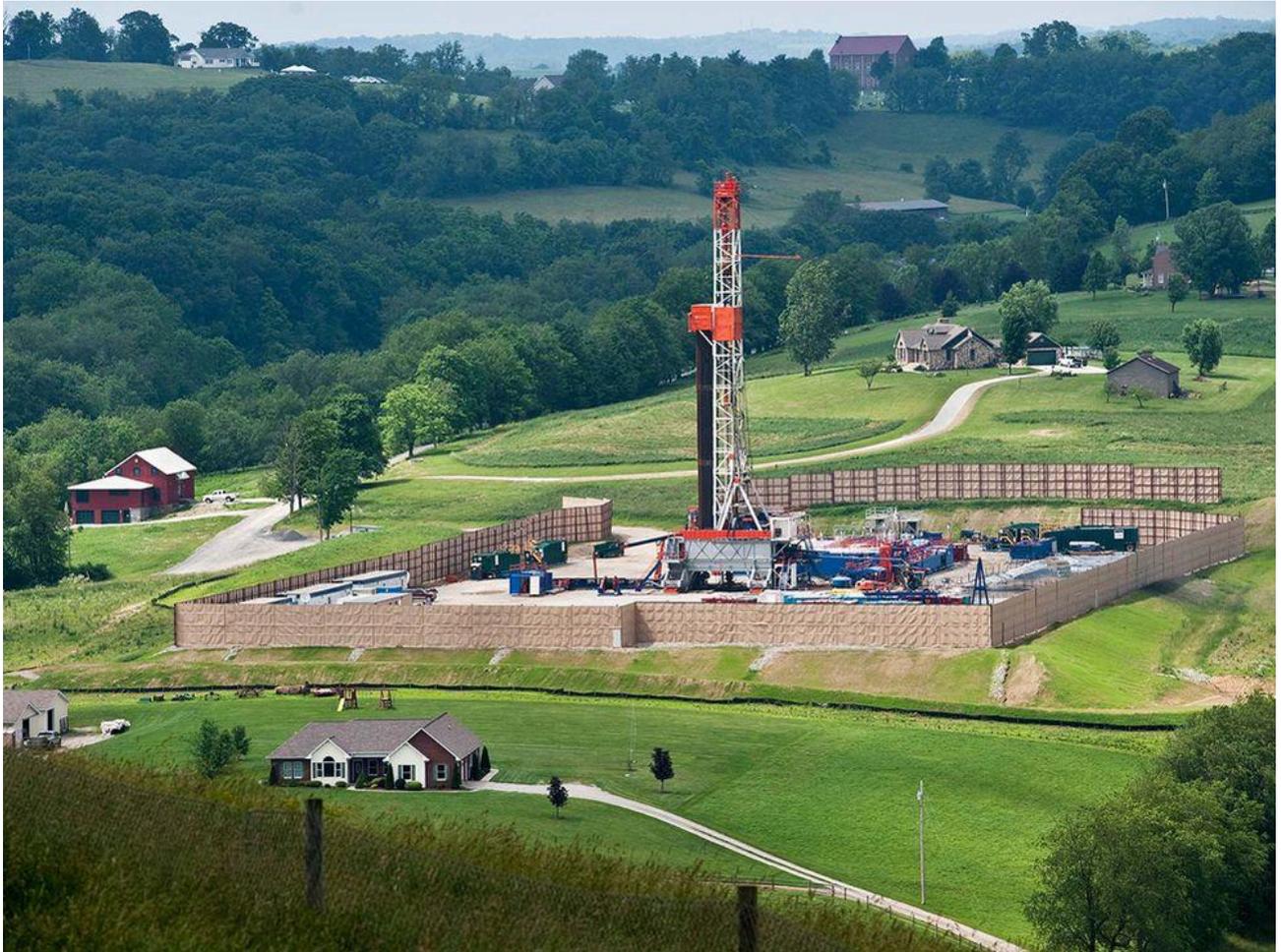


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## Natural Gas Stirs Hope and Fear in Pennsylvania



A natural gas derrick rises from the countryside near family homes in rural Hopewell Township, Pennsylvania.

Photograph by Scott Goldsmith, National Geographic

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[National Geographic News](#)

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### **SPECIAL REPORT: THE GREAT SHALE GAS RUSH**

Exploring the promise and challenge of a new energy supply.

Along the narrow two-lane roads that wind through Washington County in southwestern Pennsylvania, there is little sign that the surrounding pastures and hay bales, barns, homes, and children's swing sets all are sitting on one of the largest reservoirs of natural gas in the world.

But at second glance, an observer can see red and white lattice towers rising here and there over the hillside. New gravel roads separate the thick woods and brush. Fields feature long stretches of grass that don't quite match the surrounding meadow—recently reseeded places where new pipeline has been buried. Giant barrel-like structures, pipes and valves, painted green to blend in with the landscape, are condensate tanks and compressor stations. And chemical tank trucks, sand haulers, flatbeds stacked with lengths of pipe, and cement mixers seem to be rumbling in every direction.

It's all part of a new energy industry that's being built here. This is the epicenter of the Marcellus shale.

(See Photos: "[In the Farmland, an Energy Rush](#)" and "[Faces of the Gas Rush](#)")

### **From Barrier to Boon**

For decades, the Marcellus was known to geology buffs as a 389-million-year-old soft rock formation, a mile or more under the Appalachian Mountains, encompassing 95,000 square miles (246,000 square kilometers) in an arc from West Virginia to New York. Named for a surface outcrop of the rock near Marcellus, New York, the formation was thought of as an underground barrier, simply an annoyance to drillers who focused on little pockets of oil and gas in sandstone beneath.

But within the past three years, all of that has changed.

Applying a method developed in a similar geological formation, the Barnett shale in Texas, scores of energy companies proved that by combining and supercharging some old oil industry technologies, they could drive fissures through that rock to yield sizable amounts of natural gas.

There are shale deposits all over the United States, well-mapped thanks in part to [intensive geological research](#) done by the [U.S. Department of Energy](#) and the [U.S. Geological Survey](#) in response to the 1970s energy crises. These studies sat on shelves for decades. Now they're a key reference for producers in shale "plays," as they're called, around the nation—including the biggest by far, the Marcellus.

How big? Estimates are that the Marcellus shale holds between 50 trillion cubic feet (TCF) and 500 TCF of natural gas. At the low end, that's double the gas stores seen in Alaska's big Prudhoe Bay at the dawn of its development. At the high end, the reserves would be second to those of the world's largest natural gas field, the Pars field of Iran and Qatar.

But unlike Pars, this gas isn't in the middle of the Persian Gulf. It's right in the heart of the energy-hungry East Coast of the United States. The eastern tip of the formation is less than 100 miles from New York City. With development centered in Pennsylvania, it's a location that has lured billions of dollars of investment by companies around the world. Defying critics who wonder how such an energy boom can be sustained in a slow economy, companies from India, Japan, Norway, and elsewhere have descended on the scene, wowed by the Marcellus shale's

great potential and proximity to markets.\* They also hope to take this made-in-the-USA technology overseas. The United States is the number one consumer of this fuel, but shale can be found all around the planet—and the world has plenty of interest in a new source of natural gas.

### **Shaking Up the Energy Equation?**

Most people know natural gas as the fuel that lights the blue flame on the stove. It also heats half the homes in the United States and 35 percent of the homes in Europe. But the largest use around the world is at power plants, where it is burned to generate electricity. Depending too much on natural gas for power has long been seen as risky, because its price was traditionally volatile—largely linked to the roller-coaster global oil market. So natural gas provides just 20 percent of U.S. electricity, compared to nearly 50 percent for King Coal.

The prospect of abundant, cheap natural gas in the United States—especially gas that’s easily delivered by pipeline to the populous East Coast—profoundly shakes up that energy equation. Natural gas generates electricity more efficiently than coal, with half the greenhouse gas emissions, fewer acid rain precursors and virtually free of many other troubling pollutants like mercury and particulates. Natural gas also burns cleaner than oil. And although only a tiny percentage of vehicles are now outfitted to run on natural gas, it’s capable of powering cars, trucks, and buses.

Billionaire oilman T. Boone Pickens says the United States ought to be producing vehicles to take advantage of domestic shale gas and break its foreign oil dependence. "This is our chance," Pickens told *The Philadelphia Inquirer* in an interview on the Marcellus shale. "I think it's almost divine intervention that we had all this gas show up at this time in the deal."

Gas companies in Pennsylvania also frame their role as a pivotal one in the big U.S. energy picture. "We’ve talked a lot about taking control of our energy future in this country," says Matt Pitzarella, spokesman for [Range Resources](#), the first company to drill in the Marcellus and one of the most prolific drillers. "Now we have that opportunity, and it really was literally beneath our feet all this time."

### **Reversal of Fuel Fortunes**

Not long ago, it looked like the United States was running out of natural gas.

Federal Reserve Chairman Alan Greenspan [warned Congress in 2003](#) that the nation would need to begin to import substantial amounts of the key fuel from overseas. This raised the specter of foreign gas dependence that mirrored long-standing U.S. oil dependence, and risky reliance on big reserve holders like the Persian Gulf and Russia. In Europe, which imports a quarter of its gas by pipeline from Russia, gas disruptions pose a security problem.

But precisely at the moment Greenspan was delivering his grim forecast for the United States, energy industry iconoclasts in Texas were proving definitively that combining horizontal drilling and large-volume hydraulic fracturing could unlock a huge rush of gas from shale. (Related: "[Forcing Gas Out of Rock With Water](#)") And in that same year, a Range Resources geologist decided to urge his bosses to try the method on a stubborn well he’d been working at in Pennsylvania.

Although the Keystone State was thought to have tapped out its big-time energy supplies long ago, Pennsylvania was key to the rise of oil and coal that fueled U.S. industry in the 19th and 20th centuries. The world's first oil well was drilled here, on leased farmland in Titusville in 1859.

About 100 miles south of the storied Drake Well, in 2004, Range drilled the first gas well into the shale on leased farmland in Mount Pleasant Township.

After several years of experimentation, there were nearly 20 Marcellus wells in Pennsylvania in 2007, nearly 200 were drilled in 2008, and nearly 790 last year. The Marcellus industry, now made up of 67 companies—ranging from the world's largest to some of the smallest energy players—has already drilled about 1,100 wells this year. That puts producers on track to drill somewhat less than the 1,700 wells they had aimed to drill in Pennsylvania this year, a slowdown certainly due to tough economic factors roiling the industry. But more than 2,480 permits for new wells have been issued this year in Pennsylvania, and the industry's plans call for a pace of more than 3,500 wells annually within the decade.

Marcellus drillers say they can bring 200,000 jobs to a state that has struggled to revive its industrial sector, and they have paid \$3.5 billion in lease payments and royalties to landowners in the past two years for the right to drill on private property.

(Related: [“A Drive for Jobs Through Energy”](#))

But all this means building a big extractive industry in a state that hasn't seen this kind of development in decades, right near homes and schools, in the midst of rural farmland, and close to treasured parks and forests. (Related: [“Parks, Forests Eyed for the Fuel Beneath”](#))

For Pennsylvanians, even generations past the heyday of the state's big coal- and coal-fired steel industries, it's hard to forget the havoc that an energy business can wreak on the environment. To remind them, there are 260 million tons of [abandoned waste coal in piles](#) that mar about 8,500 acres across the state. And more than 5,510 miles of the state's streams are impaired by discharges from 220,000 acres of [abandoned coal mine lands](#), Pennsylvania's worst water pollution problem.

“Been there, done that,” says Democratic Senator Bob Casey of Pennsylvania, who is pushing for greater federal oversight of the industry. “For many, many years people said, ‘Don't worry about this, don't worry about that, just get out of our way, we need to extract this natural resource from the ground.’ ”

The industry is battling to improve its image, recently hiring Tom Ridge, a former Republican governor of Pennsylvania and director of U.S. homeland security, as a strategic consultant. Early this month, Ridge and an industry group, the [Marcellus Shale Coalition](#), unveiled a set of “commitment to the community” principles, promising to implement state-of-the-art environmental protection and to improve transparency and responsiveness.

Pennsylvania native Pitzarella of Range points out how his company has pioneered reuse of wastewater from the drilling process, and how it was the first shale operator to disclose chemicals used at each of its wells. “The challenge is demonstrating to people that this is not the second coming of the coal industry from 100 years ago,” he says.

But across Pennsylvania, there also have been wastewater spills and conflicts with neighbors—for Range and for other drillers. (Related: “[A Dream Dashed by the Rush on Gas](#)”) And at least two serious documented incidents—an [EOG Resources](#) well blowout in a central Pennsylvania forest this summer and alleged faulty well construction by [Cabot Oil & Gas](#) that the state says allowed natural gas to migrate into home drinking water—have helped feed a backlash. There’s an effective moratorium on drilling above the border in New York and in eastern Pennsylvania’s Delaware River basin, enforced by a compact agency of four states and the federal government that oversees the watershed.

“The industry is poised on a knife-edge of public acceptance that could affect its license to operate for years to come,” says Timothy Wirth, a former Democratic senator from Colorado who heads up the nonprofit [United Nations Foundation](#), which is trying to ensure a safer and cleaner global climate. Wirth has touted the natural gas from shale as a “game-changer” that could help address global warming, but he says the industry’s inadequate response to land and water concerns have imperiled the fuel’s future as a bridge to a low-carbon future.

### **Harsh Economics for Gas Producers**

An even greater risk, perhaps, is that the United States shows no sign of adopting the kind of national policy to cut greenhouse gases that would increase demand for natural gas in the energy marketplace, thereby enhancing its value. In fact, one key coal industry lobbying point against congressional climate action has been to warn that utilities’ inevitable switch from carbon-intensive coal to natural gas would expose consumers to the risk of higher-priced electricity.

Ironically, natural gas prices are now extremely low—in the past two years they’ve been closer to coal prices than they have been at any other point in the past decade. That’s partly because the slow economy has kept all energy prices down. And it’s partly due to the drilling for shale gas, which has pushed new supply onto the market at a time when demand is weak. Shale gas companies, in fact, try to illustrate how they’ve benefited consumers by pointing to how the price of natural gas on the New York commodities market began to take a sharply divergent path from the price of oil in 2005 if the prices are compared by heating value. The 2009 price of natural gas on NYMEX, the New York Mercantile Exchange, was \$6.55 less than oil per million BTU, and has averaged \$8.80 less this year. The futures market price doesn’t translate exactly into what consumers are paying today, but it’s a gauge of where prices are heading. If this trend holds, Pennsylvania consumers would save \$6.8 billion and U.S. consumers would save \$205 billion annually compared to what they would have paid if natural gas prices were in line with those of oil.

But low natural gas prices, welcome as they may be for consumers, put the gas companies in a squeeze. The more they produce, the more they depress the price of natural gas. And, given the high cost of drilling wells, the harder it is to make money.

The history of the energy business is replete with boom and bust cycles: frenzy of competition to exploit a new opportunity, leading to ruin when the resulting excess of supply causes prices to plummet. A number of analysts wonder if that scenario is playing out in shale. “Most U.S. natural gas basins do not generate sufficient returns to justify drilling in today’s weak price environment, suggesting that the current growth pace is not sustainable in a market that is likely to see little near-term demand growth,” investment bank Credit Suisse said in a report earlier this year.

Today's harsh economic conditions force gas producers to cut costs. And for the time being, at least, that makes increased drilling in the Pennsylvania Marcellus even more likely. The "geologic risk" is low; companies don't have to spend money finding the well-known rock formation, and the drilling process is standardized, repeatable from well to well. In Pennsylvania, they've been able to acquire land at a relatively low price and pay lower royalty rates than in other producing states. In fact, one of the reasons the bulk of development has been in Pennsylvania rather than in neighboring West Virginia, located on the same Marcellus shale formation, is because of the Mountain State's higher taxes.

"I believe that this is one of the highest, if not *the* highest rate-of-return gas play in the United States," said Range Resources Chief Operating Officer Jeff Ventura at the company's last quarterly conference call with Wall Street analysts. Range also benefits because its acreage is in southwestern Pennsylvania, where the gas is "wet," mixed with other valuable products that can be separated out and sold, like propane and butane.

There's a catch for the drillers, though, if they want to hang on to their prime acreage. Many of the leases they signed with landowners compel them to begin drilling within a certain time frame—five years is typical—or the leases expire. So drilling continues apace. Range has told shareholders that its production will increase 14 percent this year and no less than 25 percent next year. "We believe that this accelerated drilling and completion is the right thing to do even at today's gas price," Ventura said, given the rate of return and the production the company expects over the life of its Marcellus wells.

Of course, drilling in the Marcellus is so new that nobody knows how much gas the wells ultimately will produce. And there are other uncertainties for the gas companies even as they try hard to keep their costs down. New environmental requirements—state or federal—could hike costs. Pennsylvania, its state government budget in woeful deficit, also is considering a severance tax on the industry; it is the only large oil- and gas-producing state that doesn't take a percentage of the revenue from the natural resources "severed" from its soil. Analyst Kevin Book of ClearView Energy Partners, who typically follows developments in Washington, D.C., for his energy industry clients, has been regularly reporting to them on shale policy news from Pennsylvania, because of their potential implications for any place shale stores are found. "We cannot discount the viral nature of energy policy," he wrote in one report.

So the future of the boom hangs in the balance. How successfully producers will apply their new technology, whether they can add wealth to a place while preserving its cherished land and water, and how much fuel they can provide a world in dire need of cleaner energy—all will be decided on Pennsylvania's changing farmland, in its forests, and in its shale.

*\*This report is produced as part of National Geographic's [Great Energy Challenge](#) initiative, sponsored by [Royal Dutch Shell](#), which recently acquired a stake in the Marcellus shale. National Geographic maintains autonomy over content.*