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Working Paper

MIDWEST MANUFACTURING SNAPSHOT: ENERGY USE AND EFFICIENCY POLICIES

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SUMMARY

The workforce and economies of Midwestern states are more reliant on manufacturing than in any other U.S. region. Like the U.S. as a whole, during the past decade, the Midwest lost one-third of its total manufacturing workforce.

With the central focus of state governments on economic development, there is a growing interest in understanding how industrial energy efficiency investments could contribute to regional economic recovery and long-term competitiveness for U.S. manufacturers. However, state-level energy-use data are not currently available from public sources at the level of detail needed to identify which sectors are using how much energy and where.

This paper presents detailed manufacturing energy-use and economic-activity data along with state-by-state policy summaries for the 10 member states of the Midwestern Governors Association. To help inform ongoing policy discussions across the region, this paper offers a snapshot of industrial energy use and current state approaches to reducing industrial energy intensity and energy costs for manufacturers.

CONTENTS

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INTRODUCTION

Manufacturing remains a cornerstone of the U.S. economy, and nowhere is this more evident than in the Midwest. Manufacturers are also significant consumers of energy; yet, manufacturing subsector fuel use data are not available at the state level, which greatly limits the public's understanding of industrial energy efficiency potential and other related questions of public interest. Given the centrality of manufacturing to the Midwestern economy and energy consumption, policymakers, industry and other interested stakeholders would benefit from more detailed information regarding energy use across all manufacturing sectors.[1]

The primary purpose of this paper is to enable a constructive dialogue around effective strategies for achieving complementary environmental and economic outcomes in the Midwest. For the first time, this paper estimates manufacturing subsector-specific energy use for the 10 states in the Midwestern Governors Association (MGA).[2] Detailed manufacturing energy-use and economic-activity data are presented alongside state-by-state policy summaries, giving a snapshot of where energy is being used and current state approaches for reducing energy-related costs and emissions.

Some context for this paper is worth noting at the outset. The year 2011 saw modest economic recovery for U.S. manufacturing, as a whole, after a decade of historic job losses and high energy prices. In 2012, state budgets will likely remain tight and the last of federal Recovery Act funding for state energy efficiency programs will be spent. Many policymakers are prioritizing policies that spur new investments to create jobs and economic development in their states. With these goals in mind, energy efficiency investments offer promising returns, in terms of both economic growth and employment. More productive energy use begets a more productive and efficient economy, now and for decades into the future (Laitner et al., 2012).

This working paper is divided into five main sections. The first section describes national and regional trends in manufacturing energy use and economic activity. The second section describes available public data and our methodology for deriving more detailed state-level manufacturing subsector energy-use data. The third section introduces in greater detail the concept of industrial energy efficiency (EE) and highlights four emerging policy trends. The fourth section profiles the 10 member states of the MGA, including graphics and discussion of state-specific energy use and recent manufacturing trends, as well as high-level summaries of relevant state policies. The final section discusses further work needed to build on the information presented here to more specifically identify policies needed to reduce the energy intensity and increase the cost competitiveness of Midwest manufacturing.

More productive energy use begets a more productive and efficient economy, now and for decades into the future.

Section 1: Industrial Activity and Energy Use

Industry plays an important role in the U.S. energy system and economy. In 2010, industry accounted for nearly one-third of total U.S. energy use, 20% of gross domestic product (GDP), 14% of total employment, and 70% of exports, by value. At the national level, manufacturing consumes more than 80% of total energy used by the industrial sector, with the balance used by agriculture, mining, utilities, and construction (Brown et al., 2010).

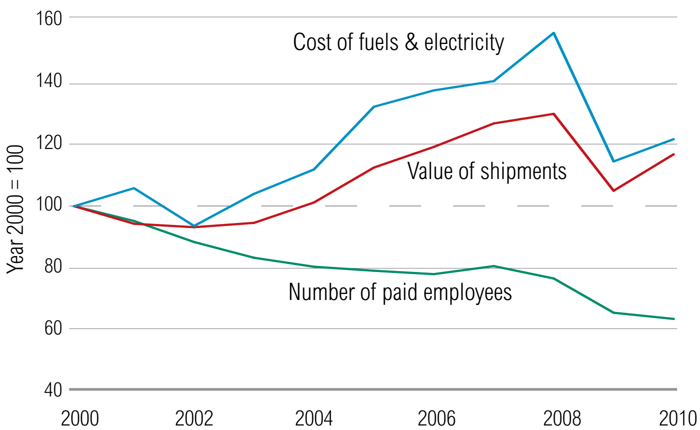
In 2010, China emerged as the world's largest manufacturer, surpassing the United States, which had held this position since 1895 (PCAST, 2011). This event punctuated an historic recent decline in U.S. manufacturing, which lost more than 30% of its workforce in the past decade (Figure 1). The U.S. economy has restructured away from manufacturing in recent decades, with services and information-based activities becoming more dominant. This structural change is compounded by increasing U.S. reliance on imported manufactured goods (NAS, 2010).

Manufacturing trade associations, organized labor, and other stakeholders have expressed a growing sense of urgency. They argue that economic recovery will not come to the United States without revitalization of the manufacturing sector (Atkinson and Ezell, 2011). This view is supported by the fact that manufacturing has been a

1 As noted in Section 2 of this paper, public data are available from government sources that describe state-level energy-use and economic-activity by industry and manufacturing, in general. However, no public data sources allow for consistent, direct comparisons on manufacturing subsector energy-use among the states of the Midwest.

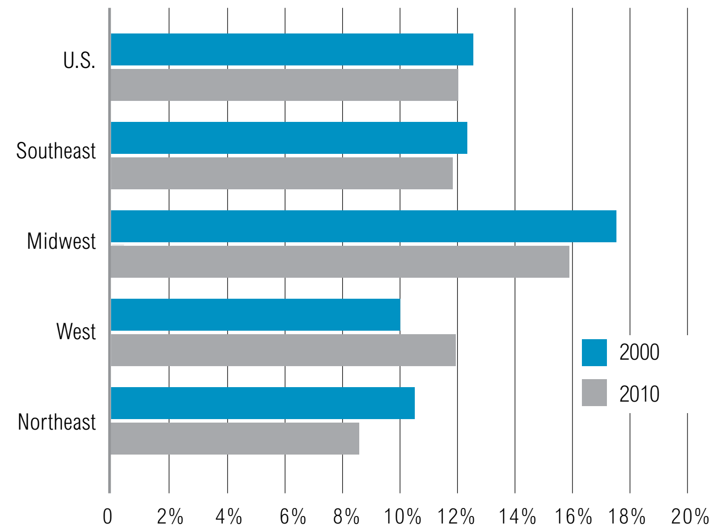
2 Member states of the MGA are Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Ohio, South Dakota, and Wisconsin.

Figure 1 | **Index of U.S. Manufacturing Costs, Value of Shipments, and Number of Employees, 2000-2010**



SOURCE: ASM.
NOTE: Cost and value are based on nominal data.

Figure 2 | **Manufacturing Share of Total GDP, 2000 and 2010**



SOURCE: U.S. Bureau of Economic Analysis

For energy-intensive subsectors like iron and steel, cement, and paperboard manufacturing… energy prices have significant implications for a company's bottom line.

leading contributor to U.S. economic recovery during the past 2 years.[3] Even as this long-standing debate continues, with some questioning whether or not the United States will ever rebuild a vibrant manufacturing base (Gertner, 2011), others see the United States as again becoming an attractive place to locate factories (*Economist*, 2011). Optimists point to a narrowing wage gap between the United States and China and the weak dollar as reasons why the offshoring trend of recent years may reverse, with a brighter future for investments in U.S. manufacturing (Kaushal et al., 2011).

For U.S. manufacturing as a whole, energy expenditures represent less than 2% of total costs. However, for energy-intensive subsectors like iron and steel, cement, and paperboard manufacturing, energy costs account for 6, 15, and 16% of each subsector's total value of shipments, respectively (EPA, 2009). In these subsectors, energy prices have significant implications for a company's bottom line; for example, several U.S. chemical plant closures during the past decade have been attributed to spikes in natural gas prices (ACC, 2011). Figure 1 illustrates that the index of total energy costs increased more quickly during the last decade than the index of value of shipments.[4] By 2008, fuel costs rose to almost 60% above their 2000 levels, while the value of shipments rose more gradually.

This recent history brings into sharper focus the practical benefits of industrial EE: increased efficiency reduces the exposure of U.S. manufacturers to future price spikes and helps to increase their long-term competitiveness (NASEO, 2012).

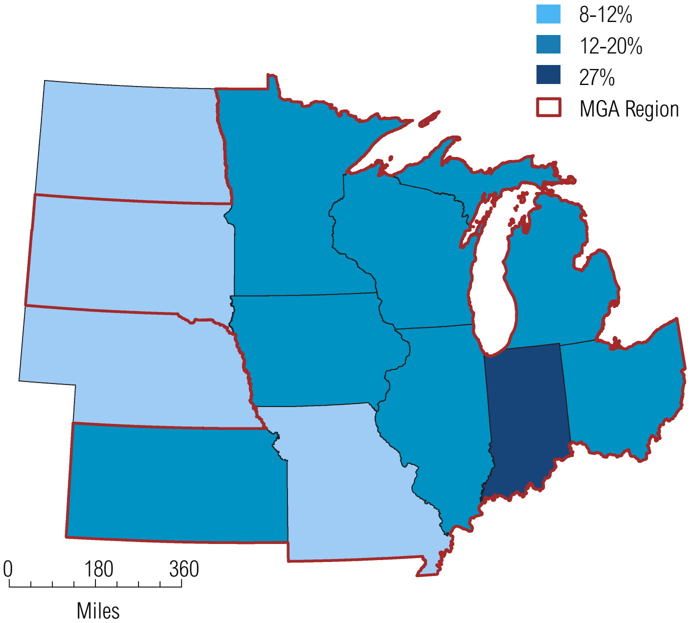
Section 1.1: Midwest Manufacturing Energy Use

The Midwest accounted for 30% of total U.S. manufacturing value-added activity in 2010, much greater than its share (22%) of the national population (U.S. Census Bureau). Figure 2 shows the manufacturing share of

3 http://www.bea.gov/newsreleases/glance.htm (January, 2012).

4 Note that the absolute value of manufacturing energy expenditures remains a small fraction of the value of shipments. Manufacturing energy expenditures surged from $75 billion in 2000 to $118 billion in 2008 and then dropped to $92 billion in 2010. Total manufacturing value of shipments grew from $4,209 billion in 2000 to $5,468 billion in 2008 and then dropped to $4,917 billion in 2010.

Map 1 | **Manufacturing Share of State GDP in the Midwest, 2010**



SOURCE: U.S. Bureau of Economic Analysis.

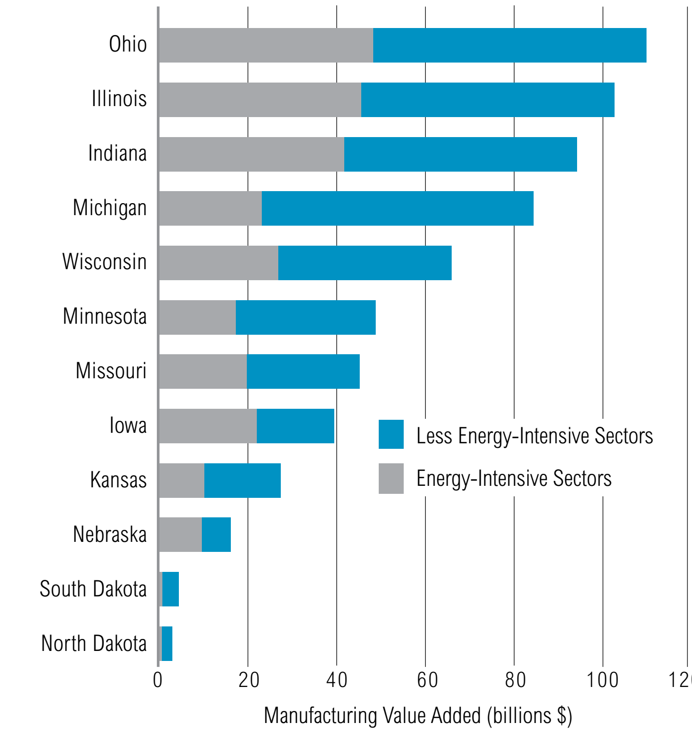
Increased efficiency reduces the exposure of U.S. manufacturers to future price spikes and helps to increase their long-term competitiveness.

total GDP for the Midwest, other U.S. Census regions,[5] and the average share for the United States overall in the years 2000 and 2010. While the manufacturing share of Midwest GDP declined from 17% in 2000 to 16% in 2010, it remained significantly higher than the national average of 12%. Adjusted for inflation, the total value of Midwest manufacturing activity remained largely flat between 2000 and 2010.

Eight states within the Midwest region experienced manufacturing growth between 2000 and 2010, while Ohio, Michigan, Missouri and Wisconsin saw significant absolute declines in the value of their manufactured goods.

5 Except when speaking of the states as members of the MGA, this working paper uses U.S. Census Bureau region categories. The Midwest region includes Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin (see Map 1).

Figure 3 | **Value Added of Midwest Manufacturing, 2010**



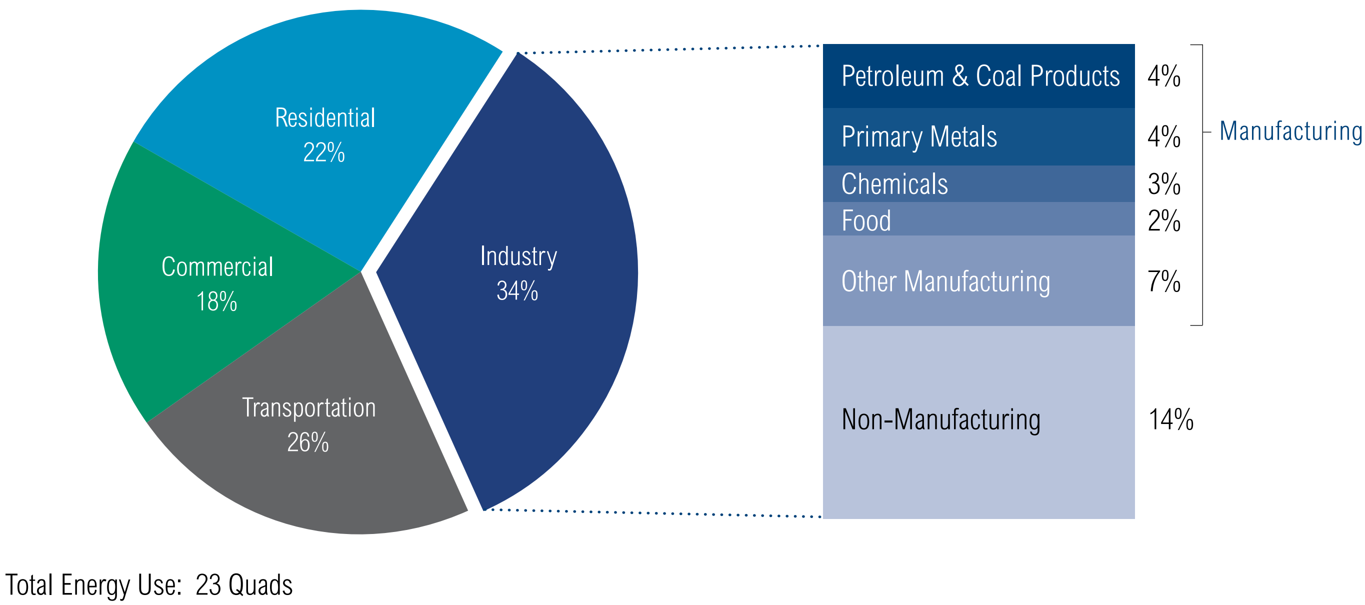
SOURCES: MECS; ASM.

Manufacturing is also important in terms of Midwest employment. Manufacturing comprised a higher share of total employment in the Midwest than in any other U.S. region, though the share dropped from 14% in 2000 to less than 10% in 2010. Every state in the Midwest lost manufacturing jobs between 2000 and 2010, with a regional average decline of 4% per year over the period.

Map 1 illustrates the portion of state economic activity accounted for by manufacturing in 2010, showing that Great Lakes states tend to have a much higher level of manufacturing activity than the Great Plains states, farther west. Figure 3 shows the value added by manufacturing for each of the 12 Midwestern states. Ohio had the highest level of manufacturing activity, followed closely by Illinois, Indiana, and Michigan. This figure also shows the relative contributions of energy-intensive and non-energy-intensive[6] subsectors to

6 For the purpose of this discussion, "energy-intensive sectors" are those North American Industry Classification System (NAICS) 3-digit level sectors that consume relatively more fuel per dollar of value added. These sectors include primary metals, petroleum and coal products, chemicals, food, nonmetallic minerals, paper, and wood products (Source: MECS, 2006, table 6.1).

Figure 4 | **Total Midwest Energy Use by Subsector, 2006**



SOURCES: SEDS; MECS, Table 1.2.

the total value added by manufacturing in each state. This shows that energy-intensive sectors are of varying importance among Midwestern states. Michigan, for example, has relatively less value added by energy-intensive subsectors, in large part because vehicle manufacturing, a high value product, made up 37% of the state's total manufactured value added, in 2010.

Figure 4 shows that industrial activity consumes more energy than any other sector in the Midwest, followed by the transportation, residential, and commercial sectors. Total Midwest energy use among all sectors amounted to 23 Quads in 2006, of which industry consumed 7.8 Quads.[7] In the same year, manufacturing[8] accounted for 60% of industrial sector fuel and feedstock[9] energy use in the Midwest. The four Midwest manufacturing subsectors[10] that consumed the most energy in 2006[11] were petroleum and coal products, primary metals, chemicals, and food processing.

Within Midwest manufacturing, energy-intensive subsectors contribute very significantly to total regional fuel use, led by primary metals (iron, steel, and aluminum).

Whereas Figure 4 shows the breakdown of total Midwest energy use by sector and subsector, Figure 5 displays the total amount of energy used as fuel (i.e., not including energy used as a feedstock) by each manufacturing subsector.

Within Midwest manufacturing, energy-intensive subsectors contribute very significantly to total regional fuel use, led by primary metals (iron, steel, and aluminum),

7 The U.S. Department of Energy Manufacturing Energy Consumption Survey (MECS) provides the most detailed assessment of regional subsector energy use. The most recent MECS data currently available are for 2006 (see Section 2 for further discussion). Quads and other energy units are defined in the glossary.

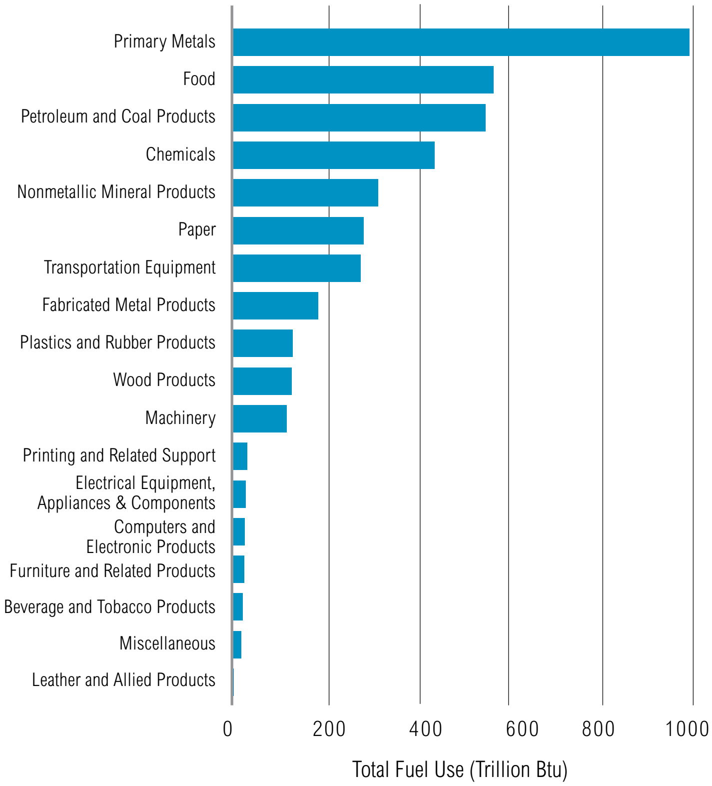
8 The broader category of industry (as defined by the NAICS) includes several sectors beyond manufacturing (NAICS 31—33), including agriculture, forestry, fishing and hunting (NAICS 11), mining and oil and gas extraction (NAICS 21), and construction (NAICS 23).

9 For some sectors of the economy, fossil energy is used not only as fuel but also as a feedstock. For example, crude oil is the primary feedstock used by refineries to manufacture transportation fuels like gasoline and diesel. Likewise, natural gas is a major feedstock for many manufactured chemical products.

10 For the purposes of this working paper, manufacturing subsectors are defined at the 3-digit NAICS code level (e.g., primary metals manufacturing: 331).

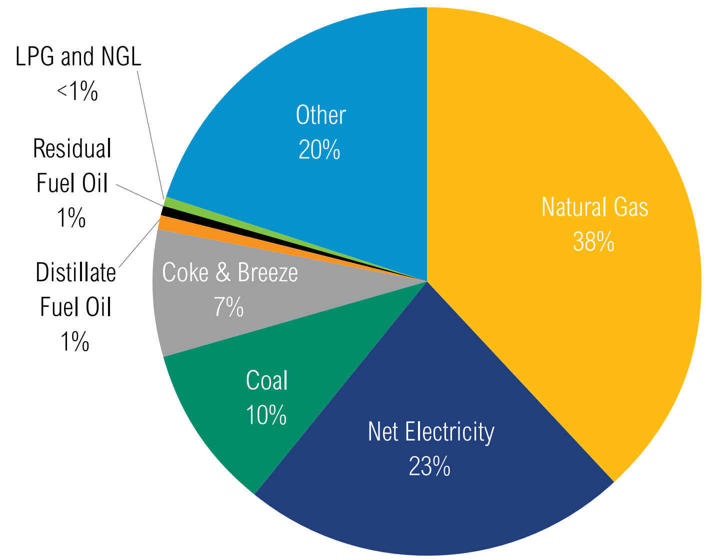
11 The year 2006 is the most recent for which energy consumption data are available at this level of geographic and sector-level detail (MECS, 2009).

Figure 5 | **Midwest Manufacturing Fuel Use by Subsector, 2006**



SOURCE: MECS, Table 3.2.

Figure 6 | **Midwest Manufacturing Energy Use by Fuel, 2006**



SOURCE: MECS, Table 3.2.

food processing, petroleum and coal products (refineries), and chemical manufacturing. For the United States as whole, in which petroleum and coal products, chemicals, and paper manufacturing subsectors use more fuel than primary metals manufacturing. Total energy consumption by Midwest manufacturing is influenced by a range of factors, including the mix of industries located in the region, the age of facility equipment, the utilization of energy efficient technologies and regional energy prices.

Figure 6 shows the breakdown of fuel consumption, on an end-use basis, for all of Midwest manufacturing in 2006.

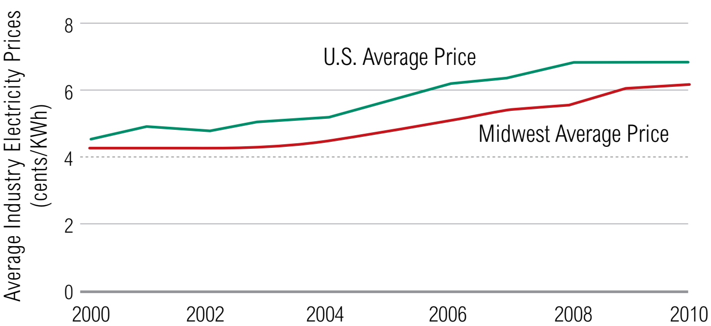
Natural gas and electricity provided more than 60% of Midwest manufacturing final energy use in 2006. The electricity portion represents primarily coal and natural gas and other fuels. Since conventional power generation only converts about one third of the input fuel into useful energy and roughly 7% of electricity is typically lost during transmission, Figure 6—which is in final energy terms—significantly underrepresents the relative amount of fuel used to generate "net electricity" consumed by manufacturers.

In 2010, Midwest industry electricity prices were on average 9% lower than the national average.

Energy prices vary regionally and by end-use sector. In 2010, the Midwest had lower electricity and coal prices than the national average, and higher natural gas prices. Among electricity end-use sectors, industrial customers typically pay the lowest rates.[12] Figure 7 shows the recent history of electricity prices; between 2000 and 2010 average Midwest industry electricity rates increased by 43% and U.S. average industry prices grew by 46%. In 2010, Midwest industry electricity prices were on average 9% lower than the national average.

12 State profiles (Section 4) include tables comparing energy prices for industrial consumers of electricity, natural gas, and coal in each state with average prices in the Midwest region and for the United States overall.

Figure 7 | **Industry Average Electricity Prices, 2000-2010**



SOURCE: U.S. Energy Information Administration, Electric Sales, Revenue, and Average Price, annual.

The unique value of this analysis is that it produces state-level estimates of energy use at the manufacturing subsector level.

A firm's decision to invest in energy efficiency (EE) improvements at manufacturing facilities can be influenced by many factors, energy prices being chief among them. Indeed, the relatively high energy intensity of Midwest manufacturing (see Box 1) has been attributed to lower regional energy prices (DOE, 2009).

Section 2: New Analysis on Energy Use

Policymakers searching for appropriate, targeted energy policy solutions can be hampered by a lack of good information regarding where energy is used. One reason for this information gap is that the U.S. Census and other public surveys of manufacturers are required to withhold state-level data if few facilities are located there, because published data could reveal confidential establishment-level information.[13] Pervasive data gaps limit the ability of stakeholders to have informed discussions and debates regarding federal and state-level policy solutions to energy-security, economic, and environmental challenges and opportunities facing the region.

13 http://www.eia.gov/emeu/mecs/mecs2002/methodology_02/meth_02.html.

Box 1 | **Midwest Manufacturing Energy Intensity**

In the context of this paper's concentration on industrial energy efficiency (EE), it is instructive to note what previous research has found regarding the relative energy intensity of regional manufacturing. This helps inform the question of whether and where targeted policies and programs could spur meaningful EE improvements.

Several different lines of evidence suggest that there is room for efficiency improvement in Midwest manufacturing, at least relative to national averages:

1. The Midwest is home to many of the oldest industrial boilers in the country. On average, oil and coal-fired boilers located in Midwestern states are more than 8 years older than boilers in the rest of the country (EPA, 2011).[a]

2. In 2006, Midwestern manufacturing in several regionally important subsectors was significantly more energy-intensive than national averages. For example, the primary metals, food processing, and vehicle manufacturing sectors were, respectively, 59%, 45%, and 32% more energy intensive (Btu/$GDP) than U.S. national averages (DOE, 2009). Energy intensities are influenced by a range of factors, only one of which is manufacturing process efficiency. Other factors include fuel choice, product mix, and the structure of the sector being measured.[b]

3. As of 2011, the Midwest region has 11 GW of installed combined heat and power (CHP) capacity, out of 84 GW nationally.[c] While CHP amounted to 8% of national electricity generation capacity in 2009, the Midwest CHP share was slightly less than 5% (CHP Installation Database).[d]

a The most recent public boiler data were collected in 2008, by the U.S. EPA, during the development of regulations for toxic air emissions from industrial sources. The industrial boiler MACT (Maximum Available Control Technology) rules were initially finalized in March 2011 and then delayed by a reconsideration process that is expected to be finalized in early 2012. Our age estimate focuses on oil-, coal-, and biomass-fired boilers (i.e., not gas-fired boilers), which will be subject to more significant compliance requirements under the pending rule.

b In terms of the structure of manufacturing, it is important to note that NAICS code definitions of "subsectors" often represent an aggregate of multiple different product lines, each of which may have significantly different energy-use profiles. For example, the "vehicle manufacturing" NAICS code classification includes everything from passenger cars to passenger jets.

c http://www.eea-inc.com/chpdata/.

d http://www.eea-inc.com/chpdata/index.html; EIA, Form EIA-860. "Annual Electric Generator Report."

Section 2.1: Data Analysis Methods

The analysis conducted for this working paper combines state and regional datasets from public sources described in Box 2. The unique value of this analysis is that it produces state-level estimates of energy use at the manufacturing subsector level, providing new insight into where energy is being used across the region, and by which sectors. While direct measures of energy use are always best, when available, this approach helps to fill an information gap by establishing a comparable and consistent data platform based on the best available public information.[14] This information is presented here to help enable constructive interstate policy dialogues, while also providing a starting point for estimating state-level industrial EE potentials across the region.

This paper's data analysis methods are summarized here; a more detailed description of these methods may be found in the appendix. The source for subsector-level total energy-use and energy-intensity[15] data is MECS 2006 (see Box 2), which applies to the entire Midwest region. State-level manufacturing subsector value added data are available from the ASM. State-level manufacturing subsector energy use is estimated by cross-referencing MECS energy intensity data with the ASM's value added information, assuming uniform energy intensity across the region, at the subsector level.[16] Given the assumption of homogenous regional energy intensity of manufacturing, the state subsector fuel use information in this paper should be regarded as useful first estimates.

14 Due to necessary assumptions and the passage of 6 years since the data were first collected, these are estimates, not a direct measure of state-level industrial energy use.

15 For this analysis, subsector-level (at the NAICS 3-digit level) energy intensity is defined as total energy use per value added (Btu per dollar of value added; MECS 2006, Table 6.1). Value-added data were used rather than value-of-shipments data because the former track physical energy-use data more closely.

16 This assumes, for example, that the same amount of energy is used to produce a dollar's worth of primary metals in Michigan as is used to produce a dollar's worth of primary metals in Minnesota.

Box 2 | Public Energy-Use Data Sources

Manufacturing energy-use data are published by government and industry association sources. To provide transparent, consistent cross-sector and regional information about Midwest manufacturing, this working paper focuses on government survey and census data. Four key government sources of manufacturing activity and energy-use data are

- the Energy Information Administration's **2006 Manufacturing Energy Consumption Survey (MECS),**
- the Energy Information Administration's **State Energy Data System (SEDS),**
- the U.S. Census Bureau's **Annual Survey of Manufactures (ASM**), and
- the U.S. Census Bureau's 2007 **Economic Census**.

Each of these sources covers different aspects of the manufacturing sector with varying time frames and granularity.

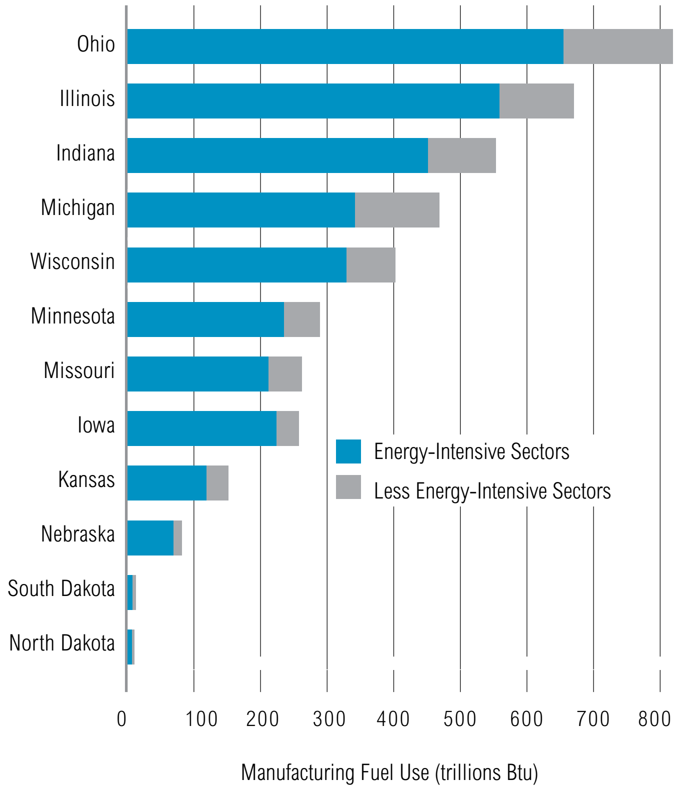
The most detailed subsector-level energy-use data are published by the MECS roughly every 4 years (since 1991). The MECS includes annual energy use by fuel, fuel-switching potential, and value added data disaggregated to manufacturing subsectors, up to the North American Industry Classification System (NAICS) six-digit level (e.g., NAICS code 331111: Iron and Steel Mills). Two limitations of MECS data are that they are only available at the national and regional level (e.g., for the 12 states of the Midwest U.S. Census region) and they are only published every 4 years, with a significant time lag. For example, the most recent MECS data were released in 2009, covering manufacturing activity in 2006.

As suggested by its name, the SEDS includes information on state-level annual energy use by fuel. However, SEDS data are only available at the aggregated sector level. In other words, the SEDS lumps all manufacturing energy use together with agriculture, construction, mining, and utilities into total industry data.

While not as comprehensive as the Economic Census, the ASM includes annual data on value added, value of shipments, number of paid employees, and other state-level information at the NAICS three-digit level (e.g., NAICS 331: Primary Metal Manufacturing) for all years between 2000 and 2010. The ASM also includes state-specific energy expenditure data aggregated to the entire manufacturing sector (NAICS 31—33). Both the MECS and the ASM include value-added data for manufacturing subsectors. If the subsector value-added information is cross-referenced, the ASM can be used to disaggregate regional MECS data to estimate state manufacturing subsector energy-use patterns (see Section 2.1).

The Economic Census and ASM contain economic and employment-related information. Economic Census data are relatively more comprehensive, but they are only released every 5 years. The most recent Economic Census data refer to 2007; because they do not overlap with 2006 MECS data, they are not used in this paper.

Figure 8 | **Midwest Manufacturing Fuel Use by State, 2006**



SOURCE: MECS, Table 3.2.

Energy-intensive sectors generated 42% of Midwest manufacturing value added, while those same subsectors accounted for 80% of regional manufacturing fuel use.

Section 2.2: Cross-state comparison

The manufacturing sector plays a varying role in the energy systems and economies of the 12 states of the Midwest. Figure 3, above, illustrates that there is significantly more absolute manufacturing activity in the Great Lakes than in the Great Plains states. Meanwhile, Figure 8 shows estimates of state-level manufacturing fuel use, as well as the relative role of energy-intensive industries in contributing to total fuel use. Energy-intensive sectors generated 42% of Midwest manufacturing value added, while those same subsectors accounted for 80% of regional manufacturing fuel use. Within the Midwest, Ohio has the highest level of total manufacturing fuel use and Iowa has the highest portion of energy-intensive subsector fuel use (Figure 8).

Without state and subsector-specific data, constant regional energy intensity (Btu of fuel use per dollar of value added) was assumed for each subsector, thereby excluding some degree of state-level variation. Therefore, these estimates provide a consistent, empirical basis for understanding the aspect of Midwest manufacturing energy use that is driven by the distribution of subsector economic activity across the region (see the appendix for more discussion).

Section 3: Industrial Energy Efficiency—Policy Trends and Opportunities

As noted above, industrial EE is an emerging topic of interest to policymakers and other stakeholders around the country who are focused on revitalizing manufacturing and reducing energy costs while improving U.S. industrial competitiveness. One example of this is the State Energy Efficiency Action Network (SEE Action),[17] a federal-state-local effort to assist state and local government EE efforts. SEE Action's primary goal is to help the nation achieve cost-effective energy efficiency by 2020, including a 2.5% average annual reduction in industrial energy intensity, plus the installation of 40 gigawatts of new, cost-effective combined heat and power (CHP).[18]

State governments, with their long-standing interests in economic development, are particularly well positioned to identify and encourage industrial EE investment. This section of the working paper briefly introduces the concept of industrial EE and relevant policy types, then discusses some emerging policy trends. This provides background and context for the next section's state-by-state policy summaries, while also highlighting possible opportunity areas for policymakers to consider in the coming months.

17 http://www1.eere.energy.gov/seeaction/combined_heat_power.html. (February, 2012).

18 Other recent examples of the growing interest in manufacturing energy efficiency include: an Industrial Energy Efficiency & Competiveness Workshop, hosted by ASERTTI in Cleveland, Ohio, in October, 2011; Ohio Governor Kasich's 21st Century Energy & Economic Summit in Columbus, Ohio, in September, 2011; and the Midwest Industrial Energy Efficiency Summit, co-hosted by MGA in Chicago, Illinois, in January, 2012.

Section 3.1: Industrial Energy Efficiency

To understand the value of industrial EE, it is useful to first understand some basics regarding how energy is used by manufacturers. While nearly every facility is unique, there are four broad categories of energy consumption in most manufacturing facilities.

Motors make up the largest single category of electricity end use in the U.S. economy, with very significant, cost-effective energy savings potential.

1. **General Manufacturing Equipment:** This first category includes a set of commonly used technologies, such as compressors, motors (fans and pumps), steam generators, and process heating equipment. All of these technologies require thermal or electric energy either generated on site or purchased from utilities or independent contractors. Improved efficiency can be achieved by switching out old equipment for newer, more efficient versions. For example, replacing electric motors has become a popular area for state and utility rebate programs. Motors make up the largest single category of electricity end use in the U.S. economy, with very significant, cost-effective energy savings potential (NAS, 2010). Additionally, plant-wide energy management efforts—such as switching off idle equipment—can significantly increase energy productivity.

2. **Specialized Manufacturing Processes:** The second category includes specialized manufacturing process technologies and equipment, which are unique to each manufacturing sector and often highly energy and capital intensive. These include blast furnaces for steelmaking, clinker kilns for cement making, crackers for petrochemical refining, and black-liquor recovery boilers for pulp and paper manufacturing. Efficiency measures in this category may involve improved operational practices or equipment upgrades (e.g., heat shields to reduce heat energy losses from open ovens);19 however, it is often necessary to replace an aging boiler or kiln to really have any appreciable impact on plant-wide energy consumption. Additionally, when plants are built or retooled, facility layout can be a factor in reducing energy use (e.g., if hot materials, like steel slabs, do not require reheating).

3. **Combined Heat and Power (CHP):** CHP is a set of cross-cutting technologies that facilities with substantial onsite demand for electricity and heating have the potential to apply productively. Rather than generating steam and electricity through separate, inefficient processes, CHP involves cogeneration of both, resulting in significant overall efficiency gains (see Boxes 3 and 4 for further discussion). CHP is gaining renewed attention recently, as economics are shifting in favor of replacing older boilers with gas-fired CHP units, to reduce fuel use and emissions, cutting costs for energy and regulatory compliance (see Section 3.2 for further discussion).

4. **Buildings:** The final category involves buildings, which include a common set of energy-consuming technologies across all sectors of the economy, such as lighting, heating and cooling, and insulation of the building envelope. Steps that can be taken to improve building energy efficiency include swapping out old equipment for more efficient versions (e.g., new lighting, insulation, and more efficient HVAC equipment), occupant or energy manager behavior change, and advanced system-control technologies.

When considering all of these energy-use categories, it is important to note that the uptake of newer cutting-edge EE technologies tends to be slow for most manufacturing equipment, due to its capital-intensive nature and long depreciation periods (Brown et al., 2011). However, as domestic manufacturers become increasingly exposed to international market competition, many older and less efficient U.S. facilities compete with companies using new state-of-the-art facilities located in developing countries. This highlights one impetus for policymakers to revisit existing policies and programs to ensure that appropriate incentives are in place for U.S. manufacturers to exploit as many cost-effective energy-saving measures as possible.

19 http://www.asertti.org/events/fall/2011/presentations-workshop/Loth.pdf. (February, 2012)

Box 3 | The Midwestern Industrial "Energy Efficiency Gap"

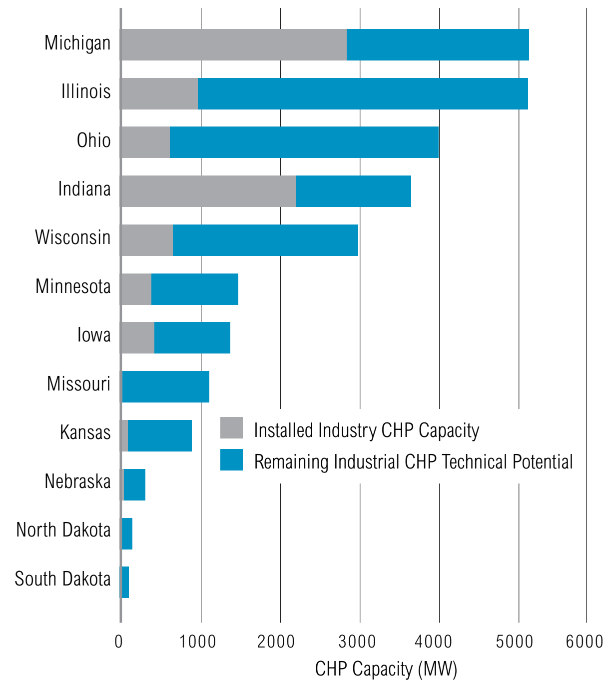
Most manufacturing firms work to cut energy usage by investing in technologies and practices that reduce waste and increase energy productivity. This is particularly true for energy-intensive manufacturers, for whom energy costs represent a substantial portion of total costs (EPA, 2007). However, despite this general tendency, a range of technical, informational and regulatory barriers prevent companies from investing in cost-effective energy-saving technologies and practices (ORNL, 2008; NAS, 2010; Chittum et al., 2010; Brown et al., 2011). This fact is reinforced by experiences with the U.S. Department of Energy's (DOE) Save Energy Now program, which has found that energy audits, technical assistance, and improved energy management practices can help even the most sophisticated firms save millions of dollars in energy costs annually (Savitz et al., 2009).

At the national level, studies conducted for the EnergyStar program[a] and the DOE's Industrial Technologies Program[b] have found that individual U.S. industrial subsectors—from iron and steel manufacturing to petroleum refineries—could be 10 to 30% more efficient within the next decade (NAS, 2010). Not surprisingly, state- and region- focused studies have also concluded that untapped energy efficiency potential is available throughout the Midwest and for all sectors of the economy (e.g., CCFA, 2009; DOE, 2009; ECW, 2009a). State-level estimates of the economic industrial efficiency resource potential, achievable by 2020, range from 20 to 30% of current energy use (ECW, 2009b; MnTAP, 2010; Neubauer et al., 2009), suggesting a role for policies, programs, and/or incentives that encourage more investment in this valuable domestic resource.

Although CHP, also known as cogeneration, is a proven technology, it remains underutilized in the United States. The Oak Ridge National Laboratory estimated that CHP amounted to 8.6% of U.S. electricity generation capacity and 12.6 % of electricity generation in 2008, compared to Denmark's CHP utilization of more than 50% of electricity generation (ORNL, 2008). Given its relatively low utilization rates in the Midwest region (see Box 1) CHP is a good example to illustrate this "efficiency gap." Figure 9 shows the breakdown of installed industry CHP capacity and remaining technical potential among the 12 states of the Midwest. Not surprisingly, the states with the greatest total potential capacity are also the ones with the highest levels of manufacturing energy use (Figure 8).

The figure shows that the status and rate of industrial CHP utilization varies widely across the Midwest. Michigan and Indiana have

Figure 9 | Midwest Industry Installed CHP and Technical Potential CHP per State



SOURCE: ICF International, Combined Heat and Power Installation Database; Hedman, 2010.

the highest level of installed CHP capacity,[c] while Illinois and Ohio have the largest remaining technical potential. Ohio stands out in that its remaining CHP potential is estimated to be more than five times larger than its currently installed capacity, though every state in the Midwest has opportunities to reduce electricity and fuel costs through increased CHP deployment.

Aggregated national and statewide EE potential estimates do not necessarily reflect the EE potential for any individual facility. Also, there are often significant differences between estimates of technical potential, economic potential, and practical potential.[d] Nevertheless, government policies and programs are often critical for bridging the efficiency gap by overcoming barriers to industrial EE investment (ORNL, 2008; NAS, 2010; Chittum et al., 2010; Brown et al., 2011).

a http://www.energystar.gov/index.cfm?c=industry.bus_industry_info_center#industry_resources. (February, 2012)

b Search for "Bandwidth" studies, here: http://www1.eere.energy.gov/library/. (February, 2012)

c Michigan and Indiana have the highest levels of installed CHP capacity mostly due to a small number of very large installations. Michigan, for example, has 1,370 MW of CHP installed at Dow Chemical and 760 MW installed at Ford & Rogue Steel. Without those two facilities Michigan's state total would drop to 971 MW—well below Illinois and Wisconsin. Likewise, Indiana has a 755 MW CHP installation at Alcoa Smelting and a 689 MW installation at Whiting Refining.

d For more discussion of this issue from a Midwest perspective, see ECW, 2009a

Section 3.2: Emerging Program, Policy, and Regulatory Trends

Identifying the right policies to address barriers to efficiency can be a challenge, in part because the barriers themselves originate from factors both internal and external to affected facilities. For example, in cases where efficiency improvements require capital-intensive investments, limited budgets and competing priorities often prevent otherwise attractive projects from moving forward. Though the past 3 years has seen an influx of federal Recovery Act[20] funding, many industrial EE projects have otherwise been inhibited by tight private capital markets. Company management can also play a significant role, as senior financial officers may not be aware of the positive long-term benefits of EE investment, or facilities may not be staffed with well-trained energy managers dedicated to continual energy productivity improvement.

Experience has shown that a suite of programs, policies, and regulations are often necessary to counter these barriers and create a positive environment for EE investment (Sciortino et al., 2011). With this goal in mind, the remainder of this section highlights four emerging trends that could substantially influence industrial EE investments in the coming months and years.

1. **Coordinated government financial and technical assistance:** Building on the strengths and successes of existing national programs and networks, such as the Manufacturing Extension Partnership (MEP), government agencies are beginning to work in closer coordination with each other when offering technical assistance to manufacturers and other small and medium-sized businesses. One example of this is the emerging E3 framework,[21] which is designed to ensure that financial and technical assistance services are delivered through a better-coordinated network of public and private sector entities, including government, universities, utilities and other service providers.

   The benefits of coordination include greater leveraging of limited resources and lower transaction costs for client businesses seeking technical assistance. Additionally, program tracking to date has found that potential cost savings to participating manufacturers double when facility assessments look for efficiencies beyond traditional "lean" practices by also cutting waste streams, material inputs, energy use, and emissions.[22]

Potential cost savings to participating manufacturers double when facility assessments look for efficiencies beyond traditional "lean" practices by also cutting waste streams, material inputs, energy use, and emissions.

2. **ISO 50001 Energy Management Standard:** In coordination with a range of government and international firms, the International Organization for Standardization (ISO) recently published ISO 50001, which offers organizations established standards for improving energy productivity through better management practices.[23] In particular, the new standard encourages comprehensive and systematic energy management planning, careful measurement of energy use and consumption, and continuous improvement in energy productivity over time. To the extent that these voluntary standards are broadly adopted, they could help raise awareness of the economic value of energy efficiency and thus help address some of the company management and informational barriers to EE, described earlier in this section.

3. **Ratepayer Funded Energy Efficiency Programs:** Another significant emerging trend is the growing role of ratepayer-funded EE programs, 85% of which are administered by electric and natural gas utilities. As local, state, and federal budgets were generally shrinking, the total annual budgets for all U.S. ratepayer-funded programs grew by 25% from 2010 to 2011, to just over $6.8 billion (IEE, 2012). As described in the state policy tables (Section 4 of this paper), in many Midwestern states these programs are relatively new, established in recent years in conjunction with utility commission orders or legislation requiring utilities to meet annual energy efficiency targets.

20 This working paper does not focus attention on the federal Recovery Act of 2009 because program funding has largely expired.

21 The MEP is currently working with the Department of Energy, the Department of Labor, the Small Business Administration and the Environmental Protection Agency to administer a more comprehensive set of services to manufacturing clients, within a single package, or framework, called E3 ("Economy, Energy and the Environment"). www.e3.gov (February, 2012).

22 Tom Murray, Environmental Protection Agency, personal communication, September, 2011.

23 http://www1.eere.energy.gov/energymanagement/about.html#iso50001. (February, 2012)

Box 4 | The Industrial Application of Combined Heat and Power

Both combined heat and power (CHP) and waste-heat recovery (WHR) systems capture heat that is normally wasted in combustion processes and use it to generate electricity or as useful thermal energy. However, since CHP/WHR involves generating electricity "on site," some do not consider it as an industrial EE measure but rather look at it as a distributed energy generation technology much like solar, wind, and other renewable energy technologies. Due to its utilization of waste heat, CHP uses approximately 40% less energy than conventional production of heat and electricity (Brown et al., 2011). CHP technologies have the potential to reach energy efficiencies of 70% to 85% when used on applicable industrial plants.

In the United States, as in the rest of the world, industrial CHP capacity is located predominantly within manufacturing subsectors with heat-intensive processes. In descending order, the five leading subsectors for CHP utilization are chemicals, refining, pulp and paper, food processing, and primary metal manufacturing (IEA, 2007). Note that these five sectors are also among the six leading energy consuming sectors in the Midwest region (Figure 5). In the Midwest 78% of CHP capacity is deployed in manufacturing facilities, as opposed to commercial-scale applications such as schools or hospitals; at the national level, manufacturing facilities account for 62% of total installed CHP.

CHP can be defined as a set of integrated technologies located on site at a manufacturing plant, providing at least a portion of the facility's demand for electric energy and the otherwise wasted heat from electrical conversion to satisfy a portion of the facility's demand for thermal energy. There are two distinct forms of CHP, as applied to the industrial sector:

- **Conventional or Topping Cycle CHP** is the sequential production of electric and thermal energy from a single dedicated fuel source. The dedicated fuel source is combusted (burned) in an engine whose sole purpose is to generate electricity, and the heat from the engine is used to provide the useful thermal energy. These systems are normally sized to meet the thermal load of the industrial facility—the level of electric generation is dependent on the thermal load.
- **Waste Heat Recovery (WHR) or Bottoming Cycle CHP** captures heat otherwise wasted in an industrial or commercial process and utilizes it to produce electricity and thermal energy. In a WHR CHP system no additional fuel is combusted and no additional emissions are generated from the CHP system.

The concept of CHP as applied to an industrial plant consists of replacing at least a portion of the electricity normally purchased from the local electric utility with base-load-quality electricity produced from an on-site CHP system. CHP can serve as a new source of electricity that inherently matches the electric grid's industrial load profiles, particularly in situations of retiring capacity or increased demand. In addition, the heat recycled from the CHP generating equipment can be utilized to replace a portion of the fuel normally used to provide thermal energy to the plant or plant process. The technical and economic effectiveness of CHP systems is very dependent on the specific plant being considered (NREL, 2009). Many factors determine whether a CHP system (topping or bottoming cycle) makes economic sense at a facility. It is not the intent of this paper to go into the technical and financial details of CHP, but it should be noted that the two keys to a successful industrial application are:

- An adequate cost spread (i.e., "spark spread") between the cost of electricity being provided by the local utility versus the cost of the fuel being utilized in the proposed conventional or topping cycle CHP system and the coincidence of the required electric and thermal load at the plant. To reach the high efficiency potential of the CHP system (70% to 85%), facilities must be able to use both the electric and recycled thermal energy being generated by the CHP system when the system is being operated.
- Bottoming cycle CHP (WHR) requires an adequate stream of waste heat (temperature and volume) from the industrial process. Since the heat is generated as a by-product of the industrial process and would otherwise be wasted/vented to the atmosphere, there must be a sufficient amount and quality of the free heat to economically capture it and convert it into electricity (normally done by producing steam to drive a steam turbine).

Industrial CHP has faced persistent barriers to its adoption in the United States. In its *2008 Industrial Technologies Market Report t*he National Renewable Energy Laboratory summarizes the present U.S. situation:

> *"Regulatory, policy, and institutional barriers persist, in spite of successes at the state and regional level, and recent federal legislation boosting tax credits for CHP. For example, electric rate structures linking utility revenues and returns to the number of kilowatt-hours sold act as a disincentive for utilities to encourage customer-owned onsite generation. In addition, CHP technology applications are impeded by interconnection issues, sundry technical barriers, and environmental permitting regulations that focus on heat input and do not recognize the higher overall efficiency improvements offered by CHP" (NREL, 2009).*

To help address these and other barriers, the U.S. Department of Energy has established 8 regional Clean Energy Application Centers, which provide information, education, and technical assistance in the application of CHP. The DOE Midwest Clean Energy Application Center is located at the University of Illinois at Chicago, Energy Resources Center.

4. **Federal Environmental Regulations and Energy Economics:** The final emerging trend is largely driven by a convergence of federal environmental regulations and rapidly changing energy economics in the context of U.S. shale gas resource development. The shale gas phenomenon has had a dramatic effect on U.S. energy markets, in some cases driving down the cost of natural gas to the point that it is nearly competitive with coal (Schmalensee and Stavins, 2011).

   Considering this new energy market in the context of existing and pending electric power sector regulations, studies have projected several gigawatts of coal-plant retirements within in the next decade (Tierney, 2011), a significant portion of which are expected to be concentrated in the Midwest (ICF international, 2011).

   Additionally, new toxic air emissions regulations for industrial boilers—the so-called boiler MACT rule—are expected to impose significant compliance costs on coal- and oil-fired boilers, which are heavily concentrated in the Midwest.

   As a result of these converging circumstances, regional base-load power generation capacity is projected to drop just as manufacturing facilities with older boilers are considering alternative compliance strategies. One possible result is a new market for natural gas-fired industrial CHP/WHR (see Box 4), which has the duel benefit of generating base-load quality power at or very close to consumer demand, while also being a low emissions, highly fuel efficient energy source for industrial facilities (Elliott et al., 2011).

   Though pending regulations create some challenges and may increase energy costs for industrial consumers, they also present new opportunities for state governments and utility commissions to reconsider EE potential as an alternative to conventional electric power generation in the context of policy deliberations and long-term resource planning. For example, air agencies can work to ensure that regulated facilities have the option to meet compliance through the use of output-based emissions standards (described in the Section 4 of this paper).

Section 4: State Profiles

This section presents three-page summaries of manufacturing-sector energy-use activity, and policies, for each state in the Midwestern Governors Association. In recent years, Midwestern state governments have built considerable momentum enacting policies to advance energy efficiency throughout the region. Since 2007, when the MGA agreed to "achieve continuous improvement in levels of cost-effective energy efficiency across the economy" (MGA, 2007), several state governments have created or expanded state laws designed to achieve this goal.

Section 4.1: Policy Tables

The following state profiles include high-level summaries of current state policies that have been identified as important for advancing industrial EE, including CHP and WHR (Brown et al., 2011; ORNL, 2008; Sciortino et al., 2011).[24] Unlike most policy analyses and summaries available from other sources, this working paper focuses exclusively on state-level energy efficiency policies that directly affect the industrial sector.[25]

The policy summaries are organized into three broad categories: (1) regulatory environment, (2) financial and technical assistance, and (3) utility programs; and 9 subcategories, each of which is described in general terms below.

REGULATORY ENVIRONMENT

Renewable Energy Standards (RESs), often referred to as renewable portfolio standards, typically require that a certain percentage of electricity sold by a utility be generated from renewable or other "alternative" energy resources. Percentage requirements usually increase incrementally each year toward a future target (e.g., 20% in 2020). Utilities with a legal requirement to meet such standards typically achieve compliance by submitting to a regulator a number of renewable energy credits, each

24 Consistent with the state-level focus of this study, the primary policies highlighted in this section either have their origins in state law or are rooted in federal authorities but largely implemented by state agencies or commissions. This working paper is not intended to offer a comprehensive catalogue of all factors that affect industrial EE investment. For example, we do not summarize state programs that focus on workforce training for energy management, which has been identified a potentially important barrier to EE (SEE Action, 2011).

25 The American Council for an Energy Efficient Economy (http://www.aceee.org/sector/state-policy; February, 2012) and the Database of State Incentives for Renewables and Energy Efficiency (http://www.dsireusa.org; (February, 2012)) provide reliable summaries of state energy efficiency policies; for the structure and content of this working paper's policy tables, we frequently reference these valuable resources, citing "ACEEE" and "DSIRE," respectively.

of which certifies that a given amount of electricity (e.g., one MWh) was generated by a qualifying energy source (FERC, 2011). The market value of credits is equal to the incremental cost of producing power from eligible sources thus creating an incentive for utilities, entrepreneurs and developers to invest in new clean energy projects.

RES policy summaries included in the state policy tables are limited to those standards for which EE or CHP investments are eligible to earn credit toward program compliance. For example, each MWh of electricity generated by CHP units qualifies for credits under the Michigan RES program (Naik-Dhungel, 2009).

Energy Efficiency Resource Standards (EERSs) are state policies to reduce the amount of electricity or natural gas consumed by utility customers through the use of EE. Similar to RESs, EERS policies are regulations that set specific EE targets which utilities are required to meet through EE programs. Annual EERS targets may specify reductions for energy use (MWh or therms), peak demand (MW), or both (FERC, 2011). Energy efficiency resource standards have been adopted by seven Midwestern states: Illinois, Indiana, Iowa, Michigan, Minnesota, Ohio and Wisconsin (Nowak et al., 2011; FERC, 2011).

Energy efficiency resource standards have been adopted by seven Midwestern states: Illinois, Indiana, Iowa, Michigan, Minnesota, Ohio, and Wisconsin.

Emissions control programs, whether established by federal or state law, are usually implemented by local or state air agencies. In the case of air pollution standards, policy design options that effectively promote or recognize energy efficiency as a viable compliance pathway are often categorized as output-based emissions standards (OBSs).[26] Traditional "input-based" regulations set limits on emissions rates,[27] which can effectively discourage the use of EE measures to help meet compliance. In contrast, OBSs[28] reward generators that have the highest "output" of product (e.g., megawatt hours of electricity and Btu of heat energy) relative to the level of pollution, thus encouraging efficient fuel combustion technologies, including CHP.

Furthermore, states may set aside a portion of tradable emissions permits to support efficiency investments by industrial or other facilities. For example, when implementing the federal Clean Air Interstate Rule (CAIR),[29] several states set-aside NO_x emissions permits for this purpose. The first compliance phase for CAIR's replacement, the Cross-State Air Pollution Rule (CSAPR),[30] had been scheduled to go into effect in January 2012.[31] CSAPR will create a new opportunity for the development of new state implementation plans (SIPs), including set-aside allowances for the purpose of supporting industrial EE, as well as CHP and WHR investments; once finalized, new SIPs will go into effect as soon as 2014.[32]

Alternative business models may be established by regulation to encourage utilities to invest in energy efficiency. Decoupling mechanisms remove the traditional dependence of utility profits on energy sales. State policies to promote utility investment in energy efficiency include fixed cost-recovery structures and lost revenue recovery mechanisms. Several states have also adopted mechanisms that tie utility profits to EE performance (ACEEE; FERC, 2011).[33] The state policy tables below primarily highlight utility decoupling programs.

Grid Access can be a very important issue for facilities that seek to install a CHP or WHR unit on site (Chittum and Kaufman, 2011). Interconnection standards specify the technical requirements and procedural process by which utility customers connect electricity generation units to the grid. Historically, U.S. electric utilities have favored large-scale centralized power generation assets,

26 http://www.epa.gov/chp/state-policy/obr_factsheet.html (February, 2012).

27 Input-based emissions standards are typically based on the amount of fuel used (e.g., pounds of pollutant per million Btus).

28 Output-based standards are based on emissions per unit of useful energy output (e.g., pounds per megawatt hour).

29 CAIR regulated SO_2 and NO_x from sources in the eastern United States, including several Midwestern states, from 2005 through 2011; a 2008 court decision remanded CAIR, giving it an abbreviated lifetime. http://www.epa.gov/cair/ (February, 2012).

30 http://www.epa.gov/airtransport/ (February, 2012).

31 In December 2011, the United States Court of Appeals for the D.C. Circuit stayed CSAPR and is scheduled to hear the case in April 2012. Meanwhile, EPA is facilitating a transition back to CAIR. http://epa.gov/airtransport/

32 Joe Bryson, on the SEE Action Industrial Energy Efficiency and CHP Webinar 1: U.S. EPA Regulations and CHP, January 17, 2012. See http://www.bcsmain.com/mlists/files/webinarvideos/webinar-1.mp4. (February, 2012).

33 For further discussion, see http://www.epa.gov/cleanenergy/documents/suca/incentives.pdf (February, 2012), and http://www.raponline.org/document/download/id/861 (February, 2012).

with little incentive to facilitate a more distributed power generation model. For decades, the lack of standardized interconnection rules has inhibited investments in a range of distributed generation technologies (NREL, 2000).

The interconnection issue has received increased attention in the past decade, with many state utility commissions adopting standards with common technical guidelines and even standard contracts.[34] Though implementation and enforcement will vary, the broader adoption of common interconnection standards should improve the investment environment for distributed generation technologies by reducing added costs, delays, and uncertainties. Most Midwestern states have adopted interconnection standards within the past few years that are technically comparable,[35] though they often only apply to investor-owned utilities (Chittum and Kaufman, 2011).

Though implementation and enforcement will vary, the broader adoption of common interconnection standards should improve the investment environment for distributed generation.

FINANCIAL AND TECHNICAL ASSISTANCE

Tax Incentives, Grants, and Loans

To reduce payback periods or provide easier access to project financing, many utility as well as state and federal government programs offer financial incentives for industrial EE through a number of different mechanisms.

Loan programs, offered by governments and utilities, help secure financing for eligible projects. To encourage certain investments, loans may be low- or no-interest, while specific terms will vary by program. Some loan programs are set up to make financing available for technologies that are either new or unfamiliar to investment banks. Local and state bonding authority may also be available for certain projects.

Property tax incentives often provide exemptions or exclusions for the cost of eligible equipment from the tax assessment on a piece of property. Corporate tax incentives may also provide tax credit to an investor for a certain portion of a capital investment. Accelerated depreciation is another common form of tax incentive for targeted capital investments.

Many state governments in the Midwest offer grants for energy efficiency projects to buy down the total cost of qualifying investments. Though very effective, grant programs tend to be relatively more costly to state and utility EE program budgets. Grants may be issued through competitive bidding processes or technical assistance programs to encourage implementation of particular recommendations.

Technical Assistance

Many Midwestern states couple grants and other incentives with technical assistance, free or low-cost energy audits, and facility assessments geared toward improving productivity through a variety of cost-saving measures, including industrial EE. As discussed in Section 3.2, federal, state, and local governments are increasing their collaboration with complementary programs administered by utilities and university extension programs. This helps to maximize the use of limited resources while meeting industrial clients' diverse and evolving needs for everything from workforce training to project financing to technical support for energy efficiency efforts.

The most important federal technical assistance programs are administered by the U.S. Department of Energy (DOE)'s Advanced Manufacturing Office (AMO)[36] — including the new Better Plants Program, the 26 regional Industrial Assessment Centers (IAC) and the 8 regional Clean Energy Application Centers (CEAC) — and the National Institute for Standards and Technology (NIST)'s Manufacturing Extension Partnership (MEP), the most comprehensive network of technical assistance providers in the country.[37] For further background and related discussion, see NASEO, 2012.

34 Last decade, model interconnection standards were established through Federal Energy Regulatory Commission orders 2003 and 2006. http://www.ferc.gov/industries/electric/indus-act/gi.asp. (February, 2012).

35 http://www.dsireusa.org (February, 2012).

36 The AMO was formerly known as the Industrial Technologies Program.

37 The E3 framework has been adopted by some cities in the Midwest region, including Columbus, Ohio; however it has yet to be adopted on a state-wide basis anywhere in the Midwest.

UTILITY PROGRAMS

Customer EE programs, with cost-recovery

Electric and natural gas utilities are playing an increasing role in state energy efficiency programs, with the intent to help meet EERS targets or voluntary goals. From 2010 to 2011, budgets for ratepayer-funded EE programs increased significantly, more than doubling in both Indiana and South Dakota (IEE, 2012). Most often, utility-administered EE programs—such as loan, rebate, and grant programs—are approved and overseen by utility commissions. In some cases, third party entities such as Focus on Energy in Wisconsin or state agencies such as the Department of Commerce and Economic Opportunity in Illinois administer energy efficiency programs available to customers of multiple utilities across the state. Program financing is typically ratepayer funded through a cost-recovery mechanism; such as a small surcharge—or system benefits charge (SBC)—on electricity consumption (e.g., $0.001/kWh).

Utility programs vary in their scope and applicability to industrial customers. While many utilities offer efficiency programs to their industrial customers, state laws often give larger industrial customers the option to "self-direct" or opt out. Opt-out provisions typically exempt customers of certain sizes from participating in, and paying for, utility EE programs. Self-direct policies typically allow qualified customers to avoid paying for SBCs, but expect such facilities to achieve EE improvements independently.

The American Council for an Energy Efficient Economy (ACEEE) classifies opt-out and self-direct programs along a continuum that ranges from pure opt-out to self-direct programs that have more structure and oversight (Chittum, 2011). These provisions vary significantly across states, as each state establishes its own parameters for eligible customers, the level of relief from SBCs, measurement and verification of efficiency performance and reporting requirements. Most states allow large energy consumers to request exemptions from paying into utility-funded programs; however, a few states exempt all users that meet certain criteria. These exemptions may be permanent or contingent upon periodic reports that demonstrate on-going energy efficiency improvements. For a more detailed discussion see Chittum (2011).

EE as a resource

Regulatory policies that recognize EE as a resource may require electric and natural gas utilities to pursue cost-effective EE and demand-response measures to reduce direct and indirect costs to consumers. Cost savings can be achieved when EE measures have the effect of avoiding or delaying the need for new generation, transmission, distribution infrastructure, and other rate-based capital-intensive investments.

ILLINOIS

In 2006 Illinois consumed 4.0 Quads of energy—more than any other state in the Midwest. Industry plays a central role in Illinois energy use, economic activity, and employment. Figure IL-1 shows the breakdown of statewide energy used for fuel and feedstock. Industry consumed more energy in Illinois than any other end-use sector. Within the broader category of industry, manufacturing accounted for two-thirds of total energy use in 2006.

Within manufacturing, petroleum and coal product manufacturing accounted for the largest share of Illinois energy use in 2006, followed by primary metals, chemicals, and food processing.

Illinois has 1.4 GW of total installed CHP capacity,[IL-1] which is equivalent to 3% of total installed electricity generation capacity, versus the national average of 8%. Within total CHP, the remaining technical potential for industry CHP in Illinois is estimated to be more than four times larger than currently installed industrial capacity (Hedman, 2010).

IL-1 This number is higher than the installed CHP capacity number in Figure 9 because it includes all CHP installations (i.e., industrial, commercial, and institutional).

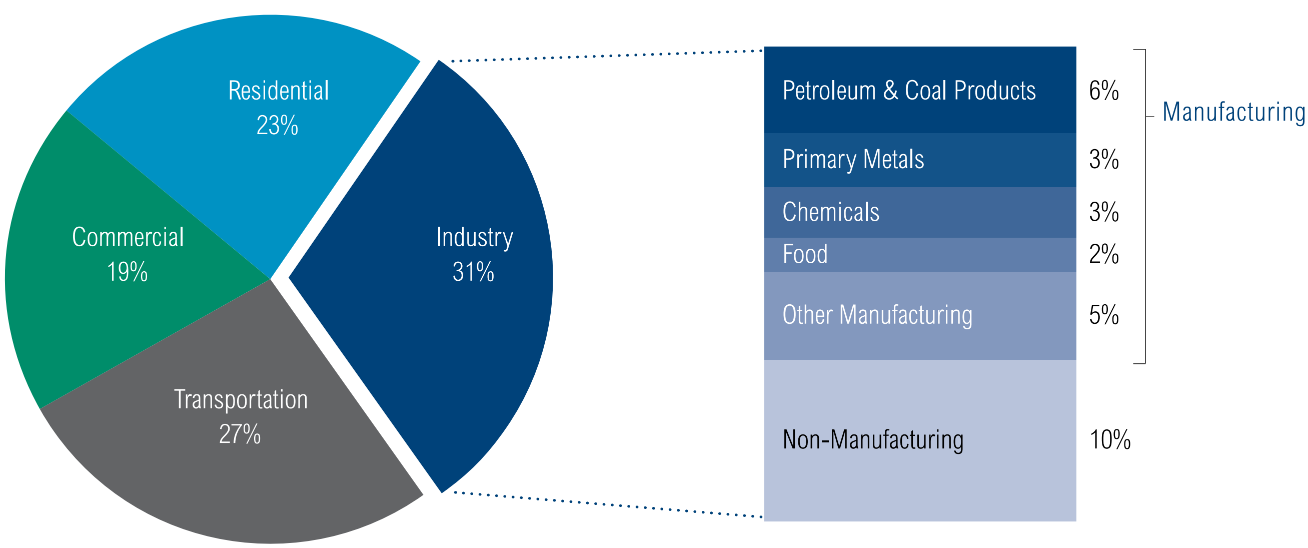
Illinois manufacturing energy expenditures (shown by "cost of fuels & electricity" in Figure IL-2) followed the national trend of peaking in 2008. Between 2000 and 2010, the index of manufacturing energy costs rose more quickly than the value of shipments index (Figure IL-2). The average difference between these two series over the period is 11%. By 2010 Illinois manufacturing energy expenditures had increased by 25%, while the total value of shipments rose by more than 10%, relative to year 2000 levels. Over the same 10-year period, Illinois manufacturing employment dropped by 34%--from 880,000 to 582,000, compared to the national manufacturing employment decline of 37% over the same period (Figure 1).

Table IL-1 | **Illinois Industry Delivered Energy Annual Average Prices (2010)**

	ELECTRICITY (cents/kWh)	NATURAL GAS ($/1,000 ft³)	COAL ($/short ton)
Illinois	6.82	7.13	50.05
Midwest average	6.19	6.66	50.68
U.S. average	6.77	5.49	59.28

SOURCE: U.S. Energy Information Administration; for details see Appendix.

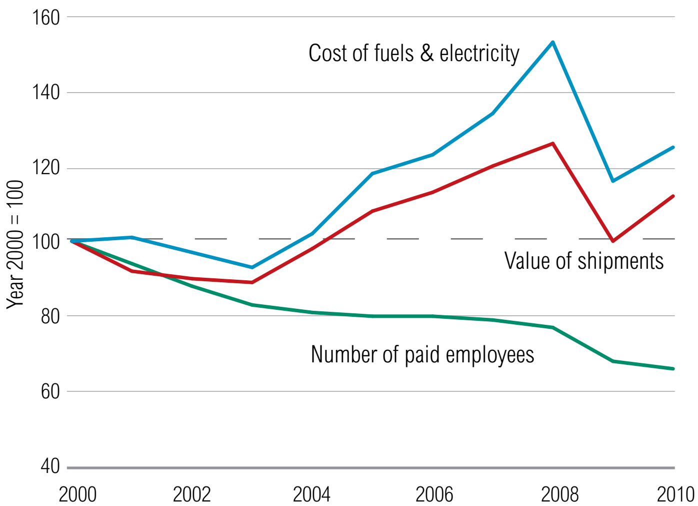
Figure IL-1 | **Illinois Total Energy Use, 2006**



Total Energy Use: 4.0 Quads

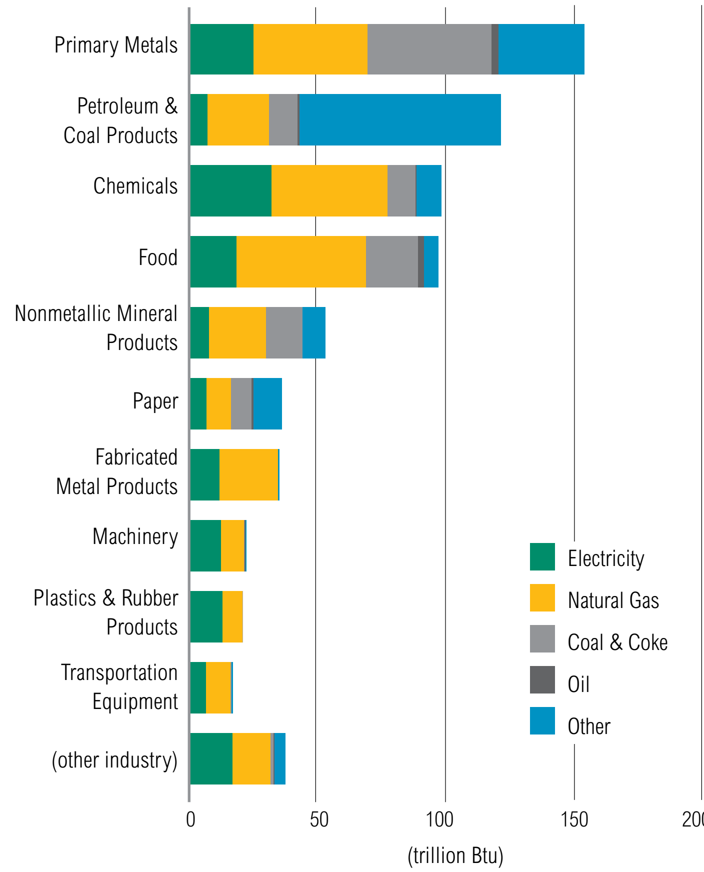
SOURCES: MECS; ASM; SEDS.

Figure IL-2 | **Index of Illinois Manufacturing Energy Cost, Value of Shipments, and Employment (2000-2010)**



SOURCE: ASM; BEA (employment)
NOTE: 2002 ASM values were linearly interpolated due to a gap in the published data.

Figure IL-3 | **Illinois Manufacturing Fuel Use by Sector, 2006**



SOURCES: MECS; ASM.

Energy prices influence demand and end-use efficiency. Table IL-1 shows Illinois, regional, and U.S.-average industry prices for electricity, natural gas, and coal. Whereas reported Illinois delivered coal prices were 16% lower than the national average, electricity was slightly more expensive and natural gas cost almost one-third more than the national average. Prices vary by end user and time of use, but the volatility of energy expenditures and this snapshot of 2010 prices suggest that Illinois industry faces a mixed picture among different fuels.

In 2006 Illinois manufacturing consumed 680 trillion Btu[IL-2] of energy for fuel use—second only to Ohio in the Midwest. Figure IL-3 shows the breakdown of Illinois manufacturing fuel use by subsector (not including energy used as feedstocks). Combined, primary metals manufacturing and petroleum and coal products manufacturing accounted for 40% of Illinois manufacturing fuel use in 2006.

Industrial energy efficiency policy took a major step forward in 2007, when the Illinois legislature passed S.B. 1592, which enacted a range of significant energy policies, including several efficiency measures with relevance to state manufacturers.

IL-2 For energy unit conversion, 1,000 trillion Btu is equivalent to 1 Quad of energy.

Table IL-2 | Illinois Key Energy and Environmental Policies

ILLINOIS	
REGULATORY ENVIRONMENT	
Renewable energy standard	The Illinois Renewable Energy Standard does not allow EE technologies or measures to qualify for compliance (DSIRE).
Energy efficiency resource standard	S.B. 1592 established an Energy Efficiency Resource Standard, which requires both electric and natural gas utilities to set annual energy-savings goals by reducing both energy delivered and peak demand. Under the rule, electric utilities are required to achieve 0.2% annual savings in 2008, increasing to 1% in 2012 and 2% in 2015 and thereafter. Natural gas utilities must achieve 0.2% annual savings in 2011, increasing to 1.5% in 2019, for an 8.5% cumulative savings by 2020 (DSIRE; ACEEE).
Emissions control programs	In 2007, the Illinois Pollution Control Board adopted CAIR through a state rulemaking process that included two provisions recognizing industrial EE. The state rule included output-based standards for regulating NO_x and SO_2 emissions. Also, NO_x allowances were set aside to support EE projects, including combined heat and power technologies.[a] However, these rules are to be phased out in 2012.[b]
Alternative business models	In February 2008, North Shore Gas and Peoples Gas and Coke were both approved for four-year revenue-per-customer decoupling pilots (ACEEE).
Grid access	Pursuant to S.B. 680, passed in 2007, the Illinois Commerce Commission established interconnection standards for distributed generation facilities, including CHP systems, with capacity ratings under 10 MW (consistent with IEEE 1547 technical standards). In 2010, the ICC set a separate set of rules, including standard agreements, for distributed generators over 10 MW (DSIRE).
FINANCIAL AND TECHNICAL ASSISTANCE	
Grants or loans	Since 1997, the Illinois Department of Commerce and Economic Opportunity (DCEO) has administered the Biogas and Biomass to Energy Grant Program. Projects eligible for 50% cost-share grants must be part of CHP systems and must be located in Illinois. The maximum grants available for feasibility studies, biogas projects, and biomass projects are $2,500, $225,000, and $500,000, respectively. The program expires April 30, 2012 (DSIRE).
Tax Incentives	There are no Illinois state tax incentives available for industrial EE.
Technical assistance	The DCEO offers the Large-Customer Energy Analysis Program (LEAP) to large energy users, including manufacturers, to help them manage and reduce energy costs through cost-effective efficiency improvements. Funded through the state EEPS Surcharge (for facilities located inside of ComEd or Ameren utility service territories) the LEAP offers a three-step energy management planning program, plus guidance regarding financial incentives that large energy users may access through state or utility EE programs.[c] The Industrial Assessment Center at Bradley University provides qualified manufacturers with free assessments and recommendations to improve energy efficiency.[d] The Energy Resources Center at University of Illinois at Chicago also provides resources on industrial energy efficiency and CHP.[e]
UTILITY PROGRAMS	
Customer EE programs, with cost-recovery	The Illinois Energy Efficiency Trust Fund, supported through an electric utility surcharge, does not support industrial EE projects (DSIRE). Illinois natural gas and electric utilities offer their customers a range of energy efficiency rebate programs (DSIRE).
EE as a resource	S.B. 1592 requires electric utilities to use cost-effective EE and demand-response measures to reduce direct and indirect costs to consumers. This can be accomplished by avoiding or delaying the need for new generation, transmission, and distribution infrastructure (ACEEE).

SOURCE: "ACEEE" refers to the American Council for an Energy Efficient Economy website: http://www.aceee.org/sector/state-policy (February, 2012); "DSIRE" refers to the Database of State Incentives for Renewables and Energy Efficiency website: http://www.dsireusa.org. (February, 2012).

a http://www.aceee.org/sector/state-policy/illinois/output-based-emissions-regulations (February, 2012).; http://www.ipcb.state.il.us/documents/dsweb/Get/Document-58394/ (February, 2012).

b The first compliance phase for CAIR's replacement, the Cross-State Air Pollution Rule (CSAPR), had been scheduled to go into effect in January 2012. In December 2011, the United States Court of Appeals for the D.C. Circuit stayed CSAPR and is scheduled to hear the case in April 2012. Meanwhile, EPA is facilitating a transition back to CAIR. http://epa.gov/airtransport/

c http://www.commerce.state.il.us/dceo/Bureaus/Energy_Recycling/Energy/Energy+Efficiency/meep_program.htm. (February, 2012).

d http://www.bradley.edu/academics/eng/Mechanical/iac/main.htm (February 2012)

e http://www.erc.uic.edu/projects/industrial.htm (February 2012)

INDIANA

In 2006 Indiana consumed 2.8 Quads of energy—making it the fourth-highest energy using state in the Midwest. Industry plays a central role in Indiana energy use, economic activity, and employment. Figure IN-1 shows the breakdown of statewide energy used for fuel and feedstock. Industry consumed 47% of total energy (including feedstocks) in Indiana—far more than any other end-use sector. Coincidentally, manufacturing accounted for 47% of Indiana industry energy use in the same year.

Within manufacturing, primary metals, chemicals, and petroleum and coal product manufacturing accounted for the largest share of Indiana's energy use in 2006.

Indiana has 2.3 GW of total installed CHP capacity[IN-1], which is equivalent to 8% of total installed electricity generation capacity, equivalent to the national average of 8%. Within total CHP, the remaining technical potential for industry CHP in Indiana is estimated to be equivalent to two-thirds of currently installed industrial capacity (Hedman, 2010).

IN-1 This number is higher than the installed CHP capacity number in Figure 9 because it includes all CHP installations (i.e., industrial, commercial, and institutional).

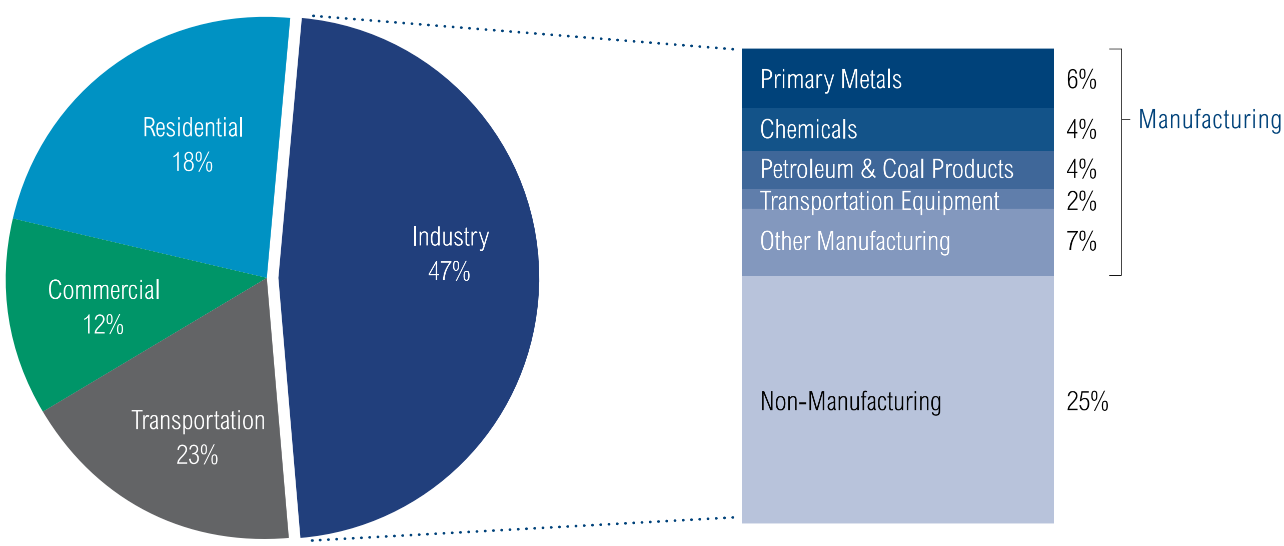
Between 2000 and 2010, the index of manufacturing energy costs (shown by "cost of fuels & electricity" in Figure IN-2) rose more quickly than the value of shipments index (Figure IN-2). The average difference between these two series over the period is 19%. By 2010 Indiana manufacturing energy expenditures had increased by 32%, while the total value of shipments rose by 28%, relative to year 2000 levels. Over the same 10-year period, Indiana manufacturing employment dropped by 31%--from 674,000 to 462,000, compared to the national manufacturing employment decline of 37% over the same period (Figure 1).

Table IN-1 | **Indiana Industry Delivered Energy Annual Average Prices (2010)**

	ELECTRICITY (cents/kWh)	NATURAL GAS ($/1,000 ft^3)	COAL ($/short ton)
Indiana	5.87	5.65	71.69
Midwest average	6.19	6.66	50.68
U.S. average	6.77	5.49	59.28

SOURCE: U.S. Energy Information Administration; for details see Appendix.

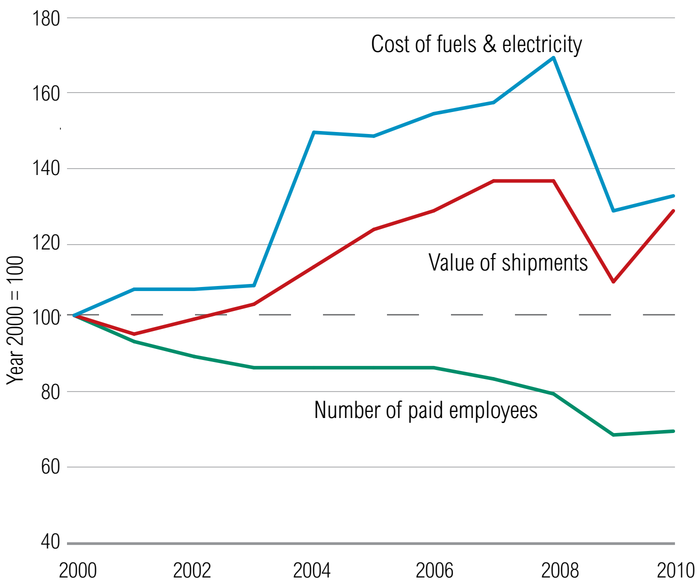
Figure IN-1 | **Indiana Total Energy Use, 2006**



Total Energy Use: 2.8 Quads

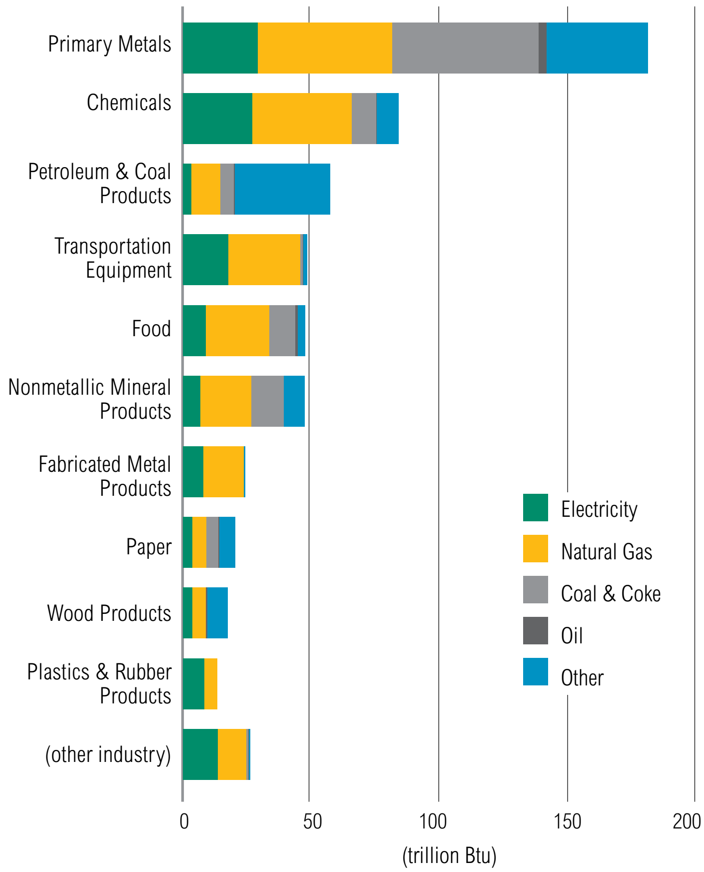
SOURCES: MECS; ASM; SEDS.

Figure IN-2 | **Index of Indiana Manufacturing Energy Cost, Value of Shipments, and Employment (2000-2010)**



SOURCE: ASM; BEA (employment)
NOTE: 2002 ASM values were linearly interpolated due to a gap in the published data.

Figure IN-3 | **Indiana Manufacturing Fuel Use by Sector, 2006**



SOURCES: MECS; ASM.

Energy prices (Table IN-1) influence demand and end-use efficiency. Whereas reported Indiana electricity prices were 13% lower than the national average, delivered natural gas and coal were more expensive than the national average by 3% and 21%, respectively. Prices vary by end user and time of use, but this snapshot of 2010 prices suggests that Indiana industry faces a mixed picture among different fuels.

In 2006 Indiana manufacturing consumed 560 trillion Btu[IN-2] of energy for fuel use. Natural gas was the most-consumed fuel for manufacturing. Figure IL-3 shows the breakdown of Illinois manufacturing fuel use by subsector (not including energy used as feedstocks). Primary metals manufacturing accounted for 32% of Indiana manufacturing fuel use in 2006.

Core pillars of Indiana's energy efficiency policy were ordered by the Indiana Utility Regulatory Commission (IURC), in 2009, pursuant to its own authority and without detailed legislative action. After a multiyear investigation of demand-side-management issues, first initiated in 2004, the IURC ultimately determined that effective DSM programs can reduce energy costs and yield overall economic benefits. The result was the state's EERS and a set of related core EE programs, implemented by investor-owned utilities in coordination with third-party administrators.

IN-2 For energy unit conversion, 1,000 trillion Btu is equivalent to 1 Quad of energy.

Table IN-2 | Indiana Key Energy and Environmental Policies

ILLINOIS	
REGULATORY ENVIRONMENT	
Renewable energy standard	Indiana's S.B. 251, passed in May 2011, includes a Clean Energy Portfolio Standard (CPS), which sets a voluntary goal for each electricity provider to obtain, by 2025, clean energy supplies in an amount that is greater than 10% of its delivered electricity in 2010. Investor-owned utilities must apply to the IURC to participate in the program, thus becoming eligible for related incentives. CHP & WHR are qualifying technologies (DSIRE).
Energy efficiency Resource standard	In December 2009, the IURC ordered all jurisdictional electric utilities to submit 3-year demand-side management plans, beginning in July 2010. Utilities must explain how they intend to achieve annual electricity savings of 0.3% in 2010, increasing gradually to 2% in 2019 (ACEEE).[a]
Emissions control programs	Indiana's State Implementation Plan for CAIR includes set-asides for EE, for which CHP is an eligible technology. Under the plan, CHP systems are regulated using output-based standards (ACEEE). However, these rules are to be phased out in 2012.[b]
Alternative business models	There are no currently active alternative business models that would serve to advance industrial EE (ACEEE).
Grid access	Indiana's interconnection standards (adopted 2005) for distributed power generation require applications and agreements to be approved by the IURC and are applicable to CHP units. The standards include a three-tier structure (up to 10 kW; up to 2 MW; over 2 MW), the lower two of which are consistent with IEEE 1547 and UL 1741 technical standards (DSIRE).
FINANCIAL AND TECHNICAL ASSISTANCE	
Grants, loans, or tax incentives	There are no Indiana state loans or tax incentives available for industrial EE.
Technical assistance	Purdue University's Technical Assistance Program[c] provides no-cost technical assistance to companies, including for EE-related measures. Purdue is also home to the local Manufacturing Assistance Partnership, which provides a range of programs, from training to technical assistance.[d] Purdue also houses an Industrial Assessment Center, providing qualified manufacturers with free assessments and recommendations to improve energy efficiency.[e]
UTILITY PROGRAMS	
Customer EE programs, with cost-recovery	The IURC 2009 order requires each utility to offer EE services through five core programs, including one for industrial and commercial customers that provides incentives for common technologies such lighting and high efficiency motors and pumps.[a]
EE as a resource	There is currently no policy in place that treats EE as a resource.

SOURCE: "ACEEE" refers to the American Council for an Energy Efficient Economy website: http://www.aceee.org/sector/state-policy (February, 2012); "DSIRE" refers to the Database of State Incentives for Renewables and Energy Efficiency website: http://www.dsireusa.org. (February, 2012).

a http://www.in.gov/iurc/2571.htm. (February, 2012).

b The first compliance phase for CAIR's replacement, the Cross-State Air Pollution Rule (CSAPR), had been scheduled to go into effect in January 2012. In December 2011, the United States Court of Appeals for the D.C. Circuit stayed CSAPR and is scheduled to hear the case in April 2012. Meanwhile, EPA is facilitating a transition back to CAIR. http://epa.gov/airtransport/

c http://www.tap.purdue.edu/. (February, 2012).

d http://www.mep.purdue.edu/prod_services/energy/default.aspx. (February, 2012).

e http://www.engr.iupui.edu/IAC/ (February, 2012)

IOWA

In 2009 Iowa consumed 1.4 Quads of energy. Industry plays a central role in Iowa energy use, economic activity, and employment. Figure IA-1 shows the breakdown of statewide energy used for fuel and feedstock in 2006. Industry consumed almost half of total energy (including feedstocks) in Iowa—far more than any other end-use sector. Within industry, manufacturing accounted for 53% of Iowa industry energy use in the same year.

Food and fabricated metal product manufacturing accounted for the largest share of Iowa manufacturing energy use in 2006, followed by chemicals and primary metals.

Iowa has 585 MW of total installed CHP capacity[IA-1], which is equivalent to 4% of total installed electricity generation capacity, versus the national average of 8%. Within total CHP, the remaining technical potential for industry CHP in Iowa is estimated to be more than twice as large as currently installed industrial capacity (Hedman, 2010).

IA-1 This number is higher than the installed CHP capacity number in Figure 9 because it includes all CHP installations (i.e., industrial, commercial, and institutional).

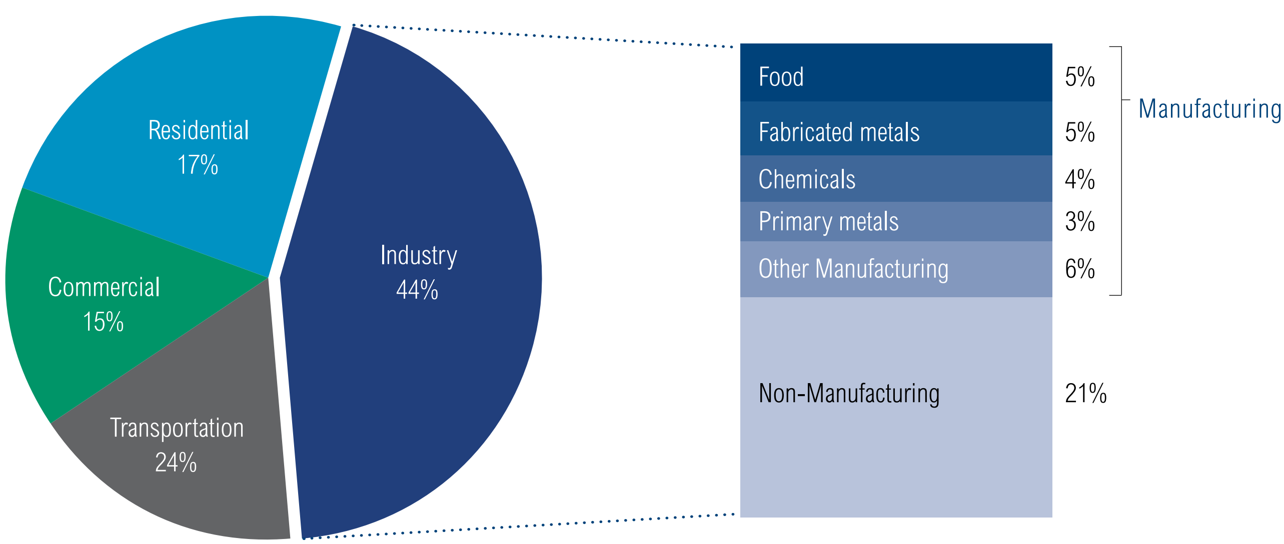
Iowa manufacturing energy expenditures (shown by "cost of fuels & electricity" in Figure IA-2) followed the national trend of peaking in 2008. Between 2000 and 2010, the index of manufacturing energy costs rose more quickly than the value of shipments index (Figure IA-2). The average difference between these two series over the period is 20%. By 2010 Iowa manufacturing energy expenditures had increased by 76%, while the total value of shipments rose by 40%, relative to year 2000 levels. Over the same 10-year period, Iowa manufacturing employment dropped

Table IA-1 | **Iowa Industry Delivered Energy Annual Average Prices (2010)**

	ELECTRICITY (cents/kWh)	NATURAL GAS ($/1,000 ft³)	COAL ($/short ton)
Iowa	5.36	6.10	49.76
Midwest average	6.19	6.66	50.68
U.S. average	6.77	5.49	59.28

SOURCE: U.S. Energy Information Administration; for details see Appendix.

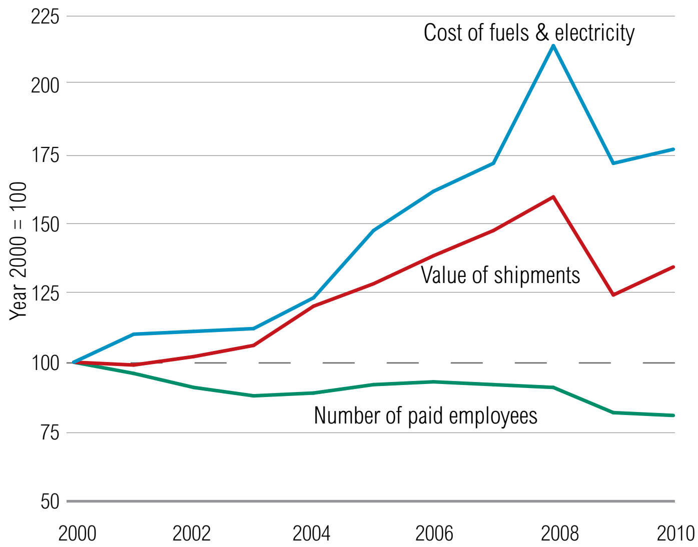
Figure IA-1 | **Iowa Total Energy Use by Subsector, 2006**



Total Energy Use: 1.3 Quads

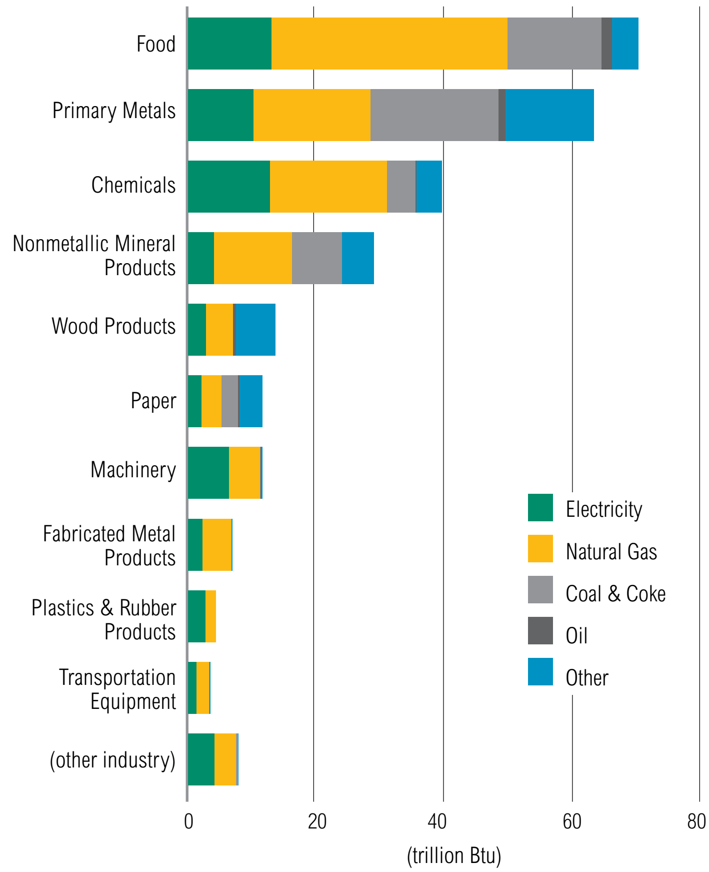
SOURCES: MECS; ASM; SEDS.

Figure IA-2 | **Index of Iowa Manufacturing Energy Cost, Value of Shipments, and Employment (2000-2010)**



SOURCE: ASM; BEA (employment)
NOTE: 2002 ASM values were linearly interpolated due to a gap in the published data.

Figure IA-3 | **Iowa Manufacturing Fuel Use by Sector, 2006**



SOURCES: MECS; ASM.

by 19%—from 256,000 to 208,000, compared to the national manufacturing employment decline of 37% over the same period (Figure 1).

Energy prices (Table IA-1) influence demand and end-use efficiency. Although reported Iowa natural gas prices were 11% higher than the national average, delivered electricity and coal were 21% and 16% cheaper than the national average. Prices vary by end user and time of use, but this snapshot of 2010 prices suggests that Iowa industry faces a mixed picture among different fuels.

In 2006 Iowa manufacturing consumed 260 trillion Btu[IA-2] of energy for fuel use. Figure IA-3 shows the breakdown of Iowa manufacturing fuel use by subsector (not including energy used as feedstocks). Food and primary metals manufacturing accounted for 51% of Iowa manufacturing fuel use in 2006.

In 2008 Iowa enacted S.B. 2386, which directed the Iowa Utilities Board to establish energy efficiency resource standards for the state's investor-owned utilities and require efficiency programs and filings from cooperative and municipal utilities. Utilities administer their own energy efficiency programs, which offer energy efficiency rebates and incentives to their customers. A few utilities offer incentives available for industrial applications, but few policies or incentives specifically address combined heat and power.

IA-2 For energy unit conversion, 1,000 trillion Btu is equivalent to 1 Quad of energy.

Table IA-2 | Iowa Key Energy and Environmental Policies

IOWA	
REGULATORY ENVIRONMENT	
Renewable energy standard	The Iowa Alternative Energy Law does not allow energy efficiency technologies to qualify for compliance (DSIRE).
Energy efficiency resource standard	Under authority from S.B. 2386, the Iowa Utility Board ordered investor-owned utilities to reduce retail sales by 1.5%. Cooperative and municipal utilities were required to establish their own efficiency goals. Annual savings goals during the period from 2009 to 13 vary by utility, ranging from 1 to 1.5% for electricity and 0.74 to 1.2% for natural gas (ACEEE; DSIRE).
Environmental protection programs	Iowa does not have output-based emission standards (ACEEE).
Alternative business models	The Iowa Utilities Board does not require decoupling but allows natural gas utilities to apply to the board for rate design changes on a case by case basis (ACEEE).
Grid access	In 2010, the Iowa Utilities Board established interconnection standards for the state's three rate-regulated utilities. The standards apply to generators up to 10MW and include PURPA qualifying facilities. The rules adopt IEEE 1547-2003 as technical standards (ACEEE; DSIRE).
FINANCIAL AND TECHNICAL ASSISTANCE	
Grants, loans, or tax incentives	Iowa's Corporate Renewable Energy Production Tax Credit applies to systems up to 5MW that are powered by renewable fuels. As of October 2011, this program is oversubscribed and new applications remain in queue (ACEEE; DSIRE).
Technical assistance	The Iowa Energy Center at Iowa State University conducts energy efficiency and renewable energy research, demonstration and education projects. The Center offers industrial total assessment audits and participates in the Compressed Air Challenge, and the DOE Steam Challenge.[a] Iowa State University also houses an Industrial Assessment Center, which provides qualified manufacturers with free assessments and recommendations to improve energy efficiency.[b]
UTILITY PROGRAMS	
Customer EE programs, with cost-recovery	Iowa's investor-owned utilities must provide energy efficiency programs for all customer types. Efficiency program costs are recovered through customer bills and there are no opt-out or self-direct programs for large industrials (ACEEE, DSIRE).
EE as a resource	Iowa's investor owned utilities are required to develop and execute energy efficiency plans that meet cost-effectiveness tests, offer programs for all customer types, contain an efficiency potential study, and include energy and capacity saving performance standards. Cooperatives and municipal utilities develop and file their own energy efficiency plans. These are not reviewed or approved by the IUB but are used for state energy planning (ACEEE).

SOURCE: "ACEEE" refers to the American Council for an Energy Efficient Economy website: http://www.aceee.org/sector/state-policy (February, 2012); "DSIRE" refers to the Database of State Incentives for Renewables and Energy Efficiency website: http://www.dsireusa.org. (February, 2012).

a The Steam and Air Compressor "Challenges" are voluntary programs to help manufacturers increase their energy productivity; http://www.energy.iastate.edu/Efficiency/Industrial/. (February, 2012).

b http://www.me.iastate.edu/iac/. (February, 2012).

KANSAS

In 2006 Kansas consumed 1.1 Quads of energy. Industry plays a central role in Kansas energy use, economic activity, and employment. Figure KS-1 shows the breakdown of statewide energy used for fuel and feedstock in 2006. Industry consumed more than one-third of total energy (including feedstocks) in Kansas—far more than any other end-use sector. Within industry, manufacturing accounted for 52% of Kansas industry energy use in the same year.

Petroleum and coal products and food manufacturing accounted for the largest share of Kansas manufacturing energy use in 2006, followed by nonmetallic minerals and chemicals.

Kansas has 134 MW of total installed CHP capacity[KS-1], which is equivalent to 1% of total installed electricity generation capacity, versus the national average of 8%. Within total CHP, the remaining technical potential for industry CHP in Kansas is estimated to be more than six times as large as currently installed industrial capacity (Hedman, 2010).

KS-1 This number is higher than the installed CHP capacity number in Figure 9 because it includes all CHP installations (i.e., industrial, commercial, and institutional).

Kansas manufacturing energy expenditures (shown by "cost of fuels & electricity" in Figure KS-2) followed the national trend of peaking in 2008. Between 2000 and 2010, the index of manufacturing energy costs rose more quickly than the value of shipments index (Figure KS-2). The average difference between these two series over the period is 16%. By 2010 Kansas manufacturing energy expenditures had increased by 51%, while the total value of shipments rose by 42%, relative to year 2000 levels. Over the same 10-year period, Kansas manufacturing employment dropped by 18%—from 204,000 to 167,000, compared to the national manufacturing employment decline of 37% over the same period (Figure 1).

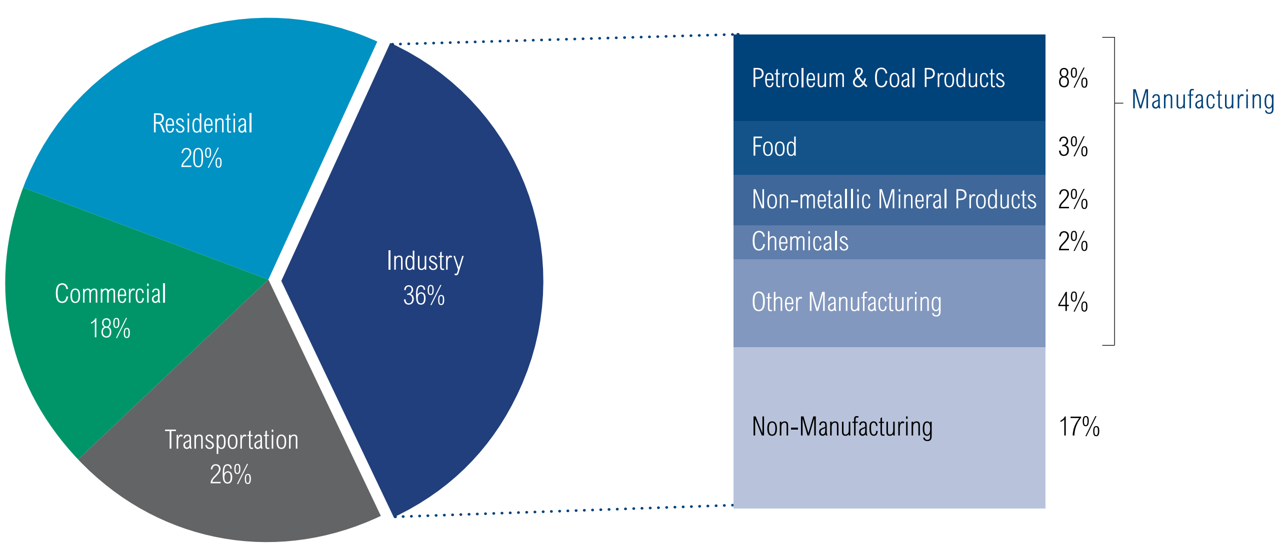
Table KS-1 | **Kansas Industry Delivered Energy Annual Average Prices (2010)**

	ELECTRICITY (cents/kWh)	NATURAL GAS ($/1,000 ft^3)	COAL[1] ($/short ton)
Kansas	6.23	5.50	25.88
Midwest average	6.19	6.66	33.00
U.S. average	6.77	5.49	44.29

SOURCE: U.S. Energy Information Administration; for details see Appendix.

1 Because the EIA withheld Kansas 2010 industry coal price data, electric utility coal price data are displayed in this table instead.

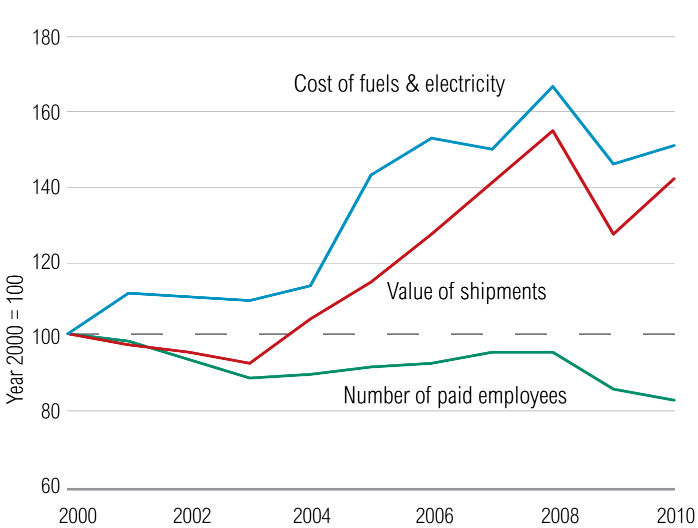
Figure KS-1 | **Kansas Total Energy Use, 2006**



Total Energy Use: 1.1 Quads

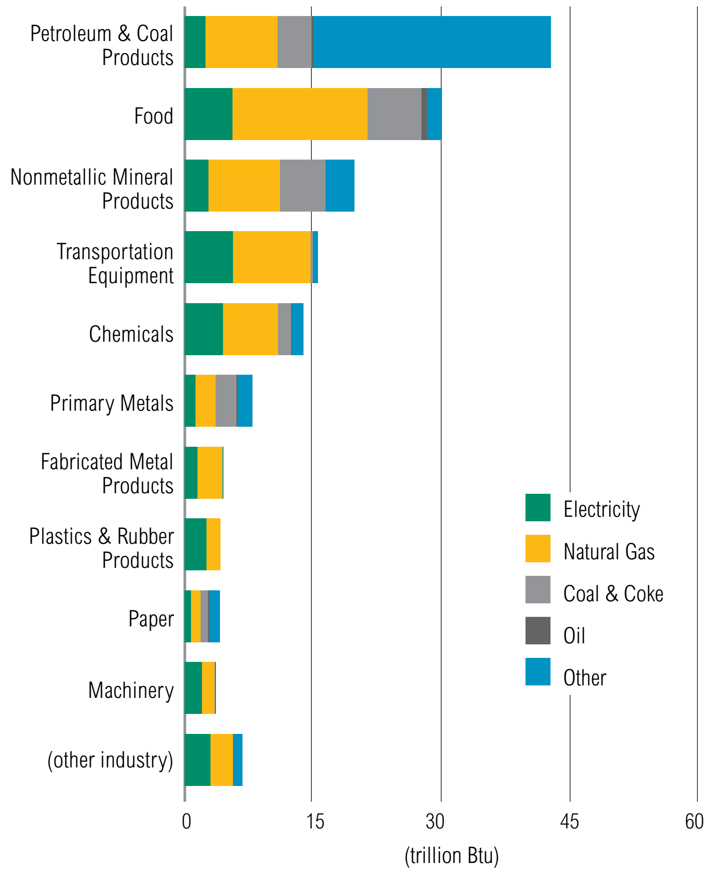
SOURCES: MECS; ASM; SEDS.

Figure KS-2 | **Index of Kansas Manufacturing Energy Cost, Value of Shipments, and Employment (2000-2010)**



SOURCE: ASM; BEA (employment)
NOTE: 2002 ASM values were linearly interpolated due to a gap in the published data.

Figure KS-3 | **Kansas Industry Fuel Use by Sector, 2006**



SOURCES: MECS; ASM.

Energy prices (Table KS-1) influence demand and end-use efficiency. Kansas has relatively cheap electricity and fuel. Reported coal prices were 42% lower than the national average, delivered electricity was 8% cheaper, and natural gas prices were equivalent to the national average in 2010. Prices vary by end user and time of use, but this snapshot of 2010 prices suggests that Kansas industry enjoys low energy prices.

In 2006 Kansas manufacturing consumed 150 trillion Btu[KS-2] of energy for fuel use. Figure KS-3 shows the breakdown of Kansas manufacturing fuel use by subsector (not including energy used as feedstocks). Petroleum and coal products and food manufacturing accounted for 48% of Kansas manufacturing fuel use in 2006.

Kansas does not require utilities to invest in energy efficiency programs, and its renewable portfolio standard does not explicitly include cogeneration and waste heat as eligible technologies. Several utilities offer incentives for commercial and industrial energy efficiency, and the state offers some incentives for cogeneration and waste heat utilization.

Petroleum and coal products and food manufacturing accounted for the largest share of Kansas manufacturing energy use in 2006, followed by nonmetallic minerals.

KS-2 For energy unit conversion, 1,000 trillion Btu is equivalent to 1 Quad of energy.

Table KS-2 | **Kansas Key Energy and Environmental Policies**

KANSAS	
REGULATORY ENVIRONMENT	
Renewable energy standard	The Kansas Renewable Portfolio Standard does not allow energy efficiency technologies to qualify for compliance (ACEEE; DSIRE).
Energy efficiency Resource standard	Kansas does not have an energy efficiency resource standard (DSIRE).
Emissions control programs	Kansas does not have output-based emission standards (ACEEE).
Alternative business models	The Kansas Corporation Commission will consider approving decoupling for electric and gas utilities, however no cases are currently in progress and none have been approved (ACEEE).
Grid access	In 2010, the Kansas Corporation Commission adopted interconnection standards for renewable energy generators up to 200 kW. Presumably these apply to CHP powered by an eligible renewable energy resource. The rules include IEEE and UL technical standards (ACEEE; DSIRE).
FINANCIAL AND TECHNICAL ASSISTANCE	
Grants, loans, or tax incentives	The Kansas Development Finance Authority is authorized to issue revenue bonds for waste heat utilization and cogeneration systems. Kansas also offers a property tax exemption and other tax incentives for these systems.[a] Efficiency Kansas offers energy efficiency loans of up to $30K for small businesses (DSIRE).
Technical assistance	The Kansas State University Pollution Prevention Institute provides environmental compliance and pollution prevention assistance to small businesses and also places interns with businesses to assist with pollution prevention.[b]
UTILITY PROGRAMS	
Customer EE programs, with cost-recovery	Kansas does not require utilities to offer customer energy efficiency programs, but the Kansas Commerce Commission has approved energy efficiency programs in a several cases (ACEEE).
EE as a resource	The Kansas Energy Council, a stakeholder advisory group, produced several annual energy plans that included energy efficiency and renewable energy resources (ACEEE). The Council was dissolved at the end of 2008.[c]

SOURCE: "ACEEE" refers to the American Council for an Energy Efficient Economy website: http://www.aceee.org/sector/state-policy; (February, 2012).). "DSIRE" refers to the Database of State Incentives for Renewables and Energy Efficiency website: http://www.dsireusa.org. (February, 2012).

a http://ks-kdoc.civicplus.com/index.aspx?NID=276. (February, 2012).

b http://www.sbeap.org/. (February, 2012).

c http://kec.kansas.gov/. (February, 2012).

MICHIGAN

In 2006 Michigan consumed 3.0 Quads of energy—making it the third-highest energy using state in the Midwest. Figure KS-1 shows the breakdown of statewide energy used for fuel and feedstock in 2006, roughly equal to the total energy consumed by the transportation and residential sectors. In 2006, Manufacturing accounted for 65% of Michigan's industry energy use.

Petroleum and coal products and primary metals manufacturing accounted for the largest share of Michigan manufacturing energy use in 2006, followed by transportation equipment and nonmetallic minerals.

Michigan has 3.1 GW of total installed CHP capacity[MI-1], which is equivalent to 10% of total installed electricity generation capacity, versus the national average of 8%. Within total CHP, the remaining technical potential for industry CHP in Michigan is estimated to be equivalent to 82% of currently installed industrial capacity (Hedman, 2010).

MI-1 This number is higher than the installed CHP capacity number in Figure 9 because it includes all CHP installations (i.e., industrial, commercial, and institutional).

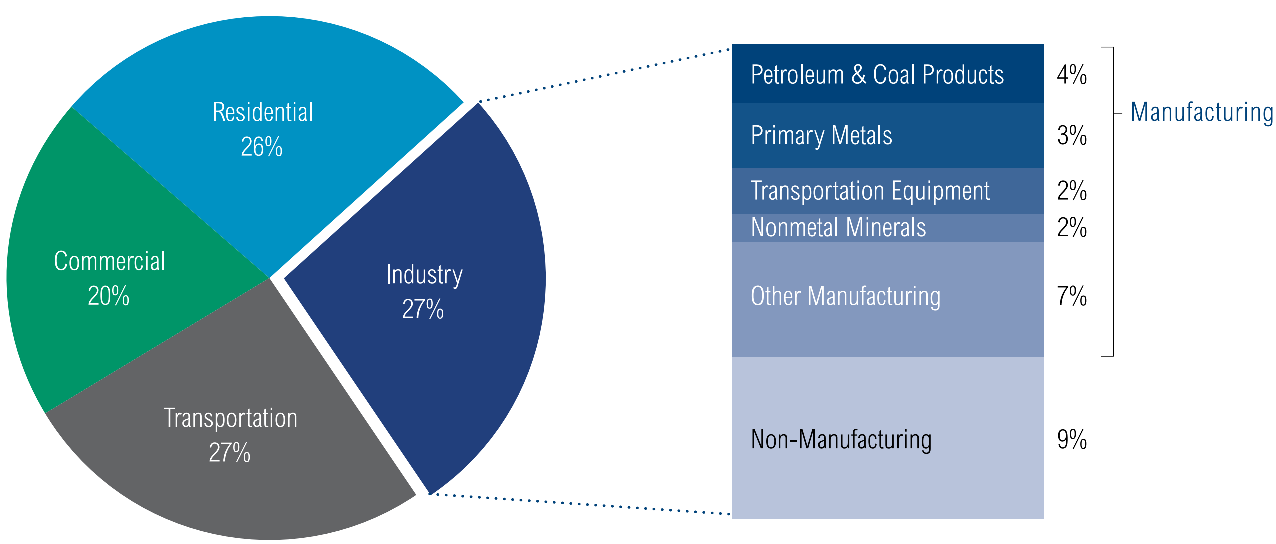
Manufacturing energy expenditures (shown by "cost of fuels & electricity" in Figure MI-2) have followed a national trend of peaking in 2008. Between 2000 and 2010, the index of manufacturing energy costs rose while the value of shipments index declined (Figure MI-2). The average difference between these two series over the period is 16%. By 2010 Michigan manufacturing energy expenditures had increased by 8%, while the total value of shipments dropped by 15%, relative to year 2000 levels. Over the same 10-year period, Michigan manufacturing employment dropped by 45%—from 910,000 to 501,000,

Table MI-1 | **Michigan Industry Delivered Energy Annual Average Prices (2010)**

	ELECTRICITY (cents/kWh)	NATURAL GAS ($/1,000 ft^3)	COAL ($/short ton)
Michigan	7.08	9.25	95.50
Midwest average	6.19	6.66	50.68
U.S. average	6.77	5.49	59.28

SOURCE: U.S. Energy Information Administration; for details see Appendix.

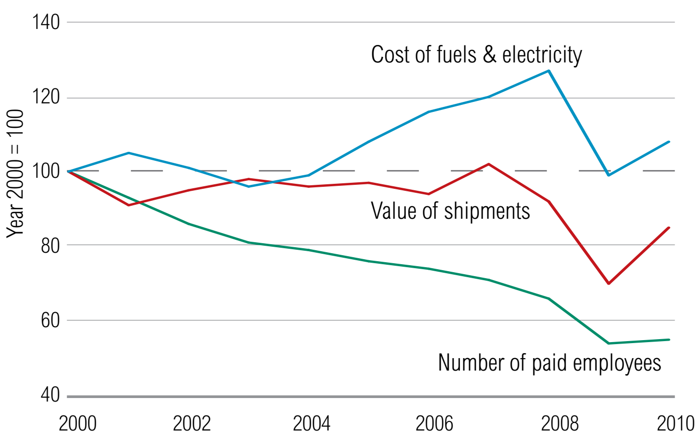
Figure MI-1 | **Michigan Total Energy Use, 2006**



Total Energy Use: 3.0 Quads

SOURCES: MECS; ASM; SEDS.

Figure MI-2 | **Index of Michigan Manufacturing Energy Cost, Value of Shipments, and Employment (2000-2010)**



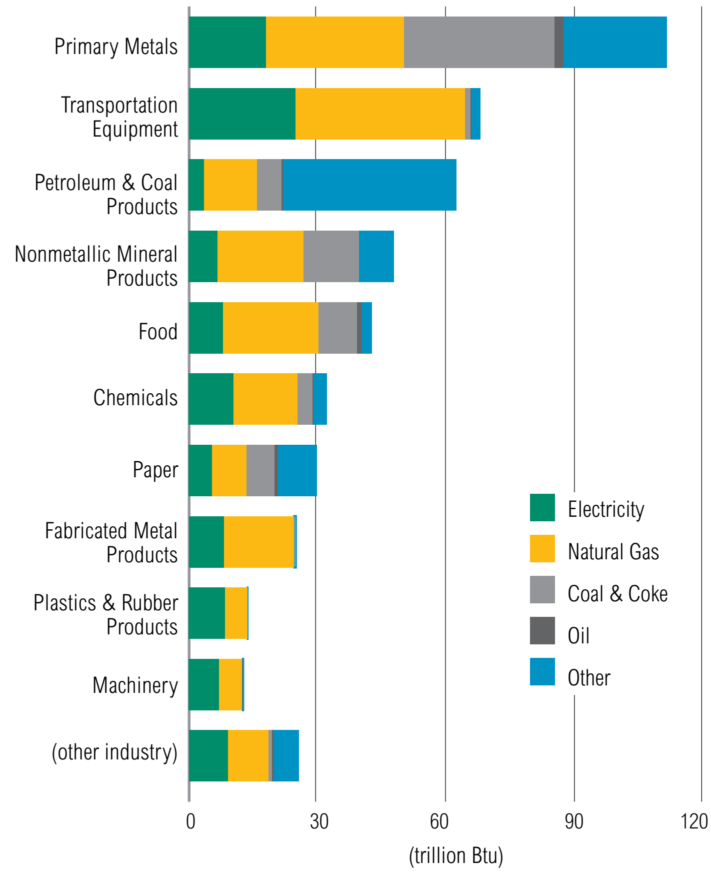
SOURCE: ASM; BEA (employment)
NOTE: 2002 ASM values were linearly interpolated due to a gap in the published data.

compared to the national manufacturing employment decline of 37% over the same period (Figure 1). Michigan experienced the largest manufacturing employment decline in the Midwest region, in both relative and absolute terms.

Energy prices (Table MI-1) influence demand and end-use efficiency. Michigan industrial energy prices were generally higher than national average prices in 2010. Electricity was slightly more expensive while coal prices were 61% higher and natural gas was 68% more expensive. Prices vary by end user and time of use, but this snapshot of 2010 prices suggests that Michigan industry faces electricity and fuel prices that are higher than the national and regional average.

In 2006 Michigan manufacturing consumed 480 trillion Btu[MI-2] of fuel. Figure MI-3 shows the breakdown of Michigan manufacturing fuel use by subsector (not including energy used as feedstocks). Natural gas was the most-consumed fuel by Michigan manufacturing. Primary metals, transportation equipment, and petroleum and coal product manufacturing accounted for 51% of Michigan manufacturing fuel use in 2006.

Figure MI-3 | **Michigan Manufacturing Fuel Use by Sector, 2006**



SOURCES: MECS; ASM.

In 2008 Michigan enacted Public Act 295, which established an energy efficiency resource standard and a renewable energy standard. Advanced clean energy, which includes CHP, can meet up to 10% of the renewable energy standard, and efficiency programs include incentives for industrial efficiency measures.

MI-2 For energy unit conversion, 1,000 trillion Btu is equivalent to 1 Quad of energy.

Table MI-2 | **Michigan Key Energy and Environmental Policies**

MICHIGAN	
REGULATORY ENVIRONMENT	
Renewable energy standard	Michigan's renewable energy standard requires utilities to generate 10% of retail electric sales with renewable energy by 2015. Up to 10% of the requirement can be met with energy efficiency and advanced clean energy credits—the latter includes industrial CHP (ACEEE; DSIRE).
Energy efficiency resource standard	Public Act 295 of 2008 established energy optimization standards that ramp up to annual savings of 1% for electric utilities and 0.75% for gas utilities in 2012 and every year thereafter. Some utilities offer incentives for industrial energy efficiency measures (DSIRE).
Emissions control programs	Michigan does not have output-based emission standards (ACEEE).
Alternative business models	Act 295 authorizes decoupling and the MPSC has approved decoupling for two electric utilities and three gas utilities (ACEEE).
Grid access	In 2008, the Public Service Commission updated interconnection standards based on five tiers of generator capacity up to 2 MW and higher. The rules adopt IEEE 1547.1 and UL 1741 as technical standards (ACEEE; DSIRE).
FINANCIAL AND TECHNICAL ASSISTANCE	
Grants, loans, or tax incentives	Michigan's Department of Environmental Quality offers a low interest pollution prevention loan program for qualifying small businesses. Energy conservation measures are eligible.[a] The Michigan Emerging Technologies Fund provides matching grants for federal SBIR/STTR (Small Business Innovation Research/ Small Business Technology Transfer) funding opportunities in four technology sectors, including CHP systems.[b] Michigan also provides property tax exemptions for alternative energy systems including CHP that are located within the NextEnergy Zone (ACEEE).
Technical assistance	The Department of Environmental Quality administers the Retired Engineer Technical Assistance Program (RETAP) program, through which retired engineers provide free pollution prevention and energy efficiency assistance to businesses and institutions.[c] The University of Michigan houses the MI Industrial Energy Center and an Industrial Assessment Center, which provide free assessments, recommendations, and other resources to help industrial plants improve their energy efficiency.[d]
UTILITY PROGRAMS	
Customer EE programs, with cost-recovery	Efficiency program costs are recovered on utility bills via a volumetric residential charge and "per meter" commercial and industrial charge. Efficiency spending is limited to 2% of total sales revenues. Large electric customers may seek exemption from most of the utility program charges. To do so, they must develop and implement multi-year, on-going self-directed plans that meet or exceed the state's EERS goals and report results annually to their utility (ACEEE, DSIRE).
EE as a resource	MCL 460.1071 states that the goal of the energy optimization plan is to reduce future costs to consumers, in part through EE measures that delay the need for the construction of new electric generators. Additionally, MCL 460.6s incorporates energy efficiency into utility integrated resource planning (ACEEE).

SOURCE: "ACEEE" refers to the American Council for an Energy Efficient Economy website: http://www.aceee.org/sector/state-policy. (February, 2012); "DSIRE" refers to the Database of State Incentives for Renewables and Energy Efficiency website: http://www.dsireusa.org. (February, 2012).

a http://www.michigan.gov/deq/0,1607,7-135-3307_3515_4144—,00.html (February, 2012).

b http://www.mietf.org/Default.aspx. (February, 2012).

c http://www.michigan.gov/deq/0,4561,7-135-3585_4848—,00.html. (February, 2012).

d http://www.miec.engin.umich.edu/ (February, 2012).

MINNESOTA

Figure MN-1 shows the breakdown of statewide energy used for fuel and feedstock in 2006. In this year, industry consumed approximately one-third of Minnesota's energy, while manufacturing accounted for roughly two thirds of the state's industry energy use.

Petroleum and coal products and food manufacturing accounted for the largest share of Minnesota manufacturing energy use in 2006, followed by paper and nonmetallic minerals.

Minnesota has 770 MW of total installed CHP capacity[MN-1], which is equivalent to 5% of total installed electricity generation capacity, versus the national average of 8%. Within total CHP, the remaining technical potential for industry CHP in Minnesota is estimated to be more than two and a half times currently installed industrial capacity (Hedman, 2010).

MN-1 This number is higher than the installed CHP capacity number in Figure 9 because it includes all CHP installations (i.e., industrial, commercial, and institutional).

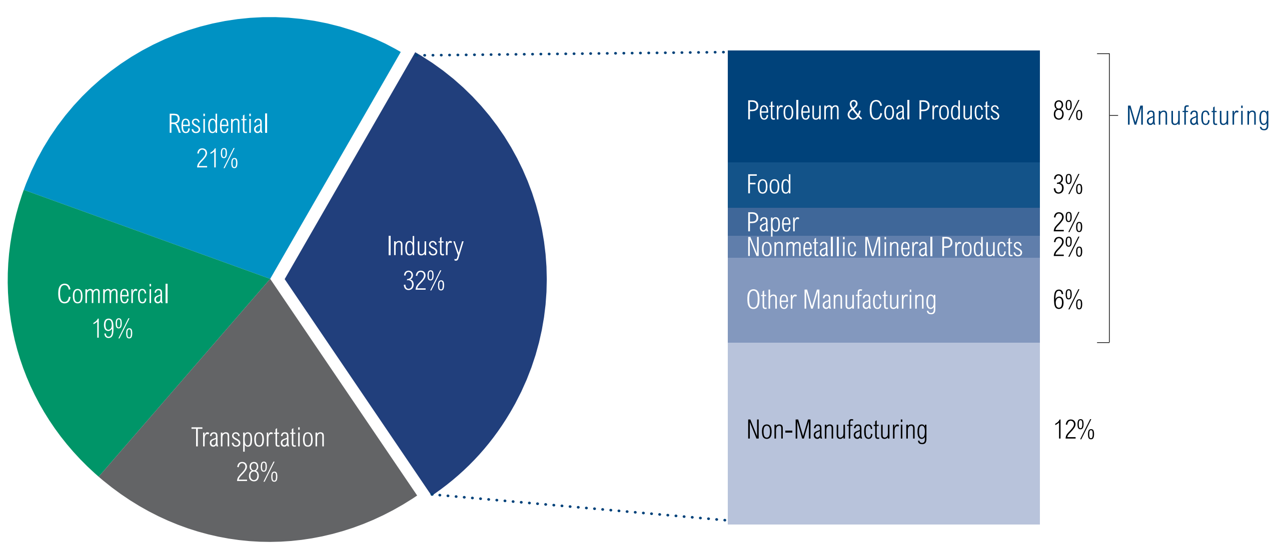
Manufacturing energy expenditures (shown by "cost of fuels & electricity" in Figure MN-2) rose substantially between 2004 and 2008. Between 2000 and 2010, the index of manufacturing energy costs rose more quickly than the value of shipments index (Figure MN-2). The average difference between these two series over the period is 9%. By 2010 Minnesota manufacturing energy expenditures had increased by 36%, while the total value of shipments rose by 24%, relative to year 2000 levels. Over the same 10-year period, Minnesota manufacturing employment dropped by 24%—from 407,000 to 308,000, compared to the national manufacturing employment decline of 37% over the same period (Figure 1).

Table MN-1 | **Minnesota Industry Delivered Energy Annual Average Prices (2010)**

	ELECTRICITY (cents/kWh)	NATURAL GAS (\$/1,000 ft^3)	COAL (\$/short ton)
Minnesota	6.29	5.58	49.06
Midwest average	6.19	6.66	50.68
U.S. average	6.77	5.49	59.28

SOURCE: U.S. Energy Information Administration; for details see Appendix.

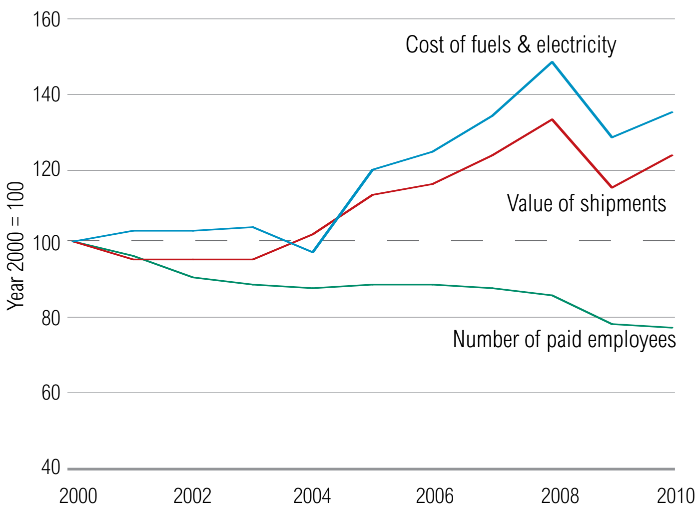
Figure MN-1 | **Minnesota Total Energy Use, 2006**



Total Energy Use: 1.9 Quads

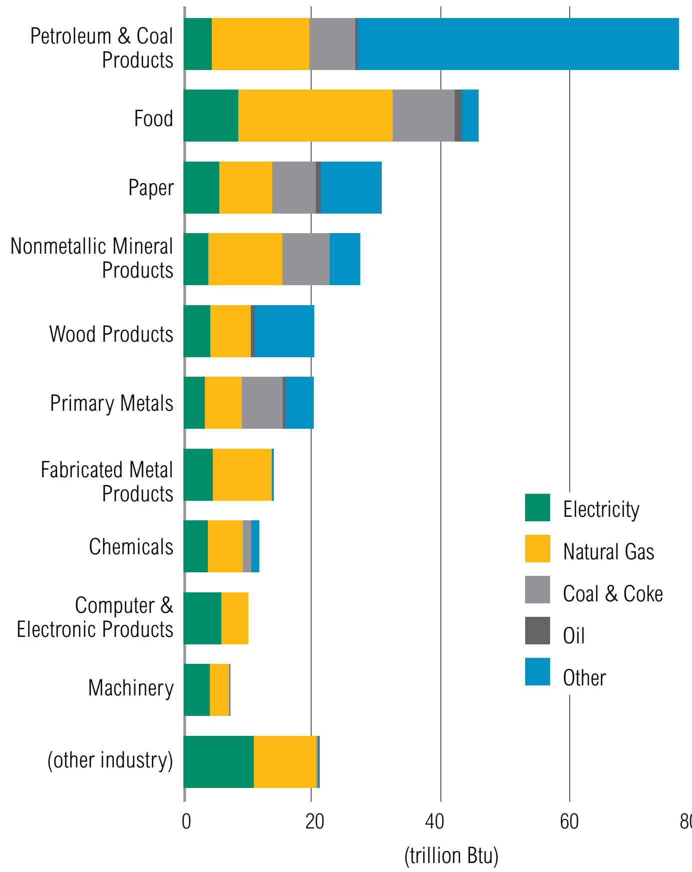
SOURCES: MECS; ASM; SEDS.

Figure MN-2 | **Index of Minnesota Manufacturing Energy Cost, Value of Shipments, and Employment (2000-2010)**



SOURCE: ASM; BEA (employment)
NOTE: 2002 ASM values were linearly interpolated due to a gap in the published data.

Figure MN-3 | **Minnesota Manufacturing Fuel Use by Sector, 2006**



SOURCES: MECS; ASM.

Energy prices (Table MN-1) influence demand and end-use efficiency. Reported Minnesota electricity and delivered coal prices were 7% and 17% lower than the national average, respectively, while delivered natural gas was slightly more expensive than the national average. Prices vary by end user and time of use, but this snapshot of 2010 prices suggests that Minnesota industry faces a mixed picture among different fuels.

In 2006 Minnesota manufacturing consumed 290 trillion Btu[MN-2] of fuel. Figure shows the breakdown of Minnesota manufacturing fuel use by subsector (not including energy used as feedstocks). Natural gas was the most-consumed fuel for manufacturing. Petroleum and coal products and food manufacturing accounted for 43% of Minnesota manufacturing fuel use in 2006.

Minnesota's 2007 Next Generation Energy Act implemented a comprehensive statewide energy efficiency resource standard and renewable energy standard. Utilities administer their own energy conservation improvement programs and offer energy efficiency rebates and incentives to their customers. Although numerous utilities offer industrial-sector programs, few policies or incentives specifically address combined heat and power.

Petroleum and coal products and food manufacturing accounted for the largest share of Minnesota manufacturing energy use in 2006, followed by paper and nonmetallic minerals.

MN-2 For energy unit conversion, 1,000 trillion Btu is equivalent to 1 Quad of energy.

Table MN-2 | Minnesota Key Energy and Environmental Policies

MINNESOTA	
REGULATORY ENVIRONMENT	
Renewable energy standard	CHP is not an eligible technology for Minnesota's renewable energy standard.
Energy efficiency resource standard	Under § 216B.241 enacted in 2007, the state requires electric and gas utilities to implement conservation improvement programs that achieve annual energy savings equal to 1.5% of average retail sales. Some utilities offer incentives for industrial energy efficiency (DSIRE).
Emissions control programs	Minnesota does not have output-based emission standards (ACEEE).
Alternative business models	The Public Utilities Commission (PUC) has the authority to approve pilot programs to assess decoupling. CenterPoint Energy has a pilot in progress and Minnesota Energy Resources filed a decoupling notice of intent.[a]
Grid access	Minnesota's interconnection standards (adopted 2004), are applicable to CHP units up to 10 MW. The standards apply to investor-owned utilities (ACEEE).
FINANCIAL AND TECHNICAL ASSISTANCE	
Grants, loans, or tax incentives	Utilities offer rebates and other incentives through their energy conservation improvement programs (CIP). In 2010, the statewide CIP budgets amounted to $160.2 million for electricity and $40.1 million for natural gas (ACEEE). The Pollution Control Agency offers an Environmental Assistance Loan Program for small and medium-sized businesses and public entities, as well as an Environmental Assistance Grant program. A request for proposals has not yet been announced for 2012.[b]
Technical assistance	The University of Minnesota's MnTAP program offers site visits and places full-time interns to assist with pollution prevention and energy efficiency assistance to businesses. The Pollution Control Agency administers the RETAP program, through which retired engineers provide free facility assessments to help businesses and institutions identify opportunities to reduce costs through energy efficiency and waste reduction.[c]
UTILITY PROGRAMS	
Customer EE programs, with cost-recovery	Pursuant to § 216B.241, Minnesota's electric and gas utilities establish EE programs to help multiple customer classes achieve required energy savings. Utilities may recover program expenses through surcharges on customer bills; large customers with over 20MW peak electric demand or 500MCF gas consumption, however, may opt-out and "self-direct" their own efforts to identify, evaluate, and implement energy conservation and efficiency improvements, reporting results after five years.[d]
EE as a resource	Minnesota's regulated utilities are required to file integrated resources plans with the PUC (ACEEE). Per §216B.241, all utilities file energy conservation improvement plans at least every 3 years. Per §216B.16, the PUC may adopt mechanisms that make cost-effective conservation a "preferred resource choice."

SOURCE: "ACEEE" refers to the American Council for an Energy Efficient Economy website: http://www.aceee.org/sector/state-policy (February, 2012); "DSIRE" refers to the Database of State Incentives for Renewables and Energy Efficiency website: http://www.dsireusa.org. (February, 2012).

a http://www.mwalliance.org/policy/minnesota-policy-info#decoupling. (February, 2012).

b http://www.pca.state.mn.us/index.php/about-mpca/assistance/financial-assistance/financial-assistance-grants-and-loans.html. (February, 2012).

c MnTAP: http://www.mntap.umn.edu/assistance.htm (February, 2012).; RETAP: http://www.pca.state.mn.us/index.php/topics/preventing-waste-and-pollution/assistance-and-resources/retap/minnesota-retap.html(February, 2012).

d See more details on page 34 of the following report: http://www.aceee.org/research-report/ie112 (February, 2012).

MISSOURI

In 2006 Missouri consumed 1.9 Quads of energy. Industry plays a smaller role in Missouri energy use, economic activity, and employment than it does in other Midwestern states. Figure MO-1 shows the breakdown of state-wide energy used for fuel and feedstock in 2006. Industry consumed less than a quarter of total energy (including feedstocks) in Missouri—less than transportation and residential energy use. Within industry, manufacturing accounted for 65% of Missouri industry energy use in the same year.

Chemicals and food manufacturing accounted for the largest share of Missouri manufacturing energy use in 2006, followed by primary metals and paper.

Missouri has 227 MW of total installed CHP capacity[MO-1], which is equivalent to 1% of total installed electricity generation capacity, versus the national average of 8%. Within total CHP, the remaining technical potential for industry CHP in Missouri is estimated to be more than sixteen times as large as currently installed industrial capacity (Hedman, 2010).

MO-1 This number is higher than the installed CHP capacity number in Figure 9 because it includes all CHP installations (i.e., industrial, commercial, and institutional).

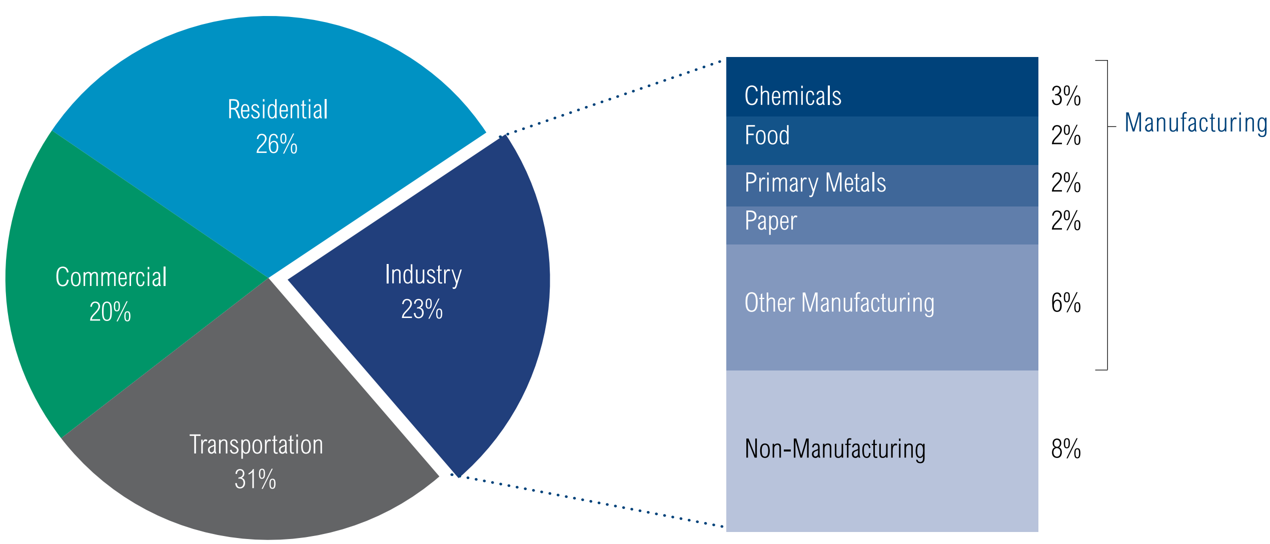
Missouri manufacturing energy expenditures (shown by "cost of fuels & electricity" in Figure MO-2) followed the national trend of peaking in 2008. Between 2000 and 2010, the index of manufacturing energy costs rose more quickly than the value of shipments index (Figure MO-2). The average difference between these two series over the period is 12%. By 2010 Missouri manufacturing energy expenditures had increased by 36%, while the total value of shipments rose by 12%, relative to year 2000 levels. Over the same 10-year period, Missouri manufacturing employment dropped by 31%—from 373,000 to 256,000, compared to the national manufacturing employment decline of 37% over the same period (Figure 1).

Table MO-1 | **Missouri Industry Delivered Energy Annual Average Prices (2010)**

	ELECTRICITY (cents/kWh)	NATURAL GAS ($/1,000 ft^3)	COAL ($/short ton)
Missouri	5.50	8.70	62.14
Midwest average	6.19	6.66	50.68
U.S. average	6.77	5.49	59.28

SOURCE: U.S. Energy Information Administration; for details see Appendix.

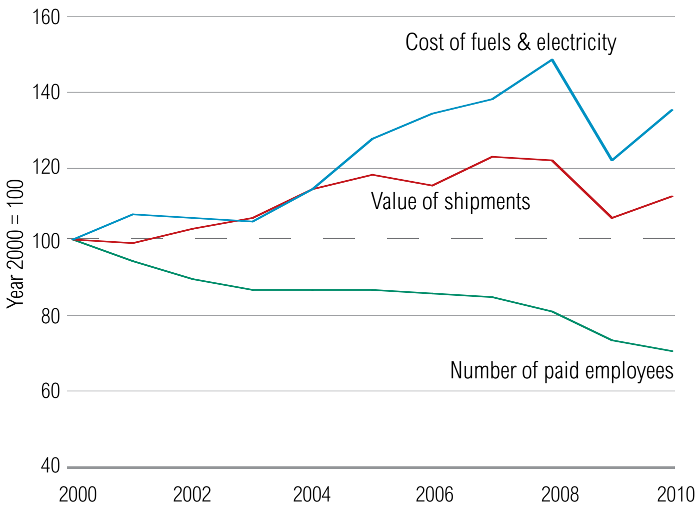
Figure MO-1 | **Missouri Total Energy Use, 2006**



Total Energy Use: 1.9 Quads

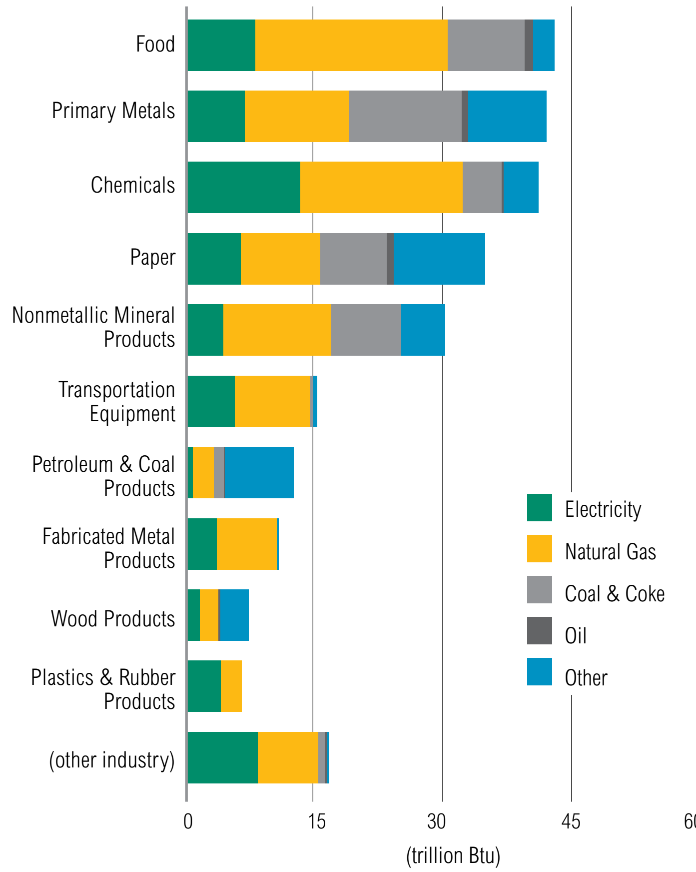
SOURCES: MECS; ASM; SEDS.

Figure MO-2 | **Index of Missouri Manufacturing Energy Cost, Value of Shipments, and Employment (2000-2010)**



SOURCE: ASM; BEA (employment)
NOTE: 2002 ASM values were linearly interpolated due to a gap in the published data.

Figure MO-3 | **Missouri Manufacturing Fuel Use by Sector, 2006**



SOURCES: MECS; ASM.

Energy prices (Table MO-1) influence demand and end-use efficiency. Whereas reported Missouri natural gas prices were 58% higher than the national average, delivered electricity was 19% cheaper than the national average. Prices vary by end user and time of use, but this snapshot of 2010 prices suggests that Missouri industry faces a mixed picture among different fuels.

In 2006 Missouri manufacturing consumed 260 trillion Btu[MO-2] of energy for fuel use. Figure MO-3 shows the breakdown of Missouri manufacturing fuel use by subsector (not including energy used as feedstocks). Food, primary metals, and chemicals manufacturing accounted for 49% of Missouri manufacturing fuel use in 2006.

Missouri's 2009 Energy Efficiency Investment Act encouraged utilities to develop comprehensive programs with the goal of achieving all cost-effective, demand-side savings. Although several utilities offer incentives for industrial efficiency measures, large customers can opt out of these programs and interconnection standards are currently limited to small systems.

MO-2 For energy unit conversion, 1,000 trillion Btu is equivalent to 1 Quad of energy.

Table MO-2 | **Missouri Key Policies**

MISSOURI	
REGULATORY ENVIRONMENT	
Renewable energy standard	CHP is not currently eligible for Missouri's renewable electricity standard (ACEEE).
Energy efficiency resource standard	Missouri's 2009 Energy Efficiency Investment Act permits the Public Utilities Commission to approve utility programs with a goal of achieving all cost-effective, demand-side savings. Cost recovery is available to programs that benefit all customer classes, and several utilities have rebates available for industrial efficiency measures (ACEEE; DSIRE).
Emissions control programs	Under its state implementation plan for the Clean Air Interstate Rule, Missouri included allowances for efficiency and for CHP based on the system's output. These rules are to be phased out in 2012.[a]
Alternative business models	Public Service Commission (PSC) rules allow utilities to request recovery of lost revenues and one gas utility has been granted a straight-fixed-variable rate structure, allowing utilities to recover lost revenues related to both fixed and variable costs (ACEEE).
Grid access	Missouri's interconnection standards only apply to systems up to 100kW that are fueled by renewable sources (ACEEE).
FINANCIAL AND TECHNICAL ASSISTANCE	
Grants, loans, or tax incentives	Missouri offers a no-interest Energy Revolving Loan program, which is available to reduce energy costs in public sector facilities (DSIRE). The state also exempts $50,000 or 70% (whichever is greater) of the assessed value of renewable energy systems, including CHP fueled by renewable resources, from property taxes.
Technical assistance	The Department of Natural Resources' Division of Energy runs a commercial and industrial program that assists businesses in understanding their energy use and possible cost-saving efficiency measures; it also explores and promotes financial incentives.[b] The University of Missouri Environmental Assistance Center provides businesses with interns, resources, and training related to pollution prevention and energy efficiency. The University of Missouri also houses an Industrial Assessment Center, which provides qualified manufacturers with free assessments and recommendations to improve energy efficiency.[c]
UTILITY PROGRAMS	
Customer EE programs, with cost-recovery	Utilities recover costs for energy efficiency programs and may also propose performance incentives and recovery of lost revenues (ACEEE). Although S.B. 376 allows three categories of large customers to opt out of the efficiency program fees, no follow-up or ongoing monitoring of these large customers' efficiency savings currently takes place.[d]
EE as a resource	In addition to S.B. 376, which established a goal of achieving all cost-effective savings, the PSC integrated resource planning rules require evaluation of demand-side and supply-side measures on an equivalent basis (ACEEE).

SOURCE: "ACEEE" refers to the American Council for an Energy Efficient Economy website: http://www.aceee.org/sector/state-policy (February, 2012); "DSIRE" refers to the Database of State Incentives for Renewables and Energy Efficiency website: http://www.dsireusa.org. (February, 2012).

a The first compliance phase for CAIR's replacement, the Cross-State Air Pollution Rule (CSAPR), had been scheduled to go into effect in January 2012. In December 2011, the United States Court of Appeals for the D.C. Circuit stayed CSAPR and is scheduled to hear the case in April 2012. Meanwhile, EPA is facilitating a transition back to CAIR. http://epa.gov/airtransport/

b http://www.dnr.mo.gov/energy/deprograms.htm. (February, 2012).

c http://iac.missouri.edu/. (February, 2012).

d See more details on page 34 of the following report: http://www.aceee.org/research-report/ie112 (February, 2012).

OHIO

In 2006 Ohio consumed 3.9 Quads of energy—second only to Illinois in Midwestern state energy use. Figure OH-1 shows the breakdown of statewide energy used for fuel and feedstock in 2006. More than one-third of Ohio's energy was consumed by industry in 2006. Manufacturing accounted for 72% of total industrial energy use (including feedstocks).

Primary metals and petroleum and coal products accounted for the largest share of Ohio manufacturing energy use in 2006, followed by chemicals and food.

Ohio has 750 MW of total installed CHP capacity[OH-1], which is equivalent to 2% of total installed electricity generation capacity, versus the national average of 8%. Within total CHP, the remaining technical potential for industry CHP in Ohio is estimated to be more than five times currently installed industrial capacity (Hedman, 2010).

OH-1 This number is higher than the installed CHP capacity number in Figure 9 because it includes all CHP installations (i.e., industrial, commercial, and institutional).

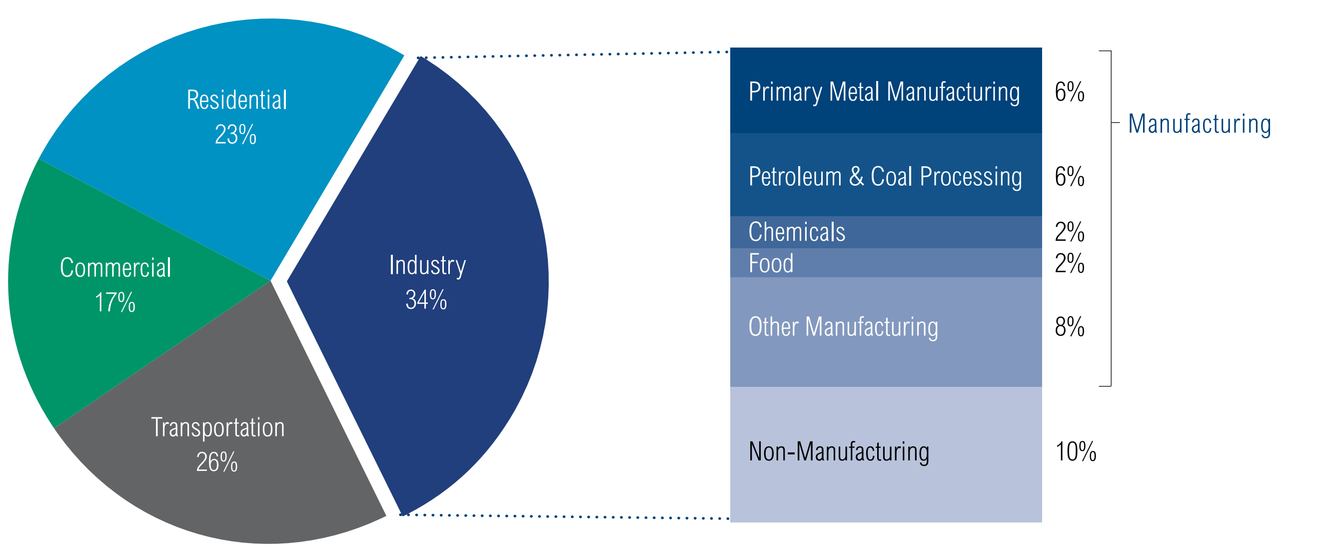
Ohio's manufacturing energy expenditures (shown by "cost of fuels & electricity" in Figure OH-2) have fluctuated over the past 10 years (Figure OH-2). After peaking in 2008, the index of manufacturing energy costs dropped below 2000 levels in 2009, while both energy costs and the value of shipments index rebounded to roughly 2000 levels in 2010. The average difference between these two series over the period is only 4%, relative to year 2000 levels. Between 2001 and 2010, Ohio manufacturing energy expenditures increased an average 4.3% more than

Table OH-1 | **Ohio Industry Delivered Energy Annual Average Prices (2010)**

	ELECTRICITY (cents/kWh)	NATURAL GAS ($/1,000 ft³)	COAL ($/short ton)
Ohio	6.40	7.40	80.59
Midwest average	6.19	6.66	50.68
U.S. average	6.77	5.49	59.28

SOURCE: U.S. Energy Information Administration; for details see Appendix.

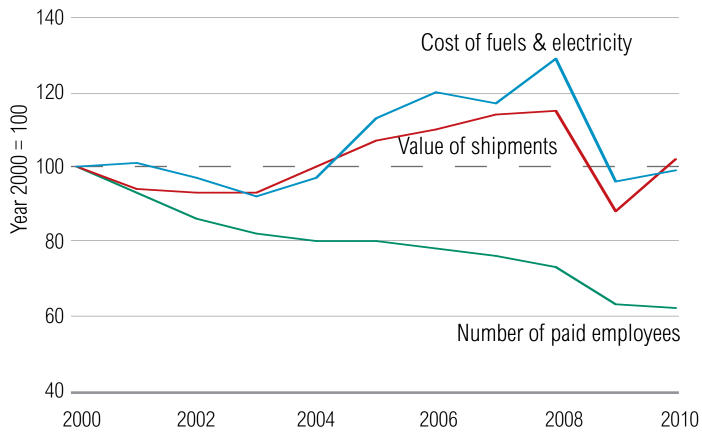
Figure OH-1 | **Ohio Total Energy Use, 2006**



Total Energy Use: 3.9 Quads

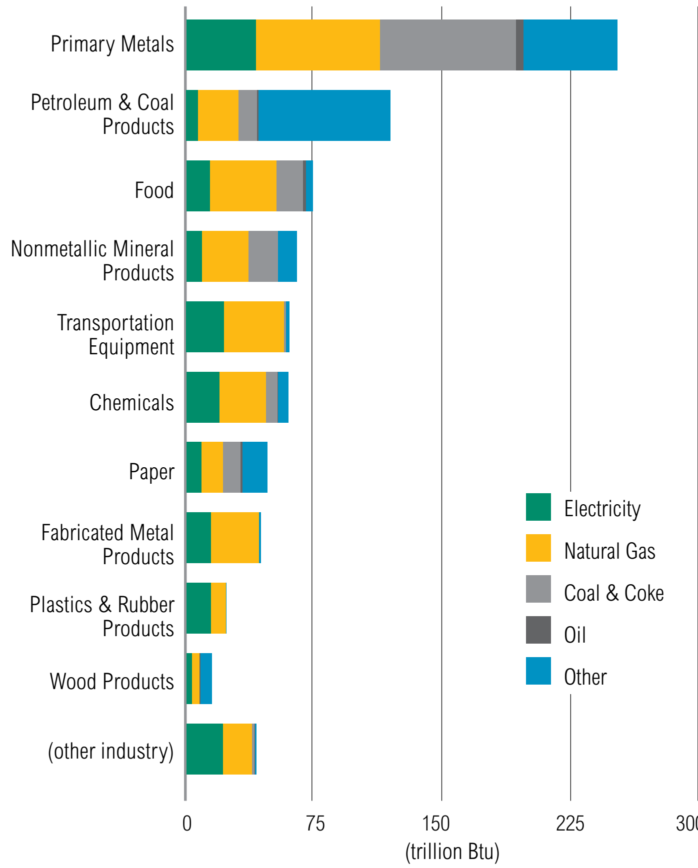
SOURCES: MECS; ASM; SEDS.

Figure OH-2 | **Index of Ohio Manufacturing Energy Cost, Value of Shipments, and Employment (2000-2010)**



SOURCE: ASM; BEA (employment)
NOTE: 2002 ASM values were linearly interpolated due to a gap in the published data.

Figure OH-3 | **Ohio Industry Fuel Use by Sector, 2006**



SOURCES: MECS; ASM.

the value of shipments, relative to year 2000 levels. Over the same ten-year period, Ohio manufacturing employment dropped by 38%—from 1,050,000 to 649,000, compared to the national manufacturing employment decline of 37% over the same period (Figure 1).

Energy prices (Table OH-1) influence demand and end-use efficiency. Reported Ohio delivered natural gas and coal prices were 35% and 36% higher than the national average, respectively, while electricity prices were slightly lower than the national average. Prices vary by end user and time of use, but this snapshot of 2009 and 2010 prices suggests that Ohio industry faces a mixed picture among different fuels.

In 2006 Ohio manufacturing consumed 830 trillion Btu[OH-2] of energy for fuel use—more than the manufacturing sector of any other Midwestern state. Figure OH-3 shows the breakdown of Ohio manufacturing fuel use by subsector. Primary metals manufacturing and petroleum and coal products manufacturing accounted for 46% of Ohio manufacturing fuel use in 2006.

In 2008 the Ohio legislature passed S.B. 221, which requires utilities to meet the state's Alternative Energy Portfolio Standard and Energy Efficiency Portfolio Standard. This legislation also established utility-run EE programs, funded through a surcharge on customer electricity bills. There are also technical assistance services available through the Ohio Center for Industrial Energy Efficiency and the University of Dayton's DOE Industrial Assessment Center.

OH-2 For energy unit conversion, 1,000 trillion Btu is equivalent to 1 Quad of energy.

Primary metals and petroleum and coal products accounted for the largest share of Ohio manufacturing energy use in 2006, followed by food.

Table OH-2 | Ohio Key Energy and Environmental Policies

OHIO	
REGULATORY ENVIRONMENT	
Renewable energy standard	In the state's Alternative Energy Portfolio Standard (S.B. 221, enacted in 2008), CHP qualifies as an eligible advanced energy resource. However, there is no clear mandate for utilities to meet this portion of the standard prior to the year 2025.[a]
Energy efficiency resource standard	The state's Energy Efficiency Portfolio Standard (S.B. 221, enacted in 2008) requires investor-owned utilities to implement energy efficiency and peak demand reduction programs that achieve 22% in cumulative electric savings by 2025.[b]
Emissions control programs	Under CAIR, Ohio sets aside NO_x allowances for CHP and other eligible highly efficient distributed electric generation projects.[c] These rules are to be phased out in 2012.[d]
Alternative business models	The Public Utilities Commission of Ohio (PUCO) has the authority to approve revenue decoupling mechanisms proposed by utilities. In November 2011, Duke Energy and AEP proposed a decoupling mechanism for rate recovery from residential and commercial customers that is currently under consideration by the PUCO (ACEEE).
Grid access	Ohio's interconnection standards (adopted 2007) are applicable to CHP units up to 20 MW. The standards include a three-tier structure that is consistent with the IEEE 1547 model (ACEEE).
FINANCIAL AND TECHNICAL ASSISTANCE	
Tax incentives	The Ohio Air Quality Development Authority can provide industry up to a 100% exemption from various state taxes for any projects that reduce air pollutants, including through conservation or energy efficiency.[e]
Grants or loans	Although the Ohio Advanced Energy Fund (established in 1999) supported an EE revolving loan fund administered by the state, directing $160 million to electricity and natural gas programs in 2010 (ACEEE), the $0.09 per month, per customer electric utility bill rider was not renewed after 2010. The program will continue to issue loans for as long as funds are available.[f]
Technical assistance	The Ohio Center for Industrial Energy Efficiency has a technical assistance program that encourages systematic energy management planning, provides site assessments, and offers related financial incentives (Boyd, 2011). The University of Dayton houses an Industrial Assessment Center, which provides qualified manufacturers with free assessments and recommendations to improve energy efficiency.[g]
UTILITY PROGRAMS	
Customer EE programs, with cost-recovery	Pursuant to S.B. 221, Ohio's investor-owned electric utilities established EE programs to serve multiple customer classes to help achieve required energy savings and peak demand reductions. Duke Energy's Smart Saver Incentive program, for example, offers rebates for a range of energy saving technology investments. Customers support these programs, which are overseen by PUCO, through surcharges on their electricity bills; opt-out or "self-direct" provisions, which exempt large energy consumers from the surcharge, vary depending on which utility serves the facility.[h]
EE as a resource	Since 2009, investor-owned utilities are required to submit to PUCO long-term forecast reports annually, including resource plans that consider the role of EE as a resource (ACEEE).

SOURCE: "ACEEE" refers to the American Council for an Energy Efficient Economy website: http://www.aceee.org/sector/state-policy (February, 2012); "DSIRE" refers to the Database of State Incentives for Renewables and Energy Efficiency website: http://www.dsireusa.org. (February, 2012).

a Chittum and Kaufman, 2011.

b http://www.development.ohio.gov/Energy/Tools/AdvancedEnergyPortfolioStandard.htm#EEPS. (February, 2012).

c http://www.epa.ohio.gov/portals/27/files/OhioGuidanceFINAL.pdf. (February, 2012).

d The first compliance phase for CAIR's replacement, the Cross-State Air Pollution Rule (CSAPR), had been scheduled to go into effect in January 2012. In December 2011, the United States Court of Appeals for the D.C. Circuit stayed CSAPR and is scheduled to hear the case in April 2012. Meanwhile, EPA is facilitating a transition back to CAIR. http://epa.gov/airtransport/

e http://www.ohioairquality.org/clean_air/large_bus_financial_benefits.asp. (February, 2012).

f http://www.development.ohio.gov/Energy/Incentives/AdvancedEnergyFundGrants.htm. (February, 2012).

g http://academic.udayton.edu/kissock/http/iac/ (February, 2012).

h See more details on page 37 of the following report: http://www.aceee.org/research-report/ie112. (February, 2012).

SOUTH DAKOTA

In 2009 South Dakota consumed 0.36 Quads of energy. Industry plays a slightly larger role in South Dakota energy use, economic activity, and employment than other end-use sectors. Figure SD-1 shows the breakdown of statewide energy used for fuel and feedstock in 2006. Industry consumed approximately one-third of total energy (including feedstocks) in South Dakota—more than any other sector. Within industry, manufacturing accounted for only 16% of South Dakota industry energy use in the same year—the lowest share in the Midwest.

Food and nonmetallic minerals manufacturing accounted for the largest share of South Dakota manufacturing energy use in 2006.

South Dakota has 24 MW of total installed CHP capacity[SD-1], which is equivalent to 1% of total installed electricity generation capacity, versus the national average of 8%. Within total CHP, the remaining technical potential for industry CHP in South Dakota is estimated to be more than twenty-seven times larger than currently installed industrial capacity (Hedman, 2010).

South Dakota manufacturing energy expenditures (shown by "cost of fuels & electricity" in Figure SD-2) followed the national trend of peaking in 2008. Between 2000 and 2010, South Dakota's index of manufacturing energy costs rose much more rapidly than the value of shipments index (Figure SD-2). The average difference between these two series over the period is 140%. By 2010 South Dakota

SD-1 This number is higher than the installed CHP capacity number in Figure 9 because it includes all CHP installations (i.e., industrial, commercial, and institutional).

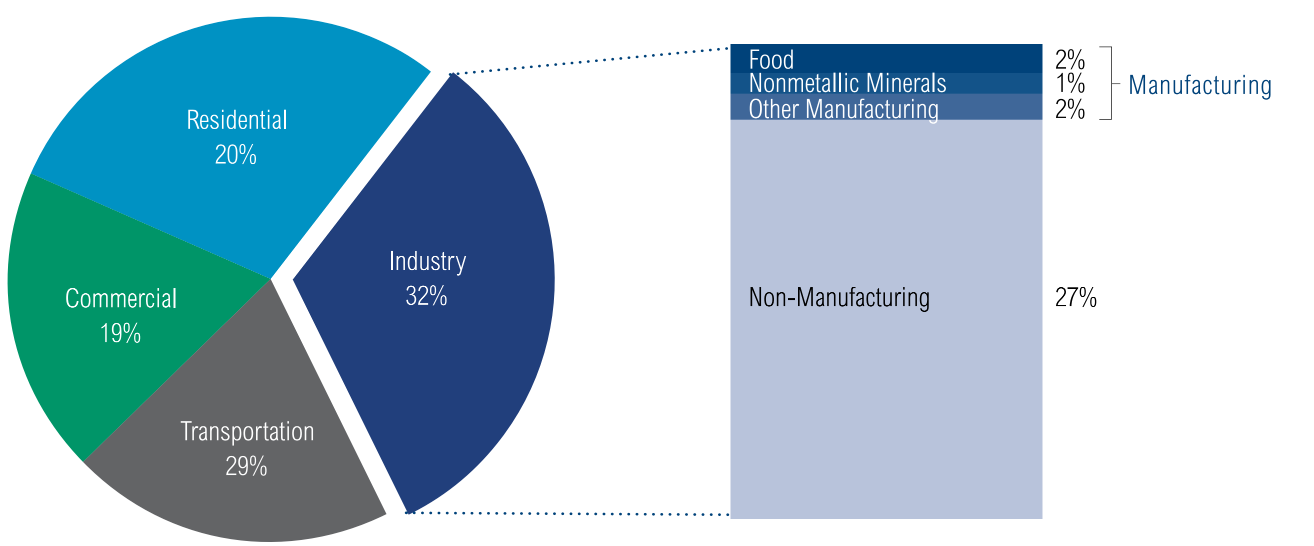
Table SD-1 | **South Dakota Industry Delivered Energy Annual Average Prices (2010)**

	ELECTRICITY (cents/kWh)	NATURAL GAS ($/1,000 ft^3)	COAL[1] ($/short ton)
South Dakota	6.07	5.92	32.49
Midwest average	6.19	6.66	33.00
U.S. average	6.77	5.49	44.29

SOURCE: U.S. Energy Information Administration; for details see Appendix.

1 Because the EIA withheld South Dakota 2010 industry coal price data, electric utility coal price data are displayed in this table instead.

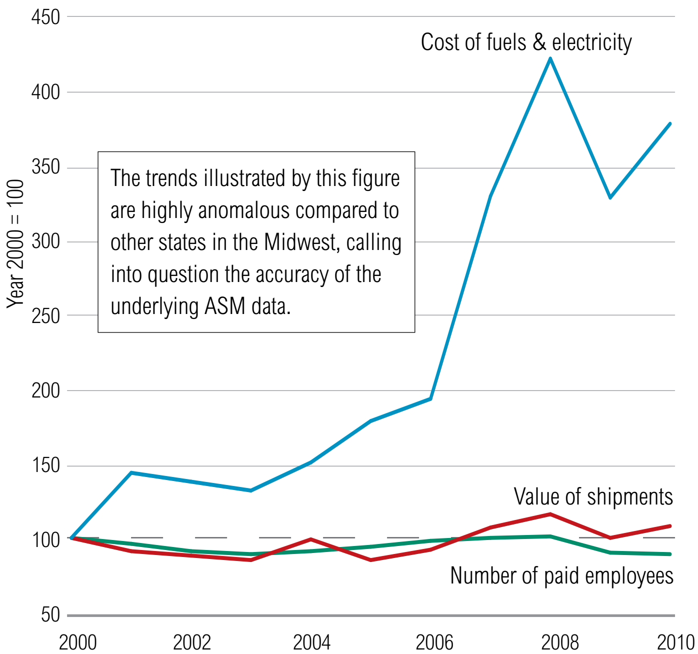
Figure SD-1 | **South Dakota Total Energy Use, 2006**



Total Energy Use: 0.3 Quad

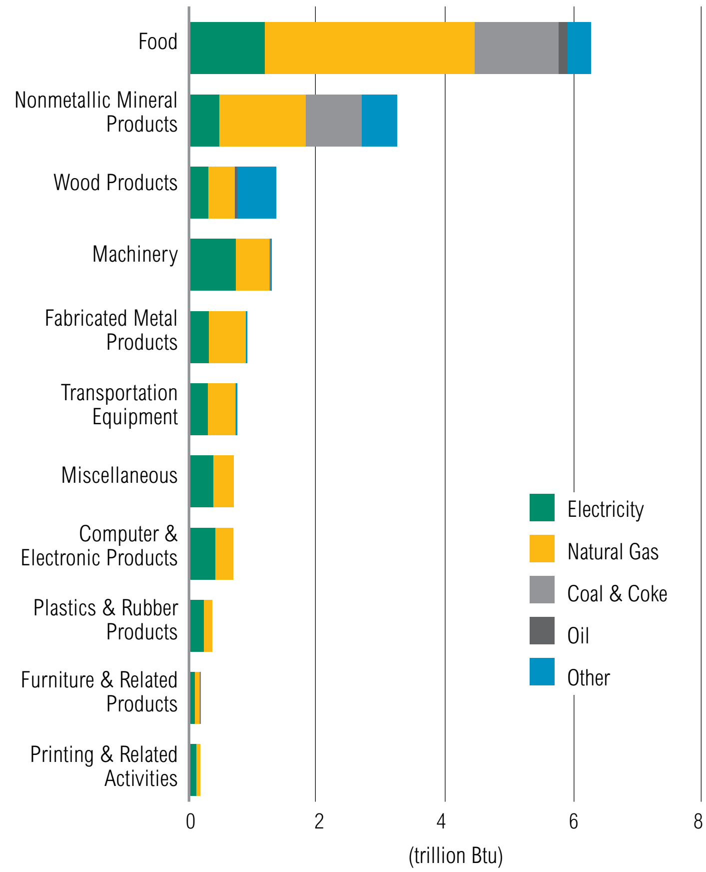
SOURCES: MECS; ASM; SEDS.

Figure SD-2 | **Index of South Dakota Manufacturing Energy Cost, Value of Shipments, and Employment (2000-2010)**



SOURCE: ASM; BEA (employment)
NOTE: 2002 ASM values were linearly interpolated due to a gap in the published data.

Figure SD-3 | **South Dakota Industry Fuel Use by Sector, 2006**



SOURCES: MECS; ASM.

manufacturing energy expenditures had increased by almost 400%, while the total value of shipments rose by only 8%, relative to year 2000 levels. Compared to other state profiles and national averages (see Figure 1 of this working paper), this result is difficult to explain and may indicate an artifact of the small sample size in the survey or another anomaly with the ASM data. Over the same 10-year period, South Dakota manufacturing employment dropped by 11%—from 44,000 to 39,200, compared to the national manufacturing employment decline of 37% over the same period (Figure 1).

Energy prices (Table SD-1) influence demand and end-use efficiency. Reported South Dakota delivered electricity and coal prices were 10% and 27% lower than the national average, respectively, while natural gas was 8% more expensive than the national average. Prices vary by end user and time of use, but this snapshot of 2010 prices suggests that South Dakota industry faces a mixed picture among different fuels.

In 2006 South Dakota manufacturing consumed 16 trillion Btu[SD-2] of energy for fuel use—the smallest amount of any state in the Midwest. Figure SD-3 shows the breakdown of South Dakota manufacturing fuel use by subsector. Food manufacturing accounted for 40% of South Dakota manufacturing fuel use in 2006.

South Dakota has a voluntary renewable energy standard, which gives credit for systems that produce electricity from waste heat. Although South Dakota does not have an energy efficiency resource standard, the Public Utilities Commission has partnered with utilities across the state to promote energy efficiency and has approved energy efficiency programs for several utilities.

SD-2 For energy unit conversion, 1,000 trillion Btu is equivalent to 1 Quad of energy.

Table SD-2 | South Dakota Key Energy and Environmental Policies

SOUTH DAKOTA	
REGULATORY ENVIRONMENT	
Renewable energy standard	South Dakota has a voluntary renewable, recycled, and conserved energy objective of 10% by 2015 of all retail electric sales in the state. SDCL § 49-34A-94 defines recycled energy as "systems that produce electricity from currently unused waste heat resulting from combustion or other processes and which do not use an additional combustion process" (ACEEE; DSIRE).
Energy efficiency resource standard	South Dakota does not currently have an EERS (ACEEE).
Emissions control programs	South Dakota does not have output-based emission standards (ACEEE).
Alternative business models	Although South Dakota does not have decoupling policies or programs in place, the Public Utilities Commission has authorized a lost revenue adjustment mechanism and performance incentives for several utilities with efficiency programs (ACEEE).
Grid access	In 2009 the PUC adopted four levels of interconnection standards for distributed generation, including CHP systems, with capacity ratings up to 10 MW. The rules adopt IEEE 1547 as technical standards (ACEEE; DSIRE).
FINANCIAL AND TECHNICAL ASSISTANCE	
Grants, loans	CHP systems are eligible for the no-interest Energy Efficiency Revolving Loan Program, which is available to schools, non-profits, and government agencies (DSIRE).
Tax incentives	The state exempts the greater of $50,000 or 70% of the assessed value of renewable energy systems, including CHP fueled by renewable resources, from property taxes.
Technical assistance	There are currently no technical assistance programs based in South Dakota.
UTILITY PROGRAMS	
Customer EE programs, with cost-recovery	The Public Utilities Commission (PUC) has approved efficiency programs for several utilities, which have made some rebates available for industrial efficiency (ACEEE; DSIRE). In 2010 the state energy efficiency program budget was $3.5 million for electricity and $1.4 million for gas. There are no opt-out or self-direct options (ACEEE).
EE as a resource	South Dakota has no policy in place that treats EE as a resource (ACEEE).

SOURCE: "ACEEE" refers to the American Council for an Energy Efficient Economy website: http://www.aceee.org/sector/state-policy(February, 2012).). "DSIRE" refers to the Database of State Incentives for Renewables and Energy Efficiency website: http://www.dsireusa.org. (February, 2012).

WISCONSIN

Figure WI-1 shows the breakdown of statewide energy used for fuel and feedstock. Industry consumed approximately one-third of Wisconsin energy in 2006, far more than any other major sector. Manufacturing accounted for two-thirds of Wisconsin's total industry energy use in the same year.

Paper, primary metals and transportation equipment accounted for the largest share of Wisconsin manufacturing energy use in 2006, followed by nonmetallic mineral products.

Wisconsin has 1.5 GW of total installed CHP capacity[WI-1], which is equivalent to 9% of total installed electricity generation capacity, versus the national average of 8%. Within total CHP, the remaining technical potential for industry CHP in Wisconsin is estimated to be more than three times currently installed industrial capacity (Hedman, 2010).

WI-1 This number is higher than the installed CHP capacity number in Figure 9 because it includes all CHP installations (i.e., industrial, commercial, and institutional).

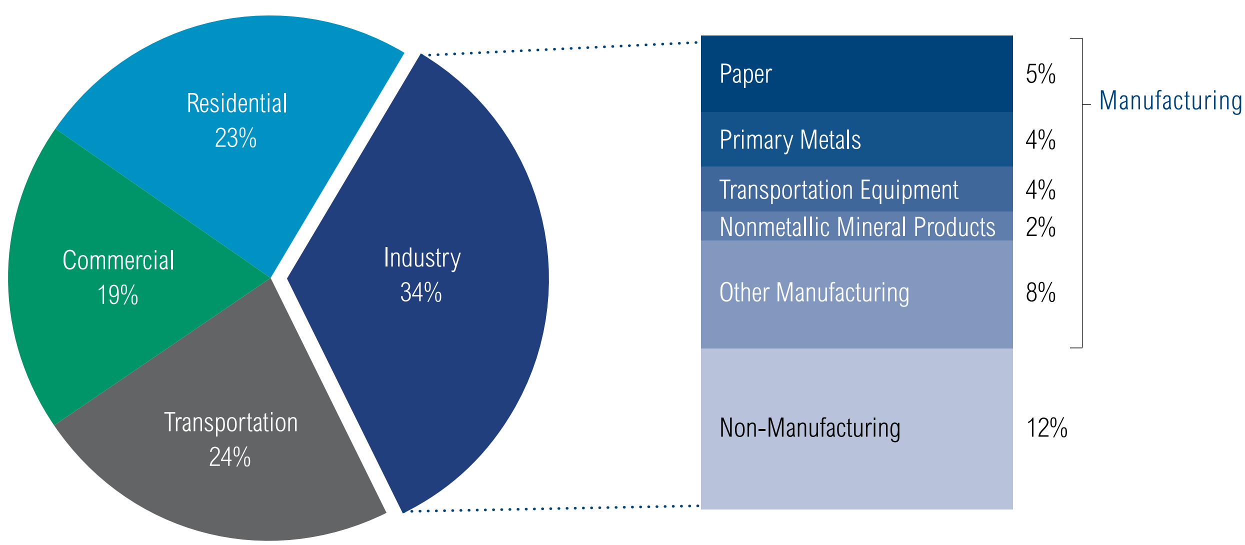
Manufacturing energy expenditures (shown by "cost of fuels & electricity" in Figure WI-2) in Wisconsin followed a national trend of peaking in 2008. Between 2000 and 2010, the index of manufacturing energy costs rose more quickly than the value of shipments index (Figure WI-2). The average difference between these two series over the period is 19%. By 2010 Wisconsin manufacturing energy expenditures had increased by 35%, while the total value of shipments rose by 14%, relative to year 2000 levels. Over the same 10-year period, Wisconsin manufacturing

Table WI-1 | **Wisconsin Industry Delivered Energy Annual Average Prices (2010)**

	ELECTRICITY (cents/kWh)	NATURAL GAS ($/1,000 ft³)	COAL ($/short ton)
Wisconsin	6.85	7.56	79.79
Midwest average	6.19	6.66	50.68
U.S. average	6.77	5.49	59.28

SOURCE: U.S. Energy Information Administration; for details see Appendix.

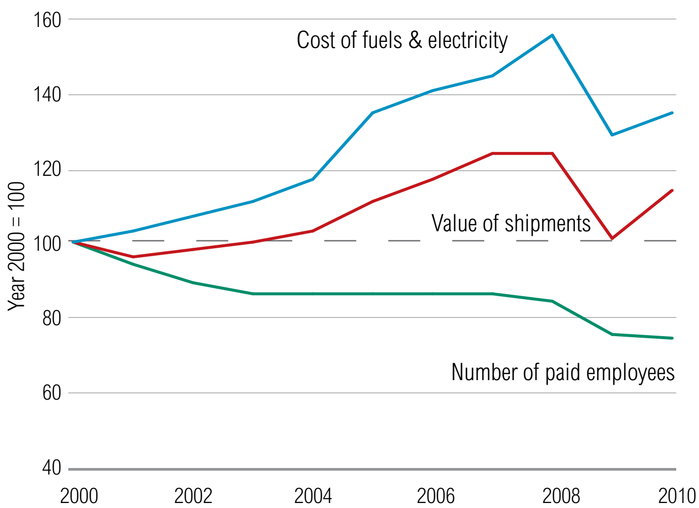
Figure WI-1 | **Wisconsin Total Energy Use, 2006**



Total Energy Use: 1.8 Quads

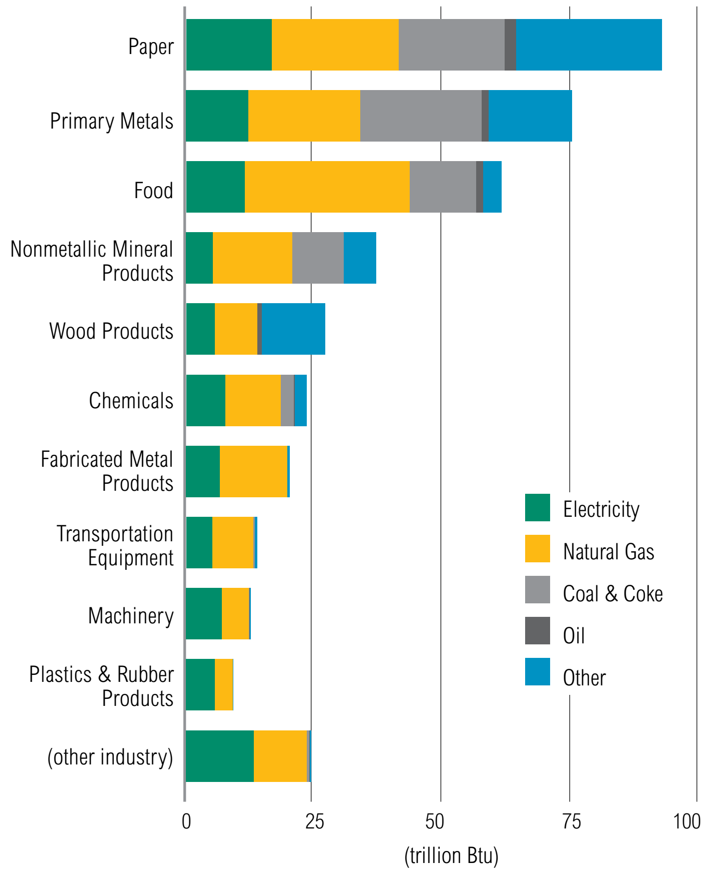
SOURCES: MECS; ASM; SEDS.

Figure WI-2 | **Index of Wisconsin Manufacturing Energy Cost, Value of Shipments, and Employment (2000-2010)**



SOURCE: ASM; BEA (employment)
NOTE: 2002 ASM values were linearly interpolated due to a gap in the published data.

Figure WI-3 | **Wisconsin Manufacturing Fuel Use by Sector, 2006**



SOURCES: MECS; ASM.

employment dropped by 26%—from 604,000 to 448,000, compared to the national manufacturing employment decline of 37% over the same period (Figure 1).

Energy prices (Table WI-1) influence demand and end-use efficiency. Energy is relatively expensive in Wisconsin—delivered natural gas and coal prices were 38% and 35% higher than the national average, and electricity was slightly more expensive than the national and regional average. Prices vary by end user and time of use, but this snapshot suggests that Wisconsin industry is subject to higher energy prices than the rest of the Midwest and the U.S.

In 2006 Wisconsin manufacturing consumed 410 trillion Btu[WI-2] of fuel. Figure SD-3 shows the breakdown of Wisconsin manufacturing fuel use by subsector. Natural gas was the most-consumed fuel for manufacturing. Paper and primary metals manufacturing sectors accounted for 42% of Wisconsin manufacturing fuel use in 2006.

In 2005, the Wisconsin Act 141 set up renewable and efficiency portfolio goals while establishing the state's energy efficiency program, Focus on Energy, which provides incentives for industrial energy efficiency. The Wisconsin Economic Development Corporation also funds a sustainability technical assistance program through the Wisconsin Manufacturing Extension Partnership.

WI-2 For energy unit conversion, 1,000 trillion Btu is equivalent to 1 Quad of energy.

Table WI-2 | Wisconsin Key Energy and Environmental Policies

WISCONSIN	
REGULATORY ENVIRONMENT	
Renewable energy standard	The Wisconsin Renewable Portfolio Standard does not allow energy efficiency technologies to qualify for compliance (DSIRE).
Energy efficiency resource standard	Wisconsin's Energy Efficiency Resource standard sets annual efficiency goals ramping up to 1.5% of peak load in 2014, for electric utilities, and 1% of peak load in 2013, for natural gas utilities. Focus on Energy implements programs to achieve these EE goals (ACEEE).
Emissions control programs	Under CAIR, Wisconsin permitted CHP systems under 25 MW to participate in a voluntary emissions-trading scheme (ACEEE).[a] These rules are to be phased out in 2012.[b]
Alternative business models	In 2008, the Wisconsin Public Service Corporation (PSC) received approval for a 4-year pilot decoupling program. In June 2011, the Wisconsin Electric Power Company received approval for a gas cost recovery mechanism (ACEEE).
Grid access	In 2004, the Wisconsin PSC established interconnection standards for investor-owned and municipal utilities. The standards apply to generators, including CHP systems, up to 15 MW (ACEEE; DSIRE).
FINANCIAL AND TECHNICAL ASSISTANCE	
Grants, loans, or tax incentives	The Wisconsin Green to Gold Fund, established in 2010, provides loans for manufacturers to improve the energy efficiency of their facilities (ACEEE).
Technical assistance	The Wisconsin Manufacturing Extension Partnership manages the Profitable Sustainability Initiative, which help small and midsized companies develop sustainable practices.[c] The University of Wisconsin-Milwaukee houses an Industrial Assessment Center, which provides qualified manufacturers with free assessments and recommendations to improve energy efficiency.[d]
UTILITY PROGRAMS	
Customer EE programs, with cost-recovery	Focus on Energy develops and administers customer energy efficiency programs, including industrial sector programs. A self-direct option exists for large customers. They must submit a plan for PSC approval, adhere to measurement and verification standards, and submit quarterly reports.[e]
EE as a resource	The PSC conducts "Strategic Energy Assessments" every 2 years for planning purposes (ACEEE).

SOURCE: "ACEEE" refers to the American Council for an Energy Efficient Economy website: http://www.aceee.org/sector/state-policy (February, 2012); "DSIRE" refers to the Database of State Incentives for Renewables and Energy Efficiency website: http://www.dsireusa.org. (February, 2012).

a http://www.epa.gov/chp/state-policy/obr_factsheet.html (February, 2012).

b The first compliance phase for CAIR's replacement, the Cross-State Air Pollution Rule (CSAPR), had been scheduled to go into effect in January 2012. In December 2011, the United States Court of Appeals for the D.C. Circuit stayed CSAPR and is scheduled to hear the case in April 2012. Meanwhile, EPA is facilitating a transition back to CAIR. http://epa.gov/airtransport/

c http://www.wmep.org/next-generation-manufacturing/sustainable-products-process-development (February, 2012).

d http://iac.uwm.edu/

e See more details on pages 48-49 of the following report: http://www.aceee.org/research-report/ie112. (February, 2012).

Section 5: Conclusions and Recommendations for Further Work

This snapshot of Midwestern manufacturing energy use and related policies and programs has three key takeaways:

- Manufacturing still plays an important role in the energy system and economy of the Midwest.
- Current public data can be combined to estimate state-level manufacturing energy use by subsector, which help stakeholders better understand where energy is being used, and by whom.
- State-level policies and programs are important for overcoming barriers to industrial energy efficiency investment. While most Midwestern states have active EE policies and programs in place, a rapidly evolving economic, energy, and regulatory picture presents new opportunities to revisit those policies.

For decades, manufacturing has declined in its importance to the U.S. economy. The past decade has seen historic job losses from the sector, particularly during the recent recession. However, manufacturing is leading the current economic recovery, and many government officials are turning their attention to economic development strategies that enable a renewed and resilient domestic manufacturing base.

As a result there is growing interest in using industrial energy efficiency to help advance Midwest economic recovery, job creation, and energy security. This paper uses detailed manufacturing energy-use and economic-activity data and state-by-state policy summaries to build an empirical foundation for understanding industry energy efficiency in the Midwest. These energy-use estimates help to address a gap in existing public sources, which do not provide manufacturing subsector-level detail on a state-by-state basis.

There is still room for improvement. In order to develop robust, specific, and reliable metrics of Midwest industry energy efficiency and related policies, further work is needed to reconcile bottom-up and top-down data sources, the latter of which were used for this study. Additionally, researchers must assess the full scale and economic implications of EE potential across the entire MW region and to identify which policy reforms would garner the broadest stakeholder support while yielding the best economic, social, and environmental outcomes. In our subsequent work, we will build on this report to help answer these and related policy-relevant questions.

APPENDIX: DATA AND METHODS

Data sources

Bureau of Economic Analysis, U.S. Department of Commerce (http://www.bea.gov/regional/gsp/).

EIA, State Energy Data System (http://www.eia.gov/state/seds/seds-data-complete.cfm#data) (February, 2012).

EIA, Manufacturing Energy Consumption Survey (http://www.eia.gov/emeu/mecs/mecs2006/2006tables.html) (February, 2012).

ICF International, 2010. Combined Heat and Power Installation Database (http://www.eea-inc.com/chpdata/).(February, 2012).

ORNL. 2008. "Combined Heat and Power: Effective Strategies for a Sustainable Future," ORNL Report 2008/224 (http://info.ornl.gov/sites/publications/files/Pub13655.pdf; (February, 2012)).

US Census, American Survey of Manufacturers (http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml; (February, 2012)).

US Census, 2007 Economic Census (http://factfinder2.census.gov/faces/nav/jsf/pages/index.xhtml; (February, 2012)).

All energy price data used in the state profile tables are from the Energy Information Administration. Electricity data are from http://205.254.135.7/electricity/sales_revenue_price/pdf/table4.pdf (February, 2012); natural gas data are from http://205.254.135.7/dnav/ng/ng_pri_sum_a_EPG0_PIN_DMcf_a.htm (February, 2012); and coal data are from EIA Report 0584 (2010), Table 34 (http://205.254.135.7/coal/annual/pdf/table34.pdf) (February, 2012). As noted in their respective state profiles, Kansas and South Dakota are the exceptions because the EIA withheld 2010 industry coal price data for these states. As a result, for Kansas and South Dakota, electric utility coal price data are displayed instead of industry coal price data.

Methods

This working paper estimates manufacturing subsector energy use for all 12 states in the Midwest region (as defined by the U.S. Census). Detailed results of these estimates are presented at the state-level for the 10 states in the MGA.

These results are estimated based on subsector-level MECS data, for Midwest manufacturing energy use, in combination with state-level manufacturing subsector value-added data from the ASM. Value-added data were used rather than value of shipments because they track physical energy-use data more closely.

First, regional-level MECS intensity coefficients (Btus per dollar of value added; Table 6.1) were applied to MECS subsector-level total fuel use (Btus; Table 3.2) to derive regional value added for each subsector, based on the MECS. Then, the derived MECS value added estimates are used to calculate regional-level intensity coefficients for each fuel type, at the NAICS three-digit subsector level. Finally, assuming homogenous regional fuel use within each manufacturing subsector, these derived intensity coefficients were applied to state-level ASM value added data to estimate, for example, the total energy use by fuel type for chemicals manufactured in Illinois, in 2006. This procedure is illustrated by the following equation:

$$\textit{Industry sector energy use}_{(state)} = \left(\frac{\textit{MidW energy use}_{(sector)}}{\textit{MidW VA}_{(sector)}}\right)\left(\textit{Sector VA}_{(state)}\right)$$

MidW: Midwest region
VA: Value Added (per subsector)

The method described above allows for new information—state-level manufacturing subsector energy use, by fuel—to be estimated based on publicly available MECS and ASM data. The drawback of using ASM data to disaggregate regional MECS fuel-use data is that it requires the assumption of homogenous energy intensity per subsector among all states (e.g., the same amount of energy use per dollar of value added in Ohio and Wisconsin paper production). This is a necessary result of using top-down energy-use and value-added data.

A comprehensive bottom-up approach to quantifying manufacturing subsector energy use (total and by fuel type) at the state-level is not possible based on public data, because physical energy use data are not available at the state- or facility-level. While these data may be collected for the purpose of conducting government surveys (e.g., for the ASM, MECS and the Economic Census), such facility-level data are not publically disclosed.

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GLOSSARY AND ABBREVIATIONS

Boiler MACT The Boiler Maximum Achievable Control Technology rules are under consideration by the Environmental Protection Agency for regulation of industrial, commercial, and institutional boiler emissions.

Btu The British thermal unit (sometimes BTU) is a traditional unit of energy equal to 1,055 joules. It is the amount of energy needed to heat 1 pound (0.454 kg) of water, which is exactly one-tenth of a UK gallon or about 0.1198 US gallons, from 39°F to 40°F (3.8°C to 4.4°C).

CAIR On March 10, 2005, EPA issued the Clean Air Interstate Rule, which was designed to permanently cap emissions of sulfur dioxide (SO_2) and nitrogen oxides (NO_x) in the eastern United States. CAIR was designed to achieve large reductions of SO_2 and/or NO_x emissions across 28 eastern states and the District of Columbia. A December 2008 court decision directed EPA to develop a new rule to replace CAIR, with CAIR remaining in effect until the new rule was put into place. The first compliance phase for CAIR's replacement, the Cross-State Air Pollution Rule (CSAPR), was scheduled to go into effect in January 2012. In December 2011, the Court of Appeals stayed the new rule, leaving CAIR in effect until a court ruling on CSAPR.

CHP Combined heat and power; for more information, see Box 4: The Industrial Application of Combined Heat and Power.

CSAPR On July 6, 2011, the US Environmental Protection Agency (EPA) finalized the Cross-State Air Pollution Rule. The rule requires states to significantly improve air quality by reducing power plant emissions that contribute to ozone and/or fine particle pollution in other states. The first compliance phase for CSAPR was scheduled to go into effect in January 2012. In December 2011, the Court of Appeals stayed the rule, leaving CAIR in effect until a court ruling on CSAPR.

EIA Energy Information Administration. An independent statistical agency of the U.S. Department of Energy. See http://eia.gov.

GDP Gross domestic product. The total value of goods and services produced by labor and property located in a given country.

kWh A kilowatt hour is a unit of energy equivalent to 3.6 megajoules; it is the amount of energy converted if work is performed at a rate of one thousand watts for one hour. The kilowatt hour is commonly used as a billing unit for electricity delivered to consumers by electric utilities.

MW A megawatt is equivalent to one million (10^6) watts. A watt is a unit of power or energy conversion equivalent to one joule per second.

MWh A megawatt hour is a unit of energy equivalent to 1,000 kWh.

NAICS The North American Industry Classification System (NAICS) is the standard used by federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the US business economy. The NAICS was developed under the auspices of the Office of Management and Budget (OMB) and adopted in 1997 to replace the Standard Industrial Classification (SIC) system; the current system was updated in 2007.

OBES Output-based emissions standards, otherwise known as output-based environmental regulations (OBR), encourage energy efficiency and clean energy supply such as combined heat and power (CHP) by relating emissions to the productive output of the energy-consuming process. The goal of OBES is to encourage the use of fuel conversion efficiency as an air pollution control measure.

Quad An energy unit equivalent to 10^{15} Btu; total U.S. energy use has recently been a bit less than 100 Quads. 1 Quad of energy is equivalent to 1,000 trillion Btu.

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About the Great Plains Institute

Great Plains Institute (GPI) is a nonpartisan 501(c)3 nonprofit corporation based in Minneapolis. Our mission is to achieve an energy system that is increasingly clean, affordable, secure and sustainable. We accomplish this mission by proactively engaging leaders from government, public policy, business, academia, and advocacy groups to develop consensus—then action—on policies, technologies and practices that will accelerate this clean energy transition.

About the Energy Resources Center

The Energy Resources Center (ERC) located at the University of Illinois at Chicago is an interdisciplinary public service, research, and special projects organization (located in the College of Engineering) dedicated to improving energy efficiency and the environment. It was established in the College of Engineering in 1973 by the Board of Trustees as an approved Illinois Board of Higher Education center with the mandate to conduct studies in the fields of energy and environment and to provide industry, utilities, government agencies and the public with assistance, information, and advice on new technologies, public policy, and professional development training. The ERC was created to have the capability of conducting traditional research in the area of energy and as a "fast response" team of experts capable of quickly extending technical expertise, advice, and professional assistance to organizations in need of the Center's resources.

About the Midwestern Governors Association

The Midwestern Governors Association (MGA) is a nonprofit, bipartisan organization that brings together governors and their staff to work cooperatively on public policy issues of significance to the region. The MGA provides governors with the opportunity to foster regional development, attain greater efficiency in state administration, coordinate a regional agenda before Congress and the Federal government and facilitate the exchange of views and experiences on subjects of importance to the people of Midwestern states.

The region's governors offer practical approaches to issues that often serve as catalysts for national strategies and solutions. With regional concerns and objectives in mind, the MGA focuses its efforts on three main policy areas: agriculture, economic development, and energy.

The MGA was created in December 1962 and its current members include the governors of the ten Midwestern states. Its efforts are led by the Executive Committee, which consists of the Chair, Vice Chair and Immediate Past Chair of the association. The governors serving in these positions are nominated and elected by their fellow Midwestern governors at the MGA's Winter Meeting in February.

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The World Resources Institute is a global environmental think tank that goes beyond research to put ideas into action. We work with governments, companies, and civil society to build solutions to urgent environmental challenges. WRI's transformative ideas protect the Earth and promote development because sustainability is essential to meeting human needs and fulfilling human aspirations in the future.

WRI spurs progress by providing practical strategies for change and effective tools to implement them. We measure our success in the form of new policies, products, and practices that shift the ways governments work, companies operate, and people act.

We operate globally because today's problems know no boundaries. We are avid communicators because people everywhere are inspired by ideas, empowered by knowledge, and moved to change by greater understanding. We provide innovative paths to a sustainable planet through work that is accurate, fair, and independent.

WRI organizes its work around four key goals:

People & Ecosystems: Reverse rapid degradation of ecosystems and assure their capacity to provide humans with needed goods and services.

Governance: Empower people and strengthen institutions to foster environmentally sound and socially equitable decision-making.

Climate Protection: Protect the global climate system from further harm due to emissions of greenhouse gases and help humanity and the natural world adapt to unavoidable climate change.

Markets & Enterprise: Harness markets and enterprise to expand economic opportunity and protect the environment.

In all its policy research and work with institutions, WRI tries to build bridges between ideas and action, meshing the insights of scientific research, economic and institutional analyses, and practical experience with the need for open and participatory decision-making.

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