

The Once and Future Fuel

Marcellus Shale harbors natural gas in varying depths under parts of West Virginia, Pennsylvania, New York, and Ohio. It also underlies portions of Maryland, Virginia, Kentucky, and Tennessee.

Shale gas brings back cheap energy, but what's the risk?

BY BETTY JOYCE NASH

Shale deposits are yielding more natural gas than ever, thanks to advances in drilling technologies. Though drilling operations can disrupt communities, they generate business for local merchants and jobs. Mineral extraction is a two-way street. And it may be a congested two-way street. Just ask Don Riggenbach.

"I'm glad they're here, but there's stuff we have to endure," says Riggenbach, president of the Wetzel County Chamber of Commerce. The county lies along the Ohio River in northwestern West Virginia, and is a drilling hot spot. During a brief telephone interview, four dump trucks hauling gravel rolled down the main road where his business is located.

By 2035, almost half of the United States' natural gas may come from shale. One of the biggest fields, or "plays," of shale gas in the world, the Marcellus Shale, sprawls at various depths under chunks of West Virginia, Pennsylvania, New York, and Ohio; it also underlies small parts of Maryland, Virginia, Kentucky, and Tennessee. A different, smaller gas play underlies several counties in North Carolina.

Though the widespread development of shale gas promises comparatively clean and cheap fuel, along with jobs, tensions have flared over costs that could be imposed on society later — long-term effects on environment and health. All energy production poses some risks; even wind power, with its turbines, can kill birds and interfere with radar signals. Resource extraction always involves risk. And damage often shows up later, sometimes much later.

Fracking

Rising natural gas prices over the previous decade spurred the innovations that made these hard-to-reach deposits economically viable. Gas was first produced from the Marcellus formation in 2005, in Pennsylvania. Gas prices peaked in 2008 at \$10.79 per thousand cubic feet (mcf); this, along with oil price spikes, helped drive the natural gas boom.

Drilling speeds and control have enabled the recovery of shale gas, according to West Virginia University geologist Tim Carr. Three-dimensional seismic imaging accurately pinpoints gas deposits. High-pressure sideways drilling, up to three miles out, puts more shale within reach. Injections of 3 million to 5 million gallons of chemicals, grit, and water shatter the shale. The water flows back to the surface; the grit holds the shale open so the gas can migrate through. This high pressure drilling with water is known as hydraulic fracturing, popularly called "fracking."

Fracking water is 0.5 percent additives, which amounts to about 15,000 gallons of chemicals in a 3-million gallon injection, according to the U.S. Geological Survey. The recovered water may hold brine, heavy metals, low levels of radioactive contaminants from decaying uranium, and volatile organic chemicals, which can include carcinogens such as benzene. Water in the Marcellus region also may contain naturally occurring methane. (Natural gas is composed mostly of methane.) Though it's not considered a health threat in drinking water, concentrated methane displaces air and poses explosion risks if not well ventilated. Methane from abandoned gas wells, underground coal mining, underground gas storage reservoirs, and shallow, naturally occurring gas can contaminate groundwater. It's hard to evaluate the risk of gas drilling on water supplies because few empirical studies exist that use before-and-after well tests.

Public Goods

Many environmental resources, such as clean air or water, are considered "public goods." It can be hard to establish systems of property rights for these goods.

And environmental protection can be expensive. Firms make trade-offs between profits and the environmental risk. "Revenues are typically realized quickly, but environmental damages impose costs over many years," writes economist Lucas Davis of the University of California, Berkeley, in a

paper published in June by the Brookings Institution. Firms can go out of business or be otherwise unable to finance cleanup, which leaves the bill with taxpayers.

People worry, for instance, that chemicals in fracking water can contaminate ground and surface waters. Underground aquifers supply fresh water for wells, usually in rural areas; municipal water systems draw drinking water from rivers and lakes. It's unclear whether chemicals can migrate from fractures into aquifers.

Reports of water contamination from hydraulic fracturing have surfaced, but few, if any, peer-reviewed studies have documented either the problem or its absence. It's difficult to definitively link a particular contamination event directly to shale gas operations, according to Sheila Olmstead, an economist at Resources for the Future (RFF). In 2011, though, the Pennsylvania Department of Environmental Protection fined Chesapeake Energy a record \$1 million for contaminating private wells through improper gas well casing and cementing.

Michael John is president of Northeast Natural Energy, based in Charleston, W.Va. "The source of peoples' water needs to be evaluated, tested prior to activity undertaken by us or any other operators in proximity," he says. "That provides everyone with a baseline as to what the water quality is in those areas." West Virginia law now requires pretesting of wells within 1,500 feet of the well pad.

A 2011 study found measurable amounts of methane in 85 percent of 60 wells sampled in Pennsylvania and New York, though the study found no evidence of drilling fluids in well water. The study indicates methane levels were 17 times higher, on average, in wells located within a kilometer of active shale gas drilling sites, according to Stephen Osborn, Avner Vengosh, Nathaniel Warner, and Robert Jackson of Duke University's Nicholas School of the Environment. The chemistry in the well water matched the methane's composition from local gas wells.

Some drilling wastewater also ends up in municipal treatment plants, but it's unclear how effectively it's treated there. In its study of shale gas development, RFF is investigating state data from such plants in Pennsylvania. "We know where the water quality monitors are in relation to those water treatment plants," Olmstead says. "If there's a signal to pick up, we're hoping we can pick it up."

Methane in the air poses risks, too, which could weaken that bridge to a low-carbon future, says Alan Krupnick, also an RFF economist. Methane traps even more heat than carbon dioxide — it's a potent greenhouse gas. Methane from gas wells can escape or is burned off at various stages of production. John notes that drilling companies do not want to burn methane unnecessarily since they can't sell the lost gas, but some methane flaring is necessary, to stabilize the flow into the pipeline, which avoids unwanted combustion.

Also, wells in various stages of production can emit chemicals into the air, including benzene and hexane, which can cause cancer and other serious health effects. A new EPA rule requires operators to capture air pollutants

starting in 2015. In the meantime, an estimated 13,000 new and existing natural gas wells are fractured or re-fractured each year; about 25,000 new wells are drilled annually.

Though one well may be only the diameter of a bowling ball, a drilling operation can cover two to 10 acres; they've altered the landscape in Marcellus country.

Expanded Footprint

The image of one lonely pump-jack drawing oil or gas on a quarter acre has been replaced by shale drilling operations that can include multiple wells, pipelines, condensate tanks, and processing stations. (John notes that, to drain the equivalent amount of gas from one drill site today, producers would have to drill many separate wells on many separate sites, which would require more roads, more pipelines.) Though communities may suffer environmental and health damages, the resource can power the local and national economy, providing jobs.

In New Martinsville, W.Va., "wet gas" deposits have sparked a drilling boom. Wet gases are so named because they can be liquefied into higher-value products such as ethane and butane. The shale gas boom there provokes mixed reactions.

"The roads are being torn up because of heavy trucks, and the traffic through this little town is probably — this is not an exaggeration — at least three times what it is normally," Riegenbach says. "Now we have gas drillers coming in, not setting down roots, not buying household items like carpet and refrigerators." He owns a carpet and tile business. The increase in traffic, though, means "gas stations, restaurants, motels are all packed, all busy, and that's a good thing."

Natural gas' outsized footprint also affects people who don't own oil and gas rights to their property. In West Virginia, surface ownership may have been sliced off from the underground resource rights more than a century ago. Morgantown, W.Va., attorney Jay Leon argues that the law applies 19th century legal concepts to 20th century drilling techniques.

"The net of that is you've got much greater impositions placed on surface owners: These are very large, industrial-scale operations," Leon says. "In some cases, they go in 24 hour-seven-day-a-week operational cycles and last for months. Before, they drilled shallow wells, and were off the property in a month."

Cases about surface owner rights are making their way through state and federal courts. At the same time, states and localities are changing laws as shale gas development spreads. West Virginia recently changed its minimum setbacks from homes to a distance of 625 feet from 200 feet, measured from the center of a shale gas well pad. Pennsylvania recently passed a new law, Act 13, regulating the industry and instituting user fees. "It was imperative that rules be modernized and strengthened," says John Hanger, who served as secretary of the Pennsylvania Department of Environmental Protection from 2008 to

2011. “The old laws didn’t reflect the volumes of water, materials, trucks, and the amount of gas now being produced.”

Act 13 also contains a controversial provision that established statewide zoning for oil and gas operations and preempted local zoning ordinances. From the industry’s perspective, notes economist Krupnick, uniform zoning rules are desirable because it’s difficult to deal with a plethora of localities. But, he adds, people may have different preferences in different places. (Half of Pennsylvania’s townships have no zoning laws.)

It’s unusual for the legislature to pass a statewide ordinance singling out an industry, says William Johnson, the attorney who represents the Pennsylvania townships of Peters and Mt. Pleasant in a lawsuit challenging the provision. “We’re not against the industry,” he says. “It’s been a huge economic boom in this state. At the same time, there is a price to pay for that. We think the removal of local authority is too high a price, and not a legal price.” This provision was ruled unconstitutional by the Pennsylvania Commonwealth Court in July. The state has appealed to the Pennsylvania Supreme Court.

As more and better science emerges about changes in water and air quality from shale gas development, and as economists study public preferences, it will be easier to understand how people value those changes and compare costs to benefits. For instance, if regulation is necessary to mitigate possible damage, then tighter standards would raise the price people pay for natural gas. How much would people be willing to pay to cut air pollution, for example? An 18-month study under way at RFF will highlight, among other things, which shale-gas activities are associated with risks that bother people the most, and identify how regulations and voluntary industry responses can affect those risks.

As an example of a voluntary response, many energy companies now manage water in a way that lessens the risks of spills and saves money. Rather than transport millions of gallons to drill sites, some firms keep the water on site or recycle it or both. That cuts the number of tanker trucks driving local roads and the risk of rollovers and spills into surface waters. Chesapeake Energy saves an estimated \$12 million a year in its Eastern Division with recycling, according to Stacey Brodak, senior director of corporate development. In northern Pennsylvania, Chesapeake recycles nearly 100 percent of produced water.

Northeast Natural Energy also recycles wastewater, according to Michael John. “To the extent that we don’t have immediate applications for produced fluid, other producers would have use of it. In the event that’s not an option, our practice is to transport it to licensed underground injection wells, operated in a way that places the fluid back at geologically appropriate levels.”

The industry is addressing these and other problems, says spokesman Travis Windle of the Marcellus Shale Coalition, a trade group of energy firms and suppliers. “We live here. My six-week-old kid lives here. My parents have a rig behind



Northeast Natural Energy’s shale gas drilling operation is located in the Morgantown Industrial Park in Monongalia County, W.Va.

their house. Like everything else, it’s about managing risk.”

Risks that aren’t managed well may leave toxic legacies. Pennsylvania, for instance, still suffers pollution damage from before the 1972 Clean Water Act. The pollution from some orphaned coal mines drains into the Chesapeake Bay.

Staying in the Game

Mineral extraction brings jobs and money, but in cycles. The natural gas industry in West Virginia employed almost 10,000 workers until 2008, with jobs mostly in construction and support activities. That number fell below 8,000 during the recession. Resource-rich states typically tax coal, natural gas, oil, timber, or other minerals to weather downturns, to offset the localities’ costs (such as environmental remediation, regulation, and infrastructure repair), and bolster revenues in general.

The money can help areas, such as the southern West Virginia coal fields, recover as an extractive industry declines. For example, coal mining counties have median household incomes below the state’s average, and family poverty rates above average, according to a 2011 study by the West Virginia Center on Budget and Policy. Health outcomes rank among the worst in eight of the 10 counties.

About 36 states impose these severance taxes to balance the costs and benefits of volatility. West Virginia has levied severance taxes on oil and gas and coal since the 1980s; the taxes represented 11 percent of its general fund revenues in fiscal 2012. Severance tax revenues are falling, though, as coal production and natural gas prices decline.

The current glut of “dry” natural gas has shifted production away from those wells and into “wet” gas regions like Wetzel County. A native West Virginian, John has been in the energy business for 30 years. Of the high oil and wet gas prices coupled with the low dry gas prices, he quips, “Our industry is accustomed to boom and bust, but we’re not used to both at the same time.”

Yet the soft prices don’t bother him. “It’s an excellent time to accumulate dry gas properties,” he says. Analysts say demand will rebound, partly through fuel switching for power generation.

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But future shale gas yields are uncertain and evolving. Original estimates of the Marcellus Shale's "unproven technically recoverable" gas have been more than halved, from 410 trillion cubic feet to 141 trillion cubic feet, according to the U.S. Department of Energy's *Annual Energy Outlook 2012*. Revised estimates forecast the Marcellus supply at about six years' worth of U.S. gas demand.

The estimates will continue to be tweaked as drilling continues, says John. "It could last for decades. I think it will. I'm expecting my kids, *their* kids, and maybe even their kids to participate in this business for a long time."

The plentiful supply and low prices may hasten fuel-switching. Trucks running on liquefied natural gas (LNG) would cut U.S. oil imports and carbon dioxide emissions; LNG would be cheaper than diesel fuel. (The interstate trucking industry's transition to a hub-and-spoke system may ease the problem of establishing LNG fueling stations.) Chesapeake Energy, the second largest U.S. natural gas producer, has invested \$150 million to develop 150 liquefied natural gas fueling stations.

Low natural gas prices have also spurred electric utilities to rebalance energy portfolios to avoid installing carbon controls. Carbon dioxide emissions from natural gas are about 45 percent lower per British Thermal Unit (Btu) than coal — and bring no soot, no mercury. (A Btu is the amount

of energy it takes to heat a pound of cold water by one degree Fahrenheit.) Dominion Virginia Power predicts that by 2017, natural gas will represent 23 percent of its electricity generation, compared to 12 percent in 2011.

"It's a game changer, there's no doubt about it," says Jim Norvelle, director of media relations at Dominion, parent company of Dominion North Carolina Power and Dominion Virginia Power. "For the near future, this company is building either gas-fired or renewable stations." And Dominion plans also to convert its import terminal in Baltimore to one for exporting LNG, for which demand is expected to grow, especially in economies such as China's.

The shale boom, environmental rules, lower economic growth, and other factors have prompted coal plant closings. In July, the Energy Information Administration reported that plant owners and operators expect to retire about 8.5 percent of 2011 coal-fired capacity between 2012 and 2016.

Predictably, shale gas regulations may go too far for the industry and not nearly far enough for environmentalists. As costs and benefits become clearer, with more research, policy tools can better satisfy concerns on both sides. In the meantime, Don Rigganbach is hoping for Wetzel County wells to produce big. The sooner royalties from wells, a share of profits, arrive in area lease-holders' hands, the sooner he'll be selling them new floor and wall coverings. **RF**

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months, totaled \$1,387 for SNAP customers; credit card sales were \$1,835. In the third full year, 2011, SNAP sales were nearly \$8,000; credit card sales were \$24,075. "Credit and debit is huge," she says.

The Byrd House Market in Richmond, Va., started accepting EBT, credit, and debit cards last year. The market is a project of the William Byrd Community House, an 89-year-old social service organization that has added a small-scale farm to grow produce for its emergency food pantry. Many Byrd House clientele and staff as well as students from nearby Virginia Commonwealth University receive SNAP benefits, says manager Ana Edwards.

Patricia Stansbury of Epic Gardens in Richmond oversees a table loaded with snap beans, onions, arugula, white radishes, and buckets of fresh flowers. "Where's the

baby bok choy?" a customer asks. People of all income levels and occupations mingle at the market, which started in 2007, from students to moms stretching a food budget to professional chefs. Shortly after the market opened, a man wearing black trousers and a white chef's jacket had snapped up the baby bok choy. "Sorry," she says. "It's all gone."

— BETTY JOYCE NASH

Editor's Note: In the Upfront section of our First Quarter 2012 issue, the article "East Coast Ports Prepare for Bigger Ships from the Panama Canal" looks at port expansions to accommodate "post-Panamax" vessels. It should be noted that the Port of Baltimore, a deepwater port at the northern fringe of the Fifth District, is preparing to make way for these large container ships.