CENTER FOR ENERGY ECONOMICS

Bureau of Economic Geology, The University of Texas at Austin

US Natural Gas

March 2010 – Windsor Energy Group & Oxford Institute for Energy Studies

Dr. Michelle Michot Foss, CEE-UT

Overall Perspectives

- 1970s & 1990s “redux” with regard to perceptions about reliability, deliverability
  - Similar policy/regulatory disconnects are happening again now
- Even without GHG policy, gas “push” is inevitable
  - With GHG caps, low carbon technologies are immature, timing of deployment and cost highly uncertain
  - Even without caps, strategic opposition to electric power transmission hinders both coal and renewables
- Oil and gas tax policies impact development
  - IDCs are particular challenge for continued drilling and exploitation

Conflicting Policy Views Persist

Even with storage at historic highs…

"Gas Short"

- Prevailing political sentiment (state regulators)
- Unconventional plays are unsustainable
- Global competition for LNG disadvantages US
- Persistent high and "volatile" prices

"Gas Long"

- Prevailing industry sentiment
- Unconventional plays are sustainable
- LNG will swing to US for storage, peak shaving
- Generally lower price deck but with price spikes

"Gas Short" Implications

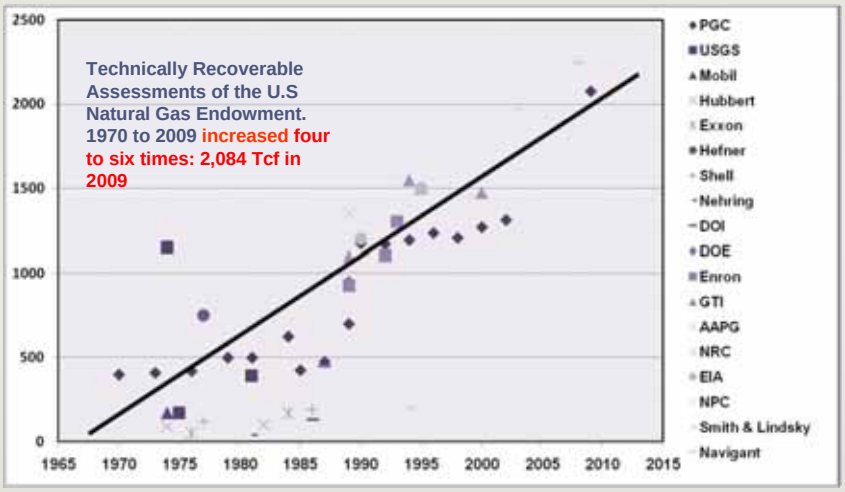
- Undermines critical assumption that gas will be available for balancing
  - Renewables dispatch sensitivity
- Limits gas to incremental use
- Used to block progress on key upstream and midstream initiatives
  - OCS and other moratoria/restrictions
  - ROW for midstream

"Gas Long" Implications

- Gas can expand beyond "bridge fuel" assumptions
  - Persistent oil:gas price premium can support mixed end uses
  - Search for non-weather sensitive base load and cohesive commercial framework (policy/regulatory/market)
- Builds customer expectations regarding pricing and price risks
  - Search for strategies to dampen volatility, moderate prices, preserve margins for producers
- Adds to pressure on producers for value
- Discourages incremental LNG development near load centers

NARUC Moratoria Study

(SAIC/GTI)



Source: Modified from Bill Fisher et. al., Bureau of Economic Geology

NARUC Moratoria Study
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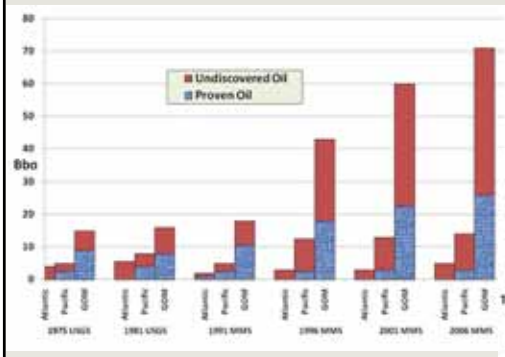
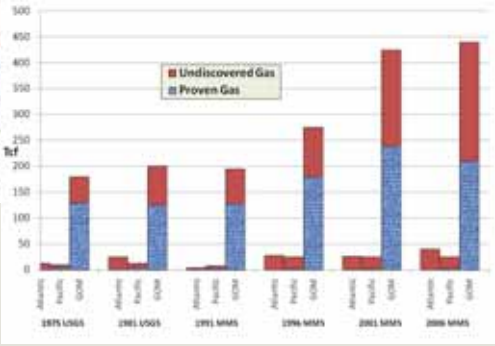


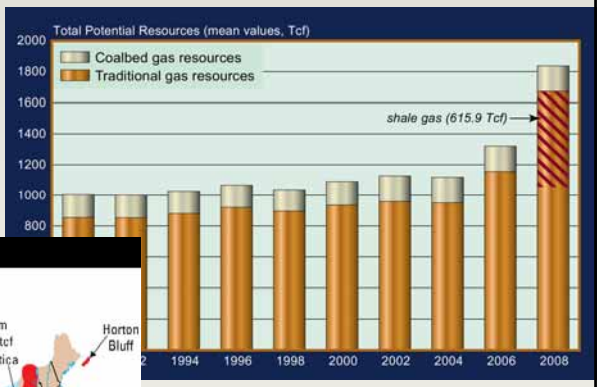
MMS Proven and Undiscovered Oil Resources (GOM Year 2006 Proven Oil Numbers Include 13 Bbo of Oil Production)



MMS Proven and Undiscovered Gas Resources (GOM Year 2006 Proven Gas Numbers Include 152 Tcf of Gas Production)

"Strengthening Our Economy: The Untapped US Oil and Gas Resources;" American Petroleum Institute, December 2008

The US Shale Gas Resource

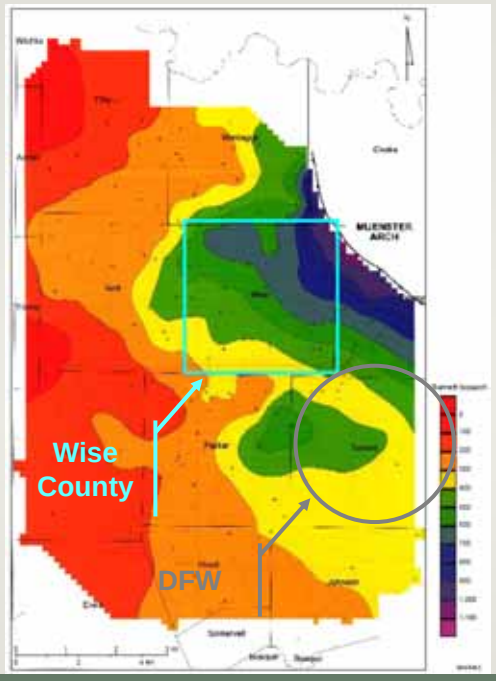


Excludes all moratoria areas

Barnett Shale

Estimated ultimate recoveries per well:

"Sweet Spot": 3.0 bcf plus
Second tier: 2.5 – 3.0 bcf
Third tier: 1.75 – 2.5 Bcf
Fourth tier: 1.25 – 1.5 bcf
Fifth tier: 0.5 – 1.25 bcf
Basin margin: 0.5 bcf



Barnett Shale Experience

- Water use for "fracing" and other Barnett Shale development is less than 1% of total water use in affected counties
  - Water use has been growing, but rate of use in future may be lower with technology improvement and recycling
  - Operators are actively testing recycling to manage water demand and produced water
- NETL Produced Water MIS

http://www.netl.doe.gov/technologies/PWMIS/

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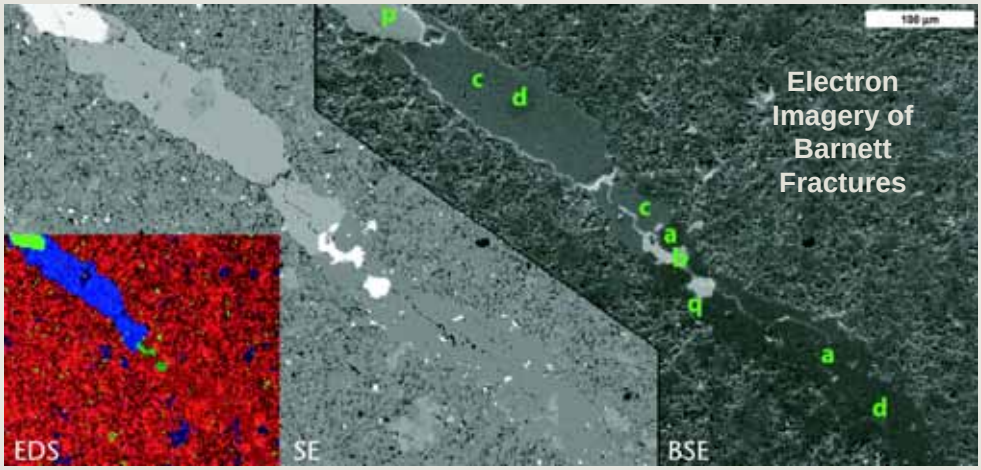
The Frontier



Gale, J. F. W., Reed, R. M., and Holder, Jon, 2007, Natural fractures in the Barnett Shale and their importance for hydraulic fracture treatments: AAPG Bulletin, v. 91, no. 4, p. 603–622.

http://www.netl.doe.gov/technologies/oil-gas/EP_Technologies/ImprovedRecovery/AdvancedStimulation/Adv_Stimulation.html

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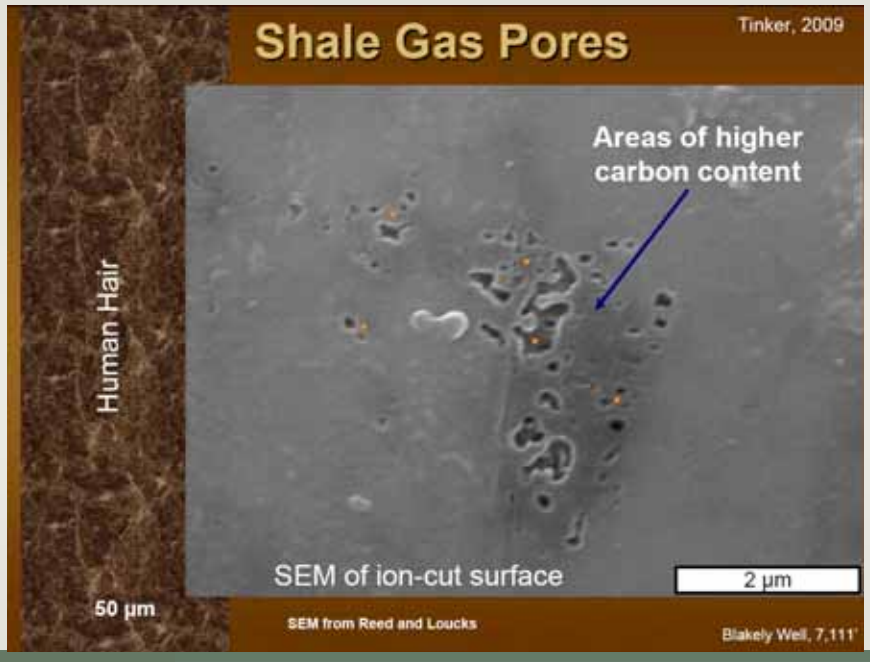

BEG-UT

New "Nanodarcy" Universe of Technology

- Detection and advanced stimulation
- Slow decline curves
- Reduce drilling (fewer rigs, lower costs)
- Manage water disposal and other production issues

Not All Opportunities are the Same

From Holditch, 2005, "Statistical Correlations in Tight Gas Sands", American Association of Petroleum Geologists (AAPG) Hedberg Conference Proceedings.
http://www.searchanddiscovery.net/documents/abstracts/2005hedberg_vail/abstracts/extended/holditch01/holditch01.htm

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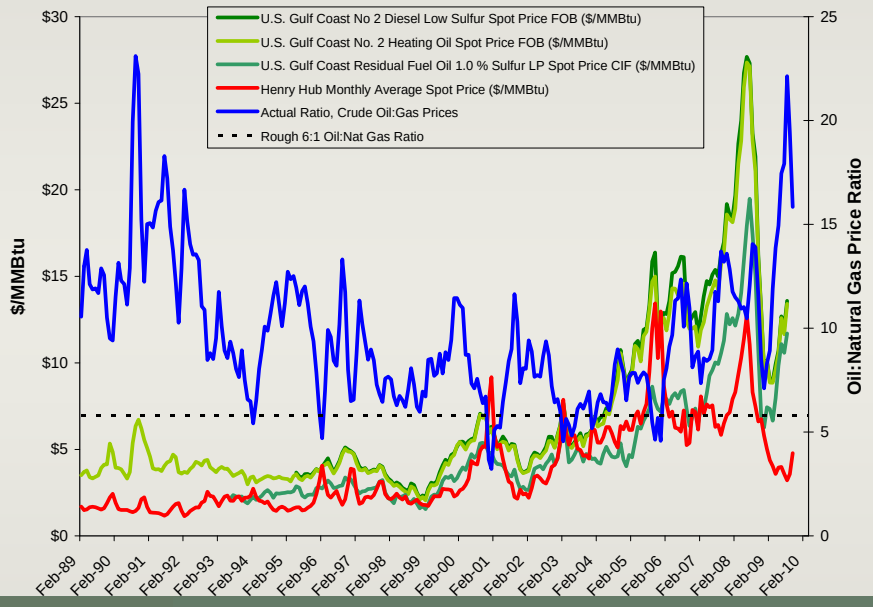
Natural Gas vs. Petroleum Prices



US EIA; NYMEX; CEE

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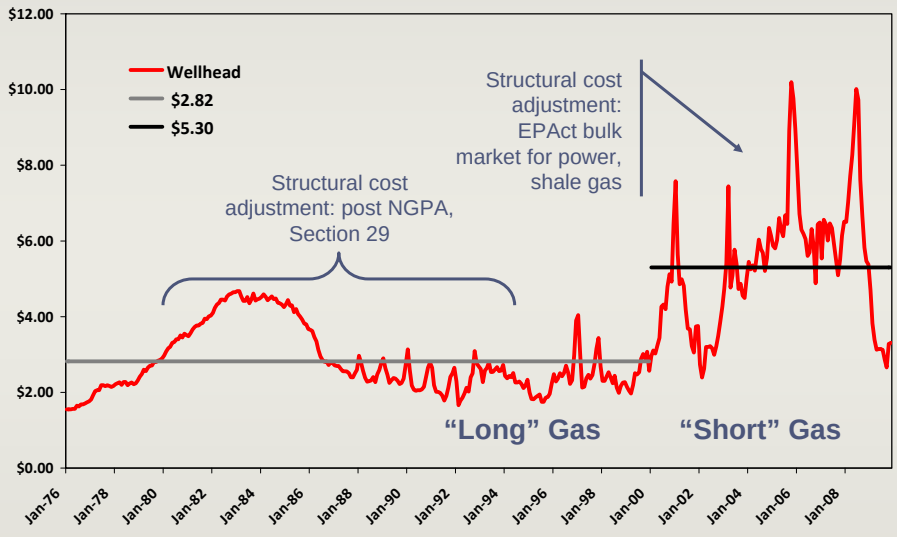
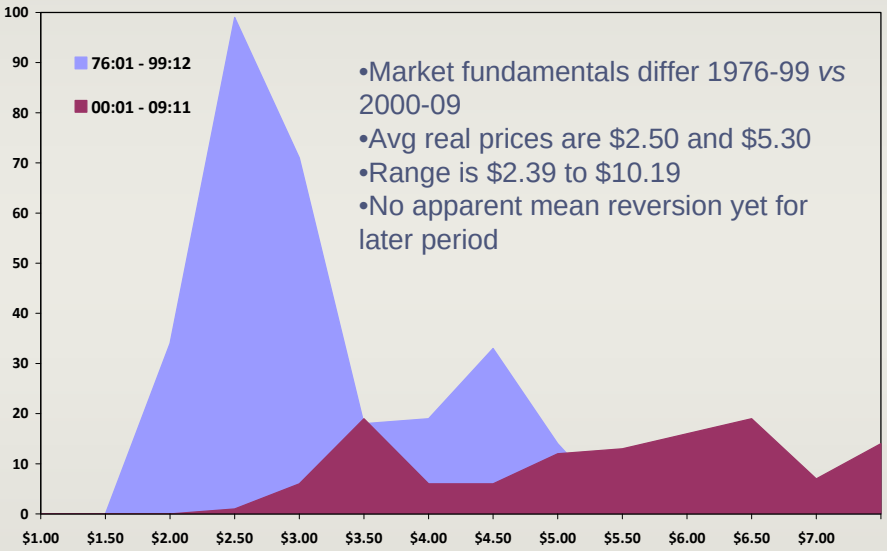
Wellhead Price Eras ($2005)

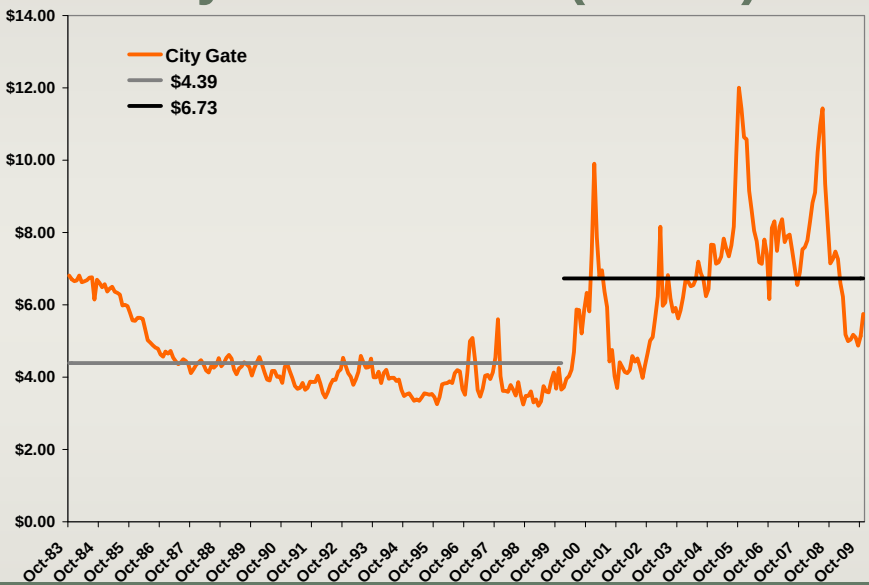


Frequency Distribution ($2005)

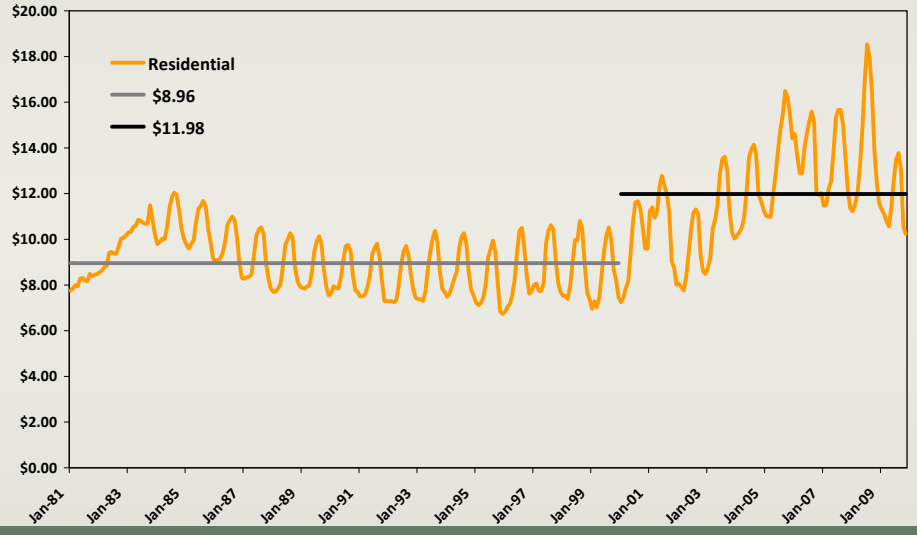


- Market fundamentals differ 1976-99 *vs* 2000-09
- Avg real prices are $2.50 and $5.30
- Range is $2.39 to $10.19
- No apparent mean reversion yet for later period

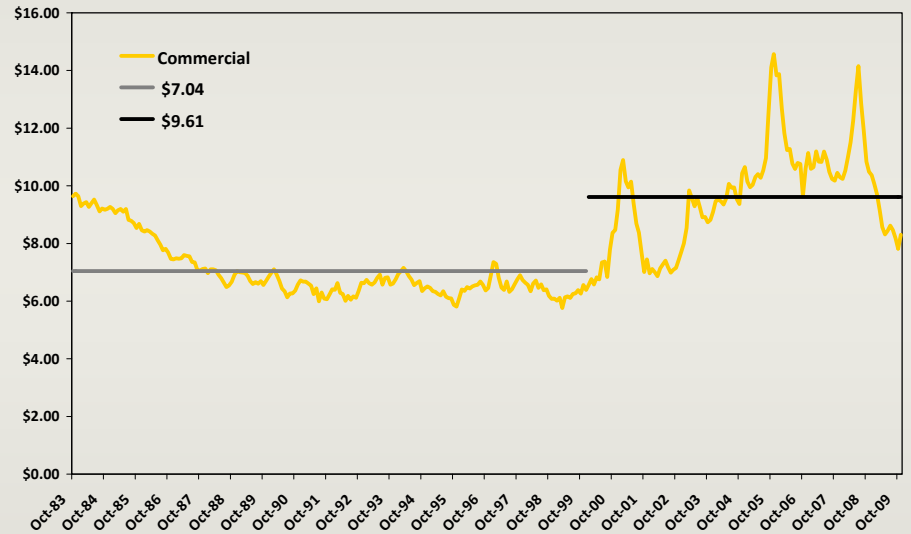
City Gate Prices ($2005)



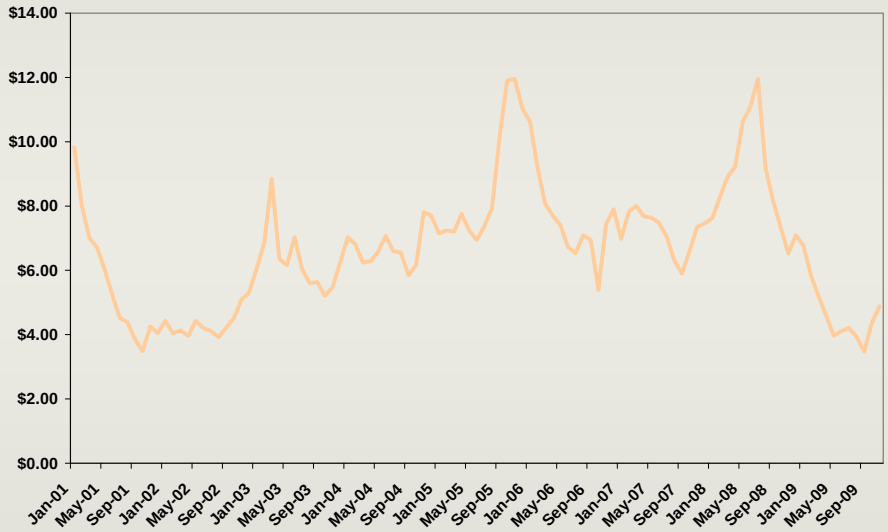
Residential Prices ($2005)



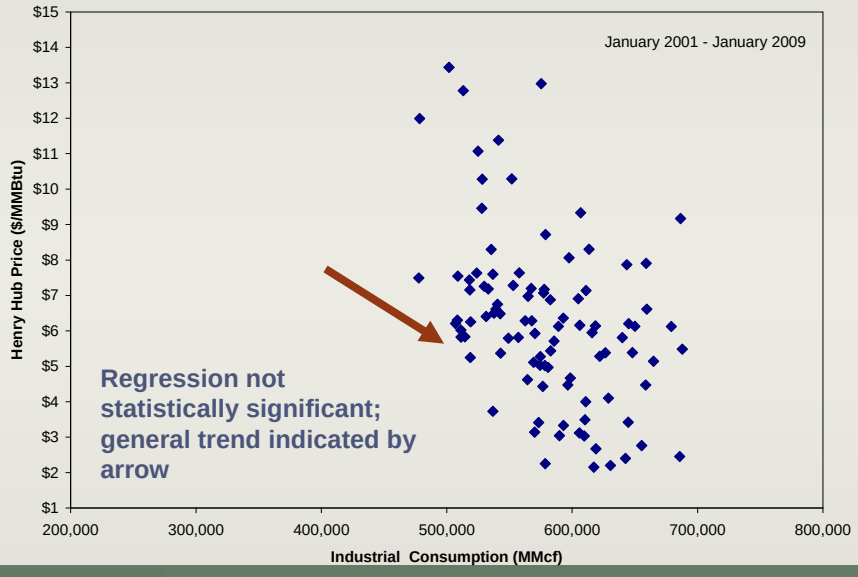
Commercial Prices ($2005)



Industrial Prices ($2005)

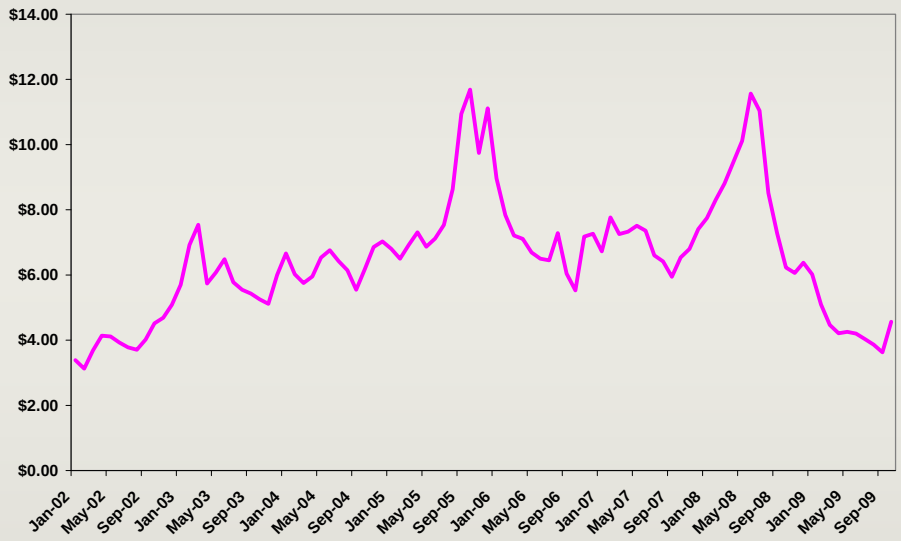


Industrial Demand and Price

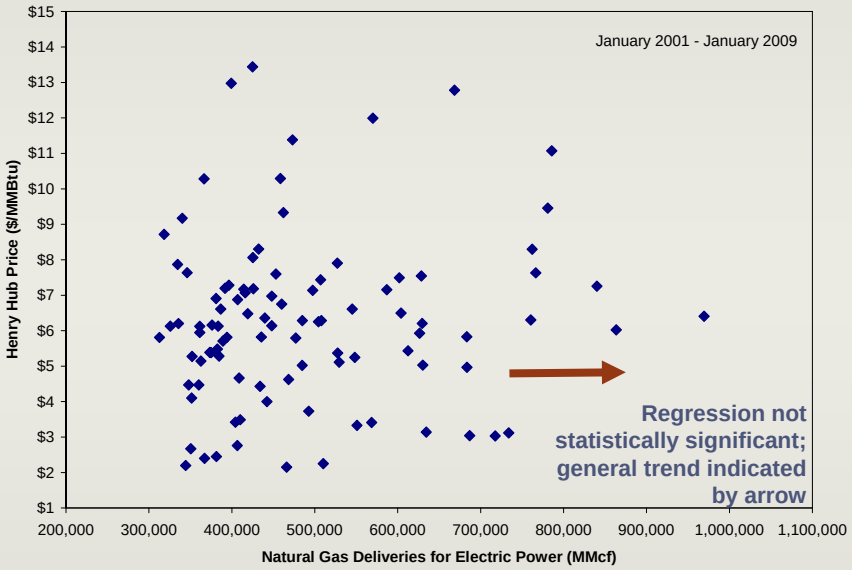


Source: U.S. EIA

Electric Power Prices ($2005)



Electric Power Demand and Price



Source: U.S. EIA

Average Price ($2005)

	Wellhead	City Gate	Res	Comm	Ind	El Pwr
Before 99:12	2.82 [a]	4.39 [b]	8.96 [c]	7.04 [b]		
00:01-09:11	5.30	6.73	11.99	9.61	6.68 [d]	6.49 [e]
Change	88%	53%	34%	37%		

[a] 76:01-99:12; [b] 83:10-99:12; [c] 81:01-99:12; [d] 01:01-09:12; [e] 02:01-09:12

*Price Volatility ($2005)

	Wellhead	City Gate	Res	Com	Ind	El Pwr
Before 99:12	7.2% [a]	6.0% [b]	6.3% [c]	2.5% [b]		
00:01-09:11	12.2%	10.5%	7.7%	5.3%	11.4% [d]	10.6% [e]
Change	71%	74%	22%	110%		

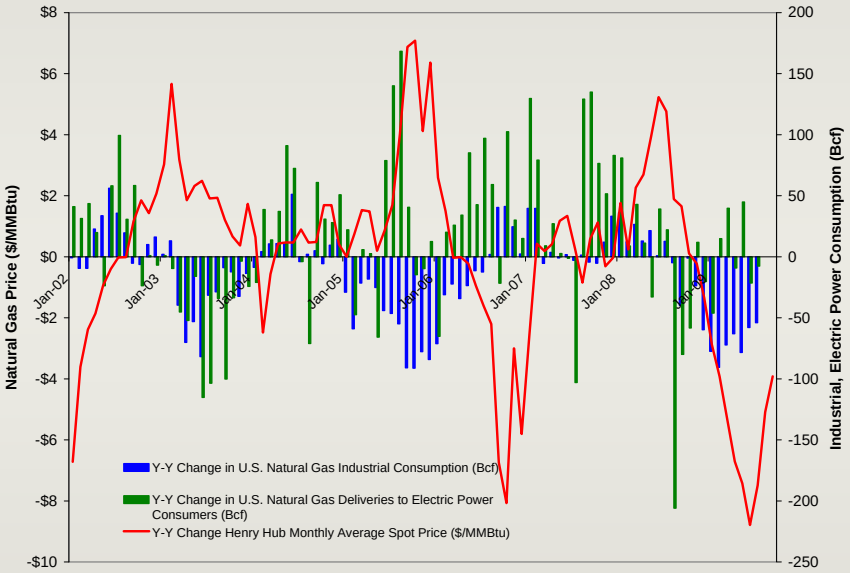
[a] 76:01-99:12; [b] 83:10-99:12; [c] 81:01-99:12; [d] 01:01-09:12; [e] 02:01-09:12

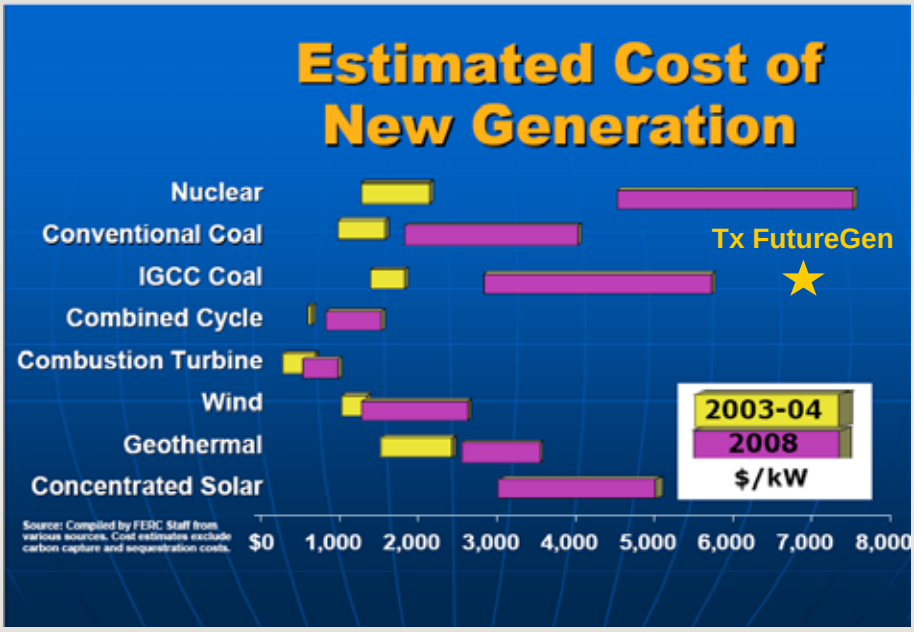
* Std dev of change in price

Price Observations

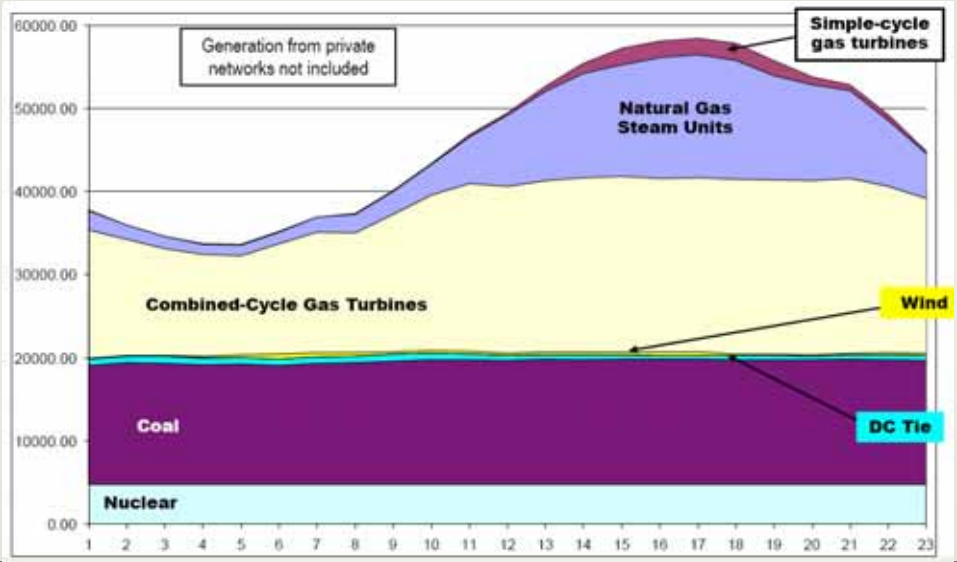
- Volatility is a sensitive issue for large users and regulated utilities; lack of data prevents analysis on changes over time
- Residential (and some commercial) customers are sheltered by regulators
- Wellhead conditions drive overall price structure and may contribute to volatility
- Electric power demand swings on marginal gas generators + renewables may contribute to volatility

Does Power Gen Add "Peakiness"?



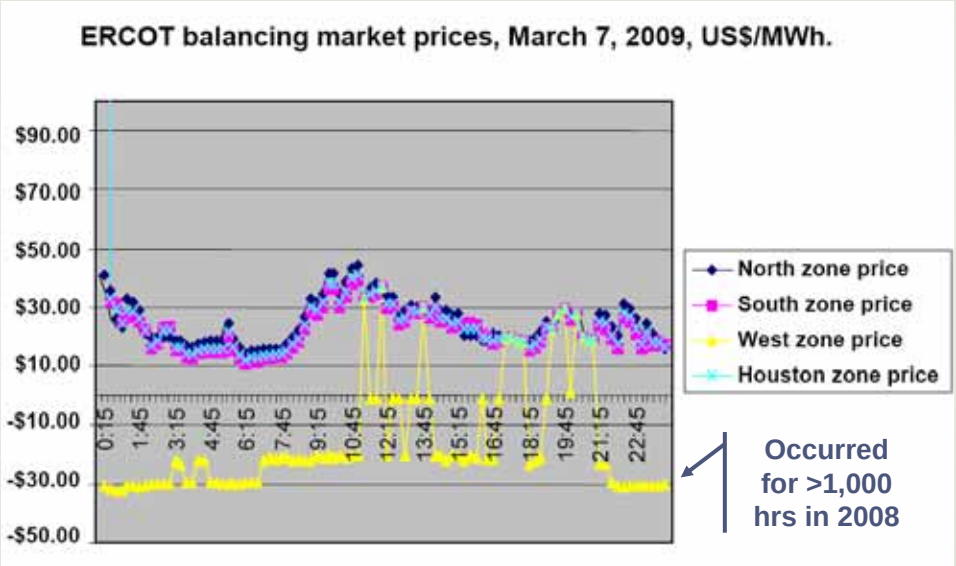


ERCOT Peak Day by Fuel Type



Source: Electric Reliability Council of Texas (ERCOT)

Does Renewable Energy Create Volatility?



Cost Estimates for 30% Wind in ERCOT

- Typical unsubsidized cost of wind energy is around US$80/MWh,
- Assume US$10/MWh incremental transmission for wind in ERCOT,
- Assume US$10/MWh proxy to cost of intermittency (incl. ramping effects),
- Total is about US$100/MWh.
- Average balancing energy market price in ERCOT is around US$50/MWh to $60/MWh.
- **Wind adds about US$50/MWh to costs.**

$Billion Here, $Billion There…

- Total annual ERCOT retail energy sales are around 3 times 10^8 MWh, retail bill around US$30 billion
- To achieve 30% renewable energy from wind would increase retail bill by *very roughly*:

  0.3 X 3 X 10^8 MWh X $50/MWh =

  US$4.5 billion