (producible oil): 20% of « in place » ie: 1.500 Gbo**
  (economically and environmentally producible)

SHALE OIL/LTO COULD DOUBLE THE REMAINING WORLD RESERVES

Source : Marc BLAIZOT – Former Exploration Manager of Total
Proceeding EAGE Congress Paris – 15 june 2017

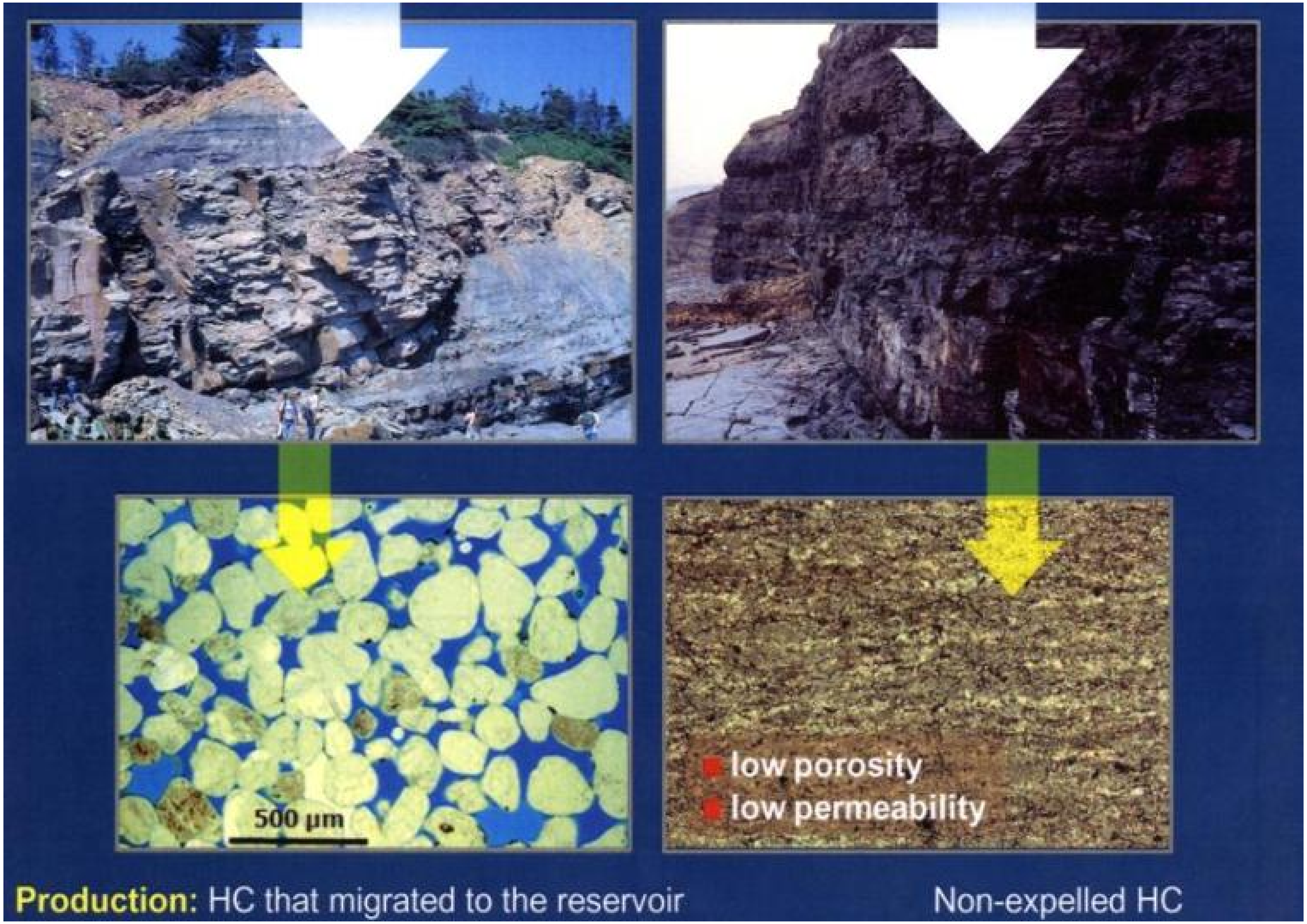
SHALE OIL AND SHALE GAS POSSIBLE SHARES OF WORLD OIL AND GAS PRODUCTIONS (2015 - 2035)



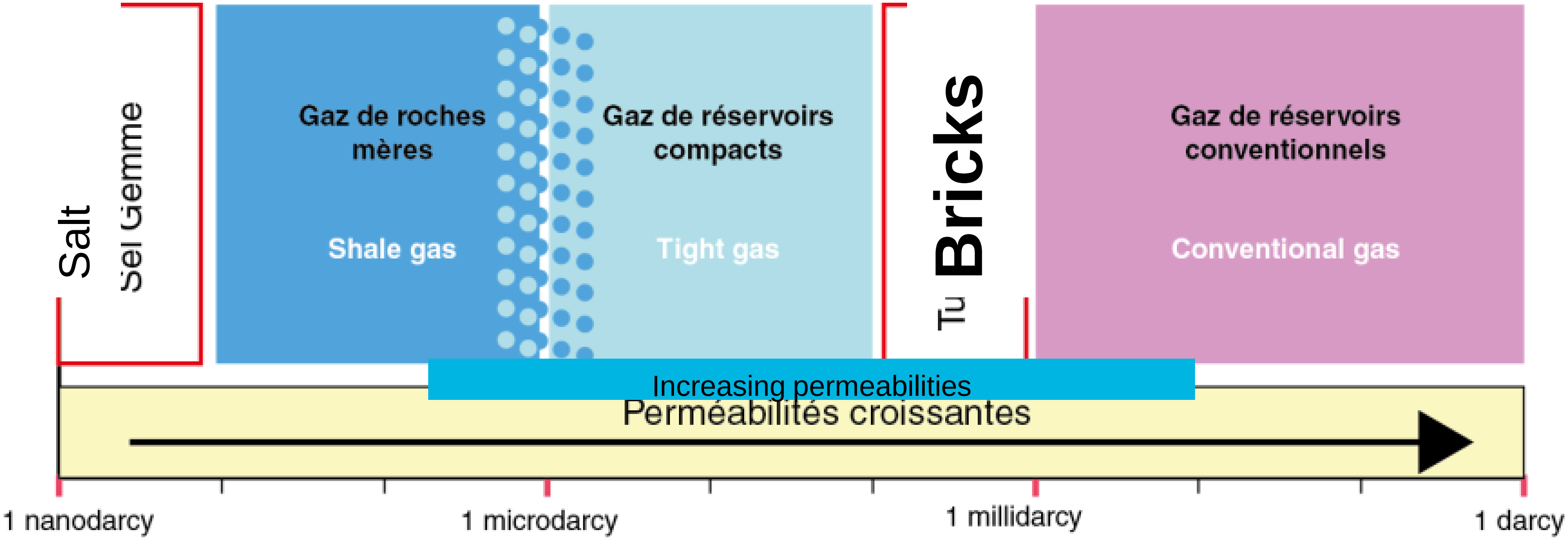
Source : BP (2016a)

WHAT ARE SOURCE ROCKS AND TIGHT FORMATIONS ?

CONVENTIONAL **NON CONVENTIONAL**



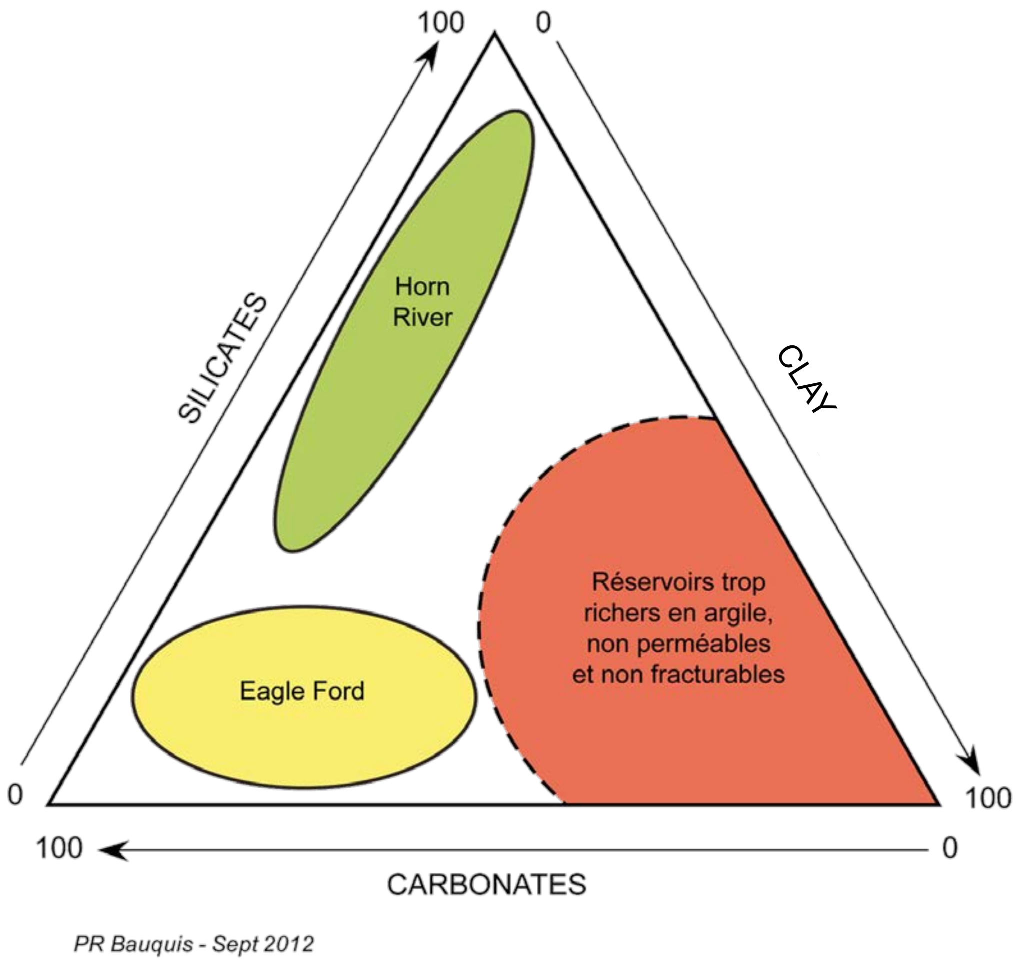
CONVENTIONAL AND NON-CONVENTIONAL RESERVOIRS



HOT SHALE PROPERTIES

Property	Eagle ford	Barnett	Haynesville	Marcellus	Horn River	Typical average
TOC, %	2-8%	3-8%	1-5%	1-5%	2-5%	0,5-10%
Porosity, %	8-18%	3-9%	6-15%	3-9%	3-7%	1-9%
Water saturation, %	7-31%	30-40%		20-45%	20-30%	10-30%
Permeability, nD	1,8-8,000	0,08-2,000	100-3,000	50-3,000	1,8^{e}-4 – 2,0^{e}-1	<1,000 - 2,0^{e}7
Static YM, Mps	1,00-2,50		1,10-2,25			4,21-5,25
Brinell Hardness Number	22	80	18	32		
Poisson’s ratio	0,25-0,27	0,15-0,6	0,15-0,35		0,15-0,35	0,21-0,28
Pressure Gradient, psi	0,4-0,8	0,5-0,6	0,7-0,9	0,3-0,8	0,5-0,7	0,43
Thickness (m)	15-150	90-150	45-105	15-107	60-150	10-40+
Sources SPE et US Doe						

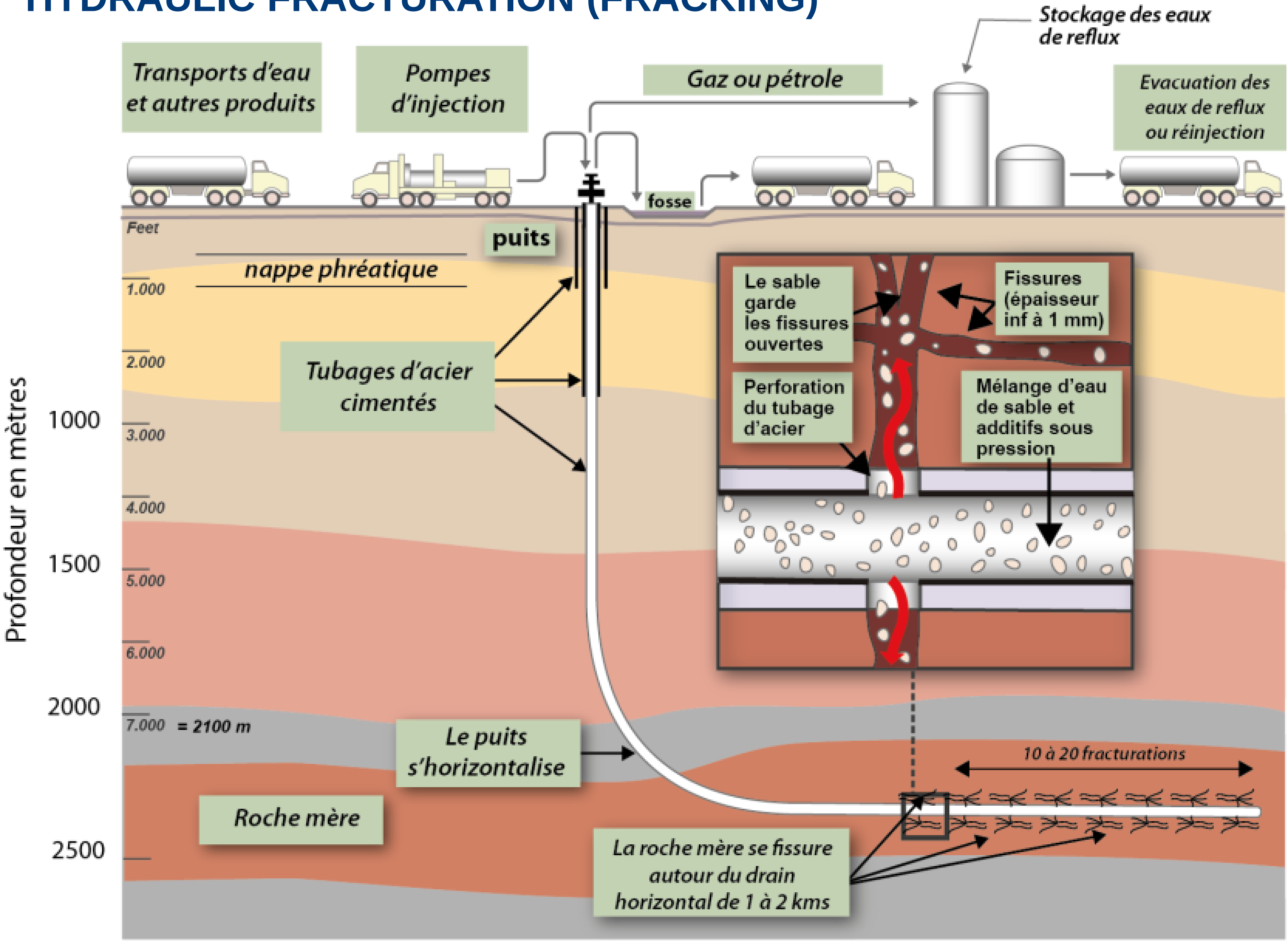
“HOT SHALES” MINERALOGY



Source : d'après Jim Buckee. Talisman ASPO 2012

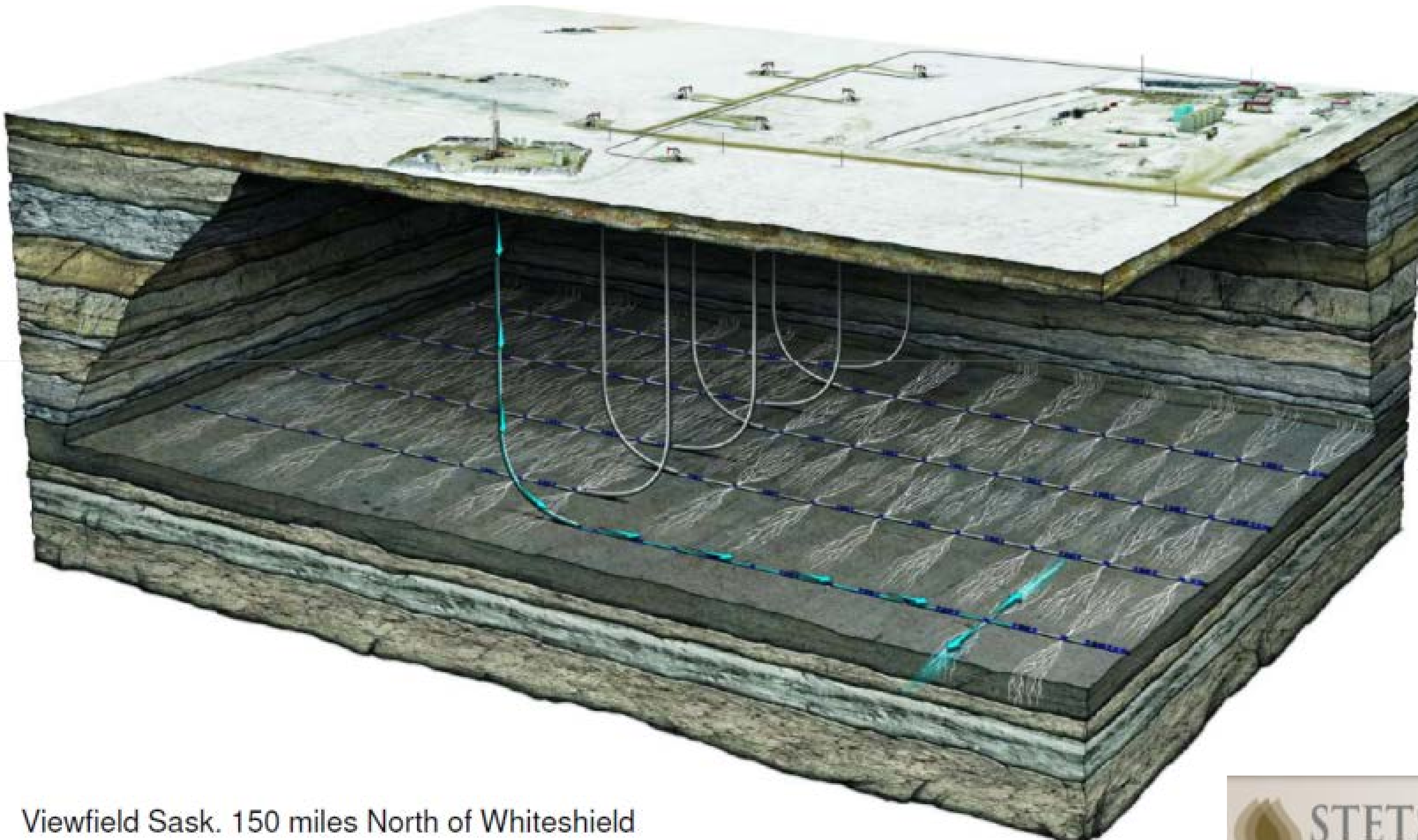
HOW TO PRODUCE TIGHT FORMATIONS ? PROBLEMS ?

HYDRAULIC FRACTURATION (FRACKING)



source : PR Bauquis - 15 janvier 2014

SHALE GAS OR SHALE OIL TYPICAL DEVELOPMENT (USA)



Viewfield Sask. 150 miles North of Whiteshield

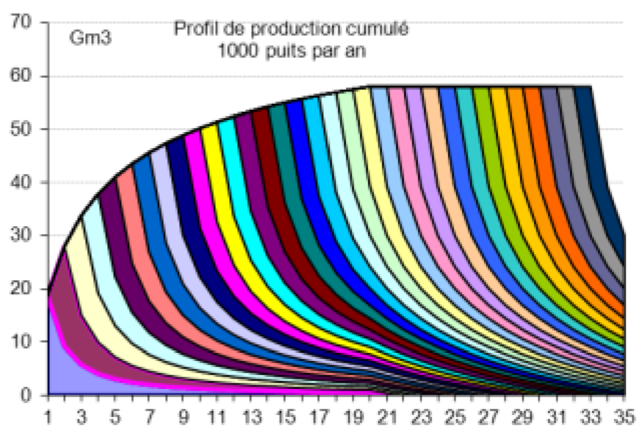
STETSON OIL & GAS LTD

SHALE OIL AND SHALE GAS: PRODUCTION MODELLING

- **Very high number of production wells**
  - US 2010 : 33,700 (50/50 P/G; 50% Hor.)
    2030 : 58,000 wells/y   (80/84 : + de 80 000 wells/y)

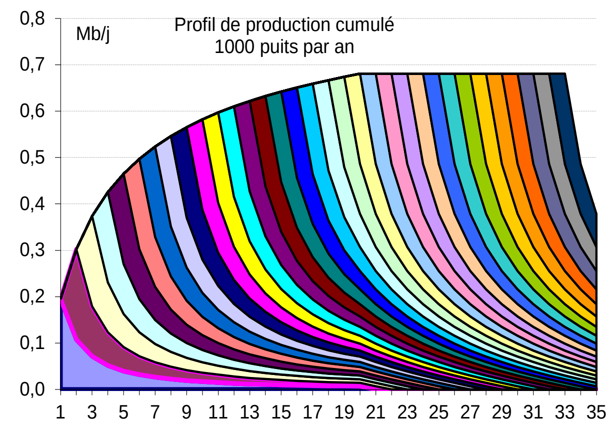
Example development base 1,000 wells per year

Shale gas-> 60 Gm3



Recovery per well: 2 BCF/ 58 Mcm

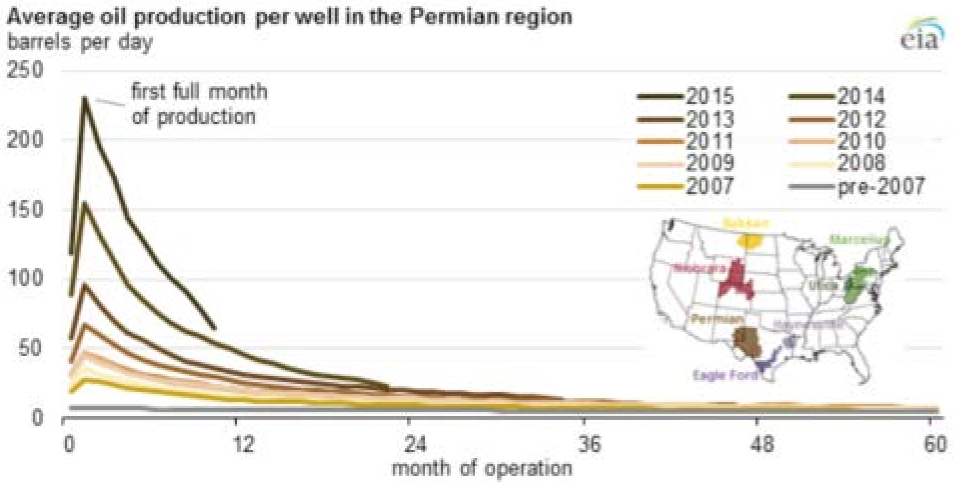
Shale oil-> 0,7 Mb/d

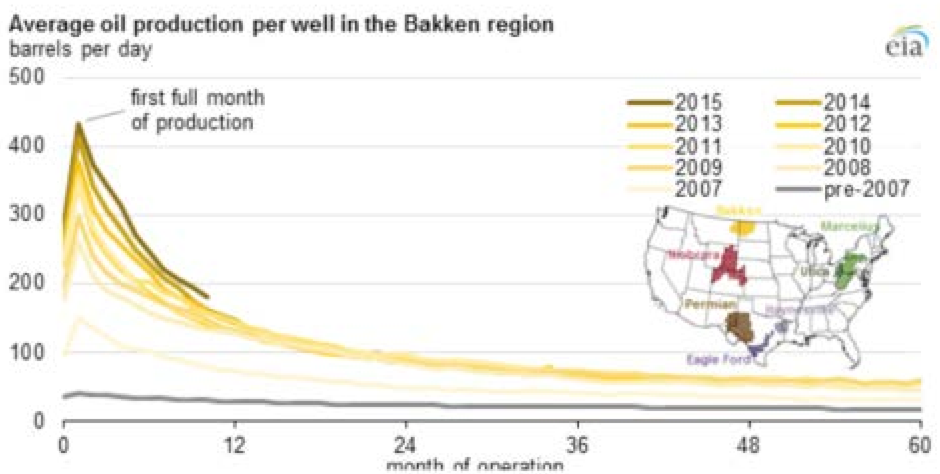


Recovery per well: 0.25 Mbbl

Guy Maisonnier 3 October, 2013

TYPICAL SHALE OIL PRODUCTION DECLINE CURVES (PERMIAN AND BAKKEN REGIONS)

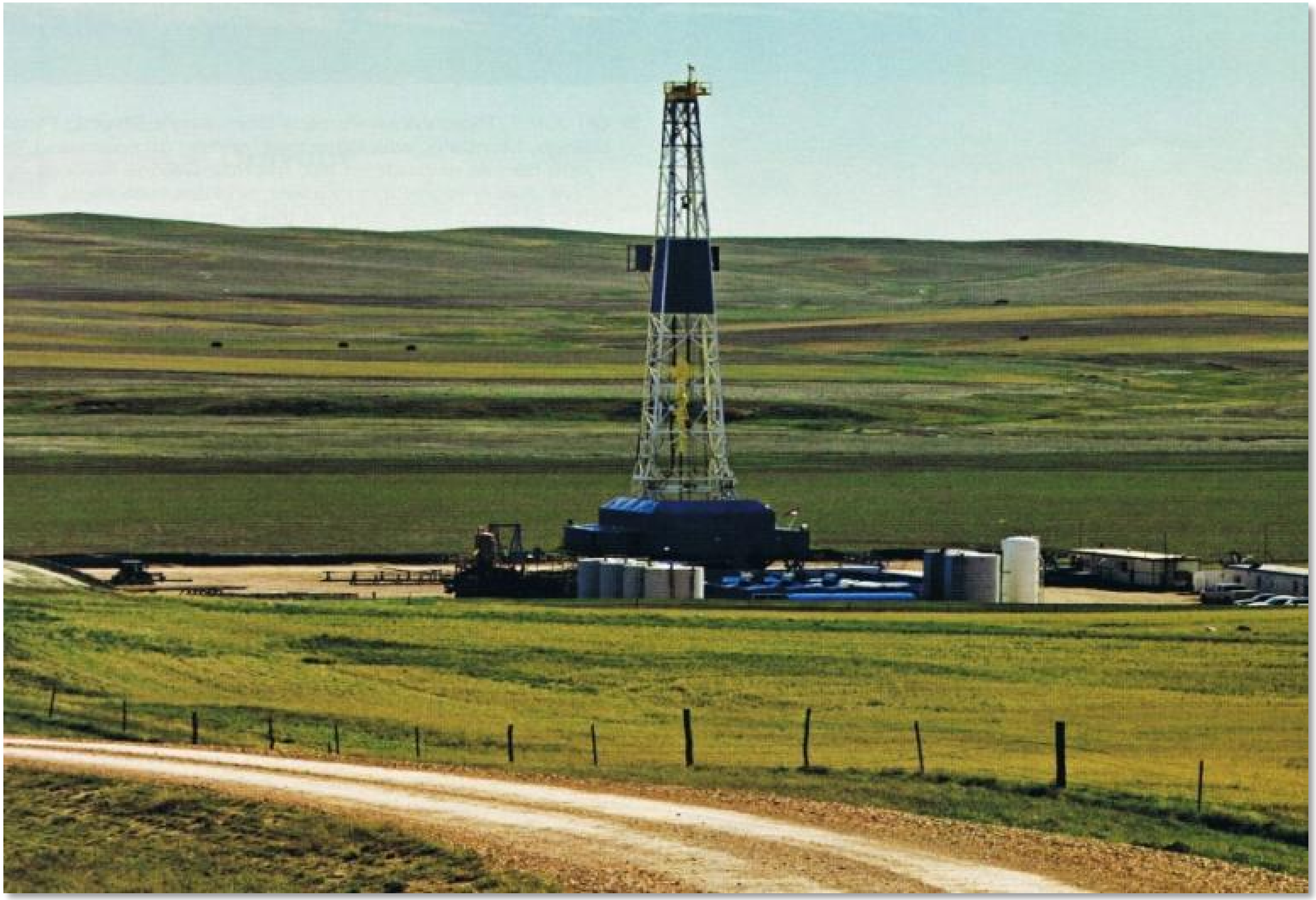




Source : EIA Drilling Productivity Report

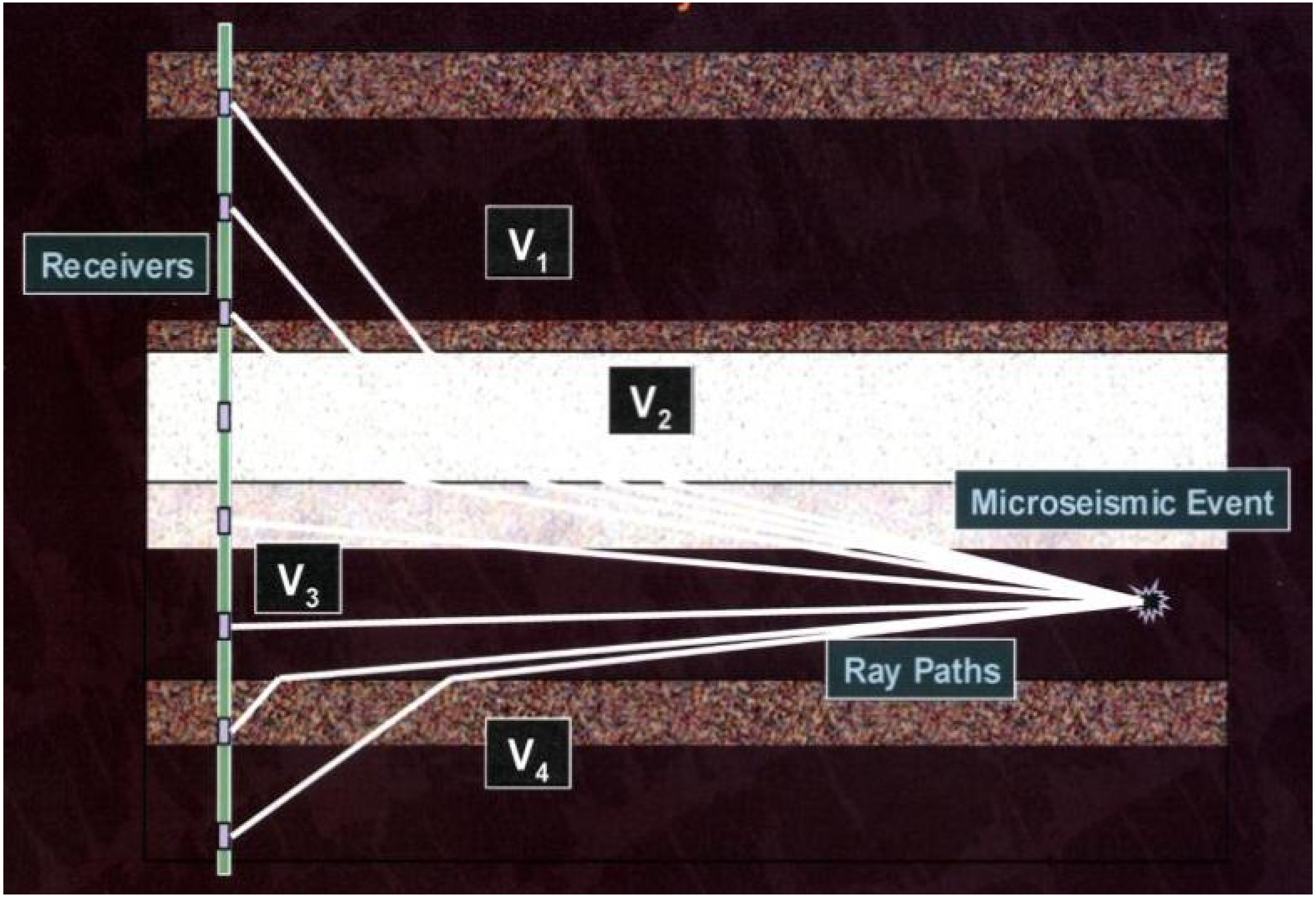
HOW PICTURES CAN « MANIPULATE » REALITIES

A ROSY VIEW

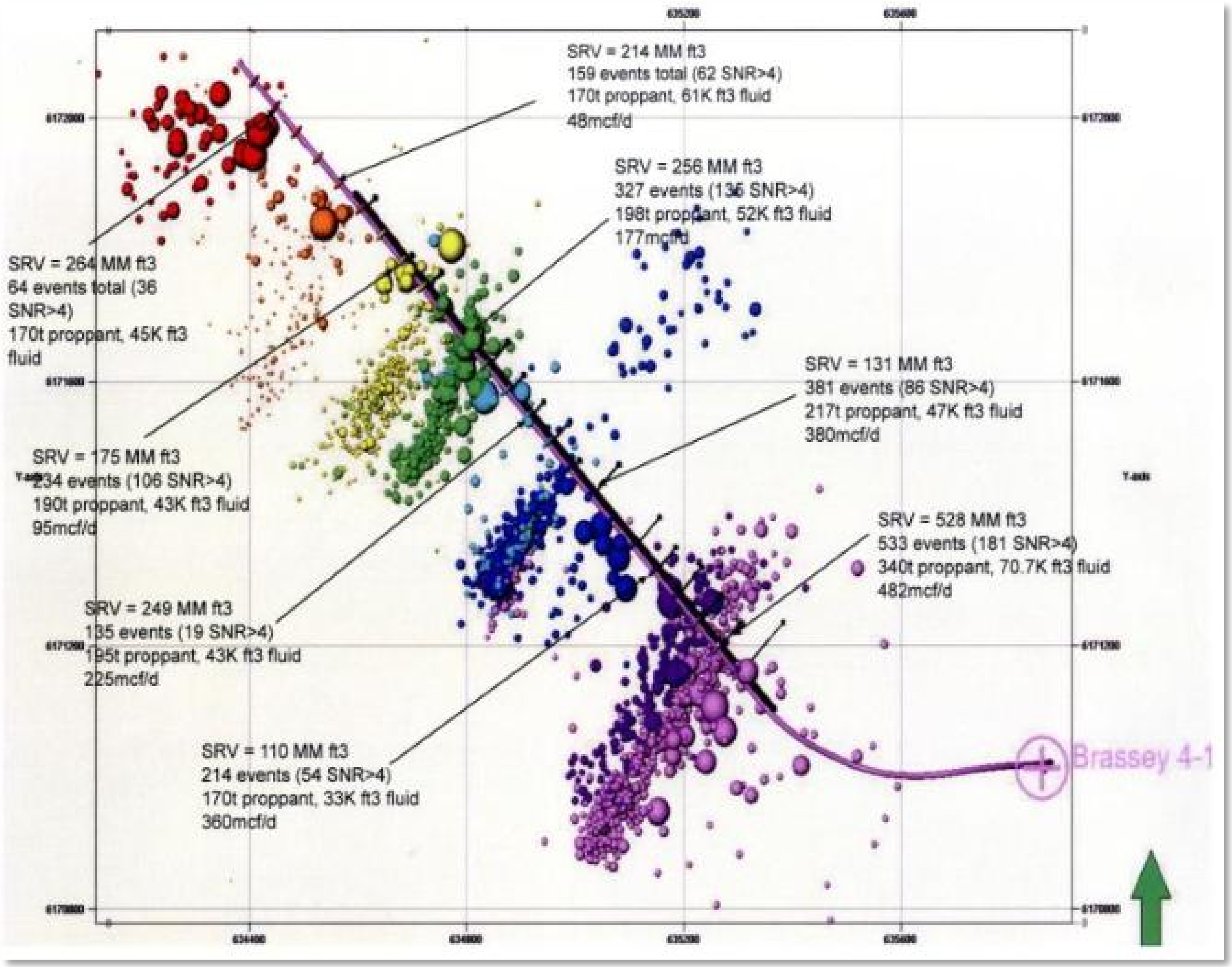


HOW PICTURES CAN « MANIPULATE » REALITIES
A DARK VIEW

WELL MICROSEISMIC RECORDING



MICROSEISMIC EVENTS IN A MULTI-FRACKED WELL

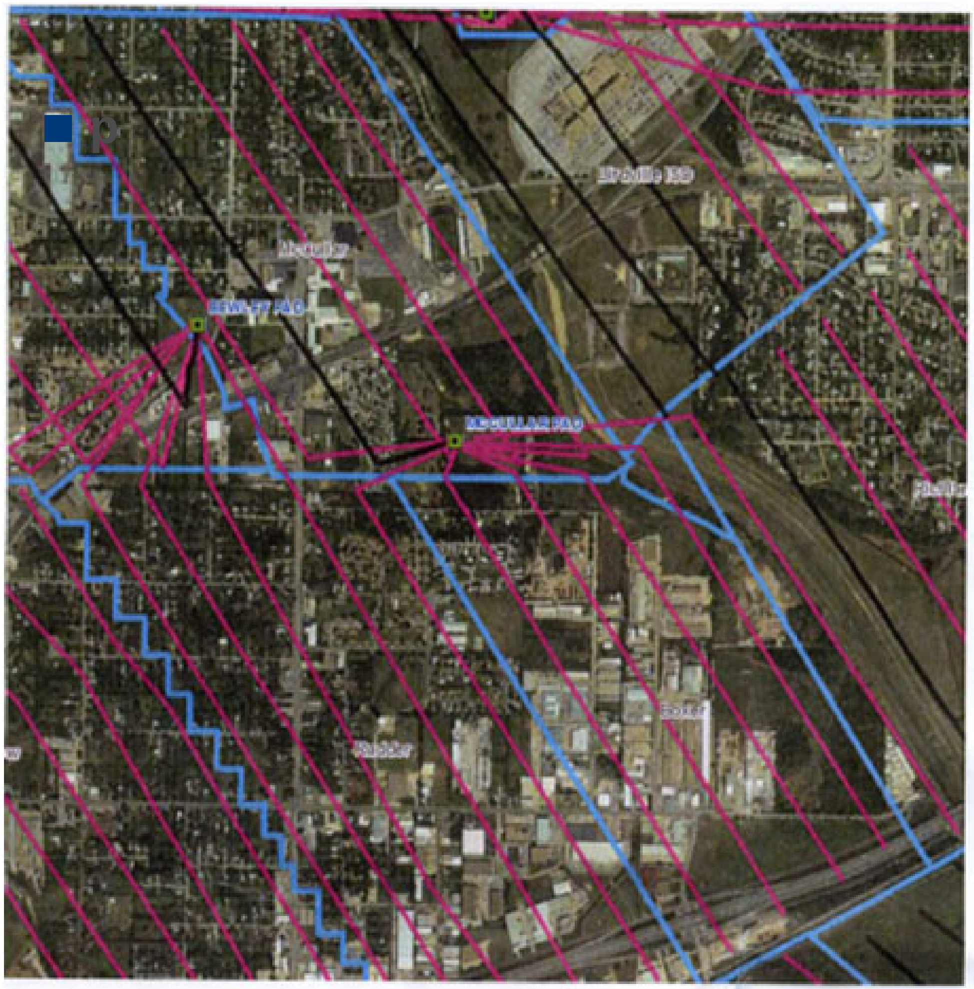


GAS SHALE EXPLOITATION

- 55 pads
- 8 wells per pad
- 300-325 wells

Dallas-Forth Worth airport

GAS PRODUCTION CLUSTERS AT DALLAS AIRPORT (DFW)



Drilling Info

Spud Date: 12/25/2010
TMD: 11,680'
TVD: 7,232'
Lateral Length: 4,026'
Drilling Days: 10
Shale Thickness: 320'

Completion Info

6 Stages
900,000 lbs of Proppant used
21,536 bbl of Fluid
3.6 Hours of Pump Time

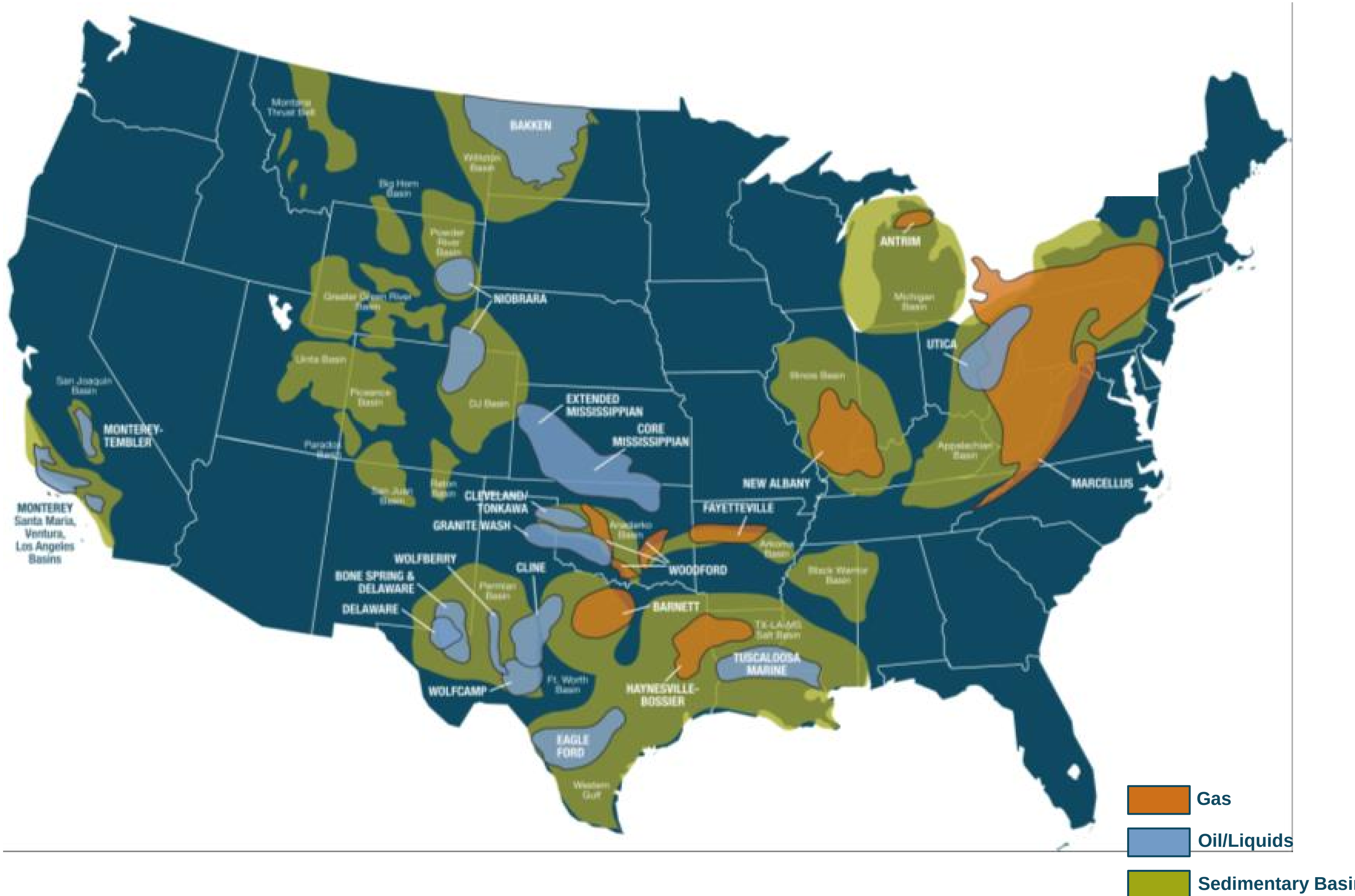
Puits McCullar 4H

Sources: Chesapeake energy

PRODUCTION CLUSTER AT DALLAS AIRPORT (DFW)

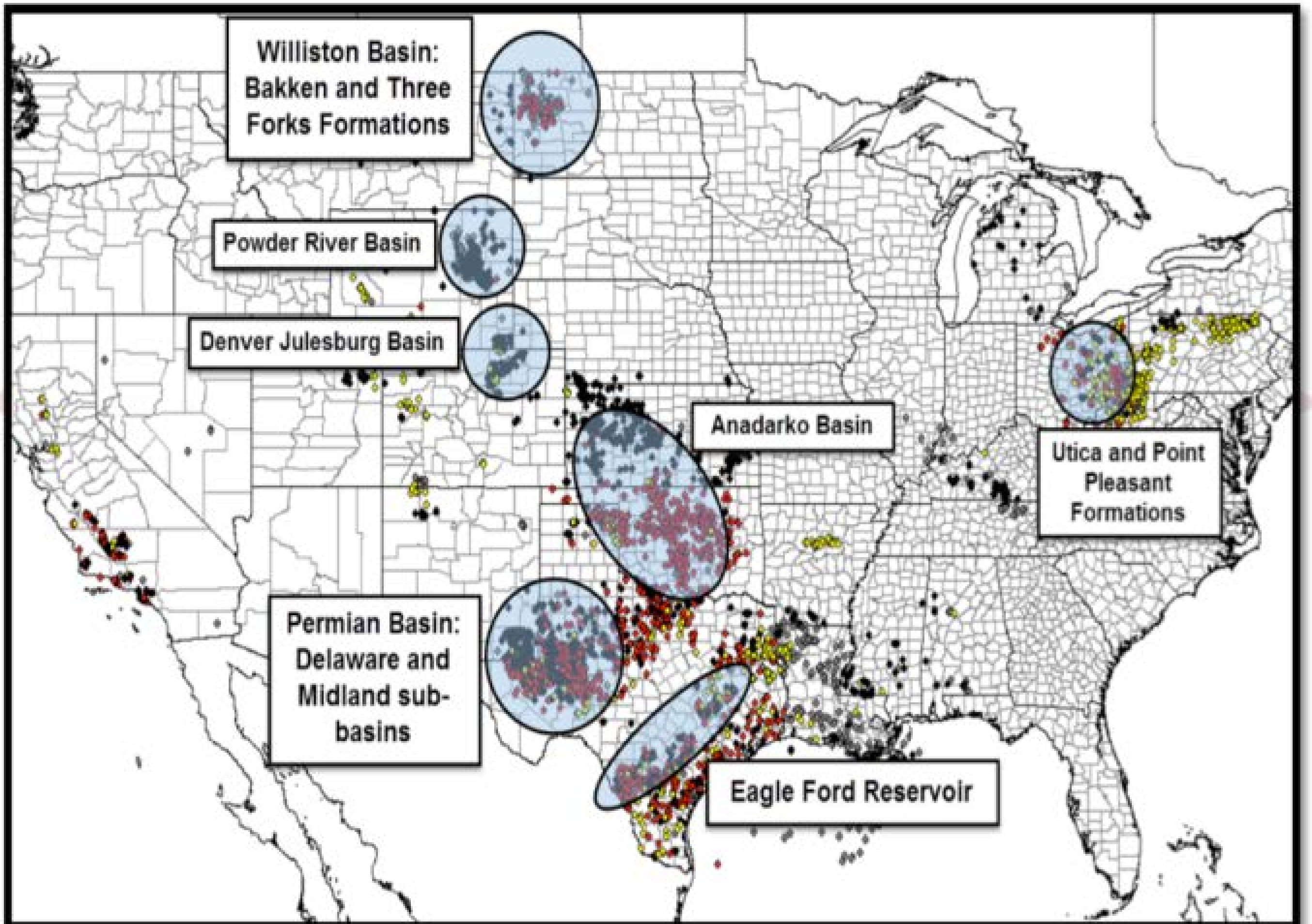
A NEW INDUSTRY BORNE IN THE US

U.S. SHALE/TIGHT GAS & LIQUIDS PRODUCTION REGIONS



Source: Wood Mackenzie Q1 2015

US SHALES PLAYS: A SIMPLIFIED MAP



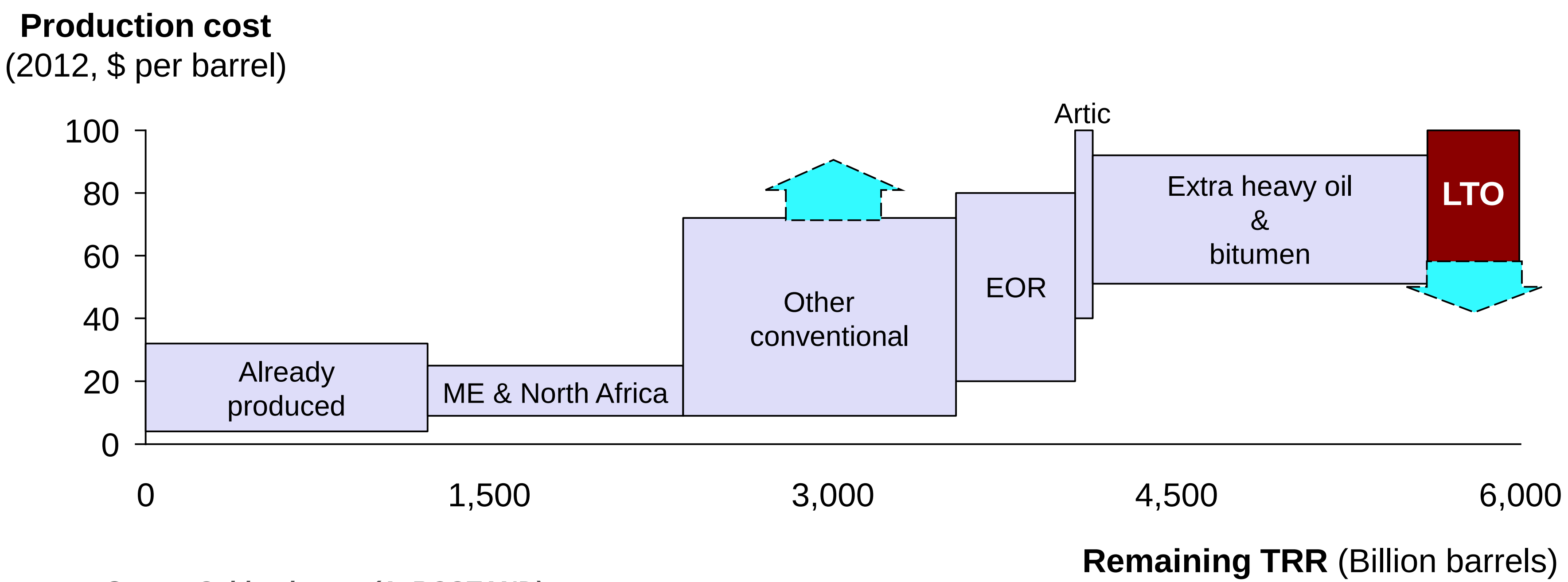
Source: EPRINC, US Oil Shale Dynamics in a Low Price Environment

Source: Drilling Info, Permits filed in past 90 days (September 2015)

Note: Black dots indicate oil, red dots indicate oil and gas, yellow dots indicate dry gas, and gray indicates all other permits including confidential product status.

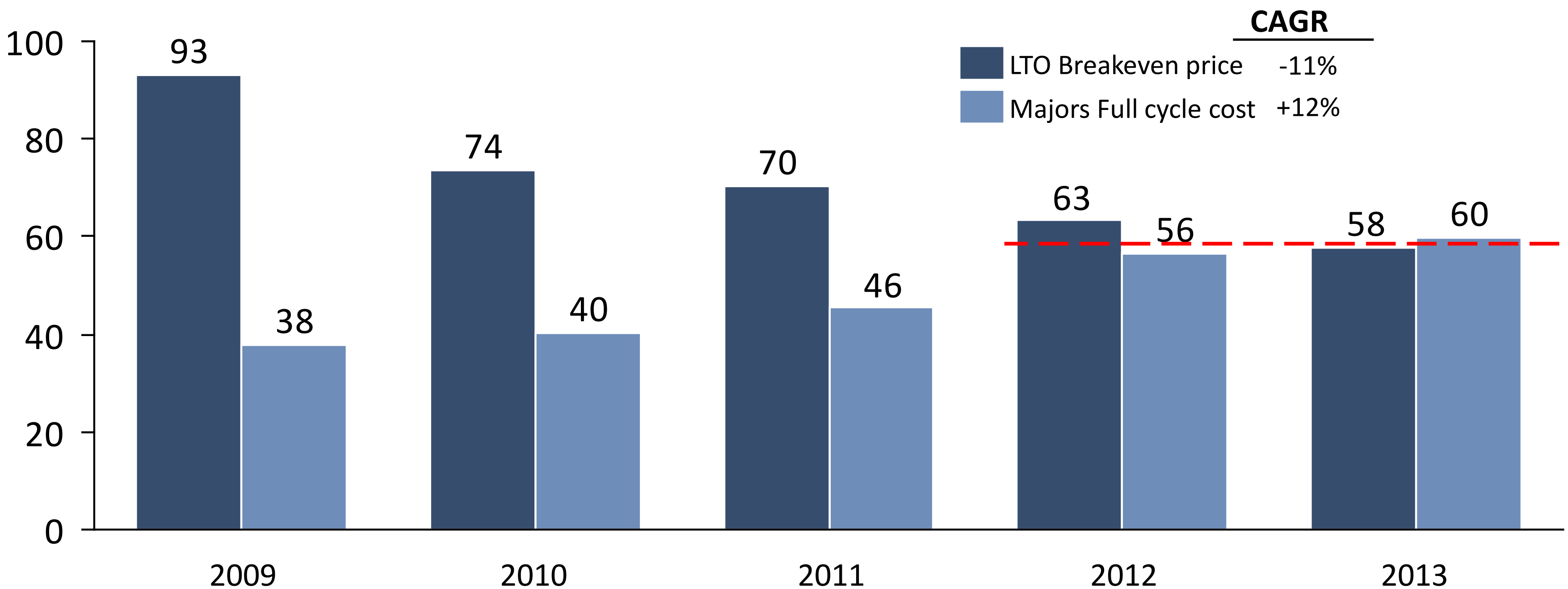
SOURCE ROCK OIL AND OTHER LTO: A FAST DECREASE OF PRODUCTION COST

SUPPLY COST OF LIQUID FUELS
$ per barrel, billion barrels



*Source: **Schlumberger (A. ROSTAND)***
Conférence Oil & Money
Londres 29-30 Octobre 2014

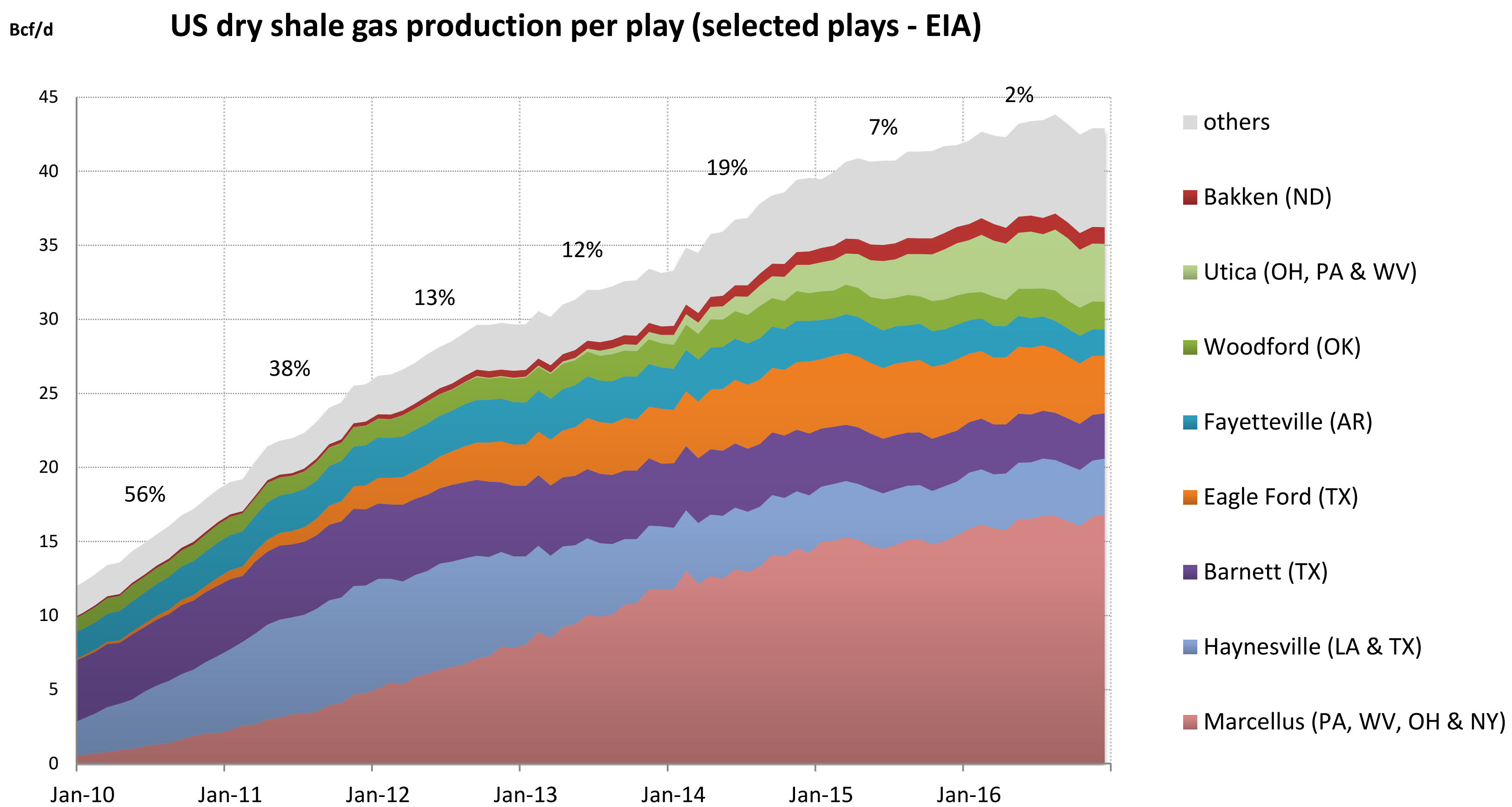
SOURCE ROCK OIL AND OTHER LTO: THEIR PRODUCTION COST ARE NOW SIMILAR TO CONVENTIONAL OIL.
HOWEVER COST STRUCTURES ARE TOTALLY DIFFERENT



*Source: **Schlumberger (A. ROSTAND)***
Conférence Oil & Money
Londres 29-30 Octobre 2014

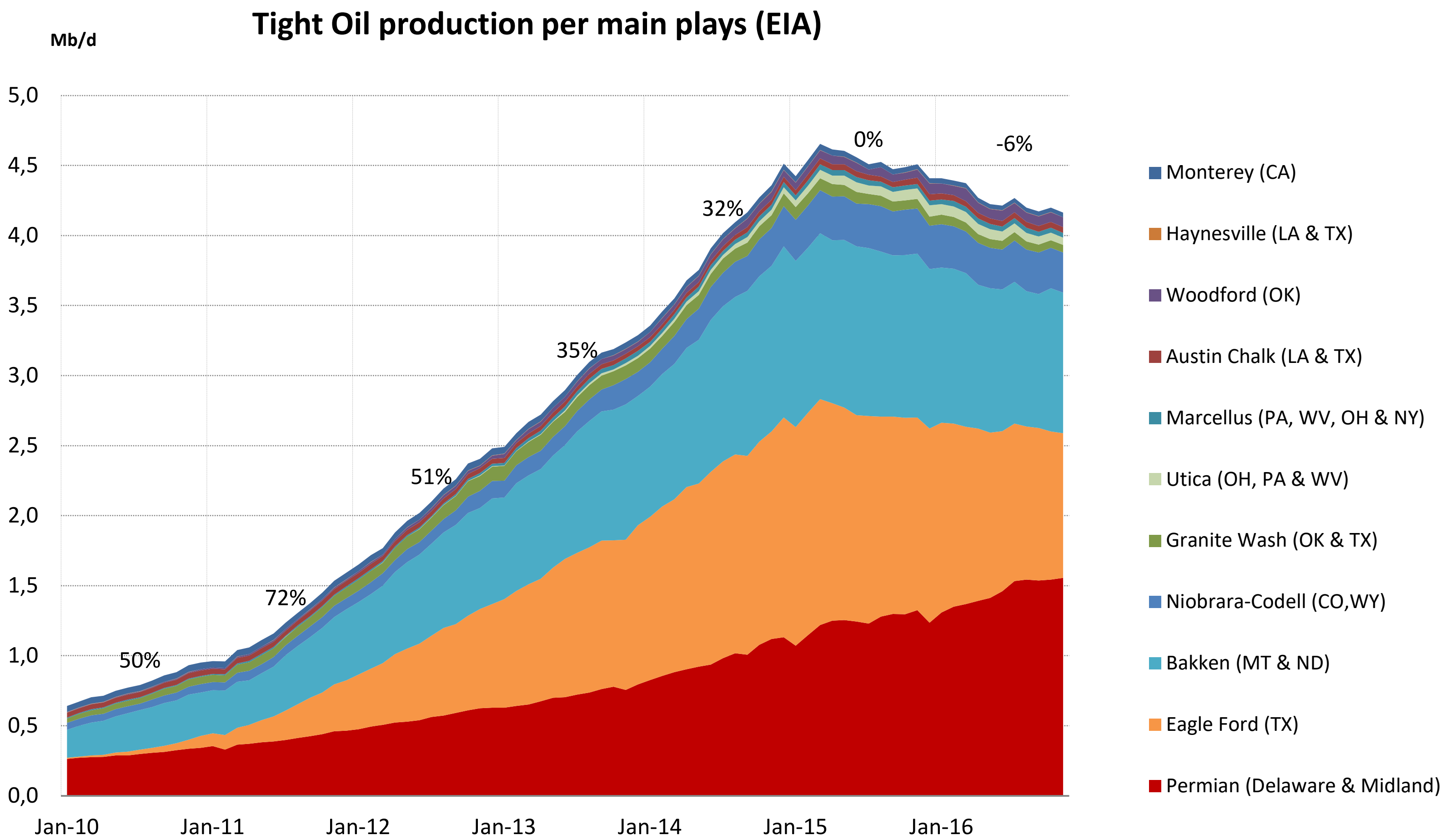
***1: F&D + Lifting costs**. Pure unconventional NAM players*
***2**: S&GA + F&D + Total Production + WACC. Majors*
***Source**: 1) Rystad, IHS; 2) Evaluate Energy; Goldman Sachs*

US SHALE GAS MAJOR PLAYS (2010 – 2017)



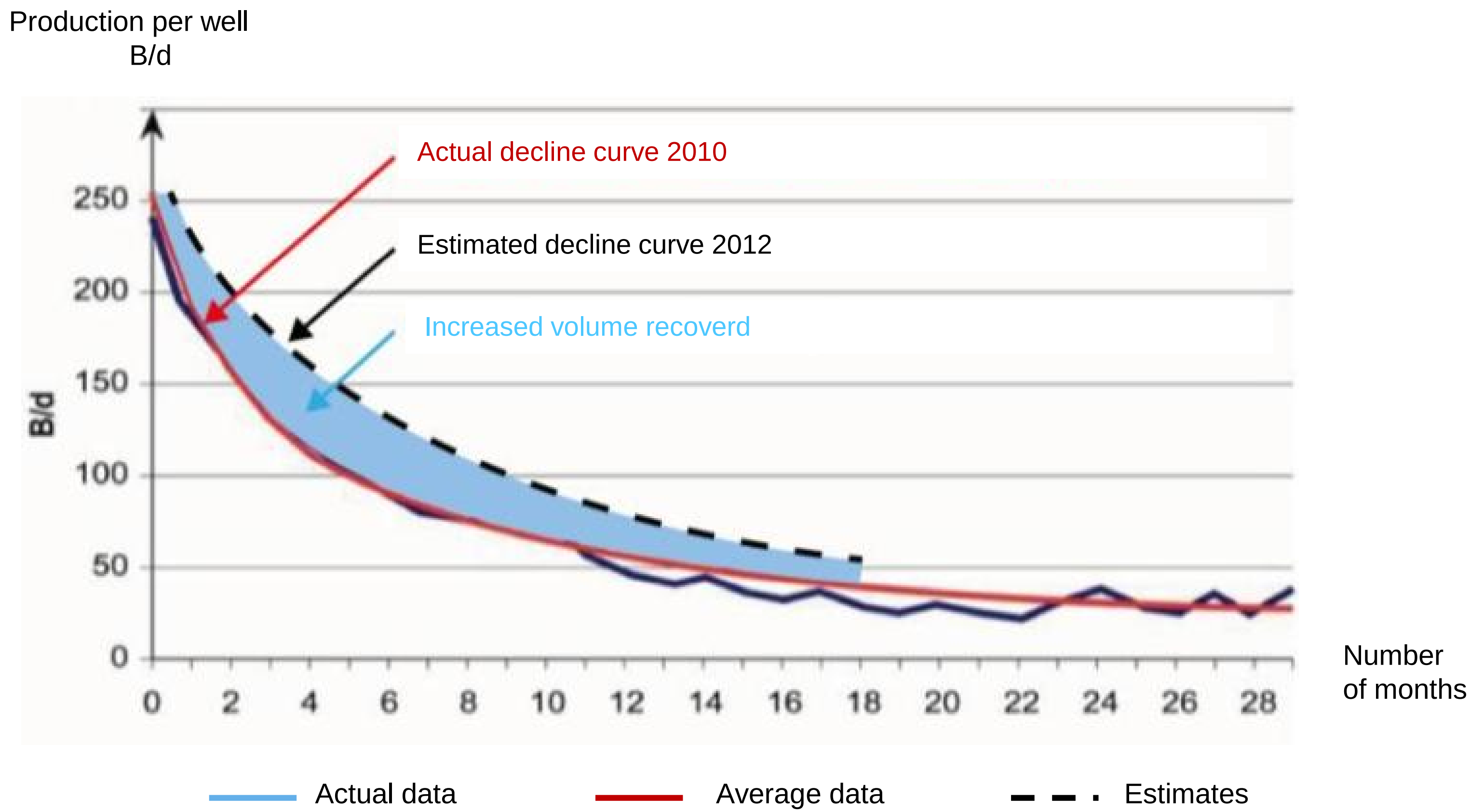
Source : EIA

US SHALE OIL / LTO MAJOR PLAYS (2010 – 2017)



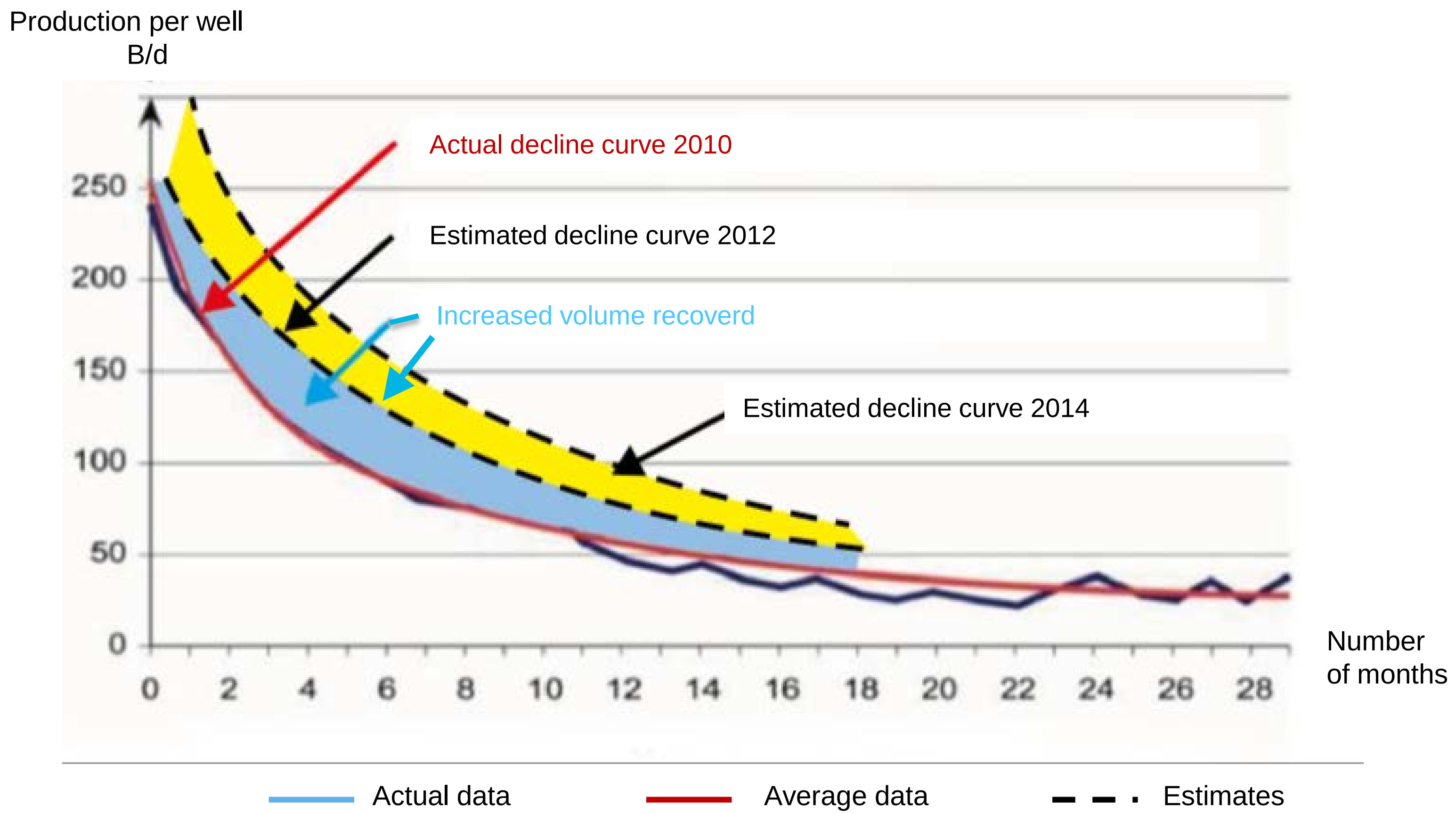
Source : EIA

BAKKEN SHALES AVERAGE PRODUCTION CURVES
A RAPID IMPROVEMENT FROM 2010 TO 2012



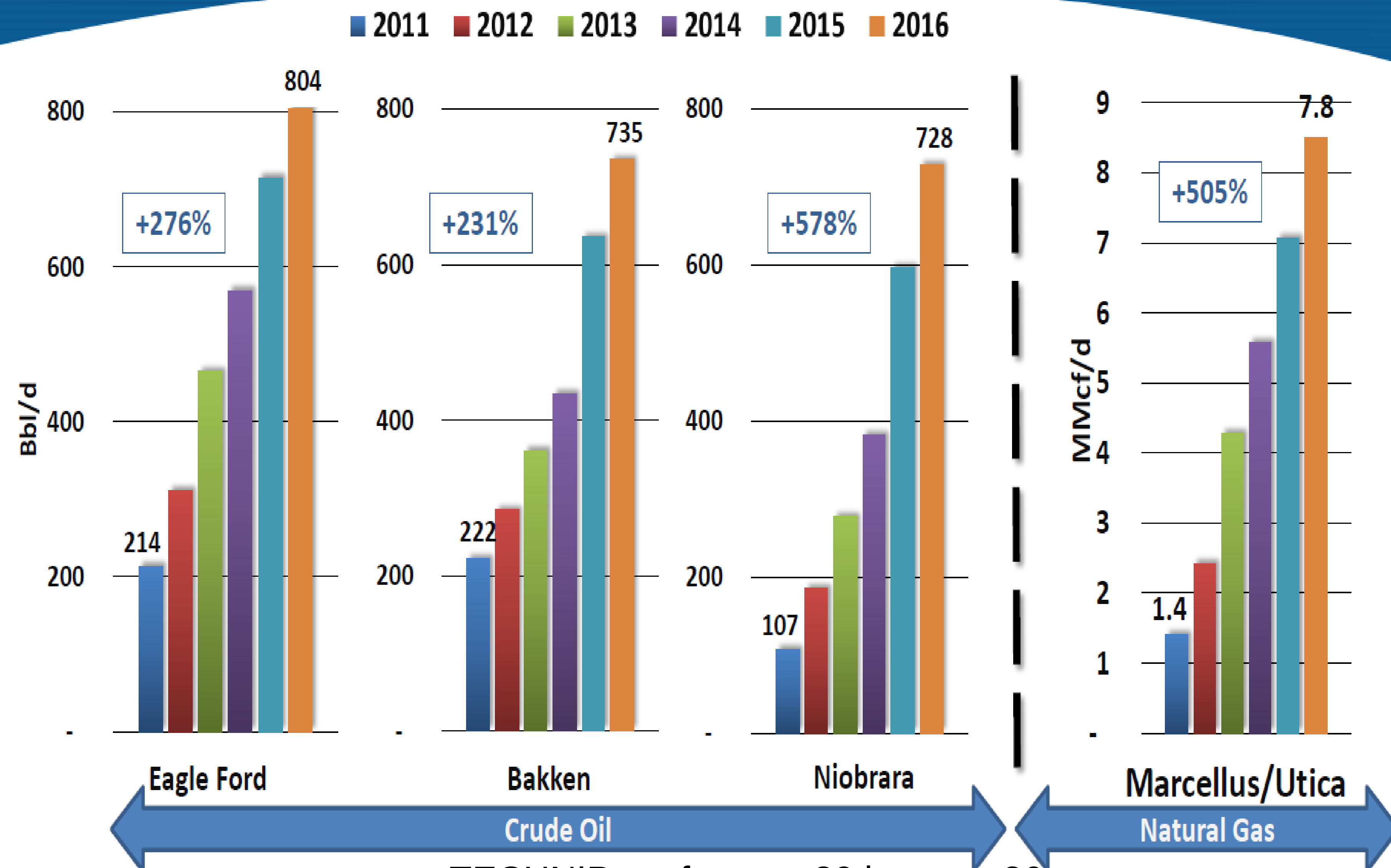
PR Bauquis – May 2013

BAKKEN SHALES AVERAGE PRODUCTION CURVES
A RAPID IMPROVEMENT FROM 2010 TO 2014



PR Bauquis – March 2012

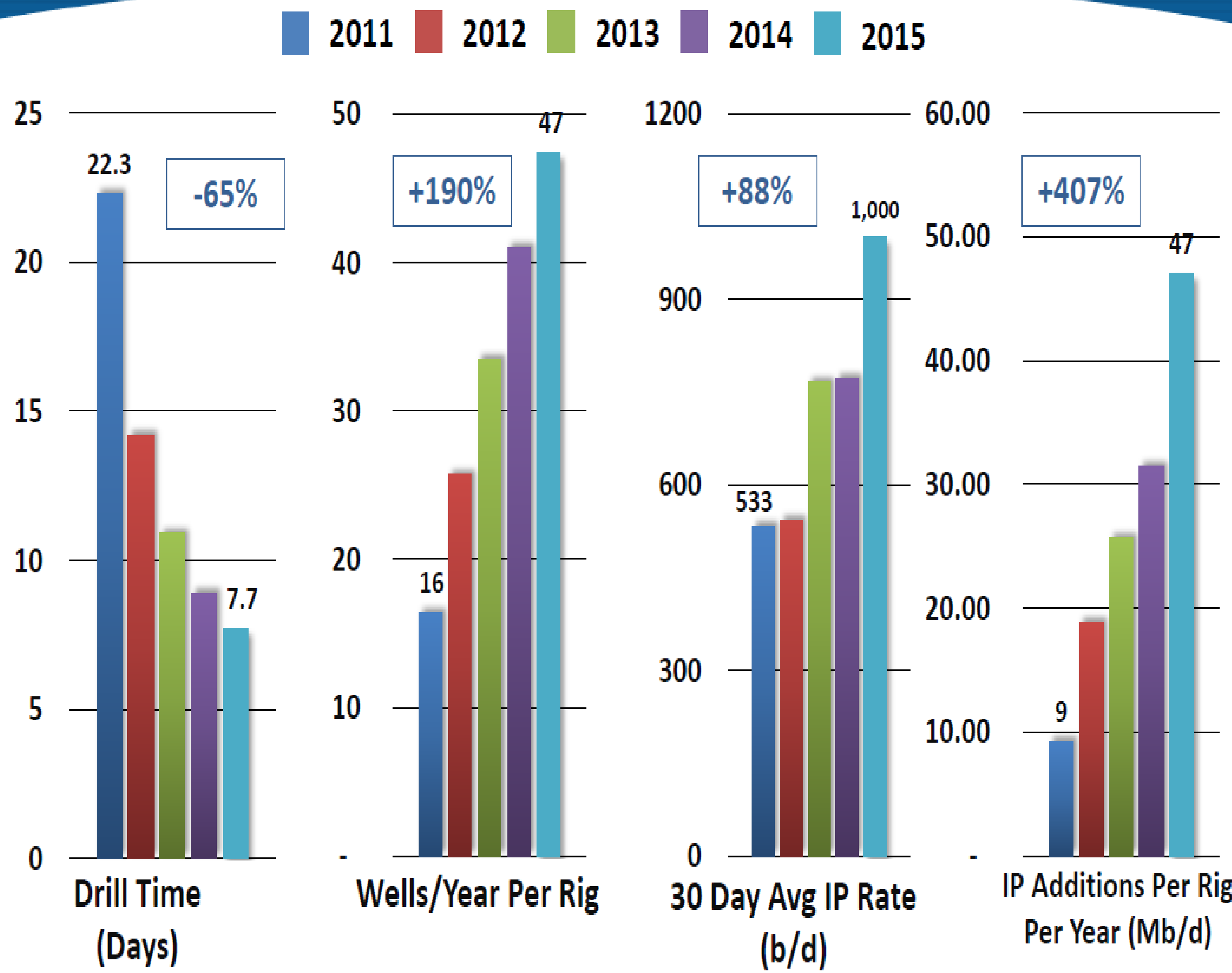
Oil and Gas Production Added Per Rig



Source: Rusty Brazil, RBN Enegy, CSIS Presentation, Febr. 2016

Source: EIA

EOG Eagle Ford Productivity Gains



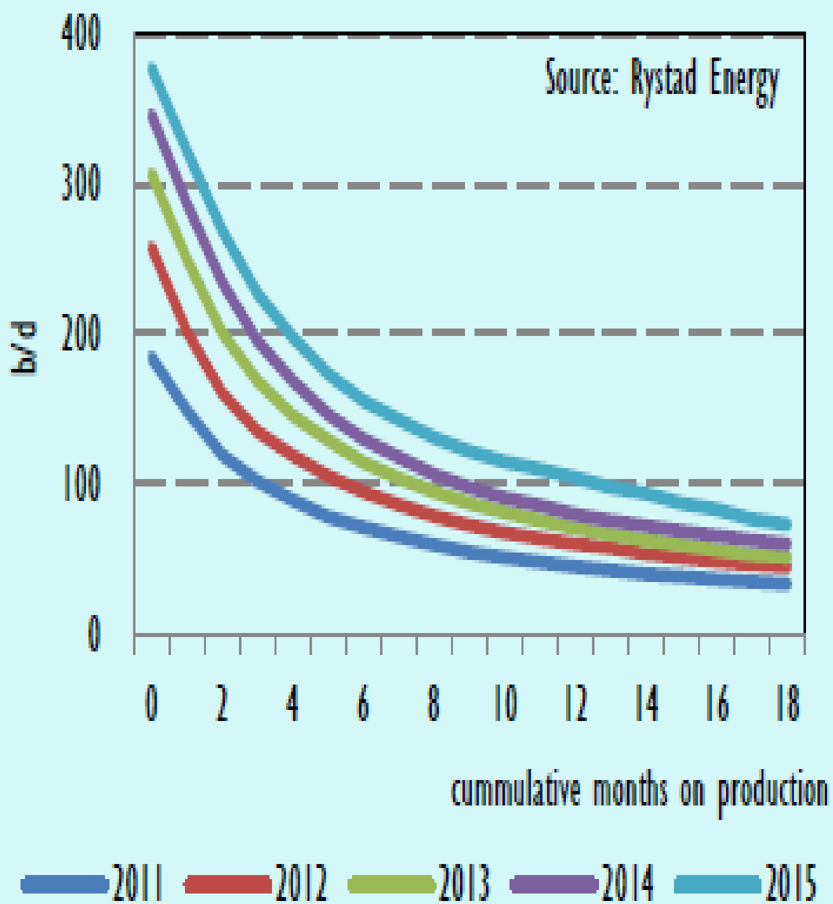
RBN Energy LLC

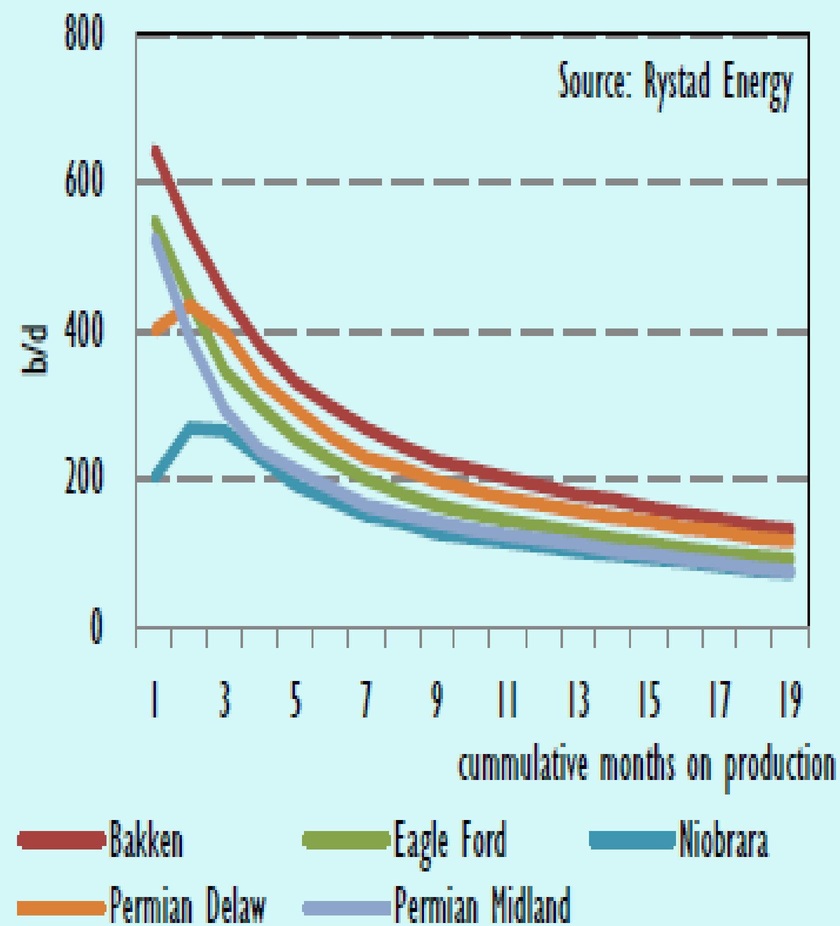
Source: Rusty Brazil, RBN Energy, CSIS Presentation, Febr. 17, 2016

Source: EOG

Average US shale play well performance

Average daily production by shale play – 2015 production start year

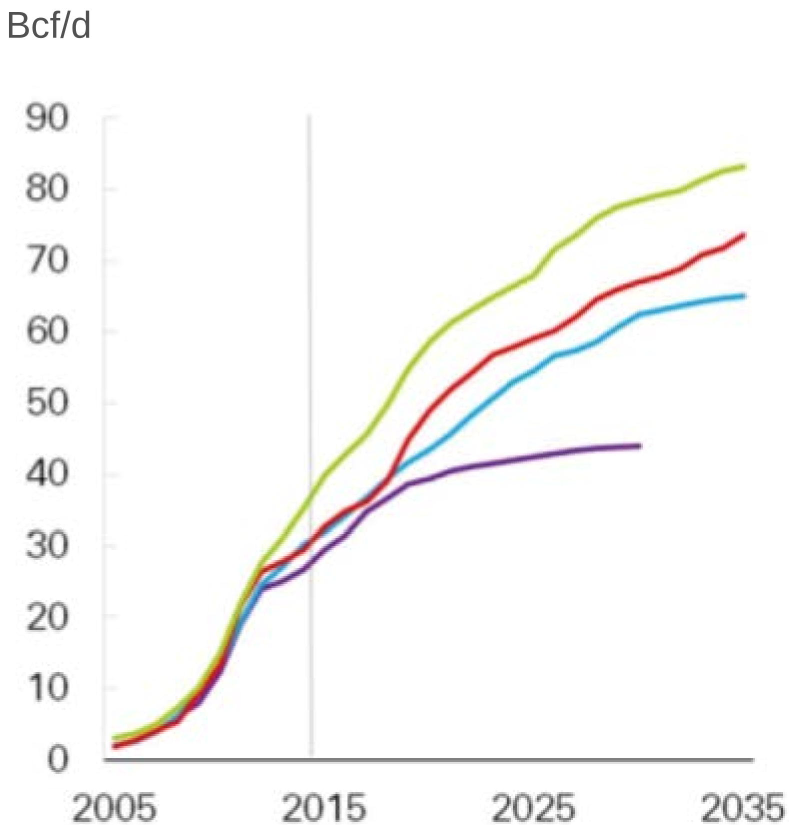




Source: IEA, Midterm Outlook, 2016

SHALE GAS AND TIGHT GAS DOMINATE THE US GAS PRODUCTION AND WILL CONTINUE TO INCREASE IN THE NEXT 20 YEARS

A 100% UNCERTAINTY MARGING AT A 2035 HORIZON !



Source BP (2016a)

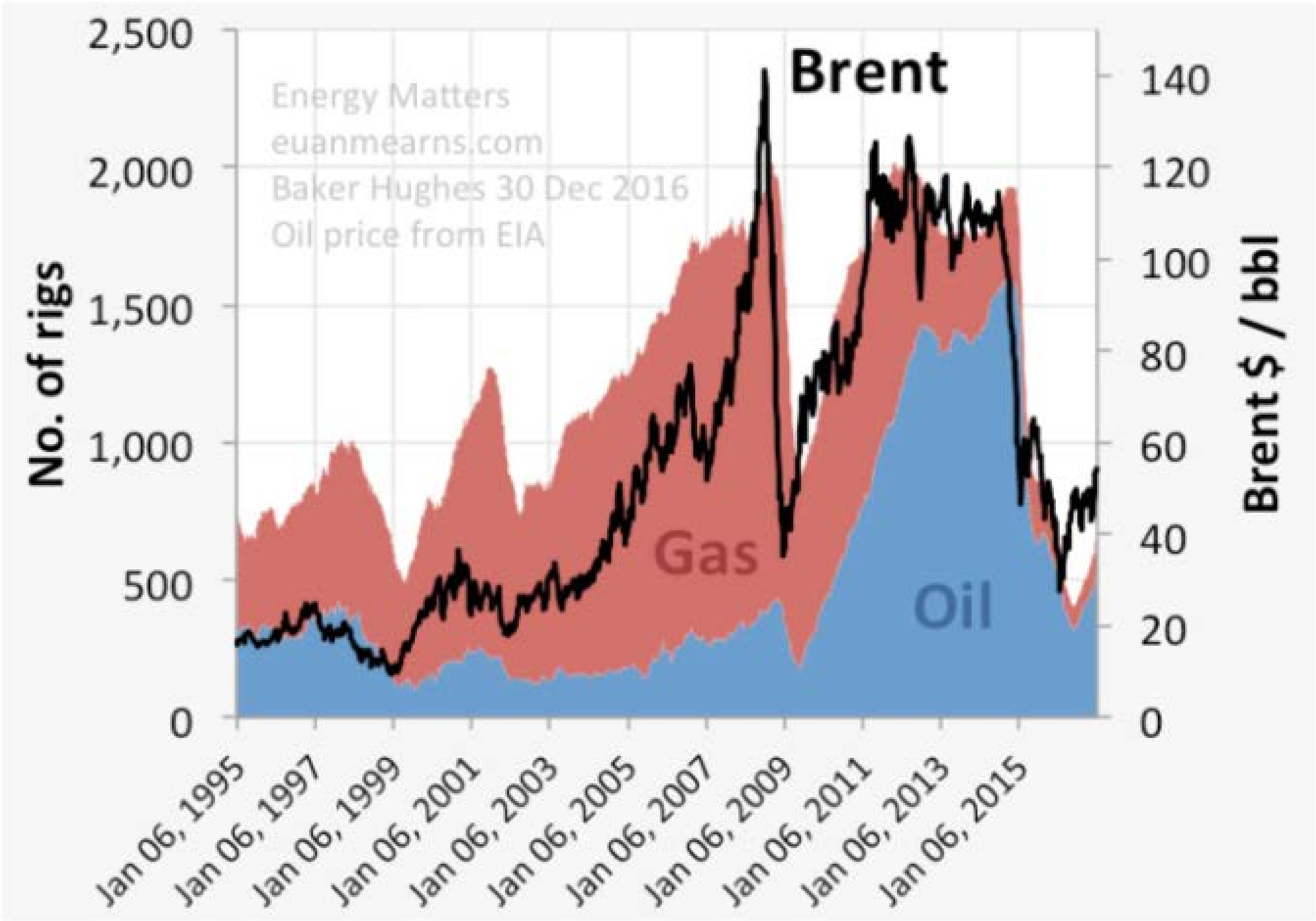
US SHALE OIL AND THE 2014 OIL PRICE COLLAPSE

DECEMBER 2014: A POLITICAL VIEW OF OIL PRICE COLLAPSE AS ILLUSTRATED BY MEDIAS

PRODUCING COUNTRIES FIRST LEAGUE (10 TO 12 MBD)

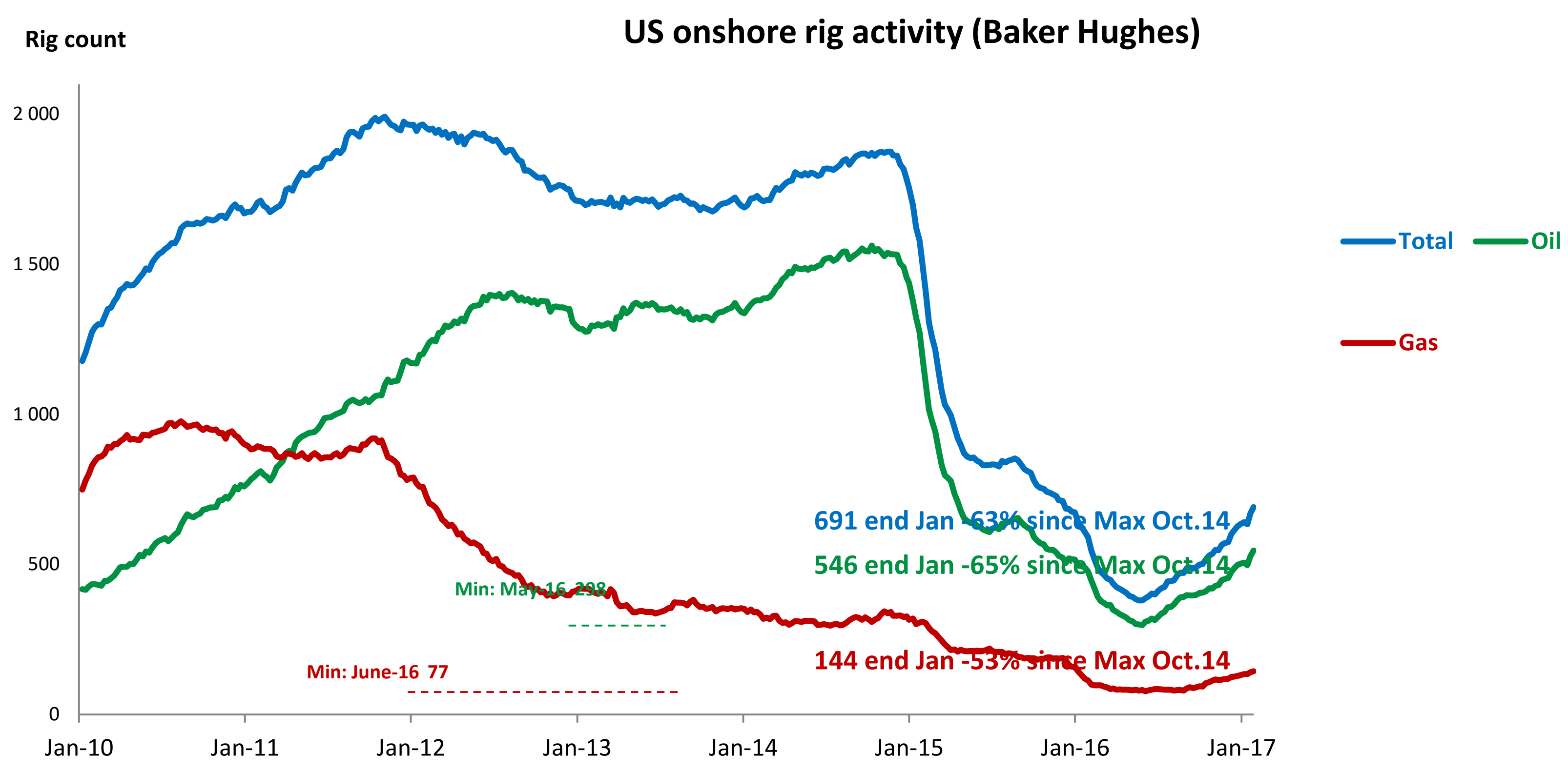
(*) US Shale Ressouces

80% OF LAND RIGS DRILLING FOR OIL (EARLY 2017) VERSUS 20% FOR GAS…VERSUS 80% FOR GAS AND 20% FOR OIL EARLY 2008



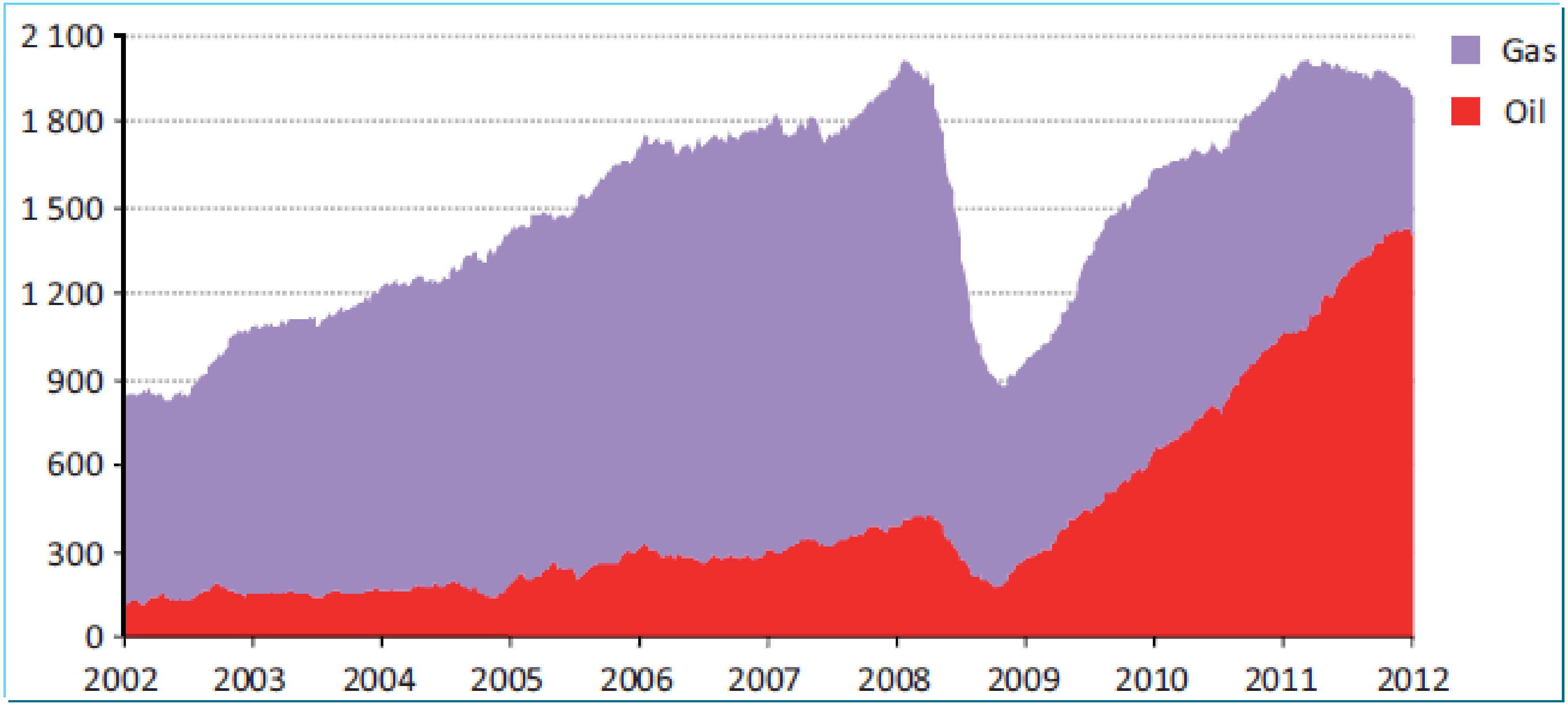
Source : Euan Mearns

OIL AND GAS RIG COUNTS IN THE US (JANUARY 2010 TO JANUARY 2017)



Source : Baker Hughes

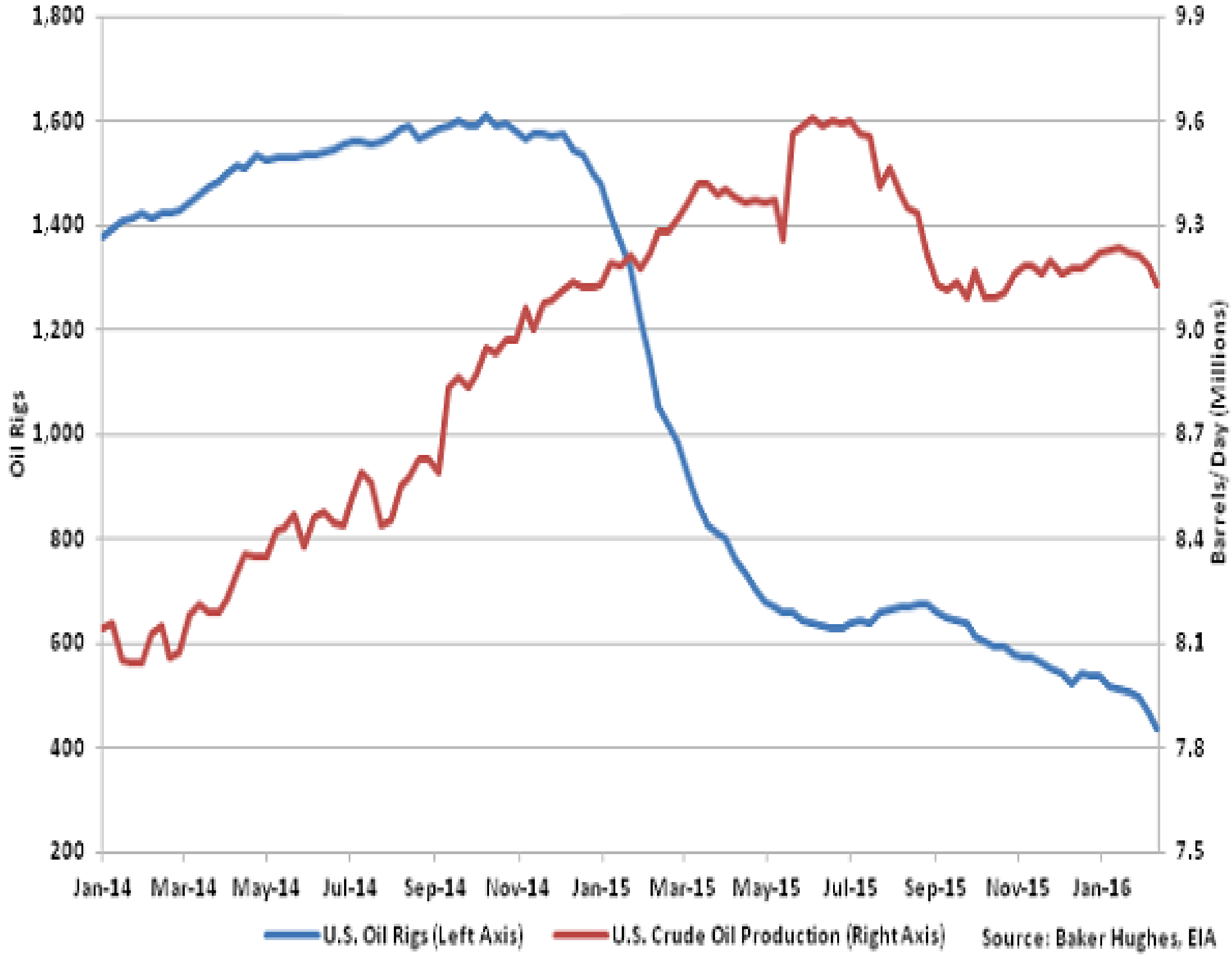
ACTIVE DRILLING RIGS IN THE US 2002 – 2012 … (SEE NEXT SLIDE FOR 2013-2015)



- **Decrease of shale gas wells in 2012 due to the plunge in gas price, while oil wells increased significantly thanks to robust oil price.**

Source: IEA WEO 2012

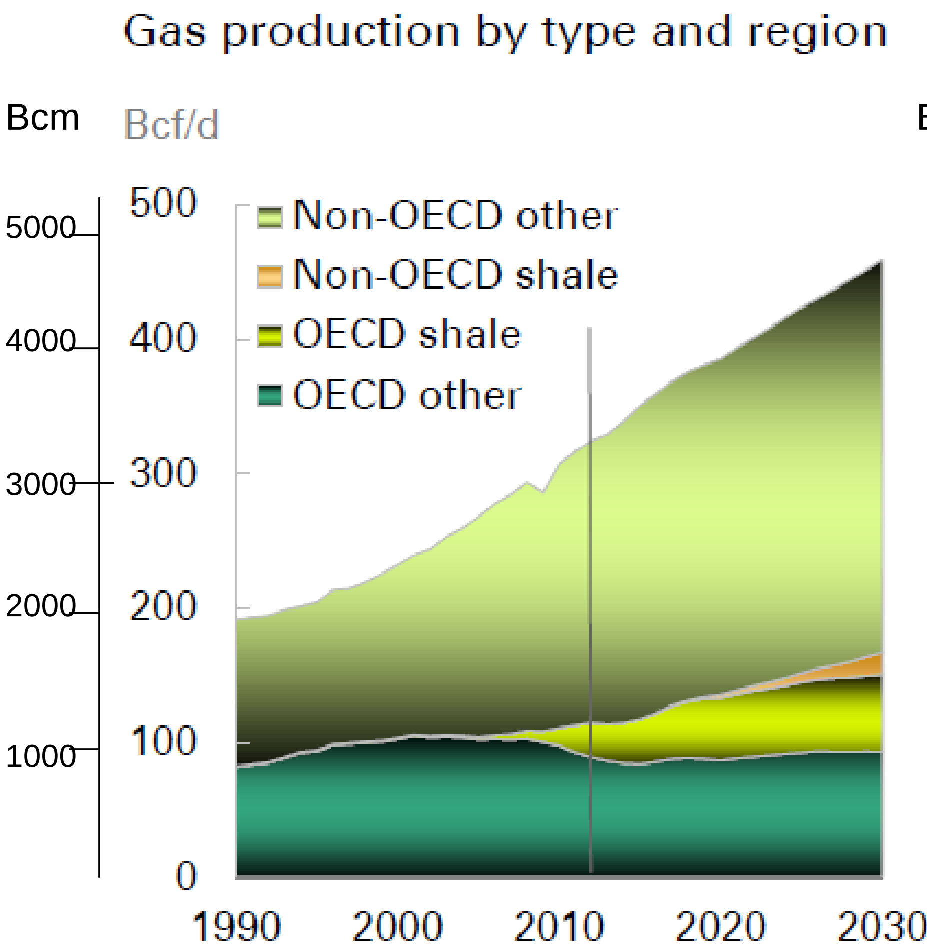
TOTAL US OIL RIG COUNT VERSUS US CRUDE OIL PRODUCTION (AND 2013 TO EARLY 2016)

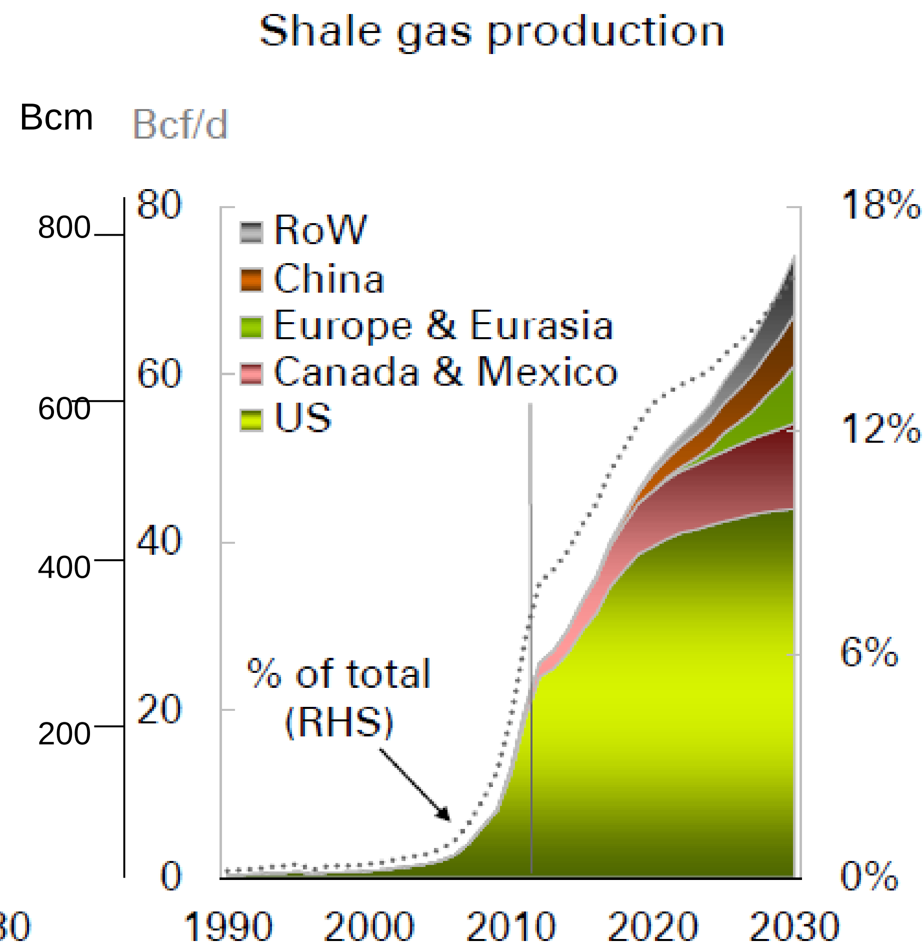


Source: Kent Moors, Calpital Research Group, March 2016

SHALE GAS PRODUCTION WILL GROW, IN & OUTSIDE US

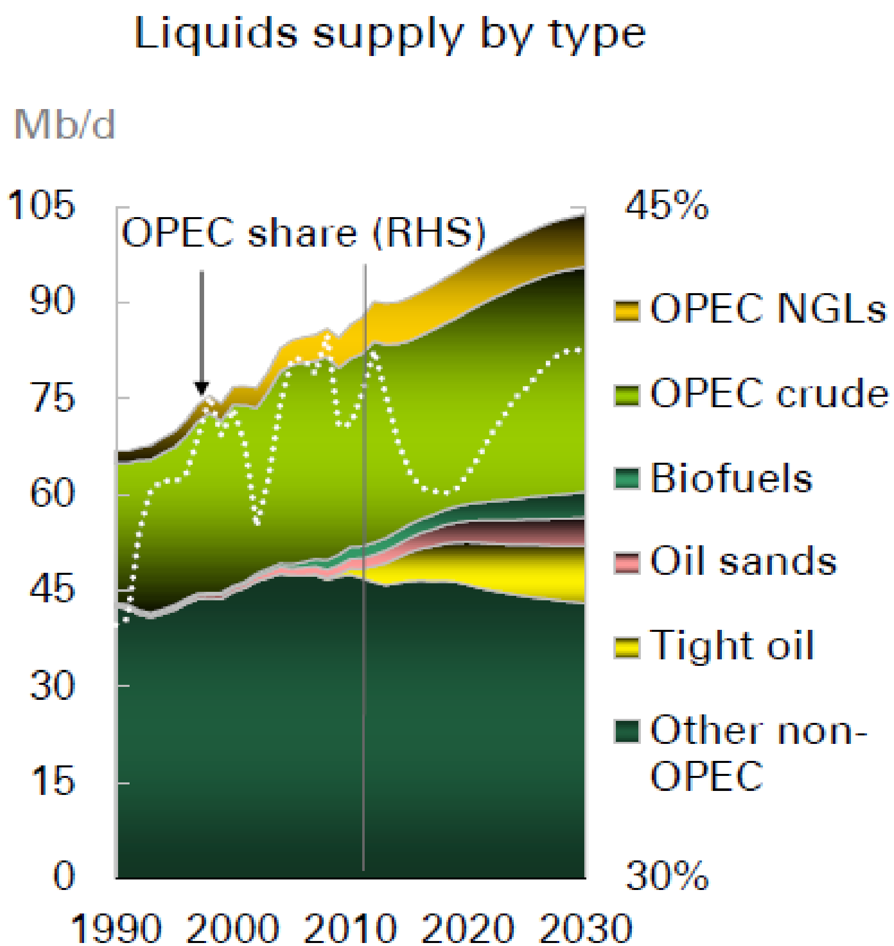
A VISION BY BP

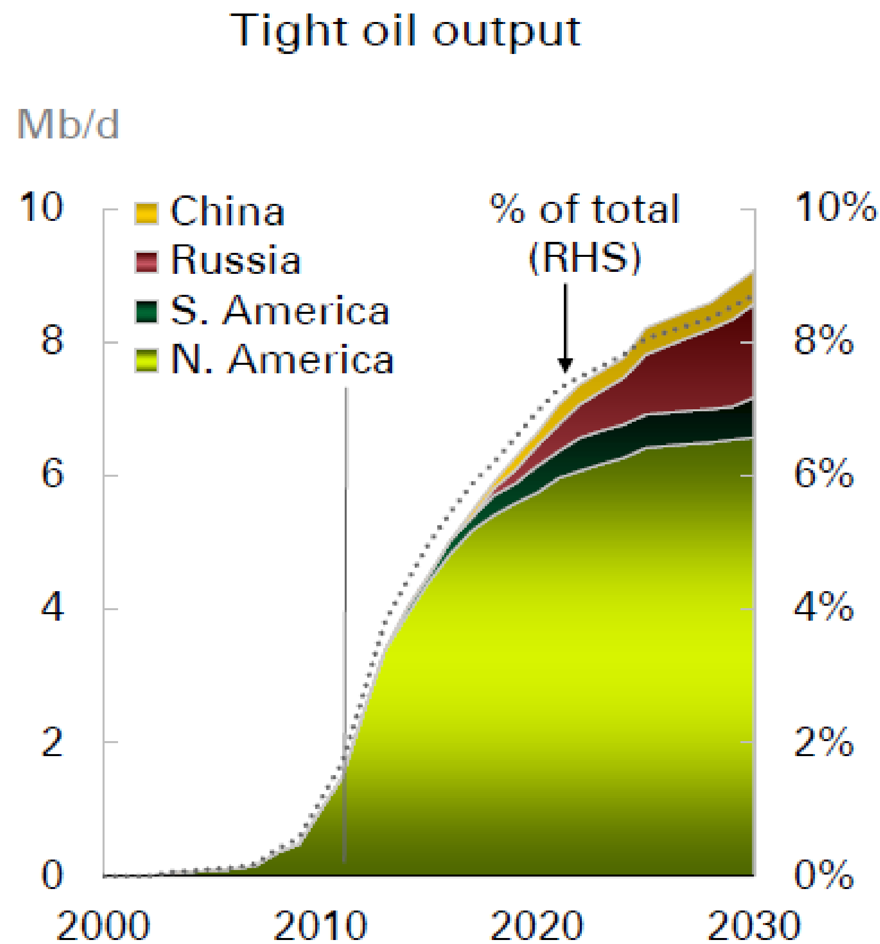




Source: BP Energy Outlook 2030

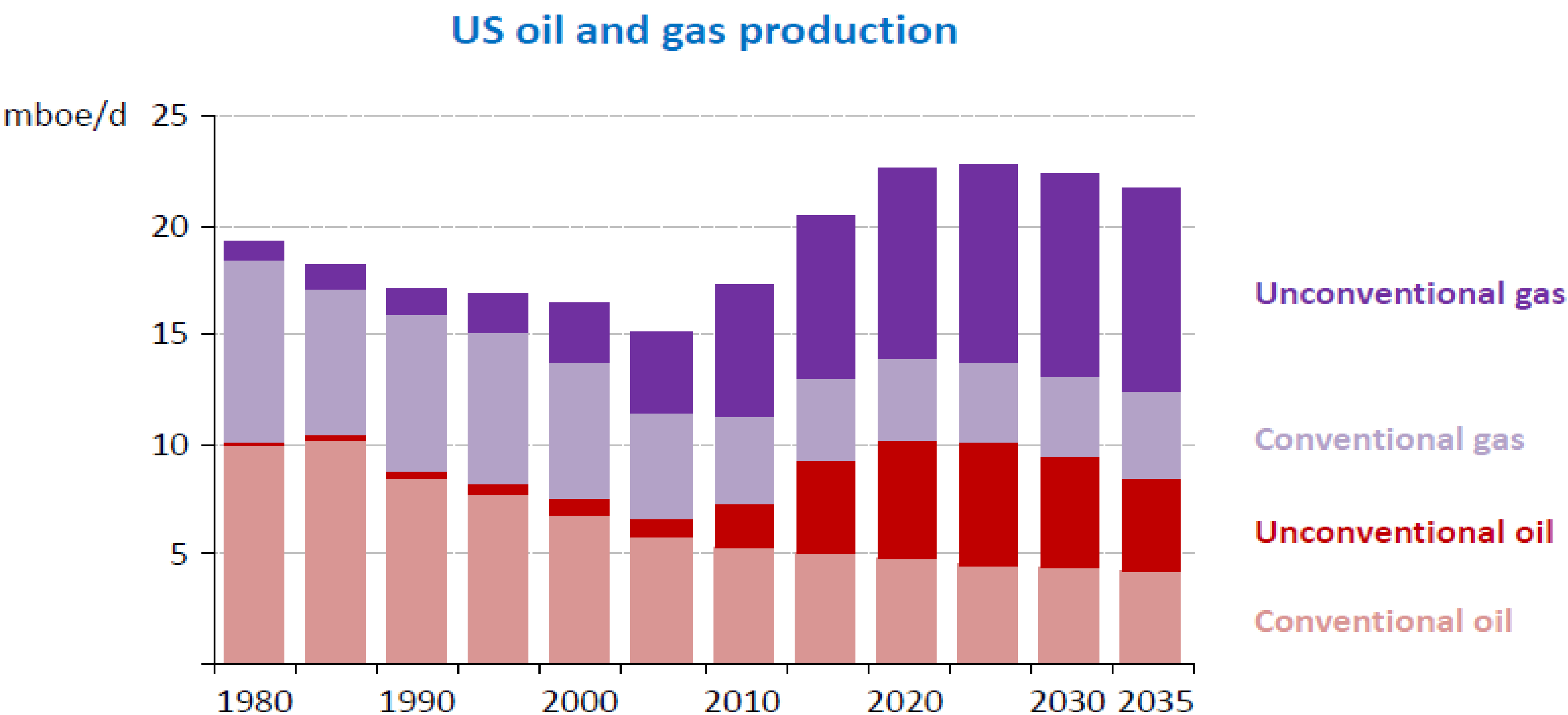
TIGHT OIL OUTPUT WILL DRIVE LIQUIDS SUPPLY
A VISION BY BP





Source: BP Energy Outlook 2030

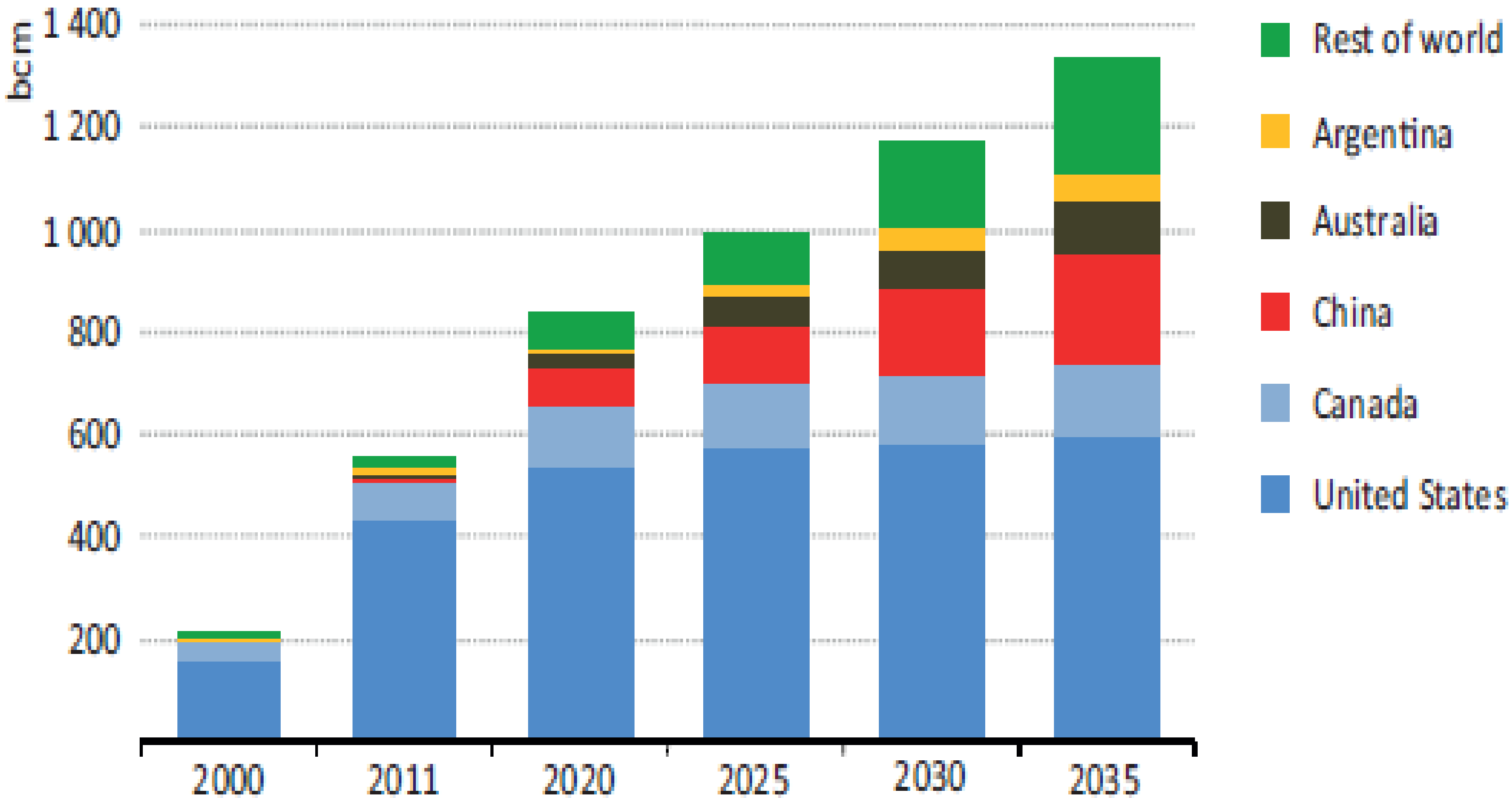
EMERGENCE OF UNCONVENTIONAL HC WILL LARGELY INCREASE US OIL & GAS PRODUCTIONS



The surge in unconventional oil & gas production has implications well beyond the United States

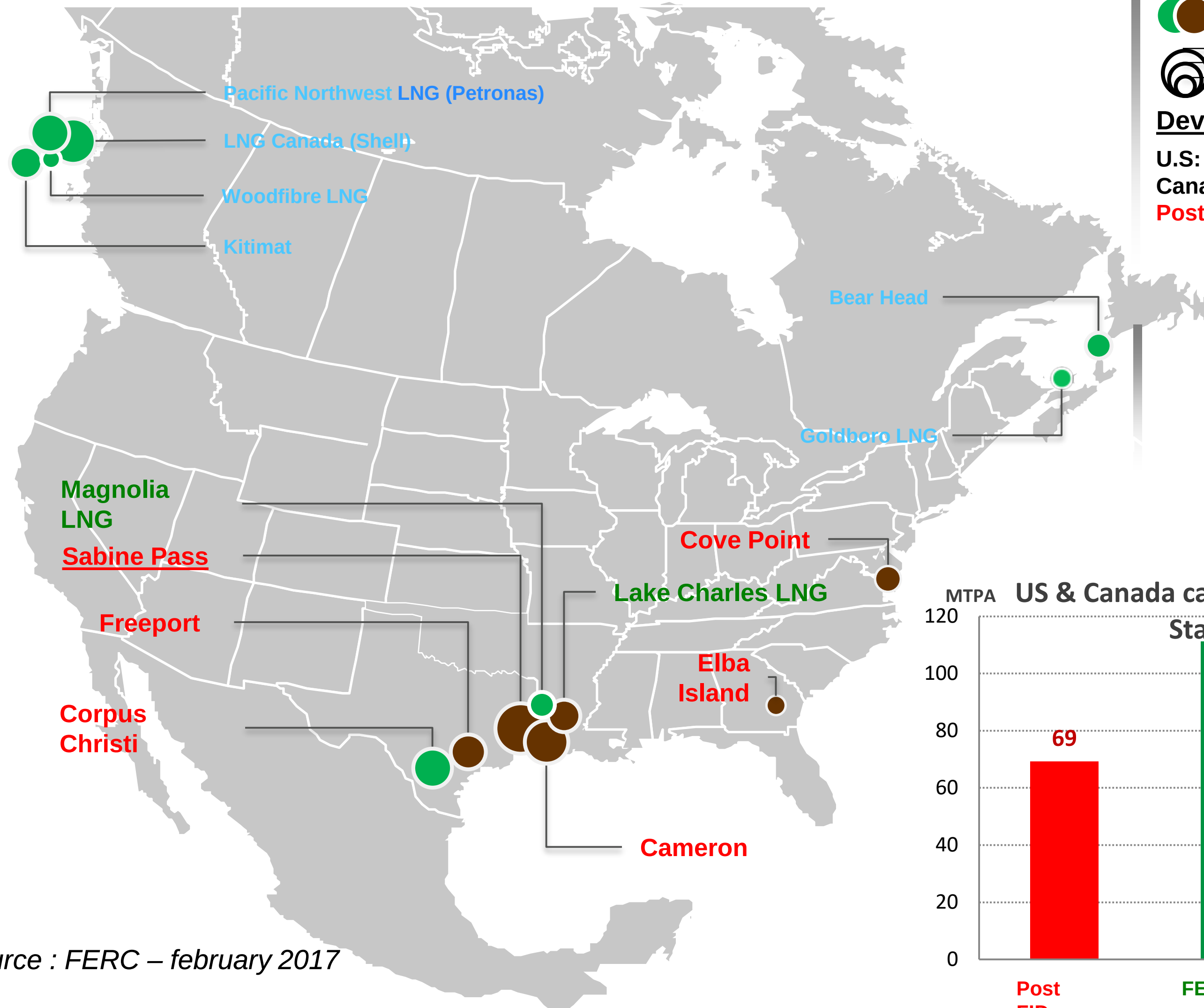
Source: IEA WEO 2012,oil include NGLs

UNCONVENTIONAL GAS PRODUCTION BY SELECTED COUNTRIES (TIGHT GAS + SHALE GAS + CBM)



Source: IEA WEO 2013

NORTH AMERICA LNG INDUSTRY WILL PLAY A MAJOR ROLE, NOT ONLY BECAUSE OF IT'S POTENTIAL CAPACITIES BUT ALSO AS A « PRICE MAKER » FOR THE WORLD LNG INDUSTRY



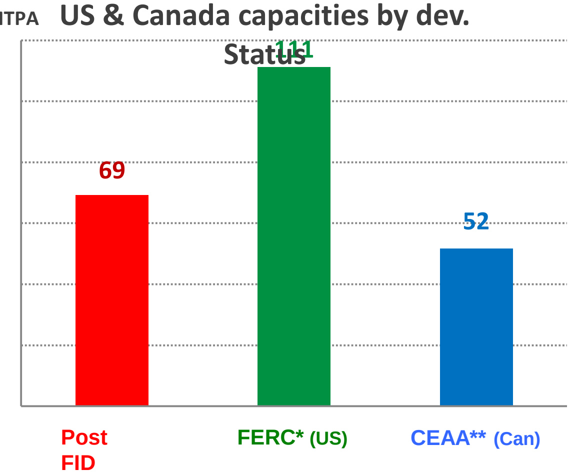
Project type

Greenfield/Brownfield

>20Mtpa
<10-15Mtpa
<5Mtpa

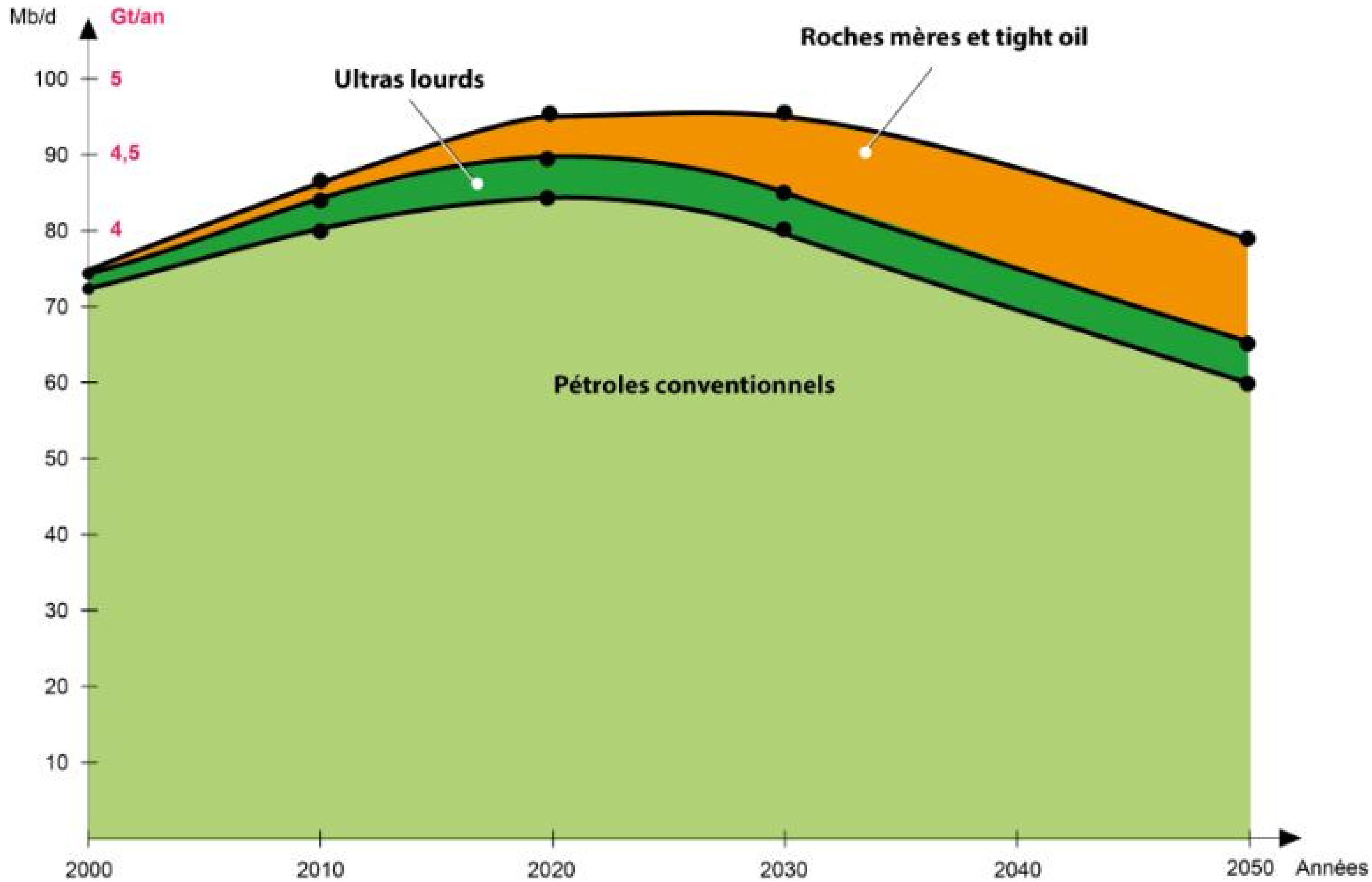
Development status

U.S: FERC* Approval
Canada: CEAA** Approval
Post FID / Operational

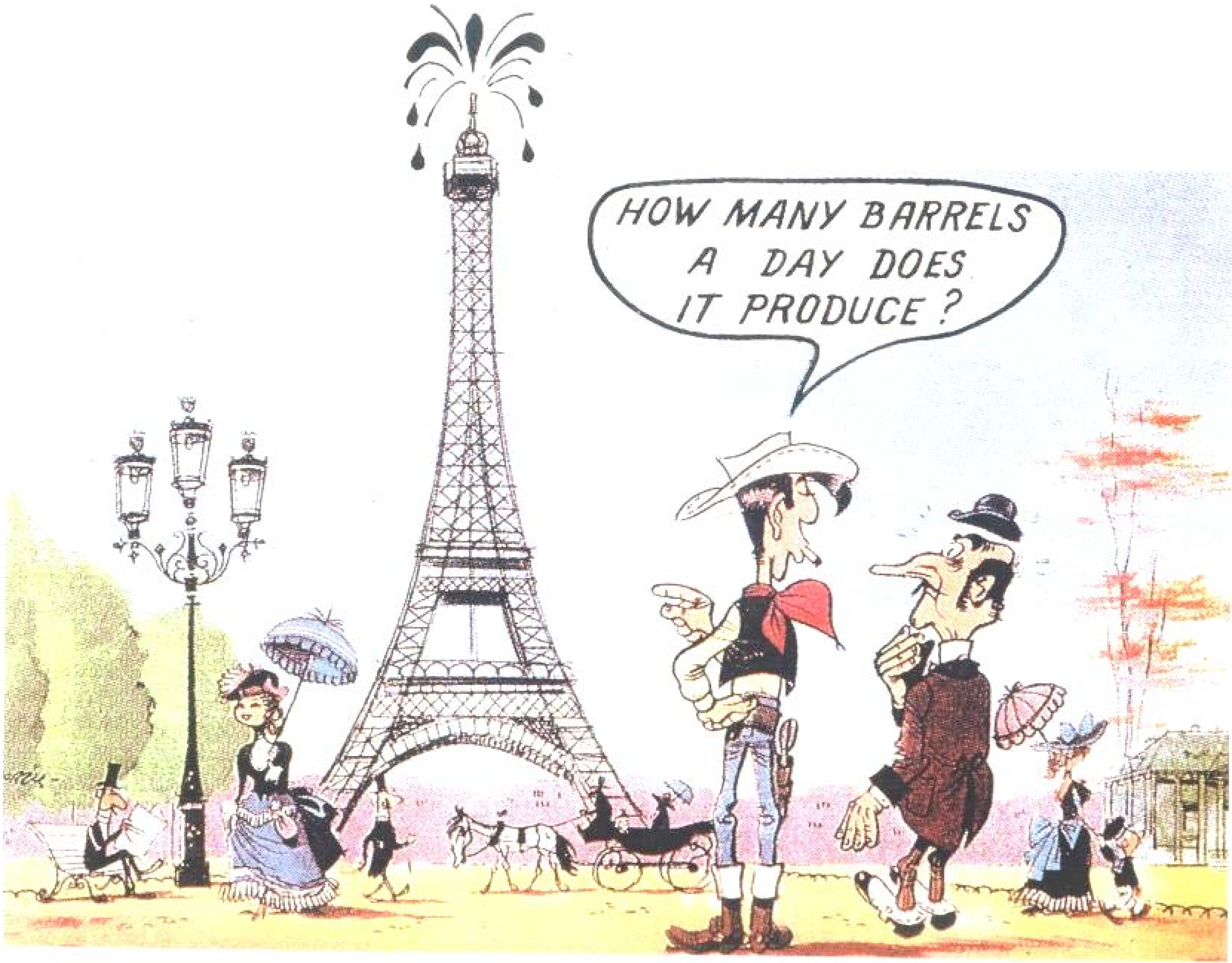


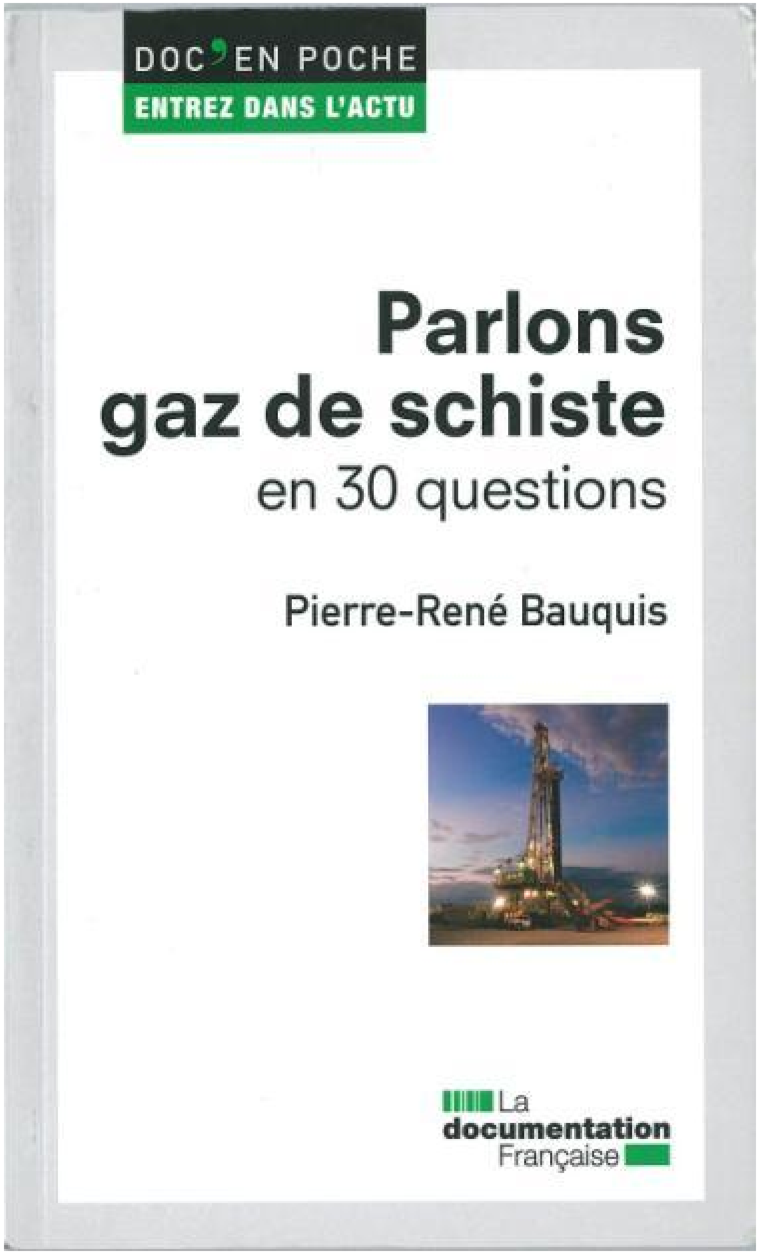
Source : FERC – february 2017

A VISION FROM THE AUTHORS (PR BAUQUIS – A PERRODON) OF WORLD NATURAL HYDROCARBON LIQUIDS 2015 - 2050



Source Alain PERRODON & PR BAUQUIS – 20 Novembre 2015


HOW MANY BARRELS A DAY DOES IT PRODUCE ?



- Pour savoir l'essentiel sur les « gaz de schistes » un petit ouvrage d'initiation pour 5,90 euros publié par la Documentation Française.
- Offrez-le à tous vos amis, et à tous les écologistes de votre connaissance.
- L'auteur (P.R. BAUQUIS) est totalement indépendant et les droits d'auteur vont à de bonnes œuvres.

(သင့်ကို) ကျေးဇူးတင်ပါတယ

Bedankt

Terima Kasih

gracias

Thank you

谢 谢

Cám ơn

شكرا

спасибо

merci

grazie

Obrigado

ขอบคุณมาก

Tusen takk