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# Natural Gas from Shale:

*Overview of Shale Development Impact on Energy Market Dynamics and Utility Contracting Strategies*

2010 NASUCA Mid-Year Conference
San Francisco
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**Presented by:**

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# Disclaimer:

Presented below is an review of market fundamentals as they have been transformed by the growth of shale gas production in the U.S.

Data presented in this overview are taken from publicly available sources, supplemented by La Capra Associates, Inc.'s observations.

Market fundamentals as characterized in this presentation are subject to change due to future actions and decisions made by market participants.

Forecasts discussed represent a trend view of the future. Daily, seasonal and annual variations around any trend can and do occur.

Producer investment decisions may change, and international events may occur that impact the world market for energy. Separately or together such changes may result in a different future than described herein.

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# Observations - 30,000 foot level:

- **New supply push has already *transformed markets***
- **Decline of Conventional Gas Supply**
- **Rise of Unconventional (Shale) Gas**
- ***"Shale Revolution"* has *transformed* gas production**
- ***Infrastructure* additions across the US offer flexibility and reliability to meet peak demand and load growth**
- ***Risks* + *Challenges* = *Opportunity***
- **DSM implications: good news / mixed results**

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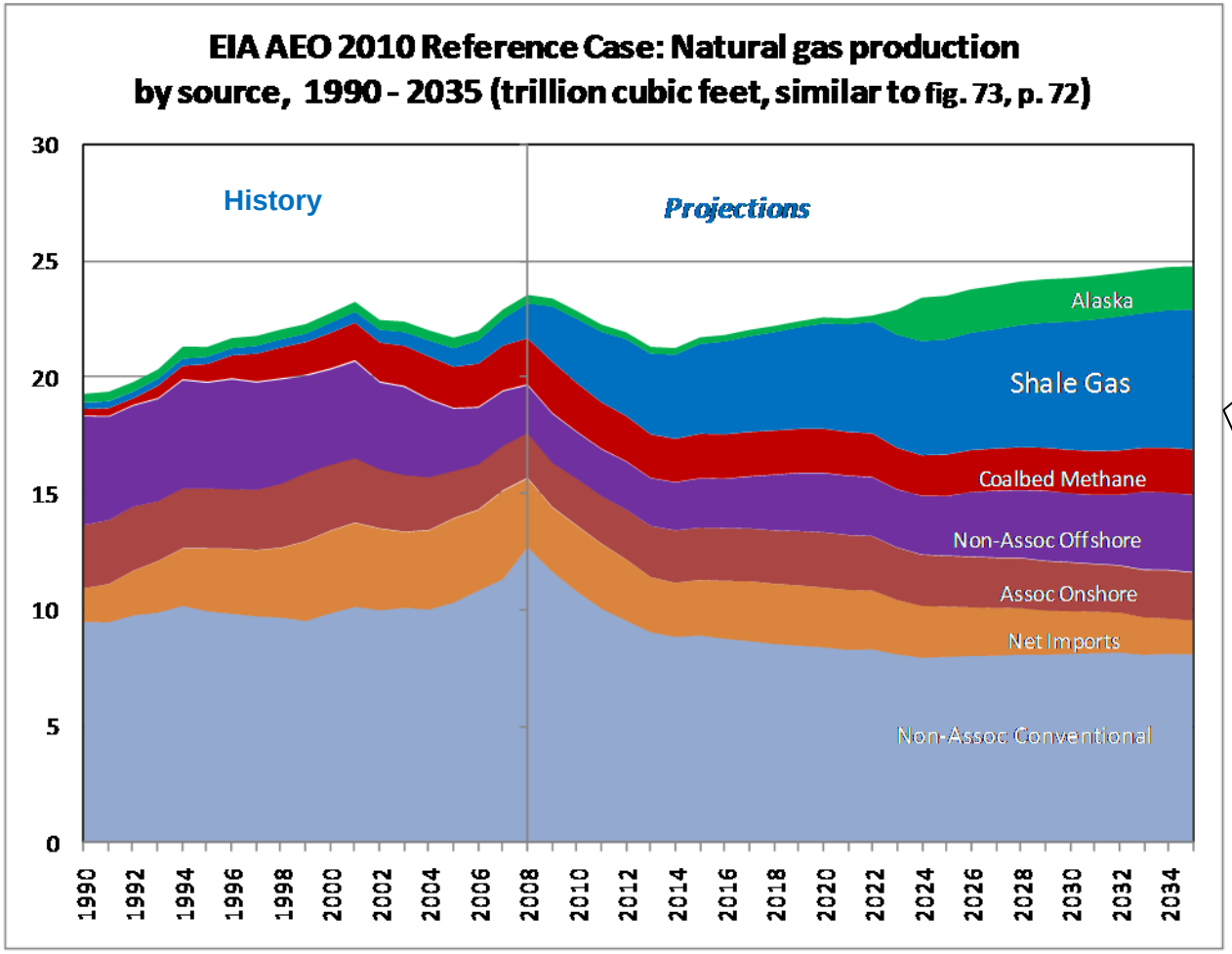
# "The Rise of Unconventional Gas Production:

*Even before the "discovery" of … shale plays the paradigm shift was clear"*

MarkWest, a midstream energy company, financial presentation




Shale Gas contribution to total Lower 48 onshore production doubles:

2010 17% 2.7 Tcf

to

2035 34% 6.0 Tcf

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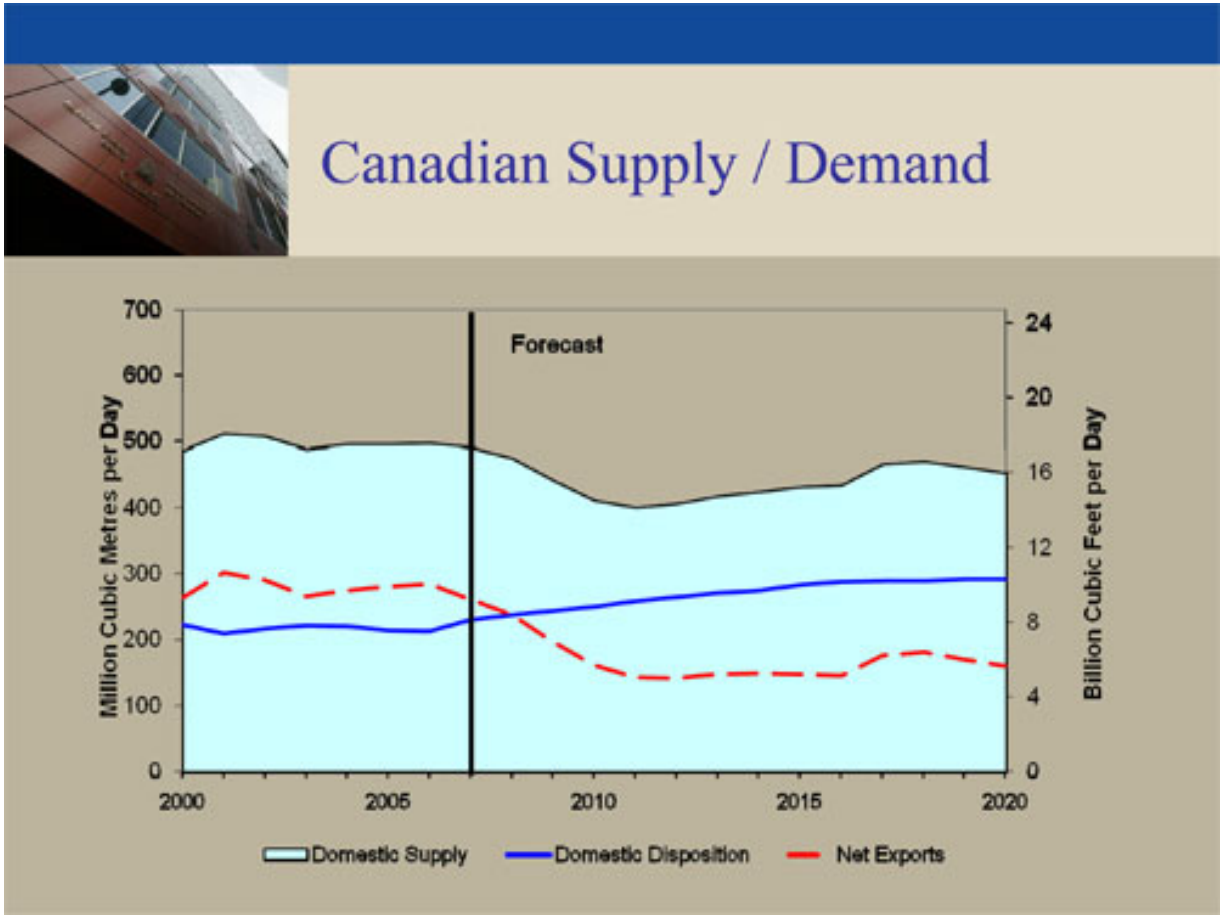
# Canada's Projected Supply & Demand Balance:
## Approx. 40% Reduction in Conventional Gas Exports 2007-2020




*Source: National Energy Board, Sept. 2009*

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# Risks - 30,000 foot level:

- **Opportunities:**
  - **enhance diversity & reliability to meet peak and load growth**
  - **with possible lower price volatility – long term**
  - **environmental advantage of gas vs coal or oil**
- **Challenges:**
  - **Scope**
  - **Scale**
  - **Timing**
  - **Environment**

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# Markets Transformed – Scope, Timing

- Basis differential narrows w/ delivery by displacement
  - 2008/09: Rockies Express Pipeline (REX) fully contracted 1.8 Bcf/d
  - 2009: Shale from Barnett, Haynesville, Marcellus
  - Some markets now trade at a discount Henry Hub
- Gulf flow patterns have changed:
  - Formerly South-to-Northeast
  - Now Gulf-to-California
- Canadian Gas Supply
  - Conventional well production in decline
  - Canada has Shale Gas, too ! (Horn River basin)
  - Northwest – Sumas basis differential now positive
- LNG: new terminals, bigger cargoes, strategic locations

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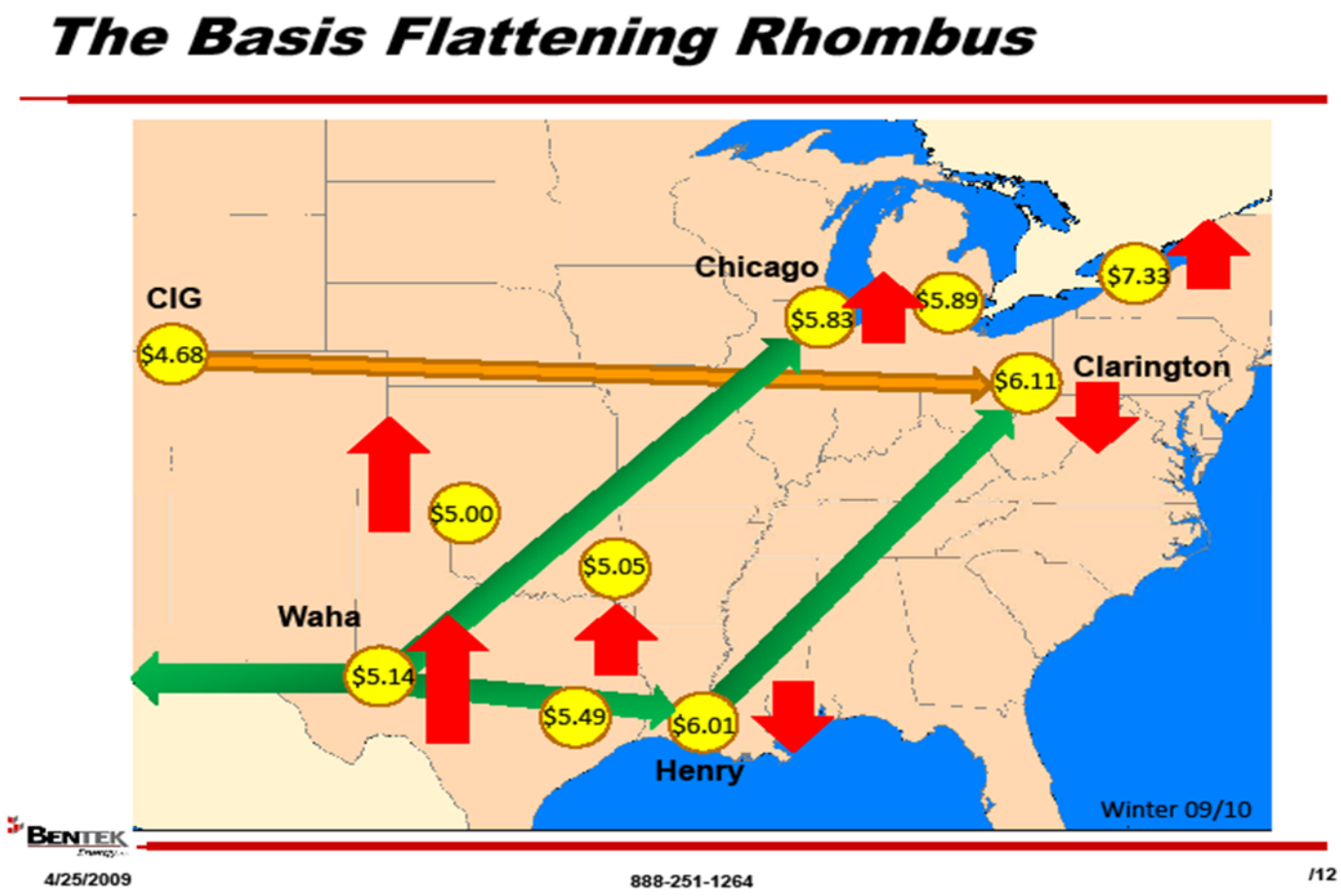
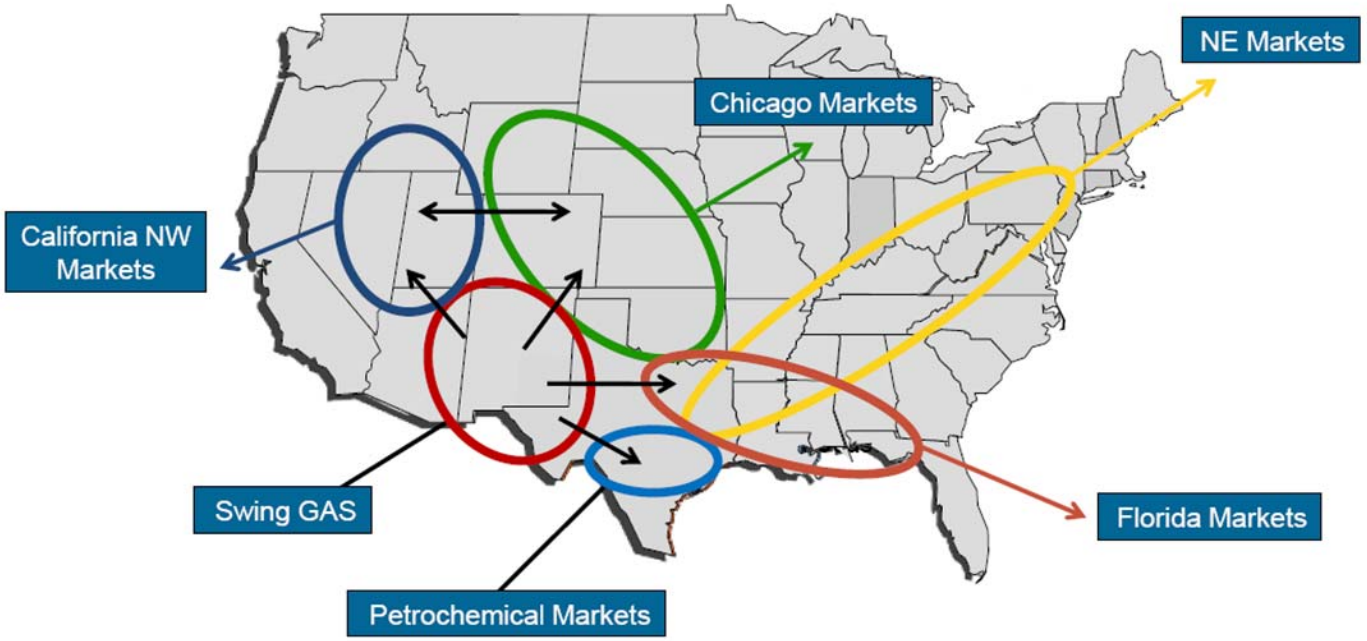
# Rockies Express Pipeline Price & Flow Impact



# Shale Gas Production Flow Impact:

## Potential Regionalization of Gas Purchases

- NE premium markets will tend to favor Marcellus and Gulf Coast production
- Market differentiation will depend on cost of transportation




- Marcellus gas should always have a premium due to economic reality of the cost of transportation

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# What is Shale Gas: Pervasive


Source: Energy Information Administration based on data from various published studies
Updated: May 28, 2009

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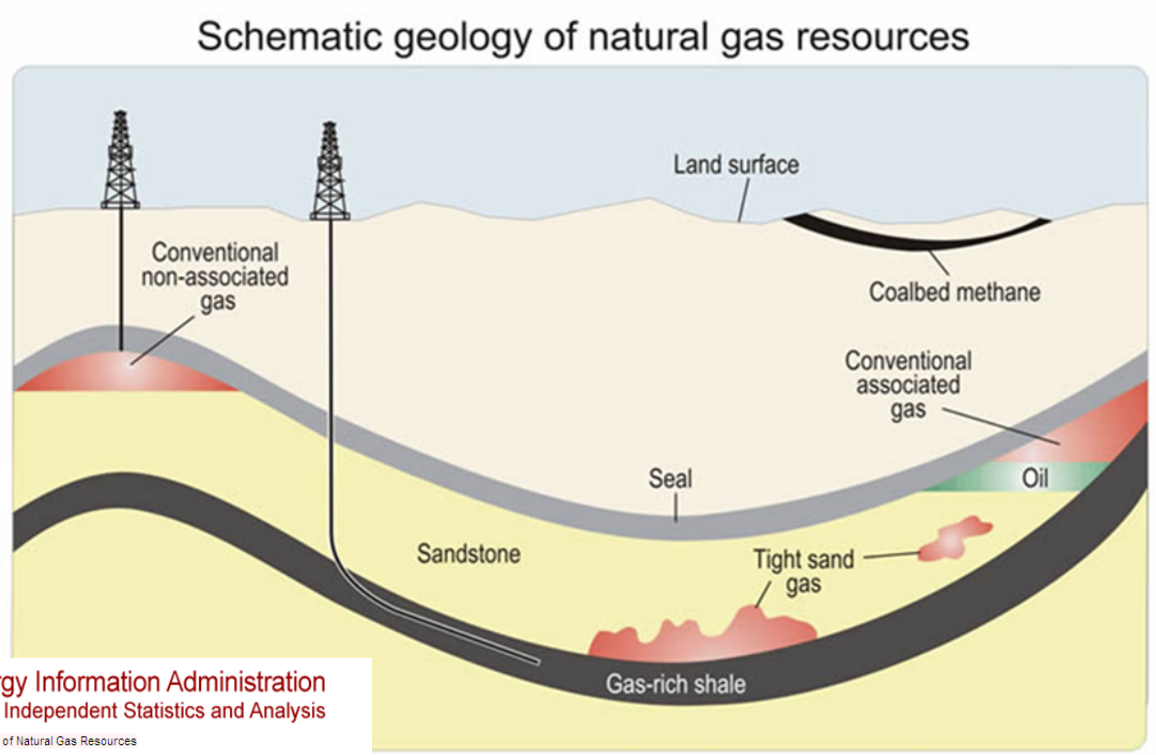
# What is Shale Gas: easier to find than conventional gas

## Schematic Geology of Natural Gas Resources

Released: January 27, 2010




eia U.S. Energy Information Administration
Independent Statistics and Analysis

Home > Natural Gas > Schematic Geology of Natural Gas Resources

- **Gas-rich shale** is the source rock for many natural gas resources, but, until now, has not been a focus for production. Horizontal drilling and hydraulic fracturing have made shale gas an economically viable alternative to conventional gas resources.
- **Conventional gas accumulations** occur when gas migrates from gas rich shale into an overlying sandstone formation, and then becomes trapped by an overlying impermeable formation, called the *seal*. *Associated gas* accumulates in conjunction with oil, while *non-associated gas* does not accumulate with oil.
- **Tight sand gas accumulations** occur in a variety of geologic settings where gas migrates from a source rock into a sandstone formation, but is limited in its ability to migrate upward due to reduced permeability in the sandstone.
- **Coalbed methane** does not migrate from shale, but is generated during the transformation of organic material to coal.

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# "Shale Revolution" – economics

- 1 shale gas well:
  - Equivalent to approx 30 conventional wells at approx half the capital cost
  - Horizontal (directional) drilling
  - Multiple fracturing of deposits
  - Reduced F&D ("Finding and Development") Costs
  - 30 – 90 day supply response to market price signal
  - May be able to complete wells & shut-in

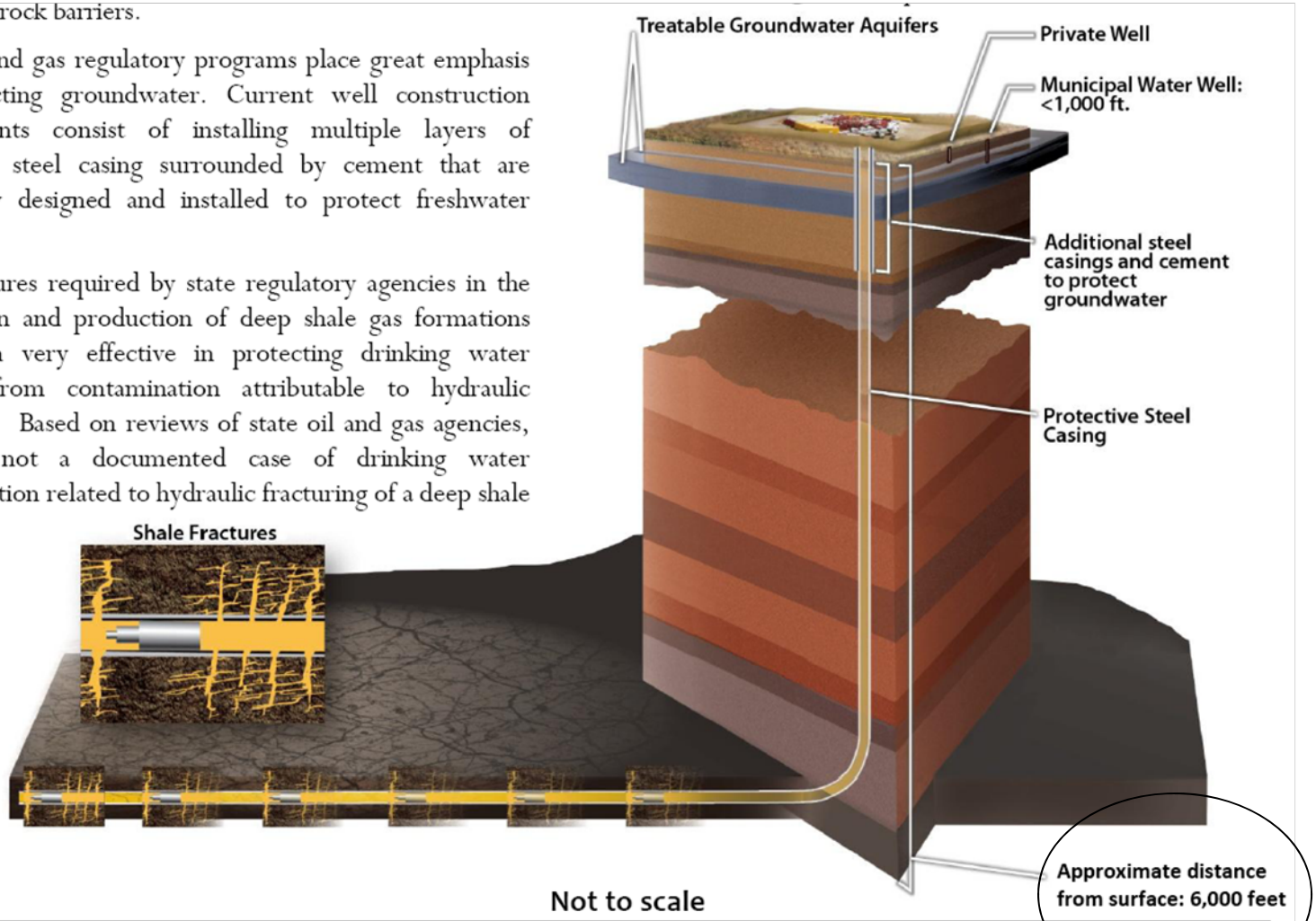
. . . "manufacturing facility" vs "boom & bust" scenario

# Schematic of a Typical Shale Gas Well: technology breakthrough

protective rock barriers.

State oil and gas regulatory programs place great emphasis on protecting groundwater. Current well construction requirements consist of installing multiple layers of protective steel casing surrounded by cement that are specifically designed and installed to protect freshwater aquifers.

The measures required by state regulatory agencies in the exploration and production of deep shale gas formations have been very effective in protecting drinking water aquifers from contamination attributable to hydraulic fracturing. Based on reviews of state oil and gas agencies, there is not a documented case of drinking water contamination related to hydraulic fracturing of a deep shale gas well.



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# Challenges for Shale? All four … writ large

- Scope
  - No one party has capacity to vertically integrate back to the wellhead
  - "Smaller" independent producers have taken the lead
  - Downstream market diversity
- Scale
  - Investment $$ to lease high yield properties
  - Coordinate size, location: gathering, liquids extraction, compression, transport
  - Downstream bottlenecks; congested load centers
- Timing
  - Technical learning curve
    - First shale well drilled 70 years ago
    - Drilling in major shale plays - within the last 4-8 years
    - Extrapolate initial results to entire region
  - Downstream transmission permit & construction (~ $20 mil/mile)
- Environment
  - Optimism / energy independence
  - State level responsibility for groundwater protection

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# Timing: Uncertain Economics

- Slow economic recovery expected:

  "Economists Expect Slow U.S. Growth", WSJ June 10, 2010
  WSJ surveyed 53 economists June 3-8, Monthly survey: Average prediction of 3% growth in GDP for remainder of 2010 and through 2011, jobless rate still high at 8.6% by end of 2011;

- Why continue drilling in face of low demand and price?
  - Low prices presumed to be due more to short term phenomena
  - Cost advantage & market positioning
    - Technical learning curve
      - F&D (< $1.00 to $1.50 per mcf)
      - Overhead (G&A ~ $0.50 per mcf )
    - JVs, VPPs maintain access to credit / investment $
  - MLP structure and tax advantage
    - Steady cash flow (especially pipeline assets)
    - Production incentive

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# Timing: Uncertain Economics & Learning Curve

## Cost Cutting and Well Optimization

**2007**
- Average initial test rate 2.4 Mmcfe/d
- Average Completion Costs $3.1 MM

**2008**
- Average initial test rate 3.6 Mmcfe/d
- Average Completion Costs $2.6 MM

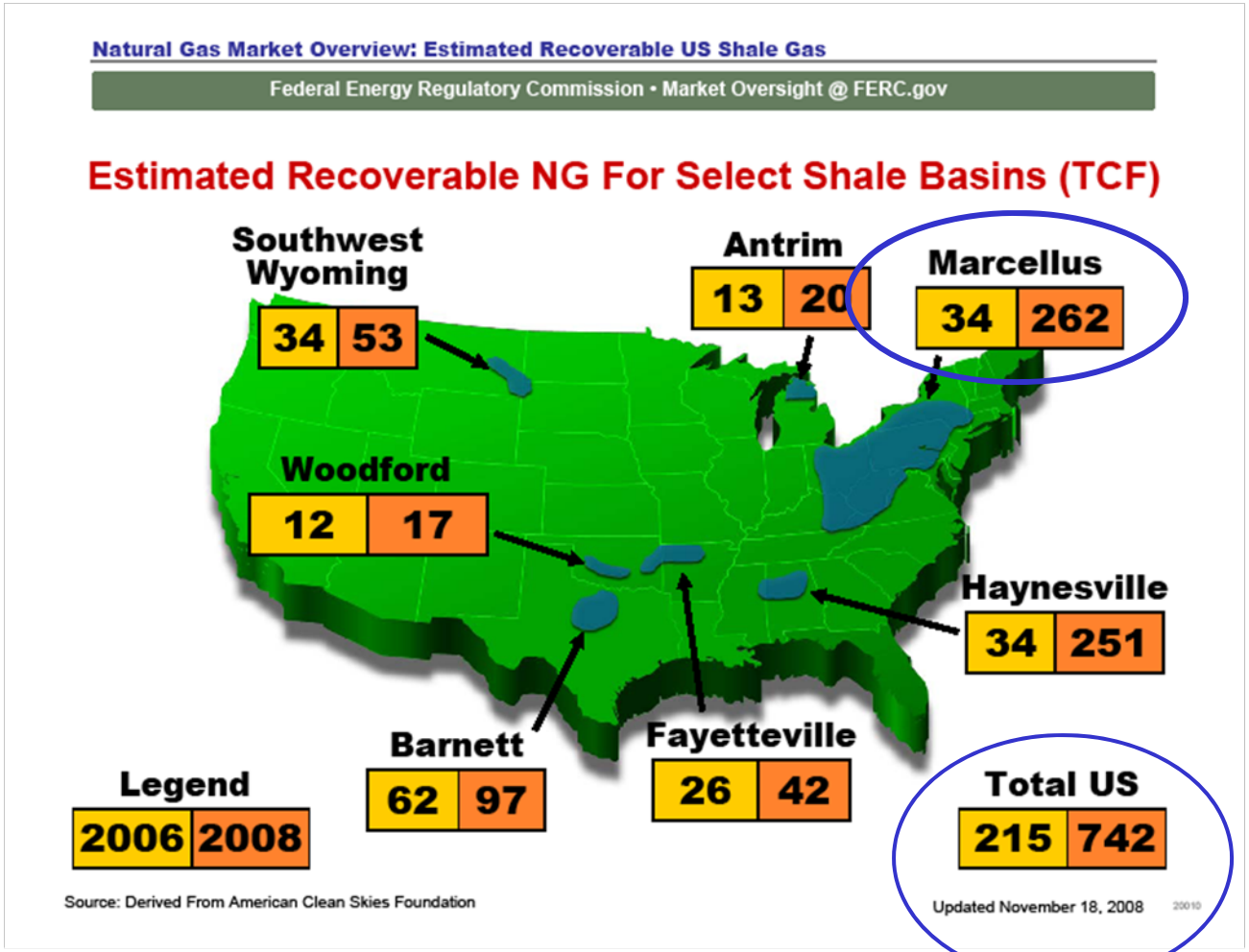
**2009**
- Average initial test rate 5.1 Mmcfe/d
- Average Completion Costs $2.1 MM

**Last 21 Wells**
- Average initial test rate 6.2 Mmcfe/d
  - *158% increase from 2007*
- Average Completion Costs $1.8 MM
  - *42% decrease from 2007*

Range Resources

Company Presentation | November 2009 | 38

# Scale: More Potential Reserves Now Considered Recoverable



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# Shale Revolution: Marcellus … Defined

## Appalachia Marcellus Shale

- For E&P, midstream and transmission pipeline companies
  - The Marcellus is a dream come true on a blank sheet of paper

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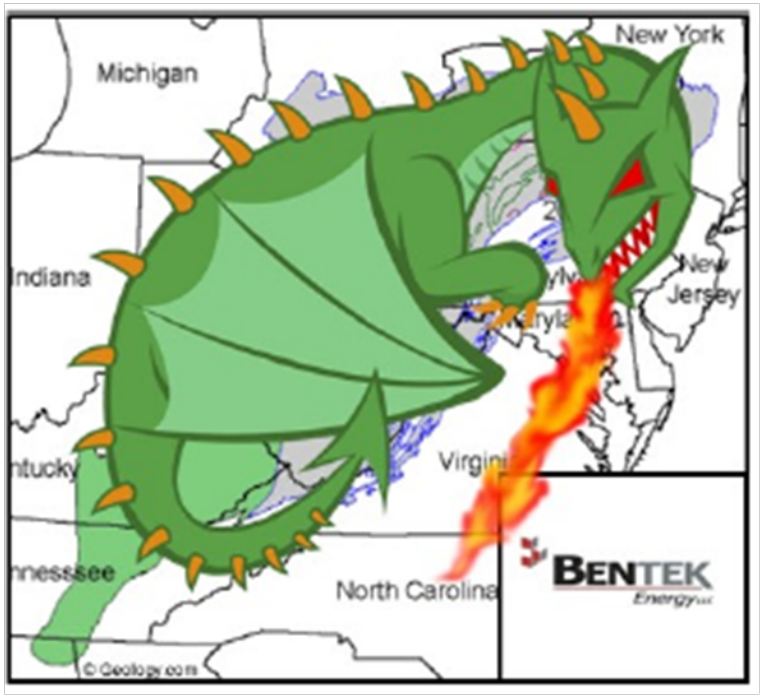
# Shale Revolution: Marcellus … Defined




***The Beast in the East™***

**Marcellus Shale Poised to Disrupt U.S. Natural Gas Market**

- Natural gas production from the Marcellus Shale in the Appalachian Basin is expected to reach between 4-6 Bcf/d by 2014.
- This growth will result in a supply displacement domino effect across North America.
- Northeast price premiums will shrink as multiple new pipelines relieve regional transportation constraints.
- Price spreads to the Northeast from western Canada, the Rockies and the Southeast Gulf are expected to tighten dramatically.

***Bentek Energy Market Alert email (excerpt) dated 3/22/10***

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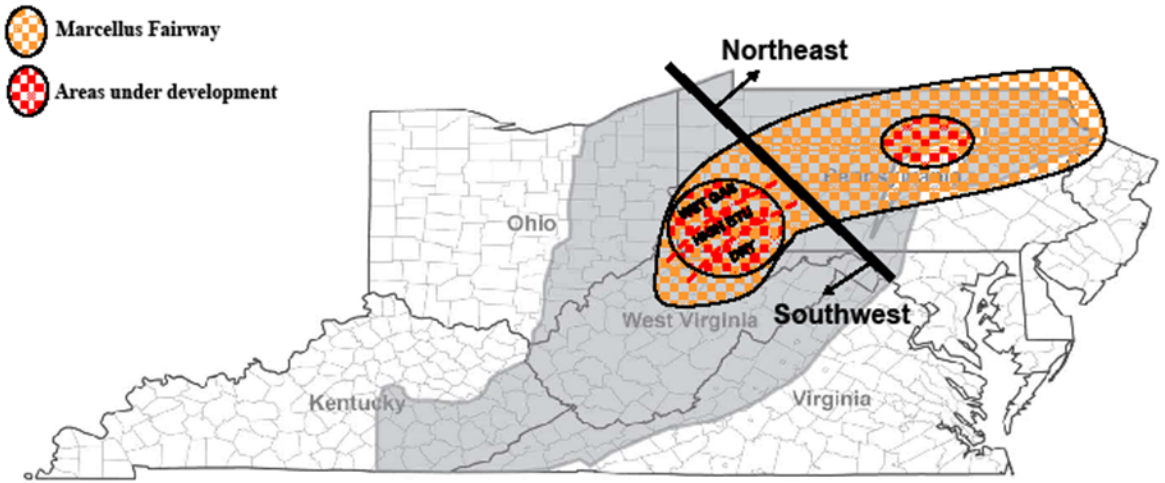
# Shale Revolution: What makes Marcellus special?

## Marcellus Shale – 2 Distinct Areas




| | Southwest | Northeast | Total |
|---|---|---|---|
| "Fairway" Acreage | 500,000 | 350,000 | 850,000 |
| Net Reserves/well | 3-4 Bcfe | 3-4 Bcfe | 3-4 Bcfe |
| Net Unrisked Potential | | | |
| Lower Range | 10 Tcfe | 5 Tcfe | 15 Tcfe |
| Upper Range | 15 Tcfe | 7 Tcfe | 22 Tcfe |

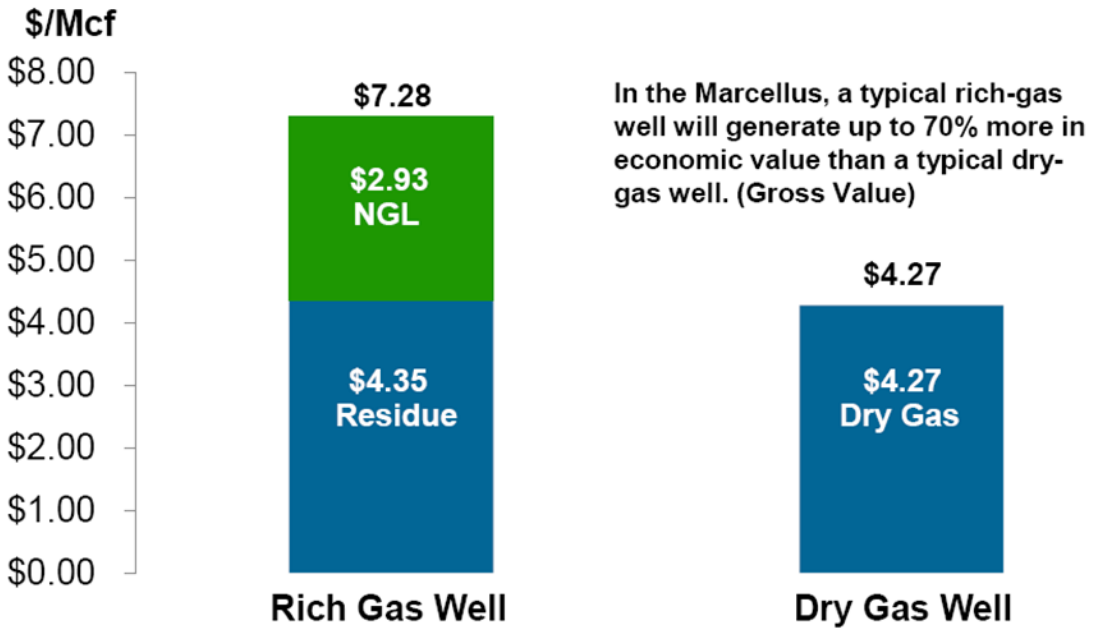
Range Resources 7

- **Total Acreage**
- **Largest US play by aerial extent**
- **Fairway**
- **Sweet Spot / NG Liquids potential**

# Shale Revolution: What makes Marcellus special?

## High - Value, Rich - Gas in the Marcellus

### Value of 1 Mcf Produced – Rich Gas vs. Dry Gas




In the Marcellus, a typical rich-gas well will generate up to 70% more in economic value than a typical dry-gas well. (Gross Value)

Dry gas assumes 1,030 Btu/cf. Rich gas assumes 1,300 Btu/cf. Assumes TCO gas and NGL prices on April 14, 2010. "NGL Value" deducts typical processing, fractionation and transportation fees.

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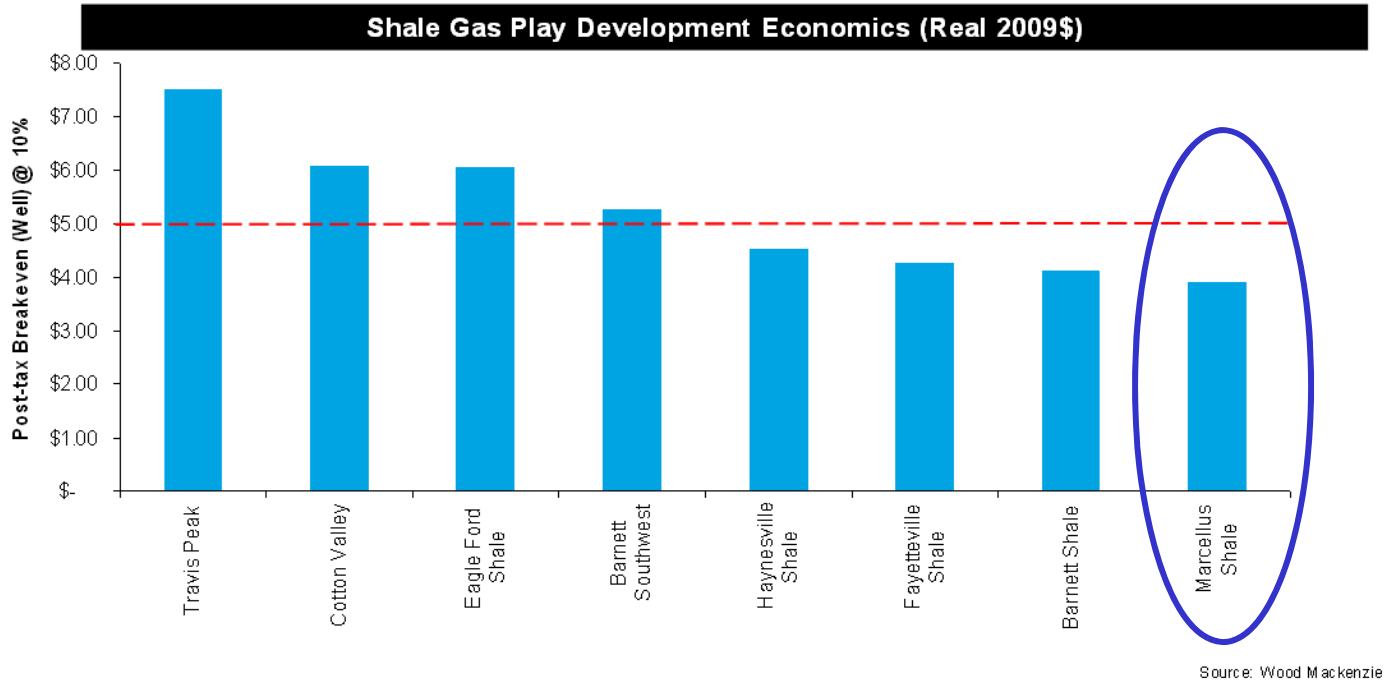
# Shale Revolution: What makes Marcellus special?

## Estimate Development Wells in Four L48 Shale Plays Break Even at Prices Below $5.00/mmbtu, With Some at $4 (Or Even Below)



# Shale Revolution: What makes Marcellus special?

## Where's the Best Place to Drill for Natural Gas in North America Today?

### Marcellus Economics Appear to be the Best in North America

- Ross Smith study dated September 4, 2009 – "The core of the Marcellus should offer a better rate-of-return than the core of any other shale play."
- Simmons & Company research – Marcellus (dry area) at $3.30 per Mcfe is the lowest "threshold price" of any unconventional gas formation , including shales, tight gas & CBM
- Bank of America study dated March 16, 2010 – Marcellus in the Southwest is economic at $1.00 per mcf because of high liquid content

### Where's the Best Place to Drill in the Marcellus?

- Best three wells drilled to date (based on 30 day IP rates) are in the Southwest part of the play (Range and EQT wells)
- Best economics are in the core part of Southwest Pennsylvania in the wet gas area.
  - At $2.50 per Mmbtu and $60 per barrel, rate-of-return is 35%

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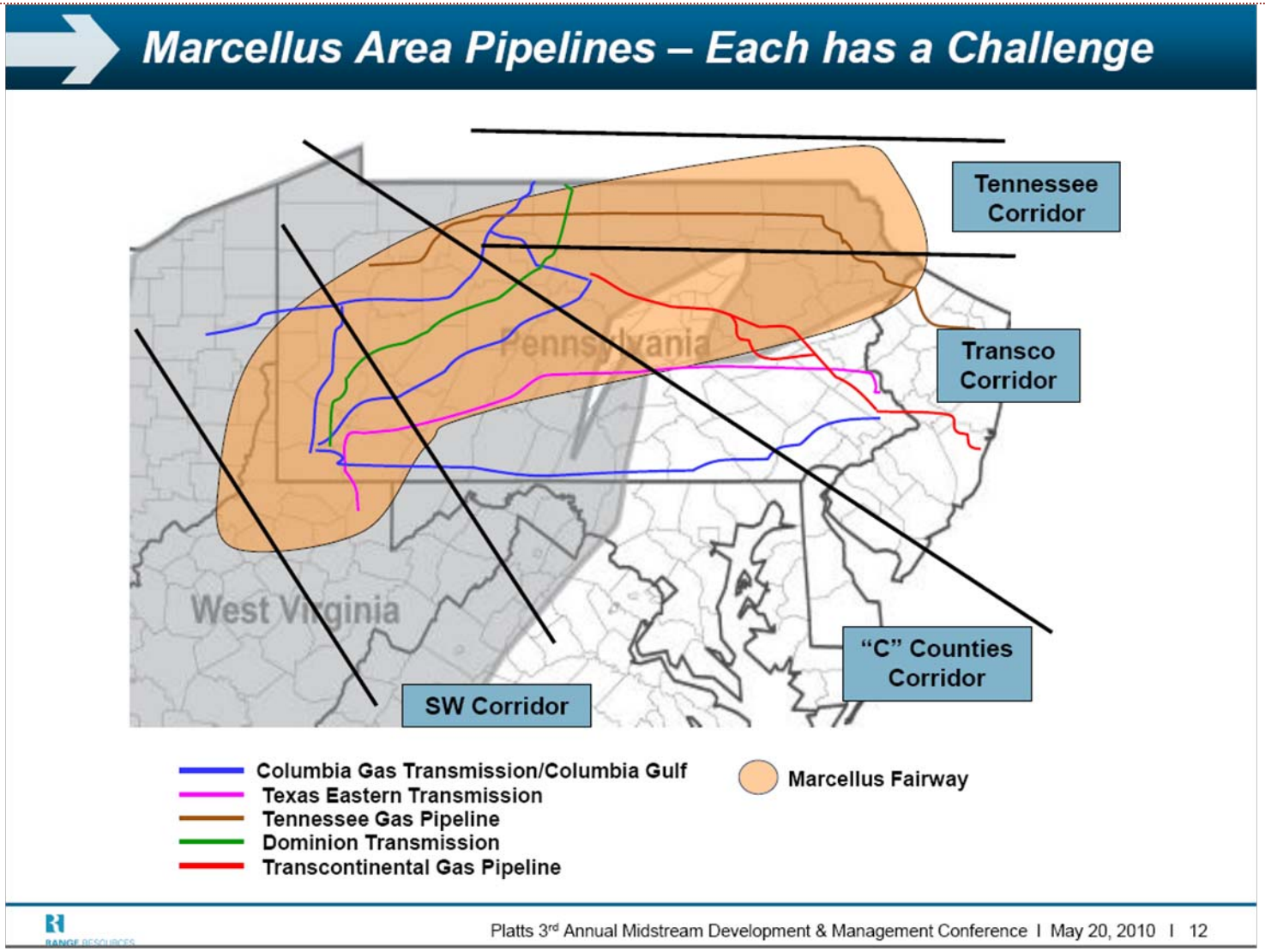
# Infrastructure:

- Interstate Pipeline: proposed expansions
  - Interstate pipelines & local distribution:
    - Multiple interconnects
    - Looping, replacement, compression
    - Lateral extensions
  - Too expensive for “demand pull”
  - “producer push” required (Range Resources and TETCO TEAM Project)
  - Incremental buildout - pipelines have a 3-5 year horizon
  - Propose rates are indicative only at this time
  - Looking for baseload market

# Scope: Infrastructure – Pipelines



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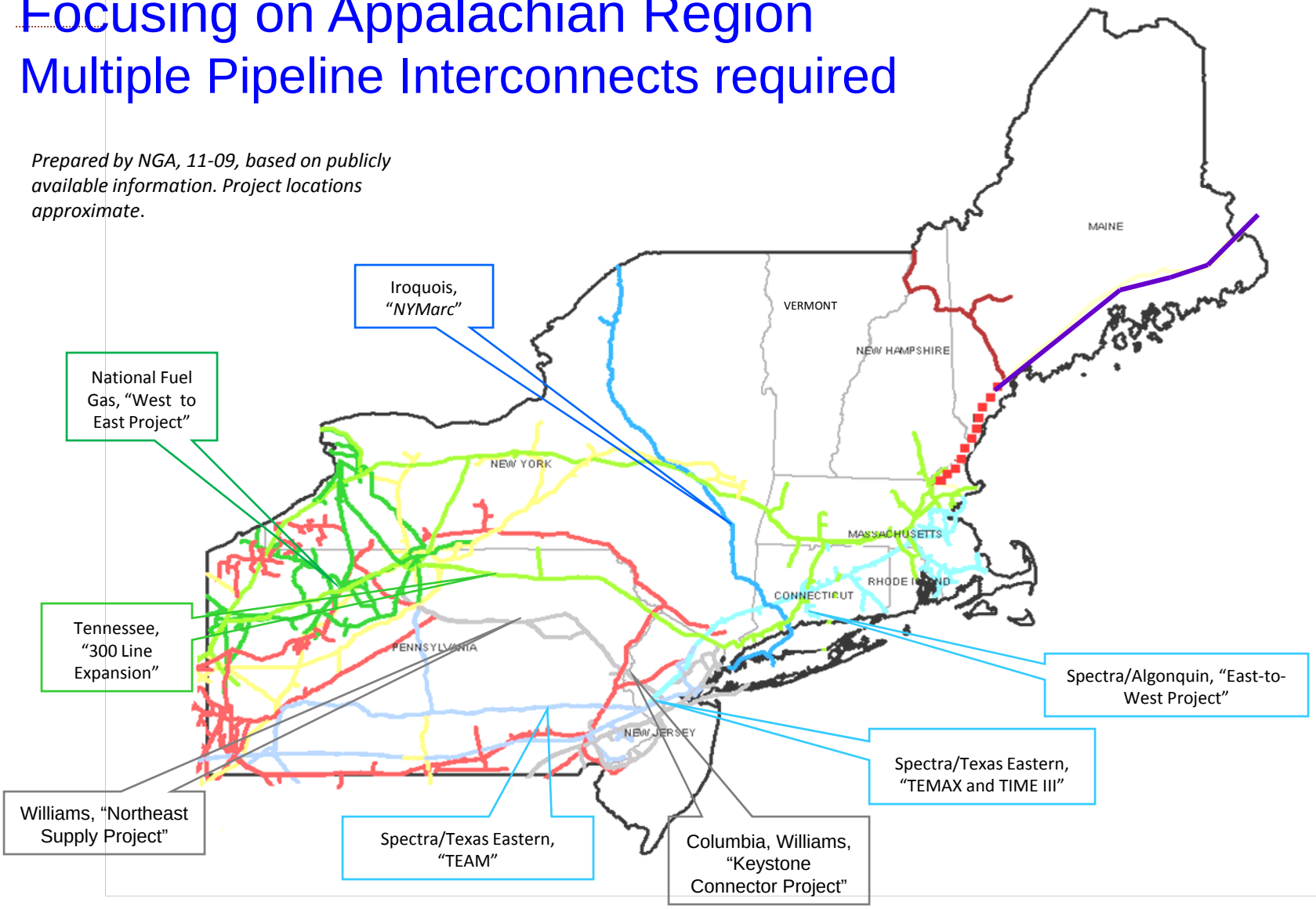
# Proposed Northeast Pipeline Projects:
## Focusing on Appalachian Region
## Multiple Pipeline Interconnects required

*Prepared by NGA, 11-09, based on publicly available information. Project locations approximate.*



# Timing: Infrastructure – Pipelines

## Potential for Regionalization of Firm Transportation

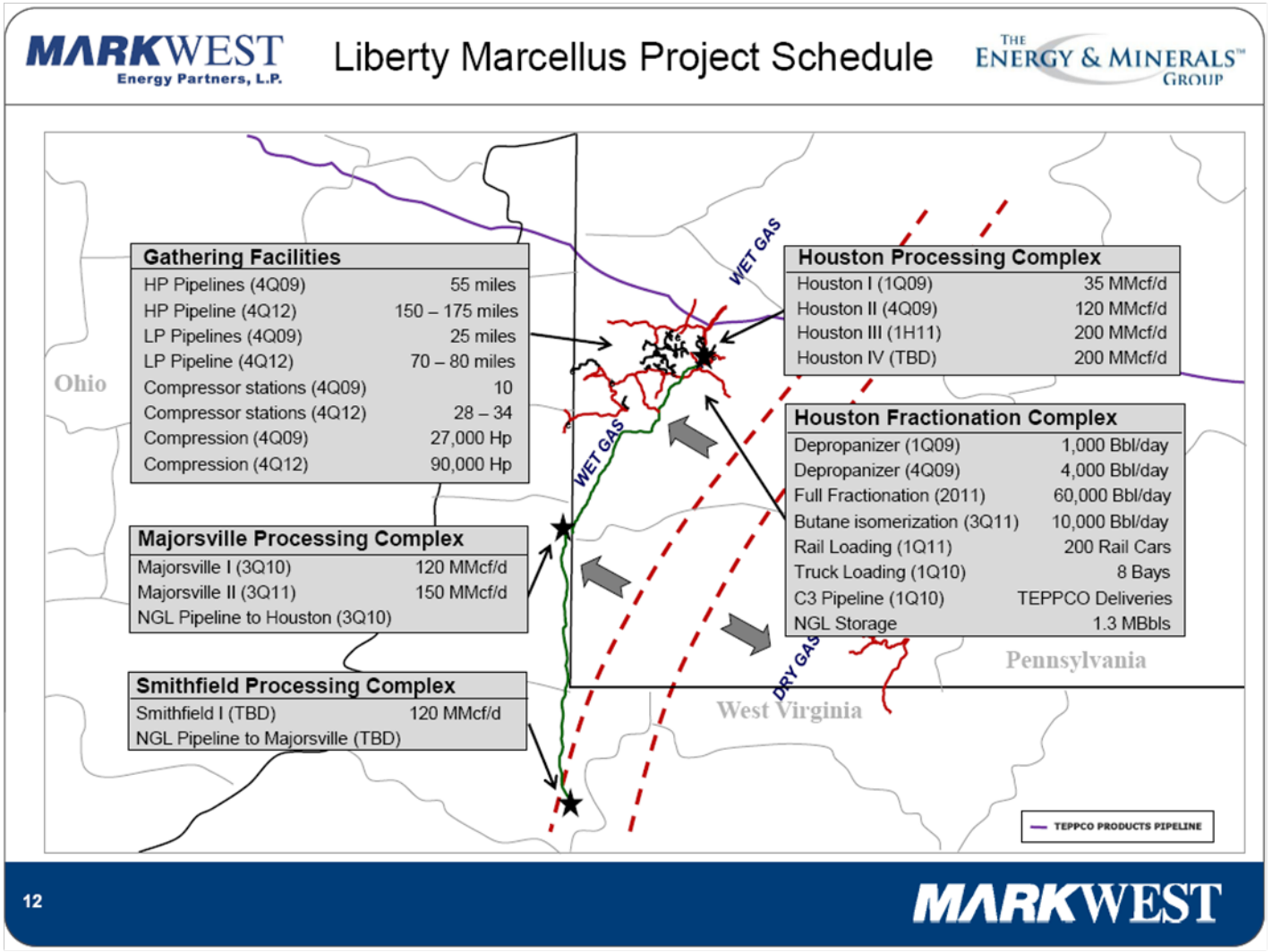
| Pipeline | System Capacity | Potential Expiration in Next 3 Years |
|---|---|---|
| Columbia Gas | 3.0 Bcf/day | 1.6 Bcf/day |
| Dominion | 5.7 Bcf/day | 3.0 Bcf/day |
| Tennessee Gas | 6.7 Bcf/day | 3.9 Bcf/day |
| Texas Eastern | 6.2 Bcf/day | 1.2 Bcf/day |
| TransContinental Gas | 7.7 Bcf/day | 2.0 Bcf/day |
| | 29.3 Bcf/day | 11.7 Bcf/day |

**40% of transportation contracts subject to renewal in next 3 years**

**Trend is to drop the southern segments**

Source: Rex tag Interstate Natural Gas Infrastructure

# Scale – Complex Midstream Investment:



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# Scale – Complex Midstream Investment:

## Unconventional Plays Require Us to Rethink Gathering

- **Preparing for the wave**
  - Dramatic changes in gas volumes
    - Wellhead vs. pad vs. central compression
    - Backbone vs. telescoping gathering
    - Even more difficult in low price environment and early stages of development
    - Permitting more challenging in the Marcellus
- **Is "Outsourcing" the new "Insourcing"?**
  - Rethinking producer/midstream relationship
  - Rethinking functional interaction
- **Varying gas composition**
  - Significant compositions in the same shale
- **Does capital investment change the equation?**
  - Significant initial and ongoing capital requirements
  - Multiple overlapping gathering systems

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MARKWEST

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# Incremental P/L Capacity being added across the US: El Paso's Ruby P/L Receives Final EIS from FERC Jan 8, 2010

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# Environment: Groundwater Protection

- Shale well completion process:
  - Water usage 3 to 4 million gallons to fracture typical well
    - in solution with sand, gel agent (<1% by volume)
    - Equivalent to typical golf course usage over 9 days
  - Operation management post well completion vs drilling process
  - Producers release chemical composition of gel agent on line

- Federal Energy Policy Act of 2005

  "… *amended* the Underground Injection Control ("UIC") provisions of the Safe Drinking Water Act *to exclude hydraulic fracturing* from the definition…"

  "Protection of groundwater resources during oil and gas extraction activities is a responsibility of state government." www.dec.ny.gov/energy/46445.html

  *(emphasis added)*

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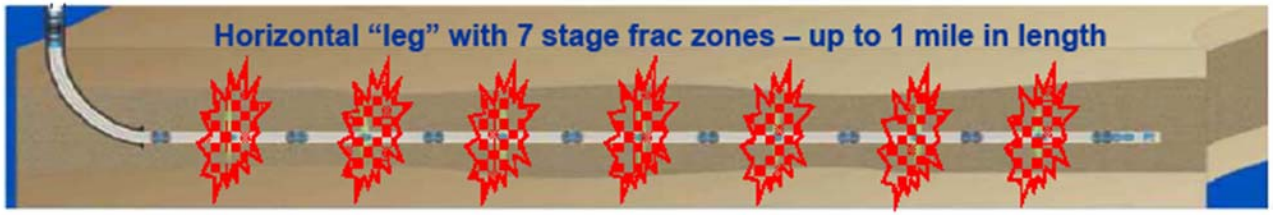
# Environment: Water Recycling

- Water is injected to stimulate fractures and desorb gas from the rock.
- Majority of water stays in the formation
- Flow-back Water *… this explanation courtesy of Range Resources web site*
  - 15% to 25% of injected water flows back to the surface as brine water
  - On site storage tanks
  - Saltwater disposal reservoirs > 1 mile underground
  - Trucked to licensed treatment facilities with National Pollutant Discharge Elimination System (NPDES) permit
  - Recycling
- Best Practices:
  - "Water recycling is a win-win" *… Range Resources*
  - Save approx $200,000 per well in trucking & treatment expense
  - Eliminates disposal cost
  - Reduces truck traffic on-site, access road damage, local noise level
  - Filed Water Management Plan approved by State DEP

# Environment: Water Recycling

## Horizontal Drilling & Multi-Stage "Slickwater" Fracing


Requires 4 - 8 Mil. gals. of water & 3 - 6 Mil. pounds of sand

TransCanada

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# Uncertain Economics ⇨ Irrational Exuberance?

- Reality Check for Irrational Exuberance:
  - What is the true marginal cost of shale gas production?
  - Will environmental concerns increase marginal cost?
  - What is market price threshold to expand production?
  - Will Shale or LNG set the market price for gas?

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# Uncertain Economics ⇨ Irrational Exuberance?

- Access to credit markets, MLP pressure
- Disputed correlations
  - IP (initial production), EUR (ultimate recovery) rates differ across plays
  - Articles, Blogs, e.g.:
    - Petroleum Truth Report, A. Berman
    - Energy Bulletin: “Shale Gas Shenanigans”
- Revolution or Repetition ?
  - similar to past hydrocarbon asset development cycles, e.g., oil sands in the southwest more than a decade ago?
- Environmental concerns
  - Bloomberg: “Shale Gas Costing 2/3 Less Than OPEC Oil Incites Water Concerns”
- LNG: Added import capacity means LNG may provide limit upside potential for gas prices, depending on world demand for gas.

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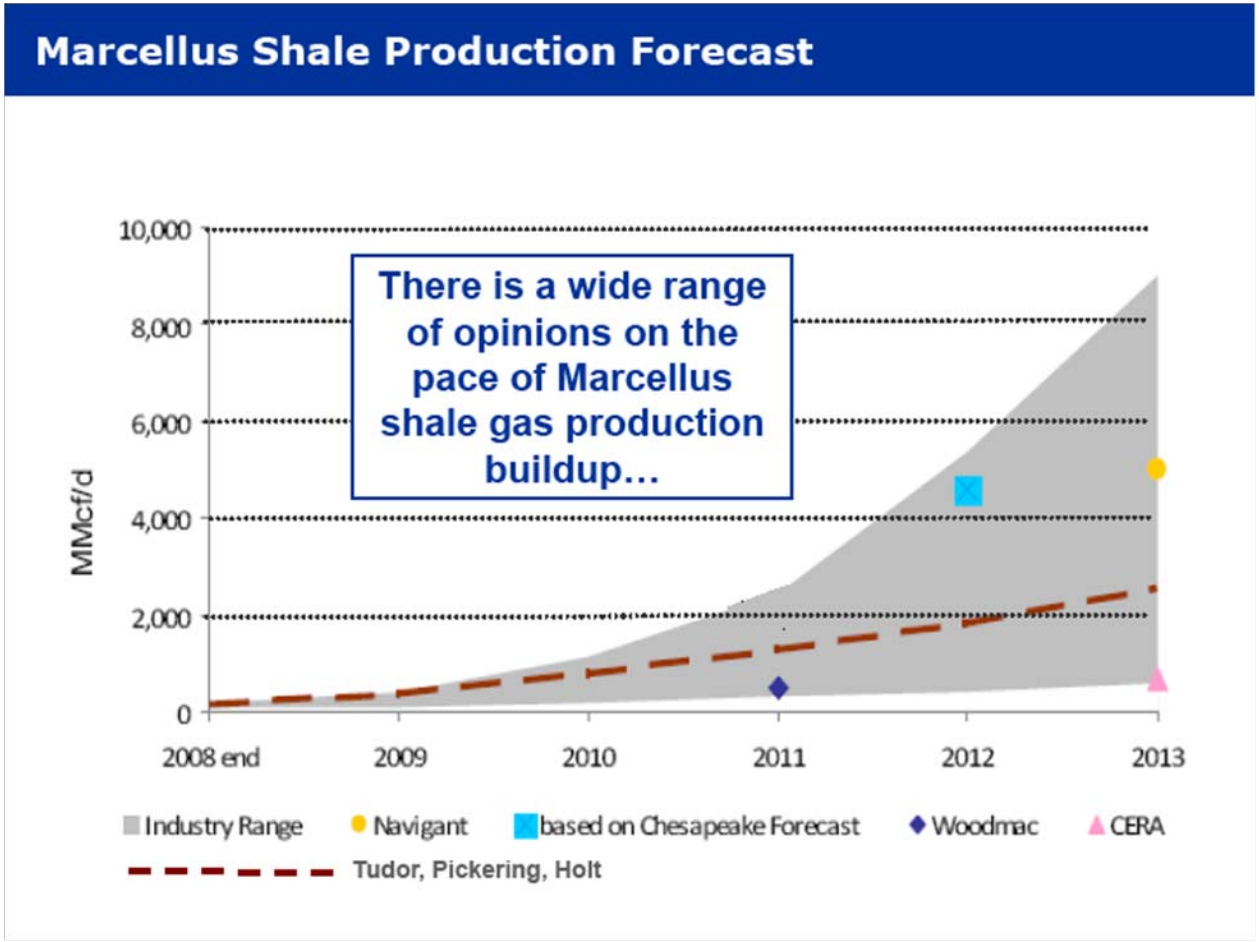
# Uncertain Economics ⇨ Irrational Exuberance?



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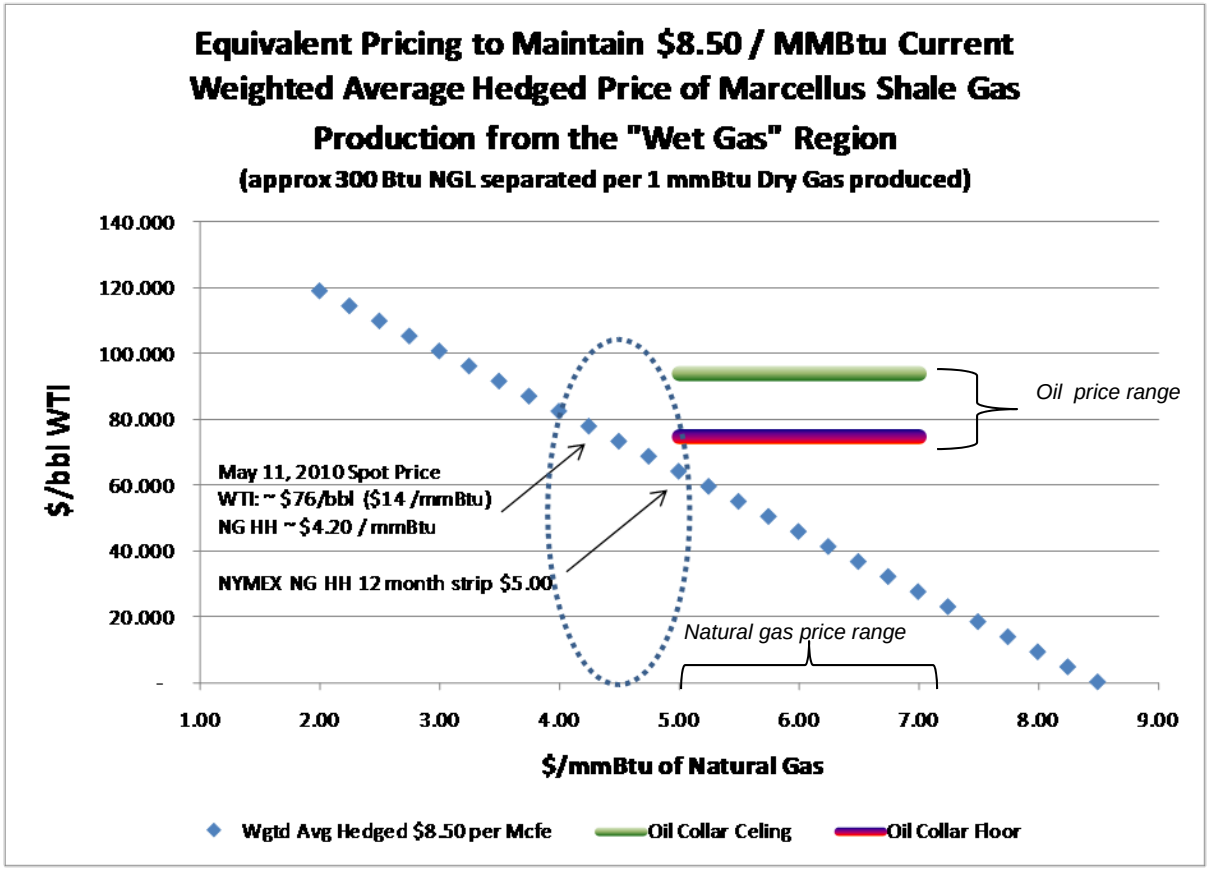
# Uncertain Economics ⇨ Irrational Exuberance ?




Independent producers publish financial reports that show 40% to 60% of each year's production hedged for 1 to 3 years out,; these reports are available on line and are closely watched by the investment community. This chart shows the range of prices obtained by Range Resources and Chesapeake Energy 's natural gas portfolios for 2009-11 was between $5.00 and $7.00 per mmBtu.. By May 2010, however, the 12 month strip for NYMEX Henry Hub had declined to about $5.00 per mmBtu, making it harder for independent producers to meet investor revenue expectations. Oil futures pricing has declined as well, reducing revenue expectations for associated NG Liquids production, In the past, especially 2009: Q3, higher oil prices applied to NGL portfolios helped to offset the impact of declining (dry) natural gas prices. As a result, some producers are refocusing their cap ex programs towards more NGL and crude oil production.

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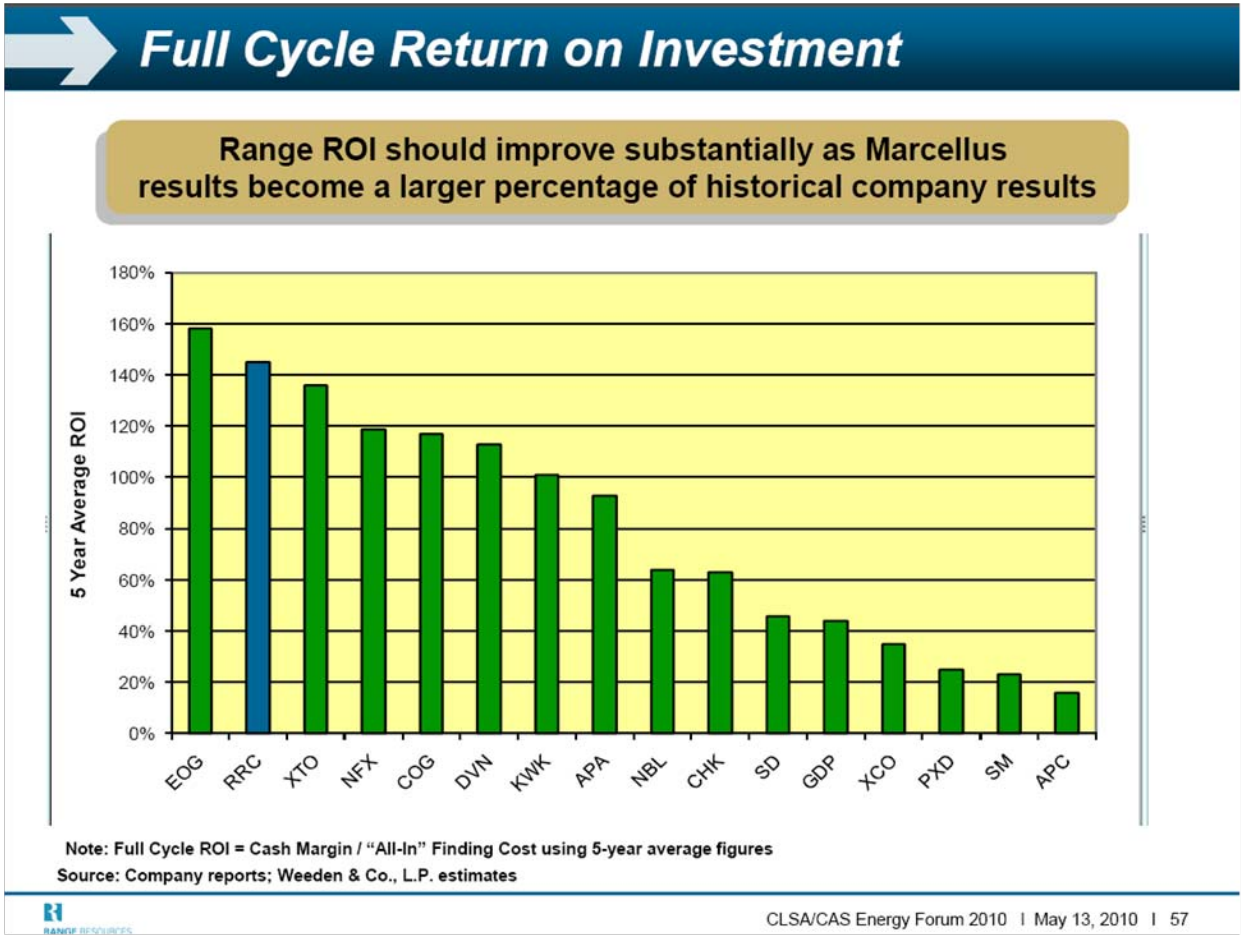
# Uncertain Economics ⇨ Irrational Exuberance ?




Some independent E&P earnings conference calls

*De-emphasize:*

- Gas shale in general
- Marcellus in particular

*Emphasize:*

- JVs, VPPs
- Oil directed investments

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# Scale: LNG ⇨ Irrational Exuberance

- LNG facilities:
  - ➢ Northeast
    - Canaport/Maritimes & Northeast Pipeline:
    - 1 Bcfd regas and transport capacity; 6-9 Bcf on site storage
    - 2 facilities off-shore Boston in operation (Neptune LNG mid-2010)
  - ➢ GOM / Southwest
    - Golden Pass, TX (ExxonMobil, Qatar supply)
    - 2.6 Bcfd regas; 15 Bcf on site storage; Q-Flex super tanker fleet
- Firm long-term K's for terminal capacity despite low prices
- US spot price attract cargoes vs world market ??

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# Scope – LNG: current operating facilities

Industries >> LNG >> Environment >> Terminals

Terminals

Click on a Terminal location to view more information.


**Terminal Locations:**

- Cameron, LA
- Cove Point, MD
- Elba Island, GA
- Everett, MA
- Kenai, AK
- Lake Charles, LA
- Peñuelas, PR
- Sabine, LA
- Freeport, TX

http://www.ferc.gov/industries/lng/indus-act/terminals/exist-term.asp

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# Challenges / Opportunities: Expectations / Forecasts

- Transform to a more liquid market:
  - Contract flexibility, spot supply available on peak
  - Shorter-term portfolio ?
  - Backfeed into New England grid has economic and physical benefits
  - Shale response to market price signal.
  - Consensus: comparatively flat price trajectory in real $
- Basic forecasting assumption:
  - Based on history, assuming technology held constant
  - Roughly speaking, technology: Ratio of Capital plus Labor to Output
  - Technological turning point
  - Courage, humility necessary to rebuild, re-specify models

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# Challenges for Shale: Difficult to Forecast

- Rig Count – to – Production Ratio as an indicator:
  - *Former* leading indicator of supply constraint
  - Shale well rig production ratio potentially 30x conventional
  - Baker Hughes (BHI) Rig Count:
    - doesn't differentiate horizontal rigs in shale plays
    - does differentiate between oil- and gas- directed rigs
  - Most recent BHI report – Appendix
  - Or: http://investor.shareholder.com/bhi/rig_counts/rc_index.cfm

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# Challenges for Shale: Difficult to Forecast

- EIA AEO 2010 forecast: Reference Case, Dec 2009
  - shale gas production is 50% higher than AEO 2009
  - assumes technically recoverable shale gas resources are 80 TCF higher than in AEO 2009 (347 tcf vs 267 tcf)
  - comparatively flat price trajectory in real $
- EIA AEO 2010 Alternative Cases released May, 2010
  - High Shale Resource Case: Reserves almost double, low prices
  - No New Shale / Low Permeable Well Drilling after 2009:
    - Slower growth in production (infill drilling allowed)
    - higher prices
    - LNG imports increase

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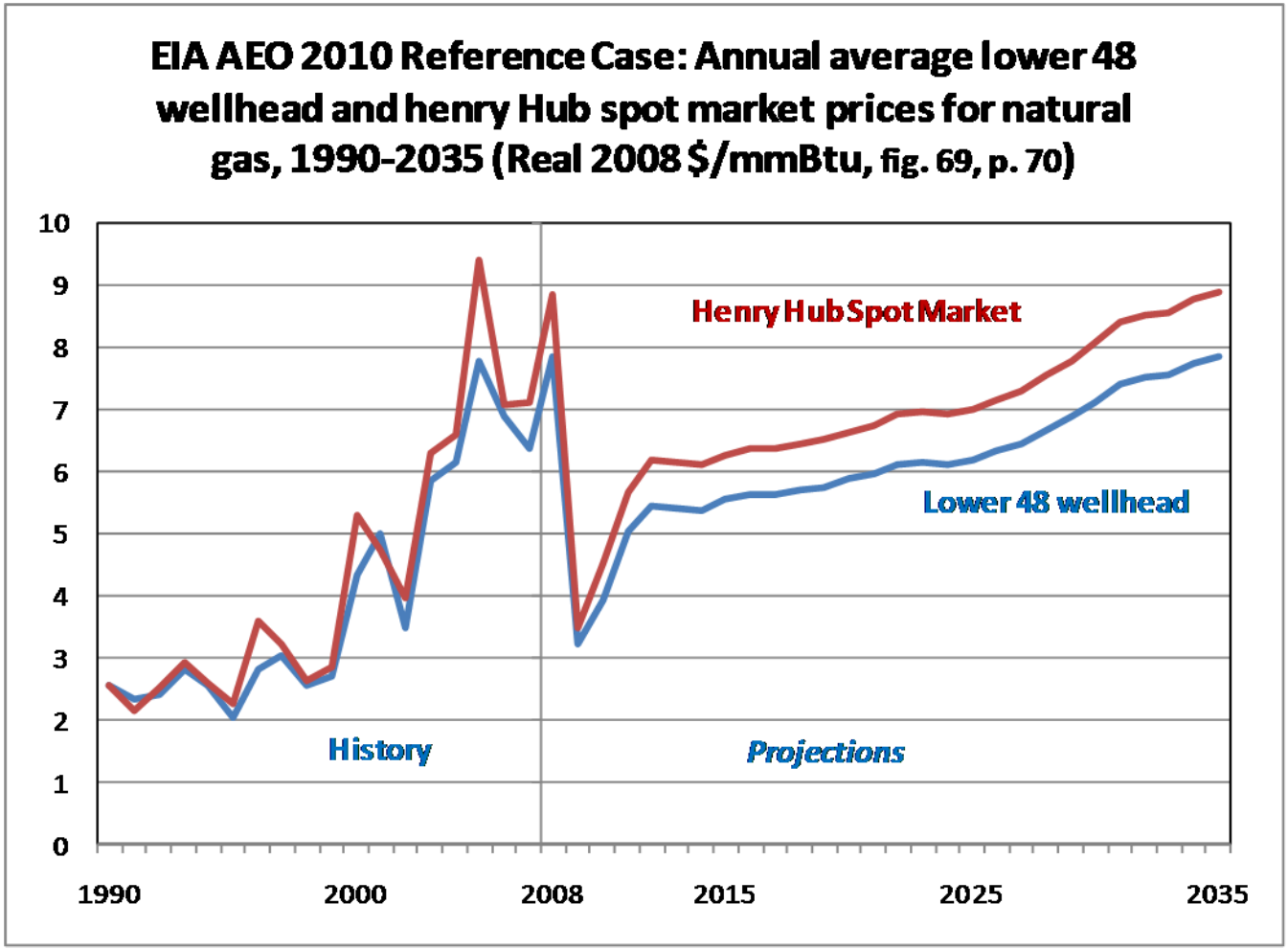
# EIA Annual Energy Outlook 2010: Reference Case



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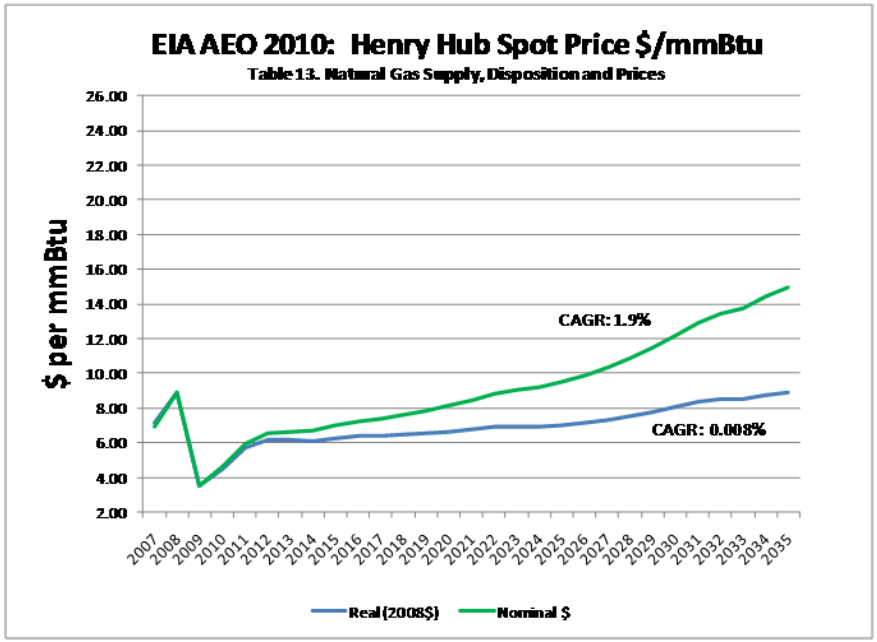
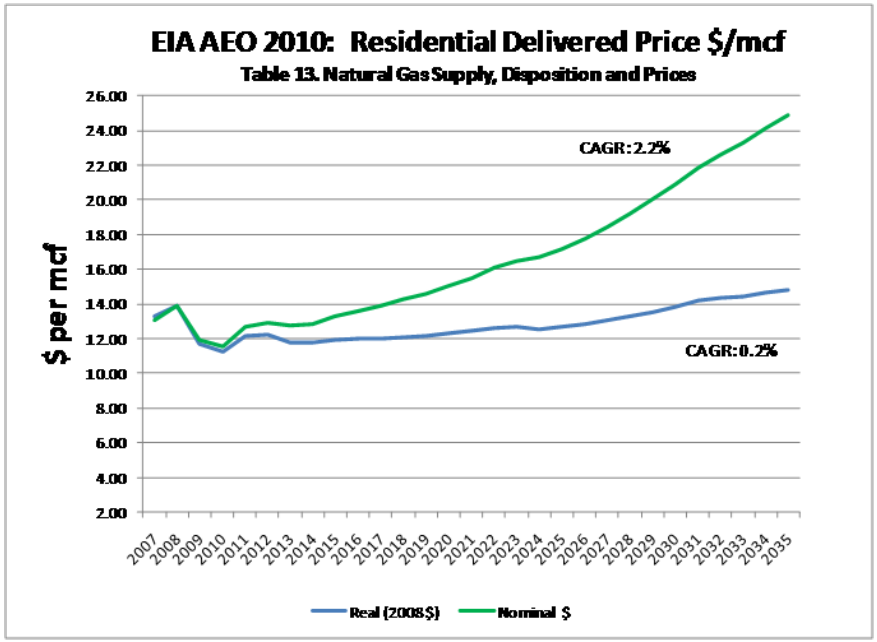
# EIA Annual Energy Outlook 2010: Reference Case



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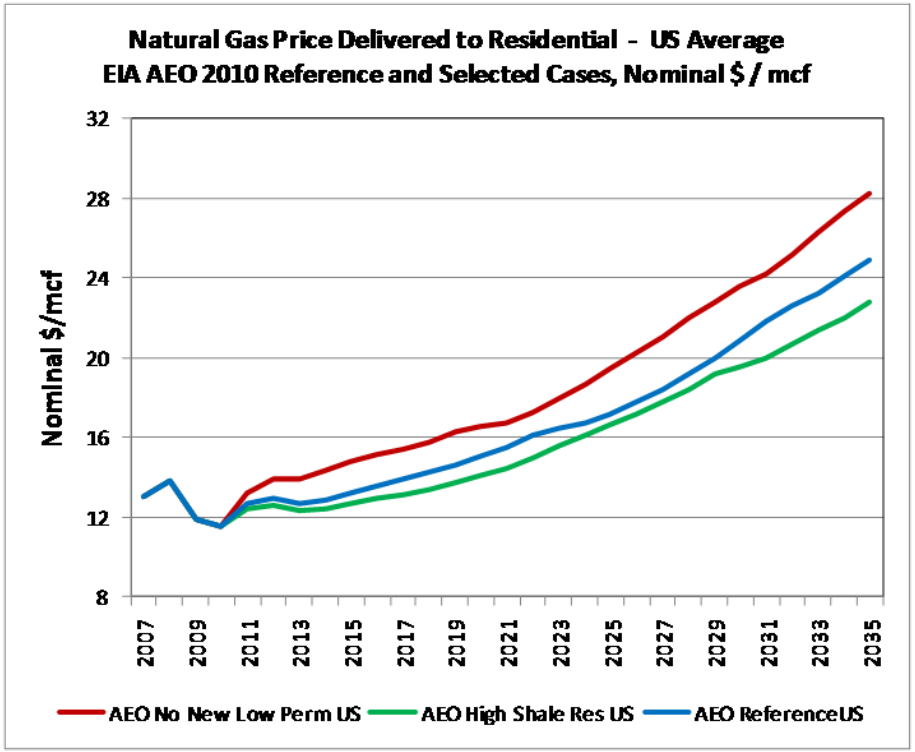
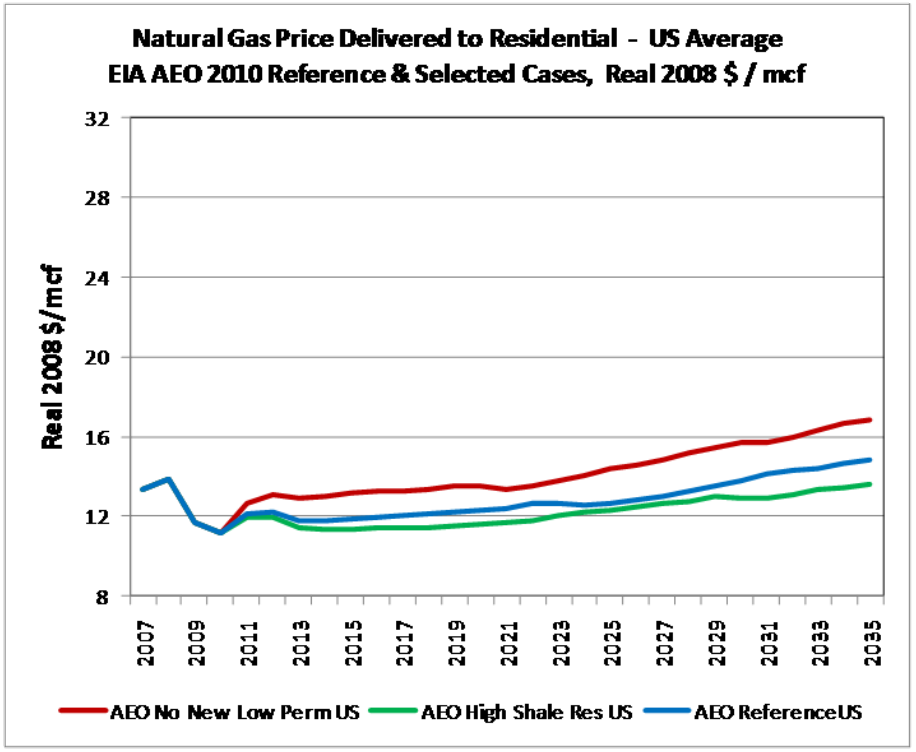
# EIA Annual Energy Outlook 2010: Alternative Cases




*DSM Implications:*

- *avoided cost calculations*
- *peak shaving, load growth*
- *less firm transport, storage required*

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# Questions?

## Thanks for Your Interest *!*

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