ENERGY SECURITY IN CENTRAL AND EASTERN EUROPE

SCIENCE-BASED DECISIONS AND U.S. BEST PRACTICES IN HYDRAULIC FRACTURING

BY KEITH C. SMITH AND MARTA SIKORSKI

MAY 2014

CEPA

Energy Security in Central and Eastern Europe

Science-Based Decisions and U.S. Best Practices in Hydraulic Fracturing

This report was produced by the Center for European Policy Analysis (CEPA).

Co-Authors: Keith C. Smith and Marta Sikorski

May 2014

Center for European Policy Analysis
1225 19th Street, NW
Suite 450
Washington, DC 20036
Tel: (202) 551-9200
E-mail: info@cepa.org
www.cepa.org

Table of Contents

Executive Summary

The countries of Central and Eastern Europe (CEE) have an opportunity to transform Europe's current energy order. As seen through the American experience, the development of untapped energy resources from shale gas in Lithuania, Poland, Romania and Ukraine is possible through hydraulic fracturing, also known as fracking. As a region heavily dependent on Russian oil and gas imports, the creation of greater energy security has long been a major policy goal for the European Union (EU) and its individual Member States. Yet misinformation about environmental and public health risks from hydraulic fracturing is shaping the European policy debate and decision-making on whether or not fracking will play a major role in the region's energy diversification strategy. While the governments of Bulgaria and the Czech Republic have already imposed bans on fracking, energy companies active in Poland, Romania and Ukraine have confronted public protests against shale exploration activities over the last year. This "fear of fracking" has not only become a significant roadblock toward CEE energy independence, but it has stymied immense opportunities for growth in manufacturing and employment across Europe. The development of domestic shale resources could play a critical role in strengthening CEE's energy strategy and advancing the EU's goal of stoking economic competitiveness.

Almost 70 years worth of U.S. experience in hydraulic fracturing can attest to its relative safety as a method of hydrocarbon extraction. Many claims about the environmental dangers from fracking cannot be substantiated by scientific fact. To this end, one approach in addressing the fears of policymakers and their constituents is through the establishment of a science-based discussion about fracking. Over the last decade, studies from the United States have yielded a growing collection of scientific data that demonstrates how new technologies and local regulations have become integral to a significant reduction of environmental and public health risks associated with fracking. What's more, the U.S. fracking model could be adapted to a CEE context, despite differences in geology and population densities. As Poland, Romania and Ukraine embark on their own shale expeditions, the success of fracking in the region would also depend on the synchronization of environmental and industry interests in protecting the environment and public health. In applying U.S. best practices in hydraulic fracturing, the countries of CEE already have a tested benchmark for safety and the tools necessary for strengthening national energy security, economic development and transatlantic ties between the United States and the region.

Policy Recommendations

1. Central and East European energy and environmental regulators would be well advised to work closely with the U.S. Environmental Protection Agency (EPA) and experienced state regulators in order to draw on their experiences regarding best practices and to judge the effectiveness of regulations regarding the latest and best hydraulic fracturing technologies. Using the U.S. experience, European governments can more rapidly and effectively bring about environmentally acceptable domestic energy production and attract experienced foreign partners.

2. CEE energy policymakers and regional officials should make it a point to investigate the claims made by the opponents of fracking. These assertions are often cloaked in scientific language that is unable to hold up to factual information once it has been closely examined by independent specialists.

3. CEE governments should adopt transparent and competitive measures for awarding permits for exploration and development. Without transparency, there is significant risk that corrupt business interests will seek exploration blocks without the intention of doing serious exploration, but with the goal of holding onto the awarded block as an investment to sell at a profit at a later point in time. Greater transparency in the awarding and licensing process would also more likely lead to environmentally safe operations.

4. CEE governments would benefit from conducting greater due diligence regarding any economic entity participating in a tender. A firm without prior experience in hydrocarbon exploration or development should prove that it has a qualified partner with sufficient technical expertise and adequate funding to carry out the tender commitments. A firm time limit should be set for beginning serious exploration. Failure to meet the deadline would result in the tender award reverting back to the control of the state.

5. Cooperative studies by fracking companies and CEE regulatory agencies should examine potential drilling sites, setting a baseline for local air pollution levels and surface and ground water quality. These studies can potentially reassure a nervous public that the government and the energy firms are serious about protecting the environment and public health, thereby strengthening local support for hydraulic fracturing. By measuring existing pollution levels, it would prevent exaggerated claims later on regarding negative effects of hydraulic fracturing.

6. Greater dissemination of fact-based information about hydraulic fracturing should be made available to CEE governments, environmental groups and the public by the United States Department of Energy (DOE) and the U.S. EPA. U.S. state regulatory agencies and research organizations could participate in public discussions in CEE capitals and in affected regions regarding their experience with hydraulic fracturing to share what worked and what did not. Representatives of the major local media outlets and environmental groups should be invited to these events, along with government and opposition figures. The emphasis should always be on what operating firms have learned by utilizing the best science for maximizing production while at the same time protecting the environment and public health.

7. Foreign and domestic companies can increase their credibility and public support by publishing full disclosure of the operations to be carried out, including the composition of chemicals, sand and water to be injected into the well site. U.S. companies should also proactively reach out to local communities with the latest information on best practices. Up to now, not enough effective outreach to local communities has taken place.

8. CEE governments would be advised to establish futures markets in each capital in order to create an institution that would help mobilize investments in energy projects.

9. Because mineral rights in the CEE region are owned by national governments as opposed to private citizens, it is important that CEE governments scrupulously carry out all agreements with local communities regarding the transfer of an agreed portion of income from natural gas sales to those areas directly affected by fracking operations. Trust between local and national authorities is essential in order to avoid damaging work stoppages by affected communities.

10. Joint ventures between national firms and American and other Western companies should be encouraged as such cooperation provides financial and technological transfers, as well as strengthens inter-European and trans-Atlantic ties.

11. While technology transfers from foreign firms to domestic energy companies should be encouraged, this should be a voluntary process. A mandatory transfer of technology could slow exploration and development as governments and companies determine what should or should not be shared with local partners.

12. CEE and U.S. governments could collaborate in establishing a European center for the analysis of best practices and the dissemination of information regarding hydraulic fracturing. Working with USAID, International Energy Agency (IEA) and the European Commission, the Center would ensure the dissemination of best practices in all EU member states. The Center could also facilitate exchanges sending CEE energy officials to the U.S. to observe the latest technologies and best practices, and bring U.S. and other specialists to Europe.

13. U.S. agencies should work with the universities and technical institutes in the CEE region to adapt U.S. best practices to local conditions and to develop newer technologies that can be adopted on both sides of the Atlantic. CEE countries possess an impressive number of highly educated technical experts and this expertise should be utilized.

Introduction: The Fracking Debate

An intense debate is currently underway in Central and Eastern Europe (CEE) regarding the strategic and economic benefits of hydraulic fracturing (fracking) and the perceived risks it could pose to the environment and public health. According to recent estimates by the U.S. Energy Information Administration (EIA), Poland, Romania and Ukraine could hold some of the largest deposits of recoverable shale gas and oil in Europe. Since 2011, a number of prominent domestic and international energy companies have secured exploration deals with CEE governments, and in some cases, have already started drilling. As the American shale revolution has demonstrated over the last decade, the benefits of shale gas are vast. At the same time, what that means for environmental and public safety is just as important.

As a region that has frequently suffered from politically motivated disruptions to gas supplies, one benefit of shale gas production would be greater energy security. Often the sole supplier of natural gas to the region, Russia has profited from pricey, long-term gas deals with the countries of CEE. Worse yet, Europe's bargaining power with Russia over gas prices is limited. Thanks to new Russian-controlled pipelines in the Baltic Sea, a proposed link in Southern Europe, and two large connections in Germany (OPAL and NEL), Europeans will continue to pay monopoly prices for gas. Indeed, Europe's dependence on imports from the East has elevated the "winner take all" dimension of Russia's energy relations with transit countries like Belarus and Ukraine. In years' past, this had the unwanted effect of elevating mundane commercial negotiations between suppliers and pipeline operators to the level of high geopolitical drama.

In strategic terms, the benefits of domestically-produced shale gas would be profound. Regional energy consumers would decrease their dependence on sole-source energy providers like Russia and insulate themselves from potential political coercion by non-EU governments. Additionally, new fuel sources would create alternatives to Russia's monopoly-pricing scheme. It would be a boon to consumers and lower the potential for state conflict over East-West pipelines. The advent of alternatives would lower these stakes and "normalize" energy relations in the CEE region.

In economic terms, Europe is lagging behind when compared to the United States. While European unemployment levels remain high, manufacturing businesses are moving out of the EU to find cheaper gas in the United States – all thanks to the shale gas revolution. Meanwhile in Germany, the EU's largest economy, a zero-carbon alternative to gas like nuclear power is no longer an option after the Fukushima disaster. This has propelled the use of cheap coal from the United States and stoked conflict with Europe's strict climate policy. As a result, European coal consumption increased by 3.3 percent from 2010 to 2011.[1]

---

[1] James Burgess, "Coal Consumption Increases in the EU: Is the Carbon Trading Scheme a Failure?" Oil Price, July 17, 2012, http://goo.gl/a7MEC6; "In Europe, Coal Regains Its Crown," *Forbes*, July 13, 2012, http://goo.gl/MtvwE.

Increased coal use has directly resulted in a similar rise in carbon emissions from power plants.[2] At the same time, the need for imported gas is growing while most of Europe currently pays three to four times more for gas than U.S. consumers.

Additionally, energy sources from hydraulic fracturing would not only decrease the strain on the balance of payments for CEE countries, but also would accelerate the competitiveness of energy-related industries like steel, petrochemicals and manufactured goods. Indeed, that goal is already a reality in the United States. It is the U.S. experience that underscores some of the possible benefits that CEE states could likewise attain. For example, U.S. consumers enjoy the lowest price for gas of any major industrial country. As a result, America has enjoyed a revival of energy-intensive industries like steel and petrochemicals, all while simultaneously creating over one million jobs. And since 2007, the increase in gas consumption contributed to a 12 percent reduction in carbon dioxide emissions in the United States as more natural gas entered the domestic market.

Yet America's shale gas revolution did not evolve without the risk of land damage, air pollution, earthquakes or water contamination from leaks and spills. As CEE countries take steps to introduce domestically produced shale gas to their energy mix, some environmental groups and political parties have pointed to claims about the harmful effects of fracking. Some fracking critics have also dismissed the possibility for an American-style fracking revolution in the CEE states because of differences in regional geology or population densities. In some parts of the CEE region, the layers of underground shale are approximately 1.5 times deeper than those typically found in the United States. Moreover, the relatively higher population density of the region means that more citizens are likely to come into contact with oil or gas rigs in their communities.

In some corners of Europe and the United States, these risks and differences have stirred up fears that fracking constitutes a significant danger to the environment and human health. One notable dimension of the policy discourse is the persistence of misinformation about fracking. As noted earlier, this fear of fracking has prevented Bulgaria, the Czech Republic, France and Germany from developing indigenous sources of natural gas. And unlike in the United States, Europe has a limited experience with fracking. This is not to say that the technique is entirely novel to Europe – on the contrary. In fact, the best example of European fracking comes from Germany's Schleswig-Holstein and Lower Saxony regions, where the process has been used since 1955 and 1976 respectively.[3]

---

[2] "Europe's Dirty Secret: The Unwelcome Renaissance," *The Economist*, January 5, 2013, http://goo.gl/RnDp1.
[3] "Germany: Fracking Since 55," *Natural Gas Europe*, November 17, 2011, http://goo.gl/dMoUQN.

In the absence of wide-spread experience, however, regional leaders and the public can draw from ample case studies and examples of how this process has worked in North America. The relative safety of fracking practices in the United States today is built on a strong foundation in science. Over the past decade the industry has matured significantly and has learned how to avoid earlier errors. New technological developments and local regulations have been essential for reducing risks such as land damage, methane leaks, spills into water supplies and mismanagement of wastewater. Thankfully, there are a variety of options for achieving a best practices approach to CEE shale gas development. These would also need to be contoured to fit local conditions for geology, surface impact, civic involvement and taxes. Ideally, such an effort would avoid any missteps from the early days of the American shale gas boom. This course would ease uncertainty and align the interests of all stakeholders – local and otherwise. If done right, fracking could help alleviate—or even eliminate—many negative economic, political and environmental outcomes in Europe.

For this reason, leaders and interest groups would gain from a fact-based discussion about fracking. This would address common fears by the interested public, domestic industries that might compete against lower-cost natural gas, and parts of the environmental lobby that are quick to accept unproven allegations about damage to land, air and water. All sides need only recognize that the safety of fracking is a common interest. Dealing rationally with the fear of fracking will be essential if CEE states are going to diversify their energy sources and achieve greater energy independence. Such a process would start with a consideration about what fracking is—and is not—while framed within a scientific consideration of risks and advantages.

Part I: What is Hydraulic Fracturing?

Hydraulic fracturing is often perceived to be a new technology, but it is not. In fact, this method for recovering oil and natural gas was first used in the United States in the late 1940s, and later, introduced in Germany in 1955. What is new, however, is the combination of hydraulic fracturing with relatively recent breakthroughs in horizontal drilling. This fundamental change allowed hydraulic fracturing to transform the world of energy in the mid-2000s.[4] Thanks to a combination of old extraction methods and new advances in drilling, exhausted energy supplies from old wells, as well as previously unreachable resources located deep below ground, became available.

The merger of old and new techniques for reaching underground resources has been nothing short of ground-breaking in the world of energy. In just over a decade, American shale gas has transformed the global energy market, lowered the price of oil and natural gas for consumers and, at least in the United States, created economic incentives to switch from higher-polluting fuel sources. This has become known as the shale gas revolution in the United States. And though not at the same magnitude, the process has also been successfully employed in oil and gas fields around the globe. So what does this process look like?

The practice of combining hydraulic fracturing with deep-source extraction begins with the construction of a *well pad*. On the surface, this is the physical location for drilling. Typically, a well pad occupies the space of approximately three football pitches. Once engineers identify the location for a well, the area is cleared to make room for a drilling rig, storage for sand and fracturing fluid, a system of pipelines and pumps to move the fluid, and a wellhead. In some cases, engineers will also have to build a network of roads to the site if they do not already exist.[5]

The *drilling* of the well depends on the depth of the shale rock below ground. In most cases, this process takes two to four weeks to complete. *Horizontal drilling* simply starts off vertically as would any conventional well, but then takes a 90-degree turn once the layer of shale is reached. This represents the horizontal portion of the drilling process; and it allows engineers to access large stretches of shale deposits deep below the surface. Compared to a traditional vertical well, horizontal drilling also allows for a much higher recovery rate of gas or oil. When complete, the well bore is then fortified by multiple layers of steel casing and cement. This step is important, since it stabilizes the integrity of the well and prevents oil or gas from escaping into soil or rock near the

---

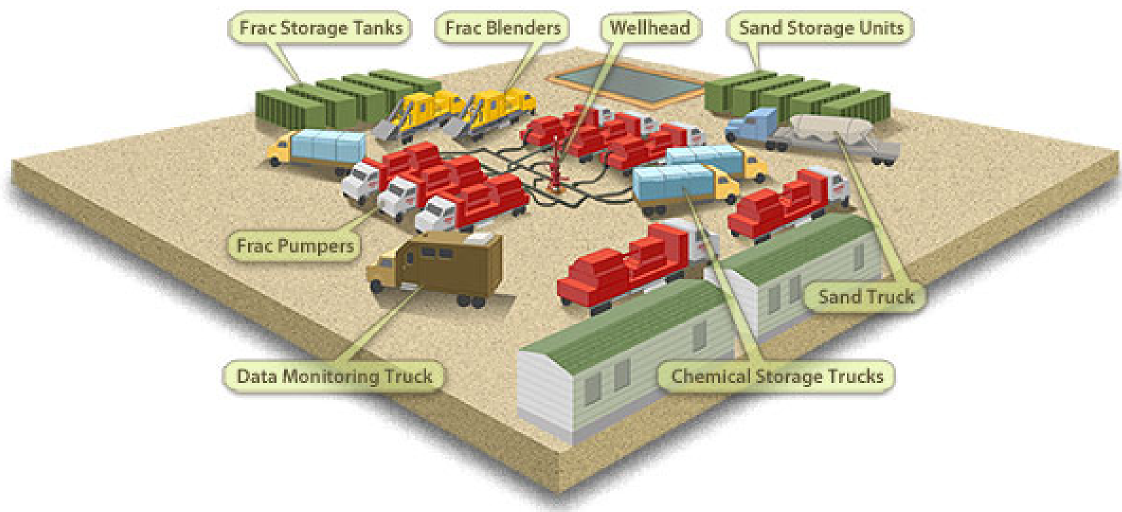
[4] Stephen P.A. Brown and Mine K. Yücel, *Energy Brief: The Shale Gas and Tight Oil Boom: U.S. States' Economic Gains and Vulnerabilities,* Council on Foreign Relations, October 2013, http://goo.gl/2kds9S.

[5] Connie Clark, Andrew Burnham, Christopher Harto and Robert Horner, *Hydraulic Fracturing and Shale Gas Production: Technology, Impacts, and Policy,* Argonne National Laboratory, September 10, 2012, 1, http://goo.gl/XyTOLr.

surface. Very deep below ground in the shale layer, the casing is perforated with small explosives. These "target zones" break the rock, which allows fracking fluid to eventually reach the shale rock.[6]

The actual method of *hydraulic fracturing* is relatively straightforward. It involves the injection of water, chemical additives and sand into the earth at very high pressure. The injected solution itself, known as fracturing fluid (or fracking fluid), is made up of 99.5 percent water and sand, and 0.5 percent diluted chemical additives. This mixture creates (or restores) small fractures in underground rock formations like shale. Different additives have a specific purpose. For example, acid dissolves carbonate mineral inside the casing of the well and allows fracturing fluids to flow more freely to the shale. Friction-reducing additives further open fractures and help the flow of sand or ceramic materials (known as *proppants*) into cracks in the shale. Proppants keep the fractures open after the pressure inside the well is reduced. As a result, engineers are able to release oil or gas from new and existing wells.[7] Finally, water flushes out the sand or ceramic material from the well bore before full-scale production begins.[8]

Typical Hydraulic Fracturing Site Layout[9]

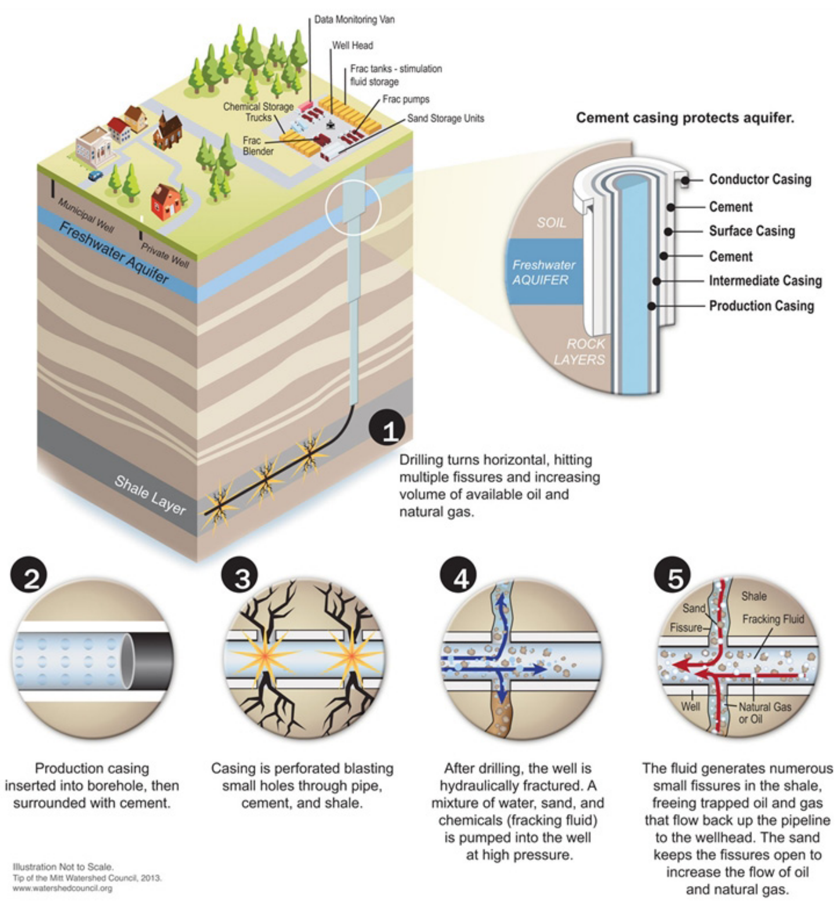


The stage after the completion of hydraulic fracturing, but before actual gas production, is known as *well completion*. The used fracturing fluid (sometimes known as *flow back water*) that comes back up the well is stored onsite for reuse or disposal before the

[6] "Oil and Gas Development using High Volume Hydraulic Fracturing," Watershed Council, http://goo.gl/lTSxBi.
[7] "Hydraulic Fracturing: The Process," Frac Focus Chemical Disclosure Registry, http://goo.gl/b3BMW.
[8] Ibid; "Chemical Use in Hydraulic Fracturing", Frac Focus Chemical Disclosure Registry, http://goo.gl/eFC5Dj.
[9] "Hydraulic Fracturing: The Process," Frac Focus Disclosure Registry.

wellhead is connected to a larger network of pipelines. This network helps to transport the gas away from the well pad. If not recycled, the wastewater's final resting place is in an underground injection well. Alternatively, wastewater could also be treated and released into local waterways for disposal. Finally, *production and processing* entails the pumping of gas from the well. Frequently, this gas is mixed with naturally-occurring water vapor and other gases that must be separated.[10] This substance, known as *produced water*, contains high levels of Total Dissolved Solids (TDS) such as methane, ethane and propane. Like flow back water, produced water can be filtered, recycled or disposed. After it is separated from water, natural gas then typically moves onto more processing or distribution through a pipeline.[11] The final step of the entire process is the removal of the wellhead once the well's production life ends, followed by *plugging* of the well bore with layers of cement to prevent any gas or fluids from escaping in the future. Lastly, engineers return the land to its original form and natural surroundings.

What is Hydraulic Fracturing?[12]

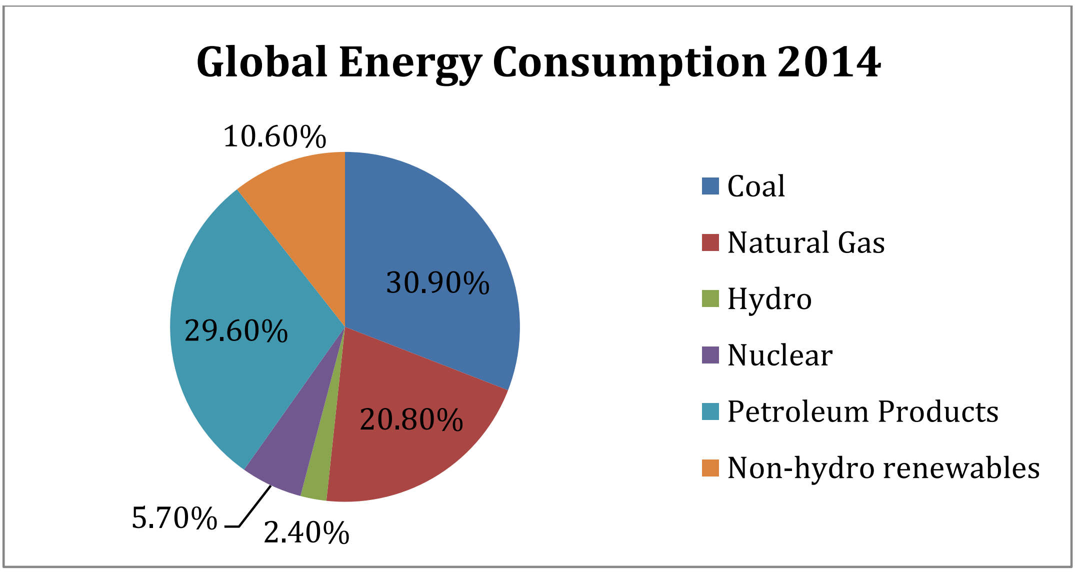


[10] "Oil and Gas Development using High Volume Hydraulic Fracturing," Watershed Council.
[11] Connie Clark, *Hydraulic Fracturing and Shale Gas Production: Technology, Impacts, and Policy*, 9.
[12] "Oil and Gas Development using High Volume Hydraulic Fracturing," Watershed Council.

(A) Why is it Being Done?

Put simply, the world needs fuel – and a lot of it. According to the most recent estimates by the EIA, the planet's demand for energy will grow by 56 percent between 2010 and 2040.[13] There are many factors driving this change, but one of the most prominent is the rise in energy demand from the fast-growing economies of China, Brazil and India. This need has placed an increased demand on the world's existing energy supplies, from non-renewable fuels like coal, oil and natural gas to renewable or zero-carbon sources like wind, solar and nuclear power. As more consumers jostle for a larger share of finite energy resources, policymakers across the globe have offered a variety of solutions – each one presenting a unique set of tradeoffs.

World Energy Mix 2014[14]



Faced with this challenge, the organizing problem for most countries is that the world's primary fuels like oil, coal and natural gas do not occur naturally where they are needed most. This is why commuters on the East Coast of the United States fuel their cars with Nigerian oil; and residents of the CEE region heat their homes with Russian natural gas. The geographic gap between the main sources of energy and the consumers who need it has become so great that few countries openly work to achieve "energy independence" from imports. Instead, most hope to create a secure, reliable link to the sources of imported energy – often at high political and economic costs.

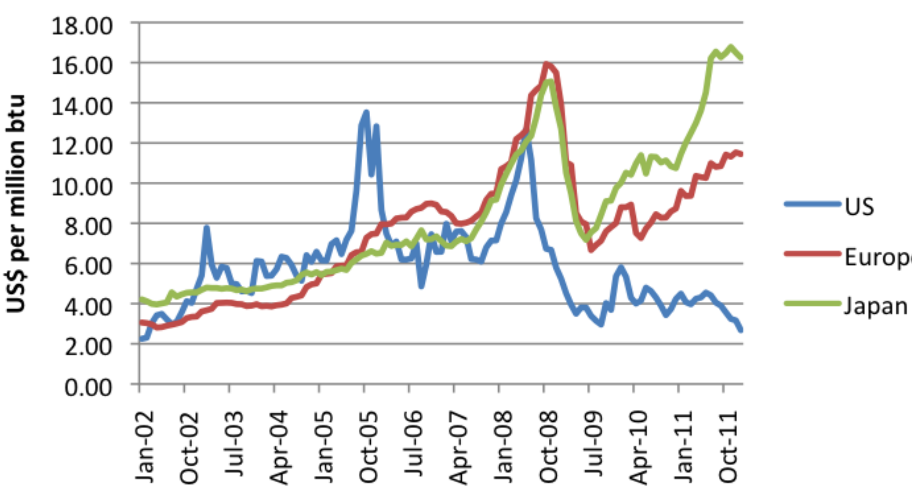
[13] U.S. Energy Information Administration, *International Energy Outlook 2013*, July 25, 2013, http://goo.gl/8vSlO7.
[14] "World Energy Mix 2014," The Economist Intelligence Unit, http://goo.gl/pju1xa.

Up until the middle part of the last decade, this thinking defined the conventional approach to energy security in Europe, the United States and Asia. Today, however, the conventional wisdom is changing in many countries. One of the drivers behind this shift in perspective is hydraulic fracturing and the subsequent shale gas revolution that it has produced.

(B) What Would a Shale Revolution Mean for CEE Countries?

It turns out that a great many countries possess potentially large quantities of underground natural gas. Instead of continuing to rely almost exclusively on outside countries for energy imports, many regions of the world could begin to produce their own indigenous supplies of shale gas. This is especially true in parts of the CEE region, where untapped shale resources exist in Bulgaria, Lithuania, Poland, Romania and Ukraine. If these countries could bring these supplies to market, they could replicate the successful example of unconventional gas production in the United States. In the CEE context, some of the most likely benefits would include decreased reliance on Russia's energy monopoly, meaningful competition within the regional gas market, lower prices for downstream consumers, an end to onerous take-or-pay contracts and increased economic competitiveness. Many of these benefits represent some of the longest and most unfulfilled policy goals of European officials. But until now, the real-world implementation of these aims has been limited. That too, could begin to change thanks to shale gas.

Price of U.S. Gas 2005-Present, Compared to UK Spot Price and Average Japanese Price[15]



[15] Energy Transformation, *Shale Gas: An Opportunity that Europe Cannot Afford to Miss*, 2013, 11, http://goo.gl/QePwFQ.

The first benefit would be reduced Russian dominance of the CEE gas market. For many countries in the region, Russia remains the sole-source provider of natural gas. From a policy perspective, this dominance is unwanted; and many within the EU have worked for decades to dismantle it. The good news is that these efforts are beginning to show some signs of progress. Thanks to initiatives like the EU's Third Energy Package, the regulatory environment inside Europe is better positioned to protect consumers against foreign energy monopolies. The bad news is that the EU is limited in what it can accomplish through regulatory changes. Unlike Western Europe, where Russia controls only 30 percent of the market, in the CEE region Kremlin-backed firms provide for nearly 70 percent of the demand for natural gas. Unsurprisingly, Russia has used its dominant market position to negotiate a higher price for the gas it delivers to CEE consumers than in the West. Worse, Russia's dominant position in the gas arena could prevent the Third Energy Package from achieving its greatest benefits for consumers. After all, what good is a more liberalized energy market, if 70 percent of all the gas traded within that market is imported from Russia and therefore based on the Kremlin's monopolistic pricing scheme?[16]

By increasing the amount of non-Russian gas traded within the CEE region, such as through shale gas, a real market for energy can begin to take shape. Greater options from a diversity of suppliers would invariably push the price of natural gas lower. With more supplies on the market, this would mean that the prices, which CEE consumers pay for gas, would begin to converge with those in Western Europe. According to one study by independent consultancies Poyry Management Consulting and Cambridge Econometrics, "Household spending on energy costs in the European Union could be lowered by as much as 11 percent by 2050."[17] In terms of Euros and cents, this possibility alone provides enormous incentive for CEE states to gear their energy policies to favor shale gas development, since it would mean better prices for consumers.

In addition to prices, the growth of shale gas resources in the CEE region would have the added benefit of limiting the long-term *take-or-pay* agreements that Russia's state-owned monopoly imposes on downstream consumers. These agreements require CEE states to purchase pre-determined quantities of gas at fixed prices from Russia over a multi-year period. If countries do not need or wish to purchase these amounts, they are nevertheless required to pay Russia for energy that was not used. While the terms of these agreements almost always favor Russia's financial interests over the interests of everyday consumers, CEE leaders often have little leeway to negotiate since the alternatives to Russian gas are so few. Once again, shale gas could change that

[16] Alan Riley, "Shale Gas – Central and Eastern Europe's Most Vital Energy Resource," *Central Europe Digest*, March 1, 2012.
[17] Poyry and Cambridge Economics, *Macroeconomic Effects of European Shale Gas Production: A report to the International Association of Oil and Gas Producers (OGP)*, November 2013, 3, http://goo.gl/7un8FE.

disparity. Clearly, Russia would continue to play an important role in providing the CEE energy space with natural gas. However, it would no longer enjoy a market-dominant position. This would empower downstream firms to not only negotiate a better deal on behalf of European consumers, but it would simultaneously help insulate countries from politically-motivated supply disruptions. On at least three occasions in the past ten years, the flow of natural gas to Europe has been halted as a result of geo-political financial disputes between Russia, Ukraine and Belarus. Should similar disruptions occur in the future, the CEE energy market would not be impacted by a shortfall due to the ability to use locally produced natural gas.

An additional, yet often overlooked, benefit of hydraulic fracturing can be found in the balance of trade. This has been particularly apparent in the case of the United States. Thanks to a dramatic reduction in gas and oil imports, fewer American dollars are now flowing overseas to pay for imported energy. This has put the U.S. trade deficit on a downward trend, most recently decreasing to 2.7 percent (as a percentage of GDP) in mid-2013. That figure represents a significant decline from America's record high deficit of 6 percent in 2006, before large-scale fracking got off the ground. While additional factors such as greater energy efficiency and slower economic growth contributed to some of the reduction, the major factor was America's increased gas and oil production from hydraulic fracturing. Looking forward, these trade benefits are likely to grow as the United States becomes a more important natural gas export nation and supplier of refined oil products to other industrialized states.

Higher employment levels are still another positive outcome of fracking. In the United States, economists estimate that the fracking revolution has been responsible for supporting a total of 1.7 million jobs (direct and indirect), thereby helping to pull the overall economy out of the deep 2008-2009 recession.[18] Importantly, most of these jobs (and related investments in infrastructure) have been created in rural areas where the effects of globalization and urbanization were particularly apparent. For example, states like North Dakota, Wyoming, Montana and Texas, all areas where energy development has been strongest, are also places where unemployment rates are all below the national average of 7.8 percent.[19]

High-value economic sectors are likewise beneficiaries of hydraulic fracturing. In the U.S. experience, shale gas has propelled growth in not only the energy sector, but the petrochemicals sector as well. In just a matter a years, the United States has become "the most attractive place in the world to invest in chemical manufacturing."[20] In fact,

[18] Jonathan Fahey, "U.S. May Soon Become World's Top Oil Producer," *AP*, October 23, 2012, http://goo.gl/dXzKpb.
[19] Ibid.
[20] Patrick Hurtson, "U.S. Chemical Industry Poised for Dynamic Expansion; Set to Outpace Overall U.S. Economy," American Chemistry Council, December 17, 2013, http://goo.gl/AQYnHY.

potential investments in the U.S. chemical industry connected to natural gas have topped $100 billion.[21] Drawn by America's lower energy costs, several large European firms such as German chemical giant BASF and privately owned French company SNF have already announced moves to the United States. The purpose of these shifts has been to benefit from America's lower-priced natural gas. For Europe, the economic advantages of developing shale resources inside the EU would be immense. If successful, some estimates predict that the growth in European energy-related employment could top between 400,000 and 800,000 jobs by 2035.[22] This is at a time when the EU's overall unemployment rate now hovers at around 12 percent. Beyond an expansion in the workforce, tax revenues from shale production could reach up to $2 trillion. Spending less on energy imports could also increase internal investments by as much as $262 billion between 2020 and 2035.

[21] Jennifer Scott, "U.S. Chemical Investment Linked to Shale Gas Reaches $100 Billion," American Chemistry Council, February 20, 2014, http://goo.gl/ZYmMK6.

[22] "EU Domestic Shale Gas Production Could Add a Million Jobs, New Study Shows," International Association of Oil and Gas Producers, November 25, 2013, http://goo.gl/OO1g9x.

Part II: Claims and Facts

With so many potential benefits to be gained from shale resources, the question becomes: What is holding Europe back?

While the answers to this question are many, one of the most prominent is the role that misconceptions and non-scientific information play in the European public debate on hydraulic fracturing. From a policy standpoint, surprisingly little attention is often given to the scientific data and best practices from the U.S. experience. Despite a limited-but-clean environmental record in Europe, and proven methods already being utilized in North America, a fear of fracking persists. It is for this reason that the following section considers some of the most repeated claims and unexamined assumptions in the CEE fracking debate. When considering if those claims conform to the best available data and on-the-ground experience of fracking, the report examines prominent—and contentious—topics, including: land surface impact, greenhouse gas emissions, fresh water consumption, ground and surface water contamination, earthquakes, and the risk of competitive disadvantages to renewable energy from shale gas.

(A) Land Surface Impact is the most visible aspect of hydraulic fracturing, since it is what most people see in areas that experience shale gas exploration and production. This includes any disturbance to the surface "that may impact visual landscape and wildlife habitats."[23] As seen from the U.S. experience, community concerns over land surface impact are often greatest in areas with high population densities, those that have little recent experience with oil and gas development, or both.[24] Hydraulic fracturing in the CEE region is more likely to occur in the vicinity of urban areas, unlike in North America, because population densities in this part of the world are notably higher than in the United States. It is for this reason that questions over surface impact is likely to be relevant for CEE communities.

Claim: *Hydraulic fracturing operations create land disturbances and habitat fragmentation due to the number of wells, equipment, roads, pipelines, trucks and waste storage sites necessary for drilling, extraction and production at each site*.[25]

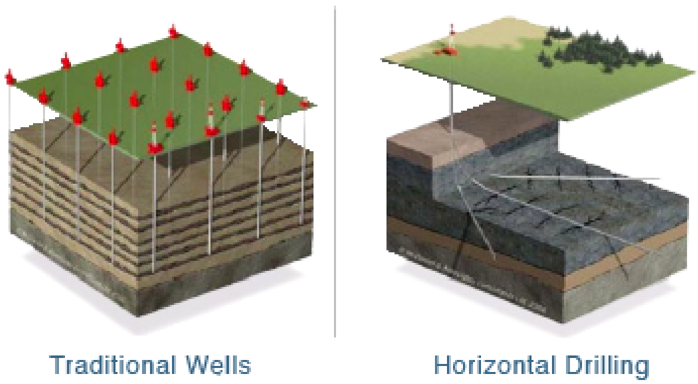
The visible alteration of landscapes is a reality that comes with any kind of energy development, be it coal mining, conventional or unconventional gas production – even

---

[23] U.S. Department of Energy, *Modern Shale Gas Development in the United States: A Primer*, April 2009, 37, http://goo.gl/fwYrf9.
[24] American Petroleum Institute, *Practices for Mitigating Surface Impacts Associated with Hydraulic Fracturing*, January 2011, vii, http://goo.gl/QkWze8.
[25] European Commission, AEA, *Support to the Identification of Potential Risks for the Environment and Human Health Arising from Hydrocarbons Operations Involving Hydraulic Fracturing in Europe*, August 2012, 31, http://goo.gl/nNoj4B.

solar and wind energy operations. In the case of hydraulic fracturing, land is invariably cleared and prepared for drilling, extraction and production. As seen in the United States, however, the advent of horizontal drilling has been a game-changer in limiting surface impact. Instead of conventional drilling methods, which require multiple locations, a single horizontal drilling pad can now replace up to sixteen traditional vertical wells.[26] This is known as a *multi-well pad*, and it has quickly become an industry norm.

Well Pad Drilling vs. Horizontal Drilling for Shale Gas Operations[27]



By drilling horizontally, engineers can reduce their surface footprint to a fraction of the size of a conventional operation – in many cases by as much as 90 percent.[28] Best of all, multi-well pads also reduce the number of trucks, roads, storage tanks and recycling or disposal equipment needed in fracking operations because travel between well sites is no longer required.[29]

However, not all land disturbances can be mitigated. In areas where these issues remain, dialogue between companies, local governments and their constituents now represent a critical dimension of energy development. Some state regulations in the United States now require all applications for drilling permits to be open to the public. Another formalized avenue of communication is the *community advisory board*, in which members of the public, local governments and industry regularly come together to identify and address environmental concerns like land disturbance issues. Moreover, the introduction of new technologies such as sound barriers, reusable access mats and low footprint rigs are further reducing surface disturbances. If similar best practices were

---

[26] U.S. Department of Energy, *Modern Shale Gas Development in the United States: A Primer*, ES-3.
[27] "Well Pad Drilling vs. Horizontal Drilling for Shale Gas Operations," America's Natural Gas Alliance, http://goo.gl/zf9jV2.
[28] "What is Hydraulic Fracturing?" Energy from Shale, http://goo.gl/j1dKpk.
[29] American Petroleum Institute, *Practices for Mitigating Surface Impacts Associated with Hydraulic Fracturing*, viii-ix.

Best Practices in Action: Community Advisory Boards

Energy companies involved in hydraulic fracturing across the United States have begun to recognize the benefits of industry-community dialogue in directly addressing fracking issues on the local level. One common channel of communication that might be considered for the CEE context is the "community advisory board." These boards are formalized structures that have encouraged a more transparent and balanced fracking debate, and have become the main forum for finding solutions to specific issues expressed by the community.

A case from Garfield County, Colorado can help visualize a community advisory board in action. The county's Energy Advisory Board (EAB) was established to bring together the public, landowners, local government and oil and gas companies under one roof to openly discuss local issues associated with fracking. The main purpose has been "to prevent or minimize conflict through positive communication and actions that encourage responsible development of resources." Monthly board meetings generally feature presentations by state or local experts on topics such as regional geology, local water or air quality studies, wellbore cementing and testing practices, just to name a few. Equally important, the board actively searches for solutions to problems expressed by the community. Resident complaints about noise, odor and traffic are tallied and openly addressed at each meeting. The community is also invited to discuss drilling permits as they are approved by the county, including traffic plans and the management of certain habitats for the protection of wildlife.

The EAB is also a medium for citizens and local organizations to engage in the state and local rule-making process. Members of the community have an opportunity to express concerns about draft bills or existing local laws on the environment and suggest changes that might better address their concerns. For example, Colorado state legislation on waste spills from industry activity requires all oil and gas operators to report spills to the local government and Colorado Oil and Gas Conservation Commission (COGCC) within 24 hours of discovery – particularly spills that are 20 barrels or greater. EAB members debated whether the legal requirement for reporting large spills should be done so immediately rather than within 24 hours, and if the requirement on the number of barrels spilled should be reduced from twenty to five. Beyond this discussion, the board also provided members with dates for public hearings and deadlines for the submission of written comments to the COGCC.

In light of the anti-fracking concerns which have been expressed in Poland, Ukraine or Romania, it is clear that more work needs to be done in building trust between the oil and gas industry, the public and local governments. An open, structured forum for dialogue can help do that. Regular updates about the progress of gas and oil exploration and production activities would also help boost transparency. By engaging citizens in open discussions with companies operating in the area about local fracking developments, community advisory boards can help establish trust and common ground in finding solutions to local concerns about planned or ongoing shale operations.

See: Garfield County, Energy Advisory Board information, 2014, http://goo.gl/NLMgOu.

implemented in a CEE setting, the resulting impact on nearby, high-density communities could be significantly mitigated.

(B) Greenhouse Gas Emissions (GHGs) and volatile organic compounds (VOCs) are a second consideration when assessing the impact of shale gas exploration, production and use. For starters, the push to limit GHGs in the atmosphere is a primary goal of the EU's current strategy for mitigating climate change.[30] Meanwhile, it is entirely understandable that local communities would wish to limit VOCs like benzene, sulfur dioxide, carbon oxide, and nitrogen oxides in the air. Importantly, both issues are linked to the benefits of hydraulic fracturing, and some of the best-available scientific studies on the topics are encouraging. What's more, the overall impact on air

[30] European Commission of the European Communities, *Package of Implementation Measures for the EU's Objectives on Climate Change and Renewable Energy for 2020*, January 2008, http://goo.gl/XDht41.

quality is especially relevant for the CEE context. First, high population densities in the region mean that fracking operations are likely to take place in close proximity to cities and townships. At the same time, this region has more fossil-fuel driven economies than in Western Europe. That much could change for the CEE region if large volumes of shale gas became available.

Claim: *Hydraulic fracturing is responsible for releasing dangerous amounts of GHG and VOC emissions into the air, particularly methane.*

A common point of contention in the debate over shale gas is that hydraulic fracturing is bad for air quality.[31] Some critics go so far as to assert that the process has a greater greenhouse gas footprint than coal because of the allegedly high rate of methane leaks at fracking sites.[32] What emerges from a science-based assessment is that improvements in air quality make for a compelling argument *in favor* of shale gas, rather than against.

As with nearly all human activities—including hydrocarbon production—some pollution is essentially unavoidable. Generators at well pads require fuel to operate. The same is true for transport trucks that move supplies to and from fracking locations. The release of carbon dioxide through internal combustion is one result of these efforts. That impact is minor, however, when compared to the overall improvement in air quality that results from making large quantities of lower-cost, lower-carbon, lower-polluting natural gas available to consumers. In the case of the United States, the shale gas revolution has injected vast amounts of natural gas into the country's energy market. This has made domestically-produced natural gas a more attractive energy source than higher-polluting fuels like coal.

Fossil Fuel Emission Levels (Pounds per Billion Btu of Energy Input)[33]

Pollutant	Natural Gas	Oil	Coal
Carbon Dioxide	117,000	164,000	208,000
Carbon Monoxide	40	33	208
Nitrogen Oxides	92	448	457
Sulfur Dioxide	1	1,122	2,591
Particulates	7	84	2,744
Mercury	0.000	0.007	0.016

[31] European Commission, AEA, *Support to the Identification of Potential Risks for the Environment*, 39.
[32] Robert W. Howarth, Renee Santoro and Anthony Ingraffea, *Methane and the Greenhouse-Gas Footprint of Natural Gas from Shale Formations*, April 2011, http://goo.gl/26NUWt.
[33] U.S. Energy Information Administration, "Natural Gas Issues and Trends 1998," in NaturalGas.org, http://goo.gl/Mgmz.

For communities that wish to breathe cleaner air, natural gas is preferable to other hydrocarbons, since it produces less carbon dioxide, carbon monoxide, nitrogen oxides and sulfur dioxide. This is equally true for unhealthy toxins and particulate matter like arsenic, beryllium, chromium, lead, nickel and radium – as in the case of coal. Since 2007, carbon dioxide emissions in the United States have fallen by 12 percent – more than any other industrialized nation in the world. Thanks in large part to the steady replacement of natural gas in the production of electricity, overall U.S. air quality has been on the rise.[34]

The remaining question therefore revolves around methane. Specifically, how much is released into the atmosphere due to fracking? This issue is important, since methane is 21 times more potent than carbon dioxide as a GHG. Once again, the science-based data is encouraging. In fact, a growing number of comprehensive tests throughout the United States, including by respected environmental groups, conclude that "shale-gas related hydraulic fracturing does not significantly change the overall level of methane emissions that escape from the natural gas system." That last finding was produced by a 2010 study at the Massachusetts Institute of Technology (MIT), which used data on methane emissions from 4,000 hydraulically-fracked wells from five shale basins across the United States. A recent high-profile study by the University of Texas also found that the leakage of methane was far below the threshold that would make coal a more attractive fuel source than natural gas (due to its potential impact as a GHG). Best of all, these findings were consistent with other assessments conducted by Cornell University and Carnegie Mellon University.[35]

The numbers also show that methane emissions in the United States have dropped drastically. The EPA's newest Greenhouse Gas Inventory report (February 2014) reveals a 17 percent decrease in methane emissions in the United States since 1990. Indeed, methane emissions from the field production of natural gas dropped by a staggering 40 percent, even as natural gas production increased by 26 percent since 2006. The change is accredited to the growing use of best practices in hydraulic fracturing such as reduced emission completions (RECs) and increased regulation on emissions.[36] While the process of evaluation is still on-going, what emerges from these studies is that initial concerns about the release of methane have not been validated by facts.

[34] U.S. Environmental Protection Agency, *Air Quality Trends*, http://goo.gl/WK3gQX.
[35] "Landmark Study: How High is Methane Leakage?", Shale Gas Europe, September, 26, 2013, http://goo.gl/3TILna; "Study: 'Fugitive' Methane from Shale Gas Production Less than Previously Thought," Massachusetts Institute of Technology, November 29, 2012, http://goo.gl/CWKjKP; "Cornell Researcher Rebuts Colleagues on Fracking Leaks," *Bloomberg Businessweek*, July 10, 2012, http://goo.gl/kLk39N; Mohan Jiang, W. Michael Griffin, Chris Hendrickson, Paulina Jaramillo, Jeanne VanBriesen and Arayana Venkatesh, "Life Cycle Greenhouse Gas Emissions of Marcellus Shale Gas," *Environmental Research Letters* (July-September 2011) http://goo.gl/9z1CDT.
[36] Katie Brown, "New EPA Data Shows Continued Decline in Methane Emissions," *Energy in Depth*, February 24, 2014, http://goo.gl/J2kIh3.

Viewed from a CEE perspective, the positive benefits of shale gas on air quality could be substantial. Most importantly, hydraulic fracturing could help the EU achieve its goals of reducing the amount of GHGs that Europeans pump into the atmosphere each year. The bad news is that the current trend inside the EU is moving in the opposite direction. Despite their best intentions to switch to lower- and zero-carbon fuels, Europeans are actually burning more coal than in previous years. With few low-cost options to choose from, overall EU coal consumption increased by as much as 4.1 percent in 2010, and 3.3 percent in 2011.[37] Worse yet, between 2010 and 2012, gas-fired power generation in Europe actually decreased by 25 percent, while reliance on coal-fired plants increased by 10 percent during the same period. This trend is a serious concern in parts of the CEE region, where reliance on thermal fuels like coal and wood remains high.[38] If best practices in hydraulic fracturing were implemented in a CEE setting, these countries could begin replacing the use of coal and lignite in power plants with domestic sources of natural gas. This would substantially help to bring regional air quality closer to EU standards. If done right, the CEE example of safe natural gas production might also encourage wider use of hydraulic fracturing in Germany, France and elsewhere in Europe.

(C) Freshwater Consumption is a third consideration that often arises in the debate over shale gas. In simplest terms, water represents the "hydraulic" competent of hydraulic fracturing. Importantly, each shale gas well is different; and the amount of water used in the hydraulic fracturing process often depends on specific geologic considerations.[39] Nevertheless, hydraulic fracturing typically requires large sources of fresh water to extract unconventional gas from underground shale formations. When communities consider the potential impact of hydraulic fracturing, they often ask how it might affect fresh water supplies and nearby wildlife.

Claim: *Hydraulic fracturing operations are responsible for "overstressing fresh water supplies."*[40]

Once again, the numbers are illuminating. It turns out that the amount of freshwater used for fracking is relatively low when compared to other sources of energy such as coal, nuclear, oil and bio fuels.

[37] "Coal Consumption Statistics," European Commission, Eurostat, http://goo.gl/tPcL1M.
[38] Danny Hakim, "Bulgaria's Air is Dirtiest in Europe, Study Finds, Followed by Poland," The New York Times, October 15, 2013, http://goo.gl/z44hvQ.
[39] American Exploration and Production Council, *The Real Facts About Fracture Stimulation: The Technology behind America's New Natural Gas Supplies*, in Energy in Depth http://goo.gl/Ib0xWa; "Gasland: Getting the Facts Straight," Shale Gas Europe, http://goo.gl/nI0bzi.
[40] "Gasland: Getting the Facts Straight," Shale Gas Europe.

Liters of Water Consumed for Various Sources of Energy[41]

Production of Energy Source	Liters of Water Consumed per 1mmBTU (per million British Thermal Unit)
Shale gas	4-6
Coal	8-120
Uranium	30-80
Oil	30-9,500
Bio fuels	9,500-higher

For any given well in the United States, the amount of water used in the fracturing process can be as little as 100 thousand gallons to as much as 6 million gallons for a single well. Overall, hydraulic fracking in America accounts for roughly 0.3 percent of total freshwater consumption.[42] This is 20 times less than the amount of water Americans used for landscape irrigation in 2011, and vastly less than all water used in the United States for the generation of electricity from coal, natural gas and nuclear (also known as thermoelectric power) each year.[43] But if the amount of water that Americans use for hydraulic fracturing is relatively low at the country level, what does this look like the local level?

A comparable equivalent to the CEE region can be found in the example of Pennsylvania. This state has a relatively high population density and it is home to some of the most intensive shale gas operations in the country. Yet even here, water consumption from fracking amounts to less than one percent of Pennsylvania's daily water usage.[44] Elsewhere, in more arid states like Texas, less frequent rainfall can heighten the impact of fracking operations during droughts. It is for this reason that new methods for reducing the use of fresh water are becoming a common practice in the industry. These include economically-sensible techniques for recycling fracking fluid or substituting untreated sea water or underground brackish water instead of fresh water. This lessens the demand on local water resources and minimizes the impact of energy exploration on the local environment.

When it comes to CEE shale gas extraction, this region's wells could require between 11,000 to 19,000 m^3 of water, equal to 2-5 million gallons.[45] Since some CEE shale

[41] International Gas Union, *Shale Gas: The Facts about the Environmental Concerns, 2009-2012 Triennium Work Report*, June 2012, in *The Impact of Shale Gas Extraction on the Socio-economic Development of Regions* by Izabela Albrycht et al., 82-83. (Krakow: The Kosciuszko Institute, 2012.)
[42] Jesse Jenkins, "Energy Facts: How Much Water Does Fracking for Shale Consume?" The Energy Collective, April 6, 2013, http://goo.gl/ugZhi.
[43] David Blackmon, "Water for Fracking, In Context," Forbes, July 1, 2013, http://goo.gl/YYTME.
[44] "How Water Usage Stacks Up," Range Resources, http://goo.gl/Z6lJHG.
[45] International Gas Union, Shale Gas: The Facts about the Environmental Concerns, 2009-2012 Triennium Work Report, June 2012, in The Impact of Shale Gas Extraction on the Socio-economic Development of Regions by Izabela Albrycht et al., 82.

Best Practices in Action: Reducing Fresh Water Consumption

There is consensus between the oil and gas industry and environmental groups that the amount of fresh water used in hydraulic fracturing operations should be, and could be, reduced. Although the total amount of fresh water used for fracking is small compared to other water-intensive industries, new water-saving practices are becoming more common. Fresh water alternatives would be particularly relevant to the CEE context, as shale plays are at times deeper underground compared to the United States, and fresh water might be scarcer and more expensive in highly populated areas. The price for transporting and utilizing fresh water for fracking operations in the CEE region is estimated to be 10 times higher than in the United States due to low water supplies and the large distance between fresh water sources and shale basins.

Sea water or underground, non-potable brine (or brackish) water are becoming common substitutes for fresh water in fracking fluid. And these substitutes address more than just the fresh water consumption issue. An added benefit is the reduction of chemical additives used in fracking fluid, such as sodium chloride, which is replaced with natural salts. In drier climates like Texas, the use of underground brine is quickly gaining traction. Rather than transporting fresh water over long distances, or draining water from local sources like rivers and lakes, some companies have been drilling for non-potable brine for use directly on-site. In fact, out of all fracking operations conducted by the Marathon Oil Company in the Eagle Ford basin in Texas, 97 percent of water used is underground brine. The trend is certainly growing outside of Texas as well. In 2011, more than 5 billion out of 26.6 billion gallons of water used in fracking jobs in the United States came from recycled or brackish water.

Apache is another global oil and gas company that regularly substitutes fresh water for alternative sources – in this case, produced water. Produced water is the water that is released from deep underground during oil and gas extractions. Laden with natural salts, sand and silt, the produced water must be filtered before reuse. At times, Apache supplements produced water with underground brackish waters, or brine, if more water for fracturing fluid is needed. In fact, on a global scale, 95 percent of all Apache fracking operations use recycled water or a combination of produced and underground brine. The combination of recycling fracturing fluid, sea water and non-potable underground brine would greatly reduce fresh water consumption and the cost of fracking in CEE operations.

See: “Recycling Water for Drilling Operations,” Apache Corporation, http://goo.gl/w92Yif; David Blackmon, “Recycling Water for Drilling Operations, in Context,” Forbes, July 1, 2013, http://goo.gl/YYTME; Kathy Wythe, “Experts Examine the Contentious Issue of Hydraulic Fracturing Water Use,” Texas Water Resource Institute, Winter 2013, http://goo.gl/Ql7z9R.

plays are 1.5 times deeper than those in the United States, more water is likely to be used during the hydraulic fracturing stage. Also, as fracking is more likely to occur in the vicinity of highly populated areas compared to the United States, the issue of water consumption for fracking may understandably become a very sensitive issue for local governments and their constituents. Fresh water-saving practices such as recycling and the use of non-potable underground brine water are becoming a common practice in the United States. It should also be considered for CEE geological conditions and population densities.

(D) Water Contamination is a fourth area of consideration in the public debate over hydraulic fracturing. In many ways, it is the most contentious. Communities that are home to hydraulic fracturing must consider the risk that chemical additives from fracturing fluid or dissolved hydrocarbons could find their way into the water that people drink – possibly through underground fractures, poorly constructed wells or surface spills.

Claim: *Fracturing fluid contains over five hundred chemicals.*

Hundreds of types of chemicals may be used to create fracturing fluid, but only a small fraction of those chemicals is actually needed for each fracking operation.[46] A universal rule is that each shale rock formation is different. As a result, the chemical make-up of fracturing fluid for one well may not work for another. In practice, the range of additives used for a single fracking operation averages between 3 and 12 in number. They make up about 0.5 percent of the fluid's components. The other 99.5 percent is water and sand. Currently, more than 75 percent of the materials used in traditional fracturing fluid are proven environmentally safe. These include additives such as sodium chloride, potassium chloride and diluted acids. Many of these ingredients are also found in common household items, such as cleaners, candy, cosmetics, antiperspirant, table salt, flavoring, toothpaste, plastics and disinfectants.[47] On the other hand, some additives such as such as benzene, ethylene glycol and naphthalene are used. It depends on the geology of a well. Yet even in these cases, industry practices are now replacing old ingredients with green alternatives.

Claim: *Oil and gas companies do not reveal the chemicals used in fracturing fluid.*

This is a common claim that would appear to conflict with fact. Local regulations on the disclosure of chemicals are typically controlled at the state level; and the disclosure of chemicals is currently a legal requirement for the majority of U.S. states that are home to fracking operations. Moreover, information on the types of chemical additives used at individual wells across the United States is becoming readily available to the public as chemical disclosure registries grow.[48] Frac Focus is one established registry created by the Ground Water Protection Council (GWPC) and Interstate Oil and Gas Compact Commission (IOGCC) to help facilitate the release of information regarding specific wells by energy companies. This kind of reporting and information disclosure represents one of the many U.S. best practices that could be applied to a CEE context. For example, the EU's existing REACH Regulation (Registration, Evaluation, Authorization and Restriction of Chemical Substances) calls for the identification of chemical substances used by manufacturers and importers—including the energy sector—and registration of chemicals in a central database managed by the European Chemicals Agency (ECHA).[49] Such resources can and should be available to European citizens.

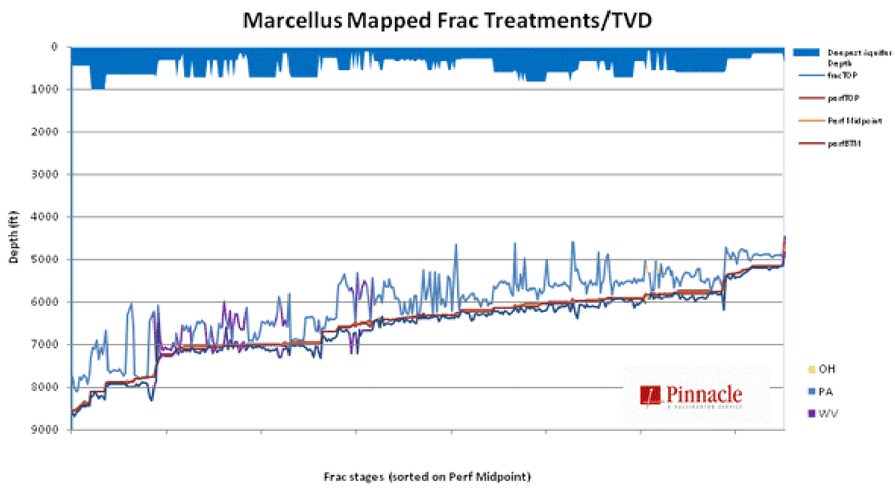
Claim: *Fracturing fluid or methane could migrate into groundwater through underground fractures.*[50]

---

[46] "What Chemicals are Used," Frac Focus Chemical Disclosure Registry, http://goo.gl/W3KFg.
[47] American Exploration and Production Council, *The Real Facts About Fracture Stimulation: The Technology behind America's New Natural Gas Supplies*.
[48] "Shale Gas: New Opportunities, New Challenges," Bipartisan Policy Center, January 2012, http://goo.gl/UJ1KFT.
[49] "Environment: REACH," European Commission, January 2013, http://goo.gl/psiHzv.
[50] Natural Resource Defense Council, *Water Fact Sheet: Hydraulic Fracturing Can Potentially Contaminate Drinking Water Sources*, July 2012, http://goo.gl/GWUbTz.

In the United States, wells are drilled at an average depth of 1.5 miles, or between one and three kilometers and inevitably must pass through groundwater aquifers. These sources of drinking water are located about one hundred meters to three hundred meters underground.[51] According to various studies, and a majority of state regulatory agencies in the United States, there has not been a single case of drinking water contamination linked to hydraulic fracturing.[52] In fact, the probability of groundwater contamination as a result of hydraulic fracturing is as low as one in 200 million – or as low as one's chances of getting struck by lightning.[53] Geophysical measurements show that shale rock is fractured at a distance from which it would be impossible for fracking fluid to reach groundwater aquifers. As seen by the data in the associated graph, thousands of feet separate the deepest drinking water aquifers from the largest fractures.

Distance between Deepest Groundwater Aquifer and Fractures from Hydraulic Fracturing[54]



*Measurements taken from fracking operations in Ohio, Pennsylvania and West Virginia.

Accounts of methane found in fresh water wells are also often blamed on fracking. Yet countless tests conducted on water wells located close to fracking sites throughout the United States have consistently demonstrated that naturally occurring methane—not

[51] American Exploration and Production Council, *The Real Facts about Fracture Stimulation: the Technology behind America's New Natural Gas Supplies*.

[52] "Hydraulic Fracturing Fact Sheet," Chesapeake Energy Corp, May 2012, http://goo.gl/goCViS; "Hydraulic Fracturing: A Safe, Proven Technology Studied for Decades by Multiple Agencies," Range Resources, http://goo.gl/O4HDhj; "State Regulators on Hydraulic Fracturing, *Energy in Depth*, http://goo.gl/tvbMvm; Jon Baker, "Study in Carroll Shows Fracking Has No Impact on Water Quality," *Times Reporter*, November 15, 2013, http://goo.gl/lRUUnX.

[53] "Hydraulic Fracturing Fact Sheet," Chesapeake Energy Corp.

[54] "Hydraulic Fracturing: The Process," Frac Focus Chemical Disclosure Registry.

shale development—is responsible for most instances of groundwater contamination. This *biogenic* methane comes from the decay of organic matter found in shallow geological formations where some water wells are found. Methane that is not naturally found near ground water formations, known as *thermogenic* methane, is located in deeper layers of rock like shale, and can only be produced by drilling for oil or gas.[55] The migration of thermogenic methane into drinking water would thus be the result of shale drilling activity. If water contamination occurs, geologists could verify the difference between the two types of methane and determine the cause through the detection of specific isotopes and traces of other hydrocarbons. Though there have been a few cases of thermogenic methane contamination of groundwater, they are much less common and almost always caused by a poorly constructed water well. Cases of biogenic methane in drinking water are much more widespread. For example, historical records in the Marcellus shale in Pennsylvania verified the presence of naturally occurring methane in water supplies well before any drilling had even begun.[56]

Another contested claim made by fracking critics is that shale fractures could cross paths with existing fractures, faults and old wells. These scenarios have long been avoided with the regular use of sophisticated mapping methods. *Geological mapping* is a critical step in the shale gas exploration process for the very purpose of identifying natural fractures and fault lines in geological formations. Once the fracking process begins, three-dimensional models of subsurface geology and *micro seismic monitoring* technologies allow operators to observe the growth of each fracture underground as hydraulic fracturing is in progress.[57]

Regulation and industry management also play a critical role in the protection against possible underground water contamination. Analysts in both the United States and Europe agree that inadequate well casings pose greater risks to groundwater contamination than underground fractures. Fracking fluid and wastewater spills from well sites into surface water are also more likely to cause contamination than underground fractures. Measures taken by industry and state regulatory agencies to ensure the integrity of well construction include testing and monitoring of the steel and cement casings. The combination of basic precautions, increased regulation and regular use of advanced technologies are actively addressing and reducing environmental issues, and are already being applied in exploration activities in Poland.

---

[55] State of Colorado Oil & Gas Conservation Commission, Department of Natural Resources, http://goo.gl/t641J.
[56] Ibid; John Krohn, "Study: Naturally-Occurring Methane 'Ubiquitous' in NE PA Groundwater," June 3, 2013, http://goo.gl/nMFaEO.
[57] Natural Resource Defense Council, *Water Fact Sheet: Best Practices for Avoiding Water Contamination Related to Hydraulic Fracturing*, 3.

Best Practices in Action: Wastewater Management

The most common method for wastewater disposal from hydraulic fracturing operations in the United States is the injection of wastewater into deep underground wells. These wells are cased in steel and cement and later sealed when full so that the fluids cannot escape. However, geology is not always suitable for the drilling of underground injection wells, as in Pennsylvania. As more wells in the Marcellus are fracked each year, existing treatment facilities have become overwhelmed with the processing of hundreds of millions of gallons of wastewater each year. This also leaves countries like Poland and Romania with limited options in managing wastewater when shale drilling operations commence. Many of the wastewater management practices currently in action in Pennsylvania could very well be applied to the CEE context. Acknowledging the problem, the oil and gas industry has begun using new practices to help alleviate treatment backlog at existing and new facilities. Similar to Pennsylvania, the underground injection of wastewater is not common practice in Europe.

A common and low cost option for managing wastewater is to reuse, or recycle, the water at the same well pad or at nearby fracking operations. Typically there are six to ten wells per pad, so recycling wastewater from one well to the next makes economic sense. Some dilution with fresh water or partial filtration of the wastewater may be required, but recycling reduces the overall amount of waste generated from fracking. Partial treatment of wastewater usually involves the evaporation or crystallization of salts, and can be done on-site with portable equipment known as “mobile water treatment facilities” at low cost.

Mobile treatment options reduce the risk of spills that might occur from the transportation of water to treatment facilities, especially in more remote drilling locations. Operators also have the offsite option of using wastewater recycling services, in which treated water is later returned onsite for reuse. When wastewater is unable to be recycled any further, it must be fully treated and discharged into local waterways. In the case of Pennsylvania, regulators have stopped accepting wastewater at public treatment facilities because they are not well-equipped to sufficiently treat high concentrations of total dissolved solids (TDS). At the very most, public facilities can accept partially treated wastewater from private treatment facilities for processing and discharge.

Pennsylvania’s unique conditions have pushed the industry to develop much needed wastewater practices that would prove greatly beneficial to regions experiencing similar limitations like CEE states. In addition to addressing the reduction of wastewater generation and fresh water consumption, recycling and wastewater treatment offer enormous potential for the development of private treatment services that would add to job growth in various communities in Poland, Romania and throughout Europe.

(E) Risk of Earthquakes or seismic activity is the fifth consideration in the debate over the environmental impacts of fracking. This risk applies to the fracking phase of hydrocarbon extraction and the injection of wastewater into underground wells for final disposal. At times, earthquakes are recorded close to fracking sites. Since high pressure is used to pump thousands and gallons of water underground, critics have attributed the cause of these underground tremors to fracking. The same has been said of underground injection wells – the final resting place of wastewater from fracking.

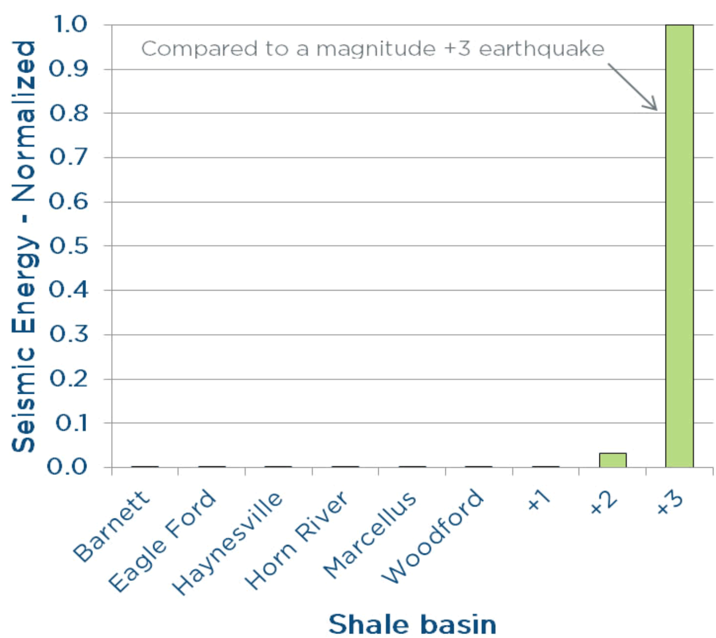
In the CEE context, the underground injection of wastewater is prohibited by the European Union unless the water is free of pollutants.[58] In the absence or limitation of such underground disposal options, as in Pennsylvania and CEE, other methods of wastewater disposal such as recycling and treatment and disposal into local waterways are growing industry alternatives.

[58] European Commission, *Impact Assessment: Exploration and Production of Hydrocarbons Using High Volume Hydraulic Fracturing in the European Union*, January 22, 2014, http://goo.gl/IySBHo.

Claim: *Hydraulic fracturing causes mini earthquakes, and is particularly dangerous if fracking occurs near an active fault line.*[59]

During the fracking phase, fracturing fluid is injected underground at very high pressure to crack shale rock and stimulate the release of natural gas or oil. Though this may be responsible for limited underground seismic activity, it is usually undetectable by humans and does not pose a threat to surrounding communities or habitats. In fact, only 3 out of 198 published examples of induced seismicity known to be felt by humans in the United States, Canada and the United Kingdom have been linked to shale gas extraction. In most instances, seismic activity resulting from fracking produces "2,000 times *less* energy than a magnitude 3.0 earthquake".[60] A recent study published by Durham University in the UK also notes that the seismic activity induced by hydraulic fracturing is minimal in comparison to other man-made triggers such as mining, geothermal activity and reservoir water storage.[61] To put this into perspective, "most fracking related events release minor amounts of energy that is roughly equivalent to...someone jumping off a ladder onto the floor."[62]

Measured Seismic Energy of U.S. Shale Basins[63]



[59] "Concerns with Hydraulic Fracturing," Watershed Council, http://goo.gl/8iFhkC.
[60] American Petroleum Institute, *The Facts About Hydraulic Fracturing and Seismic Activity*, http://goo.gl/j0ah3I; American Petroleum Institute, *Injection Wells and Induced Seismicity*, http://goo.gl/nWsQqm.
[61] Nidaa Bakhsh, "Fracking Doesn't Cause Significant Earthquakes, Study Says," *Bloomberg*, April 10, 2013, http://goo.gl/Ql5heT.
[62] Matt McGrath, "Fracking 'not significant' cause of large earthquakes," *BBC News*, April 9, 2013, http://goo.gl/Ra8P1.
[63] American Petroleum Institute, *The Facts About Hydraulic Fracturing and Seismic Activity*.

(F) Risk of Competitive Disadvantage of Renewable Energy as a direct result of shale gas is the final point of contention often used by critics in the fracking debate. This is a particularly sensitive issue for environmentalists. To that point, renewable energy makes up a significant portion of the EU's current climate and energy policy. Once the production of shale gas became economically viable in the United States, it allowed for a large, cheap supply of natural gas to become available to the domestic energy market. At the same time, the development of renewable energy has been considered generally more expensive in comparison to natural gas. Allegations have arisen that renewables are now a less attractive source of energy, and as a result, investment and production in this sector will decline. In actuality, the opposite trend in energy production has emerged.

Claim: *The low cost and new abundance of domestic natural gas will put renewable energy (solar, wind, geothermal and hydro) at a competitive disadvantage*.[64]

The production of renewable energy is rising around the world. The United States, Japan and China have collectively quadrupled solar energy generation between 2010 and 2012.[65] In fact, solar was the fastest growing sector of the energy industry in California in 2012, making it the top state for solar power deployment in the United States.[66]
In the same year, wind installations in the United States rose by 12.3 percent, making the United States the world's top wind energy producer.[67] The cost of renewables is also showing signs of increasing affordability. For example, the cost of some types of solar panels has decreased as much as 60 percent in the last two years.[68] Though investment in renewable energy has fluctuated, the upside is that production has not slowed. For example, global solar production increased by 26 percent in 2013 although investments in that sector declined by 23 percent.[69] According to the U.S. EIA, renewable energy production rose by nearly 24 percent from 2009 to 2012, surpassing energy produced by nuclear power plants.[70]

---

[64] "Renewable Energy," University of Colorado Environmental Center, http://goo.gl/APFz14; Meagan S. Mauter, Vanessa R. Palmer, Yiqiao Tang, and A. Patrick Behrer, *The Next Frontier in the United States Shale Gas and Tight Oil Extraction: Strategic Reduction of Environmental Impact*, Harvard Kennedy School, Belfer Center for Science and International Affairs, March 2013, http://goo.gl/gkEup5.

[65] Eberhard Rhein, "Solar and Wind Energy Keep Booming," *Blog Active*, March 25, 2013, http://goo.gl/Fu5GMj.

[66] Mark Anderson, "California Ranks First in Solar Installations," *Sacramento Business Journal*, April 19, 2013, http://goo.gl/ejMGE5.

[67] Ryan Koronowski, "We're Number One: U.S. Installed Most Wind Power in 2012, U.S. Company GE Wind is #1 Supplier," Climate Progress, March 27 2013, http://goo.gl/NOJcv6.

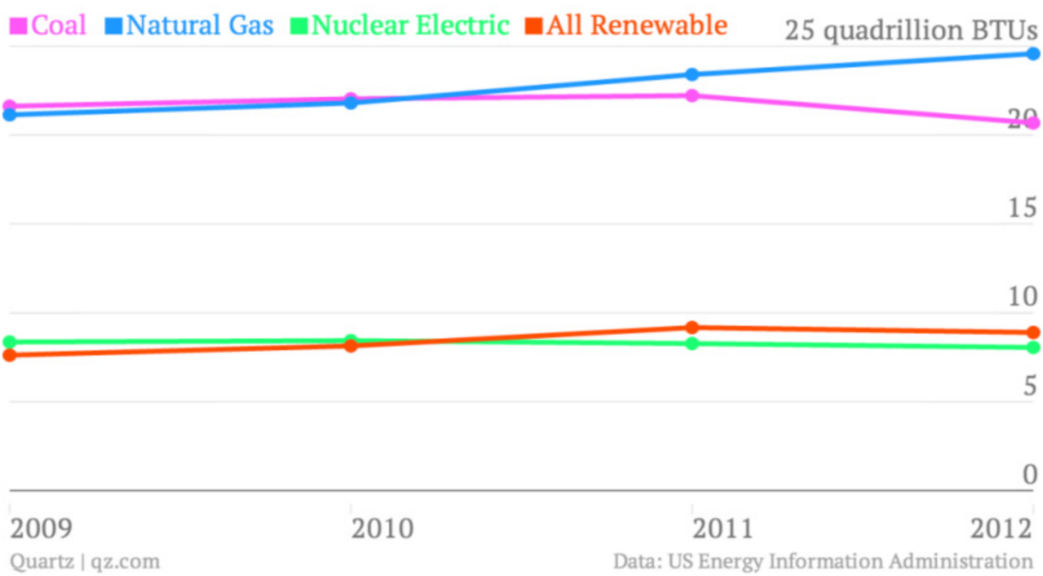
[68] Anthony DiPaola, "Shale-Gas Boom Can Complement Renewables to Cut Coal, IRENA Says," *Bloomberg*, January 10, 2013, http://goo.gl/5gw4Ke.

[69] Wendy Koch, "U.S. Wind Industry Slammed by Tax Uncertainty, Fracking," *USA Today*, April 10, 2014, http://goo.gl/4103qE.

[70] Todd Woody, "U.S. Renewable Energy Production Now Tops Nuclear Power," *National Journal/Quartz*, April 1, 2013, from U.S. Energy Information Administration, "Energy Production 2009-2012," http://goo.gl/7CQ1Q2.

Renewable energy has become an important component in the EU's Energy Roadmap, but the U.S. example has shown that simultaneous growth of both energy sectors is entirely possible. What critics of fracking also fail to recognize is that the production of natural gas and renewable energy are complementary in achieving the goal of gradually reducing carbon emissions in both the United States and Europe. The data confirms Europe does not have to give up the drive toward renewable energy for natural gas.

U.S. Energy Production, 2009-2012[71]



[71] T. Woody, "U.S. Renewable Energy Production Now Tops Nuclear Power."

Part III: The Risks of Hydraulic Fracturing and the Promise of Best Practices

Utilizing scientific evidence, the previous section demonstrated how several claims about the dangers that fracking could pose to communities, natural habitats and human health can be exaggerated. At the same time, risks from fracking continue to exist and should be addressed by governments, citizens and the energy community. Thanks to technological innovations and local regulations, we have witnessed progress. For example, the number of accidents or environmental violations at fracking sites in the Marcellus shale basin in Pennsylvania has been reduced by 60 percent in the last three years alone – demonstrating both progress and the continued need for improvement.[72] In what ways are companies, governments and citizens actively reducing these risks?

This is where best practices in hydraulic fracturing come into play. The development of new technologies and the implementation of specific environmental regulations are rapidly growing in the United States and will be integral to CEE countries, which are now beginning to explore for shale gas. As more wells are fracked, best practices are responsible for the curbing of fugitive greenhouse gas emissions and land surface impact, and encouraging the regular recycling of fracking fluid, the improvement of well integrity, and the responsible management of spills and leaks. Industry and governments are also beginning to regularly address unique local issues and involve the public. This is equally critical for maintaining environmentally responsible hydraulic fracturing operations.

A wealth of government, academic, industry and independent research from the United States on the quality of air, water and land offers insight into the best technologies and regulations in practice that are helping to protect the environment and keep the public safe from fracking's potential risks. U.S. efforts are recognized by the European energy community and there is hope that U.S. best practices will be utilized on European soil in the near future. Yet, while U.S. efforts are lauded, elements within the European Union (EU) Directorate General for Environment have actively tried to ban fracking (so far unsuccessfully) on the EU level and to push through legislation that would legally hinder industry progress on fracking in Europe.[73] Without a balanced, science-based debate in Europe, best practices from the U.S. experience will continue to be pushed aside, reducing the chances for greater energy security and economic development in countries like Poland, Romania and Ukraine.

---

[72] Timothy Considine, Robert Watson, Nicholas Considine and John Martin, *The Environmental Impacts during Marcellus Shale Gas Drilling*, Shale Resources and Society Institute, May 2012, http://goo.gl/0etCPB.
[73] Tim Ross, "EU Plan for Fracking Law Threatens UK Shale Boom," *UK Telegraph*, December 15, 2013, http://goo.gl/1jRjIN.

(A) What are Best Practices?

In broad terms, the International Energy Agency (IEA) defines the "golden rules" of unconventional oil and gas exploration and production as "full transparency, measuring, monitoring, controlling environmental impacts and sustained engagement." More specifically, best practices in hydraulic fracturing are new conventions in technology and government regulation designed and implemented specifically to address and reduce the risk of environmental issues (the stripping of topsoil, methane leaks, wastewater spills, etc.). Technologies include innovative equipment or devices, such as portable treatment systems for the filtration of fracking wastewater so that it can be reused for another fracking site. Regulations – at the national and local levels – are instigators for the widespread implementation of these new technologies. For example, permit requirements for the use of diesel engines for drilling and compressor stations at fracking sites in Pennsylvania have strict limits on greenhouse gas emissions. This has led companies to develop a natural gas fired engine to cope with these lower emission standards. Regulation also helps maintain the responsible management of well sites through the regular use of precautionary measures throughout the fracking process. For example, fracking operators are legally required to conduct underground surveys and environmental evaluations before any drilling begins in many U.S. states and some EU countries.

Though the industry and regulators in the United States are still striving to put all of the "golden rules" of fracking into practice, these rules will be crucial to gaining public trust and more widespread approval of hydraulic fracturing in Central and Eastern Europe. As exemplified in the U.S. experience, the oil and gas industry is making a notable effort to upgrade technologies and adhere to regulations. But success also greatly depends on the standard involvement of, and cooperation with, governments, regulatory agencies and communities. All parties have an interest in ensuring the safety of the environment and public health. Mutual assurance to the regular execution and enlargement of best practices in hydraulic fracturing can only help CEE policymakers in reaching these goals, and those of energy independence and greater economic growth.

One of the most critical elements to the success of hydraulic fracturing in the region is the establishment of a regulatory framework on shale gas exploration and production. Individual CEE regulations and tax laws on unconventional energy operations are either waiting for government approval, as in the case of Poland, are still in draft stage, or are largely undeveloped. While specific CEE regulations are currently lacking, an EU framework for conventional hydrocarbon extraction already exists. The European Commission has stated that the current combination of EU and national legislation,

Best Practices in Action: Center for Sustainable Shale Development

In Europe and the United States, the debate over the use of hydraulic fracturing for domestic energy production has given way to the assumption that the differences between industry and environmental group interests are irreconcilable. Though not banned at the EU level, fracking moratoria were imposed in France, Bulgaria and the Czech Republic in part because of the influence of environmental groups and green parties. Even in pro-fracking countries, public protests against the procedure have made it hard for groups to negotiate. Finding middle ground at the European Union and national policy levels has so far proven difficult, but it is not an impossible feat. The Center for Sustainable Shale Development (CSSD) in Pittsburgh, Pennsylvania is an emergent example of how voluntarily bridging the gap is feasible and more manageable at the regional level.

Under the direction of CSSD, regular and constructive dialogue between industry and environmental groups established common ground, agreeing that if fracking is here to stay, then it should be done responsibly and performed with the highest environmental safety standards. Using this consensus, the Center created environmental standards on hydraulic fracturing that both groups could agree on. The Center is comprised of groups like the Environmental Defense Fund, the Pennsylvania Environmental Council, Chevron, Shell Oil and philanthropic groups such as Heinz Endowment and the William Penn Foundation. Though several members of the energy and environmental communities have chosen not to participate, the effort is considered an unprecedented milestone in cooperation.

So far, the Center has established 15 standards that participating energy companies with operations in the Appalachian Basin have begun to implement voluntarily. The industry may concede to more rigorous environmental standards than required by state or federal regulation, but compliance does not create unbearable setbacks to shale gas production. For example, the Center requires companies to gradually phase out the use of diesel powered fracturing pump engines – considered major sources of pollution – between 2014 and 2017, based on higher EPA emission standards. By September 2015, operators will be required to recycle 90 percent of flow back and produced water from its wells. Based on an independent review of operations conducted by the Center, shale gas drilling operations can receive certification for compliance with all 15 environmental standards.

Integral to CSSD's success so far has been its regional focus on hydraulic fracturing. A cookie-cutter approach in applying U.S. best practices to international, and even national, fracking operations could undermine the effectiveness of environmental standards. Each region and country has different characteristics that make it unique. The standards that apply to the Appalachian Basin may not make sense for the Barnett Basin in Texas, let alone the Lublin Basin in Poland. For instance, the Marcellus Shale does not have suitable geology for underground injection wells for wastewater disposal, so there are more rigorous rules on the recycling and treatment of wastewater than in Colorado or Ohio. An organization like Pennsylvania's CSSD could become a potential model for creating industry-environmental consensus and achievable environmental standards based on the geological conditions in the CEE region.

See: Center for Sustainable Shale Development, Pittsburgh, Pennsylvania, http://goo.gl/RuhXi.

"satisfactorily governs all aspects of shale gas and shale oil extraction."[74] This framework applies to the domestic energy sectors of all EU member states. While it has been sufficient thus far, as shale gas develops in CEE, examples of U.S. best practices in regulation can strengthen framework for the countries in this region.

The next section will address the major environmental concerns of the European Commission: land surface impacts; greenhouse gas emissions; fresh water consumption; groundwater and surface water contamination; and wastewater management.

(B) Reduction of Land Surface Impact

As noted in the claims section of this report, a certain degree of

[74] European Parliament, *Report on the Environmental Impacts of Shale Gas and Shale Oil Extraction Activities, Committee on the Environment, Public Health and Food Safety,* September 25, 2012, http://goo.gl/xIjPm.

surface impact and disturbance is unavoidable in oil and gas extraction methods. Multi-pad wells have helped to minimize that risk. To further ease disturbances, the oil and gas industry can also take a number of precautionary measures before drilling is permitted. For instance, potential fracking sites are subject to *geophysical surveys* (comprehensive studies of the geological structure of the rocks underneath the earth's surface).[75] Surveys target specific sites for drilling, which inherently helps to reduce unnecessary surface impact. Additionally, thorough evaluations of surrounding environments are often legally required in the United States and Europe. In the UK, drilling cannot begin without an environmental license from the Environment Agency under Environmental Permitting Regulations. In the United States, fracking operators must submit a permit application to a local regulatory authority in order to receive authorization to drill for gas or oil. More often than not, permits are reviewed by a staff of engineers, geologists and environmental scientists, and the local authority has the right to deny applications if information is insufficient.[76] In environmentally sensitive areas, further regulation on the local level could reinforce drilling restrictions. For example, regulation could also prohibit the construction of roads near rivers or streams, floodplains and forests in order to protect special wildlife or resources.[77]

The drilling process itself also must go through a series of tests before fracking is permitted. The progression of both vertical and horizontal drilling require physical and chemical analyses that include well measurements, the testing of the shale formation and hydraulic fracturing tests at different depth intervals. These tests are particularly important for the CEE exploration process, as some shale gas plays are deeper than in the United States. Recent fracking tests in Poland and Ukraine (and since 1955, areas of Germany) indicate that so far, this has not been an obstacle in the extraction of shale gas from CEE shale plays.

Once the surrounding area is evaluated and approved for activity by authorities, well pad construction begins. The process generally involves the clearing and leveling of topsoil and roots, the layering of gravel or stones on the site to help support the movement of heavy equipment, and the installation of erosion controls to prevent rain runoff and contain possible leaks.[78] In this phase, and during the fracking process, noise is one prevalent and negative side effect for nearby communities. The main sources of noise pollution on-site include compressor facilities, diesel powered generators and the truck traffic for moving fluids and equipment to and from the well site. To address this issue, *sound*

---

[75] "Geophysical Survey," Cuadrilla Resources, http://goo.gl/oMbnfv.
[76] Ground Water Protection Council and U.S. Department of Energy, *State Oil and Gas Regulations Designed to Protect Water Resources*, May 2009, 18, http://goo.gl/G0FoDK.
[77] U.S. Department of Energy, *Modern Shale Gas Development in the United States: A Primer*, 48.
[78] M.S. Mauter, *The Next Frontier in the United States Shale Gas and Tight Oil Extraction* 57, http://goo.gl/gkEup5; New York State DEC, *Natural Gas Development Activities and High Volume Hydraulic Fracturing*, 2011, 5-8, http://goo.gl/3oHwyx.

Best Practices in Action: Community Investment

Fracking operations have attracted job seekers to booming towns and cities all over the United States, but not without consequence. The fracking boom is also responsible for disturbances such as noise, construction and traffic in communities and habitats close to the everyday action. As seen in North Dakota and Pennsylvania, the local response to the influx of engineers, geologists and administrators has been the quick development of new restaurants, housing, hotels, grocery stores and office buildings. The oil and gas industry has the resources to help alleviate the stress of these disruptions and town growth spurts by voluntarily investing in the infrastructure of local towns and cities.

Many examples from the U.S. experience reflect this growing trend. In Montrose, Pennsylvania, Cabot Oil and Gas Company covered costs for the construction of a new office building, and helped the community raise $4.4 million for the construction of a new hospital. Likewise, Consol Energy agreed to invest approximately $500 million into the improvement of airport infrastructure over the course of 20 years, in exchange for permitted drilling and fracking on airport property in Allegheny County, Pennsylvania. State and local organizations also receive considerable support from the industry. In Susquehanna County, Pennsylvania, Cabot Oil and Gas invested over $2.5 million into non-profit organizations, educational workshops and community events. Taxes from oil and gas production can also be viewed as a type of community investment. In Colorado, taxes from hydrocarbon production contributed to an $81.5 million Colorado Department of Natural Resources trust fund to support the protection of wildlife, forestry and water conservation.

With the beginning of shale development in Central and Eastern Europe, the same kind of financial contribution from companies could help smooth over disturbances from fracking and community growth. In this region in particular, most national governments own the mineral rights to all land, contributing to even less incentive for the public to support oil or gas development so close to home. However, compensation through community investment is one way of sharing the spoils of domestic energy production in CEE and increasing public support.

See: "Our Community," Cabot Oil & Gas Corporation, http://goo.gl/8FRblH; Jenny Wagner Calkins Media, "Dynamics of Drilling are Nothing New for Airports," *Shale Reporter*, March 1, 2013, http://goo.gl/JhxERf.

barriers are commonly used to enclose the fracking site as a way of shielding nearby communities and wildlife from the noise of everyday operations. In the United States, local governments have the right to negotiate agreements with companies, forcing them to adhere to noise issues or other concerns such as traffic limitations, speed limits and coordinated traffic patterns in residential areas.[79] What's more, EU legislation strictly enforces limitations on noise from both the equipment used and operations surrounding oil and gas extraction and production processes.[80]

Other notable technologies also offer ways to mitigate disturbances brought on by fracking. One promising and economically viable innovation in land conservation is the *reusable access mat* in place of gravel.[81] Mats allow topsoil and root structures at the well site to remain undisturbed, and they also act as a protective barrier against accidental spills or leaks throughout the operation. An overlooked benefit highlighted by a recent Harvard University study on the environmental impact of fracking is the reduction of carbon dioxide emissions by 22 percent to as much as 56 percent per fracking site. This is because the need for gravel transport to and from sites is eliminated.[82]

---

[79] Department of Energy, *Modern Shale Gas Development in the United States: A Primer*, 46-47.
[80] "What is Regulated?" Shale Gas Europe, http://goo.gl/EwH6Vl.
[81] M.S. Mauter, *The Next Frontier in the United States Shale Gas and Tight Oil Extraction*, 58.
[82] Ibid.

Drilling rigs can be eyesores against the backdrop of green landscapes, farmlands or emerging skylines. They can also take up a lot of space on the fracking site. An innovation that addresses both of these issues is the *"low footprint" rig.* The rig "takes up less space, transports more easily, uses less energy, and requires smaller crews," and also reduces site costs.[83] This technology was developed by U.S. and European-based companies and it currently operates in over eight countries. In a study by the American Association of Drilling Engineers on the performance of these rigs, carbon dioxide emissions dropped by 39 percent due to the use of electricity grids to power the drilling in place of diesel generators (which have also traditionally contributed to noise pollution).[84] As the CEE region is more densely populated, the proximity of towns to fracking sites could mean that electricity grids may become a more likely source of power for these types of rigs.

Disturbances to land caused by fracking are not irreversible. In a step toward helping alleviate the local impacts of shale gas extraction and production, energy companies and governments have begun making direct financial contributions to communities. This includes investing in the reparation of roads damaged by heavy truck traffic and the building (or improvement) of infrastructure.[85] In the UK, the government is currently promoting a £100,000 ($167,550) contribution to communities that would be affected by fracking. In the United States, companies are contributing to the costs of building new hospitals and office buildings to accommodate growing communities.

Finally, land preparation, drilling and extraction of oil and gas are also reversible because each part of the process is temporary. After the drilling and fracking phases are completed, most of the land is reclaimed to its original form. The production of gas requires only the wellhead and a system of pipelines. Total reclamation of land occurs once the production life of the well ends and the wellhead is removed. The well is then cemented to prevent future gas leaks.

(C) Reduction of Greenhouse Gas Emissions

Air pollution from fracking is another environmental risk that both fracking critics and proponents believe can be reduced even further. Greenhouse gas (GHG) and volatile organic compound (VOC) emissions are known to escape into the air during conventional and unconventional operations. The main sources of onsite pollution include diesel engines (used for drilling and pumping fracturing fluid into the well at high pressure),

---

[83] "First Movers in 'Green' Drilling: Low-Footprint Rigs," *Rigzone*, 17 November 2011, http://goo.gl/JbGcll.
[84] Ibid.
[85] Department of Energy, *Modern Shale Gas Development in the United States: A Primer*, 46-47.

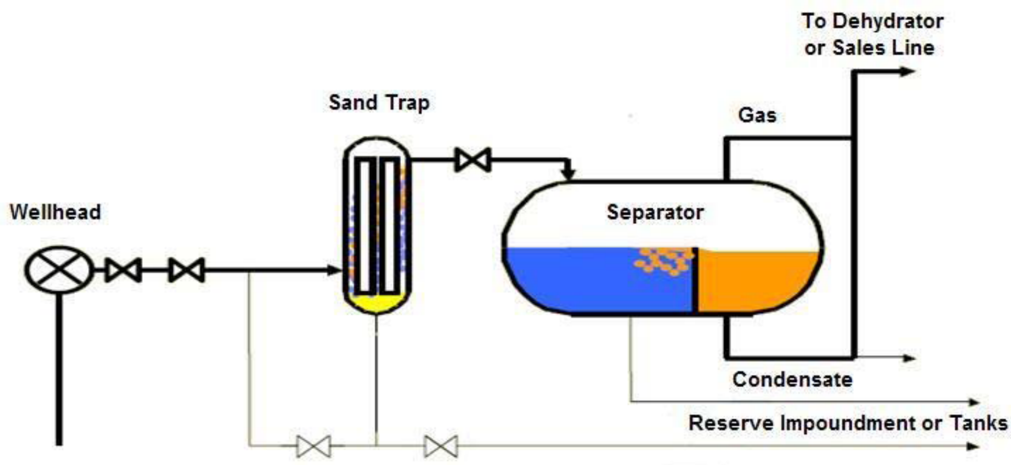
well completions (the period between fracking and natural gas production), truck traffic and methane leaks (during production and transmission).[86] To address these specific issues, the industry has begun using emission-reducing technologies such as gas-fired engines for trucks and generators, reduced emission completions (RECs) during the well completion phase and low-bleed pneumatic control valves during production and transmission that are better able to capture fugitive emissions. At the same time, government regulations in the United States are increasing limits on greenhouse gas emissions. In fact, stricter regulations have become some of the greatest incentives for technological development.

In comparison to other phases of natural gas extraction and production, the well completion phase has been responsible for releasing considerable fugitive methane emissions. Fugitive emissions are gases and compounds that escape or leak into the atmosphere. The detection and plugging of leaks is critical at all stages of the fracking process because methane – the primary component of natural gas – is a greenhouse gas that is 21 times stronger than carbon dioxide when released into the atmosphere. In conventional gas extraction, gas and fluids that come out from the wellbore are immediately connected to gas and liquid separating equipment. When used on wells that involve fracking, initially this technology could not handle the high rate at which fracturing fluid came up the well. Nor could it process the sand contained within the fracturing fluid. Alternatively, the fracking fluid and gas mixture was immediately transferred to an open ground pit (lined with protective material) and gas was vented into the air. The gas that came out of the well at this stage used to be considered uneconomical to collect or sell. A practice that has become more common is called "flaring." If natural gas is flared, or burned, methane emissions are reduced by 90 percent. The downside is the subsequent release of carbon monoxide and nitrogen oxides.[87]

The practices of venting and flaring are being replaced with a new technology known as the *reduced emission completions (REC),* or *green completions*. RECs are portable equipment designed specifically for the immediate capture of flow back water, sand and natural gas during the well completion phase.[88] It recovers 99 percent of methane during the well completion phase that would have otherwise been flared or released into the air.[89] The equipment works by capturing flow back water from the wellhead and releasing it into to a sand trap, which separates solids (sand, drilling debris) from the

[86] National Petroleum Council, *Hydraulic Fracturing: Technology and Practices Addressing Hydraulic Fracturing and Completions*, September 2011, http://goo.gl/PvwfzV.
[87] C. Clarke, *Hydraulic Fracturing and Shale Gas Production*, 9.
[88] U.S. Environmental Protection Agency, "Reduced Emission Completions," http://goo.gl/ZVwVn8.
[89] Ibid.

water and gas. The remaining fluid is then channeled to a separator tank that removes water from the gas.[90] The separated water may be treated onsite and re-used at nearby or future operations. The gas is then channeled to a pipeline for processing or sent off to market.



According to MIT and University of Texas researchers, about two-thirds of fracking operations in the United States are already capturing large portions of fugitive gases with RECs.[92] By October 2015, federal regulations will require all fracking operators to practice flaring or use RECs. Ideal for densely populated areas in Central and Eastern Europe, this technology has long been standard practice in areas like the Barnett Shale formation in Texas precisely because of the close proximity of fracking operations to towns and cities.

The production of natural gas also accounts for significant fugitive methane emissions, particularly leaks from tanks, valves and pipes during the separation and transmission of natural gas. Throughout the production and transmission phases, the main environmental risk becomes the escape of gas through "high-bleed pneumatic controller valves." These devices are powered by natural gas (or air) in order to produce a mechanical motion. [93] In this case, the pneumatic controllers are responsible for

---

[90] Ibid.

[91] Natural Gas STAR Partners, EPA, http://goo.gl/ZVwVn8.

[92] Nadya Anscombe, "Shale-Gas Emissions during Fracking Only a Quarter of Potential Amount," *Environmental Research Web*, January 4, 2013, http://goo.gl/7zgCaY; M.S. Mauter, *The Next Frontier in the United States Shale Gas and Tight Oil Extraction*, 47; "Landmark Study: How High is Methane Leakage?" Shale Gas Europe, September 2013, http://goo.gl/3TILna.

[93] U.S. Environmental Protection Agency, *Methane Emissions from the Natural Gas Industry: Pneumatic Devices*, June 1996, http://goo.gl/cwzS8R.

regulating and controlling pressure, temperature, liquid level and flow rate of liquids and gases throughout a system of tanks, compressors and pipelines. Importantly, these instruments are ubiquitous in the natural gas production and transport systems.

One technological innovation specifically designed to tackle this issue is the *low-bleed pneumatic controller valve*. The bleeding from old controllers "is collectively one the largest sources of methane emissions in the natural gas industry."[94] However, the ease with which old devices can be replaced with the new low-bleed ones is becoming regular industry practice, contributing to the decrease in methane emissions by as much as 90 percent.[95] Taking best practices a step further, air compression operated pneumatic devices reduce leaks by 100 percent. However, an electric component is required that many remote fracking sites cannot access. Since fracking operations in the CEE region may be less remote than in the United States, air compressors may be more easily accessible.

Another valid concern about the effect of fracking on air quality is diesel fuel – the traditional fuel for generating power in drilling and pumping fluids during hydraulic fracturing operations. As diesel is a major pollutant, *natural gas fired engines* have begun replacing diesel fired ones.[96] One of the main reasons for the development of this technology is stricter limitation on greenhouse gas emissions. For example, the Pennsylvania Department of Environmental Protection recently introduced changes to general permit requirements for diesel engines and compressor stations used for natural gas operations. The permit imposes emission margins that are 75-90 percent stricter than previous limits.[97] Reflecting these changes to regulation, gas-powered engines have helped reduce emissions by almost 75 percent.[98] As natural gas prices are much higher in CEE countries than the rest of Europe or the United States, the promise of electrical grids for drilling and pumping of fracking fluid may, for the time being, be the most economical option for reducing cost and greenhouse gas emissions during the drilling and fracking phases.

The best practices just discussed already have plenty to show for. The EPA's latest Greenhouse Gas Inventory report attributes the decrease in methane emissions "largely

---

[94] U.S. Environmental Protection Agency, *Convert Gas Pneumatic Controls to Instrument Air*, http://goo.gl/ikk0yh.
[95] Robert Fernandez, Robin Petrusak, Donald Robinson and Duane Zavadil, "Cost-Effective Methane Emissions Reductions for Small and Midsize Natural Gas Producers," *Journal of Petroleum Technology*, June 2005, http://goo.gl/mNKw5g.
[96] American Exploration and Production Council, *The Real Facts about Fracture Stimulation: the Technology behind America's New Natural Gas Supplies*.
[97] "DEP Announces Final Air Quality Permit for Natural Gas Operations, Proposes New Environmental Controls," Pennsylvania Department of Environmental Protection, January 31, 2013, http://goo.gl/ueCpua.
[98] Chesapeake Energy Corp, Air Emissions and Regulations Fact Sheet; "Fracking Industry Switching from Diesel to Natural Gas," *Pipeline*, January 21, 2013, http://goo.gl/rLRMIb.

to the decrease in emissions from production and distribution," particularly due to the voluntary replacement of high-bleed pneumatic devices with low-bleed ones, and increased regulation.[99] The impact of reduced emission completions (RECs) since 2006 in the field production of natural gas is also substantial. Between 1990 and 2006, emissions from the field production of natural gas increased by 23.4 percent in part due to hydraulic fracturing (especially during the well completion phase).[100] With the increased use of new technologies such as RECs, methane emissions in this sector decreased by almost 40 percent between 2006 and 2012.[101] These practices reflect the important role that technology and regulation play in the environmental safety of hydraulic fracturing.

(D) Freshwater Alternatives

The maintenance of freshwater supplies is important to local communities, towns and habitats everywhere. Though fracking operations use considerably less fresh water than in the production of other sources of energy, those on both sides of the fracking debate agree that fresh water used for shale gas development should be, and could be, reduced. The issue of water preservation becomes particularly critical in drought prone areas like Texas and densely populated areas like CEE states. To this end, new technologies are already helping to conserve water supplies.

There are several preliminary protective measures currently in practice in the United States intended to maintain sufficient fresh water supplies for nearby communities and habitats. The *management of water withdrawal* based on an assessment of regional factors and the monitoring of groundwater aquifers is one such measure.[102] In Europe, a permit is generally required to draw water from a local area. The process is slow and lengthy to ensure water does not deplete too quickly. Alternatively, fracking operators could take advantage of high surface water flows – such as precipitation and seasonal flows of rivers – to collect and store water instead of using water when levels are low due to drought.[103] *Diversification of water supply* is another way of preventing local water depletion, as multiple sources allow for the withdrawal of water in intervals. Yet these practices do not address the reduction of fresh water consumed for fracking. For this, the industry has begun using *non-fresh water sources* in the composition of fracturing fluid.

---

[99] U.S. Environmental Protection Agency, *Inventory Gas Emissions and Sinks: 1990-2012*, April 2014, 38, http://goo.gl/9cICWI.
[100] Ibid.
[101] Ibid.
[102] National Petroleum Council, *Hydraulic Fracturing: Technology and Practices Addressing Hydraulic Fracturing and Completions*, 18.
[103] Ibid.

Non-fresh water sources from underground water reservoirs (known as brine or brackish water) and sea water are becoming the main components in fracturing fluid. This eliminates the need for fresh water. The treatment of non-fresh waters to increase quality is unnecessary, according to experts.[104] Their natural salinity also decreases the number of chemicals needed in fracturing fluid, as they contain natural elements like salt that act as substitutes for additives like sodium chloride.[105] By utilizing underground brine, the number of truckloads transporting fresh water would be reduced by 1,400 for each fracking site. This practice could also reduce costs by as much as $100,000.[106] For Central and Eastern Europe, these water-saving practices would be integral to reducing initial costs of fracking operations. Also, this would eliminate the need for the use and transportation of fresh water, which is considerably more expensive in the CEE region than in the United States.

The industry has also begun to recycle fracking fluid for future use at nearby fracking operations. Before it can be used again, the wastewater must go through limited treatment to separate solids from fluid onsite. Thanks to *portable trailer-mounted treatment systems,* this fluid does not need to be transported to offsite treatment centers such as municipal sewage treatment centers. For example, the Clean Wave system treats used fracking fluid by passing it through a special filter for larger particles, which are later removed once they either float to the top or sink to the bottom.[107] Another example of onsite treatment equipment is the Integrated Treatment System (ITS). Importantly, these portable systems also eliminate storage and transport costs associated with fresh water and wastewater disposal. Largely attributed to this technology, 40 percent of water in fracking operations in the United States is recycled, and that percentage will continue to grow.[108] In the CEE context, the recycling of fracturing fluid would be a critical practice, as the injection of wastewater underground for disposal is prohibited by EU regulation.

(E) Wastewater Management

Underground injection is currently the most utilized means of final disposal for fracking wastewater in the United States. However, the practice is prohibited under EU law unless it is free of pollutants.[109] In the United States, wastewater disposal has become

104 Nathaniel Gronewold, "Halliburton's New Technology Enables Reuse of Produced Water," *E&E*, March 7, 2013, http://goo.gl/y3cQCy.

105 George E. King, "A Closed Loop System Using Brine Reservoir to Replace Fresh Water as the Frac Fluid Source," (Apache Corporation EPA Workshop on Hydraulic Fracturing, March 29-30, 2011), http://goo.gl/5iNeHK.

106 "Integrated Treatment System for Frac Water Management," Ecologix, http://goo.gl/y3cQCy.

107 "CleanWave Frac Flowback and Produced Water Treatment," Halliburton, http://goo.gl/yopWcM.

108 "How Does Technology Contribute to the Safe Extraction of Shale Gas?" Shale Gas Europe, http://goo.gl/0TsiHK.

109 "Fracturing Fluid Management," Frac Focus Chemical Disclosure Registry, http://goo.gl/gA2aDH.

a growing problem for the industry as the shale gas revolution grows. This is especially problematic for certain geological formations such as the Marcellus shale formation in Pennsylvania, which has proven unfit for wastewater storage through underground injection. Though recycling of fracking fluid is beneficial, it only delays the inevitable disposal of wastewater once it can longer be recycled. Water treatment technologies are evolving to meet this demand.

Disposal options that could aid Pennsylvania and the CEE region in the management of wastewater include *treatment and discharge* into local waterways. Similar to recycling technologies, there are a number of cleaning systems that can be used onsite that use techniques such as filtration, reverse osmosis and ion exchange.[110] The water could then be transported to municipal treatment centers for additional cleaning before it could be considered safe for disposal into nearby water systems. At the same time, these wastewater management practices offer valuable opportunities for the region. In addition to addressing the reduction of wastewater generation and fresh water consumption, recycling and wastewater treatment offer enormous potential for the development of private treatment services that would generate job growth in various communities in Poland, Romania and throughout Europe.

(F) Water Contamination Risk Reduction

As noted in the claims section of this report, though the chance of water contamination through underground fractures is extremely low, the chance of pollution through mismanagement or poor technologies is more common. The main risk comes from the construction of well casings. With regard to surface water, the chief contamination risk comes from spills and leaks from fracturing fluid and wastewater. Industry and regulatory agencies in the U.S. have taken major steps to address these issues.

Before drilling for gas or oil begins, operators could take a number of measures to substantially increase their accountability. One way is through the regular testing of water sources. In the practice of *baseline water testing and monitoring*, wells are sampled within a certain distance of a planned well pad.[111] The well's water quality is then documented as a reference point for any testing done after drilling and fracking occurs. To further accountability, some companies have begun to use tracers – distinct dyes, chemical or isotopes – in fracturing fluid that would help determine if fracking is responsible for any water contamination. Taking a step further, the practice of *post-operational water testing*, or the monitoring of water in the months and years after fracking has been completed, ensures that water testing is a regular practice. Such

---

[110] Ground Water Protection Council, *State Oil and Gas Regulations Designed to Protect Water Resources*, 30.

[111] Natural Resource Defense Council, *Water Fact Sheet: Hydraulic Fracturing Can Potentially Contaminate Drinking Water Sources*, 3; American Petroleum Institute, *Hydraulic Fracturing Operations: Well Construction and Integrity Guidelines*, 22.

testing would vastly improve public trust in domestic and international oil and gas companies. These practices are strongly recommended by the industry as a means of better identifying causes of water contamination and building credibility.[112] As seen in the CEE region, public protests against energy companies that are beginning to use fracking in Poland, Romania and Ukraine underscore this lack of trust. Such practices could play a part in reassuring citizens about fracking in their communities.

The reduction of chemical additives in fracturing fluid is another common goal that brings fracking activists and opponents closer together. Leading North American and European oil and gas companies have begun developing *green additives* as an alternative to the chemical substances used in traditional fracturing fluid.[113] The Green Frac Initiative, for example, has eliminated up to 25 percent of the additives used in fracturing fluids. The Clean Stim System, in the United States, uses ingredients sourced from the food industry that equal the performance standards of traditional fracturing fluid compositions.[114] Ingredients include fatty acids, essential oils and guar gum – substances that are also commonly used to make ice cream and beer.[115] On the European side, the UK, Netherlands and Norway, in cooperation with government regulatory agencies, have developed chemicals with reduced toxicity for use in fracturing fluid.[116]

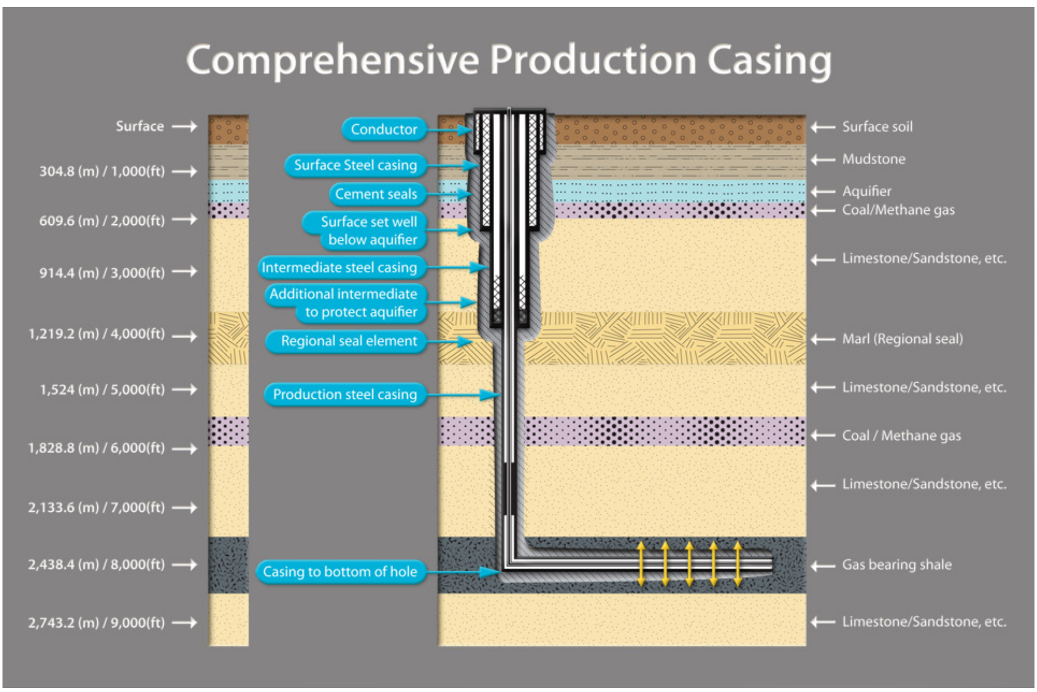
What is also critical to the safety of groundwater is the maintenance of steel and cement casings that protect the wellbore. For steel casings to maintain the strength to withstand high pressure during the fracking process, bacterial growth inside the wellbore must be controlled. Bacteria can cause the corrosion of steel and iron. Though heavily criticized, biocide is an additive that is critical in keeping steel casings healthy and strong. To address this issue, the industry has found an alternative method to destroying harmful bacteria. Leading energy companies in the United States are beginning to use *ultraviolet light* to control bacterial growth.[117] Ultraviolet light effectively kills bacteria by causing damage to its DNA structure, thereby eliminating its ability to produce proteins that cause them to replicate.[118]

---

[112] Kansas Geological Survey, University of Kansas, *Public Information Circular 34: Guidelines for Baseline Groundwater Quality Sampling in the Vicinity of Hydraulic Fracturing Operations*, March 2013, http://goo.gl/99a1Jt.
[113] Barbara Saunders, "Analysis: Research Group Defines Best Fracking Practices to Ease Concerns," *Rigzone*, September 2, 2011, http://goo.gl/s38YfD.
[114] "CleanStim Hydraulic Fracturing Fluid System Overview," Halliburton.
[115] Ryan Dezember, "Companies Release Eco-Friendly Fracking Fluids," *Wall Street Journal* via *Greenwire*, December 16, 2010, http://goo.gl/vEagqm.
[116] George E. King, *Hydraulic Fracturing 101: What Every Representative, Environmentalist, Regulator, Reporter, Investor, University Researcher, Neighbor and Engineer Should Know About Estimating Frac Risk and Improving Frac Performance in Unconventional Gas and Oil Wells*, Society of Petroleum Engineers, 2012, 35, http://goo.gl/AjpuQD.
[117] "CleanStream Ultraviolet Light Bacteria Control Process," Halliburton, http://goo.gl/WOJA5E; Range Resources, *Hydraulic Fracturing Fact Sheet*, July 2010, http://goo.gl/OSuuix.
[118] "CleanStream Ultraviolet Light Bacteria Control Process," Halliburton.

The integrity of *well construction design* is dependent on the sturdiness of the steel and cement casings surrounding well bores. They are the main safety measure against underground water contamination. Wellbores are isolated from groundwater aquifers by multiple layers of heavy steel casing that are then cemented in place to prevent soil and rock from caving in on top of the well.[119] The cement is formulated to withstand gas migration, high temperatures and mineral acids.[120] Legally, the bare minimum protection requirement for a well bore in the United States is the setting of a conductor casing (designed to prevent the sides of the drilled hole from caving in), surface casing (because drilling continues to go deeper into the ground beyond the groundwater aquifer) and the cement casing (to fill the space between the outside of the steel casing and the well bore). Several additional casings are also typically included as drilling reaches deeper underground, as indicated in the diagram below. As well integrity standards vary from one operator to another in different European states, countries in the CEE region should consider establishing minimum national (or regional) casing regulations to help increase environmental safety.[121]

Steel and Cement Casing of Wellbores for Unconventional Energy Production[122]



[119] American Petroleum Institute, *Practices for Mitigating Surface Impacts Associated with Hydraulic Fracturing*, January 2011, http://goo.gl/QkWze8; American Exploration and Production Council, *The Real Facts About Fracture Stimulation*; Range Resources, *Factsheet on Hydraulic Fracturing in the Marcellus Shale*.
[120] George E. King, *Hydraulic Fracturing 101*, 24.
[121] European Commission, *Impact Assessment: Exploration and Production of Hydrocarbons (such as Shale Gas) using High Volume Hydraulic Fracturing in the European Union*, http://goo.gl/IySBHo.
[122] "Comprehensive Production Casing," Shale Gas Europe, http://goo.gl/AomfXs.

Fracking operators in the United States have also utilized new technologies to prevent spills and leaks above ground. Initial planning techniques are precautionary measures that include the lining of well sites with protective materials and the construction of a barrier around the perimeter of each site.[123] Tanks and trucks operate on top of protective liners during the transfer of any fracturing fluid. If ground pits are used for the temporary storage of flowback water, then it is a legal requirement for operators to line them with leak proof materials – typically made of clay or synthetic materials – to prevent seepage into soil and underground water.[124] In the majority of U.S. states, companies must apply for permits to use ground pits for storage purposes. Almost half require specifications for the period of time each pit will be used.[125]

The downside to the use of ground pits for temporary storage is the increased risk of surface water contamination. For example, leaks and accidental spills from tanks, pipes, truck transport or poorly lined ground pits could migrate into nearby waterways in the event of a rain storm.[126] This is particularly dangerous if wells are located close to water sources. One notable precautionary measure that some U.S. state governments have imposed is *setback regulation*. This law requires sufficient distance between fracking sites and water sources. Complementary industry practice that could further contain the runoff of leaks or spills into waterways is *hydrologic mapping and risk analysis*.[127] Before drilling, operators evaluate the location of potential drilling sites, or existing well sites, to the nearest bodies of water.

Finally, less risky alternatives to ground pits for the temporary storage of fracking fluid or wastewater are above-ground closed tanks. The *closed-loop fluid system* consists of a system of pipelines and tanks that not only eliminate the need for temporary ground storage pits, but also facilitate water recycling.[128] Flowback water is captured at the point of extraction and the fluids travel to tanks that filter larger debris and store the water onsite. Almost 70 percent of fracking operations in Colorado and Pennsylvania currently use this technology. In the UK, the use of closed tanks for the storage of wastewater is a legal requirement. Though these tanks are a major upgrade from ground storage pits, protective measures against leaks are still taken. The majority of U.S. state governments require *containment dikes* surrounding tanks, designed to capture any fluids in case they escape.[129]

---

[123] "Hydraulic Fracturing Operations," EOG Resources, http://goo.gl/C0h1vP.
[124] "Fracturing Fluid Management," Frac Focus Chemical Disclosure Registry, http://goo.gl/gA2aDH.
[125] Ground Water Protection Council, *State Oil and Gas Regulations Designed to Protect Water Resources*, 29.
[126] "Hydraulic Fracturing Process," Intermountain Oil and Gas BMP Project, http://goo.gl/XJcSmk.
[127] Natural Resource Defense Council, *Water Fact Sheet*, 3.
[128] "Fracturing Fluid Management", Frac Focus Chemical Disclosure Registry, http://goo.gl/gA2aDH; U.S. Department of Energy, *Modern Shale Gas Development in the United States: A Primer*; J.D. Krohn, "RFF Survey Destroys Myth of Shale-Specific Risk," *Energy in Depth*, February 15, 2013, http://goo.gl/EoUETe.
[129] Ground Water Protection Council, *State Oil and Gas Regulations Designed to Protect Water Resources*, p. 29.

Part IV: Recommendations for CEE Countries

The best practices discussed in the pages above are specific technologies and regulations that are currently driving the growing safety of hydraulic fracturing in the United States. Though geological and population conditions in Central and Eastern Europe (CEE) are different from those in the United States, these best practices could be adapted to the nascent fracking experience in this region. The driving force behind the need for energy diversification and independence in CEE countries is the region's dependence on expensive hydrocarbon imports and vulnerability to politically-motivated supply disruptions. Therefore, this report is designed to assist CEE policymakers and the general public in untangling certain myths about fracking and to better understand the most advanced science and best practices that can be utilized in the exploration and production of domestically sourced natural gas and oil. Decisions concerning whether to allow fracking and where it should be permitted should take into account best practices and a thorough analysis of the long-term security and the economic costs and benefits compared to other sources of energy. Below are recommendations that stem from our analysis of these factors.

1. CEE energy and environmental regulators would be well advised to work closely with the U.S. Environmental Protection Agency (EPA) and experienced state regulators in order to draw on their experiences regarding best practices and to judge the effectiveness of regulations regarding the latest and best hydraulic fracturing technologies. Using the U.S. experience, European governments can more rapidly and effectively bring about environmentally acceptable domestic energy production and attract experienced foreign partners.

2. CEE energy policymakers and regional officials should make it a point to investigate the claims made by the opponents of fracking. These assertions are often cloaked in scientific language that is unable to hold up to factual information once it has been closely examined by independent specialists.

3. CEE governments should adopt transparent and competitive measures for awarding permits for exploration and development. Without transparency, there is significant risk that corrupt business interests will seek exploration blocks without the intention of doing serious exploration, but with the goal of holding onto the awarded block as an investment to sell at a profit at a later point in time. Greater transparency in the awarding and licensing process would also more likely lead to environmentally safe operations.

4. CEE governments would benefit from conducting greater due diligence regarding any economic entity participating in a tender. A firm without prior experience

in hydrocarbon exploration or development should prove that it has a qualified partner with sufficient technical expertise and adequate funding to carry out the tender commitments. A firm time limit should be set for beginning serious exploration. Failure to meet the deadline would result in the tender award reverting back to the control of the state.

5. Cooperative studies by fracking companies and CEE regulatory agencies should examine potential drilling sites, setting a baseline for local air pollution levels and surface and ground water quality. These studies can potentially reassure a nervous public that the government and the energy firms are serious about protecting the environment and public health, thereby strengthening local support for hydraulic fracturing. By measuring existing pollution levels, it would prevent exaggerated claims later on regarding negative effects of hydraulic fracturing.

6. Greater dissemination of fact-based information about hydraulic fracturing should be made available to CEE governments, environmental groups, and the public by the United States Department of Energy (DOE) and the U.S. EPA. U.S. state regulatory agencies and research organizations could participate in public discussions in CEE capitals and in affected regions regarding their experience with hydraulic fracturing to share what worked and what did not. Representatives of the major local media outlets and environmental groups should be invited to these events, along with government and opposition figures. The emphasis should always be on what operating firms have learned by utilizing the best science for maximizing production while at the same time protecting the environment and public health.

7. Foreign and domestic companies can increase their credibility and public support by publishing full disclosure of the operations to be carried out, including the composition of chemicals, sand and water to be injected into the well site. U.S. companies should also proactively reach out to local communities with the latest information on best practices. Up to now, not enough effective outreach to local communities has taken place.

8. CEE governments would be advised to establish futures markets in each capital in order to create an institution that would help mobilize investments in energy projects.

9. Because mineral rights in the CEE region are owned by national governments as opposed to private citizens, it is important that CEE governments scrupulously carry out all agreements with local communities regarding the transfer of an

agreed portion of income from natural gas sales to those areas directly affected by fracking operations. Trust between local and national authorities is essential in order to avoid damaging work stoppages by affected communities.

10. Joint ventures between national firms and American and other Western companies should be encouraged as such cooperation provides financial and technological transfers, as well as strengthens inter-European and trans-Atlantic ties.

11. While technology transfers from foreign firms to domestic energy companies should be encouraged, this should be a voluntary process. A mandatory transfer of technology could slow exploration and development as governments and companies determine what should or should not be shared with local partners.

12. CEE and U.S. governments could collaborate in establishing a European center for the analysis of best practices and the dissemination of information regarding hydraulic fracturing. Working with USAID, International Energy Agency (IEA) and the European Commission, the Center would ensure the dissemination of best practices in all EU member states. The Center could also facilitate exchanges sending CEE energy officials to the U.S. to observe the latest technologies and best practices, and bring U.S. and other specialists to Europe.

13. U.S. agencies should work with the universities and technical institutes in the CEE region to adapt U.S. best practices to local conditions and to develop newer technologies that can be adopted on both sides of the Atlantic. CEE countries possess an impressive number of highly educated technical experts and this expertise should be utilized.

Part V: Conclusion

Hydraulic fracturing continues to be a controversial subject. Nevertheless, the debate is entering a phase where broader knowledge of U.S. best science and practices in the field could help shape governmental policies in Central and Eastern Europe. The U.S. experience, spanning almost 70 years, has demonstrated that technological improvements, including reductions in water consumption, air pollution and land damage, have made fracking less threatening than decades prior. Not only has hydraulic fracturing become much more environmentally friendly, there have also been substantial reductions in the cost of oil and gas extraction. The transfer of the U.S. experience, including realized economic gains and lowered environmental risks, should help increase political and public support for fracking in Europe.

Hydraulic fracturing has the potential to add significantly to Central and Eastern Europe's supply of hydrocarbons, resulting in greater regional and national economic and political security. Increased domestic production would also substantially reduce the cost of imported fuels, thereby laying the groundwork for more competitive industrial development. It would reduce the region's vulnerability to monopolistic energy imports and arbitrary disruptions of natural gas supplies. The adoption of a fracking policy that would allow for the production of shale resources would also let CEE close the economic gap with the wealthier countries in Western Europe.

Unfortunately, political, environmental and business organizations outside of the CEE region will continue to supply information about hydraulic fracturing to local communities that is either patently false or contains allegations regarding environmental risks that have already been overcome through new technologies. Nevertheless, the debate is taking on new urgency in light of Russian aggression against Ukraine and the growing realization that European industrial competitiveness is lagging because of higher energy costs compared to the United States and China. CEE has substantial potential for sustained development of hydrocarbons with lower emissions of greenhouse gases and public health benefits that will result from reduced use of oil and coal. Hydraulic fracturing can provide relatively clean energy while concurrent progress is being made in developing non-subsidized renewable fuels. Both domestic and foreign energy firms, however, can only work in a political and economic milieu conducive to a certain amount of risk taking.

Other elements, such as robust energy efficiency programs, building more regional gas and electricity interconnectors and good tax and pricing policies are fundamental to bringing sustained economic development to a region of the world too often subject to the whims of more powerful neighbors. An increase in market priced renewables will eventually play an important role in achieving energy security. But for the present, renewables rely for the most part on substantial government subsidies. Resource nationalism may also slow the development of unconventional energy supplies. Political indecision can prolong a country's dependency on expensive and insecure energy imports. Also, it confers advantages to inexperienced and less technologically capable and poorly financed national firms over experienced foreign firms. Favoring domestic firms can slow a country's long-term growth prospects by undermining the country's attraction for world-class overseas investors.

In summary, the fear of hydraulic fracturing that is being promoted in much of Central and Eastern Europe threatens to keep the region dependent on powerful and nontransparent foreign economic and political interests. The answer to this fear is widespread education regarding the best science and actual field experience. A greater awareness of the reality concerning hydraulic fracturing will better serve the security and economic development interests of this region so important to European and trans-Atlantic relations. In today's world, strong, vibrant economies on both sides of the Atlantic are essential if the major issues of war, peace and prosperity are to be resolved. Greater domestic energy production carried out in an environmentally responsible manner can add significantly to Central and Eastern Europe's ability to play a strong role on the world scene.