

Gas Shales Drive the Unconventional Gas Revolution

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Unconventional Resources • Enhanced Recovery • Carbon Sequestration

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The "Paradigm Shift"

Driven by a new understanding of the size and availability of gas shales and unconventional gas, a "paradigm shift" is underway on natural gas supplies.

This "paradigm shift" began a decade ago in the U.S. with only modest fanfare.

- Low cost coalbed methane in the San Juan Basin of Colorado and New Mexico led the way.
- Next was the introduction of highly productive tight gas development at the Jonah and Pinedale fields in western Wyoming.
- Third was the emergence of the Barnett and now the other North American gas shales.

Gas Shales: *What's the Big Deal?*

"Shale Gas is the most important energy development since the discovery of oil"

Fred Julander,
CEO of Julander Energy

"Mission Critical: Can Shale Gas Save the World?"

ASPO, September 21, 2009

"Shale Gas Blasts Open World Energy Market"

The Sunday Times
November 1, 2009

Three Critical Questions

Three questions need to be addressed, if gas shales and other unconventional gas resources are to be a major pathway to a low-carbon future:

- ***Question #1. Will there be adequate supplies of natural gas?***

  Our company, Advanced Resources International, has undertaken detailed, basin-level assessments of gas shales and other unconventional gas resources. Similar work is underway by other companies and agencies.

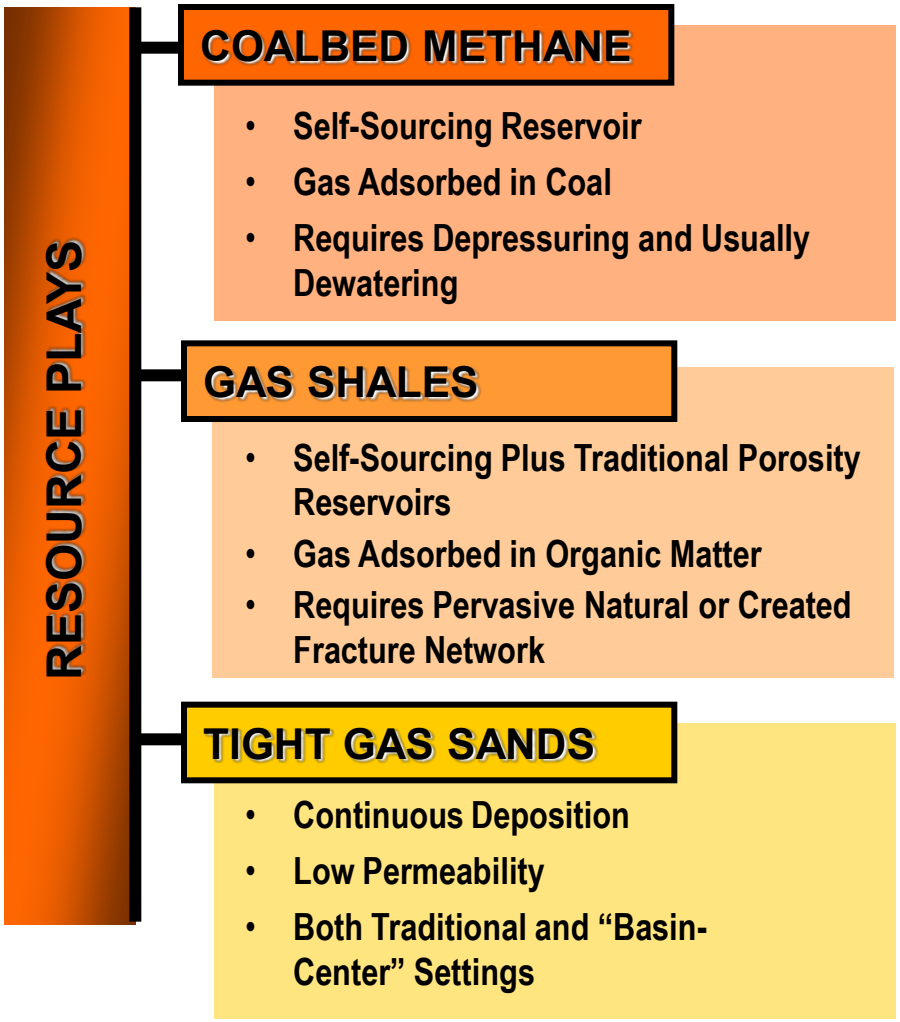
- ***Question #2. What role could technology play to assure natural gas supplies remain affordable?***

  Past R&D by DOE/NETL, GRI and industry has "cracked the technology code." Additional technology progress is needed to lower costs and improve productivity.

- ***Question #3. Can these new natural gas resources be developed in an environmentally sound way?***

  Significant segments of the industry are pursuing "green development" - - reducing surface impacts, re-using produced water and capturing methane emissions.

What Is Unconventional Gas?



- Unconventional gas formations are "continuous", deposited over large areas rather than in discrete traps.
- The geologic setting of unconventional gas is several orders more complex than conventional gas.
- For coalbed methane and gas shales, the gas source, trap and reservoir are the same, not three distinct elements as for conventional gas.

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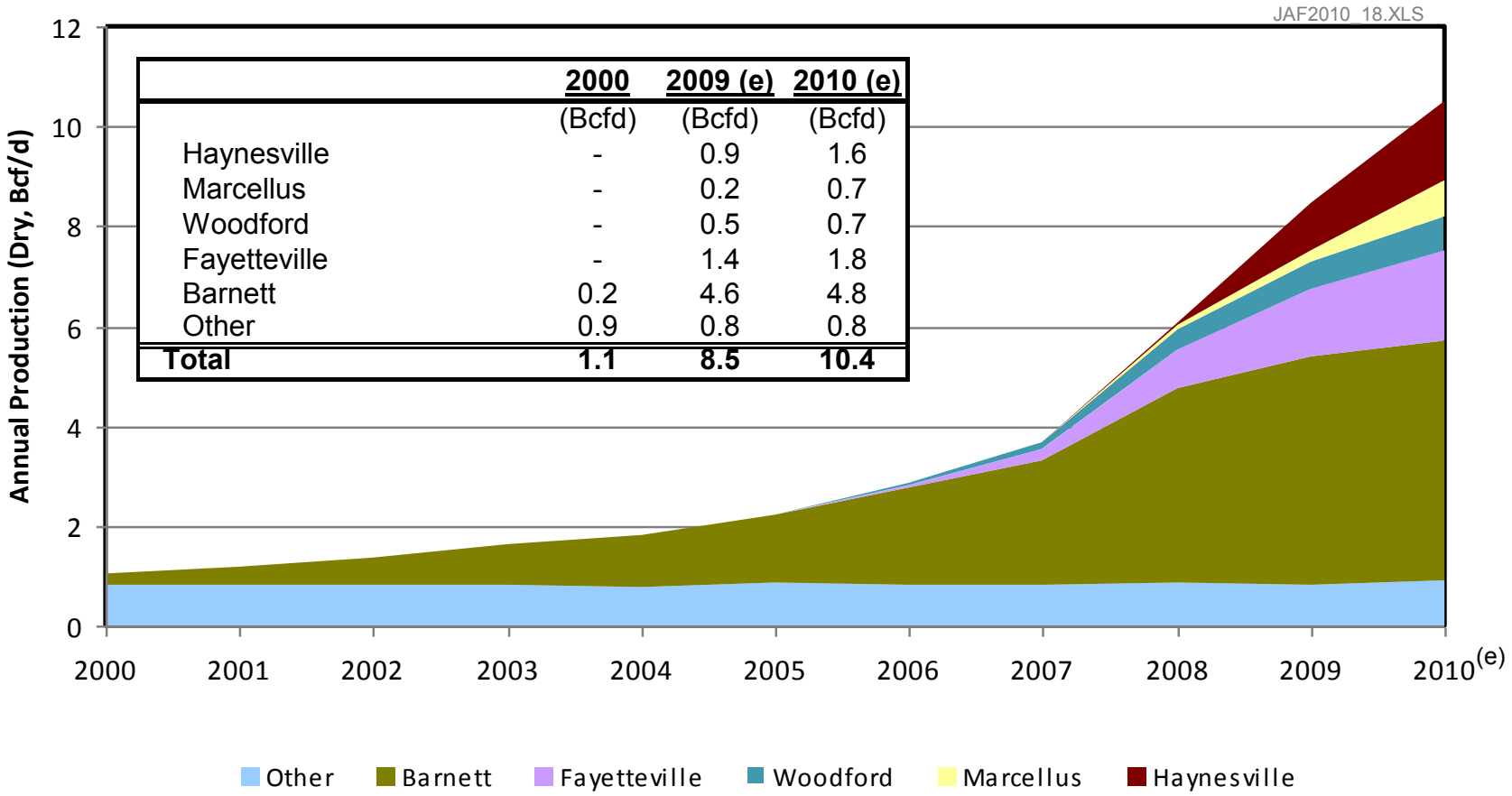
How Much Do Gas Shales Contribute Today?

Production of gas shales has gown by ten-fold and is expected to reach 10 Bcfd, equal to 18% of U.S. natural gas production this year.



	2000 (Bcfd)	2009 (e) (Bcfd)	2010 (e) (Bcfd)
Haynesville	-	0.9	1.6
Marcellus	-	0.2	0.7
Woodford	-	0.5	0.7
Fayetteville	-	1.4	1.8
Barnett	0.2	4.6	4.8
Other	0.9	0.8	0.8
Total	**1.1**	**8.5**	**10.4**

Source: Advanced Resources International (2010)

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How Large is the Gas Shale Resource?

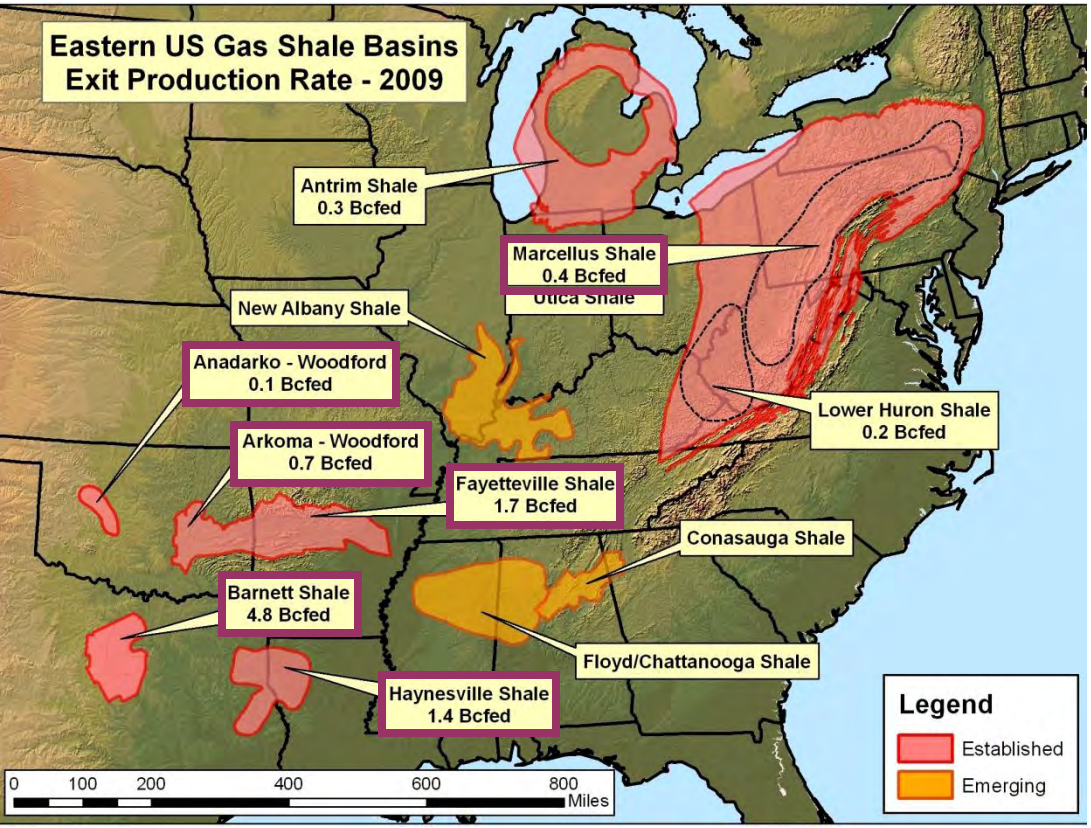
We have completed in-depth assessments of the "*Magnificent Seven*" North American gas shale basins which dominate today's activity.

Gas Shale Basins	Resource Endowment	Remaining Recoverable Resource*
	Tcf	Tcf
U.S. (5 Basins)	3,420	470
Canada (2 Basins)	1,380	240

*Approximately 25 Tcf has been produced or place into proved reserves.

Other eastern gas shale plays in the U.S. - - Antrim, Huron, Eagle Ford and Utica - - plus the numerous Western Shale basins add to this total.

Eastern U.S. Gas Shale Basins



Source: Advanced Resources International

Five of the "Magnificent Seven" gas shale plays are in the Eastern U.S.

	Resource Endowment (Tcf)	Produced/ Proved Reserves (Tcf)*	Undeveloped Recoverable Resource (Tcf)*
Barnett	250	19	40
Fayetteville	320	3	50
Woodford	300	2	30
Haynesville	790	1	130
Marcellus	1,760	-	220
Total	**3,420**	**25**	**470**

*As of end of 2008.

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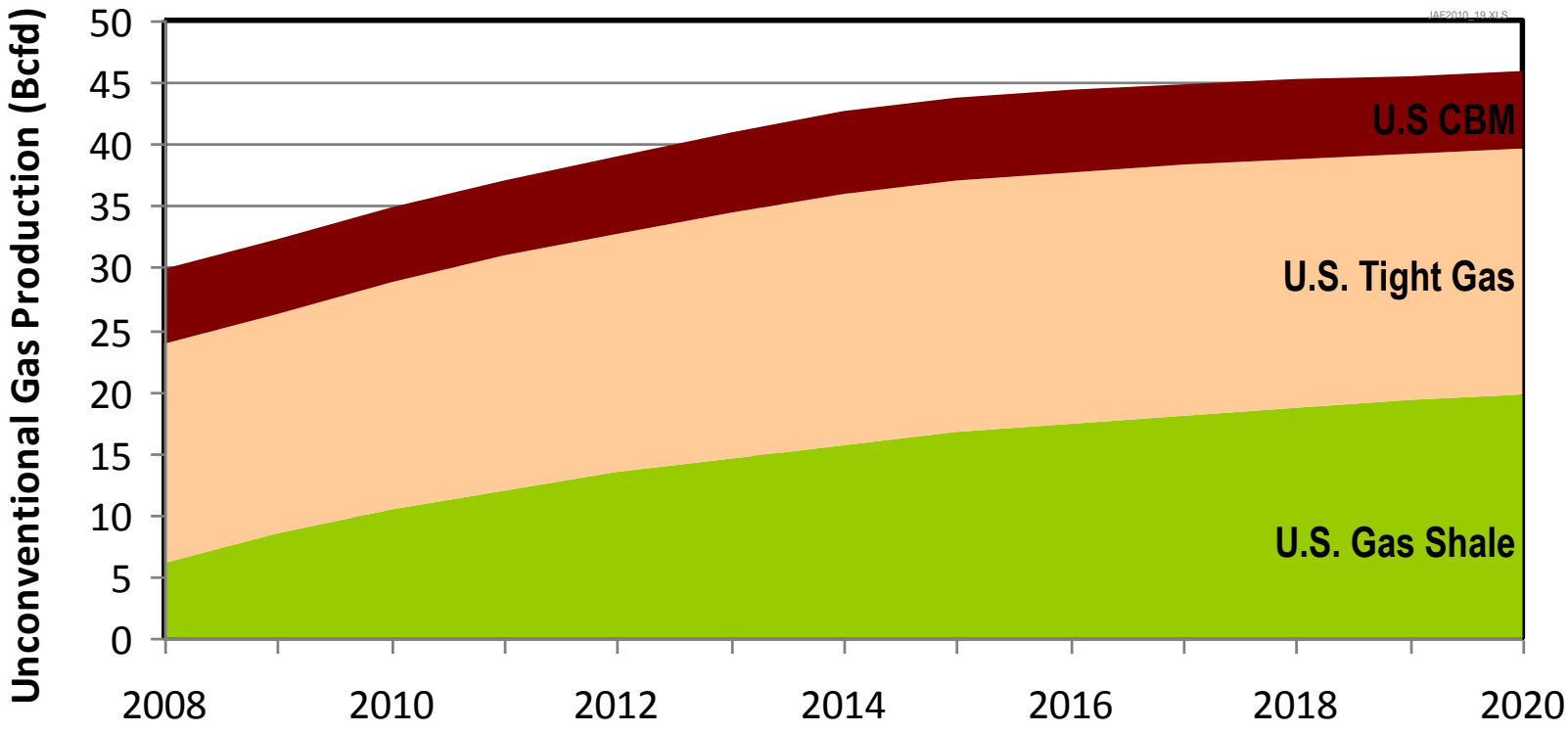
Other Unconventional Gas Resources

While the most visible, gas shales are only one of the unconventional gas resources under development today:

- ***Coalbed Methane***, including the mighty San Juan coal basin, provides 5 Bcfd.
- ***Tight Gas Sands***, in both the Rockies, the Mid-West and East, Texas, provide 18 Bcfd.

By year 2020, we look for unconventional gas (including gas shales, coalbed methane and tight gas) to provide 46 Bcfd and account for over two-thirds of total U.S. natural gas production.

Projected Gas Shale and Unconventional Gas Production*



Source: Advanced Resources International, Model of Unconventional Gas (MUGS) (2009).

*Assuming sufficient demand and a natural gas price ($US, Henry Hub) of $7/MMBtu.

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Question #2. What role could technology play to assure natural gas supplies remain affordable?

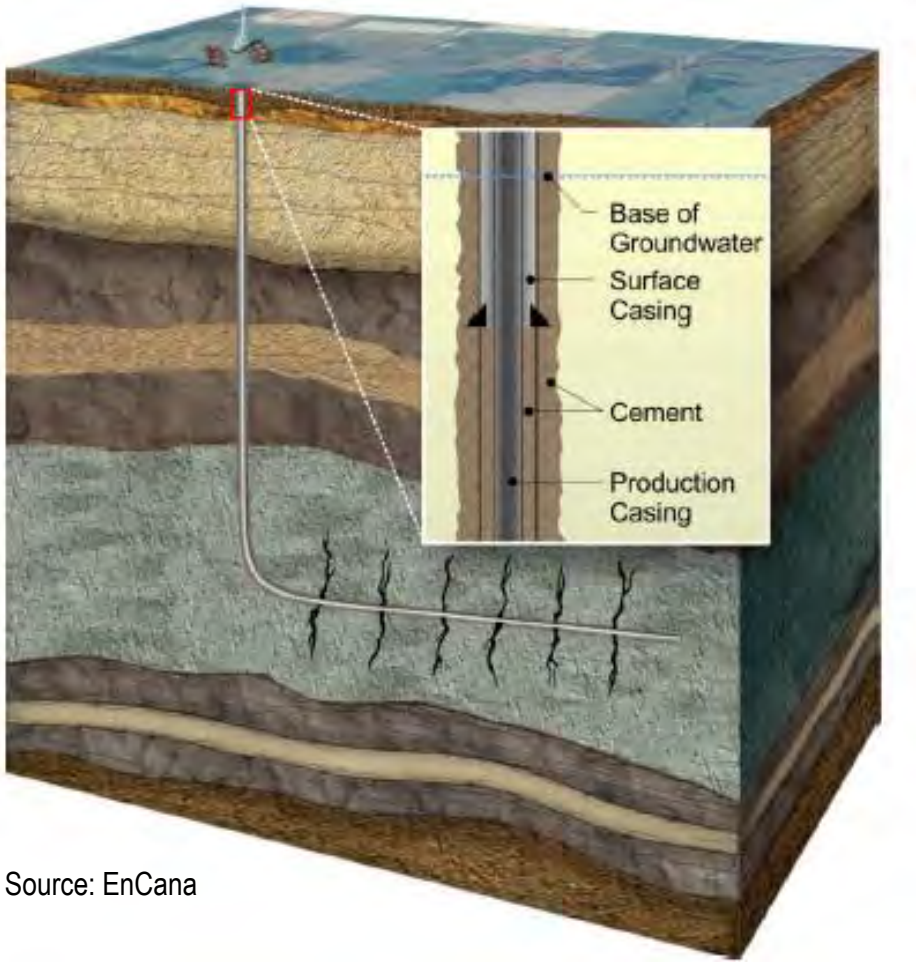
Gas shales and unconventional gas are a R&D and policy success story:

- The DOE/NETL helped build the essential resource and science knowledge base.
- The Gas Research Institute and industry launched the early technology demos.
- Section 29 tax credits (now expired) helped attract capital and build economies of scale.

However, we are still in the early, emerging stages of having an optimum set of technologies appropriate for the large lower quality portion of the unconventional gas resource.

What Changed the Game?

Horizontal Well with Multi-Stage Fracturing



Source: EnCana

Natural gas production from shallow, fractured shale formations in the Appalachian and Michigan basins of the U.S. has been underway for decades.

What "changed the game" was the recognition that one could "create a permeable reservoir" and high rates of gas production by using intensively stimulated horizontal wells.

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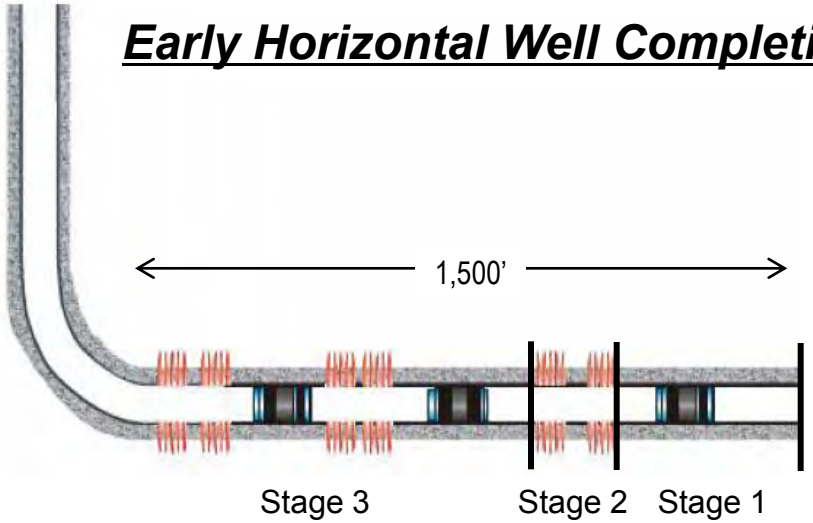
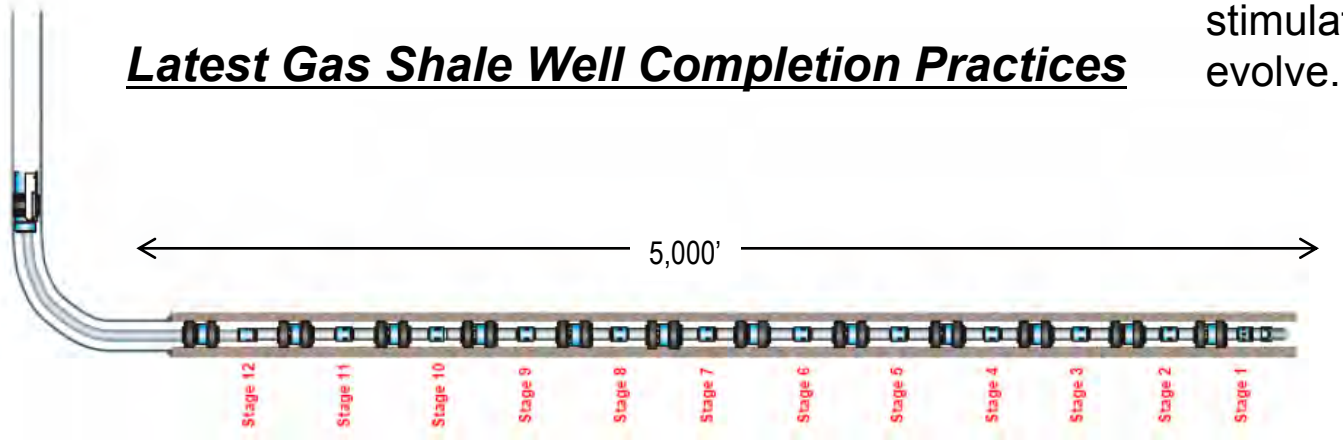
What Changed the Game?

Early Horizontal Well Completion Practices



Latest Gas Shale Well Completion Practices



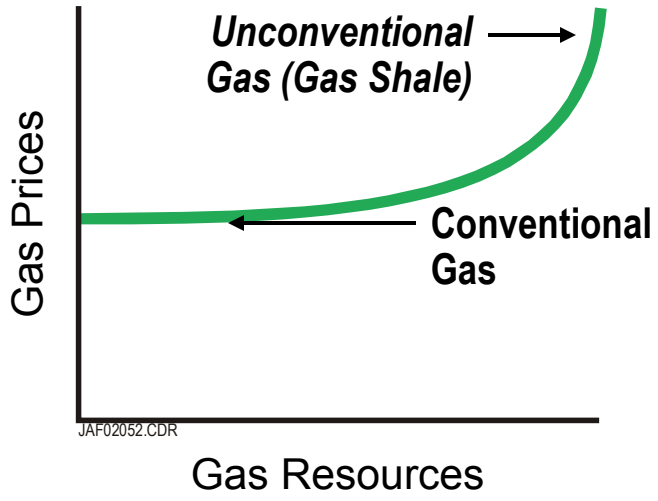
This break-through in knowledge and technology enabled the numerous deep, low permeability gas shale formations to become productive, making the Barnett Shale "the largest natural gas field in Texas".

Meanwhile, horizontal well lengths and intensity of stimulation continue to evolve.

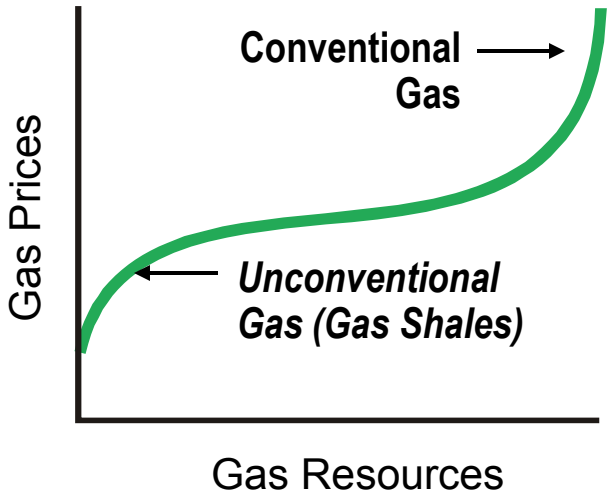
Will Gas Shale and Unconventional Gas Remain Economically Affordable?

Unconventional gas (particularly the higher quality gas shales) is today the low cost portion of the natural gas price/supply curve. Progress in technology can help unconventional gas remain an affordable resource.

Prior Perception



New Understanding



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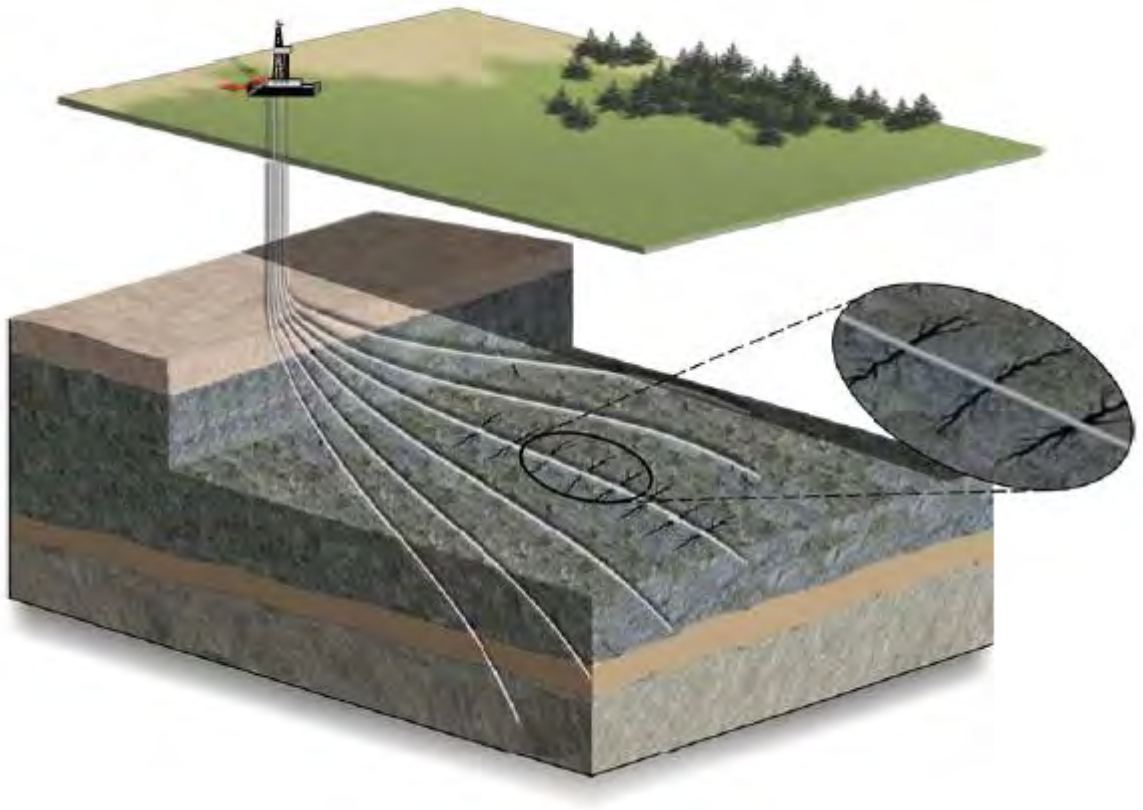
Question #3. Can these new natural gas resources be developed in an environmentally sound way?

As drilling increases and production grows, a harsher spotlight will fall on natural gas. "Green natural gas development" will help put a more environmentally friendly face on this activity.

- Reducing Surface Impacts
- Capturing Methane Emissions
- Re-Using Produced Water

"Green" Unconventional Gas Development

Reducing Land Use Impacts with Multi-Well Pads and Horizontal Wells



Source: Canadian Association of Petroleum Producers, 2010

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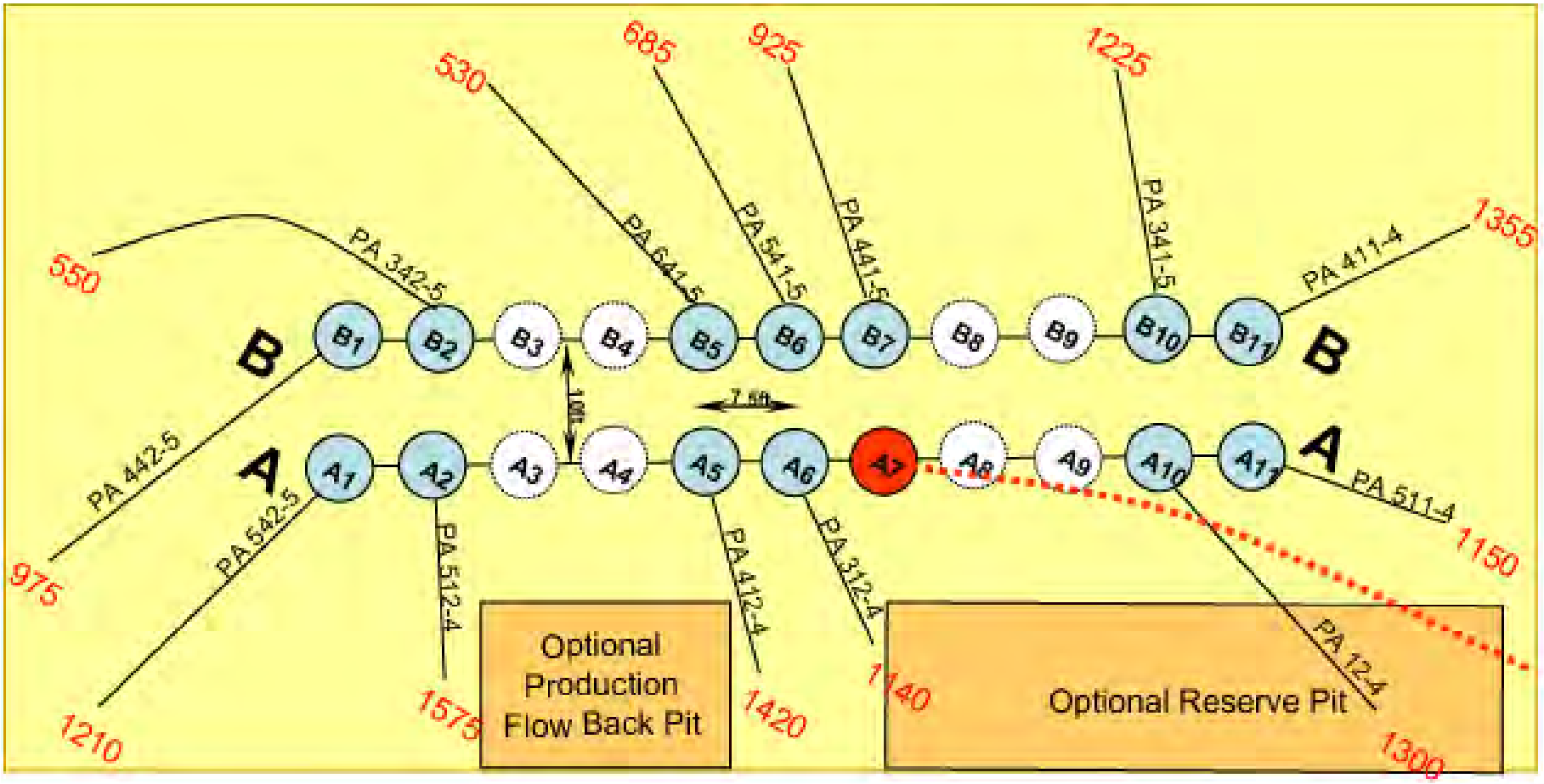
Drilling Multiple (22) Wells From A Single Well Pad

(Williams Fork/MV, Piceance Basin)



Source: Williams, 2007

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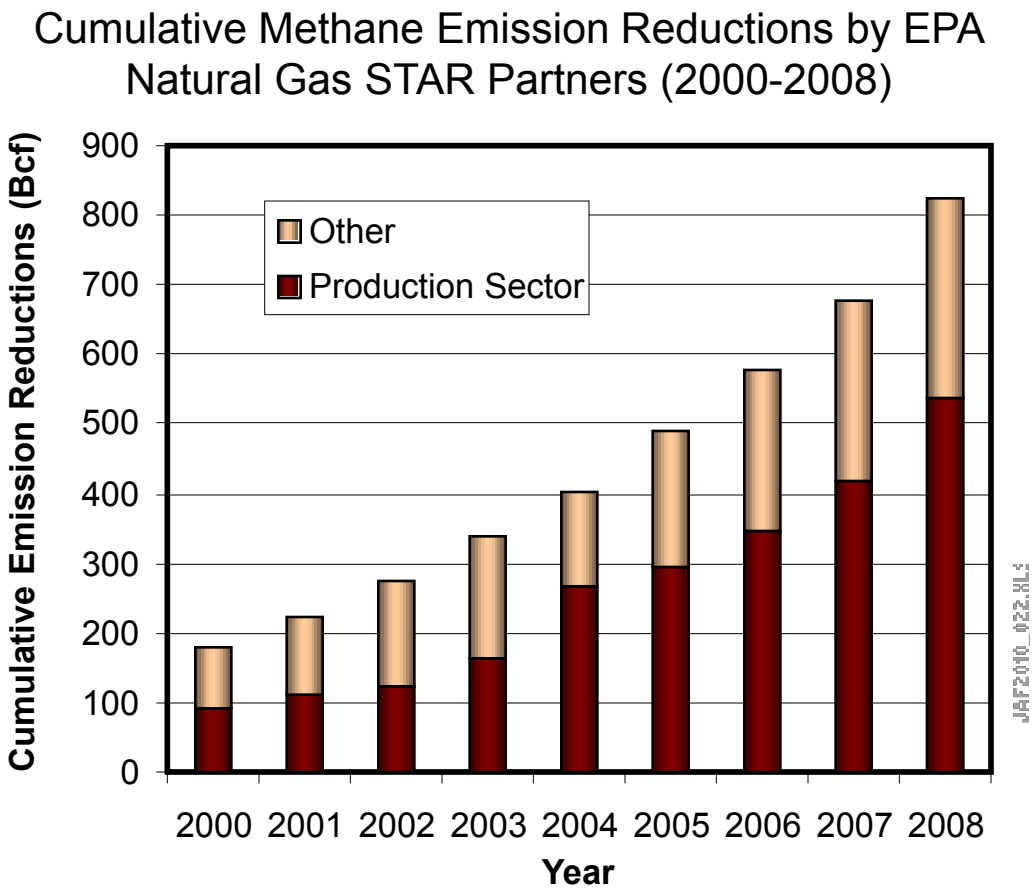
Voluntarily Reducing Methane Emissions



- Since 1990, Natural Gas Star partners have eliminated over 500 Bcf of methane emissions from the oil and gas production sector.
- Williams reports 24 Bcf of methane emissions captured with costs of $17 million and revenues of $159 million.

Source: U.S. Environmental Protection Agency (www.epa.gov.gasstar/accomplish.htm)

Welcome to the Natural Gas STAR Program

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Concluding Remarks

Our work to date shows that the nation has large supplies of gas shales and unconventional gas.

Progress in technology can help keep these natural gas supplies affordable, encouraging their greater use in power generation and transportation.

With “green development practices”, these large resources can be developed in an environmentally sound way.

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