North American Natural Gas Supply Assessment

Prepared for:
American Clean Skies Foundation

July 4, 2008

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July 4, 2008

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Introduction

NCI Conclusions

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Updating the State of North American Natural Gas Supply

- NCI was engaged to develop an accurate current assessment of North American natural gas production and recoverable reserves, with particular emphasis on the rapid, ongoing development of unconventional gas resources.
- Of the unconventional resources to be emphasized in NCI's review, shale gas is particularly important.
- Among other things, NCI was to test the premise that most public sources of gas-supply information, in particular the U.S. Energy Information Administration (EIA) have understated the contribution and potential of unconventional resources because their emergence has been too rapid for the underlying models to capture it accurately.
- This required obtaining or developing production and reserve data by basin and by type of gas on as current a basis as possible, reflecting actual conditions in the current year through the first quarter.
- Because such current data was often not directly obtainable in any organized format, NCI used a variety of approaches, including research through producer analyst presentations, reports in the trade press, and extensive direct outreach to producers and certain production-state officials.

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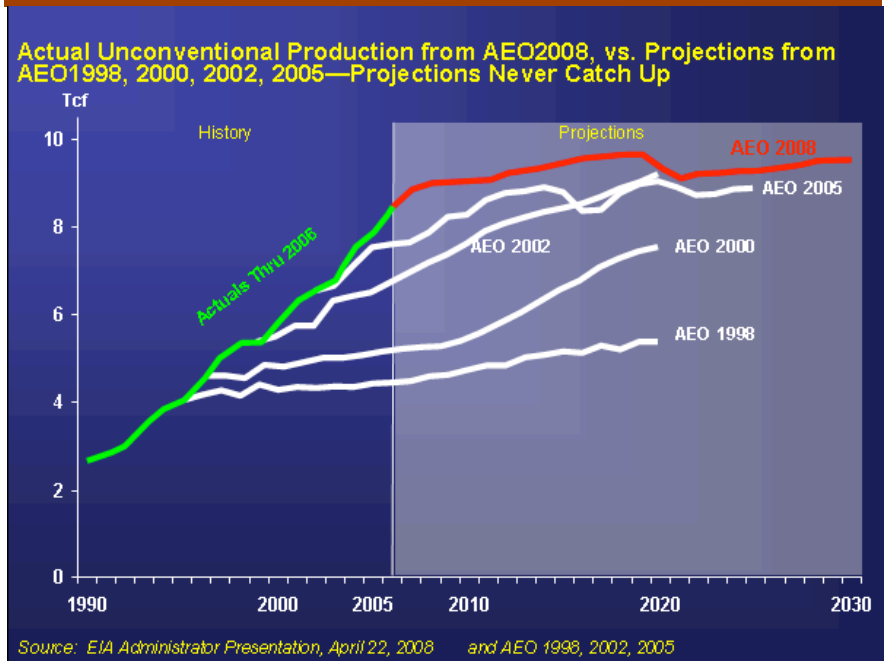
EIA Understatement of Resource Base and Development Appears Chronic

- EIA forecasts of unconventional gas production in each Annual Energy Outlook (AEO) from 1998 forward have been significantly outstripped by actual behavior.

EIA AEO Unconventional Forecasts



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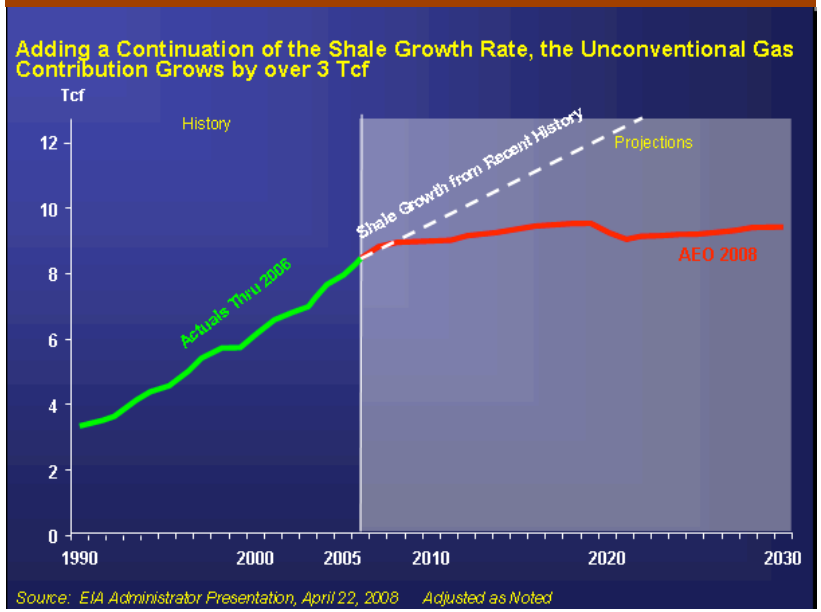
Much of EIA's Underestimate in Recent Years is in Shale Gas

- 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 EIA's most recent forecast.
- The questions to answer are :
  1) Is the rate of growth continuing; and
  2) Can the resource base support it?

EIA AEO2008 Shale Underestimate



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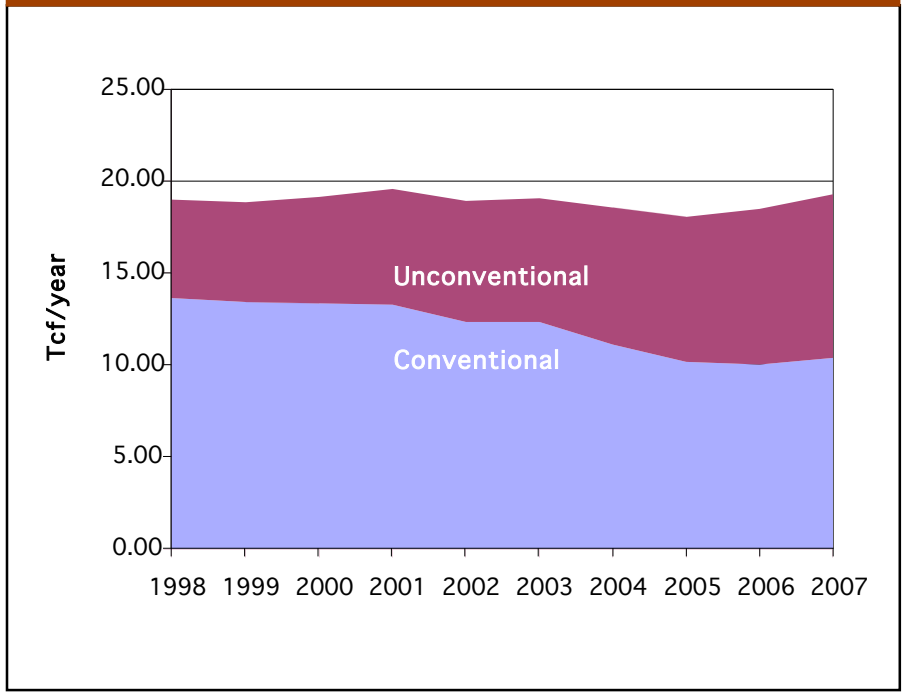
- Over the last decade, production from unconventional sources has increased almost 65%, from 5.4 Tcf/year (14.8 Bcf/day) in 1998 to 8.9 Tcf/year (24.4 Bcf/day) in 2007.
- Unconventional production has increased from 28% of total production in 1998 to 46% in 2007.

U.S. Dry Natural Gas Production (Tcf/year)



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

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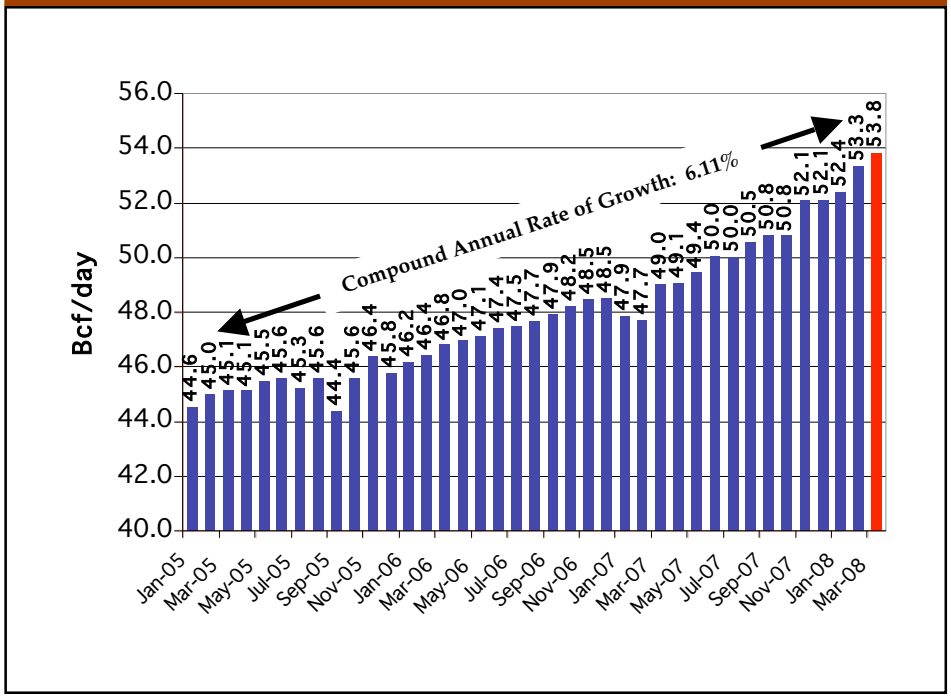
Significant Growth in Onshore Production, Driven by Unconventional

- 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%.
- Conversely, EIA's 2008 Annual Energy Outlook estimates 2006 – 2007 growth of less than half that, 2.39 %.
- First quarter 2008 growth is 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.

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



Source: EIA – Production Survey 914

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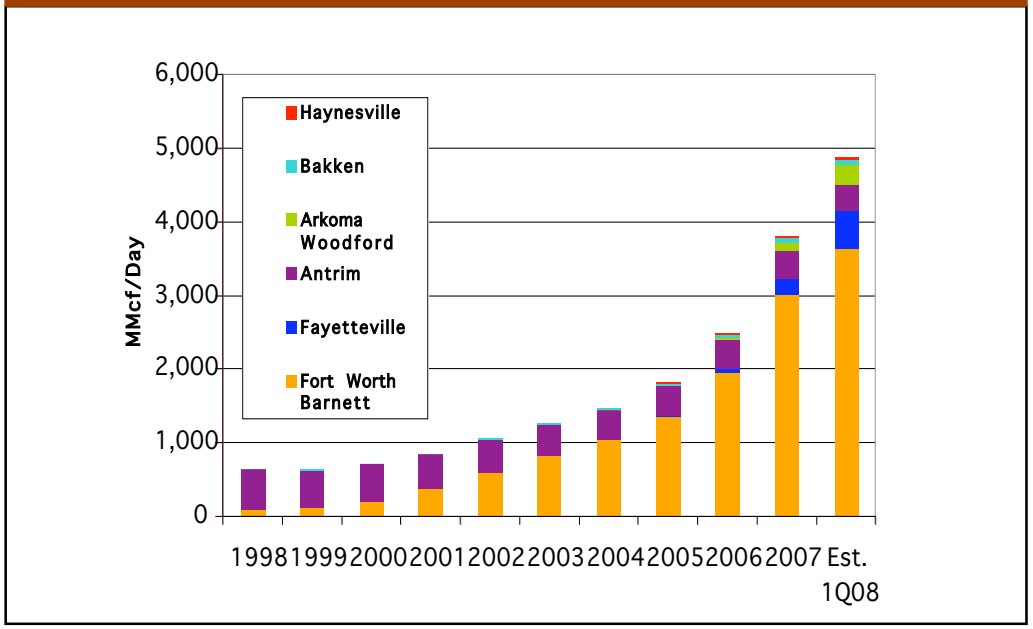
Gas Shales have Experienced Tremendous Growth in Recent Years with Barnett Leading the way and Signs of Early Followers

- Barnett has grown from 94 MMcf/day production levels in 1998 to 3,014 MMcf/day in 2007; an increase of more than 3000%.
- Based on NCI estimates, Fayetteville, Haynesville and Woodford are all showing similar signs of ramping production. Marcellus will be next.
- Technology has allowed access to and economic production of a vastly greater resource base. Specifically, improved hydraulic fracturing techniques and greatly improved horizontal drilling have allowed tight, geographically diffuse reserves to be developed in large volumes. Today's natural gas prices have enabled this use of enhanced technology to develop this resource.

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.

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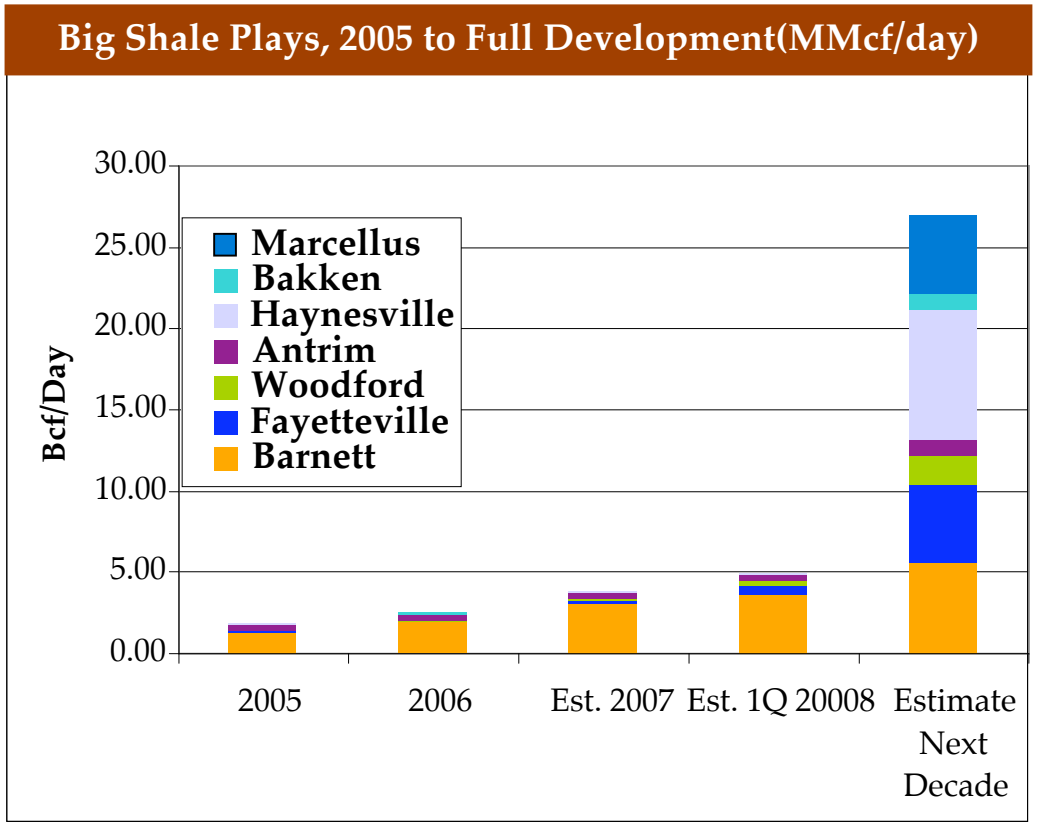
Producer Estimates Show Continuation of Accelerating Growth

- Just for the six shale plays depicted, plus Marcellus, conservative estimate of ultimate sustainable production is at least 27 Bcf per day.
- That is approximately one half of current total-U.S. Lower 48 production.
- With no adjustment, the deliverability from these seven plays would exceed 30 Bcf/day, some estimates being as high as 39 Bcf/day.
- Timing of development over the next decade will depend on rate of market growth.



Sources: Producer interviews, analyst estimates, NCI calculations.

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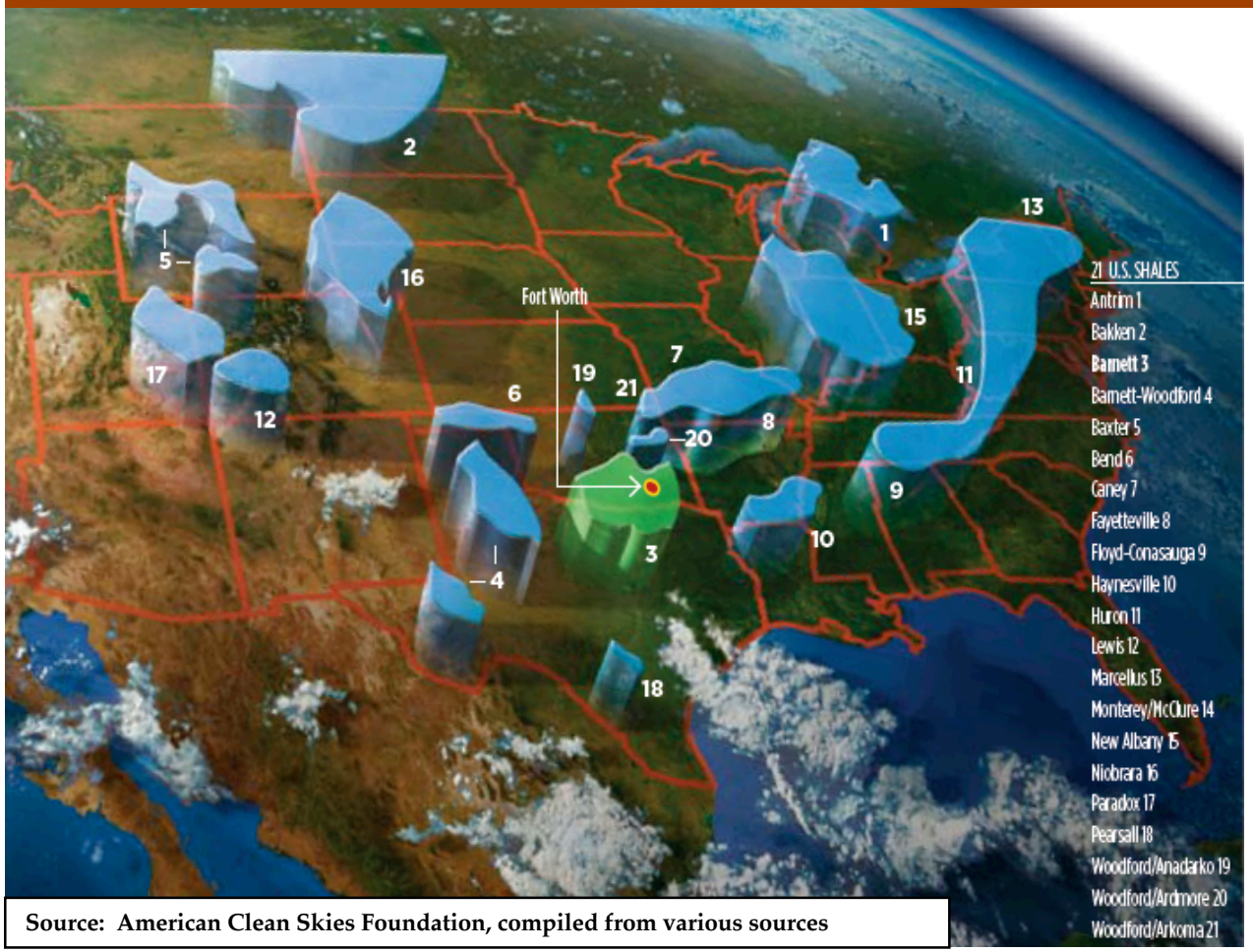
Major Shale Basins are Located Across the Entire U.S.

- There are at least 21 shale basins located in over 20 states in the U.S.
- Producing areas include Antrim, Barnett, Devonian, Fayetteville, and Woodford.
- Emerging plays include Haynesville and Marcellus.
- The following slides highlight these major plays:
  - Barnett
  - Fayetteville
  - Haynesville
  - Marcellus
  - Woodford

Major U.S. Shale Basins



Source: American Clean Skies Foundation, compiled from various sources

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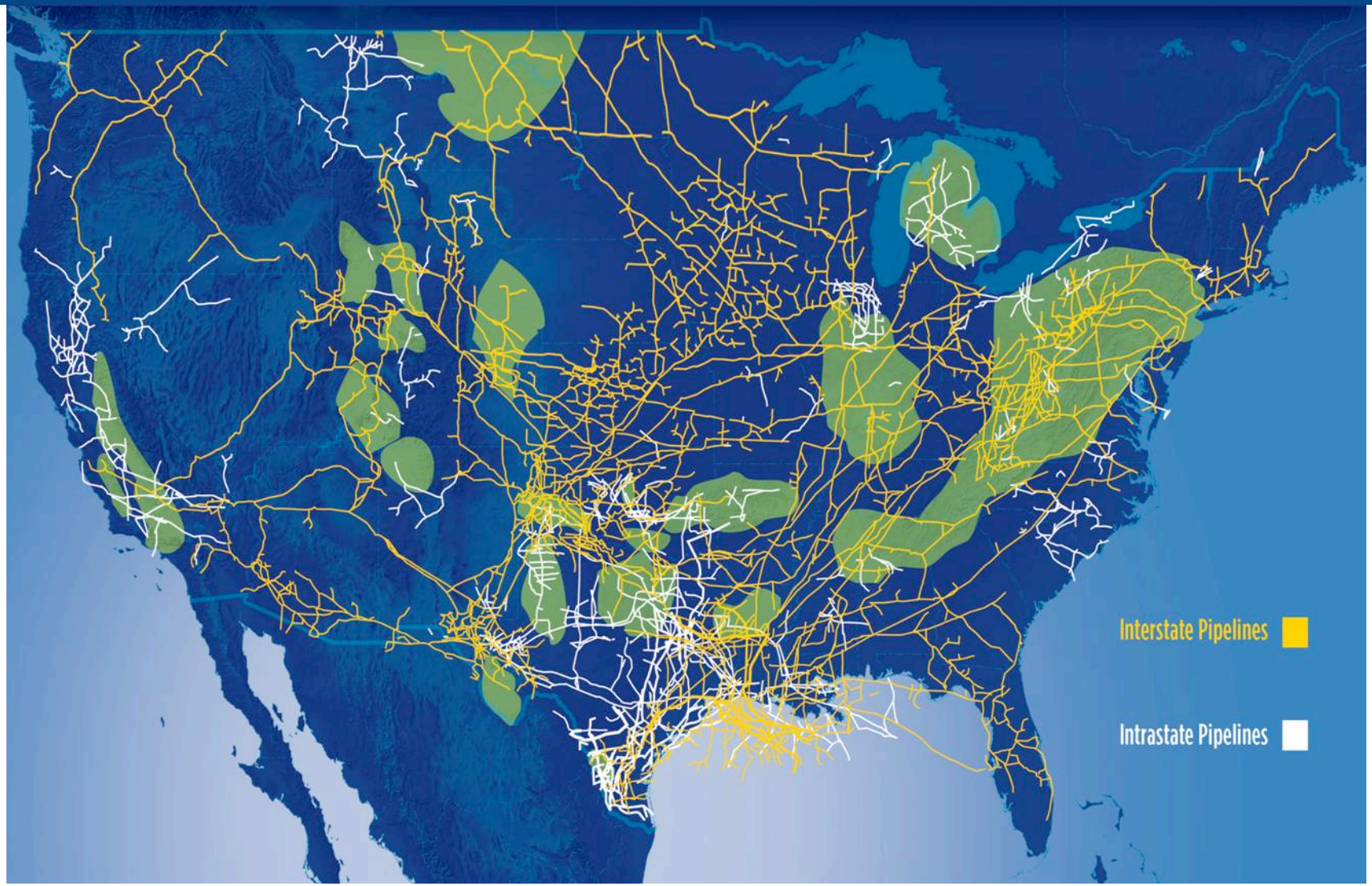
U.S. Natural Gas Shale Basins Align with Pipeline Grid



Sources: EIA, US Natural Gas Pipeline Nework

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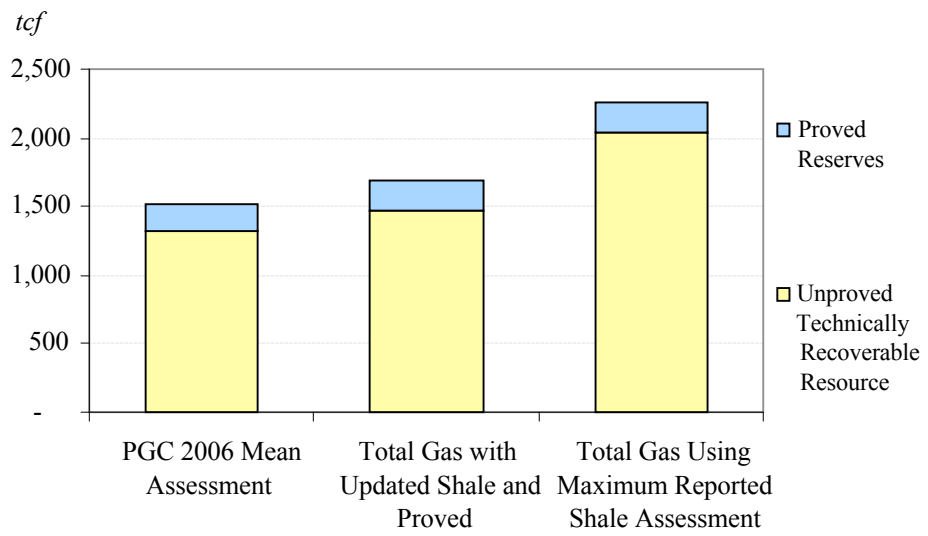
Proved Reserves Plus Assessed Resources—Life of the Gas Resource

- The 2006 PGC Report's total P3 Resource estimate was reported at 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 estimate for Shale Gas is 274 Tcf, approximately 143 Tcf higher than the Shale Gas reserves subsumed 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.

U.S. Total Gas Supply (Tcf)



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NCI Conclusions

- Unconventional gas, especially shale, has ramped up sharply over the last several years, both in terms of annual production and in terms of economically recoverable reserves. The extent of this ramp-up has not been fully captured by many reserve estimators, in particular the EIA.
- Based upon producer outreach responses, just the "big seven" shale plays are expected to reach a range of 27 to 39 Bcf/day over the next 10 to 15 years, timing that coincides with opportunities for phased expansion of natural gas use.
- Higher prices have significantly expanded the economically recoverable volumes, and are continuing to do so.
- Some producers and analysts have very high estimates of the ultimate recoverable gas, well in excess of U.S. Geological Survey (USGS) or Potential Gas Committee (PGC).
- The rapid escalation of unconventional production observed historically is continuing, and the unconventional resource base appears adequate to support that escalation to allow significantly increased volumes of unconventional production to continue for decades.
- A conservative estimate of the total domestic proved reserves and ultimately recoverable domestic resource base, adjusting from the most recent PGC study, reaches 1,680 Tcf, in excess of 88 years of U.S. production at current levels.
- Estimates by producers active in developing the shale resource are much larger, reaching levels that would imply a further increase to more than 2,247 Tcf, or 118 years at current production levels— <u>This important resource is not constrained</u>.

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2 Resource Base

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Shale Gas Resource Assessments are Stale, Inconsistent and Incomplete

- Potential Gas Committee (PGC (2006))
  - Limited description of the geology around the shales (Thickness, Extent, TOC, Thermal Maturity, Composition) but little regarding technically recoverable gas.
  - Recognition of recent activity. Expect more complete assessment in 2008 release.
- U.S. Geological Survey (USGS)
  - Good description in various studies of the geology.
  - Updates ongoing. Many of the plays with recent activity have not been updated since 1995
    - Arkoma Basin Shales (Fayetteville, Woodford, Caney) not assessed.
    - Gulf Coast Shale (Haynesville) not assessed.
    - Appalachian Shales (Marcellus, Utica, Huron, etc.) not *recently* assessed, so estimates are low.
    - Antrim Shale assessment is smaller than PGC. PGC report identifies the additional gas as being southwest of current production.
  - What might happen? Barnett Shale assessment increased from under 6 Tcf in 2000 to almost 30 Tcf when re-assessed in 2003. Similar revisions are likely in frontier areas of exploration.
- American Association of Petroleum Geologists (AAPG)
  - Various studies of regions with shale potential. Best descriptions of geology.
  - Very little data on gas in-place or technically recoverable gas.
- Egerton (2007)
  - Focus on Marcellus. Good study that prompted much of the recent activity.

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NCI Assessment Compiles Most Recent Available Data

- *NCI Technically Recoverable Gas* estimates are shown below.
- Data compiled for 22 shale plays in the U.S. Lower 48.
  - Sources for ***all*** assessed technically recoverable gas include PGC (2006), USGS (2007), Egerton (2007), AAPG studies (various years), Producer reports (2008), MMS (2006).
- Assessed technically recoverable *unconventional* gas accounts for over 60% of the onshore resource assessment, and almost half of all gas (onshore and offshore) in the Lower 48.
- Shale accounts for about 28% of the technically recoverable estimate.
  - Uncertainty of recent plays suggests this share is likely to grow.
- Reserve appreciation in existing fields is not included in the estimate below.

NCI Technically Recoverable Gas Assessment for the Lower 48

		p95	p5	Mean
Total Unconventional		***291.35***	***694.66***	***479.93***
Total Shale		*164.5*	*394.8*	*274.3*
Total Tight Gas		*72.7*	*161.2*	*117.4*
Total CBM		*54.1*	*138.7*	*88.3*
Total Conventional		***112.83***	***351.02***	***293.62***
Total Offshore L48		***246.42***	***339.66***	***287.82***
L48 Offshore Accessible		*198.13*	*225.52*	*210.54*
L48 Offshore No Access		*48.29*	*114.14*	*77.28*
Total				***984.09***

Note: Total does not include "L48 Offshore No Access"

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NCI also Collected Producer Assessments

- According to producer reports, estimates of *technically recoverable gas* are substantially higher than those available from public sources.

Shale Assessment Comparison

NCI	Maximum Reported
274.3	841.8

- Some of the differences are in plays that have been very recently assessed.
- Biggest differences in the Marcellus and Haynesville Shales (see next slide).
  — Producer reports indicate a difference of more than 600% in these two plays, totaling 228 Tcf in Marcellus and 217 Tcf in Haynesville. This makes up almost all of the difference between the NCI Assessment and the Maximum reported.
- The maximum reported gas in-place estimate is over 4,000 Tcf (see next slide). This indicates tremendous potential upside for improvement in recovery technologies.

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NCI Collected Producer Assessments by Play

		Technically recoverable gas		Gas In-Place
Shale Play	**Basin**	***NCI Mean***	***Maximum Reported***	***Maximum Reported***
Antrim	Michigan Basin	13.2	20.0	76.0
Devonian, which includes:	Appalachian Basin	69.6	311.8	1744.1
Marcellus	Appalachian Basin	34.2	262.0	1500.0
New Albany	Illinois Basin	3.8	19.2	160.0
Floyd/Chatanooga	Black Warrior Basin	2.1	4.5	22.5
Haynesville	Gulf Coast Onshore	34.0	251.0	717.0
Fayetteville	Arkoma Basin	26.0	41.6	52.0
Woodford Arkoma	Arkoma Basin	8.0	11.4	23.0
Caney and Woodford	Arkoma Basin	No Data		
Woodford Ardmore	Ardmore Basin	4.2	6.0	78.0
Barnett	Fort Worth Basin	26.2	44.0	168.0
Barnett and Woodford	Permian Basin	35.4	53.0	264.9
Palo Duro	Palo Duro Basin	4.7	8.3	41.7
Lewis	San Juan Basin	10.2	12.3	61.4
Cane Creek	Paradox Basin	No Data		
Excello/Mulky	Cherokee Platform	No Data		
Bakken	Williston Basin	1.8	3.0	15.1
Gammon	Williston Basin	No Data		
Niobrara (incl. Wattenburg)	Denver Basin	1.3	2.7	13.4
Hilliard/Baxter/Mancos	SW Wyoming	11.8	22.7	113.5
Lewis	SW Wyoming	13.5	19.7	98.3
Mowry	SW Wyoming	8.5	10.6	53.1
Monterrey/McClure	San Joaquin Basin	No Data		
Total Shale Gas Assessment		**274.3**	**841.8**	**3764.7**

Note: Total does not include "L48 Offshore No Access"

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The PGC Gas Assessment Augmented with NCI Shale Assessments

- PGC identifies shale and tight gas as "Traditional Gas", but does identify shale potential in a few plays.
- The compiled data from all sources indicate there may be up to 842 Tcf of technically recoverable shale gas, and about 3,765 Tcf of shale gas resource in-place.
  - Thus, technology can push us toward the latter (and much higher) number.
  - The AAPG identifies recovery rates for shale at between 10% and 20% typically.
  - Producer reports tend to be the most bullish regarding gas assessments—and these same producers are committing substantial capital based on these assessments.

PGC (2006) Assessment				
	Mean	Years at current production	Most Likely	Years at current production
Total CBM	166.1		157.9	
Total "Traditional" Gas	965.6		817.1	
of which the Shale Assessment is…	131.0		131.0	
Alaska	193.8		143.1	
Total	1325.6		1118.0	
+ Proved Reserves	204.0		204.0	
Total Gas Resource	1529.6	*82.6*	1322.0	*71.4*

PGC (2006) w/ NCI Shale Assessment replacing PGC Shale				
Shale Assessment	274.3		274.3	
Total	1468.9		1261.3	
+ Proved Reserves	211.1		211.1	
Total Gas Resource	1680.0	*88.4*	1472.4	*77.5*

PGC (2006) w/ NCI augmented by Producer Report Shale Assessment replacing PGC Shale				
Shale Assessment	841.8		841.8	
Total	2036.4		1828.8	
+ Proved Reserves	211.1		211.1	
Total Gas Resource	2247.5	*118.3*	2039.9	*107.4*

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3 Natural Gas in North America

Production

U.S. Unconventional Sources

U.S. Gas Shales

Canadian Unconventional Sources

Canadian Gas Shales

U.S. Imports from Canada

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Production has Increased Over the Last Few Years, Largely due to a Decade of Increased Unconventional Production

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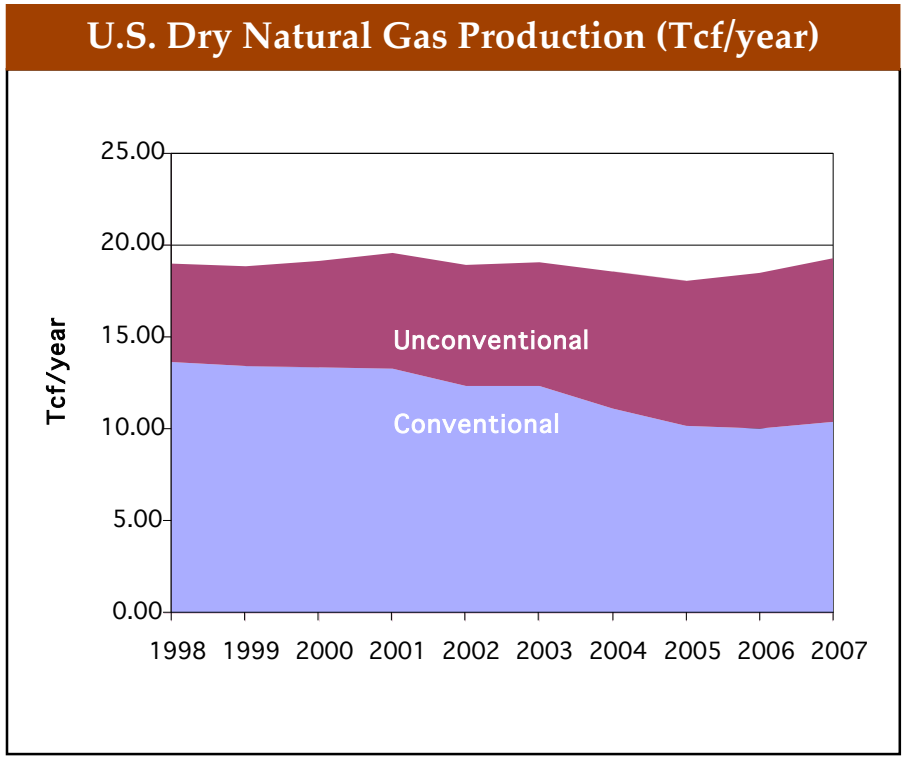

Source: EIA – Natural Gas Production Reports,
EIA AEO2008 unconventional production, NCI calculations.
See Appendix for supporting table.

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Significant Growth in Onshore Production, Driven by Unconventional

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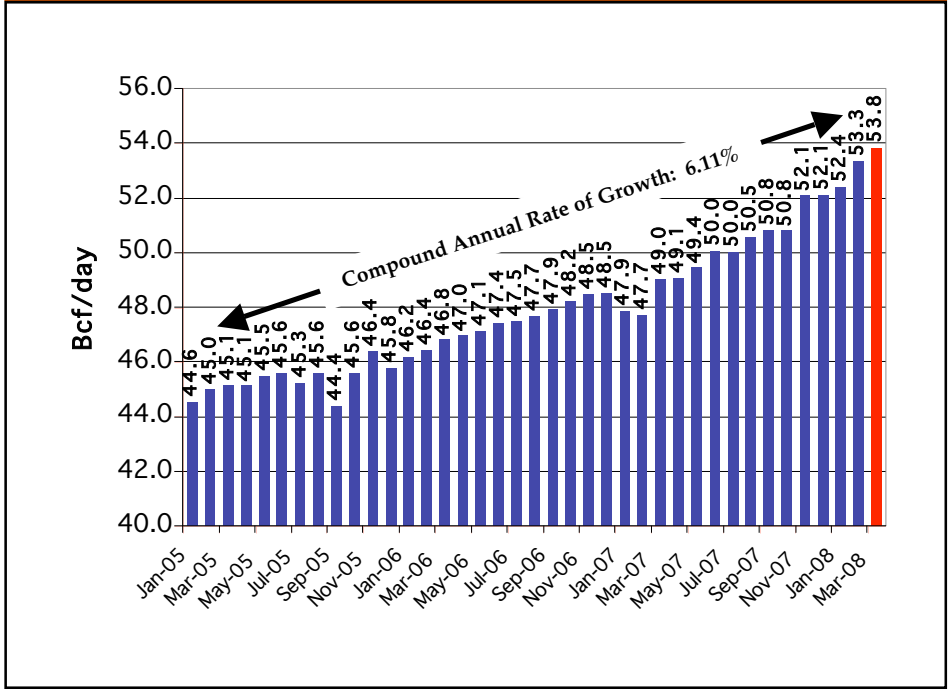
U.S. Onshore Natural Gas Production (Bcf/day)



Source: EIA – Production Survey 914

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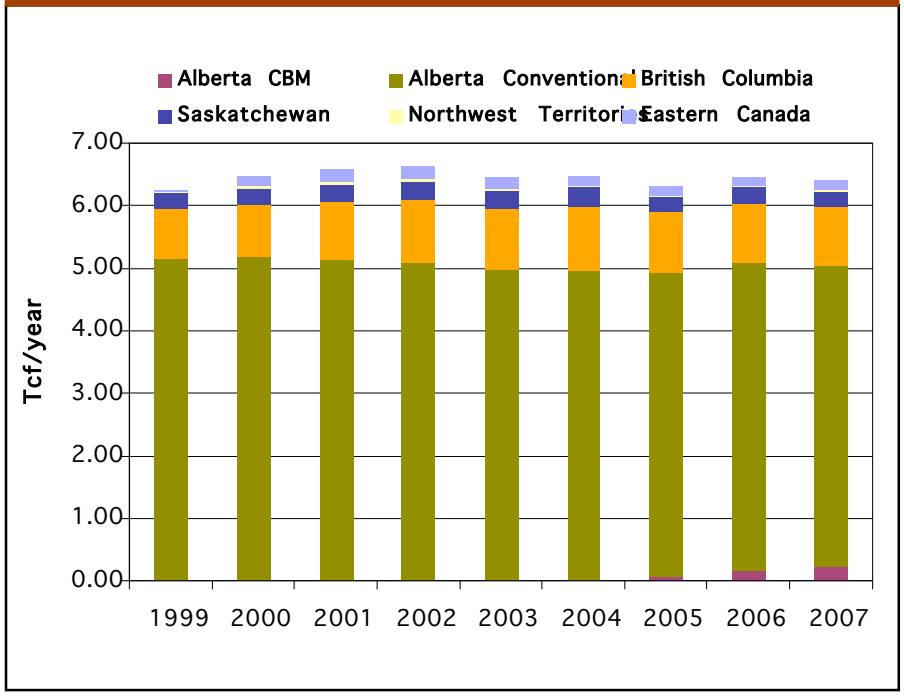
Overall Canadian Natural Gas Production Relatively Flat over Last Decade; Production is Predominantly from Alberta

- Overall production in Canada was at 6.3 Tcf/year (17.3 bcf/day) in 2007, only slightly below the 10-year average of 6.4 Tcf/year (17.5 Bcf/day).
- Alberta is the largest producing province in Canada – marketable production of 4.8 Tcf/year (13.2 Bcf/day) accounts for 78% of Canada's total production of 6.3 Tcf/year (17.3 Bcf/day).

Canada Natural Gas Production (Tcf/year)



Source: NEB (Canada), Alberta ERCB, and Lippman Consulting, Inc. (LCI)
See Appendix for supporting table.

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3 Natural Gas in North America

Production

U.S. Unconventional Sources

U.S. Gas Shales

Canadian Unconventional Sources

Canadian Gas Shales

U.S. Imports from Canada

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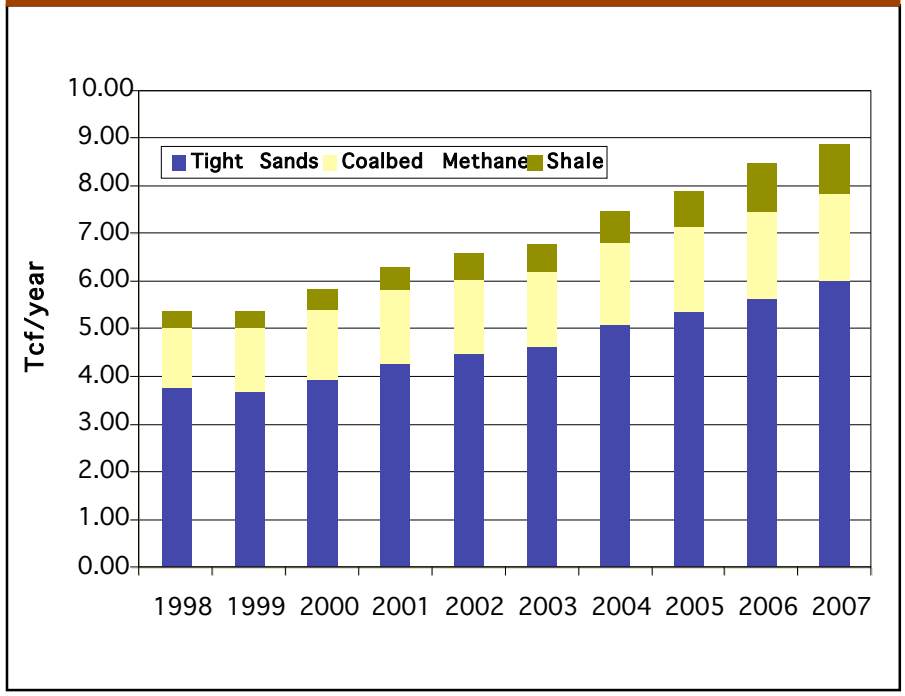
All Three Unconventional Gas Sources have Seen Growth in the Last Decade, with Gas Shale Dominating in Terms of % Increase

- Tight sands, coalbed methane, and shale have all seen growth in production over the last decade. While shale is still the smallest share of overall unconventional production (12% in 2007), it is undergoing the largest growth in % increase.
- Gas shales have experienced explosive growth in the last 10 years increasing from only 0.3 Tcf/year (0.8 Bcf/day) of production in 1998 to 1.05 Tcf/year (2.9 Bcf/day) in 2007, a remarkable 250% increase. This increase has resulted from a combination of technology improvements (in hydraulic fracturing and horizontal drilling) and a price environment that enables the use of those technologies.
- Tight sands production has increased from a level of 3.8 Tcf/year (10.4 Bcf/day) in 1998 to 6.0 Tcf/year (16.4 Bcf/day) in 2007, a growth of 58% over this time period.
- Coalbed methane production has also seen an increase, growing 38% over the last decade, from 1.3 Tcf/year (3.6 Bcf/day) in 1998 to 1.8 Tcf/year (4.9 Bcf/day) in 2007.

U.S. Unconventional Gas Production (Tcf/year)



Source: EIA AEO 2008
See Appendix for supporting table.

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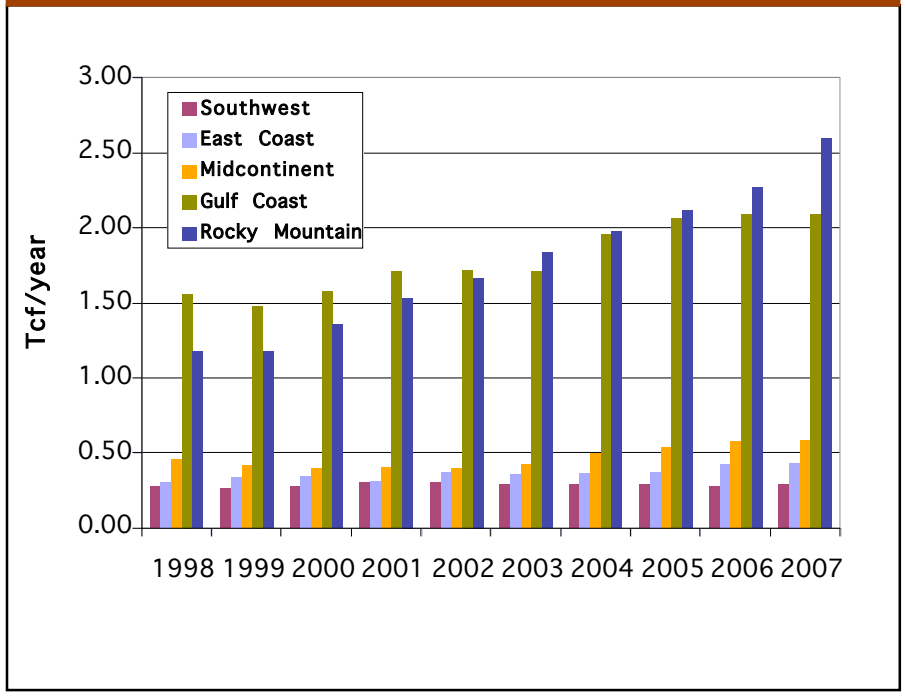
Rockies Tight Sands Production Shows Strong Growth Over Last Decade

- This and the following slide focus on regional production of tight sands and coalbed methane. Regional shale production is covered in the U.S. Gas Shales section.
- Tight sands production is greatest in the Rocky Mountain region at 2.6 Tcf/year (7.1 Bcf/day) at end of year 2007. This region has also experienced the largest 10 year percent increase of 121% over 1998 production levels of 1.2 Tcf/year(3.3 Bcf/day). The increase has been driven by improved completion techniques, hydraulic fracturing, horizontal drilling, and a price environment that accommodates their use.
- Historically the highest production region, the Gulf Coast, was surpassed by the Rockies around 2004. Current production levels of 2.1 Tcf/year (5.8 Bcf/day) have been steady since 2005.

U.S. Tight Sands Production by Region (Tcf/year)



Source: EIA AEO 2008. EIA regional definitions.
See Appendix for supporting table.

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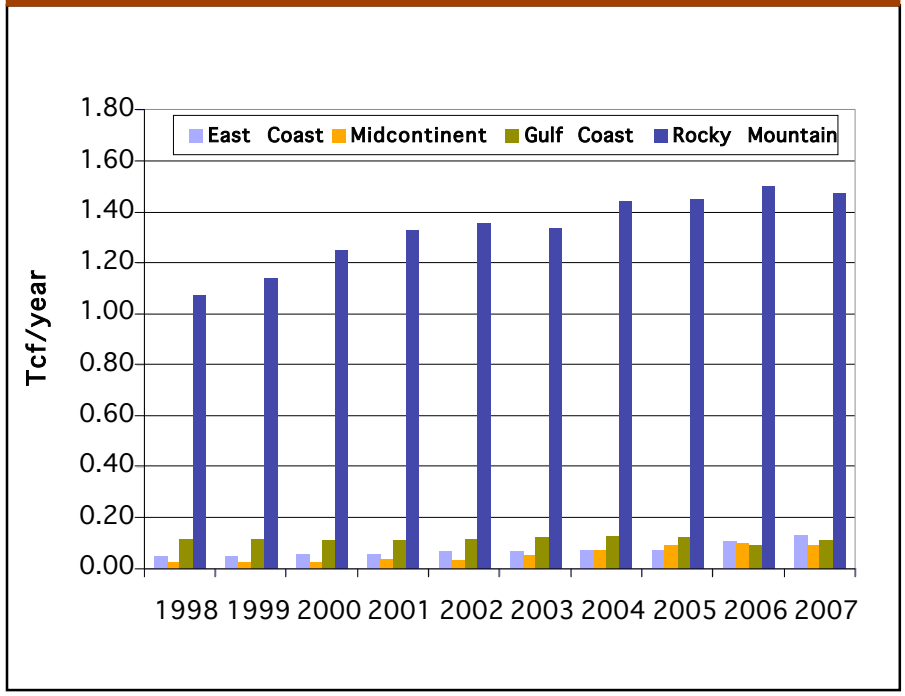
Rocky Mountain Region Dominates Coalbed Methane Production

- The overwhelming majority of coalbed methane production is from the Powder River and San Juan Basins in the Rocky Mountain region; 2007 production levels of 1.5 Tcf/year (4.1 Bcf/day) represent 81% of the 1.8 Tcf/year (4.9 Bcf/day) of total coalbed methane production.

U.S. Coalbed Methane Production by Region (Tcf/year)



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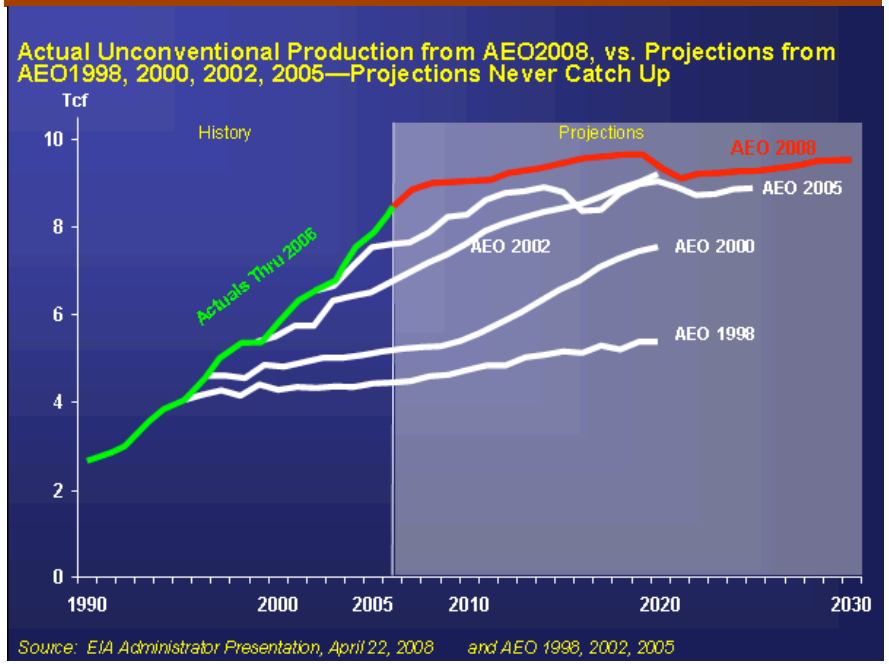
EIA Understatement of Resource Base and Development Appears Chronic

- EIA forecasts of unconventional gas production in each Annual Energy Outlook (AEO) from 1998 forward have been significantly outstripped by actual behavior.

EIA AEO Unconventional Forecasts



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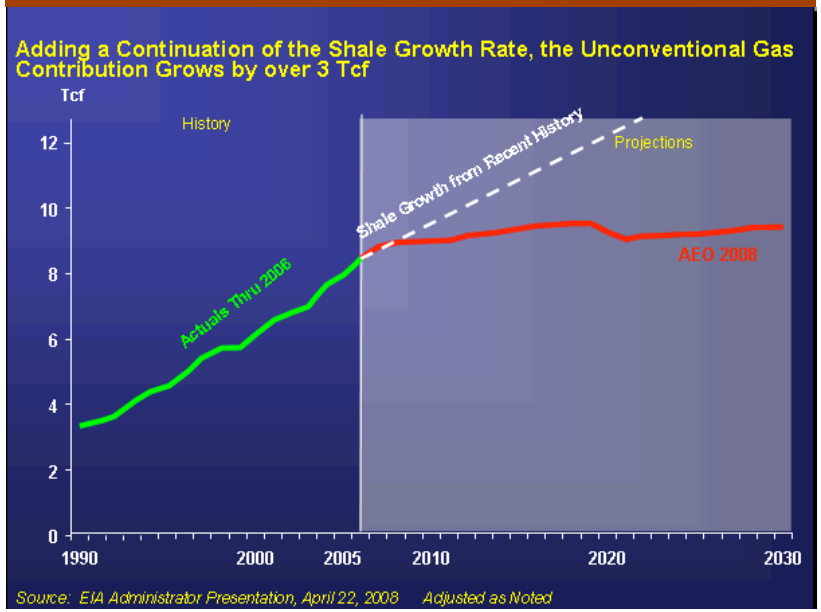
Much of EIA's Underestimate in Recent Years is in Shale Gas

- 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 EIA's most recent forecast.
- The questions to answer are :
  1) Is the rate of growth continuing, and
  2) Can the resource base support it?

EIA AEO2008 Shale Underestimate



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3 Natural Gas in North America

Production

U.S. Unconventional Sources

U.S. Gas Shales

Canadian Unconventional Sources

Canadian Gas Shales

U.S. Imports from Canada

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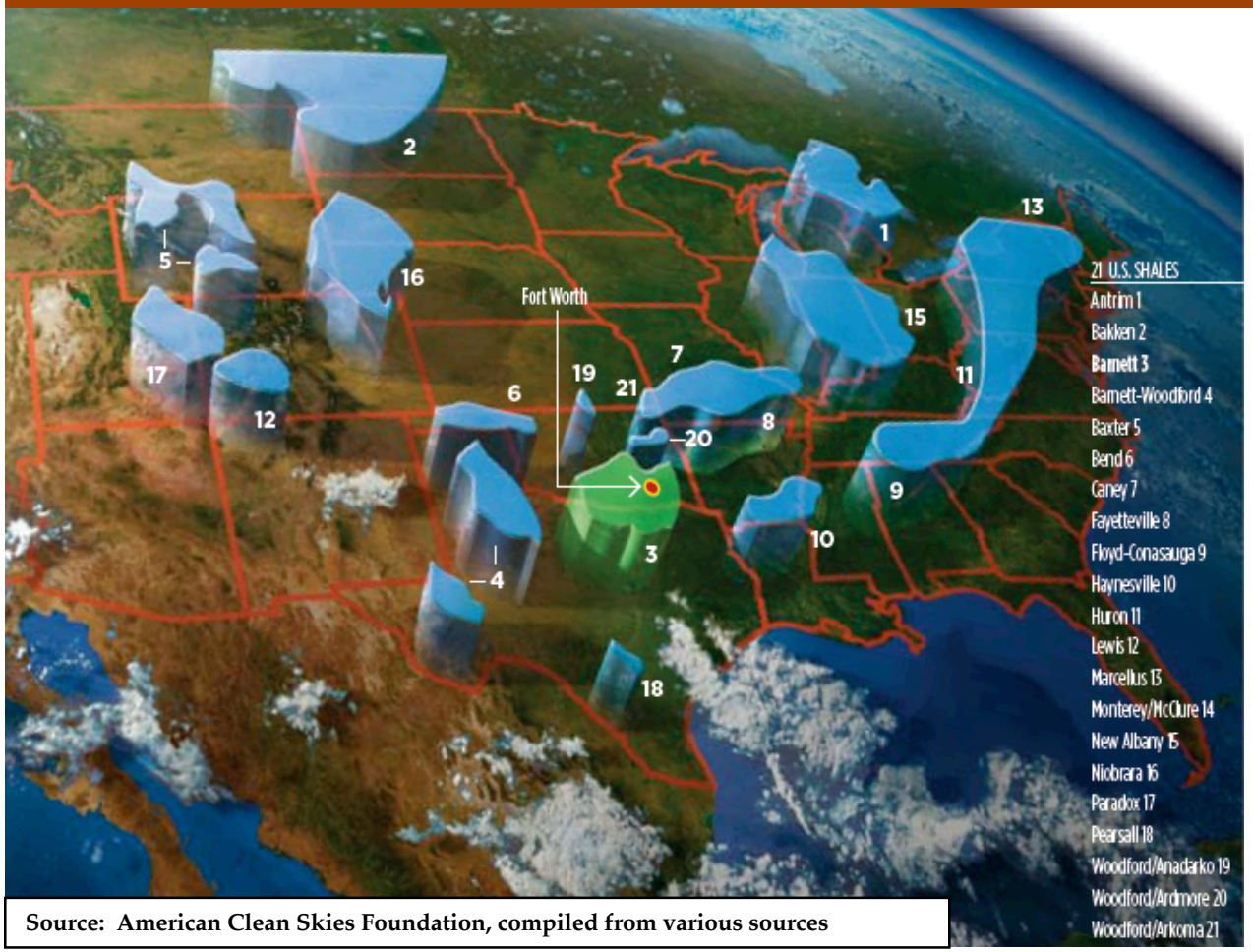
Major Shale Basins are Located Across the Entire U.S.

- There are at least 21 shale basins located in over 20 states in the U.S.
- Producing areas include Antrim, Barnett, Devonian, Fayetteville, and Woodford.
- Emerging plays include Haynesville and Marcellus.
- The following slides highlight these major plays:
  - Barnett
  - Fayetteville
  - Haynesville
  - Marcellus
  - Woodford

Major U.S. Shale Basins



Source: American Clean Skies Foundation, compiled from various sources

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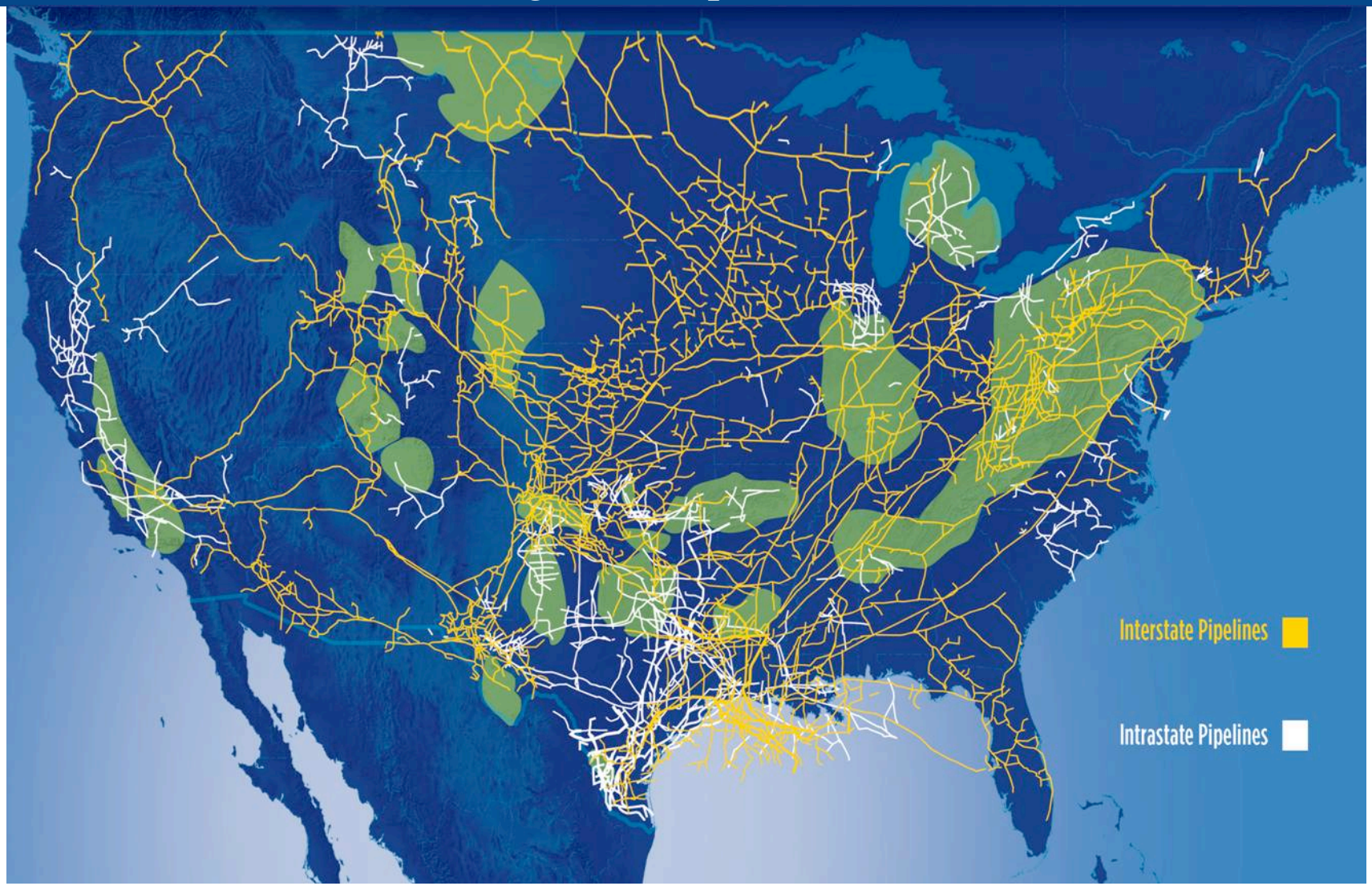
U.S. Natural Gas Shale Basins Align with Pipeline Grid



Sources: EIA, US Natural Gas Pipeline Nework

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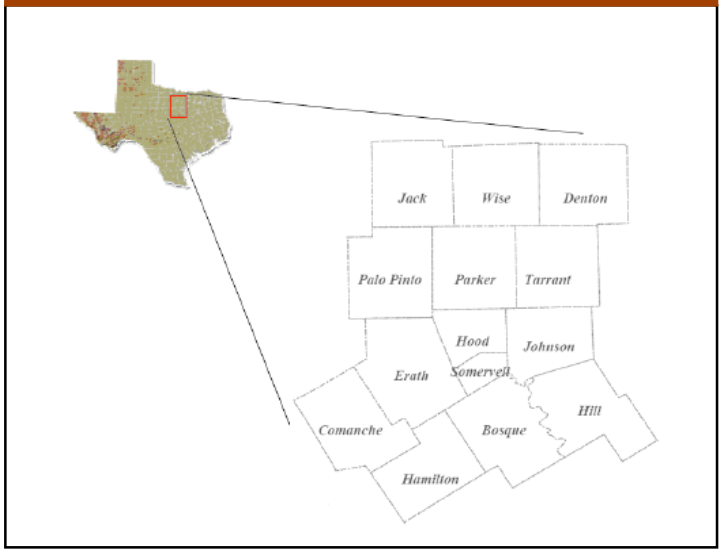
U.S. Gas Shales » Major Play Highlights » Barnett

- **Description of Play:**
  - Location – Fort Worth, Texas (north central TX).
  - Activity Level – most active shale play in U.S. by far.
- **Players:**
  - Devon, Chesapeake, XTO, EOG, Encana, Burlington Resources (now ConocoPhillips), Range Resources, Quicksilver, Carrizo, Denbury (Source: Texas RRC Top 10 Operators, 1st Quarter 2008).
- **Technically Recoverable Gas Estimate:**
  - NCI's estimate of mean technically recoverable gas is 26.2 Tcf with 'maximum reported' of 44 Tcf. Gas in place to 327 Tcf.
- **Current/Forecast Production:**
  - NCI's estimate of production for 1Q2008 is 3.6 Bcf/day and roughly 4.3% of total US total output (15% of Texas production in 2007). In a June 11 report, EIA indicated a contribution of 6% of Lower 48 production.
  - Some producer estimates for peak production to 7 Bcf/day (NCI Producer Survey).
- **Advantages/Disadvantages:**
  - Advantage – essentially known resource.
  - Disadvantage – somewhat more limited areal extent than some of the other shale plays.

Barnett Shale Counties



Source: Humble Geochemical, Pickering Energy Partners

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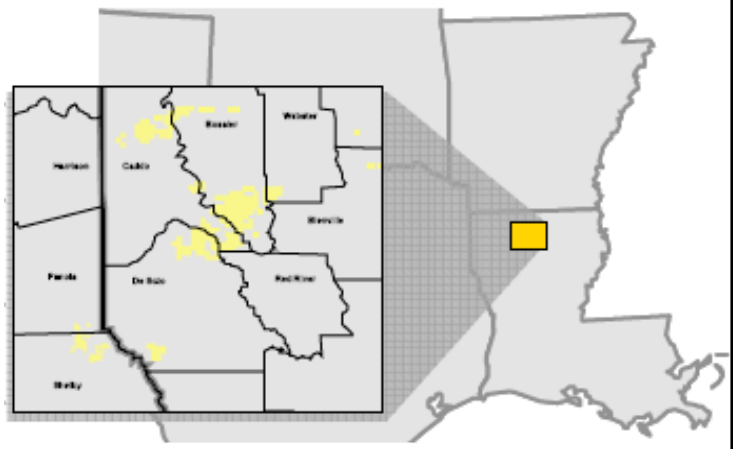
U.S. Gas Shales » Major Play Highlight » Haynesville

- **Description of Play:**
  - Very large area in Northern Louisiana, accessible to the diverse network of major interstate pipelines to the Northeast and Southeast.
  - "This is the real deal. We've touched base with every public and private player we know and truly believe this play is indeed the next big thing (CHK is allowed a great big 'I told you so' on its next conference call). Recent weeks have shown Haynesville mania in full force." (Source: Tudor Pickering Holt Energy Daily Investor Newsletter, June 11, 2008)
- **Players:**
  - Chesapeake, Encana, Shell, Petrohawk, Plains, Goodrich, EXCO, Devon, XTO.
- **Technically Recoverable Gas Estimate:**
  - NCI's estimate of mean technically recoverable gas is 34 Tcf, approximately 30% larger than Barnett's mean estimate of 26 Tcf. Producer max. reported 251 Tcf Max. gas in place to 717 Tcf.
- **Current/Forecast Production:**
  - NCI's estimate of production for 1Q2008 is 25 MMcf/day, with producer estimates that this will increase to 100 MMcf/day by year-end.
  - On June 27, Petrohawk reported a new well producing 16.8 MMcf/day
  - Some producer estimates are as high as a peak of 10 Bcf/day (NCI Producer Survey).
- **Advantages/Disadvantages:**
  - Advantage – good location for infrastructure.
  - Disadvantage – development is in early stages.

Haynesville Shale



Source: Petrohawk Presentation, RBC Capital Markets Energy Conference, June 2008

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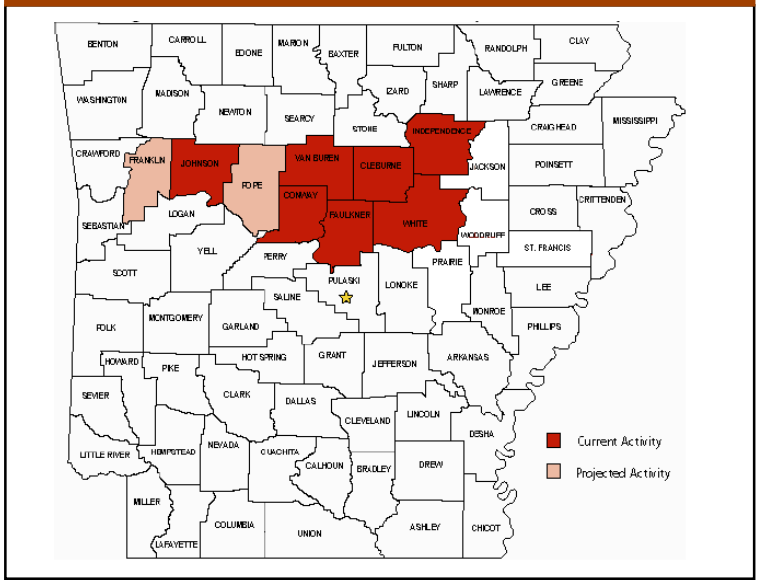
U.S. Gas Shales » Major Play Highlight » Fayetteville

- **Description of Play:**
  - Fayetteville is located on the Arkansas side of the Arkoma Basin, ranging in thickness from 50 to 550 feet and ranging in depth from 1,500 to 6,500 feet. (Source: Southwestern Energy website)
- **Players:**
  - Southwestern Energy and Chesapeake are the largest producers in this play, with 400 MMcf/day and 130 MMcf/day respectively of production in 1Q08 (Source: Southwestern Energy website and NCI Producer Survey)
- **Technically Recoverable Gas Estimate:**
  - NCI's estimate of mean technically recoverable gas is 26.0 Tcf, approximately the same as Barnett's mean estimate of 26.2 Tcf. Max. recoverable to 41.6 Tcf.
- **Current/Forecast Production:**
  - Average production for 1Q08 is 517 MMcf/day (Source: Arkansas Oil and Gas Commission).
  - Producer forecast peak production to 6 Bcf/day (NCI Producer Survey).
- **Advantages/Disadvantages:**
  - Advantage – 'friendly' gas producing area.
  - Disadvantage – structural complexity.

Fayetteville Shale



Source: University of Arkansas study, Projecting the Economic Impact of the Fayetteville Shale Play for 2005-2008, May 2006

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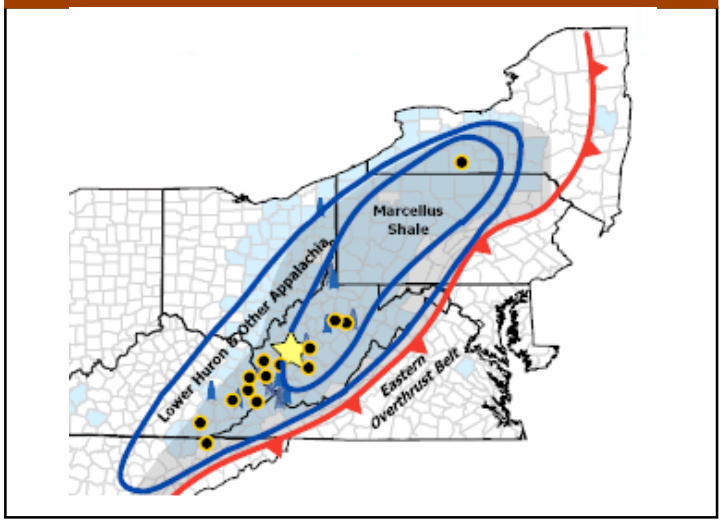
U.S. Gas Shales » Major Play Highlight » Marcellus

- **Description of Play:**
  - Core area runs through much of Pennsylvania and parts of West Virginia, Ohio, and New York.
  - Marcellus covers 54,000 square miles and extends over a 15-to-20 county area. This is a much larger scale geographically compared to Barnett, Fayetteville, and Woodford which all started out in a very finite, small area and expanded out.
- **Players:**
  - Chesapeake, Range Resources, EXCO, Atlas Energy Resources, Cabot, Chief, Southwestern, XTO, Anadarko, others.
- **Technically Recoverable Gas Estimate:**
  - NCI's estimate of mean technically recoverable gas is 34.2 Tcf, almost 31% higher than NCI's estimate of 26.2 Tcf for Barnett. Maximum recoverable to 262 Tcf with gas-in-place maximum estimates to 1,500 Tcf.
- **Advantages/ Disadvantages:**
  - Advantage - proximity to large Northeastern market (favorable basis), "super giant" area.
  - Disadvantage - lack of rigs that can drill horizontal wells, water management, non-producer area – lack of gas production experience, terrain.

Marcellus Shale



Source: Chesapeake.

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U.S. Gas Shales » Major Play Highlight » Woodford

- **Description of Play:**
  - Arkoma Basin of southeastern Oklahoma.
  - Technical Info – has entered development phase for some producers, F&D costs below $2.00/Mcf for some producers.
  - Activity Level – remains high on horizontal drilling allowing increased fracture densities and higher initial and post peak production rates.
- **Players:** Newfield, Devon, Chesapeake, Continental, Pablo, St. Mary Land & Expl., XTO, Antero, BP
- **Technically Recoverable Gas Estimate:**
  - NCI's estimate of mean technically recoverable gas is 8.0 Tcf, approximately 70% smaller than Barnett's mean estimate of 26.2 Tcf. Maximum recoverable estimates to 11.4 Tcf with gas-in-place estimates to 52 Tcf.
- **Current/Forecast Production:**
  - NCI's estimate of production for 1Q2008 is 271 MMcf/day.
  - Producer estimates as high as 1.7 Bcf per day peak from field. (NCI Producer Survey)
- **Advantages/Disadvantages:**
  - Advantage – Mid-Continent location to market.
  - Disadvantage – 6,000 to 11,000 foot depth adds to drilling costs.

Woodford Shale

Source: PetroQuest

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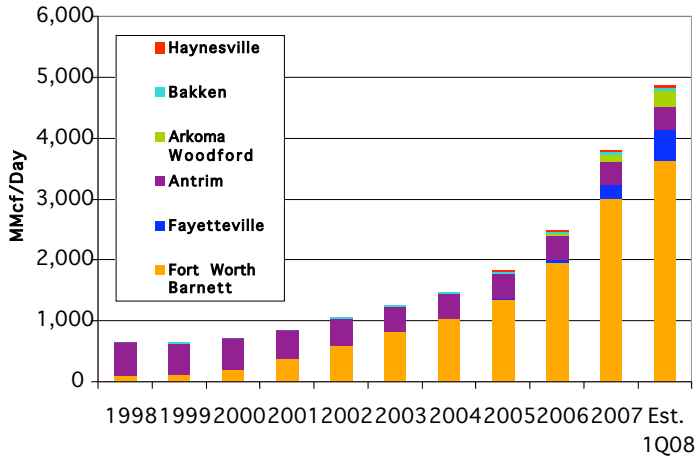
Gas Shales have Experienced Tremendous Growth in Recent Years with Barnett Leading the way and Signs of Early Followers

- Barnett has grown from 94 MMcf/day production levels in 1998 to 3,014 MMcf/day in 2007; an increase of more than 3000%.
- Based on NCI estimates, Fayetteville, Haynesville and Woodford are all showing similar signs of ramping production. Marcellus will be next.
- Technology has allowed access to and economic production of a vastly greater resource base. Specifically, improved hydraulic fracturing techniques and greatly improved horizontal drilling have allowed tight, geographically diffuse reserves to be developed in large volumes. Today's natural gas prices have enabled this use of enhanced technology to develop this resource.

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. See Appendix for supporting table.

* 1Q08 not reported yet by play but was estimated based on statistical analysis of production vs. price during the recently observed actual periods. Resulting estimates are consistent with observed growth in overall onshore gas production growth in 1Q08.

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NCI Estimated Production in 1Q08 for Key Plays

Est. Shale Gas Production (MMcf/day)				
Date	**Fort Worth Barnett**	**Fayetteville**	**Haynesville**	**Arkoma Woodford**
2007	3,014	230	17	109
Est. 1Q08	3,645	517	25	271

- NCI estimated production for a number of key plays in 1Q2008 using a regression model based on the historical relationship between production and gas price (state data used for Fayetteville).
  - Barnett – LCI data through 2007, regression model 1Q08.
  - Fayetteville – LCI data through 2007, Arkansas Oil and Gas Commission 1Q08.
  - Haynesville – LCI data through 2007, NCI estimate 1Q08.
  - Woodford – LCI data through 2007, regression model 1Q08.

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Current U.S. Production by Acreage from Producer Survey

- 16 respondents from NCI's producer survey provided information pertaining to current shale gas production by acreage.
- Each of these respondents provided a daily average production figure.
- A list of respondents and their respective production figures is provided on the following slide.

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U.S. Gas Shales » Current U.S. Production by Acreage, *cont.*

Company	Play	Production	Units	Date of Estimat
Atlas Energy Resources	Antrim	59	MMcfe/d	5/1/2008
Bankers Petroleum	Woodford - Ardmore	6	MMcf/d	4/1/2008
Carizzo	Barnett	56	MMcfe/d	3/31/2008
Chesapeake Energy Corp	Barnett	430	MMcfe/d	3/31/08
	Caney	-	MMcfe/d	3/31/08
	Fayetteville	130	MMcfe/d	3/31/08
	Haynesville	Not Disclosed		
	Marcellus	Not Disclosed		
	New Albany	-	MMcfe/d	3/31/08
	Woodford - Ardmore	25	MMcfe/d	3/31/08
	Woodford - Arkoma	40	MMcfe/d	3/31/08
CubicEnergy	Haynesville	-		
Denbury	Barnett	47	MMcf/d	12/31/2007
Devon	Barnett	594	MMcf/d	2002 to 2007 Average
	Woodford - Caney, Arkoma, & Anadarko	27	MMcf/d	Q1 2008
DomesticEnergy	Floyd	0.2	MMcf/d	
Goodrich (GDP)	Haynesville	1	MMcf/d/Well	Q1 2008
Encana	Barnett	124	MMcf/d	FY2007
	Haynesville (Deep Bossier)	143	MMcf/d	FY2007
Marathon	Bakken	0.03	MMcf/d	Q1 2008
	Piceance	4	MMcf/d	
Newfield	Woodford - Anadarko or Arkoma	196	MMcfe/d	5/27/2008
Petrohawk	Fayetteville	43	MMcf/d	Avg through 5/15/08
Petroquest	Fayetteville	3	MMcfe/d	5/6/2008
	Woodford - Anadarko or Arkoma	19	MMcfe/d	4/2/2008
Range Resources	Barnett	90	MMcf/d	5/1/2008
	Barnett and Woodford	-		5/1/2008
	Devonian/Ohio	1	MMcf/d	5/1/2008
	Floyd	-		5/1/2008
	Marcellus	.003 to .004	MMcf/d	5/1/2008
	Woodford - Ardmore	.002 to .003	MMcf/d	5/1/2008
SouthWestern Energy	Fayetteville	400	MMcf/d	Q1 2008
StormCat	Fayetteville	3	MMcf/d	5/8/2008
Williams	Barnett	38	MMcf/d	Q1 2008
	Woodford - Arkoma	18	MMcf/d	12/31/2007
XTO	Barnett	425	MMcf/d	Q1 2008
	Fayetteville & Woodford - Arkoma	215	MMcf/d	Q1 2008

Source: NCI Producer Survey

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3 Natural Gas in North America

Production

U.S. Unconventional Sources

U.S. Gas Shales

Canadian Unconventional Sources

Canadian Gas Shales

U.S. Imports from Canada

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Canadian Unconventional Gas Resources are Centered in Alberta and British Columbia; Quebec's Utica Shale Play is Embryonic

- Conventional gas accounts for most of Alberta's current production; however, CBM gas production has seen rapid growth in the past few years – growth is expected to continue.
  - Based on discussions with senior staff at the Alberta ERCB, commercial gas production from pure shale plays is non-existent.
  - Expectations for commercial shale gas production in Alberta are not nearly as high as they are in B.C., the result of significant differences in geology.
    - The Montney Play on the Alberta side of the border is 1/10 as thick as it is in B.C.
- In contrast, across the Provincial border, in B.C., almost one-third of production is unconventional, and consists of mainly tight-gas and shallow gas.
- Information on unconventional gas resources in other Provinces is limited as exploratory programs are just beginning to ramp up, i.e., Quebec.
  - This coupled with the fact that information tends to be published almost one year after data is collected by regulatory bodies, e.g., B.C. production/reserves summary for 2007 not due out until 09/2008.

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Alberta's CBM Resource Potential Covers a Wide Swath of the Province; however, Commercial Production is More Narrowly Distributed

- Two plays, the Horseshoe Canyon formation and deeper Mannville Group account for much of Alberta's CBM production and reserves.
  - Deeper Mannville CBM play first saw commercial success in 2005 and is still considered an early stage play.
    - Success to date has come as a result of horizontal drilling.
- CBM reserves data, provided by the ERCB, was available through YE2007 for the past few years.
- Gas production from CBM is up a staggering 11-fold between 2004 and 2007.
- Production is forecast to reach 1.76 Bcf/d by 2017, a CAGR of 10.3%.

Alberta CBM Reserves and Production

Year	Remaining Established Reserves (Bcf)	Production (MMcf/d)
2004	-	58
2005	740	233
2006	875	486
2007	864	661

Alberta CBM Resource Potential Map

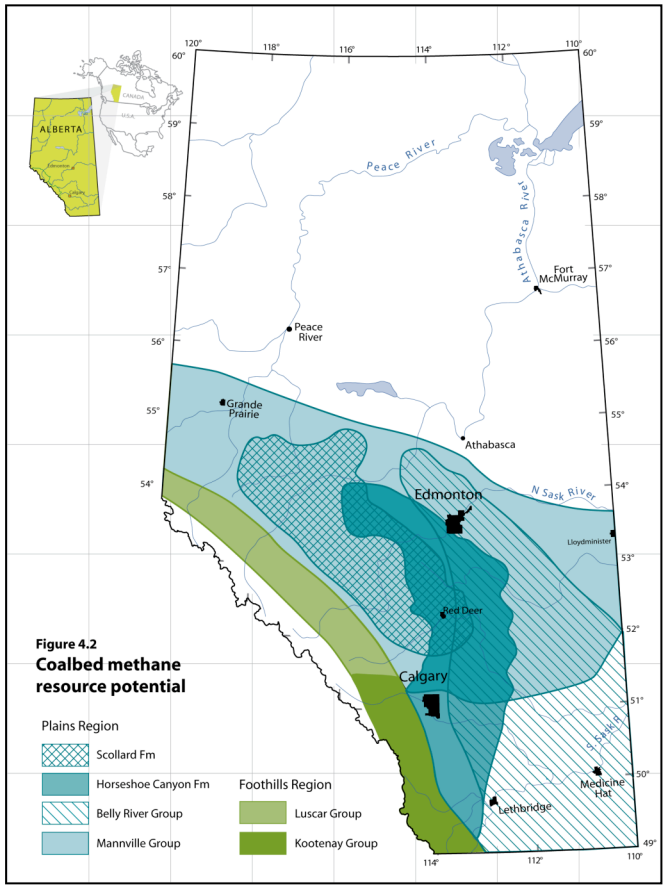

Image Source: Alberta ERCB

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Production in B.C. Occurs in the Northeast Corner of the Province. The Region is Part of the Western Canadian Sedimentary Basin (WCSB)

- Based on the most current data available from the B.C. Ministry of Energy, Mines and Petroleum Resources (MEMPR), production from tight gas was 340 Bcf for FY2006.
- Major tight gas plays include: Jean Marie Play – Greater Sierra; Cadomin Play – Cutbank; and, Montney Play – Dawson Creek.
- No commercial production of gas from CBM has been recorded to-date; however, 87 wells have been drilled through 04/2008.
- The most current estimates of remaining undiscovered market gas resources from the Province are current as of FY2006.

Resource Potential by Type

Resource Type	Estimate (Tcf)
Tight Gas	15
Shale Gas	5
CBM	4
Offshore	2.5
Interior Basins	1
Conventional	15
Total	**43**

Gas Producing Regions of British Columbia

Image Source: B.C. MEMPR

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3 Natural Gas in North America

Production

U.S. Unconventional Sources

U.S. Gas Shales

Canadian Unconventional Sources

Canadian Gas Shales

U.S. Imports from Canada

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B.C.'s More Advanced Shale Gas Plays are the Upper Montney and Horn River Plays; However, Horn River is Still an Exploratory Play

- Commercial shale gas production in the Province is still at an early stage relative to plays in the U.S. as evidenced by the lack of commercial production.
- Commercial shale gas production within the Upper Montney began in 2000-2001
  - Growth in production has been exceptional ~ 26 MMcf/d in 2005 versus > 80 MMcf/d by YE2007*.
  - Based on conversations with B.C. MEMPR staff, Horn River commercial production is still 2-5 years off.
- Encana, Apache, EOG, Devon, and Nexen are all active and have experimental schemes within the Horn River play.
- Results from experimental wells drilled within the boundaries of the Provinces' shale gas regulatory designation remain confidential for three years versus one year for normal wells.

Shale Gas Play Potential in NE B.C.

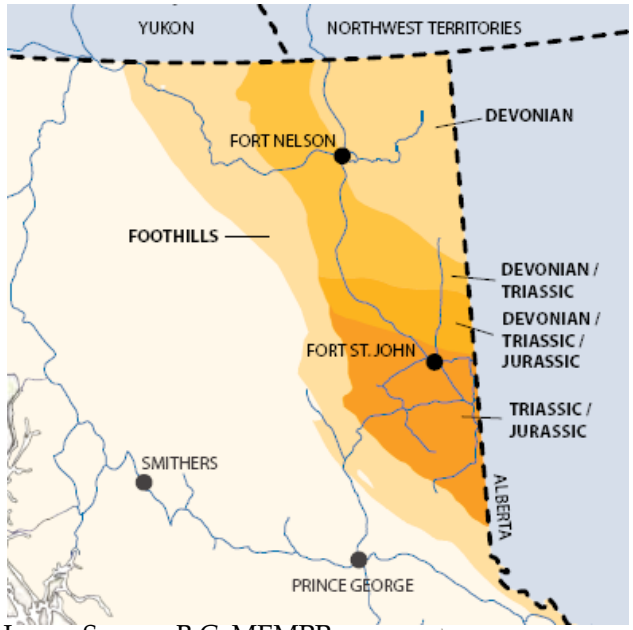

Image Source: B.C. MEMPR

*Source: B.C. MEMPR 2008 AAPG Annual Convention and Exhibition Presentation

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Current Canadian Shale Production by Acreage from Producer Survey

- None of the respondents were able to provide projected production by acreage for Canadian shale gas resources.

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Canadian Projected Shale Production by Play from Producer Survey

- Of the 66 respondents, only one, Encana, was able to provide forecasted production estimates by play.

Company	Play	Data	Units	Date of Estimate	Comments
Encana	Montney	245	MMCf/d	Q1-2008	FY2008 forecast

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3 Natural Gas in North America

Production

U.S. Unconventional Sources

U.S. Gas Shales

Canadian Unconventional Sources

Canadian Gas Shales

U.S. Imports from Canada

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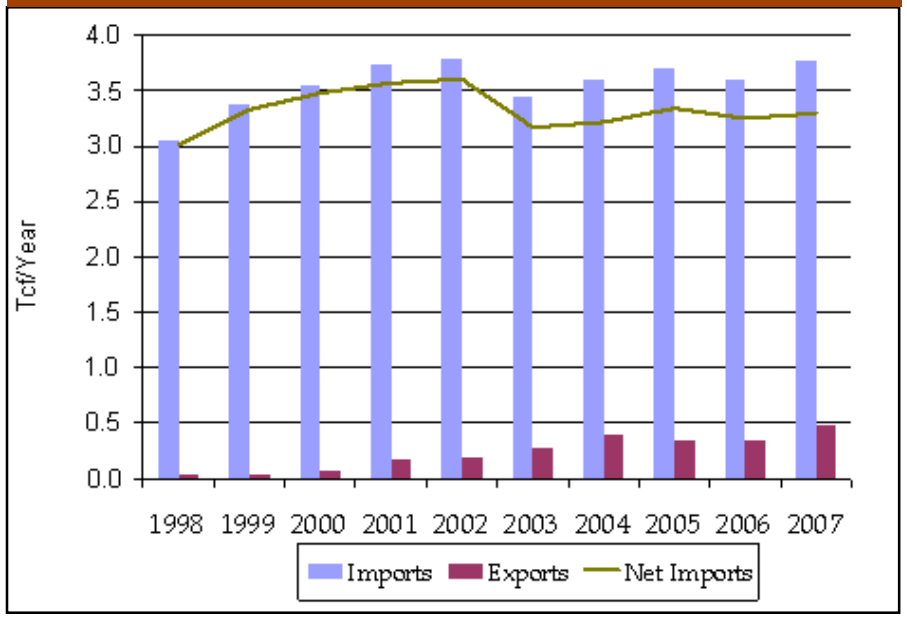
U.S. Net Imports from Canada Begin to Decline as Exports Increase

- U.S. net imports of Canadian gas have declined from a 5-year average of 3.4 Tcf/year (9.3 Bcf/day) in 1998 – 2002, to 3.3 Tcf/year (9.0 Bcf/day) in 2003 – 2007.
- This decline is largely due to an increase in pipeline exports from the U.S. to Canada.

U.S. Net Canadian Imports



Source: EIA. Note: EIA annual net imports differ on average by less than 1% from Canada's National Energy Board figures.

See Appendix for supporting table.

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4 Technology Assessment

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Technology has Aided Shale Development

- Every shale is different, so each new play has its own learning curve.
- The experience in the Barnett Shale has proved valuable in shale plays such as Woodford and Fayetteville, and may prove so in other shale plays as well.
- Shales tend to have lower recovery rates than conventional plays. Thus, future innovations could drive the technically recoverable shale gas up considerably. For example, the Marcellus Shale is estimated to have up to 516 Tcf of gas in-place (Egerton (2007)), but only yield about 10% in production. Doubling the recovery factor to 20% would substantially improve the Marcellus prospect.
- Hydraulic fracturing the shale formation is key to maintaining flow and optimizing recovery.
  - Fracing can account for up to 25% of the total development cost (Schlumberger).
  - Most shale wells are horizontal; all must be fracture treated.
  - Methods have improved substantially in the last decade. Fracs are done in sequence in order to maximize the amount of fractures for improved recovery. Commercial considerations limit the number of stages, but the more the better, generally.
  - Naturally fractured shales tend to be preferred, all else equal.
  - Much research is currently ongoing in the area of fracing. The type of fluid and proppant (the material used to hold open the fractures) are being actively researched.
- Given the amount of activity in shale and the room for technological innovation to have substantial commercial value, it is likely that new techniques will lower costs per mcf over time, just as it has with other hydrocarbons. Given the relative newness of shale development of the magnitude being seen today, we are simply lower on the learning curve, so the room to improve is likely higher.

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Much of the Active Shale Gas Production is Likely to be Profitable

- Bank of America (BoA) NYMEX Breakeven Analysis (2006) places the median price at $6.64/mcf for companies involved in shale developments. The lowest cost producer's breakeven is at about $4.20/mcf and the highest cost producer's breakeven is at about $11.50/mcf.
- In the current market, the majority of the active acreage holders in shale are profitable.
- The BoA data indicate the variability of costs of prospective acreage. Higher production rates per well favor the economics. The least cost producers tend to hold acreage positions with shale deposits that have some, if not all, of the following characteristics:
  - fairly thick;
  - are naturally fractured;
  - have high organic content;
  - are not characterized as clay-rich shales; and
  - are thermally mature.
- The shales that fit this criterion appear to be
  - Barnett, Woodford, Fayetteville, Haynesville, Marcellus, and Utica.
  - Geologic data indicate several others may have similar characteristics (Floyd (Black Warrior Basin), Huron (Appalachian Basin), Niobrara (Denver Basin), Lewis (San Juan Basin), and the Barnett and Woodford (Permian Basin)), but more work is underway in these areas as well as others.

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5 Natural Gas Consumption

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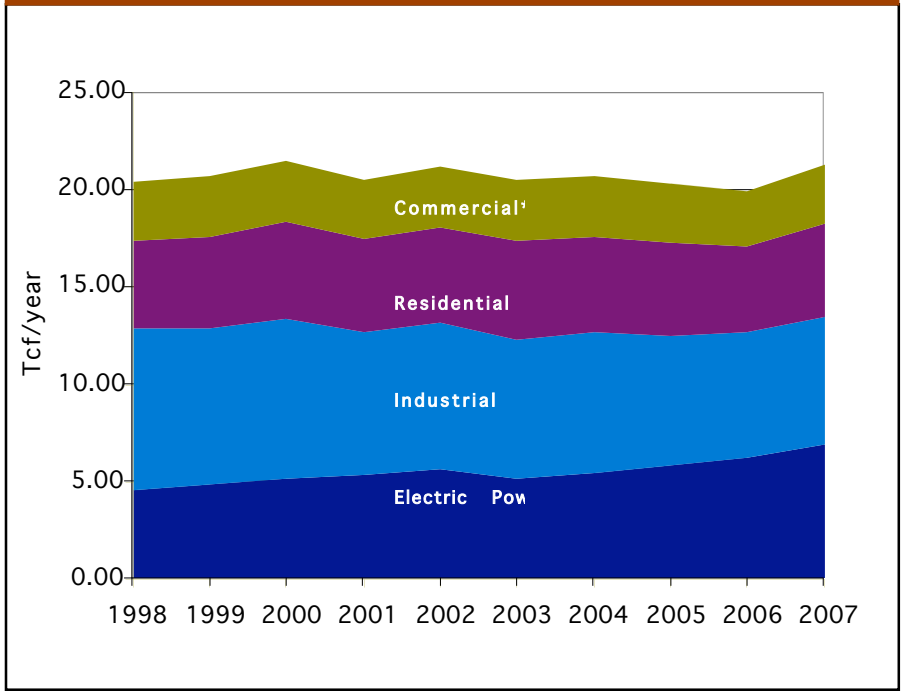
U.S. Natural Gas Consumption

Gas-fired Electric Generation Gas Demand has been Strong Over the Last Decade

- Natural gas consumption has been relatively flat in the residential, commercial and industrial sectors.
- Gas-fired electric generation is the only sector that has experienced a significant change, with an increase of demand from 4.6 Tcf/year (12.6 Bcf/day) in 1998 to 6.9 Tcf/year (18.9 Bcf/day) in 2007 (an almost 50% increase). The 10-year average annual percentage change for this sector is 12.4%.

U.S. Natural Gas Consumption by Sector



Source: EIA. * Commercial consumption includes Vehicle Fuel. See Appendix for supporting table.

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6 Methodology

Review of Publicly Available Data

Producer Survey

Lippman Consulting, Inc.

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As part of its Research, NCI Reviewed these Key Studies

- PGC (2006)
- USGS
- AAPG
- Egerton (2007)
- MMS (2006)

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As part of its Research, NCI Reviewed Reports from the Following Analysts

- Tudor Pickering Holt & Co.
- Credit Suisse Equity Research
- Turner Investment Partners
- Morningstar
- RBC Capital Markets
- Deutsche Bank Global Markets Research
- Oppenheimer
- Wachovia Securities
- Jefferies & Company, Inc.
- Natexis Bleichroeder Inc.
- Coker & Palmer
- Ziff and Associates
- Peters and Co.

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NCI Reviewed Articles and Research from the Following Publications

- SNL Energy Daily Gas Report
- Platts Gas Daily
- EnergyBiz Magazine
- Shreveport Times
- Foster Natural Gas Report
- CNN Money
- Oil and Gas Journal
- Evaluate Energy
- Bloomberg
- Wall Street Journal
- Natural Gas Intelligence

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NCI Also Reviewed ARI Articles, As Published in the Oil and Gas Journal

- A series of six articles by Vello A. Kuuskraa, President of ARI and Associates published in July and August of 2007:
  1. A Decade of Progress in Unconventional Gas
  2. The Unconventional Gas Resource Base
  3. New and Emerging Unconventional Gas Play and Prospects
  4. Nature and Importance of Technology Progress for Unconventional Gas
  5. Economics of Unconventional Gas
  6. Outlook for Unconventional Gas: The Next Decade
- The articles by ARI were identified by NCI as particularly relevant (if slightly dated) for the present report in providing the history and context of unconventional gas development growth in the country.

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NCI Also Conducted a Survey to the State Agencies Responsible for Minerals Management for the Largest 21 Natural Gas Producing States

- The State and Provincial agencies identified in each jurisdiction were allocated to NCI consultants for contacting.
- The agencies identified by jurisdiction were:

State	Agency	Website
Alabama	Alabama State Oil and Gas Board	http://www.ogb.alabama.gov/ogb/database.aspx
Arkansas	Oil and Gas Commission	http://www.aogc.state.ar.us/
Colorado	Colorado Department of Natural Resources	http://dnr.state.co.us/
Illinois	Office of Mines and Minerals - Division of Oil and Gas	http://www.dnr.state.il.us/mines/dog/index.htm
Indiana	Natural Resources Commission	http://www.in.gov/nrc/2529.htm
Kentucky	Division of Oil and Gas Conservation	http://www.dogc.ky.gov/
Louisiana	Department of Natural Resources	http://dnr.louisiana.gov/
Michigan	Department of Environmental Quality	http://www.michigan.gov/deq/0,1607,7-135-3311_4111—,00.html
Mississippi	Mississippi State Oil and Gas Board	http://www.ogb.state.ms.us/
Montana	Montana Board of Oil and Gas	http://bogc.dnrc.mt.gov/
New Mexico	New Mexico Public Regulatory Commission	http://www.nmprc.state.nm.us/index.htm
New York	Department of Environmental Conservation	http://www.dec.ny.gov/energy/1601.html
North Dakota	Natural Resources Trust Board of Directors	http://www.governor.nd.gov/boards/boards-query.asp?Board_ID=112
Ohio	Mineral Resources Management	http://www.dnr.state.oh.us/mineral/Home/default/tabid/10352/Default.aspx
Oklahoma	Oklahoma Corporation Commission - Oil and Gas Conservation Divisi	http://www.occ.state.ok.us/Divisions/OG/newweb/publications.htm
Pennsylvania	Bureau of Oil and Gas Management	http://www.dep.state.pa.us/dep/deputate/minres/oilgas/oilgas.htm
Tennessee	Tennessee Regulatory Authority	http://tennessee.gov/ecd/energy.htm
Texas	Railroad Commission	http://www.rrc.state.tx.us/
Utah	Utah Governor's Energy Policy	http://www.utah.gov/energy/governors_priorities/oil_shale_tar_sands.html
West Virginia	Office of Oil and Gas	http://www.wvdep.org/item.cfm?ssid=23
Wyoming	Wyoming State Geological Survey	http://www.wsgs.uwyo.edu/

Canadian		
Alberta	Energy Resources Conservation Board	
British Columbia	Government of BC (Ministry of Energy, Mines, and Petroleum Reso	http://www.em.gov.bc.ca/subwebs/oilandgas/stat/monthly.htm
All of Canada	National Energy Board	http://www.neb.gc.ca/df-nsi/mrgynfmtn/sttstc/mrktblntrlgsprdctn/mrktblntrlgsprdctn-eng.html
All of Canada	Statistics Canada	

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Subsequently NCI Identified Key Universities By State Who Were Thought to Be Involved With the State Agencies

- The key universities likely to be involved with the State Minerals Management were then identified for contact:

State	Agency	Website	State University*
Alabama	Alabama State Oil and Gas Board	http://www.ogb.alabama.gov/ogb/database.aspx	University of Alabama
Arkansas	Oil and Gas Commission	http://www.aogc.state.ar.us/	University of Arkansas
Colorado	Colorado Department of Natural Resources	http://dnr.state.co.us/	Colorado School of Mines
Illinois	Office of Mines and Minerals - Division of Oil and Gas	http://www.dnr.state.il.us/mines/dog/index.htm	
Indiana	Natural Resources Commission	http://www.in.gov/nrc/2529.htm	Indiana University
Kentucky	Division of Oil and Gas Conservation	http://www.dogc.ky.gov/	University of Kentucky
Louisiana	Department of Natural Resources	http://dnr.louisiana.gov/	LSU
Michigan	Department of Environmental Quality	http://www.michigan.gov/deq/0,1607,7-135-3311_4111---,00.html	Michigan State or University of Michigan
Mississippi	Mississippi State Oil and Gas Board	http://www.ogb.state.ms.us/	
Montana	Montana Board of Oil and Gas	http://bogc.dnrc.mt.gov/	Montana State
New Mexico	New Mexico Public Regulatory Commission	http://www.nmprc.state.nm.us/index.htm	University of New Mexico/New Mexico State
New York	Department of Environmental Conservation	http://www.dec.ny.gov/energy/1601.html	NYU
North Dakota	Natural Resources Trust Board of Directors	http://www.governor.nd.gov/boards/boards-query.asp?Board_ID=112	
Ohio	Mineral Resources Management	http://www.dnr.state.oh.us/mineral/Home/default/tabid/10352/Default.aspx	Ohio State University
Oklahoma	Oklahoma Corporation Commission - Oil and Gas Conservation Division	http://www.occ.state.ok.us/Divisions/OG/newweb/publications.htm	Oklahoma University
Pennsylvania	Bureau of Oil and Gas Management	http://www.dep.state.pa.us/dep/deputate/minres/oilgas/oilgas.htm	Pennsylvania State University
Tennessee	Tennessee Regulatory Authority	http://tennessee.gov/ecd/energy.htm	
Texas	Railroad Commission	http://www.rrc.state.tx.us/	University of Texas
Utah	Utah Governor's Energy Policy	http://www.utah.gov/energy/governors_priorities/oil_shale_tar_sands.html	Utah State
West Virginia	Office of Oil and Gas	http://www.wvdep.org/item.cfm?ssid=23	West Virginia University
Wyoming	Wyoming State Geological Survey	http://www.wsgs.uwyo.edu/	

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The Success in Obtaining Pertinent Information from the State Agencies and University Outreach, However Hopeful, was Minimal

- In the process to contact the State Minerals Oversight Agencies in our information gathering we experienced the following:
  - Unexpected difficulty in making the proper contact.
  - When contact was made, often the contact was not prepared or ill equipped to answer our questionnaire or answer other questions.
  - In the few times we were successful, the agency directed the consultant to State data base often with information at the well level.
  - When this occurred, NCI did not pursue this any further due to the likelihood that obtaining information from the database would be highly technical in nature perhaps requiring specialized programs to interpret or if not, the information would be beyond our limited technical abilities.
- Because of the extra time taken for the State level outreach, NCI *was not able to pursue* the outreach to the key university GeoScience, Geology or Earth Sciences Department Heads.
- This could be attempted with perhaps reasonable expectation of success, with additional time for this labor intensive outreach.

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6 Methodology

Review of Publicly Available Data

Producer Survey

Lippman Consulting, Inc.

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Producer Survey » Overview

- The American Clean Skies Foundation requested that NCI compile the most recent natural gas production information from North American natural gas producers.
- In order to comply with ACSF's request, NCI developed a producer survey according to the following parameters:
  - Contact natural gas producers responsible for 90% of gas production.
  - Find a contact person for each producer, preferably Vice Presidents of Investor Relations.
  - Find publicly available information pertaining to production of unconventional natural gas.
  - Request information for the most recent estimates, preferably the first quarter of 2008.
  - Establish a relationship with the contact person to allow for follow-up questions.

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Producer Survey » Contact List

- The Producer Survey contact list consists of 114 natural gas companies (see Appendix for complete listing).
  - Of these companies, 20 came from a current list of Top 20 Producers (Source: Chesapeake, June 2008 Investor Presentation).
  - Approximately 30 more producers came from the EIA's top producer list (Source: Table A6. Top U.S. Operators Ranked by Reported 2006 Operated Production Data, http://www.eia.doe.gov/, see Appendix for complete listing). EIA's full list of 50 producers represents roughly 72% of the NG production in the U.S.
  - In order to increase the sample size, NCI included 64 additional North American natural gas producers.
- Producers from this list were separated by play and the list was distributed amongst a group of consultants performing the phone survey.
- The consultants established a contact person from each producer to survey.

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Producer Survey » Contact Template & Script

- In order to facilitate the phone interview and create a uniform survey, each consultant was given a script and a template to fill out during the phone interview process (see Appendix for contents of the survey script).
- The template contained the following 12 questions:
  - Total Remaining Proved Reserves in Play;
  - Total Remaining Proved Reserves in your Acreage;
  - Expected Ultimate Recoverability (EUR) for Play;
  - Expected Ultimate Recoverability (EUR) for your Acreage;
  - Estimate of Total Natural Gas Resource in Play;
  - P2 Estimate (Proved + Probable);
  - P3 Estimate (Proved + Probable + Possible);
  - Current Play Production;
  - Projected Play Production;
  - Current Production for your Acreage;
  - Projected Production for your Acreage; and
  - Acreage Position.

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Producer Survey Response Rates

- Of the 114 producers contacted, NCI received responses from 66, an overall response rate of 58%.
- On a more granular basis, out of 2,875 questions asked, NCI received responses to about 16% of their questions (see Appendix for complete count of responses by category).

Questions	Response Rate	No Rresponse Rate
Total Remaining Proved Reserves in Play	5%	95%
Total Remaining Proved Reserves in your Acreage	27%	73%
Expected Ultimate Recoverability (EUR) for Play	9%	91%
Expected Ultimate Recoverability (EUR) for your Acreage	14%	86%
Estimate of Total Natural Gas Resource in Play	15%	85%
P2 Estimate (Proved + Probable)	7%	93%
P3 Estimate (Proved + Probable + Possible)	15%	85%
Current Play Production	18%	82%
Projected Play Production	8%	92%
Current Production for your Acreage	35%	65%
Projected Production for your Acreage	9%	91%
Acreage Position	73%	27%
Other	8%	92%
Total	**16%**	**84%**

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Producer Survey Results

- The frequency of responses varied amongst the categories, with "Acreage Position" showing the highest frequency of responses:

Questions	Percent of Total Respons
Total Remaining Proved Reserves in Play	2%
Total Remaining Proved Reserves in your Acreage	10%
Expected Ultimate Recoverability (EUR) for Play	3%
Expected Ultimate Recoverability (EUR) for your Acreage	5%
Estimate of Total Natural Gas Resource in Play	6%
P2 Estimate (Proved + Probable)	3%
P3 Estimate (Proved + Probable + Possible)	6%
Current Play Production	7%
Projected Play Production	3%
Current Production for your Acreage	13%
Projected Production for your Acreage	3%
Acreage Position	27%
Other	14%
Total	100%

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6 Methodology

Review of Publicly Available Data

Producer Survey

Lippman Consulting, Inc.

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Lippman Consulting, Inc. » Database Overview

- Lippman Consulting, Inc. (LCI) is a recognized provider of broad based as well as specific natural gas supply information, statistics, and intelligence for North America.
  - In particular, NCI subscribed to LCI's Production Database which contains 66 reports divided into a number of types:
    - Quarterly Regional Production Reports – covers regional wellhead production through 3Q07 in Alaska, West Coast, Permian Basin, Rocky Mountain, San Juan, Gulf Coast, Mid-Continent, Eastern U.S., and Canada. Each region further breaks-out production into more granular basins or fields.
    - Monthly Gulf Coast Production Reports – covers monthly wellhead production through 2007 in various Gulf Coast states.
    - Other Monthly Reports – includes total U.S. and Canada wellhead, dry, and marketed production, and drilling rig activity through April 2008.
    - Top 20 Producers – covers total annual production through 2007 from top 20 operators in parts of 17 U.S. states (for a few areas data is only through 2006). Also has reports on top 20 operators in three Canadian provinces through 2006.
    - Top 20 E&P Companies – covers total annual new gas discovered through 2006 from top 20 operators in same states as Top 20 Producers reports. Also includes Canadian new gas supplies through 2006.

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Lippman Consulting, Inc. » Unconventional Coverage

- LCI's Quarterly Regional Production Reports also include unconventional coverage in two main reports:
  - Lower 48 States Shale Production – contains shale production from a number of regions in the U.S. through 3Q07. Quarterly Regional Reports for specific regions extend the production data for a number of shales.
    - Mid Continent – Barnett (Texas – through 2007), Woodford (Oklahoma – through 3Q07), Fayetteville (Arkansas – through 3Q07).
    - Eastern U.S. – Antrim (Michigan – through 2007).
    - Rocky Mountain – Bakken (Montana and North Dakota – through 2007).
    - Gulf of Mexico – Haynesville (Louisiana – through 11/2007).
  - Lower 48 States Coal Seam Production – contains coal seam production through 3Q07.
    - San Juan – Colorado and New Mexico.
    - Rocky Mountain – Powder River Basin, Raton Basin, Uinta Basin, Green River Basin.
    - Gulf Coast Onshore – Black Warrior Basin.
    - Mid Continent – Cherokee Basin, Arkoma Basin, and Anadarko Basin.
    - Eastern U.S. – Appalachian Basin.

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7 Appendix

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Production » U.S.

Table: U.S. Production

Year	Total		Conventional		Unconventional		Percent Uncon-ventional
	Tcf/year	Bcf/day	Tcf/year	Bcf/day	Tcf/year	Bcf/day	
1998	19.02	52.12	13.64	37.37	5.38	14.75	28%
1999	18.83	51.60	13.46	36.87	5.37	14.72	29%
2000	19.18	52.55	13.35	36.57	5.84	15.99	30%
2001	19.62	53.74	13.31	36.47	6.30	17.27	32%
2002	18.93	51.86	12.34	33.81	6.59	18.05	35%
2003	19.10	52.32	12.31	33.73	6.79	18.60	36%
2004	18.59	50.93	11.09	30.39	7.50	20.54	40%
2005	18.05	49.45	10.16	27.83	7.89	21.62	44%
2006	18.48	50.62	10.00	27.40	8.48	23.22	46%
2007	19.28	52.82	10.41	28.51	8.87	24.30	46%
1Q 2008 (equiv.)	20.28	55.56					

Sources: Total Production – EIA Natural Gas Production Reports, Unconventional – EIA AEO2008, Conventional – NCI calculation.

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U.S. Unconventional Sources » Production by Type

Table: U.S. Unconventional Production

Year	Tight Sands		Coalbed Methane		Shale		Total	
	Tcf/year	Bcf/day	Tcf/year	Bcf/day	Tcf/year	Bcf/day	Tcf/year	Bcf/day
1998	3.77	10.33	1.26	3.46	0.35	0.95	5.38	14.75
1999	3.69	10.11	1.33	3.65	0.35	0.96	5.37	14.72
2000	3.96	10.84	1.45	3.97	0.43	1.18	5.84	15.99
2001	4.29	11.74	1.54	4.21	0.48	1.32	6.30	17.27
2002	4.46	12.23	1.57	4.31	0.55	1.51	6.59	18.05
2003	4.62	12.65	1.58	4.33	0.59	1.61	6.79	18.60
2004	5.09	13.95	1.72	4.71	0.69	1.88	7.50	20.54
2005	5.38	14.74	1.74	4.77	0.77	2.10	7.89	21.62
2006	5.64	15.46	1.80	4.92	1.04	2.84	8.48	23.22
2007	6.01	16.46	1.81	4.96	1.05	2.88	8.87	24.30

Source: EIA AEO2008.

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U.S. Unconventional Sources » Tight Sands Production by Region

Table: U.S. Tight Sands Production by Region

Year	East Coast		Gulf Coast		Midcontinent		Southwest		Rocky Mountain		Total	
	Tcf/year	Bcf/day	Tcf/year	Bcf/day	Tcf/year	Bcf/day	Tcf/year	Bcf/day	Tcf/year	Bcf/day	Tcf/year	Bcf/day
1998	0.30	0.83	1.56	4.28	0.46	1.25	0.27	0.74	1.18	3.22	3.77	10.33
1999	0.34	0.93	1.48	4.05	0.42	1.15	0.27	0.74	1.18	3.23	3.69	10.11
2000	0.34	0.94	1.58	4.33	0.40	1.09	0.28	0.76	1.36	3.72	3.96	10.84
2001	0.31	0.86	1.72	4.70	0.41	1.13	0.31	0.84	1.54	4.22	4.29	11.74
2002	0.37	1.02	1.72	4.71	0.40	1.10	0.30	0.82	1.67	4.58	4.46	12.23
2003	0.36	0.98	1.71	4.69	0.42	1.16	0.29	0.79	1.84	5.03	4.62	12.65
2004	0.36	0.99	1.97	5.38	0.50	1.37	0.29	0.79	1.98	5.42	5.09	13.95
2005	0.37	1.01	2.06	5.65	0.54	1.48	0.29	0.79	2.12	5.80	5.38	14.74
2006	0.43	1.17	2.10	5.74	0.58	1.58	0.28	0.76	2.27	6.21	5.64	15.46
2007	0.44	1.20	2.10	5.74	0.58	1.60	0.29	0.80	2.60	7.12	6.01	16.47

Source: EIA AEO2008. EIA Oil and Gas Supply Module Regions.

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U.S. Unconventional Sources » Coalbed Methane Production by Region

Table: U.S. Coalbed Methane Production by Region

Year	East Coast		Gulf Coast		Midcontinent		Southwest		Rocky Mountain		Total	
	Tcf/Year	Bcf/Day	Tcf/Year	Bcf/Day	Tcf/Year	Bcf/Day	Tcf/Year	Bcf/Day	Tcf/Year	Bcf/Day	Tcf/Year	Bcf/Day
1998	0.05	0.13	0.12	0.32	0.03	0.07	0.00	0.00	1.08	2.95	1.26	3.46
1999	0.05	0.14	0.12	0.32	0.03	0.07	0.00	0.00	1.14	3.12	1.33	3.65
2000	0.06	0.15	0.11	0.30	0.03	0.08	0.00	0.00	1.25	3.43	1.45	3.97
2001	0.06	0.15	0.11	0.31	0.04	0.10	0.00	0.01	1.33	3.64	1.54	4.21
2002	0.07	0.19	0.12	0.32	0.03	0.08	0.00	0.01	1.36	3.72	1.57	4.31
2003	0.07	0.19	0.12	0.33	0.05	0.14	0.00	0.01	1.34	3.66	1.58	4.33
2004	0.07	0.20	0.13	0.35	0.07	0.20	0.00	0.00	1.44	3.96	1.72	4.71
2005	0.08	0.21	0.12	0.33	0.09	0.24	0.00	0.00	1.46	3.99	1.74	4.77
2006	0.11	0.29	0.09	0.25	0.10	0.27	0.00	0.00	1.50	4.11	1.80	4.92
2007	0.13	0.36	0.11	0.31	0.09	0.25	0.00	0.00	1.47	4.04	1.81	4.96

Source: EIA AEO2008. EIA Oil and Gas Supply Module Regions.

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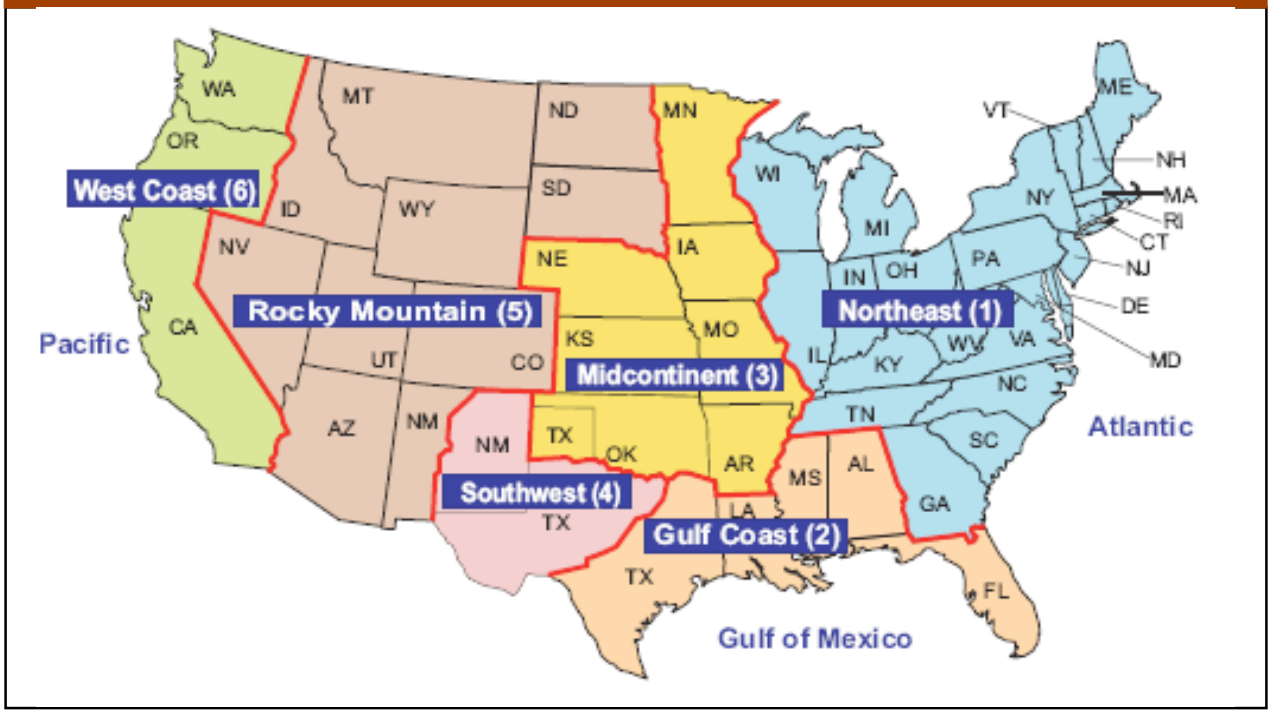
U.S. Unconventional Sources » EIA AEO2008 Regions

EIA AEO2008 Oil and Gas Supply Model Regions



Source: EIA

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U.S. Gas Shales » Shale Production by Play

U.S. Annual Average Shale Gas Production* (MMcf/Day)						
Year	Antrim	Bakken	Fort Worth Barnett	Fayetteville	Haynesville	Arkoma Woodford
1998	546	8	94	0	0	0
1999	522	7	112	0	0	0
2000	501	6	216	0	0	0
2001	479	6	367	0	0	0
2002	454	6	601	0	0	0
2003	422	9	832	0	0	0
2004	408	14	1,045	0	0	2
2005	399	31	1,369	8	25	6
2006	385	44	1,960	63	20	25
2007	373	60	3,014	230	17	109
Est. 1Q08	363	55	3,645	517	25	271

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

* 1Q08 not reported yet by play but was estimated based on statistical analysis of production vs. price during the recently observed actual periods. Resulting estimates are consistent with observed growth in overall onshore gas production growth in 1Q08.

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U.S. Imports from Canada

Table: U.S. Imports from Canada

Year	U.S. Natural Gas Pipeline Imports From Canada (Bcf)	U.S. Natural Gas Pipeline Exports to Canada (Bcf	U.S. Natural Gas Net Canadian Imports (Bcf)
1998	3,052	40	3,012
1999	3,368	39	3,329
2000	3,544	73	3,471
2001	3,729	167	3,562
2002	3,785	189	3,596
2003	3,437	271	3,166
2004	3,607	395	3,212
2005	3,700	358	3,342
2006	3,590	341	3,249
2007	3,777	482	3,295

Source: EIA. Note: EIA annual net imports differ on average by less than 1% from Canada's National Energy Board figures.

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U.S. Natural Gas Consumption

Table: U.S. Natural Gas Consumption by Sector (Tcf/year)

Date	Total Delivered to Consumers	Residential	Commercial*	Industrial	Electric Power
1998	20.44	4.52	3.01	8.32	4.59
1999	20.68	4.73	3.06	8.08	4.82
2000	21.54	5.00	3.20	8.14	5.21
2001	20.50	4.77	3.04	7.34	5.34
2002	21.23	4.89	3.16	7.51	5.67
2003	20.56	5.08	3.20	7.15	5.14
2004	20.72	4.87	3.15	7.24	5.46
2005	20.32	4.83	3.02	6.60	5.87
2006	19.94	4.37	2.86	6.49	6.22
2007	21.27	4.72	3.03	6.64	6.87

Source: EIA. * Commercial consumption includes vehicle fuel.

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Producer Survey » Contact List

Table: Producer Survey Contact List

No.	Company Name	No.	Company Name	No.	Company Name
1	Abraxas	22	CDX Gas	43	Energy Partners
2	Alta	23	Chesapeake	44	EOG Res
3	Amerada Hess	24	Chevron	45	Equitable Res
4	American Oil and Gas	25	Chief	46	Errington midland texas
5	Anadarko	26	Cimarex	47	Exco
6	Antero	27	CNX Gas	48	Exxon
7	Apache	28	Comstock	49	Fidelity Exploration and Production
8	Atlas Energy Resources	29	ConocoPhillips	50	Forest Oil
9	Audubon Gas	30	Consol Energy	51	Fortuna
10	Aurora Oil and Gas	31	Contango	52	Fossil Operating
11	Banker's Petroleum	32	Continental Resources	53	Galleon Energy Inc.
12	Baseline Oil and Gas	33	Cubic Energy	54	Gasco Energy (GSX)
13	Bill Barrett	34	Denbury	55	Gastar (Hilltop Resort Field)
14	BP	35	Devon	56	Goodrich Petroleum Corporation
15	Brigham Exploration	36	Domestic Energy Corporation	57	Hallwood
16	Brightburn Energy (MLP E&P)	37	Dominion	58	Hilcorp
17	Burlington Resources	38	East Resources	59	Hunt Oil
18	Cabot	39	Edge Petroleum	60	Junex
19	Camterra	40	El Paso	61	J-W Operating Co.
20	Canada Energy Partners	41	Encana	62	Kaiser - Francis Oil
21	Carrizo	42	Energen	63	KCS Energy

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Producer Survey » Contact List , *cont.*

Table: Producer Survey Contact List, *cont.*

No.	Company Name	No.	Company Name	No.	Company Name
64	Linn Petroleum	85	Quest	106	Ultra Petroleum
65	Marathon	86	Questar	107	Unbridled Energy
66	Mariner Energy	87	Questerre	108	Unit
67	Maverick	88	Quicksilver	109	W & T Offshore
68	Merit	89	Range Resources	110	Walter Oil & Gas
69	National Fuel Gas	90	Rex	111	Williams
70	Newfield	91	Samson	112	Winchester
71	Nexen	92	Sandridge	113	XTO
72	Noble	93	Schuepbach Energy	114	Yates
73	North Coast Energy	94	Sedna Energy		
74	Occidental Petroleum	95	Seneca		
75	Odysey Energy Limited (ODY)	96	Shell Oil		
76	Orleans Energy	97	Southwestern		
77	Pathfinder (bought back Shell's assets)	98	St. Mary Land and Expl		
78	Penn Virginia	99	Stephens Production		
79	Petrohawk	100	Stormcat Energy		
80	Petroquest	101	Sun Coast		
81	Pin Oak	102	Talisman energy (TLM)		
82	Pioneer Natural Resources (PXD)	103	Tatonka Oil and Gas		
83	Plains	104	The Houston Exploration Co		
84	Pogo	105	Tyner Resources		

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Producer Survey » Contact List , *cont.*

Table: Top 20 Producers 1Q 2008

Production Ranking	Company (c)	Ticker	Daily U.S. Natural Gas Production (a,b) 1Q'08	4Q'07	1Q'07	1Q'08 vs. 4Q'07 % Change	1Q'08 vs. 1Q'07 % Change	2007 U.S. Net Proved Reserves	2007 Proved U.S Gas Reserve Ranking	RP Ratio (d)	Drilling at US Rigs 5/23/08 (e)
1.	BP	BP	2,149	2,183	2,163	(1.6%)	(0.6%)	15,375	1	20	24
2.	Anadarko (1)	APC	2,137	2,013	2,204	6.2%	(3.0%)	8,504	6	11	35
3.	Chesapeake (2)	CHK	2,063	2,041	1,564	1.1%	31.9%	10,137	4	13	149
3.	ConocoPhillips	COP	2,063	2,203	2,312	(6.4%)	(10.8%)	12,634	3	17	35
5.	Devon (3)	DVN	1,878	1,845	1,624	1.8%	15.6%	7,143	7	10	60
6.	XTO (4)	XTO	1,708	1,671	1,264	2.2%	35.1%	9,441	5	15	71
7.	Chevron	CVX	1,666	1,675	1,723	(0.5%)	(3.3%)	3,226	11	5	10
8.	EnCana (5)	ECA	1,552	1,464	1,222	6.0%	27.0%	6,008	8	11	52
9.	ExxonMobil	XOM	1,305	1,405	1,529	(7.1%)	(14.7%)	13,172	2	28	6
10.	Shell	RDS	1,105	1,138	1,162	(2.9%)	(4.9%)	2,468	15	6	13
11.	EOG (6)	EOG	1,085	1,010	915	7.4%	18.6%	4,220	9	11	67
12.	Williams	WMB	1,013	983	845	3.1%	19.9%	4,143	10	11	29
13.	Apache (7)	APA	744	773	740	(3.8%)	0.6%	2,699	13	10	31
14.	El Paso	EP	726	757	671	(4.1%)	8.2%	3,100	12	12	23
15.	Occidental	OXY	580	578	585	0.3%	(0.9%)	2,672	14	13	5
16.	Marathon	MRO	482	474	472	1.7%	2.1%	1,007	20	6	14
17.	Newfield (8)	NFX	444	412	576	7.8%	(22.9%)	1,810	18	11	27
18.	Southwestern (9)	SWN	425	370	243	14.9%	74.9%	1,450	19	9	22
19.	Noble (10)	NBL	393	419	408	(6.1%)	(3.7%)	1,840	17	13	14
20.	Questar (11)	STR	387	336	343	15.2%	12.8%	1,868	16	13	18
	Totals / Average		23,905	23,749	22,565	1.8%	9.1%	112,918		12	705

(a) Based on company reports
(b) In mmcf per day
(c) Independents in green, majors in black, pipelines in red
(d) Based on annualized Q1'07 Production and 2006 natural gas reserves
(e) Source: Smith International Survey (operated rig count)
(f) APC 2Q '07 production is from continuing operations
(g) El Paso production is as of Q1'07

Source: Chesapeake, June 2008 Investor Presentation

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Producer Survey » Contact Template & Script

I'm _____ with Navigant Consulting.

We're working for the American Clean Skies Foundation to support them in their educational and research role as they go about explaining the advantages of natural gas as an environmentally clean and plentiful domestic energy supply resource.

The Foundation wants as current a picture as they can get of the current and expected state of development of shale, tight sands, and coal-bed methane.

We are initially focused on shale gas and so we are looking for the latest public estimates from the major operators in each shale gas play. So for [company name] that means [play names].

Can you share your company's current estimate of the total remaining proved reserves, the ultimate potential reserves, and any current and projected production for the shale gas play? Not your own acreage, but the whole play. Also, we'd need to know the date of the estimates.

We are also interested in your own company's acreage position and expected ultimate recoverability estimates from your company's position by shale gas play.

Basically, we're looking for the latest version of anything you've reported externally, or have shared in investor conferences.

We also will need the best, most current information we can get on the state of tight sands and coal-bed methane around the country. So anything you can share on either of those would be much appreciated. We may be back later with more questions in those areas.

Then, if possible, we'd also like to have a primary contact person for follow-up questions, to review anything we represent about what you've shared with us.

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Producer Survey » Results

Table: Count of Responses by Category

Questions	Responses	No Response	Total Questions
Total Remaining Proved Reserves in Play	8	155	163
Total Remaining Proved Reserves in your Acreage	48	128	176
Expected Ultimate Recoverability (EUR) for Play	15	153	168
Expected Ultimate Recoverability (EUR) for your Acreage	24	144	168
Estimate of Total Natural Gas Resource in Play	26	146	172
P2 Estimate (Proved + Probable)	12	160	172
P3 Estimate (Proved + Probable + Possible)	26	144	170
Current Play Production	32	141	173
Projected Play Production	13	158	171
Current Production for your Acreage	59	112	171
Projected Production for your Acreage	15	157	172
Acreage Position	128	48	176
Other	65	758	823
Total	**471**	**2,404**	**2,875**

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