

# Shale Gas Developments in the US, Europe and China



Howard V Rogers

Oxford Energy Colloquia

February 3<sup>rd</sup> 2015



# OIES Natural Gas Research Programme

---

## WE ARE:

- A gas research programme at a Recognised Independent Research Centre of Oxford University, specialising in fossil fuel research
- Probably the only European academic research group focussed on natural gas.

WE PRODUCE: independent research on national and international gas issues

WE ARE FUNDED BY: sponsorship by 19 companies and governments in gas producing and consuming countries

## WE ARE NOT:

- consultants, sellers of exclusive, high price business reports

In 2013 and 2014 the Oxford Institute was voted the world's No. 1 Energy and Resource Policy Think Tank

[http://repository.upenn.edu/cgi/viewcontent.cgi?article=1008&context=think\\_tanks](http://repository.upenn.edu/cgi/viewcontent.cgi?article=1008&context=think_tanks), P. 95



# Themes

- The US Shale Gas Revolution
- Prospects for Shale Gas in:
  - China
  - Europe (with focus on UK)
  - Other areas
- Conclusions

**Based on the Following Published Research:**

*'Can Unconventional Gas be a Game Changer in European Gas Markets?'*, Florence Geny, OIES, 2010,  
<http://www.oxfordenergy.org/2010/12/can-unconventional-gas-be-a-game-changer-in-european-gas-markets/>

*'Shale Gas – the Unfolding Story, Howard Rogers, Oxford Review of Economic Policy, Vol 27, Number 1, 2011,*

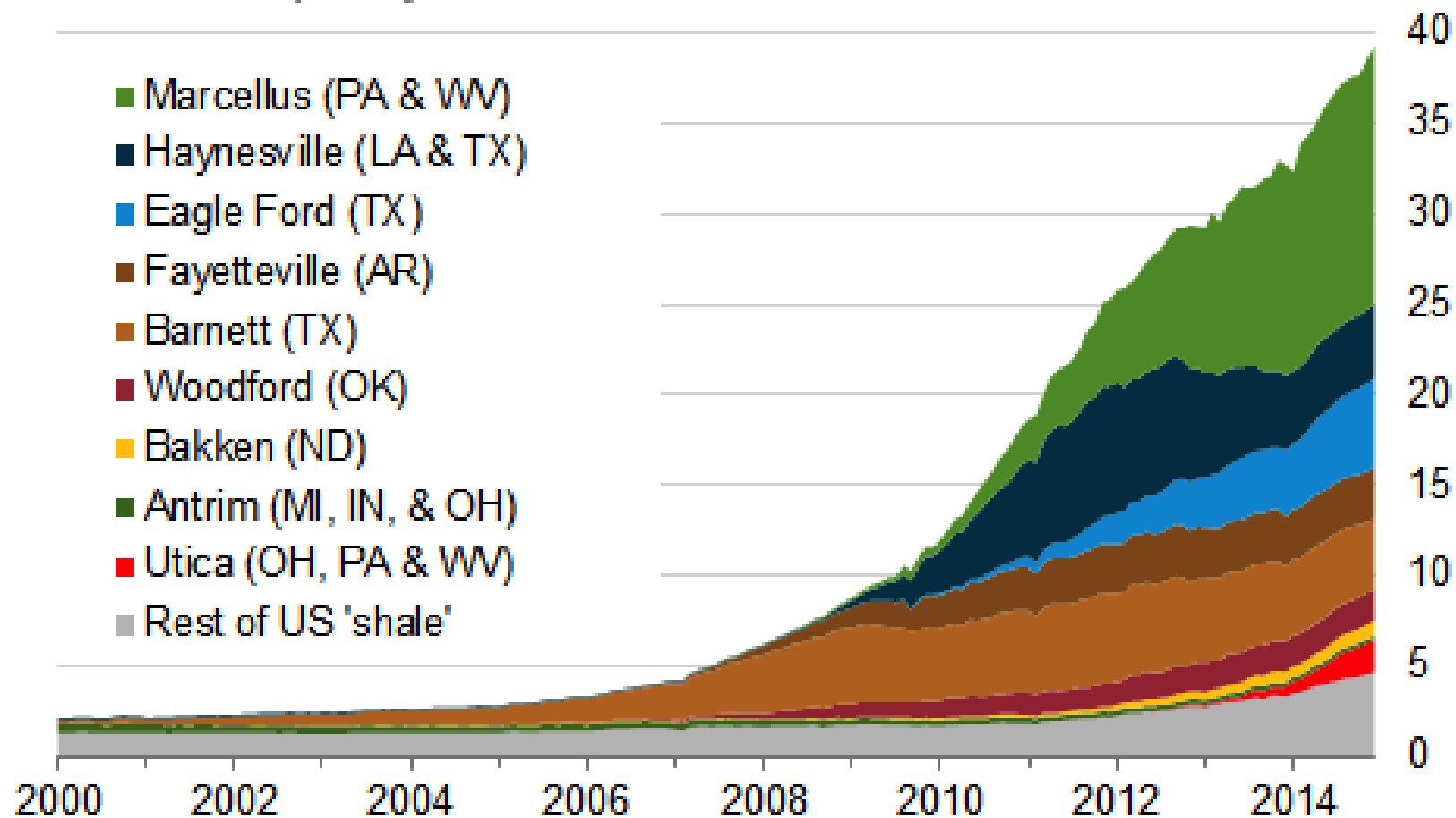
*'Will there be a Shale Gas Revolution in China by 2020 ?'*, Fan Gao, OIES, 2012,  
<http://www.oxfordenergy.org/2012/04/will-there-be-a-shale-gas-revolution-in-china-by-2020/>

*'UK Shale Gas, Hype, Reality and Difficult Questions'*, Howard Rogers, OIES 2013,  
<http://www.oxfordenergy.org/category/gas-programme/gas-programme-energy-comments/>



# US Shale Gas Production by Play – 2000 – 2014

Monthly dry shale gas production  
billion cubic feet per day

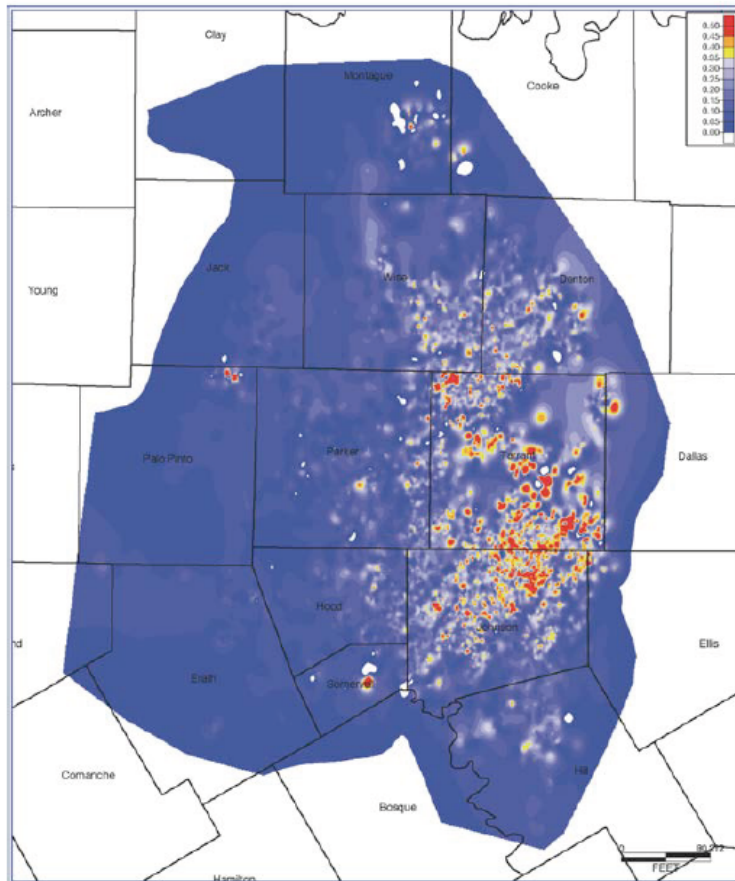


Sources: EIA derived from state administrative data collected by DrillingInfo Inc. Data are through December 2014 and represent EIA's official shale gas estimates, but are not survey data. State abbreviations indicate primary state(s).



# Shale Play Well Performance – Importance of ‘Sweet Spots’

The Barnett Shale Play has contracted to small core areas



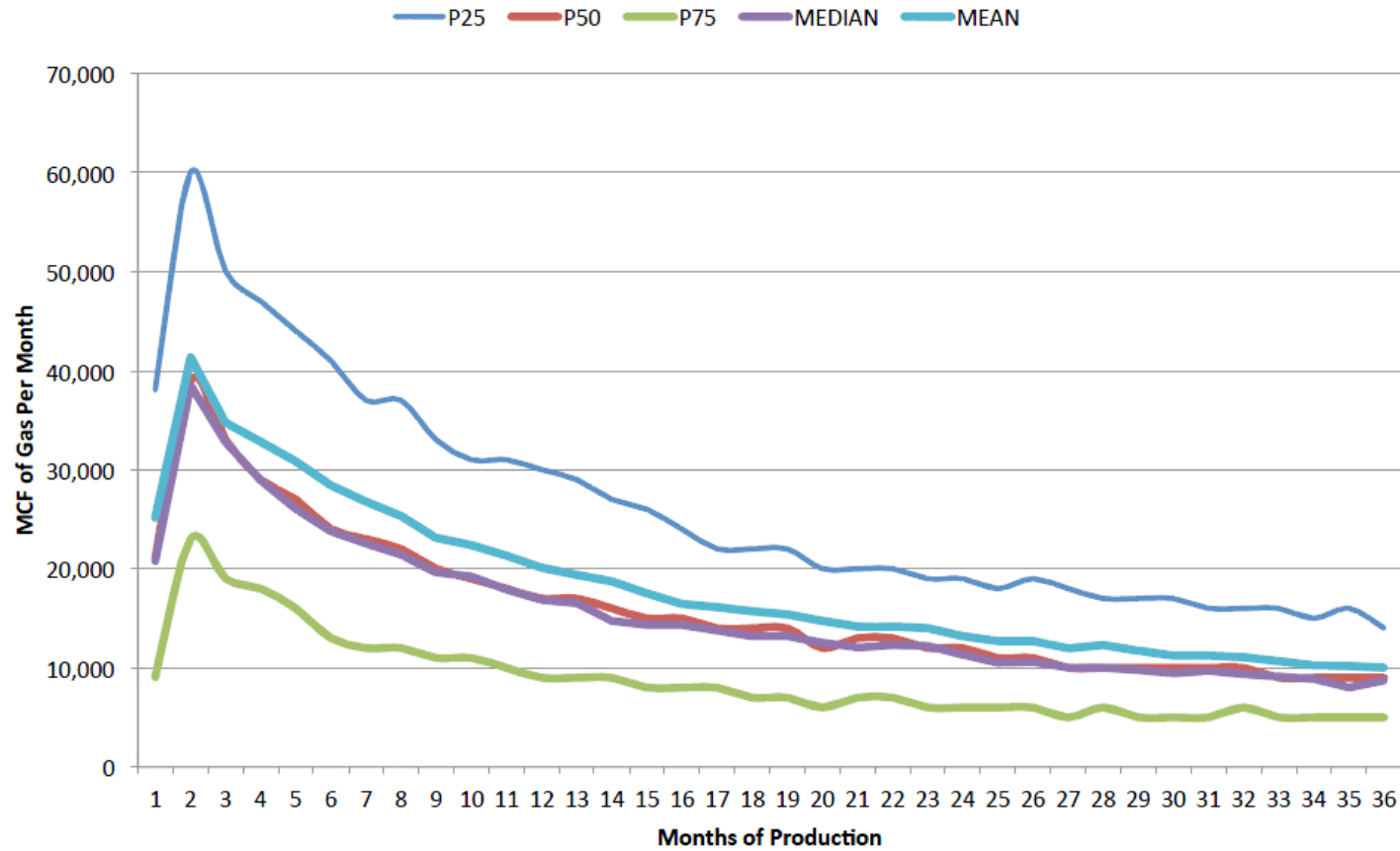
- Less than 10% of the play has the potential to be commercial (areas in red).
- Even within the core areas, well performance is uneven and considerable commercial risk exists.

First 6-month cumulative production for Barnett Shale horizontal wells. Data source: HPDI

Source: Arthur E Berman

# Shale Gas Well Decline Curves

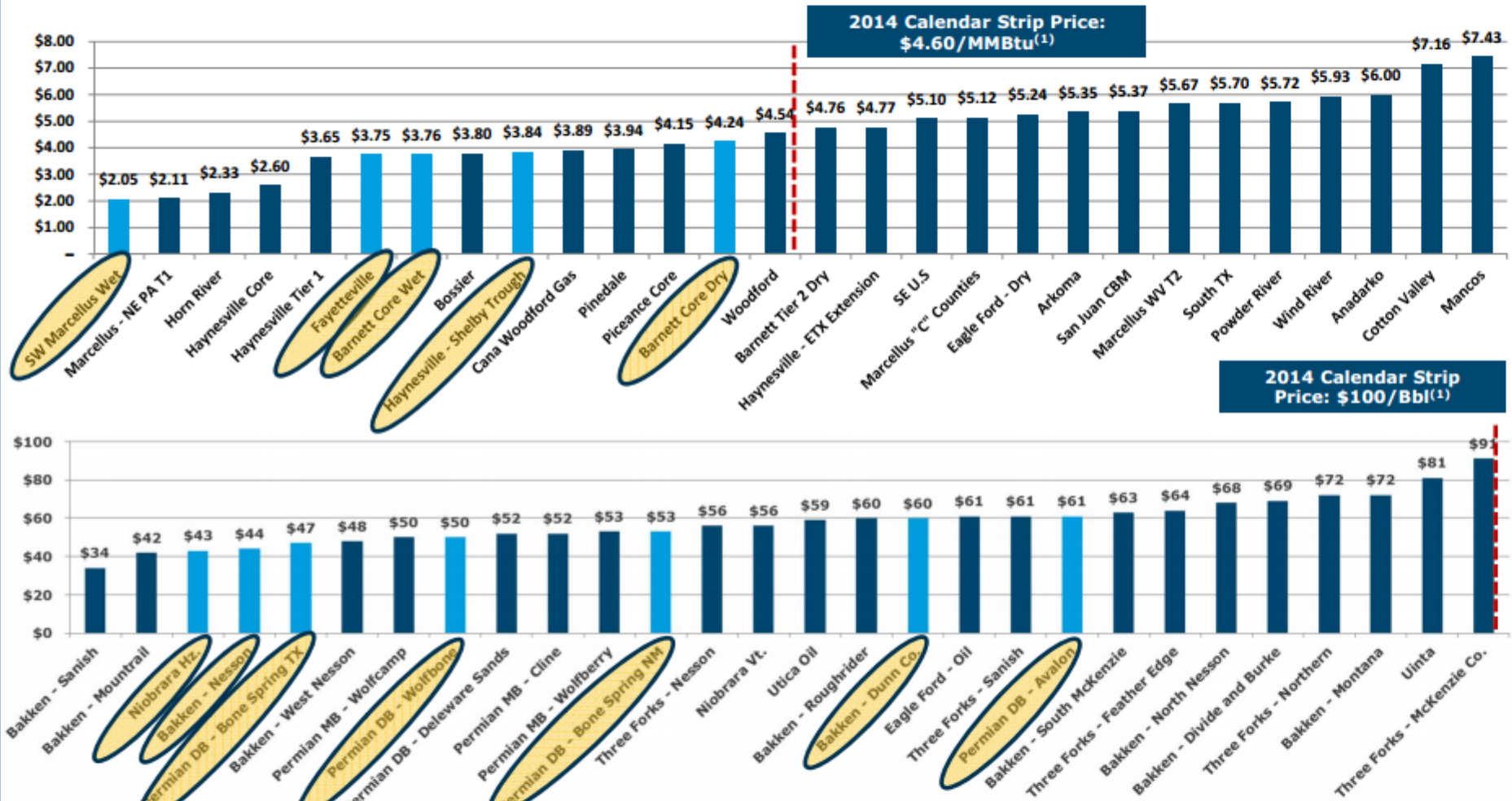
EnCana Horizontal Barnett Wells Decline Data



- 420 Barnett Shale wells suggest considerable variance in type-curve methodology.
- Mean over-predicts EUR by 10-15%.



# Break-Even Henry Hub Price For US Shale Plays (2014)



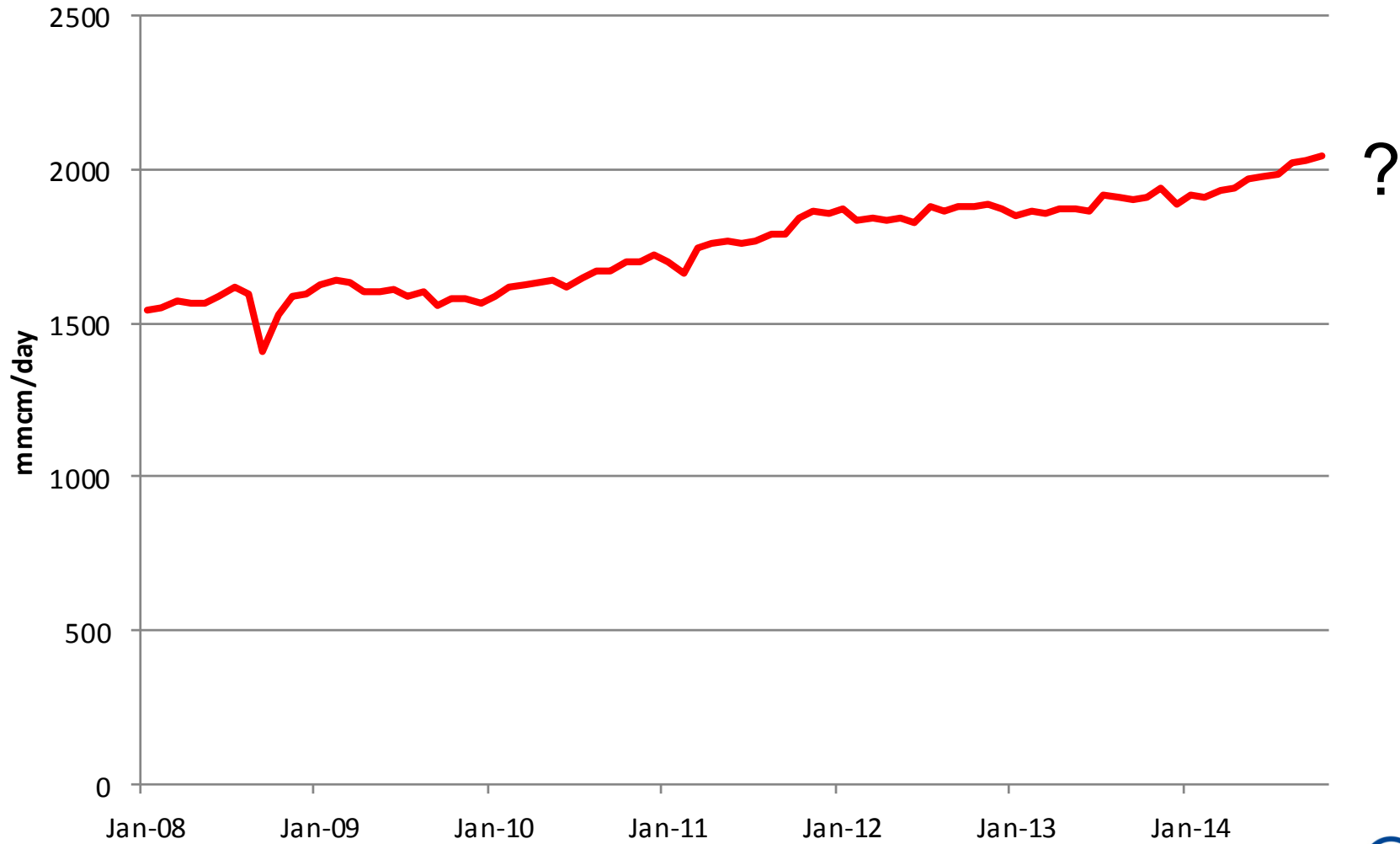
Source: Tudor Pickering Research. Breakeven Prices to earn 10% Single Well IRR.

<sup>(1)</sup> Calendar 2014 NYMEX prices as of 6/2/2014

■ Basins where Crestwood has existing assets or targeted development projects.



# US Gas Production 2008 – October 2014



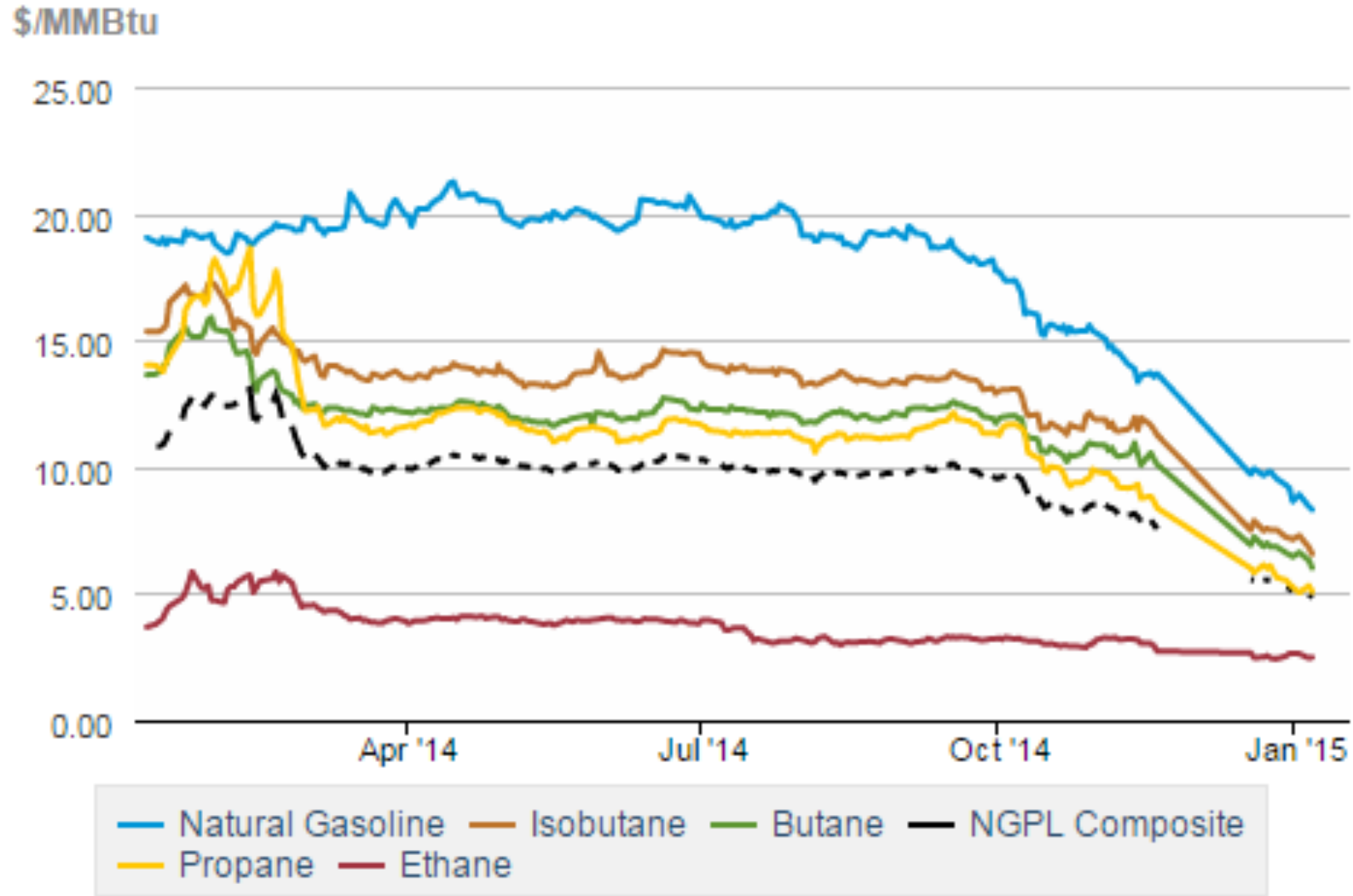
Source: EIA





# US NGL Price

## Natural gas liquids spot prices



Source: EIA



## Outlook at lower Oil and NGL prices ?

- Continued increase in US gas production due to co-production from oil and NGL-focused shale gas drilling, however oil and wet shale gas plays no longer as inherently preferable to shale gas plays.
- EIA (Jan 2015 Short Term Energy Outlook):
  - ‘Although natural gas prices have declined, and this month’s STEO lowers the Henry Hub spot price forecast, EIA expects that increases in drilling efficiency and growth in oil production (although at a slower rate) will continue to support growing natural gas production in the coming years. Additionally, with most growth coming from the Marcellus Shale, a backlog of drilled but uncompleted wells will continue to support production growth as new pipeline infrastructure comes online in the Northeast’.
- LNG exports in prospect end 2015 from Sabine Pass, but major LNG export growth from 2018 onwards.



# Shale Gas in China



A shale well at Fuling, owned by Sinopec, in Chongqing



## 2014 Update: A touch of realism, challenges clear but some cause for hope.

- In August 2012, China's National Energy Administration cut 2020 target to 30 bcma.
- Sinopec's Fuling play (Sichuan basin) the only promising play identified to date. Output expected to be 5 bcma by 2015 and 10 bcma by 2017.
- Shell and Hess have PSCs in other areas.
- Well costs and drilling times have reduced over past few years but still \$10million/well.
- Petrochina (Longwangmiao, Sichuan) expects to produce 2.6 bcma by end 2015 and overtake Sinopec in next few years.
- Hydraulic fracturing services group FTS International entered into a 15-year joint venture with Sinopec in June 2014.

Sources: <http://www.businessweek.com/articles/2014-08-08/chinas-shale-gas-production-target-cut-in-half-by-top-official>  
<http://af.reuters.com/article/energyOilNews/idAFL3N0QZ1R420140829?pageNumber=2&virtualBrandChannel=0>



November 4, 2014 11:29 am

# China levies first fines for slow progress on shale gas

Lucy Hornby in Beijing

- Pace of Chinese shale gas development has moved more slowly than officials had hoped.
- “people are losing focus by putting too much attention on details such as geology and drilling technologies,” said Xiamen University’s Lin. “The real recipe for the success story of shale gas in the U.S. lies in its scale and the openness in allowing all players to freely join the game,” he said.

<http://www.ft.com/cms/s/0/95c7f7b6-63fa-11e4-bac8-00144feabdc0.html#axzz3K4d0Md7i>

<http://www.bloomberg.com/news/2014-11-21/china-shale-boom-fizzles-as-clean-energy-imports-take-spotlight.html>



## Poland

- 64 wells drilled since mid 2010. Results underwhelming.
- ExxonMobil, Total, Eni, Marathon and Talisman have withdrawn, Chevron, ConocoPhillips and San Leon remain.
- "Exploration will continue on a smaller scale. The geology has proved difficult but the well test results are not the only factor because there's been too few of them. They come on top of the regulatory mess and together it's having a destructive impact on investment in Poland," Pawel Poprawa, Polish Energy Studies Institute
- Irish explorer San Leon Energy in January 2014 produced encouraging results from a vertical well in a shale formation in the Baltic Basin.
- *'The jury is still out but the audience has left the building'*

<http://www.platts.com/latest-news/natural-gas/Warsaw/ANALYSIS-Bleak-mood-for-Polish-shale-gas-after-26924574>,

*Platts European Gas Daily, 22<sup>nd</sup> August 2013,*

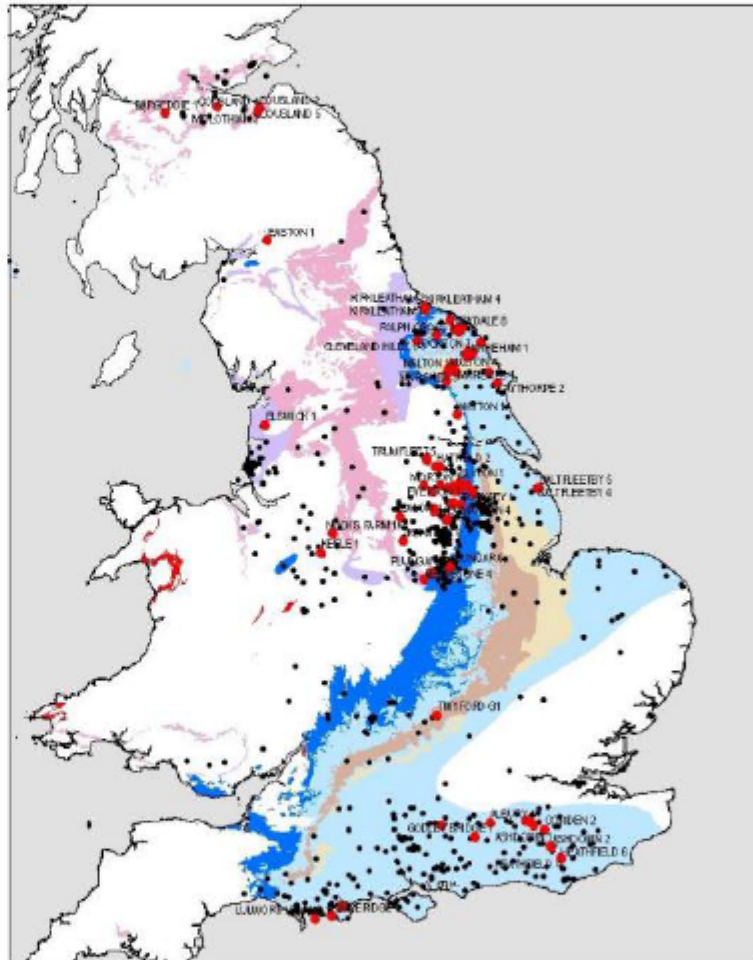
<http://uk.reuters.com/article/2014/07/31/poland-shalegas-minister-idUKL6N0Q438P20140731>,

<http://www.bloomberg.com/news/2014-01-23/europe-nears-first-commercial-shale-gas-production-in-poland-1-.html>



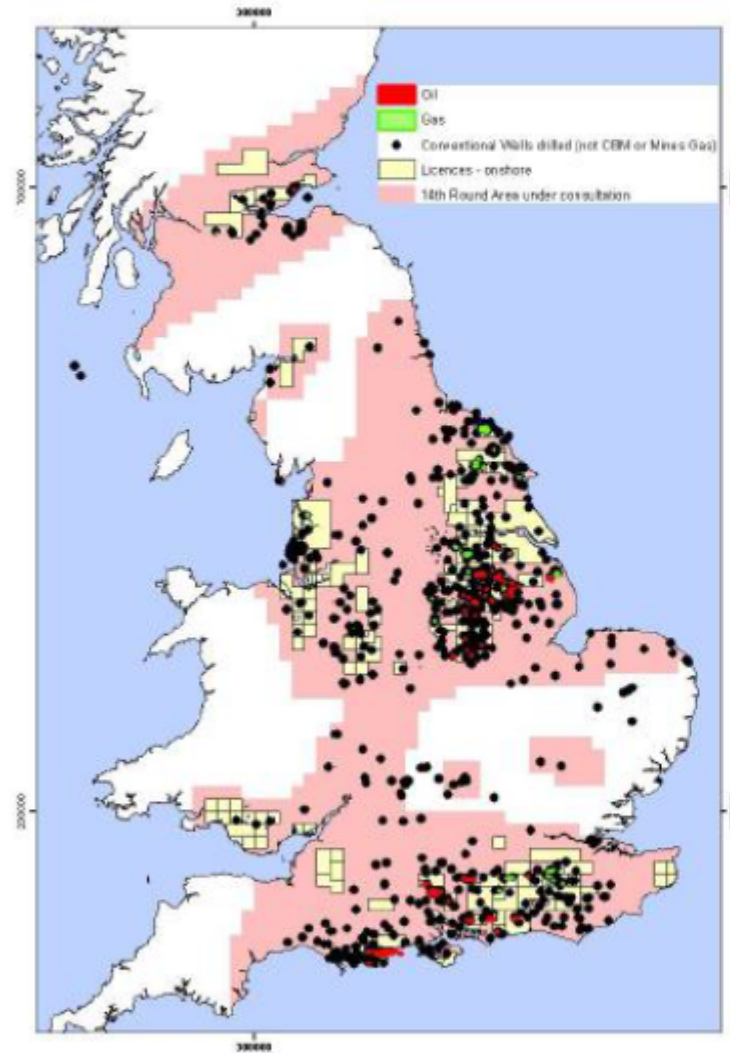
# UK Shale Gas Prospectivity

Main Areas of Shale Prospectivity



- |                                     |                                     |
|-------------------------------------|-------------------------------------|
| Kimmeridge Clay outcrop             | Conventional wells which flowed gas |
| Oxford Clay outcrop                 | Conventional well drilled           |
| Lias outcrop                        | Jurassic Lias Subcrop               |
| Namurian (Millstone Grit) outcrop   | Namurian Subcrop                    |
| Cambrian including Tremadoc outcrop |                                     |

14<sup>th</sup> Licensing Round Areas under Consideration



[https://www.og.decc.gov.uk/UKpromote/onshore\\_paper/UK\\_onsh](https://www.og.decc.gov.uk/UKpromote/onshore_paper/UK_onsh)



## Challenges to UK Shale Gas Success and Growth

- UK Regulatory Framework is robust but also complex. Requires interactions with Department for Energy and Climate Change (DECC), the Environment Agency (EA), the Health and Safety Executive (HSE), and local Planning Authorities. Ultimately, the consent to drill and to hydraulically fracture is given by DECC. Need successful exploration drilling results.
- Achieve the social licence to operate.
- Develop the onshore supply chain.
- Favourable economics re well flowrates and development and production cost versus prevailing wholesale prices.
- BUT.. Lancashire County Council may refuse Cuadrilla's application to drill next two wells on the basis of noise and traffic impacts.

Source: [http://www.fraw.org.uk/files/extreme/poyry\\_2014.pdf](http://www.fraw.org.uk/files/extreme/poyry_2014.pdf)







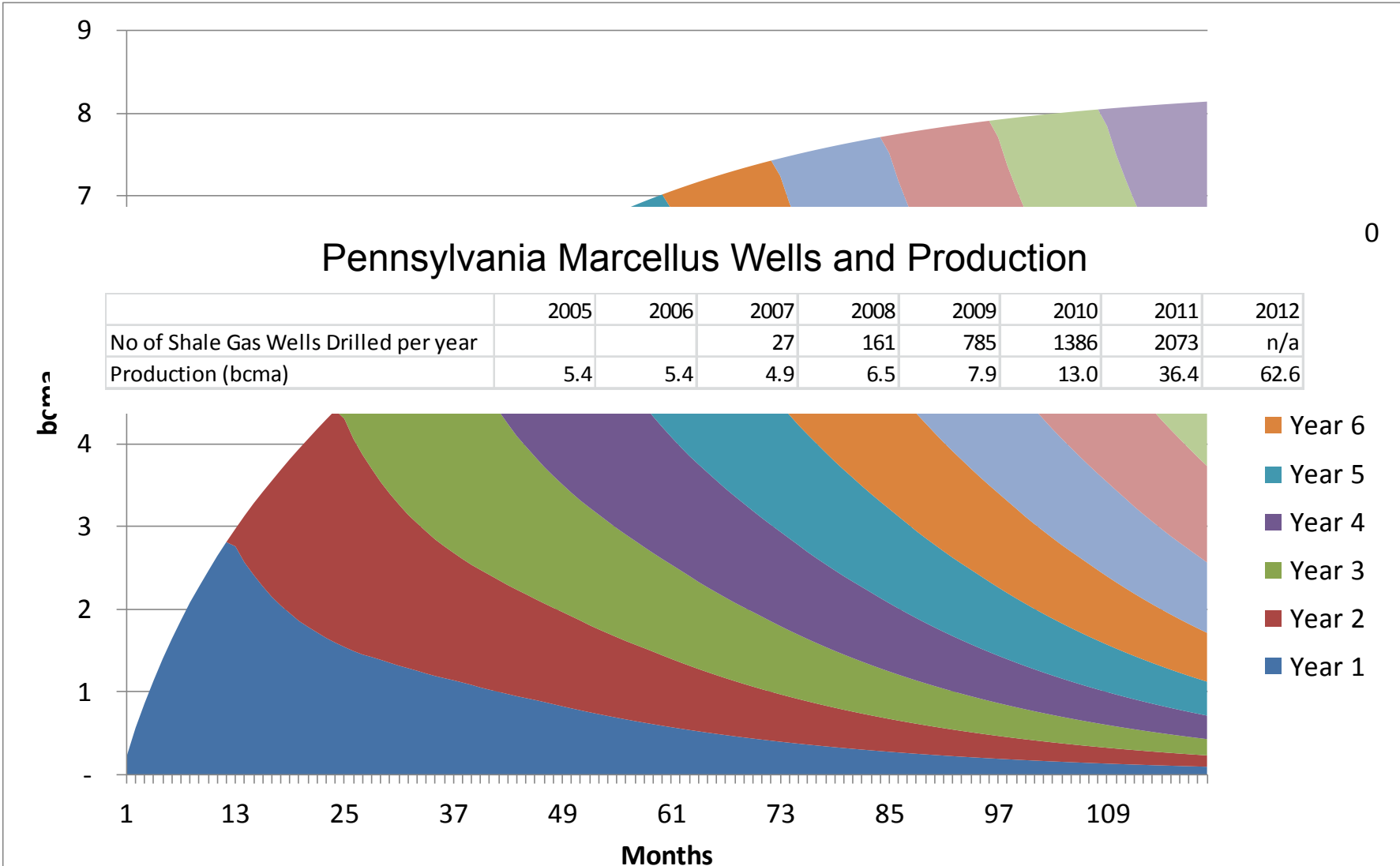
## West Virginia Shale Gas Pad – Drilling Phase ..



## Production Phase – Same Location



# UK Production from 300 wells per year (25 pads) over 10 years (Based on Barnett Shale Well Analogue)



Source: Analysis based on well data from A. Berman, Labyrinth Consulting Services, Inc



## Conclusions – Outside North America

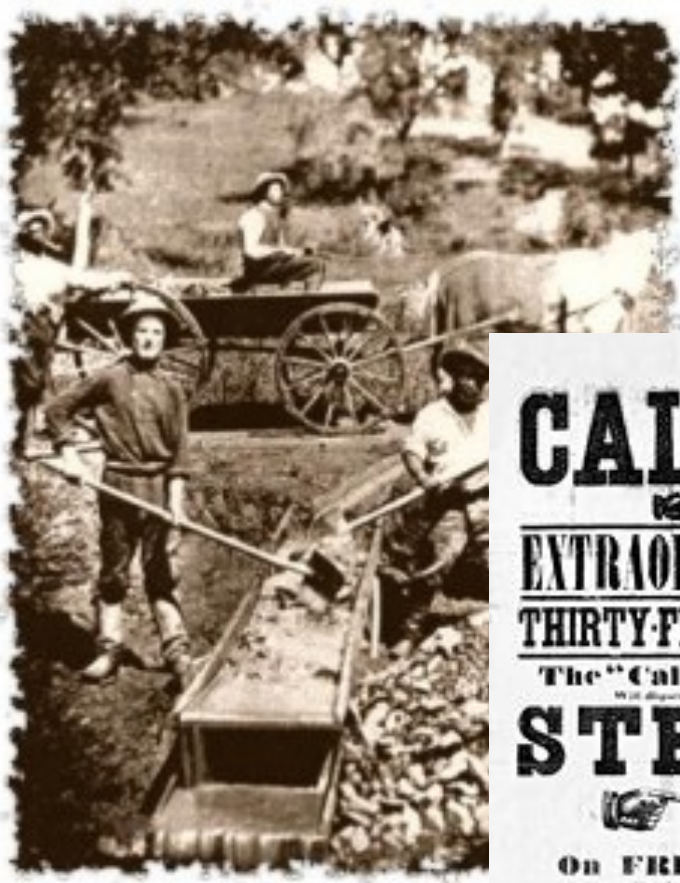
- Shale Locations where poor foreign investment framework, domestic pricing policy or lack of strategic focus will hinder progress: *North Africa, Mexico, India, Argentina (key may be liquids production)*
- Locations where shale may struggle to compete with conventional gas: *Australia*
- Locations where objections to fracking continue to slow progress: *Continental Europe.*
- China: will sufficient incentives be offered to enable technology transfer ?, pace of drilling.
- Poland: ‘Jury still out’? – are the plays of sufficient quality? Have enough wells been drilled to know ?
- UK: Supportive policy environment – need to see some wells drilled before any conclusions can be drawn – but public not convinced.



## US Shale Gas – Summary of Key Success Factors

- 100 + years of onshore oil and gas industry. Extensive geological data, generally accepted industry footprint, existing regulatory framework.
- Mineral rights mostly reside with landowner. Facilitates rapid access on bi-laterally negotiated terms.
- Many upstream players (majors, independents, ‘mom & pop’ enterprises) – competition.
- Competitive and innovative upstream service sector.
- Above all – an environment which allows a **multi-play ‘gold rush’ dynamic to develop**. Sheer number of wells drilled in short time window locates sweet-spots and best techniques, (though many players lose money initially).





**FOR CALIFORNIA!**  
**DIRECT**  
**EXTRAORDINARY INDUCEMENTS!!**  
**THIRTY-FIVE DAYS TO GOLD REGIONS!**  
The "California Steam Navigation Co."  
Will dispatch their first steamer from New York, the "SEA" and "SPLENDOR"  
**STEAM SHIP!**  
**NICARAGUA**  
WILLIAM J. BROWN, Master, in command  
**On FRIDAY, MARCH 23d, 1849,**  
Via the River St. James and Lake Nicaragua, across the Isthmus of Colon.

---

Capt. BROWN, of the U. S. Topographical Engineers,  
**200 JACK ASSES!**

**The Quickest, Safest and Cheapest!!**  
**Price of Passage Through Ninety Dollars!**  
To be paid in SPECIE, Dinner and bed Rooms, taken only.

For further particulars apply on board, or the firm of South Street, N. Y. or to the undersigned Agents for the Company. Applications by mail, to meet steamer, must be paid paid, addressed to the Company's Agents.  
ROBSON, BROTHERS & Co., 147 Wall Street, (opposite the Railroad.)







# Thank You for Your Attention



**Howard V Rogers**  
Director,  
OIES Natural Gas Programme  
[howard.rogers@oxfordenergy.org](mailto:howard.rogers@oxfordenergy.org)

OIES Gas Programme Webpage: <http://www.oxfordenergy.org/gas-programme/>