

American Shale Revolution: Key Aspects & Implications for Japan



Author Peter E. Paraschos

By Peter E. Paraschos

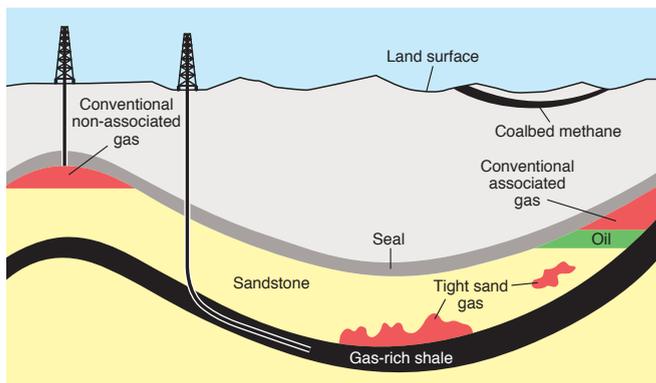
Rapid increases in US production of oil and natural gas from geologic shale formations in recent years have fundamentally altered the outlook for the US energy sector. On the eve of the so-called “Shale Revolution” in 2005, US crude oil production was in inexorable decline, while imports of oil and refined products continued to grow at a robust rate. Today in the United States, oil production is increasing at a robust rate, dependence on imported petroleum is declining, and exports of refined petroleum products are surging to record levels, winning overseas market share from European competitors.

In 2005, US natural gas production was slumping and the country was expected to become a major importer of liquefied natural gas (LNG). Today, the US is the world’s largest producer of natural gas and is expected to commence large-scale LNG exports in 2015. Robust increases in exports of liquefied petroleum gas (LPG) are positioning the US to surpass Middle East producers as the world’s largest supplier of this vital commodity. The US is increasingly being perceived as a rising energy superpower, but the implications for Japan have so far been chiefly indirect and limited.

Roots of the Shale Revolution

Oil and gas from shale formations are unconventional hydrocarbon resources that were previously too difficult and costly to extract in large quantities with traditional drilling technology. In shale formations, oil and gas are typically trapped in small pockets, which render vertical drilling largely ineffective in recovering large amounts of hydrocarbons. At the technological level, the Shale Revolution was made possible by the novel combination of two technologies that had been in use for decades – horizontal drilling and hydraulic fracturing.

Horizontal drilling was first demonstrated in the US in 1929, but only entered widespread use in the 1980s. This technology enables greater recovery of oil and gas by opening up lateral areas of oil and gas fields. Hydraulic fracturing, or “fracking”, is a “well stimulation” technology that involves the injection of fluid (chemical-laden water) and sand (“proppant”) into the lateral well bore under high pressure to fracture



Horizontal drilling & hydraulic fracturing are key to unlocking unconventional oil & gas resources.

Source: US Energy Information Administration & US Geological Survey

and prop open the surrounding shale to release trapped oil and gas.

George Phydias Mitchell, founder of the Mitchell Energy & Development Corp., is credited with pioneering the union of horizontal drilling and hydraulic fracturing during experiments conducted in the Barnett shale formation in Texas in the 1980s and 1990s. The US Department of Energy (DOE) also facilitated development of this extraction technology through a modestly funded research and development program between 1978 and 1992.

At the regulatory level, the US oil and gas industry gained the certainty it needed to begin using hydraulic fracturing technology on a large scale following passage of the Energy Policy Act in 2005. EPACT 2005 is a comprehensive, complex piece of energy legislation that contained a small, and at the time overlooked, provision that stripped the US Environmental Protection Agency (EPA) of its authority to regulate the underground aspects of hydraulic fracturing (except in cases involving diesel fuel). This provision gave industry confidence that the EPA could not heavily regulate or ban the use of fracking. This development also largely shifted the regulation of fracking to state governments, which retain primary oversight over the use of this technology.

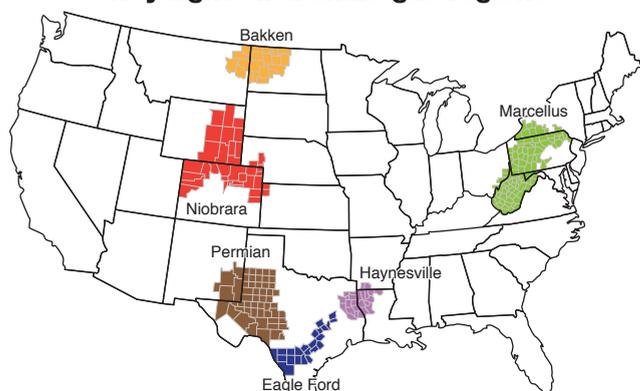
The Shale Revolution first gained momentum in the natural gas sector, with large-scale production commencing in the Barnett formation in 2006 and then spreading to other shale gas plays

Photo: Joshua Doubek / Wikimedia Commons



A drilling rig in the Bakken Shale Formation

Key tight oil & shale gas regions



Note: According to the EIA, these six regions accounted for 95% of US oil production growth and all domestic gas production growth during 2011-13.

Source: US Energy Information Administration

such as Marcellus and Haynesville. The Shale Revolution spread into the oil sector in 2008 with commercial production of the massive Bakken formation in North Dakota.

Smaller independent oil and gas companies are the driving industrial force behind the Shale Revolution in contrast to the large, vertically integrated oil companies, which tended to dismiss the growing interest in shale resources. The Shale Revolution is largely occurring on privately owned lands, where rights to explore for and produce oil and gas are more easily obtained than on government-owned lands.

Shale Gas & Tight Oil Resources: Reserves & Formations

Natural gas produced from shale formations is called “shale gas” but crude oil from such formations is increasingly called “tight oil” to avoid confusion with shale oil, which exists in non-liquid form in kerogen-laden rocks. The improving ability to extract oil and gas from shale formations has caused a significant increase in proved reserves of US oil and gas in recent years.

According to the US Energy Information Administration (EIA), proved reserves of crude oil were 33.4 billion barrels at the end of 2012, an increase of 4.5 billion barrels (15.4%) over 2011 and the highest level since 1976. Tight oil accounted for 7.3 billion barrels, or 21.8% of this total. Indeed, the EIA’s estimate of tight oil reserves more than doubled from 2011 to 2012, increasing by more than 3.7 billion barrels. The large increase in proved reserves of crude oil continues an upward trend that started in 2008 with the onset of large-scale tight oil extraction.

Proved reserves of US natural gas declined 7.5% from 2011 levels to 322.8 trillion cubic feet (Tcf) in 2012, but remain well above pre-Shale Revolution levels. Shale gas accounted for 129.4 Tcf, or 40% of total 2012 natural gas reserves. The EIA attributed most of this decline to record low natural gas prices in 2012, and predicted an improved estimate for 2013 reserves given the improvement in gas prices since 2012.

Additions to proven US oil and natural gas reserves from shale formations are continuing to outpace increases in production, according to the EIA. Shale formations are spread throughout the US in

various sedimentary basins, but only a few are currently at the forefront of US oil and gas production. Primary tight oil regions are Bakken, Niobrara, Permian, and Eagle Ford. In April 2014, the four areas produced a combined 4.1 mb/d of crude oil. Primary shale gas producing regions are Marcellus, Haynesville, and Eagle Ford. In April 2014, these regions produced 27.8 billion cubic feet of gas per day (Bcf/d).

Shale Gas Surge

US production of dry natural gas peaked in 1973 at 21.7 Tcf and then fluctuated below this level over the ensuing decades. In 2006, dry gas production began to increase significantly, and by 2011 surpassed the 1973 peak. In 2012, dry gas output reached 24.1 Tcf, exceeding the 1973 peak by 11%, and accounted for 40% of total US production. Including production of tight gas (from sandstone formations) and coalbed methane, unconventional gas accounted for 67% of total US gas output in 2012.

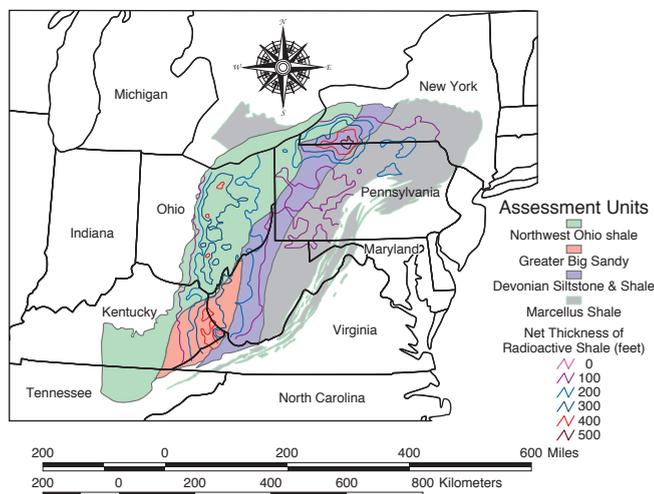
The robust increase in US natural gas output caused a substantial supply glut to develop during late 2011 and early 2012, which pushed US gas prices to historic lows near \$2.00 per million Btu (MMBtu). This in turn prompted a substantial increase in the consumption of natural gas in the electricity sector, largely at the expense of coal. Relatively low natural gas prices are also reviving energy-intensive heavy industries and giving US chemical manufacturers a significant competitive advantage.

Despite the rapid growth of its natural gas production, the US remains a net importer of natural gas. It continues to import residual amounts of LNG as well as natural gas by pipeline from Canada. The EIA recently forecast that the US will become a net exporter of natural gas in 2018.

LNG & LPG Exports

US exports of natural gas are moderately regulated by the DOE. By law, the DOE must presume it is in the US “public interest” to export

The Marcellus Shale Formation



Source: US Geological Survey

Photo: Wolfgang Meinhart / Wikimedia Commons



An LNG tanker

natural gas to countries with which the US has a free trade agreement (FTA) requiring national treatment for trade in natural gas. The US has such FTAs with 18 countries and DOE approval of applications to export natural gas on a long-term basis to them is essentially automatic. In the case of non-FTA countries, such as Japan, the same presumption still applies, but domestic opponents of natural gas exports are given an opportunity to prove any proposed export of natural gas is contrary to the public interest.

The DOE approved the first non-FTA application for the long-term export of domestically produced LNG from the lower-48 states in May 2011, when it authorized Sabine Pass LNG to export up to 2.2 Bcf/d of natural gas over a 20-year period. Sabine Pass, located on the US Gulf Coast, has also received approval from the Federal Energy Regulatory Commission to construct the required liquefaction facility. Sabine Pass is currently expected to commence operation in late 2015.

As of mid-May 2014, the DOE has approved seven applications from six projects to export to non-FTA countries. Altogether, these approved applications allow exports up to 9.3 Bcf/d, or 67 million metric tons per annum of LNG. All are scheduled to start shipments between 2015 and 2019. The total approved export amount is currently equivalent to about 13.9% of total US dry gas production in 2013.

The DOE has not set any quantitative limit on total US LNG exports. However, in its Sabine Pass approval, the DOE stated that it would evaluate the cumulative impact of LNG export authorizations when considering subsequent applications. The DOE's backlog of pending non-FTA LNG export applications exceeds 20 and accounts for about 40% of current US production. Not all of these proposed LNG exports will proceed. Even approved projects face considerable international competition, notably from planned or actual projects in Africa, Australia, Canada, and Russia.

The outlook for the emerging US LNG export sector is probably the single most monitored aspect of the American Shale Revolution from Japan's perspective. (European countries are also now seeking access to US LNG given Russia's demonstrated willingness to use its gas exports as a tool of geopolitical manipulation.) In northeast Asia, LNG prices remain the highest in the world, and improving security of supply through the greater diversification of suppliers remains a critical goal.

There is some expectation in Japan and South Korea that US LNG exports will lead to a transformation of the pricing mechanism for LNG

sales, shifting the benchmark from oil prices to gas prices closer to the US Henry Hub market price. US natural gas prices remain substantially lower than prices of LNG delivered to overseas markets. In April 2014, LNG in Japan sold for an average \$14.80 per MMBtu, compared to US spot prices near \$4.60 per MMBtu at Henry Hub. At prices near these levels, the US should become an LNG supplier to Japan. However, some analysts contend that the general impact of US LNG exports on Northeast Asian gas prices will be more modest than hoped.

LNG exports are somewhat politically controversial in the US. Environmental advocacy groups are trying to build greater national opposition to LNG exports, chiefly due to the increasing use of hydraulic fracturing to extract natural gas. While congressional Republicans generally support LNG exports, Democrats are divided between supporters representing oil and gas state interests and opponents from petroleum-importing and industrial states.

In comparison to natural gas exports, US exports of LPG are lightly regulated and rising rapidly, chiefly due to robust production and low prices in the domestic market. In 2012, the US became a net exporter of LPG for the first time, with average net LPG exports increasing from 196,000 b/d that year to 332,000 b/d in 2013. LPG exports have now surpassed those of Saudi Arabia and the United Arab Emirates and are second only to exports from gas-rich Qatar. (The global LPG market in 2013 was 8.5 mb/d.)

Asian countries, including China and Japan, are now emerging as major customers for US LPG, chiefly for chemicals production. Recent forecasts suggest that the US could export as much as 800,000 b/d of LPG by 2020, with much of the increase destined for northeast Asia, including China. In comparison to LNG exports, LPG exports are not politically controversial, though some lawmakers from states in the US Midwest and Northeast did pressure Washington to halt LPG exports when propane prices surged during the recent winter heating season.

Tight Oil Boom

US output of crude oil peaked at 9.6 mb/d in 1970 and continued to decline, hitting 5.0 mb/d in 2006. At that time, US oil production was expected to remain in decline, leaving the US increasingly dependent on foreign sources of imported oil. Due to the growth of tight oil production, however, US crude oil output has increased substantially every year since 2008, rising to 7.4 mb/d in 2013 and 8.3 mb/d in April 2014. Tight oil production as a share of total US oil output has increased from 12% in 2008 to 35% in 2012.

The US is today the fastest growing oil producer in the world, accounting for 8.2% of total global oil production in 2013 and contributing more incremental increases to the global oil supply than any other country. US dependence on imported oil is also declining. In October 2013, US crude oil production exceeded net imports of oil for the first time since 1995. Declining imports are also a function of declining domestic consumption, which peaked at 20.8 mb/d in 2005 and registered 18.8 mb/d in 2013.

US tight oil is predominantly light grade and relatively easy to refine. Robust increases in tight oil production have displaced crude imports, mainly from Africa, but also from Latin America and even Russia, releasing these supplies for other global markets. Light oil from Africa has been completely squeezed out of the US Gulf Coast refinery

market. East Coast refineries are reducing imports of light crude, but still import some on a seasonal basis. Crude oil imports from the Middle East have also been displaced, but to a much lesser extent, with Saudi Arabia and Kuwait actually increasing exports of crude oil to the US market.

Crude Oil Exports

US exports of crude oil and condensate have been tightly regulated since the Arab oil embargo of 1973-74. Prospective US oil and condensate exporters must seek US Department of Commerce approval. During the embargo, US producers could export crude oil without restriction and increasingly did so, evading government-imposed domestic price controls to sell oil in international markets where prices were much higher. Voter outrage over the resulting gasoline shortages, however, motivated Congress to ban crude oil exports.

The Commerce Department has some flexibility to allow greater crude oil exports under certain circumstances, including cases where exports are the only way to sell the oil. Crude oil exports to Canada have been permitted under these exceptions since the early 1980s. During the 1990s, exports of Alaskan crude and California heavy crude to Asian countries, including Japan, were also allowed.

US oil producers, particularly smaller, independent producers, are pushing for the ban on US crude oil exports to be lifted, and industry lobbying to win a broad exemption for condensate exports is intensifying. Independent producers, which generally lack refining assets, want access to international markets where benchmark Brent light crude continues to trade at a premium to West Texas Intermediate crude.

Moreover, there are growing concerns that rising production of light crude oil could soon exceed the capacity of the US refinery sector to process it. US refineries along the Gulf Coast are generally configured to process heavier grades of crude oil, imported mainly from Canada, Mexico, and Venezuela. At the same time, much of the crude oil being produced in Texas, especially from Eagle Ford, is light crude oil and condensate.

The US refinery sector is somewhat expanding its capacity to refine light crude, and industry is planning to build condensate splitters along the Gulf Coast to produce minimally refined products not subject to the export ban. However, large, new refineries are unlikely to be built due to high costs, intense regulatory oversight, and market uncertainties.

To a significant extent, the refinery sector in eastern Canada is now providing a safety valve for rising US light crude production, mainly from the Bakken formation: US crude oil exports to Canada are rising rapidly from 29,000 b/d in 2008 to 119,000 b/d in 2013. As of February 2014, crude oil exports to Canada averaged 240,000 b/d. Some independent estimates indicate that they could reach 400,000 b/d or more by the end of 2014.

Liberalization of the crude oil export regime could make the US a more attractive place for Japanese oil and gas companies to invest in upstream assets, further diversifying Japan's sources of overseas oil supply and strengthening Japan's energy security. Some in Congress are pushing the Obama administration to liberalize oil export regulations, particularly for condensate. In Congress, however, there is

limited interest in legislation to lift the ban, especially with congressional elections ahead in November 2014. That said, if current light oil production trends continue, greater exports will eventually need to be allowed.

Refined Petroleum Product Exports

Exports of refined petroleum products, notably gasoline and diesel fuel, are lightly regulated and can be sent to any country not under US government-imposed sanctions. In late 2011, the US became a net exporter of refined products for the first time since 1949. US refinery companies are benefitting from robust domestic production of light crude oil, which continues to trade at a substantial discount to benchmark Brent crude.

When combined with low natural gas prices, the persistence of the so-called Brent-West Texas Intermediate spread since 2011 has given the US refinery sector a major competitive price advantage. (Refined products derived from relatively cheap US light crude are exported at prices linked to the more expensive Brent crude, thus generating unprecedented profit margins for this traditionally low margin industry.)

In 2013, US exports of refined products averaged 3.5 mb/d, up 10% over 2012, according to the EIA, making the US the world's largest exporter of refined products. Exports of distillate fuel, including ultra-low sulfur diesel, averaged 1.1 mb/d in 2013. Central and South America remained the largest export market for these products, followed by Europe. US exports of gasoline averaged 550,000 b/d in 2013, with Central and South America, Europe, and Africa being the main destinations.

Overall, US exports of refined petroleum products were valued at \$111 billion in 2013, more than double 2010 levels, representing the single-largest export item in terms of value last year.

So far, increased exports of US refined products to Japan have been limited mainly to petroleum coke and oxygenates. However, increased US exports to Latin America and Europe may be having an indirect effect on Asian markets, by redirecting refined petroleum product exports from other regions (such as the Middle East) to Asian markets.

The boom in US refined product exports is not a very politically controversial issue at this time, but may become one if gasoline prices increase substantially. This could lead to the introduction of restrictive legislation in Congress. For this reason, industrial and congressional supporters of refined product exports generally avoid trumpeting this particular US export success story.

The American Shale Revolution is clearly generating multiple rapid changes in global energy markets. Over time, Japan is likely to benefit from anticipated increases in US petroleum supplies, particularly LNG and LPG, but only to the extent US petroleum exports can moderate or even reduce the global prices of these critical commodities. Much will depend on whether the US can continue to build on its initial success in exploiting shale formations. **JS**

Peter Paraschos is director of energy and geopolitical risk at International Technology and Trade Associates, Inc. (ITTA), a consulting company in Washington, DC. His primary areas of expertise include Middle East, North African, and Caspian Sea oil and gas producers as well as dynamic aspects of the North American oil and gas sector.