GAS Boom

BY MICHAEL LEVI

I'd been watching Warren Taylor and Bill Dix have at it for nearly an hour when the rain started to come down. But that didn't stop either of them. Dix, in his 60s, with a face weathered by decades on the land, wore dirty jeans, a Red Bull T-shirt and a muddy green cap over his balding head. He sipped on a grapefruit soda and spit chew as we talked. Or, more precisely, as I listened.

Twenty years had passed since Dix and his wife, Stacy, started raising Jersey heifers on this patch of southern Ohio land. Recently, though, the sleepy community had woken up. The rumors started in earnest last autumn when land brokers from out of state swooped into Athens County and started offering cash in exchange for the right to drill for oil and gas. A few years earlier, another natural-gas rush had grazed this patch of southern Ohio. In neighboring Pennsylvania, drillers had tapped into the Marcellus Shale, bringing forth billions of cubic feet of fuel. A few unsuccessful wells were drilled on the Ohio side of the border too. Just north of town, beside the highway, a sign offering financial planning to people with new gas wealth remained.

This time, it was different. The target was the Utica Shale, a layer of deep rock formed some 100 million years before the Marcellus. By now, Athens residents had already seen the intense battles that broke out across the border to their east. Many Pennsylvanians embraced the

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drillers as their economic saviors, while others cursed them for tearing apart communities and for allegedly bringing environmental ruin.

Dix was all for letting the drillers in. Many opponents, he had concluded, were hypocrites, happy to profit when their pension funds invested in ExxonMobil and Chesapeake Energy, both big players in the new rush for natural gas, but unwilling to accept gas development in their own backyard. However, it wasn't just what he saw as a double standard that rankled; it was what he thought drilling for natural gas could do for the community.

"They're worried about the Athens way of life, when the barbarians are at the door," he warned. "The rural men aren't working," he said, "and you're worrying about having to see oil rigs when you're taking your Sunday drive?"

Half an hour earlier, I'd been talking to Warren Taylor, a 61-year-old with more energy than most people half his age, when Dix drove up and joined the conversation. Taylor, wire-thin, with close-cropped hair, would have fit right in in Northern California, where he had lived for a good part of his life. Now he is the proprietor of Snowville Creamery, which promised "milk the way it used to be," and one of the more vocal area opponents of natural gas development.

Dix, who had lived around Athens his whole life, rented Snowville its property and sold the creamery its milk. The two friends, who share a stretch of land not far from the West Virginia border, were clearly used to sparring. Their disagreement didn't fit into neat lines. "I'm a far-leftist," explained Dix. Then he launched into a spirited defense of private property – particularly his right to lease his land to gas drillers.

Nor was Taylor a Luddite who just wanted technology to go away. A few minutes spent listening to him extol the virtues of the latest milk-processing equipment was enough to dispel that suspicion. After moving back to the area, Taylor bought farmland adjacent to his parents' property. "Two years later," he recalled, a neighbor strip-mined his place, and the runoff "destroyed the corn bottom that was the basis of the profitability of a 640-acre farm."

Taylor could barely contain his emotion. "A guy did a PhD in geology from Ohio State University examining that exact place on the farm and concluded that it would be a thousand years before it would return to being what it had been. Now you do the economic analysis for me on a thousand years of corn versus one year of coal," he said. "Now do you understand my perspective about fracking?"

BREAKTHROUGH

Shale gas came fast, transforming communities that had long been set in their ways. Only a few years earlier, high and volatile natural gas prices seemed inevitable. After averaging about $2 per 1,000 cubic feet during the 1990s, prices reaching a staggering $14 in late 2005. Then the cycle repeated itself, with prices sliced in half a few months later before bouncing back close to their historic highs in June 2008.

In one year, Americans might collectively spend $40 billion on natural gas; the next year, five times that. But then something surprising happened: after prices fell sharply through late 2009, as expected in a deep recession, they never recovered.

Analysts predicted $5 natural gas; then, by

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2010, they were forecasting $4. By late 2011, even those projections seemed dated. Something fundamental had changed. Output, which had been flat for about a decade through 2006, suddenly took off in 2007, rising 14 percent by 2010. The United States hadn't witnessed growth like that since the 1960s, the tail end of a two-decade-long boom sparked by the introduction of inexpensive long-distance natural gas pipeline service. By early 2012, U.S. government analysts were projecting steady increases in production and relatively low prices for decades to come. There was only one source that could account for what was happening: natural gas from shale.

The breakthrough was made possible by the adoption of two well-worn techniques. The first was horizontal drilling, which allowed developers to drill down before turning 90 degrees and drilling a mile or more sideways. That was particularly valuable for getting at shale gas, which is found deep underground in thin layers; by drilling horizontally, a well could be placed through a big slice of gas.

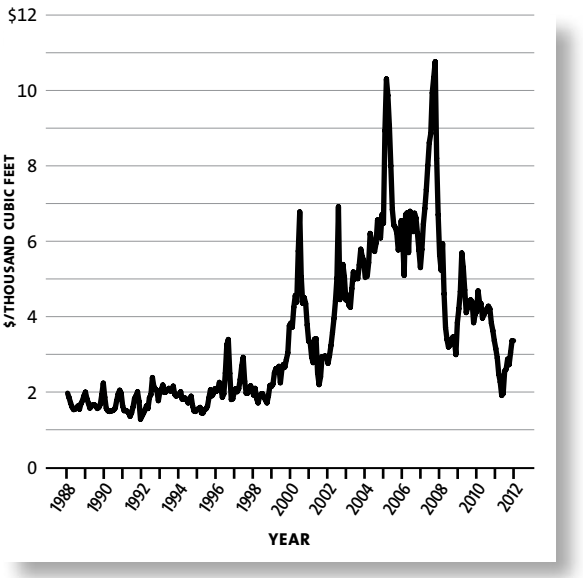
The second technology, fracking, was introduced by Stanolind Oil and Gas in 1947 in Kansas. By 1949, Stanolind had a patent on the new process, which injected water and other materials deep underground to break apart rock and help oil and gas flow.

Geologists had long known there were massive amounts of natural gas trapped in shale-rock formations. It took a stroke of innovative genius, though, to tap it. In the 1990s, George Mitchell, a Texas entrepreneur, began to experiment with combinations of horizontal drilling to span the deep shale and hydraulic fracturing to release the gas within; by the early 2000s, his engineers had made the essential commercial breakthroughs.

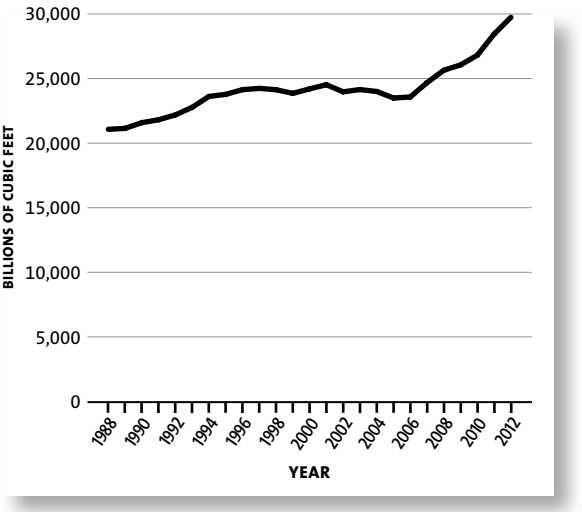
As recently as 2009, you couldn't find the term "shale gas" in the government's annual energy outlook. Yet in 2012, the government reported that nearly a quarter of U.S. production had come from shale in 2010, a fraction it projected would jump to half by 2035.

The government forecast that prices would rise only moderately, to $5 to $6, by 2020.

U.S. NATURAL GAS WELLHEAD PRICE



U.S. NATURAL GAS GROSS WITHDRAWALS



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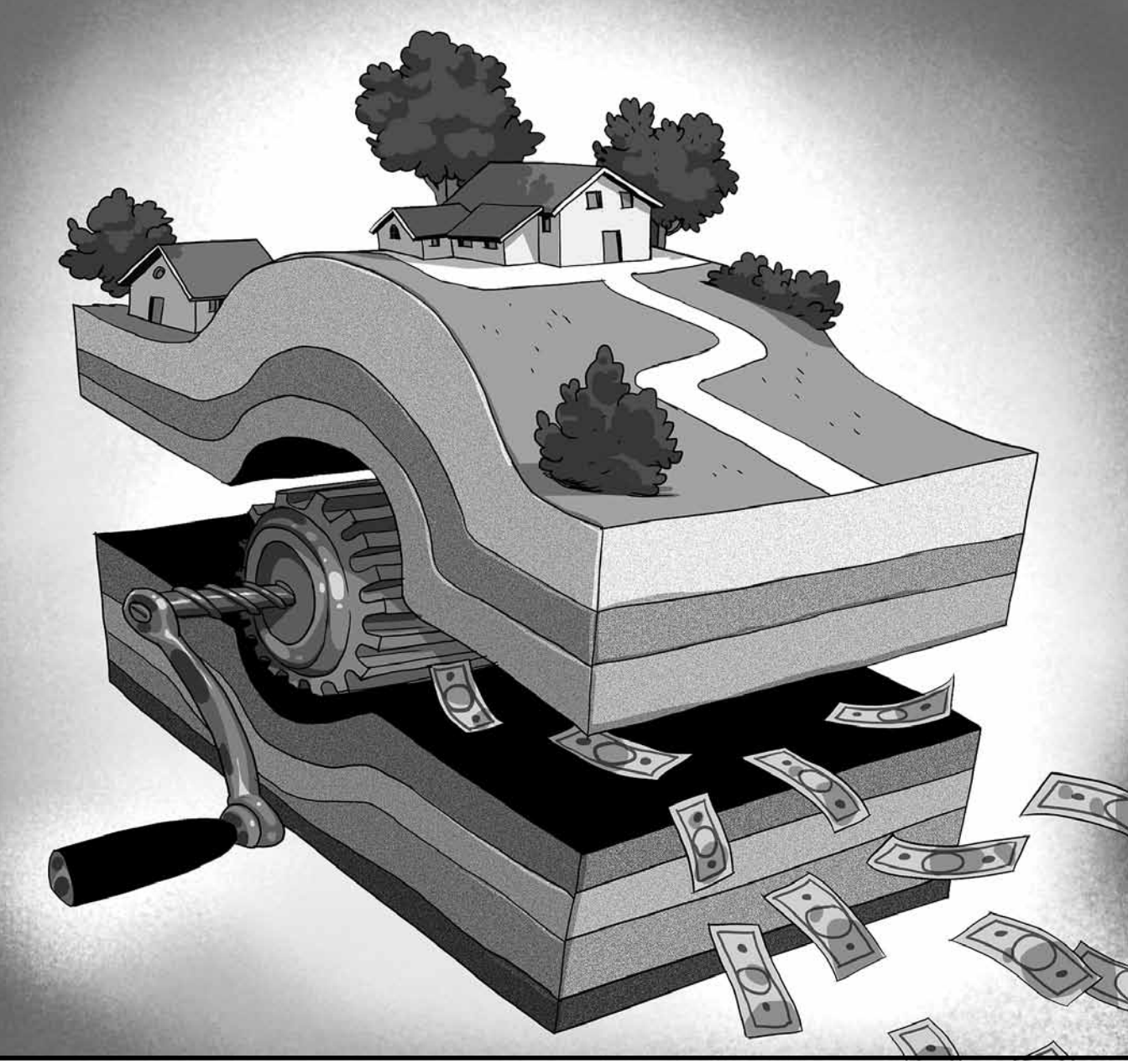

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And most Wall Street analysts agreed: natural gas appeared destined to be abundant and relatively cheap. Many pundits began speaking of natural gas as the country's economic salvation and about the geopolitical consequences that would reverberate throughout the world.

Not everyone, though, shared their enthusiasm. Neighbors argued over whether the jobs and money that industry brought were outweighed by the environmental risks like water pollution and road congestion. Others warned that cheap gas would kill renewable power, and along with it any hope of confronting climate change. One thing was for certain: shale gas's rise challenged almost every energy assumption that had been made only a few years before.

JOBS WHEN WE NEEDED THEM

It's usually difficult to figure out how much credit to give any particular development for a big gain in jobs. Most economists would say that when the economy is

working properly, it doesn't even make sense to try. But when the economy is in the dumps and the unemployment rate is abnormally high, the usual rules don't apply.

Researchers at the respected consultancy IHS Global Insight found that nearly 150,000 people were employed by the natural gas industry in 2010. And they estimated that the number could climb to 250,000 by 2020, as production from shale gas rose. But the economic consequences went further. The analysts estimated that another 190,000 jobs had been created by 2010 in industries supplying drillers, and that their number might rise to 370,000 by 2020. They also included another category, called induced employment, which counts up all the jobs created by the multiplier effect as purchasing power ripples through the economy.

Including these latter jobs is particularly controversial, but it's not unreasonable to include them when the economy is operating well below capacity. Once the researchers added them in, they estimated that shale gas was already responsible for 600,000 jobs in 2010. A month later, President Obama cited that number in his State of the Union address.

For shale gas enthusiasts, though, this was far from the end of the story. Americans wouldn't just make money extracting natural gas; they'd also profit from using it.

Shale gas is a mix of chemicals. The most abundant, methane, is the bulk of what gets burned in power plants and stoves. But natural gas comes blended with a host of slightly heavier molecules, known collectively as natural gas liquids. One of them, ethane, is particularly useful to petrochemical producers. They send it through multibillion-dollar plants called crackers to make the chemical ethylene, a core building block for everything from fleece sweaters to car doors. The only other way to make ethylene – the method Europeans and Asians depend on – is to synthesize it from naphtha, which is produced when petroleum is refined. But with oil prices far exceeding those for natural gas, U.S. producers grabbed a massive cost advantage.

The American Chemistry Council, which lobbies for the chemicals industry, claimed in 2011 that a sustained natural gas boom could support more than 400,000 jobs in the chemicals industry and among its suppliers, in the process generating $33 billion in new chemicals sales and $132 billion in boosted U.S. GDP. Estimates of this magnitude are over the top; they include not only the ethylene made from ethane, but also the fleece sweaters and car doors and other products in which ethylene ultimately ends up. The bottom line, though, remains: the U.S. chemicals industry is poised for big gains.

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Other U.S. industries using a lot of energy – steel, cement, aluminum and glass – have also become targets of speculation about potential expansion. More likely, cheap gas would help slow their decline, but substantial growth is unlikely.

Low natural gas prices have also served consumers, many of whom have been strapped for cash by the recession. This, in turn, has helped the economy through the multiplier effect. Figuring out the magnitude of this impact is tricky. Crude estimates, though, suggest that

Americans may be saving $20 to $40 billion a year on natural gas, adding perhaps $50 billion to aggregate demand (and thus to GDP in an economy operating well below capacity).

All the contributions from natural gas could collectively add up to hundreds of billions of dollars annually. Those are big numbers, but since they amount to just a percentage point or two of GDP, they're not revolutionary. People who claim that natural gas would spark a broad-based U.S. economic renaissance if only pesky environmentalists laid off are exaggerating the benefits.

THE GEOPOLITICS OF SHALE GAS

In 2011, the Department of Energy released the first estimates of shale gas resources in other countries, and the United States wasn't No. 1. That honor went to China, with an estimated 1,300 trillion cubic feet of "technically recoverable" shale gas, compared to about 900 trillion cubic feet in the United States. Close behind were Argentina (800 trillion), Mexico (700 trillion) and South Africa (500 trillion). That's a whole lot of gas: the United States uses just 20 trillion cubic feet annually.

In principle, these resources could turn geopolitics on its head. Poland, long under the thumb of Russia, is estimated to have more than 300 times as much natural gas locked in shale as it consumes every year. Estimated Chinese reserves total more than 400 times China's annual consumption. Thus, if even a modest fraction of those resources could be brought to production, China might be able to forgo fraught gas trading relationships with Russia or with troubled countries in the Middle East like Iran.

For all the promise, though, it's far too early to count on a shale gas boom beyond U.S. borders. Opposition to drilling is even more intense in Western Europe than in southern Ohio. Perhaps more important, the U.S. shale gas boom has been facilitated by a particularly attractive investment environment.

In the United States, private producers make investment decisions, while open markets let entrepreneurs sell shale gas to the highest bidder – conditions that are distinctly missing in China and (in the latter case) in Europe. Well-developed financial markets let producers sell their production several years in advance; they can then use those contracts as collateral when they finance their projects. Resources are mostly owned by individuals, not governments, keeping politics a step removed from development.

None of these features are present in other places with lots of shale (save Canada). And some of the countries where shale gas might be brought into production don't just lack a positive environment for development, they are downright hostile to it. Argentina, for example, keeps domestic gas prices artificially low, which makes a mess of economic incentives for drilling. Nor does it help that the government periodically makes it impossible to take money out of the country, or expropriates the holdings of foreign oil and gas companies.

There is another way, though, that many imagine U.S. shale gas could disrupt global markets and geopolitics: American exports of liquefied natural gas. With prices overseas at levels many times those in the United States, enthusiasm for exports has been strong.

As of late 2012, more than a dozen companies had applied for federal permits to build terminals to export the fuel, and most observers anticipated more. Were all of them actually built, they could ship more than a quarter of current U.S. natural gas consumption abroad – equivalent to nearly two-thirds of the world's liquid natural gas trade as of 2011.

But exports are unlikely to materialize at that scale. Most analysts expect U.S. prices to

stabilize at a higher level than prevailed in 2011 and 2012. Add to this the cost of liquefying and shipping natural gas, which easily adds $5 to the price of 1,000 cubic feet bound for Asia.

This is why, as of 2012, most energy analysts were predicting much more modest exports, perhaps totaling 10 percent of U.S. supplies before the decade is out. Most applications to export liquid natural gas, they concluded, would never turn into real facilities, just as scores of applications to import liquid natural gas years earlier had failed to do.

The impact on overseas markets and politics wouldn't be negligible – having alternate suppliers with lower costs would give big importers like Japan and Korea a stronger hand in dealing with producers, just as Europeans have gained in their dealings with Russia. But it might not be as transformative as many have supposed.

And even this modest impact is not foreordained. By 2012, the prospect of exports had stirred up widespread controversy, and opponents held some leverage because U.S. law requires export permits for liquid natural gas. Opponents brought a range of concerns to the table, in particular higher domestic prices for natural gas and the chemicals made from it. Nor had it escaped environmental groups that natural gas exports meant more production, which meant more environmental risk.

But there's little question that gas exports would be good for the economy as a whole. Indeed, although many will claim that gas is better used at home in manufacturing or power plants, the choice is misleading: the main impact of blocking exports would likely be less gas production.

The United States would also benefit from reinforcing an open system for world trade in energy. And because U.S. gas exports are something that other countries (like Japan and India) want, they give the United States added leverage in trade negotiations. By the same token, gas exports could also help insulate consuming countries in Europe and Asia from political arm-twisting by suppliers in Russia and the Middle East.

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The hottest speculation, though, about the geopolitical consequences of the shale gas boom focuses on whether it will be practical to use natural gas to power American cars and trucks – and by so doing, decrease U.S. reliance on oil. The Department of Energy projects that the United States will be producing nearly 14 trillion cubic feet of shale gas annually within 25 years. Put another way, shale gas will yield as much energy annually as 100 billion gallons of gasoline – almost as much as Americans now consume.

One way to employ natural gas to power cars and trucks is to use the gas to generate electricity, and then use the electricity to power electric cars. But the big barrier to doing so isn't the price or availability of natural gas, it's the cost and range of the vehicles.

The idea of compressing or liquefying natural gas and using it to power automobiles has been popularized by T. Boone Pickens, the Texas oilman-turned-alternative-energy-promoter, who has a lot of money riding on

the success of natural gas. The Natural Resources Defense Council, a major environmental group, estimates that Pickens' plan, which focuses on using government to get compressed natural gas into trucks, could reduce oil consumption by 4.9 million barrels per day – equivalent to about a quarter of U.S. oil demand.

Cars and trucks that use compressed natural gas are relatively rare in the United States. They have engines similar to those in typical cars and trucks, but because natural gas is far less energy-dense than gasoline, even after compression, vehicle range is only a quarter of that for a normal car.

Another reason natural gas vehicles aren't flying off dealers' lots is infrastructure. As of mid-2012, there were fewer than 500 publicly accessible natural gas filling stations in the country, compared to more than 100,000 gasoline stations. Closing the gap would be quite a challenge.

There are, however, some big niches where range and frequent refueling aren't major obstacles. Delivery trucks, urban buses and garbage trucks are all gasoline guzzlers that frequently return to depots, where they can be refueled. But the equation is more complicated for fuel-efficient cars and trucks that don't rack up so many miles so quickly. If drivers could save $2 for every gallon of gasoline they replaced (a likely outcome if oil prices remained around a $100 a barrel), it would take the average owner driving 12,000 miles annually about 13 years to recoup the cost of converting to natural gas.

A few unknowns create uncertainty here. If oil reached $200 a barrel and stayed near there, it would take only 6-7 years to pay off the upfront costs of conversions. Of course, $200 oil would also spur a shift toward more fuel-efficient gasoline-powered cars and create an incentive to drive less, which would erode these savings.

A more promising possibility is a drop in the purchase price of natural gas vehicles. As of 2012, the best bet was a Honda GX, which cost $7,000 more than the gasoline-powered equivalent. But it's a lot cheaper to buy a natural gas vehicle in Europe; the natural gas version of the VW Passat midsize sedan, which can run on both natural gas and gasoline, costs only $3,700 more than the pure-gasoline version. If the price difference were just $3,700 here, the breakeven point would fall commensurately.

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A third possibility is technological improvement that reduces the cost of outfitting big long-haul trucks to run on energy-dense liquid natural gas rather than compressed natural gas. Because those trucks log lots of miles, lower fuel costs can pay off rapidly. And because many of them travel on a small set of high-traffic, long-distance routes, it would be relatively easy to cover the overhead for a network of liquid natural gas fueling stations.

The last wild card is government intervention. This might take the form of tax-based subsidies for compressed-gas vehicles. Or governments might bring down the unit cost of such vehicles by buying a lot of them.

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But there's another possibility: converting natural gas into liquid fuels. The big question there is cost. In Qatar, Shell spent $20 billion to build a plant for converting 1.6 billion cubic feet of natural gas a day into 140,000 barrels of petroleum products – a project that was only viable because Qatar provided the natural gas free. But if the technology improved sufficiently or the price of oil rose sharply, gas-to-liquids projects might work in other places where natural gas was abundant.

In 2008, researchers at Carnegie Mellon University estimated that producing liquid fuels from natural gas would cost $2.30 a gallon if natural gas prices were near $9 per thousand cubic feet. When you add in distribution and marketing costs as well as taxes, that's barely competitive with gasoline.

But if fracking takes off and you redo their estimate with $5 natural gas, the cost slips to $1.45 a gallon – seemingly, a very competitive figure. The catch is that investors (especially the first-movers) would face multiple risks, ranging from an increase in natural gas prices (or a fall in oil prices) to overruns in plant construction costs; Shell's Qatar plant came in massively over budget.

THE SKEPTICS' CASE

History is littered with heralded resource booms that quickly fizzled out. Why should shale gas be different? The economic skeptics' case boils down to a three-letter acronym, EUR, short for "estimated ultimate recovery."

When a shale gas well first starts operation, production tends to be prolific. Industry experts refer to this as a high initial production rate. But then production falls, and often quickly. The initial production and subsequent decline rates combine to tell you how much gas a given well will produce – its estimated ultimate recovery.

Experts have a good idea of how much gas a well will produce in its first few years. But the skeptics point out that industry estimates of ultimate recovery typically assume two decades of production. And they charge that boosters have exploited the fact that no one has the experience with aging shale gas wells to estimate production a decade hence. Moreover, they argue that as drillers move beyond sweet spots in Texas, Louisiana and Pennsylvania, initial production will fall, too.

This debate over geology is unlikely to be resolved except through experience with shale gas wells. Absent that, though, there are still good reasons to treat the skeptics' case with a grain of salt. In particular, gas industry investors deeply discount earnings over time, which makes the first few years of production decisive in calculating the drillers' bottom line. So uncertainty about long-term performance might have smaller consequences on drilling than one might imagine.

Moreover, when skeptics estimate the impact of weaker well performance on shale gas economics, they typically treat drillers' costs as fixed. But one of the biggest costs of production – leasing land – isn't fixed at all. If the gas becomes less economical to extract, lease prices will drop in tandem, blunting the ultimate impact on production.

These shock absorbers deploy impressively in simulations of what would happen to shale gas if the estimated ultimate recovery turns out to be badly wrong. In 2011, the Department of Energy calculated that if per-well output were just half its base-case assumption, natural gas production would be 15 percent lower and prices 30 percent higher in 2035.

That's not insignificant, but it would hardly be a deal killer for shale gas development. Most analysts project U.S. natural gas prices settling in the $4 to $6 range over the long run, high enough to make money for

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producers and facilitate a wide range of uses in industry, power generation and beyond. Something truly drastic would need to happen for shale gas economics to fall apart and for prices to consistently clock in higher.

Policymakers would be unwise to assume that nothing could go wrong, though. There's a force at work here that is potentially more disruptive than economics or geology: public skepticism of drilling.

THE BACKLASH

None of the potential benefits of shale gas sway Warren Taylor or the people who joined him in Ohio's state capitol to protest gas development. For every claim about natural gas riches, Taylor can cite the danger to communities and the environment, along with the risks to businesses like his that depend on the latter.

Chuck Sammarone, mayor of Youngstown, Ohio, feels the tension quite acutely. Sammarone, who sported slicked-back hair and a bold silver tie when we met, won office in 2011 when shale-driven business was providing some hope in an area that had been in decline for decades. Sammarone, no surprise, was firmly in favor of fracking.

When an earthquake hit, though, the upside of shale gas was the last thing on his mind. For more than a year, drillers had been injecting wastewater from their operations into the Northstar 1 well, located just outside of Youngstown. Unbeknownst to the operators, the well struck near an underground fault. "Me and my wife were home," Sammarone, who is 69, recalls, "and it shook. Stuff fell off the wall."

Scientists at the Lamont-Doherty Observatory reported that the fluids pumped into Northstar 1 triggered a quake of 4.0 magnitude. And at the next city council meeting, Sammarone successfully pushed for a moratorium on injections in the area. "I'm not against drilling," he emphasized. "I'm against earthquakes." Jobs were important to Youngstown residents, but they weren't everything: "If they wanted earthquakes, they'd have moved to California."

Later in 2012, a National Academy of Sciences panel concluded that, with some simple precautions, such big tremors were entirely avoidable. But earthquakes were only the latest in a long litany of ills increasingly attributed to shale gas production.

The biggest environmental concern was water integrity. In particular, people worried that leaks of toxic fracking fluids and natural gas will pollute aquifers. (It didn't help that many drillers refused to disclose the full list of the chemicals they used.)

Most in the industry have long insisted that wells are isolated from their surroundings by thick layers of concrete and that the various contaminants found in water supplies come from other sources. The science is still out on whether they're right, but there are good theoretical reasons to believe they are.

The trickier question is whether methane itself might have migrated into water wells. In the most careful study to date, researchers at Duke University compared methane levels in drinking water near hydraulic fracturing activities with those elsewhere. They found that proximity to drilling did, indeed, make high methane concentrations more likely. The problem is that there are two explanations for this: drilling is contaminating water supplies,

or drilling is occurring in areas where there's a lot of methane around.

Industry is quick to point out that methane contamination doesn't make water unsafe to drink. But once you need to explain away flammable drinking water, you've already lost much of the battle for public acceptance. Nor does it help that excessive methane contamination can cause explosion hazards in homes.

In any case, drillers can avoid methane leaks by using better well casing that extends deep underground to seal off wells from their surroundings. The only question is whether companies will do it – and if not, whether governments will force them to.

The big water problem is not what goes into shale gas wells, but what comes out of them. Massive amounts of water are sent down into wells when they're fracked and massive amounts come back out, bringing toxic salts with them. These can be disposed of safely. But irresponsible operators have ditched wastewater in local streams or stored it in poorly constructed ponds that allow seepage into the soil.

In 2011, the International Energy Agency launched a study to answer a simple question: how much more would it cost to drill wells that met the highest safety standards? And their estimate was strikingly modest: for a mere 7 cents on the dollar more than drillers were already spending, all operations could be brought up to snuff. Note that, since drilling cost is one of several costs of delivering natural gas, the net impact on retail prices would likely be much less in terms of percentage changes.

In the end, the toughest challenge surrounding shale gas may not be protecting water or avoiding earthquakes, but managing the ways drilling affects communities. In places like Pennsylvania and Ohio that lack adequate numbers of properly trained locals, the hordes of young men who arrive from out of state to work can anger communities; one Pennsylvania lawmaker went so far as to accuse them of "spreading sexually transmitted disease among the womenfolk." Trucks are busy 24 hours a day, disturbing neighborhoods and sometimes wrecking roads. Development can happen remarkably close to where people live.

It's the mix of winners and losers that often makes gas development so fraught. You don't need to be employed in the industry or own gas-rich land to cash in on the bonanza; everyone from grocers to dentists has seen payoffs. But for some, like retirees on fixed incomes, the local inflation that accompanies an influx of shale money can be tough.

The lessons seem clear: though shale gas development can be done well, it can also be done poorly, placing promised gains at risk. And though markets will deliver on many of the opportunities stemming from shale gas regardless of what governments do, fully seizing other opportunities, like using gas to cut oil consumption, would require government to take a more active role. Whether the country will chart a course that adequately protects communities and exploits the potential of abundant natural gas remains to be seen.

POSTSCRIPT

Readers will have noticed that one big question shadowing the American natural gas renaissance has not been discussed here: the impact on climate-change management. Some view the gas boom as a great blessing, a means to slow greenhouse emissions by switching from coal-fired power. Others see it is a curse, an excuse to delay the transition to renewable fuels – and thereby raise greenhouse gas accumulations even more before governments summon the will to stop the process. It may, in fact, prove to be both. For my take on the issue, check out Chapter 4 of my new book.

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