

2016 Top Markets Report Upstream Oil and Gas Equipment Sector Snapshot

Unconventional O&G Resources

Unconventional O&G resources, such as shale, oil sands, oil shale, tar sands or coal bed methane, are hydrocarbon bearing geological formations with low permeability or porosity that cannot be developed using conventional development techniques. Unconventional O&G development uses methods such as horizontal drilling, hydraulic fracturing and in situ-types of production (commonly used for oil shale and oil sands). The exact practice of hydraulic fracturing, including the composition of the frac fluid, depends on the geologic structure, formation pressure and the well's target. Hydraulic fracturing

allows O&G companies to access more difficult reserves, which has become instrumental with unconventional O&G resources.

Numerous analyses have been conducted to try to assess the extent of global shale resources, which have resulted in a range of estimates. For example, in 2013, the U.S. Energy Information Administration commissioned Advanced Resources International (ARI) to conduct a global assessment of shale gas and shale oil in 137 shale formations in 41 countries outside the United States. Although it did not utilize

Figure 1: Map of Global Unconventional Oil and Gas Resources



Source: West Virginia GIS Technical Center

sub-surface data and can only provide broad estimates of global shale O&G resources, ARI's assessment indicated large potential for resource development of hydrocarbons from shale. The map on the previous page, developed by the West Virginia GIS Technical Center, depicts global shale resources, showing shale basins in light tan and shale plays in dark tan [see Figure 1].

U.S. companies have experimented with producing hydrocarbons from shale since the early 1980s. Around 2005, O&G companies increasingly began using the technique for commercial shale gas production that employed horizontal drilling and hydraulic fracturing with a mixture of water, sand and chemicals pumped at high pressures, generally referred to as "unconventional oil and gas." The amalgamation of these pre-existing techniques spurred a shift in the O&G sector that has now reversed the decline in U.S. oil and gas production, disrupting the predominant global oil and gas global market structure. This new market structure is characterized by increased U.S. oil and gas production, global supply outstripping demand and a massive decline in global crude oil prices. The United States is now widely viewed as the "swing producer" for the world since U.S. oil and gas production hinges on global prices and can quickly increase production as crude oil prices rise.

Shale resources represent a new frontier of O&G supply in a world of increasing energy demand. Developing hydrocarbons from shale, however, requires significant amounts of both capital and human resources, pipeline and refining infrastructure, a well-developed regulatory system and access to a dynamic and experienced O&G equipment and service supply chain. In addition, the geological, structural and resource characteristics of shale formations can vary widely from formation to formation, requiring different processes and technologies to develop shale gas wells in different areas around the world. Since the O&G industry does not have a "recipe book" on how to develop a shale gas play, extensive geological resource assessment and seismic analysis is required along with specialized equipment and highly trained professionals.

Challenges Facing Unconventional O&G Development

When considering the market implications of abundant shale resources, it is important to distinguish between a technically recoverable resource and an economically recoverable resource. Technically recoverable resources represent the volumes of oil and natural gas that could be produced with current technology, regardless of oil and natural gas prices and production costs. Economically recoverable resources are resources that can be profitably produced under current market conditions. The economic recoverability of oil and gas resources depends on three factors:

- 1) The costs of drilling and completing wells;
- 2) The amount of oil or natural gas produced from an average well over its lifetime; and
- 3) The prices received for oil and gas production.

Recent experience with shale gas in the United States and other countries suggests that economic recoverability can be significantly influenced by "above ground" factors as well as by geology. Key above ground advantages in the United States that may not apply in other locations include private ownership of subsurface mineral rights that provide a strong incentive for development, availability of many independent operators and supporting contractors with critical expertise and suitable drilling rigs, preexisting gathering and pipeline infrastructure and the availability of water resources for use in hydraulic fracturing. In part due to the rise in U.S. production and exports of crude oil and natural gas, prices have plummeted, making unconventional drilling less attractive to firms and speculators. Other factors impacting unconventional O&G development around the world include:

- 1) **Regulations** – The U.S. possesses a strong regulatory framework that provides legal protection for those experimenting with new technologies, including those related to drilling and hydraulic fracturing. In many other countries, regulatory framework is set up for conventional O&G, does not meet the needs of those interested in unconventional O&G ventures, and may face challenges surrounding regulatory implementation.

- 2) **Private Mineral Rights** – In the United States, landowners own sub-surface mineral rights on their property, a condition that does not exist in most countries.
- 3) **Infrastructure** – As with conventional extraction, unconventional O&G hinges on the ability to tap into an extensive and well-maintained transportation infrastructure. This allows the resources that are being extracted to be delivered and distributed across a country. In the United States, shale gas ventures have taken off near pipelines and terminals that can transport natural gas from producing formations to market.
- 4) **Water** – Due to the massive need for water that will be injected into the wells, countries have to not only possess enough water but also build the logistical support and infrastructure that can deliver the necessary water to the wells for hydraulic fracturing as well as manage wastewater.
- 5) **Expertise** – Technical expertise on hydraulic fracturing and shale gas exploitation is centered within the United States. In a world where shale gas and shale oil development is costly and the work is uniquely tied to geological features, developing a labor force with technical expertise remains a challenge. Generating the technical expertise necessary for unconventional development will be easier in countries with a robust conventional O&G industry than in countries with an undeveloped O&G sector.

Current Markets

To date, only the United States, Argentina, Canada and China have produced commercial volumes of either natural gas from shale deposits or crude oil from tight reservoirs. While the United States' diverse industry has formed the nucleus for its rapid growth in oil production since the mid-2000's, the low global price of oil has had a significant impact on U.S. O&G companies. At the same time, the United States remains at the forefront of the unconventional O&G revolution, leading the world in technological innovation and industry-driven regulations. As current markets continue to exploit their own unconventional O&G resources and new markets develop, U.S. companies are likely to find new avenues to export their sectoral expertise.

Argentina holds significant potential for commercial shale gas and shale oil production and could hold up to 308 Tcf of shale gas. The Neuquen Basin, located in west-central Argentina, is the epicenter of shale exploration in the country, with the Vaca Muerta shale formation possibly holding approximately 40 percent of the country's shale gas and 60 percent of its shale oil. As a net energy importer, Argentina is a bright spot for potential shale investment due to the promising geology of its basins and formations and an existing infrastructure connected to the main deposits in the Neuquen Basin. The Argentine government has continued to focus on promoting foreign investment in these projects, most notably in October 2014 with a set of reforms to the country's hydrocarbon law. Despite the promise of Argentina's sector and government attention, commercial scale shale production remains relatively undeveloped.

Canada contains several large hydrocarbon basins, holding up to 72 Tcf of shale gas. Shale resources are primarily centered in western Canada, including British Columbia, the Northwest Territories and Alberta, with smaller basins found in Saskatchewan, Manitoba, Quebec and Nova Scotia. The federal government of Canada is designated as the regulatory authority over the Canadian frontier, including the Yukon, Nunavut and the Northwest Territories, as well as the lands provided to the First Nations and certain offshore allotments. Hydraulic fracturing and onshore hydrocarbon policies are set at the province level, such as the British Columbia Oil and Gas Commission and the Alberta Energy Regulator.

China possesses the world's greatest unproved technically recoverable shale gas deposits and the third largest quantity of tight oil. China's shale resources are centered on seven basins, particularly among the South China 'shale corridor,' which encompasses the basins of Sichuan, Jiangnan and Subei alongside the Yangtze Platform. Sichuan, the most prominent of those in the corridor, is well-integrated into existing infrastructure, is close to nearby water supplies and is located near major cities. In China, shale gas exploitation is under-way, with special attention given to the Sichuan basin and the Yangtze Platform. The Chinese shale industry, however, faces several hurdles, such as (1) less favorable geological conditions, including seismically

active faults; (2) an inexperienced service sector; and (3) limited public data on geology and wells.

Frontier Markets

There are several other countries that possess sizeable shale deposits but have yet to develop their unconventional O&G industry. Based on estimates of shale gas deposits in Poland, a number of O&G companies began making significant investments in exploratory activities. Although companies did not find quantities of oil or gas that were feasible for commercial production after drilling several test wells, exploration for commercially-viable quantities of shale gas in Poland has continued. Despite efforts by the Polish government to encourage investment, the country's complicated geology, introduction of the Special Hydrocarbon Tax and lower global natural gas prices have all tempered expectations for a shale gas boom. In South Africa, the government has slowed the growth of unconventional development by taking years to finalize regulations on exploration activities and delaying the awarding of licenses. Similar to Poland, there have been

questions as to the commercial viability of South African shale amid the downward trending price of oil and the lack of any existing gas infrastructure in the country.

There are several other markets, however, that hold abundant reserves and conditions that could foster the development of new unconventional O&G markets. Mexico and Brazil, for example, are both countries that possess significant shale oil deposits. In addition, both countries host an existing O&G infrastructure, including the necessary human capital networks to launch large-scale unconventional operations in the country. In Mexico, geographic proximity and geological similarities to the United States could bolster opportunities for U.S. commercial engagement. In Brazil, a lack of unconventional O&G equipment and limited infrastructure around remote shale gas deposits provide U.S. companies with commercial prospects to meet these needs. Expectations though, especially in the short-term, should remain low, as unconventional O&G exploration and production across the global is limited by lower global oil prices.