

Engineering and Economic Challenges in Shale Gas Production

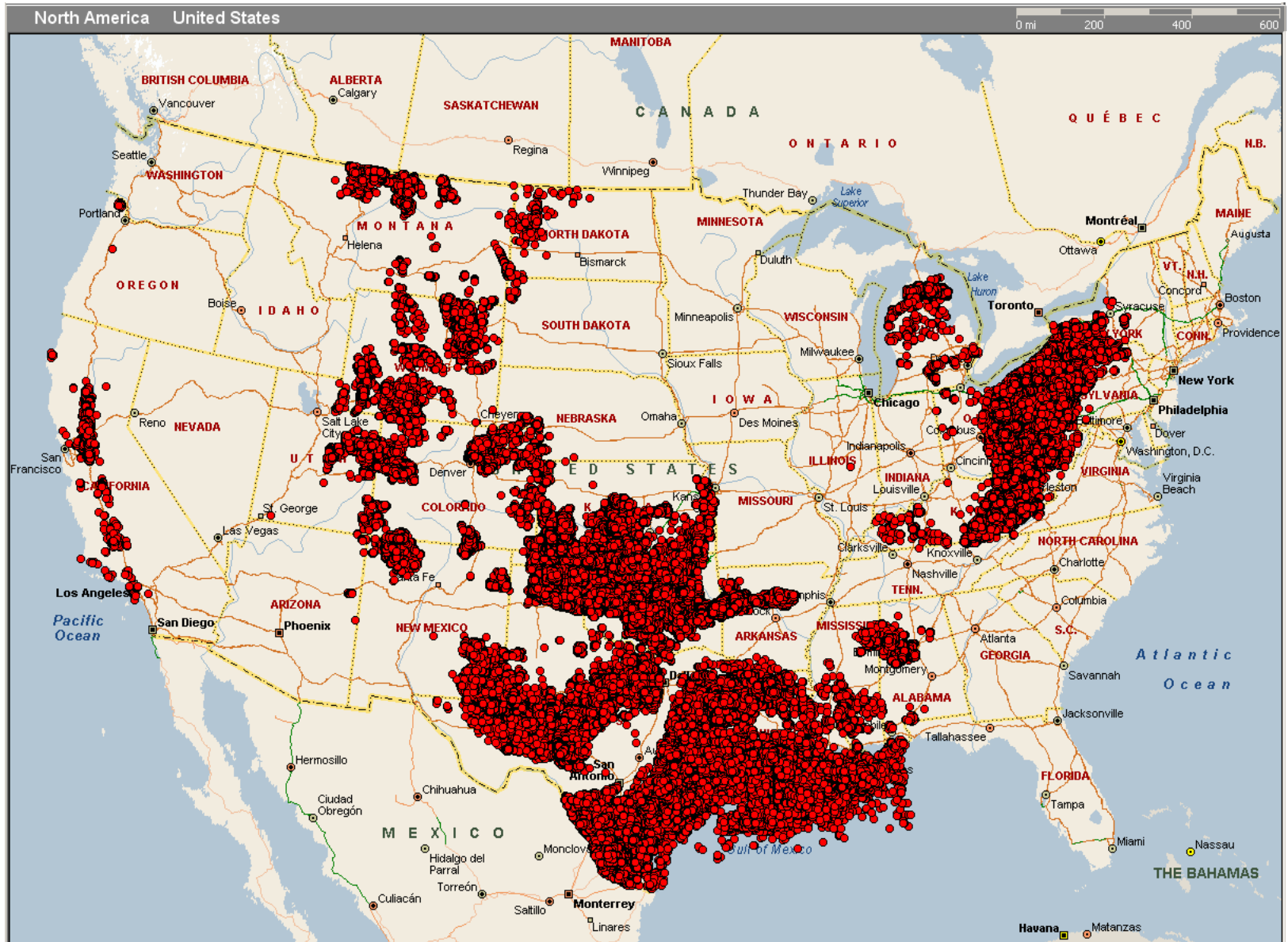
2011 Gas/Electric Partnership Conference

Feb 10th, 2011

Rob Sutton

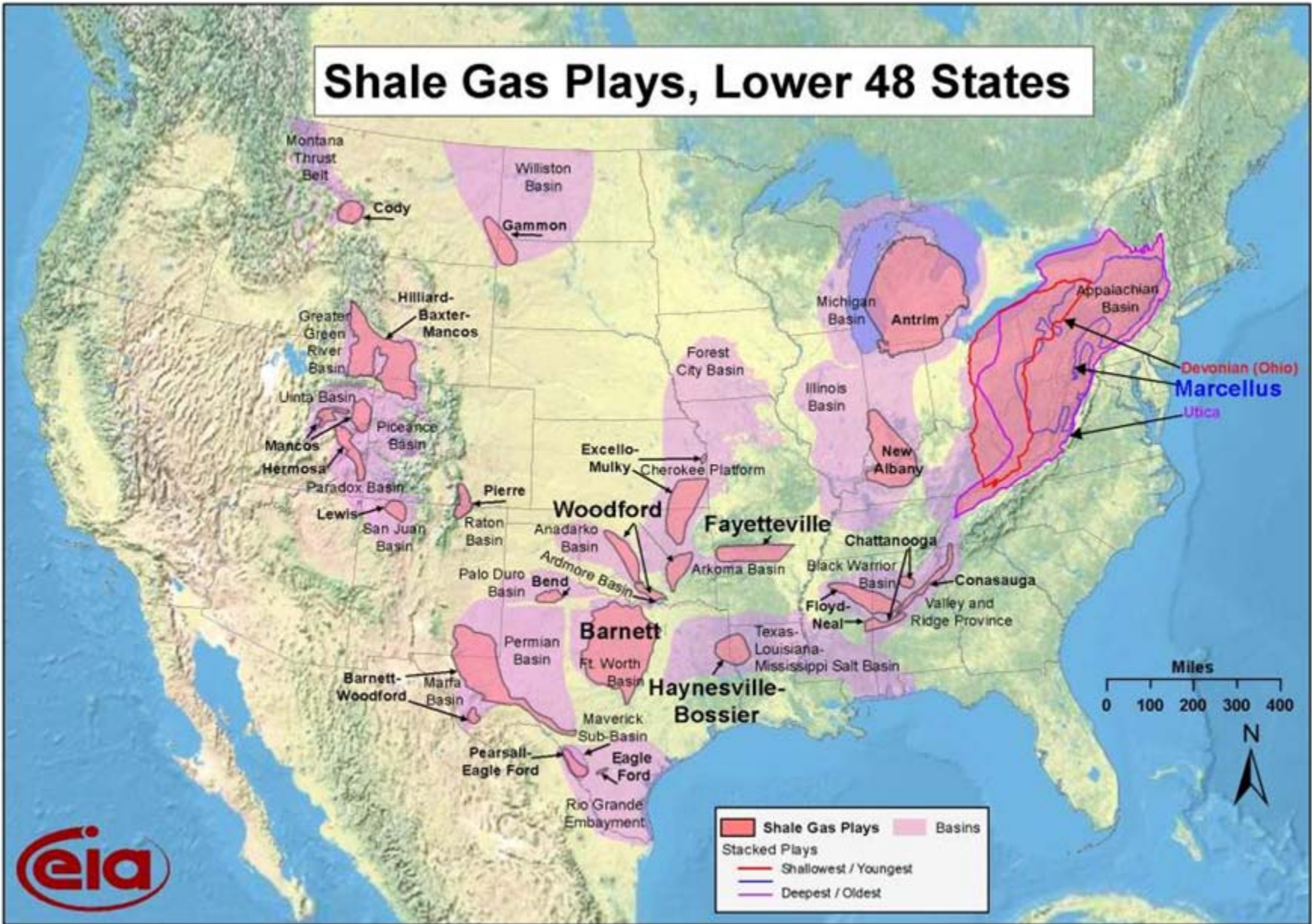
MARATHON

US Gas Well Locations



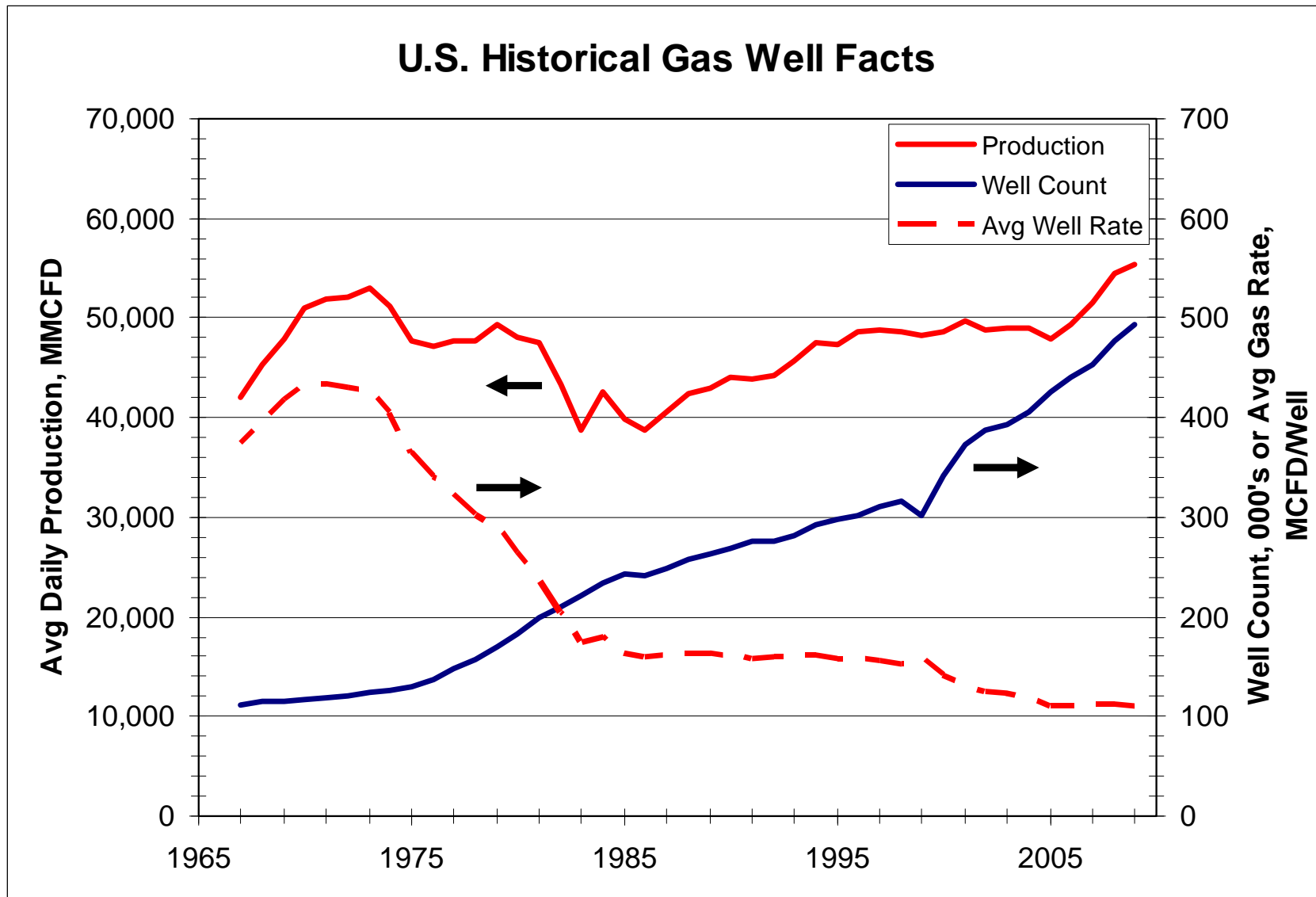
Source:
IHS
MS Streets
& Trips

Shale Gas Plays, Lower 48 States



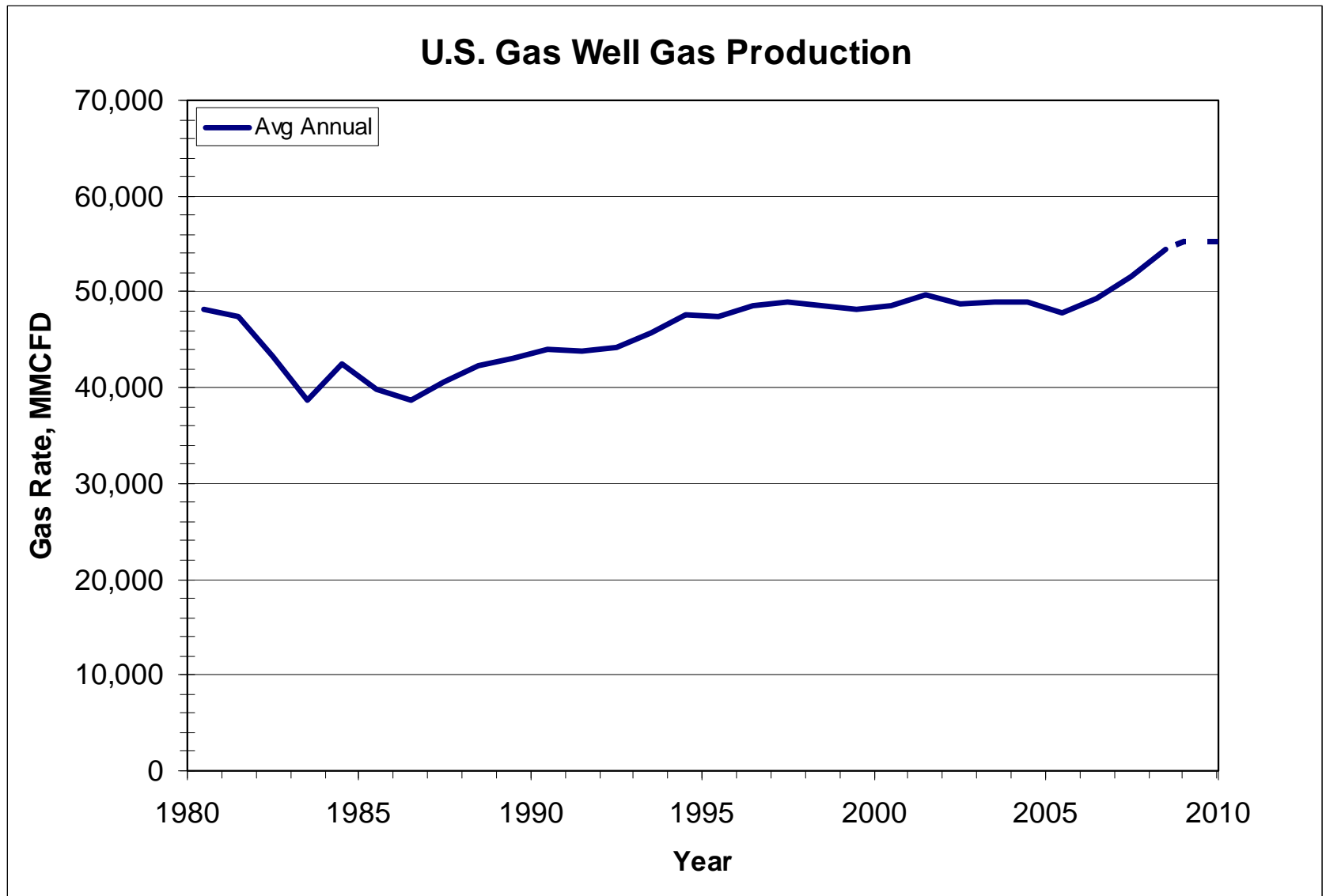
Source: Energy Information Administration based on data from various published studies.
 Updated: March 10, 2010

U.S. Gas Well Gas Production



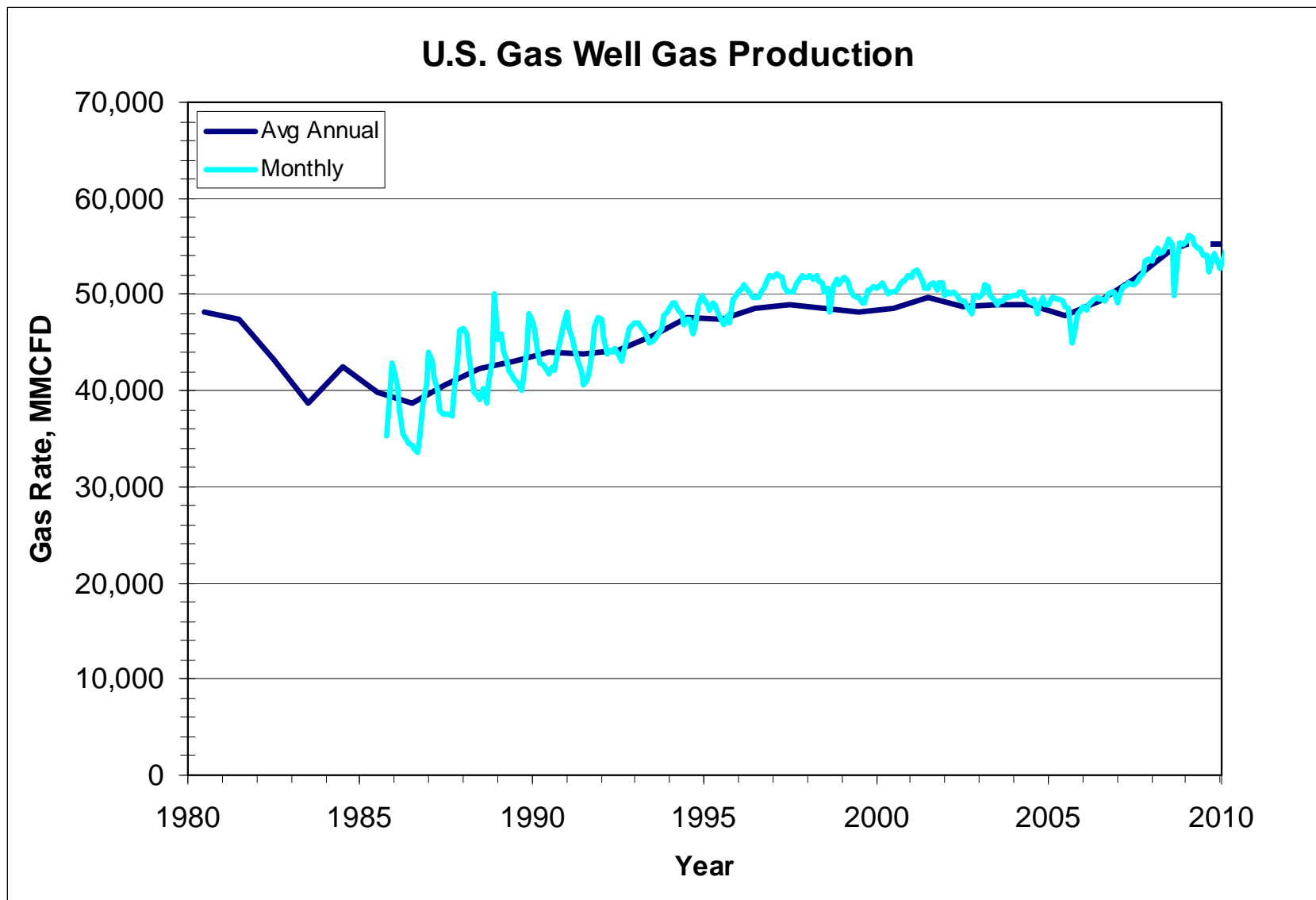
EIA

U.S. Gas Well Gas Production



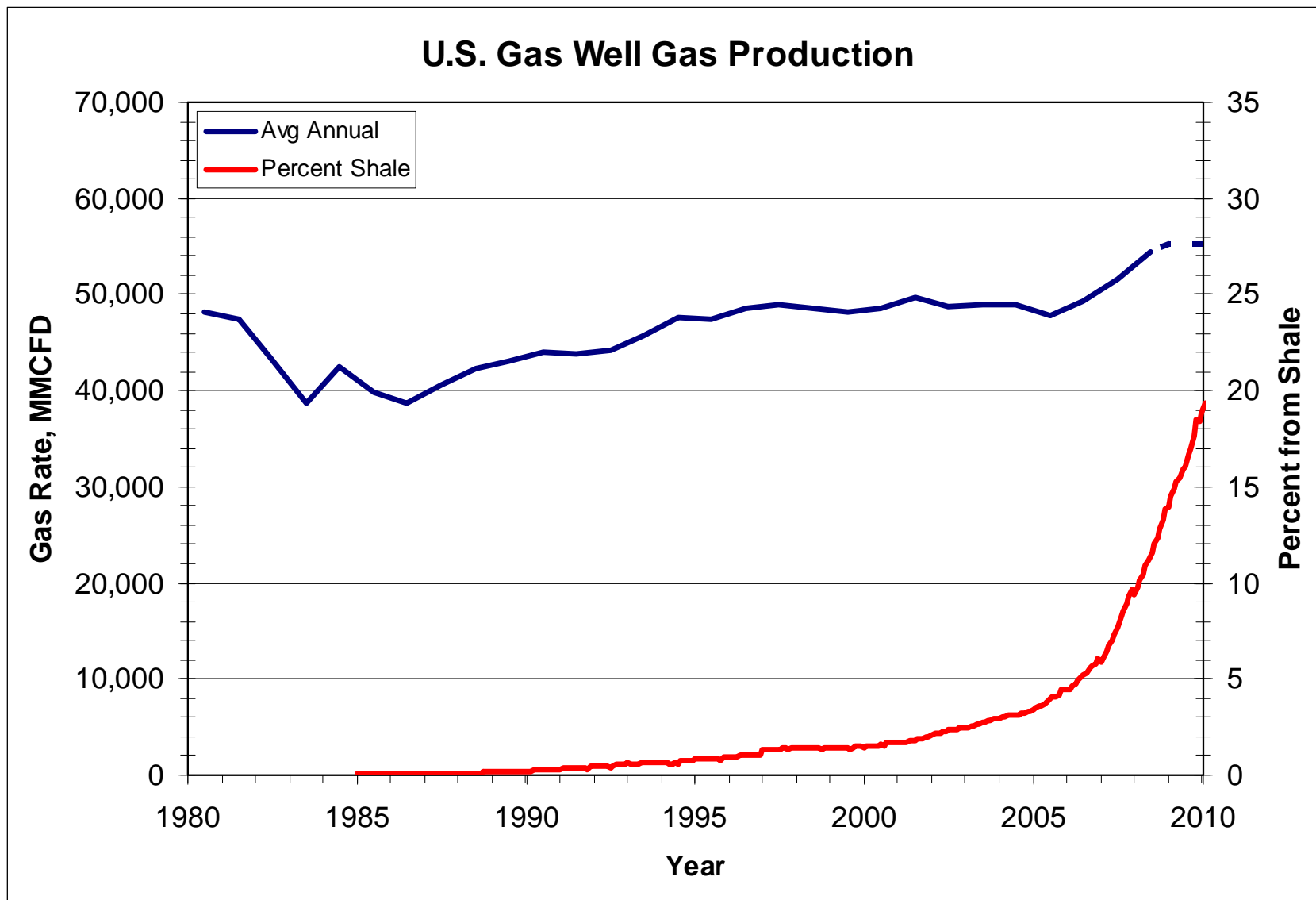
EIA

U.S. Gas Well Gas Production



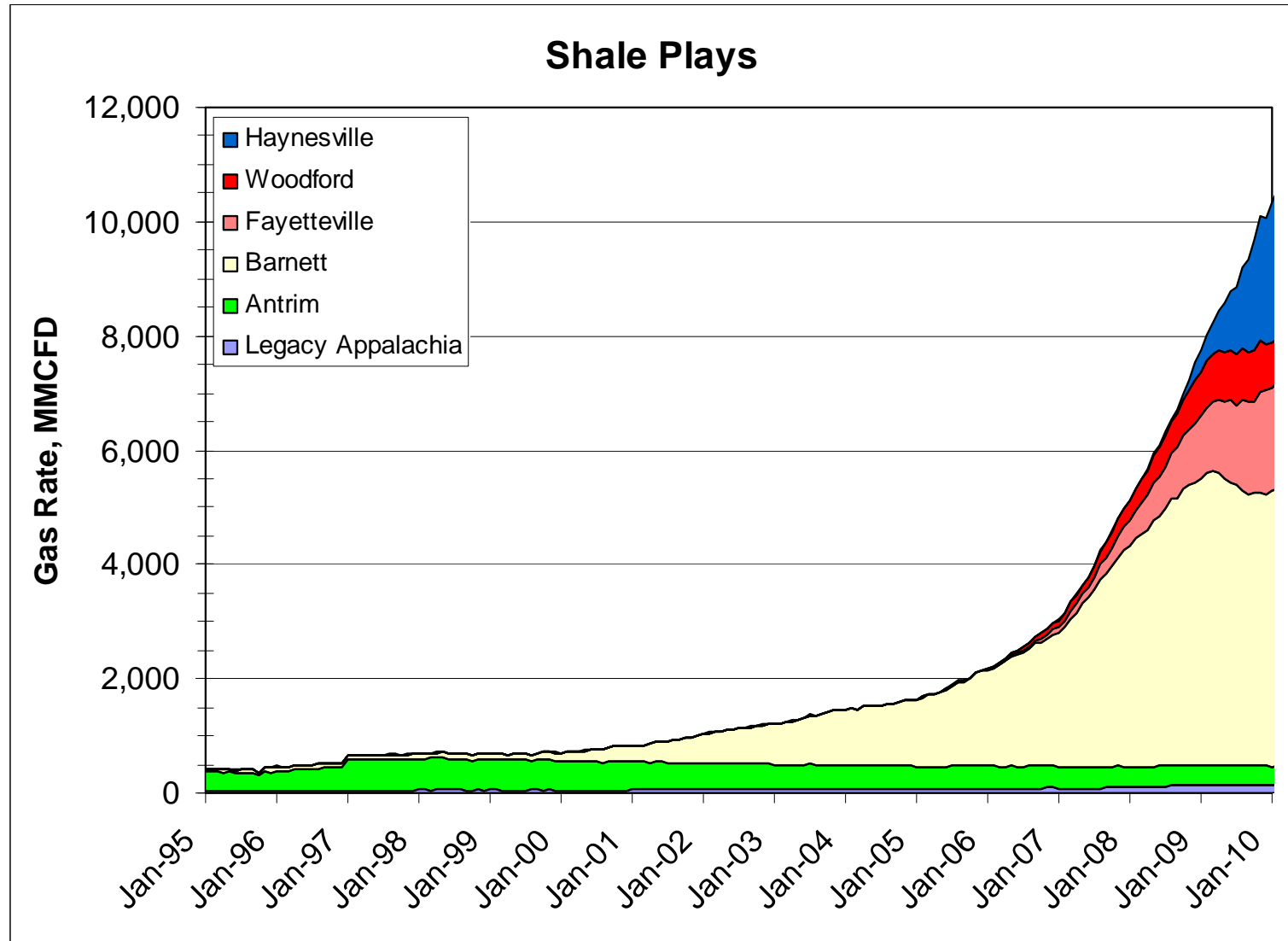
EIA & HPDI

U.S. Gas Well Gas Production



EIA & HPDI

Shale Play Rate Comparison



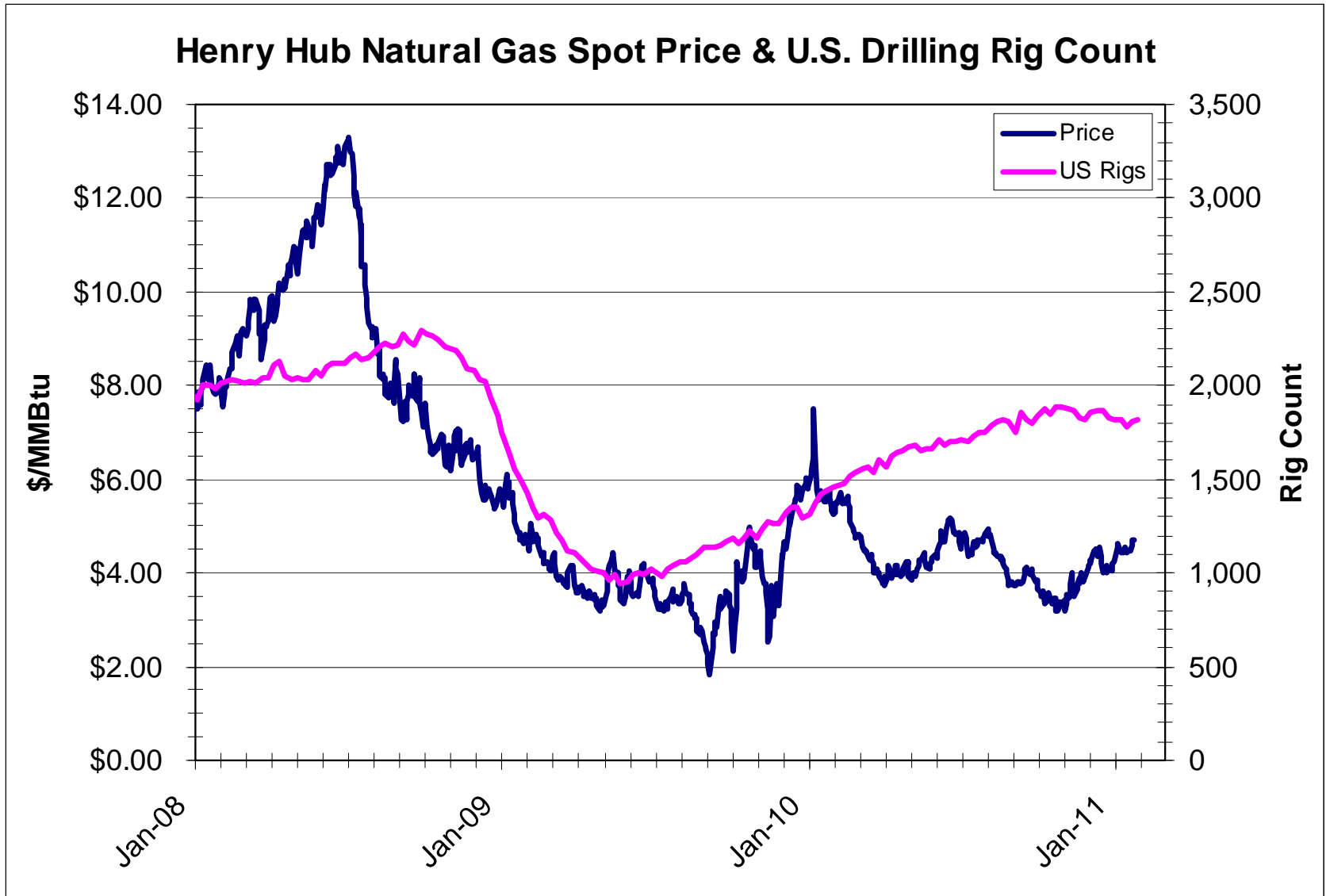
HPDI

Natural Gas – Where It's Produced

Location	2009 Avg Daily Rate, MMCFD	% of Total
Texas w/o Barnett	13,907	25.1
Texas	18,846	34.1
Wyoming	6,578	11.9
Barnett Shale 2009	4,939	8.9
Oklahoma	4,832	8.7
Louisiana	4,111	7.4
New Mexico	3,292	5.9
Colorado	3,244	5.9
Barnett accounts for 26% of total gas well gas production in Texas		
	Total	83.2

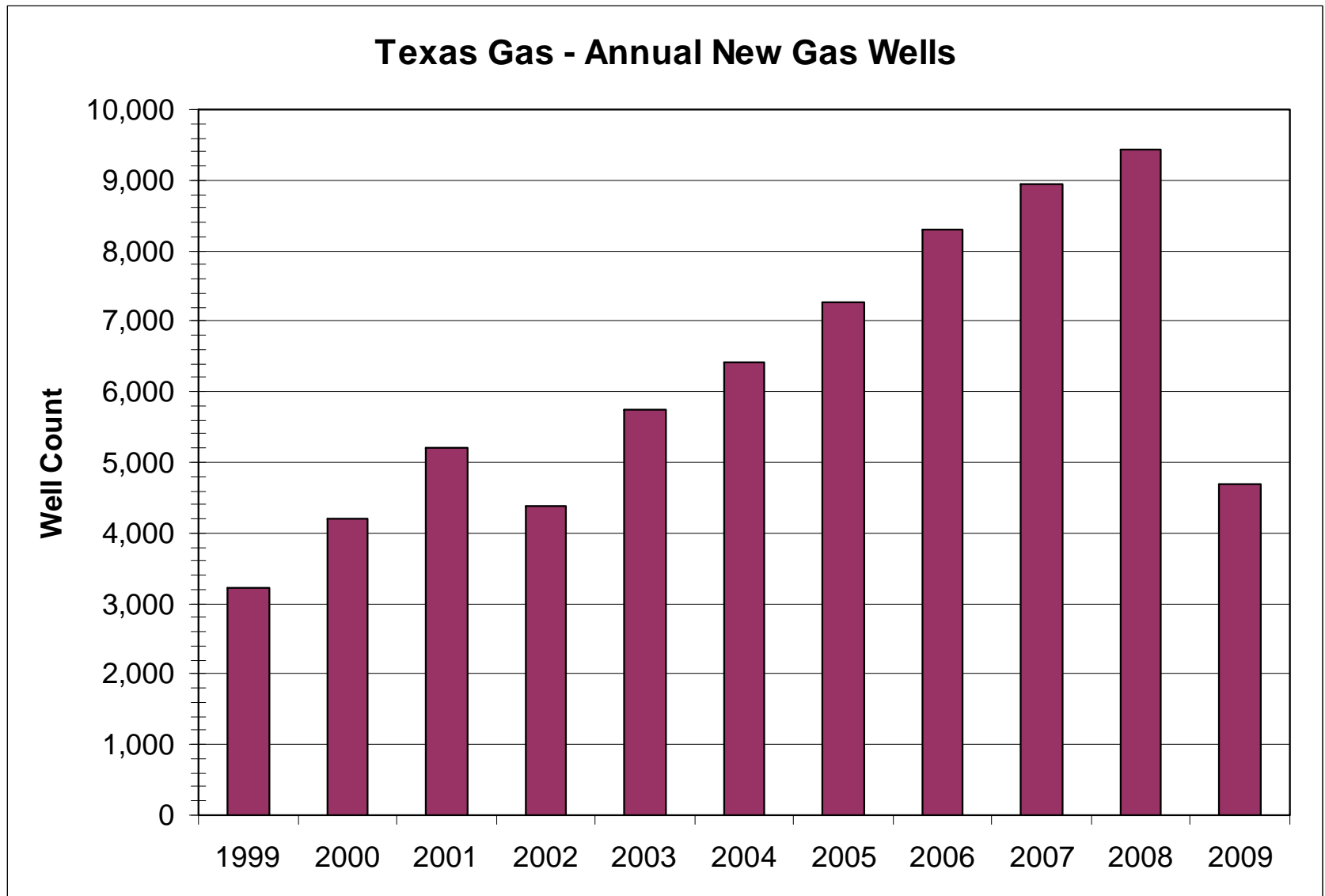
EIA & HPDI

Gas Price and Rigs



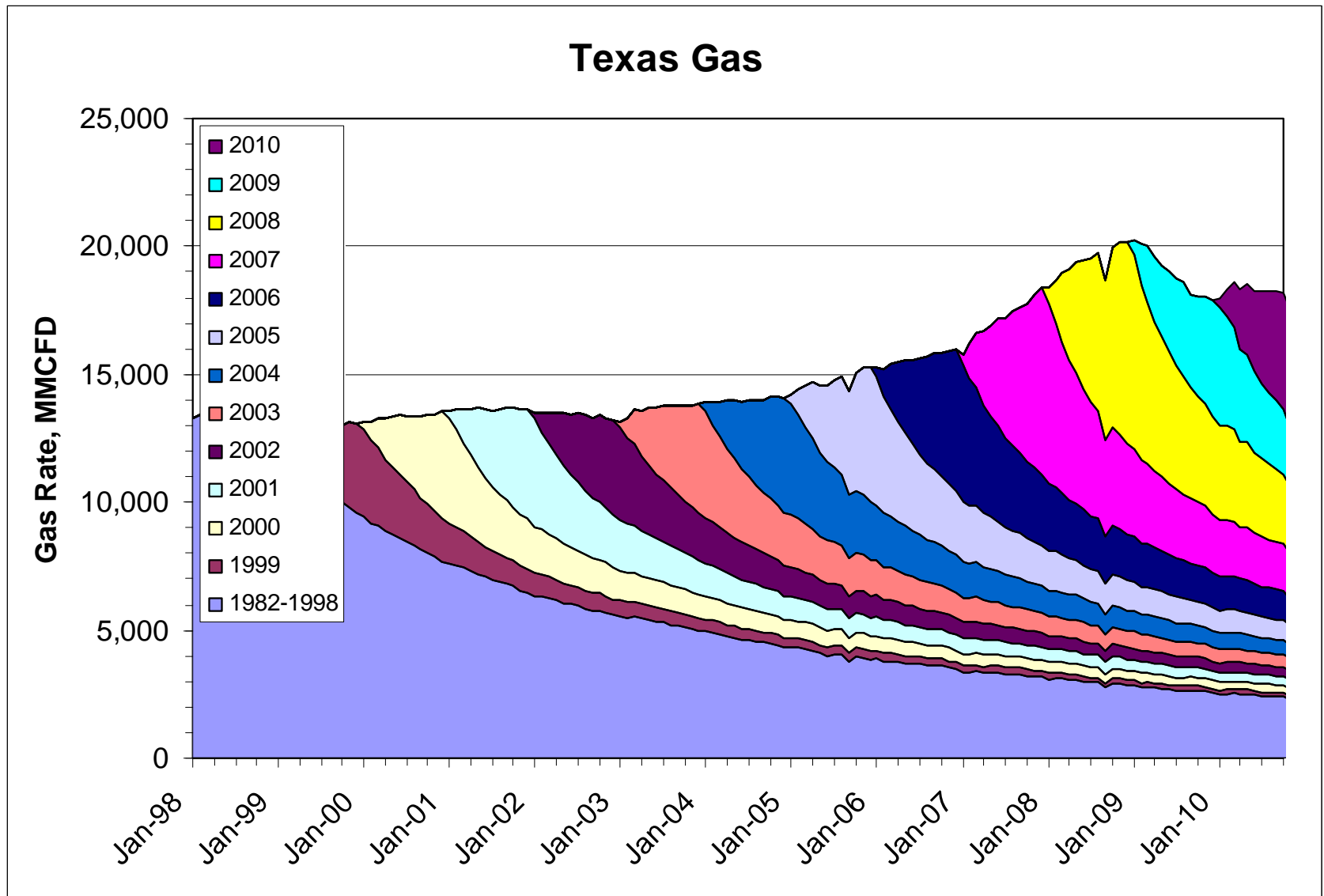
Source - EIA

Texas Gas Wells



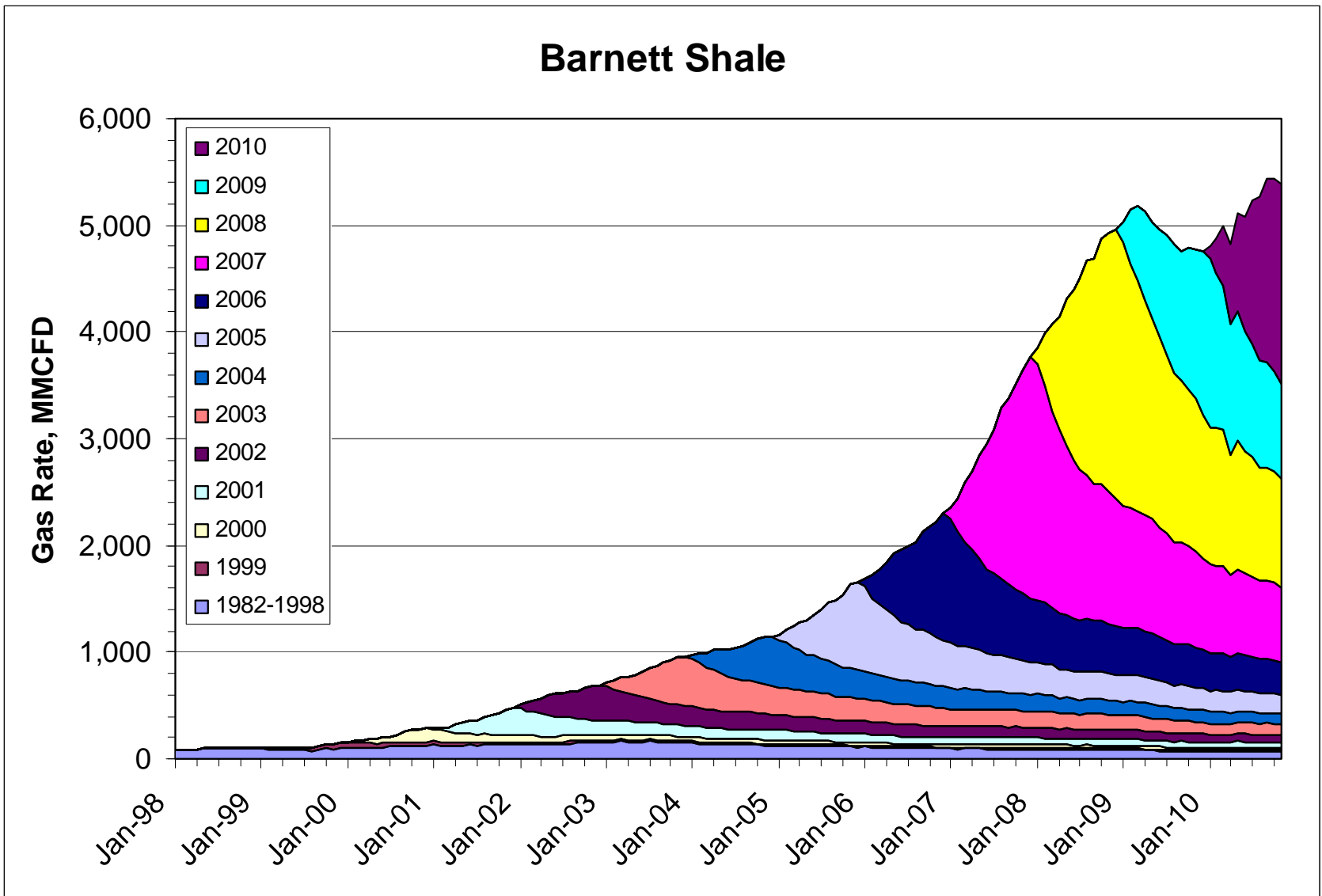
Source - HPDI

Texas Gas Wells



Source - HPDI

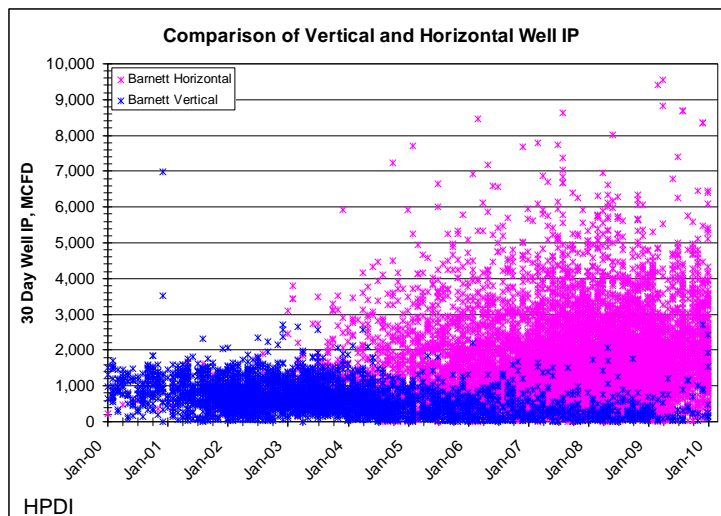
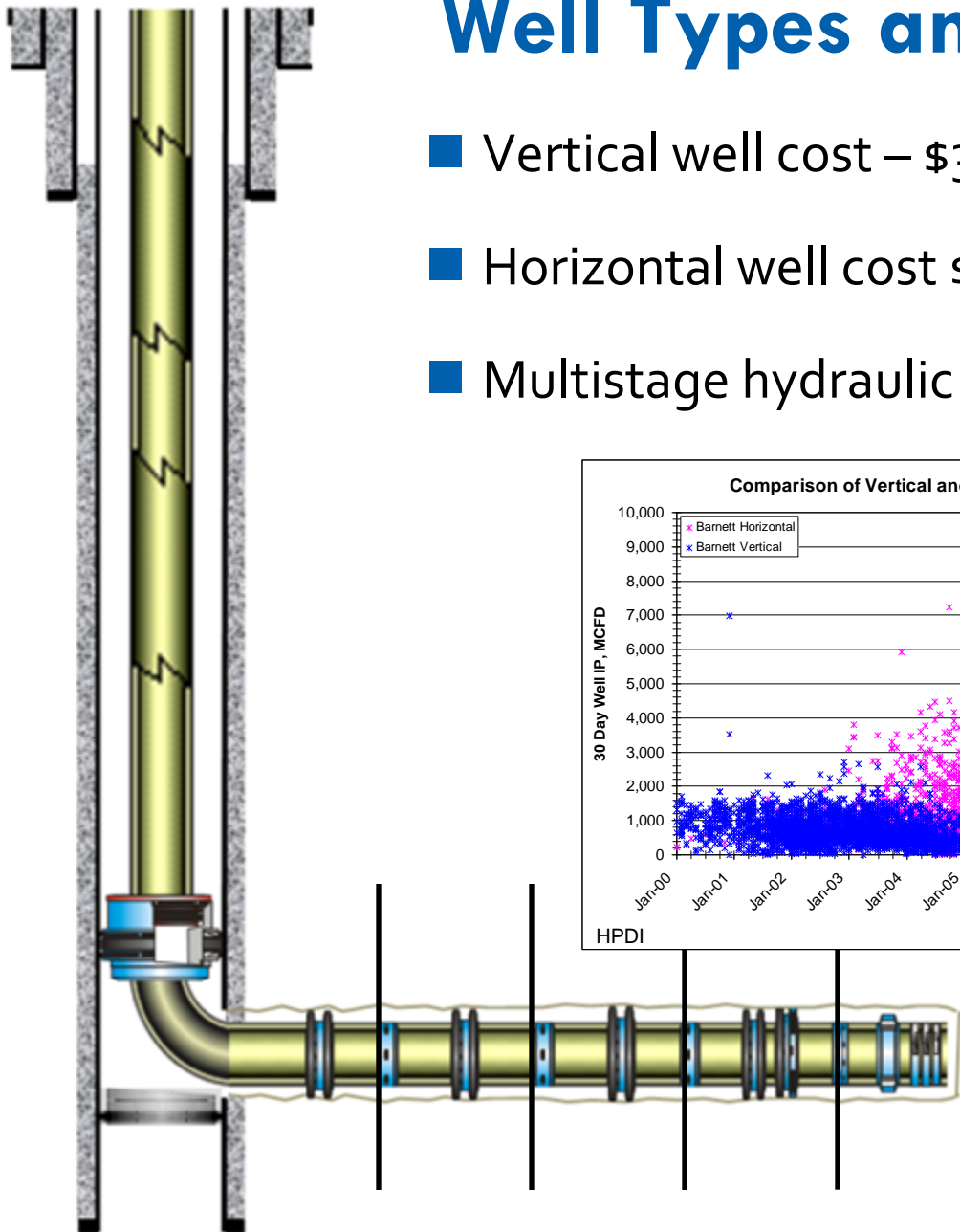
Barnett Shale Gas Production Rate



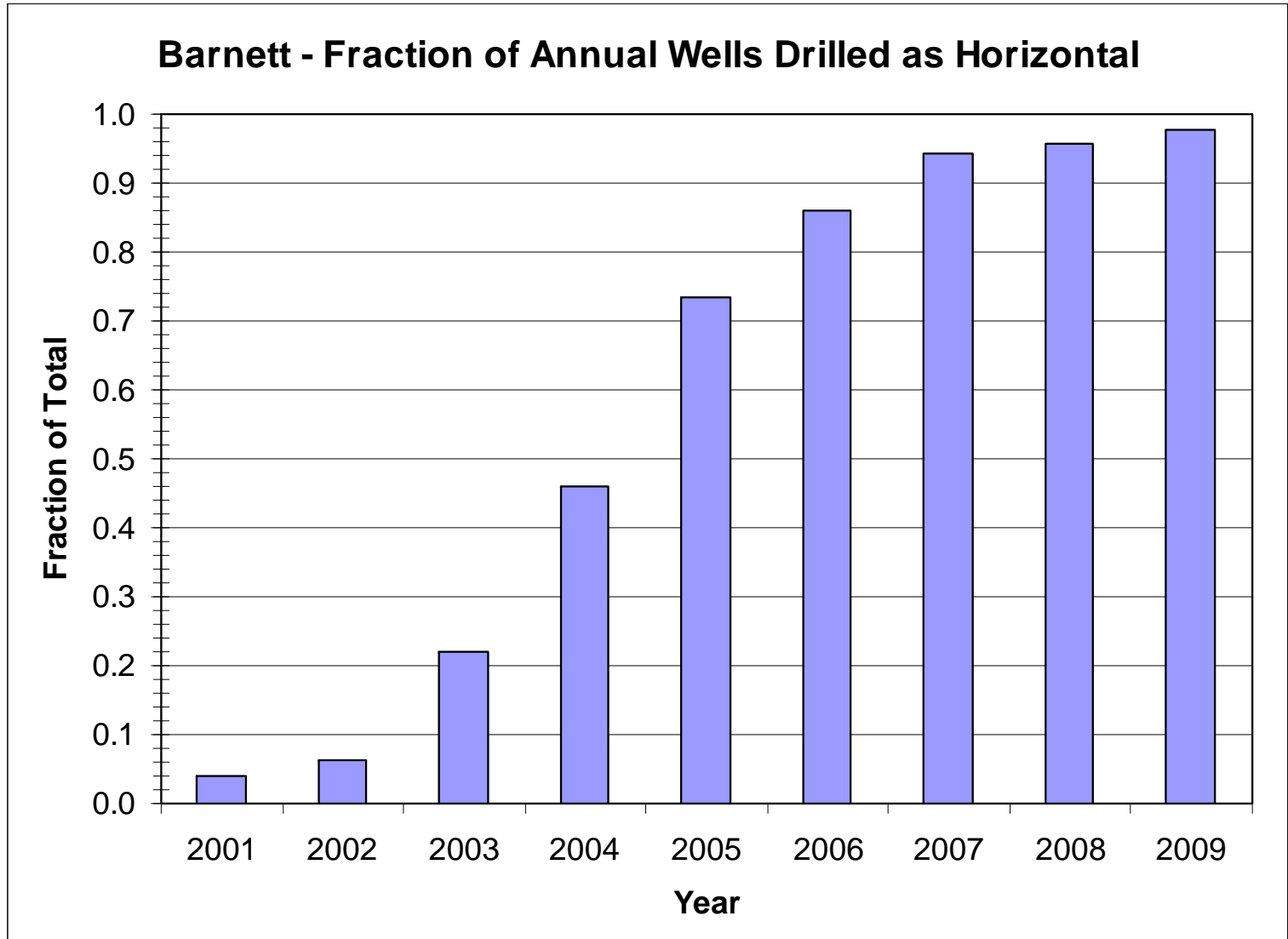
Source - HPDI

Well Types and Cost

- Vertical well cost – \$300,000-400,000
- Horizontal well cost \$2,500,000-7,000,000
- Multistage hydraulic fractured completions

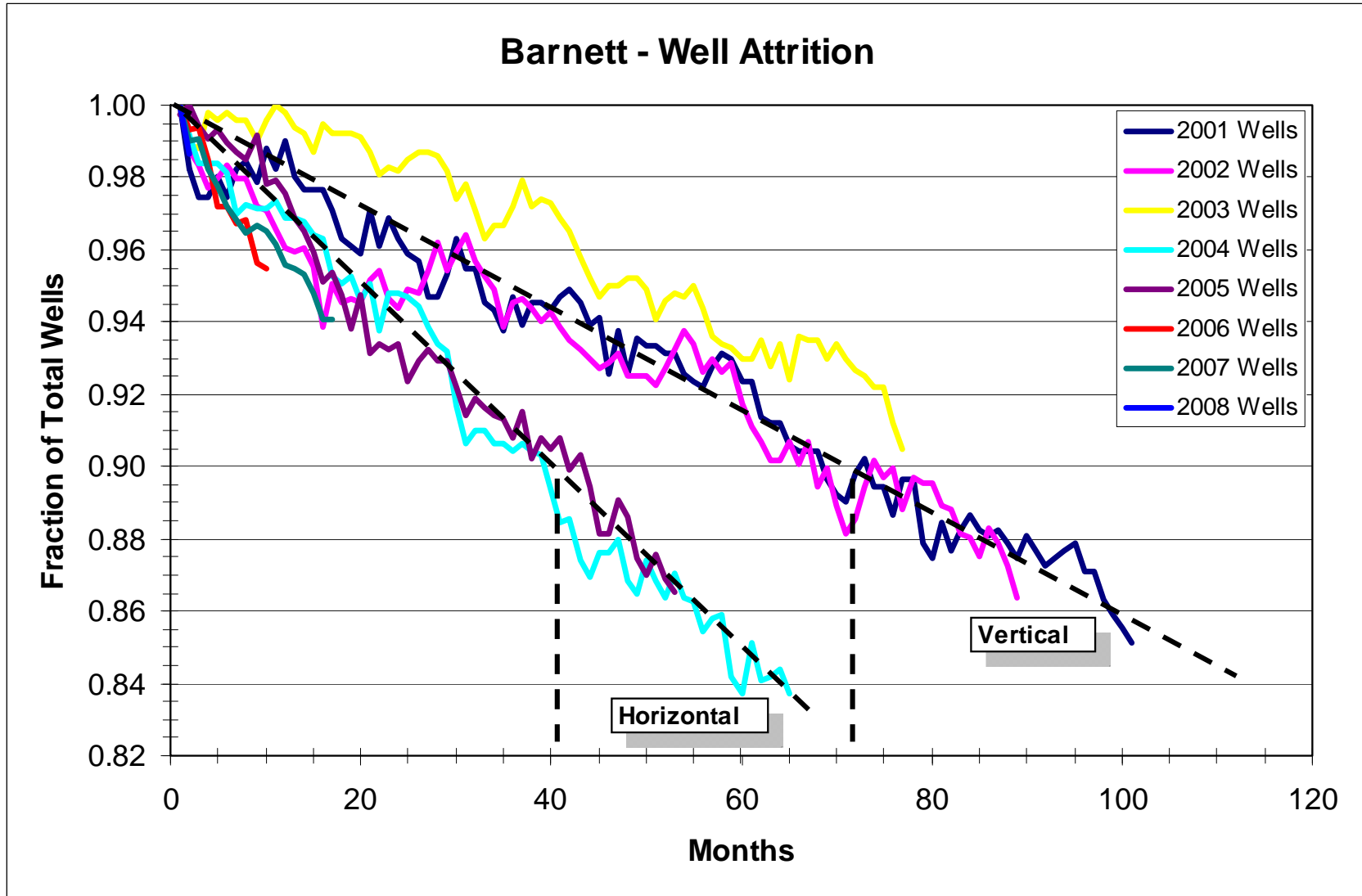


Barnett Shale Horizontal & Vertical Wells



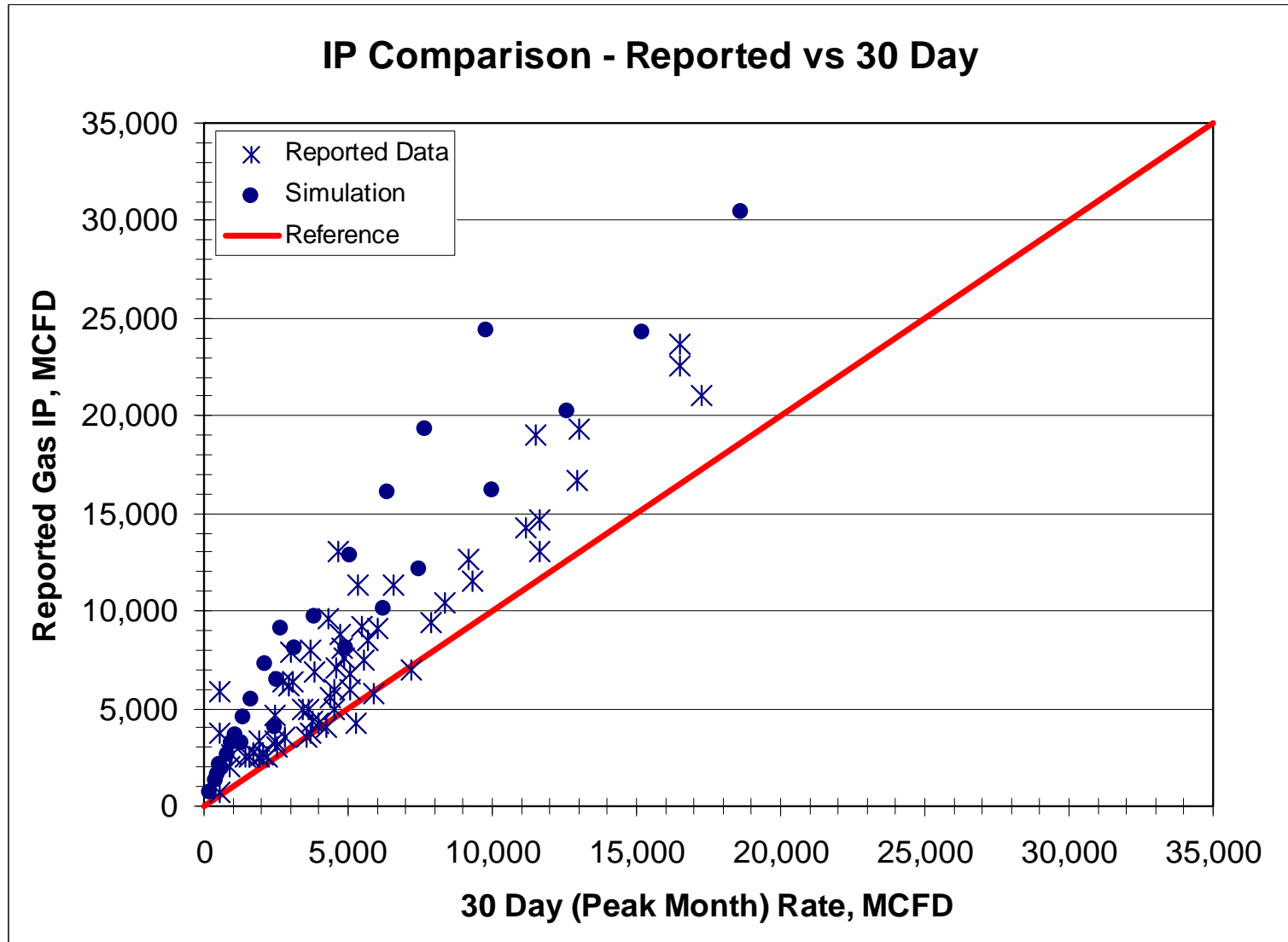
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Vertical vs Horizontal Well Attrition



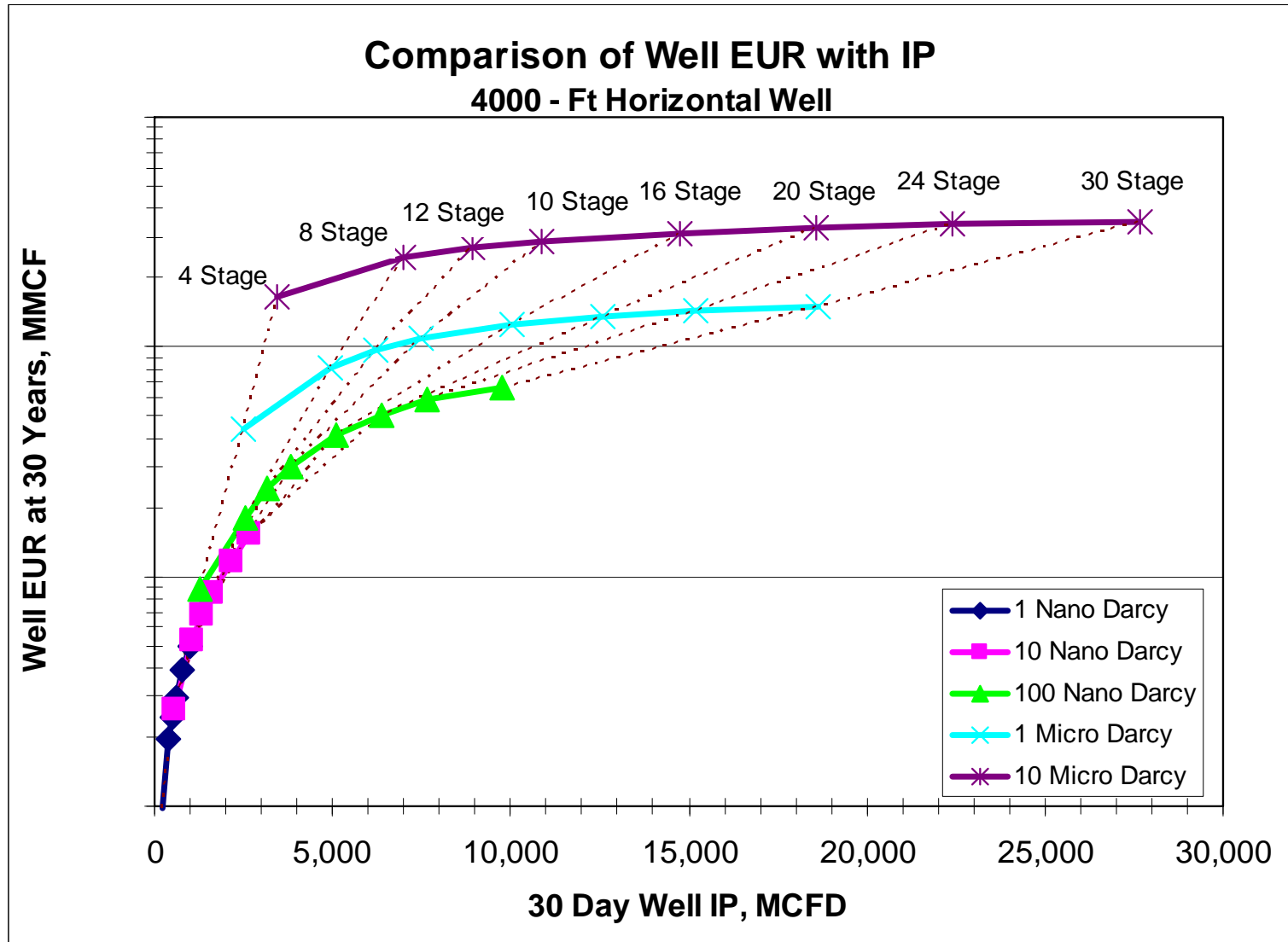
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Well IP Comparison

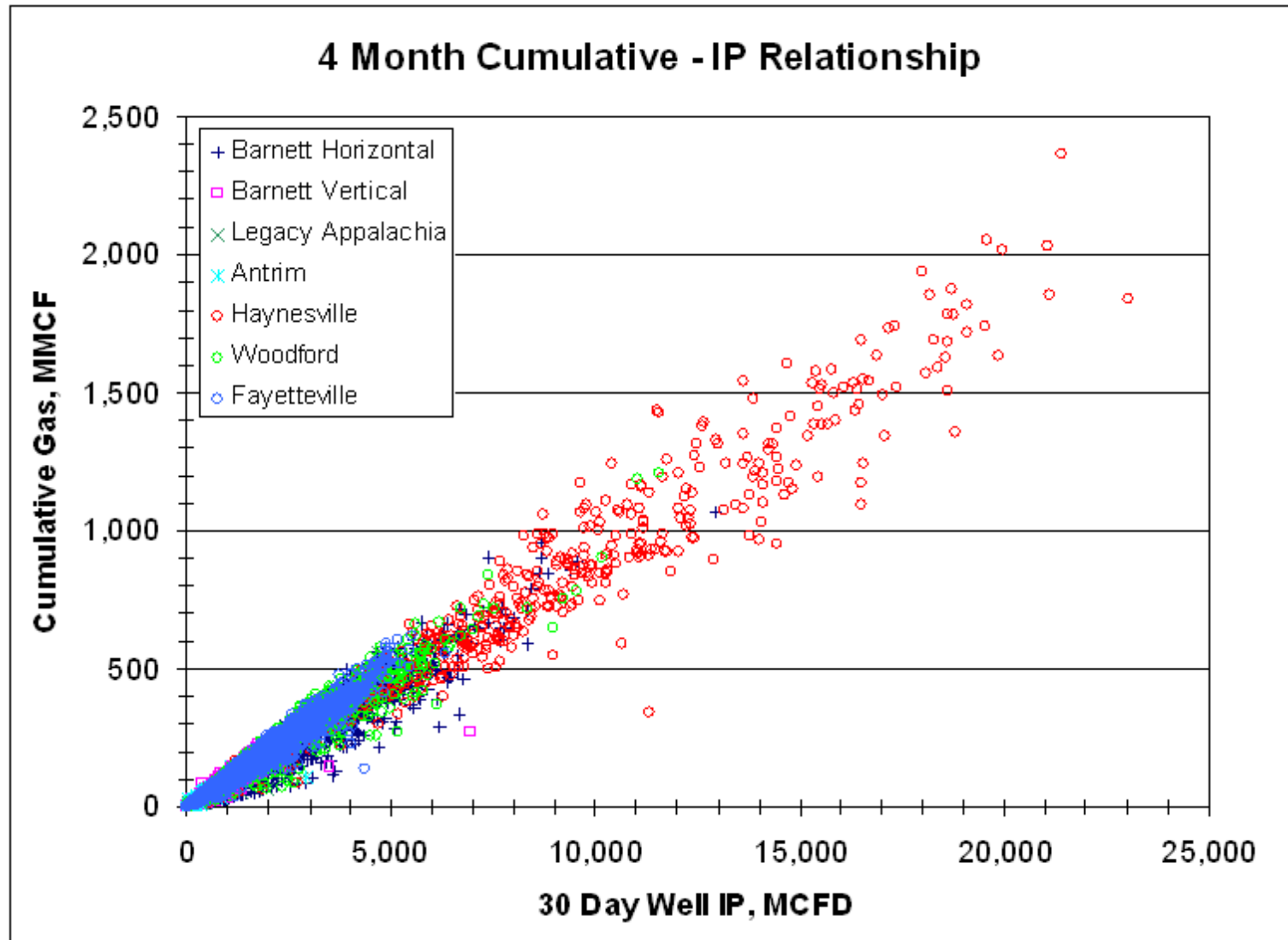


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Well EUR and IP

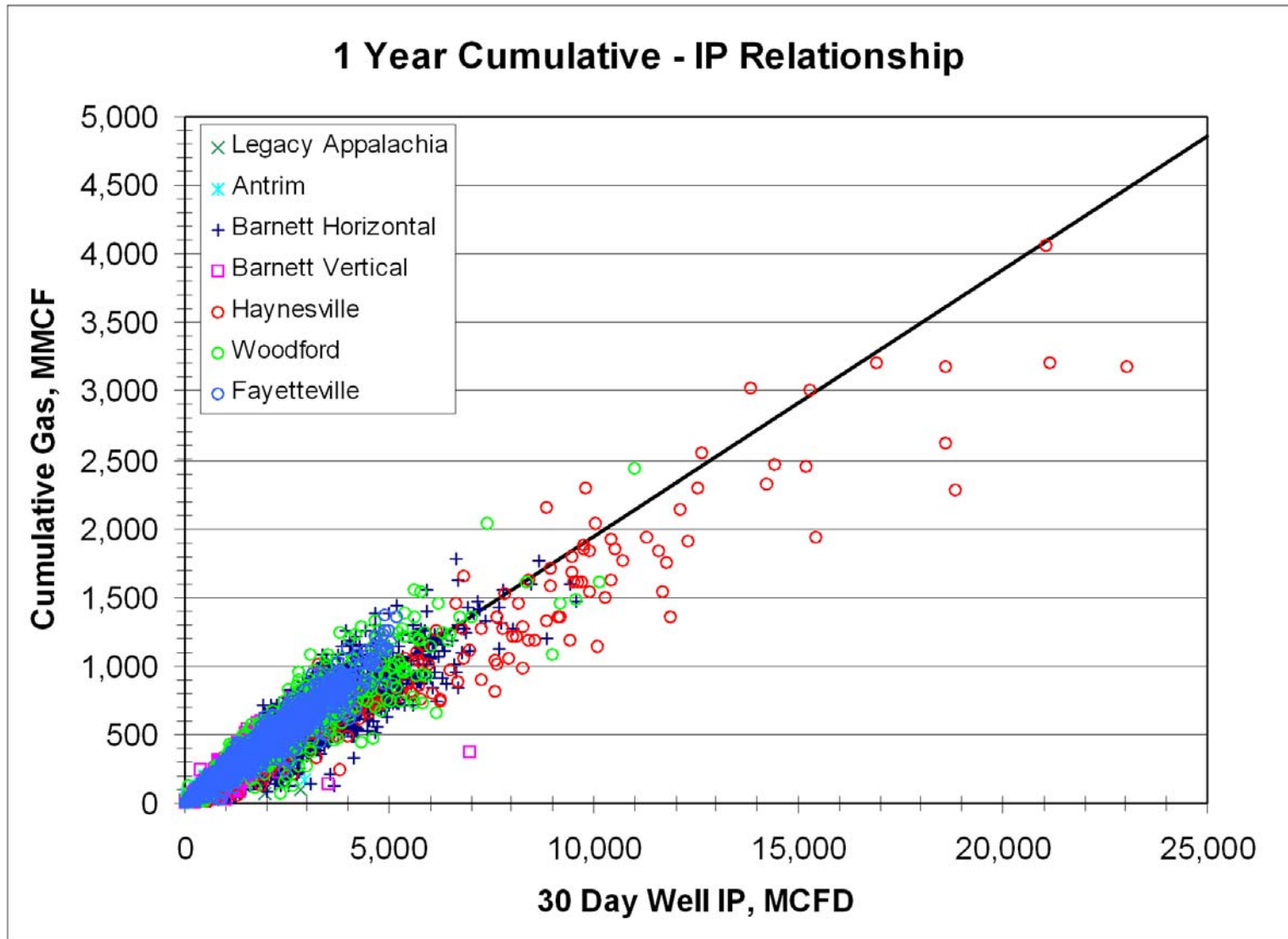


Cumulative Gas and IP Relationship

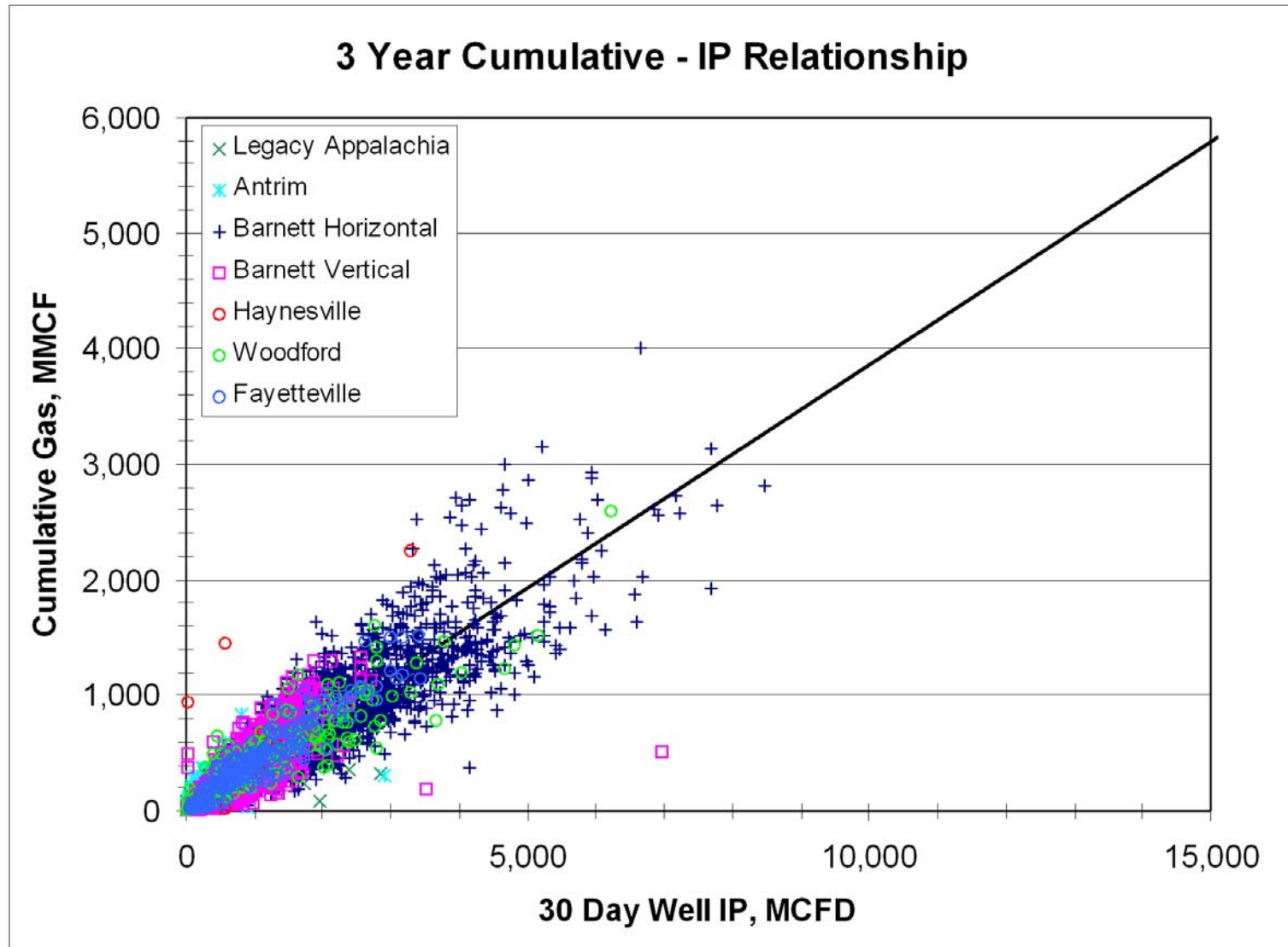


HPDI

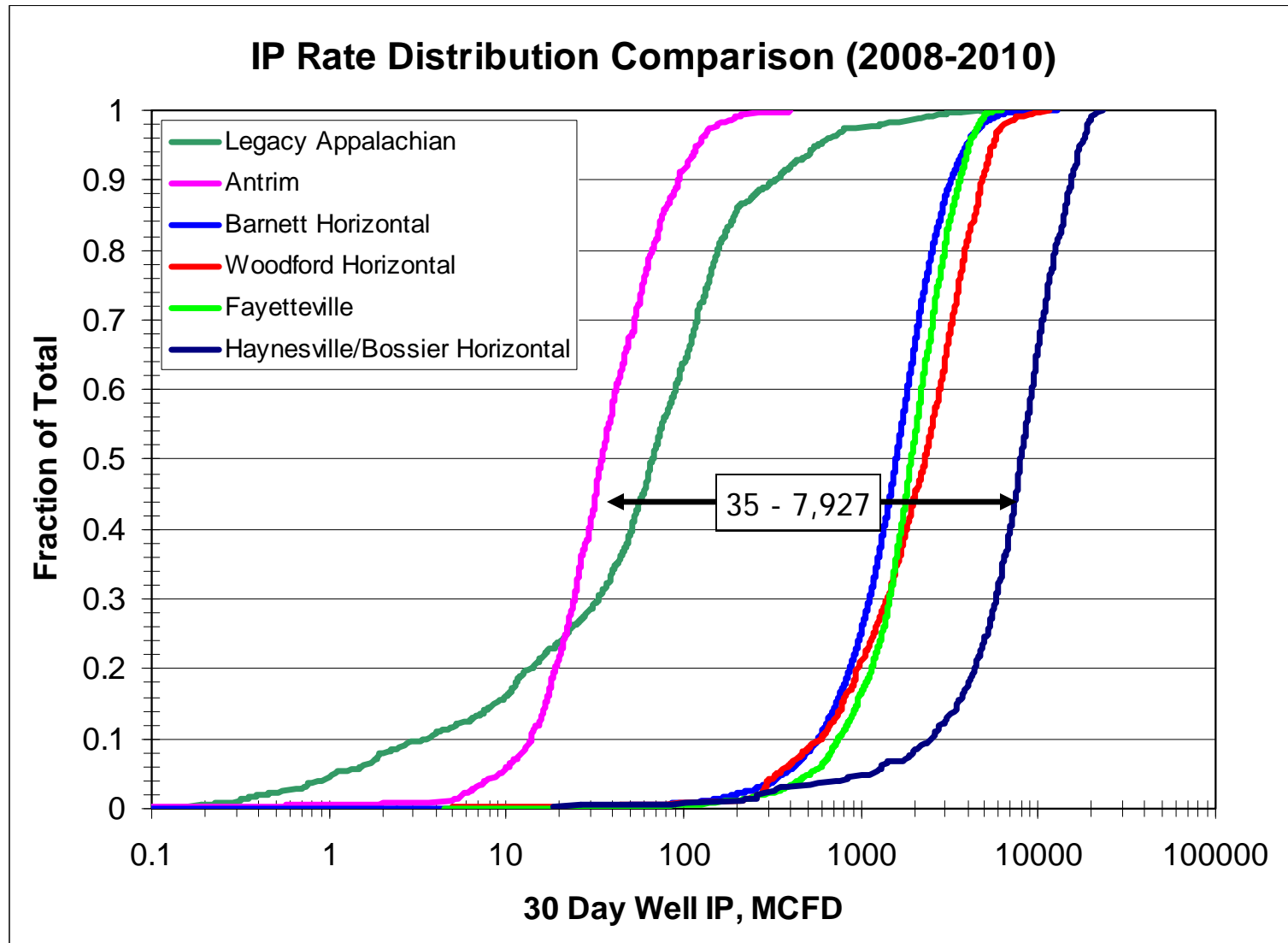
Cumulative Gas and IP Relationship



Cumulative Gas and IP Relationship



IP Distribution Comparison



HPDI

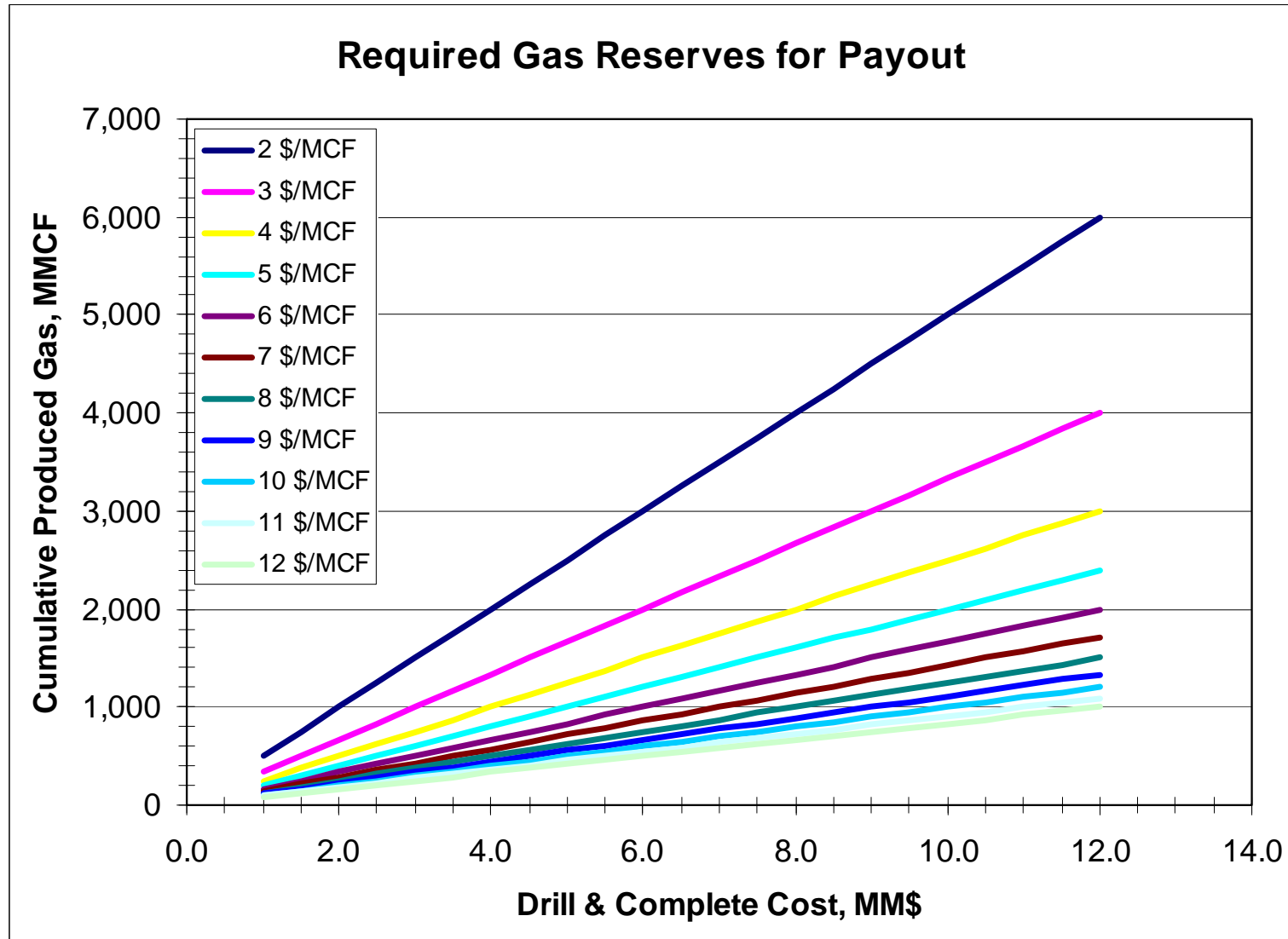
Example Use of Cum vs IP & IP Distributions

- Well cost \$4.5 MM
- Gas price \$5.00/MCF
- Desired payout 3 years

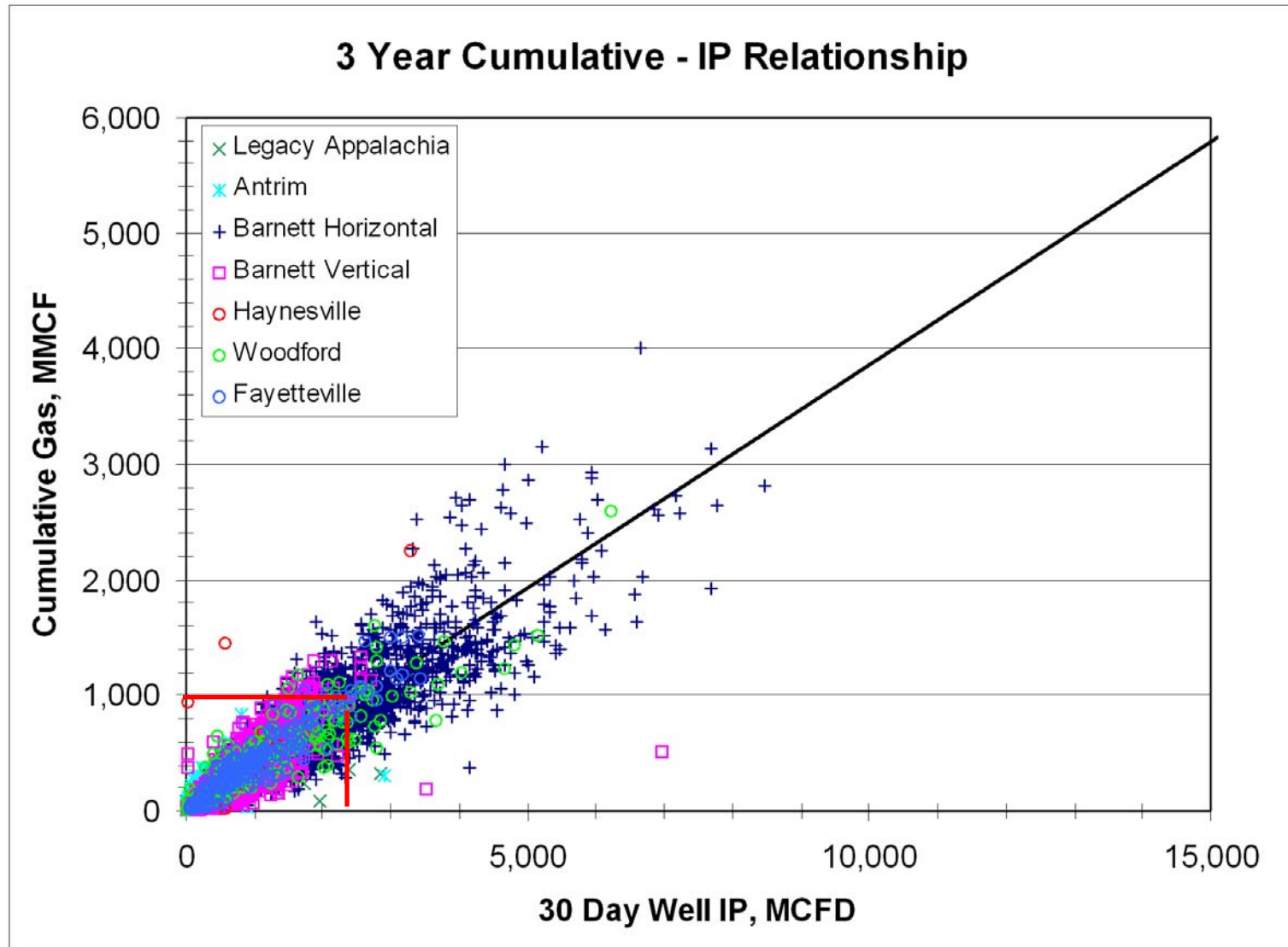
Calculate

$$\begin{aligned}\text{Vol of gas} &= 4,500,000/5.00 \\ &= 900 \text{ MMCF}\end{aligned}$$

Gas Production to Payout Well Costs

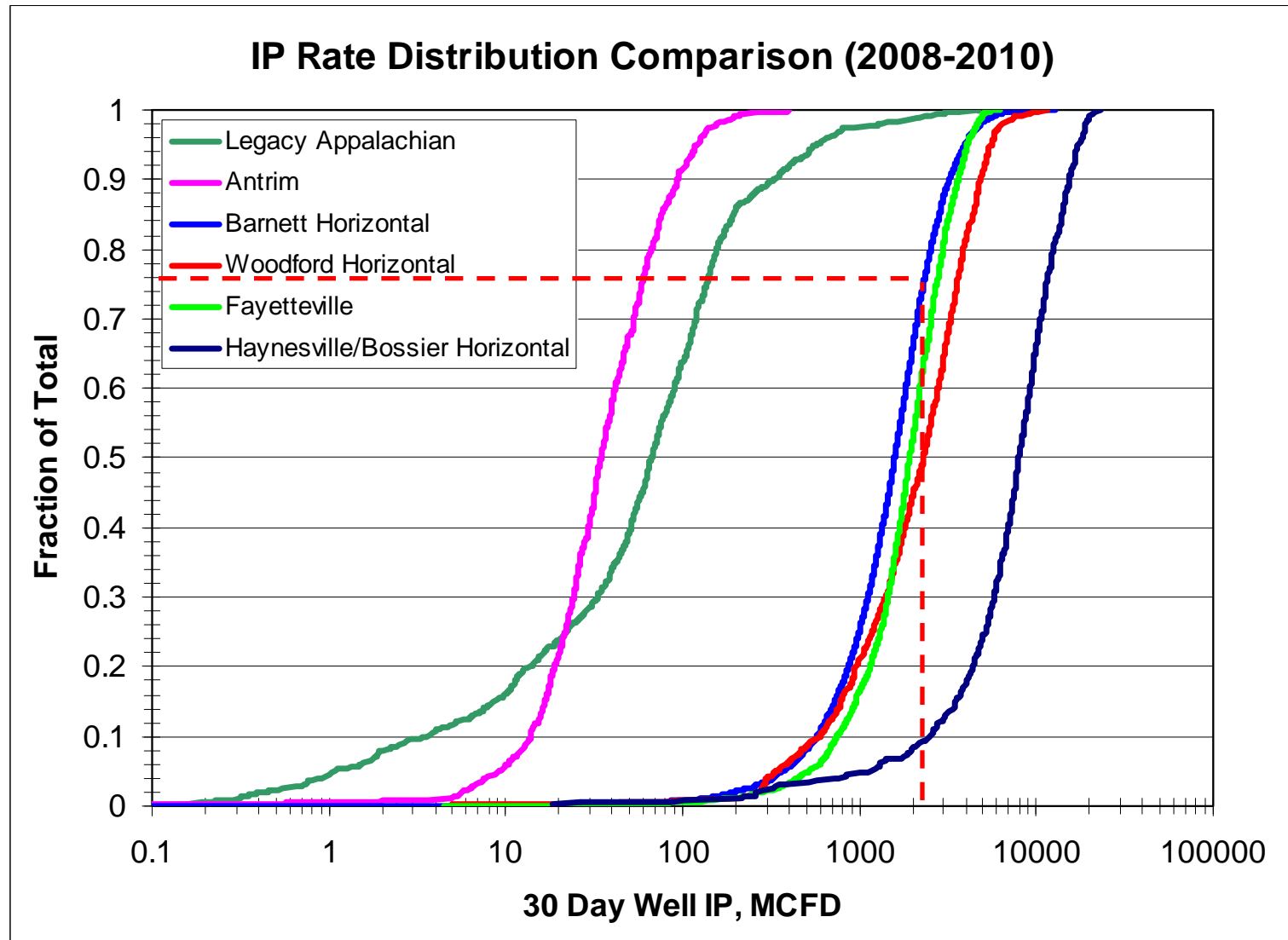


Estimated Required Well IP



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Probability of Payout



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Summary

- Shales provide a significant amount of the natural gas produced in the U.S.
 - Approximately 20% of U.S. gas well gas production
 - Premier plays currently Barnett, Fayetteville, Haynesville/Bossier & Woodford
- Use care when looking at well IP's
 - Use 30 day IP rates
- Cumulative gas vs IP relationships
 - Viable means to rank wells using early time data
 - IP can be manipulated by completion techniques
 - Not recommended for estimates of EUR
 - Application to short time periods
- Putting it all together
 - Cumulative gas vs IP relationships
 - IP rate distribution
 - Simple economic evaluation (probability of payout)

Questions