

A Comment: Natural Gas Can Lead the Way
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NATURAL GAS CAN LEAD THE WAY

Mark Zoback

Much of the debate concerning energy, climate and the economy involves how to manage the transition from fossil fuels to sustainable energy sources. In this context, it may seem ironic to promote one fossil fuel over another, but natural gas is an inexpensive, abundant and relatively clean fuel that can lead the transition away from coal and oil, while achieving significant reductions in greenhouse gas emissions and other pollutants over the next two decades. In short, increased use of domestic sources of natural gas needs to be an essential component of U.S. energy policy.

To accomplish this there are five key questions that need to be addressed: First, are domestic natural gas supplies adequate to offset the use of coal and oil to a significant degree? Second, can natural gas compete on an economic basis with coal for electricity generation? Third, is switching to natural gas necessary to achieve significant reductions of carbon dioxide emissions over the next 10 to 20 years? Fourth, is it reasonable to utilize natural gas to replace significant amounts of oil as a transportation fuel? And finally, can large-scale natural gas development proceed in an environmentally responsible manner?

With respect to supply, multiple independent assessments now put U.S. domestic natural gas resources at more than 2,000 trillion cubic feet (TCF), largely as the result of the recent success in producing gas from organic-rich shale formations found throughout the country. Let's put that into perspective. Burning less than 1 percent of those resources would provide the same amount of electricity as the billion tons of coal that are burned in the United States each year to provide the country with about half of the electricity we use.

The enormous domestic supply of gas in the United States is so large that for at least several decades there would be no effective limits on supply. Historically, the Achilles heel of the gas industry has been price volatility, but prices should remain low and relatively stable,

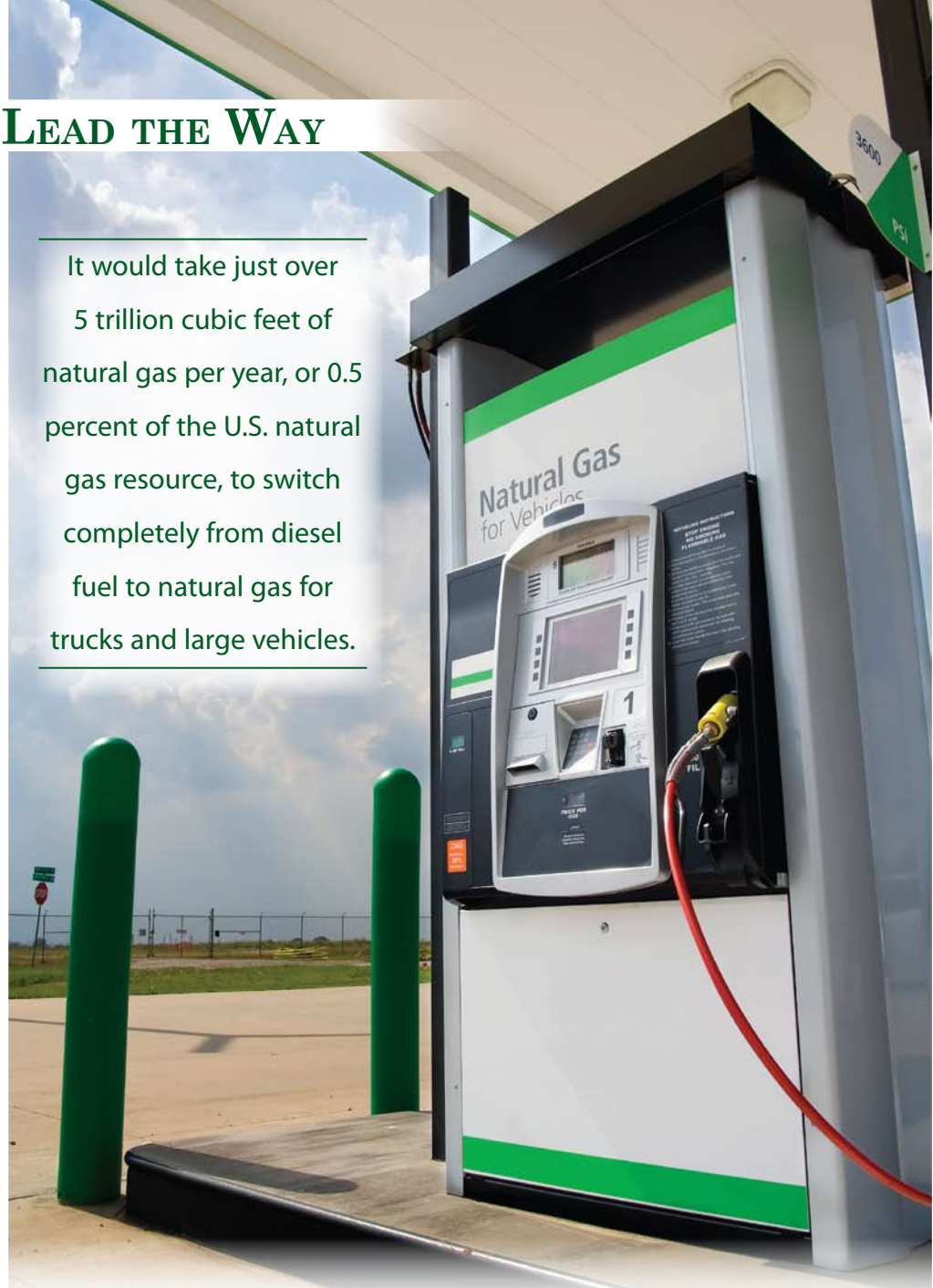
It would take just over 5 trillion cubic feet of natural gas per year, or 0.5 percent of the U.S. natural gas resource, to switch completely from diesel fuel to natural gas for trucks and large vehicles.

negating the two historical advantages of coal. The natural gas industry is well-positioned to increase drilling and production as prices and demand recover. An additional benefit of exploiting these natural gas resources is that it will translate into the creation of a broad spectrum of jobs in manufacturing, engineering, transportation and related industries. Gas production from shale in the Dallas/Fort Worth area alone, which represents only about 6 percent of the total U.S. resource, is estimated to have produced about a hundred thousand jobs during the past five years or so.

The next question is whether it is really necessary to switch a significant amount of electrical generation from coal

to gas to achieve the desired degree of emission reductions. Burning coal for electricity accounts for more than 40 percent of all carbon dioxide emissions in the United States. Natural gas emits only about half as much carbon dioxide as coal for a given amount of electricity generation. Thus, for the electrical power sector, offsetting 40 percent of coal-fired electrical generation with the existing excess capacity for electrical generation from natural gas-fired plants would meet the stated goal of the Obama administration (and Congress) of at least a 17 percent reduction in carbon dioxide emissions by 2020.

The only alternative, if we continue to use coal at current rates, is to achieve



significant emission reductions with large-scale implementation of carbon capture and storage: capturing the carbon dioxide produced at the coal-burning plants and pumping it into the ground where it would be stored for hundreds to thousands of years, ideally in nearby deep saline aquifers.

The problem with this is that not only are there a number of fundamental scientific questions about long-term carbon storage that need to be addressed (which will take time), but there are also two first-order operational challenges — where to store the carbon dioxide and how to separate the carbon dioxide from the flue gas of the plants. At the rates and volumes of carbon dioxide storage required, the great majority of deep saline aquifers in the central and eastern United States, where most of the approximately 450 coal-burning plants are located, are not likely to be suitable for carbon storage because of their low permeability. Low permeability makes it essentially impossible to inject carbon dioxide at high rates without increasing pressure in the formations to the point where it would potentially fracture the cap rock or induce seismicity.

Depleted oil and gas reservoirs are another potential site to store carbon dioxide, but the limited distribution of potential sites would require development of infrastructure for gathering and transporting carbon dioxide over huge distances. Furthermore, it is not clear how to evaluate the suitability of many gas or oilfields for long-term storage because of the possibility of leaks along the numerous old well casings found in these fields.

At the same time, large-scale implementation of carbon capture from coal-burning plants comes at high capital costs and significant reductions in plant efficiency due to the energy required to separate the carbon dioxide from the flue gas. Thus, even when geologically suitable sites for carbon capture and storage can be found, it may not be feasible to implement carbon dioxide separation at a large fraction of the aged coal-burning plants now operating in the United States. So while it is important to pursue carbon capture and storage, it is also important to recognize that it will not result in significant reductions of carbon dioxide emissions over the next

decade or two if we continue to rely on coal for half of all electricity produced in the United States.

Using gas to generate electricity would also reduce other types of pollution: It produces only a tiny fraction of the sulfur oxides, particulates and formaldehyde, and none of the mercury that comes from burning coal. Substituting natural gas for coal also eliminates the many environmental problems associated with the disposal of both coal mine wastes and the 130 million tons of fly ash produced each year in the United States alone, as well as the health impacts and healthcare costs related to mining and burning coal.

Finally, a compelling case can be made for natural gas in the transportation sector, at least until technological breakthroughs make widespread use of electric (or hydrogen) vehicles feasible. There are now about 9 million natural gas-powered vehicles in the world, but only about 100,000 in the United States. It would only take just over 5 TCF of gas per year, or 0.5 percent of the domestic natural gas resource, to switch completely from diesel fuel to natural gas for trucks and large vehicles. Doing so would reduce carbon dioxide emissions by about 25 percent and significantly reduce our dependence on foreign oil.

Although the focus of this commentary is on energy supplies and policy

in the United States, it is important to point out that organic-rich shale gas deposits are also extensive in Canada and much of Africa, Asia (including China), Australia, Europe, Russia and South America, so increased use of gas should be part of the energy policies of many nations. Each of these regions — many of which extensively use coal for electricity — should be able to exploit their own domestic shale gas resources at a large scale.

All of this said, it is important to emphasize that these critically important resources must be developed in an environmentally responsible manner — minimizing water use; limiting the footprint of wells, surface facilities and pipelines; and assuring that hydraulic fracturing, critical to the successful development of the low permeability shale, does not threaten aquifers or surface waters. Thus, while the interrelated problems of energy security, economic growth and environmental protection are of incredible scope and complexity, there seems little question that natural gas can and should play a key role in the transition to a sustainable energy future.

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