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# Placing the American Gas Boom in Perspective

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## Natural gas will continue its conquest of global and national energy supplies.

Before the end of 2005, the U.S. price of natural gas rose above $15/1,000 cubic feet, nearly 12 times the all-time low reached in 1995. Production was down by about 8 percent compared to 2001, news reports speculated about supply shortages, and gas companies were gearing for expanded imports of liquefied natural gas (LNG) from overseas. Six years later, by the second week of April 2012, the market price of U.S. natural gas fell to less than $2/1,000 cubic feet (to levels not seen since January 2002), nationwide gas extraction in 2011 was nearly 12 percent above the 2009 level, and record production was expected in 2012, when all storages would be filled to capacity. No wonder that gas companies are now planning to export LNG, and that new drilling projects have been shelved in the anticipation of gas glut.

This amazingly abrupt change of gas fortunes has been due to the rising production of shale gas. Shale gas is released by horizontal drilling followed by hydraulic fracturing of the porous rock using proprietary high-pressure mixtures of water and chemicals (the practice now widely known as fracking).

Has this been too good to last? Critics say so. They point to a substantial downward revision (roughly a two-thirds reduction) of shale gas reserves in the Marcellus formation that underlies the Appalachian states from West Virginia to New York. They claim that the industry is nothing but a variation of a Ponzi scheme (see Rolling Stone). They note that the gas flow from new wells declines exponentially in a matter of months. Their most often repeated argument is that fracking is a huge environmental disaster that will contaminate aquifers wherever it takes place.

Here is my advice. Do not get carried away either by bonanza claims (implying only sinking natural

gas prices and seeing Marcellus as the Saudi Arabia of natural gas) or by the negativism of anti-fracking activists (recently joined by Hollywood celebrities). Low prices will slow the development of shale gas. Reserve estimates of any mineral resource are always uncertain during an early stage of development (in 2011, the U.S. Geological Survey boosted its estimate of technically recoverable Marcellus gas more than 40-fold compared to its 2002 value), and even conservative assessments point to a combination of already available reserves and the most likely additional resources that would suffice (at the current rate of consumption) to supply America for at least the next 50 years.

As for Rolling Stone's accusation that Chesapeake Energy is running a Ponzi scheme, that company has responded in detail. Although many questions remain about the company's actions, even if the worst suspicions are proven, they do not invalidate long-term viability of shale gas extraction. Exponential decline of gas flow from fracked wells is a well-known phenomenon, taken into account by such pioneers of shale gas development as Terry Engelder at Penn State when they made their estimates of potential recovery. And if there is any water contamination, it is a problem that has well-known technical solutions.

All of these have been fascinating, often controversial, and newsworthy developments, and while I would not dismiss them as altogether ephemeral, I see them largely as expected ups and downs along a long trajectory of national and global energy transitions. These transitions are slow but inexorable shifts in the amounts and proportions of different primary sources of heat, light, and motion, and while they may be slowed down or accelerated (and temporarily even seemingly derailed), there is no doubt about their long-term persistence and eventual outcomes.

By the end of the 19th century, traditional biomass fuels (wood, charcoal, and straw, which together dominated energy use for millennia) were reduced to a small fraction of overall energy supply as coal became the principal fuel. The shift away from coal to hydrocarbons (crude oil and natural gas) began slowly before 1900 in the United States and Russia, and it accelerated only after World War II. By 1970, crude oil supplied 46 percent of the world's energy and its shares were 43 percent in the United States and 50 percent in Europe. There is no mystery about what will come next: Rising consumption of natural gas will eventually make it not only more important than crude oil but the single-most important fossil fuel.

Seen from this perspective, American shale gas production must be viewed as only one, albeit a major, component of gas's global rise. In 1970, natural gas supplied 18 percent of global commercial energy and that share rose to about 24 percent by 2010 (with the EU share going from less than 8 percent to 26 percent), while the worldwide crude oil share fell from 46 percent to 34 percent (and in the EU from 50 percent to 38 percent). Natural gas's rise has been slowed recently by China's extraordinarily high coal extraction rates, but these cannot be repeated in the future (the country is already a large importer of coal). Natural gas will thus continue its conquest of global and national energy supplies, with five factors behind the rise—discoveries of new large fields, diffusion of shale gas production, expansion of LNG exports, high prices of crude oil, and unrivaled efficiency of gas converters.

New giant gas fields have been discovered in such previously unpromising places as the Mediterranean off Israel's shores and deep Atlantic waters offshore near Brazil. There are extensive deposits of gas-bearing shales in Europe (particularly in Poland) and enormous resources in Asia. Recent reductions in the cost of gas liquefaction coupled with increased sizes of LNG tankers (they now rival the size of ships carrying crude oil) made LNG into a trade equivalent of oil: It can now be transported to consumers on any continent, bought without restrictive long-term

contracts, and delivered at increasingly affordable prices. The totals speak for themselves: Global LNG trade rose roughly eightfold between 1980 and 2010, and it now accounts for 30 percent of the worldwide natural gas trade.

Little has to be said about high oil prices (the price spread between liquid and gaseous hydrocarbons has reached an unprecedented level), but the conversion efficiencies achievable by furnaces and turbines burning natural gas are not sufficiently appreciated. New, super-efficient household gas furnaces convert up to 97 percent of the fuel into heat; combined-cycle generation (using the waste heat from a gas turbine to raise steam and generate more electricity in an associated steam turbine) now produces electricity with 60 percent efficiency (and 70 percent will be possible in the future).

Modern (that is, overwhelmingly fossil-fueled) civilization needs highly concentrated sources of energy that can be conveniently delivered to the megacities where most of humanity will soon live. No other fuel can fit this need as efficiently and with such a relatively low environmental impact as natural gas (its combustion releases less carbon dioxide per unit of useful energy than coal or oil). The conclusion is obvious: The world should speed up its unfolding transition from coal and crude oil to natural gas by using the fuel not only for heating, electricity generation, and as feedstock for industrial syntheses but also as a transportation fuel. Spending toward that goal would bring faster and more durable gains than subsidizing such dubious conversions as turning corn into ethanol or pouring huge sums into money-losing solar enterprises.

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