The Contribution of Shale Gas to Future U.S. Production: A View of the Resource Base*

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Abstract

Projections published in 2008 by the United States government indicated that annual U.S. gas demand could increase from the current 22 Tcf (trillion cubic feet) to 24 Tcf by the year 2016 and then decline to 23 Tcf by 2030. This would occur during a period of declining Canadian gas imports and increasing U.S. reliance on LNG imports, a commodity only available in a highly competitive market. To put these numbers into perspective, a 1 Tcf/year increase is a challenge: domestic gas production was flat for nine years prior to 2006. Gas production then increased 9% from 1Q 2007 to 1Q 2008, with Texas (i.e., the Barnett Shale) providing most of this growth.

Shale gas production, which dates from 1821 in the United States, is now rapidly increasing, accounting for approximately 7% of annual production. The U. S. Energy Information Administration estimates that shale gas production will overtake coalbed methane production by 2025, and will grow from the current 1+ Tcf to 2.3 Tcf annually by 2030. Some industry analysts, apparently using Delphi-type studies, dispute these numbers and claim that shale gas alone will account for 50% of our production within the next 10 years. The developing Haynesville and Marcellus plays are key to their predictions.

Shale gas is also an increasingly large component of future, technically recoverable resources. Both of these trends are due to improvements in exploration, completion, and production technologies, aided by wellhead price increases.

The robustness of the North American gas resource base, particularly shale gas, coalbed methane, and tight sands gas, needs to be quantified.

The latest Potential Gas Committee (PGC) biennial assessment, (September, 2007), showed an overall increase of 18% (200 Tcf) for total U.S. gas resources. The bulk of this increase was for shale gas resources assessed in the Appalachian, Anadarko, Arkoma, Ft. Worth, and Permian basins. This presentation analyzes shale gas future potential in light of past production, current proved reserves, geological, and economic realities of current and emerging Lower-48 U.S. plays and the Spring 2009 PGC natural gas resource assessment.
References


www.agia.org/NR/rdonlyres/6CC4915E.../0709PGCSLIDES.PPT


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Gas Production Replacement, L48 US

Production contribution from all well completions made prior to 1981.

Early-year production declines have accelerated since the late 1980s.

WCSB Marketable Gas Production
Grouped by Connection Year

NEB - Short Term Natural Gas Deliverability - Dec 2002
Major U.S. Basins and Shale Plays c. 2007
(Where are the Haynesville and Marcellus???)
Shale Gas Annual Production and Energy Information Administration (EIA) Forecast

The graph shows the annual production of shale gas from 1979 to 2017. The data indicates a significant increase in production over the years, with the EIA projection line showing a steady rise. The diagram is used to illustrate the growth in shale gas production and the anticipated trend according to the EIA forecast.
U.S. Shale Gas Annual Production from Five Classic Plays to 2007

Modified and updated from Hill and Nelson, 2000
Hydrocarbons From Shale – Never Say Die

Growth in Barnett Shale - Ft. Worth Basin

Presenter's Notes: Low-magnification view exhibits darker, more carbonaceous mudstone texture. Thinly laminated siliceous/argillaceous matrix hosts a mix of organic material, microcrystalline clay, silica, angular to subrounded silt, micromicas, phosphatic debris, and microfossil fragments. White, patchy chert is primarily recrystallized biotic components, especially forams and radiolarians (arrows). Magenta epoxy highlights an induced, layer-parallel microfracture. (Plane-polarized light. Scale bar = 0.5 mm)
Targeted Research – $150 Million
Acquisitions – >$8 Billion

Source: TrollArt.com – Ray Troll
Resource Development – >$15 Billion
It's not all black shale

Woodford Shale Consortium
Geochemical Properties of Gas Shales

Modified from Hill and Nelson, 2000
Exploration Considerations

- Natural fractures - Friend or Foe?
- Facies changes - greater k
- Kerogen type
- Biogenic or thermogenic gas?
- Thermal maturity
- MWD - especially w/ gas isotopes
Evolution of Antrim Shale Gas

Modified from original work by Ira Pasternack
Hydrogeology of New Albany Shale

Modified from Walter and others, 2000
Average Drill Depth to Selected U.S. Shale-Gas Plays

- Emerging: Classic, Emerging, Exploration
- Plays:
  - Antrim, New Albany
  - Fayetteville, Caney
  - Utica, Floyd, Conasauga, Gas
  - Barnett, Wolfcamp, Cane Creek
  - Manos, Hilliard

Drilling Depth: Feet
Some Elements of a Successful Shale Gas Play

- Organic Richness
- Maturation
- Gas-In-Place
- Mineralogy
- Permeability
- Brittleness
- Pore Pressure
- Productivity
- Thickness
Possible Constraints on Future Gas Supply

- Sufficient Supply to Meet Demand
- Resource Base
- Technology
- Pipeline Capacity
- Environmental Concerns
- Skilled Workforce
- Gas Price
- Regulatory & Land Issues
- Rig Availability
U. S. Shale-Gas Resource Base
(Prior to 2007)

241 Tcf Producible

Produced ~ 8.7 Tcf

Proved Reserves 10+ Tcf

Economic Recoverable 48-82 Tcf

Undiscovered 131.3 Tcf

Gas-In-Place > 500 Tcf

Modified and Updated from Hill and Nelson, 2000
Regional Resource Comparison (PGC 2007)

Data source: Potential Gas Committee (2007)
Shale Gas Assessments (PGC 2009)

- **Appalachian** (Ohio, Rhinestreet, Utica Chattanooga, Dunkirk, Conasauga, Marcellus)
- **Michigan** (Antrim, Bedford, Sunbury)
- **Illinois** (New Albany)
- **LA, MS, AL Salt** (Haynesville, Bossier)
- **East Texas** (Haynesville, Bossier)
- **Texas Gulf Coast** (Eagle Ford, Pearsall)
- **Arkoma** (Fayetteville, Caney, Woodford, Moorefield)
- **Ft. Worth** (Barnett)
- **Permian** (Barnett, Woodford)
- **Uinta** (Mancos, Manning Canyon)
- **San Juan** (Lewis, Mancos)
Increasing development costs,
technology needs, and uncertainty.
Potential Supply of Natural Gas in the United States
Report of the Potential Gas Committee (as of December 31, 2008)

Press Release
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