North American Natural Gas Supply Assessment

Presentation to

Integrated Energy Policy Report (IEPR) Workshop on Natural Gas Activities

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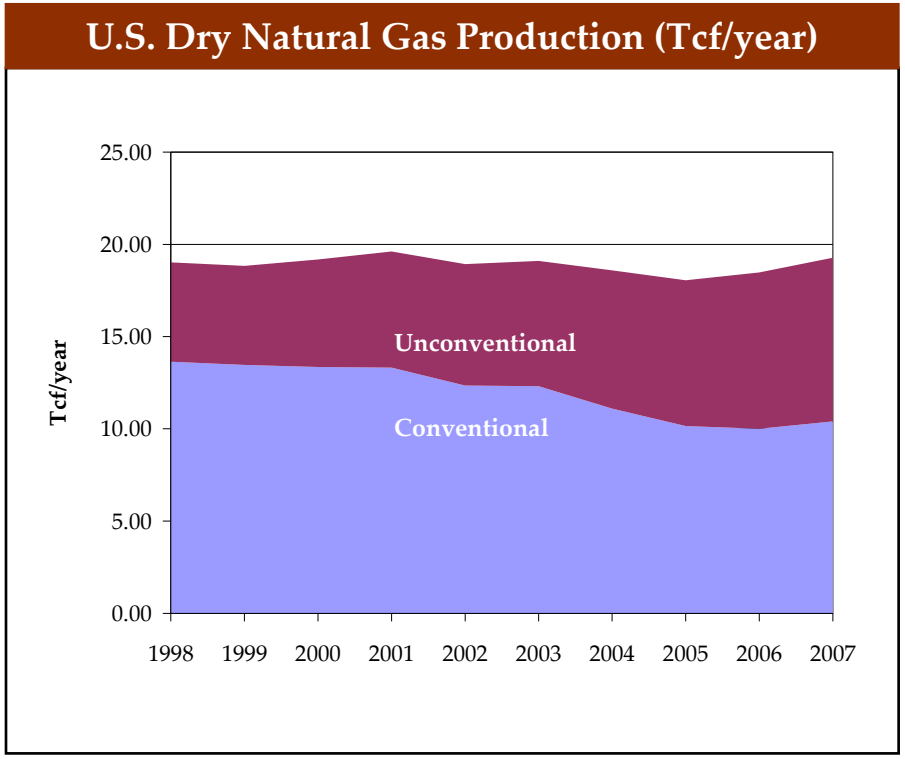
The State of North American Natural Gas Supply: Review of Groundbreaking Findings

- **Assignment:** Assess North American gas resources base and its potential, with particular attention on U.S. ***unconventional gas***, particularly ***shale gas***.
- **Process:** Gathered resource data from public sources and directly from gas producers and state agencies, plus data from Lippman Consulting Inc. The outreach included:
  - 114 producers covering 90 percent of North American production—60 percent response rate
  - Production officials in all major shale-producing states
- **Findings:**
  - Released in **Navigant Consulting's** ***North American Natural Gas Supply Assessment***, July 2008, for the American Clean Skies Foundation
  - Showed that gas production from domestic unconventional gas supply has ramped up sharply over the last several years such that ***total onshore-only production*** now equals total pre-Katrina (2005) levels from all U.S. sources (onshore and offshore).
  - That the **recoverable resource is not constrained**, that conservatively proven and ultimately recoverable domestic resources equal between 1,680 and 2,247 Tcf, or in ***excess of 88 to 118 years of U.S. production at 2007 rates of production***.
  - That **production growth in gas shale is the most dramatic**, and even with slowdowns caused by current market and financial turmoil, can increase available U.S. supply from the recent U.S. EIA AEO09 forecasts by 2020.

Study Found Total U.S. Gas Production Has Increased, Largely Due to a Decade of Increased Unconventional Production

- Total U.S. production reached 19.3 Tcf/year (52.9 Bcf/day) by the end of 2007, a 4.3% increase over the 18.5 Tcf/year (50.7 Bcf/day) level at the end of 2006.
- Production from unconventional sources increased from 5.4 Tcf/year (14.8 Bcf/day) in 1998 to 8.9 Tcf/year (24.4 Bcf/day) in 2007, an increase of almost 65%.
- ***Unconventional production*** increased from 28% of total U.S. gas production in 1998 to ***46%*** in 2007.



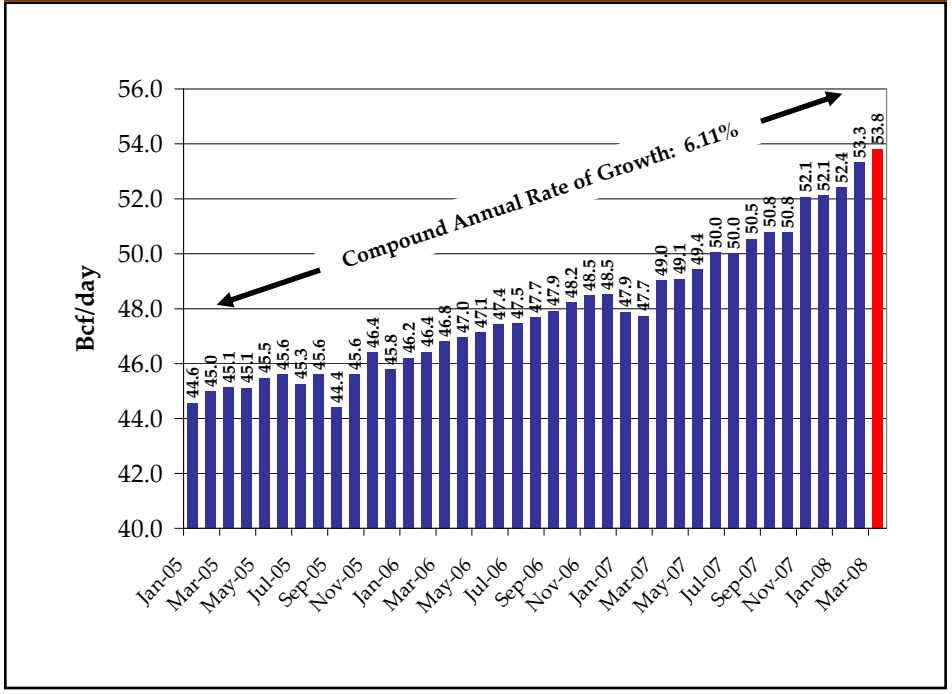
Source: EIA – Natural Gas Production Reports,
EIA AEO2008 unconventional production, NCI calculations.
See Appendix for supporting table.

U.S. *Onshore* Gas Production Growth Has Been Most Dramatic, Driven by the Growth of Unconventional Gas Supply

- Year-end 2007 onshore production was at 52.1 Bcf/day, up 7.4% over year-end 2006 levels of 48.5 Bcf/day, according to EIA Form 914 data.
- Average onshore production for 2007 exceeded 2006 by **5.32%.**
- EIA's 2008 AEO estimates 2006 – 2007 growth less than half that, **2.39%.***
- First quarter 2008 growth was even more pronounced, exceeding the same quarter in 2007 by **11.49%.**
- This accelerating growth is consistent with the upward curve in unconventional gas production.

* EIA's 2009 AEO reference case significantly increases estimates for total L 48 domestic gas production and for shale production (up 85% in 2030) compared to AEO 2008, but is still substantially lower than the NCI study findings.

U.S. Onshore Natural Gas Production (Bcf/day)



Source: EIA – Production Survey 914

Update to the Resource Assessment Study

- In continuing to follow the development of domestic unconventional gas, all signs point to **continuing unconventional gas production and reserves growth in the U.S**.
- While year-end 2008 final EIA production numbers are still months away, the production growth trends set in 2008 appear to be continuing. This despite challenging financial market conditions for many exploration and production companies and dramatically lower spot gas prices currently compared to last year.
- Some recent results published by shale producers indicate dramatic production increases for 2008, year over year, and this trend is expected to continue.
  - **Southwestern Energy** (SWN) had net production of 134.5 Bcf in 2008 compared to 53.5 Bcf in 2007 out of the Fayetteville shale; an increase of over 150%. During 2008, 604 wells were drilled, and for 2009 SWN is planning on drilling up to 650 wells and investing up to $200 million in gathering systems. (SWN 2008 Annual Report)
  - **Range Resources** expects to triple Marcellus production in 2009, with a target to exit the year at a net rate of 80 – 100 mmcfe per day (2008 Annual Report), or 36 Bcf per year.

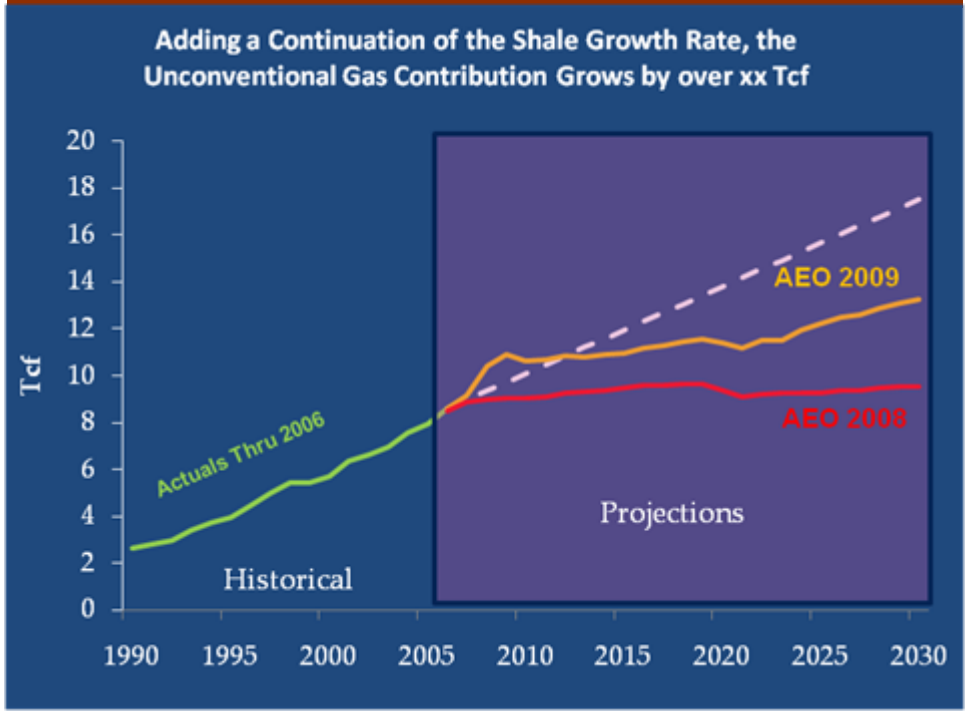
Update to the Resource Assessment Study (cont.)

- **Some recent results** (cont.)
  - **Petrohawk Energy** (HK) increased reserves from 1.06 Tcfe to 1.42 Tcfe mostly through additional shale properties, and increase of about 40%, and estimate their potential reserves to be 23.6 Tcfe, most of which lies in shale properties (April 2009 investor presentation).
  - **Quicksilver Resources** (QRI), which concentrates on unconventional gas, increased production from 211 MMcfd in Q1 2008 to 332 MMcfd in 1Q 2009, a gain of 57% (News release May 6, 2009).
  - **Devon Energy** (DVN), the largest producer in the prolific Barnett Shale formation around Fort Worth, Texas, increased its net production there to 1.2 Bcfd in Q1 2008 from 0.995 Bcfd in Q1 2007 (News release May 6, 2009).

In the Past, EIA Has Tended to Underforecast Gas Production, Especially Shale

- Measuring the rapidly increasing growth in shale production, then projecting it if the resource base can support it, yields an unconventional gas contribution well in excess of even EIA's most recent forecast.
- This despite the EIA in its Annual Energy Outlook 2009 having dramatically increased their previous U.S. domestic gas forecast by **+43.5%** for unconventional gas, including shale, by 2030, while reducing forecasts of foreign LNG imports.
- We believe our study and others that have followed may have helped to influence EIA's revision although it may still be low!

EIA AEO Shale Underestimate

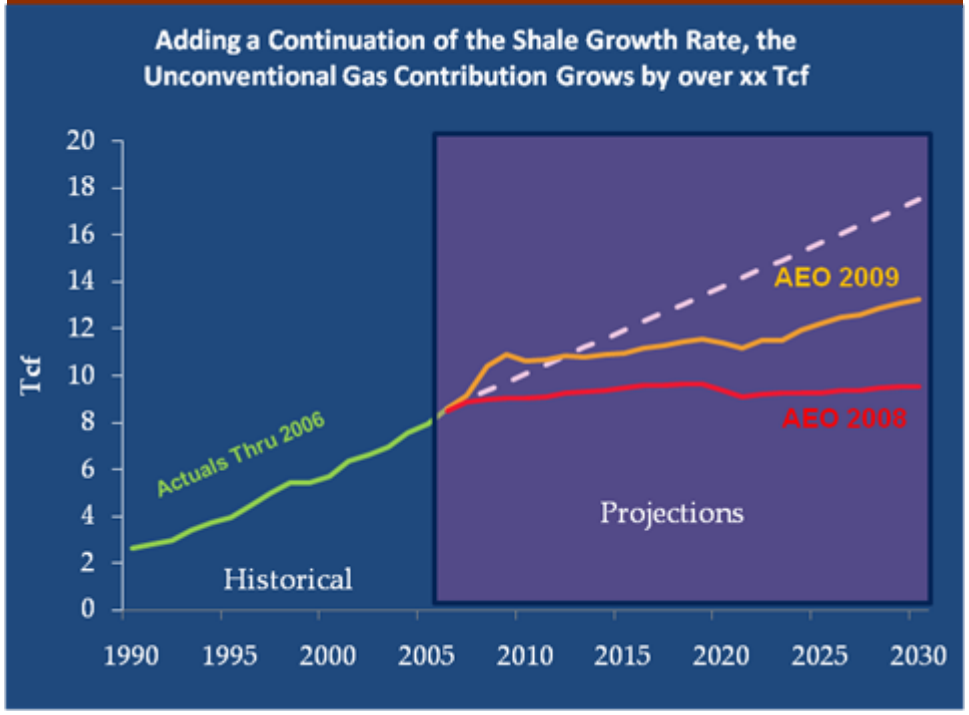


EIA Has Tended to Underforecast Gas Production, Especially Shale (Cont.)

- The key questions of course to answer are :
  1. Is the rate of growth continuing; and
  2. Can the resource base support it?

- The answer to 1. is **To Be Determined**
- The answer to 2. we believe is clearly - **Yes**

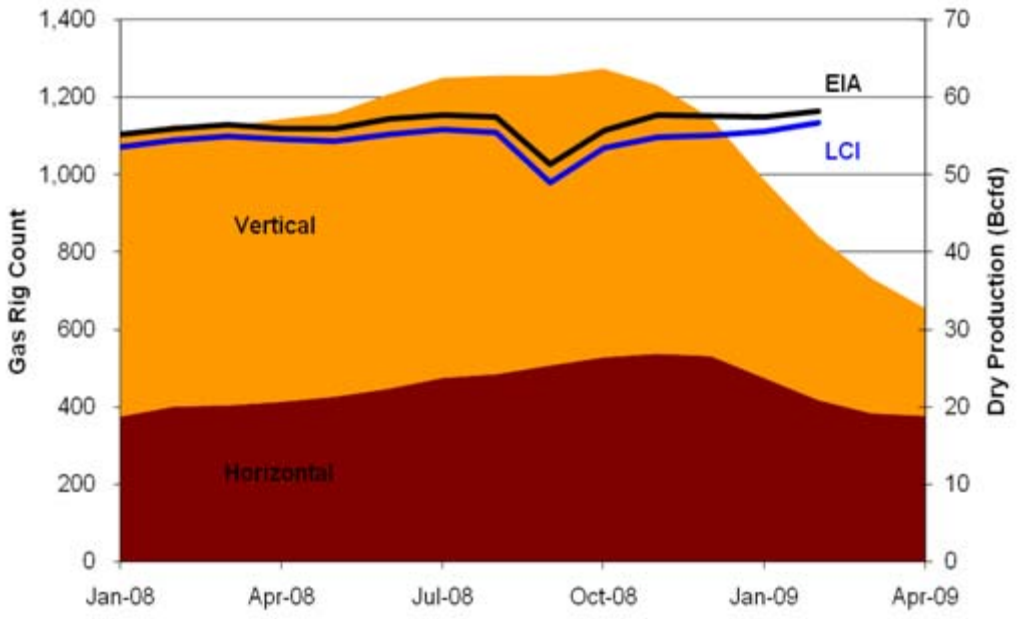
EIA AEO Shale Underestimate



Since Last Fall, Vertical Gas Drilling Has Dramatically Declined – Horizontal Drilling Has Not. Gas Production Is Also Holding Up

- Vertical gas rig counts have fallen off significantly since last year, experiencing a decline of 66% (262 rigs for the week ending April 24) from the peak of 781 rigs for the week ending July 4, 2008.
- Horizontal gas rig counts have also declined, but at 377 rigs for the week ending April 24 are still at levels near last year's low of 356 rigs (week ending Jan 4, 2008) and relatively flat year over year.
- U.S. production is still holding relatively flat, due to unconventional supplies especially from gas shales.

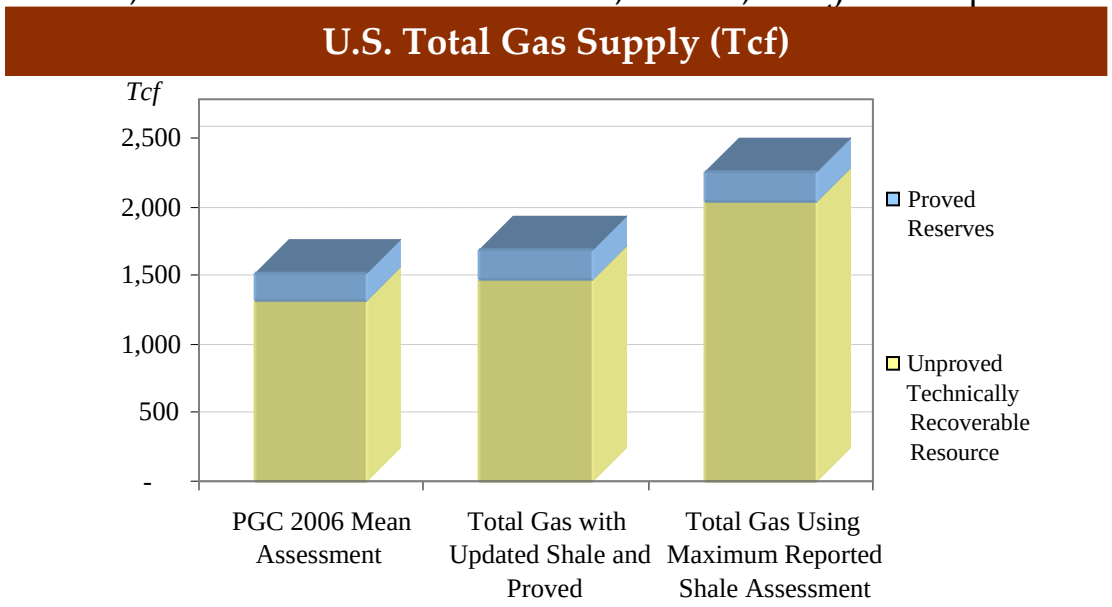
U.S. Dry Production and Gas Drilling Rigs



Sources: NCI / Smith Bits / EIA

A Key Finding of the NCI Study Was that Proved Reserves Plus Assessed Resources— Resulted in An Expanded Life of the Gas Resource

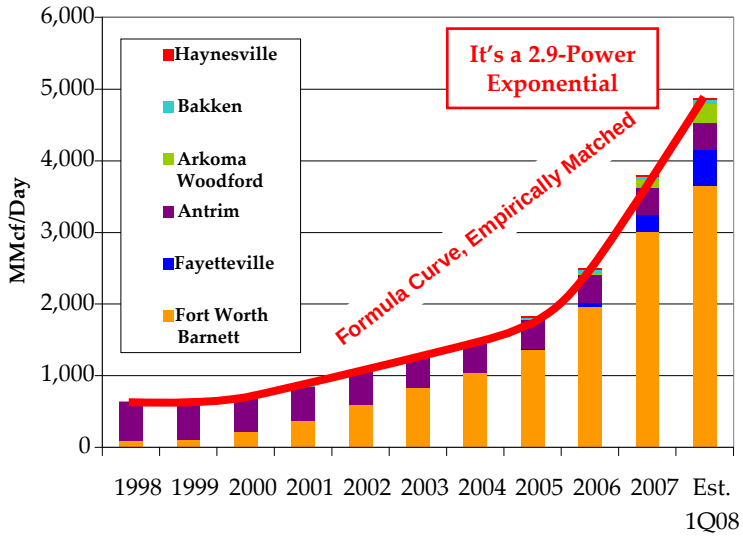
- The 2006 Potential Gas Committee (PGC) total P3 (proved, probable, and potential) resource estimate was 1,530 Tcf, inclusive of 204 Tcf of proved reserves. At that year's U.S. production rate, this is ***82 years'*** worth of gas supply.
- The mean NCI reserve estimate for shale gas is 274 Tcf, approximately 143 Tcf higher than the shale gas reserves in the PGC estimate. Adjusting for this difference, and for higher proved reserves (211 Tcf) as of year-end 2007, the total resource becomes 1,680 Tcf, ***88 years'*** worth of supply at 2007 production levels.
- The maximum reported assessment for shale, according to producer reports collected by NCI, is 842 Tcf. Using this estimate, the total would increase to 2,247 Tcf, ***118 years*** of production at 2007 levels.



What is Apparent is that Gas Shale Production Has Experienced Tremendous Growth, with the Barnett Shale in Texas Leading the Way

- Study showed Barnett growing from 0.094 Bcfd in 1998 to 3.0 Bcfd in 2007; an increase of more than 3000%; latest Barnett production actuals are 4.6 Bcfd or 8.1% of total U.S .production (from Lippman Consulting, Q32008).
- Fayetteville, Haynesville, and Woodford were also reported as showing signs of ramping production with Marcellus identified as being next.
- Technology has allowed access to and economic production of a vastly greater resource base. Specifically, ***improved hydraulic fracturing*** techniques and improved ***horizontal drilling*** have allowed tight, geographically diffuse reserves to be developed in large volumes.
- Producer estimates placed the "Big 6" plus Marcellus shale plays at <u>27 to 39 Bcfd</u> upon full development in 10-15 years.

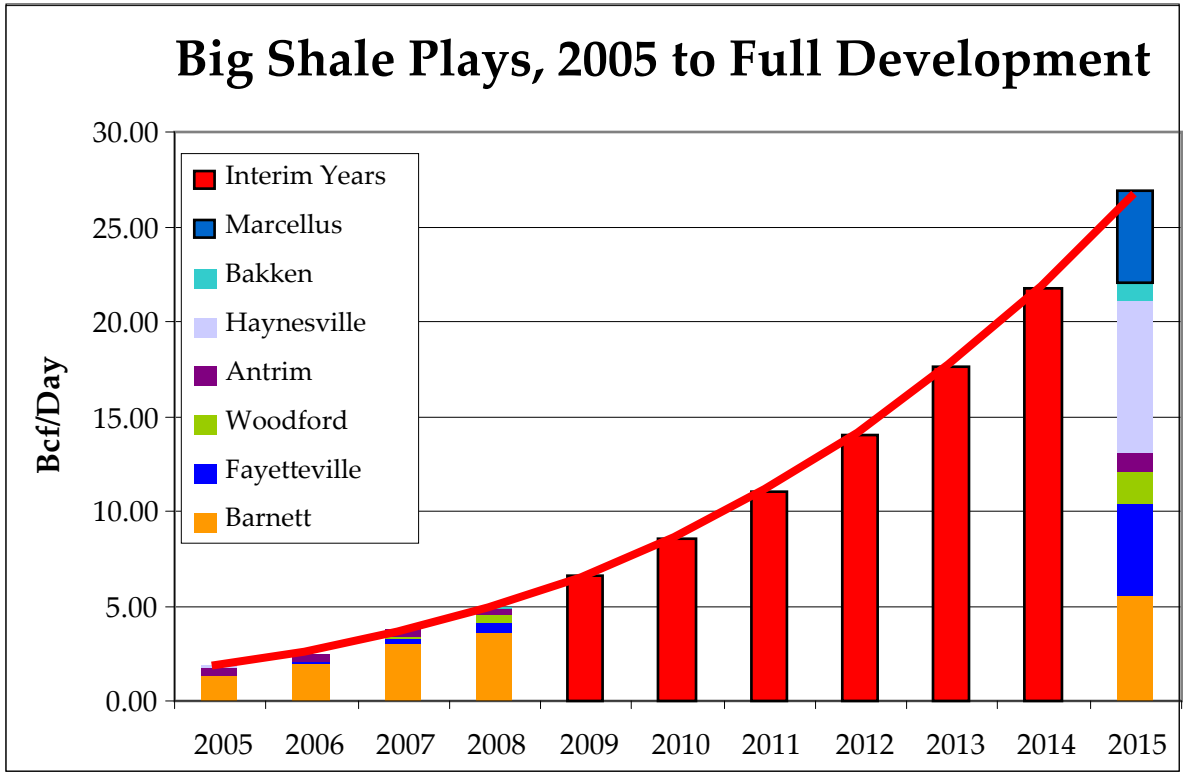
U.S. Shale Gas Production* (MMcf/day)



Sources: Lippman Consulting, Inc. Production Database, Michigan Public Service Commission, Arkansas Oil and Gas Commission and NCI Calculations.

Implications of Projected Rate of Shale Gas Growth

- If acceleration in shale gas supply growth continues, production from 'Big 6 shales, plus Marcellus' alone will be 27 Bcf/day by 2015. At EIA's 2008 average US demand of 58.2 Bcfd, even allowing for moderate growth in existing markets, this would likely be ***too much gas***



How Might Excess Gas Be Utilized by the Market?

- EIA 2009 Forecast of Lower 48 Onshore gas supply in 2020[1]: 44.0 Bcfd
- NCI Forecast of Lower 48 Onshore gas supply in 2020 (approx): 59.4 Bcfd
- Forecasting Difference: 15.4 Bcfd

Discussion scenarios for 2020 to conceptualize scale and possibilities:

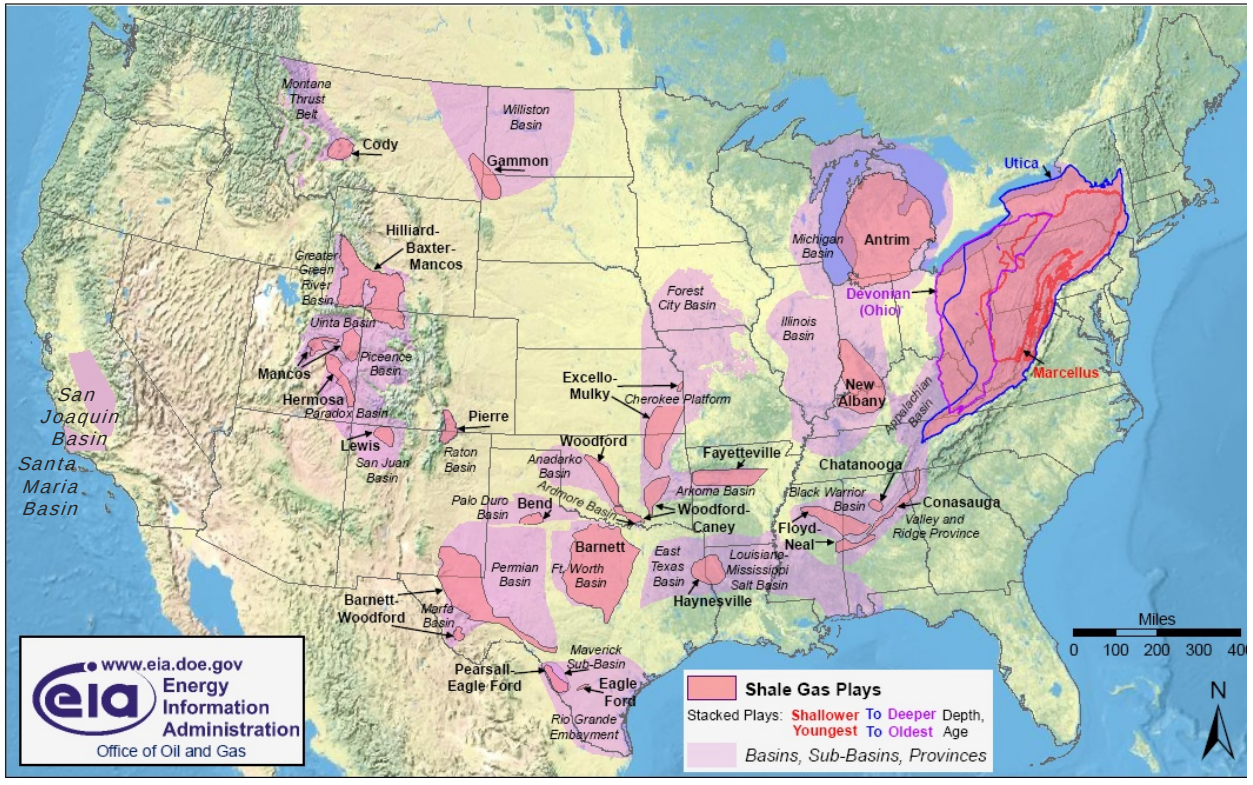
- EIA forecasts U.S diesel transport fuel use to be 20.1 Bcfd-equivalent in 2020 .
  - 15.4 Bcfd of gas could displace more than 75% of this amount.
- EIA forecasts U.S. coal demand for electric generation to be 10.5 Bcfd-equivalent more in 2020 than it is in 2009.
  - 15.4 Bcfd of gas could displace 100% of EG coal growth, and leave 4.9 Bcfd for vehicle fuel, enough to serve 10% of 2009 U.S. vehicle fuel needs. This would operate about 82,000 Honda Civic GXs annually (average 25 mpg-equivalent, 12,000 miles per year per vehicle).
  - 15.4 Bcfd also represents 21% of 2008 EIA's listed annual coal demand in 2008 of 73.7 Bcfde

[1] Source of EIA numbers is the recently released 2009 Annual Energy Outlook of the U.S. Energy Information Administration and include projections much higher than AEO 2008.

Major Shale Basins are Located Across the Entire U.S.

- There are at least 21 shale basins in over 20 states in the U.S.
- Producing areas include Antrim, Barnett, Devonian, Fayetteville, and Woodford.
- Emerging plays include Haynesville and Marcellus.
- In California, the Monterey and McClure basins (within the San Joaquin and Santa Maria basins) are potential gas shale plays.

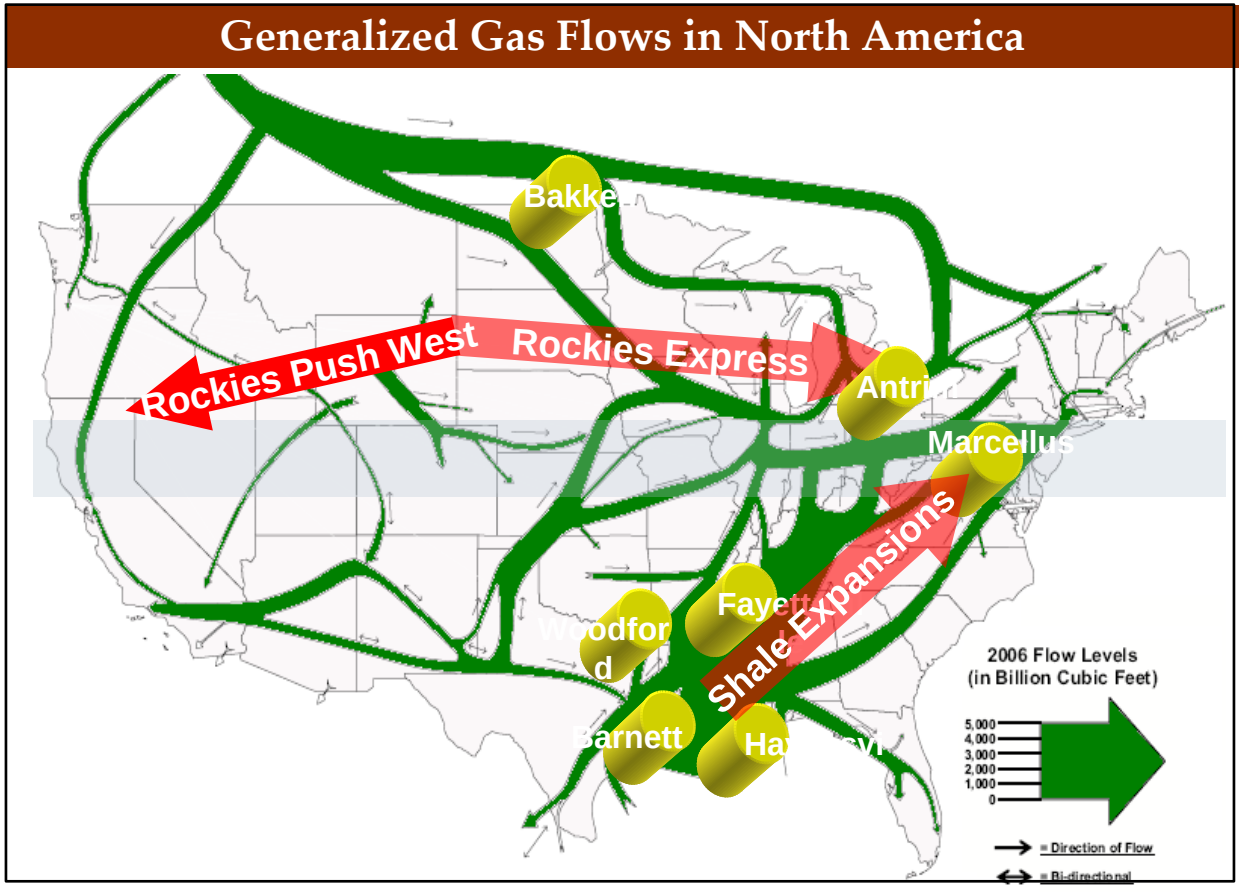
Major U.S. Shale Basins



Source: EIA, with California additions by NCI based on data from Schlumberger and Energy Velocity

Potential Implication of Gas Shale Plays for California

- While to date the U.S. Geological Survey does not show any gas shale reserves in California, the potential to turn around declining California gas production via shale basins exists.
- The major shale developments in other parts of the country will serve the same markets as the new Rockies Express pipeline. Rockies production is apt to get pushed west, into projects such as the new Ruby Pipeline proposed to Malin (CA/OR) border and the Kern River Pipeline to Topock at the SoCal border.



Source: AAPG/USGS

Supporting the Demand Side of the Market, It Appears Natural Gas is Well Positioned in the Future Low Carbon Environment

- History would show that an era of high prices usually has led to a decline in energy demand and in the converse, in a period of low prices gas demand has flourished.
- Another dynamic potentially affecting gas demand is 'climate change' and concerns over carbon and other GHG emissions.
- This we believe is expansive for gas demand in the intermediate term owing to its attributes as a 'clean' and 'plentiful' solution to this identified issue.
- Climate change policy, will see as having the affect of increasing gas demand possibly **despite** higher prices – this given gas's inherent fuel source advantages of being abundant, being clean and domestic.

We Also See The Abundant Natural Gas Supply Picture Supporting New Markets

- Natural gas supply appears well placed to serve an increasing share of the vehicle fuel market in this country.
- In the state with the largest number of vehicles in the country, other legislation already in place in California (AB 118) looks to continue to support increased use of natural gas and other alternative fuels to meet at least a portion of this market.
- According to the California Energy Commission own reports, natural gas usage in place of diesel in the heavy-duty truck sector could cut GHG emissions by 10%-20%.
- We believe the use of natural gas to replace coal in the power generation market an even more likely incremental market for natural gas as a result of the affects of State AB 32 the Global Warming Solutions Act of 2006 and Federal measures such as the Waxman-Markey proposed legislation aimed at addressing climate change and reducing GHG emissions across the country.

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The full North American Natural Gas Supply Assessment is available for download at the Navigant website at http://www.navigantconsulting.com/industries/energy/fuels/