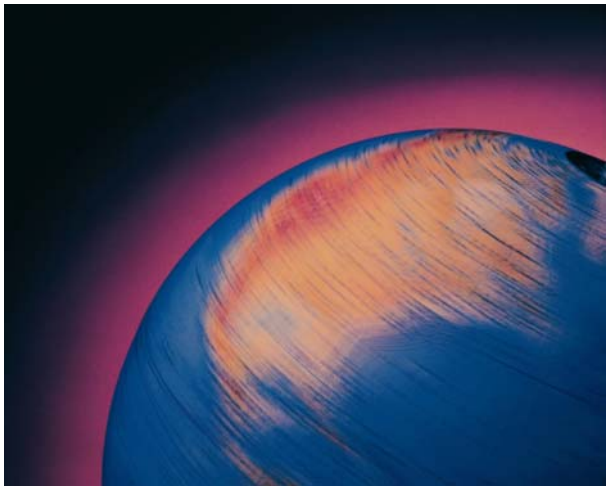
Informing the Debate

Overview of Michigan's Energy Infrastructure



Authors
Kenneth Rose

MICHIGAN STATE UNIVERSITY

Institute for Public Policy and Social Research

Institute for Public Policy and Social Research at Michigan State University

Informing the Debate

Overview of Michigan's Energy Infrastructure

Author
Kenneth Rose
Institute of Public Utilities
Michigan State University

Sponsor
The Institute for Public Policy and Social Research
Douglas B. Roberts, Ph.D.
Director

Series Editors
Ann Marie Schneider, M.S.
Institute for Public Policy and Social Research
Program Manager

Lauren Meunier
Institute for Public Policy and Social Research
Communications Assistant

MICHIGAN STATE UNIVERSITY

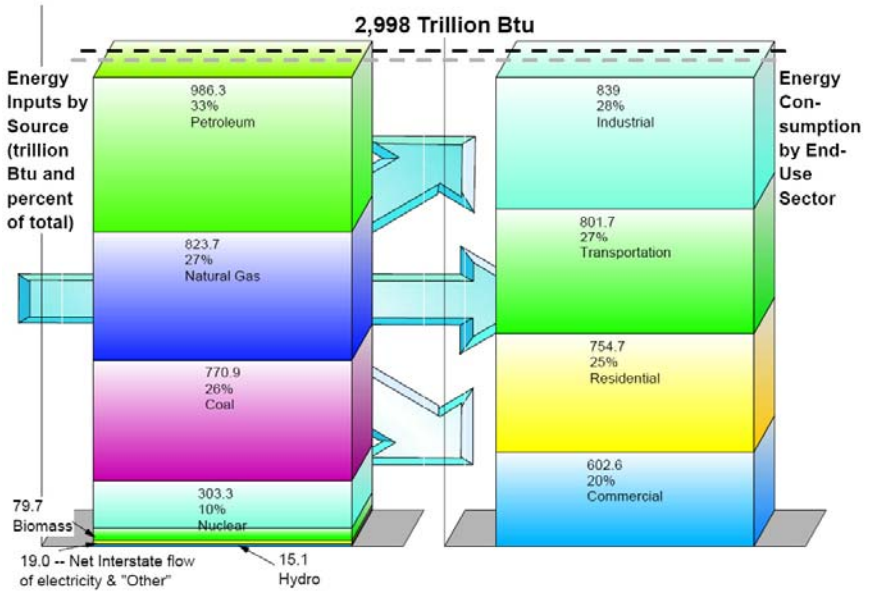
The Institute for Public Policy and Social Research is housed in the College of Social Science at Michigan State University.

Overview of Michigan's Total Energy Use

Like most large and populous states, Michigan consumes a tremendous amount of energy. In 2006, Michigan ranked tenth among states in terms of total energy consumption—using nearly three quadrillion (or 3,000 trillion) British thermal units (Btu). In terms of barrel-of-oil physical equivalents, that is nearly equal to one month's consumption of oil for the entire U.S. Figure 1 summarizes the total energy flow in the state from the major energy sources to the end use sectors. One-third of the state's energy came from petroleum products—187 million barrels during 2006[1]. Just over one-quarter of the state's energy came from natural gas (or 809.1 billion cubic feet) and another quarter from coal (or 38 million tons). Together, fossil fuels accounted for 86 percent of Michigan's energy inputs. Nuclear provided ten percent and the remaining four percent was provided by biomass, net imports of electricity and "other sources," and hydro electric power.[2]

Historically, Michigan's total energy use has been relatively steady since about 1995. The highest annual use occurred in 1999 at 3,260.5 trillion Btu and decreased by about eight percent to the 2006 level. This was mostly due to industrial energy use, which declined by 19 percent during that same time period. Energy use by the industrial sector was higher during the 1970s than any year since 1999. Residential and commercial sector energy use remained relatively stable since the mid-1990s, both reaching the sector's highest annual levels in 2005. The transportation sector, also relatively stable since the mid-1990s, reached its highest annual use in 1999, and then decreased by 4.4 percent by 2006. The electric power sector's energy consumption increased by nine percent from 1999 to 2006. Although the sectors highest annual use occurred in 2005 and this was more than double the sectors use in 1970, this sectors total energy use also remained relatively stable since 1995.

Figure 1. Michigan's Total Energy Flow, 2006.



A map of Michigan's energy facilities and how it flows into and within the state is shown in the Appendix (Figure A1). Also in the Appendix is a graph of Michigan's energy consumption of fuels by end-use sector (Figure A2).

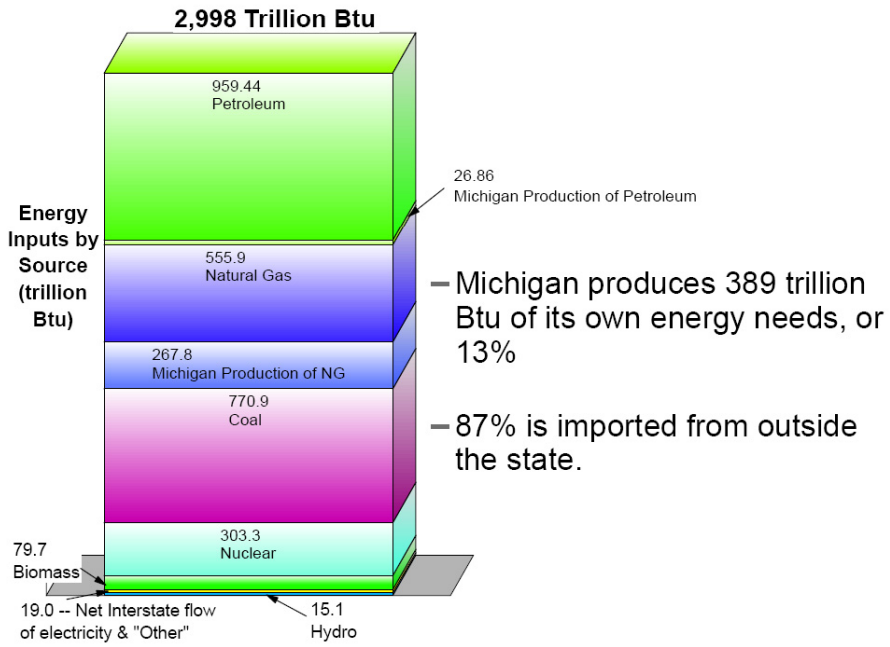
Michigan Energy Production

Michigan produces a relatively small amount of its overall energy needs from conventional sources. Only about 13 percent is produced within the state.[3] However, Michigan does produce about one-third of its own natural gas use. Figure 2 shows the energy input with the amount of natural gas and oil that is produced in Michigan. In-state petroleum production is only 2.7 percent of the Michigan's total petroleum use.

1. This includes (in order of amount used) motor gasoline (118.1 million barrels), distillate fuel oil (includes diesel fuels and fuel oils, 29.9 million barrels), and liquefied petroleum gases (LPG, 15 million barrels). In total, these three products accounts for 87 percent of the petroleum used in the state. Gasoline alone was 63 percent of the petroleum products used.
2. Further details on inputs of energy sources for electric power are provided below.
3. Of course, energy sources produced within the state are not necessarily consumed in the state. This simply nets out the difference between consumption of an energy source versus the in-state production.

Figure 3 plots Michigan's historical natural gas production in physical units. There was a steady increase in natural gas production in the state since about 1970, with the peak reached in the late 1990s. While production has fallen from the peak, the states production of natural gas in 2007 was still almost seven times the 1970 level.

Figure 2. Michigan's energy inputs in 2006, including in-state production.



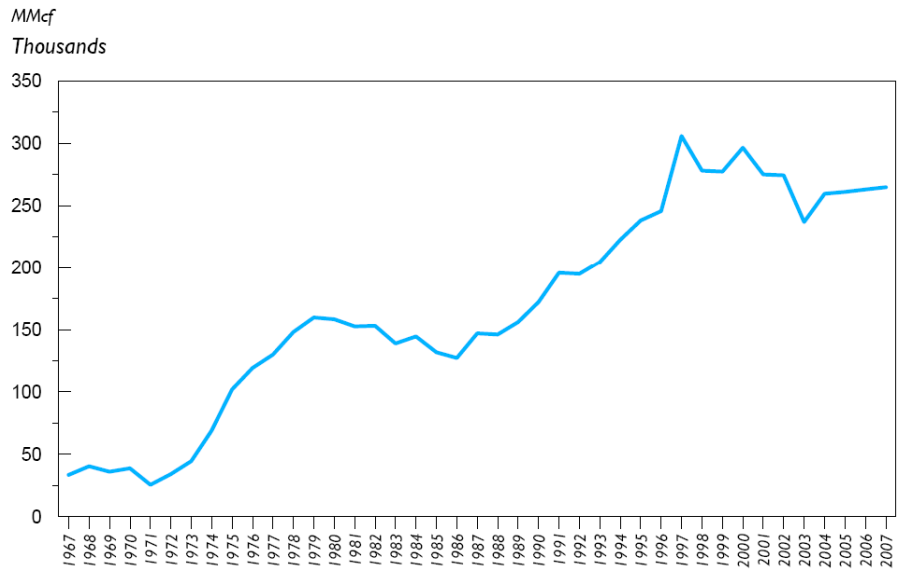
Michigan has the largest natural gas reserves of upper Midwestern states (the Antrim natural gas field in the northern Lower Peninsula) and ranks eleventh in reserves among the lower 48 states. The state's estimated reserve is over 3.6 trillion cubic feet of natural gas, or 1.5 percent of total U.S. reserves.[4] Michigan placed over one trillion cubic feet of natural gas in underground storage in the fall of 2007 and again in 2008 – more than any other state in the U.S.

Crude oil production in the state is very different. As shown in Figure 4, in the early 1980s Michigan produced over 30 million barrels of oil per year. In 2007, that had dropped to just over 5 million barrels per year.

Michigan has no recoverable coal resources – all coal is imported from outside the state (mostly Wyoming and Montana, and also from several eastern states).

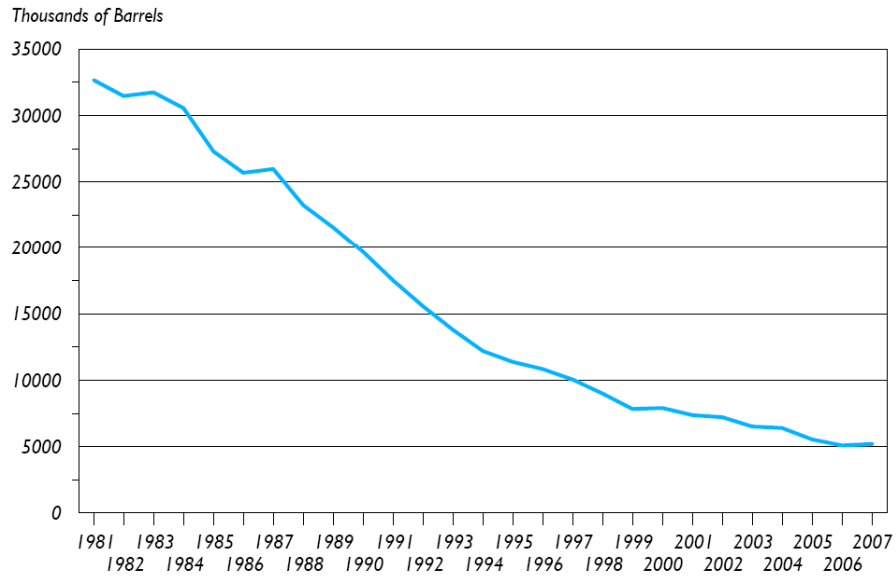
4. Based on EIA estimate of dry natural gas reserves for 2007. This is "proved reserves" of natural gas, which is defined by EIA as: "estimated quantities which analysis of geological and engineering data demonstrate with reasonable certainty to be recoverable in future years from known reservoirs under existing economic and operating conditions."

Figure 3. Michigan natural gas marketed production.



Data Source: Energy Information Administration

Figure 4. Michigan field production of crude oil, 1981 to 2007.



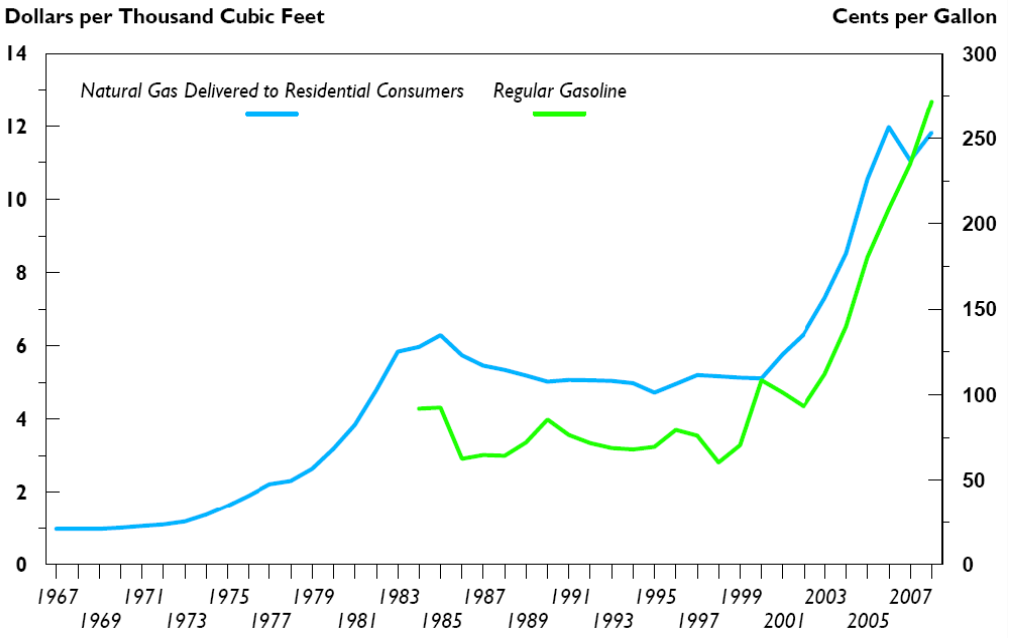
Data Source: Energy Information Administration

Michigan's Energy Prices

Figure 5 shows nominal historical price for natural gas for residential consumers and the price of regular gasoline. The graph shows the 1970s and early 1980s price increase of natural gas (the natural gas price is shown on the left axis), the relative calm of the mid-1980s to the late 1990s (where the real price was falling), and the significant price run-up seen since the year 2000.

About 80 percent of homes in Michigan use natural gas as a heating source. The price for gasoline (shown on the right hand axis in cents per gallon) has had a similar historical price pattern.

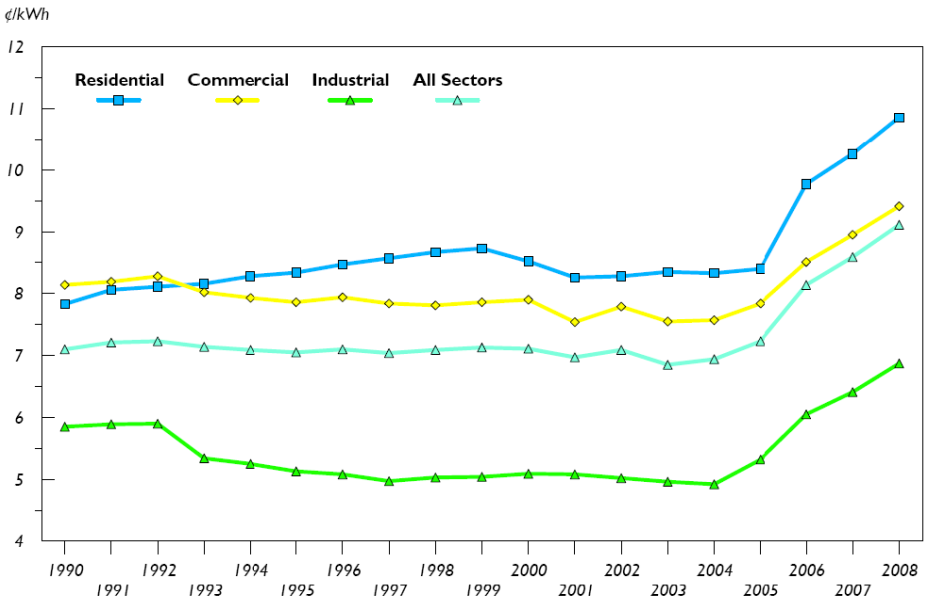
Figure 5. Price of regular gasoline and of natural gas delivered to residential consumers.



Data Source: Energy Information Administration

The average retail prices for electricity are shown in Figure 6 by sector. Since 1990, electricity prices had been relatively stable, but the average price for all sectors has increased by 33 percent from 2003 to 2008. Figure 7 plots the Michigan historical electricity price for all customers with neighboring "IOWIM" states (Illinois, Ohio, Wisconsin, Indiana, and Minnesota). The electricity prices of all the upper Midwestern states have been increasing in similar manner and have been below the national average since the beginning of this decade. However, Michigan's average price is in the upper tier of states in the region, along with Illinois and Wisconsin. The historical average retail electricity prices by sector are shown in figures in the Appendix (Figures A3 through A5).

Figure 6. Michigan average retail electricity prices.

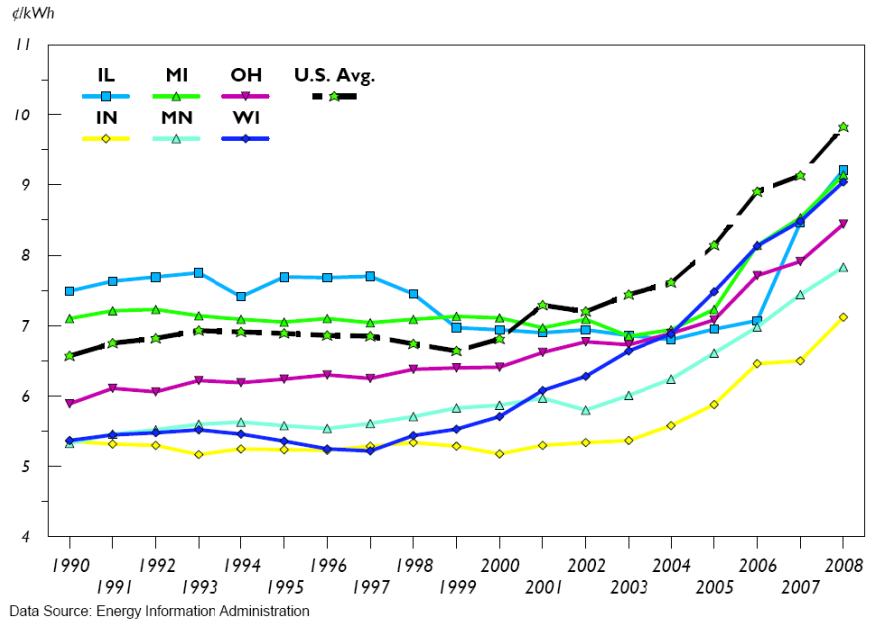


Data Source: Energy Information Administration

The Electricity Supply Sector

The overwhelming amount of electricity generated in the state comes from electric utilities. Over 86 percent of the electricity generated in the state was from electric utilities in 2006.[5] As Figure 8 shows, over 110 billion kilowatthours of electricity were generated in Michigan each year from 2001 through 2006. Other generation sources include combined heat and power generators, that is, facilities that combine industrial or commercial operation with electricity generation, and independent power producers.

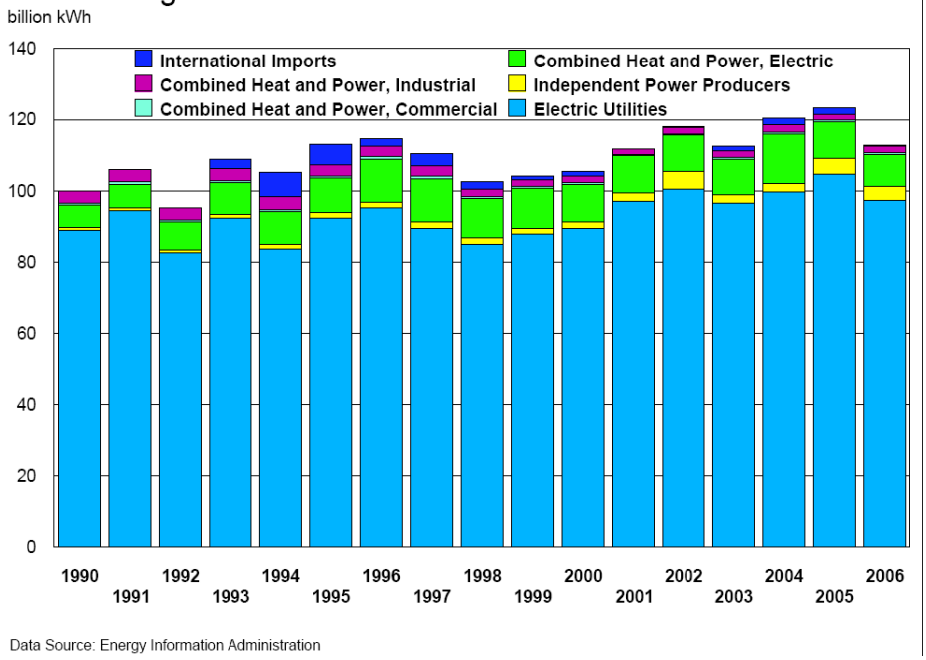
Figure 7. Average retail electricity price for all customers in Michigan and "IOWIM" states.



Data Source: Energy Information Administration

5. This includes investor-owned, municipal, and rural cooperative utilities. The large investor-owned utilities in Michigan own most of the generation capacity required to serve the customers in their territory and the distribution facilities to deliver that electricity.

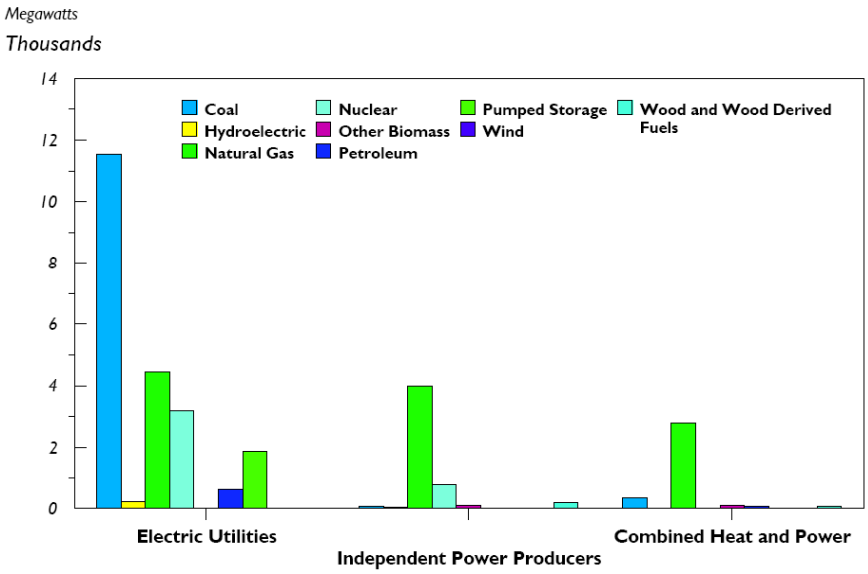
Figure 8. Michigan's electricity supply sources 1990 through 2006.



Data Source: Energy Information Administration

Figure 9 charts the fuel used by type of power producer. Electric utilities used mostly coal, followed by natural gas, nuclear and pumped storage. Independent and combined heat and power producers both used mostly natural gas.

Figure 9. Capacity by type of producer and energy source, 2007.

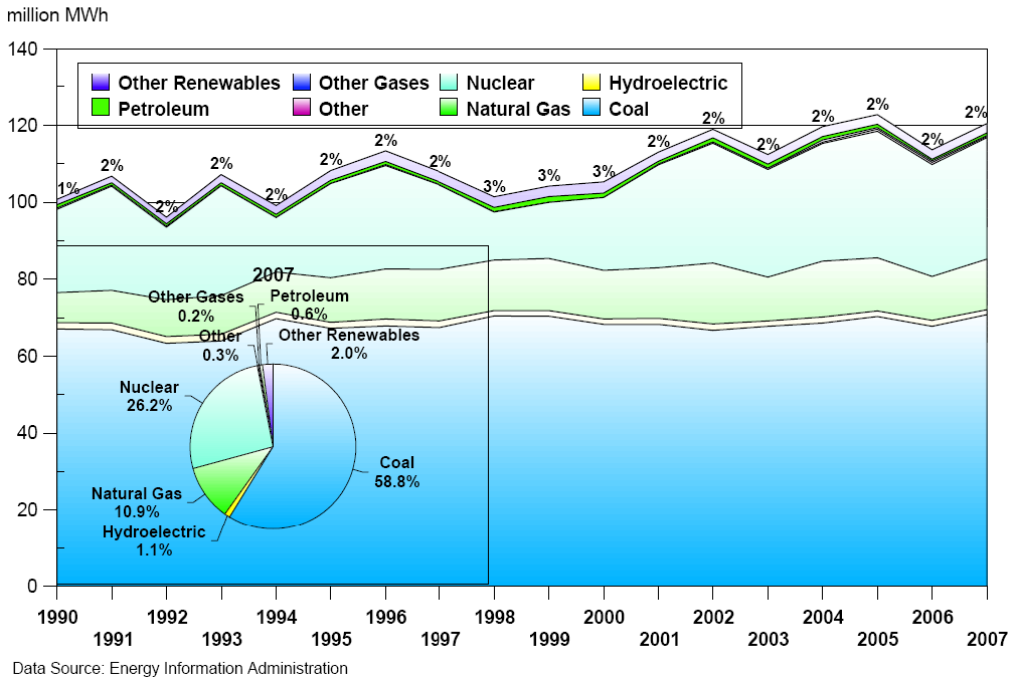


Data Source: Energy Information Administration

Figure 10 chart the fuel used for all producers in the electric power sector from 1990 through 2007. The inserted pie chart shows the percent each fuel was used in 2007. Coal was the primary fuel used for generating electricity in the state from all sources (59 percent), followed by nuclear as a source for over one-quarter of the electricity generated. The amount of electricity produced in Michigan increased by almost 20 percent from 1990 to 2007. However, the amount of electricity produced using coal increased by less than six percent during that time period, while

natural gas increased by two-thirds and nuclear by 46 percent. Hydroelectric and petroleum both decreased during this time.

Figure 10. Michigan electric power industry generation by energy source, 1990 through 2007.



Data Source: Energy Information Administration

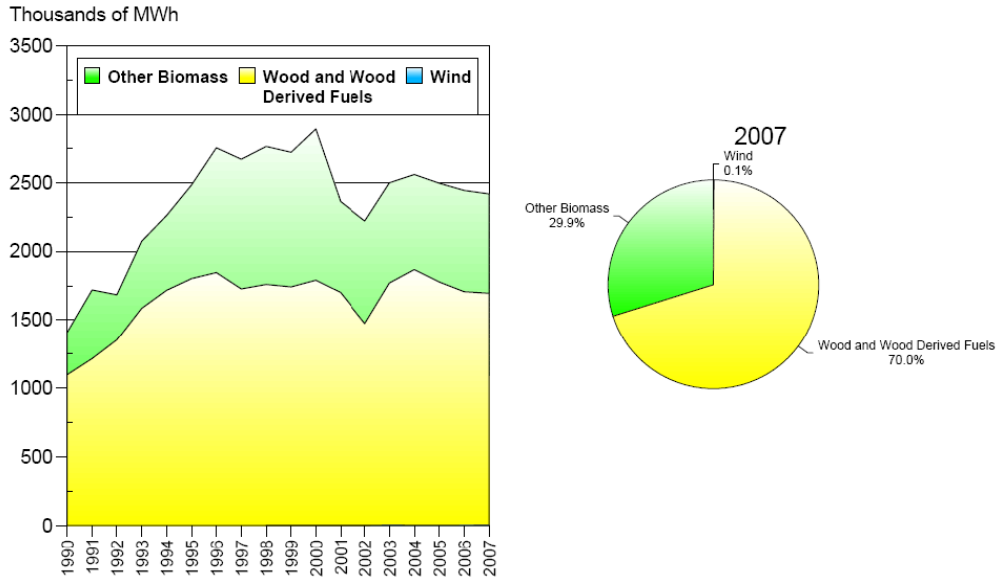
The top shaded portion of Figure 10 is the category "other renewables"), which has been about two percent of total generation for most of the seventeen-year period. A closer look at electricity produced by "other renewable" sources (basically, renewable sources other than hydroelectric[6]) is shown in Figure 11. In 2007, 70 percent of the electricity produced from these "other" sources was from wood and wood-derived fuels[7] and nearly all the remainder was generated from "other biomass" sources. The left panel of Figure 11 shows that wood and wood- derived fuels have been the main source of renewable fuel for electric generation in Michigan and have increased significantly in use since 1990. Other biomass has also increased considerably during the 17-year time period. Wood and wood-derived fuels increased by 54 percent and other biomass increased by 132 percent during this period.

Wind is also included in the definition of "Other Renewables" and is included in Figure 11; however, the total amount of electricity generated from wind was considerably smaller than the other two sources.[8] In 2007, wind provided only about 2,700 megawatthours, while wood and wood-derived fuels provided almost 1.7 million megawatthours (in contrast, coal provided 70.8 million megawatthours).

It should be noted that the total amount of wind capacity has increased considerably in the last couple of years. The Michigan Department of Energy, Labor and Economic Growth (Energy Systems Bureau) has identified a total of 130 megawatts of wind power installed in Michigan at the end of 2008 – more than double the total accumulated capacity installed at the end of 2007 (however, this compares with almost 12,000 megawatts of coal capacity or 23,825 megawatts of fossil-fueled capacity).[9]

6. EIA identified these "other" sources as: "wood, black liquor, other wood waste, biogenic municipal solid waste, landfill gas, sludge waste, agriculture byproducts, other biomass, geothermal, solar thermal, photovoltaic energy, and wind."
7. Wood and wood-derived fuels are defined by EIA as: "Wood/wood waste solids (including paper pellets, railroad ties, utility wood-based liquids), and black liquor."
8. 8 Other biomass is defined as "biogenic municipal solid waste, landfill gas, sludge waste, agricultural byproducts, other biomass solids, other biomass liquids, and other biomass gases (including digester gases, methane, and other biomass gases)."
9. This is based on EIA data of the state's summer capacity. Michigan had a total of 30,305 megawatts of summer capacity in2007 from all energy sources and types of producers.

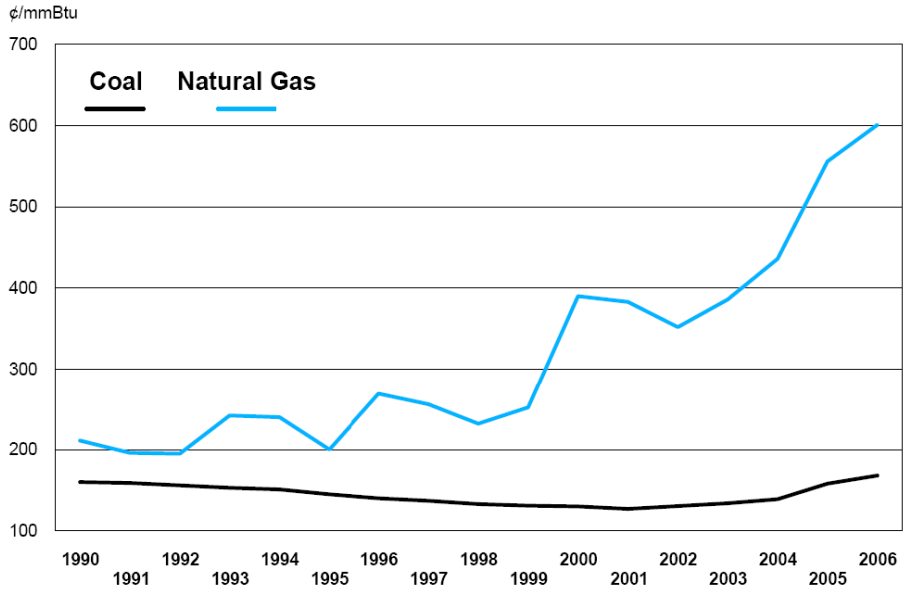
Figure 11. Michigan net generation by "other renewables," 1990 through 2007.



Data Source: Energy Information Administration

Figure 12 charts the prices for coal and natural gas for electric power generation from 1990 through 2006. There is a sharp contrast between the trends of these two fuels. Coal prices decreased between 1990 and 2001 by almost 21 percent, and then increased 32 percent from 2001 to 2006; however the overall increase for the period was only five percent. Natural gas, on the other hand, increased by 185 percent during this same period – most of that increase since 1999. This, of course, is a similar to the pattern seen for the residential consumer natural gas price shown in Figure 5 above.

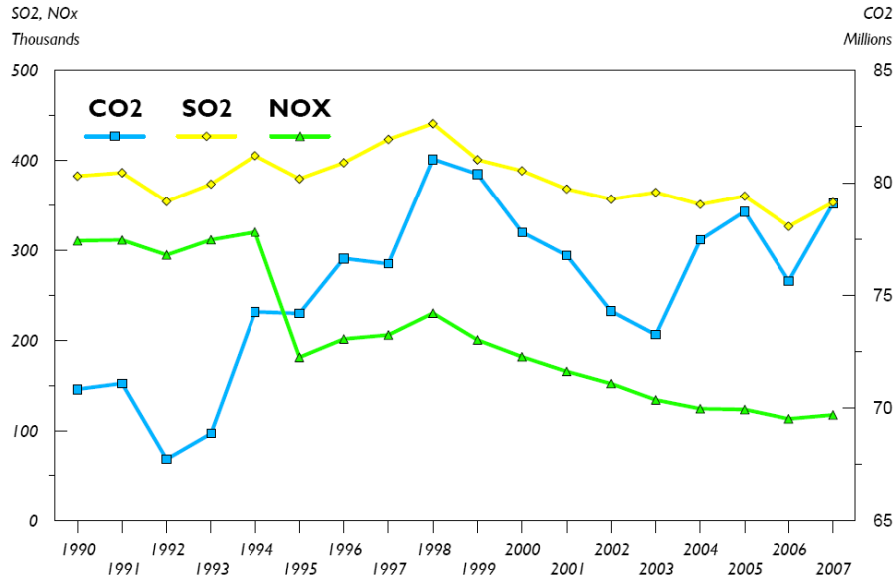
Figure 12. Michigan electric power delivered fuel prices, 1990 through 2006.



Data Source: Energy Information Administration

Michigan's considerable use of fossil fuels, of course, also means emissions of effluence from its power plants. Figure 13 plots the emissions of sulfur dioxide, nitrogen oxides, and carbon dioxide (SO2, NOx, and CO2) from 1990 through 2007. Both SO2 and NOx emissions (shown on the left axis in thousands of metric tones) have fallen during this period by 7.7 percent and 62 percent, respectively. This is largely due to the limits placed on emission of these pollutants by the 1990 Clean Air Act. Carbon dioxide, however, that currently has no mandatory limits, increased during this period – rising by nearly 12 percent. Carbon dioxide emissions are shown on the right axis, in millions of metric tons. In 2007, Michigan accounted for about three percent of total U.S. carbon dioxide emissions.

Figure 13. Michigan emissions of CO_2, SO_2, and NO_x from the electric power sector (metric tons).



Data Source: Energy Information Administration

Appendix

Additional Figures and Charts

Figure A1. U.S. Department of Energy, Energy Information Administration's figure of Michigan's energy infrastructure.

Source: EIA, http://tonto.eia.doe.gov/state/ , July 2009.

Figure A2. Michigan's energy consumption by end-use sector in 2006.

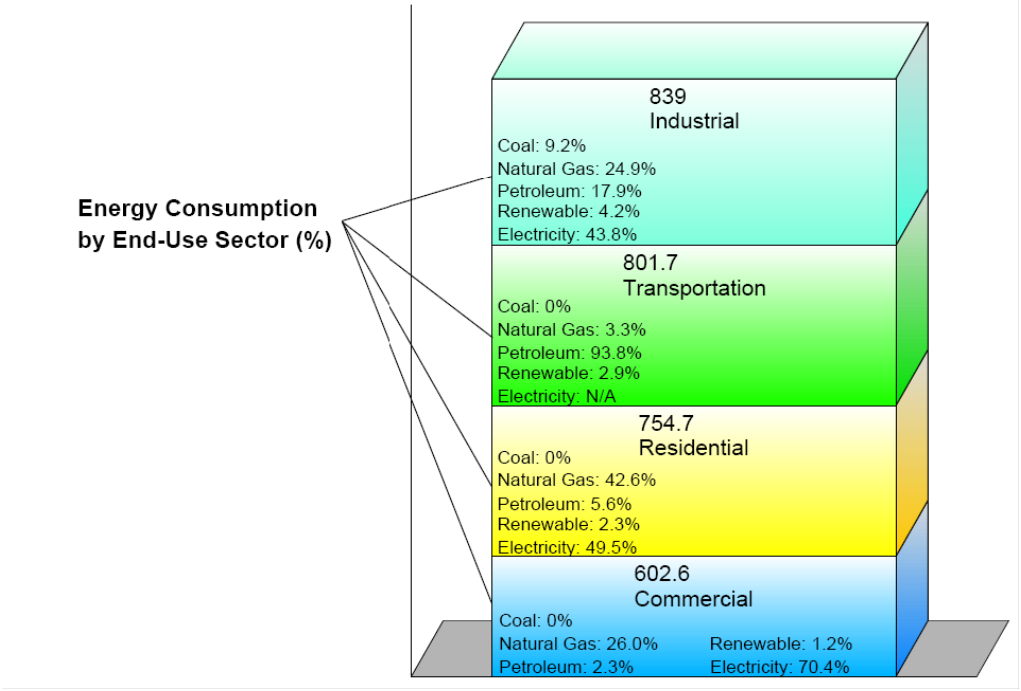
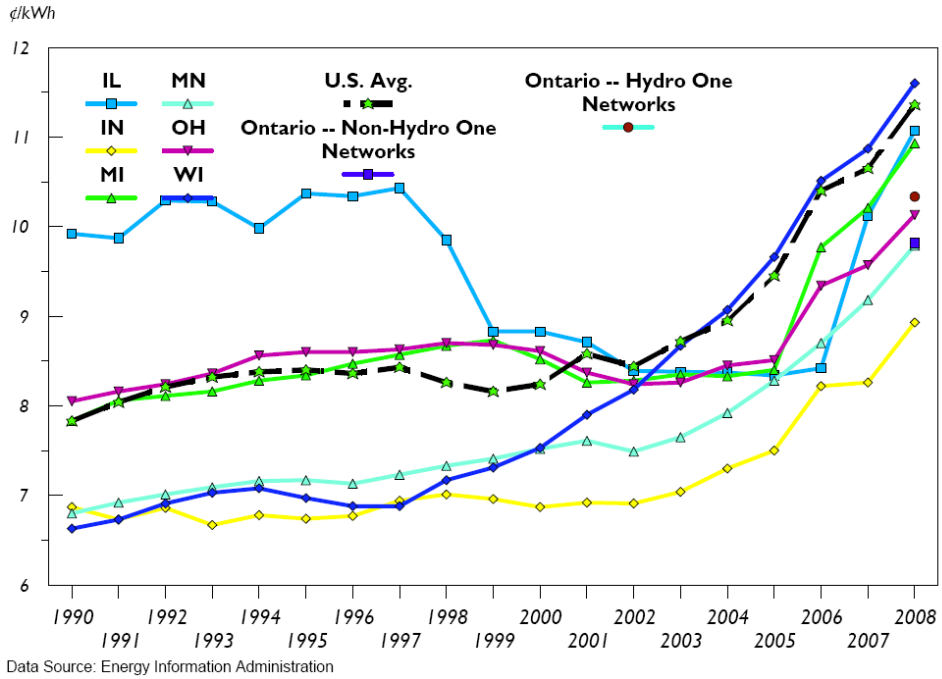
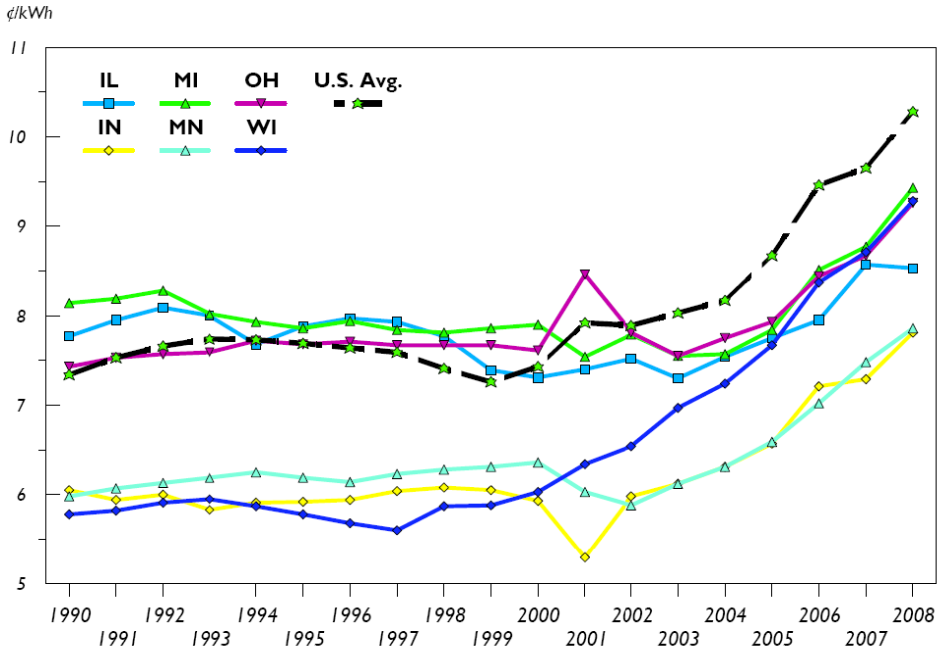


Figure A3. Average retail electricity price for residential customers in Michigan and "IOWIM" states.



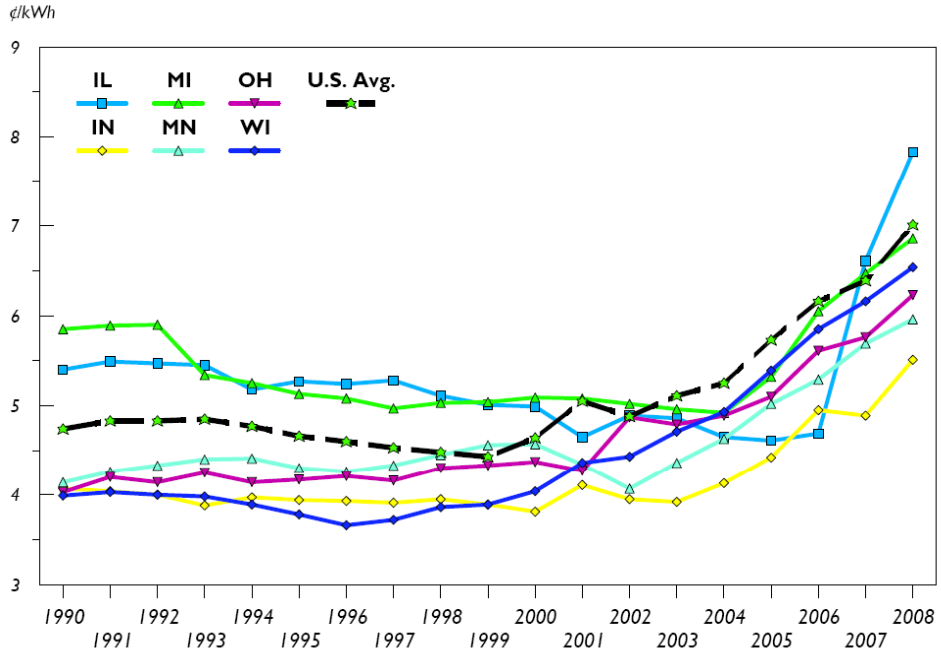
Data Source: Energy Information Administration

Figure A4. Average retail electricity price for commercial customers in Michigan and "IOWIM" states.



Data Source: Energy Informaton Administration

Figure A5. Average retail electricity price for industrial customers in Michigan and "IOWIM" states.



Data Source: Energy Information Administration

MICHIGAN STATE UNIVERSITY

Institute for Public Policy and Social Research

College of Social Science
Michigan State University
321 Berkey Hall
East Lansing, MI 48824-1111
Phone:517-355-6672 Fax:517-432-1544
Web: www.ippsr.msu.edu
Email: ippsr-action@ssc.msu.edu