

Energy Consumption

Indicator #7057

This indicator report was last updated in 2003.

Overall Assessment

Status: Mixed
Trend: Not Assessed

Lake-by-Lake Assessment

<i>Separate lake assessments were not included in the last update of this report.</i>

Purpose

- To assess the energy consumed in the Great Lakes basin per capita
- To infer the demand for resource use, the creation of waste and pollution, and stress on the ecosystem

Ecosystem Objective

Sustainable development is a generally accepted goal in the Great Lakes basin. Resource conservation minimizing the unnecessary use of resources is an endpoint for ecosystem integrity and sustainable development. This indicator supports Annex 15 of the Great Lakes Water Quality Agreement.

State of the Ecosystem

Energy use per capita and total consumption by the commercial, residential, transportation, industrial, and electricity sectors in the Great Lakes basin can be calculated using data extracted from the Comprehensive Energy Use Database (Natural Resources Canada), and the State Energy Data 2000 Consumption tables (U.S. EIA 2000). Table 1 lists populations and total consumption in the Ontario and U.S. basins, with the U.S. basin broken down by states. For this report, the U.S. side of the basin is defined as the portions of the eight Great Lakes states within the basin boundary (which totals 214 counties either completely or partially within the basin boundary). The Ontario basin is defined by eight sub-basin watersheds. The most recent data available are from 2002 for Ontario and 2000 for the U.S. The largest change between 2000 and 2002 energy consumption by sector in Ontario was a 4.4% increase in the commercial sector (all other sectors changed by less than 2% in either direction).

In Ontario, the per capita energy consumption increased by 2% between 1999 and 2000. In the U.S. basin, per capita consumption decreased by an average of 0.875% from 1999 to 2000. Five states showed decreases in per capita energy consumption, while three states had increases (Figure 1). Electrical energy consumption per capita was fairly similar on both sides of the basin in 2000 (Figure 2). Over the last four

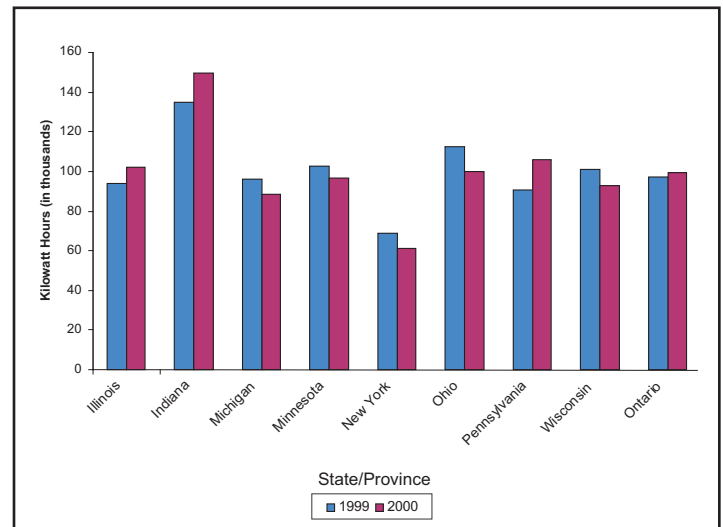


Figure 1. Total energy consumption per capita 1999-2000. 1 MWh = 1000 kWh.

Source: Energy Information Administration (2000) and Natural Resources Canada (2000)

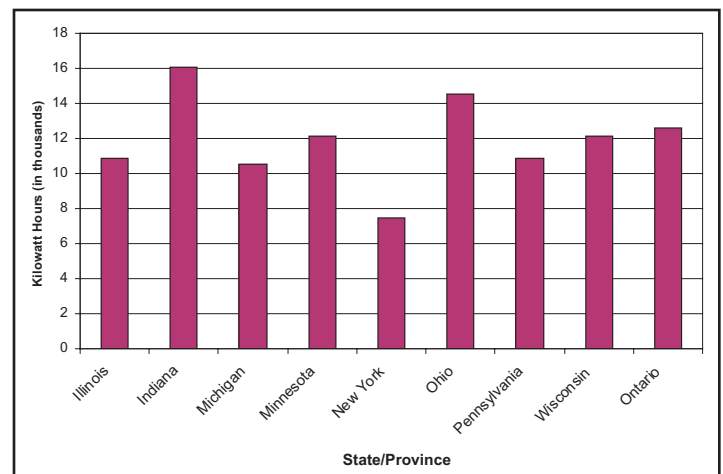


Figure 2. Electric energy consumption per capita 2000. 1 MWh = 1000 kWh.

Source: Energy Information Administration (2000) and Natural Resources Canada (2000)

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decades, consumption trends in the U.S. basin have been fairly steady, although per capita consumption increased in each state from 1990 to 2000 (Figure 3). Interestingly, New York and Ohio consumed less per capita in 2000 than in 1970. Looking at the trends in Ontario from 1970 to 2000, the per capita energy consumption has stayed relatively consistent, with the exception of an increase seen in 1980. The per capita energy consumption figures for Ontario do not include the electricity generation sector due to an absence of data for this sector up until 1978. It is important to note that the quality of data processing and validation has improved over the last four decades and therefore the data quality may be questionable for the 1970s.

Total secondary energy consumption by the five sectors on the Canadian side of the basin in 2002 was 930,400,000 Megawatt-hours (MWh) (Table 1). Secondary energy is the energy used by the final consumer. It includes energy used to heat and cool homes and workplaces, and to operate appliances, vehicles and factories. It does not include intermediate uses of energy for transporting energy to market or transforming one energy form to another, this is primary energy. Accounting for 33% of the total secondary energy consumed in the Canadian basin, electricity generation was the largest end user of all the sectors. The other four sectors account for the remaining energy consumption as follows: industrial, 22%; transportation, 20%; residential, 15%; and commercial, 12% (Table 2). Note that due to rounding, these figures do not add up to 100. There was a 0.5% increase in total energy consumption by all sectors in Ontario between 2000 and 2002.

Total secondary energy consumption by the five sectors on the U.S. side of the basin in 2000 was 3,364,000,000 MWh (Table 1). As in the Canadian basin, electricity generation was the largest consuming sector in the U.S. basin, using 28% of the total secondary energy in the U.S. side of basin. The U.S. industrial sector consumed only slightly less energy, 27% of the total. The remaining three U.S. sectors account for 44% of the total, as follows: transportation, 21%; residential, 14%; and commercial, 9% (Table 2). Note that due to rounding, these percentages do not add up to 100. Figure 4 shows the total energy consumption by sector for both the Ontario and U.S. sides of the Great Lakes basin in 2000.

The commercial sector includes all activities related to trade, finance, real estate services, public administration, education, commercial services (including tourism), government and institutional living and is the smallest energy consumer of all the sectors in both Canada and the U.S. (Table 2). Of the total secondary energy use by this sector in the Ontario basin, 57% of the energy consumed was supplied by fossil fuel (natural gas, 50%; and petroleum, 7%) and 43% was supplied by electricity. In Ontario, this

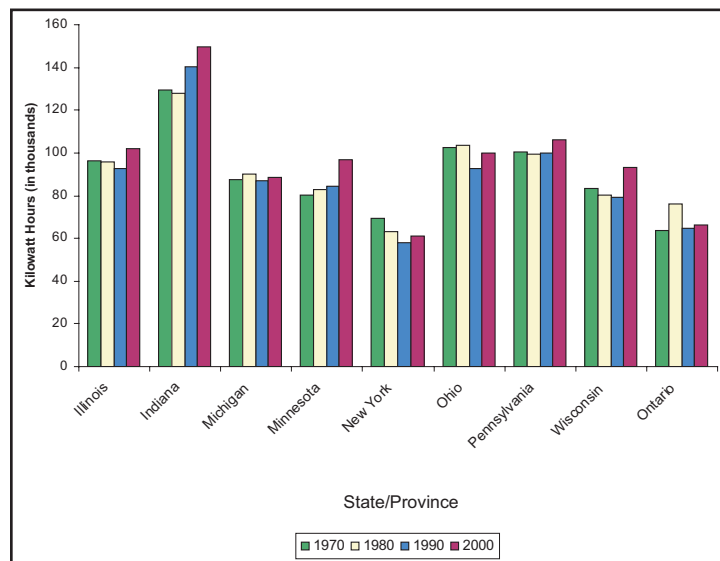


Figure 3. Total per capita energy consumption 1970-2000. 1 MWh = 1000 kWh.

Other energy sources include geothermal, wind, photo-voltaic and solar energy. The Ontario data do not include the electricity generation sector due to an absence of data for this sector until 1978.

Source: Energy Information Administration (2000) and Natural Resources Canada (2000)

State/Province	Total energy consumption by State/Province within the Great Lakes basin (MWh)	Population within the Great Lakes basin*
Ontario (2002 data)	930,400,000	9,912,707
U.S. Basin Total (2000 data)	3,364,000,000	31,912,867
Illinois (IL)	669,400,000	6,025,752
Indiana (IN)	304,900,000	1,845,344
Michigan (MI)	998,500,000	9,955,795
Minnesota (MN)	36,600,000	334,444
New York (NY)	309,600,000	4,506,223
Ohio (OH)	614,000,000	5,325,696
Pennsylvania (PA)	43,700,000	389,210
Wisconsin (WI)	387,300,000	3,530,403

* The U.S. side of the basin is defined as the portions of the 8 Great Lakes states within the basin boundary (which totals 214 counties either completely or partially within the basin boundary).

Table 1. Energy consumption and population within the Great Lakes basin, by state for the year 2000 (U.S.) and 2002 (Ontario).

The U.S. basin population was calculated from population estimates by counties (either completely or partially within the basin) from the 2000 U.S. Census (U.S. Census Bureau 2000). Ontario basin populations were determined using sub-basin populations provided by Statistics Canada.

Source: U.S. Energy Information Administration and Natural Resources Canada

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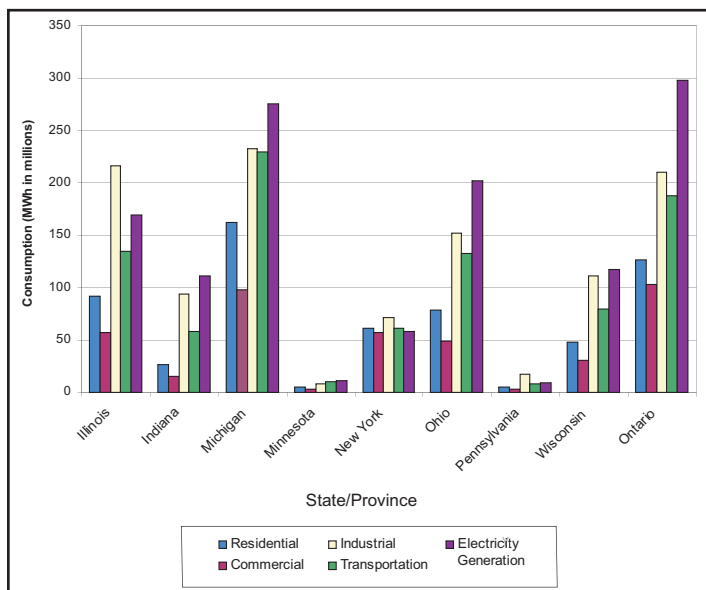


Figure 4. Secondary energy consumption within the Great Lakes basin by sector.

Note: all data are from 2000, although 2002 data from Ontario are discussed in the report.

Source: Energy Information Administration (2000) and Natural Resources Canada (2000)

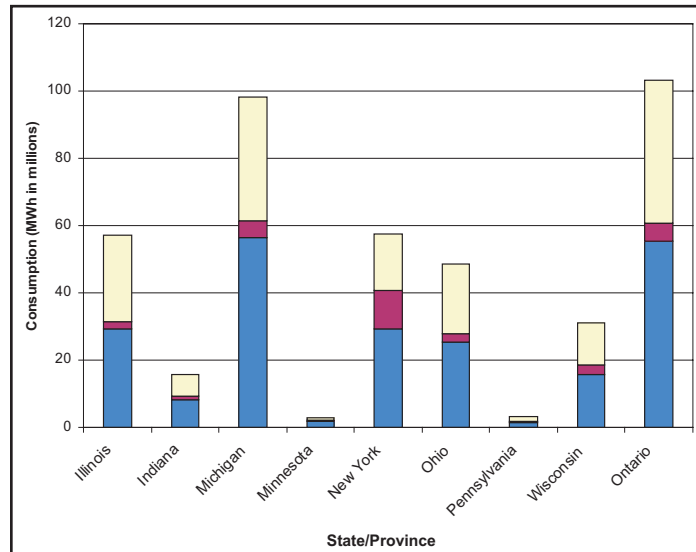


Figure 5. Commercial sector energy consumption by source, 2000.

Wood and coal were minor sources in this sector.

Source: Energy Information Administration (2000) and Natural Resources Canada (2000)

sector had the largest increase in total energy consumption,

4.4%, between 2000 and 2002. By source, on the U.S. side of the basin, 61% was supplied by fossil fuel (natural gas, 53%; and petroleum, 8%) and 39% was supplied by electricity. On both sides of the basin, the commercial sector had the highest proportion of electricity use of any sector. Figure 5 shows energy consumption by source for the commercial sector for the Canadian and the U.S. basins in 2000.

The residential sector includes four major types of dwellings: single detached homes, single attached homes, apartments and mobile homes, and excludes all institutional living facilities. Fossil fuels (natural gas, petroleum, and coal) are the dominant energy source for residential energy requirements in the Great Lakes basin. Of the total secondary energy use by the residential sector in the Ontario basin in 2002 (Table 2), the source for 67% of the energy consumed was supplied by fossil fuel (natural gas, 61%; and petroleum, 6%), 30% by electricity and 3% by wood (Figure 6).

There was a 0.3% increase in total energy consumption by the Ontario residential sector between 2000 and 2002. On the U.S. side of the basin, fossil fuels are the leading source of energy accounting for 75% of the total residential sector consumption. Natural gas and petroleum are both consumed by this sector, but it is important to note that this sector has the highest natural gas consumption of all five sectors. The remaining energy sources were electricity, 22% and wood, 3% (Figure 6).

The transportation sector includes activities related to the transport of passengers and freight by road, rail, marine and air. Off-road vehicles, such as snowmobiles and lawn mowers, and noncommercial aviation are included in the total transportation numbers. On both sides of the basin, 100% of the total secondary energy consumed by the transportation sector (Table 2) was supplied by fossil fuel, specifically petroleum. Motor gasoline was the dominant form of petroleum consumed, making up 67% of the Ontario basin total and 70% of the U.S. basin total. This was followed by diesel fuel, 27% in Ontario and 21% in the U.S., and aviation fuel, 6% in Ontario and 9% in the U.S. Figure

Sector	U.S. Basin Total Energy Consumption - 2000*	Canadian Basin Total Energy Consumption - 2002
Residential	478,200,000	127,410,000
Commercial	314,300,000	107,800,000
Industrial	903,900,000	206,410,000
Transportation	714,000,000	184,950,000
Electricity Generation	953,600,000	303,830,000

* Note: 2000 is the most recent data available on a consistent basis for the U.S. More recent data is available for some energy sources from the EIA, but survey and data compilation methods may vary.

Table 2. Total Secondary Energy Consumption in the Great Lakes basin, in Megawatt-hours (MWh).

Source: U.S. Energy Information Administration and Natural Resources Canada

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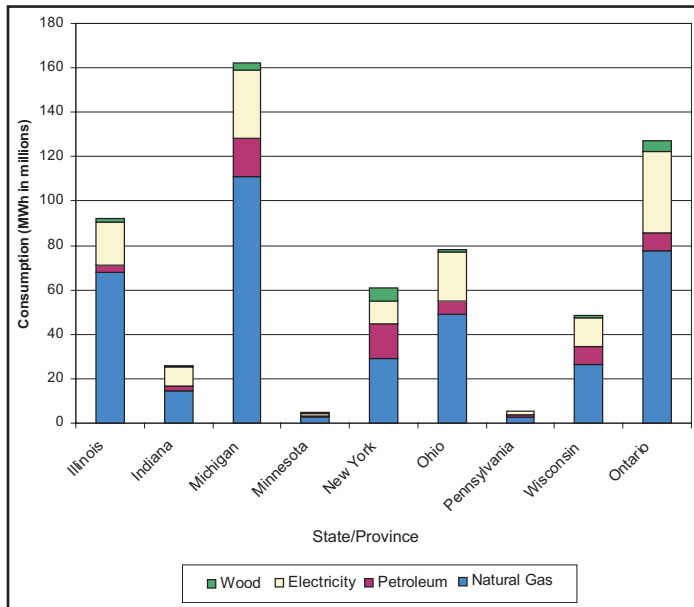


Figure 6. Residential sector energy consumption by source, 2000.

Coal, geothermal, and solar energy were minor sources in this sector.

Source: Energy Information Administration (2000) and Natural Resources Canada (2000)

7 shows energy consumption by source for the Canadian and U.S. transportation sector in 2000, which had a decrease of 1.7% in total energy consumption on the Canadian side between 2000 and 2002.

The industrial sector includes all manufacturing industries, metal and non-metal mining, upstream oil and gas, forestry and construction, and on the U.S. side of the basin also accounts for agriculture, fisheries and non-utility power producers. On the Canadian side, in 2000, 71% of the energy consumed by this sector was supplied by fossil fuel (natural gas, 35%; petroleum, 20%; and coal, 16%), 19% was supplied by electricity, and the remaining 10% was supplied by wood. Between 2000 and 2002, consumption by industry in Ontario decreased by 1.8%. In addition to these energy sources, steam was a minor contributor to the total energy consumption.

For the same sector, on the U.S. side of the basin, fossil fuels were the dominant energy source contributing 79% of the total energy (natural gas, 31%; coal, 24 %; and petroleum, 24%). The remaining sources were electricity, at 15%, and wood/wood waste, at 7%. Figure 8 shows energy consumption by source for the industrial sector on both the Canadian and U.S. sides of the basin in 2000. It is important to note that the numbers given for the Ontario industrial sector are likely underestimations of the total energy consumption on the Canadian side of the basin. Numbers were estimated using the population of the Canadian side of the basin as a

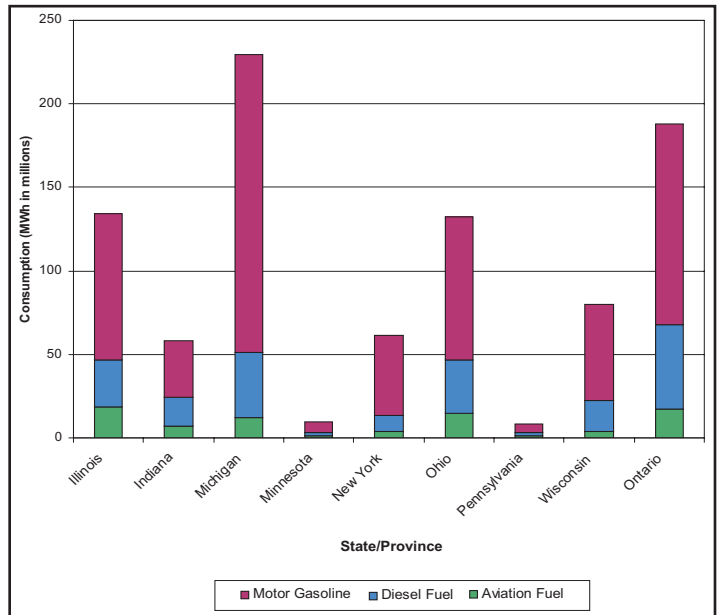


Figure 7. Transportation sector energy consumption by source, 2000.

Natural gas and electricity were very minor energy sources in this sector.

Source: Energy Information Administration (2000) and Natural Resources Canada (2000)

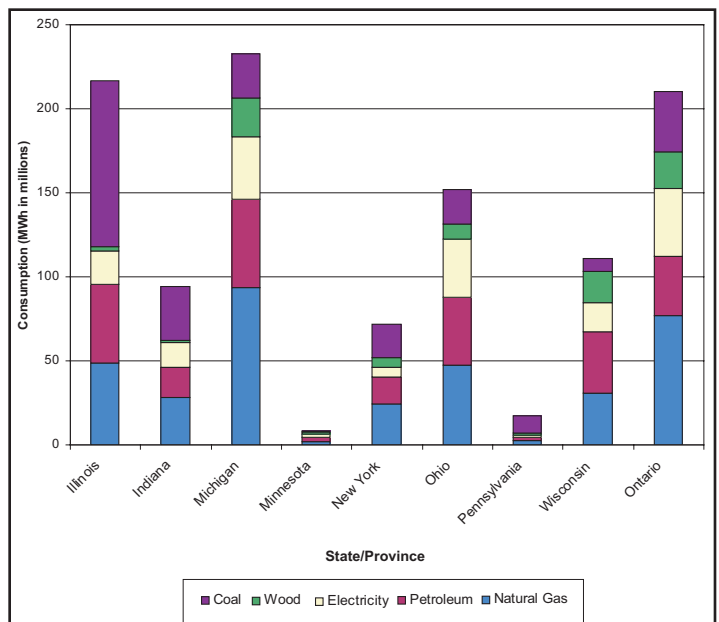


Figure 8. Industrial sector energy consumption by source, 2000.

Hydroelectric power was a minor source in this sector. U.S. data for wood include wood waste.

Source: Energy Information Administration (2000) and Natural Resources Canada (2000)

proportion of the total population of Ontario, this results in an estimation of 87% of total industrial energy use in Ontario being contained within the basin. However, Statistics Canada estimates that as much as 95% of industry in Ontario is contained within the basin. Estimating by population was done to remain consistent with the data provided for the U.S. side of the basin.

The last, and the largest consuming sector in both the Canadian and the U.S. basins, is the electricity generation sector. Of the total secondary energy use in the Ontario basin (Table 2), 67% of the energy consumed by this sector was supplied by nuclear energy, 26% was supplied by fossil fuel (coal, natural gas and petroleum), and 7% was supplied by hydroelectric energy. There was an increase in total energy use of 1.9% between 2000 and 2002 in Ontario. It is important to note that the Great Lakes basin contains the majority of Canada's nuclear capacity. Of the total secondary energy use by this sector in the U.S. basin (Table 2), 70% was supplied by the following types of fossil fuel: coal (66%), natural gas (2%), and petroleum (2%). The other two major sources, nuclear and hydroelectric energy, provided 27% and 3% respectively. This sector consumed 75% of the coal used in the entire U.S. basin. Figure 9 shows energy consumption by source for the electricity generation sector for the Canadian and U.S. sides of the basin in 2000.

The overall trends in energy consumption by sector were quite similar on both sides of the basin. Ranked from highest to lowest energy consumption, the pattern for the sectors was the same for the U.S. and Canadian basins (Table 2). Analyses of the sources of energy within each sector and trends in resources consumption also indicate very similar trends.

Pressures

In 2001, Canada was ranked as the fifth largest energy producer and the eighth largest energy consuming nation in the world. Comparatively, the United States is ranked as “the world’s largest energy producer, consumer, and net importer” (U.S. EIA 2004). The factors responsible for the high energy consumption rates in Canada and the U.S. can also be attributed to the Great Lakes basin. These include a high standard of living, a cold climate, long travel distances, and a large industrial sector. The combustion of fossil fuels, the dominant source of energy for most sectors in the basin, releases greenhouse gases such as carbon dioxide and nitrous oxide into the air contributing to smog, climate change, and acid rain.

Canada’s Energy Outlook 1996 through 2020 (<http://www.nrcan.gc.ca/es/ceo/toc-96E.html>) notes that “a significant amount of excess generating capacity exists in all regions of Canada” because demand has not reached the level predicted when new power plants were built in the 1970s and 1980s. Demand is projected to grow at an average annual rate of 1.3 percent in Ontario and 1.0 percent in Canada overall between 1995 and 2020. From 2010 to 2020, Ontario will add 3,650 megawatts of new gas-fired and 3,300 megawatts of clean coal-fired capacity. Several hydroelectric plants will be redeveloped. Renewable resources are projected to quadruple between 1995 and 2020, but will contribute only 3 percent of total power generation.

The pressures the U.S. currently faces will continue into the future, as the U.S. works to renew its aging energy infrastructure and develop renewable energy sources. Over the next two decades, U.S. oil consumption is estimated to grow by 33%, and natural gas consumption will increase by more than 50%. Electricity demand is forecast to increase by 45% nationwide (National Energy Policy 2001). Natural gas demand currently outstrips domestic production in the U.S. with imports (largely from Canada) filling the gap. 40% of the total U.S. nuclear output is generated within five states, including three within the Great Lakes basin (Illinois, Pennsylvania, and New York) (U.S. EIA 2004). Innovation and creative problem solving will be needed to work towards balancing

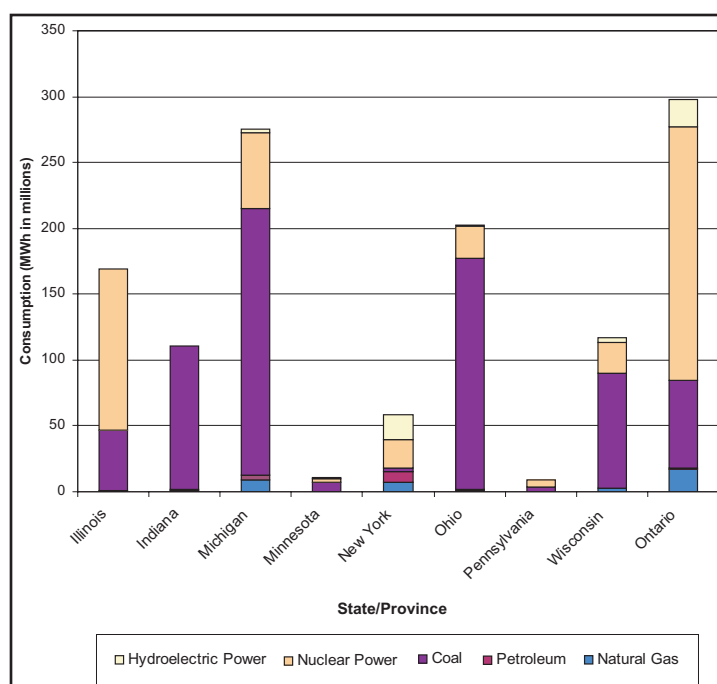


Figure 9. Electricity generation sector energy consumption by source, 2000.

Wood and wood waste were very minor energy sources in this sector.

Source: Energy Information Administration (2000) and Natural Resources Canada (2000)

economic growth and energy consumption in the Great Lakes basin in the future.

Management Implications

Natural Resources Canada, Office of Energy Efficiency has implemented several programs that focus on energy efficiency and conservation within the residential, commercial, industrial, and transportation sectors. Many of these programs work to provide consumers and businesses with useful and practical information regarding energy saving methods for buildings, automobiles, and homes. The U.S. Department of Energy Office of Energy Efficiency and Renewable Energy recently launched an educational website (<http://www.eere.energy.gov/consumer/>), which provides homes and businesses with ways to improve efficiency, tap into renewable and green energy supplies, and reduce energy costs. In July 2004, Illinois, Minnesota, Pennsylvania, and Wisconsin were awarded \$46.99 million to weatherize low income homes, which is expected to save energy and cost (EERE 2004). The U.S. Environmental Protection Agency Energy Star program, a government/industry partnership initiated in 1992, also promotes energy efficiency through product certification. In 2002, Americans saved more than \$7 billion in energy costs through Energy Star, while consuming less power and preventing greenhouse gas emissions (U.S. EPA 2003). In addition to these programs, the Climate Change Plan for Canada challenges all Canadians to reduce their greenhouse gas emissions by one metric ton, approximately 20% of the per capita production on average each year. The “One-Tonne Challenge” offers a number of ways to reduce the greenhouse gas emissions that contribute to climate change and in doing so will also reduce total energy consumption.

Renewable energy sources such as solar and wind power are available in Canada, but constitute only a fraction of the total energy consumed. Research continues to develop these as alternate sources of energy, as well as developing more efficient ways of burning energy. In the United States, according to the U.S. Energy Information Administration, 6% of the total 2002 energy consumption came from renewable energy sources (biomass, 47%; hydroelectric, 45%; geothermal, 5%; wind, 2%; and solar, 1%). The U.S. has invested almost a billion dollars, over three years, for renewable energy technologies (Garman 2004). Wind energy, cited as one of the fastest growing renewable sources worldwide, is a promising source for the Great Lakes region. The U.S. Department of Energy, its laboratories, and state programs are working to advance research and development of renewable energy technologies.

Comments from the author(s)

Ontario data are available through Natural Resources Canada, Office of Energy Efficiency. Databases include the total energy consumption for the residential, commercial, industrial, transportation, agriculture and electricity generation sectors by energy source and end use. Population numbers for the Great Lakes basin, provided by Statistics Canada, were used to calculate the energy consumption numbers within the Ontario side of the basin. This approach for the residential sector should provide a reasonable measure of household consumption. For the commercial, transportation and especially industrial sectors, it may be a variable estimation of the total consumption in the basin. The data are provided on a nation-wide or province-wide basis. Therefore it provides a great challenge to disaggregate it by any other methods to provide a more precise representation of the Great Lakes basin total energy consumption.

Energy consumption, price, and expenditure data are available for the United States (from 1960 to 2000) through the Energy Information Administration (EIA). The EIA is updating the State Energy Data 2000 series to 2001 by August 2004. There may be minor discrepancies in how the sectors were defined in the U.S. and Canada, which may need further investigation (such as tourism in the U.S. commercial sector, and upstream oil and gas in the U.S. industrial sector). Actual differences in consumption rates may be difficult to distinguish from minor differences between the U.S. and Canada in how data were collected and aggregated. Hydroelectric energy was not included in the industrial sector analysis, but might be considered in future analyses. In New York state, almost as much energy came from hydroelectric energy as from wood. Wisconsin and Pennsylvania also had small amounts of hydropower consumption.

In the U.S. the current analysis of the total basin consumption is based on statewide per capita energy consumption, multiplied by the basin population. The ideal estimate of this indicator would be to calculate the per capita consumption within the basin, and would require energy consumption data at the county level or by local utility reporting areas. Such data may be quite difficult to obtain, especially when electricity consumption per person is reported by utility service area. The statewide per capita consumption may be different than the actual per capita consumption within the basin, especially for the states with only small areas within the basin (Minnesota and Pennsylvania). The proportion of urban to rural/agricultural land in the basin is likely to influence per capita consumption within the basin. Census data are available at the county and even the block level, and may in the future be combined with the U.S. basin boundary using GIS to refine the basin population estimate.

Additionally, the per capita consumption data for the U.S. in Figures 1, 2, and 3 are based on slightly different energy consumption

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totals than the data in Tables 1 and 2. The next update of this indicator should examine whether it is worthwhile to include the minor sources in the sector analysis on both sides of the basin or to exclude them from the per capita figures.

Acknowledgments

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Last Updated

State of the Great Lakes 2005

[Editor's Note: Links to sources were updated for this publication when possible.]