FRACKING:

THE NEW GLOBAL WATER CRISIS

food&water europe

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About Food & Water Europe

Food & Water Europe is the European program of Food & Water Watch, a nonprofit consumer organization based in the United States that works to ensure the food, water and fish we consume is safe, accessible and sustainable. So we can all enjoy and trust in what we eat and drink, we help people take charge of where their food comes from, keep clean, affordable, public tap water flowing freely to our homes, protect the environmental quality of oceans, force government to do its job protecting citizens, and educate about the importance of keeping shared resources under public control.

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Executive Summary

Within the past decade, technological advances in horizontal drilling and hydraulic fracturing, or "fracking," have enabled the oil and gas industry to extract large quantities of oil and natural gas from shale formations in the United States. However, the practice has proven controversial. Pollution from modern drilling and fracking has caused widespread environmental and public health problems and created serious, long-term risks to underground water resources.

In this report, Food & Water Europe reviews the risks and costs of shale development that have been demonstrated in the United States, including economic costs that run counter to industry-backed claims about the economic benefits of the practice.

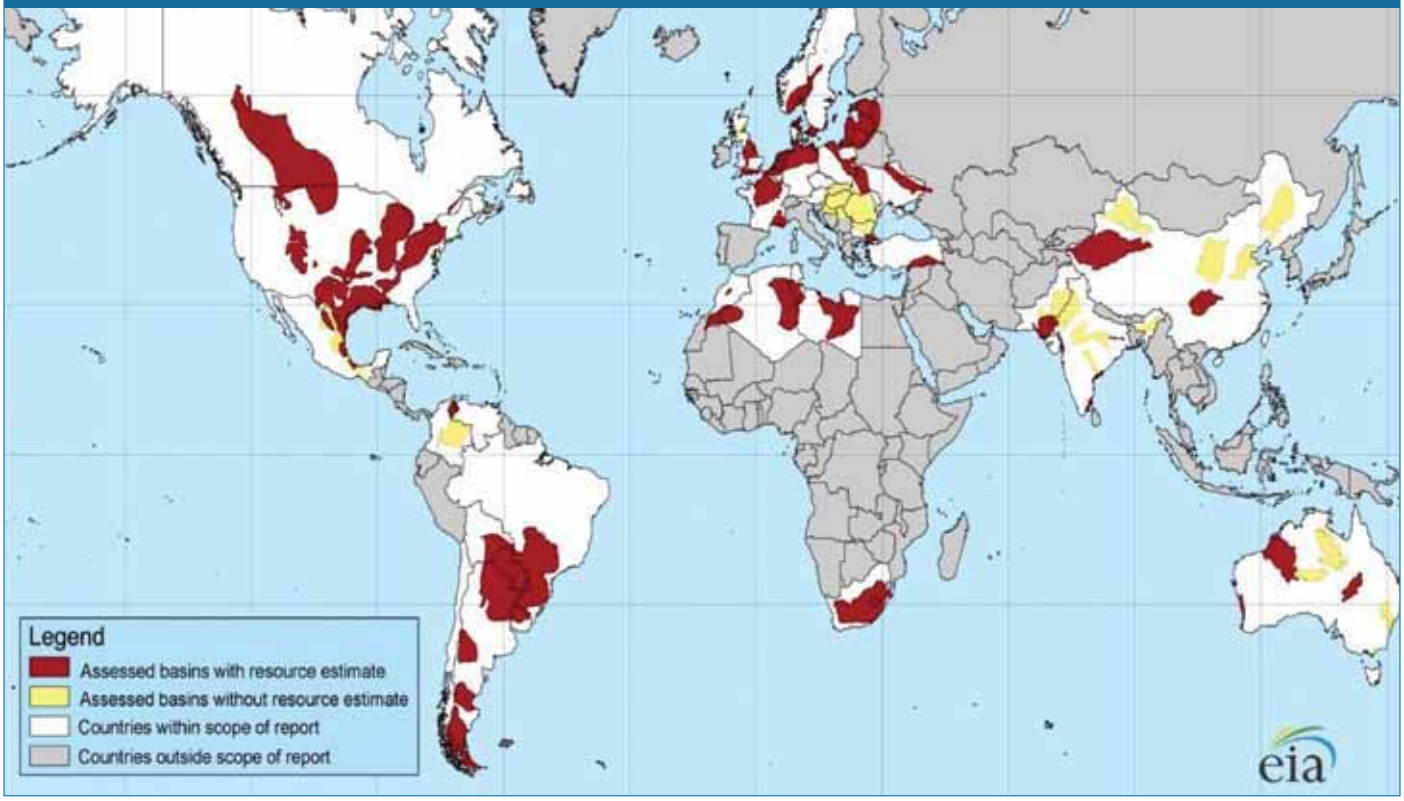
Food & Water Europe then summarizes the state of shale development in six selected countries: France, Bulgaria, Poland, South Africa, China and Argentina.

Briefly:

- Strong public opposition to fracking in France and Bulgaria has led to national bans on the practice.
- The government of Poland has welcomed oil and gas industry plans to develop shale resources in the country, but charges of bribery during the process of awarding leases have tainted these plans.
- Pending an environmental review by the South African government, Royal Dutch Shell may soon be granted permission to drill and frack in South Africa's Karoo Basin.
- The Chinese government is pushing an expansion of shale development, and numerous oil and gas companies are partnering with Chinese firms, both in the United States and in China.
- In Argentina, oil and gas companies have begun developing shale oil and shale gas resources in the Neuquén Basin, with the support of the Argentinean government.

Instead of exposing their citizens to the damages of modern drilling and fracking, countries around the world should enact national bans on the practice and invest aggressively in the deployment of energy efficiency and renewable energy technologies.

Technically Recoverable Shale Gas Resources *(Does not include shale oil)*



Source: U.S. Energy Information Administration, based on Advanced Resources International, Inc. data. Last updated April 5, 2011.

Introduction

Advances in drilling technology and hydraulic fracturing, or "fracking," have now made it economically feasible to extract oil and natural gas from shale and other impermeable rock formations.[1] However, while such drilling and fracking has been a boon for the oil and gas industry in the United States, it has been a nightmare for Americans exposed to the pollution that accompanies shale development.[a]

The oil and gas industry is now poised to take this nightmare global. International private and state-owned oil and gas companies are partnering with U.S. companies, providing capital for U.S. shale development in exchange for the experience of learning drilling and fracking techniques pioneered in the United States.[2] Many of these companies are also working to secure rights to extract shale oil and shale gas resources worldwide, and in some countries exploratory drilling and fracking is already underway.[3]

Because natural gas is a relatively clean-burning fossil fuel, compared to oil and coal, natural gas has been touted as an energy source that could potentially serve as a bridge to a low-carbon future powered by clean and renewable energy resources.[4] However, looking beyond shale gas combustion to the full environmental impact of shale gas development reveals that shale gas is not the environmentally friendly natural gas that had been envisioned as a bridge. Not only does shale gas development lead to dangerous air and water pollution, but some scientific studies of greenhouse gas emissions from shale gas development suggest that using shale gas instead of coal to generate electricity may actually accelerate climate change in coming decades.[5]

Of course, in contrast to the case of shale gas, there is no pretense that shale oil will offer environmental benefits.

This report reviews the risks and costs of shale development, as demonstrated in the United States, and calls on countries to ban the dangerous practice. To illustrate the global reach of the threat that modern fracking now poses to public health and the environment, the status of shale development in six

a For simplicity, the term "shale development" is used in reference to the extraction of oil and natural gas from shale and other impermeable rock formations, including coalbeds, "tight" sandstones and siltstones. Shale development involves the modern combination of horizontal drilling and multi-stage, high-volume fracking.

selected countries – France, Bulgaria, Poland, South Africa, China and Argentina – is briefly summarized.

History and the Next Wave of Fracking

Fracking is the process of injecting fluid – typically a mixture of water, sand and chemicals – into wells at high pressure to crack rock formations, allowing oil and/or gas contained in these formations to flow more easily into a well.[6]

Fracking is not a new technique. Oil and gas companies have used fracking since the 1860s to stimulate oil-well production.[7] Halliburton is credited with the first commercial application of fracking to produce natural gas,[8] and by 2000, fracking was used in 90 to 95 percent of all U.S. oil and gas wells.[9] However, the scale of modern fracking is a radical departure from that used in conventional oil and gas development.[10]

Conventional natural gas drilling targets limestone and other rock formations through which gas readily flows.[11] Once a pocket of gas is identified within these permeable formations, a vertical well is drilled down until the reservoir is reached and gas begins to flow into the well.[12] After the flow rate of gas significantly declines, these conventional wells may be fracked to temporarily improve production from the aging well.

In contrast, unconventional natural gas development targets natural gas held in shale, tight sandstone and coalbed formations, which restrict the flow of natural gas unless they are fracked.[13] Similarly, fracking is essential to free "tight oil" from otherwise impermeable rock formations so it can flow into a well.[14 b]

The combination of advanced fracking and horizontal drilling technologies has made it economically feasible to extract large quantities of shale oil and shale gas.[15] While fracking allows the oil and gas to flow into a well to begin with, horizontal drilling through a relatively thin layer of shale, for example, gives each well more exposure to the oil and gas in the shale.[16]

Once vertical and horizontal drilling is finished, and well casings are cemented, developers inject millions of gallons of fracking fluid to crack apart the rock and prop it open so that the gas can be released.[17] Depending on geology, between 25 and 75 percent of the millions of gallons of fracking fluid used for each well returns to the surface as wastewater.[18] A large volume of salty water containing naturally occurring contaminants is also typically produced at each well as wastewater.[19] Combined, these wastewaters contain the toxic chemicals added to fracking fluid, as well as any radioactive materials and other pollutants leached from deep underground.[20]

Not content with its technological advances, the oil and gas industry is developing the capacity to increase the amount of fracking fluid and pressure being used in order to generate larger fractures and ultimately extract more oil and gas per well.[21]

How Fracking Impacts the Human Right to Water

Water use

Fracking a single shale well requires millions of gallons of water. Widespread shale development would thus compete with essential water needs in regions prone to water shortages.

Water pollution

Shale development presents inherent short-term and long-terms risks to water quality.

Climate change

Shale development is likely to accelerate global climate change in the coming decades, contributing to increased variability in seasonal and annual rainfall patterns. Such variability, in the form of either flooding or prolonged droughts, will stress water utility systems.

The U.S. Experience: Adding Up the Risks and Costs

The increasing scale of drilling and fracking operations needed for shale development has increased the risks and costs of the practice. Modern fracking requires millions of gallons of water for each well, and thus widespread shale development can compete with essential water needs in regions prone to water shortage.[22] Public water resources can also be polluted at different stages of shale development or long after the development has occurred, resulting in significant public health costs. Additional public health costs are due to air pollution from modern shale development, and rural economies suffer from

b Shale oil, which requires fracking to extract, is usually referred to as "tight oil" so as to avoid confusion with oil shale.

the negative impacts that widespread drilling and fracking have on agriculture and tourism.

Fracking's impact on public water resources

Examples of water pollution in the United States from shale development

Fracking has been implicated in the contamination of water supplies across the United States. ProPublica identified more than 1,000 cases of water contamination near drilling sites documented by courts, states and local governments around the country prior to 2009.[23] Pennsylvania cited 451 Marcellus Shale gas wells for 1,544 violations in 2010 alone. Notable affected communities include:[24]

Pavillion, Wyoming: In 2010, the U.S. Environmental Protection Agency released a preliminary study that found possible drinking water contamination near fracking wells and recommended that residents avoid drinking their tap water.[25] The U.S. EPA investigated 39 rural water wells and found benzene and methane in wells and groundwater.[26] The wells were also contaminated with the fracking fluid additive 2-butoexythanol phosphate, which has harmful health effects.[27] In December 2011, the U.S. EPA released a draft report concluding that fracking likely led to methane contamination of deep groundwater near Pavillion, and that shallow groundwater contamination was likely due to surface spills of fracking wastewater.[28]

Dimock, Pennsylvania: In 2009, Pennsylvania regulators ordered the Cabot Oil and Gas Corporation to cease all fracking in Susquehanna County after three spills at one well within a week polluted a wetland and caused a fishkill in a local creek.[29] The spills leaked 8,420 gallons of fracking fluid containing a Halliburton-manufactured lubricant that is a potential carcinogen.[30] Fracking had so polluted water wells that some families could no longer drink from their taps.[31] Pennsylvania fined Cabot more than $240,000, but it cost more than $10 million to transport safe water to the affected homeowners.[32] In December 2010, Cabot paid $4.1 million to 19 families that contended that Cabot's fracking had contaminated their groundwater with methane.[33] In 2012, the U.S. EPA began providing clean drinking water to these families after Cabot had been released of its obligation to do so by the state of Pennsylvania.[34]

Garfield County, Colorado: Garfield County's 8,000 natural gas wells have inched closer to residential areas.[35] A hydrological study found that as the number of gas wells in the heavily fracked county increased, methane levels in water wells also rose.[36] State regulators fined EnCana Oil and Gas for faulty well casings that allowed methane to migrate into water supplies through natural faults.[37] In 2008, a wastewater pit in Colorado leaked 1.6 million gallons of fluid, which migrated into the Colorado River.[38]

Parker County, Texas: In 2010, the U.S. EPA determined that fracked gas wells had contaminated a drinking water aquifer with methane, benzene and other natural gas chemicals that were chemically fingerprinted to the gas well.[39]

How shale development pollutes freshwater resources

There are many ways that drilling and fracking contaminate public freshwater resources. First, even before fracking fluid chemicals are injected underground, they can be spilled at the sites of wells[40] or in traffic accidents,[41] resulting in local contamination.

The chemicals used to make fracking fluids are far from safe. Scientists have found that 25 percent of fracking chemicals could cause cancer; 37 percent could disrupt the endocrine system; 40 to 50 percent could affect the nervous, immune and cardiovascular systems; and more than 75 percent could impair sensory organs and the respiratory system.[42]

A second major pathway of contamination stems from the need to dispose of the several million gallons of fracking wastewater that flows to the surface after each well is fracked. This wastewater contains not only the potentially toxic chemicals used in fracking fluid, but also natural contaminants from deep underground, including total dissolved solids (e.g., salts, barium, strontium), organic pollutants (e.g., benzene, toluene) and normally occurring radioactive material (NORM) such as Radium 226.[43] A 2011 *New York Times* investigative report found that nearly three-quarters of the more than 240 Pennsylvania and West Virginia gas wells studied produced wastewater with high levels of radiation, including at least 116 wells with levels that were hundreds of times the U.S. EPA's drinking water standard, and at least 15 wells with levels thousands of times the standard.[44]

Surface water pollution from drilling and fracking occurs with leaks, blowouts and other accidents at the sites of a shale well[45]; spills from traffic accidents while fracking wastewater is being trucked to disposal sites[46]; or spills from the intentional and illegal dumping of fracking wastewater.[47] In 2010, a shale gas well blowout led to a 75-foot tall geyser of gas and drilling fluid that spilled 35,000 gallons on the ground before it was contained.[48] In January 2011, approximately 21,000 gallons of fracking wastewater spewed from a Tioga County, Pennsylvania, well when a valve was erroneously left open, releasing hazardous chloride, sodium, barium and strontium, as well as hydrochloric acid used in the fracking fluid.[49] Two months after a fire in the company's fracking liquid storage tanks injured three people, a Chesapeake Energy well spurted

thousands of gallons of fracking fluid in Bradford County, Pennsylvania, due to an equipment failure.[50] Pennsylvania had cited Chesapeake Energy 284 times for violations and taken 58 enforcement actions since the beginning of 2008.[51]

Also, surface water can be polluted by discharges from treatment facilities that receive fracking wastewater but that are not equipped to treat many of the contaminants this wastewater contains.[52] For example, between 2008 and 2009 in Pennsylvania, at least half of fracking wastewater went to public sewage plants that were not equipped to treat NORM.[53] Pennsylvania's rivers have also had rising levels of bromides, a trend of particular concern because bromides can react with disinfectants during water treatment to form brominated trihalomethanes (THM).[54] Once formed, THM are difficult and costly to remove from the water supply, and exposure to THM is implicated in cancer and birth defects.[55] Yet, according to ProPublica, no Pennsylvania wastewater treatment plant was expected to be able to remove total dissolved solids, including bromides and chlorides, from the water until 2013.[56]

In December 2010, the Center for Healthy Environments and Communities (CHEC) at the University of Pittsburgh tested treated water being discharged into a creek from a treatment facility in Indiana County, Pennsylvania, that had received fracking wastewater. The CHEC analysis found that the average concentration of barium was about 14 times the U.S. EPA drinking water standard, strontium was

present at an average concentration of about 746 times the standard, benzene was present at twice the standard and total dissolved solids were present at 373 times the standard.[57]

Drilling and fracking have also caused methane and contaminants in fracking wastewater to seep into underground drinking water supplies directly, without ever reaching the surface.[58]

A National Academy of Sciences study found that average methane concentrations in shallow drinking water wells in active gas areas were 17 times higher than those in non-active areas, possibly due to leaky gas-well casings.[59] In 2008, a house in Ohio exploded after methane infiltrated its water source, largely because of fracking.[60] In 2010, after the U.S. EPA instructed Wyoming residents not to drink their water because of contamination from a common fracking fluid, some residents also used fans while bathing to reduce the likelihood of explosions.[61] In 2010, the U.S. EPA determined that two homes in Texas were at risk of explosion because of high levels of natural gas found in their water from nearby fracking operations.[62]

The U.S. EPA has reported that toxic fracking fluid has contaminated at least one water well in West Virginia and likely others.[63] In 2004, in Colorado, a faulty natural gas well casing led to contamination of water 4,000 feet away from the well site.[64] In November 2011, the U.S. EPA released a draft report on contaminated groundwater near drilling and fracking operations in Pavillion, Wyoming, concluding that "the data indicate likely impact to ground water that can be explained by hydraulic fracturing."[65]

Many of the cases of direct groundwater contamination, either by methane or fracking wastewater, are likely due to faulty casing of the well where the well passes through an aquifer. Multiple, concentric casings are being used to try to reduce the risk of such direct contamination, but human errors will always occur regardless of the robustness of the well casing designs. Yet this is not the only risk to underground resources.

The fact that, depending on geology, 25 to 75 percent of fracking fluid returns to the surface means that millions of gallons of fracking fluid stays underground indefinitely after it is injected into a well.[66] Once underground, fracking fluid mixes with the naturally occurring brines and is subject to geological forces and chemical processes over the long term, from years to decades. How far and how fast this blend can travel, and how it might change chemically, is impossible to know and control. Potential pathways for contaminants to flow into aquifers include the well into which fracking fluid is injected, nearby abandoned wells,[67] induced fractures in the shale from fracking, and existing natural fractures in the bedrock.[68]

Modern shale development thus risks irreversible damage to vital underground drinking water resources over the long term. While this possibility may be remote, it is too serious of a risk to accept.

Air pollution from fracking

Shale development results in more emissions of greenhouse gases, smog-inducing compounds and other hazardous air pollutants than conventional oil and gas development. This air pollution comes from the exhaust of generators and compressors at shale well sites, from heavy-duty truck traffic and from the venting of wastewater storage tanks, and it can seriously degrade air quality. This means there are significant health and environmental impacts when examining the full life-cycle of shale gas, and these significant impacts negate some of the benefits that stem from shale gas being a clean-burning fossil fuel. As for shale oil, there are no air-quality or climate benefits claimed.

Shale gas is composed primarily of methane, which is a potent greenhouse gas.[69] Recent scientific stud-

ies have demonstrated that, due to the amount of fugitive methane released during modern shale gas development as compared to during conventional gas development, any increased use of shale gas instead of coal may actually accelerate climate change in the coming decades, not reduce climate change impacts.[70] This is despite the fact that shale gas emits significantly less carbon pollution when burned.[71] Crucially, this also assumes that demand for shale gas would displace demand for coal, not supplement it; if such displacement does not happen, then the impact on climate would be far worse.[72] It is therefore misguided for governments around the world to open up their countries to shale development under the pretext of fighting global climate change.

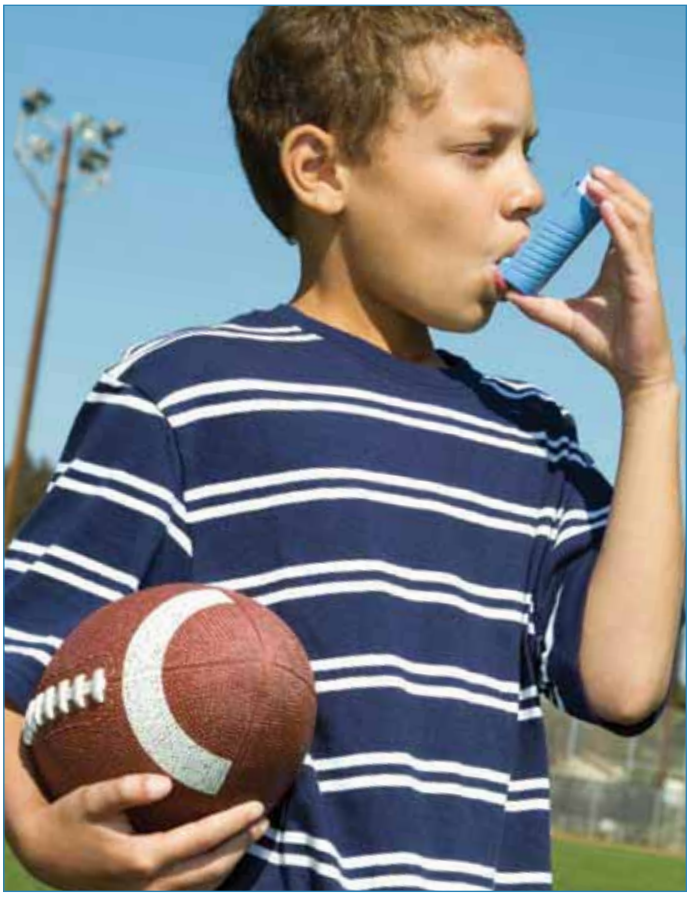
Hazardous air pollutants found near fracking sites include methanol, formaldehyde and carbon disulfide.[73] Volatile organic compounds, including nitrogen oxides, benzene and toluene, are also discharged during fracking.[74] These compounds mix with emissions from heavy-duty truck traffic, large generators and compressors at well sites to form ground-level ozone that can, in turn, combine with particulate matter to form smog.[75] Long-lasting exposure to smog has been linked to various cancers, heart disease, diabetes and premature deaths in adults, and to asthma, premature birth and cognitive deficits in children.[76]

It is extremely difficult to make direct links between individual health outcomes and unknown exposure levels to air pollutants. However, there are numerous reports of public health problems that coincide with the onset of shale development and that are likely due to the resulting air pollution.

For instance, residents of DISH, Texas, who lived near 11 natural gas compression stations became concerned about the odor, noise and health problems they were experiencing, which included headaches and blackouts. They also observed neurological defects and blindness in their horses.[77] Their mayor fruitlessly reported these accounts to Texas regulators and eventually hired a private environmental consultant, who in 2009 found that air samples contained high levels of neurotoxins and carcinogens.[78] The Texas Commission on Environmental Quality found airborne benzene, which can cause immune disorders and cancer, near Barnett Shale wells at levels of 500 to 1,000 parts per billion – more than five times higher than allowable limits.[79]

In Wyoming, drilling and fracking have caused ground-level ozone pollution to exceed amounts recorded in Los Angeles, affecting the quality of life for Wyoming residents.[80] In Texas, a hospital system serving six counties with intensive shale gas development reported asthma rates three times higher than the state's average.[81] The natural gas and oil industry in the Barnett Shale area produced more smog-forming emissions during the summer of 2009 than were produced by all motor vehicles in the Dallas-Fort Worth metropolitan area.[82] Yet ground-level ozone pollution from shale gas development is not just a local problem; it can be transported hundreds of miles by prevailing winds before combining with particulate matter to form smog.[83]

These accounts illustrate the serious public health impacts of modern shale development,[84] and highlight the narrow thinking in assuming that a transition to shale gas will reduce air pollution simply because shale gas burns more cleanly than other fossil fuels.



The U.S. Experience: Exaggerated Claims of Economic Benefits

The shale development rush has not only endangered public health in the United States through pollution of the air Americans breathe and the water Americans drink; it has also harmed local economies. While industry promotes job creation and local investment, proponents typically do not account for the long-term economic damage and the significant erosion of communities' quality of life that can outweigh any benefits.[85] Many of the purported economic benefits are just a mirage – energy companies based elsewhere typically do not buy drilling and fracking supplies from local businesses, and shale development jobs typically go to transient workers who move from shale play to shale play.[86]

New wells bring fleets of trucks that crowd and damage rural roads and carry potentially hazardous wastewater. New York estimated that, if the state allowed shale gas development, each well would require between 890 and 1,350 heavy-duty truckloads.[87] Noisy drilling rigs operate 24 hours a day, 7 days a week.[88] Scenic vistas are replaced with a landscape of gas wells, which lowers property values and harms tourism and recreation industries like hunting and fishing. In Wise County, Texas, properties with gas wells have lost 75 percent of their assessed value.[89] Natural gas rigs devalue not only the property where they are located, but also the value of neighboring properties.[90]

During construction and drilling, gas wells significantly increase heavy truck traffic, and locals bear the cost of repairing wear and tear on local roads. The Pennsylvania Department of Environmental Protection estimates that building and fracking a well requires 1,000 heavy-duty truck trips.[91] Increased truck traffic damages local infrastructure and can increase the risk of truck accidents on small, rural roads.[92] Fracking also requires pipelines to transport the gas, which can pose safety hazards from explosions.[93] In 2011, a pipeline explosion in Allentown, Pennsylvania, killed five workers; other explosions have occurred elsewhere in Pennsylvania and in Ohio, California, Michigan and Texas, some fatal.[94]

Farmers, whose livelihoods depend on the health of the land, face especially stark choices. Persistently low milk prices have threatened dairy farms in Pennsylvania and New York, and the prospect of gas royalty payments is tempting. Farmers lease their land to gas companies with the promise of minimal impact.[95] However, livestock have died from drinking water tainted with spilled fracking fluids.[96] In 2009, 16 cattle died after apparently drinking fluid that escaped from a Louisiana fracking well.[97] In 2010, Pennsylvania quarantined 28 cows that may have consumed water tainted by a fracking spill that could contaminate their meat.[98] Organic farmers could lose their premium prices if industrial fracking fluid pollutes their crops or livestock.[99] Farm sales could be destroyed if pollution threatens livestock, crops or farmland.[100]

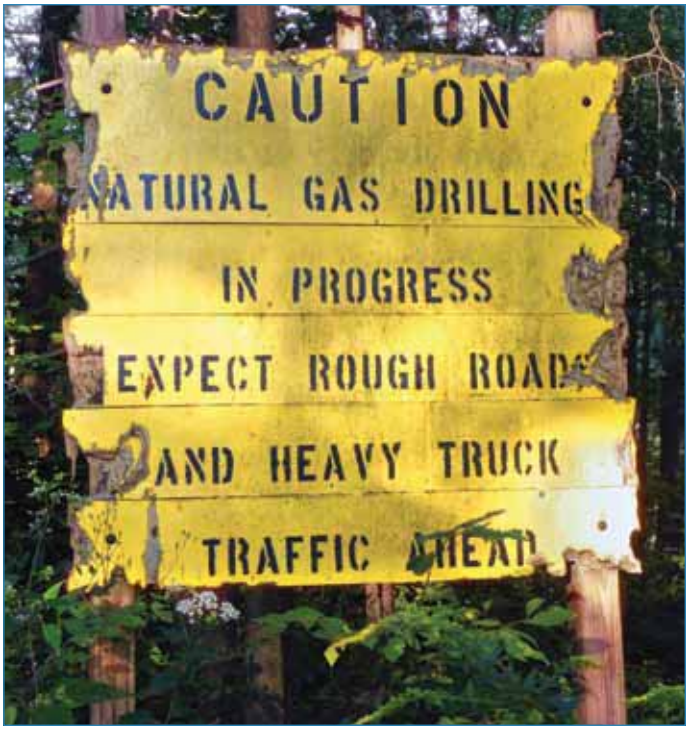


IMAGE BY NICHOLAS / COMMONS.WIKIMEDIA.ORG

In contrast to the legacy of environmental pollution that shale development leaves behind, any economic gains from drilling and fracking are short-lived: employment, construction, housing demand and even royalty payments are significant at first, but diminish quickly as well productivity declines and drilling and fracking operations move elsewhere.[101] Almost all of the jobs associated with shale development come during the drilling and fracking stage, but it takes less than one year to prepare a well site and conduct the drilling and fracking.[102] This means that industry employees, most of whom are transient workers with shale development experience, just move from new well to new well as the number

of drilled wells increases.[103] Also, there is considerable uncertainty over estimates of the amount of shale gas reserves that is technically recoverable using current technology, and over how long individual wells will actually be productive. If production falls more rapidly than expected, as some industry analysts anticipate,[104] then there would be smaller royalty checks and fewer production-phase jobs over the long term. In August 2011, it was reported that some shale gas producers received subpoenas from the U.S. Securities and Exchange Commission for documents on actual well production and reserve estimates, after the *New York Times* reported concerns expressed by some in the industry and government that the shale boom has been overstated.[105]

Finally, estimates of the amount of technically recoverable – not necessarily economically recoverable – shale resources in the United States have varied widely.[106] In January 2012, the U.S. Energy Information Administration cut its estimate of technically recoverable shale gas by about 42 percent from the estimate it used just one year earlier.[107] This raises serious questions about whether countries should stake their energy futures on shale resources, given that the U.S. EIA's estimates of international shale resources may be similarly flawed.[108] Indeed, initial exploratory drilling in Poland conducted by Exxon has not yielded commercially viable production levels.[109]

Fracking Around the World

Mineral rights ownership

In the United States, landowners typically own the right to develop oil and gas reserves beneath their own private land.[110] As a consequence, the oil and gas industry has had a natural alliance with landowners who seek individual financial gain from selling leases and receiving royalty payments.[111]

According to Ben van Beurden, head of Shell Chemical, "[shale gas development] works a whole lot better if the mineral rights to the gas actually belong to the land owners."[112] He continued, "[i]n places like northwestern Europe, mineral rights are being held by the state so the only thing as a land owner you have is inconvenience."[113]

Indeed, in many countries, governments own and control subsurface mineral rights.[114] On one hand,

Snapshot of Global Shale Gas Activity

Africa: Royal Dutch Shell has led the push to drill and frack for shale gas in South Africa's Karoo Basin.[115] The Sirt Basin, in Libya, and the Ghadames Basin, which underlies parts of Algeria, Tunisia and Libya, are also targeted for shale gas development.[116] In Tunisia, Cygam Energy has begun exploratory drilling and fracking, and Chinook Energy Inc. has leased 3 million acres of land.[117] In Morocco, the national oil and gas company has been studying its shale gas potential.[118]

Oceania & Asia: ExxonMobil, Royal Dutch Shell, Chevron, BP and ConocoPhillips are among the foreign companies investing in China's shale resources — be it shale oil or shale gas.[119] ConocoPhillips and New Standard Energy, an Australian company, are partnering to develop shale gas resources in western Australia's Canning Basin, although New South Wales, Australia's most populated province, has temporarily suspended shale development.[120] In New Zealand, the Taranaki Regional Council has granted permission for fracking of conventional natural gas wells to continue.[121]

Latin America: In Argentina, exploratory drilling has begun in the Neuquén Basin, led by Apache Corporation, Total and ExxonMobil.[122] In October 2009, Uruguay's government-owned petroleum company entered a contract with Texas-based Schuepbach Energy LLC to assess its shale gas potential.[123] While shale development is not actively underway in Mexico, Brazil, Chile, Paraguay and Bolivia, these countries are believed to each have significant shale resources.[124]

Europe: In June 2011, France became the first country to ratify a nationwide ban on fracking.[125] In January 2012, Bulgaria also enacted a nationwide ban on the practice.[126] Exploration in England, in Northern Ireland and in the German province of North Rhine-Westphalia has been suspended as of April 2011.[127] Chevron, ConocoPhillips and ExxonMobil have each leased over 1 million acres in Poland, and ExxonMobil has leased an additional 2 million acres combined in Germany and the Netherlands.[128] In November 2011, the Scottish government granted its first license to allow fracking,[129] and Ireland is expected to also grant exploratory shale drilling licenses, pending a government review of environmental impacts.[130]

this means that the oil and gas industry does not benefit in these countries from private landowners who apply public pressure on their governments to expand drilling and fracking in hopes of gaining financially. But, on the other hand, state control over mineral rights means that national governments around the world may view the potential revenues from selling access to the highest-bidding oil and gas companies as worth the public risks and costs of shale development.

France

If French landowners receive both authorization and a concession from the French government, they do have the right to extract and dispose of minerals on their land.[131] However, the national government or a third party can also develop these same resources through the same permitting and concession process, after a public enquiry and bidding process.[132]

In 2010, numerous companies leased land in the Paris Basin, which is targeted as a resource of both shale gas and tight oil, and in the Southeast Basin, which is targeted for shale gas.[133] The French government issued exploration permits to many of these companies and their partners, including Vermillion Energy, Total SA, Torreador Resources in partnership with Hess, and Schuepbach Energy, an American company that was in partnership talks with the French energy company GDF Suez.[134] However, French citizens cried foul when they learned that the permits had been issued without public deliberation.[135]

Activists began circulating a petition in January 2011 that initially led to a moratorium on fracking in France, followed in June 2011 by a national ban on the practice.[136] France's Environment Minister, Nathalie Kosciusko-Morizet, stated "[w]e have seen the results in the U.S. There are risks for the water tables and these are risks we don't want to take."[137]

Total SA maintains that its permit to develop shale gas in the Southeast Basin should not have been revoked and has challenged France's ban on fracking.[138]

Bulgaria

In Bulgaria, potential shale gas resources are owned by the state, not by landowners.[139] In June 2011, Chevron agreed with the Bulgarian government to pay €30 million for a five-year permit to conduct exploratory shale gas drilling on 4,400 square kilometers of land near the city of Novi Pazar.[140] The Bulgarian Prime Minister, Boyko Borisov, rejected charges by the leader of an opposition party that the agreement had been finalized.[141] The resulting confusion, combined with concerns about the environmental impacts of fracking, fueled demonstrations against the deal.[142] Months later, this grassroots political pressure culminated in the Bulgarian government revoking the agreement with Chevron and passing a national ban on fracking.[143]

Poland

Poland has the highest estimated reserves of shale gas in Europe,[144] and the country's government has welcomed the industry with open arms.[145] ExxonMobil, Chevron, Total, Realm Energy and Talisman are among the oil and gas companies seeking to develop shale gas reserves in Poland.[146] By 2012, over 100 licenses for shale gas exploration had been granted in the Baltic and Podlasie Basins by the national government of Poland,[147] which owns all gas deposits and transfers development rights through concessions.[148]

SHALE GAS PROTEST IN BULGARIA. IMAGE BY ©ALEXHG1 / DREAMSTIME.COM

The Polish government has pushed for exploratory drilling to be intensified so that shale gas production can begin as soon as 2014.[149] However, the government's efforts to commercialize shale gas in Poland have been complicated by charges of corruption, in January 2012, involving government officials and the shale gas industry.[150] The government charged that bribes had been offered by the industry, and accepted by government officials, to secure shale gas leases.[151]

Rather than award these licenses through a competitive bidding process, the Polish government awarded them at low costs on a first-come, first-served basis, and some have argued this has made the process prone to corruption.[152]

South Africa

Royal Dutch Shell has led the push for access to shale gas in South Africa,[153] where shale gas development rights are owned by the state, not by landowners.[154] In 2009, the Petroleum Agency South Africa granted permission to Shell to conduct an assessment of shale gas resources in the Karoo Basin.[155] However, farmers and environmentalists in the area expressed concerns about the risks and costs of drilling and fracking for shale gas.[156] In April 2011, South Africa's cabinet acknowledged these concerns and established a moratorium on shale gas exploration in the Karoo Basin to allow time for a government study of the impacts of fracking.[157] This moratorium was set to expire at the end of February 2012, pending recommendations in the government study.[158]

On November 11, 2011 the National Planning Commission, an advisory body to the South African government, released its National Development Plan (NDP).[159] In addressing energy, the NDP recommends enabling "exploratory drilling to identify economically recoverable coal seam and shale gas reserves, while environmental investigations will continue to ascertain whether sustainable exploitation of these resources is possible."[160] The NDP calls for shale gas development and investment in shale gas electricity generation to be "fast tracked," provided that "environmental concerns are alleviated"[161] and "provided the overall environmental costs and benefits outweigh the current costs and benefits associated with South Africa's dependence on coal, or with the alternative of nuclear power."[162]

However, widespread drilling and fracking in the Karoo could jeopardize the NDP's objectives to provide clean drinking water for all and reduce urban water demands by 2030,[163] and, with respect to climate change, scientific studies suggest that replacing one fossil fuel with another is likely misguided.[164]

China

China's National Energy Administration has reportedly integrated shale gas into its national energy plan.[165] The chairman of Sinopec, China's second-largest oil company, believes that China could overtake the United States in shale gas.[166] In November 2009, the United States and China launched the U.S.-China Shale Gas Initiative[167] to facilitate Chinese efforts to gain technical expertise in shale gas development.[168]

Royal Dutch Shell, which has $4 billion in total energy investments in China, has teamed up with PetroChina.[169] Together, these companies drilled and fracked China's first exploratory horizontal shale gas well in March 2011 in the Sichuan Basin. Three months later, China's Ministry of Land Resources initiated bidding rounds for commercial shale gas development permits.[170] China, which maintains state ownership of oil and gas resources, has limited initial commercial development access to domestic companies.[171]

Fracking would risk the food and freshwater resources on which millions of Chinese depend. The Sichuan Basin lies beneath one of China's most populated and agriculturally important areas, Sichuan Province, which is home to almost 100 million

people and has farmland that supplies a significant portion of China's staple foods.[172] Despite recent government efforts, environmental regulatory protections in China are lacking.[173]

Argentina

In Argentina, either the national government or provincial governments own oil and gas rights.[174] According to the U.S. EIA, Argentina has the third highest amount of technically recoverable shale gas in the world, primarily in the Neuquén Basin, and shale gas exploration has commenced.[175] The Argentinian oil and gas company YPF is partnering with Apache Corporation, an American company that has about 1 million acres in shale leases in Argentina.[176] In December 2010, Apache Corporation conducted the first multistage fracking of a horizontal shale gas well in Latin America.[177]

In addition to its gas resources, the Neuquén Basin is expected to hold significant quantities of tight oil.[178] Total, ExxonMobil and EOG Resources have each begun to invest in developing these resources.[179] However, widespread drilling and fracking for oil and gas in the Neuquén basin is likely to have negative impacts on tourism that is important to the economy of Neuquén Province.[180]

Shale development would also place large demands on water resources in the region[181] and, as such, can be expected to exacerbate environmental justice concerns about access to potable water in Neuquén Province.[182]

Conclusion

Natural gas has long been considered as an alternative fuel, both for transportation and for generating electricity, that can serve as a bridge to a future powered by clean, renewable energy resources.[183] However, shale gas is not the natural gas that had been envisioned.

The rapid expansion of shale gas development and fracking in the United States has resulted in significant environmental and public health problems, and become an ongoing public health and environmental experiment. Many of these problems are inherent to the practice and cannot be avoided through regulation.

Taken together, spills of toxic fracking fluid and fracking wastewater,[184] water well contamination from the underground migration of methane[185] and toxic fracking fluid,[186] local and regional air pollution problems from shale development,[187] explosions at the sites of shale wells,[188] and substantial emissions of the global warming pollutant methane during drilling and fracking[189] make the dangers of shale development clear.

Countries not yet exposed to the risks and costs of drilling and fracking have an opportunity to choose a different path, one that "meets the needs of the present without compromising the ability of future generations to meet their own needs."[190] Enacting a national ban on fracking and investing in the deployment of energy efficiency and renewable energy technologies will set a sustainable course.

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