Abundant Natural Gas Could Mean a Paradigm Shift in U.S. Energy Markets and Policy

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In recent years, the outlook for U.S. natural gas markets has changed dramatically. As recently as 2008, most forecasts showed the United States growing increasingly dependent on imports of liquefied natural gas (LNG). But some new assessments show that North America is awash in natural gas resources, with estimates of shale gas resources more than doubling since 2007, while estimates of conventional natural gas resources remained steady.

This paradigm shift began more than a decade ago with the gradual development of new technologies that provided access to resources that were previously considered too expensive to produce. Low-cost coalbed methane in the San Juan Basin of Colorado and New Mexico was first. Next came new techniques for the development and production of natural gas in tight sand formations in western Wyoming. Finally, several major shale gas fields were opened up: the Barnett shale in Texas, Horn River (British Columbia), Marcellus (Pennsylvania, New York, and West Virginia), and Haynesville (Arkansas and Louisiana).

Greater shale gas resources promise big changes in U.S. energy markets, including permanently lower natural gas prices and increased self-sufficiency in natural gas. More natural gas will also enhance opportunities to reduce carbon dioxide (CO_2) emissions and increase energy security by substituting natural gas for other fuels, such as coal and petroleum. In some cases, the increased use of natural gas would require new technology and infrastructure development.

Although estimates of shale gas resources are favorable, considerable uncertainty exists because the industry cannot yet well predict how resources in the ground translate into future yields. In addition, numerous environmental concerns have been raised about its development and production. A cautious approach would be to design any climate or security policy in a way that is robust across different projected futures.

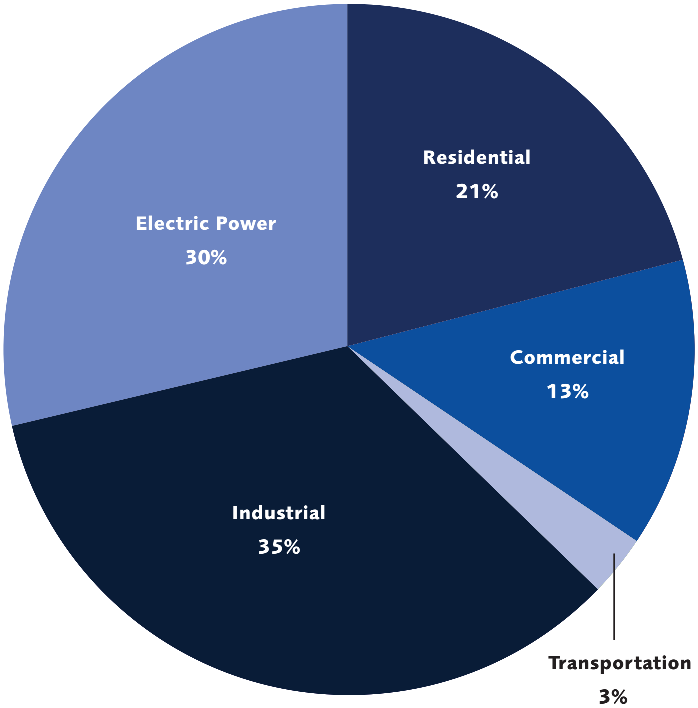
Advances in Technology

Although natural gas has been produced at low rates from shallow, permeable shale formations in Appalachia, Michigan, and Colorado for decades, the oil and gas industry also has been long aware of the natural gas resources trapped in deep shale formations. Ranging 5,000 to 10,000 feet below the surface, deep shale gas formations are characterized by low permeability that naturally impedes the flow of natural gas out of the formation through the borehole to the surface and raises production costs.

What has changed is the development of a new combination of horizontal drilling and fracturing techniques that greatly increase access to deep shale gas formations and yield high rates of natural gas production. Horizontal drilling involves first drilling downward then turning to create a long, horizontal bore through the underground structure holding natural gas. This horizontal borehole increases exposure of the resource to an outward passage. After the horizontal borehole is created, the next step is hydraulic fracturing—

FIGURE 1.

U.S. Natural Gas Consumption by Sector, 2008



which is most commonly accomplished by forcing a combination of water, sand, and chemicals into the borehole. This procedure further opens up the structure and increases the natural gas flow into the horizontal borehole, in which the gas collects before it is brought to the surface.

Environmental Concerns

Although estimates of shale gas resources are rosy, the industry has limited experience in actually producing shale gas and cannot yet well predict how resources in the ground translate into future yields. Environmental concerns and the prospects for additional environmental regulation add to the potential uncertainty about future shale gas production.

The organic and inorganic chemicals used to supplement the fluids used in hydraulic fracturing and the contaminants in the associated water produced with the natural gas are among the primary concerns. The industry has resisted disclosing their chemical additives for proprietary reasons, but the natural contaminants include various salts (mostly sodium chloride) and benzene (a powerful industrial solvent thought to be carcinogenic). If these chemicals or contaminants are accidentally spilled or leak into groundwater as a result of faulty preparation of the drill hole, the harm can be severe. Similar problems arise in the context of deepwater drilling for oil and natural gas, as the recent horrendous oil spill in the Gulf of Mexico attests.

Although the Obama administration has instituted a six-month moratorium on deepwater offshore oil exploration, the development of shale gas resources is mostly regulated by state environmental and resource agencies. In a move that was widely anticipated, New York State recently banned the development of shale gas resources in the watershed that provides much of New York City's drinking water. Drilling in most other areas continues under varying state regulations.

EPA is taking steps toward registering and regulating the chemicals used in hydraulic fracturing. Industry sources variously say that should EPA regulation materialize, it could have no effect, could slightly increase the cost of producing natural gas from shale formations, or could completely shut it down. The likely effects could vary greatly by area.

U.S. Awash in Natural Gas

Natural gas already plays an important role in U.S. energy use, and it is widely used throughout the economy. Ranking second only to oil, natural gas accounted for nearly 25 percent of total U.S. energy consumption in 2009. While oil and coal usage is concentrated in transportation and electric power, respectively, natural gas is used across a variety of sectors in the U.S. economy. The industrial sector is the largest, accounting for nearly 35 percent of total natural gas consumption (as shown in Figure 1). The electric power sector accounts for nearly 30 percent. The residential and commercial sectors account for 21 percent and 13 percent, respectively, and a small amount is used in the transportation sector.

Greater natural gas supplies could considerably enhance the fuel's role in the U.S. energy mix. As might be expected, a larger supply would yield lower projected natural gas prices (Figure 2), resulting in a strong gain in U.S. natural gas consumption—nearly 11 percent above a baseline scenario in 2030 (Figure 3). The biggest jump would be in the electric power sector, which shows 22.5 percent greater use of natural gas, due primarily to the substitution of natural gas for other energy sources. Some of the gain would come from increased electricity use brought about by lower electricity prices.

International Implications

According to my analysis, more abundant shale gas supplies could put the United States in a position of being a net exporter of natural gas by 2030, rather than a net importer, as is projected by the U.S. Energy Information Administration. Between now and then, U.S. natural gas imports would be substantially lower than previously projected. Even if the United States does not become a net exporter of natural gas, its reduced imports are already having profound effects on the world natural gas market.

Suppliers around the world had been gearing up to supply LNG to the United States—by developing new liquefaction facilities, export terminals, tankers, import terminals, and regasification facilities. But abundant supplies and depressed prices in the U.S. natural gas market have kept out and will keep out nearly all of that LNG. Natural gas producers worldwide are facing substantial pressure to reduce prices below those set in existing contracts indexed to crude oil prices.

Pursuing Climate Policy

We might expect more abundant natural gas to reduce overall U.S. CO_2 emissions because the emissions from natural gas are about 45 percent lower per Btu than coal and 30 percent lower than oil. But markets don't always conform to our expectations. In the absence of federal regulation to reduce such emissions, abundant natural gas supplies seem likely to have little effect on U.S. CO_2 emissions. While lower natural gas prices push coal out of the way, some zero-carbon (nuclear and renewable) electric power sources also would be displaced. In addition, market interactions reduce projected prices for all energy resources. The combined effect is to boost the projected energy consumption for 2030 by slightly more than 1 percent and the projected CO_2 emissions by slightly less than 1 percent.

With a federal climate policy in place, however, abundant natural gas could moderately lower the cost of reducing CO_2 emissions by displacing more coal from the electric power sector and limiting gains in the projected use of nuclear and renewable power generation (Figure 4). These changes translate into a reduction in climate policy costs that amounts to about $30 million in 2012 and rises to about $300 million in 2030.

Climate Policy Outside the Power Sector

Opportunities for switching between natural gas and higher-carbon fuels (mostly oil products) currently seem to be limited in the transportation, industrial, residential, and commercial sectors. Conse-

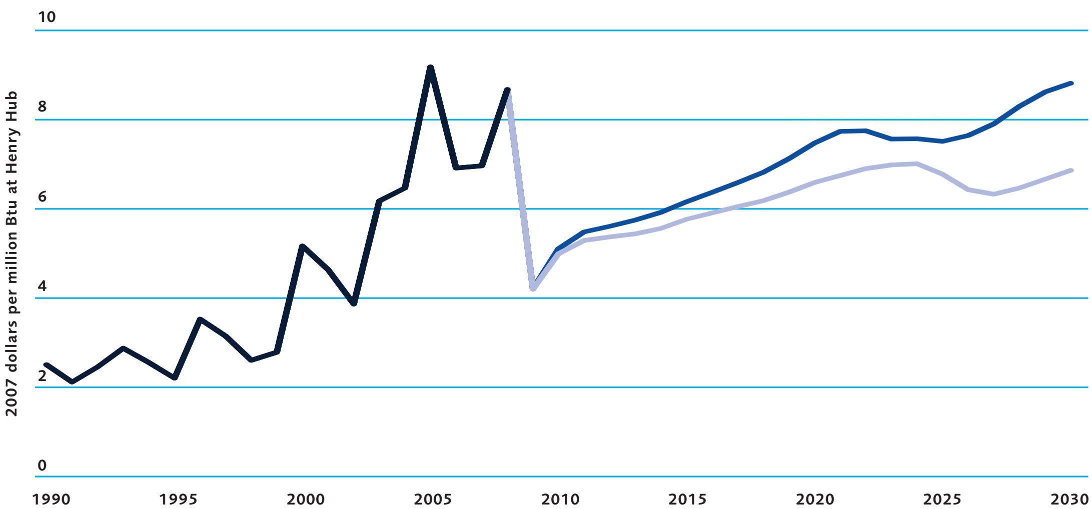


FIGURE 2.

U.S. Natural Gas Prices

Historical
Without Abundant Shale Gas
With Abundant Shale Gas

Sources: EIA and NEMS-RFF Projections

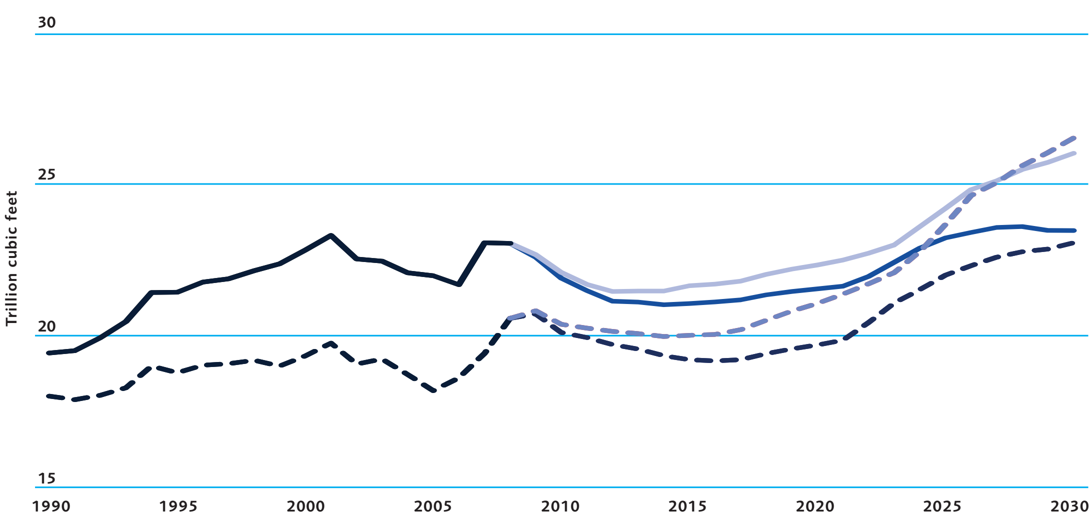


FIGURE 3.

U.S. Natural Gas Consumption and Production

Historical Consumption
Consumption with Abundant Shale Gas
Consumption without Abundant Shale Gas
Historical Production
Production with Abundant Shale Gas
Production without Abundant Shale Gas

Sources: EIA and NEMS-RFF Projections

quently, reducing CO_2 emissions in those sectors seems likely to depend more heavily on energy conservation, and introducing a low-carbon policy in the absence of other changes could reduce rather than increase their projected natural gas consumption.

Changes in these sectors could enhance the use of natural gas in the pursuit of climate policy, but there are challenges to overcome. In the transportation sector, the deployment of new technology is required. For example, heavy trucks might use LNG instead of diesel fuel. The greater use of electric or plug-in hybrid autos would allow the substitution of electricity generated with natural gas for gasoline. These technologies are less affordable and lack a supporting infrastructure, such as LNG refueling stations and electric vehicle charging stations.

For the industrial sector, the conventional wisdom is that "everyone who can switch from oil to natural gas has done so." In the residential and commercial sectors, a lack of infrastructure makes it difficult for the few using heating oil to switch to natural gas. Easing any and all of these barriers could enhance the role of natural gas use in climate policy in ways that are not currently foreseen.

Pursuing Energy Security

Without increased shale gas resources, the United States was on a path to increased dependence on imported natural gas—both through pipelines from Canada and LNG cargos from around the world. Expectations of increased LNG imports suggested the United States was facing small but growing energy security issues related to the potential disruption of its natural gas supplies. Greater reliance on domestic shale gas sources reduces such concerns.

Using domestic natural gas supplies to further enhance U.S. energy security depends mostly on displacing oil consumption. Oil consumption exposes the United States to security externalities that are associated with the economic losses arising from the oil price shocks that result from disruptions in world oil supplies. The possibilities and obstacles for using natural gas to displace oil to enhance energy security are the same as for climate change.

Uncertainty and Policy

Uncertainty about shale gas resources has implications for climate and energy security policy because policies that mandate the use of specific fuels or technologies require accurate predictions about future resource availability and technology change to be cost-effective. However, policies that provide pricing, such as cap-and-trade systems or taxes, do not require such accurate predictions.

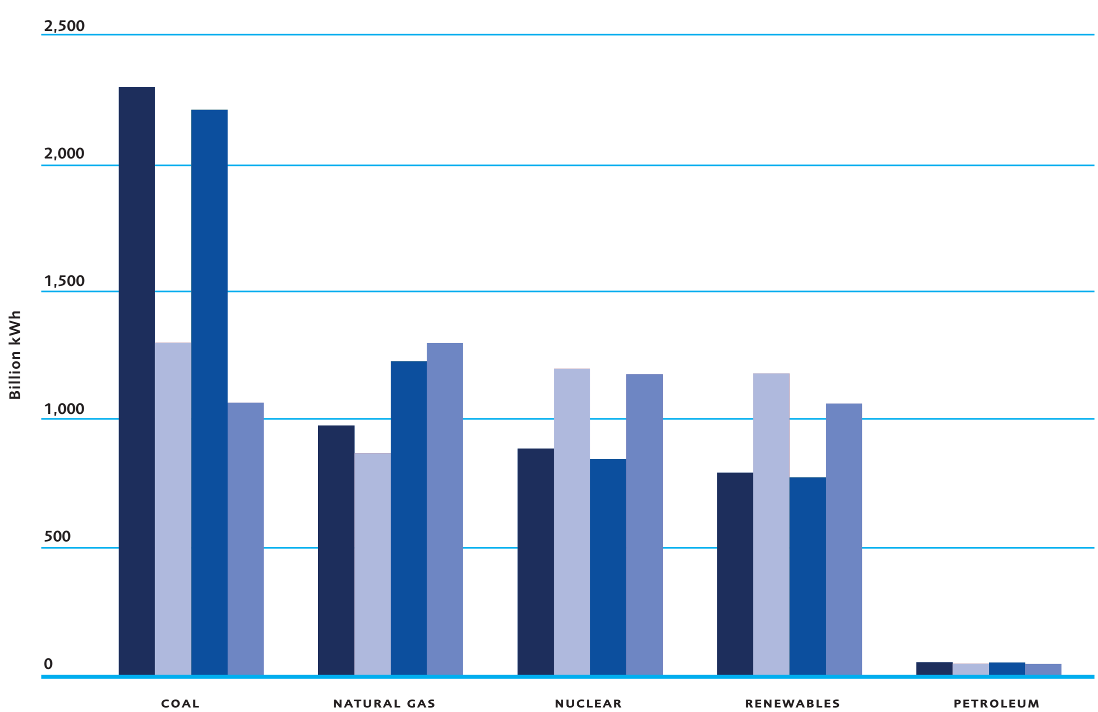
Pricing CO_2 emissions and the security externalities associated with oil dependence will give market participants an incentive to seek out the most cost-effective means for reducing CO_2 emissions and oil dependence, which makes such policies robust across different projected scenarios. If natural gas is as abundant as recent estimates of shale gas resources suggest, reliance on market-based climate polices will favor its use. If it proves less abundant, market-based policies will yield other means for reducing CO_2 emissions and oil dependence. Either way, a combination of policy and market incentives will yield the lowest-cost approach to reducing CO_2 emissions and oil dependence. ■

FIGURE 4.

Electric Power Generation bySource, 2030

- Low Gas, No Climate Policy
- Low Gas, Climate Policy
- High Gas, No Climate Policy
- High Gas, Climate Policy

Source: NEMS-RFF Projections



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