Shale Development: Contexts and Consequences, National and Global

Douglas Southgate, Ohio State University
southgate.1@osu.edu

21 October 2011

Antecedents: Policy Reform and Technological Innovation

The remnants of ocean-beds hundreds of millions years old, shale formations thousands of feet underground hold enormous quantities of untapped hydrocarbons. Until very recently, however, these formations were rarely exploited, not only due to their depth but also because of their impermeability. Instead, oil and gas were extracted mainly from strata such as limestone and sandstone, toward which a fraction of the hydrocarbons originally contained in shale had migrated over geologic time.

But for the Natural Gas Policy Act (NGPA) of 1978, shale and other "unconventional" resources might still rest undisturbed today. Enacted a few years after energy prices skyrocketed, due to a shut-off of fossil fuel deliveries by Middle East exporters, this legislation did away with a comprehensive set of regulations governing pricing and production. In effect, a nationwide market for natural gas was created – largely by guaranteeing universal access to the interstate pipeline system, at fees approved by the Federal Energy Regulatory Commission (FERC). This deregulation spurred exploration and extraction in new settings. It also encouraged the development of technology for exploiting subsurface deposits formerly regarded as uneconomic.

Technological advances following deregulation can only be described as stunning. Thanks to these advances, for which the private sector is largely responsible, the expense of finding and extracting natural gas has fallen markedly, including from shale. A case in point is seismic reflection, which uses sound waves to locate promising resources with a degree of precision that was unimaginable not so long ago. Harnessing this technology, one major U.S. firm finds hydrocarbons more than 98 percent of the time it drills down to shale formations.

Drilling has revolutionized as well. More than six decades ago, firms that provide drilling services to the oil and gas industry pioneered techniques for directional (or horizontal) drilling, as an alternative to the vertical boring that the oil and gas industry had relied on since its earliest days in places like Ohio and Pennsylvania. These techniques have improved so much that underground resources can now be reached from a production pad a mile or more away and encompassing less than ten acres. Multiple perforations can be made from the same pad, which allows for the recovery of hydrocarbons underlying a circular area two miles across with minimal disturbance of the landscape.[1]

Hydraulic fracturing is another technique that has been employed for decades, yet has gotten much better in recent years. This process involves the high-pressure injection of fluid into hydrocarbon-bearing rock. Consisting mainly of water, this fluid also contains "propants" such as sand (needed to keep open the small cracks created by fracturing and through which gas and oil flow out) as well as chemicals in small concentrations (e.g., non-toxic gelling agents that prevent propants from settling out in the aqueous solution). Along with horizontal drilling, "fracking," as this technique is commonly called, is a routine feature of shale development, not to mention the production of "tight" gas (i.e., gas lodged in dense geologic strata).

---

[1] Hydrocarbon recovery has been enhanced thanks to the application of micro-seismic technology – in the specific form of small transmitters/receptors placed right behind drill bits that are used to guide equipment penetrating far below the surface of the land.

Impacts on the U.S. Gas Market

Technological improvement since the NGPA became U.S. law has had substantial impacts on the natural gas sector. These impacts are entirely in line with what happens whenever private firms, guided by market forces, find and adopt better ways to serve its customers. That is, consumers, not producers, capture the lion's share of the benefits of better technology, most tangibly in the form of lower prices.[2]

The price-impacts of natural gas deregulation contrast sharply with predictions about the sector that experts and policy-makers have made in the past. For example, the authors of the chapter on natural gas in a widely-cited report on energy published soon after passage of the NGPA were certain that resources would continue growing scarcer, thereby driving up inflation-adjusted (or real) prices over time.[3] Many had the same outlook on market trends as recently as six or seven years ago. This is illustrated by the warning that Federal Reserve Chairman Alan Greenspan issued in 2004 about falling U.S. output. Indeed, America's central banker was worried enough about gas availability to advocate the construction of a large number of coastal terminals capable of receiving liquefied natural gas (LNG) from other countries, so that imports would make up for dwindling domestic supplies.[4]

Greenspan issued this call about three years after large-scale, commercial extraction of gas from shale got underway – to be specific, production from the Barnett formation in northern Texas. Since that time, gas supplies from shale consistently have grown faster than output has declined from conventional fields, both on land and offshore. An unambiguous sign of this shift is that the share of national supplies obtained from shale, which was just 4 percent in 2005, now stands at 23 percent.[5] With extraction of tight gas also going up, overall supply has increased. Mainly because of shale development, gas production is expected to continue rising.[6]

As long as shale was the source of a modest portion of U.S. supplies, natural gas was relatively expensive, selling for as much as $6 per million British thermal units (mmbtu) at the wellhead. But after spiking above $10 per mmbtu during the first half of 2008, when crude petroleum was changing hands for as much as $146 per barrel, wellhead prices have stayed low, never rising above $4 per mmbtu since late 2008 – by which time gas production had ramped up from various shale deposits around the country.[7]

Shale development has not only made natural gas more affordable. It also has decoupled the natural gas and oil markets. During the early years of the twenty-first century, the ratio of the value of a barrel of oil to the value of one mmbtu of gas hovered between 6:1 and 8:1. Since then, petroleum generally has grown more expensive as gas has gotten cheaper. As a result, the price ratio consistently has exceeded 15:1 for nearly three years. The last time this relationship held was in the late 1970s and early 1980s, when the market value of petroleum shot upward in the wake of the Iranian Revolution.

---

[2] Examples of lower prices and other benefits for consumers of better technology are too numerous to count. Certainly, there are many such examples in the food economy – Douglas Southgate, Douglas H. Graham, and Luther Tweeten, The World Food Economy, Second Edition (Hoboken: John Wiley, 2011).

[3] I.C. Bupp and Frank Schuller, "Natural gas: How to slice a shrinking pie," in Robert Stobaugh and Daniel Yergin (eds.), Energy Future: Report of the Energy Project at the Harvard Business School (New York: Random House, 1979).

[4] Associated Press, "Greenspan: Natural gas imports must grow," 27 April 2004 (http://www.msnbc.msn.com/id/4845905/ns/business-oil_and_energy/t/greenspan-natural-gas-imports-must-grow/).

[5] The Economist, "The future of natural gas: Coming soon to a terminal near you," 6 August 2011, pp. 51-53.

[6] U.S. Energy Information Agency, Annual Energy Outlook 2011 with Projections to 2035 (Washington: 2011), p. 3.

[7] U.S. consumers are accustomed to volumetric pricing of natural gas, rather than pricing based on energy-content. However, this content varies, from 1.01 to 1.07 mmbtu per thousand cubic feet. A price of $4 per mmbtu is equivalent to $3.88 per thousand cubic feet for gas with 1.03 mmbtu per thousand cubic feet.

Global Repercussions

Since it abandoned regulated pricing and production of gas in favor of market allocation before any other nation, the United States pioneered hydraulic fracturing, horizontal drilling, and other technologies for exploiting unconventional resources. There are environmental risks associated with this development, risks that are non-trivial and must be managed. However, the benefits of extracting gas and other hydrocarbons from shale – which include reduced dependence on sources of energy that are more expensive and in many cases pose a greater threat to the environment – are compelling.

Shale formations, which appear to be widely distributed throughout the world, are now being exploited or are about to be in a handful of other nations, such as Poland (which may have Europe's largest reserves), South Africa and China.[8] But even though drilling in these countries has yet to add significantly to energy supplies, U.S. extraction of natural gas from shale is having noticeable effects in foreign markets already.

In particular, the LNG formerly slated for delivery to this country is instead going elsewhere. One consequence of this has been to diminish Europe's dependence on Russian energy. Russia provided 27 percent of the gas consumed by its western neighbors in 2009, but by 2040 this share is expected to fall to 13 percent.[9] More broadly, worries that Iran, Russia, Venezuela, and other exporters might form a price-fixing cartel, similar to the Organization of Petroleum Exporting Countries (OPEC), have dissipated.[10]

Exporters' hopes for such a cartel will recede further as their customers break free of the monopolistic grip long held by companies like Russia's Gazprom. As long as these customers lacked alternative supplies, the exporters insisted on long-term contracts featuring prices pegged to the market value of petroleum, which is the most remuneration that monopolistic suppliers could hope to receive. But in recent years, increased LNG availability in Europe has enabled some customers to win agreement from Gazprom that spot-market prices, which are considerably lower than oil-referenced prices, henceforth will be used to value up to 15 percent of the gas delivered via the Russian firm's pipelines. Likewise, China is refusing to sign long-term contracts with Gazprom in which petroleum prices are the basis for valuing natural gas.[11]

A genuine global market for natural gas does not yet exist. A clear indicator of this is that prices still vary substantially from place to place. Consider Japan, which has stepped up imports of LNG (and coal) in the wake of the Fukushima nuclear disaster of March 2011 and where the price is around $15/mmbtu. This is approximately four times the current reference price in the United States, charged at Henry Hub, Louisiana.

Due to various market adaptations, price gaps of this magnitude will not last. Where gas is affordable, as it is and will continue to be in the United States, electricity generation will increase at gas-fired plants, which have numerous advantages over all competing sources of electricity.[12] Likewise, affordable gas ought to lead to the expansion of manufacturing. The U.S. chemical industry is a case in point, not only because it is energy-intensive but also due to its use of ethane and other natural gas liquids (NGLs) as feedstock.[13] Additionally, investment should occur in fleets of buses, delivery trucks, and other vehicles that run on natural gas. But as demand grows due to these adaptations to cheap gas, prices in places like the United States will rise, converging toward values in other markets.

---

[8] The Economist, op. cit.
[9] Ibid.
[10] Kenneth B. Medlock III, Amy Myers Jaffe, Peter R. Hartley, "Shale gas and U.S. national security," Baker Institute for Public Policy, Rice University, Houston, July 2011.
[11] The Economist, op. cit.
[12] Matt Ridley, "The shale gas shock," The Global Warming Policy Foundation, London, 2011.
[13] Thomas Kevin Swift, Martha Gilchrist Moore, and Emily Sanchez, "Shale gas and new petrochemicals investment: Benefits for the economy, jobs, and U.S. manufacturing," American Chemistry Council, Washington, March 2011.

Even greater price increases can be expected here if the United States becomes an exporter of LNG. This would require substantial spending, both on the conversion of existing import facilities into export terminals as well as the construction of new terminals. But if and when this investment happens, the U.S. gas market will no longer be isolated from the world market, and price differences will narrow.

Equilibrium in natural gas markets around the world does not require identical prices everywhere. To the contrary, even if the prices Americans pay become linked to prices overseas, as will happen if the United States becomes an important LNG exporter, gas will still cost up to $3 per mmbtu less in this country than in importing regions such as Europe, due to the costs of liquefying gas here, transporting LNG across the Atlantic, and converting LNG back into gas over there.[14] Moreover, the global gas market that is taking shape, slowly but surely, will be decoupled from the international petroleum market. Exactly as has happened in this country, gas prices will no longer be tied to oil prices and the benefits of affordable energy will spread around the world.

Conclusions

In the drive to find domestically-produced substitutes for imported fossil fuels, many Americans pin their hopes on government. In some ways, reliance on the public sector makes sense. For example, investment in basic scientific research is often undertaken or underwritten by governmental agencies because the findings of this research, which are critical for subsequent applications in the marketplace, have no commercial value (of the sort needed to attract the interest of profit-seeking firms) in and of themselves. Much harder to justify, though, are subsidies, which frequently masquerade as investments – to be specific, subsidies for energy sources and technologies that are unable to compete unaided in the marketplace, at least for the time being.

In light of the disappointing results of much governmental subsidization of forms of energy that currently are uncompetitive, the lessons to be learned from the gas sector are important, even heartening. As emphasized in this brief paper, policy reform more than three decades ago caused natural gas to be allocated by market forces, not regulators. In addition to catalyzing the search for new resources, deregulation has led to impressive technological gains, mainly by the private sector. Thanks to these advances, shale formations that contain enormous quantities of hydrocarbons are for the first time being exploited. The primary beneficiaries of this development are not energy companies, but rather their customers, who in the United States and eventually in other parts of the world will be supplied reliably with affordably-priced natural gas for a long time to come.

Truly, the shale boom is a significant and welcome accomplishment.

---

[14] Donald Hertzmark, Principal, DMP Resources, Washington, personal communication on 2 October 2011.