

## MANAGER INSIGHTS

## The Unconventional Resource Revolution: A Geologist's Perspective

By: Shawn Reynolds, Portfolio Manager



With over 25 years of experience working as both an exploration geologist and an analyst covering global energy companies, Shawn Reynolds is an established thought leader in the energy space. He has been quoted in myriad trade publications and has authored articles published in technical periodicals focusing on the reservoir architecture of potential hydrocarbon basins around the world.

### Overview

- Recent and continuous advancement of drilling and development technologies has allowed energy companies to unlock known but previously untapped “hydrocarbon capacity.” Initially focused on natural gas, these same technologies are also accessing prolific oil reservoirs.
- Application of these technologies is expanding both in terms of capability and geographic reach. We believe this will result in the commercialization of substantial new volumes of oil and natural gas.
- The development of unconventional natural gas has already structurally altered the North American natural gas market. We believe the unconventional revolution will soon transform the global markets for both crude oil and natural gas.

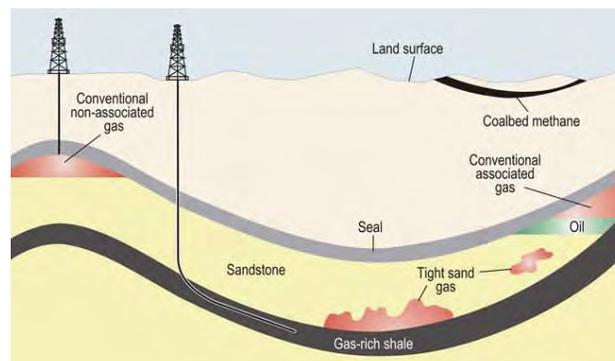
### Introduction

Over the past decade, the rapid evolution of two known technologies - extended reach horizontal drilling and multi-stage hydraulic fracturing - has unlocked traditionally tight and non-productive oil and gas reservoirs. This has led to a substantial increase in recoverable reserves and output from these “unconventional” reservoirs. These reservoirs were previously known to have hydrocarbons in them, but there was no way to access this capacity with conventional methods. The advancement of these technologies has allowed energy companies to tap into this capacity and essentially may enable the industry to uncover unconventional horizons everywhere.

### The Role of “Fracking” and Horizontal Drilling

Horizontal drilling and hydraulic fracturing (or “fracking”) have been used by the global oil and gas industry for decades. Horizontal drilling dates back to the 1930s in the U.S. and was the dominant drilling method used in developing the western Siberian oil fields during the 1950s and 1960s. Horizontal drilling currently accounts for 60% of all drilling in the U.S. Initial wells followed slightly deviated paths, in many cases to overcome surface location restrictions or potential subsurface geologic hazards. Horizontal drilling aimed at tapping unconventional resources originally drilled out several hundred feet from the vertical leg of the well with the goal of accessing the maximum volume of reservoir. Today, horizontal legs typically stretch to 2,000-7,000 feet, even reaching as far as 10,000 feet or more. This has opened up the contact with new potential reservoir rock several orders of magnitude greater than in vertical wells.

Fracking and other forms of reservoir stimulation began in the U.S. in the 1950s. Fracking can be described as the act of pumping fluid and sand down a well at high pressure. The pressure causes the surrounding rock to fracture. When the pressure is relieved, a thin layer of sand props open the fractured rock, acting as a conduit to allow natural gas or oil to flow to the well so that it can be recovered. The actual physical engineering act of fracking happens at virtually every conventional well in the U.S. Early fracking extended 10-100 feet from a borehole. Today, massive, multi-stage fracking techniques reach several hundred feet on either side of an extended reach horizontal borehole accessing and opening up a massive volume of potential reservoir rock.



Source: U.S. Energy Information Administration and U.S.G.S.

**Unconventional Drilling Technologies Lead to Capacity Increases**

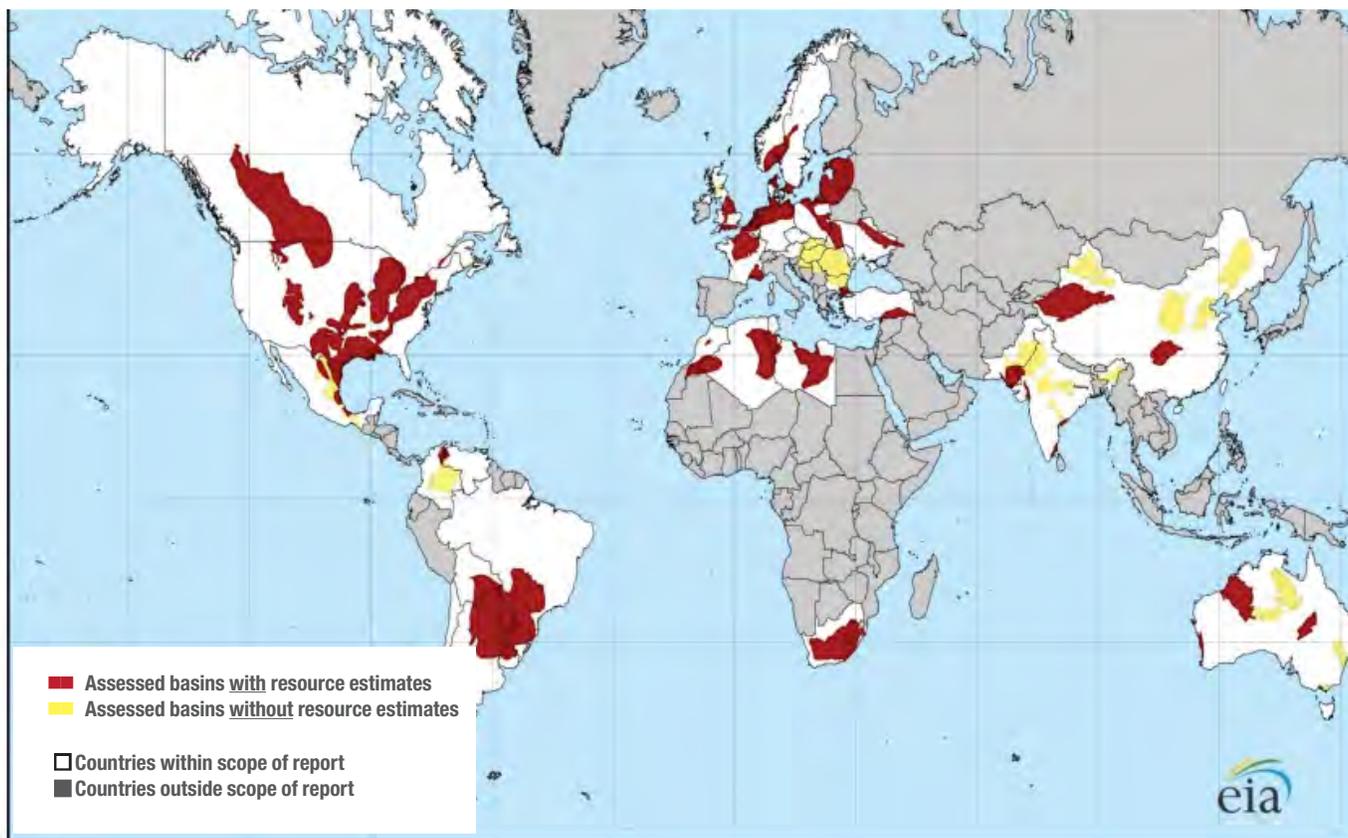
From about 2004 to 2009, the unconventional story was centered on natural gas. Ten years ago, the U.S. appeared to be short of natural gas and prices rose to upwards of \$15. The techniques just described resulted in a tremendous increase in resource capacity; it was hugely successful from an energy supply and energy independence point of view. The United States Geological Survey estimates that remaining fracturable shale gas resources are over 2,000 trillion cubic feet (Tcf) or nearly 100 years of supply. Ten years ago less than 1% of U.S. natural gas supplies came from unconventional shale gas. Today, shale gas production accounts for nearly 25% of total U.S. production. Over that same time period, total U.S. natural gas output fell as low as 18.1 Tcf, but rebounded to 23.0 Tcf currently (the highest level ever).

Now, these same technologies are beginning to be tested on oil reservoirs. Early results are promising. Domestic crude oil production has rebounded to 6.09 million barrels per day in January 2012 from a 60 year low of 4.95 million barrels per day in 2008. From an equity investment point of view, this is a good indication of the potential independent E&P companies and their oil service cousins are unlocking in the Bakken trend in North Dakota and the Permian Basin of west Texas. The Bakken trend is increasingly being viewed as a new major oil reserve in the U.S., while a tremendous amount of interest has also been sparked in the vast amount of petroleum saturated rocks in West Texas.

**Effects of Low Natural Gas Prices on Unconventional Energy Companies**

The increased production from unconventional natural gas resources has had a dramatic impact on natural gas prices. In 2011, Henry Hub spot natural gas prices started the year at approximately \$4.50/mcf and ended at around \$3.00/mcf. As expected, the decline has been a substantial headwind for many gas levered E&P companies. However, numerous companies in the process of unlocking vast new unconventional gas resources delivered impressive performance in 2011. Cabot Oil & Gas (which currently does 95% of its business in natural gas) was up 101% last year, the best performing stock in the S&P 500 Index. The company delivered exceptional volume growth and made substantial reserve additions with very little geologic risk exposure.

Nevertheless, with natural gas prices so low, pure natural gas drilling is clearly receding. For “dry gas producers” (i.e., those companies that only produce natural gas), current economics makes producing very tough. The gas rig count in the U.S. has fallen over 25% in the last year. Currently, much more drilling is focused on oil or natural gas liquids such as butane, propane, and ethane (NGLs). Oil rigs account for more than 66% of all drilling in the U.S. and activity is up 50% over the last year. Typically associated natural gas is produced along with crude oil and/or NGLs, so there is still a substantial natural gas stream being produced from these liquids wells. With crude prices at very strong levels, as much as 50% of total well-head production can be dry gas and the well can still be profitable.



Source: Lambert Energy Advisory

### Environmental Concerns

In our view, the only valid environmental concerns regarding horizontal drilling and hydraulic fracking relate to the fact that they are simply industrial activities that require established conventional regulatory oversight. It is highly improbable that a fracking operation taking place some 10,000 feet in the subsurface could actually reach into an active ground water aquifer which typically is, at the most, several hundred feet deep.

Similarly, the fluid mixture that is used in fracturing operations are 99.5% water and sand and it is unlikely that significant contamination could occur. In reality, hydraulic fracturing requires a large volume of frack fluid, which in turns necessitates large scale water sourcing, handling, treatment and disposal operations. These are all above ground activities and indeed should be monitored and controlled on a scale in-line with similar practices that have been in place for the oil and gas industry in the U.S. for many decades.

Given that fracking has been part of the normal course of operations in the industry, a whole-sale ban on the practice would effectively cease drilling in the U.S. In our view, this would lead to an extremely sharp price response for both natural gas and oil. Crude prices of \$200 per barrel and gas prices of \$20/mcf would not be unrealistic outcomes. Interestingly, much of the hysterical commentary is inconsistently oriented towards fracking, but only when associated with horizontal drilling. Media reports that New York has banned fracking are not entirely accurate. Fracking permits for vertical wells are being issued utilized today. The current moratorium applies to fracking in horizontal wells only.

### The Expansion of Unconventional Drilling

Countries around the globe are really just starting to look at these technologies. China, for example, has been drilling coalbed methane formations for many years. Shale gas drilling was not part of the industry until very recently. Unconventional shale drilling is now a rapidly developing theme in China with the likes of Royal Dutch Shell forming joint ventures with the Chinese national oil companies. We're also seeing these same trends in Argentina and Poland. Coal seam gas has been drilled in Australia for many years, and they too are now starting off on the shale trends. India has also shown some interest, though they have not really acted yet. The unconventional oil and gas theme is really just starting to develop internationally. Some of the big issues for these companies will be access to water, especially for countries like China, Argentina, and Australia.

### Implications

The long-term implications of the success of the unconventional revolution could be significant. Natural gas prices in the U.S. and Canada are significantly lower than almost any other industrialized country in the world. This has created a generous tail wind to North American manufacturers that benefit from cheap energy prices and/or are major suppliers to the oil and gas industry. In addition to driving down electric power generation prices (U.S. electricity prices have increased approximately 3% since 2010 with the U.K up 13%, Germany up 11% and Japan up 7.5%), chemical companies and refiners are taking advantage of the cheap energy source and feedstock. Well over a dozen chemical companies have already announced capacity expansions as the U.S. is now one of the cheapest places to manufacture commodity petrochemicals and plastics in the world. Furthermore, U.S. Steel and Valourec have both announced new plants in Ohio to provide the increased demand for Oil Country Tubular Goods, as well as to access the cheap fuel needed to run the plants.

While the advent of unconventional drilling for oil in the U.S. is still relatively nascent, the impact of a sharp turnaround in U.S. production has delivered substantial benefits to several aspects of the U.S. economy. Increased crude volumes from unconventional plays such as the Bakken trend in North Dakota and Montana have played a significant role in the blow out in basis between West Texas Intermediate and Brent oil prices. This differential has, in turn, created a significant benefit for many mid-continent and Rocky Mountain based refiners. Perhaps a more broadly desirable outcome has been the strong growth in employment that has emanated from ramped up drilling activity. In fact, North Dakota has the lowest unemployment rate in the country and other energy intensive states, such as Texas, Oklahoma, Arkansas and Louisiana also boast rate well below the national average.

Future benefits of increased unconventional oil and gas production could be even more significant. For every one million barrel per day increase in U.S. oil production, the country would save roughly \$35-\$40 billion in annual expenditures for imported crude oil. Estimates are that unconventional crude volumes could increase by as much as four to five million barrels per day over the next five to 10 years.

The perception of a prolonged period of lower natural gas prices has amplified debate around the viability of compressed natural gas-powered vehicles (CNG). CNG vehicles are used all over the world in both commercial, transit and consumer fleets. The U.S. has inexplicably been reluctant to embrace the potential of CNG. The infrastructure needed for compressed natural gas-run automobiles is basically in place while the cost for infrastructure to support an electric car fleet is on the order of a trillion dollars. Even converting 5% of the total U.S. fleet to CNG would have a substantial impact on petroleum product demand and the ancillary effects of further reduction in crude oil imports as well as environmental benefits.

### Conclusion

The unconventional resource revolution has firmly established itself in the U.S. oil and gas industry. Domestic natural gas volumes have increased to record levels and prices have fallen to levels not seen in over ten years. Indigenous crude volumes looked to be on a perpetual decline in 2008. The application of horizontal drilling and hydraulic fracturing to unconventional oil reservoirs has sharply reversed that trend. We believe E&P companies and oilfield service operators have and will continue to generate significant shareholder value via their exposure to this revolution. The international arena has just begun to explore the potential for unconventional resource plays.

Van Eck allocates significant resources to this important investment category. Van Eck's global hard assets investment team strongly believes that new unconventional technologies deployed to extract gas and oil from shale deposits is a "game changer", both domestically and, in time, internationally. The implications of these developments are both immediate, as in the substantial fall in the price of natural gas over the past few years, and long term, in terms of rising competitiveness and diminishing energy dependence.

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