

# Industrial Energy Efficiency as a Resource by Region

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## ABSTRACT

The energy intensity of specific manufacturing sectors can vary greatly from region to region within the United States. By identifying energy intensity by region, it becomes possible to determine whether a manufacturing sector in one region has a significantly higher energy intensity than the national average for that sector, in addition to making other cross-region comparisons. With this information, regional partnerships, utilities, and state energy offices can better identify which regional industries to target when developing and deploying energy efficiency resources.

This paper is based on four *Energy Efficiency as a Resource* regional reports that examine the energy intensities for manufacturing industries throughout the four U.S. Census Bureau regions: the Midwest, Northeast, South, and West. These reports were developed by the U.S. Department of Energy's (DOE's) Industrial Technologies Program (ITP) using data from the U.S. Census Bureau's Annual Survey of Manufactures (ASM) and the Energy Information Administration's (EIA) Manufacturing Energy Consumption Survey (MECS). This paper will identify areas of opportunity for energy intensity improvement across U.S. regions and industrial sectors.

The reports highlight industries with energy intensities above that sector's national average in 2006. Using regional average energy prices, energy savings are calculated for each region based on the potential for the regionally significant industries to operate at the national average energy intensity level rather than their current (2006) levels. The reports found that if these selected industries had operated at the national average energy intensity in 2006, the sum of these energy savings would have been 2,635 trillion Btu, totaling approximately \$29.3 billion in energy cost savings.

## Introduction

Energy intensity<sup>1</sup> for specific manufacturing sectors can vary greatly from region to region within the United States. By evaluating energy intensity on a regional basis, manufacturing sectors that have an energy intensity significantly higher than the national average can be easily identified. Reducing the energy intensity of each region to the national average has the potential cost savings in the billions of dollars. The following analysis identifies the industrial sectors in each region that, in 2006, had energy intensities well above the national average energy intensity for that sector. With this information, regional organizations, utilities, and state energy offices can better identify which industries in their region are most in need of energy efficiency resources and can potentially offer the greatest energy savings impact.

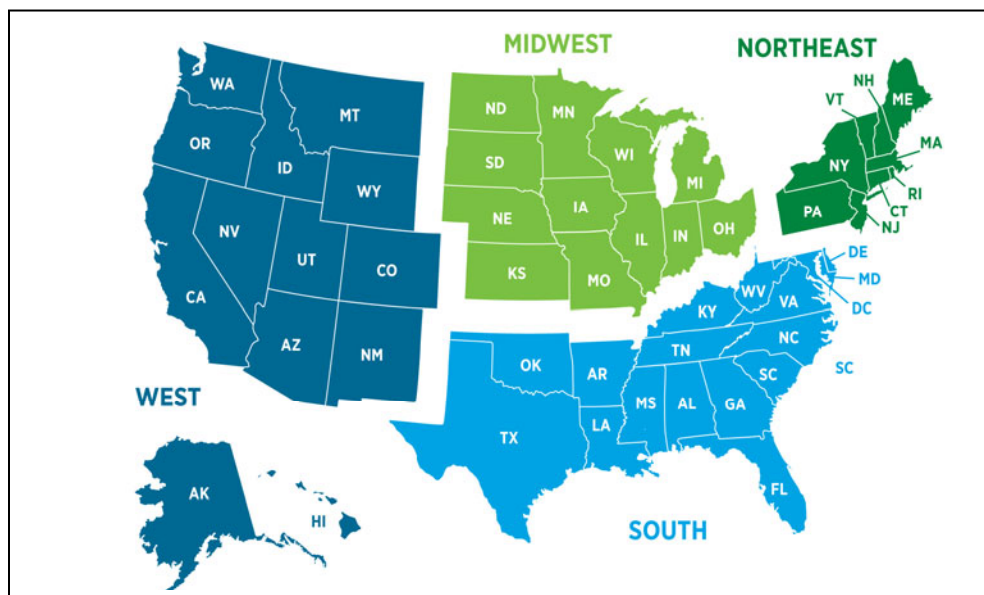
This paper is based on four *Energy Efficiency as a Resource* regional reports developed by the U.S. Department of Energy's (DOE) Industrial Technologies Program (ITP) that examine

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<sup>1</sup> 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.

the 2006 energy intensity of industries throughout the four U.S. Census Bureau regions: the South, Midwest, West, and Northeast (Figure 1). Each report focuses on the energy and financial savings available within these regional industries if they were to operate at the national average energy intensity. The analysis behind these reports relies, in part, upon the U.S. Energy Information Administration's (EIA) Manufacturing Energy Consumption Survey (MECS), which provides regional data according to NAICS code (down to seven-digit subsectors where available). EIA updates MECS data every 4 years; this paper uses the 2006 MECS data, since, at the time of writing, 2010 data was not yet available. The full reports contain more detailed information on the identified sectors within each region and can be viewed at [http://www1.eere.energy.gov/industry/states/technical\\_reports\\_analyses.html](http://www1.eere.energy.gov/industry/states/technical_reports_analyses.html).

**Figure 1. U.S. Census Bureau Regions**



Source: Census Bureau 2000

Energy prices, which vary from region to region, play an important role in determining the energy intensity of industries across the United States. Energy-intensive industries often seek to operate in regions where energy prices are lower, rather than leveraging energy efficiency to reduce operational costs. Energy prices are often influenced by the availability of natural resources in a region. As a result, more industries operate in areas where abundant energy resources and lower energy prices exist – driving the need for energy efficiency in other less-endowed regions to remain a competitive location for industry. For example, a significant portion of the aluminum smelting industry has traditionally located itself in the northwest, within the Census Bureau's West region, of the United States to take advantage of the lower cost of energy produced by the large hydro-electric power stations in the area. To clarify, although there are areas within the West region where access to energy sources have lowered prices, the overall average price in the region remains relatively high, since the region also includes densely populated states such as California where energy demand is high. The analysis in these regional reports found that the two regions with the lowest energy prices, the Midwest and the South, experienced higher-than-average energy intensities, in contrast to the Northeast and West

regions, where energy prices are higher. Nonetheless, this analysis found many important manufacturing industries in each of the four regions that could benefit from lowering their energy intensity.

Table 1 displays the 2006 regional average industrial energy prices used in this analysis. EIA provides average industrial energy prices by state. For this analysis, the average industrial price for each region was found by averaging the prices of the states located within the region. The Midwest and the South had the lowest energy prices at \$10.85 per million Btu and \$10.99 per million Btu, respectively. In 2006, the Northeast's average industrial energy price at \$13.51 per million Btu was 25% higher than Midwest's. The West's energy price at \$12.72 per million Btu was 17% higher than prices in the Midwest (EIA SEDS 2008).

**Table 1. 2006 Regional Average Industrial Energy Prices**

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

Source: EIA 2008

It should be emphasized that the energy and economic savings estimated in this paper are based on each of the regions merely lowering their energy intensities in each of the highlighted manufacturing sectors to the national average that existed in 2006 for that sector. Regardless of energy price, each region had manufacturing sectors operating at energy intensity levels well above the national average for that sector, implying that each region could capture these energy savings by improving efficiency in order to lower energy intensity to the national average. These estimates do not include the possible savings that could have resulted from the regions implementing additional energy efficiency improvements. Using the regional average energy prices, the reports found that if the sectors in each region highlighted in detail later in this paper had operated at the national average energy intensity in 2006, the sum of these energy savings would have been 2,635 trillion Btu,<sup>2</sup> totaling approximately \$29.3 billion in energy cost savings,<sup>3</sup> as seen in Table 2 (DOE 2009).

<sup>2</sup> Estimated energy savings is determined as follows: Energy Consumed – [Energy Consumed / (1 + Percent Difference of Regional Energy Intensity from National Average)] = Energy Savings Estimate. This estimate is used throughout the report.

<sup>3</sup> Estimated cost savings are determined as follows: Energy Savings Estimate x Average Regional Price per million Btu = Cost Savings. These savings assume an average regional energy cost as illustrated in Table 1. This estimate is used throughout the report.

**Table 2. 2006 Estimated Energy and Economic Savings by Region**

Region	Estimated Annual Energy Savings in 2006 (in trillion Btu)	Estimated Annual Economic Savings in 2006 (in million \$)
South	1,763	\$19,381
Midwest	670	\$7,270
West	144	\$1,830
Northeast	58	\$789
<b>Total</b>	<b>2,635</b>	<b>\$29,270</b>

Source: EIA. 2008

## Energy Intensity Improvement Opportunity across U.S. Regions and Industrial Sectors

### The South

**Table 3. U.S. Census Bureau, the South Region States (17)**

• Alabama	• Georgia	• North Carolina	• Virginia
• Arkansas	• Kentucky	• Oklahoma	• West Virginia
• Delaware	• Louisiana	• South Carolina	
• District of Columbia	• Maryland	• Tennessee	
• Florida	• Mississippi	• Texas	

Source: Census Bureau 2000

Table 3 lists the 17 states that are located in the South region according to the Census Bureau. The top manufacturing sectors in each region are identified as those with the highest value of product shipments compared to other regions nationally. The South led the nation in 10 manufacturing sectors in 2006, 5 of which operated at a significantly higher energy intensity than the national average (Census Bureau ASM 2006). The manufacturing sectors in the Southern region with the greatest potential for energy savings were Chemicals Manufacturing, Printing and Related Support Activities, Paper Manufacturing, Textile Product Mills, and Plastics and Rubber Products Manufacturing (EIA MECS 2006). Table 4 shows the estimated energy and financial savings from these five sectors if each had operated at its sector's national average energy intensity level. Of particular note is that the Chemical Manufacturing sector in the South used an astonishing 83.8% more energy to produce \$1 of GDP than the national average for this sector.

**Table 4. Estimated Savings in the South If Sectors Operated at their National Average Energy Intensities**

<b>Manufacturing Sector</b>	<b>Percent Above Sector National Average in 2006</b>	<b>Potential Annual Energy Savings in 2006 (in trillion Btu)</b>	<b>Potential Annual Economic Savings in 2006 (in million \$)</b>
Chemicals (NAICS 325)	83.8%	1,120	\$12,313
Printing & Related Support Activities (NAICS 323)	71.9%	15	\$170
Paper (NAICS 322)	60.2%	590	\$6,482
Textile Product Mills (NAICS 314)	41.5%	19	\$209
Plastic & Rubber Products (NAICS 326)	15.6%	19	\$207
<b>Total</b>		<b>1,763</b>	<b>\$19,381</b>

Source: Census Bureau 2008; EIA 2009

Availability of lower-than-average energy prices was one of the larger factors responsible for this high energy intensity across the Southern region as compared with the other three regions (as shown in Table 1). Another contributing factor to higher energy intensity in many of these Southern manufacturing sectors was the lower shipment values compared to the national average. All other factors being equal, a product that has a lower shipment value will have a higher energy intensity level. This is due to the influence of GDP on both energy intensity and the relative value of shipments for a given product. Nonetheless, even after normalizing for this disparity in product value, these sectors of the South’s manufacturing industry used significantly more energy to produce their products.

**Economic significance.** The South’s large potential for efficiency improvements in its manufacturing sector should be viewed as a significant energy resource. Based on 2006 U.S. Census Bureau and EIA data, if the energy intensities of the five sectors in Table 4 were at parity with the national average, the South would have reduced energy consumption by 1,763 trillion Btu and saved more than \$19.4 billion in the process. The magnitude of energy savings would have been equivalent to the annual energy required to heat 31.4 million households in the United States (EIA AEO 2007).

### The Midwest

**Table 5: U.S. Census Bureau, the Midwest Region States (12)**

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

Source: Census Bureau 2000

Table 5 displays the 12 states constituting the Census Bureau’s Midwest region. The Midwest led the nation in terms of value of shipments in seven industries in 2006. Of these seven sectors, five operated at a higher energy intensity level than the national average: Primary Metals, Food, Machinery, Transportation, and Fabricated Metals (Census Bureau ASM 2008;

EIA MECS 2006). These five sectors, listed in Table 6, represented the largest opportunities for energy savings in Midwest manufacturing. For example, the Midwest primary metals manufacturing sector used 59% more energy to produce \$1 of GDP when compared to the national average for this sector. This disparity was concentrated specifically in the Iron, Steel, and Ferroalloy Manufacturing subsectors within the Primary Metals sector.

**Table 6. Estimated Savings in the Midwest If Sectors Operated at their National Average Energy Intensities**

Manufacturing Sector	Percent above sector National Average in 2006	Potential Annual Energy Savings in 2006 (in trillion Btu)	Potential Annual Economic Savings in 2006 (in million \$)
Primary Metals (NAICS 331)	59.0%	361	\$3,917
Food (NAICS 311)	44.6%	175	\$1,899
Machinery (NAICS 333)	33.7%	29	\$315
Transportation (NAICS 336)	32.3%	68	\$738
Fabricated Metals (NAICS 332)	24.3%	37	\$401
<b>Total</b>		<b>670</b>	<b>\$7,270</b>

Source: U Census Bureau 2008; EIA 2009

In 2006, the Midwest had the lowest average industrial energy price in the nation at \$10.85 per million Btu. As was the case in the South, the high energy intensity seen in the Midwest was largely a result of the lower-than-average energy prices across the region. These low energy prices were the result of high concentrations of coal-fired electricity within the Midwest region and neighboring states that supply electricity to the Midwest.

As in the Southern region, another contributing factor to higher energy intensity in many of these Midwest manufacturing sectors was the relatively low shipment values compared to the national average shipment value (Census Bureau ASM 2008). Yet, even with relatively low-value products, the Midwest had the potential to significantly lower its energy intensity.

**Economic significance.** As displayed in Table 6, if Midwest 2006 energy intensities were at parity with the national average in the five industries noted in Table 6, the Midwest would have reduced energy consumption by 670 trillion Btu and saved \$7.3 billion in the process.

## The West

**Table 7. U.S. Census Bureau, the West Region States (13)**

• Alaska	• Hawaii	• New Mexico	• Wyoming
• Arizona	• Idaho	• Oregon	
• California	• Montana	• Utah	
• Colorado	• Nevada	• Washington	

Source: Census Bureau 2000

The 13 states located in the Census Bureau's West region are identified in Table 7. The West led the nation in terms of value of shipments in three industries in 2006: Apparel,

Computer and Electronic Products, and Miscellaneous (Census Bureau ASM 2008). Unlike the Midwest and the South, where many of the leading industries operated at relatively high energy intensities, the West's energy intensity was below the national average for its three leading industries (EIA MECS 2009). This stemmed in part from the higher energy prices in the West in comparison to the South and the Midwest. The West's energy prices were \$1.87 per million Btu more than in the Midwest and \$1.73 per million Btu more than in the South. However, the West still experienced significantly higher-than-average energy intensities in several important sectors and subsectors, including: Dairy Products; Beverage and Tobacco Product Manufacturing; Animal Slaughtering and Processing; Alumina and Aluminum Production and Processing; Fruit and Vegetable Preserving and Specialty Foods Manufacturing; Petroleum and Coal Product Manufacturing; and Paper Manufacturing. Table 8 displays these sectors where the West was operating above the national average energy intensity level.

**Table 8. Estimated Savings in the West If Sectors Operated at their National Average Energy Intensities**

<b>Manufacturing Sector</b>	<b>Percent above sector National Average in 2006</b>	<b>Potential Annual Energy Savings in 2006 (in trillion Btu)</b>	<b>Potential Annual Economic Savings in 2006 (in million \$)</b>
Dairy Products (NAICS 3115)	104.1%	27	\$343
Animal Slaughtering and Processing (NAICS 3116)	36.8%	6	\$76
Fruit and Vegetable Preserving and Specialty Foods (NAICS 3114)	18.3%	10	\$127
Beverage and Tobacco Products (NAICS 312)	59.6%	10	\$127
Alumina and Aluminum Production and Processing (NAICS 3313)	20.5%	4	\$51
Petroleum and Coal Products (NAICS 324)	9.5%	67	\$852
Paper (NAICS 322)	7.6%	20	\$254
<b>Total</b>		<b>144</b>	<b>\$1,830</b>

Source: U Census Bureau 2008; EIA 2009

**Economic Significance:** Based on 2006 U.S. Census Bureau and EIA data, the seven Western manufacturing sectors could have reduced energy consumption by approximately 144 trillion Btu and saved approximately \$1.83 billion in energy costs during 2006 at region's average industrial energy price of \$12.72 per million Btu, if they had operated at energy intensity levels equivalent to the national average for their sectors.

## The Northeast

**Table 9. U.S. Census Bureau, the Northeast Region States (9)**

• Connecticut	• New Hampshire	• Pennsylvania
• Maine	• New Jersey	• Rhode Island
• Massachusetts	• New York	• Vermont

Source: Census Bureau 2000

Table 9 displays the nine states that constitute the Census Bureau's Northeast region. The Northeast did not lead the nation in terms of value of shipments in any manufacturing sector, according to the 2006 Annual Survey of Manufactures, primarily due to the Northeast having the highest regional energy prices in the nation (Census Bureau ASM 2008). Manufacturers often prefer to operate in areas with lower energy prices, making the Northeast less attractive. The lack of a large industrial presence in the Northeast implied the region would have fewer shipments, lowering the overall value of shipments. The Northeast's industrial energy prices were \$1.87 per million Btu higher than in the Midwest. However, the Northeast still experienced higher-than-average energy intensity in certain important sectors, implying the Northeast has notable room for improvement in these sectors.

The Northeast's manufacturing sectors where the disparity in intensity resulted in the greatest overuse of energy, and thus had the greatest potential for savings, include Beverage and Tobacco Manufacturing, Transportation Equipment Manufacturing, Miscellaneous Manufacturing, Computer and Electronic Product Manufacturing, and Nonmetallic Mineral Product Manufacturing (EIA MECS 2009). Table 10 displays the potential for savings in these sectors if they were to operate at their national average energy intensity.

**Table 10. Estimated Savings in the West If Sectors Operated at their National Average Energy Intensities**

<b>Manufacturing Sector Description</b>	<b>Percent above National Average in 2006</b>	<b>Potential Annual Energy Savings in 2006 (in trillion Btu)</b>	<b>Potential Annual Economic Savings in 2006 (in million \$)</b>
Beverage and Tobacco Products (NAICS 312)	62.3%	5	\$67
Transportation Equipment (NAICS 336)	53.8%	23	\$306
Miscellaneous Manufacturing (NAICS 339)	44.4%	7	\$91
Computer & Electronic Products (NAICS 334)	18.3%	4	\$56
Nonmetallic Mineral Products (NAICS 327)	13.2%	20	\$269
<b>Total</b>		<b>58</b>	<b>\$789</b>

Source: Census Bureau 2008; EIA 2009

In the Northeast sector, the Beverage and Tobacco Product Manufacturing offered the greatest potential for savings, the sector operating at an energy intensity 62% above the national average. Beverage production constituted approximately 91% of the sector's value of shipments



in the Northeast, while tobacco production accounted for only 6%. Nonetheless, tobacco production in the Northeast had an astonishingly high energy intensity compared to the national average – 748% above the national average – whereas beverage production was slightly below the national average energy intensity.

**Economic significance.** Based on 2006 U.S. Census Bureau and EIA data, the five sectors could have reduced energy consumption by approximately 58 trillion Btu and saved approximately \$789.1 million in energy costs during 2006 at the region's average energy price of \$13.51 per million Btu. Harnessing energy efficiency as an energy resource will provide the Northeast with an alternative to the conventional approach of increasing electricity generation to meet the region's energy demands. Simultaneously, reducing energy consumption will save manufacturers money in the short term, as well as over the long term, by reducing their monthly energy bills.

## **Summary**

In 2006, there were significant opportunities across the nation to save money and energy by targeting key energy intensive industrial sectors and delivering tools and resources that help these manufacturers lower their energy intensity. Table 11 shows the key sectors highlighted in this paper.

**Table 11. Key Sectors by Region and Estimated Savings If Operated at their National Average Energy Intensity**

<b>Region</b>	<b>Identified Higher Energy Intensity Sectors than National Average</b>	<b>Potential for Annual Energy Savings in 2006 (in trillion Btu)</b>	<b>Potential for Annual Savings in 2006 (in million \$)</b>
South	<ul style="list-style-type: none"> <li>• Chemicals Manufacturing</li> <li>• Printing and Related Support Activities</li> <li>• Paper Manufacturing</li> <li>• Textile Product Mills</li> <li>• Plastics and Rubber Products Manufacturing</li> </ul>	1,763	\$19,381
Midwest	<ul style="list-style-type: none"> <li>• Primary metals Production</li> <li>• Food</li> <li>• Machinery</li> <li>• Transportation</li> <li>• Fabricated metal Products</li> </ul>	670	\$7,270
West	<ul style="list-style-type: none"> <li>• Dairy Products</li> <li>• Beverage and Tobacco Product Manufacturing</li> <li>• Animal Slaughtering and Processing</li> <li>• Alumina and Aluminum Production and Processing</li> <li>• Fruit and Vegetable and Specialty Food Manufacturing</li> <li>• Petroleum and Coal Product Manufacturing</li> <li>• Paper Manufacturing</li> </ul>	144	\$1,830
Northeast	<ul style="list-style-type: none"> <li>• Beverage and Tobacco Manufacturing</li> <li>• Transportation Equipment Manufacturing</li> <li>• Miscellaneous Manufacturing</li> <li>• Computer and Electronic Product Manufacturing</li> <li>• Nonmetallic Mineral Product Manufacturing</li> </ul>	58	\$789
<b>Total Estimated Savings</b>		<b>2,635</b>	<b>\$29,319</b>

Source: DOE 2009

Besides energy and cost savings, the benefits of reducing energy intensity include:

- Increasing manufacturer competitiveness through reduced operating costs;
- Reducing manufacturers' future energy costs by mitigating the need for utilities to invest in new generation and transmission, a cost that would be passed on to the consumer;
- Insulating manufacturers from fossil energy price volatility; and
- Efficiently meeting state, local, and national utility goals for energy resource and greenhouse gas emissions.

In sum, if the energy intensities of the key industries highlighted herein for each region were at parity with the national average for their sectors in 2006, energy consumption could have been reduced by a total of 2,635 trillion Btu, saving approximately \$29.3 billion in the process. Analyzing the energy performance of various sectors regionally in comparison with their national averages has thus highlighted the significant opportunity for reducing energy use that is within easy reach and the various industries in different regions that utilities and state energy offices need to prioritize for energy efficiency efforts.

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