Energy Efficiency and Economic Development in the Midwest

Skip Laitner, John DeCicco, Neal Elliott, Howard Geller, Marshall Goldberg, Robert Mowris, and Steven Nadel

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American Council for an Energy-Efficient Economy
1001 Connecticut Ave. NW, Suite 801, Washington, DC 20036 (202)429-8873
2140 Shattuck Ave., Suite 202, Berkeley, CA 94704 (510)549-9914
Please contact the Berkeley office for ordering information.

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PREFACE

The American Council for an Energy-Efficient Economy (ACEEE) is a non-profit research organization dedicated to advancing energy efficiency as a means of promoting both economic prosperity and environmental protection. It is based in Washington, DC.

ACEEE has been conducting a series of national, state and regional studies to examine the potential employment and macroeconomic benefits of increased investments in energy efficiency technologies. Primary funding for this study was provided by the Pew Charitable Trust. Additional support was provided by the Energy Foundation and the Joyce-Mertz Gilmore Foundation.

Many people worked together to produce this report. Skip Laitner led the overall project and conducted the macroeconomic analysis. Robert Mowris and Steve Nadel conducted the buildings and appliances energy efficiency analyses. Neal Elliott and John DeCicco conducted the industrial and transportation efficiency analyses, respectively. Marshall Goldberg provided background data and analysis on the region's energy and economic profile. Howard Geller wrote the section on demand-side management and provided overall guidance and review.

Useful information and/or comments on a review draft were provided by Howard Learner and Jimmy Seidita with the Environmental Law and Policy Center, David Festa with the Center for Clean Air Policy, Pete Jackson with the Illinois Department of Natural Resource's Division of Energy, Jeff Johnson of Battelle Pacific Northwest Laboratories, and Marc Ross from the University of Michigan. The authors thank these individuals for their assistance.

EXECUTIVE SUMMARY

Energy is the lifeblood of the economy. It is needed to power office equipment and production machinery, and to transport both people and freight. It provides light, heat and air conditioning for homes, schools and businesses. Energy is also a critical ingredient for a diverse set of consumer goods that range from medicines and children's toys to food and automobiles.

But energy that is inefficiently or inappropriately used can constrain the economic activity of a state or region and thereby limit the job creation process. With abundant opportunities for energy efficiency improvements as well as the development of renewable resources, the Midwest region of Illinois, Indiana, Michigan and Ohio is seemingly well-positioned to move from a heavy reliance on fossil and nuclear fuels towards a more sustainable energy future.

In 1992 the region as a whole spent approximately $70.8 billion to provide heat, light, power and transportation for residents and businesses alike. The annual energy bill is 8.2 percent of the region's combined Gross State Product (GSP) while the United States as a whole spent only 7.8 percent. The total energy expenditure is also 1.6 times greater than the combined annual tax collections by state governments in the region.

Concern about both economic development and environmental degradation has stimulated interest in improving energy efficiency. Policy makers and business leaders are seeking strategies that enhance economic growth while providing environmental benefits. Improving energy efficiency is one such strategy. Interest in energy efficiency continues in spite of dramatic reductions in real energy prices in the past decade.

This reports examines current energy consumption patterns in the four-state Midwest region and projects energy consumption through 2010 assuming business-as-usual policies and trends. It then develops a high energy efficiency scenario assuming more aggressive implementation of cost-effective energy efficiency measures, and it analyzes the potential economic benefits of the high efficiency scenario.

The energy and macroeconomic analyses build on previous efforts undertaken by the American Council for an Energy-Efficient Economy (and others) in such studies as *America's Energy Choices: Investing in a Strong Economy and a Clean Environment*, and also *Energy Efficiency and Job Creation: The Employment and Income Benefits from Investing in Energy Conserving Technologies*.

The major findings of the Midwest analysis include:

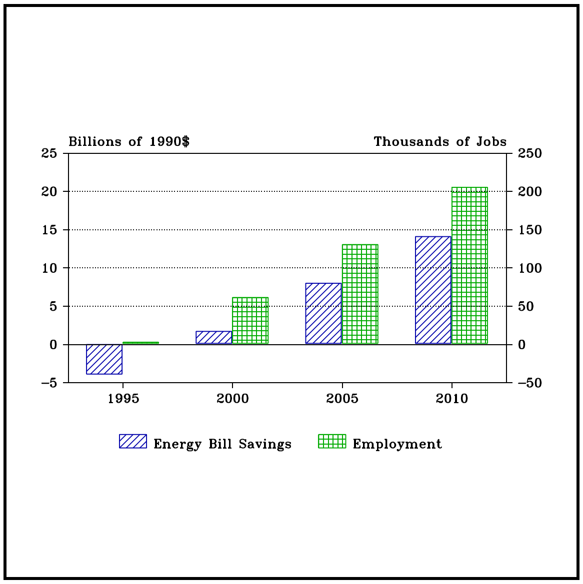
******* In 1992, the region consumed a total of 12,410 trillion Btus of energy for all end-uses, 329 million Btus per capita. If we were to think of this energy use in terms of an equivalent amount of gasoline, the region's economy requires the equivalent of 2,630 gallons of gasoline per capita per year. This is about two percent greater than for the United States as a whole.

******* The accelerated energy efficiency scenario developed in this study would lower the region's energy requirements in 2010 to 7 percent below the 1992 consumption level, and 26 percent below energy consumption projected for 2010 in the baseline scenario, without reducing energy services or standards of living. In terms of Btus per dollar of GSP, this implies a 2.3 percent annual reduction in the Midwest's energy intensity. Without accelerated energy efficiency investments, the region's energy intensity would decline at a rate of only 0.4 percent per year.

*** The high efficiency scenario would also have positive environmental impacts in the region. Energy-related carbon emissions, for example, would be reduced by at least 66 million metric tons in the year 2010, a 26 percent reduction compared to emissions in 2010 in the baseline scenario.

*** A $104 billion investment in energy efficiency technologies between 1995 and 2010 would yield a cumulative energy bill savings of $183 billion over that same period (all values in 1990 dollars). This implies a benefit-cost ratio of 1.75 over the 16-year period of analysis. But this understates the cost-effectiveness of the energy efficiency investments since energy savings will continue for many years after 2010.

*** The investment in energy efficiency technologies would increase net employment in the region) from a modest increase of 3,000 jobs in 1995 to 205,000 jobs by 2010. The latter figure is equivalent to the number of jobs supported by the output, expansion, or relocation to the region of 1,367 small manufacturing plants.



*** The employment benefits from energy efficiency investments could reduce the region's unemployment level in 2010 by nearly one percentage point) from the recent level of 4.7 percent, for example, to about 3.8 percent.

*** Looking only at electricity, implementing the high efficiency scenario in the region would result in a net increase of 132,400 jobs by the year 2010. This is about 65 percent of the total employment gain for that year from the high efficiency scenario for all sectors. Improvements only in the fuel efficiency of automobiles and other light duty vehicles would yield a net employment gain of 14,100 jobs in 2010.

*** To help residents of the Midwest capture the full benefits of the high efficiency scenario, we suggest that a number of policies be adopted at the state or regional level, including:

* State-of-the-art building energy codes plus training and support for effective implementation of residential and commercial building codes;

* Greatly expanded demand-side management programs by both natural gas and electric utilities, along with greater support from utility regulators for cost-effective DSM programs;

* Expanded technical and financial support to accelerate both energy and process efficiency improvements in the industrial sector;

* Policies which improve the fuel economy of cars and light trucks;

* Improved energy price signals including a revenue-neutral energy or carbon tax to encourage investments in energy efficiency in all sectors; and

* Creation of a Sustainable Energy Development Agency in the region, or in each state, that would fund research, development, demonstration, and promotion activities in support of energy efficiency and renewable energy implementation.

These initiatives, along with other actions that can be taken to increase energy efficiency, would result in a stronger economy and a cleaner environment in the Midwest in the coming decades.

I. INTRODUCTION

Energy is the lifeblood of the economic process. It is needed to power office equipment and production machinery, and to transport both people and freight. It provides light, heat and air conditioning for homes, schools and businesses. Energy is also a critical ingredient for a diverse set of consumer goods that range from medicines and children's toys to food and automobiles. But energy that is inefficiently or inappropriately used can constrain the economic activity of a state and thereby limit the job creation process.

The midwest region of Illinois, Indiana, Michigan, and Ohio imported more than 70 percent of its combined energy needs in 1992.[1] The region spent $70.8 billion for its total energy use.[2] This annual energy bill represents about 8.2 percent of the regions's estimated Gross State Product) about 5 percent more than the U.S. average. Also in 1992, these same state governments collected a total of $43.3 billion in taxes and license fees.[3] This means that regional energy expenditures were 1.6 times greater than the combined annual tax collections for 1992.

Conventional energy expenditures consume a significant share of the region's total economic resources. Moreover, the inefficient use of these energy resources acts as a brake on the economic process, and it contributes to excessive air pollutant emissions. Historically, it has also contributed to higher electricity costs due to construction of nuclear power plants) which have proved to be more costly and controversial than anyone originally believed) and other factors.[4] For those reasons, efforts to accelerate investments in energy efficiency and renewable energy technologies are generating interest throughout the nation.

Stricter clean air regulations are diminishing the desirability of the region's large reserves of medium and high sulfur coal. Yet the region's utilities are still heavily dependent on this resource. What once was a major income and employment asset for three out of four of the states in the region now offers only declining job opportunities while, at the same time, contributes to a serious acid rain problem.

1. Despite the large concentration of coal production in this region, especially in the states of Illinois, Indiana and Ohio, about half of the region's coal resources were imported. Moreover, less than 10 percent of its oil and natural gas requirements were produced locally. These are estimates by the author using a variety of data from the Energy Information Administration, among others.

2. Energy Information Administration, *State Energy Price and Expenditure Report 1992*, U.S. Department of Energy, Washington, DC, December 1994.

3. *U.S. Statistical Abstract 1994*, U.S. Department of Commerce, Bureau of the Census, Washington, D.C., 1994, Table 479.

4. According to a nationwide study of residential electricity rates, two of Ohio's electric utilities, Cleveland Electric Illuminating and Toledo Edison, and one of Illinois', Commonwealth Edison Company, have some of the highest rates in the country and made the list of "twenty-five most expensive companies." This information is based on data contained in a press release by the National Association of Regulatory Utility Commissioners (NARUC), April 8, 1994, highlighting some of the results in the *1993 Summer Survey of Residential Electric Utility Bills*. For more information on the recently released report contact NARUC in Washington, DC.

The importance of maximizing energy efficiency as a strategy for enhancing both environmental quality and economic development opportunities is evidenced by the findings of many recent studies. Promoting energy efficiency investments not only cuts costs for the user, but it reduces pollutant emissions and yields positive benefits for the larger economy.[5]

In spite of the economic benefit documented by these recent studies, some states have been slow to develop and implement energy efficiency technologies and renewable energy resources. One reason is the significant up-front investment is needed in order to reap full advantage of these alternative resources. In short, it takes money to make money.

Unfortunately, alternative energy strategies are also forced to compete against the significantly larger federal and state tax subsidies given traditional energy resources.[6] Also, in contrast to many other business investments, the benefits of energy efficiency investments tend to be diffuse, accruing to many people over the long-run rather than for a few investors in the short-run.

New policy initiatives can go a long way to overcome the momentum of present energy subsidies and provide energy efficiency and renewable energy technologies with the level playing field needed to encourage their widespread adoption. These same policies can also help bolster public trust in energy decision making.

The need for new programs and policies has been confirmed in numerous studies as well two state initiatives in the midwest region. In 1991, Governor Voinovich of Ohio announced in his State of the State message his intent to develop new programs and policies known as *The Ohio Energy Strategy Foundation Report*. This was published in the spring of 1994.

The *Ohio Energy Strategy* states that "Ohio's citizens and government should develop and utilize energy resources in a manner which fosters economic growth, enhances global competitiveness, employs efficiency and conservation standards, and ensures energy security and environmental quality." The report references a number of broad strategies and initiatives to accomplish these goals.[7]

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5. Among others, see, *America's Energy Choices: Investing in a Strong Economy and a Clean Environment*, (Cambridge, MA: The Union of Concerned Scientists, 1991); Howard Geller, John DeCicco and Skip Laitner, *Energy Efficiency and Job Creation: The Employment and Income Benefits from Investing in Energy Conserving Technologies*, (Washington, DC: American Council For An Energy-Efficient Economy, October 1992); Steve Clemmer, *The Economic Impacts of Renewable Energy Use in Wisconsin*, Wisconsin Energy Bureau, Madison, WI, April 1994; and Economic Research Associates, *Energy Investments For A Stronger Louisiana Economy: The Benefits of Accelerated Investments in Energy Efficiency*, prepared for Citizens Fund, Washington, DC, May 1991.

6. See, for example, Douglas N. Koplow, *Federal Energy Subsidies: Energy, Environmental, and Fiscal Impacts*, The Alliance to Save Energy, Washington, DC, April 1993. According to this study, federal energy subsidies alone totaled $39 billion in 1989. Fossil and nuclear resources received 88 percent of this amount, while energy efficiency and renewable energy resources received only 12 percent of the benefit.

7. See *The Ohio Energy Strategy Foundation Report*, Public Utilities Commission of Ohio, March 1994, page 7; for a brief description of the strategies and initiatives see pages 7-13 of the report.

A similar initiative was also begun for Indiana in 1991. Recognizing the changing landscape of energy use, economics and the environment, the Indiana Energy Forum was established by the Indiana General Assembly.[8] Like the Ohio initiative, the Indiana report confirms that energy efficiency initiatives would help save residents money, ensure a clean and safe environment, and help Indiana industries become more competitive.

The purpose of this report is to better understand how additional investments in energy efficiency technologies can contribute to lower energy expenditures, new employment opportunities for residents of the Midwest region, and a generally strengthened economic activity and quality of life.

Recognizing that energy consumption and expenditure patterns depend upon the social and economic make-up of a state or region, this report begins with a brief economic profile of the region in Section II. Section III provides background information on the region's energy use patterns. It includes information on energy resources, expenditures and electricity consumption.

Section IV develops both a business-as-usual and a series of three high efficiency scenario for the region through the year 2010. It provides an estimate of the investment needed to achieve the resulting energy bill savings in the high efficiency scenario, based upon detailed analysis of energy efficiency potential in each end-use sector.

Section V summarizes the analytical method used to identify the net employment gains and other net economic benefits from the high efficiency scenario. Section VI presents the results of the economic impact analysis. Section VII identifies some of the past and current policy initiatives designed to promote energy efficiency improvements. It then offers specific policy recommendations to ensure that the region is able to secure the full benefits of greater energy efficiency.

Finally, Section VIII draws some brief conclusions and summarizes the policy recommendations needed to capture the greater efficiency potential. The analysis contained in the report confirms the hypothesis that aggressive implementation of energy efficiency improvements throughout the midwest economy could yield significant economic and environmental benefits to the region.

TABLE 1. SELECTED ECONOMIC AND DEMOGRAPHIC DATA

Category	U.S.	Region
Rural Population (1990 percent of total)	24.8	24.9%
Population Density (per square mile)	72.1	208.2

8. See the *Indiana Energy Policy Forum*, Final Report, Indiana Department of Commerce, Office of energy Policy, December 1992.

Persons Per Household (1990)	2.63	2.63
1992 Per Capita Personal Income (current $)	$20,131	$19,912

Source: The Midwest region as identified in this report includes Ohio, Indiana, Illinois, and Michigan. The population data contained in this table is based on calculations from 1990 census data found in various tables in the *Statistical Abstract of the United States 1994*. The Per Capita Personal Income data reflects values found in the *Survey of Current Business*, August 1994. State specific data for a variety of energy and demographic statistics are offered in Appendix A of this report.

II. ECONOMIC PROFILE OF THE MIDWEST REGION

A. Population and Income

The combined population of Illinois, Indiana, Michigan and Ohio rose slightly from 35.8 million people in 1970 to 37.7 million people in 1992. This represents a relatively small increase of 5.3 percent in just over 20 years. By comparison, the U.S. population rose by 25 percent in that same period (1970-1992). A smaller population growth might generally be taken as an indication of a smaller level of growth in energy use. As we shall see, this turns out *not* to be the case for a variety of reasons.

As Table 1 indicates on the previous page, approximately 25 percent of the regional population lives in rural areas. This ranges from a low of 15.4 percent in Illinois to a high of 35.1 percent in Indiana. The regional average, however, is essentially the same as the U.S. average.

When the total populations are viewed in terms of density per square mile, the region's average density of just over 208 persons per square mile is almost three times greater than that of the United States as a whole. Individually, Indiana and Michigan have a density of just over twice the U.S. average while Illinois and Ohio are almost three and four times greater, respectively.

The average number of persons per household is the same for the United States and the region. In spite of these similarities in household size, the more densely populated nature of the region) especially states like Ohio with 269 persons per square mile) suggests that the region may consume less energy for its transportation uses than does the United States as a whole. Indeed, the per capita transportation energy consumption in the region is only 84 percent of that for the nation as a whole.

In 1980, the region's average per capita personal income of $10,116 was approximately 102 percent of the average per capita income in the United States.[9] By 1992, the region's per capita income fell to just under 99 percent of the U.S. average. This slight decline occurred despite slow population growth and a record high personal income (the two factors used to estimate per capita personal income) for each of the states in the region.

9. This value is based on the sum of a population-based weighting for each of the states.

In an overall comparison with other states, Indiana ranked 31st in per capita income in 1992, trailing all the states in its region. Illinois ranked 7th, Michigan 19th, and Ohio 26th.[10] Lower income usually suggests that a state (or region) consumes less energy per capita than the national average. As it turns out, this is not true. In fact, when all end-use sectors are considered, the state of Indiana consumed approximately one third more energy per capita than the weighted average for the region and almost 12 percent more per capita than the U.S. as a whole.

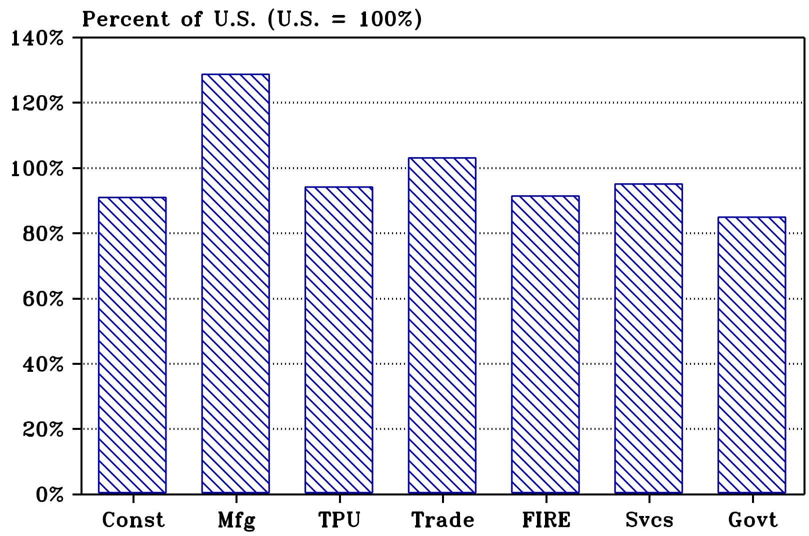
10. See the *U.S. Statistical Abstract 1993*, op. cit., table 704.

B. Employment

The regional economy supported a combined total of just over 20 million jobs in 1992.[11] Measured on a per capita basis, the regional employment level was 98 percent of the national average, with the region's businesses providing 0.53 jobs per resident compared with a U.S. total of 0.54 jobs per resident.

Figure 1 illustrates the employment intensities (i.e., a measure of the number of persons employed) in selected economic sectors within the region. The figure indexes the region's combined per capita employment in each sector to that of the United States as a whole.

FIGURE 1. REGIONAL 1992 SECTORAL EMPLOYMENT INTENSITIES



Source: Estimates are calculated from data published by the Bureau of Economic Analysis.

Sectors having an employment intensity greater than 100 percent are those which provide more jobs per capita compared to the same sectors within the United States. Similarly, those sectors with an employment intensity less than 100 percent provide fewer jobs per capita compared to those same sectors for the nation as a whole.[12]

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11. The employment data that follows are provided by the Bureau of Economic Analysis, U.S. Department of Commerce, Washington, DC, 1993. The data include wage and salaried employees as well as proprietors, self-employed, farm workers, unpaid family workers, private household workers and members of the Armed Forces.

12. The economic sectors noted include: (1) construction (referenced as "Const") - businesses/contractors involved in general building, heavy construction, special trades and other construction activities; (2) businesses involved in wholesale and retail trade ("trade"); (3) manufacturing ("Mfg") - businesses producing nondurable goods such as food products, textile products, chemicals, etc., and durable goods such as lumber and wood products, glass products, machinery, motor vehicles, etc.; (4) finance, insurance, and real estate ("FIRE") - businesses involved in banking, investment services, insurance and real estate;

As shown in Figure 1 on the previous page, the combined manufacturing sector is the backbone of the region's economic base with an employment intensity that is 129 percent of the nation as a whole. Manufacturing is strong in each of the states ranging from a high of 155 percent of U.S. levels in Indiana to a low of 110 percent in Illinois. Employment in the region's transportation and public utilities, wholesale and retail trades, and services sectors, although not as strong, closely parallels the national labor intensities.
The remainder of the economic sectors reviewed) construction, finance, insurance and real estate businesses (FIRE), and government) all have employment intensities significantly lower, ranging between 85 and 91 percent compared with the United States as a whole. Stated differently, only two of the seven industries noted in Figure 1 have employment intensities equal to, or greater than the U.S. as a whole. However, the combined number of employees in the more energy-intensive industries is significantly higher than for the U.S. average.

According to the U.S. Department of Energy, just six industries account for 84 percent of total energy use in the manufacturing sector. These include: food processing, chemicals, petroleum refining, pulp and paper, primary metals, and stone, glass and clay products.[13] The region's employment intensity in these six industries is approximately 127 percent of the U.S. average and only slightly lower than that of the overall regional manufacturing sector.[14] Normally, this suggests a higher level of industrial use of energy in a region or state. This holds true for Ohio and Indiana who both have higher employment intensities in the six industries. Similarly, Illinois and Michigan which have lower employment intensities in these industries, also have lower industrial energy use.

These same four states, with the exception of Michigan, have historically produced a considerable amount of medium and high sulfur coal, yet this abundant resource now provides relatively few jobs in the region. The region produced just over 10 percent of the nation's total coal production in 1993. This represented a reduction of almost 23

(5) transportation and public utilities ("TPU") - businesses involved in rail, air and bus transportation, trucking and warehousing, pipelines, communications, and electric, gas and sanitary services among others; (6) services ("Svcs") - businesses providing any number of services including: business, auto repair, recreational, household, health, legal, education, etc.; and (7) government ("Govt") - federal, state and local government including civilian and military enterprises. For more details on the specific type of business, products, or services within each of the respective sectors refer to the *Standard Industrial Classification Manual*, Office of Management and Budget, Washington, DC., 1987.

13. See, "Manufacturing Energy Consumption Survey Preliminary Estimates 1991," *Monthly Energy Review*, Energy Information Administration, U.S. Department of Energy, Washington, DC, September 1993, pages 1-4.

14. In spite of the significant presence of energy intensive industries, Mike McKee, vice-president and general manager for Ohio Oil Gathering (a crude oil transport company) noted during a personal communication in October 1994 that only approximately 300,000 barrels of oil are refined in the state of Ohio. Most of the crude oil produced in Ohio is transported primarily to major refineries in Pennsylvania and West Virginia. The in-state total of refined oil represents a very small percentage of the 9.2 million barrels of crude oil produced in Ohio. (This annual total for 1992 is based on personal communications with Mike McCormick at the Ohio Division of Oil and Gas, in September 1994). Mr. McKee also noted that the trend in oil well drilling in Ohio is towards deeper more productive wells. Although these new wells are helping sustain existing employment in this end of the industry, over time he believes there will be fewer total wells and fewer employees in the industry.

million short tons) approximately 20 percent less) than the region's coal production one year earlier, due apparently to the on-going shift to low-sulfur western coal.

Coal mining represents the roots of many of the region's residents. It defines the social fabric of a large number of communities. The changing structure of the coal industry can be seen in the dramatic drop in employment levels in the region's coal industry between 1979 and 1990) prior to the adoption of the Clean Air Act amendments. In 1979 employment in the coal industry was estimated at 42,668 jobs. By 1990 this had fallen to 23,220 jobs, a drop of nearly 46 percent.[15]

The prospects for future employment in the coal mining industry continue to be bleak.[16] By 1992 coal employment in the region fell almost another 15 percent to 19,778 jobs. These remaining jobs represented approximately 0.1 percent of the region's total employment for 1992.[17]

C. Energy Efficiency Industries

Unlike the conventional energy supply industries, employment related to increasing energy efficiency and utilizing renewable energy sources is on the rise in the Midwest region. There is increasing demand for energy auditors and energy service companies (i.e., companies that provide financing and/or installation of energy efficient equipment). Likewise, there are new opportunities and markets for manufacturers of energy-efficient equipment and process controls. Consider the following examples from within the region:

* The Whirlpool Corporation employs over 4,000 workers to manufacture energy-efficient refrigerators in Evansville, IN. Whirlpool is also preparing to manufacture highly efficient clothes washers at its facility in Clyde, OH, in response to anticipated tough new efficiency standards. Whirlpool plans to invest hundreds of millions of dollars and employ over 3,000 workers for manufacturing these redesigned clothes washers.[18]

* The Motorola Corporation began manufacturing high quality electronic ballasts in Buffalo Grove, IL in 1991. This highly automated manufacturing facility only

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15. Coal mining employment includes: production, preparation plant, supervisory, clerical, reclamation and others. This employment information is based on data from the Bureau of Economic Analysis, op.cit. According to *The Ohio Energy Strategy Foundation Report*, op. cit., page 75, technological and process advances increased productivity 100 percent) from 25 tons per job-day to nearly 50 tons per job-day during this same period (1979-90).

16. For a brief assessment of Ohio's coal future see "Outlook Bleak for Ohio Coal," *The Columbus Dispatch*, Columbus, OH., Sunday, May 15, 1994, as well as the editorial "Handwriting on Wall, Ohio's Coal Industry is on Borrowed Time," Wednesday, May 25, 1994, page 8A, in the same paper.

17. This information is based on coal mining employment data from the Bureau of Economic Analysis, op. cit. According to information supplied by Mack Swinford, Geologist with the Ohio Geological Survey, in August 1994, total annual coal industry employment in 1993 declined still further.

18. Personal communication with Vince Anderson, Whirlpool Corporation, Evansville, IN, Jan. 1995.

employs "hundreds of workers", but Motorola is expanding electronic ballast production and may start making other energy-efficient lighting products in the near future.[19]

* The Advanced Transformer Co., a subsidiary of Philips Lighting, employs about 1,000 workers in the assembly of electronic ballasts (including state-of-the-art dimmable electronic ballasts) in Auburn, IN. This expanding facility also indirectly supports workers at suppliers in the region, including copper and steel producers in Indiana and Ohio.[20]

* Owens-Corning Fiberglass Corp. employs nearly 2,000 workers in manufacturing fiberglass insulation in Newark and Mount Vernon, OH. Owens-Corning is expanding production having recently invested about $50 million in a new manufacturing plant. This facility produces a new type of fiberglass insulation which is lighter and more compact than conventional fiberglass insulation.[21]

* Honeywell Inc. manufactures building energy management and control systems in Arlington Heights, IL. This plant, Honeywell's primary facility making building controls, employs about 550 workers. [22]

Other manufacturers of energy-efficient products in the Midwest include Reliance Electric, Inc. which produces energy-efficient motors and adjustable speed drives in Cleveland, OH; MagneTek Universal Electric which produces energy-efficient lighting products in Huntington, IN and efficient motors in Owosso, MI; Cooper Industries which produces energy-efficient light fixtures in IL, Landis and Gyr which produces energy management and control systems in IL, and General Electric which produces energy-efficient lamps in Bucyrus and Circleville, OH. GE also produces energy-efficient electrically-commutated motors in Fort Wayne, IN. While the "energy efficiency industry" is diffuse and somewhat difficult to identify, it is a real and growing presence in the Midwest.

Some companies in the region are also developing innovative energy efficiency and renewable energy technologies. For example, Phillips Engineering of St. Joseph, MI has developed a gas-fired absorption heat pump which reduces gas use for residential space heating by about 50% compared to typical new gas furnaces. This exciting technology is going to be produced and marketed by the Carrier Corp. in the near future.

Cummins Power Generation, Inc., in Columbus, Indiana, and United Solar Systems Corporation, in Troy, Michigan are manufacturing solar thermal engines and

19. Personal communication with Howard Wolfman, Motorola Lighting Division, Buffalo Grove, IL, Jan. 1995.

20. Personal communication with Norm Grimshaw, Advanced Transformer Co., Rosemont, IL, Jan. 1995.

21. Personal communication with Brad Oelman, Owens-Corning Fiberglass Corporation, Granville, OH, Feb. 1995.

22. Personal communication with Glen Skovholt, Honeywell, Inc., Minneapolis, MN, March 1995.

photovoltaic systems, respectively, to meet a growing demand for renewable energy technologies. Sunpower Inc., located in Athens, Ohio is developing and commercializing new energy technologies such as a free-piston Stirling engine to generate electricity using solar, biomass or other fuel sources.[23] These and other entrepreneurial companies are developing cutting edge technologies which could make significant contributions to the region's economy in the future.

In addition to these direct employment opportunities, and counter to state efforts to shore up the declining coal industry,[24] groups like Rural Action, Inc., a Community Development Corporation in Ohio, are evaluating other equally valuable resources and looking at new strategies and partnerships. Recognizing the limited time span for coal employment, the group is working with local communities on "rural renewal" strategies which include job retraining. Rural Action is working with communities to help retrain today's coal miners to be energy auditors, a growing field of employment which is helping residents, business, utilities and the government save money.[25]

D. Energy Intensity Indicators

Comparing data on energy use per dollar of Gross State Product (GSP)[26] offers additional insights about the role of energy as part of the Midwest economy. Table 2 contains relevant data for both the United States and the region.

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23. This information is based on personal and written communications with Meg Hummon at Sunpower Inc., in Athens, Ohio, in August 1994. See also "EPA Touts Compressor for its Energy Efficiency," *Wall Street Journal*, Friday, June 4, 1993, page B10.

24. Illinois and Ohio have made the most aggressive moves in their region to help maintain their coal industry. In Illinois, the most recent efforts include the passage of Illinois Public Act 87-143 also referred to as the 1991 Illinois Coal Act. The Act effectively required Illinois electric utilities to burn Illinois coal. In so doing, the Act, which was invalidated by a Federal district court decision, would have limited the options of those utilities which might otherwise have switched to low-sulfur western coal to meet Phase I Clean Air Act standards but ensured markets for the state's medium and high sulfur coal. This information is based on personal communications with Bonnie Eynon at the Illinois Department of Energy, Coal Development and Marketing Division, January 1995 and the *Quarterly Coal Report*, October-December 1993, op. cit., page 9.

In a similar move aimed at assisting the declining coal industry, the state of Ohio passed a 1985 ballot issue amending the state constitution and providing up to $100 million in state bond financing to support the Ohio Coal Development Office's coal research and development activities. For more detail on projects and programs supported by these funds see the *Ohio Coal Development Agenda*, Ohio Department of Development, Ohio Coal Development Office, Columbus, Oh, 1992.

25. This information is based on personal and written communications with Carol Kuhre, director of Rural Action Inc., in August 1994. For more information on this or other programs contact Rural Action in Athens, Ohio.

26. This refers to the total value of goods and services at market prices produced by the state's economy in a given year. It includes the total purchases of goods and services by private consumers and government, gross private domestic capital investment, and net foreign trade.

As Table 2 illustrates, the region's residents and businesses spent the equivalent of 8.2 percent of the region's combined GSP on energy.[27] This ratio of energy expenditures to GSP compares to the U.S. ratio of only 7.8 percent. The state of Illinois, however, actually spent a considerably smaller percentage of its GSP (7.2 percent) compared with the other states and the U.S. as a whole. This is due to the relatively large GSP in the state) considerably higher than the other states. Ohio, Indiana and Michigan each spent higher percentages of their GSP on energy expenditures, 8.8, 9.5, and 8.3 percent respectively.

Likewise, the level of energy intensity for the region as a whole (measured as the number of Btus[28] consumed per dollar of GSP) is also significantly higher) about 6 percent greater than the U.S. level. In other words, every dollar of valued-added products generated in the region requires more energy and a higher level of spending for energy than the U.S. average.

TABLE 2. 1992 ENERGY CONSUMPTION PER DOLLAR OF GSP

	GSP (Billion $)	Energy Expenditures (Billions $)	Energy Expenditures As % of GSP	Energy Consumption (Trillion Btu)	Btus Per Dollar GSP
United States	$6,037	$472.8	7.8%	82,128	13,605
Region	$862	$70.8	8.2%	12,412	14,395

Source: The data in this table reflect primary rather than end-use energy consumption. They are adapted from the August 1994 issue of the *Survey of Current Business*, U.S. Department of Commerce, Bureau of Economic Analysis (BEA), and the Energy Information Administration's (EIA) *State Energy Price and Expenditure Report 1992*. The GSP data have been updated from 1991 figures using published information on personal income for 1992.

Contrary to this higher level of energy intensity for the region as a whole, we once again see that the state of Illinois, with the highest energy expenditures and second highest Btu consumption, has the lowest energy intensity in the region (11,732 Btus per dollar of GSP). In fact, Illinois is the only state in the region below the U.S. average, and is significantly lower than any of the other states which range from 13,871 in Michigan to 15,451 in Ohio to 19,629 in Indiana.

Although the measure of energy used to produce economic output is not a direct indicator of energy efficiency (i.e., industries can be efficient users of energy but still

27. This includes total expenditures for coal, natural gas, petroleum and electricity in the residential, commercial, industrial and transportation sectors.

28. Btus, or British Thermal Units, refers to the energy or heat value per unit quantity of fuel. One Btu is the quantity of heat needed to raise the temperature of 1 pound of water by 1 degree fahrenheit at or near 39.2 degrees fahrenheit; or roughly equivalent to the amount of heat given off by one wooden kitchen match.

consume large amounts of energy relative to other economic activities), it is interesting to note that the region uses more industrial energy per capita than the United States.

The region has a disproportionately larger share of industries which are more energy-intensive (as previously referenced). This may indicate a significant base of industries on which to build future energy policy. The four-state region as a whole accounts for approximately 14.3 percent of the nation's combined GSP and utilizes 15.1 percent of the total energy consumed nationwide.

III. REGIONAL ENERGY USE PATTERNS

A. An Overview

Overall, energy consumption in the region decreased approximately 0.4 percent between 1970 and 1992. However, as Table 3 indicates below, energy consumption actually increased 3.3 percent during the seventies and then declined 3.6 percent between 1980 and 1992. When viewed on a per capita basis we see that total energy consumption decreased 5.5 percent during this latter period, dropping from a high of 348 million Btus (MBtu) in 1980 to 329 MBtu in 1992.

Table 3 shows that energy consumption in the industrial sector is responsible for most of the total decline of energy use during 1980-1992, falling 11.9 percent. Much of the change in industrial energy use resulted from the decline of the steel industry. The impact on the region's total consumption is not surprising when we consider that the industrial sector has consistently accounted for almost 40 percent of the region's energy consumption for the years noted.

In spite of this overall decline, Table 3 also reveals that energy consumption in the commercial and transportation sectors has risen substantially since 1980. Commercial sector consumption has increased 8.9 percent while the transportation sector increased 4.8 percent. Although total and per capita energy consumption declined significantly during the same period, Ohio and Indiana consumed more energy per capita in 1992 than did the nation as a whole, consuming 5 percent and 32 percent more respectively.

As Table 4 indicates below, the region consumed 328.9 MBtu per person in 1992 compared to the U.S. total of 322 MBtu. If we were to translate this energy into an equivalent amount of gasoline, it turns out that the region requires 2,630 gallons of gasoline equivalent per capita per year. Even with the decline noted above, the industrial sector together with the residential and commercial building sectors consumed more energy per capita than the U.S. averages. Only the transportation sector requires less energy than the U.S. per capita consumption.

The industrial sector in the Midwest uses 108 percent of the U.S. average per capita energy use. It is interesting to note, however, that industrial energy use per capita is only eight percent greater than the national average while manufacturing employment is 29 percent greater than the national average.

TABLE 3. REGIONAL ENERGY CONSUMPTION 1970-1992
(IN TRILLION BTU)

Sector	1970	1975	1980	1985	1990	1992	Percent change	
							1970-80	1980-92
Residential	2,756.4	2,943.0	2,892.1	2,681.6	2,691.5	2,800.2	4.9%	-3.2%
Commercial	1,531.2	1,693.9	1,769.7	1,783.7	1,898.0	1,927.7	15.6%	8.9%
Industrial	5,737.0	5,625.0	5,544.0	4,707.6	4,900.4	4,884.1	-3.4%	-11.9%
Transportation	2,435.3	2,736.8	2,670.3	2,605.9	2,913.7	2,797.7	9.6%	4.8%
Total	12,459.9	12,998.7	12,876.1	11,778.8	12,403.6	12,409.7	3.3%	-3.6%
Per capita (MBtus)	348	356	348	321	334	329	0.2%	-5.5%
Population (000s)	35,844	36,535	36,977	36,670	37,117	37,746	3.2%	2.0%

Source: The information in this table reflects primary rather than end-use energy consumption. The data are derived from data in the *State Energy Data Report 1992*, the *Statistical Abstract of the United States 1994*, the Bureau of Economic Analysis.

Taking the major end-use sectors one at a time, the residential sector requires considerably more energy in the region at 117 percent of the national average. This is consistent with the cold winter temperatures although variations in energy efficiency might also play a role.

Commercial sector energy use is only slightly higher than the national average at 101 percent of the U.S. consumption. While the region has higher heating requirements than the country as a whole, it also has low space cooling needs. Air conditioning is a major end-use in commercial buildings.

In spite of this greater energy consumption in the residential, commercial and industrial sectors (compared with the U.S. average), the transportation sector lags far behind, at 84 percent of the U.S. average. This appears to be due primarily to greater population densities in the region.

TABLE 4. A COMPARISON OF 1992 PER CAPITA ENERGY CONSUMPTION
(IN MILLION BTUS)

	Residential	Commercial	Industrial	Transportation	Total
Region	74.2	51.1	129.5	74.2	328.9
United States	63.5	50.5	119.9	88.1	322.0

Region as Percent of U.S.	117%	101%	108%	84%	102%

Source: The information in this table is derived from data in the *State Energy Data Report 1992*, and the *Statistical Abstract of the United States 1994*. Regional estimates are based on the sum of a population based weighting for each of the states.

B. Energy Expenditures

The region used about 2.1 percent more energy per capita in 1992 than did the United States as a whole. The average energy price for that year was about one percent lower in the Midwest compared to the U.S. As a result, the per capita energy bill in 1992 of $1,876 was about 1.2 percent greater than national average.

Per capita GSP in the region was 3.5 percent lower than the national average. The end result is that families and businesses in the region spent nearly five percent more of the region's GSP for energy than did the average U.S. resident or business.[29] The Midwest's total energy expenditure was $70.8 billion in 1992. This is 60 percent larger than that region's combined collection state income and sales taxes in 1992.[30]

Table 5 provides a breakdown of total energy expenditures by fuel type and end-use sector. The expenditures are divided between coal (other than that used by electric utilities), natural gas, petroleum and electricity. The data indicate that the region's residents and businesses spent just under 78 percent of their total energy expenditures on petroleum and electricity.

The transportation sector was the largest energy user in dollar terms accounting for almost one-third of the region's 1992 total energy expenditures. Following transportation, the residential and industrial sectors each accounted for just under 26 percent, and the commercial sector accounted for approximately 17 percent.

TABLE 5. 1992 REGIONAL END-USE EXPENDITURES BY SECTOR AND FUEL (IN MILLIONS OF CURRENT DOLLARS

Sector	Coal	Natural Gas	Petroleum	Electricity	Total

29. The state's total energy expenditures for 1992 are based on the *State Energy Price and Expenditure Report 1992*, op. cit. The population and income data are taken from the *Survey of Current Business*, August 1994 and the *Statistical Abstract of the United States 1994*, op.cit.

30. According to the published data, the four-state region collected a combined $43.4 billion in state income and sales taxes in 1992. See, *Statistical Abstract of the United States 1994*, op. cit.

Residential	$31.6	$6,831.9	$1,104.9	$10,206.0	$18,174.4
Commercial	$32.2	$2,815.2	$379.4	$8,631.8	$11,858.6
Industrial	$1,199.3	$4,184.9	$4,402.8	$8,501.6	$18,288.6
Transportation	$0.0	$0.0	$22,429.3	$28.3	$22,457.6
Total Expenditures	$1,263.1	$13,832.0	$28,316.4	$27,367.7	$70,779.2

Source: This information is based on data contained in the Energy Information Administration's *State Energy Price and Expenditure Report 1992*. Based on this EIA reporting format agricultural uses are included in the industrial class together with mining, construction and manufacturing. Government uses are included with the commercial uses, together with trade and service industries.

IV. ENERGY CONSUMPTION SCENARIOS

This section of the study offers an insight into what an energy efficient future might look like) both in terms of the needed investment to develop energy efficiency technologies, and in terms of the energy bill savings and employment benefits which might accrue to such investments.

The section begins by mapping out four energy scenarios, including a baseline growth projection and three high efficiency scenarios. The baseline projection of energy consumption in the Midwest builds on current energy use patterns and then adapts the sector and end-use projections through 2010 found in the Energy Information Administration's *Annual Energy Outlook 1994* (AEO94).[31]

The first alternative scenario includes efficiency investments among all major energy resources in the period 1995 through 2010. The second examines efficiency investments only in electricity end-uses. The third examines efficiency improvements in the nation's cars and other light duty vehicles.

A. Baseline Energy Consumption Scenario

We began by establishing a reasonable baseline projection of energy consumption patterns in the period 1992 through 2010, assuming current trends and policies are continued. A variety of Energy Information Administration (EIA) data were used for this purpose. The starting point for the regional baseline projection was the actual primary energy use patterns in Illinois, Indiana, Michigan and Ohio for the residential, commercial, industrial and transportation sectors in 1992.[32]

31. Energy Information Administration, *Annual Energy Outlook 1994*, U.S. Department of Energy, Washington, DC, January 1994.

32. See *State Energy Data Report*, op. cit.

With the exception of industrial energy use, the projected change in energy consumption reflected the forecasts contained in the AEO94.[33] In that report, total energy use in the residential sector was forecast to grow at a rate of 0.3 percent annually in the period 1992-2010. The energy growth rates for the commercial and transportation sectors were forecast to increase 0.5 and 1.5 percent, respectively. For electricity, it was forecast that both residential and commercial uses would increase 0.7 percent annually. Transportation uses of electricity were omitted in this analysis.

Because the industrial sector represents a group of end-users that is significantly different at the regional level than at the national level, a different approach was used. As described in more detail below, the result was a projected growth rate of 1.6 percent for total energy and 1.7 percent for electricity uses. These growth estimates account for charges in activity level for each industry group. The forecast also accounts to some degree for the reduction in fuel intensity and increase in electricity intensity due to energy efficiency improvements from modernization and changes in product mix.[34] The AEO94 shows a slightly smaller increase of 1.2 percent for all end-uses in the industrial sector and a slightly larger figure of 1.8 percent for electricity end-uses.[35]

The average annual growth rate in total primary energy use was projected at 1.28 percent for the region, which is only slightly higher than the AEO94 national growth trend of 1.20 percent annually. The growth rate for electricity only was estimated to be 1.15 percent in the midwest region compared to the AEO94 national electricity growth trend of 1.26 percent annually.[36] Figures 2 through 4 highlight the overall trend of the baseline projections and alternative efficiency scenarios in the period 1992 through 2010 for total energy consumption (Figure 2), electricity only consumption (Figure 3), and transportation fuels (Figure 4).

Using the sectoral growth assumptions, we projected that total primary energy use in the four-state region would rise from 12,410 TBtu in 1992 to 15,600 TBtu in 2010, a 25.8 percent increase in consumption over that period. This trend is illustrated as the "Baseline Projection" in Figure 2.

Electricity growth was projected to rise from 418 million kilowatt-hours (kWh) in 1992 to 513 million kWh in 2010, a 23 percent increase in consumption over that same period. The baseline electricity trend is illustrated as the "Baseline Projection" in Figure 3.

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33. *Annual Energy Outlook 1994*, op. cit. It should be noted that since this analysis has been completed, the *Annual Energy Outlook 1995* has been issued. Although there are some modest changes in price changes and energy growth trends, they do not affect the overall results discussed here.

34. M.H. Ross, P. Thimmapuram, R.E. Fisher and W. Maciorowski, *Long Term Industrial Energy Forecasting (LIEF) Model (18 Sector Model)*, Argonne National Laboratory, Argonne, IL, 1993.

35. Some observers feel that the *Annual Energy Outlook* under projects electricity growth and over projects fuel growth because it does no adequately take into account increased use of electrotechnologies and changes in processes and products used by manufacturers (per conversation with M.R. Ross, University of Michigan, Ann Arbor, MI, April 1995). Acknowledging this potential problem, this report however relies upon the *Annual Energy Outlook* forecast for its energy growth assumptions.

36. It should be noted that the intent of the analysis was not to "forecast" energy trends, but to "project" reasonable energy use patterns for purposes of evaluating the impact of a high energy efficiency scenario.

Finally, the growth of transportation fuels was projected to increase from 23.4 billion gallons in 1992 to 29.3 billion gallons in 2010, a 25 percent increase. The baseline growth in these fuels is illustrated as the "Baseline Projection" in Figure 3.

FIGURE 2. MIDWEST TOTAL ENERGY SCENARIOS (IN TBTUS)

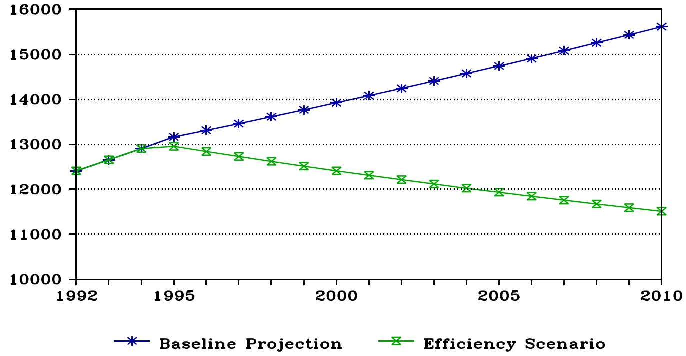


FIGURE 3. MIDWEST ELECTRICITY SCENARIOS (IN BILLION KWH)

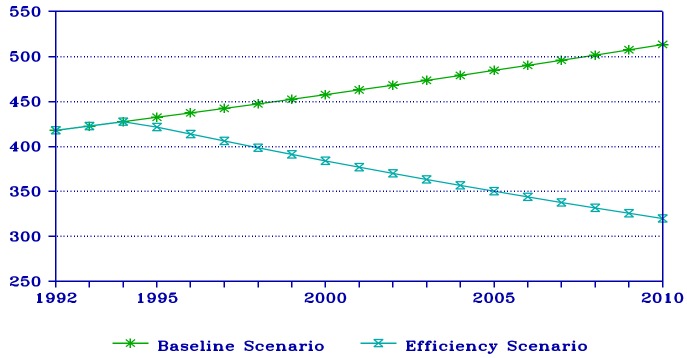
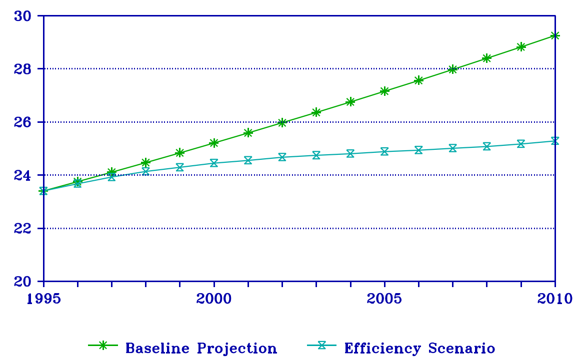


FIGURE 4. MIDWEST TRANSPORTATION SCENARIOS (IN BILLION GALLONS)



Source: Calculations for all three figures on this page by the American Council for an Energy-Efficient Economy based upon assumptions described in the text.

B. High Efficiency Scenarios

The efficiency trends for both the total energy and the electricity-only scenarios, on the other hand, were adapted from scenarios that build on assumptions about cost-effective energy efficiency investments. The data are taken from a variety of industry and other published sources. For the most part, the efficiency scenarios are based upon technologies that are now cost-effective and available in the marketplace. A few of the energy efficiency measures are advanced technologies that are expected to be available in the near future.

The "Efficiency Scenario" shown in Figure 2 suggests that the baseline consumption for total energy in the year 2010 could be lowered by 26 percent, from 15,600 to only 11,300 TBtus. This would put the Midwest region's energy consumption at about seven percent below its 1992 level. The "Efficiency Scenario" for electricity shown in Figure 3 suggests that electricity consumption could be reduced by 38 percent, or about 23 percent below the 1992 levels. The transportation "Efficiency Scenario" shown in Figure 4 suggests that transportation fuels could be reduced by 14 percent, or about 23 percent below the 1992 levels.

Table 6 summarizes both the cumulative investment required for each major end-use sector to achieve the 26 percent total energy savings, the 38 percent electricity savings, and the 14 percent savings in transportation fuels over the 16-year period from 1995 through 2010. It also highlights the cumulative energy bill savings as well as the benefit-cost ratios associated with each end-use sector. The comparison understates the overall cost-effectiveness of the energy efficiency investments because energy savings will continue well beyond 2010.

To build the energy efficiency scenarios, the economy was disaggregated into the four basic end-use sectors as in the baseline projections. These included: (1) residential buildings, (2) commercial buildings, (3) industrial applications in the agricultural, mining, construction and manufacturing sectors; and (4) automobiles and light-duty trucks within the transportation sector. Separate analytical models unique to each of the four end-use sectors were used to construct the efficiency scenarios.

The analysis attempted to identify an optimum level of cost-effective energy efficiency improvements that could be obtained by the year 2010. The economic criterion applied in the energy efficiency analysis was that the amortized cost of saved energy for a given energy efficiency technology would be less than or equal to the long-run marginal cost of conventional energy resources.

TABLE 6. CUMULATIVE EFFICIENCY INVESTMENTS AND SAVINGS: 1995-2010
(In Billions of 1990 Dollars)

	Residential	Commercial	Industrial	Transportation	Total
Full Efficiency Scenario					
Investment	30.5	12.5	45.0	16.3	104.3
Savings	56.7	40.9	55.6	29.8	182.9

Benefit-Cost Ratio	1.86	3.27	1.23	1.82	1.75
Electricity Only Scenario					
Investment	13.7	11.4	26.6	0	51.7
Savings	33.2	38.5	32.8	0	104.4
Benefit-Cost Ratio	2.42	3.37	1.23	NA	2.02

The macroeconomic analysis reviewed in subsequent sections uses a 1990 base-year. For that reason, the long-run cost is assumed to be the 1990 price paid by each end-use sector in the Midwest for each displaced energy resource. This assumes increases in the price of energy match the rate of inflation. While not an exact measure of long-run energy costs, it is a conservative assumption given the anticipated real energy price increases published by the U.S. Department of Energy.[37]

Each efficiency investment is assumed to be amortized over its effective life using a five percent real discount rate. For example, installing more efficient lighting fixtures in an existing office building might reduce electricity consumption annually by about 4.85 kilowatt-hours (kWh) per square foot of occupied space at a cost of $0.50 per square foot. Once the change is made, the equipment can be expected to last 20 years.

At a five percent discount rate, the investment would be amortized at a rate of 8.02 percent annually.[38] Thus, the annualized cost is $0.50 times 0.0802, or $0.0401 per square foot. Saving 4.85 kWh implies a cost of saved energy (CSE) of $0.0401 divided by 4.85, or $0.0083 per kWh. Since the 1990 commercial cost of electricity in Ohio was $0.073 per kWh, this particular measure would clearly be considered cost effective. All technology choices were treated in this manner. A more complete description of the end-use analyses and the assumptions that were used in the analysis which follows.

An important caveat should be noted at this point. The intent of the high efficiency scenarios is to construct a reasonable profile of investments and energy use impacts, assuming that cost-effective efficiency measures are widely adopted over the 16-year period of the analysis. Hence, this analysis is not a forecast of what will likely occur given current trends. The high efficiency scenarios represent, however, a highly possible energy future and, as we will show, a desirable economic future for the Midwest region.

1. Building Efficiency

37. See, *Annual Energy Outlook 1994*, op. cit., Table A3. In that volume, the average annual increase in real energy prices for the period 1992-2010 are shown to be 0.6 percent for electricity, 1.7 percent for petroleum products and 2.3 percent for natural gas. Rising real costs imply that new resources will cost more than the cost of existing resources.

38. This is based upon the standard amortization formula, $i/(1-(1/(1+i)^n))$, where i is the discount rate and n is the life of the measure.

ACEEE developed residential and commercial building prototypes using the DOE-2.1E building energy simulation computer program.[39] Commercial building prototypes were developed using data from the Gas Research Institute, Lawrence Berkeley Laboratory, Union Electric Company and PSI Energy.[40] Residential building prototypes were developed using data from a number of sources that are summarized in a study by the American Council for an Energy-Efficient Economy.[41] Both sets of building prototypes were adjusted to reflect regional data found in a variety sources from the Energy Information Administration.[42]

Four residential and eight commercial building prototypes were developed in addition to the residential appliance profiles. The residential prototypes include Existing Multifamily Apartment, New Multifamily Apartment, Existing Single Family Detached, and New Single Family Detached. The commercial prototypes include Existing Medium Office, New Medium Office, Existing Medium Retail, New Medium Retail, Existing School, New School, Existing Warehouse and New Warehouse. For those weather sensitive heating and cooling loads, weather patterns for the East North Central Census region were used to adapt the DOE-2.1E model. Residential appliance data were developed specifically for this analysis.[43]

From the data generated by the DOE-2.1E model, four building composites were created and applied in the residential and commercial scenario analyses, respectively. The composites were derived from regional estimates of total square footage of the available

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39. Use of the DOE-2.1E model and the data assumptions that underpinned the analysis are documented in a June 1994 unpublished technical memorandum prepared for ACEEE by Robert Mowris, a consulting engineer based in Berkeley, CA. More details of the buildings analysis are provided in Appendix B of this report.

40. See, *481 Prototypical Commercial Buildings for Twenty Urban Market Areas*, GRI-90/0326, Gas Research Institute, Arlington, VA, April 1991; A. Usibelli, et al., *Commercial-Sector Conservation Technologies*, Lawrence Berkeley Laboratory, Berkeley, CA, 1985; *Existing Commercial Building Prototypes*, *Union Electric DSM Potential Study*, Union Electric Company, St. Louis, MO, June 1993; and Synergistic Resources Corporation, *New Construction Benchmark Survey*, PSI Energy, Plainfield, IN, December 1992.

41. Loretta Smith and Steve Nadel, *Energy Efficiency Codes and Standards for Illinois*, American Council for an Energy-Efficient Economy, Washington, DC, December 1993.

42. See especially, the East-North Central building data found in, Energy Information Administration, *Household Energy Consumption and Expenditures 1990*, U.S. Department of Energy, Washington, DC, February 1993; and Energy Information Administration, *Commercial Buildings Energy Consumption and Expenditures 1989*, U.S. Department of Energy, Washington, DC, April 1992.

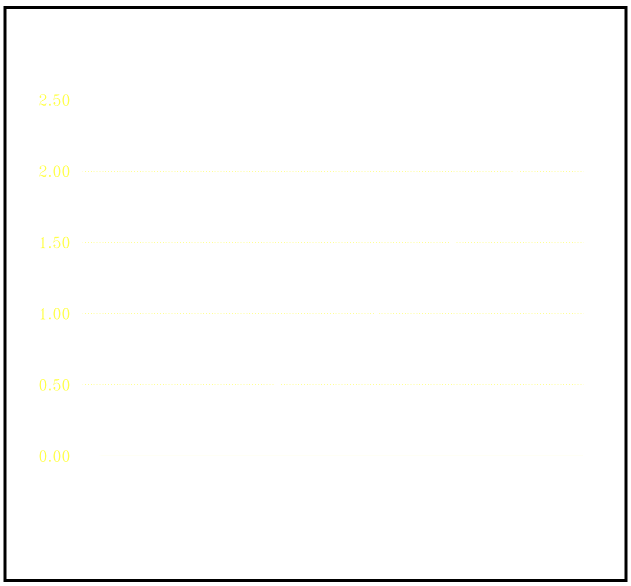
43. Steve Nadel, unpublished appliance analysis drawing from a variety of contemporary resource data, American Council for an Energy-Efficient Economy, Summer 1994. The appliances include natural gas and electric water heaters, clothes washers and dryers, refrigerators, freezers and lighting. See also Appendix B for further discussion on residential appliance energy savings.

building types. Residential appliance and other energy savings) including lighting, water heating and other uses) were estimated separately. Thus, the residential composites reflect only the space conditioning (i.e., heating and cooling) needs of those buildings. The commercial buildings composites reflect heating, cooling, lighting and office equipment loads.

Figure 5 offers a typical efficiency cost curve for the heating and cooling of Midwest buildings. It also highlights where each of the building types fall in relation to that average. The vertical axis shows the investment needed per square foot of building type. The horizontal axis shows the level of savings that might be achieved per square foot. As an example, each $1.00 investment in energy efficiency upgrades can be expected to save, on average, about 48 thousand Btus (kBtu) of primary energy use for that square foot of building space. This trend is shown as the solid line curve in Figure 5.

Table 7 summarizes the results of the energy efficiency analysis for the residential and commercial sectors. An overall cost effective potential ranging from 32 percent in new commercial buildings to 56 percent for efficency improvements in space conditioning in existing residential buildings was found. These are the maximum levels of energy savings found to be cost-effective within the building sectors.[44]

FIGURE 5. BUILDING COST CURVES



The baseline residential projection was designed to reflect an average 0.3 percent annual growth in primary energy consumption in the years 1992 through 2010. Within that growth pattern, we assumed that existing residential units would be lost at the rate of 0.8 percent per year. They would be replaced by new dwellings that met tighter building code standards at the rate of 1.1 percent annually. Appliance energy use would grow at a rate of about 0.4 percent annually. These values generally reflect the reference case data found in *Annual Energy Outlook 1994* previously noted.

The efficiency investments begin in 1995 for the residential high efficiency scenario. Because of the large number of existing residential dwellings, it was assumed that only 80 percent of the cost-effective savings would be achieved in existing buildings by the year 2010. This implies that

44. The energy savings shown in Table 7 might be properly referred to as the economic potential for efficiency potential. As will be seen later in the discussion, other assumptions such as market penetration rates translate into savings of only 36 percent compared to baseline assumptions rather than the 50+ percent suggested by Table 7. The same comment applies to the commercial buildings as well.

existing buildings would be retrofitted at a linear rate of five percent annually over the 16-year period 1995 through 2010. More energy-efficient appliances would be adopted at the same rate of five percent annually. For new dwellings, it was assumed that additional savings would be captured in as many as 90 percent of the units within a 5-year period, ramping up at a linear rate of 18 percent of new units per year.

The result of these assumptions is that by the year 2010, residential energy consumption would be 36 percent lower compared to baseline projections. This implies a 2.9 percent annual rate of reduction in residential energy use relative to the baseline projection.

TABLE 7. SUMMARY DATA FOR BUILDING EFFICIENCY ANALYSIS

Category of Impact	Residential Buildings (MBtu/dwelling)			Commercial Buildings (kBtu/sf)	
	Space Conditioning Existing Units	Space Conditioning New Units	All Other Uses Including Appliances	All Uses Existing Units	All Uses New Units
Base Usage Per Unit	89.6	52.4	93.9	195.1	144.3
Cost-Effective Savings Per Unit	50.2	27.4	31.2	76.0	46.3
Overall Savings (%)	56%	52%	33%	39%	32%
Electricity Savings (%)	21%	26%	80%	88%	97%
Natural Gas Savings (%)	79%	74%	20%	12%	3%
Efficiency Investment Per Unit	$1,506	$1,373	$765	$1.29	$0.85
First Year Savings Per Unit	520	$458	$225	$0.51	$0.32
Simple Payback (years)	5.4	8.7	3.4	2.6	2.7
Average Energy Price ($/MBtu)	$5.59	$5.73	$7.21	$6.64	$6.84
Cost of Saved Energy ($/MBtu)	$2.41	$4.01	$1.97	$1.36	$1.47

Notes: All energy values and prices reflect primary rather than end-use perspectives. Electricity was converted using the assumption of a 32 percent delivered efficiency. The energy costs reflect weighted primary energy costs. These vary according to the fuel mix assumed in each building prototype. The "MBtu/Dwelling" refers to a value of million Btus per residential unit while "kBtu/sf" refers 1,000 Btus per square foot. Simple payback is derived by dividing the efficiency investment by the anticipated first-year savings. The cost of saved energy reflects the annualized cost of the efficiency investment (in dollars per million Btus) as amortized over the life of the investment, using a five percent real discount rate.

As shown in Table 6, the high efficiency residential scenario requires a $30.4 billion efficiency investment over the period 1995 through 2010. Cumulative energy bill savings (based upon 1990 energy prices) would be $56.7 billion.[45] Hence, the benefit-cost ratio for a residential building scenario is 1.86. This ratio is a conservative estimate since energy savings will continue after 2010.

The high efficiency electricity scenario for the residential sector requires a $13.8 billion investment to lower consumption by 33 percent compared to year 2010 baseline projections. Cumulative electricity bill savings would be $33.2 billion for a benefit-cost ratio of 2.42.

The baseline commercial sector scenario was designed to reflect an average 0.5 percent annual growth in primary energy consumption in the years 1992 through 2010. The commercial efficiency investments also begin in 1995. Existing commercial buildings would be lost at the rate of 1.3 percent per year while new units would be built at the rate of 1.8 percent annually. Again, these values generally reflect the reference case data found in the *Annual Energy Outlook 1994*.

In the case of existing commercial buildings, we assumed that 90 percent of the full economic energy efficiency improvements would be captured over the 16-year period. This implies that efficiency improvements in existing commercial buildings will increase linearly at a rate of 5.63 percent annually. For new buildings, it was assumed that 90 percent of the economic savings would be captured within a 5-year period, ramping up at a linear rate of 18 percent per year.

The result of these assumptions is that by the year 2010, commercial sector energy consumption would be 35 percent lower compared to baseline projections. This implies a 2.8 percent annual rate of reduction in commercial energy use relative to the baseline scenario.

As shown in Table 6, the high efficiency scenario requires a $12.5 billion efficiency investment in energy efficiency measures in commercial buildingsover the period 1995 through 2010. Cumulative energy bill savings (also based upon 1990 energy prices) would be $40.1 billion. Commercial use of electricity would drop an estimated 45 percent for an investment of $11.3 billion through 2010. Cumulative electric bills savings would be an estimated $38.3 billion. The benefit-cost ratios would be 3.21 and 3.39 for the total energy and electric-only scenarios, respectively. The higher benefit-cost ratios are an indication of the more cost-effective energy savings that can be captured in commercial buildings, due to the extensive opportunities for efficiency improvements in electricity uses, such as commercial lighting, motors, space conditioning, and office equipment.

2. Industrial Efficiency

45. The macroeconomic analysis of the high efficiency scenario is based upon a 1990 Midwest input-output economic model. To simplify the analysis, 1990 energy prices were used in determining energy bill savings. Since real prices are expected to increase (see note 33, supra), this tends to understate savings in the economy.

The industrial sector represents a diverse grouping of entities including: farming, agricultural services, forestry, fisheries, mining, construction and manufacturing. Because of this diversity, and the fact that energy use is an integral part of many of the operations performed in this sector, a different approach was required from that used for buildings.

As part of this effort, ACEEE has developed a methodology for the estimation of base case energy consumption in the industrial sector at the state level and the potential for cost-effective energy-efficiency improvements. This analysis requires three steps: (1) project a consumption baseline for the industry groups in each state and then aggregate to the region; (2) estimate the economically viable savings potential from efficiency measures for each industry group in the region; and (3) estimate the investment necessary to achieve and maintain that savings.

Information on energy consumption within the industrial sector at any level other than the national level has been difficult to obtain and is of varying quality. Energy end-use varies widely among the different industry groups, and even among industries within some of those groups, so the energy efficiency opportunities also vary.[46]

Among the states, the distribution of industries can vary widely. Though the total fuel consumption in the four states studied is similar, there is significant variation in the distribution among the 12 industry groupings considered (Figure 6). Estimated electricity consumption is significantly higher in Ohio than in the other states (Figure 7) in large part because of the high consumption in metals, chemicals, mining and paper industry groups. In particular, the presence of two older, large electricity consumers, an aluminum (SIC 3334) plant in Hannibal and a uranium enrichment (SIC 2819) plant in Portsmouth will account for a significant portion of this concentration.[47] Because actual consumption at these facilities is unknown, the distribution of electricity may under reflect consumption in the primary metals and chemicals sectors.

46. R. Neal Elliott, *Electricity Consumption and the Potential for Electric Energy Savings in the Manufacturing Sector*, American Council for an Energy-Efficient Economy, Washington, DC, 1994; M.H. Ross, et al., op. cit.

47. personal communication with M.H. Ross, University of Michigan, Ann Arbor, MI.

FIGURE 6. ESTIMATED 1991 INDUSTRIAL FUEL CONSUMPTION

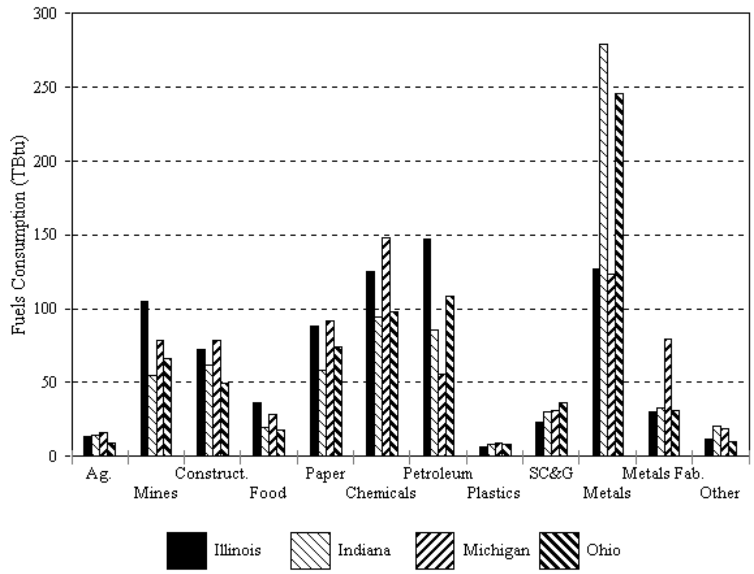
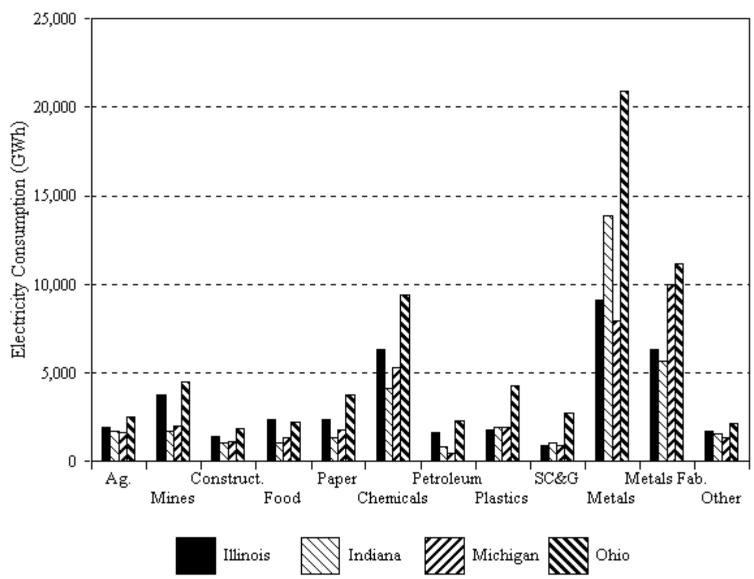


FIGURE 7. ESTIMATED 1991 INDUSTRIAL ELECTRICITY CONSUMPTION



Source: Calculations by the American Council for an Energy-Efficient Economy based upon assumptions described in the text.

As a result of these factors, it is important to have a representative disaggregation of energy use within the industrial sector in order to make meaningful estimates of the potential for energy efficiency improvements and identify areas of greatest opportunity for energy savings. This study uses state employment data to apportion *State Energy Data Report*[48] estimates of industrial energy consumption at the state level to eleven industrial groupings.

Annual Energy Outlook 1994[49] projections for energy growth for industrial groups at the national level are combined with Bureau of Economic Analysis[50] estimates of employment growth at the national and state levels to develop estimates of energy consumption growth for each industry grouping at the state level. These data are then used to project a baseline energy consumption for the industry sector to the year 2010. Estimates of consumption are made for electricity, all other fuels combined, and total primary energy. As mentioned previously, this procedure leads to assumed annual growth rates of 1.6 percent for all energy uses and 1.7 percent for electricity during 1992-2010.

The energy efficiency potential was estimated using conservation supply curves derived from the Long-Term Industrial Energy Forecasting (LIEF) model.[51] Most conservation supply curves have been developed by combining various characteristic measures for a particular market. Such an approach is impractical for the industrial sector because of the complexity and site-specific nature of many efficiency measures.

The LIEF curves were developed from a historical analysis from 1958-1985 of sectoral energy intensities and prices. The model segregates industries into 18 categories that have similar energy use characteristics based on their historical energy use data, and treats electricity and all other fuels use separately.

The LIEF model uses electricity and fuel prices to estimate the economically acceptable energy efficiency potential. We estimated average regional energy prices for each fuel[52] by consumption weighting the average state prices of each fuel. The fuel price for each industry is calculated using the regional average fuel prices and the national average fuel mix[53] to develop a consumption-weighted fuel price.

As is evident from Table 8, there is some price variation among the states, particularly for electricity. While this price structure has been in place for some time meaning that

48. *State Energy Data Report 1992*, op. cit.

49. *Annual Energy Outlook 1994*, op. cit.

50. Bureau of Economic Analysis, *Regional Employment Database*, U.S. Department of Commerce, Washington, DC, 1994.

51. Ross, et al., op. cit.

52. *State Energy Price and Expenditure Report 1992*, op. cit.

53. "Manufacturing Energy Consumption Survey Preliminary estimates, 1991", op.cit.

some of the extra efficiency opportunities already have been implemented, the high electricity price states of Illinois and Michigan may account for a disproportionate share of the electricity efficiency potential. A similar situation exists for fuel, though to a lesser extent since the price variations for petroleum, coal and natural gas cancel each other out. For example, Illinois has the highest gas prices but the lowest coal prices.

Table 9, on the following page, presents the average regional electricity and fuel prices for 11 industry groupings and the efficiency potential by industry at different energy prices. The savings potential is measured as the percent reduction from the baseline consumption estimate of a given industry.

The potential efficiency values in Table 9 are developed specifically for the four-state region. The maximum economic savings potential was assumed to be the point on the curve at which the marginal cost of energy saved equalled the current fuel or electricity price. In the case of electricity, the average 1990 price of industrial electricity ($0.047/kWh) was used.[54] For other fuels, the estimated average price based on fuel mix for that particular industry group was used. The efficiency curves reflect the different savings potential based upon price and industry.

As an example, if a food processing plant pays $0.04 per kilowatt-hour (kWh) for electricity, the efficiency potential is 48 percent of current consumption. For a primary metals manufacturing plant, the savings potential is only be 32 percent at $3.00 per million Btus. The difference is a function of both the way each industry typically uses energy and the steps already undertaken by that industry to save energy.

The investment needed to achieved a particular level of energy savings is based on the assumptions of an average ten-year technology life and a five percent real discount rate. In reality, the life of the measures will vary depending upon the measure and the point in the economic cycle of the specific plant at which the measure is applied. Ten years is the median life for many of the industrial measures and is used as a simplifying assumption.

Efficiency investments in the high efficiency scenario are estimated by multiplying the estimated energy savings in each year by the average capital cost. The investment is calculated for each industry grouping since the average fuel price varies by industry due to differences in fuel mix. Because the average measure life is assumed to be 10 years, the capital expenditures made in the first years must be repeated beginning in 2005 in order to maintain the savings realized in those prior years.

TABLE 8. MIDWEST REGIONAL AND STATE INDUSTRIAL FUEL PRICES AND CONSUMPTION

Fuel Prices (1)	4-State Region	Illinois	Indiana	Michigan	Ohio

54. *State Energy Price and Expenditure Report 1992*, op. cit.

Electricity ($/kWh)	0.047	0.054	0.041	0.058	0.040
Residual ($/MBtu)	2.57	2.29	2.64	3.15	2.54
Distillate ($/MBtu)	6.21	6.67	6.14	6.01	5.78
LPG ($/MBtu)	9.43	9.55	9.36	9.36	9.36
Nat. Gas ($/MBtu)	3.82	4.01	3.57	3.72	3.92
Coal ($/MBtu)	1.68	1.58	1.72	1.78	1.63
1991 Consumption (2)					
Electricity (GWh)	179,786	39,299	35,743	35,062	69,682
Fuel (TBTU)					
Coal	860	151	343	118	248
Natural Gas	1,112	282	232	303	295
Petroleum (3)	976	337	222	155	263

Notes: (1) Source: *1991 State Energy Data Report*, op.cit.
(2) Source: *1991 State Energy Price and Expenditure Report*, op. cit.
(3) Petroleum consumption weighting is applied to distillate, residual and LPG.

It is assumed that 100 percent of the maximum savings shown in Table 9 is achievable by the year 2010. But it is assumed that energy efficiency measures are implemented gradually. In particular, the annual savings, beginning in 1995, was estimated as one-sixteenth of the maximum potential. In other words, it is assumed that the efficiency measures are implemented linearly over the 16-year period.

TABLE 9. COST-EFFECTIVE SAVINGS POTENTIAL BASED ON ENERGY PRICE

Industry	Average 1990 Price		Electricity Savings ($/kWh)			Fuel Savings ($/MBtu)		
	Electricity	Fuel	$0.02	$0.04	$0.06	$3.00	$5.00	$7.00
Agriculture	$0.047	$6.76	10%	40%	53%	35%	49%	57%
Mining	$0.047	$4.18	10%	40%	53%	37%	54%	62%
Construction	$0.047	$4.79	10%	40%	53%	35%	49%	57%
Food	$0.047	$3.10	21%	48%	59%	32%	44%	51%
Pulp & Paper	$0.047	$1.32	11%	25%	32%	22%	29%	34%
Chemicals	$0.047	$2.67	11%	25%	32%	22%	29%	34%
Petroleum Refining	$0.047	$1.43	11%	25%	32%	35%	49%	57%
Rubber and Plastics	$0.047	$3.63	14%	57%	71%	37%	54%	62%
Primary Metals	$0.047	$2.13	4%	22%	31%	17%	25%	30%
Metal Fabrication	$0.047	$3.52	14%	57%	71%	37%	54%	62%
Other Manufacturing	$0.047	$2.78	21%	48%	59%	32%	44%	51%

Notes: This table shows the energy savings potential in percent based upon the price of energy paid by the respective industry. The electricity prices are shown as dollars per kilowatt-hour ($/kWh) while fuel prices are dollars per million Btus ($/MBtu). The savings refer to the percent reduction from baseline consumption estimates. The estimates shown here are taken from the Long-Term Industrial Forecast (LIEF) model described in the text.

The result of these assumptions is that by the year 2010, primary energy consumption in the industrial sector is reduced by 26 percent compared to the baseline projection. Total electricity consumption decreases over time in the high efficiency scenario, resulting in 35 percent less electricity consumption in 2010 compared to baseline projections. The potential for conserving industrial fuels is a more modest 20 percent. In large part, this is because average fuel prices are low in key industries such as steel, paper, chemicals, and petroleum refining.

The high efficiency scenario requires a $45.0 billion investment in greater energy efficiency over the period 1995 through 2010 (in constant 1990 dollars). Cumulative bill savings (based upon 1990 energy prices) would be $55.6 billion. Hence, the benefit-cost ratio for the industrial sector scenario is 1.23.[55]

3. Transportation Efficiency

In the transportation sector, only light duty vehicle (i.e., cars and light trucks) fuel efficiency improvements are estimated as part of the overall high efficiency scenario. In other words, truck, air and water travel were ignored as were any effects from reduced travel demand (i.e., increased use of mass transit or carpooling). Thus, only about 60 percent of the transportation fuel consumption is directly addressed in this analysis.

An engineering-economic analysis was performed in 1993 by DeCicco and Ross to estimate the costs of improving new light duty vehicle fuel economy under varying assumptions about the availability of technology. For the purposes of this study, ACEEE adopted the mid-range estimates of the 1993 report for the 1995-2005 time period. These are given as a cost curve in Figure 8. The efficiency improvement potential for 2010 is based on the higher-range estimates, using a similar methodology.[56]

The curve in Figure 8 represents the average new vehicle price increment (referenced in 1990 dollars) needed to achieve a given percentage increase in new vehicle fuel economy (measured in miles per gallon) over the base year level. To facilitate

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55. At first glance, the industrial benefit-cost ratio may appear to be unusually low. But we need to make a distinction between the benefit-cost ratio of a project and a scenario. A single project with a payback of 4 years and a life of 10 years will have a benefit-cost ratio of 2.5. But a scenario with investments made annually over a 16-year period, will always be incurring new investments, especially in the outlying years which may never pay for themselves within the time frame of the scenario, but which may be excellent investments as individual projects. This is all the more important to understand within the industrial sector since many projects may have effective lives of less than 10-years (compared to commercial buildings, for example, which may last 20, 30, 40 or more years). This means that in the 11th year, not only will a new investment be required to achieve a new level of efficiency, but the investments made in year one will have to be made yet again to keep the same level of efficiency benefit.

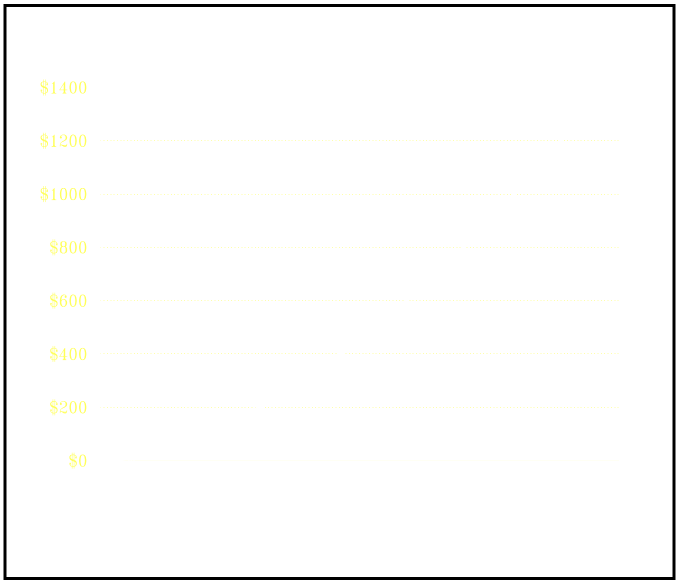
56. John M. DeCicco and Marc Ross, *An Updated Assessment of the Near-Term Potential for Improving Automotive Fuel Economy*, American Council for an Energy-Efficient Economy, Washington, DC, November 1993. The mid-range values referred to here are the Level 2 estimates in the DeCicco/Ross study while the higher-range values are the Level 3 estimates.

comparisons at various fuel prices, the empirically derived cost-benefit estimates were fit to a power function. The following relationship represents the DeCicco-Ross mid-range cost curve:

$$COST = \$1468 * PCNT^{1.6937}$$

where COST is average new vehicle price increment (in 1990 dollars) and PCNT is percentage fuel economy increase over the base year level.[57] Economic measures such as cost of saved energy (CSE) were derived from this relation using standard formulas and appropriate assumptions regarding vehicle usage, lifetime, and discount rate.

FIGURE 8. VEHICLE EFFICIENCY COST CURVE



Technology improvements for raising new car and light truck fuel economy are assumed to be phased in over a roughly 10-year time horizon (by 2005). For example, this scenario would have average new car fuel economy reaching 36 miles per gallon by 2000 and 45 miles per gallon by 2005, compared to 27.8 miles per gallon in 1995.

The appropriate gasoline price against which to compare the costs of fuel economy improvement is a levelized retail fuel price over the ownership period of the vehicles. For example, the projected national average gasoline price in 2010 is $1.37/gallon (in 1990 dollars, including state and federal taxes). This price provides a reasonable estimate of the average avoided fuel cost over the life of new vehicles sold in 2005.

The cost of saved energy for automotive technology improvements is computed using a five percent real discount rate and a 12-year vehicle lifetime. Using these life-cycle costing assumptions yields the estimate that 65 percent improvement in fuel economy would be cost-effective for new vehicles in 2005.

Market-wide costs of fuel economy improvement are estimated at the new car and light truck retail level. While initial investments are made by the auto industry and their suppliers, the costs of technology improvement are assumed to be fully passed on to car buyers. We assume a linear increase in new fleet fuel economy starting in 1996; we use a rate of six percent improvement per year, so that by 2005 the new vehicle fleet has an efficiency 60 percent higher than that in the base year (slightly below the estimated cost-effective potential of 65 percent).

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57. The fit is quite good for this cost curve since the R-squared value is 0.997.

Ongoing advances in automotive engineering are expected to make yet further efficiency improvements available in the post-2005 time frame. As noted above, we assume that further progress is captured by the DeCicco and Ross high range estimates, which estimate the technical feasibility of a 90 percent improvement (over the 1990 new fleet average fuel economy). Therefore, we assume that annual six percent increases in fuel economy continue through 2010, by when a 90 percent improvement would be achieved. This implies a new car fuel economy of 53 miles per gallon in 2010.

To estimate the energy savings from higher fuel economy, one must account for the vehicle stock (all cars and trucks, new and used, in service within a given year) and its turnover. A stock retirement model was constructed using vehicle usage and scrappage statistics.[58] This model first estimates the EPA-rated fuel economy of all cars and light trucks on the road by weighting vehicles of a given age according to their probability of survival to that age and the average number of annual miles driven by age. Further details on this technique are described by DeCicco.[59]

Because on-road fuel economy is lower than EPA-rated fuel economy, a 20 percent downward adjustment is made to account for the shortfall, based on the estimates of Mintz et al.[60] Finally, adjustments are made to account for the takeback (rebound) effect of greater driving because higher fuel economy lowers the cost per mile. Takeback was computed using an elasticity of travel with respect to fuel cost of -0.1 based.[61] The result is a series of estimates of the projected real-world average fuel economy of cars and light trucks on the road (new and used) in each future year, corresponding to the progress in new vehicle fuel economy described above.

Based upon the economic assumptions found in the *Annual Energy Outlook 1994*, total transportation energy use was projected to rise by about 1.5 percent annually in the baseline scenario. Adapting the light-duty vehicle efficiency assumptions described above, consumption will rise by only 0.5 percent annually. Unlike the buildings sectors, for example, this is still a positive growth rate since efficiency improvements are only made in vehicles that account for about 60 percent of total transportation energy.

Again referencing data in Table 6, the cumulative investment required by consumers for increasing vehicle efficiency is estimated at $16.3 billion while the cumulative savings are pegged at $29.8 billion (in 1990 dollars). Thus, the benefit-cost ratio is 1.82.

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58. See, S.C. Davis and S.G. Strang, *Transportation Energy Data Book: Edition 13*, Report ORNL-6743, Oak Ridge National Laboratory, March 1993.

59. See John M. DeCicco, "Projected fuel savings and emissions reductions from light vehicle fuel economy standards," *Transportation Research* 29A(1), forthcoming, 1994.

60. M.M. Mintz, A.R.D. Vyas, and L.A. Conley, "Differences between EPA-test and in-use fuel economy: are the correction factors correct?", Paper No. 931104, Transportation Research Board, Washington, DC, January 1993.

61. D.L. Greene, "Vehicle use and fuel economy: How big is the 'rebound' effect?", *Energy Journal* 13(1), January 1992.

V. Economic Impact Analysis

With both the baseline projection and the efficiency scenario established, the question posed by the analysis is: "What are the employment and other macroeconomic benefits for the four-state region if the baseline energy use were reduced by 26 percent, or about 4,200 TBtu by the year 2010?"

In effect, we are examining the benefits of lowering energy consumption from a projected annual growth rate of about 1.3 percent to an annual decline in the state's energy requirements of about 0.4 percent. One tool that can assist in that type of evaluation is referred to as input-output modeling, sometimes called multiplier analysis.

A. Input-Output Analysis

Input-output models initially were developed to trace supply linkages in the economy. For example, they show how purchases of lighting equipment not only benefit lighting manufacturers, but also the fabricated metal industries and other businesses supplying inputs to those manufacturers.

The employment that is ultimately generated by expenditures for energy efficiency will depend on the structure of a local economy. States which produce fabricated metal products, for instance, will likely benefit from expanded sales of locally manufactured high-efficiency ballasts; states without such production will not benefit in the same way.

Table 10. Midwest Employment Multipliers for Selected Economic Sectors

Sector	Employment Multipliers
Oil Refining	0.9
Natural Gas Utilities	2.3
Oil/Gas Mining	6.3
Electric Utilities	7.0
Motor Vehicles	7.6
Insurance/Real Estate	9.0
Primary Metals	9.0
Pulp and Paper Mills	9.1
Food Processing	10.1
Other Manufacturing	10.3
Coal Mining	11.3

Stone, Glass, Clay	11.9
Metal Durables	12.0
Construction	18.6
Wholesale Trade	19.6
Finance	21.3
Agriculture	22.7
Services	27.7
Government	27.9
Retail Trade	42.2
Education	46.1

Source: Adapted from IMPLAN database for the States of Illinois, Indiana, Michigan and Ohio. The employment multipliers represent the direct and indirect jobs supported by a one million expenditure for goods or services purchased from a given sector.

Different expenditures support a different level of total employment. Table 10, on the previous page, compares the total number of jobs in Midwest region directly and indirectly supported for each one million dollars of expenditures within key sectors such as agriculture, construction, manufacturing, utility services, wholesale and retail trade, services, and government.[62] For the purposes of this study, a job is defined as sufficient work to employ one person full-time for one year.

Of immediate interest in Table 10 is the relatively small number of jobs per million dollars supported by expenditures for fossil fuels or gas and electric utility services. This is reflected in the relatively small multipliers for electric (7.0) and gas (2.3) utilities compared to other sectors of the economy. As it turns out, much of the job creation from energy efficiency programs is derived from the difference between jobs within the utility supply sectors and jobs which are supported by respending energy bill savings in other sectors of the economy.

B. An Illustration: Jobs From Government Efficiency Improvements

62. In this study we have adapted the 1990 IMPLAN model for the analysis. See, for example, *Micro IMPLAN User's Guide*, Minnesota IMPLAN Group, Stillwater, MN, January 1993. Table 10 presents what are referred to as Type I multipliers, incorporating only the direct and indirect effects of an expenditure. Adding the induced effect) i.e., the additional level of impact made possible by the respending of wages in the Midwest economy) would generate what are known as the Type II multipliers (or Type III multipliers as referenced in the IMPLAN model). However, since household spending is part of the final demand changes it was decided to limit the employment and other macroeconomic impacts to the Type I multipliers. This will tend to understate the net effect of the efficiency scenario. For more information on this point, see, Ronald E. Miller and Peter D. Blair, *Input-Output Analysis: Foundations and Extensions*, Prentice-Hall, Inc., Englewood, NJ, 1985, pages 25-30.

To illustrate how a job impact analysis might be done, we will use the simplified example of a state agency that installs $1.0 million of efficiency improvements. Government agencies, traditionally large users of energy due to heating and air conditioning loads, significant use of electronic office equipment and the large numbers of persons employed and served, provide substantial opportunities for energy saving investments. The results of this example are summarized in Table 11, below.

The assumption used in this example is that the investment has a positive benefit-cost ratio of 2.00. This is a smaller but comparable ratio as those shown in Table 6. If we anticipate that the efficiency changes will have an expected life of 15 years or more, then we can establish a 15-year period of analysis. We further assume that the efficiency upgrades take place in the first year of the analysis, while the energy savings occur in years one through 15.

TABLE 11. JOB IMPACTS FROM GOVERNMENT ENERGY EFFICIENCY IMPROVEMENTS

Expenditure Category	Amount ($ Million)	Job Multiplier	Job Impact
Government Efficiency Improvements in Year One	$1.0	18.2	18.2
Raising Investment Revenue to Fund Efficiency Improvements	-$1.0	27.9	-27.9
Energy Bill Savings in Years One through Fifteen	$2.0	27.9	55.8
Lower Utility Revenues in Years One through Fifteen	-$2.0	6.9	-13.8
Net Fifteen-Year Change	**$0.0**		**32.3**

Note: The employment multipliers are taken from the appropriate sectors found in Table 10. The jobs impact is the result of multiplying the row expenditure change by the row multiplier. For more details, see the text.

The analysis also assumes that we are interested in the *net effect* on employment and other economic changes. This means we must first examine all changes in business or consumer expenditures) both positive and negative) that result from a movement toward energy efficiency. Then each change in expenditures must be multiplied by the appropriate multiplier (taken from Table 10) for each sector affected by the change in expenditures. The sum of these products will then yield the net result for which we are looking.

In our example there are four separate changes in expenditures, each with their separate multiplier effect. As Table 11 indicates, the net impact of the scenario suggests a gain of 32.3 job-years in the 15-year period of analysis. This translates into a net increase of

2.2 jobs each year for 15 years. In other words, the efficiency investment made in government facilities is projected to sustain an average of just over two jobs each year over a 15-year period compared to a "business-as-usual" scenario.[63]

C. Evaluating the High Energy Efficiency Scenarios

The employment analysis of the high energy efficiency scenarios was carried out in a very similar manner as the example described above. That is, the changes in energy expenditures brought about by investments in energy efficiency technologies were matched with their appropriate employment multipliers. There are several modifications to this technique, however.[64]

First, it was assumed that only 80 percent of the efficiency investments would be spent within the four-state region. Interviews with personnel from various state agencies in the region suggest this may be a conservative value since most efficiency investments are carried out by local contractors and dealers. However, some portion of the "value-added" of some energy efficiency measures will come from outside the region.

As it turns out, the level of locally-installed efficiency upgrades does matter, especially in the early years of the analysis; that is, before the energy bill savings begin to show a significant return. For example, in 1995 the employment benefits for the Midwest would turn negative if more than 50 percent of the upgrades were performed by out-of-region contractors or other businesses. By 2010, however, this level would have to rise to more than 90 percent before the employment gains are fully eroded. Thus, to maximize employment within the region, investments in the early years might want to emphasize the use of locally-based businesses as much as possible.

Second, an adjustment in the employment impacts was made to account for future changes in labor productivity. As outlined in the Bureau of Labor Statistics *Outlook 1990-2005*, productivity rates are expected to vary widely among sectors, ranging from a -0.2 percent annual productivity loss in educational services (as more teachers and staff are hired to increase the teacher-student ratio) to a 3.2 percent annual productivity gain in coal mining (where such gains have already led to significant job losses).[65]

To illustrate the impact of productivity gains, let us assume a typical labor productivity increase of one percent per year in manufacturing. This means, for example, that

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63. The estimate may be a conservative one when we recall that commercial buildings as a whole were shown to have a benefit-cost ratio of about 3.3 compared to the assumption of 2.0 used in this example.

64. For a more complete review of how this type of analysis is carried out, see, Howard Geller, John DeCicco and Skip Laitner, *Energy Efficiency and Job Creation*, op. cit.

65. Bureau of Labor Statistics, *Outlook 1990-2005*, BLS Bulletin 2402, U.S. Department of Labor, Washington, DC, May 1992.

compared to 1995 a one million dollar expenditure in the year 2010 will support only 86 percent of the number of jobs as in 1995.[66]

Third, for purposes of estimating energy bill savings it was assumed that energy prices would rise at the rate of inflation from their 1990 levels. This is, in part, to simplify the matching of energy prices with an input-output model based upon 1990 price relationships. This produces a more conservative impact than might otherwise be reported since energy bill savings will be somewhat understated.

There are two important exceptions to this presumption, however: (a) that a decline in consumption would cause a downward pressure in the variable costs of supplying energy resources, and (b) that in the early years of the study the fixed costs associated with producing energy would prompt a small increase in energy prices.[67] While this might represent a "deadweight loss" in some respects, the effect will be overcome by a reduction in energy consumption that is larger than the very small energy price increase.

Fourth, it was assumed that approximately 80 percent of the investment upgrades would be financed by bank loans which carried an average 10 percent interest rate over a five-year period. To limit the scope of the analysis, however, no parameters were established to account for any changes in interest rates as less capital-intensive technologies (i.e., efficiency investments) are substituted for conventional supply strategies, or in labor participation rates) all of which might affect overall spending patterns.

While the higher cost premiums associated with the energy efficiency investments might be expected to drive up the level of borrowing (in the short-term) and, therefore, interest rates, this upward pressure would be offset to some degree by the investment avoided in new power plant capacity, exploratory well drilling, and new pipelines. Similarly, while an increase in demand for labor would tend to increase the overall level of wages (and thus lessen economic activity), the modest job benefits are small compared to the current level of unemployment or underemployment. Hence the effect would be negligible.

Fifth, for the buildings and industrial sectors it was assumed that a program and marketing expenditure would be required to promote market penetration of the efficiency improvements. This was set at 15 percent of the efficiency investment for those sectors.[68] For the transportation scenario it was assumed that, since the efficiency improvements would be an integral part of all new vehicle purchases, a "program" expenditure would not be necessary.

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66. The calculation is $1/(1.01)^{15} * 100$ equals $1/1.161 * 100$, or 86 percent.

67. This is a working estimate by the American Council for an Energy-Efficient Economy for use in this analysis. Based upon a 40 percent average fixed cost, energy prices would go up by an estimated seven percent in the year 2010, for example. On the other hand, a 26 percent drop in consumption would put a similar downward pressure on energy prices that would likely offset this trend) particularly in later years as fixed costs are fully depreciated.

68. This was the same value as used in *Energy Efficiency and Job Creation*, op. cit.,

Finally, it should again be noted that the full effect of the efficiency investments are not accounted for since the savings beyond 2010 are not incorporated in the analysis. Nor does the analysis include other productivity benefits which are likely to stem from the efficiency investments. These can be substantial, especially in the industrial sector.

Industrial investments that increase energy efficiency often result in achieving other economic goals like improved product quality, lower capital and operating costs, or capturing specialized product markets.[69] To the extent these "co-benefits" are realized in addition to the energy savings, the economic impacts would be amplified beyond those reported here.

VI. Macroeconomic Results

The investment and savings data from each of the three high efficiency scenarios were used to estimate three sets of impacts for the five-year periods of 1995, 2000, 2005, and 2010. The procedure was similar to the steps outlined in Section V(B) of this report, and as modified by the assumptions described in Section V(C). For each scenario, then, each change in a sector's spending pattern for a given year was matched to the appropriate sectoral multiplier. These negative and positive changes were summed to generate a net result shown in the tables that follow.

The first of the three impacts evaluated here is the net contribution to Gross State Product (GSP) measured in millions of 1990 dollars. In other words, once the gains and losses are sorted out in each scenario, the analysis provides the net benefit of a scenario in terms of the region's overall economy. The second impact is the net gain to the region's wage and salary compensation, also measured in millions of 1990 dollars. The final category of impact is the contribution to the region's employment base as measured by full-time jobs equivalent. The results are presented on a scenario-by-scenario basis, as follows.

A. Full Efficiency Scenario

Table 12 summarizes the economic analysis of the high energy efficiency scenario for the Midwest region. It provides the estimated economic benefits of accelerated efficiency improvements in all sectors. The table provides an estimate of the net increase in GSP and wage and salary compensation (in millions of 1990 dollars) as well as the net employment gain for selected five-year intervals through the year 2010.[70]

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69. Office of Technology Assessment, *Industrial Energy Efficiency*, Congress of the United States, Washington, DC., September 1993, page 65. For a more complete discussion on this point, see, Joseph J. Romm, *Lean and Clean Management: How to Boost Profits and Productivity by Reducing Pollution*, Kodansha American, Ltd., 1994.

70. The macroeconomic benefits shown in Table 11 are not intended to be precise estimates of future economic gain for the Midwest. Rather, the intent is to show the pattern and magnitude of economic benefits associated with all three energy efficiency scenarios described in the text compared to a baseline projection. Although we anticipated a number of impacts

There are a number of different aspects of Table 12 worth noting before commenting on the impacts in more detail. The first is that the impacts are largely positive. By the year 2010, Gross State Product (GSP) for the region is projected to increase by $1.3 billion (in 1990 dollars) despite initial losses in the years 1995 through 2000. Wage and salary compensation and employment could rise by about $4.6 billion (in 1990 dollars) and 205,200 jobs, respectively, by 2010.

Second, while these increases are significant, the impacts are relatively small in comparison to overall activity of the regional economy. By the year 2010, for instance, the region's GSP might grow to $1.1 trillion (in 1990 dollars).[71] Thus, adding $1.3 billion to the regional GSP in the year 2010 represents an increase of only 0.1 percent. Similarly, the increases in wage and salary compensation and jobs in 2010 represent an increase of only 0.7 and 1.0 percent, respectively, by 2010.[72]

On the other hand, if the impacts are small in relation to the larger economy, it is only because the scale of investment is also relatively small. The anticipated $104 billion cumulative efficiency investment (from Table 6) is estimated to be less than 0.7 percent of the cumulative GSP in the period 1995 to 2010.

TABLE 12. IMPACT OF HIGH EFFICIENCY SCENARIO - ALL FUELS

Year	Change in Gross State Product (Million$)	Change in Wage and Salary Compensation (Million$)	Net Jobs Gain
1995	($930)	$130	2,900
2000	($420)	$1,240	61,300

such as changes in labor productivity and energy prices (as they might occur in response to increased energy efficiency), a more rigorous assessment would account for other factors as well. These include an assessment of how homes and businesses would buy goods and services from each other as new technology is introduced, and as prices for goods and services other than energy begin to change. Still, the magnitude of impact is sufficiently robust to indicate significant macroeconomic benefits from the accelerated use of energy efficiency technologies.

71. This assumes that real GSP will grow at an average annual growth rate of about 2.0 percent in the 18 years between 1992 and 2010. As referenced in Table 2, GSP in 1992 was $862 billion in 1992 dollars which is roughly $796 billion in 1990 dollars. Hence, $796 billion times 1.02^{18} equals $1,137 billion, or $1.1 trillion.

72. These numbers assumes that wage and salary income and jobs will grow at an average annual rate of 1.40 and 0.6 percent, respectively. See, Bureau of Economic Analysis, *Regional Projections to 2040, Volume 1: States,* U.S. Department of Commerce, Washington, DC, June 1990, pages 44 and 45.

2005	$400	$2,160	130,500
2010	$1,300	$4,620	205,200

Notes: Dollar figures are in millions of 1990 dollars while employment reflects the actual job total. The implied benefit/cost ratio across the 16-year period is 1.75. The calculations are based upon a working analysis by ACEEE January 1995. They assume a 26 percent reduction in energy use over the year 2010 forecasted values.

Looking at the results in more detail, we note that GSP suffers from an initial loss in the first years in contrast to the small but positive gains in compensation. In 1995, the first year of the proposed efficiency investments, for example, GSP falls by $930 million while compensation rises by $130 million.

This apparent contradiction is the result of two different influences at work in the economy. First, the initial outlay for energy efficiency investments has not begun to pay for itself in terms of energy bill savings. This tends to dampen the growth of the region's GSP. At the same time, changes in the production recipe of the economy) largely the turn toward more labor-intensive purchases in the efficiency scenario) increase the share of benefit enjoyed by working men and women.

Wage and salary compensation is one category of the elements that comprise GSP, constituting about 60 percent of the GSP total. Thus, while overall GSP can fall, wage and salary compensation can rise as labor payments are substituted for investment capital in the larger economy. By 2010 both values are strongly positive although the trade-off between labor and capital continues.

In the high efficiency scenario, the employment impacts start modestly with a net employment gain of about 2,900 jobs in 1995. The annual total continues to climb to a net gain of 205,200 jobs in the year 2010.

If we think of the job benefits as if they were provided by the relocation of a series of small manufacturing plants to the four-state midwest region, then we can say that a 26 percent reduction in overall energy use would produce new employment that is the equivalent to the jobs supported by about 1,368 new manufacturing plants during this period of analysis.[73] More importantly, these are jobs that tend to be more evenly distributed throughout the region. This is because the energy efficiency investments and resulting energy bill savings tend to behave more like small manufacturing plants which can be more easily located in the small rural areas as well as in the larger urban regions.

Perhaps another way to look at this issue is to see how the alternative energy future would change the regions's unemployment rate. In November 1994 the region's

73. This estimate is based on the year 2010 average of 205,200 jobs. It assumes a small manufacturing plant would employ 100 persons. For each job in the manufacturing plant, a total of 1.5 jobs would be supported in the economy. Therefore, each 150 jobs created by the alternative energy scenario is equivalent to the output of one small manufacturing plant. Dividing 205,200 by 150 suggests the equivalent of 1,368 small manufacturing plants equivalent in the midwest region.

unemployment rate was estimated at 4.7 percent.[74] If that continues through the year 2010 when total employment is estimated to rise to 20.7 million jobs,[75] then the total regional unemployment would be 1.0 million. Adding another 205,200 jobs to the economy would be sufficient to lower the average unemployment rate from 4.7 percent to 3.8 percent.

Table 13, on the following page, offers yet another insight into the projections. It shows how each of the major economic sectors are affected in the year 2010 in the high efficiency scenario. These are sorted according to the anticipated job impacts beginning with those sectors which suffer losses.

As elsewhere it should noted that the results in Table 13 are not intended to be precise forecasts but rather approximate estimates of overall impact. Indeed, while the aggregate totals offer reasonable insights into the benefits of energy efficiency, some of the individual sectors show impacts that are sufficiently small that the results may swing one way or another depending upon even modest changes in the assumptions.

74. Bureau of Labor Statistics, *Labstat Bulletin Board*, U.S. Department of Labor, Washington, DC, as downloaded in January 1995.

75. *Regional Projections to 2040*, op. cit.

TABLE 13. ENERGY EFFICIENCY IMPACTS BY SECTOR IN 2010

Sectors	Jobs	Compensation	GSP
Electric Utilities	(31,100)	($2,140)	($8,320)
Natural Gas Utilities	(8,600)	($420)	($1,240)
Wholesale Trade	(3,000)	($140)	($200)
Coal Mining	(10)	$0	$0
Refining	(10)	$0	$0
Oil/Gas Mining	400	$0	$40
Other Mining	600	$30	$210
Pulp and Paper	700	$40	$60
Stone, Glass, Clay	1,000	$50	$80
Food Processing	1,400	$70	$140
Transportation, Communications, Utilities	2,500	$110	$200
Primary Metals	2,900	$180	$240
Agriculture	5,200	$40	$150
Education	5,200	$100	$100
Metal Durables	5,400	$300	$430
Insurance, Real Estate	5,900	$130	$850
Other Manufacturing	6,400	$350	$620
Motor Vehicles	7,500	$620	$1,090
Government	11,800	$410	$430
Finance	19,800	$780	$1,000
Retail Trade	33,600	$510	$760
Construction	55,500	$1,660	$2,080
Services	82,200	$1,930	$2,590
Total	205,200	$4,620	$1,300

Notes: Numbers in parentheses reflect losses in that sector. Jobs refers to the net jobs created in each sector. Compensation refers to the net gain in wage and salary income by sector. GSP refers to the net Gross State Product created in each sector. All dollar values are in millions of 1990 dollars.

As might be expected, the energy industries (including wholesale trade which delivers bulk petroleum products) incur overall losses in jobs, compensation and GSP. But this result must be tempered somewhat as the industries themselves are undergoing internal restructuring. For example, as the electric utilities engage in more demand-side management and other alternative energy investment activities, they will undoubtedly employ more people from the business services and engineering sectors. Hence the negative employment impacts should not necessarily be seen as job losses; rather they might be more appropriately seen as future occupational trade-offs.

Explained differently, while the electric utilities may lose an estimated 31,000 traditional jobs due to selling less energy, they might gain many of those jobs back if they move aggressively into the energy efficiency business, thereby absorbing some of the job gains assigned to other sectors such as the construction and service sectors. In effect, if they expand their participation in the energy efficiency market, their job totals could increase relative to the estimates based on the conventional definition of an electric utility as an energy supplier.

One interesting and apparently contradictory result appears in Table 13. This is the small but positive impact of efficiency improvements in the oil and gas mining industries. While the efficiency scenario would tend to reduce sales by these businesses, the efficiency investments in these sectors can generate sufficient savings to compensate for the lost sales. For example, in reviewing Table 9, we note that the electricity costs and other fuel bills can be reduced by about 40 percent in the mining industries in the year 2010 based on 1990 energy prices.

Table 13 shows four big "winners" under the high efficiency scenario. These are the collective manufacturing sectors (with a net sum of 25,300), retail trade (33,600 jobs), construction (55,500 jobs) and, finally, the service sectors (82,200 jobs). Manufacturing, retail trade and the service sectors are winners largely for two reasons. First, they benefit from the new investments in energy efficiency programs and technologies. Second, they benefit from the higher level of goods and services sold in the Midwest as people and businesses respend their energy bill savings elsewhere in the economy.

The construction sector is a winner primarily as the industry that most directly benefits as special trade contractors and others are hired to install the new technologies and make the requisite efficiency upgrades. The construction sector alone pulls in about 27 percent of the net job increases in the year 2010. Using the construction industry as a benchmark for evaluation, it might be noted that about one-fourth of the net job impacts in 2010 are from the efficiency investments made in that year. The balance of the impacts (or three-fourths) are the result of the respending of the energy bill savings.

B. Electricity-Only Scenario

This section reviews the impacts of energy efficiency investments made only to reduce electricity use within the Midwest region. In the high efficiency scenario, electricity use in 2010 drops 38 percent relative to electricity use that year in the baseline scenario. The cumulative investment in energy efficiency measures during 1995 through 2010 is estimated at $52 billion while energy bill savings reach $104 billion in that same period of time. Table 14, on the following page, summarizes the results for the same five-year periods as in the full efficiency scenario.

Perhaps the most interesting result is the drop in regional GSP for each year that is reviewed. This reflects the capital-intensive nature of the electric utility industry which requires nearly $3.00 in total assets for each dollar of revenues generated by the utility. This is almost three times more than Fortune 500 companies which, on average, require just over one dollar in assets for each dollar of revenue.[76] As the revenues of electric utilities decrease under an accelerated energy efficiency scenario, the amount of capital investment also decreases (i.e., fewer new power plants are built). This, in turn, lowers the overall value-added and GSP for the region as a whole.

On the other hand, the wage and salary compensation share of GSP actually increases in all four periods evaluated here. This is for two reasons. First, new electric plants are displaced by more cost-effective efficiency investments which are also more labor-intensive. Second, the respending of energy bill savings is used for consumer and business purchases which are also more labor-intensive.

As a result of this change in the economic mix, net employment rises. We might note, for example, that while electricity efficiency investments account for about one-half of the total investment (as shown in Table 6), by the year 2010, electricity efficiency improvements account for 65 percent of the net employment benefits. The latter is shown by comparing the results in Tables 12 and 14. Table 15 offers greater detail on how each sector is affected by the electricity efficiency scenario in 2010. As might be expected, the traditional electric utilities sector loses the most jobs. In fact, it appears this employment impact is even greater for this scenario than in the full efficiency scenario.

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76. See, Energy Information Administration, *Financial Statistics of Major U.S. Investor-Owned Electric Utilities 1993* (Washington, DC: U.S. Department of Energy, DOE/EIA-0437(93)/1, 1994); and "A Review of This Year's Fortune 500," *Fortune,* April 18, 1994.

TABLE 14. IMPACT OF HIGH EFFICIENCY SCENARIO - ELECTRICITY ONLY			
Year	**Change in Gross State Product (Million$)**	**Change in Wage and Salary Compensation (Million$)**	**Net Jobs Gain**
1995	-$650	$30	500
2000	-$1,000	$530	37,100
2005	-$1,630	$1,250	81,400
2010	-$2,500	$2,100	132,400

Notes: Dollar figures are in millions of 1990 dollars while employment reflects the actual job total. The implied benefit/cost ratio across the 16-year period is 2.02. The calculations are based upon a working analysis by ACEEE January 1995. They assume a 38 percent reduction in energy use over the year 2010 forecasted values.

This difference in scenario impacts can be explained by examining the influence of energy bill savings on the purchase of other goods and services. About two percent of personal consumption expenditures is devoted to the purchase of electricity. Thus, about two percent of the difference in wage and salary compensation between Tables 13 and 15 would be used to increase electricity consumption compared to energy savings otherwise projected. This tends to back out some jobs losses in this scenario compared those portrayed in Table 13.[77]

Table 15 points to an important opportunity for utilities to from an accelerated energy efficiency scenario. As noted earlier, the estimated loss of 31,500 jobs in the year 2010 assumes a traditional economic structure for electric utilities. Thus, as fewer conventional power plants are needed as a result of efficiency gains, fewer traditional utility jobs are sustained.

As utilities become more proactive in the area of demand-side management and other similar programs, they will take on new employees to carry out these new responsibilities. One might assume, therefore, that utilities could incorporate at least part of the 137,000 jobs gained in the construction and service sectors. If they absorbed

77. In effect, the actual energy savings shown in Figures 2, 3, and 4 would be slightly lower than might be established through straight engineering estimates. However, the nature of the model use to derive the economic impact of efficiency investments implicitly account for this very small rebound effect as shown in the difference between Tables 13 and 15. Since it is this effect we are interested in, no attempt was made to adjust the final energy consumption figures shown in those Figures.

just one-fourth of these jobs, for example, the job losses in the utility sector become positive.
It should also be remembered that these are not job losses in the strict sense of the word. Rather, the data in Table 15 are differences between a business-as-usual projection of future employment and jobs made available from an accelerated energy-efficiency scenario. In the aggregate, there is a significant positive gain in both employment and wage and salary compensation, and a drop in unemployment rate.

C. High Efficiency Vehicle Scenario

This scenario analyzes the macroeconomic impacts of increased vehicle efficiency alone. It anticipates a cumulative investment in efficiency measures of $16.4 billion from 1995 through 2010. Lower fuel costs would save $29.8 billion in that same period. The impacts associated with the high efficiency light duty vehicle scenario are summarized in Table 16. Only three years are shown since the efficiency improvements are assumed to begin in 1996. The reason is that it was felt that a one-year lag would be needed to account for the manufacture of more energy-efficient automobiles compared to the other efficiency improvements which could be made more immediately.

The net impacts are considerably smaller for the vehicle efficiency scenario than for the other two high efficiency scenarios. The reason here is that the scale of efficiency investment is much smaller than for the other end-use sectors. Table 6 indicates that only 16 percent of total efficiency investment is in more efficient light duty vehicles.

As with the other scenarios, the sector-by-sector impact of the transportation scenario is shown in Table 17. The pattern of losses and gains changes with this scenario compared to the other two. For example, the biggest job losses are in the trade and government sectors. The reason for this is that reduced gasoline sales impact all three sectors heavily, including lost gasoline tax revenues. The motor vehicles sector shows a positive job increase which reflects the higher cost of new automobile purchases.

The car and light truck market is, of course, a nationwide market. While a subset of states, if large enough, can have targeted vehicle improvements (as in the case of California emissions standards), the improvement in vehicles described here would best be implemented for the entire U.S. market.

TABLE 15. ELECTRIC EFFICIENCY IMPACTS BY SECTOR IN 2010

Sectors	Jobs	Compensation	GSP
Electric Utilities	(31,500)	($2,160)	($8,410)
Natural Gas Utilities	(2,000)	($90)	($280)
Coal Mining	(300)	($30)	($50)
Transportation, Communications, Utilities	(200)	($10)	($20)
Refining	(100)	($10)	($40)
Oil/Gas Mining	100	$0	$10
Other Mining	200	$10	$80
Stone, Glass, Clay	400	$20	$30
Pulp and Paper	400	$20	$30
Motor Vehicles	400	$30	$60
Food Processing	800	$40	$80
Primary Metals	1,700	$110	$150
Education	2,100	$40	$40
Agriculture	2,300	$20	$70
Metal Durables	2,600	$140	$200
Wholesale Trade	2,900	$130	$190
Insurance, Real Estate	3,000	$70	$440
Other Manufacturing	3,400	$180	$330
Finance	6,800	$270	$340
Government	20,200	$700	$740
Construction	26,000	$780	$980
Retail Trade	41,700	$640	$950
Services	51,400	$1,210	$1,620
Total	132,400	$2,100	($2,480)

Notes: Numbers in parentheses reflect losses in that sector. Jobs refers to the net jobs created in each sector. Compensation refers to the net gain in wage and salary income by sector. GSP refers to the net Gross State Product created in each sector. All dollar values are in millions of 1990 dollars.

TABLE 16. IMPACT OF HIGH EFFICIENCY SCENARIO - VEHICLES ONLY			
Year	**Gross State Product (Million$)**	**Wage and Salary Compensation (Million$)**	**Net Jobs Gain**
2000	$290	$160	3,800
2005	$890	$520	9,900
2010	$1,639	$970	14,100

Notes: Dollar figures are in millions of 1990 dollars while employment reflects the actual job total. The implied benefit/cost ratio across the 16-year period is 1.82. The calculations are based upon a working analysis by ACEEE January 1995. They assume a 14 percent reduction in energy use over the year 2010 forecasted values.

In this case, because it builds cars for the whole nation, the Midwest region could benefit much more from the investments in efficiency improvement at a nationwide scale than indicated here. We have not estimated the effect here, but our earlier work analyzing the U.S. as a whole indicates up to 244,000 more jobs nationwide) 47,000 in the motor vehicle industry.[78] Many of these would undoubtedly be concentrated in this four-state region.

While this study was undertaken as a largely regional analysis, we also estimated the employment impacts on a state-by-state basis for the full efficiency scenario in 2010. The methodology was straightforward, decomposing the net employment gains on the basis of state energy consumption patterns in each of the four end-use categories. Table 18 shows the results of this analysis. Illinois and Ohio each account for about 30 percent of the net increase in jobs, Michigan accounts for about 22 percent, and Indiana for about 17 percent. It interesting to note that this methodology results in an estimate of net employment gain in Ohio that is almost identical to the gain projected in a separate analysis for that state alone.[79]

78. *Energy Efficiency and Job Creation*, op. cit.

79. The Ohio study employed the same methodology and set of efficiency measures and assumptions as this study. See S. Laitner, J. DeCicco, N. Elliott, H. Geller, and M. Goldberg, *Energy Efficiency as an Investment in Ohio's Economic Future*, American Council for an Energy-Efficient Economy, Washington, DC, Nov. 1994.

TABLE 17. TRANSPORTATION EFFICIENCY IMPACTS BY SECTOR IN 2010

Sector	Jobs	Compensation	GSP
Retail Trade	(12,100)	($190)	($280)
Wholesale Trade	(5,300)	($240)	($360)
Government	(2,300)	($80)	($80)
Oil/Gas Mining	(900)	($10)	($80)
Petroleum Refining	0	$0	$10
Other Mining	100	$0	$20
Natural Gas Utilities	100	$0	$10
Coal Mining	100	$10	$10
Pulp and Paper	100	$10	$10
Food Processing	100	$10	$10
Electric Utilities	200	$10	$40
Primary Metals	200	$10	$10
Stone, Glass, Clay	200	$10	$20
Agriculture	400	$0	$10
Construction	600	$20	$20
Other Manufacturing	800	$40	$80
Insurance, Real Estate	1,100	$20	$150
Transportation, Communications, Utilities	1,200	$50	$90
Metal Durables	1,400	$80	$110
Education	2,000	$40	$40
Motor Vehicles	6,900	$570	$1,010
Finance	8,900	$350	$450
Services	10,300	$240	$320
Total	14,100	$970	$1,640

Notes: Numbers in parentheses reflect losses in that sector. Jobs refers to the net jobs created in each sector. Compensation refers to the net gain in wage and salary income by sector. GSP refers to the net Gross State Product created in each sector. All dollar values are in millions of 1990 dollars.

Table 18. State-By-State Employment Impacts in 2010	
State	**Net Job Gains**
Illinois	62,700
Indiana	35,300
Michigan	46,200
Ohio	61,000
Total	205,200

VII. Midwest Energy Policy: Review and Recommendations

Support for maintaining and developing the region's fossil fuel resources (i.e., coal, oil and natural gas) and load building by many of the area utilities have overshadowed efforts to increase energy efficiency and reduce the cost of energy services over the past 20 years. For example, the state of Ohio provides up to $100 million (at any one time) in state bond financing to support the Ohio Coal Development Office's coal research and development activities.[80]

In addition, Illinois and Indiana have passed laws to protect state coal producers by encouraging local utilities to install scrubbers as a means of meeting the requirements of the 1990 Clean Air Act Amendments rather than switch to low-sulfur western coal or adopt other cleaner acid rain control strategies.[81] Although much of the Midwest's energy priorities historically have been focused on coal and coal development, other more sustainable energy strategies are ripe for promotion.

Residents and businesses are starting to connect energy efficiency with quality of life and economic competitiveness, rather than simply accept energy use as a fixed quantity and cost. However, a serious commitment to secure that economic return will require important policy changes, implementation of cost-effective energy programs, and clear direction from each state utility commission to their respective utilities. More specifically, state and regional policy initiatives will need to encourage the investment of $104 billion in energy efficiency technologies over the period 1995 through 2010. Current policy initiatives will fall considerably short of achieving that goal.

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80. The Coal Development Office supports both currently available technologies and advanced technologies which may be available in the future. For more information on these efforts see *Ohio Coal Development Agenda*, op. cit.

81. The U.S. Court of Appeals for the Seventh Circuit ruled early this year that the 1991 Illinois law violated the prohibition against economic protection for industries from the rigors of interstate competition. Since the state of Indiana is also under the jurisdiction of the Seventh Circuit, this could also weaken the Indiana law. See, "Appeals Court Dumps Illinois Coal Act," *The Electricity Daily*, Volume 4, Number 8, January 12, 1985, page 1.

This section reviews existing policies and programs that support energy efficiency improvements in the Midwest. We also recommend new and expanded initiatives in six policy areas that would lead to greater adoption of cost-effective measures.

A. Building Codes

Building energy codes are an effective and widely used strategy for ensuring that new buildings are relatively energy efficient. The Energy Policy Act of 1992 (EPAct) requires states to meet or exceed the ASHRAE 90.1 model standard for new commercial buildings. EPAct also requires states to consider meeting or exceeding the CABO Model Energy Code for new residential buildings (but states can choose whether or not to do so). At this time, Ohio is the only state in the region that is in compliance with EPAct. With the exception of Illinois, which has no existing statewide energy codes,[82] the rest of the states in the region have adopted or are in the process of adopting codes in response to the EPAct requirements.

Ohio adopted more stringent residential and commercial codes in mid-1994. Ohio adopted the 1993 version of the Council of American Building Officials' (CABO) Model Energy Code (MEC) for residential buildings and a codified version of ASHRAE 90.1 with the addition of the BOCA 1993 National Building Code requirements for commercial buildings. The effective date for the new residential building code is being delayed, however, and does not take effect until July 1, 1995. This delay is due to the difficulty of assuring that local code officials and builders understand the new code, as well as the need for a compliance verification tool. Once these new building codes take effect, the energy efficiency of new buildings should begin to increase.[83]

Indiana has adopted the 1992 CABO MEC with Indiana amendments and anticipates adopting the 1995 MEC (which incorporates ASHRAE 90.1 for commercial buildings by reference) to comply with the EPAct requirements in late 1995. The Indiana amendments adopt federal standards for some appliance efficiencies, update insulation requirements, and add language required by state law. In addition, efforts are underway to train builders and local code officials and develop compliance strategies. In particular, an energy rating system has been developed to assist builders and code officials. Through builder participation in the rating program and on-going training for building officials and builders, the state hopes to alleviate problems in interpreting

82. According to Pete Jackson, Demand Side Management Specialist at the Illinois Department of Energy and Natural Resources, although there is no statewide energy code or official efforts underway to adopt one, the Illinois Council of Code Administrators is considering supporting a statewide code. Currently, there are a variety of regulations which cover limited categories such as state-owned buildings and factory-built structures. Mr. Jackson also noted that of the 1,200 municipalities in the state with populations over 1,000 only an estimated 400 currently have building energy codes in place.

83. ASHRAE stands for the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. BOCA refers to the Building Officials and Code Administrators International. All references to the Ohio building codes are based upon a personal communication with Terry Smith, Field Representative with the Office of Energy Efficiency, Ohio Department of Development, September 1994.

component calculations or tradeoffs and ensure a high degree of code compliance at the local level.[84]

Similar to Indiana, efforts to meet EPAct requirements are also underway in Michigan. Although the state is currently operating under ASHRAE 90A-80 standards for residential and commercial buildings, legislation to adopt BOCA 1993 building codes (referencing the 1993 MEC) has been pending in a legislative committee for over a year. Upon approval by the committee, the new code will take effect. However, it is unknown when the committee will act upon the legislation.[85]

Implementing state-of-the-art building codes could have significant impacts for states in the region. A recent analysis for Illinois shows that adopting the model building codes referred to in EPAct could cut energy use in affected buildings by 10-18% and lower consumers' energy bills by more than $600 million over a ten-year period.[86] Also, these building codes are very cost effective for consumers, based on energy prices similar to those in the Midwest.

But code adoption at the state level is just one step towards increasing the energy efficiency of new buildings. Building codes are implemented and enforced at the local level in each of the states. Energy code compliance is critical for achieving the potential benefits, and compliance levels are surprisingly low in many states.[87] Designers and builders need to be trained on how to comply with new building codes. Local code officials need training as well as adequate financial and technical resources for enforcing the codes. In order to make the new codes a success, state agencies and possibly utilities should sponsor education, training and compliance programs, as appears to be occurring in Indiana.

B. Demand-Side Management

Utilities in many parts of the country have played an active and effective role in promoting greater energy efficiency among their customers through demand-side management (DSM) programs. Such programs, which often include information, technical assistance and financial incentives, are justified based on saving energy at lower cost than supplying energy.

Review of Current DSM Efforts

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84. This information on the status of Indiana building codes and meeting EPAct requirements is based on a personal communication with Mark Jensen, Analyst at the Indiana Department of Commerce, Office of Energy Policy, in January 1995 and information contained in the *Indiana Energy Policy Forum*, op.cit., pages 10-13.

85. This information is based on personal communications with Jerry Mash, Technical Advisor at the Michigan Competitive Utility and Energy Resources Division, and Irvin Poke, Chief of the Plan Review Division at the Michigan Department of Labor, Bureau of Construction Codes, both in January 1995.

86. *Energy Efficiency Codes and Standards for Illinois*, op. cit.

87. Ibid.

Utilities nationwide spent nearly $3 billion (1.5 percent of revenues) on DSM programs in 1994.[88] Strong DSM programs often result following the adoption and implementation of integrated resource planning.

A few utilities in Illinois, Indiana, Michigan, and Ohio have undertaken significant DSM programs, but these utilities are the exception rather than the rule. Table 19 lists recent DSM budgets and electricity savings levels for the major investor-owned utilities in the region.[89] These 19 utilities report spending a total of $172 million on DSM programs in 1993 and estimate they will spend $159 million in 1994.[90]

88. E. Hirst and S. Hadley, "The DSM Sky Hasn't Fallen Yet", *The Electricity Journal*, December 1994.

89. Table 18 is based on data that utilities are required to report to the Energy Information Administration. These data were reported to the EIA in April, 1994; they reflect actual DSM program activity in 1993, projected DSM activity in 1994 and 1998. A few utilities with annual DSM expenditures under $500,000 are not included in the table. Personal communication from S. Hadley, Oak Ridge National Laboratory, Oak Ridge, TN, January 1995.

90. The DSM expenditures and savings levels reported to the EIA in some cases are based on targets rather than actual levels, and consequently may be overstated. For example, Ohio Edison had a target of spending $15 million on DSM in 1993, but actually spent less than $2 million. Personal communication with the Center for Clean Air Policy, Washington, DC, January 1995.

TABLE 19. UTILITY DSM EXPENDITURES AND IMPACTS IN THE MIDWEST

Utility	State	DSM Spending (Million $)		Annual Energy Saved (Gigawatt-Hours)		Annual Peak Reduction (Megawatts)		1994 DSM Spending (percent of revenue)
		1993	1994	1993	1994	1993	1994	
Consumers Power Co.	MI	53	15	280	596	135	155	0.7
PSI Energy Inc.	IN	35	34	141	289	76	83	3.2
Dayton Power & Light Co.	OH	31	18	90	90	16	16	2.0
Ohio Edison Co.	OH	15	23	61	134	396	427	1.1
S. IN Gas & Elec. Co.	IN	6	10	16	36	45	58	3.9
Cincinnati Gas & Elec. Co.	OH	4	13	6	47	26	57	1.0
Detroit Edison Co.	MI	4	8	149	76	42	70	0.2
Cleveland Electric Illum. Co.	OH	3	3	19	35	96	98	0.2
Commonwealth Edison Co.	IL	3	8	2	--	173	171	0.2
Ohio Power Co.	OH	3	4	18	40	202	217	0.2
Indianapolis Power & Light Co.	IN	3	6	41	72	26	52	1.0
Columbus Southern Power Co.	OH	2	3	26	50	37	49	0.3
Central IL Light Co.	IL	2	3	0	--	62	77	1.0
Toledo Edison Co.	OH	2	2	16	24	5	68	0.2
IA-IL Gas & Electric Co.	IL	2	2	--	23	--	7	0.6
IN-MI Power Co.	IN	1	2	4	10	87	91	0.2
South Central Power Co.	OH	1	1	--	--	25	25	1.2
Central IL Pub. Serv. Co.	IL	1	1	--	--	--	--	0.1
IL Power Co.	IL	1	--	34	34	166	158	--
Total		172	159	903	1556	1615	1879	0.6

Source: Personal Communication with Stan Hadley, Oak Ridge National Laboratory, TN, January 1995.

Reported DSM expenditures for 1994 represent only 0.6 percent of revenues for these 19 utilities as a whole. For comparison, utilities nationwide expect to spend over 1.5 percent of their revenues on DSM programs in 1994. Likewise, the utilities listed in Table 19 projected that their DSM programs will cut electricity use by only 0.3 percent of their total sales in 1994, compared to DSM savings of 1.9 percent of sales for all U.S. utilities.[91] Clearly, utilities as a whole in this four-state region are far behind other utilities in promoting greater energy efficiency.

A few utilities in the Midwest have made substantial investments in DSM and greater energy efficiency. Consumers Power Company in Michigan has operated the largest DSM programs in the region, following an order from its state PUC that included a revenue loss recovery mechanism, financial incentives for good DSM performance, and the possibility of penalties for poor performance.

Consumers Power has offered a wide range of DSM programs including free home weatherization for low-income households, rebates to stimulate the purchase of energy-efficient products by all customer classes, and even limited promotion of gas rather than electric heating. An evaluation of Consumers Power's ten initial DSM programs offered in 1992-93 showed that the programs had a levelized cost of about $0.02 per kWh saved and achieved a high degree of customer satisfaction.[92]

Unfortunately, Consumers Power recently proposed abandoning IRP principles, using the rate impact test rather than the total resource test to screen and evaluate the cost effectiveness of DSM programs, dropping the shareholder incentives/penalties, and eliminating all DSM programs starting in mid-1995. The utility states that its proposal is motivated by concerns regarding possible retail wheeling in the future (the state PUC has approved a limited retail wheeling experiment), competition from IPPs, cogeneration, and municipalization, and possible rate impacts from continued active DSM programs.

Utility commission staff strongly oppose these proposals and have recommended that Consumers Power spend about $96 million on DSM programs in 1995 and 1996, which they estimate will provide about $170 million in net economic benefits for consumers in Michigan as well as a net gain of 450 job-years of in-state employment.[93] An interim order by the state PUC requires Consumers Power to continue spending $30 million/yr on DSM programs until this formal proceeding is concluded. But while this debate continues, the future for DSM in Michigan is highly uncertain. Detroit Edison, the other major electric utility in this state, has experimented with a considerably more modest set of efficiency programs and has resisted expanding its DSM efforts.

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91. The electricity savings and peak demand reduction values are based on cumulative DSM programs through the year specified.

92. "Direct Testimony of Mr. Charles R. Budd on Behalf of Consumers Power Co.", filed before the Michigan Public Service Commission, Case No. U-10554, September 1994.

93. Testimony of Thomas S. Stanton on Behalf of the Michigan Public Service Commission", before the Michigan Public Service Commission, Case No. U-10554, November 18, 1994.

Among major utilities in the region, PSI Energy in Indiana (now merged with Cincinnati Gas and Electric Company)[94] is investing the most money in DSM in relation to its revenues. PSI has offered a comprehensive set of programs to encourage efficiency improvements by all of its customer classes, including information, promotion, incentive and direct installation programs. PSI has been given financial incentives to pursue cost-effective efficiency measures, including recovery of lost revenues and shareholder incentives based on DSM program performance.

PSI claims it surpassed its 1995 DSM performance goals in early 1994, and has achieved an overall benefit-cost ratio of 2.0 for all DSM programs operated during 1990-94 (including start-up, administration and evaluation costs).[95] PSI estimates that it reduced electricity use among its customers by 1.0 percent due to DSM programs implemented through June, 1994. Furthermore, PSI Energy agreed to significantly expand its DSM programs as a condition for approval of its merger with Cincinnati Gas & Electric Co (CG&E). In an agreement with Citizens Action Coalition of Indiana and the Environmental Law and Policy Center, both PSI and CG&E agreed to carry out DSM programs sufficient to reduce annual sales and peak demand by 1 percent in each of the next five years.[96]

Dayton Power & Light (DP&L) is the utility that has gone the furthest in promoting energy efficiency in Ohio. In 1991, DP&L agreed to spend $60 million on DSM over a four-year period. A DSM program design collaborative was established involving DP&L and a variety of non-utility partners (including the Sierra Club).[97] DP&L spent about $30 million (2.0 percent of revenues) on DSM programs in 1993, with estimated savings of 90 GWh (0.6 percent of total sales). DP&L has emphasized consumer education and programs for residential customers in their initial set of DSM programs (based on budget allocation), although limited spending on commercial and industrial DSM programs has yielded the most cost-effective energy savings.[98]

The largest utility in the region, Commonwealth Edison, is doing very little to promote energy efficiency among its customers. ComEd and the Illinois Commerce Commission (ICC) are gridlocked on the DSM issue, with ComEd refusing to ramp up its DSM programs until the ICC approves cost recovery, and the ICC refusing to grant cost recovery until ComEd ramps up and proves the worthiness of its DSM programs. In the meantime, there is an urgent need for energy efficiency services in the ComEd service area. For example, a 1994 pilot commercial lighting DSM

94. This merger became effective in late October 1994.

95. See "Demand-Side Management", report presented to the Indiana Utility Regulatory Commission by PSI Energy Inc., Plainfield, IN, October 1994.

96. Personal communication with Jimmy Seidita, Environmental Law and Policy Center, Chicago, IL, March 1995.

97. See Martin Schweitzer et al., *Making a Difference: Ten Case Studies of DSM/IRP Interactive Efforts and Related Advocacy Group Activities*, op. cit., page 25.

98. See David Festa, Catherine Morris, and Denise Rouleau, *Strengthening DSM in Ohio*, Center for Clean Air Policy, Washington, DC, 1995.

program was oversubscribed in a matter of days, with seven applicants turned away for each applicant served in the first month alone.[99]

Commonwealth Edison did propose increasing DSM spending to $23 million per year in 1995 in order to undertake a broader set of DSM programs, although these proposed programs primarily target peak load reduction. While this proposal represents a step forward, it appears to fall far short of a comprehensive energy efficiency effort consistent with IRP principles.[100] Furthermore, the ICC approved only $6 million out of the $23 million DSM budget request made by ComEd.[101]

Recommendations

A few utilities in the Midwest have made some useful initial steps in the areas of IRP and DSM. But much more needs to be done if the Midwest is to realize the large energy and economic benefits offered by effective IRP and DSM. Regarding IRP, while initial plans have been prepared by the states' utilities, these plans in general include poorly designed and/or relatively few DSM programs, inappropriate DSM screening procedures, and relatively low avoided costs.[102] The plans need to be revised and improved, particularly with respect to energy efficiency opportunities.

Outside of Consumers Power, PSI Energy, Dayton P&L, and Southern Indiana G&E, DSM programs offered so far by utilities in the four states are very modest in scale and limited in scope. These programs appear to have had little impact on energy demand, and are not being viewed as an economical alternative to expanding generating capacity.

Utilities in the Midwest should commit to adopting greatly expanded and improved DSM programs if they appear to be cost effective from the societal perspective. Expanded DSM programs should be adopted by both natural gas and electric utilities. In order to develop comprehensive, state-of-the-art DSM programs with broad support, utilities should continue to work with the "collaboratives" that have been formed in the region or start collaboratives with energy efficiency advocates if they do not yet exist. Such collaboratives have proven to be a very useful strategy for directly and rapidly developing effective DSM programs in various regions of the country.[103] However, it is important to note that collaboratives are successful only in

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99. Personal communication with Jimmy Seidita, Environmental Law and Policy Center, Chicago, IL, March 1995.

100. See direct testimony of David Birr on behalf of the City of Chicago, before the Illinois Commerce Commission in Proceeding 92-0268, February 1, 1994.

101. See *Illinois Regulators Slash ComEd's DSM Budget from $23 Million to $6 Million*, Demand-Side Report, McGraw-Hill, Inc., New York, NY, Jan. 19, 1995, page 4.

102. Personal communication with David Festa, Center for Clean Air Policy, Washington, DC, Nov. 1994.

103. For a review of ten collaborative efforts aimed primarily at designing comprehensive, broadly supported DSM programs, see M. Schweitzer, M. English, S. Schexnayder, and J. Altman, "Energy Efficiency Advocacy Groups: A Study of Selected Interactive Efforts and Independent Initiatives", ORNL/CON-377, Oak Ridge National Laboratory, Oak Ridge, TN,

the context of a strong commitment by the utility and the PUC to improve energy efficiency. As experience in Ohio has shown, establishing a "collaborative" is not constructive if the utility and PUC do not support strong DSM programs.

Expanded DSM programs should include substantial incentive payments and other features necessary to overcome the barriers inhibiting widespread adoption of energy efficiency measures by consumers in all sectors. Comprehensive approaches should be adopted to facilitate market transformation in key end uses and influence one-time opportunities for upgrading efficiency (e.g., when a building is constructed or rehabilitated).[104]

The issue of increased competition and utility industry restructuring is overshadowing considerations such as promoting greater energy efficiency as of early 1995. State policy makers, including legislators and PUCs, should make it clear early in the restructuring debate that improving energy efficiency will be an important objective of any initiative to increase competition and lower the costs paid by consumers for energy services.

Utilities in the Midwest should expand their DSM efforts based on the substantial economic benefit and service to consumers that such programs can provide, no matter what is done regarding utility restructuring. Moreover, DSM investments should be viewed as a strategic option for avoiding or deferring capital investment in electricity supply systems, including avoiding repowering of older power plants and installation of environmental compliance technologies (i.e., efficiency can reduce the need for other pollution control measures).[105] Utilities and the PUCs should revise their methodologies for calculating avoided costs, such that these determinations include future capital costs and environmental costs that could be avoided by investments in energy efficiency resources.

Some utilities in the Midwest (specifically major utilities in Wisconsin and Minnesota) have adopted this perspective and have already reduced electricity use by 2-3 percent and peak demand by 6-9 percent through their DSM programs.[106] A few utilities in the Midwest have conducted legitimate IRPs and have set significant near-term DSM targets, but this is still the exception among utilities in these states.

New DSM program design and analysis should be performed using well-established IRP principles, leading to new electricity savings and peak demand reduction targets

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March 1994.

104. H. Geller and S. Nadel, "Market Transformation Strategies To Promote End-Use Efficiency," in *Annual Review of Energy and Environment*, Annual Reviews, Inc., Palo Alto, CA, 1994.

105. For an example of the role that DSM programs can play in meeting Clean Air Act requirements in the Midwest, see S. Nadel, J. Jordan, C. Holmes and K. Neal, "Using DSM to Help Meet Clean Air Act Targets: A Case Study of PSI Energy", ACEEE, Washington, DC, Oct. 1994.

106. The best utilities in the Midwest with respect to DSM programs include Wisconsin Electric Power, Wisconsin Public Service, and Northern States Power. These utilities were spending 2-7 percent of their revenues on DSM programs as of 1992. See, *Costs and Effects of Electric Utility DSM Programs*, op. cit.

should be set. These targets should be revised periodically based on real world results. Utilities with minimal DSM experience should then undertake comprehensive pilot programs. More experienced utilities should move to second and third generation program designs that capture a greater fraction of the cost-effective savings potential. For example, it is estimated that PSI Energy could increase its cost-effective long-term energy savings by 45-104 percent through expanding its DSM programs.[107]

State utility commissions can obviously play a key role in securing a greater commitment to IRP and DSM in the Midwest. Regulatory reforms have been adopted in OH, IN, and MI so that utilities could potentially profit from implementing substantial and cost-effective DSM programs. But these rate recovery and incentive provisions do not appear to have been implemented so far in the Midwest region.[108] Of course this relates to the limited amount of DSM activity in these states.

The PUCs in all four states should reaffirm their support for these principles and make them operative, in conjunction with greater DSM commitments on the part of utilities. PUCs need to unambiguously declare their support for cost-effective energy efficiency resources, even if it raises electricity rates in the short run. Utility commissions in all four states should allow rapid cost recovery for cost-effective DSM programs in between major rate cases, allow utilities to recover "net lost revenues" due to cost-effective DSM programs, and possibly allow utilities to keep a portion of the net societal benefits generated by DSM programs. PUC support for energy efficiency and DSM is especially important given the uncertainty about the future structure of the utility industry.

Last but not least, thorough evaluation of the costs and benefits of DSM programs is needed. Monitoring and evaluation of actual programs will help utilities understand the impacts they are having and will improve DSM program design. Good evaluation is also needed to support recovery of net lost revenues and provide utilities with financial incentives for operating effective programs. Techniques for DSM program evaluation have been developed for many years and are well-proven in other regions of the country.[109]

C. Industrial Energy Efficiency

An integrated strategy should be adopted to stimulate widespread industrial energy efficiency improvements. Such a strategy should address all aspects of the energy efficiency implementation process: opportunity identification, design and installation, financing, and training and operation. Government and utility programs can help to reduce the cost and hassle of identifying efficiency improvements (e.g., through

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107. See Nadel, Jordan, Holmes and Neal, op. cit.

108. Personal communication with David Festa, op. cit. There has been some recovery of DSM expenses through settlement agreements, however.

109. See E. Hirst and J. Reed, eds., "Handbook of Evaluation of Utility DSM Programs", ORNL/CON-336, Oak Ridge National Laboratory, Oak Ridge, TN, Dec. 1991; also Proceedings of the Energy Program Evaluation Conferences, available from Gail Ettinger, 309 Davis St., Evanston, IL 60201.

surveys as well as technical and purchasing assistance) and the cost of installing efficiency measures (e.g., through rebates and loans).

In the past, the New York State Energy Office (NYSEO) conducted comprehensive industrial energy efficiency programs with these characteristics. NYSEO's *Flexible Technical Assistance Program* provided audit, design assistance, procurement and implementation services. The *Energy Investment Loan Program* provided financing with interest rate subsidies to commercial lenders for their customers' energy-efficiency projects, and the *Construction Services and Professional Training Programs* provided training, technical assistance and resources to all levels of industrial staff from engineers to operators. Also, utilities in New York have conducted industrial DSM programs complementing the state's activities. These combined programs have achieved impressive results, especially in encouraging industrial facilities to make process-related improvements.[110]

Opportunity Identification

Identification of energy-efficiency opportunities is the first step in the process. Utilities have close contact with industrial energy users and are in a good position for delivering information. Utilities as part of their DSM programs can offer training for customers on efficiency technologies, audit services, and assistance in identifying the experts required to take advantage of efficiency opportunities. A number of utilities around the country have implemented highly successful industrial DSM programs, and utilities in the Midwest region should look to these efforts as models.[111]

The Energy Analysis and Diagnostic Centers (EADC) are an existing resource that could be augmented with funds from both the state government and electric utilities. There are three EADCs located in the region -- based at the University of Dayton, University of Michigan, and Bradley University.[112] This successful program, which receives its core funding from the U.S. Department of Energy, provides low-cost audits to small and medium-sized firms. It identifies energy savings opportunities that can be pursued by other key players such as gas and electric utilities, or by the industries themselves. In addition, the program trains engineers in industrial energy-efficiency techniques, and these individuals often seek employment as energy managers in local industries.

Technical and Design Assistance

Lack of specialized expertise and energy services can be barriers to implementing efficiency opportunities.[113] The Midwest Manufacturing Technology Center in Ann

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110. R. Neal Elliott and Aliza Weidenbaum, "Financing of Industrial Energy Efficiency Through State Energy Offices," *Proceedings of the 16th Industrial Energy Technology Conference*, Houston, TX, April 13-14, 1994.

111. Steven M. Nadel and Jennifer A. Jordan, *Designing Industrial DSM Programs that Work*, American Council for an Energy-Efficient Economy, Washington, DC, December 1993.

112. U.S. Department of Energy, *Energy Analysis and Diagnostic Center Program Description*, Washington, DC, 1994.

113. Howard S. Geller and R. Neal Elliott, *Industrial Energy Efficiency: Trends, Savings Potential, and Policy Options*, American Council for an Energy-Efficient Economy, Washington,

Arbor, Michigan (funded by the U.S. Department of Commerce) provides one example of the kind of resource available in the region. Other centers sponsored by the states, utilities and industry could be developed, increasing the scope and availability of expertise to assist industry with energy-efficiency and productivity enhancements.

Since the development of this expertise is costly, it would be reasonable for state agencies and utilities in the region to pool their resources. A regional effort along these lines has been established in the Southeastern United States, and could be copied in the Midwest. The North Carolina Alternative Energy Corporation has established an Industrial Electrotechnology Laboratory (IEL) which now operates in South Carolina and Virginia as well as North Carolina. The IEL provides technical training, assistance and testing services to industrial users in areas such as electric motor systems, product heating and drying, and low-emission coatings. The IEL allows industrial customers to develop and evaluate process technology changes in a near-production environment without disrupting the manufacturing operation.[114]

Another model program has begun in Wisconsin, where a Performance Optimization Service (POS) is promoting a systems approach to identify, assess and optimize the performance of industrial motors systems. This program offers comprehensive technical training and support to end-users and motor systems design engineers. One goal of the program is to increase the knowledge and expertise base of the local design community.[115]
The expansion of the POS program to the Midwest region has been discussed as part of the Midwest Motor Systems Collaborative, a regional initiative of state governments, utilities, industry, and universities in the region with support from the U.S. DOE Motor Challenge Program.[116] This initiative should be supported, and similar regional joint efforts should be considered in other energy end-use areas.

Financing

It would be helpful to create a regional "energy bank" for industries and commercial building owners in the Midwest, particularly for small to medium-sized companies which tend to be more capital constrained than larger firms. This type of program could build upon the Ohio Energy Bank that is being established to assist local governments with funding of energy efficiency projects. We recommend that states and utilities work with the financial community to make attractive financing more widely available. Based on the New York experience, we suggest establishing a total loan pool of around $250 million in the four-state region.

DC, 1994; and U.S. Department of Energy, *Efficient Electric Motor Systems for Industry*, Washington, DC, 1993.

114. Personal communication with Dr. Robert Koger, President, Alternative Energy Corporation, Research Triangle Park, NC.

115. Edward Carroll, Barbara J. McKellar and Ronald G. Wroblewski, "Wisconsin's Performance Optimization Service: Utilities and Trade Allies Delivering a Service to Improve Industrial Motor-Driven System Performance", *Proceedings, ACEEE 1994 Summer Study on Energy Efficiency in Buildings*, American Council for an Energy-Efficient Economy, Washington, DC, pages 9.85-9.91.

116. Personal communication, Richard Hackner, Wisconsin Center for Demand-Side Research, Madison, WI.

States in the region could sell bonds for this purpose, with financing provided to larger companies at market rates. If possible, small and medium-size companies could be offered financing at below-market interest rates, with utilities and/or states subsidizing the loans as part of their DSM efforts.

Operation

Once energy efficiency measures and process improvements are installed, individual plant staff must learn how to operate this equipment correctly. The New York program is unique in that it provides customized training as part of its energy services program.[117] On-the-job training services provided by states and utilities in the Midwest would help insure that industrial equipment is operated and maintained properly and that the energy savings potential of efficiency improvements is realized. Expanding the EADC program in the region would increase the pool of engineers with energy-efficiency expertise, and developing energy engineering curriculum within the region's community college systems also could help.

Promoting Advanced Technologies

In addition to promoting currently available energy efficiency measures, the states and utilities in the region should encourage technological innovation in the industrial sector. This can lower energy intensity as well as create new opportunities for economic growth. Technological innovation is also critical for industrial competitiveness and environmental protection over the long run.

The National Industrial Competitiveness through Energy, Environment, and Economics ($NICE^3$) program can be viewed as a model effort in this area. $NICE^3$, a joint program of the U.S. Department of Energy and the Environmental Protection Agency, provides matching grants to state government and industry partnerships that demonstrate innovative energy efficiency and waste reducing technologies. Six projects have been funded in the region, and some of these projects have successfully demonstrated new techniques for reducing energy use, cutting emissions, and saving businesses money. States and utilities in the region should provide additional resources for $NICE^3$ or similar projects.

By coordinating efforts and providing comprehensive assistance to industry on energy efficiency, the region can plot a more productive and secure future for its industrial sector. Many energy efficiency improvements offer multiple benefits such as reducing production costs, improving product quality, and lowering environmental emissions, in addition to providing energy savings. In fact these other benefits can be of greater value than the energy savings.[118] Thus, an industrial energy efficiency strategy in the region should emphasize the broad benefits that result from industrial process improvements and modernization.

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117. See Elliott and Weidenbaum, op. cit.

118. *Industrial Energy Efficiency: Trends, Savings Potential, and Policy Options*, op. cit. See also, *Electricity Consumption and the Potential for Electric Energy Savings in the Manufacturing Sector*, op. cit.; Joseph J. Romm, **Lean and Clean Managment**, Kodansha International, New York, NY, 1994.

D. Light Vehicle Efficiency

Three types of policy options are available to states for improving the energy efficiency of cars and light trucks. We recommend that the midwestern states pursue these options through legislation and resolutions to implement them in forms that are appropriate to each state in the region, given state fiscal policies and economic interests. First, the region should enact vehicle purchase price incentives ("feebates") linked to efficiency. Second, the region should procure vehicles that are the most efficient in each vehicle class and coordinate efforts for similar efficient vehicle procurement efforts by municipalities and private fleet purchasers in the state. Finally, the region should provide concerted political support for stronger Federal policies to advance vehicle efficiency.

Michigan and Ohio are first and second, respectively, in terms of the number of vehicle production facilities. The Midwest region as a whole is also home to many important auto parts supplier firms. Historically, most lasting improvements in vehicle efficiency have come from improved technology rather than market shifts among type of vehicles. This will also be the case for future efficiency improvements, especially if they are policy-driven. Thus, the region's vehicle manufacturers will benefit from selling more energy-efficient, higher value vehicles. State leadership in this area will pay a double dividend: first, increased economic activity through in-state investments in efficient vehicle production; and second, the widespread consumer benefits resulting from the savings on gasoline expenditures as more efficient vehicles come into use.

Under current market conditions and those likely to prevail in the absence of a major oil supply disruption, there is low consumer and manufacturer interest in higher fuel economy. Each state in the region can create revenue-neutral incentive for higher efficiency by establishing feebates: lower taxes or rebates on vehicles that are more efficient than average. These rebates could be financed by higher taxes or fees on less efficient vehicles. In the region, the current sales tax rate on vehicle purchases ranges from 4.00 to 6.25 percent.[119] This could be converted to a sliding-scale feebate system with a tax ranging from 0 to 10 percent of a vehicle's sales price.[120]

States can lead the way to more efficient vehicles by establishing procurement policies for state fleets to buy the most efficient vehicles in a given class. States can also

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119. Local jurisdictions may add another one to two percent to this base rate. Personal communication with the Ohio Department of Taxation, Columbus, OH.

120. Further discussion of how to design such a proposal and a review of other states' efforts to develop efficiency-linked vehicle incentives is provided by J.M. DeCicco, H.S. Geller, and J.H. Morrill, *Feebates for Fuel Economy: Market Incentives for Encouraging Production and Sales of Efficient Vehicles*, American Council for an Energy-Efficient Economy, Washington, DC, May 1993. See also, W.B. Davis, and D. Gordon, *Using Feebates to Improve the Average Fuel Efficiency of the U.S. Vehicle Fleet*, Report LBL-31910, Energy Analysis Program, Lawrence Berkeley Laboratory, Berkeley, CA, January 1992. The state's authority to enact feebates is presently clouded by a preemption dispute between the U.S. Department of Transportation and the State of Maryland. In 1992, Maryland enacted a modest feebate, converting the state's existing flat 5 percent titling tax into a sliding-scale tax depending on fuel economy but capped at a one percent differential. Implementation was challenged by the Bush Administration's Department of Transportation but the Maryland Attorney General has defended the proposal, noting that only technical changes would be needed to avoid violating preemption clauses. Resolution of this dispute is still pending.

multiply the effects of its own procurement by playing a coordinating role for similar procurement efforts by county and municipal fleets along with voluntary efforts by private fleets.

A similar strategy is now being pursued for alternative fuel vehicles. However, the scope of such efforts is limited by alternative fuel infrastructure needs. An effort to purchase efficient gasoline vehicles could have a much broader scope and is likely to deliver greater fuel conservation and emissions reduction benefits in a more timely fashion. An efficient vehicle procurement strategy can be designed with two stages. One stage would be directed toward bulk purchases of current production vehicles that are "best-in-class" in terms of fuel efficiency.

The second stage could be directed to advanced, next-generation vehicles having substantially higher efficiencies, should they become available. This element could be tied to a nationwide effort to provide a "Golden Carrot" for ultra-efficient vehicles. This proposal, termed the "Green Machine Challenge," is being explored as a way to accelerated the commercialization of promising advanced technologies for vehicle efficiency.[121] Such a program can be viewed as a market pull complement to the advanced efficient vehicle technology research and development efforts being pursued by U.S. automakers through the Partnership for a New Generation of Vehicles.

Vehicle efficiency improvement is just one) albeit the largest) of the opportunities for improving energy efficiency in state and regional transportation systems. Particularly in cities and in corridors connecting the region's many centers of economic activity, policies for reducing vehicle-miles travelled and providing better transit, intercity rail, and intermodal services are also important. While analyzing the potential role for such broader transport efficiency measures is beyond the scope of this study, these approaches can make an additional contribution to reducing energy and environmental costs in the region.

Finally, it is important to note that cars and light trucks are produced for a national, if not international market, in which any one state holds only a small share of the market. All states will benefit from an overall improvement in car and light truck efficiency. While the leverage of any one's states market is limited, all bear a responsibility to help set the nationwide direction of the market.

For this reason, Federal policy plays a determining role in the types of vehicles consumers can buy. This role is particularly crucial in areas of public concern, such as safety, emissions, and efficiency. Since the region stands to greatly benefit from a nationwide effort for higher vehicle efficiency, the states should, therefore, play an active role in pressing for the full range of Federal policies to induce greater vehicle efficiency, including stronger fuel economy standards, feebates linked to higher efficiency (in which state feebates can complement a more widespread and substantial Federal program), and a nationwide Green Machine Challenge.

121. John DeCicco and Andrew deLaski, *The Green Machine Challenge: A Concept for Promoting Ultra-Efficient Vehicles*, American Council for an Energy-Efficient Economy, Washington, DC, March 1995.

E. Price Signals

Conventional energy sources are heavily subsidized, resulting in relatively low energy prices in Midwest and throughout the United States.[122] At the same time, each state relies on income and sales taxes for a major source of its needed revenues. By shifting a portion of this tax burden away from income and consumption at-large to energy consumption, the resulting energy price change would make efficiency even more attractive. The lower income and sale tax rates would also have a positive effect on the regional economy while allowing the state to continue providing needed government services. Moreover, if the price increase was the result of a carbon-based energy tax, the price changes would be a clear signal that encouraged the use of low-carbon fuels and renewable energy sources such as biomass, solar energy, and windpower.

There are a number of ways to offset consumer and business taxes so that when combined with higher energy taxes, the net result is revenue neutral.[123] There could be direct reductions in income taxes across the board. Generally, however, a greater efficiency benefit will be obtained if a portion of the energy tax offset is linked to investments which directly improve energy efficiency. Instead of a general income tax reduction, a portion of the offset could be a tax credit for investments in energy-efficiency improvement up to the individual's or company's state tax liability.

Because studies have shown that for the industrial sector investments in process modernization lead to greater overall energy efficiency,[124] ACEEE recommends that any investment for process improvement be allowed under a tax credit, if the tax credit approach is followed. Any surplus revenues resulting from the energy tax would then be used to fund programs such as the Energy Bank, or to make technical services available to energy consumers.

F. Forming a Sustainable Energy Development Agency

Our final policy recommendation is to create a Sustainable Energy Development Agency, either within individual states or at the regional level. In most cases this can be done by folding existing programs like Ohio's Coal Development Office into the new Sustainable Energy Development Agency.

There are a number of reasons for this recommendation. First, as noted earlier in this report, coal is a very small and a declining industry in the region. In fact, regional employment in the coal industry fell to under 20,000 jobs as of 1992) less than 0.2 percent of total employment within the four states. Moreover, the outlook for the region's coal industry is bleak given increasing automation and shifts towards low-sulfur western coal, the adoption of national acid rain reduction requirements through the 1990

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122. This point was discussed in the introduction of this study. See, *Federal Energy Subsidies: Energy, Environmental, and Fiscal Impacts*, op. cit.

123. F. Muller and J.A. Horner, "The promise of state carbon taxes: opportunities and policy issues," *State Tax Notes*, March 8, 1993; R.C. Dower and M.B. Zimmerman, "The Right Climate for Carbon Taxes: Creating Economic Incentives to Protect the Atmosphere," World Resources Institute, Washington, DC, August 1992.

124. Marc H Ross and Daniel Steinmeyer, "Energy for Industry", *Scientific American*, September, pages 89-98, 1990.

Clean Air Act Amendments, and increasing concern about global warming and commitments by the United States and other nations to reduce carbon dioxide and other greenhouse gas emissions.

Unlike the coal industry, energy efficiency improvements and renewable energy technologies are growth industries with an extremely promising future. Given its traditional strength in manufacturing fabricated goods such as motors, appliances, lighting products, and insulation materials, the region has the potential to become a leading manufacturer of energy efficiency technologies. The region also has substantial wind and biomass energy resources, and could develop manufacturing and production capacity related to these energy sources as well.[125]

Some states including California, Florida, Iowa, New York, and North Carolina fund and operate state energy R,D&D agencies that emphasize energy efficiency and renewable energy technologies. These agencies support technology research and development, demonstrations, field monitoring, and in some cases education, training and other implementation activities. A number of the state energy R,D&D agencies are funded through small utility surcharges or utility contributions.[126]

A Sustainable Energy Development Agency in the region, or in each of the states, could provide a number of functions in working with manufacturers and consumers in the region, including: (1) applied R&D and demonstrations of advanced energy efficiency and renewable energy technologies; (2) technology and market assessments; and (3) support for technology transfer and commercialization. The agency could also help the region's utilities and state agencies in the design and evaluation of energy efficiency and renewable energy programs, and possibly assist with training or technical assistance concerning building code implementation or improving industrial energy efficiency. In summary, a Sustainable Energy Development Agency could be of great value in helping the Midwest achieve the economic and environmental benefits outlined in this report.

VIII. CONCLUSION

Based on the analysis of the high energy efficiency scenarios, it seems clear that a policy of accelerated energy efficiency improvements can help ensure that citizens and businesses in the Midwest obtain energy-related services at the lowest possible overall cost. Total statewide expenditures for energy services (including energy efficiency expenditures) in 2010 are about 12 to 15 percent lower in the high efficiency scenario relative to the baseline scenario.

Moreover, accelerated energy efficiency investments would provide significant macroeconomic and environmental benefits. For example, we estimate a net increase of 205,000 jobs in the Midwest by 2010 as a result of pursuing the high efficiency scenario. Those jobs are equivalent to the employment supported directly and indirectly by about 1,367 small manufacturing plants. On the environmental side, we estimate that the energy savings would lead to about 66 million metric tons fewer carbon emissions

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125. See, *Powering the Midwest: Renewable Electricity for the Economy and the Environment* (Cambridge, MA: Union of Concerned Scientists, 1993).

126. For more information on these state energy R,D&D agencies, see Jeffrey P. Harris, et al., "Energy-Efficiency Research, Development and Demonstration: New Roles for U.S. States," *Energy Policy*, December, 1993, pages 1205-1216.

per year by 2010. The high efficiency scenario will also reduce emissions of sulfur dioxide (SO_2), nitrogen oxides (NO_x), volatile organic compounds (VOCs), particulates, and toxic metals. In this way, energy efficiency will help the utilities and states meet or exceed their Clean Air Act requirements.[127]

Hence, energy efficiency investments are more than mere cost-cutting measures. They yield both positive environmental benefits and net employment gains. Given the higher employment and income opportunities, energy efficiency investments should be viewed as a critical economic development strategy for the Midwest.[128]

One important aspect of the energy efficiency scenario is that "it takes money to make money." In order to achieve the level of economic benefits illustrated in Table 12, policies must be adopted and effectively implemented to encourage a $104 billion investment in the period 1995 through 2010. Averaged out over the 16-year period, this implies an average annual investment of $6.5 billion) about nine percent of the region's current energy bill.

While the investment is modest in comparison with the anticipated energy expenditures, it will take an average of 3-5 years for energy efficiency investments to pay for themselves. Thus, the state and its private investors will be laying out greater sums of money than are being saved in the early years of the program. In fact, the cross-over point where annual savings exceed annual investment will not occur until about the year 2000, assuming that large-scale investments begin in 1995.

Overcoming the initial hurdle of redirecting financial investments away from conventional energy resources and towards energy efficiency technologies will not occur without concerted action by policy makers in each of the four states, along with critical support from the Federal government.

To help residents of the Midwest capture the full economic benefits of a high efficiency scenario, we suggest that a number of policies be adopted at the state or regional level, including:

*** State-of-the-art building energy codes plus training and support for the effective implementation of residential and commercial building codes;

*** Greatly expanded demand-side management programs by both natural gas and electric utilities, along with greater support from utility regulators for cost-effective DSM programs;

*** Expanded technical and financial support to accelerate both energy and process efficiency improvements in the industrial sector;

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127. For example, in an analysis conducted with PSI Energy, ACEEE found that enhanced DSM programs could reduce SO_2 emissions in 2010 by 20,000-29,000 tons, 13-19 percent of the total emissions reduction required due to the 1990 Clean Air Act Amendments. See, Steven Nadel, et al., *Using DSM to Help Meet Clean Air Act Targets: A Case Study of PSI Energy*, American Council for an Energy-Efficient Economy, Washington, DC, November 1994.

128. A recent report evaluating the Clinton Administration's *Climate Change Action Plan* reached a similar conclusion noting that it could lead to as many as 260,000 more jobs for the United States in the year 2010. See, Skip Laitner, *The Climate Change Action Plan as an Economic Development Strategy for the United States*, American Council for an Energy-Efficient Economy, Washington, DC, May 1994.

*** Policies which improve the fuel economy of cars and light trucks;

*** Improved energy price signals including a revenue-neutral energy or carbon tax to encourage investments in energy efficiency in all sectors; and

*** Creation of a Sustainable Energy Development Agency at the regional or state level that would fund R&D, demonstration, and promotion activities in support of energy efficiency and renewable energy implementation.

These initiatives, along with other actions that can be taken to increase energy efficiency, would result in a stronger economy and a cleaner environment in the Midwest in the coming decades.