U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

INDUSTRIAL TECHNOLOGIES PROGRAM

Energy Efficiency as a Resource: Midwest Region

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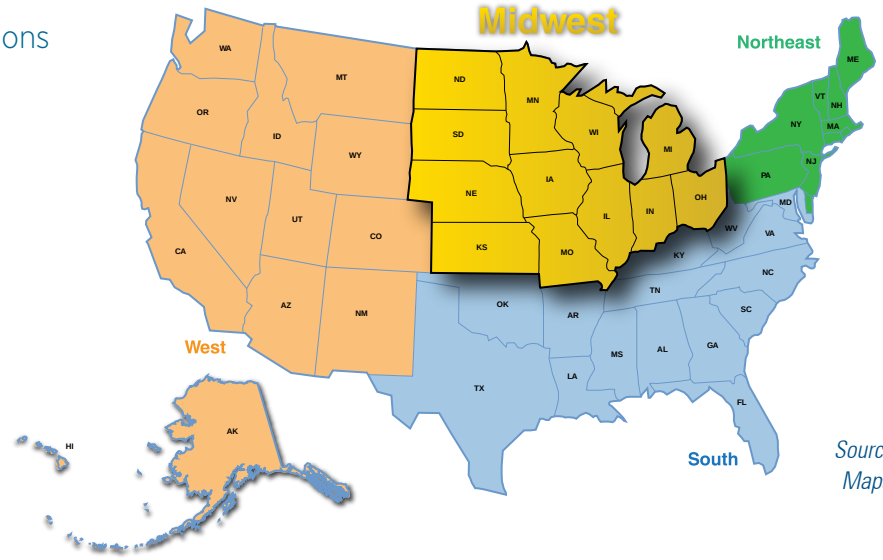
Exhibit 1:
U.S. Census Regions



Source: Stats Indiana, Boundary Maps. www.stats.indiana.edu/maptools/boundary.asp.

1. Midwest Region Energy Intensity

The Midwestern United States is one of four regions defined by the U.S. Census Bureau (Exhibit 1), composed of the following states:

- Illinois
- Indiana
- Iowa
- Kansas
- Michigan
- Minnesota
- Missouri
- Nebraska
- North Dakota
- Ohio
- South Dakota
- Wisconsin

This region leads the nation in terms of value of shipments in many important manufacturing sectors. In 2006, these leading industries included food, leather and allied product, printing and related activities, primary metal, fabricated metal product, machinery, and transportation equipment manufacturing. Exhibit 2 provides value of shipment data for the four census regions that make up the U.S. manufacturing sector. Highlighted rows are where the Midwest leads the nation in product shipments.

Despite leading the country in value of shipments within the sectors listed above, the Midwest has significantly higher energy intensities* compared to the national average in six of these seven sectors. These sectors include food, leather, primary metals, fabricated metals, machinery, and transportation equipment products. Exhibit 3 details the relative energy intensity of five of these industries compared to the national average.+

Exhibit 2: 2006 Value of Shipments across Each Census Regions

NAICS Code	Manufacturing Sector Description	Value of Shipments by Census Region ($1,000s)			
		Midwest	Northeast	South	West
311	Food	$204,666,920	$65,793,261	$167,671,682	$98,574,804
312	Beverage & Tobacco Products	$17,311,076	$10,376,689	$67,096,187	$24,179,977
313	Textile Mills	$1,098,299	$4,963,887	$27,712,405	$1,970,605

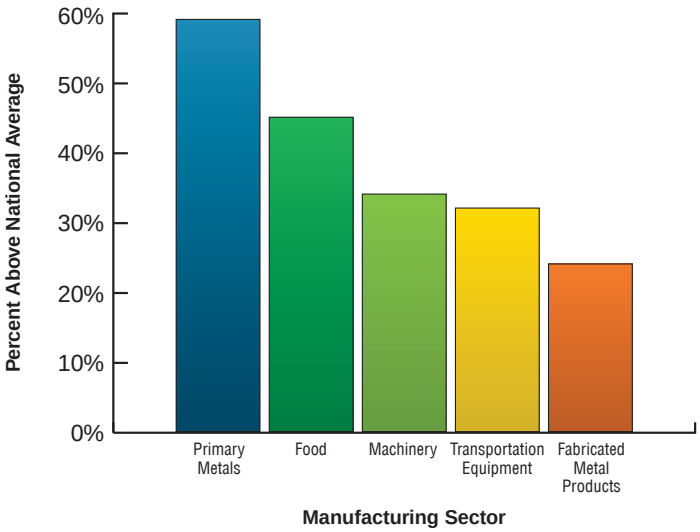
* Energy intensity is the measure of energy consumed, in British Thermal Units (Btu), per dollar of gross domestic product (GDP) earned. GDP is equivalent to the value added to a manufactured good.

\+ Leather and allied products manufacture is not included in this study because there were large gaps in data reported for Michigan by the U.S. Census Bureau, making the energy intensity results statistically incorrect.

NAICS Code	Manufacturing Sector Description	Value of Shipments by Census Region ($1,000s)			
		Midwest	Northeast	South	West
314	Textile Product Mills	$2,735,095	$3,349,553	$22,290,390	$3,322,493
315	Apparel	$1,613,014	$6,799,668	$9,979,108	$10,774,562
316	Leather & Allied Products	$1,416,708	$1,144,563	$689,199	$832,329
321	Wood Products	$23,771,713	$11,108,678	$48,983,012	$28,098,923
322	Paper	$47,115,379	$28,350,897	$69,716,583	$20,686,685
323	Printing & Related Activities	$35,013,054	$21,770,053	$25,769,420	$16,141,181
324	Petroleum & Coal Products	$81,870,541	$46,307,975	$275,272,040	$91,124,660
325	Chemicals	$138,746,405	$122,465,240	$342,698,414	$51,185,822
326	Plastic & Rubber Products	$75,452,678	$29,422,093	$79,933,459	$26,167,217
327	Nonmetallic Mineral Products	$32,037,818	$17,491,499	$50,065,523	$25,597,119
331	Primary Metals	$92,601,422	$40,650,773	$77,814,960	$21,484,148
332	Fabricated Metal Products	$118,929,503	$52,537,662	$99,115,323	$46,303,596
333	Machinery	$143,226,056	$44,898,571	$104,749,626	$33,294,459
334	Computer & Electronic Products	$62,566,287	$64,150,714	$118,927,414	$144,802,804
335	Electrical Equipment & Appliances	$43,387,114	$19,417,128	$44,584,064	$11,071,376
336	Transportation Equipment	$331,468,454	$45,738,269	$225,728,247	$95,807,598
337	Furniture	$27,548,271	$10,243,628	$32,353,880	$14,888,967
339	Miscellaneous	$37,948,982	$37,022,053	$34,738,984	$39,342,698

Source: U.S. Census Bureau, 2006 Annual Survey of Manufactures, Stats for All Mfg by State. http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=EAS&_tabId=EAS1&_submenuId=datasets_5&_lang=en&_ts=266925692376.

Exhibit 3: 2006 Midwest Energy Intensity Compared to National Average



Sources: U.S. Census Bureau, 2006 Annual Survey of Manufactures, Stats for All Mfg by State. http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=EAS&_tabId=EAS1&_submenuId=datasets_5&_lang=en&_ts=266925692376. Energy Information Administration, 2006 Manufacturing Energy Consumption Survey, Table 1.2. www.eia.doe.gov/emeu/mecs/mecs2006/2006tables.html.

Much of this high energy intensity is a result of lower-than-average energy prices across the Midwest region, as compared with the other three regions (Exhibit 4). The average energy prices used in Exhibit 4 reflect the full range of fuels, including coal, natural gas, petroleum, and biomass. This lower price is the result of high concentrations of coal-fired electricity within the Midwest region and neighboring states that supply electricity to the Midwest. Additionally, natural gas prices in 2006 were near the national average, which is considerably lower than gas prices in some regions — most notably the Northeast.[1] Lower energy prices tend to promote greater energy consumption. Also, energy-intensive industries will seek to operate in geographical regions where energy prices are low, leading to higher energy intensities across the region.

Another contributing factor to higher energy intensity in many of these Midwestern manufacturing sectors is relatively low shipment values compared to national average shipment values. All other things being equal, a product that has a lower shipment value will have a higher energy intensity. This is due to the influence of GDP on both energy intensity and the relative value of shipments for a given product. Even with relatively low value products, the Midwest has the potential to significantly lower its energy intensity. The Midwest's lower value products compared to national average product values — as evidenced by the "GDP: Material Inputs" ratio (Appendices A and B) — do not justify the much higher energy intensities for Midwest products. This concept is further supported by details in each of the following sections of this report.

Harnessing energy efficiency as a resource will provide the Midwest with an energy source alternative to the historical approach of solely increasing energy supply. Reducing energy consumption will save manufacturers money in the short term by reducing monthly energy bills. Long-term energy cost-savings will also result from investments in energy efficiency rather than energy supply. The adoption of energy efficiency technologies is highly dependent on avoided costs by consumers and utilities. When avoided costs are greater than the cost of energy efficiency technologies, adopting these technologies will become a more attractive option for industrial energy consumers. When avoided costs are lower than the cost of implementing the energy efficiency

Exhibit 4: 2006 Regional Average Industrial Energy Prices

Region	Average Industrial Sector Energy Price ($/Million Btu)
Midwest	$10.85
Northeast	$13.51
South	$10.99
West	$12.72

Source: Energy Information Administration, State Energy Data System, Tables S6 and S4a, November 2008. www.eia.doe.gov/emeu/states/_seds.html.

technologies, however, customers will find more value in simply consuming the energy without investing in these technologies. In addition, energy prices are the most significant point of reference in considering cost avoidance. Electricity and natural gas prices are especially important because these energy sources are the most widely used. These prices vary greatly depending on geographic location and must be considered on a regional and state basis. Energy costs will lower by reducing the amount of energy generation and transmission that occurs. Furthermore, pending carbon legislation in the United States also proposes the reduction of energy supply value compared to energy demand savings over the long term as the pending legislation would increase the price of energy and the cost of using energy.

Aggregating the short- and long-term energy savings means a more profitable and competitive Midwestern industrial manufacturing sector, both now and in the future. Additionally, investing in energy efficiency will insulate Midwest industry from fossil energy price volatility and shocks, such as Hurricane Katrina's effect on natural gas prices in 2005 and 2006. For utilities, using energy efficiency instead of traditional energy supply means energy needs can be met by making small, incremental investments in energy efficiency rather than large, risky investments in energy supply. Pending carbon legislation would further increase the need for non-emitting energy resources that would be increasingly expensive for utilities to own and operate. Meeting state and national energy consumption and greenhouse gas emissions goals will also become increasingly important.

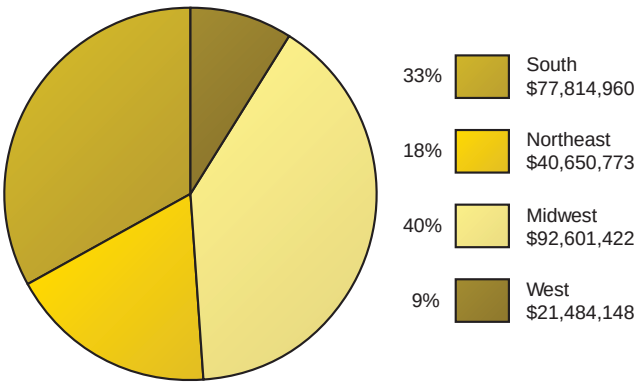
This report will detail five leading Midwest manufacturing sectors in terms of value of shipments with significantly higher-than-average energy intensities. These sectors are primary metal products, food, machinery, transportation, and fabricated metal products. The report will provide detailed information on manufacturing industry subsectors and identify key energy-saving opportunities. Based on 2006 U.S. Census Bureau ("Census") and Energy Information Administration (EIA) data, the five Midwest manufacturing subsectors could have reduced energy consumption by 670 trillion Btu[ψ] and saved approximately $7.3 billion§ in energy costs during 2006 at the $10.85 per million Btu price level. See Appendices A and B for detailed energy-consumption data.

1.1. Primary Metal Products Manufacture (NAICS 331)

The Midwest has long been associated with providing the nation's machinery and transportation needs. Most notable is its historical involvement in automobile

Exhibit 5: 2006 National Primary Metal Product Shipments

(IN THOUSANDS OF DOLLARS)



Source: U.S. Census Bureau, 2006 Annual Survey of Manufactures, Stats for All Mfg by State. http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=EAS&_tabId=EAS1&_submenuId=datasets_5&_lang=en&_ts=266925692376.

ψ Potential energy savings is determined by: Energy Consumed - Energy Consumed / (1 + Percent Difference of Midwest Energy Intensity from National Average) = Energy Savings Potential. This estimate is used throughout the report.

§ Potential cost savings are determined by: Energy Savings Potential x $10.85 per Million Btu = Cost Savings. This savings assumes an average Midwest energy cost of $10.85 per million Btu as illustrated in Exhibit 4. This estimate is used throughout the report.

Exhibit 6: 2006 Midwestern Primary Metal Manufacture Summary

Description (NAICS Code)	Percentage of Total Shipments	Estimated Midwest Energy Intensity (Btu/$GDP)	Estimated National Energy Intensity (Btu/$GDP)	Percent Above National Average
Primary Metal Products (331)	100.0%	32,419	20,393	59.0%
Iron and Steel Mills and Ferroalloy (3311)	40.8%	79,719	33,229	139.9%
Foundries (3315)	20.1%	10,418	8,961	16.3%
Nonferrous, Non-Aluminum Metals (3314)	12.0%	13,266	7,899	67.9%
Alumina and Aluminum Production (3313)	10.8%	17,606	22,889	-23.1%
Steel Product Manufacturing from Purchased Steel (3312)	8.4%	6,782	5,930	14.4%

Note: Subsector percentages may not total to 100 percent due to census data withholding. Some subsectors may not be shown because of incomplete data. See Appendix A for more detailed Midwest data and Appendix B for more detailed national data. Appendices A and B also contain additional notes on data.

manufacturing. Machinery- and transportation-equipment manufacturing requires feedstock upstream of the finished products, such as cast engine transmission housings, forged connecting rods, and a variety of other metal components. Illinois, Indiana, and Ohio led the region in producing primary metal products in 2006.[2] The Midwest produced 40 percent of the nation's primary metal shipments in 2006 (Exhibit 5).

The Midwest's primary metal production is the aggregate of subsectors, which include iron, steel, ferroalloy, aluminum, and nonferrous alloy manufacturing and processing, as well as metal casting. Iron, steel, and ferroalloy production and metal casting subsectors make up over 60 percent of the Midwest's primary metal manufacturing shipments. Exhibit 6 provides information about the Midwest's primary metal manufacturing subsectors. Information includes the percentage of subsector shipments as part of the larger primary metal manufacture shipments, energy intensity, and GDP–Material Input ratio.**

As a whole, the Midwest primary metals manufacturing sector uses 59 percent more energy to produce one dollar of GDP when compared to the national average for this sector. The vast majority of this disparity in energy intensity is due to the iron, steel, and ferroalloy manufacture. This Midwestern subsector has more than twice the energy intensity of the national average for the subsector. Other manufacturing subsectors have energy intensities much more in line with the national averages. Midwestern aluminum manufacturing actually uses 23 percent less energy to produce one dollar of GDP when compared to the national average.

** The *GDP–Material Input* ratio is an important measure for determining the relative value of unit product shipment in the Midwestern region compared to the national average. Most importantly for this analysis, this ratio has an impact on energy intensity because energy intensity is a rate of energy use per dollar of GDP. When the *GDP–Material Input* ratio is lower than the national average, this indicates that energy intensity is artificially high due to relatively lower shipment value. The inverse is also true.

Exhibit 7: Primary Metal *GDP–Material Input* Ratio

Description (NAICS Code)	Midwest *GDP–Material* Input Ratio	National *GDP–Material* Input Ratio
Primary Metal Products (331)	0.48	0.55
Iron and Steel Mills and Ferroalloy (3311)	0.34	0.58
Foundries (3315)	1.03	1.1
Nonferrous, Non-Aluminum Metals (3314)	0.33	0.39
Alumina and Aluminum Production (3313)	0.42	0.39
Steel Product Manufacturing from Purchased Steel (3312)	0.51	0.58

See Appendix A for more detailed Midwest data and Appendix B for more detailed national data.

See Appendix A for more detailed Midwest data and Appendix B for more detailed national data.
A portion of the high energy intensity is a result of the relatively low product value of Midwestern primary metal shipments. This fact is especially evident in the disparity between Midwest and national iron, steel, and ferroalloy *GDP–Material Input* ratios. Despite this product value disparity, the Midwest primary metals industry uses significantly more energy to produce its products compared to the rest of the nation. This can be seen in the fact that the percentage difference in the Midwest and national *GDP–Material Input* ratios is smaller than the difference in their energy intensities.

If the Midwest primary metals sector used energy at the same rate as the rest of the nation, the region could have reduced its consumption from 972 to 611 trillion Btu in 2006. This 361-trillion Btu energy-consumption reduction is approximately equivalent to the annual energy required to heat 6.4 million households in the United States.[3] The reduction in energy consumption would also have yielded approximately $3.9 billion in production cost-savings for the Midwest primary metals industry.

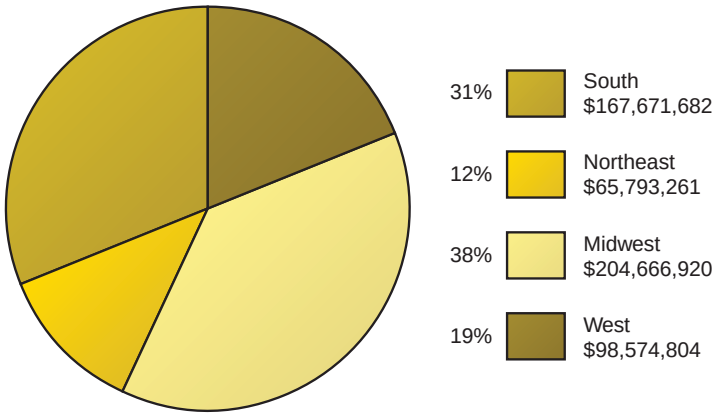
1.2. Food Manufacture (NAICS 311)

The Midwest is anecdotally called the nation's "breadbasket," growing or raising much of the food that the United States consumes. Consequently, the Midwest is also engaged in the processing of raw grains, fruits, vegetables, and livestock grown and raised in the region. This manufacture ranges from slaughtering cows for beef to turning milk into

cheese to baking bread. Illinois, Iowa, Nebraska, and Wisconsin were the region's largest contributing states in 2006.[4] The Midwest region as a whole was responsible for roughly 38 percent of the nation's manufactured food shipments in 2006 (Exhibit 8).

Exhibit 8: 2006 National Manufactured Food Product Shipments

(IN THOUSANDS OF DOLLARS)



Source: U.S. Census Bureau, 2006 Annual Survey of Manufactures, Stats for All Mfg by State. http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=EAS&_tabId=EAS1&_submenuId=datasets_5&_lang=en&_ts=266925692376.

Midwest food manufacturing is composed of several subsectors. Animal slaughtering, grain and oilseed milling, and dairy product manufacture make up 64 percent of the Midwest's manufactured food shipments. Exhibit 9 provides information about the Midwest's food manufacturing subsectors.

The aggregated Midwest food manufacturing sector has an energy intensity that is nearly 45 percent higher than the national average. Animal slaughtering, the Midwest's top food manufacturing subsector, has an energy intensity that is roughly 60 percent higher than the national average, while grain and oilseed milling has an energy intensity 27 percent higher than the national average. However, dairy manufacture in the Midwest has an energy intensity that is 7 percent lower than the national average.

Part of this high energy intensity in the food industry as a whole, and in the animal slaughtering and grain and oilseed milling subsectors, is due to the relatively low value of shipments. This is indicated by the disparity between Midwest and national *GDP–Material Input* ratios. Relatively low product value results in lower GDP, which then results in higher energy intensity when compared to the national average. Nonetheless, the disparity in shipment value only accounts for a portion of the high energy intensity. This can be seen in the fact that the percentage difference in the Midwest and national *GDP–Material Input* ratios is smaller than the difference in their energy intensities.

Exhibit 9: 2006 Midwestern Food Manufacture Summary

Description (NAICS Code)	Percentage of Total Shipments	Estimated Midwest Energy Intensity (Btu/$GDP)	Estimated National Energy Intensity (Btu/$GDP)	Percent Above National Average
Food (311)	100.0%	7,349	5,081	44.6%
Animal Slaughtering (3116)	31.3%	6,836	4,300	59.0%
Grain & Oilseed (3112)	17.5%	20,156	15,870	27.0%
Dairy Products (3115)	15.2%	4,662	5,012	-7.0%

Note: Subsector percentages may not total to 100 percent due to census data withholding. Some subsectors may not be shown because of incomplete data. See Appendix A for more detailed Midwest data and Appendix B for more detailed national data. Appendices A and B also contain additional notes on data.

Exhibit 10: Food *GDP–Material Input* Ratio

Description (NAICS Code)	Midwest *GDP–Material* Input Ratio	National *GDP–Material* Input Ratio
Food (311)	0.60	0.77
Animal Slaughtering (3116)	0.34	0.55
Grain & Oilseed (3112)	0.54	0.54
Dairy Products (3115)	0.45	0.47
Other (3119)	1.18	1.25
Fruit & Vegetable Preserving (3114)	0.93	0.98
Bakeries (3118)	1.77	1.74
Animal Food (3111)	0.98	0.74
Sugar & Confectionary (3113)	1.14	1.25

See Appendix A for more detailed Midwest data and Appendix B for more detailed national data.

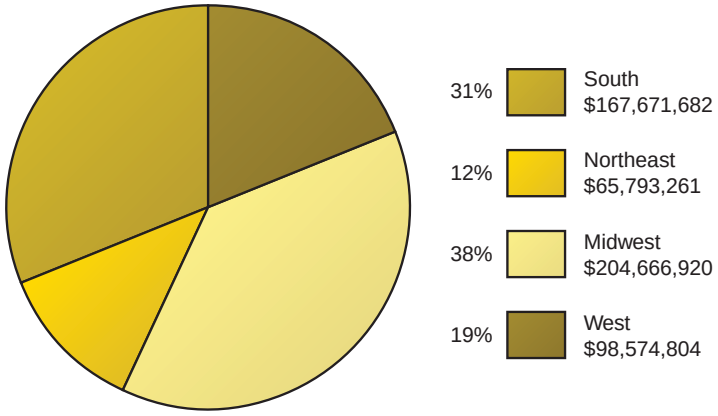
The remainder of the high energy intensity in the Midwest's food sector and related subsectors is due to inefficient use of energy. If the Midwest food manufacturers operated with the national average energy intensity, it would have consumed 393 trillion Btu instead of 568 trillion Btu to produce the same amount of goods in 2006. This 175-trillion Btu reduction in energy consumption would have avoided the need for approximately 15 500 megawatt power plants.± These energy savings would have yielded approximately $1.9 billion in savings that year.

1.3. Machinery Manufacture (NAICS 333)

Midwest states are historically associated with machinery manufacture. Machinery ranges from tractors for agriculture to milling machines for machine shops to equipment for heating, ventilation, and air conditioning equipment. This historical trend of machinery manufacture continued with Illinois, Indiana, Iowa, Michigan, Ohio, and Wisconsin leading the region in 2006.[5] Additionally, the Midwest shipped 44 percent of the total value of national machinery shipments in 2006 (Exhibit 11).

Exhibit 11: 2006 National Machinery Product Shipments

(IN THOUSANDS OF DOLLARS)



Source: U.S. Census Bureau, 2006 Annual Survey of Manufactures, Stats for All Mfg by State. http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=EAS&_tabId=EAS1&_submenuId=datasets_5&_lang=en&_ts=266925692376.

± Assuming 80 percent capacity: (0.8)*(500 MW)*(365 days)*(24 hours)*(10^3) = 3,504,000,000 kWh. (3,504,000,000 kWh)*(3412) = 12 trillion Btu per power plant. (175 trillion Btu)/(12 trillion Btu) = 14.6 power plants.

Exhibit 12: 2006 Midwestern Machinery Manufacture Summary

Description (NAICS Code)	Percentage of Total Shipments	Estimated Midwest Energy Intensity (Btu/$GDP)	Estimated National Energy Intensity (Btu/$GDP)	Percent Above National Average
Machinery (333)	100.0%	1,766	1,321	33.7%

Note: Subsector percentages may not total to 100 percent due to census data withholding. Some subsectors may not be shown because of incomplete data. See Appendix A for more detailed Midwest data and Appendix B for more detailed national data. Appendices A and B also contain additional notes on data.

The larger machinery manufacturing sector is further broken down into a variety of subsectors. The Midwest is most heavily involved in agricultural, construction, and mining machinery, followed by miscellaneous machinery and engine, turbine, and power transmission equipment. These subsectors contribute 67 percent of the Midwest's total machinery shipments. Exhibit 12 provides a comprehensive summary of machinery manufacture subsectors.

The machinery manufacturing sector as a whole consumes nearly 34 percent more energy per dollar of GDP compared to the national average for this sector. [¥]

The vast majority of the machinery manufacturing energy intensity is a result of inefficient energy use because the *GDP–Material Input* ratio for the Midwest is nearly at parity with the nation. This indicates that the Midwest products are of equivalent value to the national average; thus, the energy intensities should be the same for the Midwest and national average. Nonetheless, there are a couple of Midwest subsectors whose energy intensity may suffer from low-value products, most notably engine, turbine, and power transmission equipment, along with industrial machinery.

Exhibit 13: Machinery *GDP–Material Input* Ratio

Description (NAICS Code)	Midwest *GDP–Material Input* Ratio	National *GDP–Material Input* Ratio
Machinery (333)	0.84	0.88
Agriculture, Construction & Mining Machinery (3331)	0.7	0.7
Other Machinery (3339)	0.95	0.96
Engine, Turbine & Power Transmission Equipment (3336)	0.47	0.56
Metalworking Machinery (3335)	1.58	1.44
HVAC Equipment (3334)	0.93	0.96
Commercial & Service Machinery (3333)	1.22	1.15

See Appendix A for more detailed Midwest data and Appendix B for more detailed national data.

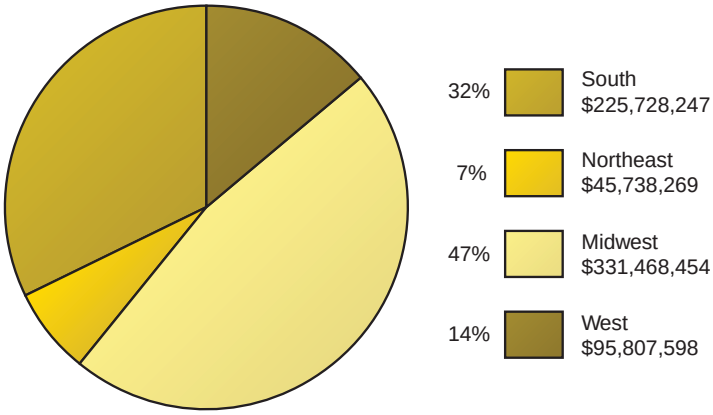
The Midwest consumed 116 trillion Btu during the manufacture of machinery in 2006. If the Midwest had the same energy intensity as the rest of the nation in this sector it would have consumed 87 trillion Btu. This difference of 29 trillion Btu would be approximately equivalent to the energy produced by 1,748 1.5 megawatt wind turbines and would have saved machinery manufacturers approximately $314.7 million in 2006.[6]

1.4. Transportation Equipment Manufacture (NAICS 336)

Detroit, Michigan, in the heart of the Midwest, has long been nicknamed "Motor City." During 2006, the Midwest — specifically Michigan, followed by Ohio and Indiana —remained the nation's premier transportation equipment manufacturer. Cars, trucks, and their related parts make up the largest component of Midwest transportation equipment manufacture, but the Midwest is also engaged in aerospace and boat manufacture. In 2006, the Midwest produced 47 percent of the nation's transportation product shipments (Exhibit 14).

Exhibit 14: 2006 National Transportation Equipment Product Shipments

(IN THOUSANDS OF DOLLARS)



Source: U.S. Census Bureau, 2006 Annual Survey of Manufactures, Stats for All Mfg by State. http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=EAS&_tabId=EAS1&_submenuId=datasets_5&_lang=en&_ts=266925692376.

The majority of the Midwest's transportation equipment production comes from motor vehicle and motor vehicle parts manufacture. These subsectors account for more than 75 percent of the region's transportation equipment shipments in 2006. Exhibit 15 provides a detailed summary of each subsector of the larger transportation equipment manufacturing subsector.

Exhibit 15: 2006 Midwestern Transportation Equipment Manufacture Summary

Description (NAICS Code)	Percentage of Total Shipments	Estimated Midwest Energy Intensity (Btu/$GDP)	Estimated National Energy Intensity (Btu/$GDP)	Percent Above National Average
Transportation Equipment (336)	100.0%	2,418	1,828	32.3%
Motor Vehicle (3361)	39.9%	1,542	1,242	24.2%
Motor Vehicle Parts (3363)	35.3%	--	--	--
Aerospace Products (3364)	7.6%	1,003	1,014	-1.1%

Note: Subsector percentages may not total to 100 percent due to census data withholding. Some subsectors may not be shown because of incomplete data. See Appendix A for more detailed Midwest data and Appendix B for more detailed national data. Appendices A and B also contain additional notes on data.

In aggregate, the Midwestern transportation equipment manufacturing sector used 32 percent more energy, when compared to the national average, to produce one dollar of GDP in 2006. In a limited amount of time, this could be due to the disparity in value of product between the Midwest's products and the national average product. The larger part of the high energy intensity is a representation of the Midwest's opportunity to use energy efficiency as a resource.

For example, although product value is at parity with the national average, the Midwest uses 24 percent more energy, when compared to the national average, to produce one dollar of GDP within the motor vehicle subsector. If the Midwest motor vehicle subsector operated with the same energy intensity as the rest of the nation in 2006, it would have reduced energy consumption by 10 trillion Btu. This energy is valued at over $100 million.

For the transportation equipment manufacturing sector as a whole, it could have reduced its energy consumption from 277 to 209 trillion Btu in 2006. This 68-trillion Btu reduction is equivalent to the energy required to heat 1.2 million households in the United States.[7] The 68 trillion Btu in energy-consumption reduction would have also provided the transportation manufacturing sector with a $737.8 million reduction in energy costs for 2006.

Exhibit 16: Transportation *GDP–Material Input* Ratio

Description (NAICS Code)	Midwest *GDP–Material Input* Ratio	National *GDP–Material Input* Ratio
Transportation Equipment (336)	0.53	0.59
Motor Vehicle (3361)	0.34	0.34
Motor Vehicle Parts (3363)	0.67	0.66
Aerospace Products (3364)	1.14	1.08
Motor Vehicle Body & Trailer (3362)	0.63	0.59
Other Transportation Equipment (3369)	0.54	0.59
Railroad Rolling Stock (3365)	0.56	0.58
Ship & Boat (3366)	0.69	1.13

See Appendix A for more detailed Midwest data and Appendix B for more detailed national data.

1.5. Fabricated Metal Products Manufacture (NAICS 332)

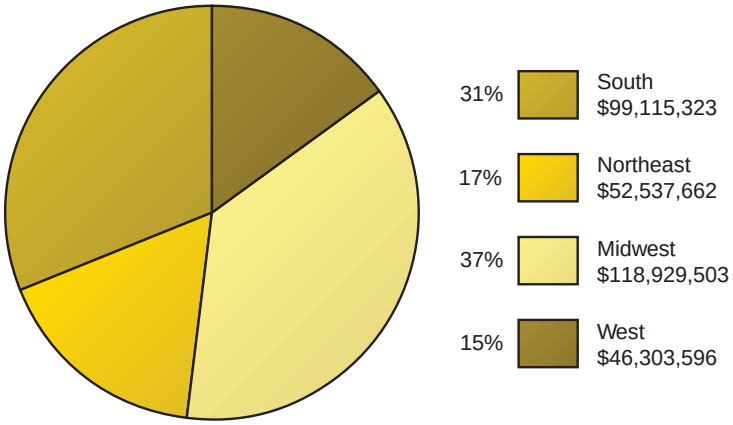
Fabricated metal products are the feedstock for many of the finished machinery and transportation equipment products that the Midwest produces. Fabricated metal products include hand tools, machine shop products, nuts, bolts, and a variety of other metal components. In 2006, Illinois and Ohio led the Midwest region in fabricated metal product production, contributing to the region's 37 percent share of national product shipments (Exhibit 17).

The Midwest's fabricated metal products sector is mostly composed of machine shops, structural materials, and miscellaneous fabricated metal products. These three subsectors made up nearly 60 percent of the larger sector's value of product shipments in 2006. More information on each of the fabricated metal products subsectors can be found in Exhibit 18.

The entire Midwest fabricated metal products sector has an energy intensity that is 24 percent higher than the national average. Subsector energy consumption was not available from the Energy Information Administration. This high energy intensity is largely due to the sector's inefficient use of energy. Midwest product values are on parity with the rest of the nation; therefore, are not a contributing factor to the

Exhibit 17: 2006 National Fabricated Metal Products Shipments

(IN THOUSANDS OF DOLLARS)



Source: U.S. Census Bureau, 2006 Annual Survey of Manufactures, Stats for All Mfg by State. http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=EAS&_tabId=EAS1&_submenuId=datasets_5&_lang=en&_ts=266925692376.

Exhibit 18: 2006 Midwestern Fabricated Metal Products Manufacture Summary

Description (NAICS Code)	Percentage of Total Shipments	Estimated Midwest Energy Intensity (Btu/$GDP)	Estimated National Energy Intensity (Btu/$GDP)	Percent Above National Average
Fabricated Metal Products (332)	100.0%	2,915	2,345	24.3%
Machine Shops, Turned Products, Screws, Nuts & Bolts (3327)	20.3%	--	--	--
Structural Metals (3323)	19.2%	--	--	--
Other Fabricated Metal Products (3329)	19.1%	--	--	--
Forgings & Stampings (3321)	12.0%	--	--	--

Note: Subsector percentages may not total to 100 percent due to census data withholding. Some subsectors may not be shown because of incomplete data. See Appendix A for more detailed Midwest data and Appendix B for more detailed national data. Appendices A and B also contain additional notes on data.

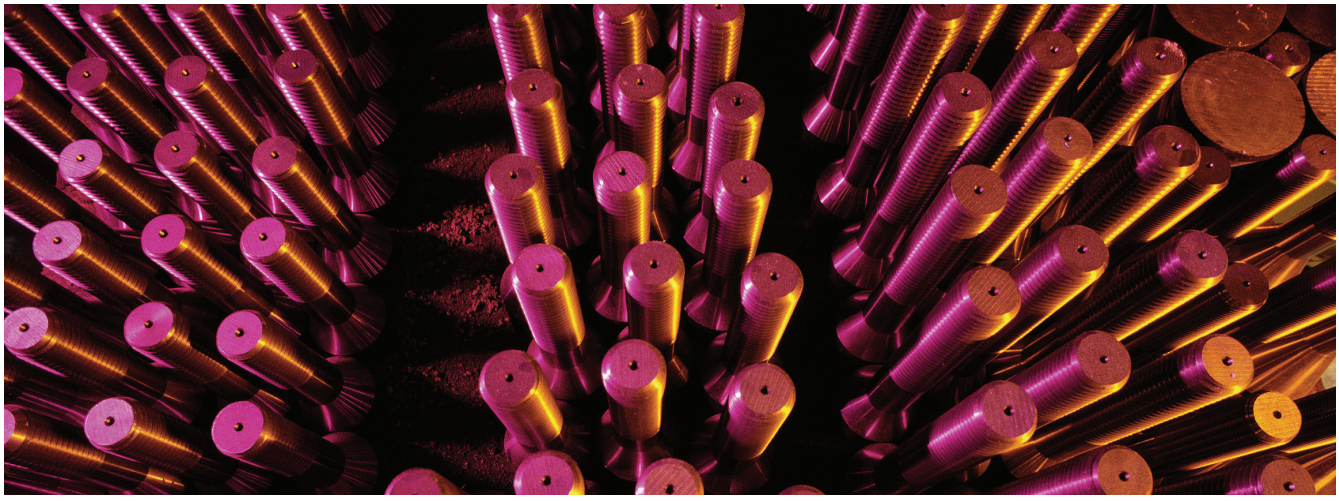
Exhibit 19: Fabricated Metals *GDP–Material Input* Ratio

Description (NAICS Code)	Midwest *GDP–Material Input* Ratio	National *GDP–Material Input* Ratio
Fabricated Metal Products (332)	1.13	1.12
Machine Shops, Turned Products, Screws, Nuts & Bolts (3327)	1.42	1.59
Other Fabricated Metal Products (3329)	1.43	1.35
Forgings & Stampings (3321)	0.82	0.85
Coating, Engraving & Heat Treating Activities (3328)	1.43	1.33
Boilers, Tanks & Shipping Containers (3324)	0.78	0.79
Hardware (3325)	1.36	1.29
Spring & Wire Products (3326)	0.92	0.9
Cutlery & Hand Tools (3322)	1.27	1.39

See Appendix A for more detailed Midwest data and Appendix B for more detailed national data.

region's relatively high energy intensity. However, the fabricated metal products' largest subsector — machine shops — has a lower product value than the national average and could influence this subsector's energy intensity.

In 2006, the Midwest fabricated metal products sector consumed 185 trillion Btu. This could have been reduced to 148 trillion Btu if the Midwest sector consumed energy at the same intensity as the national average. This 37 trillion Btu in energy-consumption reduction would be equivalent to avoiding the need for more than three 500 megawatt power plants. [§§] Estimated energy cost-savings from the 37-trillion Btu energy-consumption reduction total $401.5 million.



[§§] Assuming 80 percent capacity: (0.8)*(500 MW)*(365 days)*(24 hours)*(10^3) = 3,504,000,000 kWh. (3,504,000,000 kWh)*(3412) = 12 trillion Btu per power plant. (37 trillion Btu)/(12 trillion Btu) = 3.08 power plants.

2. Moving Forward

The Midwest has a significant energy resource in its efficiency potential. The nation-leading industries discussed in this report could reduce operating costs significantly by lowering energy intensities to national average levels. A summary of additional benefits includes:

- Reducing short-term manufacturer energy costs by lowering energy bills through conservation
- Increasing manufacturer competitiveness through reduced operating costs
- Reducing long-term manufacturer energy costs by reducing spending on generation and transmission
- Insulating Midwest manufacturing sectors from fossil energy price volatility and shocks
- Reducing utility investment risk by using energy efficiency instead of traditional energy supply
- Meeting state and national utility goals for energy resource and greenhouse gas emissions

It should be emphasized that the energy and economic savings estimated in this report are based on the Midwest merely lowering its energy intensities to the national average that existed in 2006. These estimates do not include the possible savings that could result from the Midwest implementing additional energy efficiency improvements that would allow it to lead the nation in these sectors in terms of energy intensity. As mentioned earlier, if Midwest energy intensities were at parity with the national average in these five industries, the Midwest would have reduced energy consumption by 670 trillion Btu and saved $7.3 billion in the process. Exhibit 20 shows the 2006 energy consumption of each of the five sectors detailed in this report, along with the potential energy savings and energy consumption if these sectors operated with energy intensities equal to the national average for each sector. Additional savings can be realized by moving lower than national average levels to become leaders in energy efficiency, as well as product shipments.

The Midwest can become a national leader in energy intensity by making changes to the way it consumes energy. Utilities, government organizations, non-governmental organizations, and energy consumers must make an effort to support programs that reduce energy consumption, save money, and increase industry competitiveness. Improving processes and reducing energy consumption will help the Midwest to continue its position as a global manufacturing leader.

Exhibit 20: 2006 Potential Energy and Economic Savings with National Average Energy Intensities

Manufacturing Sector Description	Energy Saved in Trillion Btu if at National Average	Economic Savings in Billions
Primary Metals (NAICS 331)	361	$3.9
Food (NAICS 311)	175	$1.9
Machinery (NAICS 333)	29	$0.3
Transportation (NAICS 336)	68	$0.8
Fabricated Metals (NAICS 332)	37	$0.4

3. Appendices

Appendix A: Midwest Manufacturing Sector and Subsector Details

NAICS Code	Region	NAICS Code	Material Inputs ($1,000)	Value of Shipments ($1,000)	GDP ($1,000)	Energy Consumed (Trillion Btu)	Energy Intensity (Btu/$GDP) ***	*GDP–Material Input* Ratio
311	Midwest	Food	$127,789,177	$204,666,920	$77,293,446	568	7,349	0.6
3111	Midwest	Animal Food	$5,925,093	$11,692,603	$5,787,464	--	--	0.98
3112	Midwest	Grain & Oilseed	$23,412,637	$35,886,921	$12,700,691	256	20,156	0.54
3113	Midwest	Sugar & Confectionary	$2,625,208	$5,551,505	$2,991,525	--	--	1.14
3114	Midwest	Fruit & Vegetable Preserving	$7,912,549	$15,221,916	$7,321,791	--	--	0.93
3115	Midwest	Dairy Products	$21,432,011	$31,056,179	$9,651,998	45	4,662	0.45
3116	Midwest	Animal Slaughtering	$47,641,206	$63,986,421	$16,384,698	112	6,836	0.34
3118	Midwest	Bakeries	$5,501,152	$15,188,557	$9,717,668	--	--	1.77
3119	Midwest	Other	$8,354,256	$18,185,300	$9,832,029	--	--	1.18
331	Midwest	Primary Metals	$63,112,585	$92,601,422	$29,982,454	972	32,419	0.48
3311	Midwest	Ferroalloy	$28,035,181	$37,762,110	$9,558,533	762	79,719	0.34
3312	Midwest	Steel Product from Purchased Steel	$6,041,226	$9,032,624	$3,096,257	21	6,782	0.51
3313	Midwest	Aluminum	$7,126,917	$10,017,217	$3,010,304	53	17,606	0.42
3314	Midwest	Nonferrous, Non-Aluminum Metals	$8,560,773	$11,106,395	$2,789,046	37	13,266	0.33
3315	Midwest	Foundries	$9,244,985	$18,637,703	$9,502,427	99	10,418	1.03
332	Midwest	Fabricated Metal	$56,255,537	$118,929,503	$63,473,203	185	2,915	1.13
3322	Midwest	Cutlery & Handtools	$1,548,922	$3,493,727	$1,964,674	--	--	1.27

*** Values are estimates and may be slightly over or understated due to Census and EIA data availability.

NAICS Code	Region	NAICS Code	Material Inputs ($1,000)	Value of Shipments ($1,000)	GDP ($1,000)	Energy Consumed (Trillion Btu)	Energy Intensity (Btu/$GDP) ***	*GDP–Material Input* Ratio
3323	Midwest	Structural Metals	$12,182,501	$22,842,886	$10,713,047	--	--	0.88
3324	Midwest	Boilers, Tanks & Shipping Containers	$5,440,070	$9,581,369	$4,224,277	--	--	0.78
3325	Midwest	Hardware	$1,921,532	$4,524,023	$2,618,776	--	--	1.36
3326	Midwest	Spring & Wire Products	$1,975,440	$3,777,839	$1,824,030	--	--	0.92
3327	Midwest	Machine Shops, Turned Products, Screws, Nuts & Bolts	$10,027,683	$24,201,915	$14,225,594	--	--	1.42
3328	Midwest	Coating, Engraving & Heat Treating Activities	$4,650,729	$11,254,044	$6,656,906	--	--	1.43
3329	Midwest	Other Fabricated Metal Products	$9,552,283	$22,758,118	$13,622,608	--	--	1.43
333	Midwest	Machinery	$77,864,975	$143,226,056	$65,696,388	116	1,766	0.84
3331	Midwest	Agriculture, Construction & Mining Machinery	$25,115,854	$42,645,638	$17,696,030	--	--	0.7
3332	Midwest	Industrial Machinery	$5,059,101	$10,027,484	$4,995,282	--	--	0.99
3333	Midwest	Commercial & Service Machinery	$3,164,592	$6,957,050	$3,851,745	--	--	1.22
3334	Midwest	HVAC Equipment	$7,012,446	$13,445,415	$6,525,014	--	--	0.93
3335	Midwest	Metalworking Machinery	$6,097,696	$15,913,529	$9,647,975	--	--	1.58
3336	Midwest	Engine, Turbine & Power Transmission Equipment	$14,236,896	$20,899,939	$6,720,776	--	--	0.47

NAICS Code	Region	NAICS Code	Material Inputs ($1,000)	Value of Shipments ($1,000)	GDP ($1,000)	Energy Consumed (Trillion Btu)	Energy Intensity (Btu/$GDP) ***	*GDP–Material Input* Ratio
3339	Midwest	Other Machinery	$16,505,589	$32,048,391	$15,651,336	--	--	0.95
336	Midwest	Transportation Equipment	$217,988,337	$331,468,454	$114,578,482	277	2,418	0.53
3361	Midwest	Motor Vehicle	$98,344,573	$132,162,627	$33,714,012	52	1,542	0.34
3362	Midwest	Motor Vehicle Body & Trailer	$12,109,931	$19,723,430	$7,683,630	--	--	0.63
3363	Midwest	Motor Vehicle Parts	$70,105,928	$117,171,645	$47,199,813	--	--	0.67
3364	Midwest	Aerospace Products	$12,264,542	$25,311,015	$13,962,982	14	1,003	1.14
3365	Midwest	Railroad Rolling Stock	$1,908,858	$2,812,646	$1,071,965	--	--	0.56
3366	Midwest	Ship & Boat	$1,522,553	$2,580,505	$1,057,953	--	--	0.69
3369	Midwest	$4,079,969	$6,229,271	$6,229,271	$2,202,785	--	--	0.54

Sources: U.S. Census Bureau, 2006 Annual Survey of Manufactures, Stats for All Mfg by State. http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=EAS&_tabId=EAS1&_submenuId=datasets_5&_lang=en&_ts=266925692376. Energy Information Administration, 2006 Manufacturing Energy Consumption Survey, Table 1.2. www.eia.doe.gov/emeu/mecs/mecs2006/2006tables.html.

Appendix B: National Manufacturing Sector and Subsector Details

NAICS Code	Description	Material Inputs ($1,000)	Value of Shipments ($1,000)	GDP ($1,000)	Energy Consumed (Trillion Btu)	Energy Intensity (Btu/$GDP)	*GDP–Material Input* Ratio
311	Food	$304,156,757	$536,939,160	$233,406,940	1,186	5,081	0.77
3111	Animal Food	$19,517,061	$33,987,755	$14,470,496	--	--	0.74
3112	Grain & Oilseed	$37,328,017	$56,978,067	$19,974,377	317	15,870	0.54
3113	Sugar & Confectionary	$12,631,236	$28,225,160	$15,747,921	--	--	1.25
3114	Fruit & Vegetable Preserving	$28,395,046	$56,160,818	$27,731,755	169	6,094	0.98
3115	Dairy Products	$51,205,998	$75,251,632	$24,142,949	121	5,012	0.47
3116	Animal Slaughtering	$96,862,515	$149,576,741	$52,793,268	227	4,300	0.55

NAICS Code	Description	Material Inputs ($1,000)	Value of Shipments ($1,000)	GDP ($1,000)	Energy Consumed (Trillion Btu)	Energy Intensity (Btu/$GDP)	*GDP–Material Input* Ratio
3117	Seafood	$6,525,838	$10,841,959	$4,320,676	--	--	0.66
3118	Bakeries	$19,814,852	$54,244,718	$34,417,050	--	--	1.74
3119	Other	$31,876,193	$71,672,310	$39,808,447	--	--	1.25
331	Primary Metals	$152,498,998	$234,384,209	$84,343,146	1,720	20,393	0.55
3311	Ferroalloy	$59,488,392	$93,327,526	$34,367,111	1,142	33,229	0.58
3312	Steel Product from Purchased Steel	$12,610,146	$19,594,560	$7,251,050	43	5930	0.58
3313	Aluminum	$30,886,848	$42,311,838	$11,927,211	273	22,889	0.39
3314	Nonferrous, Non-Alumi-num Metals	$33,442,761	$45,692,844	$13,165,477	104	7,899	0.39
3315	Foundries	$16,070,849	$33,457,440	$17,632,297	158	8,961	1.1
332	Fabricated Metal Products	$150,710,560	$317,214,471	$169,321,729	397	2,345	1.12
3321	Forgings & Stampings	$16,861,773	$30,888,330	$14,270,045	--	--	0.85
3322	Cutlery & Handtools	$4,437,969	$10,608,229	$6,189,214	--	--	1.39
3323	Structural Metals	$44,030,223	$83,538,607	$40,144,960	--	--	0.91
3324	Boilers, Tanks & Shipping Containers	$15,761,116	$27,821,164	$12,388,008	--	--	0.79
3325	Hardware	$4,565,839	$10,367,700	$5,882,490	--	--	1.29
3326	Spring & Wire Products	$5,210,539	$9,862,992	$4,695,987	--	--	0.9
3327	Machine Shops, Turned Products, Screws, Nuts & Bolts	$21,789,568	$56,194,769	$34,738,960	--	--	1.59

+++ Values are estimates and may be slightly over or understated due to Census and EIA data availability.

NAICS Code	Description	Material Inputs ($1,000)	Value of Shipments ($1,000)	GDP ($1,000)	Energy Consumed (Trillion Btu)	Energy Intensity (Btu/$GDP)	*GDP–Material Input* Ratio
3328	Coating, Engraving & Heat Treating Activities	$10,489,174	$24,279,830	$13,914,027	--	--	1.33
3329	Other Fabricated Metal Products	$27,564,360	$63,652,851	$37,098,038	--	--	1.35
333	Machinery	$174,623,062	$326,583,345	$154,459,745	204	1,321	0.88
3331	Agriculture, Construction & Mining Machinery	$46,229,703	$77,457,707	$32,431,376	--	--	0.7
3332	Industrial Machinery	$18,385,377	$38,192,795	$19,973,841	--	--	1.09
3333	Commercial & Service Machinery	$10,921,663	$23,243,452	$12,544,257	--	--	1.15
3334	HVAC Equipment	$20,146,209	$39,206,207	$19,305,810	--	--	0.96
3335	Metalworking Machinery	$11,528,701	$28,096,396	$16,553,247	--	--	1.44
3336	Engine, Turbine & Power Transmission Equipment	$27,225,135	$42,010,201	$15,135,350	--	--	0.56
3339	Other Machinery	$40,186,274	$78,376,587	$38,515,864	--	--	0.96
336	Transportation Equipment	$442,242,003	$699,034,220	$260,882,742	477	1,828	0.59
3361	Motor Vehicle	$196,030,689	$261,860,058	$66,045,757	82	1,242	0.34
3362	Motor Vehicle Body & Trailer	$22,717,166	$36,015,758	$13,474,840	--	--	0.59
3363	Motor Vehicle Parts	$122,031,484	$202,298,964	$80,485,945	--	--	0.66
3364	Aerospace Products	$70,267,186	$143,003,326	$75,906,290	77	1,014	1.08

NAICS Code	Description	Material Inputs ($1,000)	Value of Shipments ($1,000)	GDP ($1,000)	Energy Consumed (Trillion Btu)	Energy Intensity (Btu/$GDP)	*GDP–Material Input* Ratio
3365	Railroad Rolling Stock	$7,779,299	$12,082,276	$4,479,408	--	--	0.58
3366	Ship & Boat	$12,446,418	$26,510,585	$14,064,167	--	--	1.13
3369	Other Transportation Equipment	$10,969,762	$17,263,253	$6,426,335	--	--	0.59

Sources: U.S. Census Bureau, 2006 Annual Survey of Manufactures, Stats for All Mfg by State. http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=EAS&_tabId=EAS1&_submenuId=datasets_5&_lang=en&_ts=266925692376. Energy Information Administration, 2006 Manufacturing Energy Consumption Survey, Table 1.2. www.eia.doe.gov/emeu/mecs/smecs2006/2006tables.html.

4. Endnotes

[1] Energy Information Administration, State Energy Data System, Tables S6, S8, S4a, and S6a, November 2008. www.eia.doe.gov/emeu/states/_seds.html.

[2] U.S. Census Bureau, 2006 Annual Survey of Manufactures, Stats for All Mfg by State. http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=EAS&_tabId=EAS1&_submenuId=datasets_5&_lang=en&_ts=266925692376.

[3] Energy Information Administration, Annual Energy Outlook, Table 4. http://www.eia.doe.gov/oiaf/aeo/pdf/aeotab_4.pdf.

[4] U.S. Census Bureau, 2006 Annual Survey of Manufactures, Stats for All Mfg by State. http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=EAS&_tabId=EAS1&_submenuId=datasets_5&_lang=en&_ts=266925692376.

[5] U.S. Census Bureau, 2006 Annual Survey of Manufactures, Stats for All Mfg by State. http://factfinder.census.gov/servlet/DatasetMainPageServlet?_program=EAS&_tabId=EAS1&_submenuId=datasets_5&_lang=en&_ts=266925692376.

[6] http://www.eia.doe.gov/oiaf/aeo/assumption/pdf/renewable.pdf. Energy Information Administration, Annual Energy Outlook, Table 4. http://www.eia.doe.gov/oiaf/aeo/pdf/aeotab_4.pdf.

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