Natural gas drilling has taken off rapidly around the U.S. in recent years, creating a “gold rush” atmosphere in some rural communities. This heightened drilling activity holds tremendous economic development potential for many rural regions; however, it also poses numerous planning and development-related challenges. Communities that seek to capitalize on underground oil and gas reserves are grappling with difficult decisions related to land use, transportation, air and water quality, housing, and workforce issues. The drilling boom has happened so quickly in parts of Appalachia that many local communities haven’t had the opportunity to develop long-term, strategic plans around how and where drilling will take place. More critically, the primary players making land use decisions regarding well siting are private gas companies, individual landowners, state permitting agencies, and regional watershed management commissions, with some local input. For some persistently poor rural areas, the natural gas drilling boom is a huge game-changer. However, there are debates over how long the drilling will last and what will be left behind. What are the hidden costs, and how can they be accounted for? When wells are no longer active, what types of infrastructure will remain? How will rural landscapes change? How can communities employ sound planning techniques to take advantage of these opportunities to support the long-term sustainability of their regions? These decisions will impact the communities and regions at the heart of the drilling boom for decades to come.
I understand that there are no restrictions on submitting a paper that was published previously. (If applicable, please state where and when the paper was published: This submittal is an updated/revised version of an issue brief that I wrote in May 2010 titled “Natural Gas Drilling in the Marcellus Shale”, located here: http://bit.ly/OsgrSP.)

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Natural gas drilling has taken off rapidly around the U.S. in recent years. From Colorado to Texas to Pennsylvania, energy companies are investing in cutting-edge technology to tap into a vast energy reserve which lies below the surface of many communities. This heightened drilling activity, which in some areas complements new and existing oil drilling operations, holds tremendous economic development potential for many rural regions. However, the growth of this industry also poses numerous planning and development-related challenges, including strains on local transportation networks and other types of infrastructure as well as environmental impact concerns.

Communities that seek to capitalize on underground oil and gas reserves are grappling with difficult decisions related to land use, transportation, air and water quality, housing, and workforce issues, and the impacts of those decisions will affect the landscape of rural and small town America for generations to come.

BACKGROUND

While natural gas drilling in the U.S. dates to the early 19th century, large-scale drilling operations only began in the past two decades, initially in Colorado, Wyoming, and Texas. Previously, shale gas was thought to be too difficult and costly to extract because it was trapped in shale rock formations deep below the Earth’s surface. However, recent technological innovations have allowed extraction to become much more cost-effective, and fluctuations in oil prices have led shale gas production in the U.S. to become more profitable.  

As technology continues to evolve and drilling becomes more widespread, estimates about the amount of available natural gas under American soil have varied greatly, further promoting an atmosphere of speculation that is affecting rural communities in many states. In 2011, the Energy Information Administration estimated that the U.S. has 482 trillion cubic feet (TCF) of technically recoverable natural gas, and that U.S. shale gas production has increased 12-fold since 2002. As of 2009, natural gas provided about 22 percent of the nation’s energy, used primarily for electrical generation and residential heating. Expansion of natural gas as an energy source offers a number of advantages: when burned, natural gas emits less carbon dioxide than coal or oil. If U.S.-sourced natural gas can supply a larger share of the nation’s energy demand, particularly as a transportation fuel, it could help reduce dependency on foreign oil and promote job creation and economic development.

More than 20 different basins of varying sizes and capacities hold gas in geological formations around the country. The gas industry has increasingly focused on the Marcellus Shale and Utica Shale formations, which underlie a multi-state region in central and northern Appalachia. Current estimates show the Marcellus holds approximately 141 TCF of recoverable gas; during 2011 alone, Marcellus production doubled, further compounding the “gold rush” atmosphere in some communities in the Marcellus region.

The discovery of a potential major energy source in such close proximity to the highly-populous Northeast corridor of the U.S. has powerful implications, not only for the national and global economies, but also for the rural and exurban communities that sit atop this valuable resource. The upsurge in shale gas drilling in rural parts of Appalachia—particularly those parts that have dealt with persistent poverty spanning generations—and the tempting knowledge that this could be just a hint of what’s to come, has already begun to transform these communities.
This paper highlights natural gas drilling activities in the Marcellus as a case study, but similar issues affect both gas and oil drilling in other parts of the Appalachian basin, and in other parts of the country; North Dakota, Texas, Arkansas, and many more states are tackling similar issues. Indeed, these conversations echo the same struggles that rural America has experienced with other resource-extraction and energy production industries, such as coal mining.

**Process.** Natural gas is difficult to extract from shale because the gas is trapped in tiny pores within the rock, but two technological innovations have made extraction commercially viable. First, hydraulic fracturing, or fracking, began to be used on a large scale in the 1990s. Fracking shatters the tight shale formation by pumping a mixture of water, chemicals, and sand into the rock through a well bore at extremely high pressure, creating tiny cracks and fissures which release the gas so it can be conveyed to the Earth’s surface through pipelines.

The second innovation is horizontal drilling. Typically, the shale layer is about a mile underground, beneath the aquifer. The well bore is drilled vertically through the Earth’s surface, the aquifer, and the layers of rock below. Upon entering the shale layer, the drill bit is steered sideways to access more of the shale through the single well. This way, multiple wells can be drilled from a single platform, increasing production efficiency and opening access to shale formations underneath structures or roads, or in areas that are difficult to access.

The first phase of the drilling process begins with gas companies surveying gas reserves and negotiating with landowners to lease mineral rights and rights-of-way to allow gas companies to build pipelines and conduct drilling operations. The drill bit and pipeline are driven into the ground and the fracking mixture pumped in. After the well is drilled, the rig equipment is removed along with any remaining fracking fluid. Next, the extraction phase takes at least a year but can last for many years, depending on productivity of the well. The gas enters pipelines and is usually treated onsite to remove water vapor and other gases, and may be transported to a larger facility for additional processing. Natural gas is also pressurized at compression stations and odorants are added to the gas at odorant injection stations. Since natural gas is colorless and nearly odorless, odorants ensure that leaks may be detected before a fire or explosion occurs.

**LAND USE AND INFRASTRUCTURE IMPACTS**

**Land Use.** The initial drilling requires land clearing; construction of access roads; hauling of heavy equipment, piping, water, sand and chemical mixtures for fracking; and construction of the drilling rig and fracking ponds. Drilling operations in rural areas can disrupt natural landscapes, and potential side effects can include increased stormwater runoff, disturbances to wildlife habitat, destruction of scenic lands and viewsheds, and displacement of agricultural operations. Furthermore, thousands of miles of gathering lines and pipelines must be built to connect the natural gas of the Marcellus to the major markets of the East Coast. Finally, since a new gas well is most productive when it is first drilled, energy companies must continue drilling new wells to support revenue streams.

Drilling into shale beds to extract natural gas is an intense industrial operation, and it is taking place in many rural communities with little strategic planning in place. The drilling boom has happened so quickly in the Marcellus that many local governments haven’t had the opportunity to create or update plans to address drilling; most of these communities’ zoning ordinances were adopted prior to the realization that natural gas would be a viable industry in their communities.
While natural gas well permitting regulations vary from state to state, the primary players making land use decisions regarding well siting are private gas companies, individual landowners, state permitting agencies, regional watershed management commissions, and in some instances, local governments. In Pennsylvania and New York, ground zero for the Marcellus activity, local governments have little control over the drilling activity.

According to state statute, the Pennsylvania Department of Environmental Protection (DEP) has primary authority over regulation of natural gas drilling. In February 2012, Pennsylvania approved legislation that placed more stringent regulations on many aspects of fracking. These new requirements allow DEP to consider comments from municipalities when reviewing permit applications; however, they also prohibit municipalities from adopting any well siting requirements that are more stringent than state rules. In New York, the Department of Environmental Conservation has authority over well siting and permitting. The State of New York has had a moratorium on the issuing of new permits for natural gas drilling for four years while DEC prepares new rules to address horizontal drilling and fracking in the Marcellus. However, more than 100 local governments have adopted zoning codes that prohibit or restrict fracking.

Since mineral rights negotiations are primarily carried out between a landowner and a gas company, with state approval, community decision-making processes may have little impact on where wells and pipelines will be located. For instance, one or more landowners could agree to allow drilling on their property; if adjacent landowners refuse, they could still be subject to potential ancillary impacts of the drilling. In some places, citizen groups have organized at the local level to hold community meetings and debate both sides of the drilling issue. Groups of landowners have also formed alliances to respond to prospective drillers or negotiate leasing agreements with energy companies. However, large-scale, consensus-based, strategic planning around how and where a network of wells and pipelines should be built is simply not happening, and these decisions will impact communities and regions for decades to come.

**Water.** The amount of water needed to frack a new well can range from two to five million gallons of water per well. Approximately one-third of the water used in fracking will return to the surface. This byproduct, known as produced water or frack water, may be contaminated from contact with natural gas and with the more than 200 chemicals used in fracking. The produced water which returns to the surface must be stored and treated, often in lined ponds onsite. Over the entire production span of a well, which can last as long as 40 years, a well can generate approximately 84 to 420 gallons of produced water per day, potentially reaching millions of gallons over the well’s lifetime.

Rural communities may be more likely to rely on small-scale water systems and wastewater facilities, and many residents rely on well water. The fragmentation of the water supply and treatment system coupled with the uncertainty of the impacts of the natural gas drilling process have created an atmosphere of apprehension among some residents. Due to anecdotal cases of water supply contamination associated with natural gas drilling in parts of Pennsylvania and other states, there are concerns about the impact of withdrawals on local public water supplies, possible contamination of groundwater supplies or surface water, runoff from well pad sites and roadways, fragmentation of wildlife habitat and disturbance of sensitive lands adjacent to water bodies.
More than 72 percent of the Susquehanna River Basin—which provides drinking water to approximately 6.2 million people—overlaps with the Marcellus play. Approximately 36 percent of the Delaware River Basin, which provides drinking water to over 15 million people, overlaps with the Marcellus. Although the major energy markets of the East Coast could benefit from the energy reserves located in the Marcellus, their water supply (and likewise, their economic stability) could be threatened by increased drilling activity.

**Transportation.** Energy companies must transport heavy equipment and pipes to drilling sites to develop the well pad and construct the drilling rig. The fracking process requires large amounts of water, sand and chemicals, and all of those materials must be transported. The frequent traffic and heavy loads have resulted in considerable wear and tear on rural roads that may not be built for such activity; local roads can erode and crush under heavy weights, and are often too narrow to accommodate big trucks and equipment.

**Other Impacts.** The influx of new population associated with the drilling boom has stressed the housing supply in some areas. In parts of northern and central Pennsylvania, rents have reportedly doubled or tripled in the past several years, placing a squeeze on low-income residents. Hotels, motels, and campsites have seen spikes in bookings, impacting the local tourism industries. Furthermore, the additional population can strain community services and emergency services such as police and fire, and contribute to transportation congestion.

Drilling operations can be disruptive to neighbors. The operation of heavy equipment, noise and vibrations from seismic surveys, periodic pressure releases from valves at the well sites, and increased truck traffic all mean increased noise disturbances. There have been isolated incidents of reduced air quality, as drilling can increase emissions of nitrous oxide, volatile organic compounds, particulate matter, sulfur dioxide, and methane.

**ECONOMIC IMPACTS**

The potential economic impact of natural gas drilling cannot be overlooked. Drilling activity in Pennsylvania’s portion of the Marcellus holds significant potential to offer landowners large royalties and dividends, generate tax revenue, and create jobs and increase wages. Because the drilling activity has begun so recently and taken off so quickly, and because the amount of recoverable gas is still under debate, economic impact estimates vary.

**Leasing.** Property owners could reap handsome rewards from the gas located under their property. Price negotiations for leasing and royalty agreements have risen dramatically in the past few years. Companies have leased mineral rights for anywhere from $300 to $5,000 per acre, and have gone as high as $14,000 per acre. Landowners also negotiate royalty agreements with companies to receive a percentage of the profits from drilling on their property. Future production estimates vary wildly, but if the market plays out according to some expectations, landowners could see astronomical returns. For many rural residents, these windfall profits could be the ticket to long-term financial security for themselves and their families (and likewise, raises many additional challenges related to management of sudden wealth).

**Public Revenues.** Municipalities hope to benefit both from increased property tax revenue and sales tax revenue as well as the payment of impact fees or bonds to finance the repair and construction of transportation facilities and other community facilities. Some communities are eye-
ing increased community wealth and potential new investors in community development. For several years, Pennsylvania and other states have debated adopting a severance tax on the extraction of natural gas, as many western states already use, which would generate additional revenue for public coffers.

**Jobs.** In Pennsylvania, much of the drilling activity is being carried out by companies based elsewhere, using employees imported to the region in shifts. Companies have also begun to develop workforce training courses for local residents. The shale gas industry demands not only drilling crews, but also workers to design and construct pipelines, access roads, compressor stations and other facilities, all of which require a high degree of specialization. The industry relies upon teams of landmen, surveyors, engineers, attorneys, and other professionals to negotiate lease and royalty agreements.

One study by Penn State University found that Marcellus-related activity generated a total of $11.2 billion value added in Pennsylvania in 2011. The industry contributed $1.1 billion in state and local tax revenues, and supported nearly 140,000 jobs. The study projects that by 2020, the Marcellus economic activity may support over 250,000 jobs and generate $2 billion in annual state and local tax revenues.17

### LONG-TERM OUTLOOK

The shale gas drilling boom has raised many questions for the residents of Pennsylvania and New York, and other states. The economic development potential is enormous, both for local communities and the state and national economies. However, there are debates over how long the drilling will last and what will be left behind. What are the hidden costs, and how can they be accounted for? When wells are no longer active, what types of infrastructure will remain? How will rural landscapes change? How can communities employ sound planning techniques to take advantage of these opportunities to support the long-term sustainability of their regions?

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