

**ASPO 9**  
**April 2011**

**Jean-Marie**  
**Bourdaire**

# **UNCONVENTIONAL GAS**

- **Part 1: US modest initial expectations**
- **Part 2: US technology acceleration**
- **Part 3: US challenges and issues**
- **Conclusion: What about the world?**

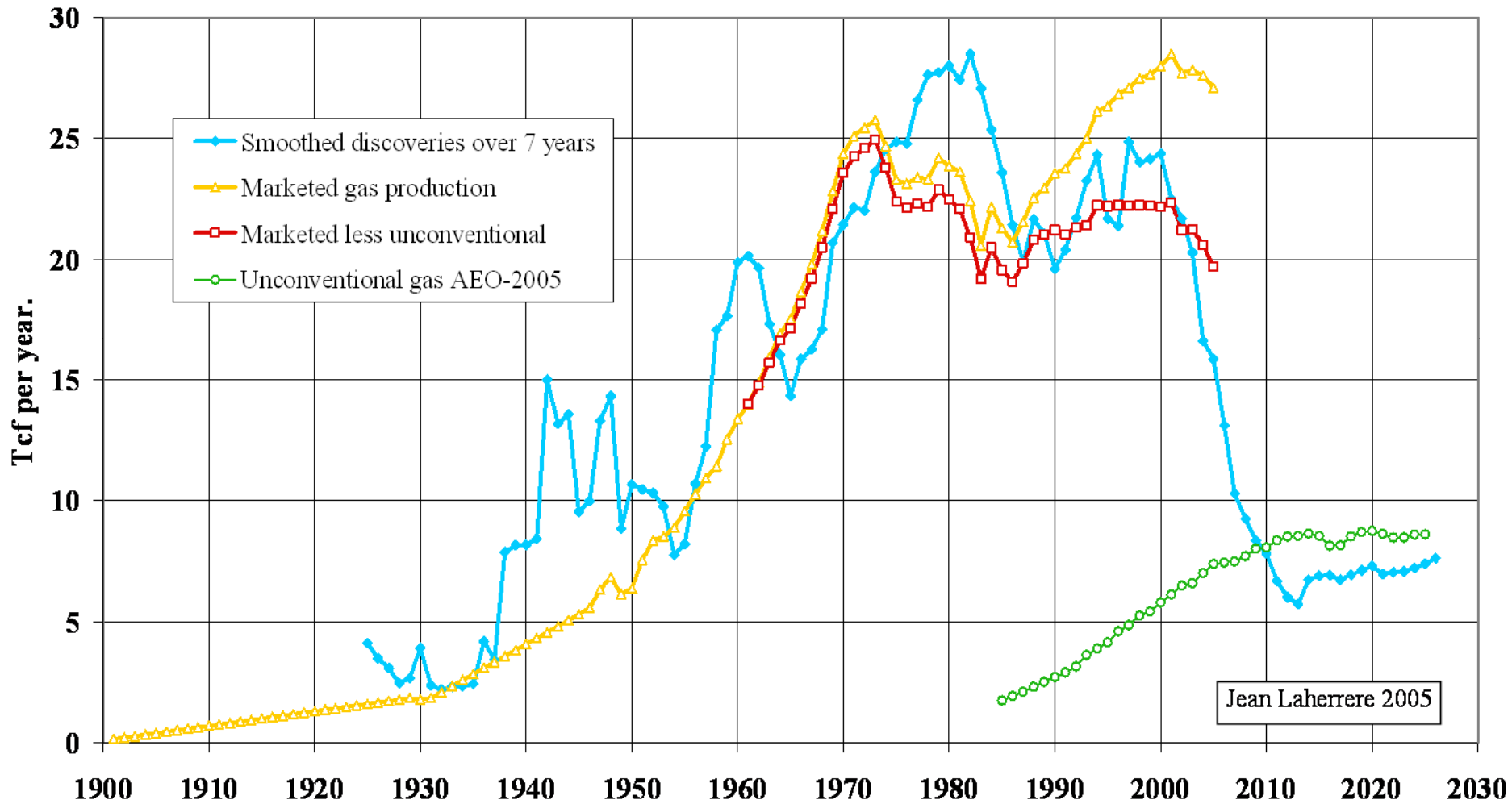
# PART I: US MODEST START-UP

- **1970-2000**: Unconventional gas (on average 70% tight gas, 20% CBM and 10% gas shale up to 2008) has grown slowly from less than 1 Tcf/y in 1970 to ~5 Tcf/y in 2000
- **2000-2008**: Unconventional gas was foreseen to reach a 9 Tcf/y plateau in 2010-25, but the fall of conventional gas was such that much increased LNG imports were to be needed
- **2008**: Oil & natgas prices, and the US rig count, collapse. To maintain their production, operators deploy new technologies, which are at the origin of the shale boom

***Because of their belief that LNG imports were set to grow, many operators have developed LNG terminals***

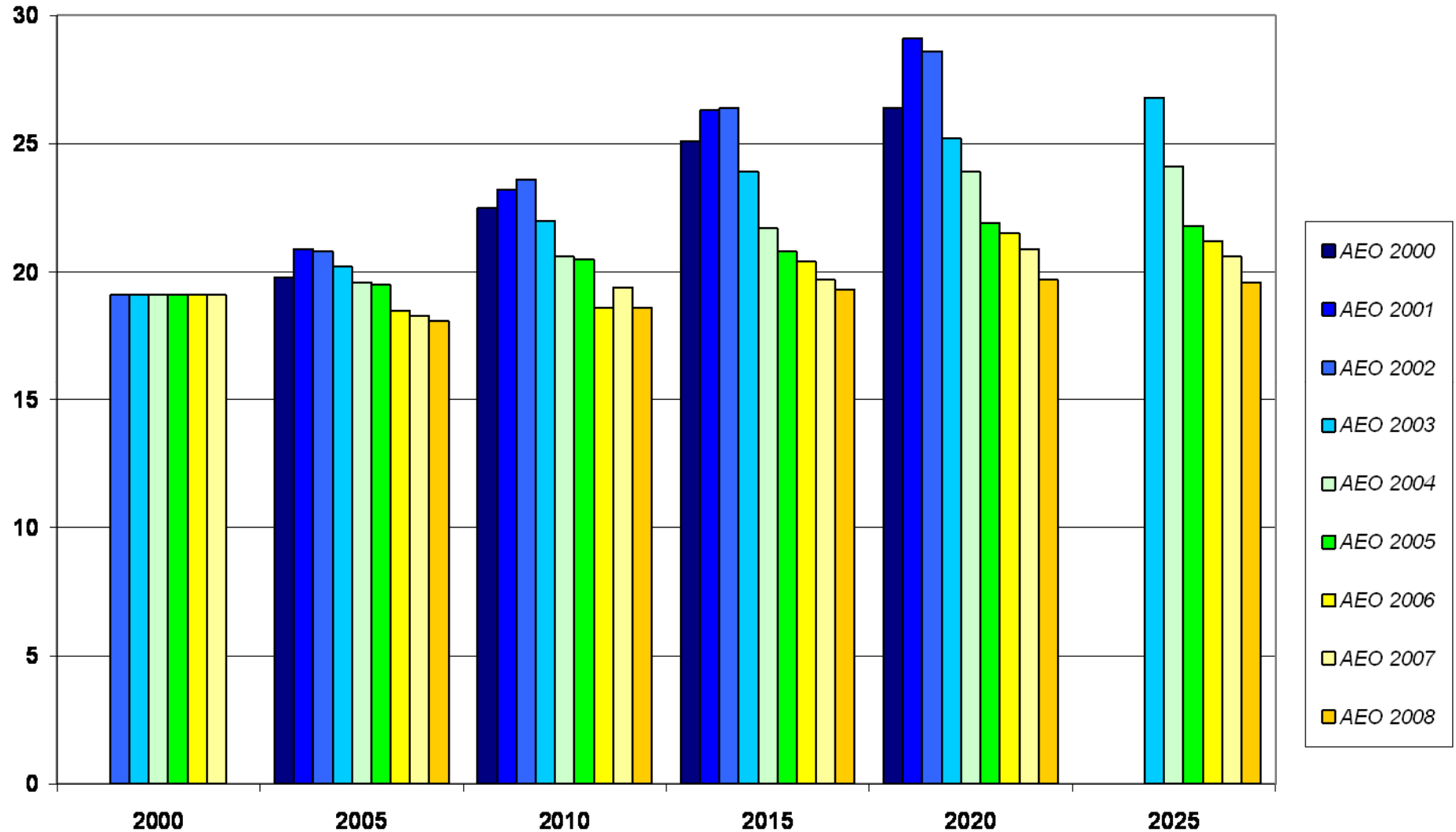
# THE PRE-2008 VISION

## NORTH AMERICA NATURAL GAS Productions and 23-year shifted conventional gas discoveries



# AEO FORECASTS: 2000-2008

## US DOMESTIC PRODUCTION (TCF)

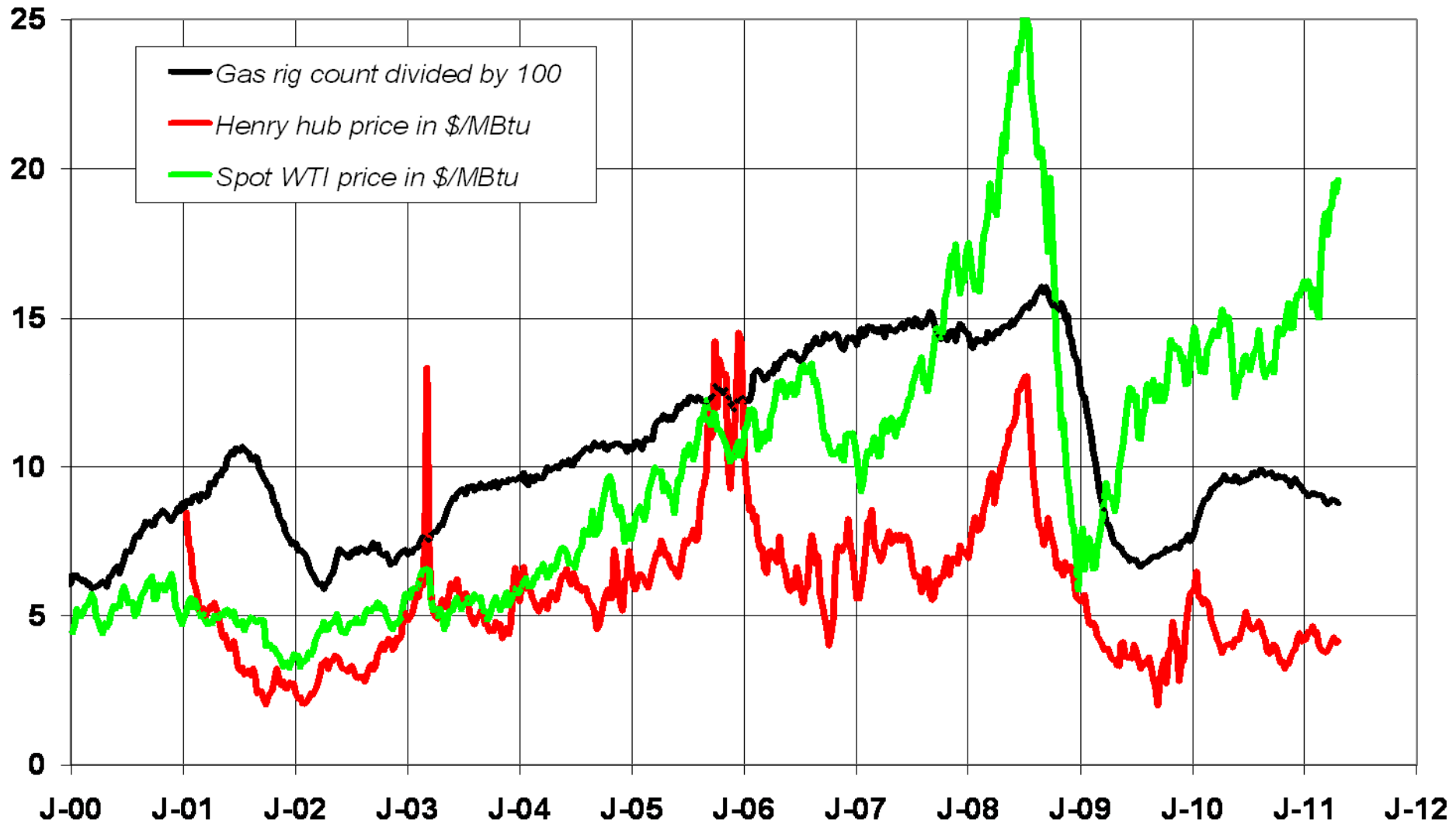


# LNG SABINE PASS TERMINAL



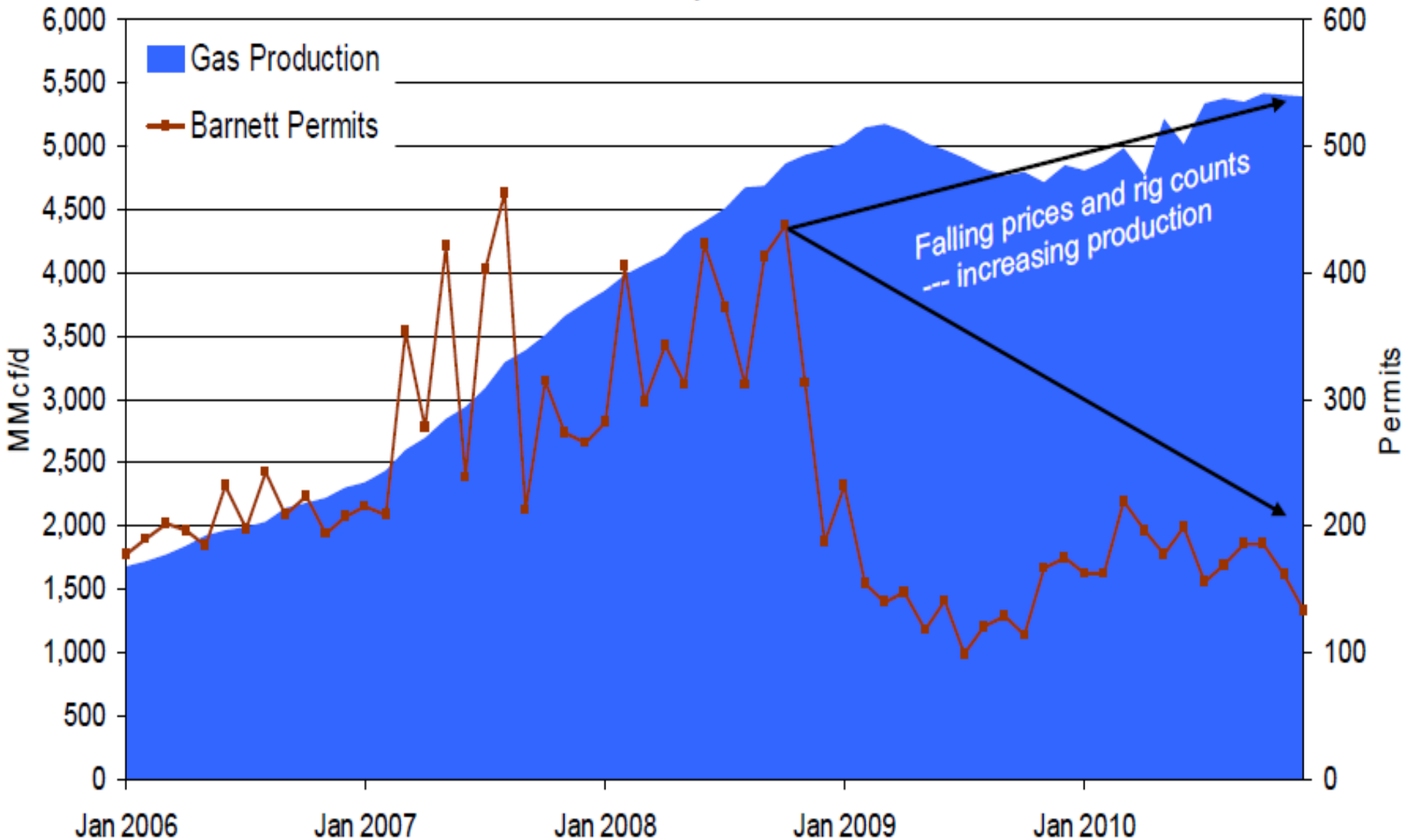
# 2008: THE COLLAPSE...

## NATURAL GAS RIGS NUMBER VERSUS HH PRICE



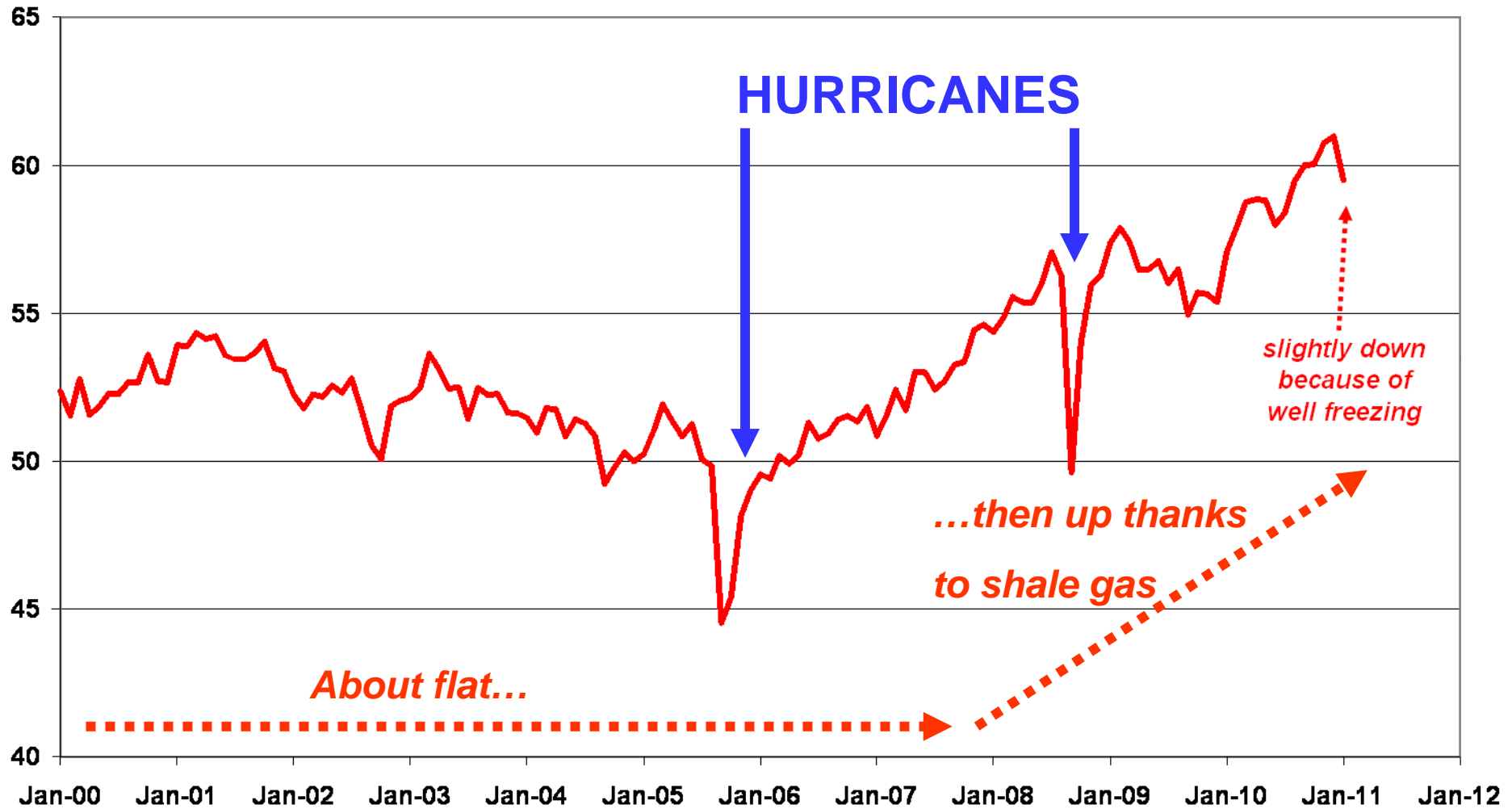
# ...EXCEPT FOR PRODUCTION...

Barnett Shale Play Fort Worth Basin



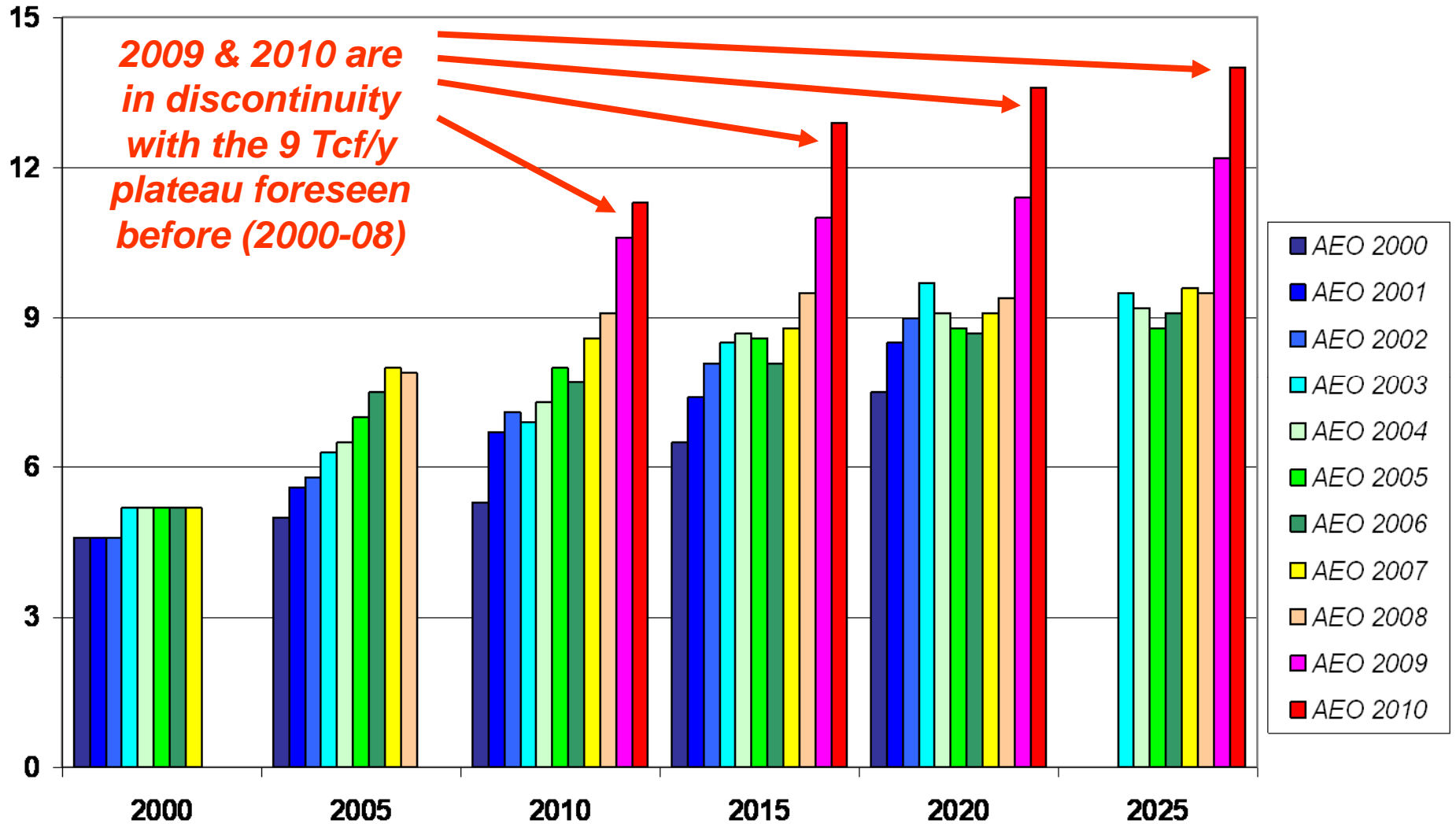
# ...RESILIENT AND GROWING

## US DRY NATURAL GAS PRODUCTION (BCF/D)



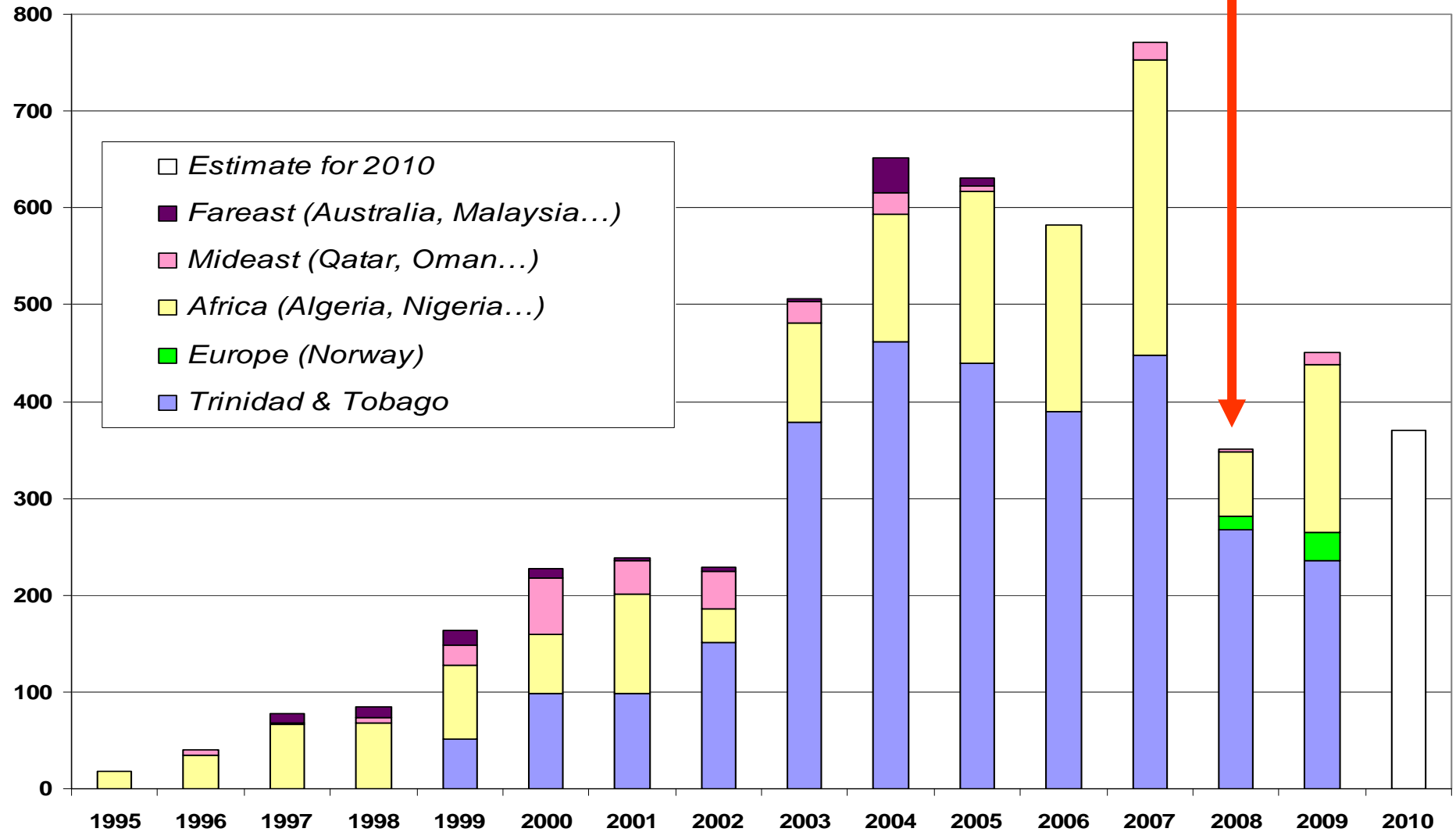
# AEO SHOW A BREAK IN 2008...

## US UNCONVENTIONAL GAS PRODUCTION (TCF)



# ...AS DO US LNG IMPORTS

## US GROSS LNG IMPORTS (BCF PER YEAR)

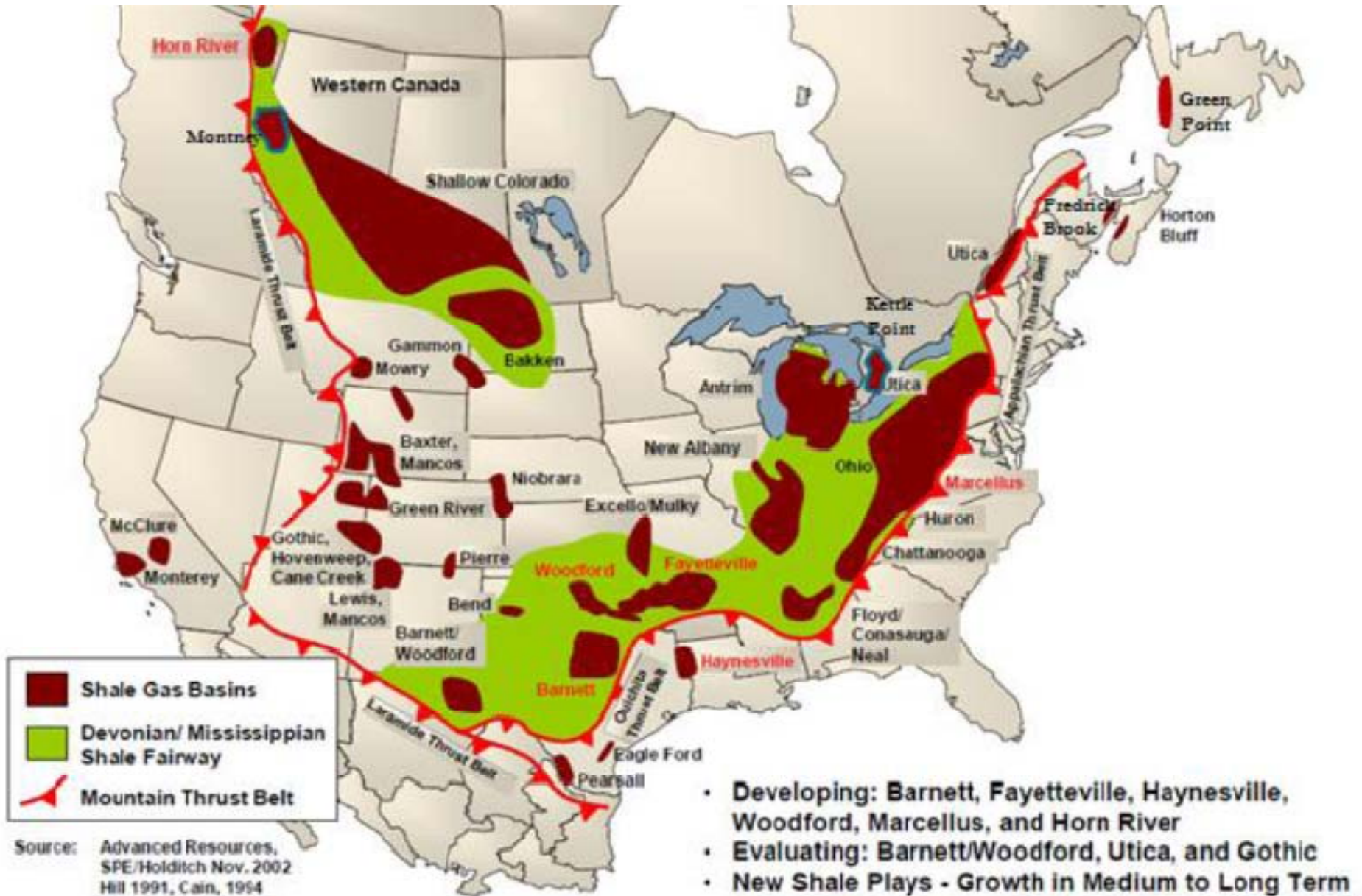


# PART II: TECHNOLOGY DRIVE

- Thanks to the hedging on high pre-2009 prices, shale gas production starts to surge making LNG imports to decline
- The “sea change” is the generalization of horizontal drilling with a focus on shales with liquids (condensates/NGL)
- Increased frack pressure, more sophisticated fracking fluids, and re-fracking of wells in production
- Better productivity and lower costs thanks to the targeting of sweet spots, learning curves, and shorter drilling times
- Restricted-choke techniques to manage underground back pressures and extend well life and production profile

***Producers better manage their IP and land-owners their leasing rates to optimize economic conditions***

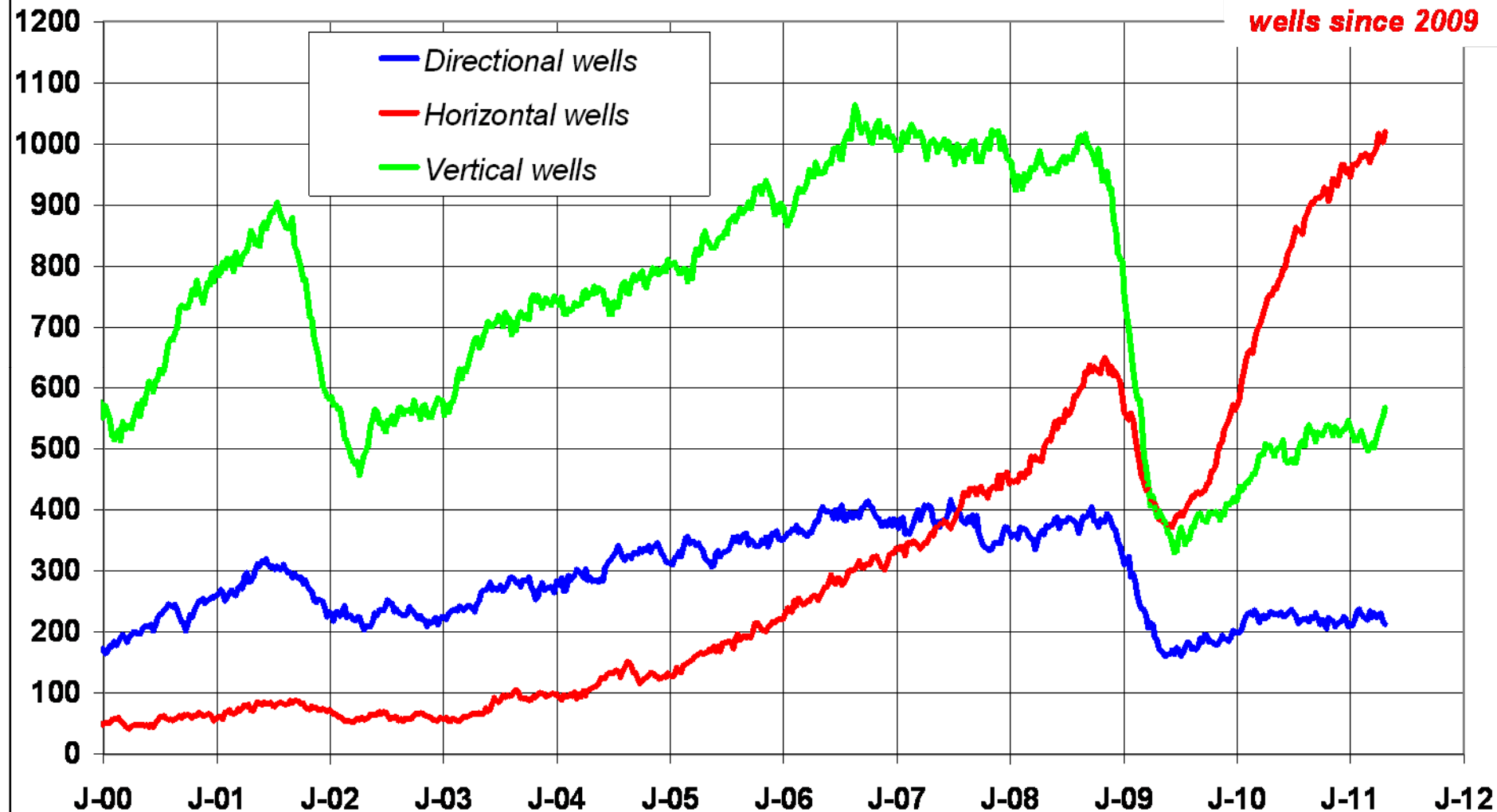
# MAIN SHALE GAS DEPOSITS



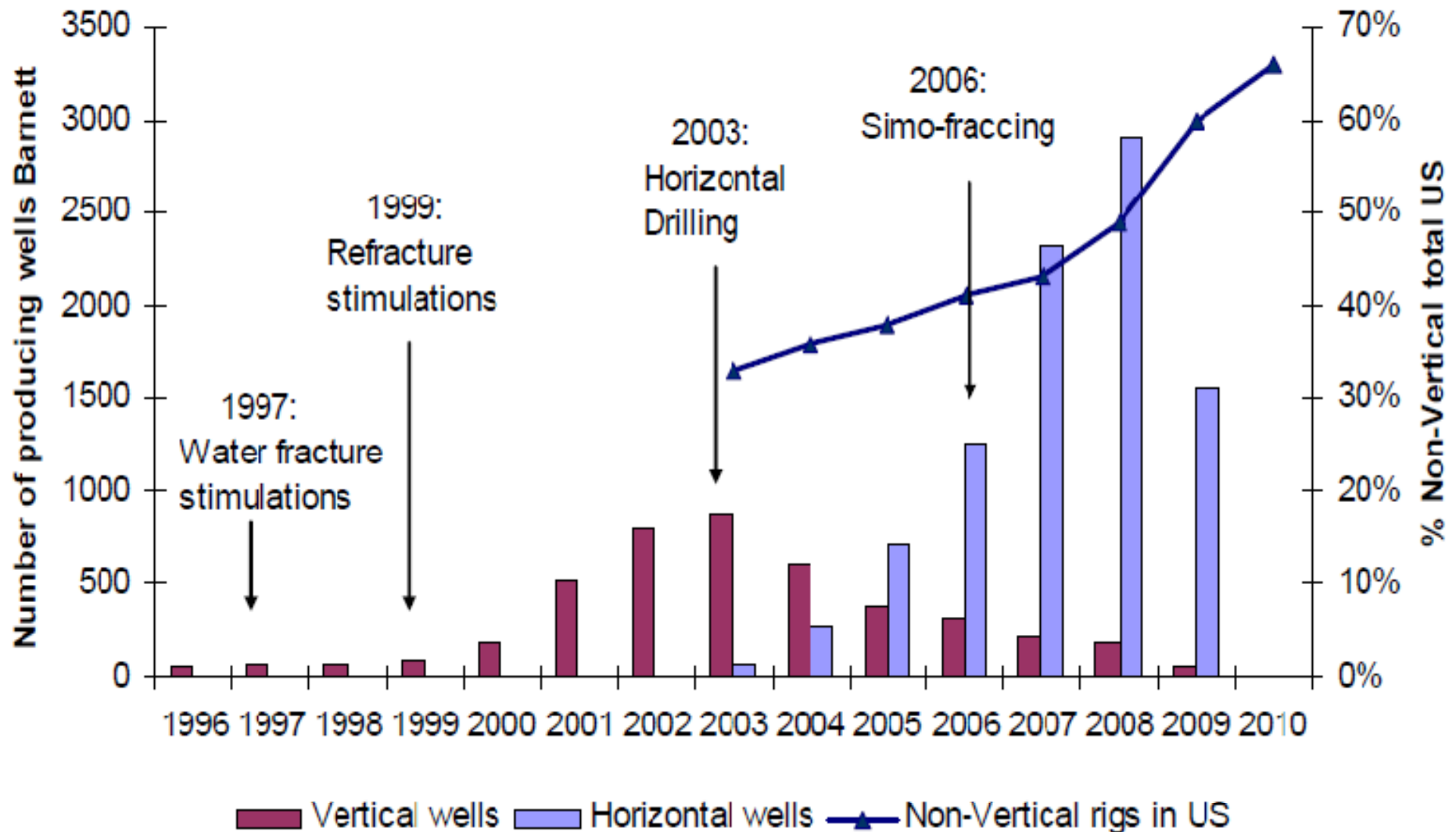
# SPLIT OF US RIGS BY TYPES...

## US TYPES OF WELLS (%)

*Note the rebound of horizontal shale wells since 2009*

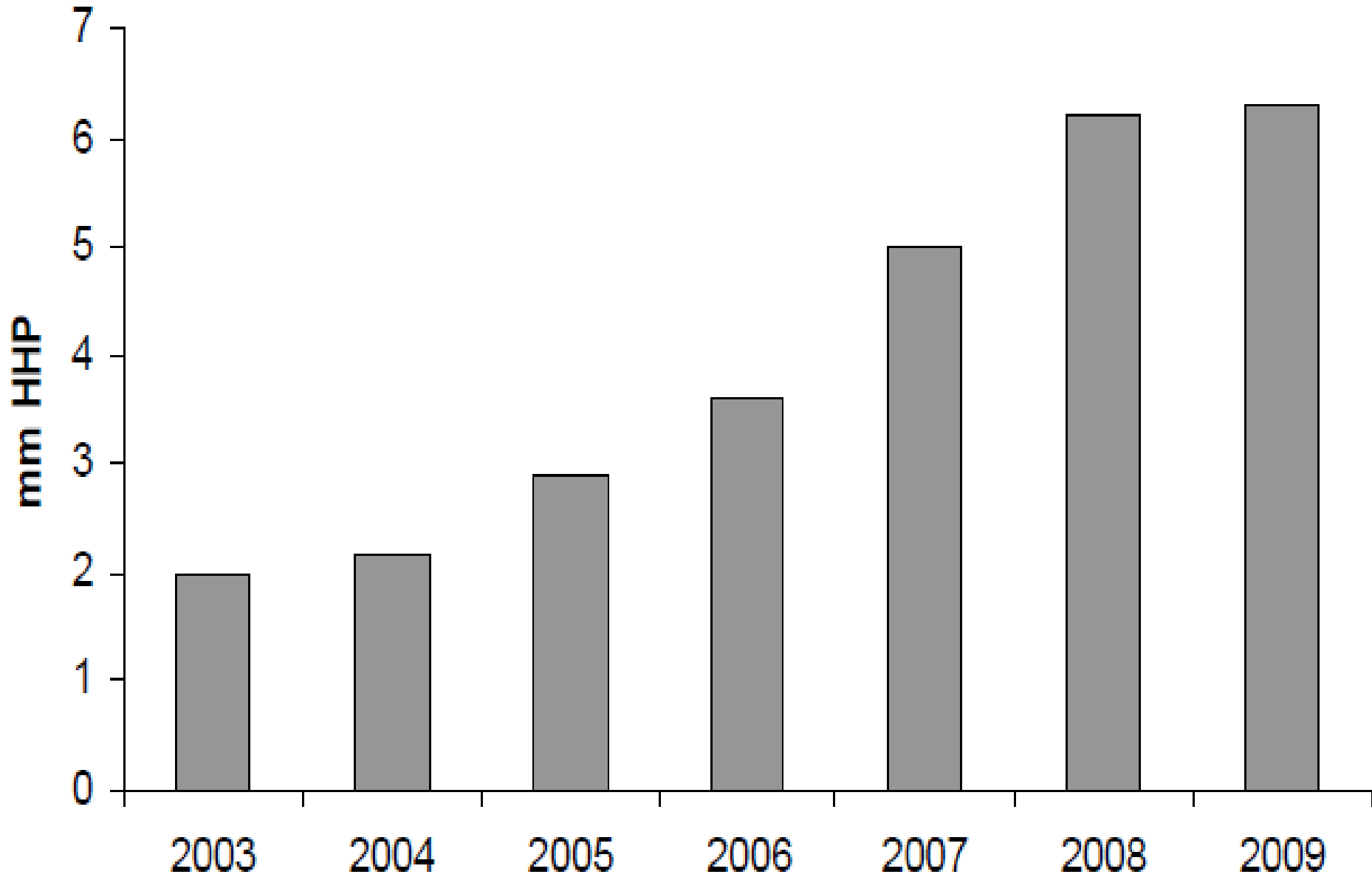


# ...E.G. IN BARNETT SHALE



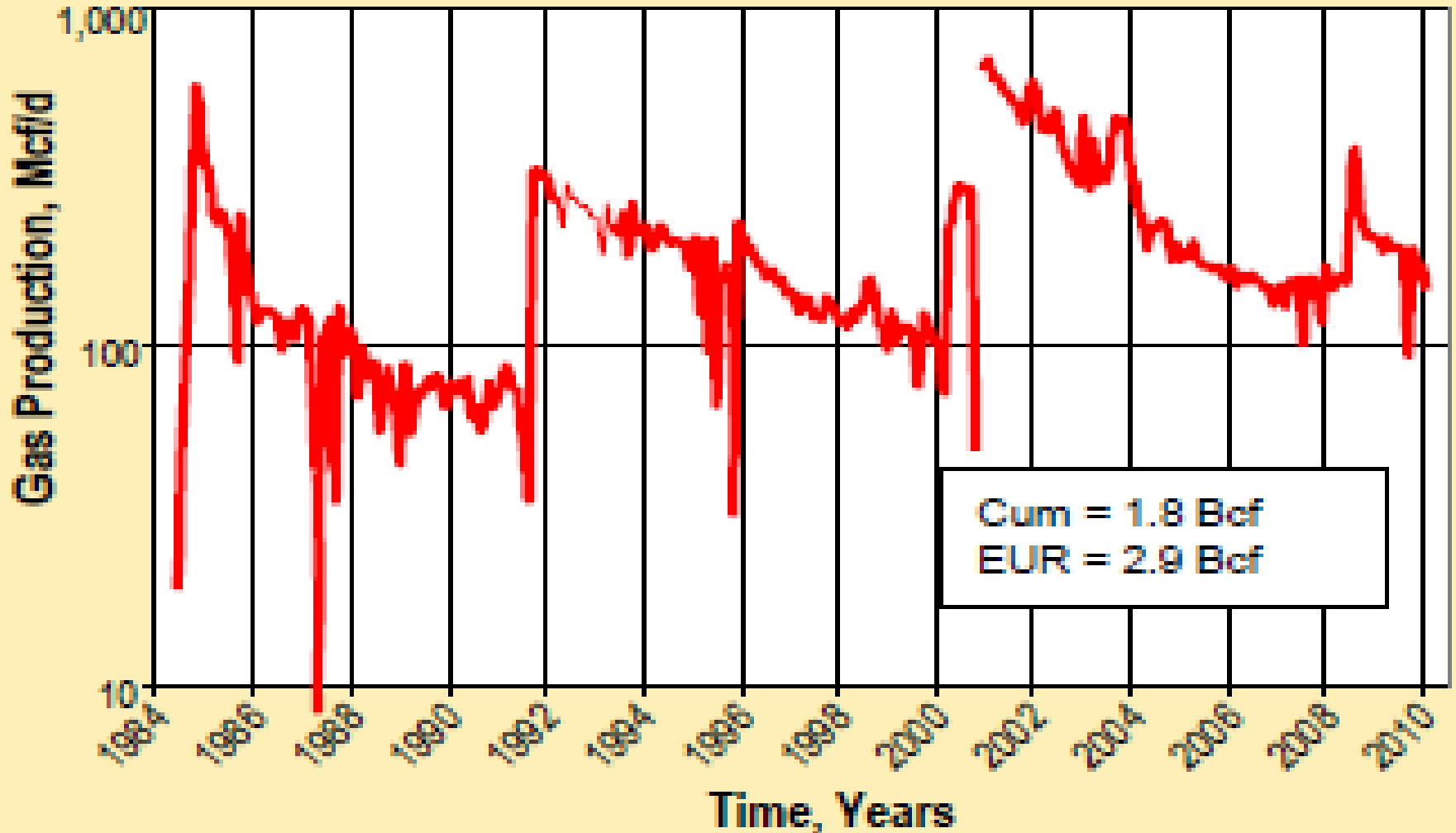


# PRESSURE PUMPING CAPACITY



# REFRACTURE STIMULATION

*Johnson No. 2 Well*



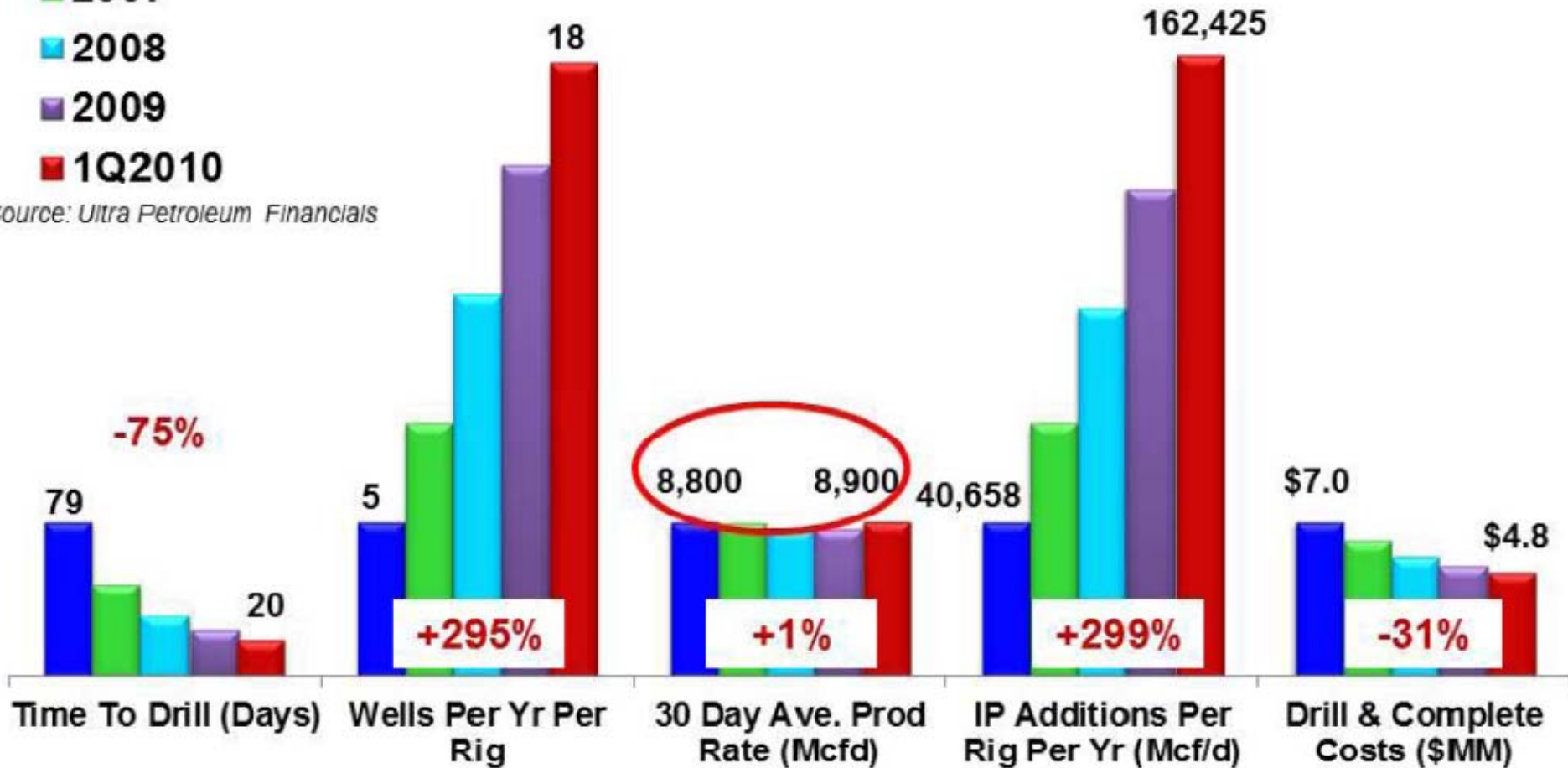
# 2006-10 PRODUCTIVITY GAINS

## *Ultra Petroleum Productivity Gains*

### Pinedale Field, Wyoming



Source: Ultra Petroleum Financials



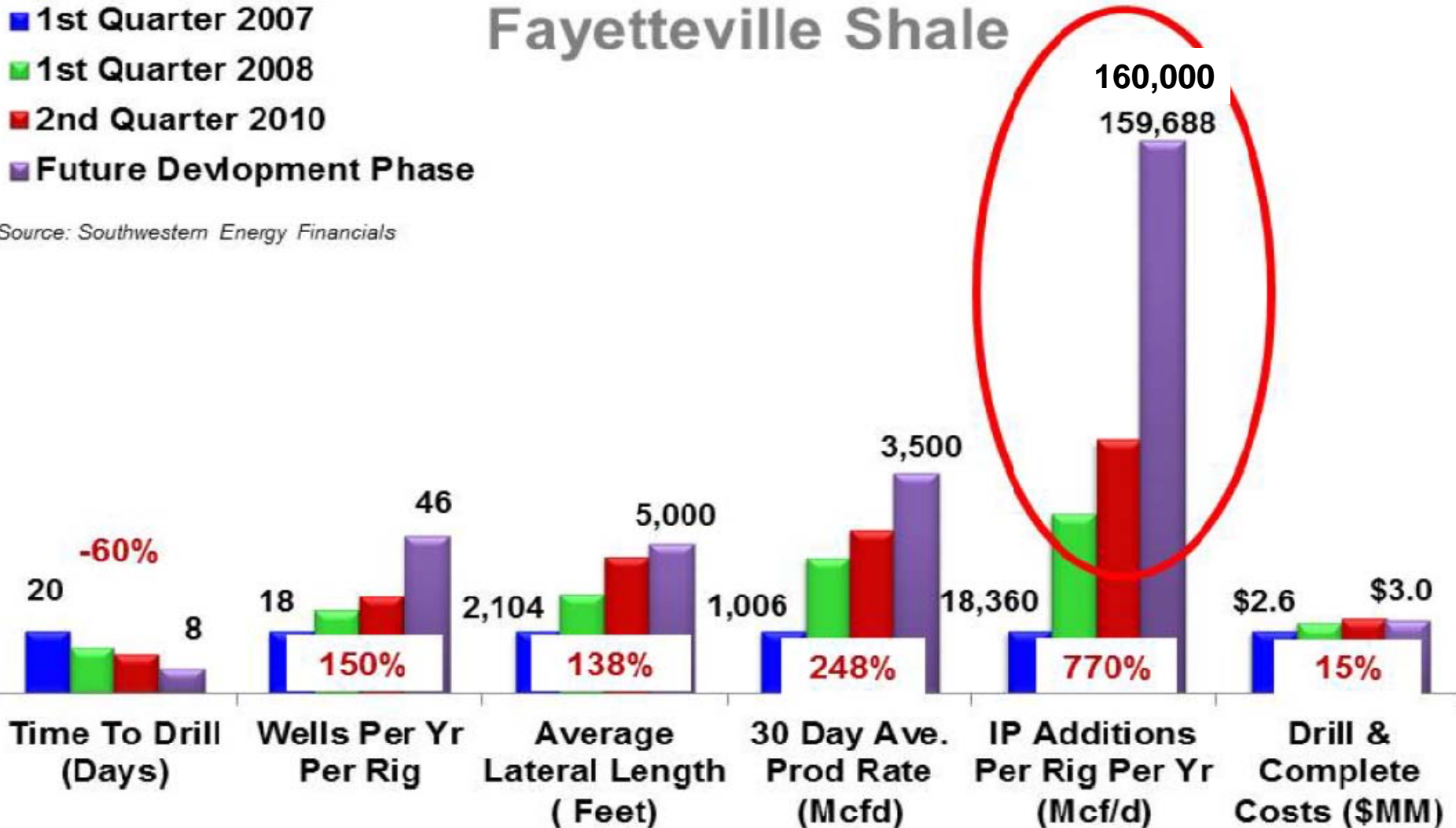
# 2007-10 PRODUCTIVITY GAINS

## *Southwestern productivity gains*

- 1st Quarter 2007
- 1st Quarter 2008
- 2nd Quarter 2010
- Future Development Phase

### Fayetteville Shale

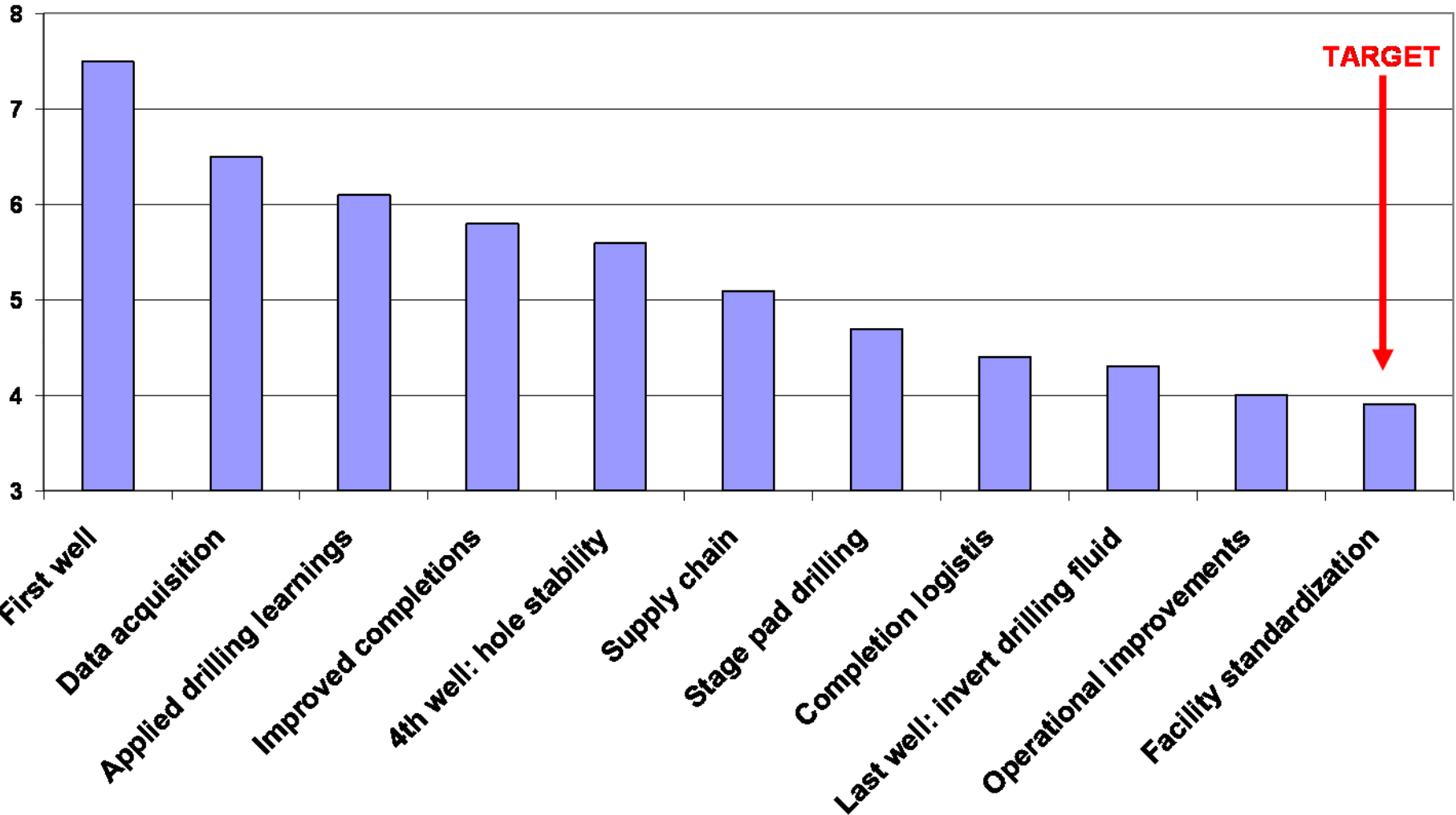
Source: Southwestern Energy Financials



# WELL COST REDUCTIONS

## EXAMPLE: MARCELLUS D&C COSTS (M\$)

Source: TALISMAN ENERGY



# PART III: CHALLENGES & ISSUES

*Is the development of shale gas like a Ponzi scheme, and are US gas majors behaving like Madoff?*

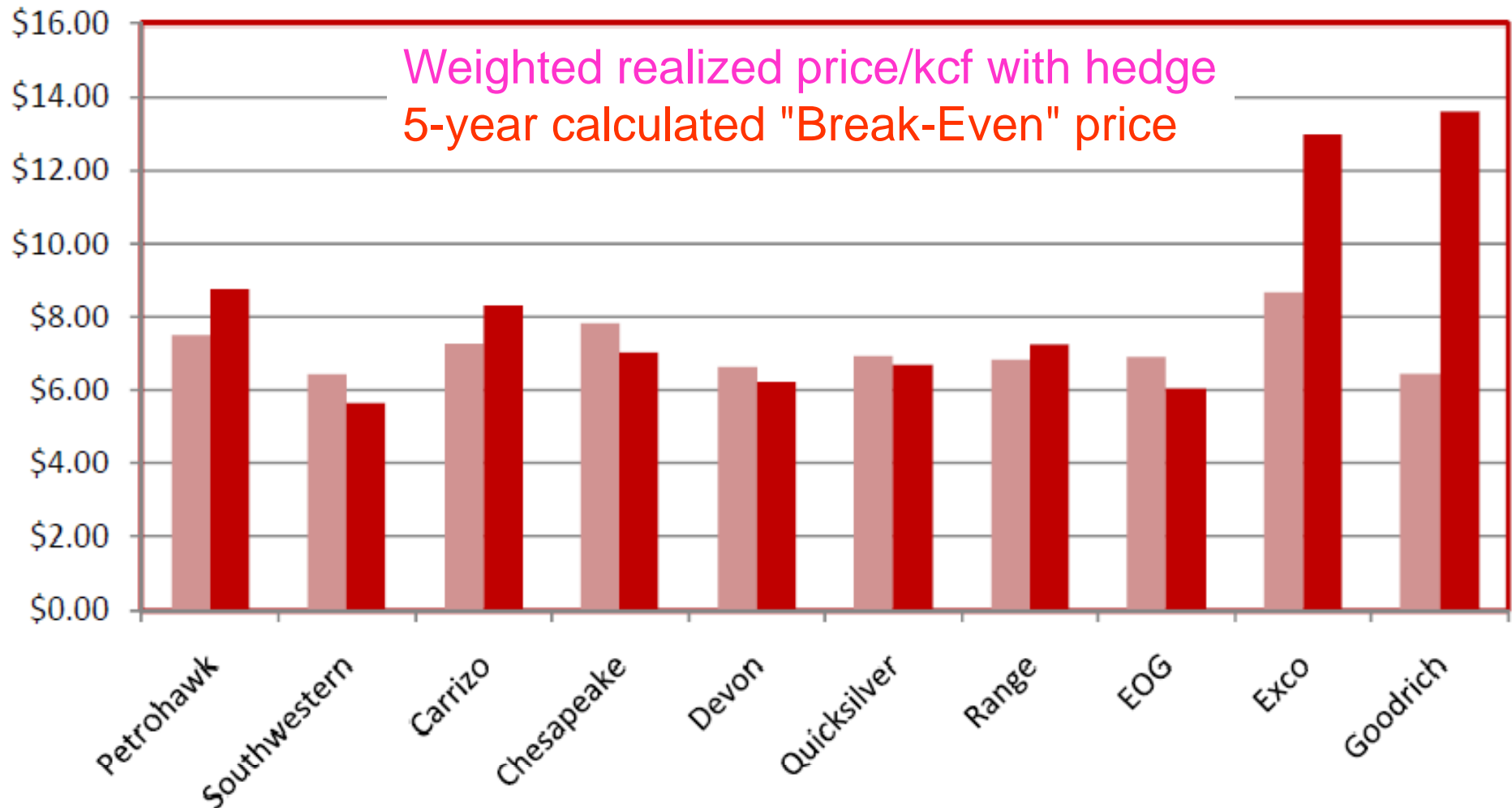
*Art. Berman sees major limitations such as:*

- High costs, poor economics and destruction of capital
- Infrastructure limitations (pipelines and NGL-stripping plants)
- Physical fundamentals (small core areas, fast decline rates)
- Average break-even prices higher than current prices

*But, if some operators may fool some analysts for a while...  
...the entire industry cannot be wrong for ever*

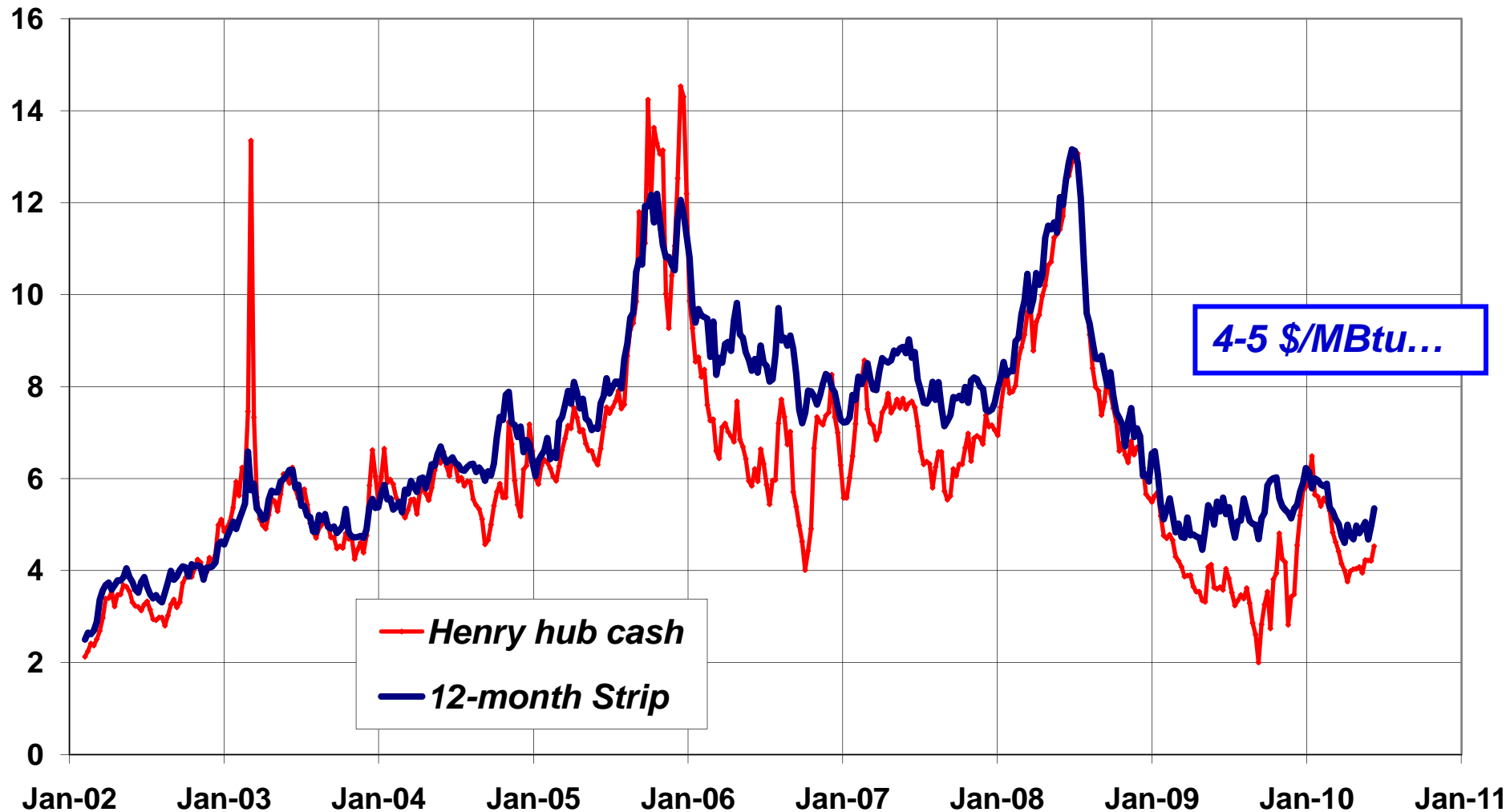
# LOW OR HIGH COST PLAYS?

*Berman's selected 5-y production costs per kcf are misleading given the rapid productivity gains and cost reductions since 2004, and especially after 2009*



# ARE HH PRICES TOO LOW?

US SPOT AND 12-MONTH STRIP PRICE (\$/MBTU)



# OR GOOD WITH NGL-LIQUIDS?

**\$4.00 NYMEX equates to \$6.34 per one mcf**

\$4.00 NYMEX Henry Hub  
 \$85.00 NYMEX WTI  
 Based on 12/10 Gas Quality <sup>(1)</sup>  
 Assumes 1130 Btu

Wellhead Production  
 1 mcf of Natural Gas

Natural Gas &  
 Ethanes

NGLs

Condensate

Production by product

.91 mcf

2.25 gallons/mcf

.012 bbls/mcf



Gross realized by product

\$3.98 net

\$1.61 net <sup>(2)</sup>

\$0.75 net

**\$6.34 per one mcf**

Gathering, compression and  
 transportation (deducted from gas price)

\$0.75 to \$1.25<sup>(3)</sup>

**...or 6+ /MBtu**

Operating expenses

\$0.25 to \$0.40<sup>(3)</sup>

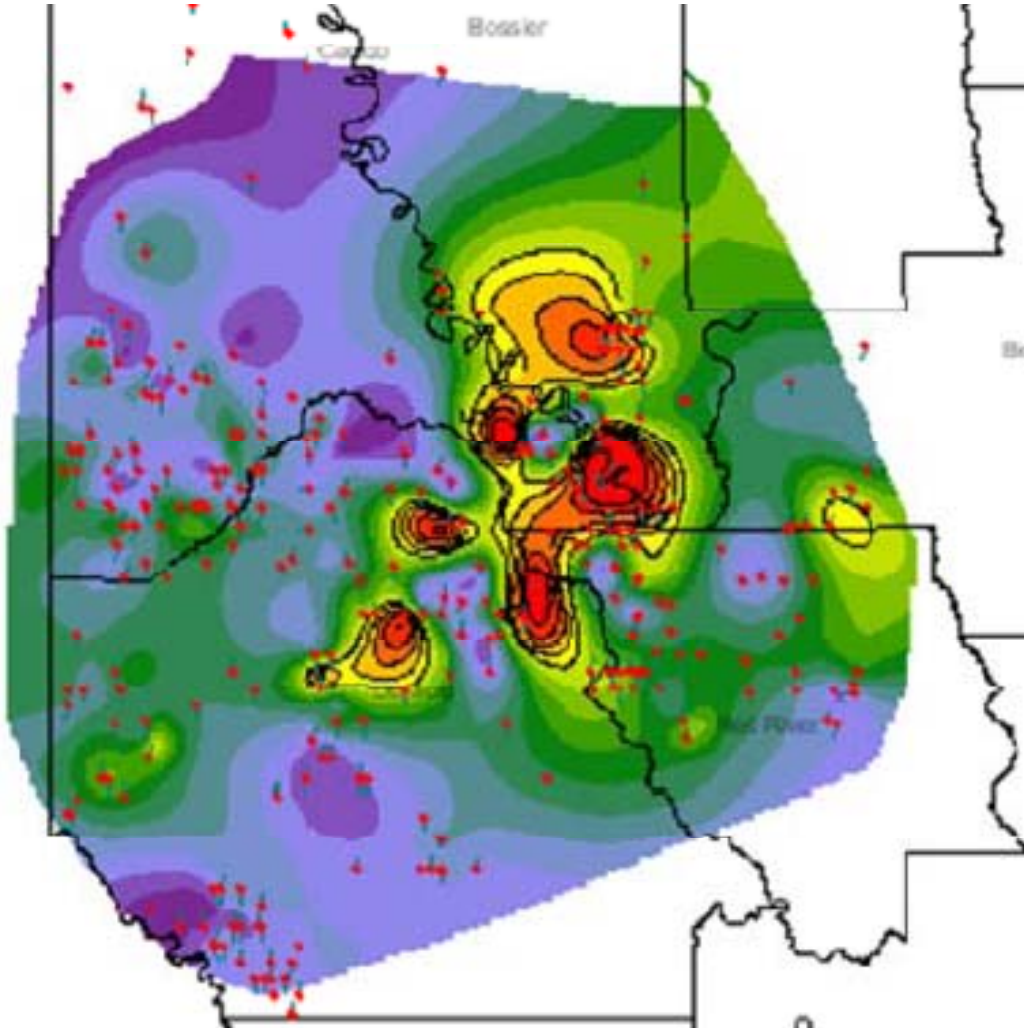
(1) Realization will change as gas quality changes

(2) Uses 2 years correlation factor of WTI to Marcellus realized of .5123 and net realized price of \$36.80 after deductions

(3) Will decline over time as volumes decrease

# HAYNESVILLE CORE AREA

*But 1 section (640 acres) can hold reserves up to 500 Bcf!*

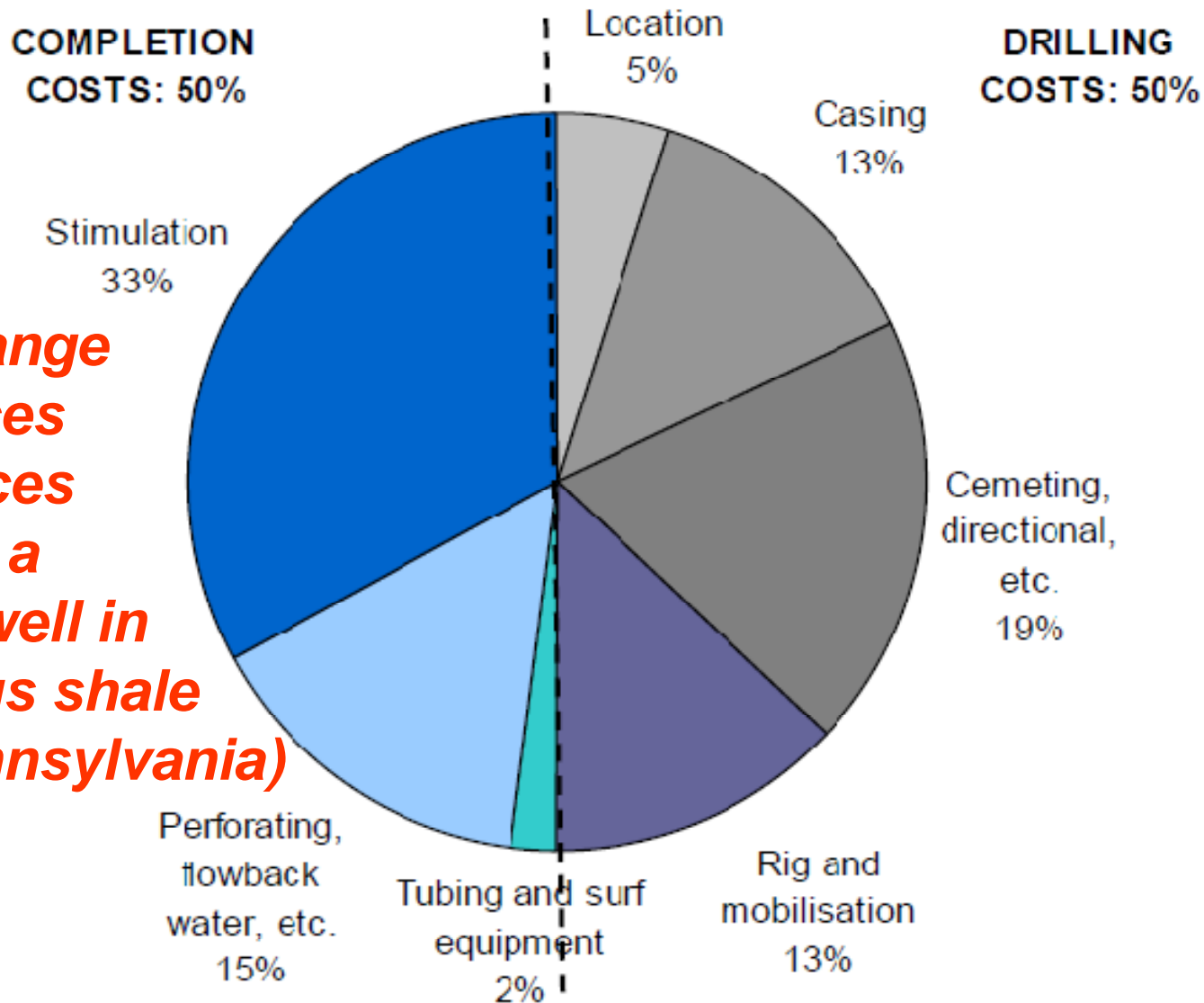


- In Haynesville shale the emerging core area includes ~110 000 acres or about 5 townships.
- i.e. ~**8%** of the 1.5 M-acres play area in Louisiana within the drilling limits.
- It was recently ranked the 4th largest gas field in the world, and the largest in North America.
- Operators claim 6.5-7.5 Bcf per well. How can HK and EXCO wells be twice better than those of CHK or EOG?

*A. E. BERMAN, Dec 2, 2010*

# ARE COSTS TOO HIGH?

*Total Haynesville well said to cost 9 M\$...*



*...but Range Resources announces 4 M\$ for a similar well in Marcellus shale (SW Pennsylvania)*

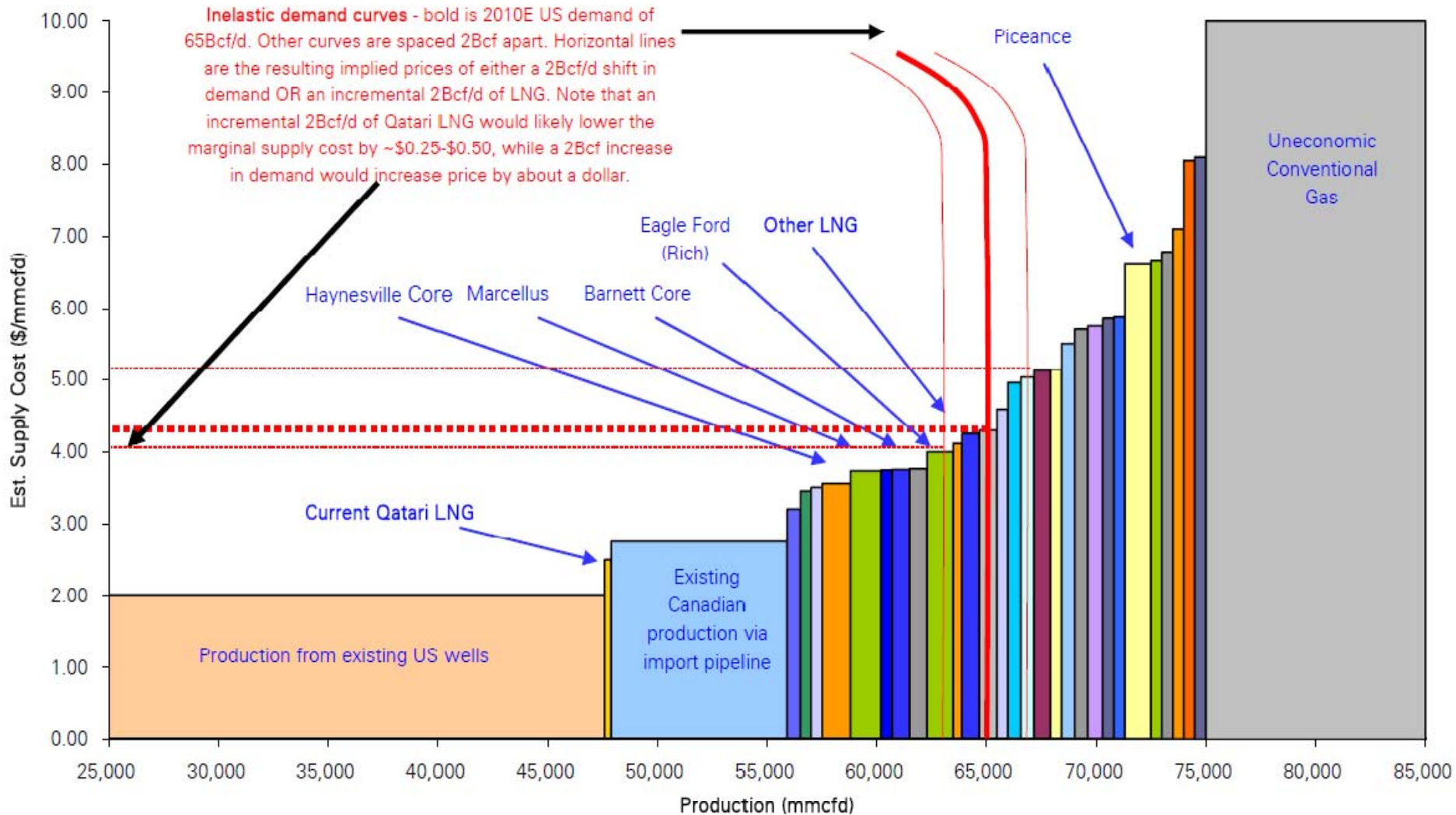
# YES SAYS ART. BERMAN...\*

*He doubts that shale plays can be commercial and says...*

- “...Most operators maintain the illusion of success...
- ...Growth is subsidized by debt and sales of assets...
- ...High decline rates call for continuously drilling...
- ...Mostly high-cost plays: \$7 based on SEC 10-K...
- ...Overstated booked reserves (80% are undeveloped)...
- ...Undeveloped reserves must be drilled within 5 years...
- ...Destruction of shareholder equity (write-downs & sales)...
- ...And falling strips that do not allow hedging...”

*Source: “Shale Gas, Abundance or Mirage?” presentation in Quebec, Dec. 2010*

# NO SAYS WOODMAC\*



Source: Deutsche Bank/Woodmac supply cost curve estimates Sept. 2010

# EXAMPLES OF ECONOMICS

*Source: Enterprise Products Partners L.P.*

<b><u>Company</u></b>	<b><u>Play</u></b>	<b><u>Break Even</u> (\$/kcf)</b>
<b>Ultra</b>	<b>Pinedale Lance Sands</b>	<b>2.8</b>
<b>Williams</b>	<b>San Juan Conventional</b>	<b>4.7</b>
<b>Talisman</b>	<b>Eagle Ford Rich gas</b>	<b>4.0</b>
<b>Goodrich</b>	<b>Haynesville</b>	<b>3.3 - 4.6</b>
<b>Newfield</b>	<b>Arkoma Woodford</b>	<b>3.0 - 4.6</b>
<b>Chesapeake</b>	<b>Fayetteville</b>	<b>4.0 - 4.7</b>
<b>Range</b>	<b>Marcellus rich shale</b>	<b>2.4</b>

# TRUE SHALE GAS REALITIES

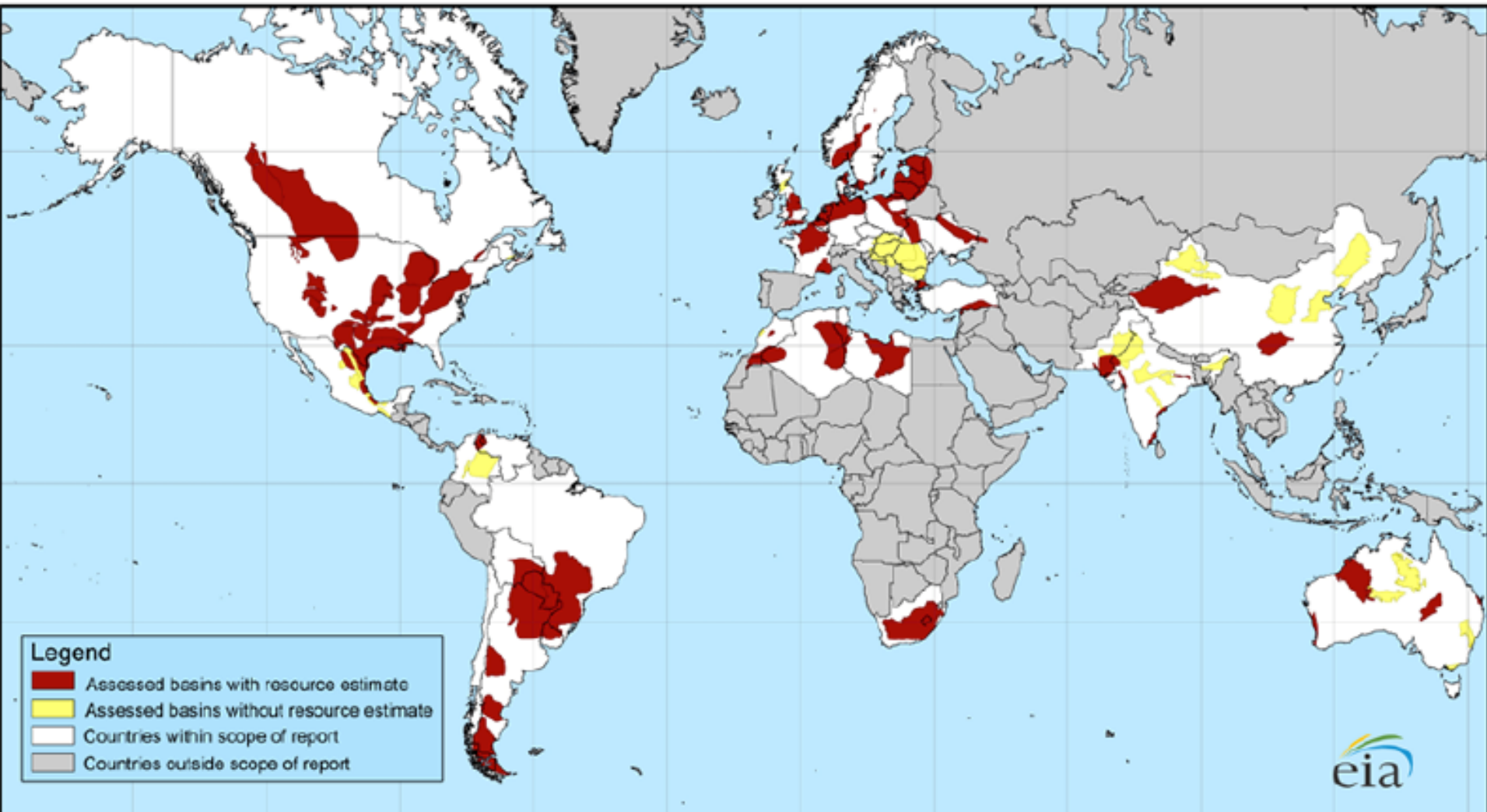
- Shales are the last unconventional gas in development, and still are at the beginning of the learning curve. The pace of technological improvement will continue
- EUR (expected ultimate reserves) critically depend on the type of decline (exponential or hyperbolic) but economics become irrelevant after 10-20 years
- High costs plays: NGL make part of the economic value; Core areas with good IP are small (a few %), but overall reserves may be very large (a “game-changer”)
- Good operators will manage environmental concerns but infrastructure (NGL plants and pipelines) is critical

# CONCLUSION: WHAT FUTURE?

- **In North America**: Exports of a few % of production as LNG will sustain a balanced price level (5-6 \$/kcf) which, in turn, will allow production to grow evenly.
- **In Europe**: Unconventional gas prospects are remote: not only spot LNG imports push prices down but the EU E&P legislation needs to be deeply redrafted
- **In Asia-Pacific**: Neither China unconventional (still far away), nor Australian CBM-to-LNG (2-3 Bcf/d) will be game changers and decouple LNG from oil soon.

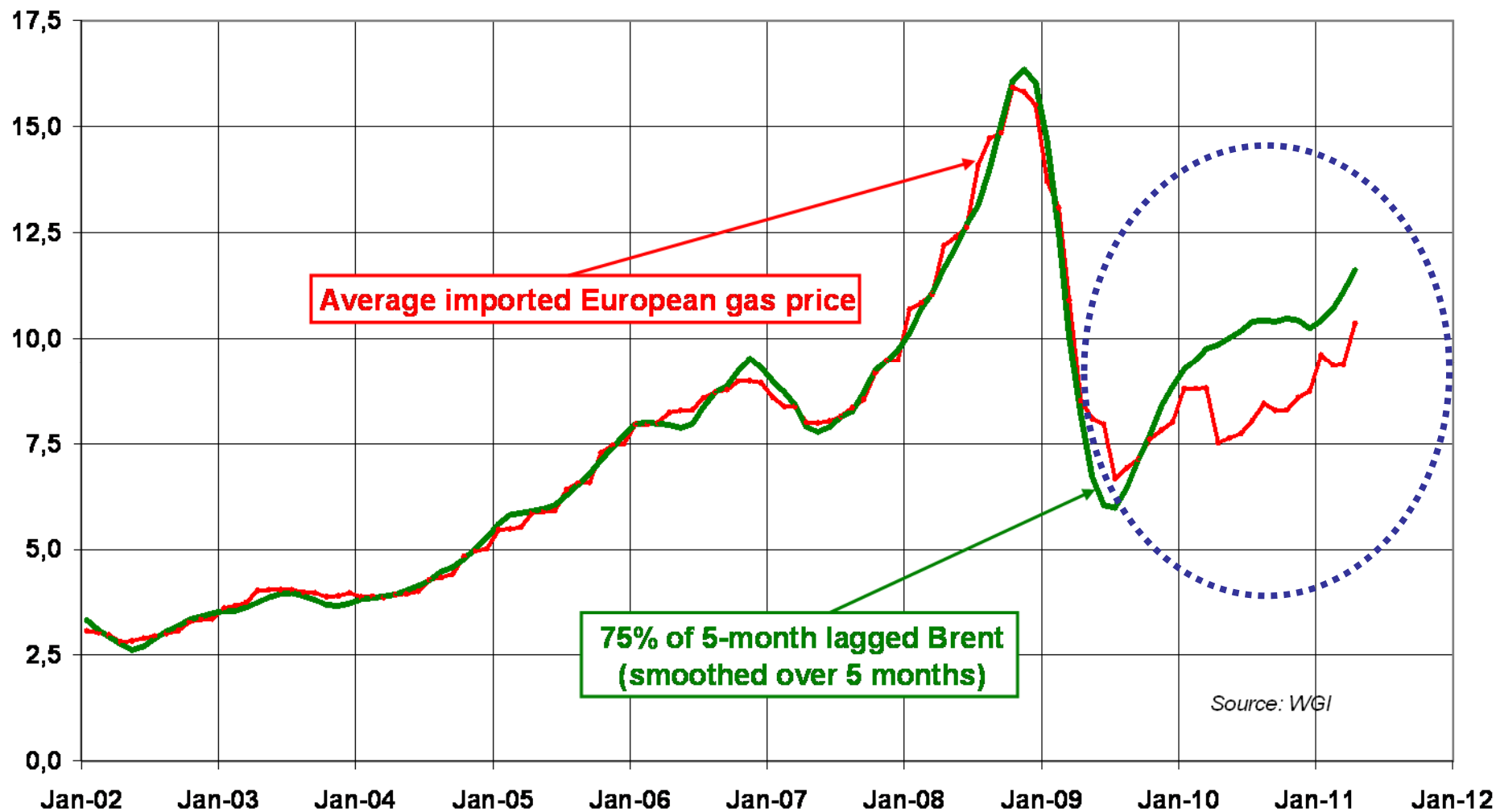
# WORLD SHALE RESOURCES

6 622 Tcf of which 20-30% may be recoverable



# EU OIL-NATGAS DECOUPLING

## EU AVERAGE MONTHLY BORDER PRICE (\$/MBTU)



# ASIA-PACIFIC

- Some countries like Korea did succeed to lower their LNG supply cost but oil-indexation will likely remain, especially in the post-Fukushima context
- The nuclear crisis will add new LNG requirements in Japan (+7 Mt/y?), Asia-Pacific (China? India?) and Western Europe (?), and push LNG prices up
- High LNG prices make unconventional attractive but controlled domestic prices reduce the incentives as well as the lack of liquids in “dry” gas such as CBM

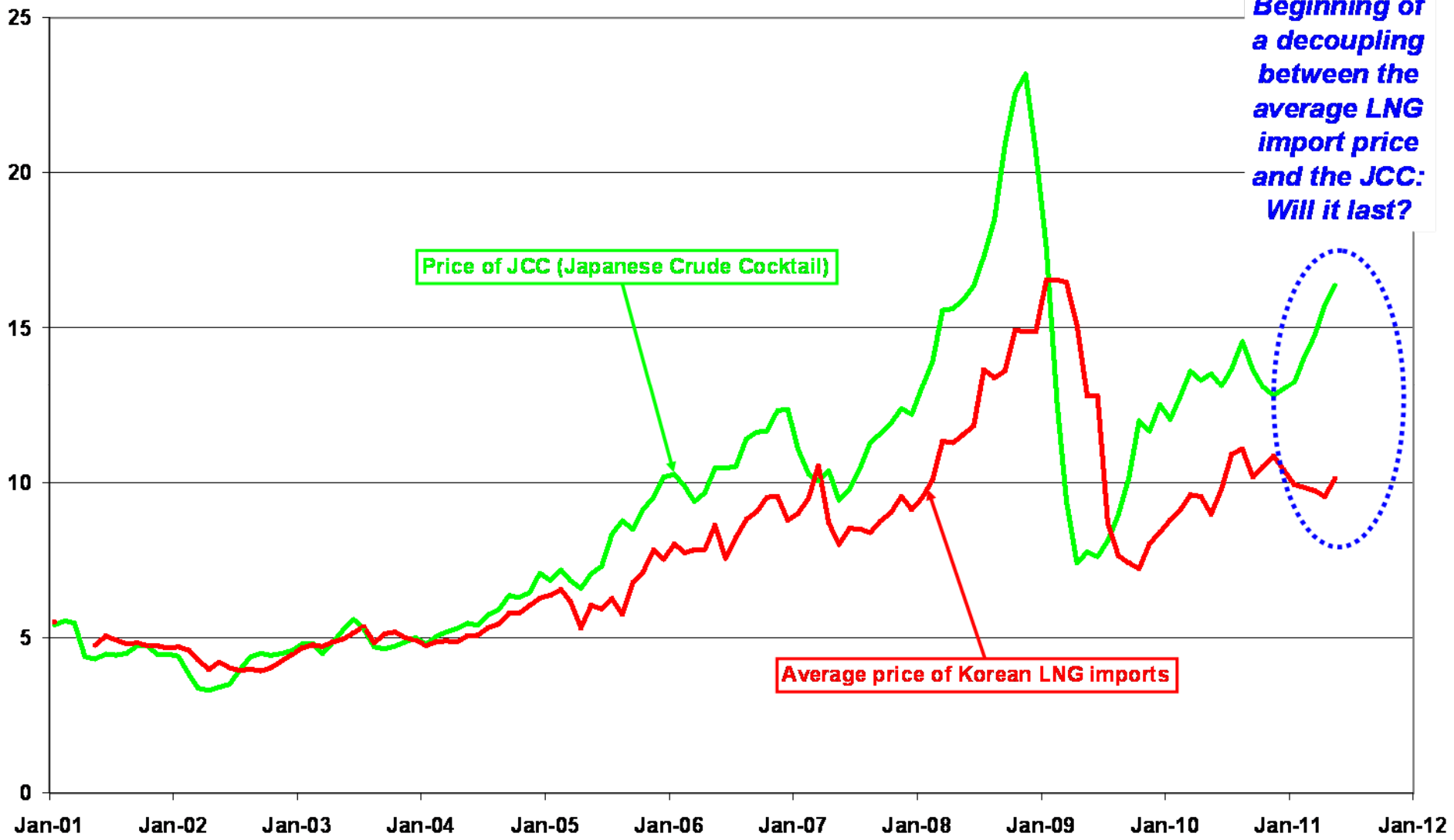
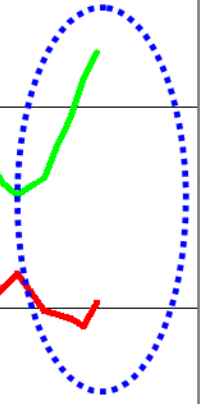
# KOREAN LNG DECOUPLING

PRICES OF JCC & IMPORTED LNG IN KOREA (\$/MBTU)

*Beginning of a decoupling between the average LNG import price and the JCC: Will it last?*

Price of JCC (Japanese Crude Cocktail)

Average price of Korean LNG imports



A scenic landscape of a river flowing through a forested valley. The river is in the middle ground, surrounded by rocky banks and dense green trees. The sky is bright and slightly hazy. The overall scene is peaceful and natural.

# MARCELLUS LANDSCAPE

**THANK YOU**