March, 2013

Potential of Renewable Energy for Michigan's Future

Prepared by the Great Lakes Wind Collaborative[1]

For the 2013 "Readying Michigan to Make Good Energy Decisions" to assist Governor Snyder's efforts to gather public input on Michigan's energy future

The Great Lakes Wind Collaborative (GLWC) is pleased to provide input on the potential role of wind energy for Michigan's energy future. The Great Lakes Wind Collaborative is commenting on wind energy specifically because this wind energy is the focus of the collaborative and where the members have the most expertise.

The GLWC is a multi-stakeholder coalition that aims to facilitate and support a coordinated, sustainable approach to addressing wind energy deployment and use issues in the Great Lakes region. GLWC Members represent a wide spectrum of interests throughout the binational Great Lakes region, including wind developers, federal, state, provincial and local government representatives, environmental non-profit organizations, utilities, academic institutions and others. GLWC members are committed to working together to identify and address the technical, environmental, regulatory, educational and financial issues related to the deployment of wind energy resources. The credibility of the GLWC's work derives from the fact that they were developed through collaborative processes and consensus building.

The GLWC recognizes that wind energy decisions are part of a broader consideration of environmental, social, and economic costs and benefits of energy and power and applauds Governor Snyder for recognizing this context in the effort explore "affordable and reliable energy and no regrets for our future" --Michigan's energy future. The governor's energy forums provide an important opportunity to develop solutions that will lower electricity costs for Michigan families and businesses, while in turn, diversifying the state's energy portfolio.

Affordability

Affordability depends on many factors, including the cost of the energy source, any fuel or driver needed to convert that energy into power (e.g. water used for thermo-electric combustion), and on the benefits that reduce other economic, social or environmental costs in a broader context.

The fuel source for wind power is wind, which is free and of limitless supply. Unlike coal or natural gas, the price of the wind as fuel source will never go up or down with market cycles wind will always be free. Affordability should also consider the costs of turning the fuel source into power, or electricity. Converting wind into power requires wind turbines. The cost of wind turbines has varied in the past

[1] The Great Lakes Commission has served as the Secretariat for the Great Lakes Wind Collaborative (GLWC) since 2008 when the Collaborative was formed. Contact Victoria Pebbles at vpebbles@glc.org or 734-971-9135.

decade, and following an increase in the late 2000s (as turbine sizes increased), prices have declined since 2008, while capacity factors (efficiency) have increased[2].

Onshore wind in Michigan has become cost competitive with natural gas and it may have some benefits of locking in power prices for a long period that would hedge against the possibility that natural gas prices would increase in the future. Therefore, increasing the share of Michigan power that comes from onshore wind offers a cost effective option.

The third annual Michigan Public Service Commission report on the implementation of the state's renewable energy standard and its cost effectiveness has recently been issued.[3] The report indicates that the actual cost of renewable energy contracts (mostly wind energy contracts) submitted to the

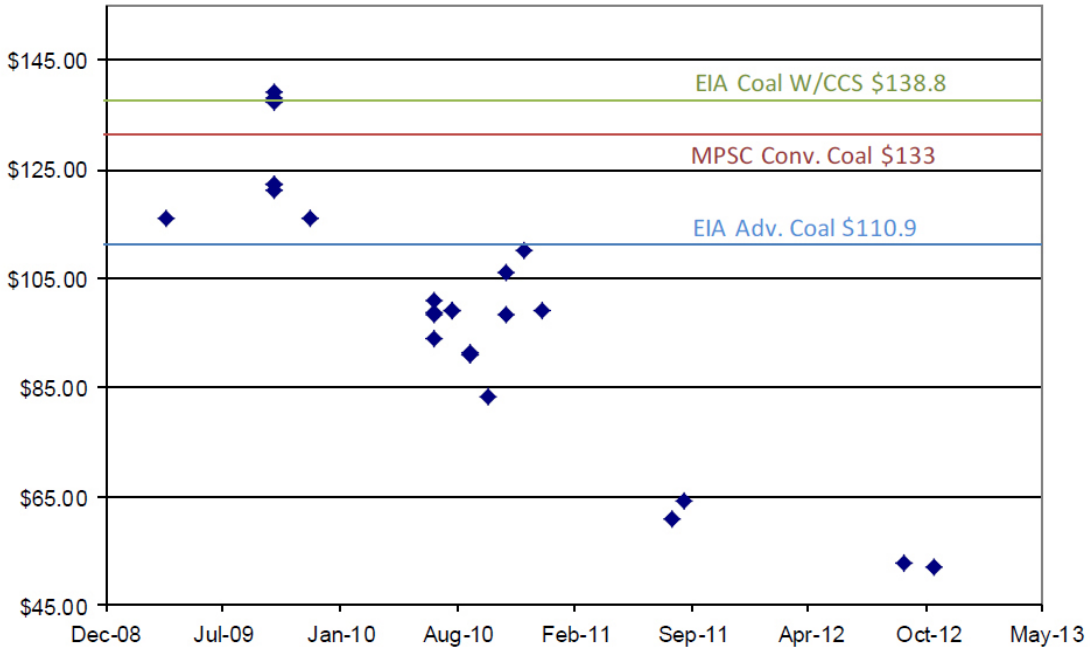

Figure 1: Levelized Cost of MPSC-Approved Contracts Over Time Compared to the Cost of New Coal Fired Facilities. From Michigan Public Service Commission February 2013 Report on the Implementation of the P.A. 295 Renewable Energy Standard and the Cost-Effectiveness of the Energy Standards

[2] Bolinger, M., and Wiser, R., Understanding Trends in Wind Turbine Prices Over the Past Decade, Lawrence Berkeley National Laboratory, October 2011, available from http://eetd.lbl.gov/ea/emp.

[3] Michigan Public Service Commission, 2013. Report on the Implementation of the P.A. 295 Renewable Energy Standard and the Cost-Effectiveness of the Energy Standards. http://www.michigan.gov/documents/mpsc/implementation_of_PA295_renewable_energy_411615_7.pdf

Commission continue to go down. The most recent contracts approved by the Commission for new wind capacity have levelized costs in the $52 per MWh range which is about 10 percent less than the cheapest levelized contract prices from a year ago, half the levelized cost of the first renewable energy contracts approved in 2009 and 2010, and well below costs of advanced coal-fired units. The downward trend is shown in Figure 10 from the recently issued MPSC report.

Thermoelectric water **withdrawal** from Great Lakes basin power plants by fuel type and cooling technology in millions of gallons per day (MGD).

Fuel Type	Open-Loop	Closed-Loop	TOTAL
Coal	15245	860	**16105**
Nuclear	7020	619	**7639**
Oil	267	0.4	**267.4**
Gas	539	341	**880**
Renewables	N/A	316	**316**
TOTAL	**23071**	**2136.4**	

Thermoelectric water **consumption** from Great Lakes basin power plants by fuel type and cooling technology in millions of gallons per day (MGD).

Fuel Type	Open-Loop	Closed-Loop	TOTAL
Coal	151	9	**160**
Nuclear	191	37	**228**
Oil	3	0	**3**
Gas	2	5	**7**
Renewables	N/A	4	**4**
TOTAL	**347**	**55**	

Source: Sandia National Laboratories, 2010

Meanwhile, converting fossil fuels to power requires a facility to extract the raw fuel source, pipelines or trucks to transport the fuel, a plant or facility that uses energy to convert the fuel into power. All of these, the mining/extraction, the pipelines/trucks (and the roads they use), and the power plants have hard costs. Each of these steps in the fossil-fuel-based energy value chain also has environmental and public policy externalities that are often not factored in, such as the costs of road maintenance and repair, harmful air emissions from the trucks and the power plants (including carbon), and the vast amounts of water used, degraded or lost (see below).

What is affordable for Michigan should not only consider costs by today's market value, but also long term costs, intangible costs (social and environmental externalities) as well as benefits. Simply put, affordability equals costs minus benefits. Some costs can be easily monetized (the costs of a wind turbine) while others are more difficult (e.g., public health and environmental impacts associated with mercury emissions from coal fired power plants). We urge that the issue of affordability consider present and future market and non-market (e.g., social and environmental) values. The following discussion offers some perspective on considering the relationship between power generation and water resource impacts.

Consideration of the Energy-Water Nexus: No Regrets for Michigan's Water Resources

In 2006, nearly 70 percent of the 8-state Great Lakes region's electric supply came from fossil fuel (coal, petroleum, and gas-fired) thermoelectric power plants, while more than 25 percent of the region's electricity came from nuclear plants. [4] The most recent data available show the picture has not changed much. [5] The vast majority of this power is generated through "thermoelectric power generation"

[4] Great Lakes Commission, 2009. *The Energy Water Nexus: Implications for the Great Lakes*.
[5] Great Lakes Power Plant Fleet data set, compiled by Sandia National Laboratories, 2010.

whereby the heat from these fuels is used to convert purified water to high pressure steam which turns a turbine to generate electricity. [6]

The water used in thermo-electric power may be free, but it requires energy (and costs money) to pump the water to the plant and cool that water so it can be safely discharged into Michigan's cold-water ecosystems. Fish and other organisms may be caught in or killed by power plant cooling systems, and warmed discharge water may negatively affect habitat and have adverse life cycle impacts; these costs should be considered. Costs associated with cooling water used by power plants are likely to increase as our waters warm due to climate change. Pending federal clean air regulations will likely increase the cost of fossil fuel production as fossil fuel plants are required to install more sophisticated pollution control technologies.

Furthermore, other impacts from fossil fuel power plants can be significant. Coal-fired power plants remain the largest source of mercury emissions in the Great Lakes and nationally. Mercury is responsible for statewide fish consumption advisories in seven of the eight Great Lakes states, posing threats to human health (including neurodevelopmental impacts to children), fish (such as walleye), and wildlife (including fish-eating birds such as the common loon).[7] In addition, fossil fuel-driven climate change poses a number of threats to ecosystems and human well-being in the region, including further stresses to the Great Lakes (such as lower water levels, exacerbated hypoxia in some areas, increased harmful algal blooms), stresses to terrestrial species (e.g. moose), changes in agricultural productivity, and other impacts.[8]

The nexus between thermoelectric power production and water use has important implications for the water and water dependent natural resources of the Great Lakes Basin. A recent study by the Great Lakes Commission found that approximately one-quarter of all of the watersheds in the Great Lakes basin may be ecologically vulnerable to water withdrawals under certain "low-flow" conditions – conditions that are likely to be more frequent in the future as the impacts of climate change become more severe.[9] Additionally, more than half of the 102 watersheds studied were found to be at moderate to high risk of degrading ecological health due to additional thermal impacts. Already, more than a third of these watersheds in the Great lakes basin have water quality that is moderately to highly impaired according to the U.S. EPA and state reports. An interactive map allows users to see which watersheds in Michigan are vulnerable, where existing power plants are located, and how much water they use (http://erie.glin.net/glew/).

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[6] Pebbles, V. and C. Bradley, 2011. *Integrating Energy and Water Resources Decision Making in the Great Lakes Basin: An Examination of Future Power Generation Scenarios and Water Resource Impacts.* Great Lakes Commission. Ann Arbor, Michigan.

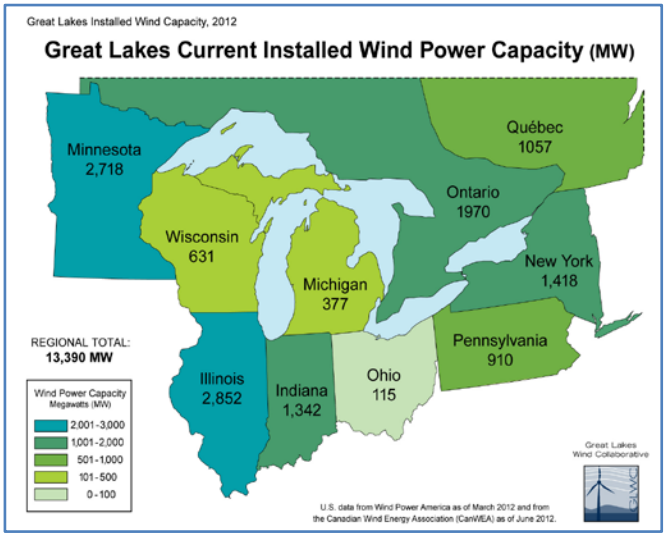
[7] Evers, D.C., Wiener, J.G., Driscoll, C.T., Gay, D.A., Basu, N., Monson, B.A., Lambert, K.F., Morrison, H.A., Morgan, J.T., Williams, K.A., Soehl, A.G. 2011. Great Lakes Mercury Connections: The Extent and Effects of Mercury Pollution in the Great Lakes Region. Biodiversity Research Institute. Gorham, Maine. Report BRI 2011-18. 44 pages, and references therein.

[8] See for example: Kling, G.W., K. Hayhoe, L.B. Johnson, et al., 2003. *Confronting Climate Change in the Great Lakes Region: Impacts on our Communities and Ecosystems.* Union of Concerned Scientists, Cambridge, Massachusetts, and Ecological Society of America, Washington, D.C.; and *U.S. National Climate Assessment Midwest Technical Input Report*. J. Winkler, J. Andresen, J. Hatfield, D. Bidwell, and D. Brown, coordinators. Available at http://glisa.umich.edu/docs/NCA/MTIT_Biodiversity.pdf.

[9] Pebbles and Bradley, 2011.

Reliability

The GLWC recognizes that wind is part of a diverse energy portfolio for the Great Lakes region, including all of Michigan. The GLWC accepts that wind is variable—it does not blow at the same intensity across the same area at all times. That said, the GLWC does not equate variability with unreliability. The GLWC believes—and credible studies show—that some wind variability can be diminished through transmission improvements as well as integrating other renewable energy sources. A number of efforts are underway to address planning and reliability considerations as wind and other renewable sources continue to grow, such as through the North American Electric Reliability Corporation Integrating Variable Generation Task Force.[10] Currently, MISO uses a probabilistic planning technique to assess wind energy's contribution to overall capacity, to aid in integration and reliability.[11] Policy approaches to help address regional transmission issues with offshore wind generation in the Great Lakes have been identified.[12] The GLWC believes that investments in transmission, and improved coordination among and accountability by Regional Transmission Organizations can improve electric power system reliability and balance power to maximize the timely delivery of clean, renewable energy, including wind.



Like affordability, reliability also deserves consideration in context of the energy's value chain. Wind may be variable, but the wind energy value chain has far fewer links that can be disrupted or broken. In contrast to wind, fossil fuels must be extracted, processed and transported; each of these steps in the fossil energy value chain is subject to secondary reliability (and social and environmental) risks inherent to these processes: oil and gas drilling accidents (and potential threats to water supplies from routine hydraulic fracturing operations), pipeline leaks/oil spills (e.g., the 2010 Enbridge incident that leaked more than 1 million gallons of oil into the Kalamazoo River, and natural gas pipeline explosions such as the San Bruno, CA September 2010 explosion that killed eight people), trucking or shipping accidents. In the case of potential spills in the Great Lakes which provide drinking water to 26 million people, the stakes are even higher.

A Sustainable Energy Future for Michigan

A sustainable energy future for Michigan will leverage Michigan's inherent natural and human capital assets in ways that enhance their quality and productivity over the long term. While wind energy is not without its own environmental risks, the GLWC believes that wind offers inherent advantages over most conventional forms of electric power. The GLWC Best Practices Toolkit" offers many suggested policies

[10] North American Electric Reliability Corporation, 2012 Long-Term Reliability Assessment, November 2012, available from http://www.nerc.com/files/2012_LTRA_FINAL.pdf.
[11] *Ibid.*
[12] Balanchander, A. et al., 2011. Transmission-Related Policy Options to Facilitate Offshore Wind in the Great Lakes, prepared for Great Lakes Wind Collaborative, available from http://deepblue.lib.umich.edu/handle/2027.42/83515.

and practices that states can adopt to improve how, when and where wind energy development occurs and to ensure that wind energy development occurs in a sustainable manner. These include smart wind energy siting policies, for onshore and offshore (http://www.glc.org/energy/wind/bestpractices.html).

Michigan has a considerable latent, yet talented, manufacturing workforce with skills that can be readily transferred to support the renewable energy industry, including wind. According to the Cleveland-based GLWN, Global Wind Network, Michigan is driving the future of North America's wind industry with technology-leading manufacturers such as Holland's Energetx Composites (blades), Monroe's Ventower (towers), and Eaton Rapid's Astraeus (machining). As part of the Great Lakes region supply chain, Michigan manufacturers are well positioned logistically to play an important role in the development of the offshore wind industry. A solid network of fabrication facilities located near Michigan's coast will serve as an advantage in the production of offshore foundations and equipment.

A 2008 analysis by the National Renewable Energy Laboratory[13] for the GLWC showed that an additional 1,000 MW of wind development in each of the 8 Great Lakes states (8,000 MW) would produce more than $9 billion in lifetime economic output impacts, including 97,000 jobs over the 20 year life of the project. This same analysis showed that a commensurate reduction in fossil fuel generation would eliminate 23 million tons of CO_2 emissions and save 11 million gallons of water *each year*. That same analysis also showed that a 20% wind scenario for the region would create nearly 750,000 jobs (not including manufacturing) with more nearly $80 biillion in lifetime economic output. What is significant about these figures from 2008 is that at the time the analysis was performed, the U.S. was purchasing all of its turbines from overseas and the analysis assumed no U.S. manufacturing or any jobs associated therewith.

Scenario	2,000 MW by 2020	10,000 MW by 2030
Construction Period Jobs	Jobs	Jobs
Project Development and Onsite Labor Impacts	6,446	50,445
Construction and Interconnection Labor	5,026	43,345
Construction-related Services	1,420	7,101
Turbine and Supply Chain Impacts	23,635	198,028
Induced Impacts	20,370	165,730
Total Impacts	**50,451**	**414,203**

Great Lakes Offshore Wind Jobs and Economic Development Impact Analysis, 2012

A 2012 study by Illinois State University[14] on the Jobs and Economic Development Impact of Offshore wind in the Great Lakes looked at the jobs and economic development impacts from low, medium and high offshore wind installations in the Great Lakes. This study which did look at domestic manufacturing input indicated that 2,000 megawatts of installed offshore wind in the Great Lakes by 2020 would generate more than 50,000 jobs during construction. Of these, more than 20,000 would be supply chain-related (i.e., manufacturing) and more than 1,500 total jobs would be created per year over the life of the project (20 years).

A scenario with 10,000 megawatts of installed wind in the Great Lakes by 2030 would create more than 400,000 jobs during construction, including nearly 200,000 manufacturing-related jobs. Compared to the

[13] Lantz, E., 2008. Great Lakes Region Economic, Carbon, and Water Impacts from Wind Power, summary of impacts, methodology, and considerations. Wind Powering America
[14] Loomis, D., 2012. Jobs and Economic Development Impact of Offshore Wind in the Great Lakes Region

previous scenario, the five-fold increase in installed wind resulted in an eight-fold increase in job creation. These results are based on gross job growth.

For each type of energy, costs *and benefits,* now and into the future, should be carefully weighed and considered in determining an appropriate energy mix for Michigan's energy future. Additional resources that can help ensure sustainable wind development is part of that future are available on the GLWC web site at http://www.glc.org/energy/wind/publications.html.