

Worldwide Gas Shales and Unconventional Gas: A Status Report

Prepared By:
Vello A. Kuuskraa, President
Scott H. Stevens, Vice President
ADVANCED RESOURCES
INTERNATIONAL, INC.
Arlington, VA

December 12, 2009
Copenhagen, Denmark

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 world natural gas supplies.

This “paradigm shift” began a decade ago in North America 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.

The final segment of the “paradigm shift” - - the worldwide pursuit of gas shales and unconventional gas - - has only just started, with Australia, China and Europe in the lead. Europe, still in “dress rehearsal”, could also emerge with a lead role.



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Gas Shales: What's the Big Deal?

“Shale Gas Blasts Open World Energy Market”

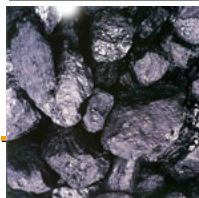
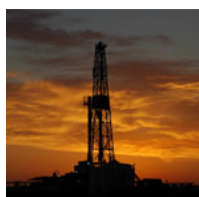
The Sunday Times
November 1, 2009

“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?”

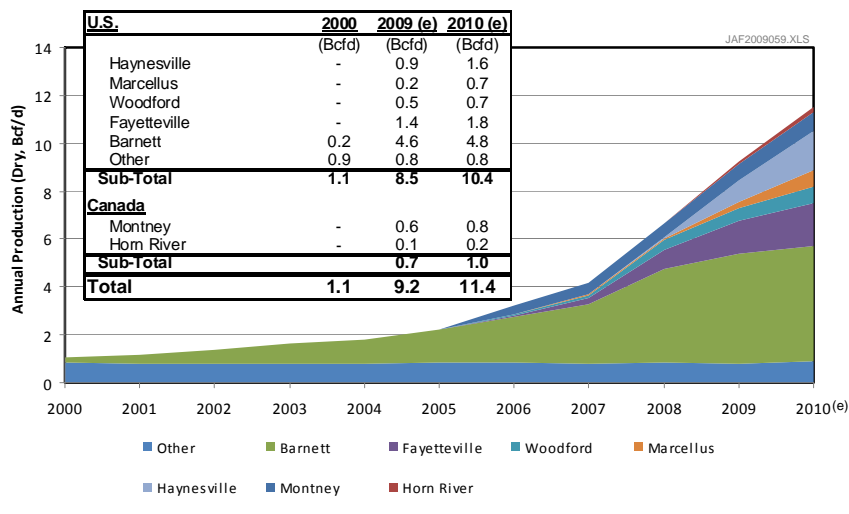
ASPO, September 21, 2009



The North American Gas Shale and Unconventional Gas Experience

How Much Do Gas Shales Contribute Today?

Production from North American gas shales has grown by ten-fold during this decade and is expected to exceed 11 Bcf/d (320 Mcmd) this coming year.



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How Large is the Gas Shale Resource?

We have completed basin-level assessments of the "Magnificent Seven" North American gas shales which dominate activity.

Gas Shale Basins	Resource Endowment		Recoverable Resource	
	Tcf	Tcm	Tcf	Tcm
U.S. (5 Basins)	3,760	107	475	13
Canada (2 Basins)	1,380	39	240	7

The resource endowment for these "Magnificent Seven" gas shales of 146 Tcm (5,140 Tcf) already exceeds Rogner's (1997) estimate for all of North American gas shale of 109 Tcm (3,840 Tcf).

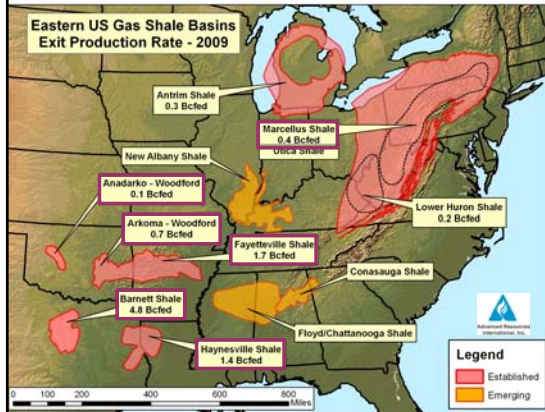
The numerous still to be defined and smaller gas shale plays in the U.S. (e.g., Antrim, Huron, Eagleford) and in Canada (e.g., Liard, Cordova and Utica) will add to these totals.

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JAF028151.PPT December 7, 2009



Eastern U.S. Gas Shale Basins

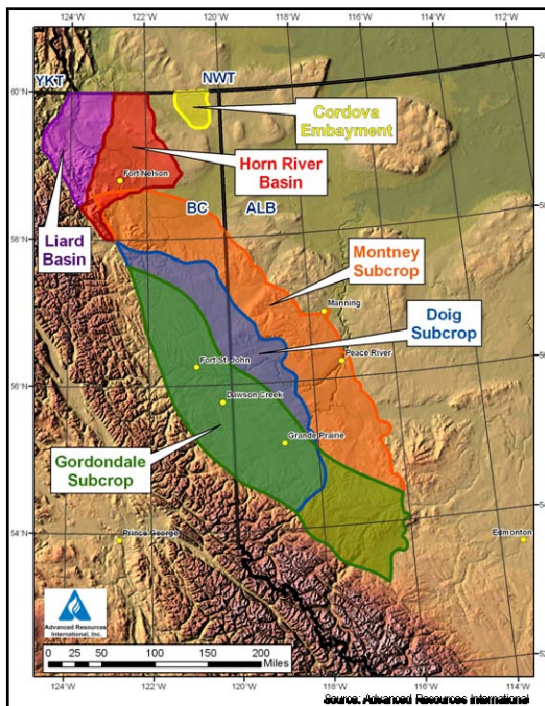


Five of the "Magnificent Seven" gas shale plays are in the Eastern U.S.

	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	2,100	-	200
Total	3,760	25	450

Source: Advanced Resources International

*As of end of 2008.



Western Canada Gas Shale Basins

Canada's Horn River and Montney are two of the "Magnificent Seven" gas shale plays.

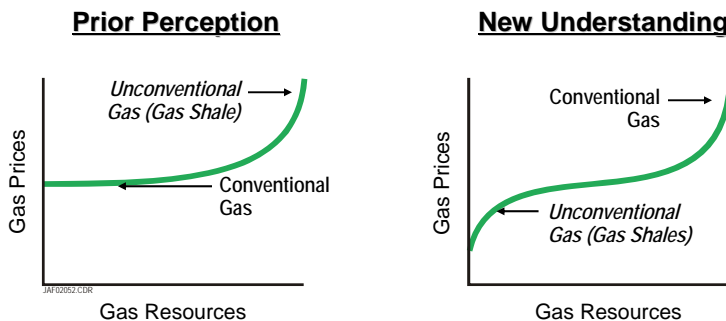
	Resource Endowment (Tcf)	Recoverable Resource (Tcf)
Horn River	760	130
Montney*	620	110
Total	1,380	240

Source: Advanced Resources International



Are Gas Shales Economically Affordable?

With a new understanding of supply costs, unconventional gas and particularly the higher quality gas shales make up the low cost portion of today's North American natural gas price/supply curve.



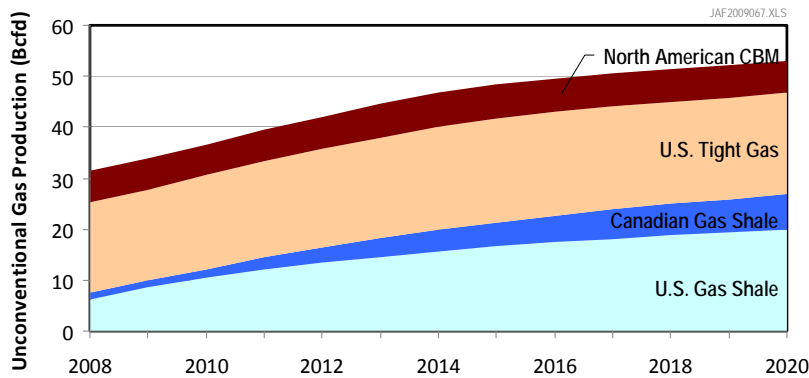
Other North American Unconventional Gas Resources

While the most visible, gas shales are only one of the unconventional gas resources under development in North America.

- **Coalbed Methane**, which had its start in the U.S. San Juan coal basin, provides over 5 Bcfd (150 Mcmd) in North America.
- **Tight Gas Sands** provides nearly 18 Bcfd (500 Mcmd) in the U.S.

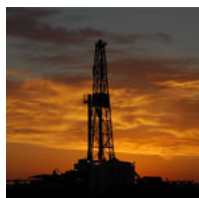
Adding coalbed methane and tight gas to our expectations from gas shales, we look for unconventional gas to provide 52 Bcfd (1,470 Mcmd) by 2020 and account for nearly two-thirds of total North American natural gas production.

Projected North American Gas Shale and Unconventional Gas Production*



Source: Advanced Resources International (2009)

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



World Gas Shales and Unconventional Gas

How Big Are World Gas Shale Resources?

All currently published resource estimates for world gas shales start with Rogner's 1997 study ⁽¹⁾:

- Gas Shale Resource Endowment: 16,110 Tcf (456 Tcm)

The International Energy Agency "World Energy Outlook (2009)" assumed that about 40% of Rogner's resource endowment would become recoverable:

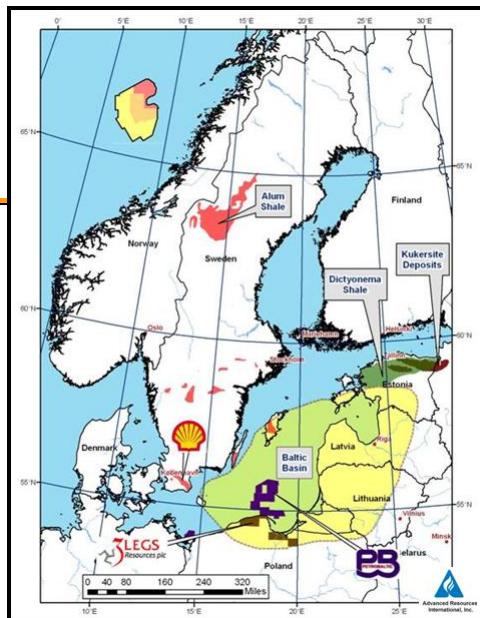
- Gas Shale Recoverable Resource: 6,350 Tcf (180 Tcm)

While undoubtedly large, only basin- and play-level ("bottom up") appraisals of the diverse gas shale basins of the world will build confidence on the size, quality and producibility of this natural gas resource.

⁽¹⁾ Rogner, H. H., 1997, "An Assessment of World Hydrocarbon Resources", *Annual Review of Energy and Environment*.



European Gas Shales: Overview



While gas shale exploration is underway in many of the European basins, three areas stand out - - the Alum Shale of Sweden, the Silurian Shales of Poland and the Mikulov Shale of Austria.

Our preliminary gas shale resource assessment is 1,000+ Tcf (~30 Tcm), with a potential recoverable resource of 140 Tcf (4 Tcm).



World Gas Shales: Overview

A number of the major and leading independent oil and gas companies are circling the globe looking for high quality gas shales. Based on the experience to date in North America and Europe, it is likely that Rogner's resource endowment estimate for gas shales of 16,110 Tcf (456 Tcm) will prove to be conservative.

- **China and India.** Both China and India have numerous gas shale basins that are only now starting to be evaluated. Just recently, Shell and PetroChina announced plans to jointly evaluate and develop the gas shales in Sichuan Province.
- **Other Countries.** Gas shale exploration is underway in many other parts of the world, including Australia, New Zealand and Southern Africa where Statoil, Chesapeake and Sasol recently announced joint plans.

How Large Are the Other World Resources of Unconventional Gas?

Coalbed methane (CBM), which once enjoyed the spotlight and enthusiasm as the gas shales of today, is one of the "other" unconventional gas resources.

- Our company, along with many others, toured the world looking for the next "San Juan Basin Fairway" and its world class CBM resource.
- Our country-by-country assessment of CBM is 3,540 to 7,630 Tcf (100 to 216 Tcm), with an estimated 830 Tcf (24 Tcm) recoverable.

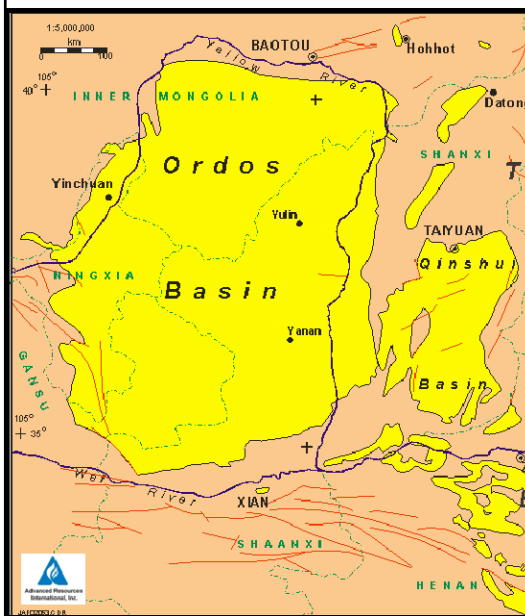
Tight gas sands, which today is still the largest source of North American unconventional gas, is only now starting to be developed, with prospective basins in South America, the Middle East and China.

- Rogner's resource endowment estimate for tight gas is 7,400 Tcf (210 Tcm).
- The IEA's estimate of recoverable tight gas resource (starting with Rogner's in-place values) is 390 Tcf (110 Tcm).

Much work remains for defining the tight gas sand resources of the world.

World Coalbed Methane Resources (Tcf)

Country	CBM Resource In-Place (Tcf)	CBM Recoverable Resource (Tcf)
Russia	450-2,000+	200
China	700-1,270	100
United States	500-1,500	140
Australia/New Zealand	500-1,000	120
Canada	360-460	90
Indonesia	340-450	50
Southern Africa (incl. Carbonaceous Shales)	90-220	30
Western Europe	200	20
Ukraine	170	25
Turkey	50-110	10
India	70-90	20
Kazakhstan	40-60	10
South American/Mexico	50+	10
Poland	20-50	5
TOTAL (Tcf)	3,540-7,630	830
TOTAL (Tcm)	(100-216)	(24)



China's CBM, Tight Gas and Gas Shale Resources Are Large and Challenging

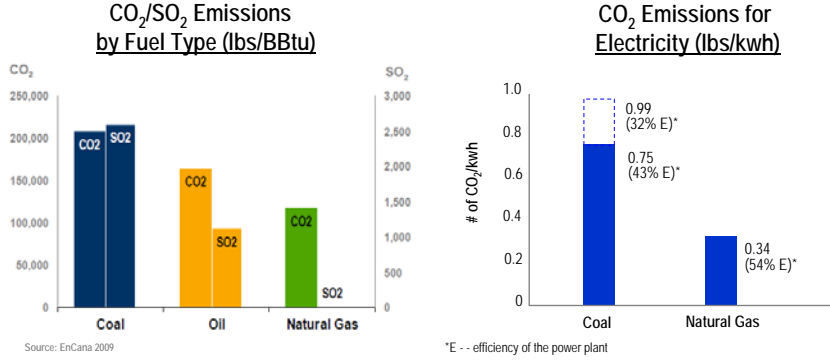
- CBM: 1,270 Tcf GIP. Over 3,000 drilled wells; horizontal CBM wells show promise in the Qinshui Basin.
- Tight Gas: Producing >400 MMcfd from the Ordos Basin.
- Recently, Shell and PetroChina signed an agreement to appraise the gas shale basins of Sichuan.

Source: Advanced Resources International



The Challenge Now Is Building Demand for Natural Gas in a Carbon Constrained World

The natural gas resource base, particularly with the worldwide pursuit of gas shales and unconventional gas, is large. It could provide lower CO₂ emissions options for power generation and possibly for transportation than from continued use of coal and oil.



Source: EnCana 2009



Office Locations
 Washington, DC
 4501 Fairfax Drive, Suite 910
 Arlington, VA 22203
 Phone: (703) 528-8420
 Fax: (703) 528-0439

Houston, Texas
 11490 Westheimer, Suite 520
 Houston, TX 77042
 Phone: (281) 558-6569
 Fax: (281) 558-9202

