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Careful What You Wish For: The Shale Gas Revolution and Natural Gas Exports

By Frank A. Wolak

Energy industry observers have called the development of unconventional natural gas extraction technology the most important innovation in the industry in the past 50 years. Horizontal drilling technology to reach deep underground shale formations and hydraulic fracturing technology to break apart the shale for a controlled release of the natural gas trapped inside are the two major breakthroughs that have enabled the commercial viability of shale gas. Both of these technologies were primarily developed in the United States and, for the most part, by new entrants rather than established firms. For example, Chesapeake Energy, currently the nation's second largest natural gas producer, specializing in unconventional natural gas technology and ranked 229 in the 2012 Fortune 500, was established in 1989.

Calling shale gas technology revolutionary does not exaggerate its impact on the domestic natural gas industry. In less than ten years, the United States has gone from having what the U.S. Energy Information Administration (EIA) said was enough natural gas reserves to last fewer than 15 years at current rates of consumption and wholesale natural gas prices as high as $13 per million BTU (MMBTU) to natural gas reserves estimated to last 50 to 100 years and wholesale prices below $3 per MMBTU.

Widespread deployment of this technology has led to a dramatic increase in U.S. natural gas production. Figure 1 plots monthly natural gas withdrawals from January 1997 to September 2012. The tremendous increase since January 2005 is purely the result of unconventional natural gas development. This increase in production has been accompanied by a substantial drop in the real wholesale price of natural gas since January 2005 and more than 25-year lows in real natural gas prices. This is shown in Figure 2, which plots

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About The Author

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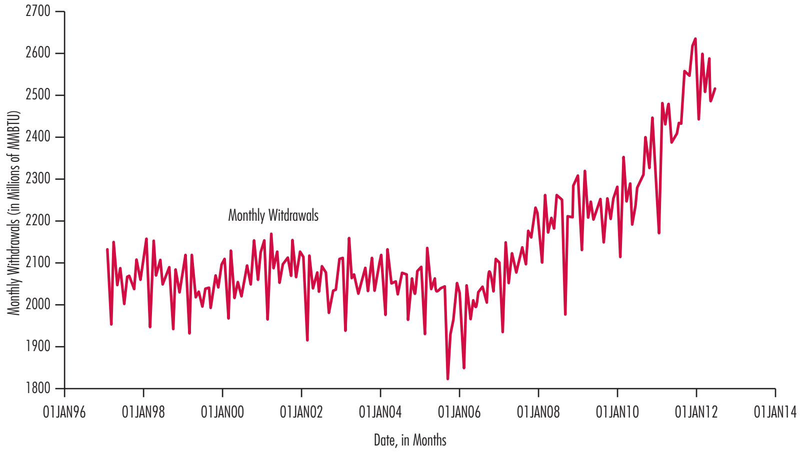
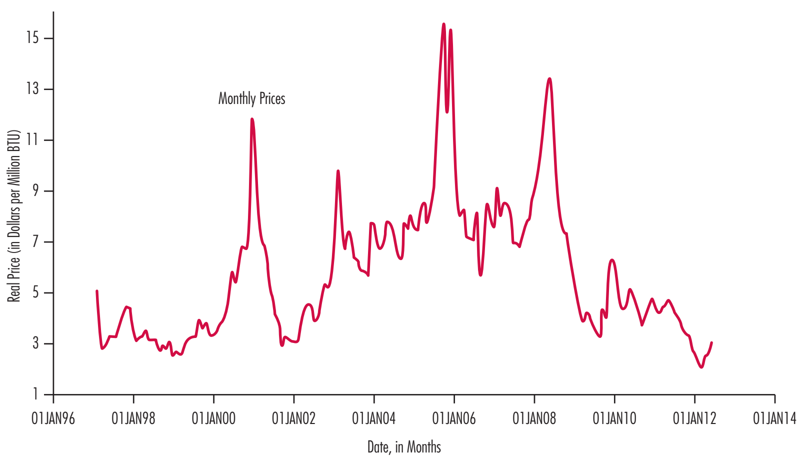
Figure 1. Monthly Natural Gas Withdrawals in U.S. in Millions of MMBTU



Data source: *http://www.eia.gov/dnav/ng/hist/n9010us2m.htm*

Figure 2. Real Price of Natural Gas at Henry Hub in September 2012 Dollars



Data source: *http://www.eia.gov/dnav/ng/hist/rngwhhdm.htm*

real natural gas prices at Henry Hub in Louisiana, a major U.S. trading hub for natural gas, in September 2012 dollars deflated by the Bureau of Labor Statistics Consumer Price Index for Urban Consumers.

The rest of the world has yet to realize significant benefits from the shale gas revolution for two reasons: (1) exporting natural gas from the United States requires specialized facilities to liquefy the gas for seaborne transportation and none of these facilities currently exist in the U.S. and (2) the developers of the shale gas extraction technology have yet to deploy it with sufficient scale outside of the United States in spite of the fact that many countries, most notably China, have large shale gas reserves.

Current landed prices for liquefied natural gas (LNG) suggest that exporting shale gas from the United States would be extremely profitable. Figure 3 gives the estimated landed prices for LNG at various locations around the world for November 2012. Current estimates of the average cost of liquefaction, shipping, and regasification are less than $4/MMBTU, which suggests that the price differentials between U.S. locations and locations anywhere else in the world would yield tangible profits for U.S. suppliers exporting to these locations.

These facts have not gone unnoticed by the energy industry, Wall Street, or Washington. Almost every week articles appear in the business and popular press touting the profit potential of U.S. natural gas exports. However, for the reasons discussed below, I believe these profits are unlikely to be realized. Enthusiasts for investing billions of dollars in natural gas export facilities should be careful what they wish for and learn from the experience of investors in natural gas import facilities, many of which now sit idle or operate at far below full capacity. Instead, these investors should focus on developing new uses of natural gas in the U.S. electricity and transportation sectors. As I note below, these uses make both short- and long-term economic sense and have significant environmental benefits.

Figure 3. **Estimated Landed LNG Prices for November 2012 in $/MMBTU**

Source: *http://www.ferc.gov/market-oversight/mkt-gas/overview/ngas-ovr-lng-wld-pr-est.pdf*

What Is the Comparative Advantage of U.S. Firms?

This is the first question any potential investor in a natural gas export facility should ask. Is a firm able to site, permit, construct, and begin operation of a natural gas export facility faster than other firms are able to explore, develop, and begin production using shale gas extraction technology in a potential export market? The time from siting to the start of operation of LNG export facilities is estimated to take at least 6 years and as long as 10 years. In contrast, the time from the start of drilling to operation of a shale gas field is typically less than four months.

Taking this comparison further, a potential investor should also bear in mind that the environmental regulations governing shale gas exploration and development in many of the potential export destination countries in Figure 3 are likely to be less stringent than those in the United States. Labor and many materials costs are also likely to be lower in most of these countries. All of these factors point to cheap natural gas being available in these countries in the near future. By the end of 2012, China expects to produce a small but significant amount of shale gas. It also has set the very ambitious goal of having shale gas provide 6 percent of its total energy needs by 2020. India, the world's other major energy consumer, has substantial shale gas reserves and ambitious shale gas development plans.

This logic points to a not improbable "build it and no one comes" outcome for an investor in an LNG export facility, after spending billions of dollars and six years to complete the project. It is very likely that by the time the export facility is completed significant shale gas production activity will be taking place in many potential U.S. export markets and that prices at these locations will be below the delivered price of U.S. LNG to these locations. These locations are also likely to become potential competitors to the United States in the global LNG market. The $3/MMBTU to $4/MMBTU differential for liquefaction, transportation, and regasification implies that even if these wholesale prices at these locations are double those in the United States, LNG from the U.S. would have a difficult time competing with domestic supplies of natural gas in these countries.

There is one major factor working in favor of the profitability of shale gas exports. Horizontal drilling technology and hydraulic fracturing are well-understood technologies, but how they are best applied to extract shale gas depends on the details of the local geology. During the early stages of the development of shale gas in the United States, significant trial, error, and expense went into finding the most cost-effective way to extract these resources. Consequently, a major source of uncertainty facing shale gas developers outside of the United States is how transferrable the experience in the U.S. will be to these other countries and how long it will take to find the best way to deploy the best methods for the local geology. Nevertheless, betting against the ability of U.S. firms working with local partners to address these issues seems unwise, because it is a bet against what U.S. firms excel in—developing and commercializing new technologies and products.

A final argument against the rapid development of shale gas resources in other parts of the world is the potential inability of U.S. firms to gain access to these resources at commercially attractive terms. A number of factors can prevent this: 1) the unwillingness of the local governments to sign contracts with U.S. firms on desirable terms, 2) the lack of well-defined subsurface property rights to allow exploration, and 3) the lack of the necessary pipeline and other infrastructure to carry the gas to the market once it has been found. History has shown that all of these factors are genuine concerns, but given how long it takes to bring online an LNG facility in the United States and how long that facility will need to operate to recover the extremely large cost to construct it, it is hard to imagine that these challenges cannot be overcome in that time frame in a number of regions with large shale gas reserves.

If the United States Doesn't Export LNG, What Should It Do with the Natural Gas?

The economic forces described above are very likely to lead to a significant increase in the global supply of natural gas in the next decade and lower natural gas prices throughout the world. How then should the United States best take advantage of its lead in shale gas technology? Conditions in the global oil market and persistently high gasoline and diesel prices argue for greater use of natural gas in the transportation sector. Recent Environmental Protection Agency (EPA) standards require reductions in mercury and air toxics pollutants from coal-fired and oil-fired power plants. At current prices, increasing the amount of natural gas consumed in the electricity sector is a low-cost way to comply with these standards. Both of these sectors are substantial potential sources of increased demand for natural gas. The transportation sector accounts for roughly 30 percent and the electric power sector roughly 40 percent of total primary energy consumption in the United States.

Both oil-based fuels (primarily gasoline and diesel fuel) and natural gas can be used to power an internal combustion engine. At current domestic wholesale prices, natural gas is a substantially cheaper source of heat energy (BTUs) than oil. There are roughly 5.8 MMBTU per barrel of crude oil. This fact implies that a price of \$90 per barrel, approximately the current price of West Texas Intermediate (WTI) crude oil, the price of an MMBTU from oil is \$15.50 = \$90/bbl 5.8 MMBTU/bbl. This is more than four times higher than the current wholesale price of natural gas at Henry Hub. This substantial BTU cost advantage of natural gas versus oil implies that substituting natural gas for gasoline and diesel fuel in the U.S. transportation sector could yield significant dollar-per-mile costs savings to the U.S. economy.

There are few technological barriers to the widespread use of natural gas in the transportation sector. Many vehicles currently on roads around the world (primarily in developing countries) are powered by compressed natural gas (CNG), where the natural gas is kept under high pressure to conserve storage space in the vehicle. The major challenge to increased use of CNG is the availability of fueling stations. For this reason, CNG is currently used in vehicle fleets—taxis, buses, and trucks—that travel fixed routes or round-trips from a fixed origin and therefore require only a small number of fueling stations. CNG vehicles are also used by some small businesses and individuals with on-site access to natural gas. However, this requires the installation of equipment to compress the natural gas that is subsequently injected into the vehicle's storage tank. Many industry observers have argued for greater use of CNG in the long-haul trucking industry because vehicles typically travel along the major interstate highways, which would limit the need for fueling stations beyond the major interstate highway network. These uses of natural gas could easily soak up the additional supply of natural gas in the United States.

There are also environmental advantages to the increased use of natural gas in the transportation sector. Natural gas contains virtually no sulfur and produces fewer nitrogen oxides and particulates when it is burned than gasoline and diesel fuel. It also turns slightly more of the available MMBTUs of heat energy into useful energy to drive the engine than gasoline and diesel fuel. Consequently, both in terms of reduced local air pollutants and greenhouse gas emissions, increased use of natural gas in the transportation sector delivers significant environmental benefits.

Because the vast majority of oil consumed in the United States is used in the transportation sector, increasing the amount of natural gas used

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in this sector can significantly reduce the demand for imported oil. This has both national security and economic security benefits. U.S. consumers will be less exposed to global oil prices and they will spend a smaller fraction of their budgets on oil from countries that are not particularly friendly to the United States.

A longer-term benefit to the United States from the increased use of natural gas in the transportation sector also plays into its strength at developing and deploying new technologies. The United States can become a leader in the design of technologies and the accompanying delivery infrastructure for the widespread utilization of natural gas in the transportation sector. When other countries decide to make the transition to greater use of natural gas in the transportation sector, U.S. firms will be ready with the best technologies and infrastructure designs.

The United States currently produces between 40 and 45 percent of its electricity from coal. Oil provides less than 1 percent of the electricity consumed in the United States. Although coal is an extremely low cost source of BTUs, coal-fired power plants have higher construction costs per megawatt (MW) of installed capacity than natural gas-fired generation units. Coal-fired generation units are also less efficient at translating BTUs of input fuel into megawatt-hours (MWh) of energy than combined-cycle gas turbine (CCGT) generation units. Therefore, even though the $/MMBTU cost of energy from coal delivered to many electricity generating sites in the United States is still less than the current $/MMBTU price of natural gas, the marginal cost of producing energy from a CCGT generation unit can be less than that for a coal-fired steam turbine facility. Because of the lower capital cost of CCGT units relative to coal-fired generation units, the average cost producing electricity from a natural gas-fired power plant can also be lower than that for a coal-fired power plant, even if the marginal cost of producing energy is lower for a coal-fired power plant. Particularly in those parts of the United States that are located far from the Power River Basin in Montana and Wyoming, the economics can favor replacing coal-fired generation with natural gas-fired generation at current prices for natural gas and coal.

Factoring in the requirements of the EPA's Mercury and Air Toxics Standard (MATS) and the large number of coal-fired power plants that must be retired or retrofitted to meet these standards, the case for using more natural gas in the electricity sector is even stronger. Re-powering existing coal-fired generation facilities to use natural gas can be the least-cost compliance option with MATS. Because natural gas-fired generation units produce a third to a half of the greenhouse gas emissions per MWh of energy produced compared with coal-fired generation units, there is an additional global environmental benefit from increased use of natural gas in the electricity sector.

Don't Bet Against the Ingenuity of U.S. Firms

Investing in an LNG export facility is akin to betting that the U.S. regulatory and environmental protection processes will allow an export facility to be sited, built, and put into operation significantly faster than the U.S. firms with access to shale gas resources can make horizontal drilling and hydraulic fracturing technology commercially viable in other parts of the world. This is an extremely risky bet, given the long history of successful transfers to other countries around the world of technologies developed and commercialized in the United States. A superior strategy for the United States would seem to be sticking to its strengths and developing and commercializing transportation, electricity generation, and other technologies that make use of the cheap natural gas that is likely to come to rest of the world as a result of the diffusion of shale gas extraction technology.

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