Center for American Progress

Making Fracking Safe in the East and West

Environmental Safeguards on Shale Gas Production Needed as China Begins Development

Melanie Hart, Daniel J. Weiss
October 2011

New and improved horizontal drilling, combined with hydraulic fracturing technologies, enable the United States to develop its abundant supply of natural gas from shale rock deep below the earth's surface. China holds huge shale reserves as well and plans to follow suit. It would like to import technologies from the United States to do so, but the United States and its oil companies should not supply China with hydraulic fracturing technology without combining that technology with safety standards and environmental best practices. This includes capturing fugitive greenhouse gas emissions, monitoring the chemicals used in fracking fluid, and treating the wastewater to avoid contaminating local waterways.

This brief will review the factors leading China to seriously consider shale gas development and the potential problems the country faces in making this development a reality. It then examines shale development in the United States before closing with recommendations on how both countries can safely extract shale gas.

We start with a brief look at what shale gas is and the potential environmental problems shale development can produce if it does not follow best practices.

What is shale gas?

Shale gas is natural gas trapped in shale rock deep below the earth's surface. Until recently, it was inaccessible for development due to its depth and concentration. New advances in horizontal drilling techniques combined with hydraulic fracking technology have enabled producers to capture this once elusive resource.

Environmental concerns in shale gas development

Shale gas can reduce greenhouse gas emissions. Natural gas burns much more cleanly than coal or oil, so it produces less acid rain, smog, and toxics that damage public health and contribute to global warming. This is why many experts believe that shale gas could be the bridge between our fossil fuel reliance in the 20th century and clean renewable energy in this one.

Shale gas production, however, presents many pollution threats to the people of both nations that could negate its benefits. This includes surface and drinking water contamination, air pollution, and global warming pollution.

U.S. President Barack Obama and Chinese General Secretary Hu Jintao recognized the importance of shale gas development to their nations by agreeing to the U.S.-China Shale Gas Resource Initiative in November 2009. This agreement fosters cooperation between these two nations by providing U.S. assistance to assess, develop, and promote investment in China's shale gas reserves and to help develop operational best practices and effective environmental safeguards in China.

Our two nations are already making good progress on the exploration and development aspects of this agreement. But environmental cooperation is lagging behind. This is partly because the United States is still struggling to develop the most effective regulatory model for safeguards here at home.

Significantly more work is needed to ensure that both countries maximize the benefits from shale gas development—namely reducing oil imports and pollution—while minimizing the environmental risks.

Below we outline the available shale gas resources, primary pollution concerns, and environmental regulatory bodies in both nations.

TABLE 1

Shale gas production in China and United States

	China	United States
Shale gas reserves	1,300 trillion cubic feet	862 trillion cubic feet
Shale gas production 2010	0	4.8 trillion cubic feet
Shale gas production 2015	229 billion cubic feet*	7.2 trillion cubic feet
Shale gas production 2020	2.8 trillion cubic feet*	8.2 trillion cubic feet
Major environmental threats from shale gas production	Methane, carbon dioxide and hydrogen sulfide release; water use in a country already facing severe water shortages	Surface and groundwater contamination; air pollution; methane release
Primary regulatory body	China does not yet have a specific regulatory framework for shale gas, but the critical regulators will be the Ministry of Land and Resources (exploration permits), the Water Ministry (water use and wastewater treatment), and the Ministry of Environmental Protection (emissions monitoring)	States regulate toxic chemical disclosure, groundwater contamination; Federal govt. sets air and water pollution standards; no controls on methane

*=Chinese targets based on the latest proposals from China's National Energy Administration. They do not yet have higher-level approval, and senior leaders may reduce them to account for environmental and water conservation concerns. These NEA targets are included to illustrate China's intentions rather than provide an accurate projection of future shale gas production.

Sources: Energy Information Administration; CAP research

China's interest in shale gas development

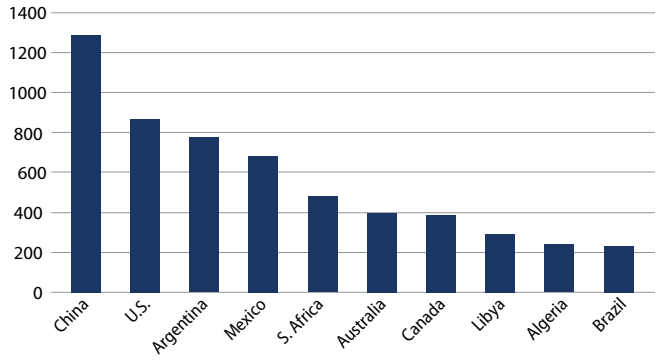
From the Chinese perspective, the more homegrown energy supplies they can add to their current energy mix the better. China and the United States are the world's largest energy consumers and greenhouse gas emitters. Both nations are blessed with ample homegrown energy supplies, but both also import significant amounts of oil. China also imports increasing amounts of coal and natural gas to power its ever-expanding economy.

Price and supply fluctuations in China's oil and coal imports triggered disruptive electricity blackouts in 2011, and that has increased their interest in shale gas, which should be a more stable and predictable energy source since China's resources appear to be abundant and the central government can more easily control the pricing for domestically produced energy supplies.

FIGURE 1

Estimated shale gas technically recoverable resources by country

(Trillion cubic feet)



Source: U.S. Energy Information Administration.

Over the long term, Chinese shale gas will be cheaper than importing liquefied natural gas over long-distance pipelines from Central Asia. But at least in the short term, shale gas will not be a game-changer in China as it has been in the United States where development is less costly and already underway.

China's shale gas developments thus far

The U.S. Energy Information Administration estimates that China has 1.275 trillion cubic feet of technically recoverable shale gas reserves. If that estimate is correct, China has the largest shale gas reserves in the world. (see chart)

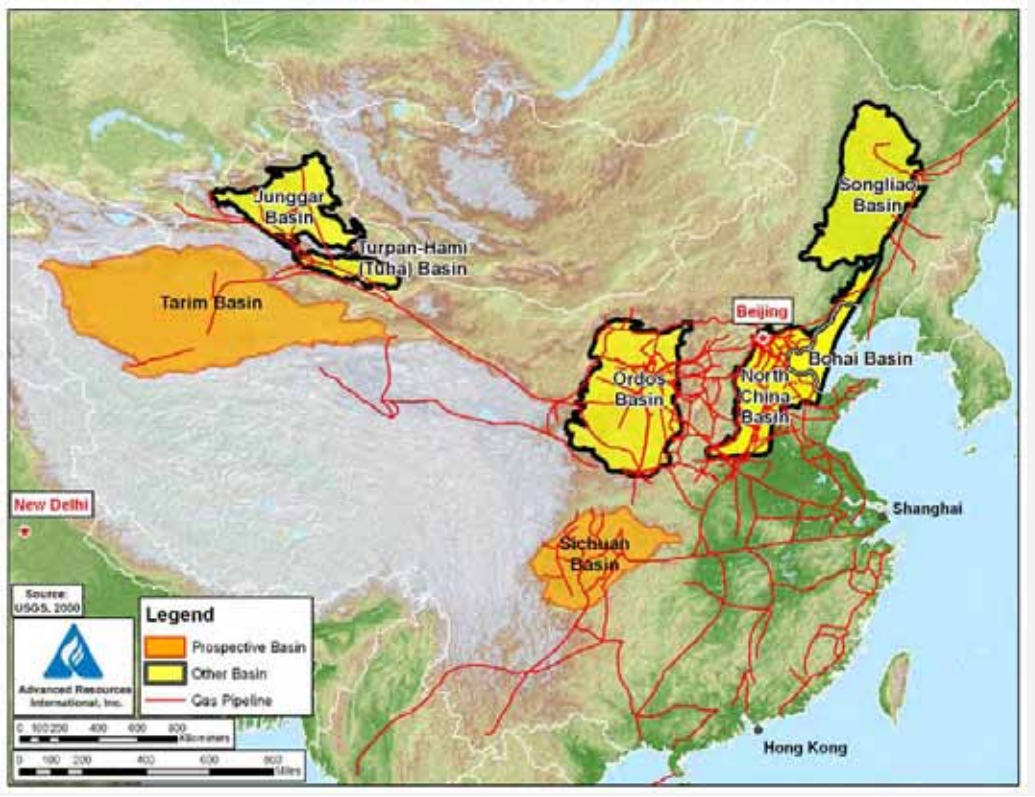
China has seven major onshore shale basins (see map on next page). But only two—Sichuan and Tarim—are well suited for commercial development. Those two basins contain marine shale with sufficiently high organic content and sufficiently low clay content to make the quality of the natural gas (based on the organic matter) worth the development costs.

The Chinese government thus far has only issued permits for the Sichuan basin, which is located much closer to China's urban and industrial demand markets and therefore offers a much better business case for developers.

China has not produced any shale gas for commercial use, and it is not clear how quickly it will ramp up production. China's National Energy Agency set a draft production target of 6.5 billion cubic meters or 229 billion cubic feet annually by 2015 and 2.8 trillion cubic feet annually by 2020. It is not clear, however, if those NEA targets are feasible or if they will receive central government approval.

FIGURE 2

China's key shale basins and natural gas pipeline system



Source: http://www.eia.gov/analysis/studies/worldshalegas/pdf/fullreport.pdf.

China's major state-owned energy companies are new to the shale gas industry, so they are teaming up with major international companies for shale gas exploration. The bilateral shale gas initiative with the United States led to multiple U.S.-China industry partnerships. Chevron, Shell, BP, EOG Resources, Newfield Exploration, ConocoPhillips, Schlumberger, and Baker Hughes have all been working on the ground in China to help the Chinese explore their shale potential.

Those partnerships are starting to pay off. Sinopec (working with BP) completed China's first successful hydraulic fracturing exercise (successfully used U.S. fracturing technology to extract shale gas) in May 2010. And PetroChina (working with Royal Dutch Shell) drilled China's first horizontal shale gas exploration well in Sichuan's Weiyuan block in March 2011.

China's Ministry of Land Resources, or MLR, launched the first round of bidding for China's first commercial development permits in June 2011. Only six state-owned energy companies were allowed to submit bids: PetroChina, Sinopec, Cnooc, Shaanxi Yanchang petroleum, CUCBM, and Henan Provincial Coal Seam Gas.

The MLR divided the Sichuan basin into exploration and development blocks and put four blocks up for bid. According to Chinese regulations, each shale block must receive at least three bids before it can be auctioned off. Only two blocks received enough bids—Nanchuan and Xiushan—so only those two blocks were licensed. SinoPec and Henan Coal Seam Development Corp. were the two winners.

The MLR is currently preparing to open up the second and third rounds of bidding. The second round will take place in the fourth quarter of 2011. That round will be open to private companies. The major foreign oil companies mentioned above are hoping to leverage their technology and know-how to gain access to China's shale market, but the second-round bidding will be limited to Chinese majority enterprises only.

China faces technical challenges

China faces several hurdles to developing its shale gas reserves. For one, there are several characteristics of China's shale deposits that will raise development costs. Compared to the United States, China's shale deposits are generally located deeper underground. They also contain more nonhydrocarbon gasses—particularly hydrogen sulfide, possibly carbon dioxide and nitrogen—and they are located in rougher (more hilly/mountainous) terrain.

China also lacks the technology to develop these deposits. China's oil companies are depending heavily on the United States for shale technology.[1] Their firms are acquiring overseas assets to gain horizontal drilling and hydraulic fracturing technology in addition to the exploration partnerships mentioned above. PetroChina, for example, purchased stakes in Australia's Arrow Energy, and Sinopec recently announced a deal to acquire Daylight Energy, a Canadian shale producer. CNOOC purchased stakes in Chesapeake Energy (United States) and Exoma Energy (Australia).

But the proven technology solutions developed for the U.S. market may not be a good fit in China since China's shale deposits differ geologically from those in the United States. And Chinese firms may struggle to adjust those solutions to fit local conditions. In addition, U.S. energy companies have limited influence on how their Chinese partners use U.S. technology and whether they employ the operational best practices developed in the United States—China is only awarding exploration and development rights to majority Chinese entities, so that means that the U.S. participants are always minority partners and cannot exert operational control.

Water shortages are another challenge. Shale development requires vast amounts of water, and that will be difficult in China where water supplies are already scarce. This is one reason why Chinese leaders are only issuing permits for the Sichuan basin, where water scarcity is less of a problem than the arid Tarim basin.

China's pipeline infrastructure is also a potential bottleneck. The central government is working to increase pipeline capacity. But infrastructure expansion takes time, and current pipeline constraints will further slow Chinese shale development.

China's Ministry of Land and Resources announced a development target of expanding shale gas from 8 percent to 12 percent of China's natural gas production by 2020.

Natural gas currently accounts for 4 percent of China's domestic energy consumption, and Chinese leaders are aiming to increase that to 10 percent by 2020. At best, then, Chinese leaders are shooting for shale gas to account for around 1 percent of overall energy consumption by 2020.

Even in the best case scenario the actual greenhouse gas reductions from switching from coal to shale gas would be minimal in the near term since shale gas will only account for a small percentage of China's energy mix. The biggest short-term environmental issue, therefore, is the potential local environmental impacts from shale gas development.

Environmental challenges with Chinese shale gas

As in the United States, some in China are concerned that shale gas development could trigger a major pollution crisis.

U.S. environmental impact studies suggest that sound equipment and operational best practices are critical for protecting groundwater and limiting fugitive gasses from shale extraction. But development companies will not follow those best practices without strict environmental regulation. And environmental regulation is not something China is good at.

China's Environmental Protection Ministry, or MEP, is underfunded, and the ministry struggles to accurately monitor what is going on at the local level. Even when local-level Environmental Protection Bureaus, or EPBs, possess accurate information about local production operations, those officials are subordinate to the regional provincial, municipal, and county-level People's government units (similar to state, municipal, and county governments in the United States), and the People's government officials (who are responsible for the region as a whole) generally prioritize economic growth over environmental protection.

So where there are Chinese shale developments, if exploration and development activity produces harmful emissions or other pollution you can be sure that the local People's government (which earns tax revenue from commercial developments in their region) will use its budgetary and personnel authority to keep the local EPB quiet.

As in the United States, China's shale market developments are already outpacing legislation. Chinese leaders are working on a major environmental protection bill, the "Technology Policy for Preventing Environmental Pollution from Oil and Natural Gas Extraction."[2] But the current draft does not include guidelines for shale gas development, and it would be difficult to add in shale-specific guidelines at this point in the drafting process. China's guidelines for conventional gas will not be adequate for addressing the specific environmental concerns associated with shale.

China faces bigger air pollution risks since its shale gas deposits generally contain more poisonous hydrogen sulfide than U.S. deposits. Hydrogen sulfide is a toxic pollutant, and it is also highly corrosive, so it can corrode drilling equipment and increase fugitive emissions of other pollutants such as methane. Preventing these problems will require strict emission standards and advanced drilling and gas purifying technology—two things China will struggle with.

But even though China's environmental regulators are relatively weak and underfunded, we can expect China to be stricter on water issues than U.S. regulators. In general, China's Water Ministry has more political power than the MEP because China suffers from severe water shortages. And when China's water supplies are too low or too polluted that shuts down industrial production. (Air pollution does not have the same immediate economic impact.)

China has a history of shutting down factories or forbidding certain production practices because they use or contaminate too much water. The central government capped coal production in the 12th five-year plan to address water concerns, and Chinese leaders already restrict permits for new coal liquefaction projects due to their high water consumption rates.

Water shortages are one reason China is only issuing development permits for the Sichuan shale basin, not for the Tarim. China's water concerns will almost certainly result in tighter regulations for wastewater treatment at shale development sites, which is something we already see in other Chinese industries.

United States shale gas development

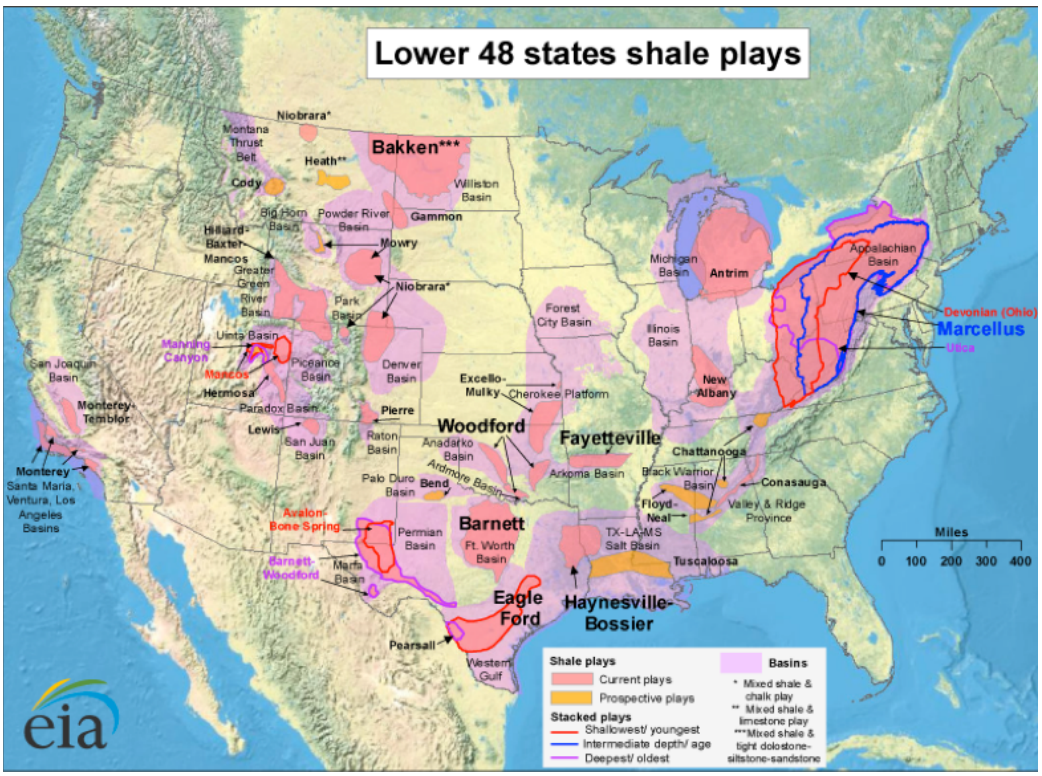
Pulitzer Prize-winning energy author Daniel Yergin notes how quickly natural gas from shale formations joined the energy mix in the United States:

> *Shale gas really has been a revolution that's happened extremely rapidly… It's gone from being virtually none of our natural gas production to about 30 percent of our total natural gas production.*

This big change in the U.S. energy portfolio is the result of technological advancements to produce significant amounts of shale gas. These gas reserves are locked within shale rock deep in the earth. Improvements in horizontal drilling combined with hydraulic fracturing or "fracking" enables companies to free and collect the natural gas otherwise trapped in the shale rock.

FIGURE 3

Shale gas plays in the lower 48 states



Source: Energy Information Administration based on date from various published studies. Updated: May 9, 2011.

The ability to collect this formerly unavailable natural gas has increased projected resources by one-third to 2.5 trillion cubic feet of gas. This is "enough to supply over 100 years of use" according to the Energy Information Administration.

Annual U.S. shale gas production increased by 15 times between 2000 and 2010, from 0.3 trillion cubic feet to 4.5 trillion cubic feet. Shale gas composed a much greater portion of the U.S. natural gas supply between 2000 to 2009, growing from 2 percent to 14 percent. EIA projects that in 2035 shale gas will provide nearly half of all total U.S. natural gas supply.

The largest shale gas play is the Marcellus that runs from upstate New York through Western Pennsylvania, eastern Ohio, West Virginia, and eastern Kentucky. As of January 2009, it held more than half of the "undeveloped technically recoverable shale gas" remaining in shale plays according to EIA.

Two of the early plays developed were the Barnett shale around Ft. Worth and the Haynesville play on both sides of the Texas-Louisiana border. These two hold an estimated 6 percent and 10 percent, respectively, of the undeveloped shale gas.

TABLE 2

Environmental laws and exemptions for the oil and gas industry

Environmental law	Exemption
Safe Drinking Water Act	Hydraulic fracturing exempt from regulation
Clean Water Act	Oil-and-gas operations exempt from stormwater runoff regulation
Clean Air Act	Oil-and-gas exploration and production exempt from the act's regulation of aggregated small sources of air pollutants
Emergency Planning and Community Right to Know Act	Oil-and-gas exploration and development exempt from reporting toxic emissions in the Toxic Release Inventory
Resource Conservation and Recovery Act	Oil-and-gas field wastes exempted from control
Comprehensive Environmental Response, Compensation, and Liability Act	Oil and gas are not defined as hazardous substances
National Environmental Policy Act	Oil-and-gas development enjoys broad categorical exclusions from comprehensive environmental impact statements

Environmental challenges with U.S. shale gas production

Producing natural gas from these and other shale plays is no simple task, though. The fracking process involves injecting huge volumes of water mixed with sand and chemicals deep underground to fracture rock formations and release trapped gas. This process risks contamination of underground drinking water supplies, as well as the contamination of surface water from the discharge of wastewater that is a byproduct of drilling. In addition, fracking can release previously trapped methane gas—a potent greenhouse gas pollutant. Finally, the surface fracking operations—including diesel trucks and generators—release the ingredients for smog, which also poses health risks.

Unlike air and water pollution from most other industrial sources, the federal government has very limited ability to require shale gas producers to reduce their water, air, and global warming pollution. Under pressure from big oil companies, Congress has exempted oil and gas production from numerous health and safety laws. (see table above) Consequently, the states have primary responsibility for establishing and enforcing safeguards for shale gas production.

For instance, many citizen groups and neighbors adjacent to fracking operations would like companies to provide full public disclosure of the toxic and other chemicals used in their fracking fluids. These operations are currently exempt from the Toxic Release Inventory reporting requirements under the federal Community Right to Know law, but states can require such disclosure.

Some companies have volunteered to disclose some information about the chemical components of their fracking fluid. But this is no substitute for industrywide reporting.

Some states have begun to require some disclosure in 2011:

> *Earlier this year, Texas became the latest state to draft regulations requiring the disclosure of chemicals used in the hydraulic fracturing process. Michigan and Montana issued similar regulations over the summer, joining Arkansas, Wyoming, and Pennsylvania as states recently active in regulating hydraulic fracturing.*

It is also up to the states to establish drinking water safeguards for fracking. The Energy Policy Act of 2005 exempts fracking from the safe underground disposal requirements of the Safe Drinking Water Act.

The U.S. Department of Energy, however, found that "state laws generally give the state oil and gas director or agency the discretion to require whatever is necessary to protect human health and the environment." This means that agencies responsible for natural gas production—not agencies with responsibility and expertise for health or environmental protection—develop and implement drinking water safeguards for fracking.

Such an oversight system may be why ProPublica, a nonprofit investigative journalism organization, "reported about hundreds of cases of water contamination in more than six states where drilling and fracking are taking place" since 2008.

Fracking can also contaminate surface rivers and lakes due to the discharge of its wastewater into these waters or sewage treatment plants not designed to remove fracking-related pollutants. These contaminants pass through partially or completely untreated into the receiving waters.

A *New York Times* investigation found that:

> *A well can produce over a million gallons of wastewater that is often laced with highly corrosive salts, carcinogens like benzene and radioactive elements like radium, all of which can occur naturally thousands of feet underground. Other carcinogenic materials can be added to the wastewater by the chemicals used in the hydrofracking itself.*
>
> *Wastewater… is sometimes hauled to sewage plants not designed to treat it and then discharged into rivers that supply drinking water.*

Air pollution is also a byproduct of fracking. The Environmental Protection Agency determined that fracking produces carcinogens such as benzene and toluene, volatile organic compounds that contribute to smog, and methane.

Fortunately, EPA has the authority to require reductions of these pollutants, and this July it proposed standards to achieve:

… nearly 95 percent reduction in VOCs emitted from new and modified hydraulically fractured gas wells. This significant reduction would be accomplished primarily through use of a proven technology to capture natural gas that currently escapes to the air. That gas would then be made available for sale… the proposed rule is anticipated to quickly result in a net savings of nearly $30 million annually.

The proposed reduction standards must be finalized by February 2012.

In President Barack Obama's March 30, 2011 energy proposal he noted that shale gas could play a large role in U.S. energy policy, particularly with the mitigation of these environmental impacts:

Recent technology and operational improvements in extracting natural gas resources, particularly shale gas, have increased gas drilling activities nationally and led to significantly higher natural gas production estimates for decades to come.

The Administration is taking steps to address these [environmental] concerns and ensure that natural gas production proceeds in a safe and responsible manner.

As part of this effort the president asked Secretary of Energy Steven Chu to convene an Advisory Board Shale Gas Production Subcommittee. Its charge was:

To identify, within 90 days, any immediate steps that can be taken to improve the safety and environmental performance of fracking and to develop, within six months, consensus recommended advice to the agencies on practices for shale extraction to ensure the protection of public health and the environment.

The first set of recommendations was issued on August 11, 2011. They focused on immediate steps that shale gas producers could take to reduce the pollution threat posed by fracking.

They included the following steps:

- "Improve public information about shale operations," and make it easily available.
- "Improve air quality: Reduce emissions of air pollutants, ozone precursors, and methane as quickly as practicable. The Subcommittee supports adoption of rigorous standards for new and existing sources of methane, air toxics, ozone precursors and other air pollutants."
- "Protection of Water Quality" by industry adoption of "best practices" for well development and construction, and other operations. Conduct baseline assessments of water contamination before fracking begins to better assess new contamination.
- Prompt public "disclosure of fracturing fluid composition."

- Reduce "the use of diesel fuel … there is no technical or economic reason to use diesel … [reduce] the use of diesel engines for surface power in favor of natural gas engines or electricity where available."

The subcommittee is in the midst of a second 90-day review period when it plans to focus more on the "regulatory schemes in place" to reduce environmental contamination, as well as "the creation of a timetable and action plan for implementation of the Subcommittee's recommendations." The second review should speed oil and gas companies' implementation of the earlier recommendations, as well as provide guidance about the appropriate federal and state enforcement roles. In addition, the National Academy of Sciences should undertake a comprehensive and credible study of the lifecycle greenhouse gas emissions from the production and use of shale gas.

Bilateral shale gas cooperation: Safeguards are essential in both nations

The U.S.-China Shale Gas Resource Initiative aims to provide U.S. technical assistance to China across all aspects of shale gas development, including safety and environmental protection. So far, however, China's policymakers have paid little attention to safeguards. This follows the U.S. model. Shale gas production here has far outpaced the establishment and enforcement of pollution protections.

Environmental protection remains a low priority for both sides. Neither nation wants to risk the commercial potential of China's shale gas by vigorously pursuing environmental protection there. Most of the U.S. companies involved in these bilateral exploration and development projects want to exchange assessment and extraction technology for Chinese commercial market access.[3] The Chinese want technology transfers from the United States that include the more mature and advanced technologies that the United States often holds back due to intellectual property right concerns.[4]

Now that the initial exploration phase in China is complete, the United States must help prevent the environmental consequences of Chinese shale gas production. If China does not follow best practices to capture greenhouse gases, it is highly likely that shale development will *increase* China's emissions instead of decreasing them. And that will worsen climate change.

A major Chinese environmental disaster, such as groundwater pollution, could be devastating for China's economy. It could also easily increase public opposition to fracking in the United States, just like the Fukushima nuclear meltdown in Japan increased American opposition to nuclear power. The U.S. companies involved in China's shale industry therefore have a strong incentive to support bilateral environmental protection efforts.

Energy producers with new technologies are far ahead of environmental safeguards. In China, this struggle will be even bigger than it is here in the United States because the

Chinese are importing this technology from us and starting a new industry overnight. China's Environmental Protection Ministry has not conducted extensive studies on shale gas development, and Chinese journalists have recently begun traveling abroad to study our shale developments and learn from our experiences and concerns.[5] But that education process will take time—just as it did here—and China's environmental activists face more constraints than their U.S. counterparts.

In sum, the United States and its oil companies should not export hydraulic fracking technology without pairing that technology with safety standards and best environmental practices.

Melanie Hart is a Policy Analyst on China Energy and Climate Policy and Daniel J. Weiss is a Senior Fellow and the Director of Climate Strategy at American Progress.

Endnotes

Note: All translations are the authors' own.

1 Lin Nan and Chen Shaozhi, "Ye yan qi ge ming: jie ti tian ran qi shi bi ran qu shi?" (Shale Gas Revolution: Is the Trend to Replace Natural Gas Inevitable?), Xinhua Caijing (Xinhua Finance and Economics), May 4, 2011, available at: http://news.xinhuanet.com/fortune/2011-05/04/c_121377374.htm.

2 China's Environmental Ministry, "Shi you tian ran qi kai cai ye wu ran fang zhi ji shu zheng ce" (Technology Policy for Preventing Environmental Pollution from Oil and Natural Gas Extraction), available at http://www.mep.gov.cn/pv_obj_cache/pv_obj_id_9766690D3434D92868EDCF076B6C6C7710570200/filename/W020091019369619465677.pdf.

3 "Zhong mei ye yan qi he zuo: ge you suo tu" (China-United States Shale Gas Coopeation: Each Side Has its Own Plans), Zhongguo Huagong Bao (China Chemical Industry News), June 8, 2010, available at: http://www.cheminfo.gov.cn/ZXZX/page_info.aspx?id=276022&Tname=hgyw&c=10.

4 Ibid.

5 "Ye yan qi kai cai wei xie di xia shui" (Shale Gas Development Threatens Groundwater), Xin Shiji (21st Century), September 12, 2011, available at: http://finance.sina.com.cn/roll/20110912/033410466235.shtml.