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MAY 2014

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Quantifying the Shale Gas Revolution's Impact on U.S. Industrial Energy Consumption

THE CARLYLE GROUP

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Quantifying the Shale Gas Revolution's Impact on U.S. Industrial Energy Consumption

By Jason M. Thomas

The basic contours of the case for an energy-based "reindustrialization" in the U.S. have been known for some time: the surge in the supply of recoverable domestic natural gas will exert downward pressure on the path of energy prices, which will increase the competitiveness and profitability of energy-intensive industries, resulting in faster growth in U.S. industrial production.[1] However, official U.S. government forecasts have only recently been adjusted to account for the broader economic implications of cheap domestic energy. Instead of declining as a share of U.S. GDP and energy consumption, as the government forecast four years ago, the industrial sector is now expected to account for **all** of the net increase in U.S. energy consumption over the next decade.

The updated 2014 Energy Information Administration (EIA) forecasts underscore the economic interdependence between the energy development, electric power, and industrial sectors. Lower domestic energy costs not only make energy-intensive businesses more competitive relative to competitors in other nations, but also increase their competitiveness relative to other domestic industries. The impact of a decline in energy prices is directly proportional to energy's share in a business' cost base; a 30% decline in energy prices could reduce the total operating costs of a concrete producer by 15% but only shave 1% off of the total costs of a software developer. Lower operating costs can result in increased operating profits for the concrete manufacturer and higher returns per dollar of installed capital. By increasing the relative returns of energy-intensive businesses, lower energy prices allow these businesses to attract more discretionary capital, which could increase their output and result in more net energy consumption.

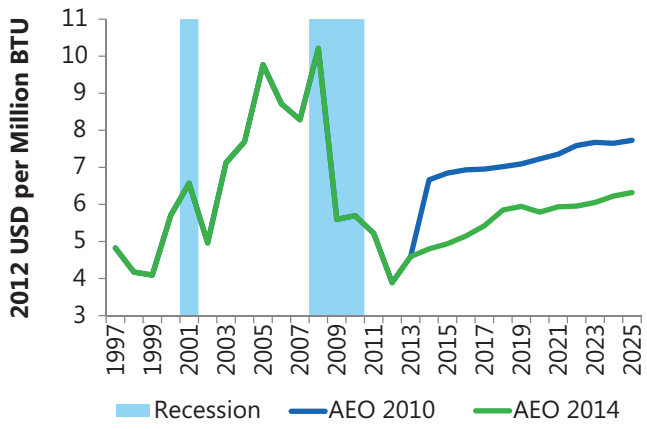
The long-run forecast for industrial energy spending exhibits a familiar "J-curve" pattern. In the short-run, price declines dominate and real industrial energy spending falls. Over time, real industrial energy spending increases as higher expected returns on energy-intensive activities lead to increases in productive capacity and output. Real industrial electricity and natural gas spending are expected to grow by $23 billion and $17.5 billion, respectively, by 2025, 3x more incremental spending than forecast in 2010. Fixed investment in energy-intensive productive capacity creates a larger, more dependable revenue base for power and natural gas producers, which can help reduce risk associated with energy investments.

Shale's Impact on Natural Gas Prices & Consumption

Between 2006 and 2010, the amount of natural gas produced from shale formations in the U.S. more than quadrupled, from 1 trillion cubic feet to 4.8 trillion cubic feet. The dramatic rise in shale gas production over this period led the EIA to revise its methodology for estimating domestic energy resources to include 750 trillion cubic feet of "technically recoverable" shale gas, which was equal to more than 50% of the previously assumed supply of domestic natural gas. The implications of the shale gas boom were not immediately reflected in the EIA's forecasts for natural gas prices and consumption. In 2010, the EIA expected natural gas prices to rebound to pre-recession levels in nominal terms by 2014. Economy-wide natural gas consumption was forecast to grow by just 0.3% annually between 2009 and 2025.[2] As subsequent EIA Outlooks have made clear, these forecasts were inconsistent with the upward revisions to domestic energy resources. Unless the gas remained in the shale, undeveloped, the increase in the supply of natural gas would likely push prices lower and increase domestic gas consumption.

As shown in Figures 1 and 2, the EIA has substantially revised its 2010 Annual Energy Outlook (AEO) price and consumption forecasts to ensure their consistency with assumed supply dynamics. Relative to the 2010 forecast, the EIA now expects the supply shock from shale gas will deliver a 20% decline in the real cost of natural gas (measured in inflation-adjusted, 2012 dollars) and a 5.3x increase in incremental natural gas consumption by 2025 (growth of 5.8 instead of 1.0 quadrillion BTU).

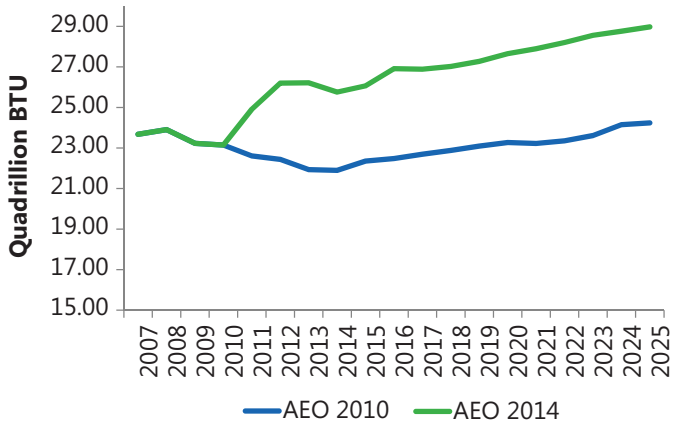
Figure 1: Real Industrial Natural Gas Prices, Actual & Forecast (2012 - 2025)



1 See, for example, "Cheap Gas and U.S. Reindustrialization," Economic Outlook, The Carlyle Group, April 2012.

2 2010 American Energy Outlook, Energy Information Administration.

Figure 2: Total U.S. Consumption of Natural Gas Prices, Actual & Forecast (2012 - 2025)

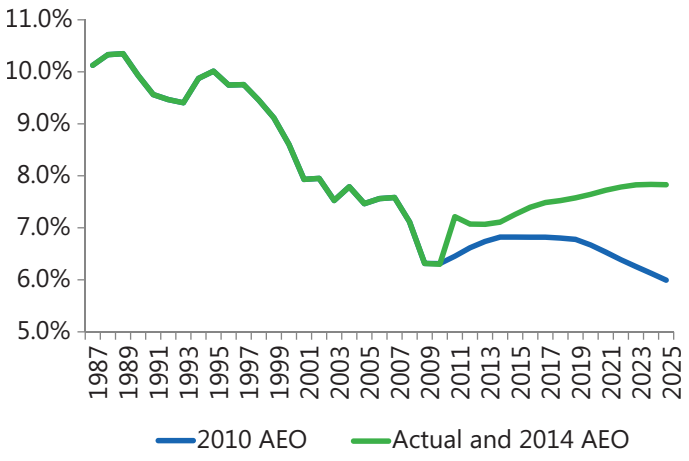


Implications for Industrial Output & Energy Consumption

In the near-term, most of the increased natural gas consumption is anticipated to come from electric utilities switching to gas from coal and other fuels. The EIA estimates that 30% of all electricity generated in 2012 came from gas, 1.7x greater than the 2012 share forecast in 2010.[3] Fuel substitution of this sort has modest *short-term* implications for the broader economy, as the same economic activities are simply powered by different fuels.

Over time, fuel substitution and low natural gas prices are expected to produce fundamental shifts in the structure of the U.S. economy. Rather than assuming the same economic activities simply rely more heavily on natural gas, the EIA forecasts that less expensive energy will spur substantially faster growth in energy-intensive activities. The EIA expects industrial production to grow by 32%, in real terms, over the next 10 years, 1.83x more growth over this period than forecast in 2010.[4]

Figure 3: Energy-Intensive Industrial Output as a Share of U.S. GDP, Actual & Forecast (2012 - 2025)[5]



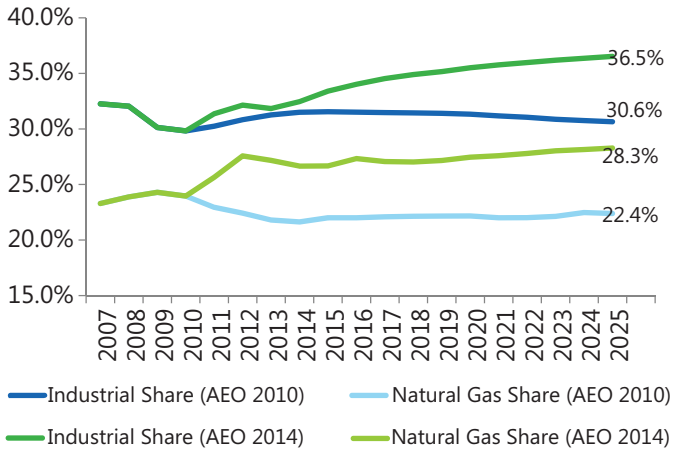
3 EIA, 2014 and 2010 AEO, Reference Case.

4 2014 AEO Total Industrial Shipments measured in 2012 dollars.

5 Carlyle estimate based on EIA and NIPA data.

Energy-intensive manufacturing has been declining as a share of the U.S. economy since the mid-1970s. In 2010, the EIA assumed that this trend would continue, with the output of the most energy-intensive manufacturing subsectors – paper, chemicals, cement and stone, iron and steel, aluminum, and glass – forecast to fall from 7.1% of 2008 GDP to just 6.0% of GDP in 2025. The EIA now recognizes that a continuation of past trends is inconsistent with assumed natural gas supply growth. In the 2014 AEO, lower energy prices cause past trends to reverse. Between the end of the recession in 2009 and 2025, energy-intensive manufacturing is forecast to grow 26% more than the economy as a whole and see its share of U.S. GDP rise by 1.7 percentage points to 8.0% (Figure 3).

Figure 4: Shares of Total U.S. Energy Production & Consumption, Actual & Forecast (2012 - 2025)

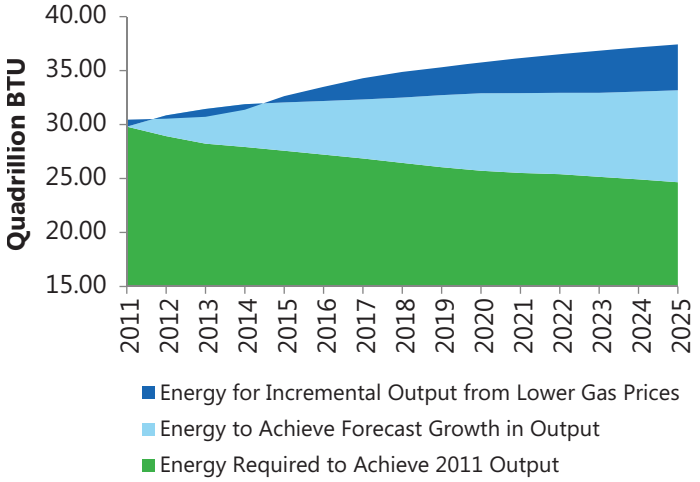


The assumed increase in industrial production and natural gas consumption are two sides of the same coin. As shown in Figure 4, the assumed increase in natural gas' share of total 2025 energy production is matched by the increase in the industrial share of total 2025 energy consumption. When natural gas was assumed to account for a declining share of U.S. energy production, the industrial share of total energy consumption was also assumed to decline modestly. Now that natural gas' share of total energy production is assumed to grow by nearly one-fifth, the industrial share of U.S. energy consumption is also expected to rise. In fact, the forecast 6.06 quadrillion BTU increase in industrial energy consumption is expected to account for 104% of the total growth in domestic energy consumption over the next decade, as the energy consumed by the rest of the economy falls by 250 trillion BTU over this period.

The assumed growth in industrial energy consumption is remarkable when accounting for the anticipated improvement in energy efficiency over that period. In 2011, it took 5,140 BTU to generate one dollar of industrial output. By 2025, producing the same industrial output will require just 4,264 BTU. As shown in Figure 5, the amount of energy required to produce the 2011 level of industrial output is expected to decline by 17% over the next decade. The 22% increase in

industrial energy consumption comes from 48% growth in real industrial production, including the 13 percentage points of growth attributable to lower energy prices.

Figure 5: Forecast Industrial Energy Consumption & Efficiency



Real Industrial Electricity & Gas Spending

The benefits of less expensive energy will not accrue entirely to the industrial sector. Natural gas and power producers will capture some of the gains through increased sales. The forecast growth in industrial energy demand in response to large price declines generates a familiar "J-curve" pattern in real industrial spending on both natural gas (Figure 6) and electricity (Figure 7). Initially, declines in the market price of natural gas and electricity cause real industrial energy outlays to fall, reducing the revenue of power and natural gas producers. Eventually, the growth in industrial output more than compensates for the price declines, causing real industrial energy outlays to exceed the 2010 forecast by 2017 and rise thereafter.

Figure 6: Forecast Real Growth in Industrial Natural Gas Expenditures, 2011-2025

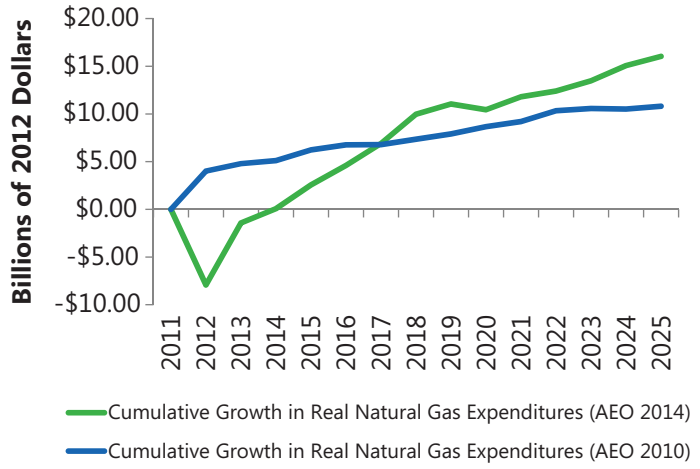
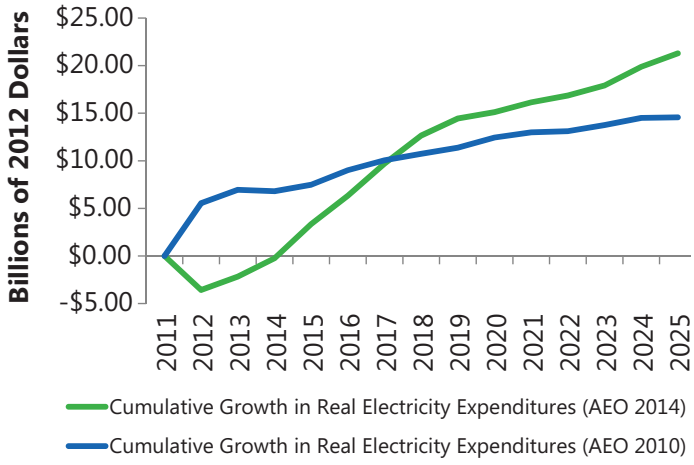


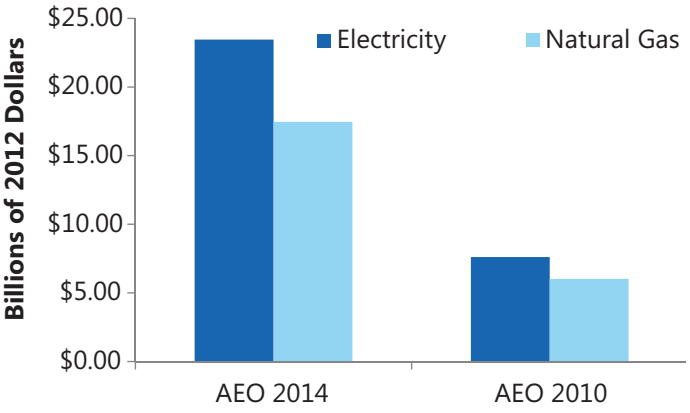
Figure 7: Forecast Real Growth in Industrial Electricity Expenditures, 2011-2025



As shown in Figure 8, real industrial natural gas spending is assumed to rise by $17.5 billion between 2013 and 2025, nearly 3x larger than the $6 billion real growth assumed in 2010. Direct industrial natural gas consumption is used mostly to heat production facilities and fire boilers and furnaces.

Interestingly, the growth in real industrial electricity spending is assumed to be much larger, as utilities increasingly rely on natural gas-powered plants and pass some of the savings onto industrial customers. Lower electricity rates reduce the cost of powering electric machine drives, motors, pumps, and fans, which account for more than 25% of total energy consumption in the textile, plastics, and rubber industries.[6]

Figure 8: Forecast Growth in Real Industrial Electricity & Gas Spending, 2011-2025



Potential Risks to EIA's Forecast

Even if the EIA's 2025 industrial production forecast proves accurate, it would be unrealistic to assume uninterrupted, linear

6 EIA, Today in Energy, October 18, 2013.

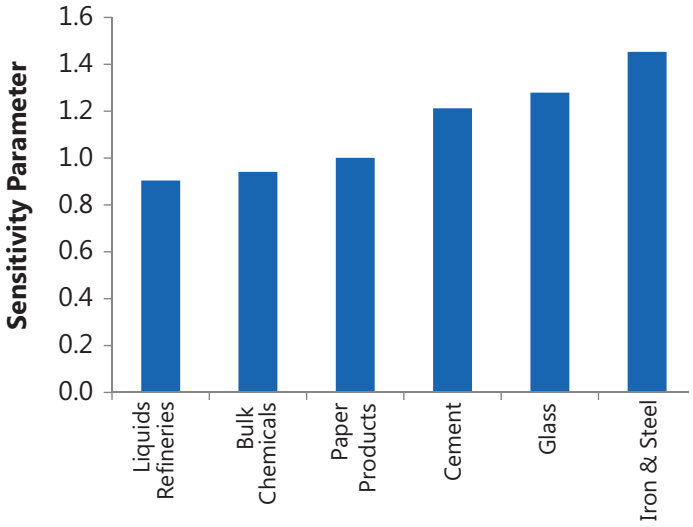
growth between now and then for two reasons. First, the most energy-intensive industries are also the most sensitive to broader trends in the economy. Figure 9 measures the sensitivity of output to U.S. GDP growth for the five industries where energy accounts for the largest share of average costs. The reported "sensitivity parameter" is analogous to an industry's "beta" in an asset pricing context, as it represents the covariance of industry output relative to the variance of GDP growth. Only refineries and chemicals have a "beta" lower than one, suggesting their output varies less than the economy as a whole, while the betas of the cement, glass, and base metals suggest these industries exhibit boom and bust cycles, with more rapid growth than GDP in expansions and larger contractions in broader downturns. Low energy prices are not likely to prevent output in these industries from contracting sharply in the next recession.

Overall, industrial electricity consumption is expected to rise by more than $23 billion in real terms between 2013 and 2025, 3x larger than the $7.6 billion in real growth assumed in 2010.

Second, to achieve the forecast growth in industrial production, energy-intensive businesses will have to invest heavily in additional productive capacity over the next decade. A sustained decline in energy costs increases the expected returns on fixed investment – property, plant, equipment – in direct proportion to energy's share of a business' total costs and marginal product, holding all else constant.[7] Other factors are not likely to be constant over the next decade. For example, the supply of complementary labor may prove to be inadequate, resulting in an acceleration in wage inflation that offsets the benefits of cheap energy. A disruption to capital markets, shift in the regulatory regime, or unexplained increase in risk aversion among managers could also lead to less investment than appears optimal today. Limits of emissions of greenhouse gases from large entities, such as the emerging "cap-and-trade program" in California, could drive greater energy efficiency and disrupt the historic correlation between industrial output and energy outlays.

The EIA's 2014 Outlook is significant because of its internal coherence, not because of the precision of its point estimates for industrial production and energy consumption. The interdependence of energy development, production, and consumption creates a series of equalities where increases in one variable or set of variables have implications for others. If future natural gas development tracks the 2014 forecast, it is reasonable to expect growth in the industrial sector's productive capacity will do the same.

Figure 9: Energy-Intensive Industries' Sensitivity to U.S. GDP Growth[8]



Conclusion

The shale gas boom is not occurring in an economic vacuum. By reducing domestic energy prices and increasing the profitability of energy-intensive activities, the development of 750 trillion (or more) of recoverable shale gas resources will likely have a lasting impact on the structure of the U.S. economy. Revised U.S. government data have helped to quantify the magnitude of the prospective energy-based "reindustrialization." Based on historic relationships between prices, output, and fixed investment, shale gas development will likely cause energy-intensive industrial production to grow 53% over the next decade, in real terms, and account for a larger share of economic output in 2025 than it does today. A larger energy-intensive industrial sector will translate to more energy spending, with industrial electricity and natural gas expenditures expected to rise by over $40 billion in real terms over the next ten years.

7 Wohlgenant, M. (2012), "Input Complementarity Implies Output Elasticities Larger than One: Implications for Cost Pass-Through," Theoretical Economics Letters.

8 Carlyle estimate based on EIA and NIPA data.

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