Shale gas
Still a boon to US manufacturing?

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With contribution from National Association of Manufacturers and The American Chemistry Council

At a glance

US shale gas development is maturing swiftly. Its momentous growth is not only changing the country's energy mix, and affecting energy markets globally. It's also giving US manufacturing a boost through significant cost savings and jobs creation, according to a PwC analysis.

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Introduction

Shale gas activity in the US has taken root in the last several years, and its effects on the country's energy mix and energy independence have progressed beyond prognostication and shaped new realities. The 'shale effect' on manufacturing, too, is taking shape—making the US a more attractive locale due to relatively low energy and feedstock costs. This report takes a look at what shale gas has meant for US manufacturing and what may lie on the horizon.

Shale gas revisited

The surge in shale gas production and consumption in the US has proven a genuine game changer on a number of fronts including: strengthening US energy security and independence, and helping trigger a resurgence in US manufacturing.

Indeed, natural gas has altered the energy landscape in ways few would have foreseen just five years ago. Consider just a few milestones reached in large part due to domestic shale gas and oil activity. The US overtook Russia as the world's largest natural gas producer in 2010[1], and is projected to surpass Saudi Arabia and Russia as the global leader in oil production by 2015, according to the International Energy Agency(IEA).[2] Meanwhile, 84% of the country's energy demand was met through domestically produced energy in 2013, up from 69% in 2005,[3] as natural gas prices in the US fell some 75% over the same period. The US now eyes real prospects of becoming a significant exporter of liquefied natural gas.

So, what does this all mean for US manufacturing? According to a new analysis by PwC, shale gas development could have the following impacts on US manufacturing overall:

- Annual cost savings of $22.3 billion in 2030 and $34.1 billion in 2040.
- 930,000 shale gas-driven manufacturing jobs created by 2030 and 1.41 million by 2040.

The most likely beneficiaries in a scenario of continued low natural gas prices and high yields include energy-intensive manufacturing sectors such as metals, as well as those sectors—most notably chemicals and petrochemicals—which use natural gas as a feedstock. This report highlights major developments in the US shale gas industry and analyzes potential impacts on the US manufacturing sector.

1 International Energy Agency statistical database, retrieved on September 22, http://www.iea.org/statistics/statisticssearch/report/?country=USA&product=naturalgas&year=2010.

2 "U.S. to Be Top Oil Producer by 2015 on Shale, IEA Says", November 12, 2013.

3 "Domestic production satisfies 84% of total U.S. energy demand in 2013", retrieved on US Energy Information Agency. http://www.eia.gov/todayinenergy/detail.cfm?id=16511, June 2, 2014.

Shale gas fueling America's rise as global energy powerhouse

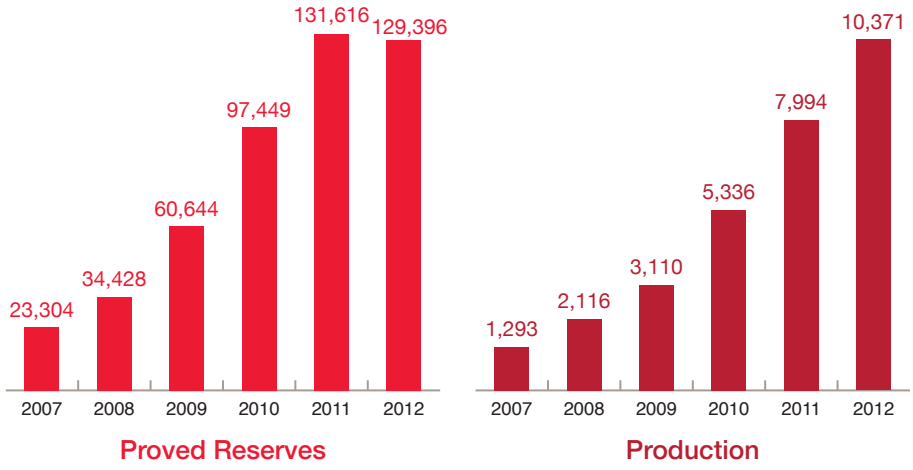
US production surges on

Shale gas production has continued to rise unabated over the last several years. With extraction of US (and Canadian) shale-derived fossil fuels being carried out quickly and in high volume, shale gas persists to change the face of North American energy mix. Shale resources comprise 29% of total US crude oil production and 40% of total US natural gas production.[4] The EIA (US Energy Information Administration) also estimates that shale gas represents 32% of all technically recoverable wet natural gas in the US.[5] Since 2007, shale gas production and proven reserves have risen steadily (see charts).

What is shale gas and fracking?

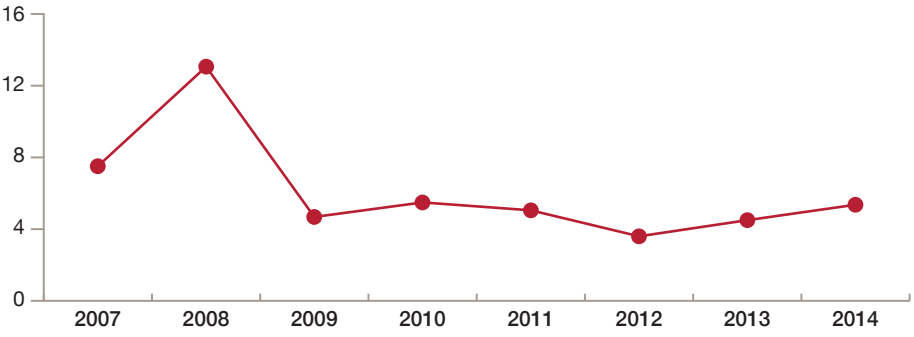
Hydraulic fracturing (fracking) is a technology for extracting trapped natural gas or oil through the fracturing of shale rock formations to increase the flow of the natural gas or oil, thereby enabling greater amounts to be recovered. The wells are either drilled vertically or horizontally and can be done to depths of thousands of feet. Fractures are produced by injecting fluids (containing water, proppant such as sand or ceramic pellets, and chemicals) at high pressure into shale fractures, which are enlarged, then kept open by the proppant. After the natural gas is extracted to the surface, a 'fracking' fluid (or so-called 'flowback' or 'produced water', a cocktail of water, sand and the injected chemicals) then rises to the surface through the wellbore, and is either treated or disposed of. Hydraulic fracturing requires much more water for deeper wells than conventional natural gas drilling.

Figure 1: US shale gas proved reserves and production, 2007-2012
(Billion Cubic Feet)



Source: "US Crude Oil and Natural Gas Proved Reserves, 2012" EIA, April 2014.
http://www.eia.gov/dnav/ng/hist/res_epg0_r5301_nus_bcfa.htm

Figure 2: Staying low: US natural gas prices 2004-2014
Industrial prices at July of each year, (US Dollars per Thousand Cubic Feet)



Source: US Energy Information Administration database,
http://www.eia.gov/dnav/ng/ng_pri_sum_dcu_nus_m.htm

4 Shale oil and shale gas resources are globally abundant, January 2, 2014, EIA website, http://www.eia.gov/todayinenergy/detail.cfm?id=14431.

5 "Technically recoverable shale oil and shale gas resources: an assessment of 137 shale formations in 41 countries outside the United States," EIA, June 2013.

Eyes now cast toward exporting LNG…

Prospects of the US growing into a significant exporter of LNG (liquefied natural gas) have grown, with a rising pool of companies applying for permits to export. The Department of Energy, Office of Fossils Energy, had received 44 applications to export domestically produced LNG from the lower 48 states as of October 21, 2014.[6] As of October 2014, FERC (Federal Energy Regulatory Commission) had approved four LNG export projects with 14 additional LNG export projects proposed to FERC.[7]

The timing for US exporters could likely be very good. Consider that 32% of China's natural gas consumed in 2013 was imported, up from 2% in 2006, according to the EIA. The country, which is keen on increasing its use of natural gas, presently has 10 regasification terminals. In 2012, it was the third-largest natural gas importer behind Japan and South Korea. In 2013, it imported 870 billion cubic feet (Bcf) of LNG, with 2014 imports forecast to be even stronger.[8]

…and on exporting shale gas know-how

A number of countries have begun to examine the production potential of shale formations in their countries. Poland, for example, has leased out shale lands and has drilled 43 test shale gas wells as of 2013. Argentina, Australia, China, England, Mexico, Russia, Saudi Arabia, and Turkey have also explored the potential in their shale formations.[9] With rising global interest in exploiting this resource, exporting hydraulic drilling know-how, technology, and hardware could present significant opportunities for US energy and oil and gas services companies and manufacturers that supply them.

Take China's push to build a domestic shale gas industry. While its natural gas production has tripled since 2003, its foray into shale gas has fallen short of expectations, despite having the world's highest technically recoverable shale gas reserves.[10] In 2013, China became the world's third-biggest natural gas consumer, following the US and Russia, and the International Energy Agency predicts China's consumption will nearly double by 2019. Due to difficult geology and high extraction costs, however, the country recently nearly halved its 2020 target for domestically developed shale gas.[11]

Energy infrastructure build-out also likely to benefit manufacturers

In addition to the shale-linked benefits to manufacturers discussed thus far, manufacturers could also benefit from the considerable volume of infrastructure (e.g., machinery, turbines, pipes) required to meet natural gas demand—not only in the US, but also in other countries—to ramp up their own natural gas development. Manufacturers supplying products needed for the continued build-up of infrastructure required for the extraction and distribution of shale gas (not to mention the infrastructure needed for exporting LNG in high volume) will likely be chief beneficiaries of the shale gas boom. Just consider, for example, that in 2013 alone, North America constructed (or planned for construction of) 41,810 miles of pipeline.[12]

6 "Summary of LNG Export Applications" US Department of Energy Fossil Energy Office, website retrieved on November 7, 2014, http://energy.gov/fe/downloads/summary-lng-export-applications-lower-48-states.

7 FERC Authorizes Construction of Cove Point Export Project," Docket No. CP13-113-000, FERC website, September 29, 2014; http://www.ferc.gov/industries/gas/indus-act/lng/lng-export-proposed.pdf.

8 "Natural gas serves a small, but growing portion of China's total energy demand," US Energy Information Administration, August 18, 2014.

9 Shale oil and shale gas resources are globally abundant, January 2, 2014, EIA website, http://www.eia.gov/todayinenergy/detail.cfm?id=14431.

10 "Natural gas serves a small, but growing, portion of China's total energy demand," EIA, August 18, 2014.

11 Orcutt, Mike, "China's Shale Gas Bust," August 12, 2014.

12 Rita Tubb, "Pipeline & Gas Journal's 2013 Worldwide Construction Report," Pipeline & Gas Journal, January 2013, Vol. 240 No. 1.

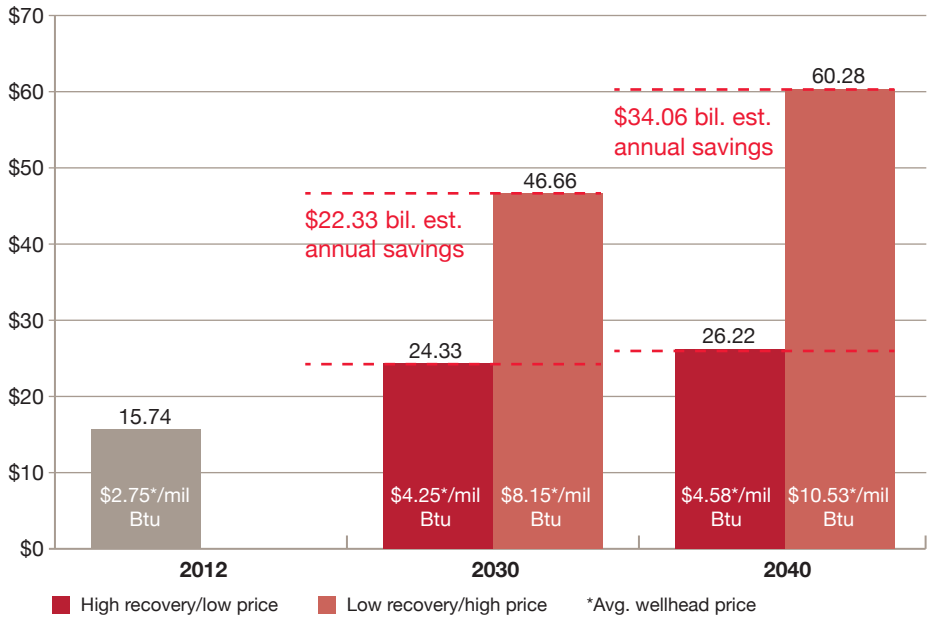
Continued low shale gas prices could save US manufacturers over $22 billion by 2030

Our analysis for this report looked at how low natural gas prices (largely due to increased shale gas resources) could translate into cost savings for US manufacturers through benefits of using natural gas as an energy source and as feedstock for manufacturing (with chemicals industry). While manufacturers could also naturally benefit from the incremental demand for products needed to extract natural gas, this benefit was not included in our analysis.

We estimated, based on our model, annual cost savings of $22.3 billion in 2030 and $34.1 billion in 2040, assuming a *high natural gas recovery and low-price scenario* were to persist[13] (see chart). Cost savings benefits could potentially be higher if the elasticity of demand is included. These potential savings are up markedly from a similar analysis carried out by PwC in 2011, which estimated that manufacturers could save up to $11.6 billion annually by 2025 and $11.2 billion by 2035 in a high-recovery, low-price scenario.[14]

In the *low shale recovery case* (i.e., 50% less gas is recovered from each shale formation vs. the reference case), natural gas costs for the manufacturing sector could increase 91% to $46.7 billion, in 2030, and by 130% to $60.3 billion, in 2040.

Figure 3: Natural gas/US manufacturing cost sensitivity analysis
Total US manufacturers estimated annual natural gas expenses under high and low shale gas recovery/price scenarios ($ billion)



Source: EIA, PwC Analysis

13 Note: To arrive at these estimates, we used the annual volume of natural gas consumed by manufacturers from the most recent Manufacturing Energy Consumption Survey (MECS) and estimates of future wellhead gas prices under reference, low and high shale gas recovery scenarios. The most recent MECS indicates that US manufacturers used 5,725 trillion Btu of natural gas (not including natural gas liquids, or NGLs) during 2010 for all purposes.

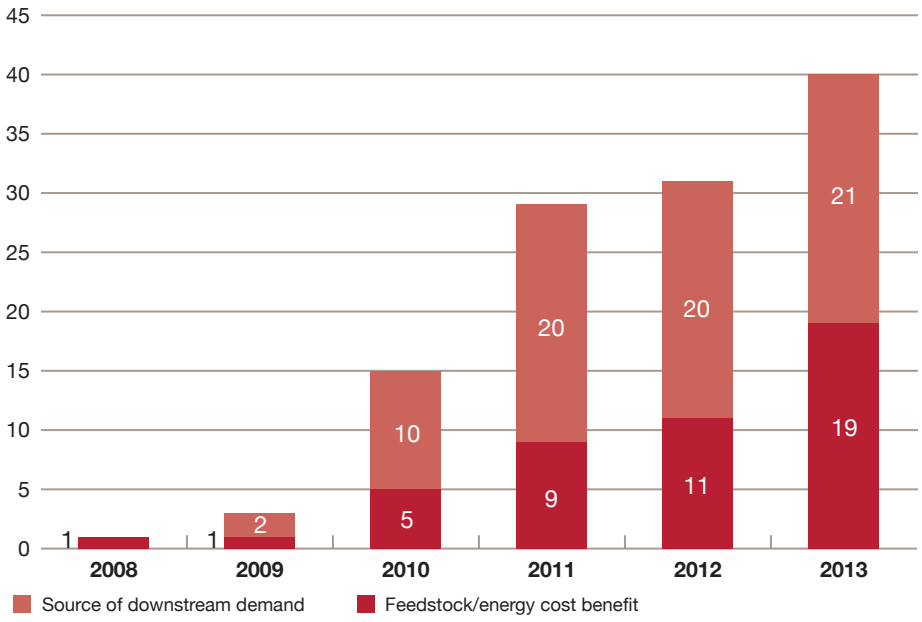
14 "Shale gas: A renaissance in US manufacturing?" PwC, 2011.

Shale gas spurring US manufacturing growth

We also looked at how shale gas was impacting manufacturers through the lens of public disclosures by executives in a survey of SEC filings for US chemicals, metals, and industrial manufacturers. Our survey found a continued rise in the number of companies commenting to the investment community about the potential for shale gas activity to affect their business. In 2013, we found that 40 US manufacturing companies included shale gas impacts in their public filings, up from 15 in 2011 that we found in a previous PwC analysis.[15]

In particular, we looked at two ways in which companies describe such a shale gas impact: 1) as a source for growth in demand for their products, and 2) as a feedstock and/or energy benefit. Our analysis showed that, over the period surveyed, roughly half attributed the potential impact of shale gas activity on their business as a source of downstream demand, and about half noted the feedstock/energy benefit (see chart).

Figure 4: Manufacturers' public disclosure of shale gas impact
Number of companies disclosing shale gas impact in SEC filings (2008-2013)



Source: Company SEC filings and PwC analysis

15 "Shale gas: A renaissance in US manufacturing?" PwC, 2011.

Which manufacturing sectors stand to benefit most?

We expect chemicals and metals companies may be the greatest beneficiaries among US manufacturers. Chemical companies are benefiting from the affordable feedstock and low natural gas prices, which are helping drive investments in expansions and new facilities by companies in this sector. Metals companies and industrial manufacturers are benefiting from the rising demand for products and equipment needed for the extraction, distribution, storage, and processing of natural gas. Energy-intensive manufacturing sectors, such as metals and cement, may continue to benefit from relatively low energy prices.

Chemicals sector benefiting from affordable feedstock

Beyond recognizing the benefits of low natural gas prices, manufacturers are making moves to take advantage. The American Chemistry Council, for example, reports that as of September 2014, it had identified 197 chemicals and plastics projects (new plants, expansions or processes) in the US—tied to relatively inexpensive natural gas from shale formations—that are worth roughly $125 billion in potential new investment. The Council estimates that this new investment—of which 64 percent is from companies based outside the US—could potentially create over 700,000 jobs by 2023. Most of the projects identified are aimed at increasing production of ethylene, and ethylene derivatives.[16]

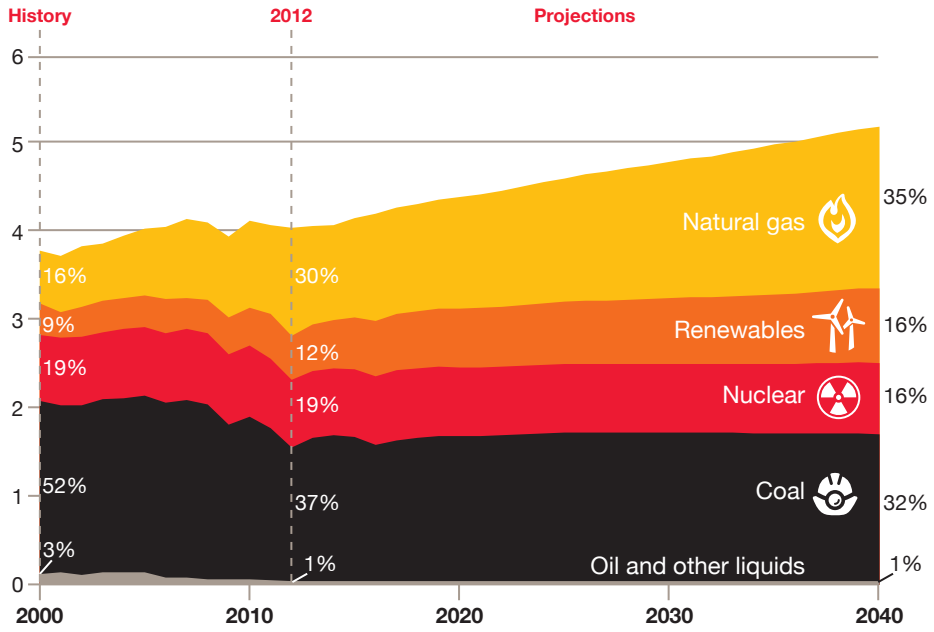
Power costs for US industrial sector forecast to remain stable

Industrial natural gas prices have fallen considerably over the last decade (see chart). Continued low-price scenario could, as our analysis indicates, hold important implications in cost savings for manufacturers. Going forward, electricity costs for the US industrial sector are forecast to increase annually by an average of just 0.8% through 2040, when 35% of electricity is forecast to be generated by gas-fired power plants, up from 16% in 2000, according to the EIA (see chart).

"Thanks to the shale gas production boom, the United States is the most attractive place in the world to invest in chemical and plastics manufacturing. It's an astonishing gain in competitiveness."[17]

Cal Dooley
ACC President and CEO

Figure 5: US electricity generation by fuel, 1990-2040
(trillion kilowatt hours per year)



Source: "AEO2014 Early Release Overview" EIA, http://www.eia.gov/forecasts/aeo/er/early_elecgen.cfm

16 "U.S. Chemical Investment Linked to Shale Gas Reaches $100 Billion," American Chemistry Council press release, February 20, 2014.

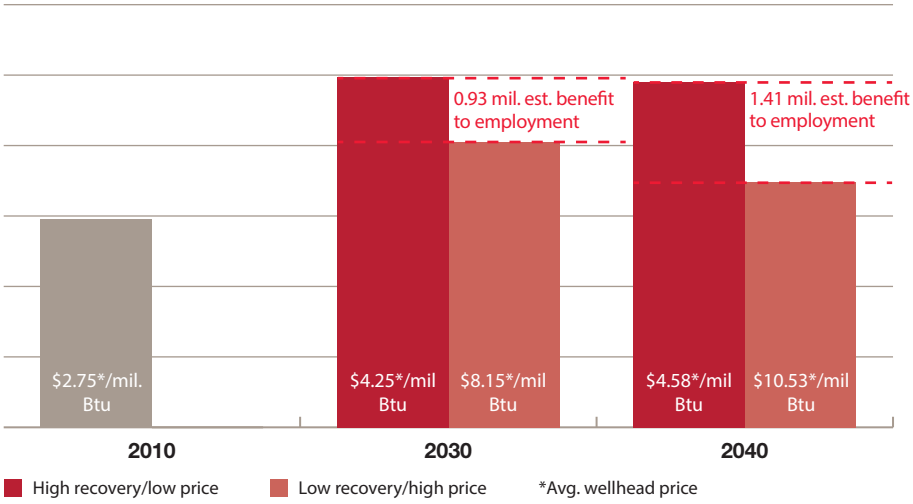
17 Ibid.

Expected natural gas effect on manufacturing jobs: 1.41 million by 2040

According to a PwC analysis, we estimate that the continued shale gas activity in the US will translate into new manufacturing jobs growth, contributing 930,000 shale gas-driven jobs by 2030 and 1.41 million by 2040. These estimates are comparable to estimates we carried out in a 2011 study (1.31 million jobs in 2025 and 1.08 million in 2035).[18] Indeed, shale-driven jobs growth has already taken root. A report from the US Conference of Mayors found that energy-intensive manufacturing sectors added over 196,000 jobs from 2010-2012 in the country's metro areas alone, with inexpensive natural gas being a main driver.[19] We see pockets of higher job growth existing in the regions of shale gas production, particularly the Marcellus basin and Gulf Coast, where natural gas prices tend to be lower because of the lower gas distribution costs. *[Please note: The regression model used to arrive at these estimates is the same used in our 2011 model, using estimates for natural gas prices under high and low scenarios.]*

We must note that these estimates do not include possible jobs growth from likely LNG exports, the potential development of which is still unclear. It is interesting to note, however, that the American Petroleum Institute has estimated that LNG exports will generate between 7,800 and 76,800 net jobs between 2016 and 2035, mostly in the manufacturing sectors tied to refining, petrochemicals, and chemicals.[20]

Figure 6: Natural gas/US manufacturing employment sensitivity analysis
Estimated change in US manufacturing employment under high and low shale recovery/price scenarios



Source: BLS, EIA, PwC Analysis

18 "Shale gas: A renaissance in US manufacturing?" PwC, 2011.

19 "Impact of the Manufacturing Renaissance from Energy Intensive Sources," US Conference of Mayors, March 20, 2014.

20 "US LNG Exports: Impacts on Energy Markets and the Economy," ICF, API, May 2013.

Shale gas wild cards to watch

Our estimates are based in part on forecasts of natural gas supplies and production supplied by the IEA. However, there exist other developments and trends that signal, or potentially could result in, reduced benefits of shale gas development to US manufacturers. Below are some such developments important to industry, governmental, and public stakeholders as the shale gas phenomenon continues to unfold.

Supply exceeding demand, unrealized LNG export potential

It is possible that there may be periods of over-supply, which could lead to a slowing of investment in shale gas development and a reduction in the downstream activity supporting that development (e.g., drilling equipment, processing infrastructure, and transport pipes). Over-supply could also occur if LNG exports are not carried out to the degree and at the speed that is potentially possible (as mentioned earlier in this report). Over-supply could also exacerbate the challenge of building out infrastructure in regions that have yet to produce significant amounts of natural gas (e.g., the Mid-Atlantic region as it relates to the Marcellus shale formation).

Insufficient natural gas refueling infrastructure

There still exists the need for the US to accelerate its natural gas distribution infrastructure in order for natural gas prices to be competitive through the country, rather than lower prices tending to occur in areas closest to shale gas production (i.e., the Mid-Atlantic, or near the Marcellus formation). Indeed, as more reserves are discovered and more wells established in new regions, more manufacturing regions will stand to benefit through lower gas prices.

Natural gas trucking continues to sputter

Additionally, the impacts of shale gas could be amplified if natural gas were to become a more common transportation fuel. So far, this is not the case, with natural gas fueled trucks still comprising a tiny fraction of the country's fleet. Part of the reason for the slow development is the higher price for these vehicles. But another more basic impediment to their widespread use is the lack of fueling infrastructure. Lower transportation costs through the use of natural gas trucking would likely benefit manufacturers through lower distribution and logistics costs. But, in order for this to happen, there would need to be a significant growth in the number and network of natural gas fueling stations, not to mention new fleets of natural gas trucks and retro-fitting kits. Consider that there are only 349 public natural gas filling stations in the US (291 compressed natural gas and 58 liquefied natural gas), a pittance compared to the nation's some 120,000 gasoline filling stations.[21,22]

Redrawing shale gas tax policies: have energy MLPs reached their shelf life?

Changes in tax policy could affect capital investments in shale gas plays and alter the investment picture. In particular, a significant amount of the capital investment in shale development in the US has been powered by master limited partnerships (MLPs), corporate structures that are not taxed as corporations and which are exempt of corporate tax on oil and gas transportation and storage infrastructure.[23]

Environmental issues

The environmental effect of hydraulic fracturing, the process used to create fractures in shale rock, is still being studied. The primary area of interest is the potential for contamination of water sources from chemicals used during fracking; several states have announced moratoria on the process. Increased transparency regarding the chemicals should help allay concerns. In addition, the Environmental Protection Agency is conducting a study on the environmental effects of hydraulic fracturing, which will likely help shape future discourse on the use of this technology.

21 "Shale gas: A renaissance in US manufacturing?," PwC, 2011.

22 "U.S. LNG Exports: Impacts on Energy Markets and the Economy," ICF, API, May 2013

23 "Natural Gas: Tax-favored partnerships have fueled the shale gas boom—will that continue?," E&E.com, May 29, 2013.

Conclusion

The last half-decade has ushered in a larger, and more mature shale gas industry to an extent that there is potential that the US industry could become a significant exporter of natural gas and the technological expertise to develop in countries keen on building their own domestic shale gas industries.

As the shale gas push in the US still powers on, we estimate that there still exists a likelihood that manufacturers will benefit across a number of fronts, assuming that shale gas is extracted at high rates and that natural gas prices remain relatively low.

We estimate 1.4 million manufacturing jobs added and $34.1 billion in cost savings by 2040 as a result of the benefits to manufacturing through relatively low energy and feedstock prices linked to domestic natural gas production. Investment in shale gas development, and in manufacturing sectors that benefit from that development, continues to pour in. And more companies are publicly disclosing a link between natural gas production as a material advantage to their businesses in SEC filings (40 in 2013 compared to 15 in 2010).

However, as the industry has continued to grow, so has the urgency for all stakeholders—government, environmental watchdog groups, regulators, educational institutions, and private enterprises—to ensure that the industry grows with transparency and with a vigorous pursuit toward the safety of all processes and technologies deployed. Certainly, the natural gas boom has already demonstrated that it can be a bona fide driver of manufacturing in the US and can help the country curb its carbon footprint and add jobs. But these scenarios will likely play out only so far as the industry can ensure environmental safety, public trust, and common support.

For the manufacturing sectors, part of achieving this will be continuing to improve and refine the industry—by, for example, introducing innovations that cut water use and mitigate air pollution. Indeed, such innovations are already being carried out. By refining and improving shale gas development further, US manufacturers may place themselves in a position to be even stronger global leaders in this technology, on top of the benefits shale gas brings the sector described in this report.

Methodology

Natural gas/US manufacturing cost sensitivity analysis

This sensitivity analysis uses the annual volume of natural gas consumed by the manufacturing sector, as well as EIA estimates of natural gas prices in 2030 and 2040 under low and high shale recovery scenarios. The low shale recovery scenario assumes that 50% less gas is recovered from each shale formation, which would lead to the higher price estimates in the pink columns in 2030 and 2040. The high shale recovery scenario assumes that 50% more gas is recovered from each shale formation, which would lead to the lower price estimates in the red columns in 2030 and 2040. If we set aside elasticity of demand, then the difference in annual natural gas costs to the manufacturing sector under high vs. low scenarios is over $22 billion by 2030.

EIA natural gas spot prices under high and low recovery scenarios are in real (2012) dollars. All other prices are in nominal terms.

Natural gas/US manufacturing employment sensitivity analysis

For this natural gas employment sensitivity analysis, we created a time series regression which primarily uses natural gas prices and a binary recession variable to predict domestic manufacturing employment. We then used the EIA natural gas recovery/price scenario estimates described in our natural gas/US manufacturing cost sensitivity analysis to find the predicted difference in manufacturing employment under the high recovery/low price and low recovery/high price scenarios. Our forecast is that high shale extraction could result in almost one million extra manufacturing jobs in the US economy by 2030 and 1.4 million more by 2040.

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