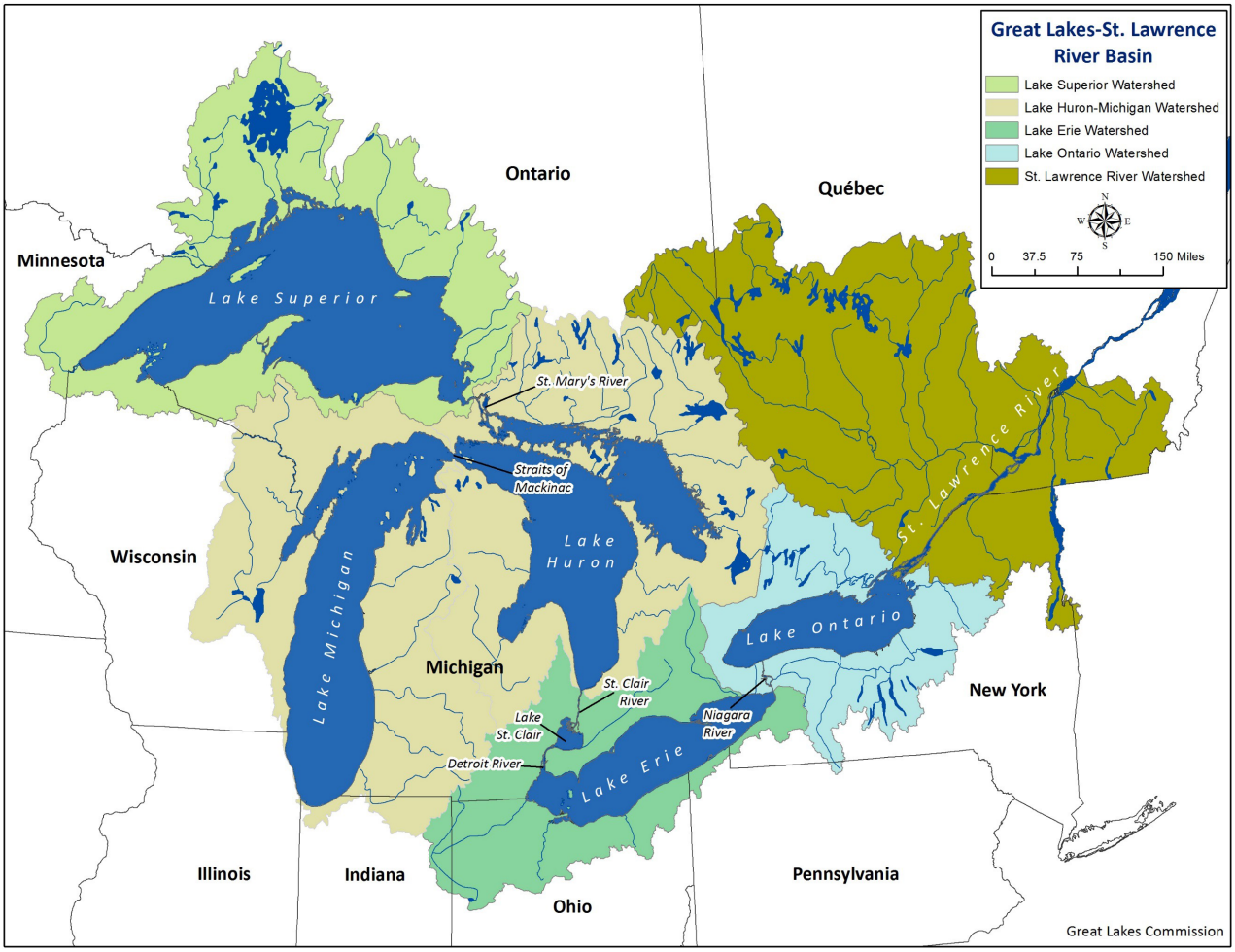

Potential Changes in Water Use Resulting from Retirement of Thermoelectric Power Plants in the Great Lakes Basin

Prepared for the Conference of Great Lakes and St. Lawrence Governors and Premiers

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Introduction

Water withdrawals for thermoelectric power production comprise the largest water use sector in the Great Lakes-St. Lawrence River Basin (Basin). According to the Great Lakes Commission's (GLC) 2015 Annual Report of the Great Lakes-St. Lawrence River Regional Water Use Database (Report), 29,696 million gallons per day (mgd) were withdrawn for thermoelectric power production (figure 1). This constitutes about 70 percent of all withdrawals in the Basin.

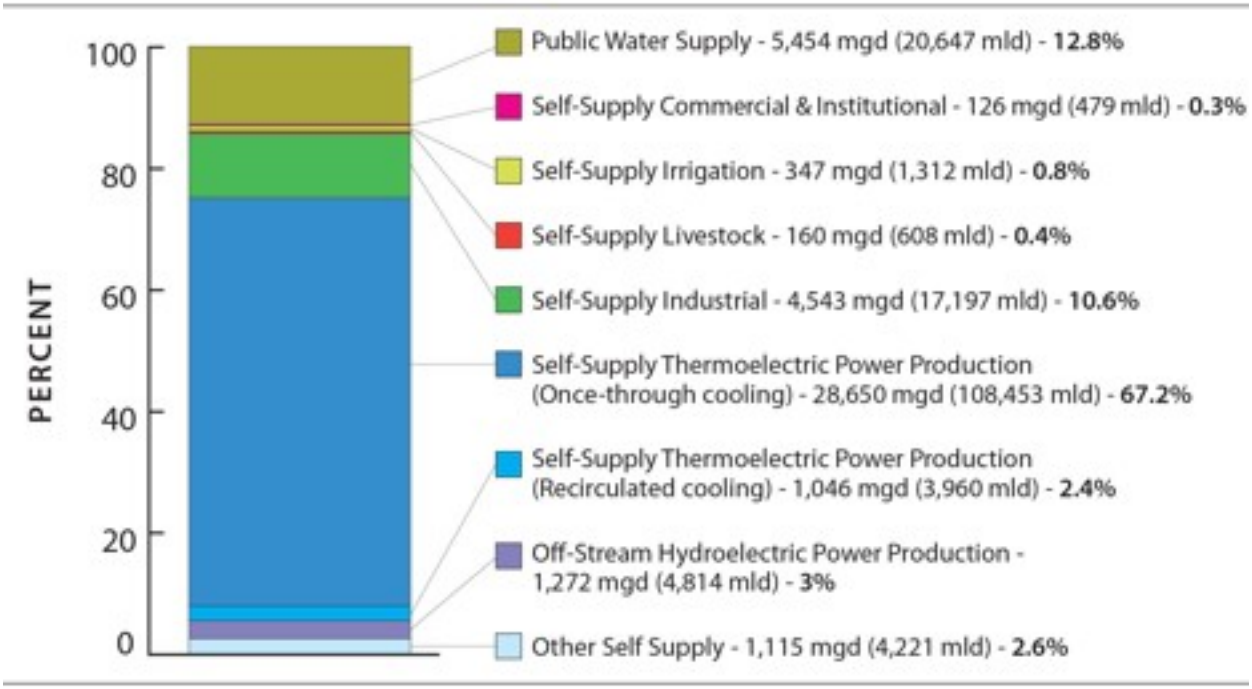

Figure 1.—*Water Withdrawals by Water Use Sector (excluding in-stream hydroelectric water use). (Source Great Lakes Commission, 2015)*

Consumptive use (CU) related to withdrawals for thermoelectric power generation is much lower than total withdrawals. The GLC Report states that the thermoelectric power generation sector was just the third largest CU sector in the Basin in 2015. Total CU for the Basin was 2,331 mgd and CU for thermoelectric power generation was 513 mgd. Although this CU is much smaller than total withdrawals for the sector, thermoelectric power generation CU constitutes 22 percent of all CU for the Basin.

In recent years, power companies have retired many thermoelectric power plants in the Basin, and more retirements are planned (figure 2). Most of these plants are fueled by coal. Several factors are driving these retirements of coal-fueled plants, including aging plants, high operational costs, movement toward natural gas-fueled plants and renewables, and regulatory

changes seeking to lower emission of greenhouse gases.

Figure 2.—*Past and planned power plant retirements (red denotes 2000-2014; yellow denotes 2014-2050). (Source: Power Plants Retired by EPA Regulations (EPA Modeling and Announced Retirements, September 2014.)*

As Secretariat to the Great Lakes-St. Lawrence River Water Resources Regional Body (Regional Body) and the Great Lakes-St. Lawrence River Basin Water Resources Council, (Compact Council), the Conference of Great Lakes and St. Lawrence Governors and Premiers (The Conference) regularly evaluates the cumulative impact of withdrawals, consumptive uses, and diversions in accordance with provisions in the Great Lakes—St. Lawrence River Basin Sustainable Water Resources Agreement (Agreement) and the Great Lakes—St. Lawrence River Basin Water Resources Compact (Compact). A new five-year cumulative impact assessment will be completed for the years 2011-2015. Given recent and planned retirements of thermoelectric power plants, the Conference decided to evaluate changes in water withdrawals and CU associated with thermoelectric power generation in the Basin.

This paper summarizes the results of this project. The project considered two time periods. First, historical changes in withdrawals and CU for 2011-2015. Second, potential changes in withdrawals and CU from 2016-2025 resulting from planned or proposed thermoelectric power plant retirements.

For 2011-2015 water use, each state (Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, and Wisconsin) and province (Ontario and Québec) in the Basin was asked to submit information for each power plant in their jurisdiction within the Basin, including the source Great Lake(s) watershed, and the amount of withdrawal and CU for each of the five years. Pennsylvania and Quebec do not have any thermoelectric power plants in the Basin. Ontario is unable to make plant-by-plant water use information public. Consequently, this paper includes information only from the other seven States.

For plant retirements 2016-2025, there are various sources of information, including state water managers, state agencies that oversee electrical utilities, power company web sites and press releases, and newspaper articles.

Thermoelectric Water Withdrawals and Consumptive Uses 2011-2015

All seven states show a decreasing trend in water withdrawals for thermoelectric power generation from 2011-2015 (figure 3). Michigan has the largest withdrawals, followed by Wisconsin, New York, and Ohio. When withdrawals are grouped by Great Lake Basin, Lake Michigan-Huron has the largest withdrawals, followed by Lake Erie, Lake Ontario, and Lake Superior (figure 4).

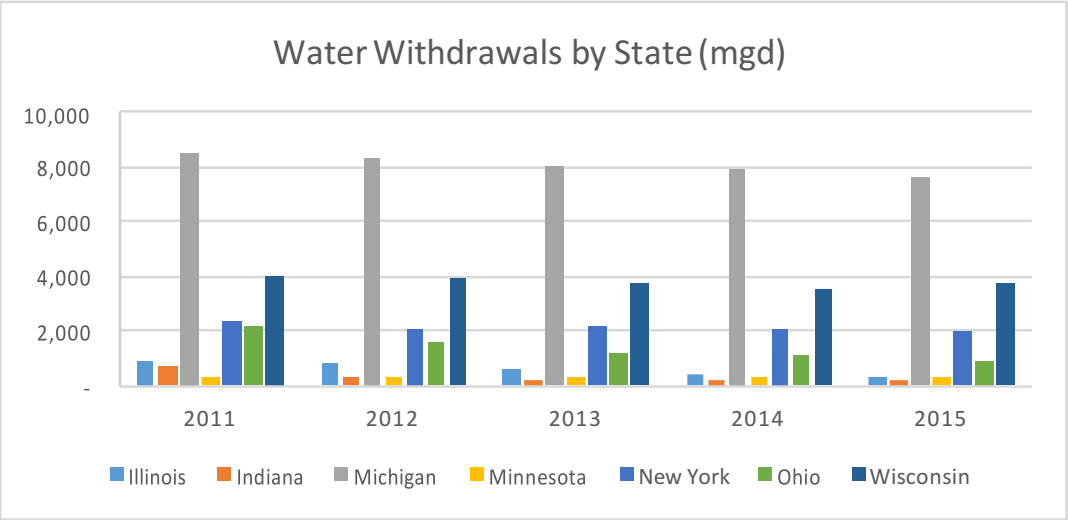

Figure 3.—*Water withdrawals for thermoelectric power generation by state. (Source: State water managers).*

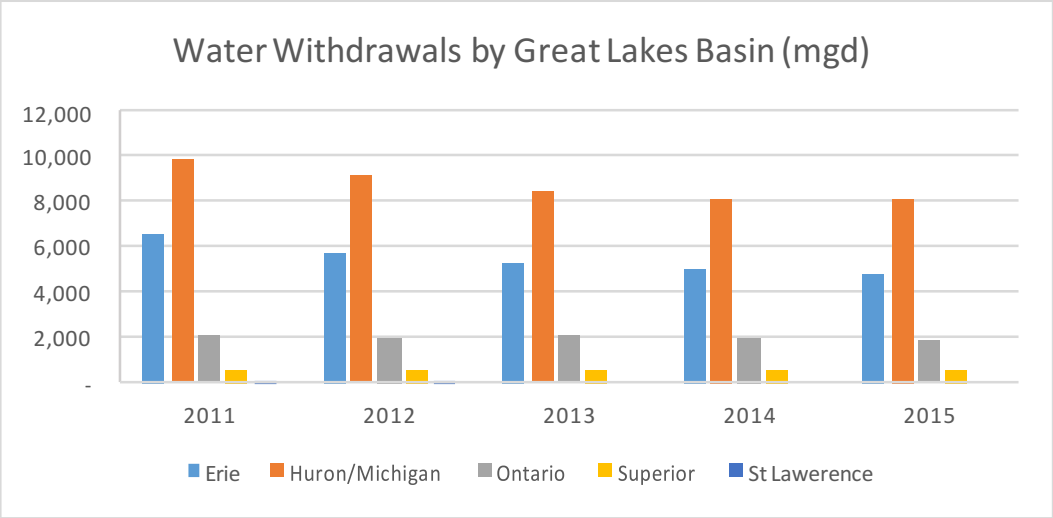

Figure 4.—*Water withdrawals for thermoelectric power generation by Great Lakes Basin. (Source: State water managers)*

Consumptive water use for thermoelectric power generation in each state is lower in 2015 than in 2011. However, some years show an increase from the previous year (figure 5). Michigan has the largest CU, followed by New York, Wisconsin, and Ohio. When CU is grouped by Great Lakes Basin, Lake Michigan-Huron and Lake Erie have the largest CU, followed by Lake Ontario and Lake Superior (figure 6).

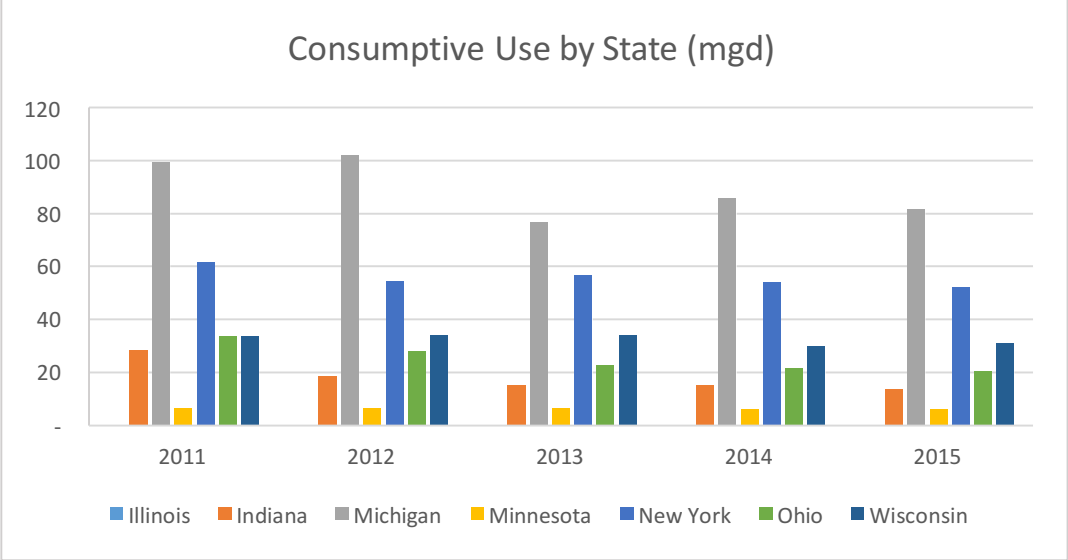

Figure 5.—*Consumptive use from thermoelectric power generation by state. (Source: State water managers)*

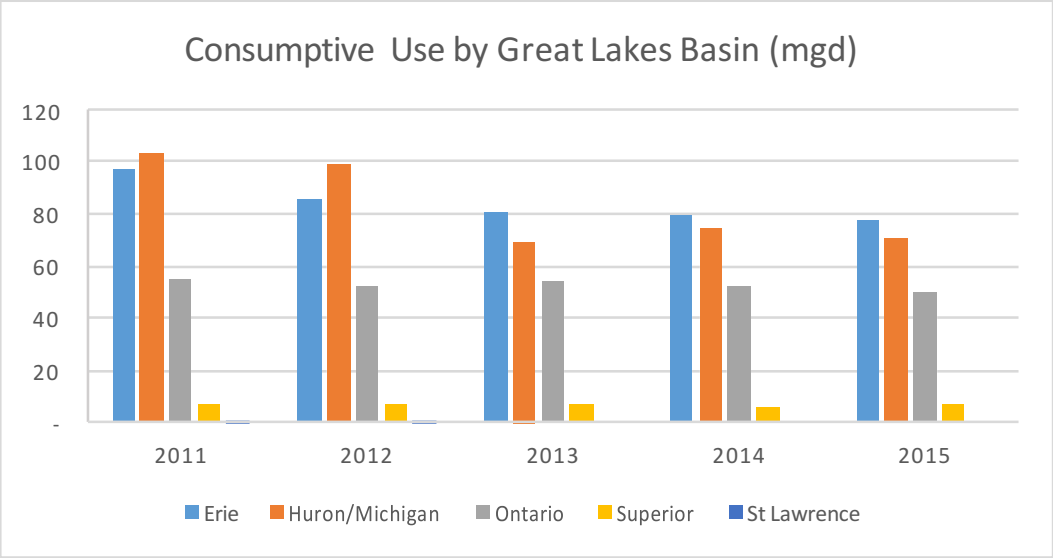

Figure 6.—*Consumptive use from thermoelectric power generation by Great Lakes Basin. (Source: State water managers)*

Considering withdrawals and CU for thermoelectric power generation for the entire Great Lakes Basin, excluding Ontario, withdrawals decreased from 19,131 mgd in 2011 to 15,262 mgd in 2015 (figure 7). Likewise, CU decreased from 263 mgd in 2011 to 205 mgd in 2015 (figure 7).

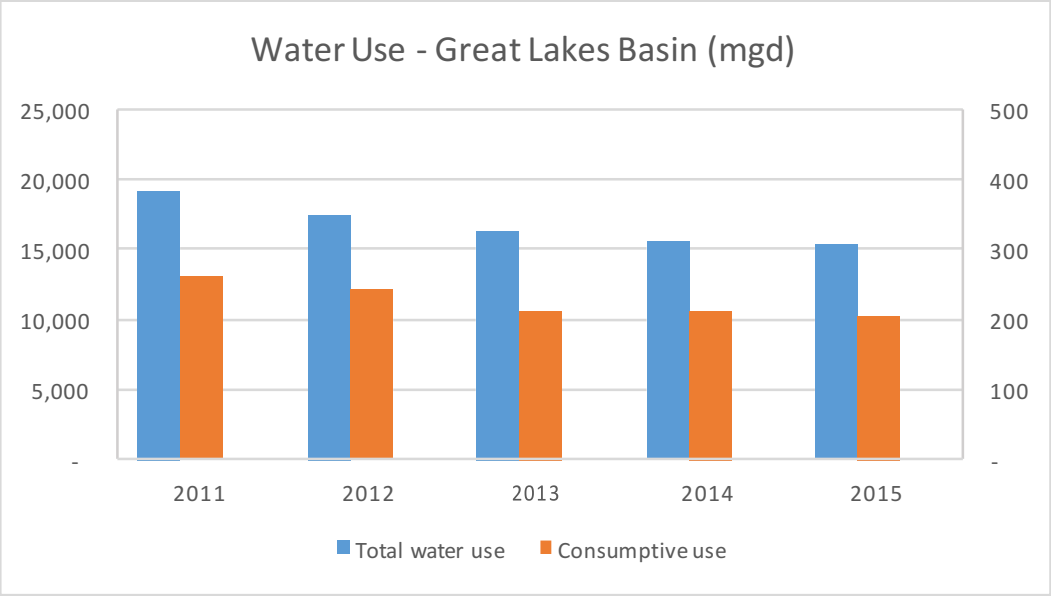

Figure 7.—*Water withdrawals and consumptive use for thermoelectric power generation for the Great Lakes Basin (excluding Ontario). Note: consumptive use is plotted using the right-hand y-axis. (Source: State water managers)*

Decreases in withdrawals and CU from 2011-2015 are associated, in part, with retirements of 12 power plants. Every state but New York had at least one power plant retirement; Michigan had the most with 4 retirements (table 1). Each Great Lake Basin, except Lake Ontario, had at least one power plant retirement; Lake Michigan-Huron had the most with 6 retirements (table 2).

State	2011 - 2015
IL	1
IN	2
MI	4
MN	1
NY	0
OH	3
WI	1
Total	12

Table 1.—*Thermoelectric power plant retirements by state, 2011-2015. (Various sources)*

Basin	2011 - 2015
E	5
HM	6
O	0
S	1
Total	12

Table 2.—*Thermoelectric power plant retirements by Great Lakes Basin, 2011-2015. (Various sources)*

Projected Reductions in Water Withdrawals and Consumptive Uses by 2025

Twenty-one power plant retirements are planned or proposed from 2016-2025. Every state has at least one planned retirement; Michigan has the most with 11 (table 3). Each Great Lake Basin has at least two planned retirements; Lake Michigan-Huron has the most with 11 (table 4).

State	2016 - 2025
IL	1
IN	1
MI	11
MN	1
NY	3
OH	1
WI	3
Total	21

Table 3.—*Planned or proposed thermoelectric power plant retirements by state, 2016-2025. (Various sources)*

Basin	2016 - 2025
E	6
HM	11
O	2
S	2
Total	21

Table 4.—*Planned or proposed thermoelectric power plant retirements by Great Lakes Basin, 2016-2025. (Various sources)*

To estimate the reduction in water withdrawals and CU associated with plant retirements the following approach was used. The reported 2015 values of water withdrawal and CU, for a given plant that has a planned retirement by 2025, were estimated to be the amounts by which 2025 water withdrawals and CU would be reduced for that plant.

The reduction in total withdrawals by 2025 due to retirement of thermoelectric power plants in the Basin is 3,784 mgd (table 5). About 70 percent of the reduction, 2,667 mgd, will come from Michigan. The next largest reduction, 347 mgd, will be in New York. Considering reduction in water withdrawals by Great Lakes Basin, Lake Erie will have the largest reduction, 1,858 mgd, followed by Lake Michigan-Huron at 1,379 mgd (table 6).

State	Water withdrawal (mgd)
IL	14.80
IN	207.35
MI	2,666.63
MN	156.39
NY	346.84
OH	179.70
WI	212.23
Total	3,783.94

Table 5.—*Amount of reduction in water withdrawn by thermoelectric power plants by 2025 due to planned or proposed plant retirements from 2016-2025 by state.*

Basin	Water withdrawal (mgd)
E	1,858.31
HM	1,379.43
O	230.84
S	315.37
Total	3,783.94

Table 6.—*Amount of reduction in water withdrawn by thermoelectric power plants by 2025 due to planned or proposed plant retirements from 2016-2025 by Great Lakes Basin*.

The reduction in CU by 2025 due to retirement of thermoelectric power plants in the Basin is 48 mgd (table 7). Michigan will account for 62 percent, 30 mgd, of the reduction,. The next largest reduction, 7 mgd, will be in New York. Considering reduction in CU by Great Lakes Basin, Lake Michigan-Huron will have the largest reduction, 27 mgd, followed by Lake Erie at 13 mgd (table 8).

State	Consumptive Use (mgd)
IL	0.00
IN	4.15
MI	29.71
MN	3.13
NY	6.94
OH	1.80
WI	2.12
Total	47.84

Table 7.—*Amount of reduction in consumptive use by thermoelectric power plants by 2025 due to planned or proposed plant retirements from 2016-2025 by state.*

Basin	Consumptive Use (mgd)
E	12.90
HM	27.04
O	4.62
S	3.29
Total	47.85

Table 8.—*Amount of reduction in consumptive use by thermoelectric power plants by 2025 due to planned or proposed plant retirements from 2016-2025 by Great Lakes Basin.*

For the seven states considered in this paper, CU for thermoelectric power generation in 2015 was 205 mgd. The projected CU in 2025 is 154 mgd. Thus the projected decrease from 2015 to 2025 in CU is 51 mgd or 25 percent. However, the decrease in CU from 2011-2015, when only 12 power plants were retired, was 58 mgd. Thus, there may be other factors other than plant retirements influencing decreases in CU.

Confounding Factors and Limitations

Three primary issues limit the conclusions of this report regarding reductions in CU from 2016 to 2025. First, potential regulatory changes in emission standards could affect whether an individual plant is retired. Second, for some states, particularly New York, plans for further plant retirements are unclear and appear to change from year to year. Third, power companies are and will be replacing lost power generation from retired plants. Much of this will be conversion to natural gas-fired plants. These plants will withdraw and consumptively use water, although at significantly lower rates than other fuel sources such as coal (figure 8 and table 9). This paper did not consider the number, locations, and water use of new plants to replace lost power generation in the Basin.

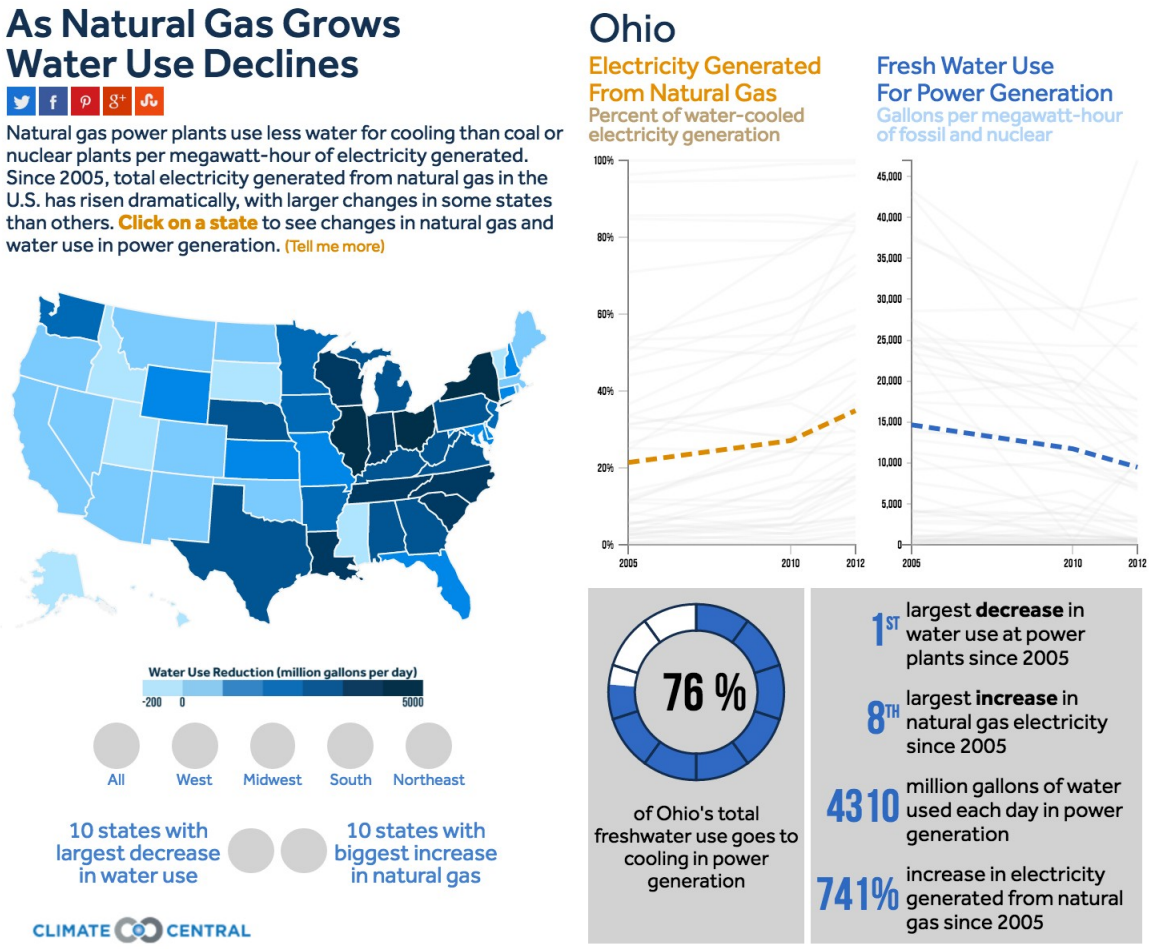

Figure 8.—*Changes in amount of electricity generated from natural gas and fresh water use from power generation. Similar information is available for all Great Lakes states at http://www.climatecentral.org/news/water-use-declines-as-natural-gas-grows-19162*

	Once-Through		Recirculating		Dry-Cooling	
	Withdrawal	Consumption	Withdrawal	Consumption	Withdrawal	Consumption
Coal (conventional)	20,000 - 50,000	100 - 317	500 - 1,200	480 - 1,100	N/A	N/A
Natural Gas Combined Cycle	7,500 - 20,000	20 - 100	150 - 283	130 - 300	0 - 4	0 - 4
Nuclear	25,000 - 60,000	100 - 400	800 - 2,600	600 - 800	N/A	N/A
Solar Thermal (trough)	N/A	N/A	725 - 1,109	725 - 1,109	43 - 79	43 - 79

Table 9.—*Water withdrawn and consumed for power plant cooling, in gallons of water required per megawatt-hour of electricity produced. (Cited source J. Macknick, R. Newmark, G. Heath, and K.C. Hallet. 2012 at http://www.ucsusa.org/clean-energy/energy-and-water-use/water-energy-electricity-cooling-power-plant#ftn1)*

Relation of Reduction in Consumptive Use to Cumulative Impact Assessment

Pursuant to provisions in the Compact and Agreement, the Conference will complete an assessment of the cumulative impact of withdrawals, consumptive uses, and diversions for the years 2011-2015. In conducting the assessment, the Conference may want to consider how past changes in withdrawals and CU for thermoelectric power generation are related to other changes in CU and diversions. Furthermore, the assessment could include a forward-looking component associated with planned or proposed power plant retirements from 2016-2025.