The Changing U.S. Industrial Landscape

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ABSTRACT

There have been many changes in U.S. manufacturing in recent years. Many plants have closed, for a variety of reasons, and many manufacturing jobs have been eliminated. Many sectors have declined in the last five years in terms of total output and electricity use, while others have grown. Overall, U.S. industrial electricity use has decreased by 3.5% since 1998, but has been increasing slowly since 2001.

Industrial natural gas use in the U.S. has decreased by over 11% since 1998 as natural gas prices have more than doubled. Chemical plants relying on natural gas as a feedstock will continue to move plants overseas in search of cheaper natural gas sources.

Understanding the changing industrial landscape is important to utilities, energy service providers, and manufacturing energy assistance providers. Many manufacturing sectors will continue to have a hard time competing with imports made with low-cost labor in countries such as China or Mexico. Other sectors will continue to do well here, due to a variety of factors including the need for close ties with suppliers or customers, the need for highly trained workers, high costs of shipping products from overseas, and various innovations in new products and manufacturing methods.

Slump or Revival?

Diverse opinions abound about the well-being of manufacturing in the U.S. In April of 2005 the Institute for Supply Management (ISM) reported that manufacturing sector grew for the 23rd consecutive month according to its data. However, ISM also stated that the trend was definitely towards a lower rate of growth. (Institute for Supply Management 2005)

On the other hand, between 2001 and 2004, 3.3 million U.S. manufacturing jobs were lost and manufacturing employment declined by 14 percent (U.S. Dept. of Labor 2005a). Many of these lost jobs were due to plant closures, and some experts predict that U.S. facilities in many manufacturing sectors will continue to fold in the face of increasing penetration of imported manufactured goods from countries with cheap labor (Bernard, Jensen, and Schott 2004).

Sorting out which sectors are growing and which are in decline is important for organizations offering energy efficiency or other types of assistance to manufacturers. In addition gaining a realistic perspective on the trends in manufacturing energy use is important for many organizations, including utilities, economic development organizations, and organizations involved with energy resource planning.

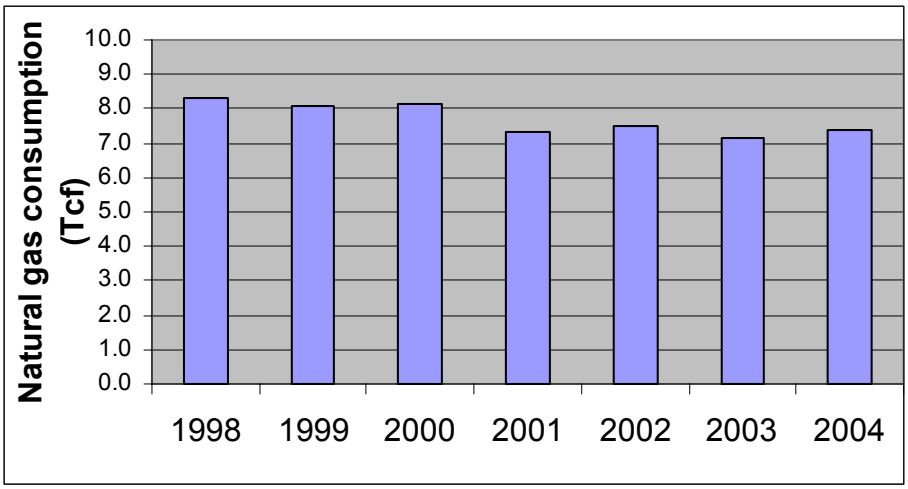
Industrial Energy Use Trends

In the period from 1998-2004, there was a significant decrease in industrial energy use. Industrial natural gas consumption declined mainly a result of impacts on one sector – chemical manufacturing, while electricity use decreased slightly, due to declines spread across many manufacturing sectors.

Declining Industrial Natural Gas Demand

There has been a 11% drop in U.S. industrial natural gas demand since 1998, more than triple the decrease in industrial electricity consumption during this period. (See Figure 1.) The main culprit is the high cost of natural gas in the U.S. compared to many other parts of the world. The average wholesale price of natural gas in the U.S. has increased by over a factor of two in the last four years, from about $2.50/MMBtu in 1999 to $5.90/MMBtu in 2004 (Platts 2005).[1] The U.S. currently has significantly higher natural gas prices than many other countries throughout the world. For example, the current wholesale price of natural gas in Brazil is only about $2.80/MMBtu (Platts 2004).

Figure 1. U.S. Industrial Natural Gas Demand



Source: EIA 2004

Most of the decline in U.S. industrial natural gas demand is from the chemical industry, in the sectors in which natural gas is used as a feedstock. About 31% of total U.S. industrial natural gas demand is for feedstock use, with the remaining 69% for use as a fuel (EIA 2004b). Natural gas costs can range from 10% to 80% of total operating costs for some chemical producers, with nitrogenous fertilizer and ethylene producers at the higher end of the spectrum (Gupta 2003). The U.S. has increased fertilizer imports by 43% since 2001 as a direct result of

[1] Another way to look at gas prices is in terms of prices of futures contracts. In January of 2000, NYMEX futures contracts for Jan. 2003 natural gas (three years ahead) were available for $2.70/MMBtu. In March of 2005, the price of futures for March of 2008 was $7.05/MMBtu (nearly triple the price available in January of 2000). Most industrial gas purchasers do not use contracts of more than 2-3 years in length.

declining domestic fertilizer production. Methanol production also uses natural gas as a feedstock, and one-half of U.S. methanol production capacity has been shut down in the last five years (Gupta 2003). Louisiana's industrial gas demand has dropped by about 24% from 1998-2003, mainly due to closures of chemical plants.

As a result of the high domestic natural gas prices, many smaller chemical companies are permanently closing plants or temporarily idling production capacity. High gas prices forced PCS Nitrogen to stop production and consider permanently closing one of its two ammonia plants in Geismar, Louisiana. Koch Industries closed the second of its two plants in Sterlington, Louisiana in February of 2003 (Associated Press, 2004).

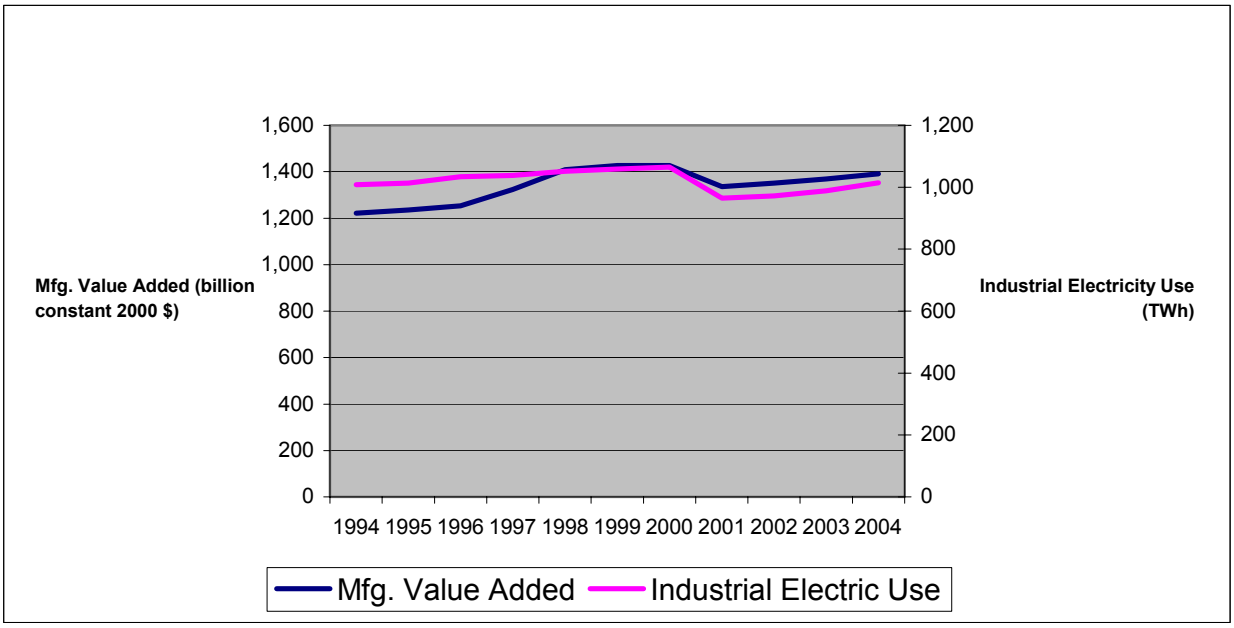
The large multi-national chemical companies are also closing plants in the U.S., and are opening new facilities in countries where natural gas is cheaper. Chemical companies will continue to move plants overseas as long as natural gas is significantly more expensive in the U.S. Dow Chemical has closed four of its major chemical plants in North America in the last two years – one in Louisiana, two in Texas, and one in Alberta – and replaced them with increased production or new plants in Germany, the Netherlands, Malaysia, Argentina, and Kuwait (Washington Post 2004). According to Gina Gibbs Foster of Dow, natural gas prices in the U.S. would have to be $3-4/MMBTU to be competitive with Dow's overseas companies (Gibbs Foster 2005). Platts projects that wholesale natural gas prices at Henry Hub will remain in the $5.50-$7.50-MMBtu range through 2009 (Platts 2005).

Many other chemical companies are beginning to invest heavily overseas. Chevron Phillips Chemical has recently closed down two U.S. steam crackers in Texas while continuing to pour money into plants in Qatar and Saudi Arabia. One nitrogenous fertilizer producer recently closed down one of its U.S. plants and opened a new plant in Trinidad. Five major chemical producers, Dow, BASF, BP, Shell, and Exxon Mobil have invested heavily in ethylene joint ventures in China for completion this decade. Formosa Plastics shut down a Baton Rouge plant and made plans to expand its chlor-alkali operations in Taiwan.

Industrial Electricity Use and Total Manufacturing Output

There is a strong correlation between total manufacturing output and industrial electricity use. As shown in Figure 2, total U.S. manufacturing output and industrial electricity consumption increased from 1994-2000, dropped from 2000-2001, and have been making a modest comeback since 2001. U.S. Industrial Electricity Consumption decreased by about 3.5% between 1998 and 2004. "Manufacturing Value Added," an indicator of total manufacturing output, decreased by about 1.3% between 1998 and 2004 (based on constant 2000 dollars). Manufacturing Value Added is the value of goods shipped from U.S. facilities minus the value of the input materials purchased by the facilities. Manufacturing value added is a better indicator of total U.S. manufacturing output than total manufacturing sales, because the latter does not account for products partially manufactured abroad and shipped back to the U.S. for final assembly and sale.

Figure 2. U.S. Industrial Electricity Consumption and Manufacturing Output



Source: EIA 2005a; U.S. Bureau of Economic Analysis 2005; U.S. Dept. of Labor 2005b [2]

"Industrial" as defined by the EIA's energy use data, includes mining, agriculture, and construction in addition to manufacturing. Industrial energy use and total manufacturing output are not directly comparable, but manufacturing represents about 85% the total industrial electricity consumption, and as total manufacturing output increases, the industrial electricity consumption increases as well. Mining accounts for about 6%, agriculture 4%, and construction, forestry and fishing account for the remainder (Schipper 2004).

There is no direct correlation between manufacturing output and jobs. Total manufacturing jobs in the U.S. reached their peak in 1979 and then began to decline gradually until 2000, when they dropped more sharply. From 2000 to 2003, U.S. manufacturing employment decreased by about 15 percent. One study estimates that about one-fourth of these manufacturing job losses were due to plant closures caused by foreign competition, and the rest were mainly due to increased labor productivity or the recession of 2001 (Bartik 2004).

Although the overall change in industrial electricity consumption over the last six years has been relatively minor, some states have seen a large drop in industrial electricity consumption during this period, and some states have seen an increase. Table 1 shows the top six states ranked by the loss of industrial electricity demand from 1998-2003. The five states highlighted in bold appear in the top ten in both lost electricity demand and lost manufacturing jobs, suggesting a correlation between the two, due to manufacturing plant closures. Some manufacturing sectors have experienced growth over the past six years, while others have seen a significant decline (see "sector-wide impacts" section below).

[2] The "mfg. value added" values from the Bureau of Economic Analysis were converted to constant 2000 dollars using the producer price index for finished goods from the U.S. Department of Labor.

Table 1. States with Greatest Loss of Industrial Electricity Consumption

State	Change in Industrial Electricity consumption, 98-03 (MWh)	Percent Change	Change in Manufacturing Jobs, 98-03	Percent Change
WA	-20,906,110	-55.6%	-94,000	-26.1%
OH	-15,341,087	-21.0%	-176,133	-17.1%
CA	-13,403,790	-21.7%	-273,100	-14.7%
MN	-5,606,130	-19.9%	-50,525	-12.7%
TX	-4,950,140	-4.8%	-161,383	-15.0%
IL	-4,667,060	-10.8%	-172,850	-19.1%
U.S. Total		**-6.0%**		

Source: EIA 2005b, U.S. Census Bureau 2004

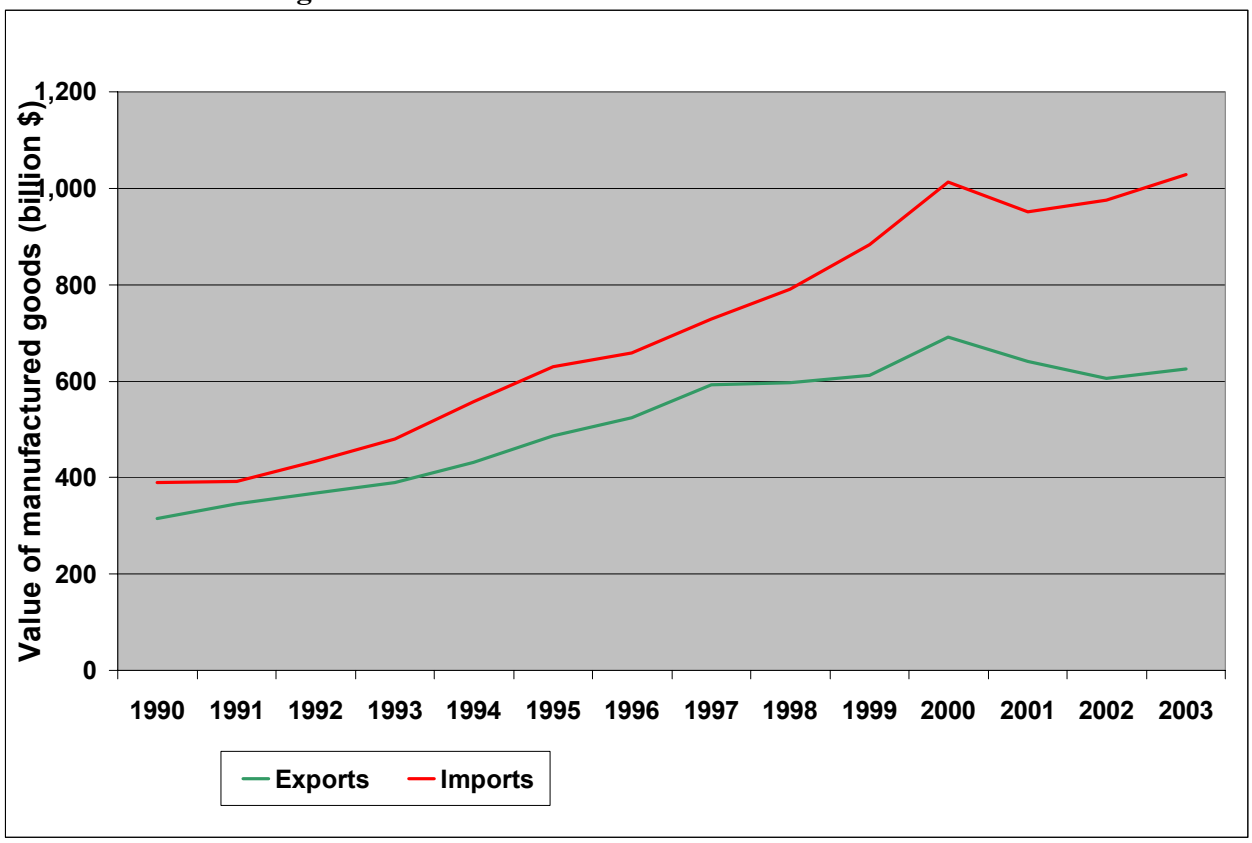
Impacts of Imported Goods on Total Manufacturing Output

Although the total U.S. manufacturing output has grown since the 2001 recession, its rate of growth in the past three years has been sluggish. From 1994-2000, the total manufacturing value added (MVA) grew by about 2.6% per year in constant dollars. From 2001 – 2004 the total MVA grew by only about 1.6% per year. The U.S. GDP has grown at about the same rate from 2001 – 2004 as it did from 1994 – 2000. (U.S. BEA, 2005b). An important contributing factor to the recent sluggishness in the growth in manufacturing output is the increasing levels of imports of manufactured goods. In order to predict future trends and patterns for industrial energy use, it is important to understand the impacts on total manufacturing output of the increasing levels of imported manufactured goods.

As the gap between imports and exports of manufactured goods increases, it has a direct impact on total U.S. manufacturing sales (and on total output).[3] Figure 3 shows the increase in this trade deficit in manufactured goods (in nominal dollars), especially in the last seven years (International Trade Administration, 2003). In 2003 the trade deficit in manufactured goods amounted to $400 billion, which was 29 percent of the total U.S. manufacturing value added (MVA) for that same year (International Trade Administration 2003; U.S. Department of Commerce 2004). The increasing trade deficit in manufactured goods is a strong contributing factor to the declining rate of growth in total manufacturing output.

[3] The total sales ($) of U.S. manufactured goods equals the total purchases of manufactured goods by U.S. consumers, plus the value of exports of U.S. manufactured goods, minus the value of U.S. imports of manufactured goods.

Figure 3. U.S. Trade Deficit in Manufactured Goods



Source: International Trade Administration 2004

The trade deficit in manufactured goods will probably continue to grow, although at a slower pace than it grew from 1998-2003, due to several dampening factors. These stabilizing factors include the recent increases in marine shipping costs, which have more than tripled since 2002 (Elliott 2004), the significant increase in crude oil prices in the last year (which also adds to shipping costs), and a likely further devaluation of the U.S. dollar. Despite these factors, however, many economists predict that the overall U.S. trade deficit and the trade deficit in manufactured goods will continue to increase, considering that the devalued dollar and increased shipping costs have had little effect on the deficit so far (Cooper and Madigan 2004).

Winning and Losing Sectors

Some sectors have declined in total output in the last six years, due to several important factors. Understanding these factors will help manufacturing assistance organizations to make better decisions about targeting of their efforts. Table 2 shows the changes in manufacturing output and job losses for each of the 3-digit NAICS manufacturing sectors since 1998 (US Bureau of Labor Statistics 2004). Growth sectors include chemicals,[4] miscellaneous, petroleum and coal, and food and beverage products. According to one recent study, the sectors most at risk

[4] The chemical sector as a whole actually grew during the 1998-2003 time period. This is because only a small part of the chemical industry relies significantly on natural gas as a feedstock.

from increasing imports and foreign competition include leather goods, apparel, and furniture. Based on factors including a relatively low level of required worker expertise and easy to transport products, these sectors may experience increases in the percentage of imported products from low-wage countries of more than 20 percentage points by 2011 (Bernard, Jensen, and Schott 2004). As discussed above, the chemical sectors using natural gas as a feedstock, such as nitrogenous fertilizers and ethylene, are also at serious risk of further plant closures due to the high U.S. natural gas prices.

Table 2. Sector-Wide Losses of Total Output and Jobs

NAICS	Sector Name	Percentage change in manuf. value added (98-03) (adjusted for inflation (PPI))	Percentage change in number of manuf. jobs (98-03)	Energy intensity (energy costs/value added)
331	Primary metals	-26.8%	-25.7%	16.0%
313	Textile mills	-25.4%	-38.7%	8.2%
314	Textile product mills	-25.4%	-17.2%	3.1%
333	Machinery	-19.5%	-23.7%	1.6%
334	Computer & electronics	-17.0%	-25.7%	1.2%
315	Apparel	-10.8%	-51.1%	1.5%
316	Leather & allied products	-10.8%	-45.5%	2.1%
323	Printing & related support	-9.5%	-17.9%	2.2%
322	Paper	-8.1%	-16.9%	9.9%
337	Furniture & related products	-7.5%	-10.6%	1.6%
332	Fabricated metal products	-7.3%	-15.0%	2.9%
327	Nonmetallic mineral products	-4.8%	-8.0%	9.2%
335	Electrical equipment & appliances	-1.6%	-22.3%	2.0%
326	Plastics & rubber	-0.4%	-13.5%	4.3%
321	Wood products	1.4%	-12.0%	4.9%
336	Transportation equipment	2.5%	-14.5%	1.5%
325	Chemicals	10.2%	-8.5%	6.4%
339	Miscellaneous	15.6%	-9.4%	1.1%
324	Petroleum & coal products	16.1%	-14.8%	16.7%
311	Food	17.3%	-2.3%	3.4%
312	Beverage & tobacco products	17.3%	-4.0%	1.2%
	Total manufacturing	**-2.8%**		

Sources: U.S. Bureau of Economic Analysis 2005, U.S. Bureau of Labor Statistics 2004, U.S. Census Bureau 2005

One of the main factors in determining which types of manufacturing will survive here is the exposure of U.S. companies to cheaper labor available abroad. The average cost of labor in the U.S. for manufacturing jobs is $21/hour, compared to $2.40/hour in Mexico, and under

$1.00/hour in China (U.S. Bureau of Labor Statistics 2004, Electronics Supply and Manufacturing 2003).

Within the sectors impacted heavily by imports of manufactured goods, there are three ways that the pressure of foreign competition is felt. There are small and medium-size companies that close due to direct competition from foreign companies, in China or Mexico for example. Secondly, some companies choose to outsource part of their manufacturing operations to foreign plants to reduce overall manufacturing costs. Third, multi-national corporations close their U.S. plants and relocate the manufacturing operations to their new or existing foreign plants when it is more profitable to do so. For example, Carrier, a subsidiary of United Technologies Corp., recently announced it would close its air conditioner manufacturing facility in New York. The air conditioners will now be made at a Carrier plant in Mexico and then shipped back to the U.S. for final assembly and testing (West 2004).

Energy-Intensive Sectors

Table 2 shows that of the top five energy-intensive sectors (shaded), the only two that have seen a high percentage lost output (and jobs) are the primary metals sector (NAICS 331), which includes the aluminium and steel industries, and textile mills (NAICS 313).

The primary metals sector lost 27% of its total output and 26% of its jobs from 1998-2003, indicating that various competitive pressures, including the high costs of energy, have had a serious impact. The aluminum industry uses a great deal of energy, mainly electricity, in the production of aluminum. The price of electricity in the northwestern U.S. has increased significantly in the past five years due to shortages of hydroelectric power and increased reliance on natural gas-fired generation. As a result, eight of the nine aluminum plants in the State of Washington have closed since 1998. In search of cheaper energy, Alcoa has recently opened a large new aluminum plant in Trinidad and Tobago. This plant will generate its own electricity on-site with a combined heat and power system fired with the domestically-produced natural gas available (Alcoa 2004).

There have also been several plant closures in the steel industry, along with several mergers to consolidate assets and improve efficiencies. Imports from China have increased recently for easier to ship steel products such as rebar, adding to the pressures. To stay competitive, U.S. Steel companies have made progress on improving energy efficiency, reducing energy intensity by 17% since 1990 (Gravatt 2005). There has also been a trend in the steel industry in the last five-ten years to purchase coke from foreign companies rather than producing it on-site, which reduces energy use significantly (mainly coal use). In addition U.S. steel makers are using higher percentages of scrap iron, which also reduces energy and material costs (Fillman 2001).

Factors for Survival

While some sectors may be destined to continue to decline and lose market share to cheaper labor markets offshore, there are others that are in a good position to survive and even grow domestically. The Financial Times (FT) recently developed a set of ten factors to help companies in the U.S. or Europe decide whether it makes sense to manufacture their products in China. The FT's system focused on three main areas: the market position of the company making the product (how strong is the competition), supply chain issues (proximity to customers and suppliers, weight and fragility of products), and the manufacturing processes (complexity, level

of skill required). According to this system, products that do not make sense to produce in China (and are therefore more likely to continue to be manufactured in the U.S.) would have the following main characteristics:

- closer ties to U.S. customers and/or suppliers,
- heavier or more fragile products (more difficult to ship),
- more complex production processes (requiring more highly trained workers and higher capital expenditures on technology), and/or
- less intense competition (Marsh 2004).

Supplementing the criteria mentioned by the Financial Times, Terry Foecke suggests the following criteria for sectors or types of manufacturing that are more likely to stay vibrant in North America (Foecke 2004a):

- Products with low shelf-life (e.g., food, biochemicals)
- Companies that require close ties and/or close proximity with customers (e.g., specialty chemicals, industrial gases, military equipment and supplies)
- Sectors with heavy raw materials usage (or energy) and good, cheap supplies available locally (e.g., construction and building materials, Aluminum)
- New advances in technology with close ties to universities (e.g., advanced materials)
- Capital-intensive, high value-added products.

In addition Foecke notes that there may be several sectors in transition, including chemical sectors switching from chemical to biological feedstocks, and various sectors switching from high-volume production of standard products to low-volume manufacturing of customized products. Several new technologies and methods are part of the latter trend, including new developments in powder metallurgy and in the concept of flexible manufacturing (Foecke 2004b).

Role of Energy Efficiency

Although energy is a relatively small percentage of total operating costs for most sectors, improvements in energy efficiency could help many companies to remain competitive. Energy cost savings go straight to the bottom line, and can have a significant impact on improving profits. In addition, in many cases improvements in energy use can also have important "non-energy benefits," such as reducing process upsets or reducing down-time, which can have a large impact on improving overall productivity and profits. As one example of the potential synergies between energy efficiency and improved competitiveness, a quarry tile maker in Washington saw an opportunity to expand its product line and began investigating a new type of energy-efficient oven. Avista Utilities worked with the company to test the new oven, and subsequently agreed to cover part of the initial investment, which allowed the company to go ahead and install the new oven. The new oven allows the company to produce four times as much product, in a greater variety of types and styles, using only 10% more natural gas. The new oven and expanded product line allowed the company to grow its business, while many similar companies in the area went out of business during this time period (Leinard 2004).

Projections for the Future

In the chemical sector, Platts expects that additional plant closures will occur in the sectors using natural gas as a feedstock. With the prices of crude oil expected to remain in the $45-50/bbl range, some industrial companies may burn additional natural gas as an alternative to fuel oil. However, any modest increases in the use of natural gas as a fuel are not likely to offset the continued declines in consumption by the chemical industry. Therefore, we expect U.S. industrial natural gas consumption to continue to decline slightly over the next five years, through 2009. (Platts 2005). This prediction is much less optimistic (lower expected growth) than that of the EIA (EIA 2005c).[5]

Industrial electricity use (and total manufacturing output) may continue to grow at a modest rate, despite continued increases in the manufacturing trade deficit. However, different sectors will continue to grow (or decline) at very different rates. Regardless of energy costs, manufacturers of products that can be easily shipped and that do not require large investments in technology or highly trained workers will probably continue to close plants in the U.S. as imports of products from low wage countries continue to increase. However, these plant closures may be offset by growth in other sectors with domestic advantages such as close ties with customers and suppliers. In addition new industries may thrive through new developments in technologies or manufacturing methods. Manufacturing in the U.S. is not doomed, but will have to continue to adapt and innovate to remain competitive.

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[5] In its "Annual Energy Outlook 2004," the EIA predicts growth in industrial energy consumption beginning in 2005 of about 1.1% per year for manufacturing heat and power, and 0.8% per year for nonfuel use (feedstocks and asphalt).

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