Economic and Market Impacts of Abundant International Shale Gas Resources

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Unconventional Resources • Enhanced Recovery • Carbon Sequestration

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The Paradigm Shift in International Natural Gas Supplies

Driven by new understandings of the size and productivity of shale gas (and unconventional gas), a "paradigm shift" is underway on natural gas supplies.

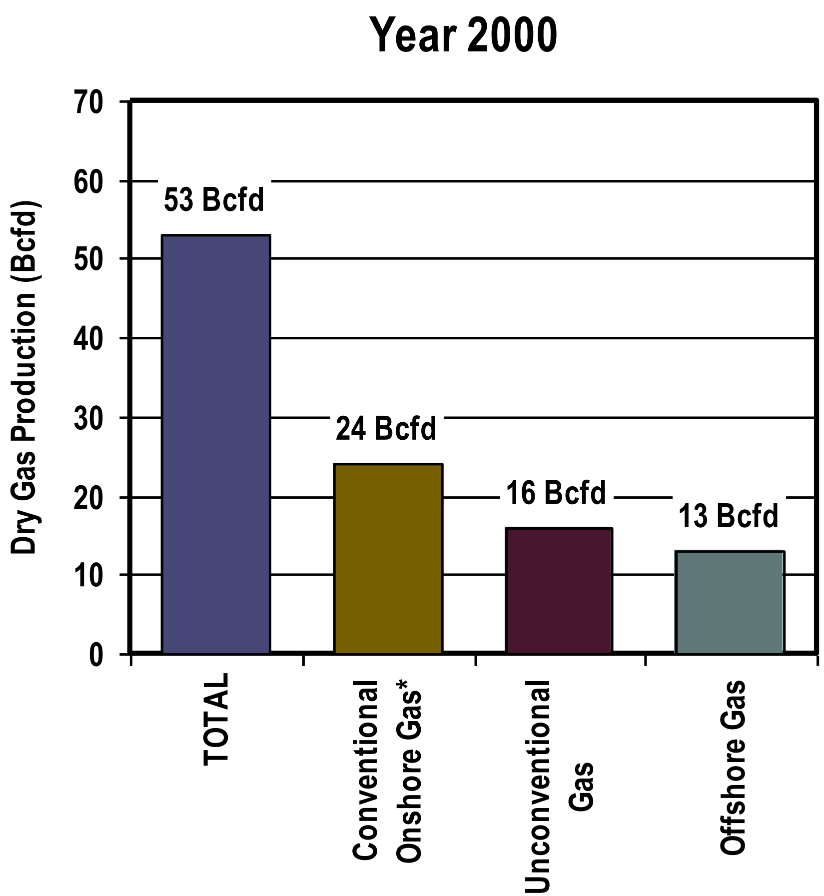
This "paradigm shift" began a decade ago in the U.S., with only modest fanfare, but has grown in momentum and importance with continued improvements in technology and technical understanding.

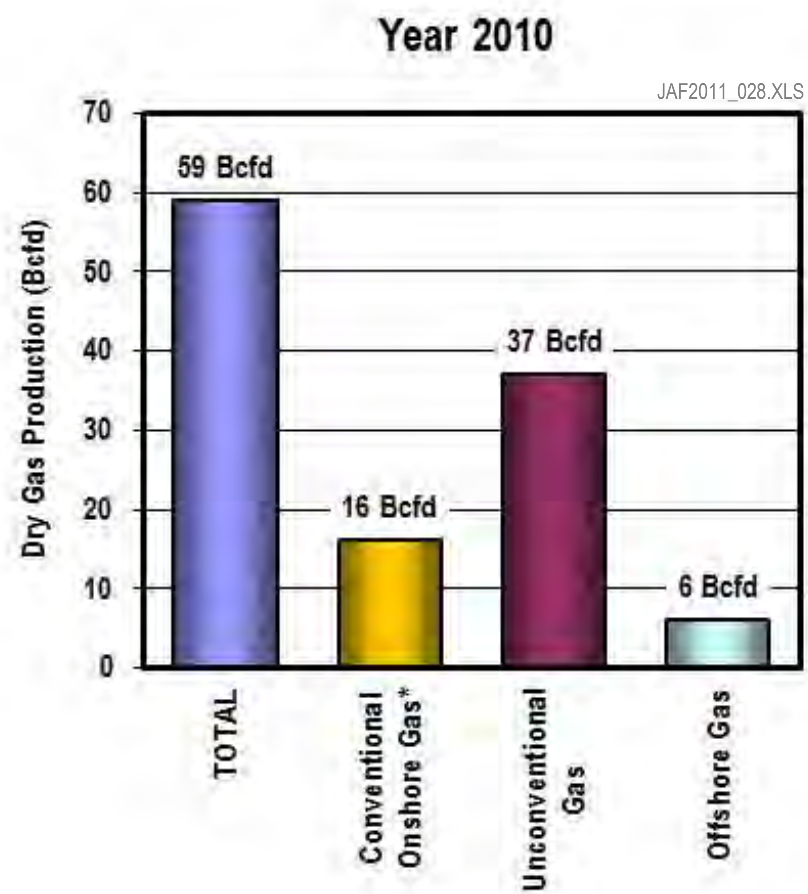
- It began with the discovery of low-cost coalbed methane in the San Juan Basin and the highly productive tight gas sand at Jonah and Pinedale.
- The emergence of the Barnett and the other major U.S. shale gas plays further established the "game changing" importance of unconventional natural gas.

Now, with the recognition that large shale gas resources exist worldwide, this paradigm shift is likely to reach far beyond our border.

Unconventional Gas Is Now the Dominant Source of U.S. Natural Gas Production

Growth in unconventional gas production, now providing over 60% of U.S. natural gas supply, has more than replaced declines in conventional onshore and offshore production.





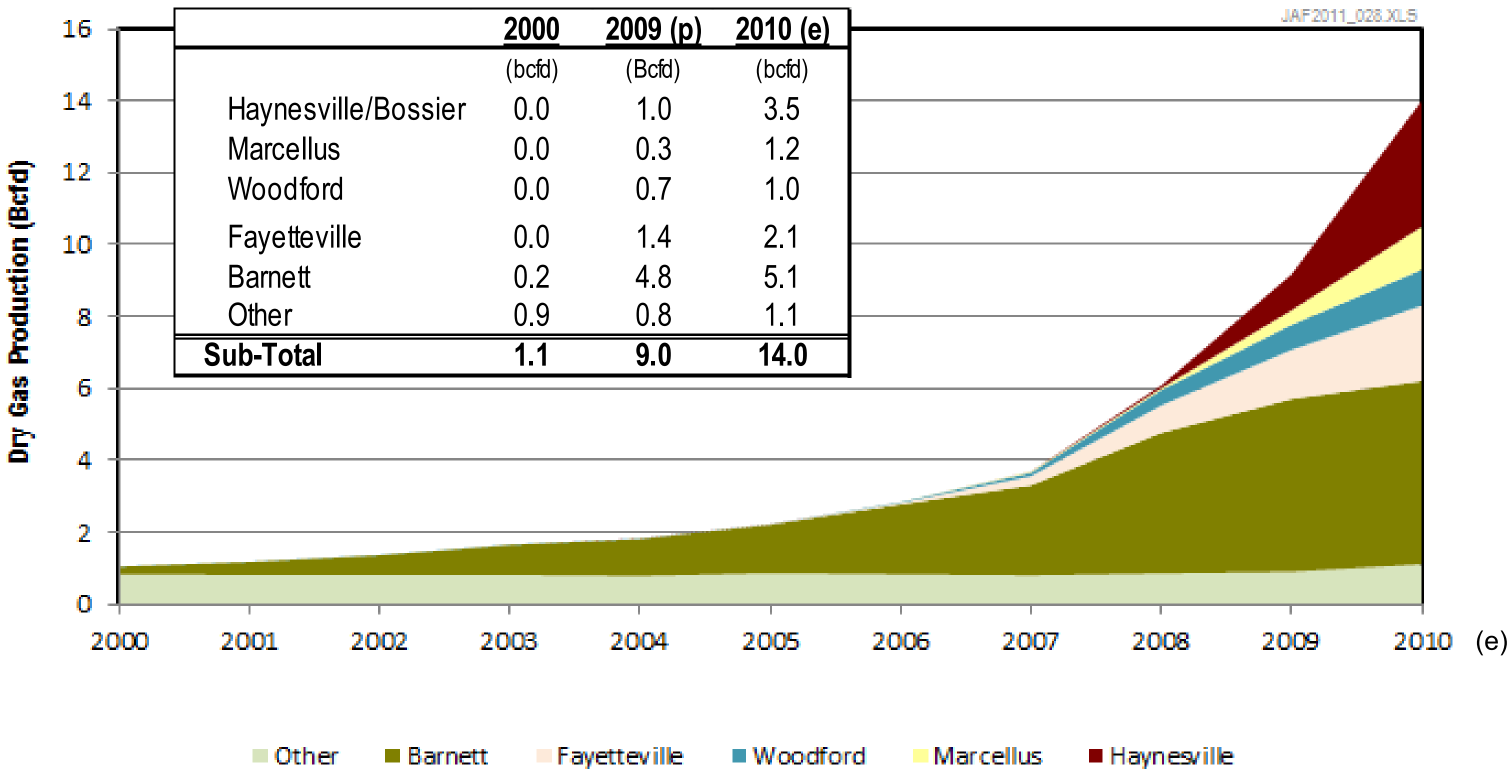
*Includes onshore associated, non-associated and Alaska.
Source: U.S. Energy Information Agency (2010); Advanced Resources Int'l (2010).

How Much Does U.S. Shale Gas Contribute Today?

Production of shale gas has grown by ten-fold and provided 14 Bcfd, equal to nearly a quarter of U.S. natural gas production.

Annual Shale Gas Production, Wet (Bcfd)

	2000	2009 (p)	2010 (e)
	(bcfd)	(Bcfd)	(bcfd)
Haynesville/Bossier	0.0	1.0	3.5
Marcellus	0.0	0.3	1.2
Woodford	0.0	0.7	1.0
Fayetteville	0.0	1.4	2.1
Barnett	0.2	4.8	5.1
Other	0.9	0.8	1.1
Sub-Total	**1.1**	**9.0**	**14.0**



Source: Advanced Resources International (2010)

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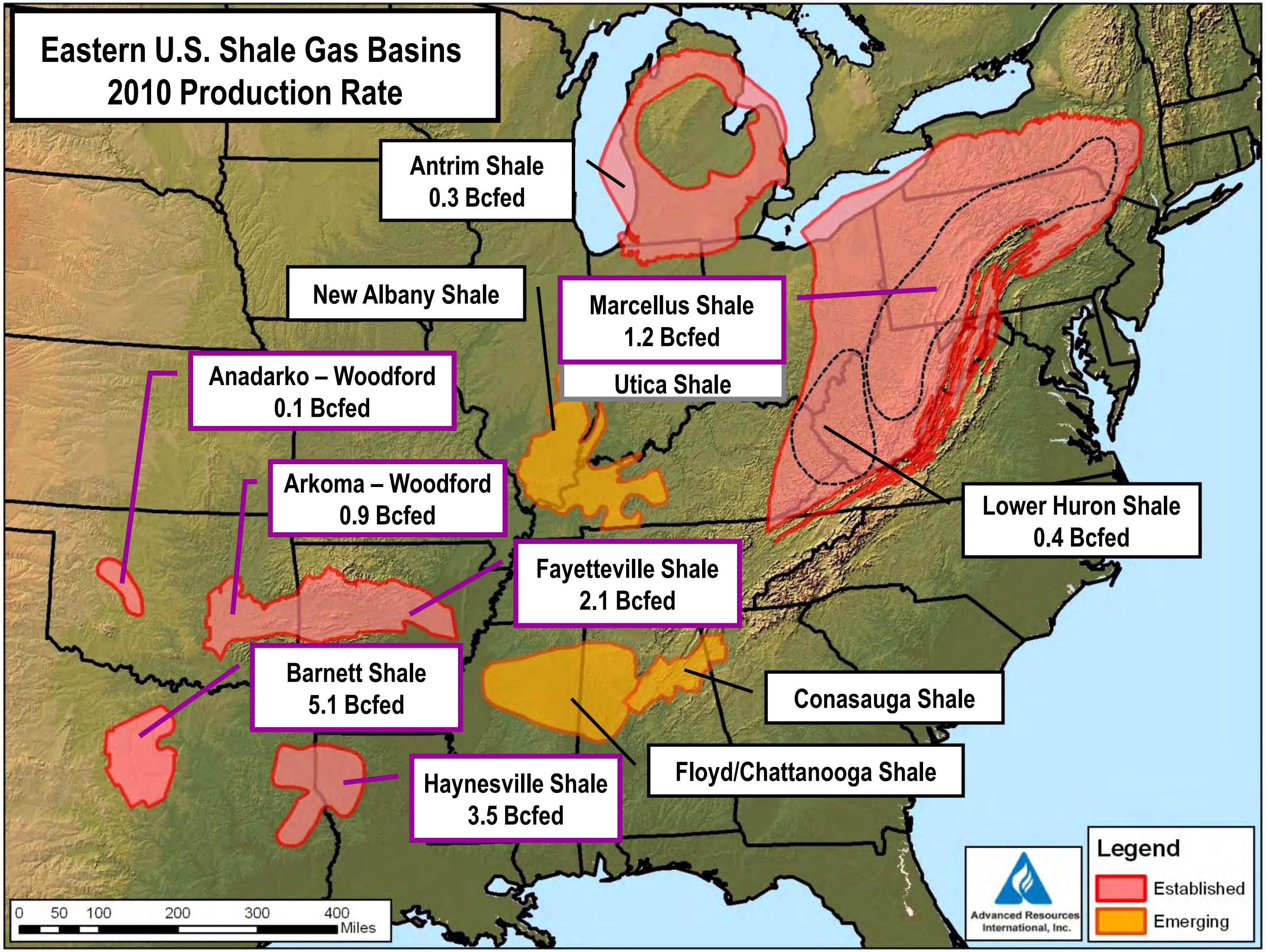
U.S. Shale Gas Basins

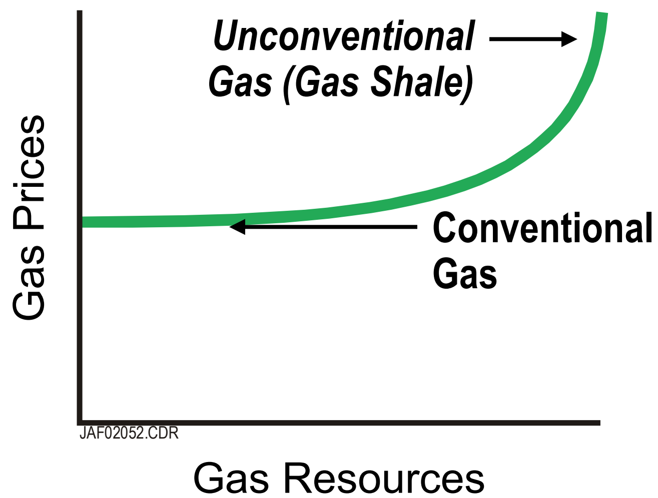


Source: Advanced Resources International

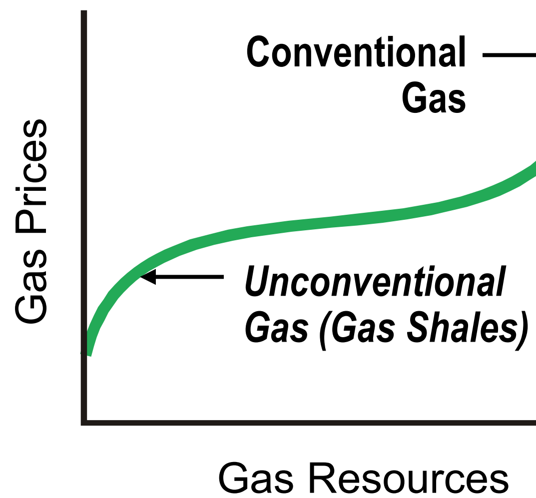
How Have Shale Gas and Unconventional Gas Impacted Natural Gas Prices?

Unconventional gas (particularly the higher quality gas shales) is today the low cost portion of the natural gas price/supply curve.

Prior Perception



New Understanding



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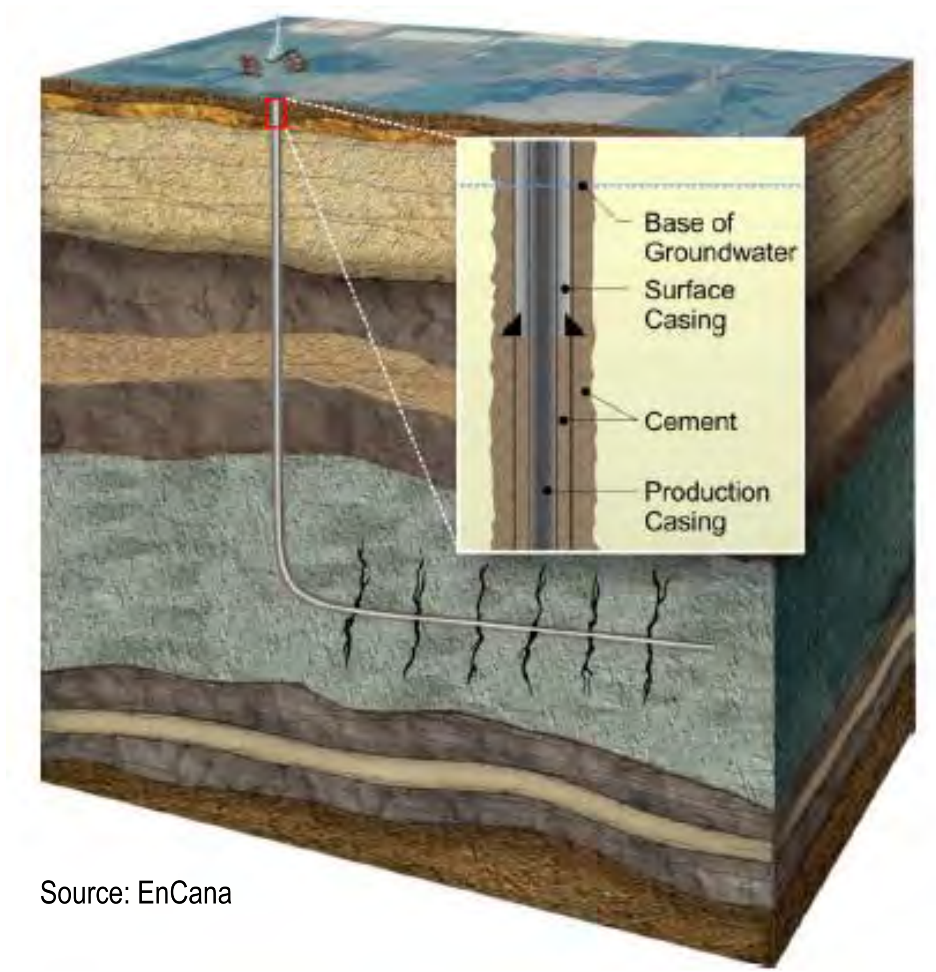
What Changed the Game?

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.

Progress in Technology Converted and Unproducible Resource into a Large, Low Cost Source of Energy

Shale gas 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.

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Progress in Technology Lowers Costs of Producing Gas Shales

An example of the impact of technology progress and continuing cost reductions is provided by improvements in well performance for the Fayetteville Shale.

Time Frame	New Wells on Production	Average IP Rate (Mcf/d)	Average 30th Day Rate	Average Lateral Length
1st Qtr 2007	58	**1,260**	**1,070**	2,100
2nd/3rd/4th Qtr 2007	197	1,770	1,490	2,750
1st Qtr 2008	75	**2,340**	**2,150**	3,300
2nd/3rd/4th Qtr 2008	244	2,920	2,480	3,720
1st Qtr 2009	120	**2,990**	**2,540**	3,870
2nd/3rd/4th Qtr 2009	326	3,670	2,720	4,170
1st Qtr 2010	106	**3,200**	**2,390**	4,350
2nd/3rd/4th Qtr 2010	447	3,400	2,550	4,570
1st Qtr 2011	137	**3,230**	**2,670**	4,980

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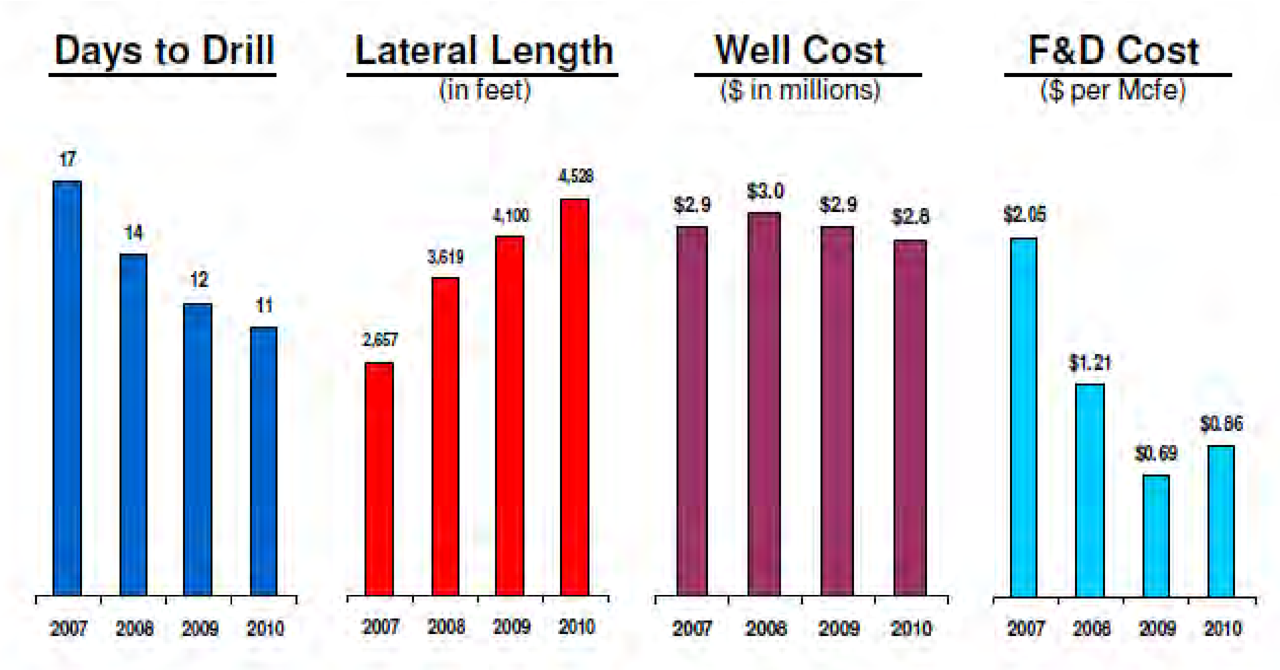
Cost Reduction and Performance Improvements

Case Study: Fayetteville Shale. This shale play, currently producing 2.6 Bcfd (end of 2010), began active development with horizontal wells in 2007. The combination of increased drilling efficiencies, lower well costs for longer horizontal wells, and significantly increased well performance has lowered F&D costs from $2.05/Mcf in 2007 to $0.86/Mcf in 2010.



Source: Southwestern Energy 2011

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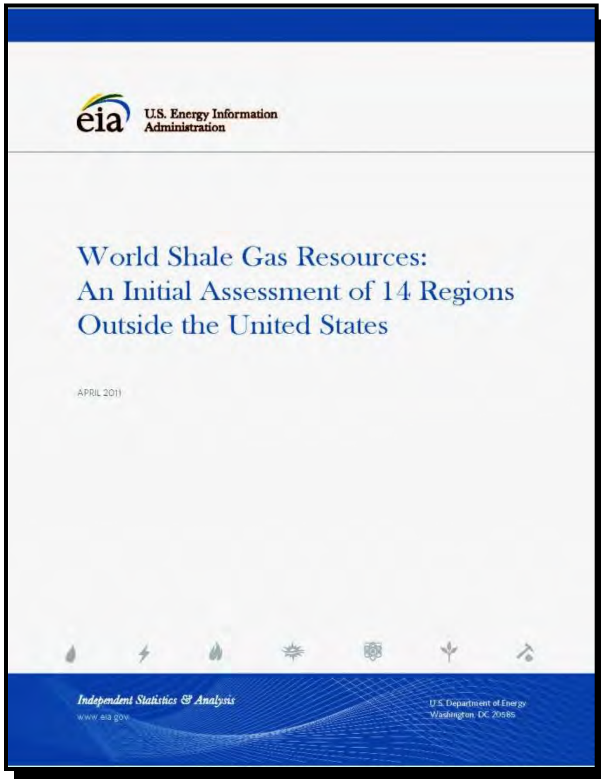
Addressing the Fundamental Questions for International Shales

Clearly, the emergence of shale gas has had a profound impact on U.S. natural gas markets and our outlook for future natural gas supplies.

Projecting the impact of shale gas and unconventional gas for the rest of the world requires that we first address a series of fundamental questions:

- *How large is the shale gas resource base?*
- *Where are the high quality ("hot spot") shale gas plays?*
- *Will the shale gas resource be developed in an environmentally sound way?*

"International Shale Gas Assessment"


eia U.S. Energy Information Administration

World Shale Gas Resources:
An Initial Assessment of 14 Regions
Outside the United States

APRIL 2011

Independent Statistics & Analysis
www.eia.gov

U.S. Department of Energy
Washington, DC 20585

The "International Shale Gas Resource Assessment" was conducted by Advanced Resources International, Inc. (ARI) for the U.S. DOE Energy Information Administration (EIA).

The study investigators would have, if allowed, devoted the entire study budget to just one country and would have judged this time and budget investment "well spent". Alas, that was not possible.

As such, this shale gas resource assessment captures our "first-order" view of the gas in-place and technically recoverable resource for 32 countries and 48 shale gas basins.

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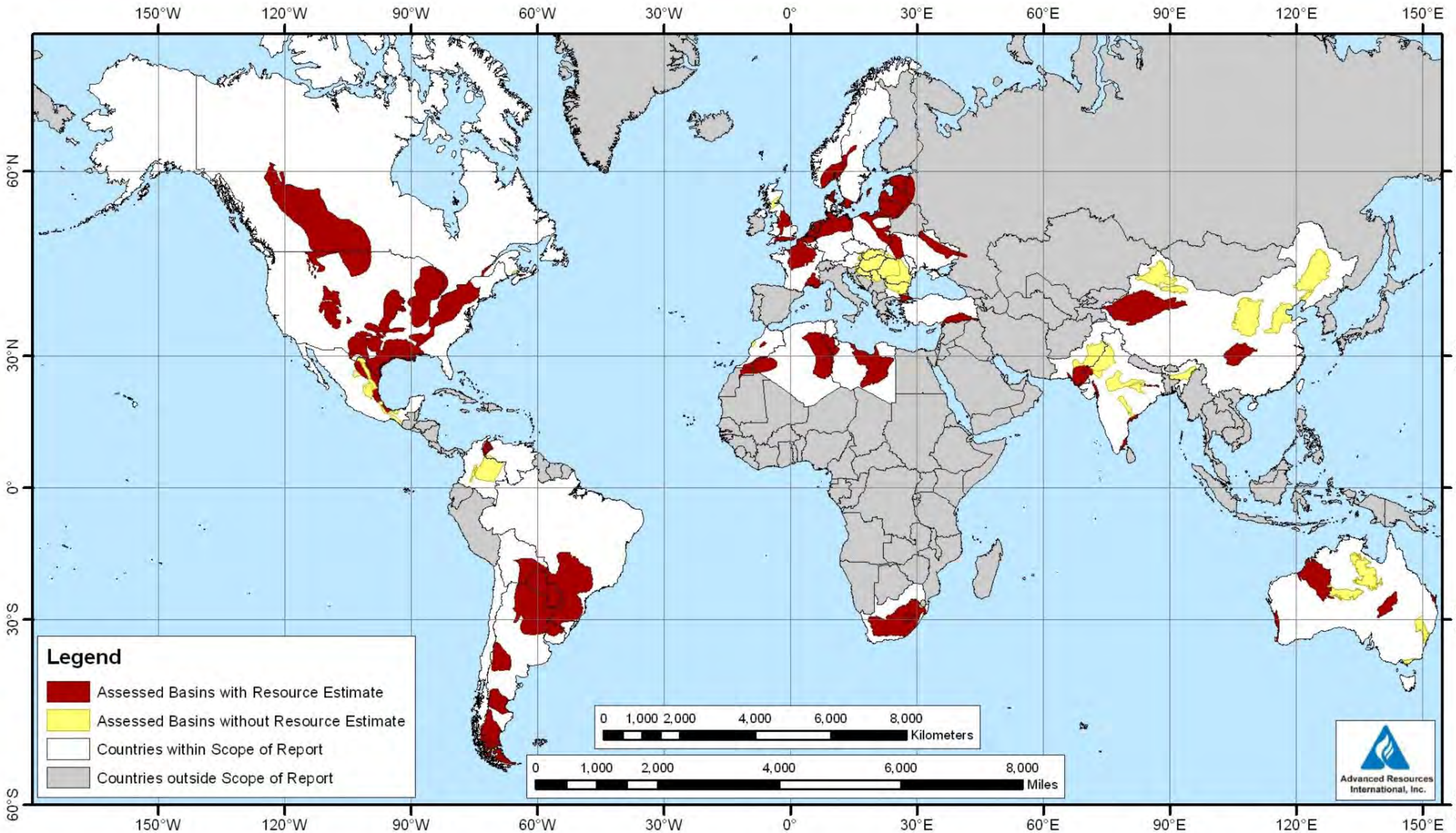
Shale Gas Basins Included in International Shale Gas Assessment



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The Scope of "International Shale Gas Resource Assessment"

Continent	Region/Country	Number of Countries	Number of Basins	Number of Gas Shale Formations
North America	I. Canada	1	7	9
	II. Mexico	1	5	8
	Subtotal	2	12	17
South America	III. Northern South America	2	2	3
	IV. Southern South America	6	4	7
	Subtotal	8	6	10
Europe	V. Poland	1	3	3
	VI. Eastern Europe	3	3	3
	VII. Western Europe	7	6	9
	Subtotal	11	12	15
Africa	VIII. Central North Africa	3	2	4
	IX. Morocco	3	2	2
	X. South Africa	1	1	3
	Subtotal	7	5	9
Asia	XI. China	1	2	4
	XII. India/Pakistan	2	5	6
	XIII. Turkey	1	2	3
	Subtotal	4	9	13
Australia	XIV. Australia	1	4	5
	Total	32	48	69

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Three Important Resource Assessment Considerations

Three points are important to keep in mind when viewing this shale gas resource assessment:

- ***Prospective Areas.*** The resource assessments only assess the higher quality, "prospective areas" of each shale gas basin. Lower quality areas in these basins, which may hold additional resources, are not included.
- ***Success/Risk Factors.*** The resource values for each basin have been risked for: (1) the probability that the shale gas formation will (or will not) have sufficiently attractive gas flow rates to become developed; and (2) an expectation of how much of the prospective area will be developed in the foreseeable future.
- ***Other Countries and Basins.*** Significant areas of the world - - Russia, Middle East, Indonesia, Central Africa, etc. - - are not included in the study.

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Our Resource Assessment Methodology

Our shale gas resource assessment methodology consisted of five main steps:

1. Conduct preliminary geologic and reservoir characterization of shale basins and formation(s).
2. Establish the areal extent, thickness and key reservoir properties of the major shale gas formations.
3. Define the prospective area of each shale gas formation.
4. Estimate the risked shale gas in-place.
5. Calculate the technically recoverable shale gas resource.

How Did We Do It?

Conducting Preliminary Geologic and Reservoir Characterization of Shale Basins and Formation(s).

The resource assessment begins with the compilation of data from multiple public and private sources. This initial step serves to define the shale gas basins and to select the major shale gas formations to be assessed. Geological and reservoir data were assembled for each major shale formation, including the following:

- Depositional environment of shale (marine vs non-marine)
- Areal extent of target formation
- Depth (to top and base of shale interval)
- Structure, including major faults
- Gross shale interval
- Organically-rich gross and net shale thickness
- Total organic content (TOC%, by wt.)
- Thermal maturity (Ro%)
- Pressure gradient
- Temperature gradient
- Mineralogy

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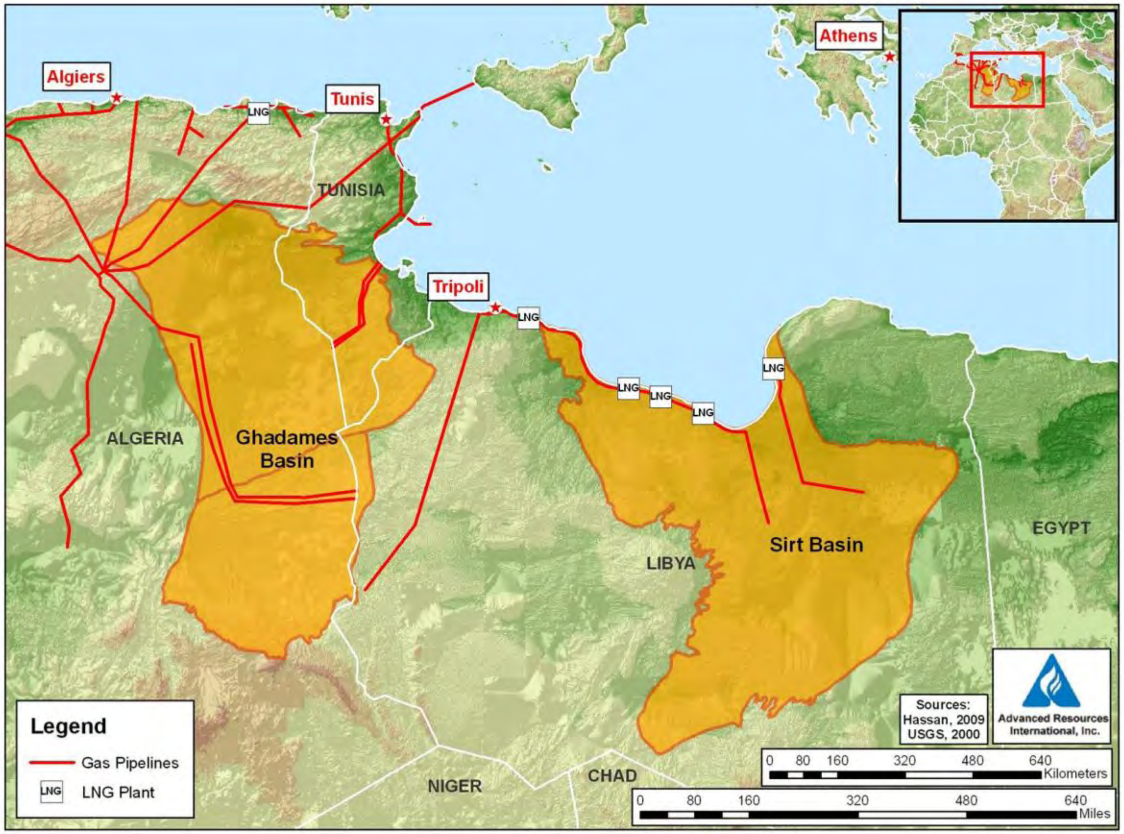
How Did We Do It?

Shale Gas Basins and Pipeline System of Central North Africa



The Ghadames Basin underlies 121,000 mi^2 in eastern Algeria, southern Tunisia and western Libya.

The basin contains reverse faulted structures which provide structural traps for conventional oil and gas sourced from Devonian-age and Silurian-age organic rich shale source rocks.

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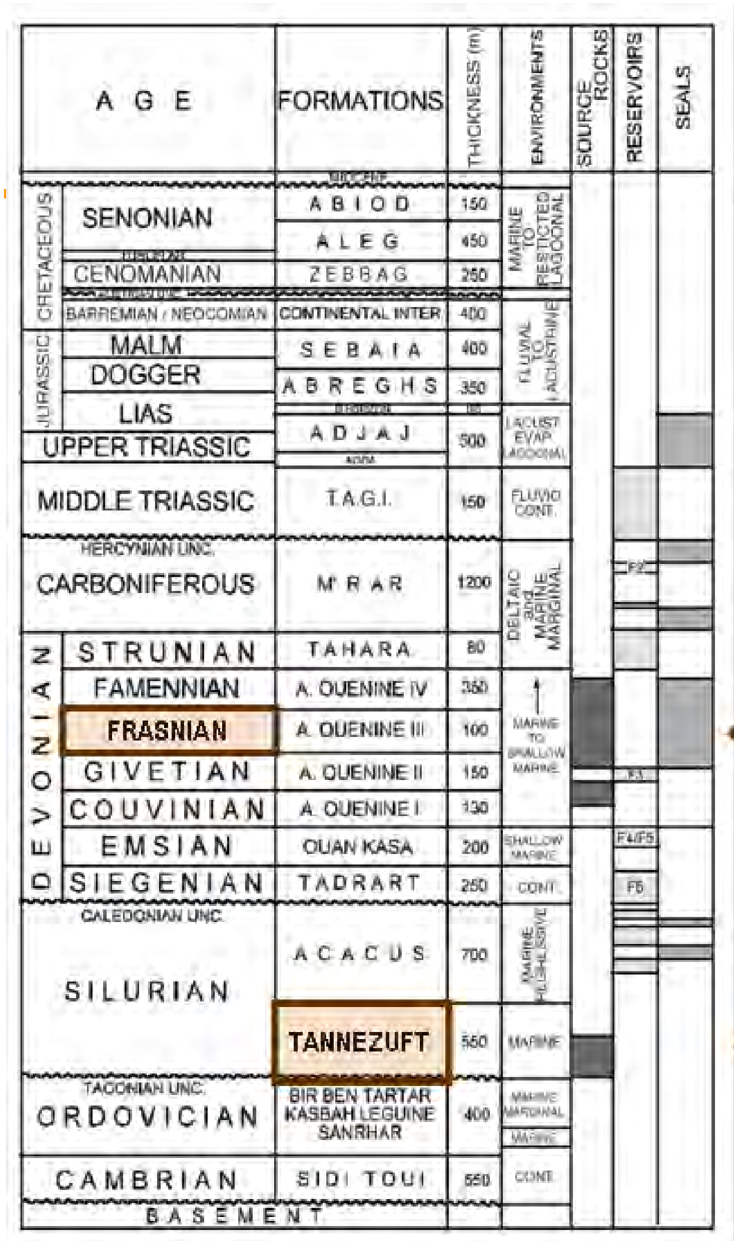
How Did We Do It?



Identifying the Major Shale Formations

Stratigraphic columns, well logs, source rock studies and other data were used to select the major shale formations for further study.

The stratigraphic column for the Ghadames Basin of southern Tunisia identifies two promising marine deposition source rocks:

- The Lower Silurian Tannezuft Shale
- The Middle Devonian Frasnian Shale

Southern Tunisia, Ghadames Basin Stratigraphic Column
(Two shale gas formations, Silurian Tannezuft and Devonian Frasnian)

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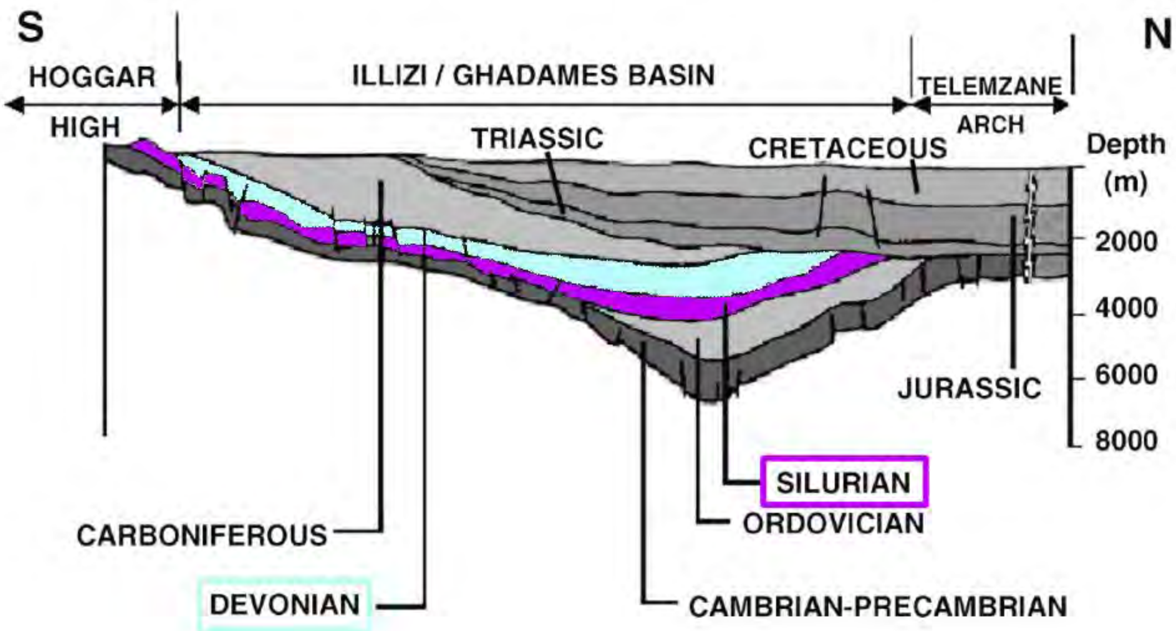
How Did We Do It?

Areal Extent of Shale Formation



To establish the areal extent of the basins and shale formations, we used a variety of sources:

- Regional and local cross-sections in technical literature.
- Internal previously prepared cross-sections.
- USGS and other formation data.

Southern Tunisia Ghadames Basin Structure Depth Map and Cross Section
(Two major shale gas formations, Devonian Frasnian and Silurian Tannezuft)

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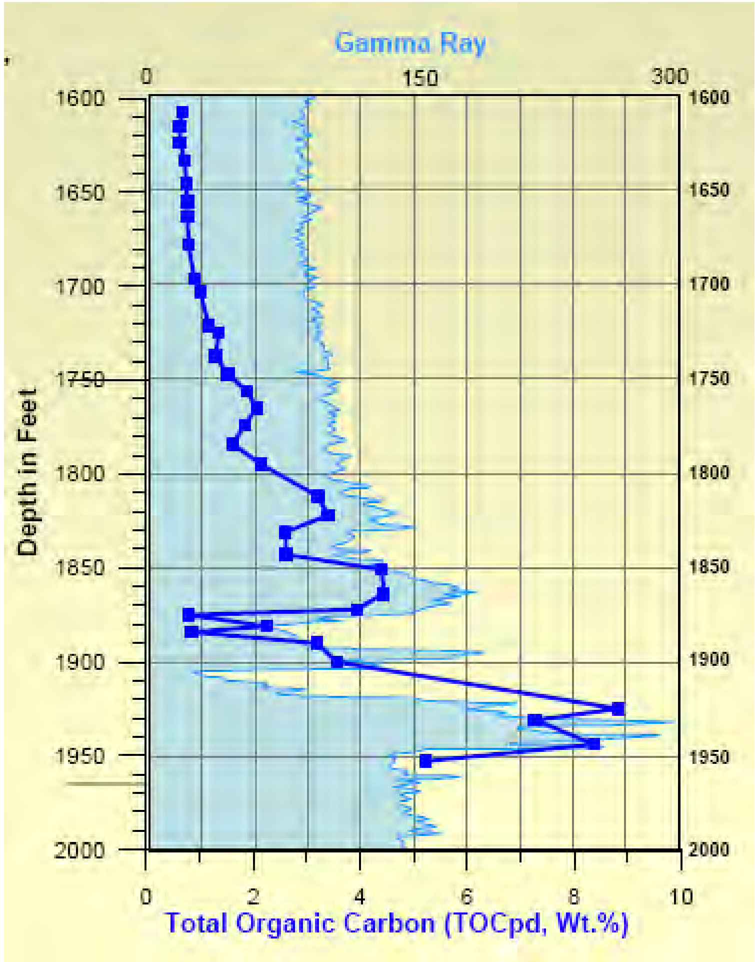
How Did We Do It?

Relationship of Gamma Ray to Total Organic Carbon and Net Pay

Organically Rich Marcellus ~200'



Source: J. Reed, 2008

A critical step is to establish the organically rich portion of the shale interval and the net completable pay:

- We relied heavily on published gamma ray logs that correlate reasonably with TOC.
- We used a 2% TOC cut off and other data to define completable net pay.

Beaver Meadow #1 Well, Chenango County, New York

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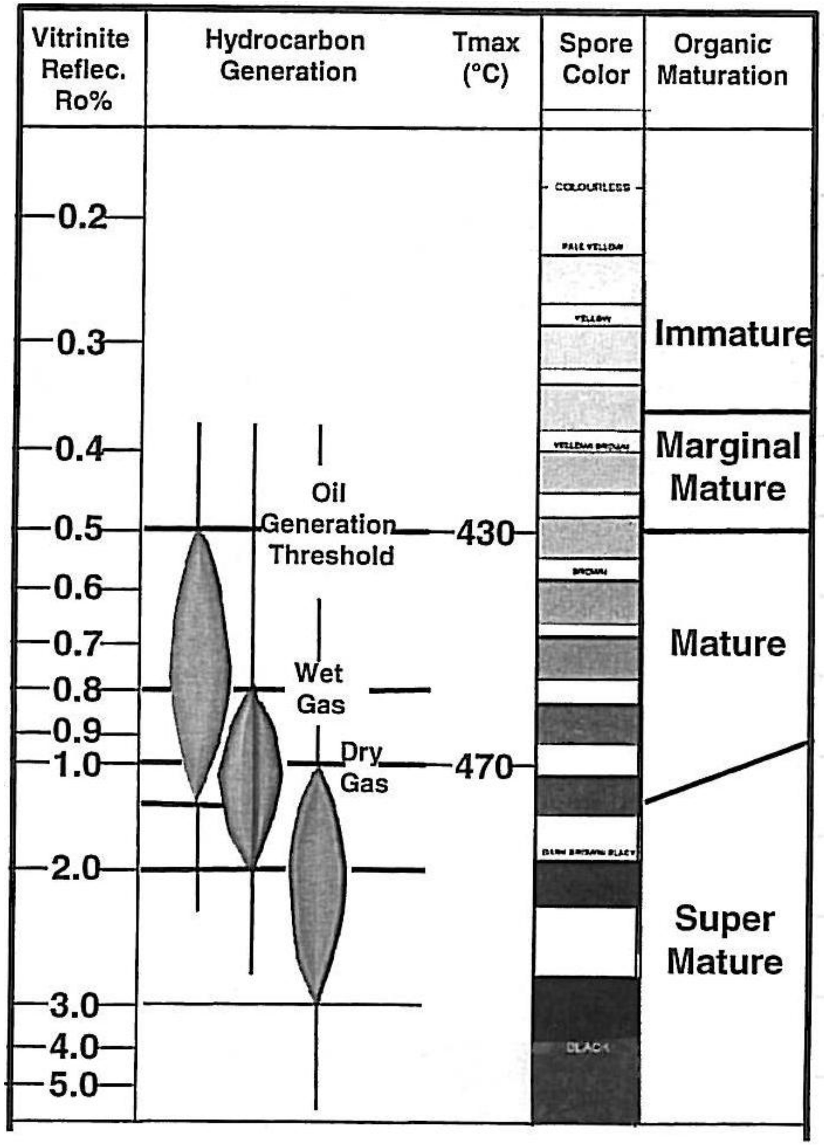
How Did We Do It?

Defining the Prospective Area for Each Shale Gas Formation.

An important and challenging step is to establish the portions of the basin that, in our view, are deemed to be prospective for shale gas development. The criteria used to establish the prospective area include:

- ***Depth.*** The depth criterion for the prospective area is greater than 1,000 meters, but less than 5,000 meters (3,300 feet to 16,500 feet).
- ***Total Organic Content (TOC).*** In general, the TOC of prospective area needs to be equal to or greater than 2%.
- ***Thermal Maturity (Ro).*** The Ro (vitrinite reflectance) of the prospective area needs to be greater than 1.0% (wet gas window) and 1.3% (dry gas window).



Thermal Maturation Scale

How Did We Do It?

Using Thermal Maturity To Delineate Areas Prospective For Shale Gas

- The prospective area needs to have a vitrinite reflectance (Ro) greater than 1.0%, with a second higher quality prospective area defined as having a Ro greater than 1.3%.
- Higher thermal maturity settings also lead to the presence of nanopores which contribute to additional porosity in the shale matrix.

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How Did We Do It?

Estimating the Gas In-Place (GIP)

Detailed geologic and reservoir data were assembled to establish the free and adsorbed gas in-place (GIP) within the prospective area. Adsorbed gas is typically the dominant in-place resource for shallow, highly organically-rich shales. Free gas becomes the dominant in-place resource for deeper, higher clastic content shales.

- ***Free Gas In-Place.*** The amount of free gas in-place for a given area (acre, square mile) is governed by the following reservoir properties:
  - Pressure/Temperature
  - Gas-filled porosity, and
  - Net organically-rich shale thickness.
- ***Adsorbed Gas In-Place.*** A Langmuir isotherm is established for the prospective area of the basin using available data on TOC and thermal maturity. The Langmuir isotherm (VL) is combined with pressure data to estimate adsorbed gas in-place.

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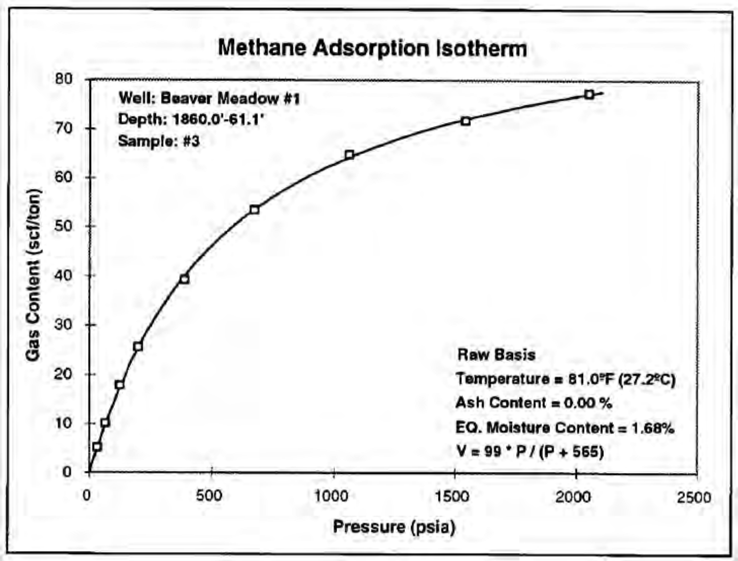
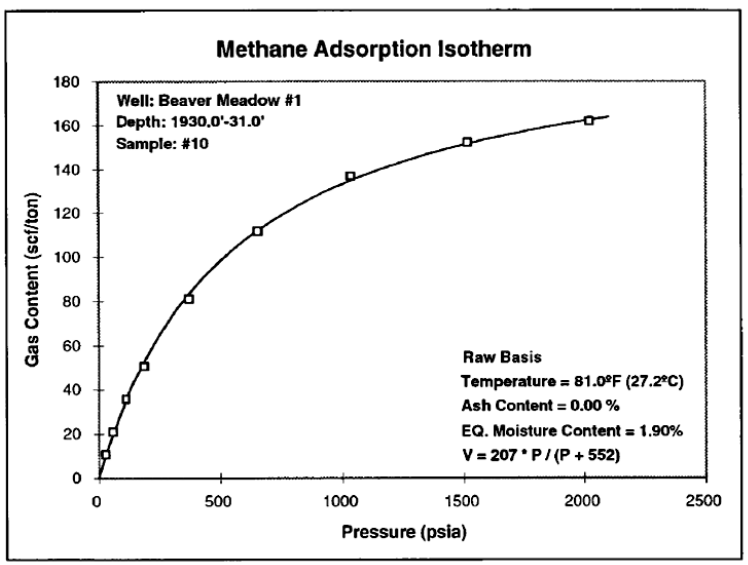
How Did We Do It?

Adsorbed Gas Content: Lower TOC
(Gas Content in scf/ton vs pressure)



Adsorbed Gas Content: Higher TOC
(Gas Content in scf/ton vs pressure)



Establishing Adsorbed Gas In-Place

The Langmuir volume (VL) is the maximum volume of gas that can be adsorbed on to the organics for a unit of shale. It is a function of the organic richness and thermal maturity of the shale.

The Langmuir pressure (PL) is a function of how readily the adsorbed gas on the organics in the shale matrix is released as a function of a finite decrease in pressure.

Adsorbed gas content is calculated using the formula below (where P is original reservoir pressure).

GC = (VL * P) / (PL + P)

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How Did We Do It?

Establishing Success/Risk Factors

Two success/risk factors are used to estimate risked gas in-place:

- ***Play Success Probability Factor***. Captures the likelihood that at least some significant portion of the shale gas formation will provide gas at attractive flow rates and become developed. Shale gas formations already under development have a play success probability factor of 100%. More speculative shale gas formations may only have a play success probability factor of 30% to 40%.
- ***Prospective Area Success (Risk) Factor.*** Combines issues that could relegate a portion of the prospective area to be unproductive, such as - - areas with high structural complexity, areas with lower thermal maturity, and the edge areas of a prospective area with low net organic thickness.

As exploration proceeds and knowledge increases, the prospective area success (risk) factors will change.

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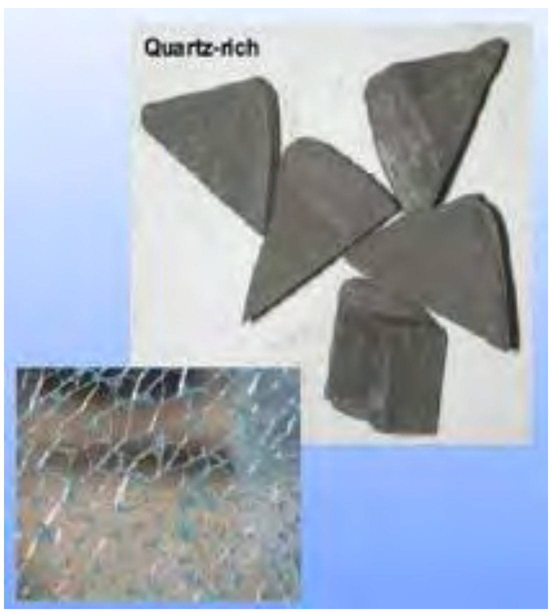
How Did We Do It?

Importance of Mineralogy on Recoverable Resources. The mineralogy of the shale, particularly its relative quartz, carbonate and clay content, governs the efficiency of the hydraulic fracture.

A. Quartz-Rich (Brittle)



Barnett Shale

B. Clay-Rich (Ductile)

Cretaceous Shale

Source: CSUG, 2008

- High clastic content shales are brittle and shatter, providing multiple fracs.
- High clay content shales are plastic and absorb energy, providing planar fracs.

How Did We Do It?

Estimating the Technically Recoverable Resource.

Three factors - - shale mineralogy, reservoir properties and geologic complexity - - are used to assign a gas recovery factor:

- ***Favorable Gas Recovery***. A 30% recovery factor of the gas in-place for shale gas formations that have low clay content, low to moderate geologic complexity and favorable reservoir properties.
- ***Average Gas Recovery.*** A 25% recovery factor of the gas in-place for shale gas formations that have a medium clay content, moderate geologic complexity and average reservoir pressure and properties.
- ***Less Favorable Gas Recovery.*** A 20% recovery factor of the gas in-place for shale gas formations that have medium to high clay content, moderate to high geologic complexity and below average reservoir properties.

A high recovery factor of 35% and a low recovery factor of 15% are applied in a few exceptional cases.

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How Did We Do It?

Using a play success probability of 60% and a prospective area success factor of 50% provides a risked gas in-place (GIP) for the Silurian Tannezuft Shale of 520 Tcf.

Shale Gas Reservoir Properties and Resources of Central North Africa

Basic Data	Basin/Gross Area		Ghadames Basin (121,000 mi²)		Sirt Basin (177,000 mi²)	
	Shale Formation		Tannezuft	Frasnian	Sirt-Rachmat	Etel
	Geologic Age		Silurian	Middle Devonian	Upper Cretaceous	Upper Cretaceous
Physical Extent	Prospective Area (mi²)		39,700	12,900	70,800	70,800
	Thickness (ft)	Interval	1,000 - 1,800	200 - 500	1,000 - 3,000	200 - 1,000
		Organically Rich	115	197	2,000	600
		Net	104	177	200	120
	Depth (ft)	Interval	9,000 - 16,500	8,200 - 10,500	9,000 - 11,000	11,000 - 13,000
		Average	12,900	9,350	10,000	12,000
Reservoir Properties	Reservoir Pressure		Overpressured	Overpressured	Normal	Normal
	Average TOC (wt. %)		5.7%	4.2%	2.8%	3.6%
	Thermal Maturity (%Ro)		1.15%	1.15%	1.10%	1.10%
	Clay Content		Medium	Medium	Medium/High	Medium/High
Resource	GIP Concentration (Bcf/mi²)		44	65	61	42
	Risked GIP (Tcf)		520	251	647	443
	Risked Recoverable (Tcf)		156	75	162	111

Applying a favorable gas recovery factor of 30% leads to a risked technically recoverable shale gas resource of 156 Tcf for this shale gas formation.

Tunisia has 13 Tcf of the technically recoverable resource from the Silurian Tannezuft Shale in the Ghadames Basin. (Libya and Algeria have the remainder.)

How Large is the In-Place International Shale Gas Resource?

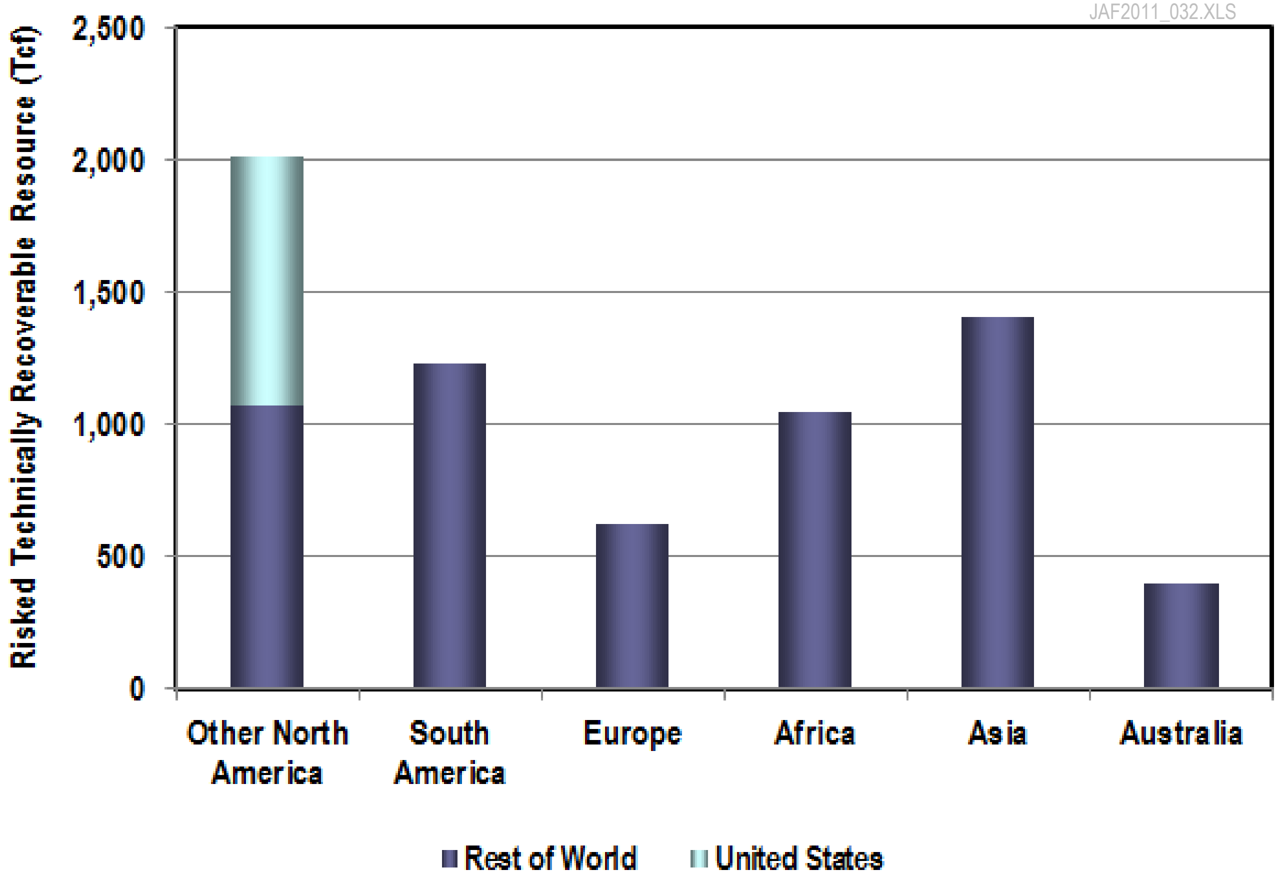
Although the exact resource numbers will change with time, our work shows that the international shale gas resource is vast.

- Overall, we have identified and assessed a shale gas resource of about 25,800 Tcf of risked gas in-place, including U.S. shale gas resources.*
- Applying appropriate recovery factors, we estimate a technically recoverable shale gas resource of 6,700 Tcf.

Importantly, much of this shale gas resource exists in countries with limited conventional gas supplies or where the conventional gas resource has largely been depleted, such as in China, South Africa and Europe.

*U.S. shale gas resources have recently been updated by Advanced Resources International, Inc.

How Large is the Technically Recoverable International Shale Gas Resource?



*Includes 940 Tcf of U.S. technically recoverable shale gas. (Source: Advanced Resources International, Inc., 2011)

What Did We Find?

Risked Gas In-Place and Technically Recoverable Shale Gas Resources

Continent	Risked Gas In-Place (Tcf)	Risked Technically Recoverable (Tcf)
U.S.	3,760	940
Other North America	3,856	1,069
South America	4,569	1,225
Europe	2,587	624
Africa	3,962	1,042
Asia	5,661	1,404
Australia	1,381	396
Total	**25,776**	**6,700**

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What Did We Find?

Comparison Of Study Findings

Prior to this study, only one other publically available study has addressed the overall size of the shale gas resource - - the valuable work by H-H. Rogner (1997).

- Overall, we established a risked shale gas in-place of 25,800 Tcf (including our shale gas in-place estimate for the U.S. of 3,760 Tcf). This compares to Rogner's estimate of 16,112 Tcf of shale gas in-place.*
- The largest and most notable areas of difference are for Europe, Africa and North America.

*A number of the large shale gas resource areas (such as Russia, Central Africa and the Middle East) have not yet been included in our study (but are included in Rogner's shale gas resource numbers).

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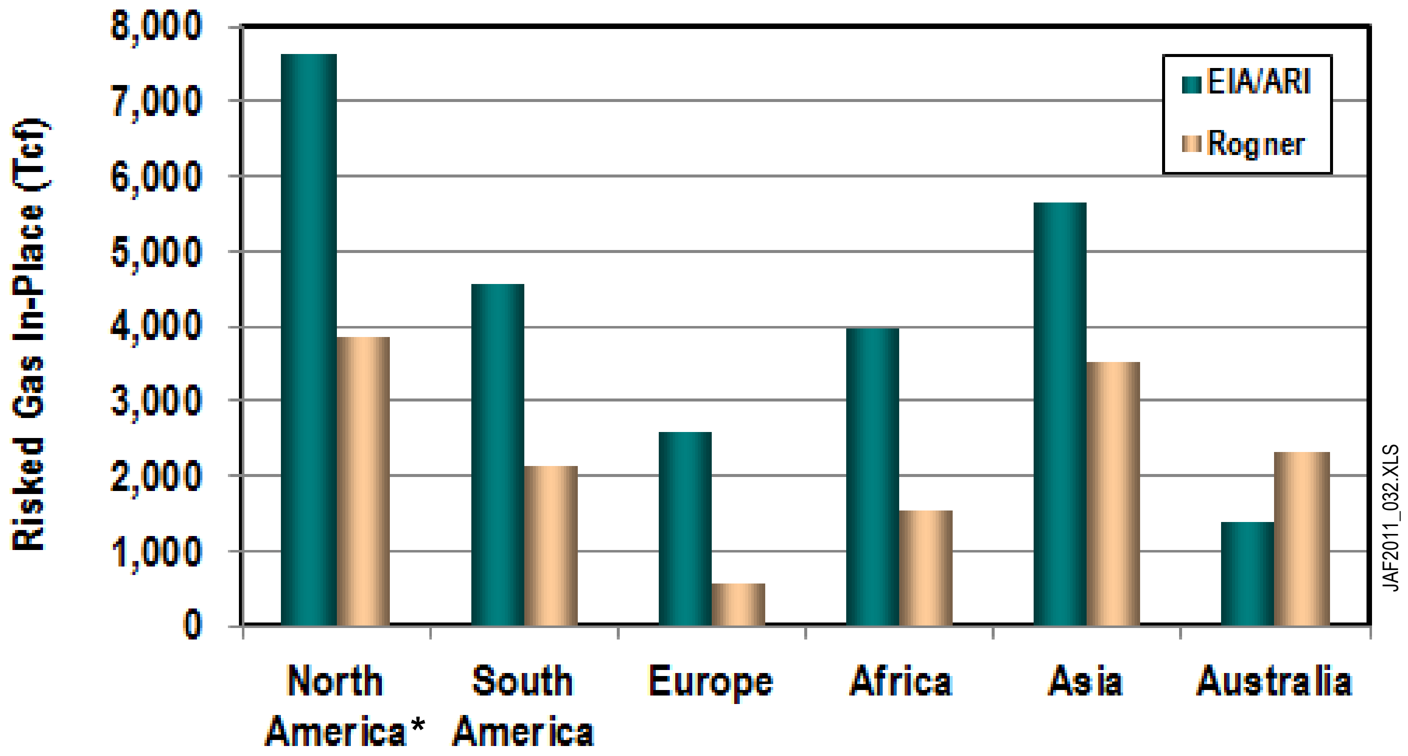
Comparison of Rogner's and This Study's Estimates of Shale Gas In-Place



*Includes 3,760 Tcf of U.S. shale gas in-place. (Source: Advanced Resources International, Inc., 2011)

3. What Did We Find?

Comparison of Rogner's and This Study's Estimates of Shale Gas In-Place

Continent	H-H Rogner (Tcf)	EIA/ARI (Tcf)
1. North America*	3,842	7,616
2. South America	2,117	4,569
3. Europe	549	2,587
4. Africa**	1,548	3,962
5. Asia	3,528	5,661
6. Australia	2,313	1,381
7. Other***	2,215	n/a
Total	**16,112**	**25,776**

Source: Rogner, H-H., "An Assessment of World Hydrocarbon Resources", Annu. Rev. Energy Environ. 1997, 22:217-62.

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* Includes U.S. shale gas in-place of 3,760Tcf, based on estimated (ARI) 940 Tcf of technically recoverable shale gas resources and a 25% recovery efficiency of shale gas in-place.

** Our modified Rogner estimate for Africa includes one-half of Middle East and Central Africa (1,274 Tcf) plus all of Sub-Saharan Africa (274 Tcf).

*** The Other category includes FSU (627 Tcf), Other Asia Pacific (314 Tcf), and one-half of Middle East and Central Africa (1,274) Tcf.

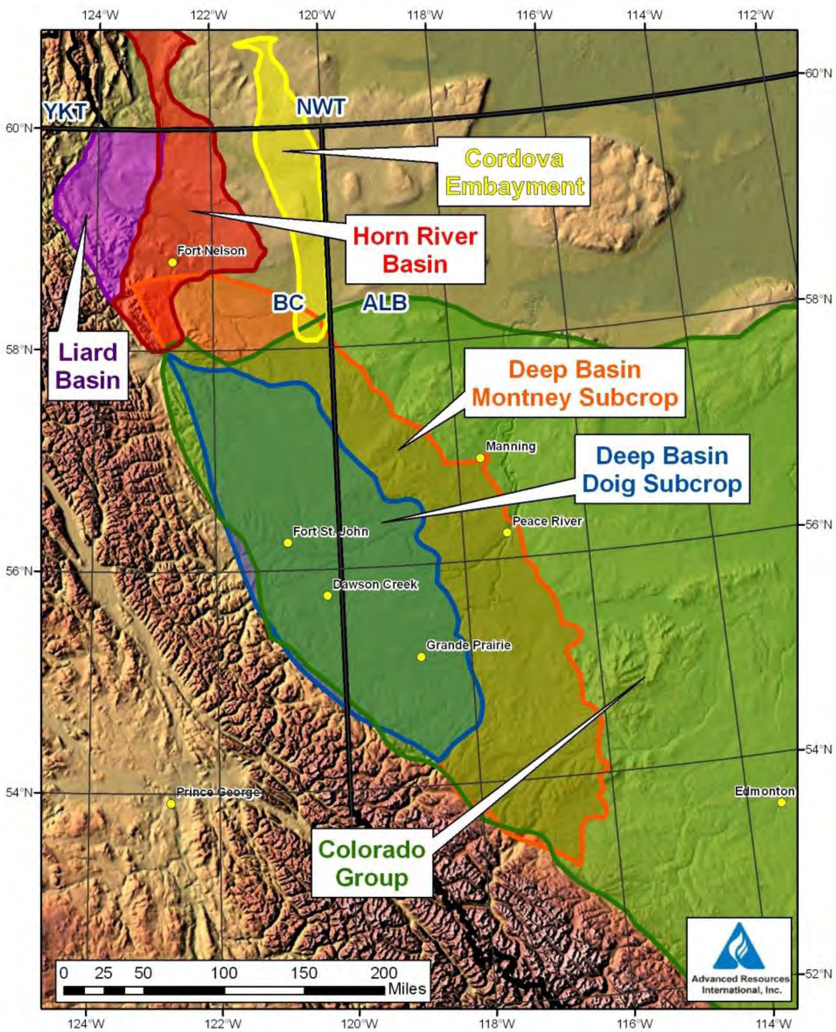
Overview of Shale Gas Resources in Selected Countries/Regions

Five areas of the world appear to have particularly attractive shale gas resources:

- Canada
- Mexico
- Southern South America
- Europe, particularly Poland
- China

Canada's Shale Gas Resources and Basins

Shale Gas Basins of Western Canada



Source: Advanced Resources International

Even with recent declines, Canada is still the world's third largest producer of natural gas, with production at nearly 16 Bcfd.

After years of decline, Canada's proved reserves of 58 Tcf have stabilized.

Development of the abundant shale gas resources of Western and Eastern Canada (plus CBM and tight gas sands) could reverse the decline, as shown below:

	Western Basins	Eastern Basins	Total Canada
	(Tcf)	(Tcf)	(Tcf)
Gas In-Place*	1,326	164	1,490
Technically Recoverable*	355	33	388

*Geologically Risked

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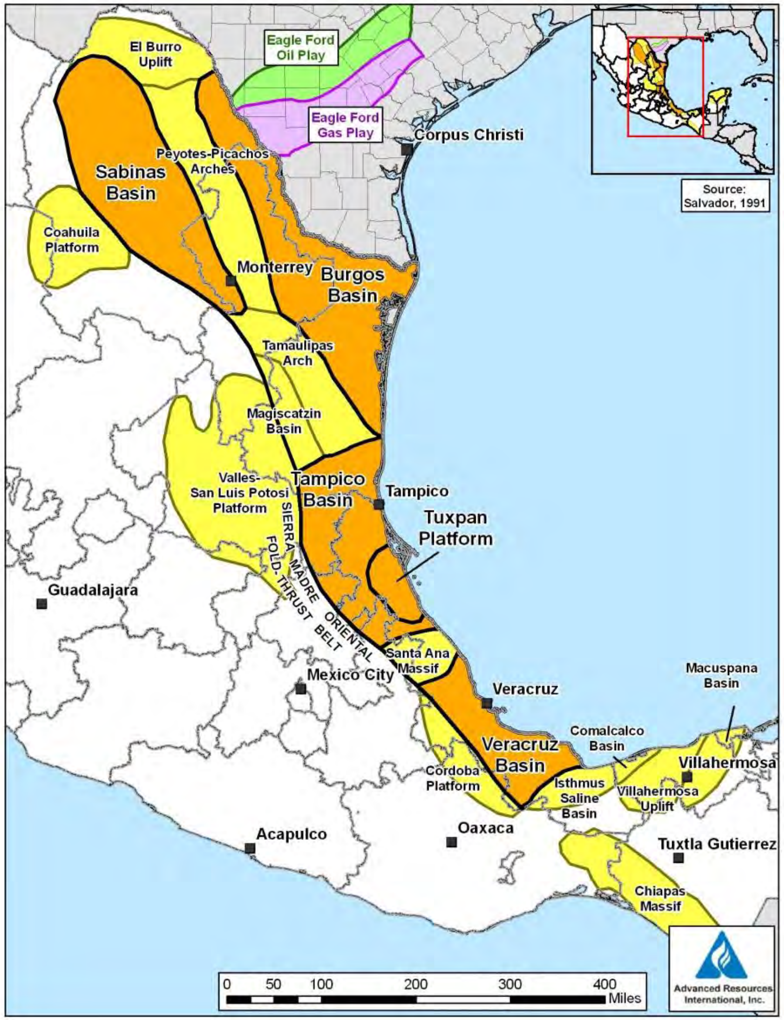
Mexico's Shale Gas Resources and Basins

Onshore Shale Gas Basins of Eastern Mexico



Source: Advanced Resources International

While still an important producer, Mexico is today a net importer of natural gas:

- Production: 4.9 Bcfd
- Consumption: 5.9 Bcfd

Mexico's remaining proved natural gas reserves of 13 Tcf are modest.

However, Mexico has major potential for new reserves from its multiple gas shale basins. Our study identified:

- Geologically-risked shale gas in-place of 2,366 Tcf.
- Technically recoverable resources of 681 Tcf.

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Southern South America's Potential Shale Gas Resources and Basins

Onshore Shale Gas Basins of Southern South America

Source: Advanced Resources International

Southern South America has four major shale gas basins - - Neuquen, San Jorge, Austral-Magallanes and the Parana-Chaco complex.

Our shale gas resource assessment for these basins includes:

- 4,449 Tcf of risked gas in-place
- 1,195 Tcf of technically recoverable resource

The shale resources in the smaller Tertiary-age rift basins in coastal Brazil would add to these totals.

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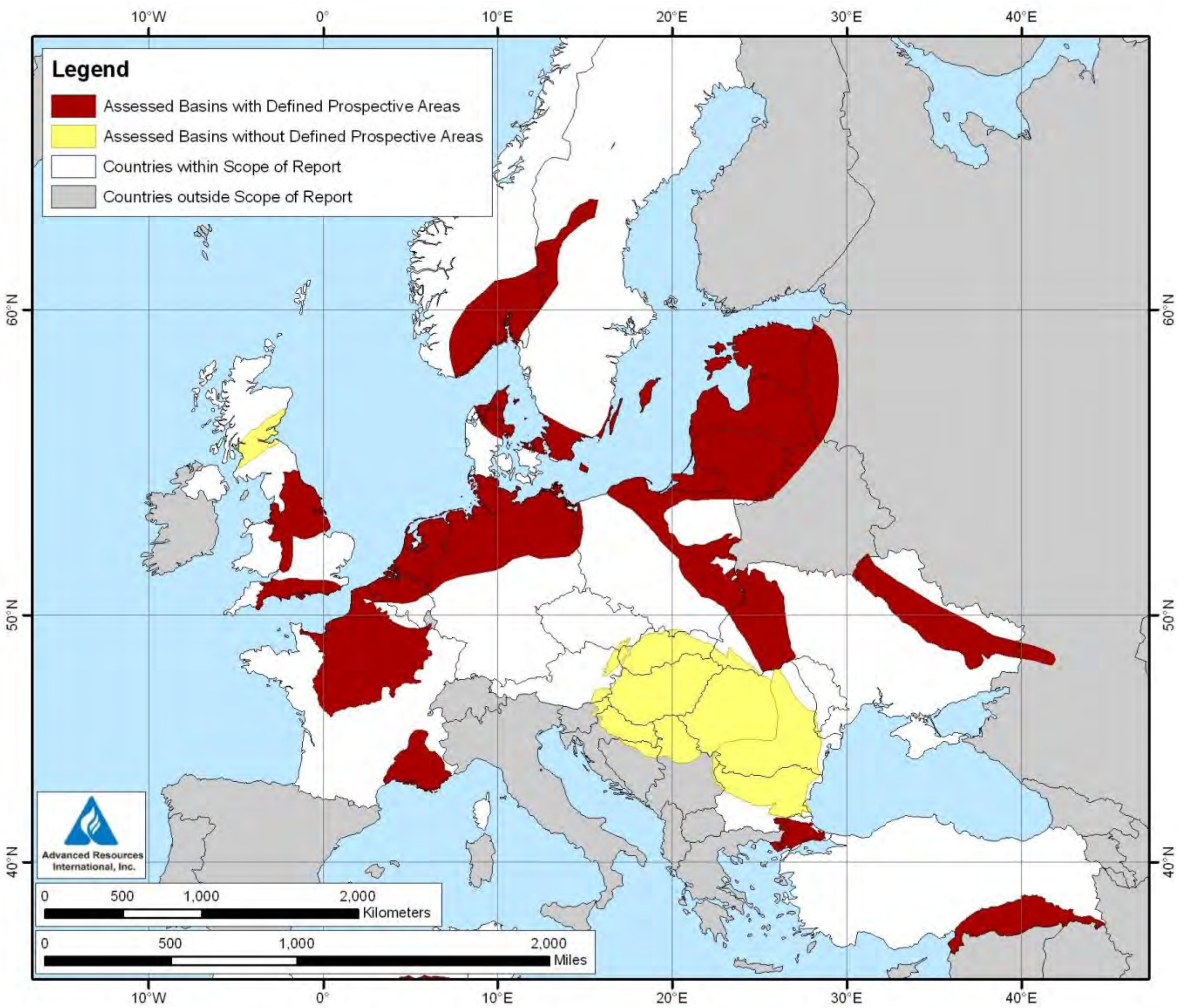
Europe's Shale Gas Resources and Basins

Western/Eastern Europe including Turkey Shale Gas Basins



Europe's shale gas resources (assessed by our study) exist in the Ordovician Alum Shale of Scandinavia, the Permian/Carboniferous shale of the Paris Basin, and a host of other shale gas basins.

Our shale gas resource assessment for Europe identified:

- 2,650 Tcf of risked gas in-place.
- 640 Tcf of technically recoverable resource.

The above shale gas resource values include Western and Eastern Europe plus Turkey.

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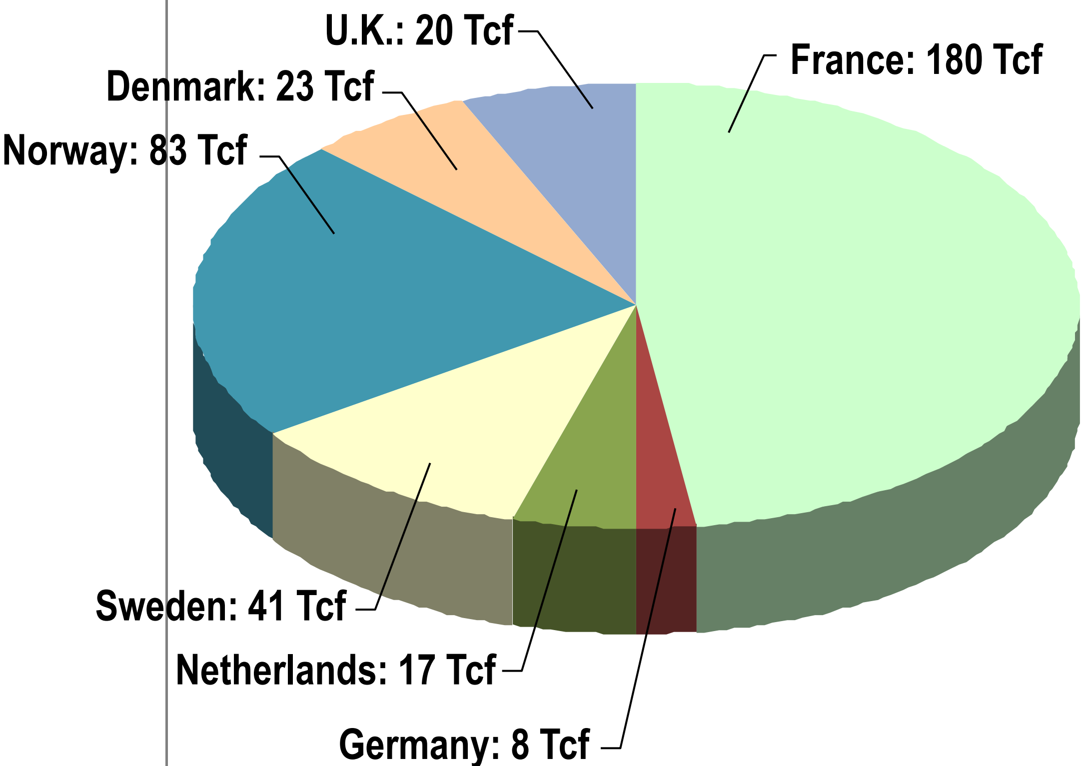
Distribution of Western Europe's Shale Gas Resources

Technically Recoverable Resources (Tcf)



France holds large technically recoverable shale gas resources (180 Tcf) in the Paris and South-East basins.

Norway's (83 Tcf) and Sweden's (41 Tcf) shale gas resources are within the Alum Shale of the Baltic Basin.

Smaller but still significant shale gas resources exists in Denmark (23 Tcf), Netherlands (17 Tcf) and Germany (8 Tcf).

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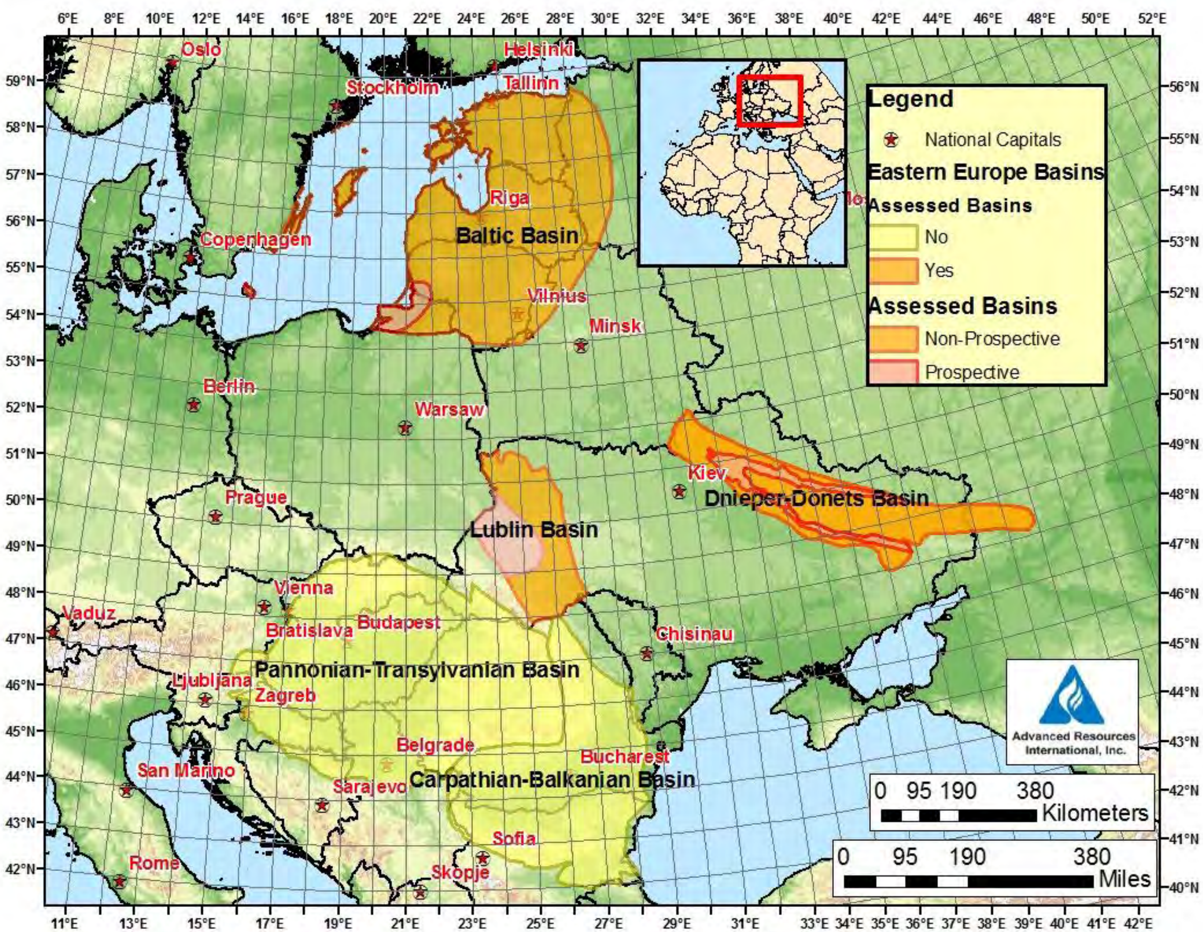
Eastern Europe's Shale Gas Resources and Basins

Onshore Shale Gas Basins of Eastern Europe



Eastern Europe* has large shale gas resources in Ukraine, Lithuania and Kaliningrad (Russia). These resources exist in three basins:

- Baltic
- Dnieper-Donets
- Lublin

Our shale gas assessment for Eastern Europe* indicates a modest size resource:

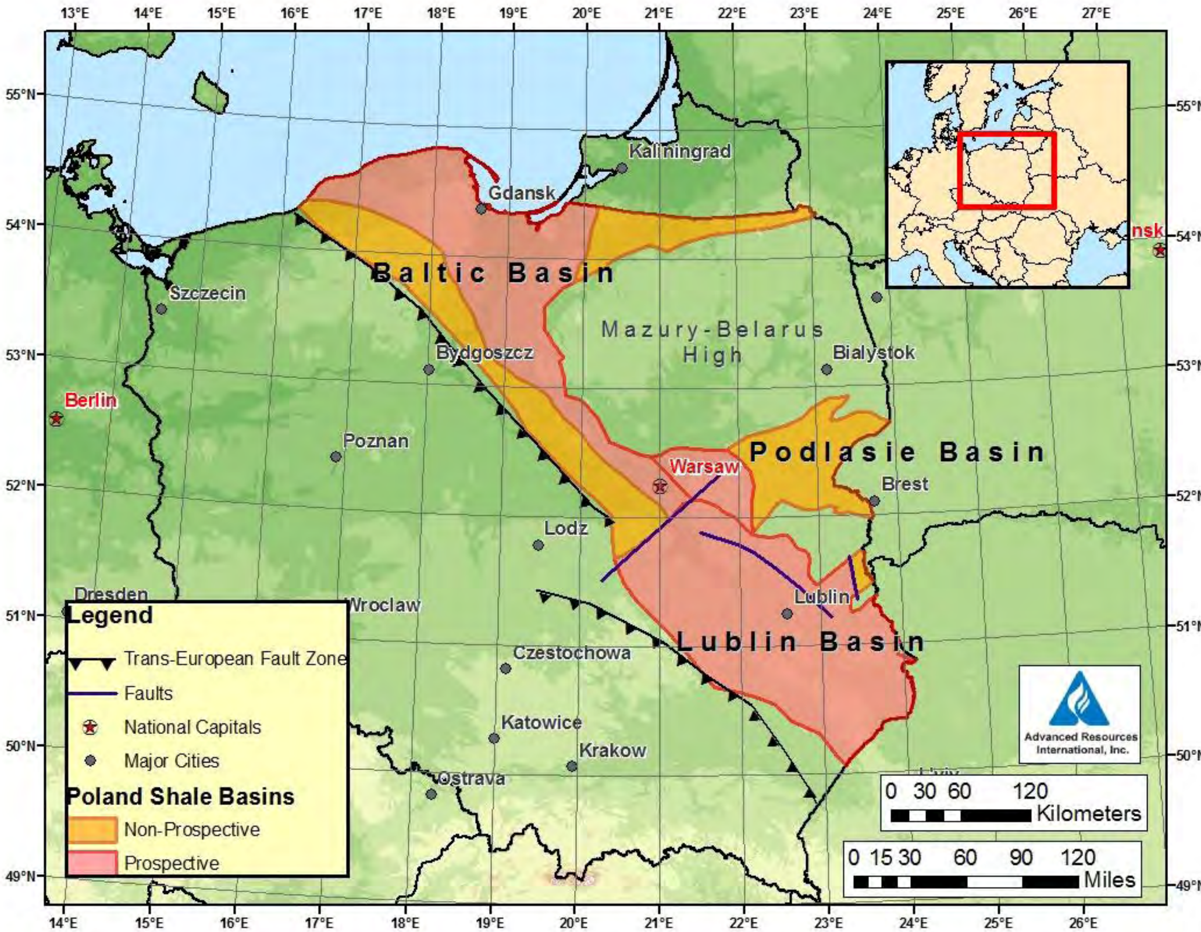
- 290 Tcf of risked shale gas in-place.
- 65 Tcf of technically recoverable resource.

Additional shale gas potential, not assessed by this study, exists in the Pannonian-Transylvanian Basin and the Carpathian-Balkanian Basin in the southern portion of Eastern Europe.

*Not including Poland.

Poland's Shale Gas Resources and Basins

Onshore Shale Gas Basins of Poland



Poland appears to hold some of the geologically most favorable shale gas resources in Europe, primarily in three basins:

- Baltic
- Lublin
- Podlasie

Our shale gas assessment for Poland indicates a large resource base:

- 792 Tcf of risked shale gas in-place.
- 187 Tcf of technically recoverable resource.

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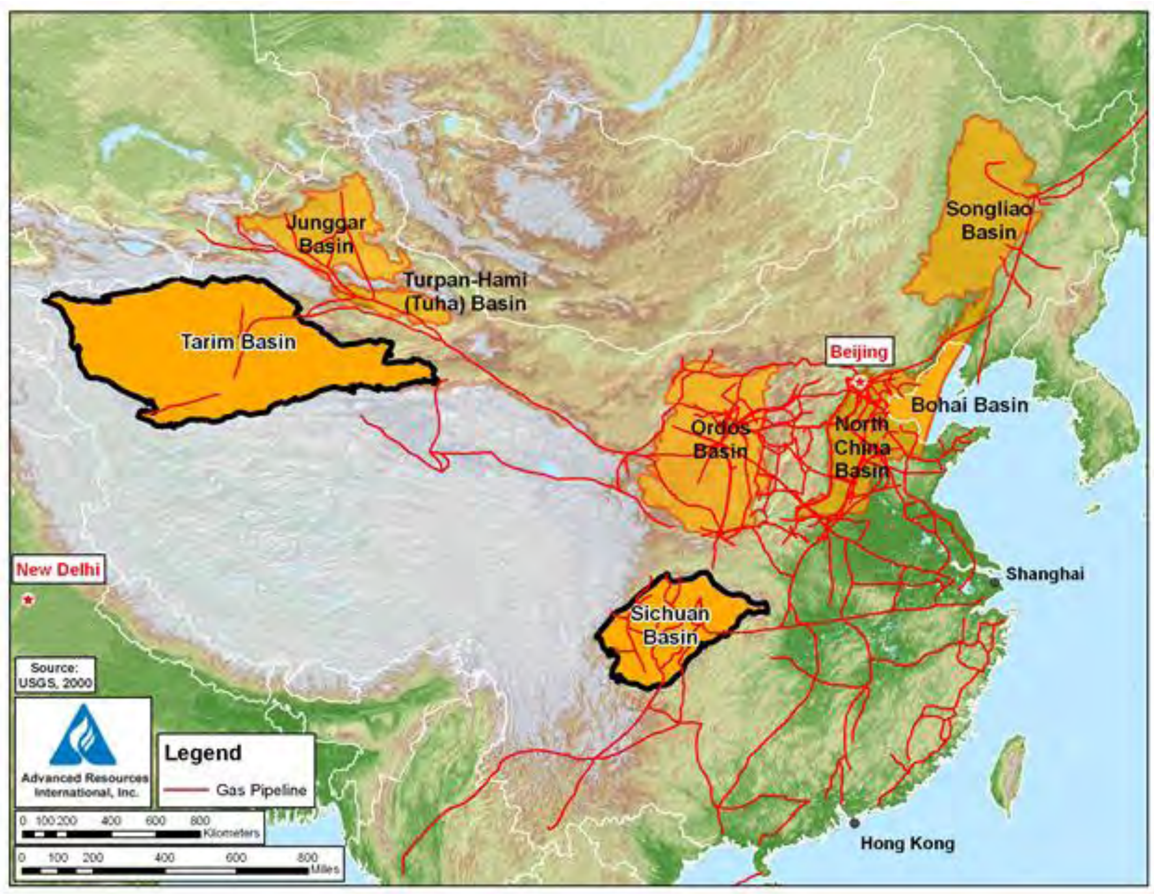
China's Shale Gas Resources and Basins

Onshore Shale Gas Basins of China



While China is the 10th largest natural gas producer in the world, with 8.0 Bcfd (in 2009), its consumption of natural gas at 8.4 Bcfd exceeds its production.

China's natural gas reserves have been static, at 80 Tcf, for the past several years.

China's top two priority basins - - Tarim and Sichuan - - together contain an estimated 5,101 Tcf of risked shale gas in-place, with 1,275 Tcf of technically recoverable resource.

Source: Advanced Resources International

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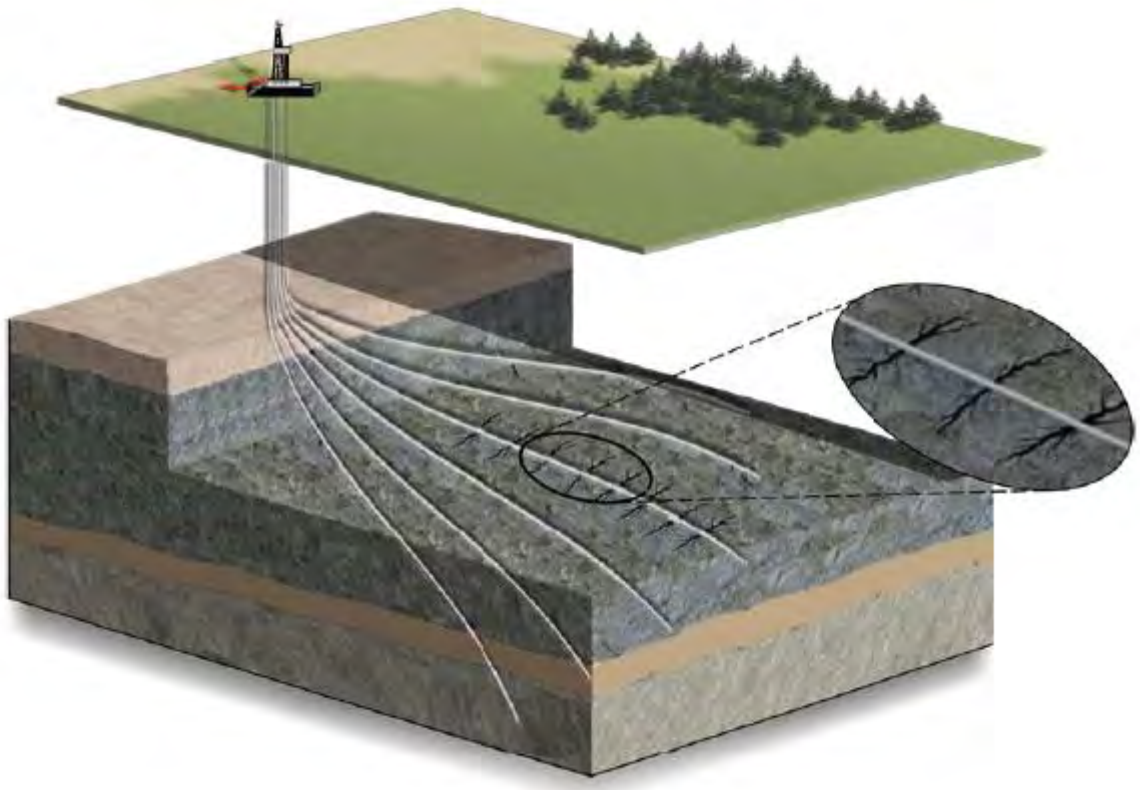
Will These New Natural Gas Resources Be Developed In An Environmentally Sound Way?

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 and reduce costs.

- Reducing Land Use Impacts
- Reducing Water Use and Disposal
- Capturing Methane Emissions
- Assuring Environmentally Safe Wells and Hydraulic Fractures

"Green" Unconventional Gas Development

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



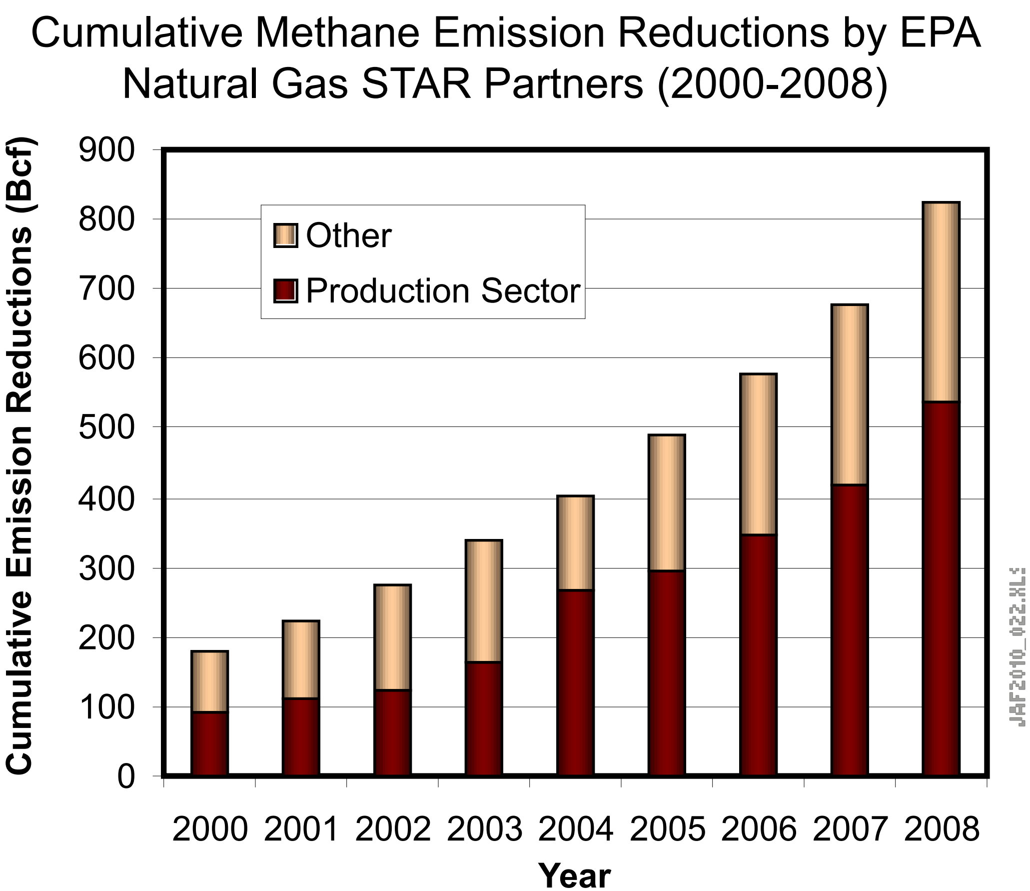
- Multi-well pad drilling reduces land use impacts and rig mob/demob time.
- Operators can save \$100,000 to \$200,000 per well by using multi-well pad drilling.

Source: Canadian Association of Petroleum Producers, 2010

Reducing Water Use and Disposal

- The simplest and most economic option for reducing water use and disposal is recycling the produced frac water.
- Doing so can save up to $200,000 per well and avoid 1,000 water trucks on the road.
- Recycling the produced water may involve modest treatment to remove suspended solids, iron sulfide, and scale forming materials.

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)

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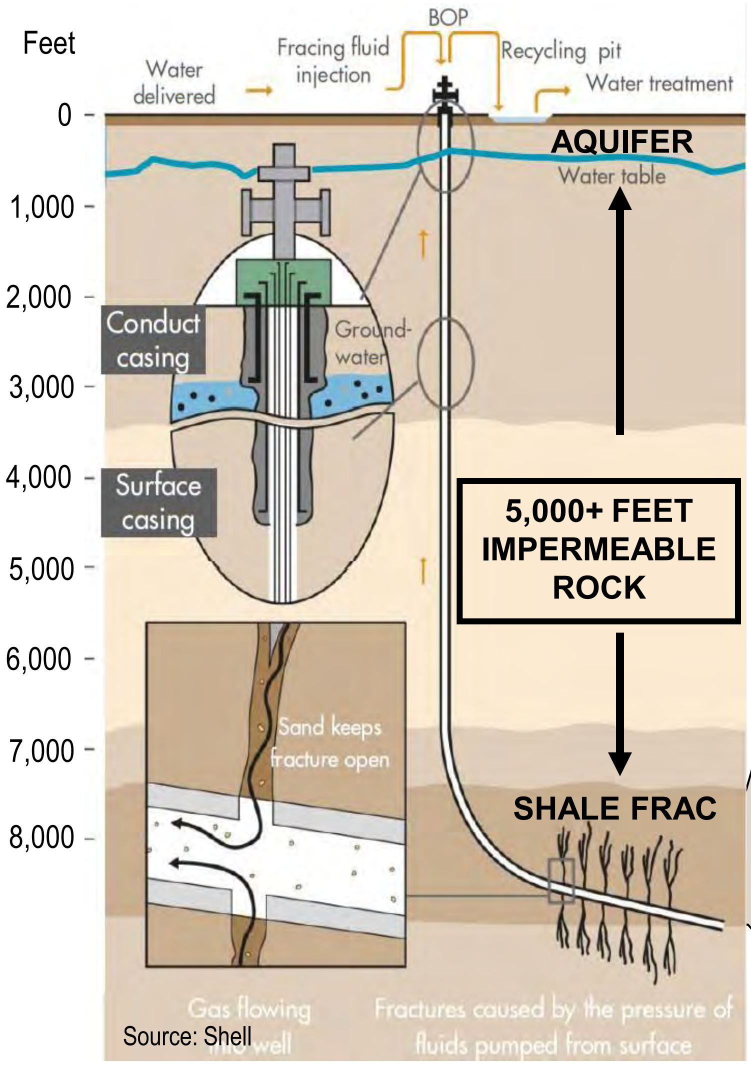
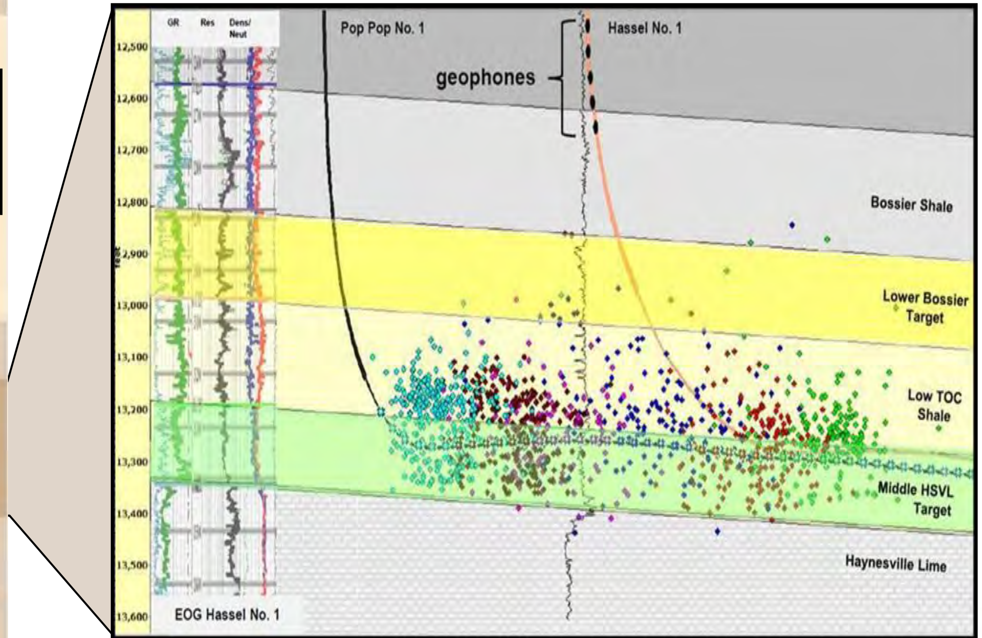
Properly Designing the Well and Monitoring the Frac



Source: Shell

- The well is designed with steel casing and cement to protect groundwater aquifers.
- The shale interval is 5,000 to 10,000 feet below the water table, protected by unfractured strata.
- Real-time micro-seismic monitoring reveals that the fractures remain in the shales, deep underground.



Source: EOG

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Concluding Remarks

Our work to date shows that the U.S. and Europe have large resources of shale gas and other unconventional gas. The challenge is to pursue progress in technology so that these resources can be converted into economical reserves.

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

Bountiful supplies from gas shales and unconventional sources can provide many benefits:

- Promote progress on climate change by substituting natural gas for coal in old, inefficient power plants.
- Increase energy security by replacing imported petroleum for transportation with CNG and low CO_2 emissions power for electric cars.

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