

Shale Gas

A renaissance in US manufacturing?

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With contribution from
National Association of
Manufacturers

At a glance

Lower feedstock and energy costs from shale gas could help US manufacturers.

More chemical, metal, and industrial manufacturers are communicating to investors that shale gas developments have driven demand for their products.

US manufacturers could employ approximately one million more workers by 2025.



Introduction

The economic environment remains difficult for many US manufacturers, with soft demand and margin pressures making it harder to grow their domestic workforces. In this analysis, we present our point of view on how shale gas resources can help the sector address these challenges and create more jobs in the United States.

Executive summary

Shale, savings, growth, and jobs

During the last couple of years, increased commercialization of alternative energy has ushered in mounting debate on the impact—or lack of impact—that the deployment of new energy sources has on US job creation. Shale gas is one such alternative energy source that has drawn momentous investment and discussion as the country pursues a cleaner and more sustainable energy mix. Indeed, the shale gas industry has captured national attention, with even the names of reserves—Marcellus, Utica, Bakken, Barnett, and Eagle Ford—recognizable as national assets by even the casual observer... And for good reason. The amount of shale gas in these reserves and others potentially makes the United States one of the top producers of shale gas in the world.

While there has been a sharp focus cast upon shale gas—both on its potential promise and possible drawbacks—as a tenable energy source, there has been less focus on how shale gas impacts other industries. This led PwC to ask a simple but important question: “What could a growing shale gas industry mean for manufacturing job creation in the United States going forward?”

Potential opportunities

A PwC analysis finds that full-scale and robust shale gas development through 2025 would likely have a number of knock-on effects for other industries, particularly the manufacturing and chemical sectors. Given a scenario calling for high recovery of shale gas and low prices of natural gas, the US manufacturing sector and the broader US economy could stand to benefit in the following ways:

Energy affordability

Lower feedstock and energy costs could help US manufacturers reduce natural gas expenses by as much as \$11.6 billion annually through 2025.

Demand growth

In 2011, 17 chemical, metal, and industrial manufacturers commented in SEC filings that shale gas developments drove demand for their products, compared to none in 2008.

More jobs

US manufacturing companies could employ approximately one million more workers by 2025 due to benefits from affordable energy and demand for products used to extract the gas.

This report demonstrates how shale gas can lead to each of these opportunities, based upon our analysis of trends in, and forecasts of, the domestic economy, manufacturing, and employment.

An increase in domestic investment

With shale gas resources more abundant than previously thought, US manufacturers can look forward to multiple new opportunities and a significant uptick in employment in the sector. Chemicals and metals companies are expected to gain the greatest benefit over the next several years. Chemicals companies can acquire affordable feedstock, meriting greater capital expenditures in the United States. For metals companies and some industrial manufacturers, opportunities abound to sell the equipment required for more robust drilling activity.

Many companies have already announced new investment plans geared to the development of shale gas. Our research on recent capex plans shows an increase in domestic investment going to support

incremental gas production, along with more explicit communication to investors about shale-related growth opportunities. An underappreciated part of the shale gas story is the substantial cost benefit to manufacturers, based on estimates of future natural gas prices as more shale gas is recovered. Historically, there has been an indirect relationship between the level of energy prices, such as those for natural gas, and the level of domestic manufacturing employment, as manufacturers consume approximately one-third of all the energy produced in the United States. Consequentially, this relatively abundant domestic energy source has the potential to drive an uptick in US manufacturing over the long term and create new jobs in the sector.

Figure 1: Estimated shale gas and reported natural gas reserves, trillion cubic feet (tcf), 2009

| | Proved natural gas reserves | Technically recoverable shale gas |
|----------------------------------|------------------------------------|------------------------------------------|
| United States | 273 | 862 |
| Total of regions surveyed | 1,274 | 6,622 |
| Total world | 6,069 | N/A |

Source: EIA, "World Shale Gas Resources: An Initial Assessment of 14 Regions Outside the United States," April 2011; Total world technically recoverable shale gas reserve estimate not available as Russia, Central and Southeast Asia, Middle East, and Central Africa were not included in the EIA assessment due to conventional reserves and limitations of information/funding.

Revival of a domestic energy source

Interest in shale gas has increased as technology has reduced extraction costs. Techniques include horizontal drilling—drilling down and then turning the drill horizontally—which allows multiple wells to be drilled from one location, increasing productivity, and hydraulic fracturing or “fracking,” which uses a mixture of primarily sand and water to create pressure inside a well, crack the shale rock, and bring natural gas to the surface.

Opinions on the level of shale gas reserves have varied significantly, but estimates of technically recoverable reserves have generally increased over time. In April 2011, the US Energy Information Administration (EIA) estimated that the United States had 862 tcf of technically recoverable shale gas during 2009.¹ This figure represents:

The second-largest reserve amount among countries included in the survey

13% of the total estimate from basins in 32 countries sampled

More than three times the EIA estimate of existing proved natural gas reserves in the United States

Per EIA estimates, the Marcellus basin, located primarily in the mid-Atlantic, is considered the largest shale deposit in the United States with 410 tcf of technically recoverable natural gas.² However, a more recent assessment from the United States Geological Survey (USGS) estimates approximately 84 tcf of technically recoverable gas in this formation, underscoring the uncertainty around these figures.³ The EIA has indicated that it will use the new USGS figures, which are roughly 80% lower than the earlier EIA estimate, in its model. This new USGS estimate is also noteworthy because it compares with the USGS’s own 2002 estimate of Marcellus shale gas of 2 tcf. Thus it illustrates how entities have generally increased their own shale gas estimates over time due to technological improvements.

In addition to the difference between the EIA and USGS numbers, other sources also vary in their assessment of total shale gas in the United States, e.g., the Potential Gas Committee estimate of 687 tcf, or 36% of total potential resources,⁴ and ICF International estimate of 1,394 tcf.⁵ While these estimates may vary, shale gas looks to be integral to future US natural gas production. In the EIA’s Annual Energy Outlook 2011,⁶ shale is forecasted to drive an increase in domestic natural gas production through 2035. Without this contribution, total natural gas production would decline.

1 <http://www.eia.gov/analysis/studies/worldshalegas/>

2 http://www.eia.gov/pub/oil_gas/natural_gas/data_publications/crude_oil_natural_gas_reserves/current/pdf/table13.pdf

3 <http://www.usgs.gov/newsroom/article.asp?ID=2893>

4 <http://www.potentialgas.org/>

5 http://www.ontarioenergyboard.ca/OEB/_Documents/EB-2010-0199/ICF_Market_Report_20100820.pdf

6 <http://www.eia.gov/forecasts/aeo/>

Affordable feedstock/energy and more demand from energy end market

Manufacturing industries can benefit from additional natural gas production due to two key factors:

Lower feedstock/energy costs resulting from an increased and stable supply

Incremental demand for products needed to extract the gas

To assess the potential feedstock/energy cost benefit from shale gas, we took the annual volume of natural gas consumed by US manufacturers from the most recent Manufacturing Energy Consumption Survey (MECS)⁷ and estimates of future wellhead gas prices under high, reference, and low shale gas recovery scenarios.⁸ The most recent MECS indicates that US manufacturers used 5,911 trillion Btu of natural gas (not including natural gas liquids, or NGLs), during 2006 for all purposes.

As shown in Figure 2, using the EIA high shale recovery case scenario (50% more gas is recovered from each shale formation vs. the reference case), for natural gas prices and assuming consistent levels of volume yields a total cost of natural gas to manufacturers of \$27.0 billion and \$31.6 billion in 2025 and 2035, respectively. However, in the low shale recovery case (50% less gas is recovered from each shale formation vs. the reference case), natural gas costs for the manufacturing sector could increase 43%, to \$38.7 billion, in 2025, and 35%, to \$42.7 billion, in 2035. A limitation of this analysis is that natural gas is an elastic

commodity, so changes in prices should lead to changes in the quantity demanded. However, even when considering potential adjustments to volume, it is clear that US manufacturers can receive substantial cost advantages with increased shale gas supply.

Another way to judge the impact of shale gas on manufacturers is to review public disclosures by executives. Our survey of SEC filings for US chemicals, metals, and industrial manufacturers from 2008 through mid-October 2011 (Figure 3), shows a significant increase in the number of companies commenting to the investment community about shale gas potential. The total number of companies that disclosed shale gas impacts in 2011 (through October 15), easily surpassed that of the last three years combined, indicating growing importance in the outlooks of US manufacturers.

An interesting underlying trend in the data is the relative increase in companies that view shale gas activity as a source of growth in demand for their own products. Based upon the research of these industries, there were 17 US manufacturers disclosing higher demand due to shale gas development so far in 2011 and none in 2008. The rapid increase makes sense given that companies that sell goods such as metal tubular products and drilling and power-generation equipment are likely to experience near-term growth in sales as domestic natural gas production rates move higher. Higher production levels would yield positive impacts even further upward in the value chain; for example, manufacturers of components used in drilling equipment should also benefit.

⁷ <http://www.eia.gov/emeu/mecs/mecs2006/2006tables.html>

⁸ <http://www.eia.gov/forecasts/aeo/>

Figure 2: Natural gas cost sensitivity analysis

Total US manufacturers estimated annual natural gas expenses under high and low shale gas recovery/price scenarios, \$ billion

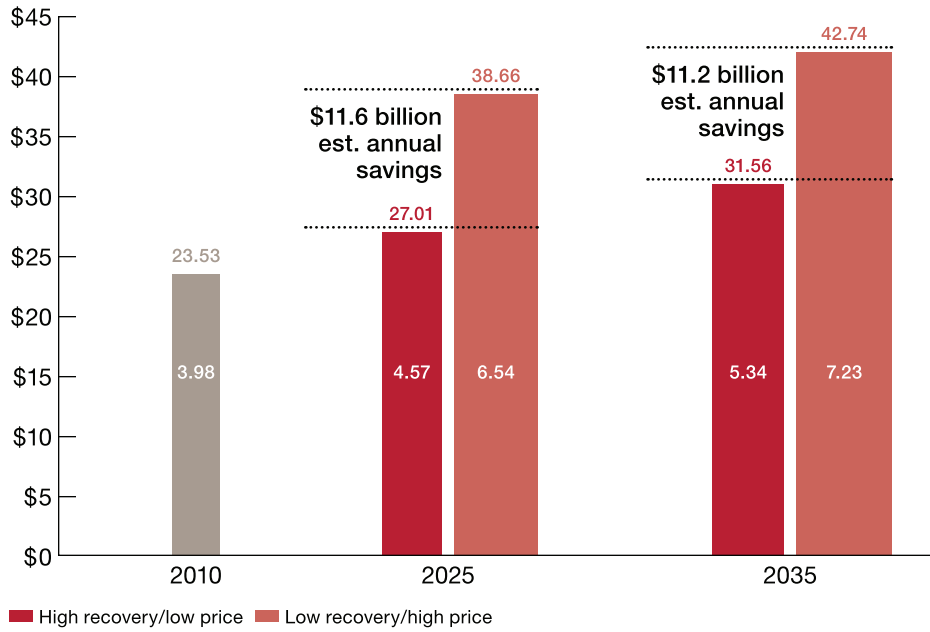
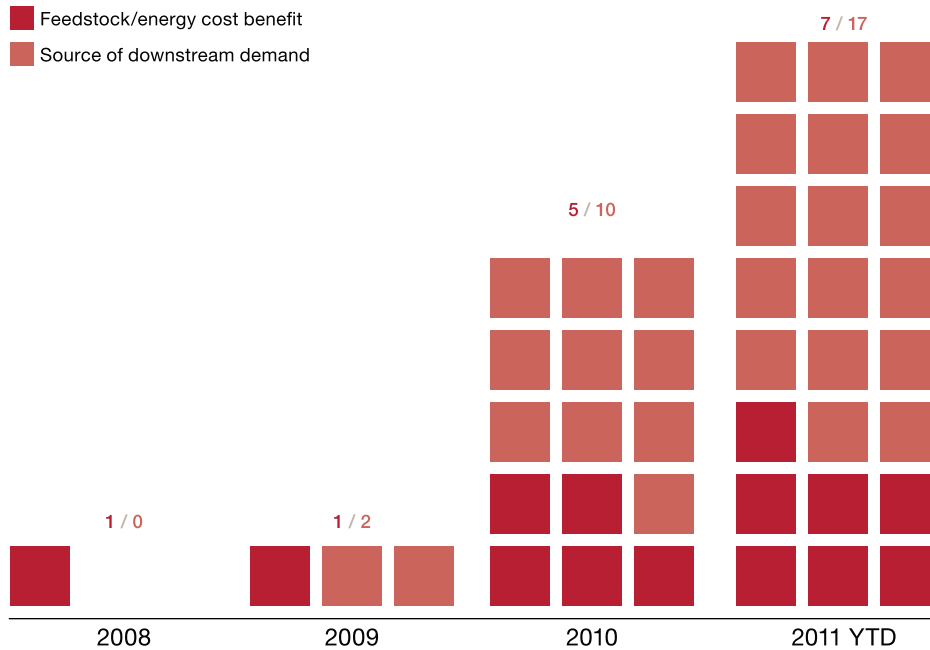


Figure 3: Manufacturers disclosing impact from shale gas, 2008–2011 YTD

Number of chemical, metal, and industrial manufacturers disclosing shale gas impacts



“The safe production of shale gas has been a game-changer in a variety of regions and among a variety of sectors throughout our economy—notably manufacturers. At a time when national economic and employment indicators are uncertain at best, shale gas producers and their vast and dynamic supply chain are providing families and communities jobs and economic development at a time when they’re needed most. The Marcellus Shale is a case study in the transformative impact of the natural gas industry. In Pennsylvania and surrounding states, tens of thousands of jobs are now supported by our industry and dozens of sectors—from steel to construction firms—have been revitalized through the promise of clean-burning and abundant American energy.”

Kathryn Z. Klaber
President, Marcellus Shale Coalition

Investment story in the United States begins to play out

There are numerous examples of shale gas already contributing to greater manufacturing investment in the United States. Most of these announcements are from chemical companies seeking cost advantages over foreign competitors. The cost difference comes from less expensive ethane, a natural gas liquid derived from shale gas. Ethane is used heavily in US chemicals plants, while overseas competitors tend to rely more on oil-based naphtha. In addition, manufacturers outside the chemical industry have also announced expansion plans due to incremental energy resources. Some of these cost-based rationales among chemicals and other manufacturers include:

Dow Chemical plans to build a new ethylene unit on the Gulf Coast by 2017; restart a dormant ethylene unit in Louisiana by 2012; increase ethane feedstock flexibility at Louisiana and Texas locations (2014 and 2016, respectively); and construct a new propylene unit in Texas by 2015. Feedstock is expected to come from a variety of sources, but include supply contracts for Marcellus and Eagle Ford shale gas.⁹

Formosa Plastics plans to spend \$1.5 billion on an 800,000 mt/year ethylene plant and downstream assets in Texas by 2015, partly due to availability of shale gas feedstock.¹⁰

Chevron Phillips Chemical Co announced a feasibility study to be completed this year on the merits of constructing an ethane cracker and ethylene derivatives facilities at a current site on the Gulf Coast using shale gas feedstock.¹¹

Bayer Corp. is reported to be discussing opportunities with chemicals companies to build an ethane cracker at current sites in the middle of the Marcellus shale basin.¹²

Westlake Chemical will expand ethylene capacity in Louisiana by the end of 2012 and again in 2014, and may also expand in Kentucky to use expected lower-cost North American feedstock.¹³

Shell Oil is building a petrochemical refinery in the Appalachians due to Marcellus shale gas reserves.¹⁴

Nucor is building a \$750 million direct-reduced iron facility in Louisiana, and received a permit to build another plant, while securing a natural gas supply agreement that is expected to include nearby shale resources.¹⁵

9 Esposito, Frank. "Feedstock boon may aid processors." *Plastics News*, May 2, 2011 and "Dow Unveils Plans to Integrate and Grow North America Performance Business with Shale Gas Liquids." *Manufacturing Close-up*. April 30, 2011
10 Chemweek's Business Daily. August 1, 2011

11 "Contracts and Projects: May 2011." *Process Engineering*. June 6, 2011

12 Katz, Jonathan. "The New Black Gold." *Industry Week*. May 1, 2011

13 Chemweek's Business Daily. April 11, 2011

14 Begos, Kevin. "Shell to decide by end of year where to locate huge new gas plant: Pa., Ohio or W. Va." *Associated Press*. September 2, 2011

15 "Nucor breaks ground in Louisiana DRI project." *Steel Times International*. March 10, 2011

Several other companies are making investments in the United States based on the opportunity to sell equipment for shale gas plays. These include:

US Steel invested \$95 million in an Ohio plant to help meet demand from shale gas extraction activities.¹⁶

Vallourec is spending \$650 million on a new plant in Ohio to supply steel pipe for companies extracting shale gas.¹⁷

TMK IPSCO is constructing an R&D facility in Houston to develop products for North American resource markets, with demand expected from hydraulic fracturing and Marcellus shale.¹⁸ The company will also add a second pipe threading line to an Ohio facility to meet demand from Marcellus shale.¹⁹

These types of announcements are likely to become more common, with more companies outside the chemicals and metals industries planning new capital expenditures in the United States to take advantage of lower costs resulting from shale gas.

An affordable, reliable supply of natural gas can also lead to changes in manufacturing processes. Several domestic steel companies have indicated interest in using natural gas to produce direct reduced iron (DRI). Direct reduction can involve using natural gas to reduce iron ore pellets, which are then converted into steel via electric arc furnace. Nucor²⁰ and US Steel²¹ are examples of steel companies that have already made investments in DRI or are considering such investments.

The global impact of shale gas also could be significant. For example, under the old assumption that domestic supplies would be limited, companies built liquefied natural gas (LNG) import facilities in the United States; that trend has now reversed, and there is more interest in conversion to LNG export terminals. Because these imports are not needed as much in the United States, they can be used instead to meet demand in Europe and Asia, which could also help to lower gas prices in these regions and potentially contribute to some convergence of the regional differences in gas prices.

16 "Valley can be heart of industries." Tribune Chronicle. June 17, 2011

17 Mitchell, Adam. "From Exporter to Local Partner; French Steel-Tube-Maker Vallourec is Expanding Production Beyond its European Heartland, Says CEO Crouzet." The Wall Street Journal. July 18, 2011

18 Feser, Katherine. "Deal of the Week: Pipe maker to build home for research." Houston Chronicle. May 9, 2011

19 Kath, Jonathan. "The New Black Gold." Industry Week. May 1, 2011

20 "Nucor Announced Ground Breaking in St. James Parish Project." Nucor Corporation, accessed October 17, 2011. <http://www.nucor.com/investor/news/releases/?rid=1536511>

21 "U.S. Steel making play to reduce coke consumption, use natural gas." nwtimes.com, accessed October 17, 2011. http://www.nwtimes.com/business/local/article_788e5feb-2bf1-5748-82a8-30789d943196.html

Significant job creation potential

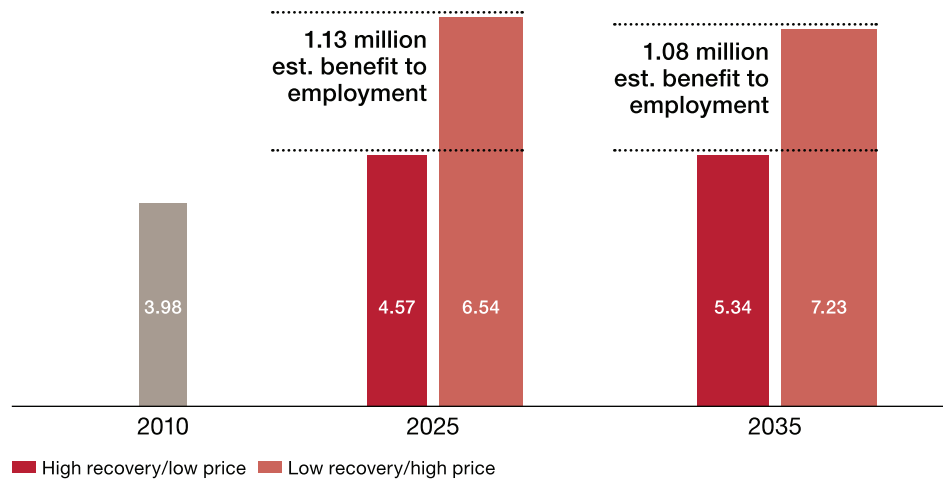
As companies expand and open more facilities in the United States, more manufacturing jobs will be created. PwC has estimated the potential benefit to manufacturing employment from lower natural gas prices, ceteris paribus. Based upon our regression model, there exists the opportunity to significantly boost US manufacturing in the future. Specifically, using estimates for natural gas prices under high and low shale recovery scenarios, we expect that manufacturing employment could increase by approximately one million workers at several future points in time in a high shale recovery scenario compared to low shale recoveries.

Shale gas-rich areas within the United States, including states around the Marcellus basin and the Gulf Coast, would likely benefit the most from this incremental employment. This is because, all other factors being equal, manufacturing investment is likely to flow to areas where the cost of transporting natural gas from shale deposits would be relatively low.

Other factors, such as productivity gains, can influence the overall level of employment. It seems reasonable, however, to expect that new shale gas resources could provide a significant long-term boost in US manufacturing employment. This presents an intriguing opportunity for the United States in light of the current labor market woes.

Figure 4: Natural gas employment sensitivity analysis

Estimated change in US manufacturing employment under high and low shale recovery/price scenarios, million



Source: BLS, EIA, PwC analysis

...we expect that manufacturing employment could increase by approximately one million workers at several future points in time in a high shale recovery scenario compared to low shale recoveries.

Potential limiting factors

An analysis involving shale gas needs to address potential headwinds.

One challenge is a need to build out infrastructure in regions that haven't already produced significant amounts of natural gas, e.g., the mid-Atlantic as it pertains to the Marcellus shale formation. This is relevant to manufacturers as well as other sectors, such as transportation, which could benefit from increased natural gas supplies, although views have varied on this subject. For example, in order to convert more of the US medium and heavy truck fleet to natural gas, more refueling facilities would need to be built. This would likely require government policy support in order to offset high upfront costs. However, such a transition in the transportation sector would also help manufacturers due to the need for new trucks, refueling equipment, and natural gas retrofit kits. Separately, evolving tax policies will also have a significant impact on shale gas production.

The environmental impact of hydraulic fracturing, the process used to create fractures in shale rock, must be studied more. The primary area of interest is the potential for contamination of water sources from chemicals used during fracking; several states have announced moratoriums on the process. Increased transparency regarding the chemicals used in fracking should help allay some environmental concerns. In addition, the Environmental Protection Agency (EPA) is conducting a study of the environmental effects of hydraulic fracturing, with preliminary results expected in late 2012. This will shape future opinion on environmental impacts. States also have an opportunity to enact regulations now that are reasonably strict and take into account local needs.

“More and more Americans are beginning to recognize the enormous potential of shale gas. The impact of increased shale gas development will ripple through our economy, with manufacturers, in particular, seeing great benefits. Shale gas development has the potential to boost manufacturing employment by one million jobs by the middle of the next decade.”

Jay Timmons
President & CEO, National Association of Manufacturers

Conclusion

Shale gas has the potential to spark a US manufacturing renaissance over the next few years, boosting revenue and driving job creation, as a result of several substantial advantages. These include greater investment in US manufacturing facilities, stemming from more affordable natural gas feedstock; and increased demand from the domestic energy end-market to increase natural gas production. Recent company announcements already indicate an upward trend in shale gas's positive impact on US manufacturers, from both investment and demand perspectives.

We believe that the factors are in place for these trends to continue, despite concerns and uncertainties over how, and to what extent, the United States should use its shale gas reserves. Several possible obstacles could prevent manufacturers from realizing the economic benefits of this resource.

The long-term energy cost advantages that manufacturers can gain through shale gas are also significant—and often a neglected part of analyses on shale's economy-wide effect going forward. We estimate a cost savings for US manufacturers of approximately \$11 billion annually, by combining recent natural gas consumption levels with potential natural gas prices under high and low shale recovery scenarios.

Another long-term economic benefit is the shale gas industry potential to significantly increase hiring. Given the historical relationship between domestic energy prices and manufacturing employment, we believe that a high-level of shale gas recovery could lead to approximately one million more manufacturing jobs by 2025, and by 2035, when compared to low shale gas recovery scenarios.

Clearly, greater investment in US manufacturing plants and higher levels of employment can be a boon to the US manufacturing sector. To achieve these positive results, however, manufacturers will likely need to become active stakeholders in the shale gas industry. Such advocacy means supporting certain tax and regulatory issues promoting the growth of the industry, as well as supporting environmentally safe and transparent gas extraction methods and public education and community outreach programs. While domestic energy companies will face many of these issues more directly, manufacturers will benefit only if shale gas is extracted profitably and safely. Effectively communicating the value that shale gas can create for US workers and communities is essential to achieving these outcomes.

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