Energy Policy and U.S. Industry Competitiveness

Rachel Halpern, Sarah Lopp, Samuel Beatty, and others, U.S. Department of Commerce, International Trade Administration, Office of Energy and Environmental Industries

ABSTRACT

In the past five years, world oil prices have risen dramatically, and U.S. natural gas prices grew to be significantly higher than natural gas prices in most other countries. U.S. businesses have been hit by higher energy costs for fuel, feedstock, buildings, and transportation, in both energy-intensive industries and less energy intensive industries, as well as in the services sector. Many manufacturers in energy intensive industries say that rising energy costs are their biggest challenge. They base many decisions, including those about shutting down U.S. production and investing in other countries, on the cost of energy in the United States.

This paper provides an overview of energy use by U.S. manufacturers and the impact of rising energy prices on U.S. manufacturing competitiveness, and discusses policies that could help U.S. manufacturers remain competitive in the current energy price environment. It draws from statistical data from the U.S. government and other sources, detailed industry knowledge held by U.S. Department of Commerce analysts, and extensive discussions with other U.S. government experts and industry representatives.

The paper discusses a number of policy ideas, including supply-side initiatives such as allowing domestic energy production to increase by opening more areas to development, and many demand-side initiatives such as incentives to reduce natural gas use by utilities and consumers. It also discusses solutions that could be implemented in the short term, such as incentives to help manufacturers purchase energy-saving equipment, interagency cooperation to reduce regulatory barriers to improving industrial energy efficiency, and additional support of existing programs that help manufacturers reduce energy use.

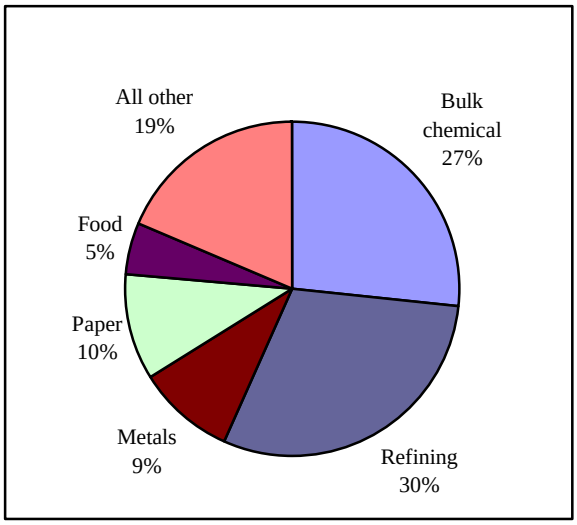
Overview: How U.S. Industry Uses Energy

In 2002, U.S. manufacturers used 22.7 quadrillion Btu of energy, including oil, natural gas, electricity, and renewable energy.[1] (EIA, MECS 2002) The largest energy consumers were the manufacturers of "bulk" chemicals (organic, inorganic, and petrochemicals, but excluding pharmaceuticals), and petroleum refiners, both of which use oil and natural gas as a fuel and feedstock. (Figure 1) The paper and forest products industry, the metals industry, and the food industry are also large consumers. Energy use by all other manufacturers, including machinery, transportation, computers, and apparel, totaled only 19 percent of industrial energy consumption.

Natural gas is the largest single source of energy used by U.S. manufacturers, making up 37 percent of industrial energy consumption in 2002. (Figure 2 and Table 1) Other petroleum-based fuels, including liquefied petroleum gas, natural gas liquids, and fuel oil, were second with 19 percent. Electricity made up another 16 percent of supply.

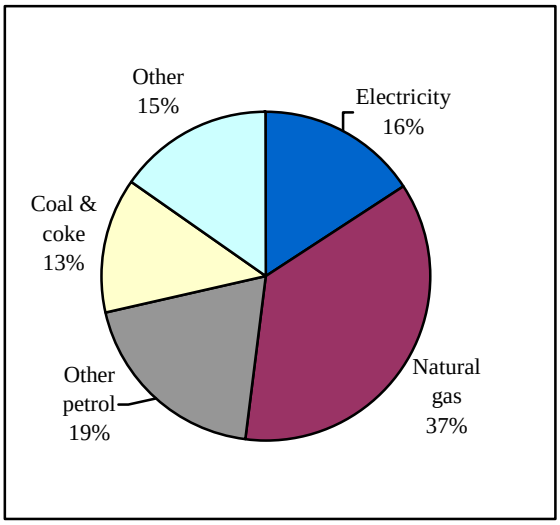
[1] This study uses mostly data from the EIA's 2002 Manufacturing Energy Consumption Survey, which is the most recent data available that covers many industries.

Figure 1. Energy Use by Industry Sector as Portion of Total Industrial Use, 2002



EIA, MECS 2002, Table 1.2.
Includes fuel used as feedstock in refining and chemicals industries.

Figure 2. Types of Energy Used by Manufacturers, 2002



EIA, MECS 2002, Table 1.2.
Does not include fuel used as refining industry feedstock. Other petrol = liquefied petroleum gas, natural gas liquids, fuel oil. Other = mostly renewables, biomass.

Table 1. Major Energy Sources for Manufacturers in Selected Industries

Less energy intense	More energy intense
• Machinery	• Chemicals & refining – petroleum, natural gas
• Computers	• Glass – natural gas
• Transport equipment	• Paper/forest products – renewables (biomass)
• Apparel	• Aluminum – electricity
• Food	• Iron & steel – coal, natural gas, electricity
Mostly natural gas and electricity	• Cement – coal

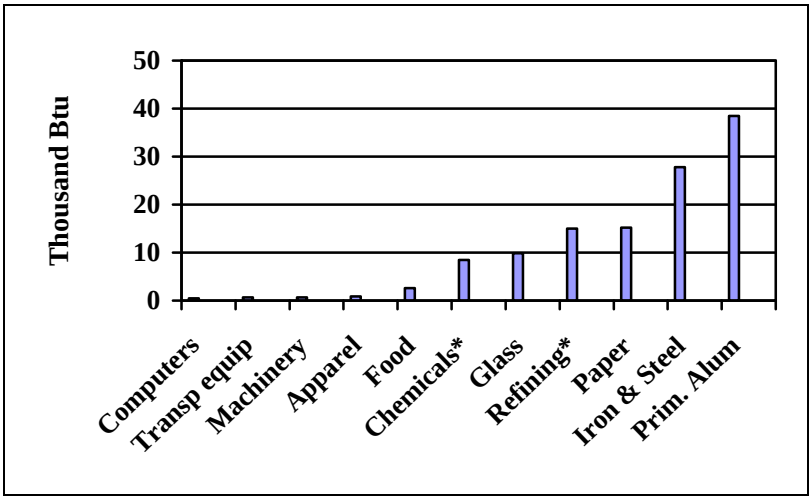
The primary aluminum industry, which used 38,500 Btu of energy per dollar of output in 2002, ranks as the most energy intensive industry, followed by iron and steel at 27,800 Btu per dollar of output. (Figure 3) The petroleum refining and chemicals industries used 15,000 Btu and 8,500 Btu respectively for fuel per dollar of output – figures that would be much higher if feedstock were included. (Data was not available.) The paper and forest products, glassmaking, and food industries are also energy intensive, while industries such as computer and machinery manufacturing use little energy relative to output.

Trends in Energy Intensity

The amount of energy used in the U.S. economy per unit of GDP has been steadily decreasing over the past thirty years. Since 1980, energy consumption per unit of GDP has decreased by 3 percent per year. In 2006, energy intensity was at an all-time low of 8.73 thousand Btu per dollar of GDP. (Figure 4.) This means U.S. businesses are able to produce

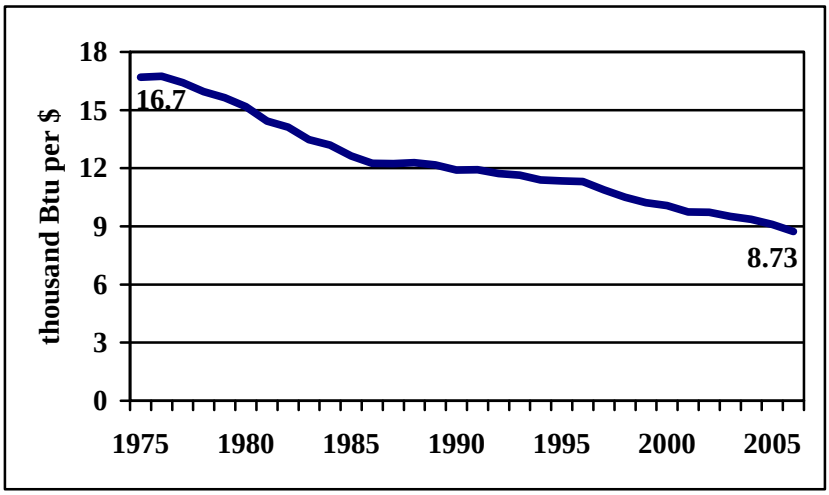
more with the same or lower amount of energy as in previous years. The decline in energy intensity reflects growth in the service sector relative to the manufacturing sector, as well as efficiency gains in all sectors. Almost every manufacturing sector, whether it is relatively energy intensive or not, has reduced its energy intensity since 1991. (Table 2)

Figure 3. Energy Use per Dollar of Shipments, 2002[2]



EIA, MECS 2002, Table 6.1. *Does not include energy used as feedstock.

Figure 4. U.S. Energy Consumption per Dollar of GDP, 1975-2006



EIA, Monthly Energy Review April 2007. In 2000 dollars.

[2] It should be noted that for some industries such as aluminum, a product whose prices fluctuate considerably on the world market, it makes more sense to report energy consumption per unit of production. According to the Aluminum Association, it takes about 103 million Btu of energy to produce one ton of primary aluminum. However, we were unable to find such statistics that allow for comparison across industries.

Table 2. Energy Consumption by Selected Industries per Dollar of Shipments (million Btu)

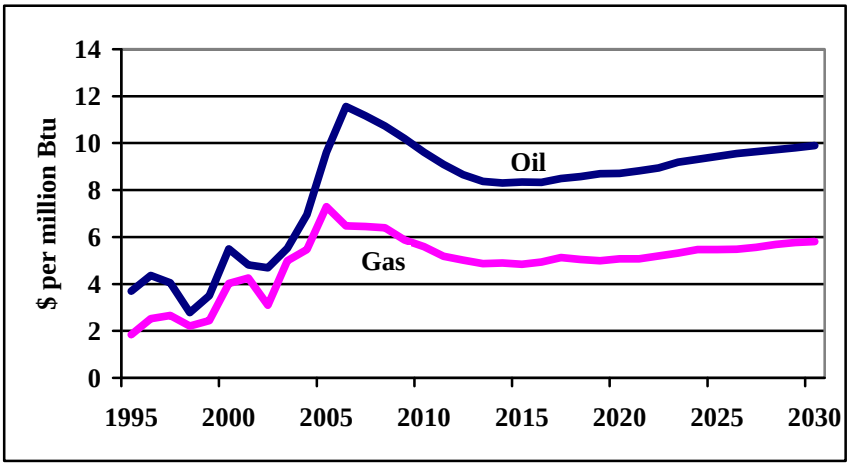
Industry	1991	1994	1998	2002
Chemicals*	11.1	10.3	9.5	8.5
Paper	20.1	19.0	18.7	15.2
Metals	17.6	16.1	15.8	14.2
Transportation equipment	1.0	0.9	0.8	0.7
Machinery	1.0	0.8	0.8	0.7

EIA, MECS 2002, 1998, 1994, 1991. *Does not include feedstock.

Impact of High Energy Prices on Manufacturers

Despite the trend towards reduced energy intensity among manufacturers in all sectors, recent high world oil prices and U.S. natural gas prices have increased costs for businesses in every sector, and have had a disproportionate impact on manufacturers in energy-intensive industries such as metals, chemicals, and forest products. The services sector and less energy intensive manufacturers also face higher electricity and transportation costs. While oil and gas prices are expected to moderate over the next few years, they are not expected to return to 1990s levels, according to EIA projections. (Figure 5.)

Figure 5. Crude Oil and U.S. Natural Gas Prices, Projections to 2030



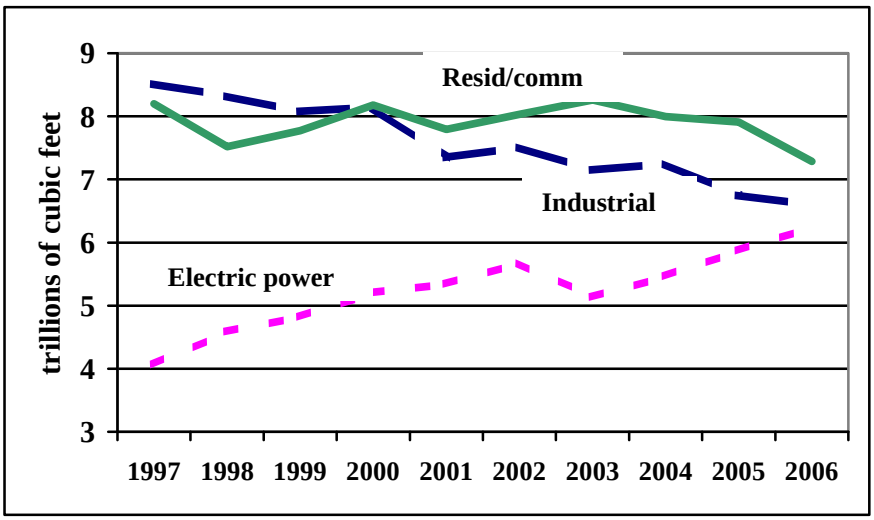
EIA, Annual Energy Outlook 2007. In 2005 dollars.

Although oil and natural gas prices have increased all over the world, natural gas prices in the United States are far higher than natural gas prices in most other countries. In the fall of 2005, a particularly difficult year, natural gas in the U.S. cost almost an average of almost $9 per million Btu. At the same time, gas in Europe was under $7, Asia under $6, and Trinidad, Russia, and the Middle East under $2. (Swift 2005.)[3]

[3] Natural gas, which is still mostly transported by pipeline, is traded in regional markets and prices vary by region (unlike oil). There are differences among the markets as well- for example, in the Middle East, Saudi Arabia's government sets the price of natural gas, and this price is considered a gauge for the region. The increasing global trade of liquefied natural gas may eventually bring natural gas prices closer together around the world.

Today's U.S. natural gas price scenario is in many ways a product of well-intentioned government policies that have increased demand for natural gas in the electric power sector. Over the past two decades, power producers, seeking to limit emissions in response to U.S. and state environmental regulations, have turned to natural gas as a fuel. However, domestic natural gas supply (both production and imports) has remained flat, at around 22 trillion cubic feet (tcf) for the past decade. The primary consumers of natural gas have changed, though- the electric power sector increased its use of natural gas by 53 percent since 1997, (4.0 tcf to 6.2 tcf in 2006) while the industrial sector has reduced its use of natural gas by about 22 percent (8.5 tcf to 6.6 tcf in 2005). (Figure 6)

Figure 6. U.S. Natural Gas Consumption by Sector



EIA, Natural Gas Consumption by End-Use.

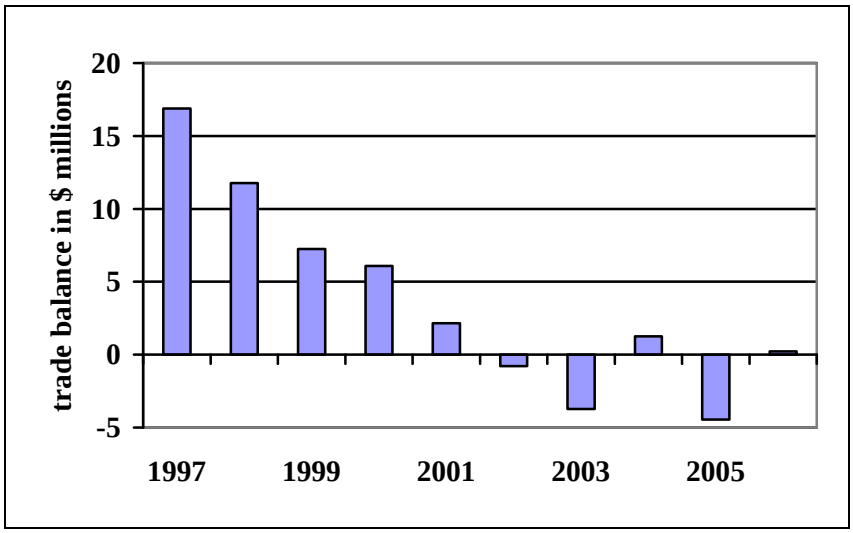
Power producers also have a greater ability to enter into long-term gas contracts, which limit the impact of price fluctuations, and can often pass higher fuel costs on to their customers, which manufacturers who compete with imports usually cannot do.

Impact of High Energy Prices on Chemicals Industry

Recent high U.S. natural gas prices relative to world oil prices have eroded the U.S. chemicals industry's competitive position. Because natural gas prices have traditionally been relatively low in the United States, the U.S. chemicals industry relies heavily on natural gas for fuel and feedstock. Chemical manufacturers rely on natural gas for 58 percent of their fuel, and natural gas and natural gas liquids for 58 percent of their feedstock. (ACC 2005) In Europe and Asia, the chemicals industry relies mostly on naphtha, a petroleum-based feedstock. The increase in U.S. natural gas prices has helped reduce and even eliminate in some recent years the United States' trade surplus in bulk chemicals. The U.S. trade balance for the chemicals industry, excluding pharmaceuticals, declined from $16.8 billion in net exports in 1997 to $218 million in net exports in 2006. (Figure 7) Chemical plants are closing in the United States, as companies move their facilities and dollars to countries where natural gas is cheaper, particularly to the Middle East where natural gas prices are a fraction of prices in the United States. Of the 120

largest chemical plants being built around the world as of mid-2005, only one was located in the United States. (Arndt, 2005)

Figure 7. U.S. Trade Balance for Chemicals (not including pharmaceuticals)



U.S. Department of Commerce, 2007 HS codes 28, 29, 31-34, 38-40.

Spending by the U.S. chemicals industry has increased dramatically. In 2002, the U.S. chemicals industry spent $32 billion on energy. According to the American Chemistry Council, spending on energy had increased to $52 billion by 2004, a 64 percent increase over energy spending in 2002. (ACC 2005)

It is worth noting that the trade balance for the U.S. chemicals industry was declining before natural gas prices started to rise in 2000. Chemicals industry experts admit that there are many factors involved, including an expanding surplus in polymers. Industry executives say that for them, however, the largest factor in determining where to locate new plants or whether to invest resources in existing ones is the high price of energy in the United States.

Impact of High Energy Prices on Metals Industry

Aluminum: The primary aluminum industry is distinct among the energy-intensive industries in that aluminum manufacturers rely on electric power for over 80 percent of their energy needs, since aluminum production is an electrolytic process. From 1997 to 2004, the average price paid for electric power by the primary aluminum industry increased from 2.4 cents per kWh to 3.4 cents, or 41 percent. (Census, ASM 2004 and 2001.)[4] Because of high electric power costs, U.S. aluminum production has fallen by one-third over the past five years. (Table 3) During this time, the United States went from being the largest aluminum producer in the world to the fourth largest, behind China, Russia, and Canada.

[4] Because the details of the contracts and rates paid are closely held by the industry, exact data on the rates that most of the aluminum companies pay for electric power are not available- nor is there data about how much electricity is used vs. natural gas and other fuels. The average rate that primary aluminum manufacturers pay for purchased power can be calculated from Census data showing total power purchased and the total paid.

Table 3. Primary Aluminum Production (thousand metric tons)

Year	U.S.	Rest of World
2000	3668	20632
2001	2637	21663
2002	2707	23393
2003	2703	25197
2004	2516	27284
2005	2500	28700

U.S. Geological Survey, Mineral Commodity Summaries, January 2006.

In decades past, many aluminum smelters (representing up to 40 percent of production at one time) took advantage of low electric power rates offered by the Bonneville Power Administration (BPA) in the Pacific Northwest and located new plants in that area. Recent BPA rate increases, along with rising raw material costs and industry overcapacity, have contributed to many of these smelters closing operations or cutting back on production. BPA customers probably now produce less than 10 percent of the aluminum in the United States. Aluminum manufacturers have begun turning to countries in the Middle East, as well as Iceland and Trinidad and Tobago, where energy is cheaper, to build new capacity, instead of the U.S.

Iron and Steel: The iron and steel industry depends more heavily on natural gas (29 percent of its fuel in 2002- EIA MECS 2002) High natural gas prices have led to the closure of all U.S. direct-reduced iron steel mills. To take advantage of lower energy and raw materials costs, the U.S. steel industry has invested in iron making operations in Trinidad and Tobago and Brazil.

Unlike the aluminum industry, most U.S. steel mills appear to be able to pass on at least some of their higher energy costs through higher prices or energy surcharges, in part because the market for steel mill products remains strong. While exports of steel mill products have declined somewhat from 2005's record level, exports remain relatively high.

Impact of High Energy Prices on Other Industries

Pulp and paper: Although the pulp and paper industry is unique among industries in its heavy use of renewables, particularly biomass, for energy, it still used natural gas to supply 21 percent of its energy in 2002. (EIA, MECS 2002) Most natural gas in mills is used to comply with regulatory initiatives of the 1990s which direct power generation and emissions controls toward the use of natural gas. From 2000 to 2005, the cost of fuels and purchased electricity for the pulp and paper industry increased from $6.9 billion to $8.8 billion, a 26 percent increase. (ASM 2005) Industry sources attribute the closing of 232 mills and loss of 182,000 jobs (12 percent of employment in this sector) since 2000 to this rise in energy costs.

Non-energy intensive industries: Even industries that are not energy-intensive have been affected by rising energy prices. More than a dozen major U.S. auto parts suppliers filed for bankruptcy in 2005, due primarily to high energy and steel costs, which they were not able to pass on to their customers, the major auto makers.

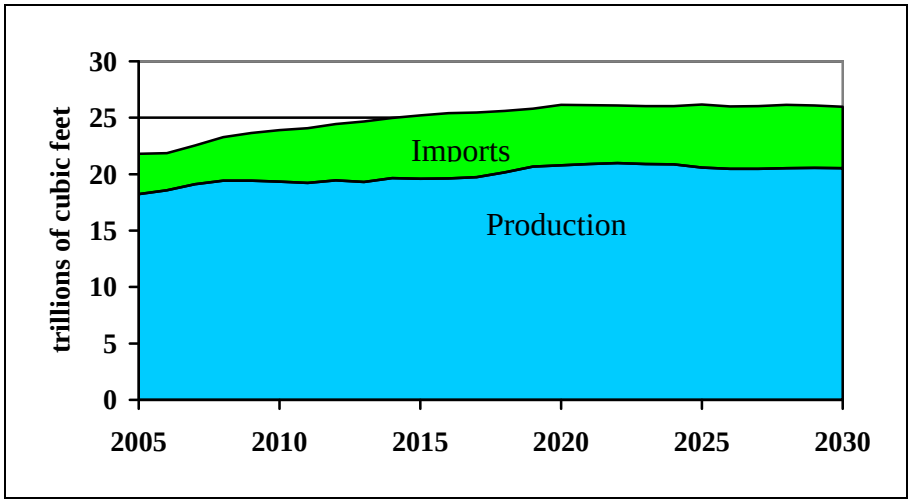
In numerous conversations and meetings, manufacturers, industry association officials, and government experts told us that rising energy costs are a top concern and have led to

declining exports and reduced sales. They base many decisions, including decisions about whether to invest in U.S. production, on the cost of energy in the United States.[5]

Policy Solutions

Supply-Side. Without expanded access for energy companies to oil and gas resources in the U.S., the EIA estimates that domestic gas production will increase by an average of only 0.5 percent per year until 2030, while imports of gas (particularly liquefied) will increase by 1.7 percent per year in order to meet demand (Table 8). Allowing domestic natural gas production to increase by opening access to areas that are currently off-limits, such as the Outer Continental Shelf (OCS) would likely have a great impact on prices. Although building up natural gas production in most areas would take 5-10 years, opening the OCS would have an immediate effect on natural gas prices in the futures market, and natural gas production could begin immediately in some areas where there is already infrastructure. According to a 2003 report by the National Petroleum Council removing the moratoria on exploration and production in the OCS and speeding the permitting process for Rocky Mountain resources could add 3 billion cubic feet per day (or about 1 trillion cubic feet per year) of production by 2020- about five percent of projected domestic gas production that year. The study estimated that this would reduce average gas prices by $0.60 per million Btu. (NPC, 2003)

Figure 8. U.S. Natural Gas Production and Imports to 2030



EIA, Annual Energy Outlook 2007, Table 13

Demand-Side: Reducing Overall Use of Natural Gas. The government could also enact policies to reduce the demand for natural gas in all sectors, particularly the electric power sector. A recent review by analysts at the Berkeley National Laboratory of a number of studies of the effect on natural gas prices of increasing the use of renewable energy found that the studies concluded that for every 1 percent decrease in demand for natural gas in the U.S. (which would

[5] Dissenting views on the impact of energy prices should be noted. For example, a 2005 study by the Department of Commerce's Economics and Statistics Administration (ESA) concluded that natural gas prices did not cause poor performance in most energy-intensive industries during the 2000-2004 period. (ESA, 2005)

today total about 200 billion cubic feet) natural gas prices would decrease by 0.8 to 2.0 percent. (Wiser and Bolinger 2007)

Policies that would decrease demand for natural gas could include increased support for research and development of alternative energy sources, including nuclear, coal gasification, and clean coal technologies; incentives for utilities to adopt new technologies that allow them to meet environmental goals without using additional natural gas, such as a permanent Production Tax Credit for alternative energy sources; programs that help consumers use less electric power such as time-of-day rates for commercial and residential electricity customers; and incentives for energy efficiency measures.

Demand-Side: Helping Manufacturers Save Energy. As noted previously, U.S. manufacturers have made great strides in reducing their energy use over the past thirty years. However, there are still gains that could be made. A recent ACEEE study found that there are still numerous opportunities for manufacturers to reduce their energy use. (Shipley and Elliott 2006) Companies are not always able to implement all of the energy saving measures that they could for a variety of reasons, even when they have a clear picture of what needs to be done to reduce energy costs. According to staff at the Department of Energy's Industrial Technologies Program (which performs plant assessments to help companies save energy) for example, the plants that they assess implement, on average, about 40 percent of their energy saving recommendations.

Cost Issues: Manufacturers and industry analysts say that the most important factor in determining whether or not to implement energy savings measures is cost. Although costs are generally low for projects that reduce energy use on the margins, such as plant lighting and heating, projects that produce major energy savings often require large investments in new equipment, controls, or training. Proposals for such investments must compete for a company's capital with other projects- such as investing in facilities in countries where energy costs are lower already. The rate of return for energy savings projects may not satisfy a company's internal requirements, or the payback period may be too long.[6] Uncertainty about future energy prices also makes projected cost savings less certain. This issue could be addressed if there were tax incentives for the purchase of capital equipment that would reduce energy use, which would make such projects more attractive to companies. The availability of low cost loans, provided by or backed by the government, could also make a difference.[7]

Regulatory and Legal Issues: Another factor that affects whether a company invests in new equipment that could reduce energy use is concern about the possibility of going through the New Source Review (NSR) process, mandated by the Clean Air Act. NSR requires stationary sources of air pollution to get permits before they start construction on a major modification or installation of new equipment. The regulations are often unclear as to what constitutes a major

[6] Although we were unable to find any studies addressing this issue among U.S. manufacturers, a recent study of the Swedish foundry industry showed that limited access to capital was the largest barrier to implementing energy efficiency projects. (Rohdin, Thollandar, Solding.) In addition, the ACEEE study found that, because many low-cost energy efficiency improvements have already been made in the manufacturing sector, efficiency improvements today cost on average more than they did 20 years ago.

[7] This is not without precedent. In February of this year, the Overseas Private Investment Corporation (OPIC) announced a program to support loans to companies (including refineries and petrochemicals producers) *outside* the U.S. to purchase energy-saving equipment, as a way to promote U.S. exports of such equipment.

modification, and the NSR process can be lengthy and costly, which makes some companies reluctant to invest in new equipment.

Some companies would benefit from being able to switch the type of fuel that they use depending on cost. Such switching is not an option available to many companies. (Table 4) Many large plants have equipment that can only burn natural gas, which was purchased years ago, when the expectation was that natural gas prices would remain relatively low. A few companies do have the technical ability to switch from natural gas to coal or other fuels, but their environmental permits allow them to burn only one kind of fuel (usually natural gas). EPA is working on new rules that will clarify to companies and state regulators the possibility of issuing permits to use different kinds of fuels, and provide assistance on how to do so. However, given the small number of manufacturers who already have the equipment needed to switch fuels, such rule changes would be of limited benefit.

Table 4. Capability to Switch from Natural Gas to Alternative Energy Sources, 2002

Industry	**Natural gas (billion cubic feet)**		
	Total consumed	**Switchable**	**Not switchable**
Paper	490	158	285
Chemicals*	1634	164	1052
Metals	652	83	495

EIA MECS 2002, Table 10.2. Does not include natural gas used as feedstock.

Some companies partner with energy service companies (ESCOs), which develop, implement, and finance energy efficiency projects. ESCOs assume the project's risks, and are paid through the company's energy savings. Since the adoption of the Sarbanes-Oxley Act, however, many companies have been wary of "off balance sheet" partnerships such as these, especially when the potential cost savings from efficiency projects are small.

These regulatory and legal issues could be addressed if the relevant government agencies would work together to coordinate policies and provide guidance to manufacturers so that barriers to improving industrial energy efficiency are reduced or eliminated.

Government Programs. There are already several U.S. government programs that help manufacturers reduce their energy use, and expanding them may be worth considering. Many companies and associations have worked with the Department of Energy's Industrial Technologies Program (ITP), which invests in research and development to help industry reduce energy use. ITP also advises companies on energy savings measures by performing plant assessments for the country's largest energy users; providing software and training to firms; and funding centers of energy efficiency expertise at universities that small and medium companies can consult. Some of ITP's services are free, and some are rendered on a cost-sharing basis.

Other companies have reduced their energy use by working with the Department of Commerce's Manufacturing Extension Partnership (MEP). Although MEP does not focus solely on energy efficiency, it has helped many small and medium-sized companies optimize their energy use, and also has staff with expertise in helping such firms obtain financing.

Finally, more frequent collection of data by the government about energy use by manufacturers would help better inform policy makers. Currently, the EIA collects such data

only every four years. The Census Bureau, in its Annual Survey of Manufactures, collects a small amount of data every year, but it is limited to total fuel and electricity costs.

Conclusion

The future of manufacturing energy-intensive products in the U.S. may depend on energy policies that are chosen today. Although companies in every industry sector have dramatically improved their energy efficiency over the past few decades, these efforts have not been enough for companies in the more energy-intensive sectors to offset recent increases in oil and gas prices. The policy ideas presented in this paper are meant to stimulate a larger discussion of what can be done to reduce the impact of high energy costs on manufacturers, and the relative costs and benefits of these and other ideas. While some of the potential solutions, such as increasing domestic energy production and reducing natural gas use, are medium- to long-term, there are actions that can be taken in the short term, such as creating tax incentives and loan programs, and removing some of the regulatory barriers to improving energy efficiency.

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