Offshore Wind Energy Development in the Great Lakes:

A Preliminary Briefing Paper for the Michigan Renewable Energy Program

April 2005

by Scott Pryor,[1] Mark Shahinian,[2] and Matt Stout[1]

[1] MS/MBA candidate, University of Michigan School of Natural Resources & Environment and Stephen M. Ross School of Business
[2] MS/JD candidate, University of Michigan School of Natural Resources & Environment and Law School

This page is intentionally left blank.

Acknowledgments

The authors thank the many people who assisted them in their research by providing valuable information, comments and helpful feedback. Contributors include:

Jim Bredin, Office of the Great Lakes, Michigan Department of Environmental Quality
John Dunlop, American Wind Energy Association
Dennis Elliott, National Renewable Energy Laboratory
Tom Graf, Wetlands and Submerged Lands Unit, Michigan Department of Environmental Quality
Kurt Guter, North American Wind Energy
Donna Heimiller, National Renewable Energy Laboratory
Walter Musial, National Renewable Energy Laboratory
Sergio Pacca, Center for Sustainable Systems, University of Michigan
Bonnie Ram, Energetics Corporation.
Marc Schwartz, National Renewable Energy Laboratory
John Sarver, Michigan Energy Office
Tom Stanton, Michigan Public Service Commission
Norm Stevens, DTE Energy
Bill Stockhausen

The Michigan Renewable Energy Program (MREP) extends its sincere appreciation to the three major authors of this briefing paper, who volunteered their time to work on this project. Their expert assistance and the support of their professors are greatly appreciated.

Though MREP Collaborative Participants and various outside experts were invited to review and comment on drafts of this report, the final report reflects the views of the authors, which are not necessarily those of the Michigan Public Service Commission, its Staff, or participants in the Michigan Renewable Energy Program Collaborative.

The Michigan Renewable Energy Program (MREP) of the Michigan Public Service Commission is ultimately responsible for this report. Any errors or omissions are the responsibility of MREP Staff. Comments and suggestions are welcomed, and should be directed to:

Tom Stanton, Coordinator
Michigan Renewable Energy Program
Michigan Public Service Commission
P.O. Box 30221
6545 Mercantile Way; Suite 7
Lansing MI 48911-5990
Voice: (517) 241-6086
Fax: (517)373-3113
Email: tstanton@michigan.gov

MREP welcomes the opportunity to collaborate on projects with students and faculty. Interested parties are invited to explore the MREP Web site – http://www.michigan.gov/mrep – to identify possible ideas for projects, or contact Mr. Stanton to obtain a current list of ideas or to make suggestions for additional projects.

Table of Contents

List of Tables

List of Figures

1. Executive Summary

The State of Michigan possesses significant wind resources, especially within its boundaries over the Great Lakes. These resources, combined with recent offshore wind energy successes in Europe, have encouraged this preliminary assessment of the potential for offshore wind energy development in Michigan and the Great Lakes. Wind energy technology has improved significantly over the last few decades and commercial offshore turbines are now approaching 3.6 megawatts (MW) in capacity. Technological advancements combined with government incentives have made wind energy fully cost-competitive with traditional sources of electricity. The advantages of offshore wind in Michigan include higher average wind speeds compared to onshore sites, proximity to population centers and grid connections, at least somewhat mitigated aesthetic and noise concerns, and the ability to transport and deliver very large pieces of wind energy equipment using a well-established water transportation infrastructure.[3]

Although the technical impediments to offshore wind development are gradually becoming more clearly defined, environmental and regulatory uncertainties have continued to impede progress and to date there has been little serious interest in offshore development in the Great Lakes. Significant opportunities exist, however, for Michigan to learn from developers of offshore wind energy in Europe and other U.S. states. The authors of this report recommend that Michigan policy makers undertake the initial steps to:

- initiate outreach to potential stakeholders, including relevant agencies in the neighboring Great Lakes states and Canadian provinces, to develop appropriate mechanisms for interstate coordination, establish dialogue regarding development opportunities, and try to achieve consensus on a near-term approach to further research and development;

- identify or if necessary establish a permit process, at least for the purpose of siting offshore meteorological equipment for completing resource assessments;

- identify the most appropriate offshore locations for completing data acquisition and experimental and demonstration installations;

- assess offshore wind resources, to more accurately measure the available potential; and,

- promote wind turbine and equipment manufacturing in Michigan, particularly in lakeshore communities.

[3] Land-based wind turbines are already approaching the maximum size for generators and components that can be delivered via highway or rail, and manufacturers are now looking to offshore applications with delivery by ship as a means of achieving additional economies of scale with even larger generators. See pages 7 and 12.

2. Introduction

This briefing paper has been completed in response to the Michigan Public Service Commission's May 18, 2004 Order in Case No. U-12915. MPSC Staff recommended in its first annual report on the Michigan Renewable Energy Program (MREP) that MREP Collaborative members work cooperatively with the Michigan Wind Working Group (WWG) and interested parties in neighboring states "to develop a briefing paper on offshore wind energy development for the Great Lakes" (p. 31). In the May 18 order (p. 4), the Commission accepted that recommendation.[4,5]

The WWG held a brainstorming session at its July 22, 2004 meeting, to develop a list of questions and potential problems that would need to be addressed regarding offshore wind development in the Great Lakes. About three-dozen issues were identified, including questions and concerns involved with resource assessment, siting, engineering, environmental effects, and legal and regulatory approvals. Those issues were relayed to staff at the U.S. Department of Energy (DOE) National Renewable Energy Laboratory (NREL). After some investigation by NREL Staff, DOE sponsored three presentations at the October 5, 2004 WWG meeting in Lansing.[6] The three presentations included: (1) Offshore Wind Development, by Bonnie Ram, Energetics Corporation; (2) Michigan Wind Maps, by Dennis Elliott, National Renewable Energy Laboratory; and, (3) Wind Power Siting and Development Best Practices, by John Dunlop, American Wind Energy Association.[7]

Soon after these presentations to the WWG, the three co-authors from University of Michigan attended an MREP Open Forum meeting at Lawrence Technological University in Southfield, Michigan, where they saw newly published wind resource maps of Michigan and learned about the progress to date in understanding offshore wind development issues for the Great Lakes. Following the Open Forum meeting, the students volunteered to co-author this briefing paper.

Michigan wind maps compiled and verified by NREL indicate a very significant potential for offshore wind energy production (see Figure 2).[8] Much of Michigan's total wind resource that might be harnessed for energy development lies offshore, over the Great Lakes. Offshore wind is a potentially huge resource that could make a significant contribution to Michigan's energy

[4] Documents associated with this case, including Commission Orders, are available on the Commission's Web site, at http://efile.mpsc.cis.state.mi.us/cgi-bin/efile/viewcase.pl?casenum=12915. On this Web page, the MPSC First Annual Staff Report on MREP is document 0116 and the Commission's May 18, 2004 Order in Case No. U-12915 is document 0136.
[5] All Web sites and Web-based documents referenced in this report were viewed in January–March, 2005.
[6] The presentations were shared with an audience of about 40 people at the MPSC offices in Lansing, and DOE's Midwest Regional Office made the meeting available via Web conference for interested parties from the Great Lakes Region. A dozen remote locations throughout Michigan and the Midwest Region connected to the meeting using the Web conference capability.
[7] The presentations are available on the Energy Office Web site, at http://www.michigan.gov/eoworkshops.
[8] Michigan Wind Energy Resource Maps are available in PDF and JPEG file formats on the Michigan Energy Office Web site, at http://www.michigan.gov/cis/0,1607,7-154-25676_25774-101765--,00.html. For those interested in more detailed analysis, geographic information system (GIS) meteorological data sets are available in CD-ROM format from the Michigan Energy Office. See http://www.michigan.gov/cis/0,1607,7-154-25676_25768---,00.html.

future. Calculations for this report by the National Renewable Energy Laboratory estimate there is a total of 44,000 MW of offshore wind generating capacity near Michigan's shorelines.[9, 10]

Preliminary discussions were held among representatives of Michigan's Wind Working Group (WWG) and Michigan Renewable Energy Program (MREP), with Staff from Michigan's Department of Environmental Quality, Office of the Great Lakes and Land and Water Management Division. Importantly, the State of Michigan owns the bottomlands of the Great Lakes, from the shores of our state out to the boundary lines between Michigan and neighboring states and the Canadian province of Ontario.[11] Indications are that permits would be required from both the State of Michigan and the U.S. Army Corps of Engineers before any wind systems could be constructed in the Great Lakes. Additional research will be needed before it can be determined how any fees that might be associated with offshore wind development will impact State revenues.

Offshore wind energy development in Europe is accelerating. Installed capacity grew from zero in the early 1990s to 613 MW, as of October 2004. An additional 20,000 MW of offshore wind capacity is being "tentatively explored" in Europe, a limited portion of which is already in "advanced" planning stages.[12] Given Michigan's large wind resource and the proven success of offshore wind developments in Europe, many MREP participants support efforts to further analyze the potential for offshore wind energy development in the Great Lakes. However, a large number of issues – environmental, financial, regulatory, and technical – must be addressed before development can take place. In this report, several of these issues are identified and preliminary recommendations are made regarding how to proceed with the further exploration of offshore wind energy development in Michigan.

---

[9] This estimate reflects only the wind resources identified in current wind maps (up to 12 miles offshore) and excludes specific protected areas plus all areas within 5 miles of the shoreline.

[10] Michigan's present total installed electric power generation capacity is about 29,000 MW. See U.S. DOE, Energy Information Administration, http://www.eia.doe.gov/cneaf/electricity/st_profiles/michigan.pdf.

[11] Each Great Lakes State holds title to submerged lands underlying the Great Lakes in trust for the benefit of the public. *See Illinois Central Railway Commission v. Illinois,* 146 U.S. 387, 452 (1892). *See also* MCL Ann. § 281.960 (West 1999) (title to the lands beneath the Great Lakes in Michigan is vested statutorily). http://law.utoledo.edu/ligl/spring2000/publicwater.htm

[12] S. Shaw, M.J. Cremers, G. Palmers, E. (2002). *European Wind Energy Association Report: Enabling Offshore Wind Developments*, Brussels, Belgium; www.ewea.org/documents/offshore%20-%20EWEA%20version%20.pdf.

3. Wind Energy Technology

Wind-driven electricity generation occurs when wind propels the blades of a wind turbine, turning a rotor. The rotor turns a generator that produces electricity, which can then be properly conditioned (that is, converted to the appropriate voltage and synchronized with the grid's alternating current) so that it can be fed through cables to the electric power grid. Several turbines can be grouped together to form a wind power plant.

Windmills have existed for centuries, but the commercial development of wind-electric generation began in earnest in the United States in the early 1980s, following the energy crises of the 1970s. Turbines in the 80s had modest generating capacity, generally ranging from 50-200 kW, with geared transmissions and induction generators powered by high-rpm, structurally stiff rotor blades. Turbines were mounted on top of steel truss or tube towers.

In the 1990's, turbines grew in capacity to about 750 kW and incorporated advancements such as variable speed, independent blade pitch control, quieter designs, and resin-infused blades. Now, 2.0 MW turbines with towers 100 meters high and blades 80 meters in diameter are common. The larger size machines generally result in lower costs per kWh.

Technological progress continues today. More advanced materials are being used and manufacturers are experimenting with structurally flexible designs. The largest turbines commercially available today are 3.6 MW units, manufactured by General Electric and designed for offshore use. Turbines of up to 5.0 MW are currently under development.[13]

4. Cost of Wind Energy

Four main factors affect the costs of wind energy: (1) energy produced; (2) total installed costs; (3) operations and maintenance costs; and, (4) financing costs and incentives.

Energy generated is a significant factor in the cost of wind energy, as the bulk of electricity costs for wind generation are calculated as the installed costs divided by the total amount of electricity produced over a turbine's lifetime. Turbine technology is a major factor in energy generation, and the location of the turbine is the other major determinant. For any given wind machine, the quantity and value of electricity generated depends on the particular qualities of the wind's speed, duration, and variability at each location. Small differences in average wind speed can add up to large differences in power, as the power available in the wind increases proportionally with the cube of the wind speed. Wind variability is another important factor in determining wind electricity costs. Variability can make power more or less valuable, depending on the time of

[13] One MW = 1,000 kW. A typical Michigan home might use an average of about 800 kWh per month, or 9,600 kWh per year. On average, that would be a bit more than 1 kW of capacity on a continuous basis, but residential demands are highly variable, according to how much electricity-using equipment is in operation at any particular time. At times of peak demand, a typical Michigan home might require as much as about 5 kW of capacity. Thus, each MW of capacity is usually considered to be an ample quantity to provide service to about 200 to 300 homes.

year and time of day the winds blow, and therefore how closely wind power output matches the timing of consumer demands for power.[14]

Total installed costs include turbines (74-82% of total costs), foundations[15] (1-6%), electrical grid interconnection systems[16] (1-9%), and construction costs (% varies by site). Generally speaking, foundation and construction costs currently tend to be higher for systems installed over water, as opposed to land, and grid interconnection costs will vary significantly depending on the distance between wind sites and the existing utility grid.[17] Operation and maintenance costs account for 20-25% of the cost of electricity over the lifetime of a wind turbine. Operation and maintenance includes insurance, regular maintenance, repair, spare parts and administration.[18]

Financing costs and incentives also play a big part in determining the cost of electricity production from wind power development. Interest rates based on the risk premiums demanded by lenders[19] and tax treatment, including available incentives, are important. The federal production tax credit (presently 1.8 ¢/kWh) is a big contributor to the cost-competitiveness of wind power development in the U.S.[20] While they do not directly affect the costs of wind power, state Renewable Portfolio Standards (RPSs) have significantly boosted the demand for wind power and contributed to large-scale wind development. Currently, 19 states and the District of Columbia operate under RPSs, including Michigan's neighboring states Wisconsin, Minnesota, Iowa, Pennsylvania and New York, and Illinois has adopted a non-punitive renewable portfolio goal.[21]

A recent academic study examined trends in wind power costs and found that each doubling of worldwide installed wind capacity has been associated with wind energy cost reductions of about 20 percent.[22] This trend is generally expected to continue for the foreseeable future as the

---

[14] In Michigan, for example, the general tendency is for peak electric power needs to occur during the hottest days in the summer, when high temperatures and humidity generally combine with no or very low-speed wind, thus resulting in the highest air conditioning demands. The peak wind production, on the other hand, tends to be in the spring, fall, and winter when electric demands are much lower. In the most promising locations in Michigan, however, wind generators can be expected to produce at least some useful power nearly every single day.
[15] Based on experience with foundations for land-based towers and turbines, it is expected that location and water depth will significantly impact foundation costs for offshore systems.
[16] Costs associated with grid interconnections generally increase as cable electric carrying capacity and length increase.
[17] Morthorst, Poul Erik and Hugo Chandler. "The Cost of Wind Power." *Renewable Energy World*. July-August 2004, v7, n4. pp. 126-137.
[18] Ibid.
[19] See Standard & Poors credit report on wind power – Pratt, Terry, et al., *Sustainability and Creditworthiness of European and U.S. Wind Power*. 12/18/2003.
[20] This tax credit was recently renewed by Congress, through 2005. In the past, the federal government has also provided just under $4 million per year as a renewable energy production incentive to tax-exempt public utilities. However, this program expired January 2004 and has not been renewed. See "The Crippling Cost of Legislative Limbo," *Windpower Monthly*, v20, n9, September 2004, pp. 23-24; http://www.windpower-monthly.com.
[21] See http://www.dsireusa.org.
[22] Junginger, M. (2005). "Global experience curves for wind farms," *Energy Policy* 33:133–150; www.chem.uu.nl/nws/www/publica/e2004-58.pdf.

production of wind generators and associated equipment benefits from increasing economies of scale in manufacturing.[23]

As shown in Table 1, wind energy, as a result of technological advancements and financial incentives, has become fully cost-competitive, in new construction, compared to traditional sources of electricity.[24]

Table 1: Estimated Electricity Generation Costs

Energy Source[1]	Costs (¢/kWh)	Estimated Externalities (¢/kWh)	Estimated Total (¢/kWh)
Wind with federal tax incentives	3 – 5	0.1 – 0.3	3.1 – 5.3
Wind without federal tax incentives	4.8 – 6.8	0.1 – 0.3	4.9 – 7.2
Coal	4.3 – 4.8	2.3 – 16.9	6.6 – 21.7
Coal (short-term fuel and operating costs alone)	2 – 2.5	2.3 – 16.9	4.3 – 19.4
Natural Gas[2]	3.4 – 5.0	1.1 – 4.5	4.5 – 9.5
Nuclear	10 – 14	0.2 – 0.8	10.2 – 14.8
Biomass	7 – 9	0.2 – 3.4	7.2 – 12.4
Solar Photovoltaics	24 – 48	0.1 – 0.3	24.1 – 48.3

Source: Adapted from Sawin, Janet L., 2004, *Mainstreaming Renewable Energy in the 21st Century*, Washington, DC: Worldwatch Institute, Worldwatch Paper 169, p. 13; http://www.worldwatch.org.

Notes: [1] Unless otherwise labeled, all energy sources represent combined capital and operating costs for a newly constructed power plant.

[2] Representing a new natural gas-fired plant, *not* including the recent run-up in natural gas prices. With natural gas prices at current levels, fuel costs for a new plant are estimated to be in the range of 5.0 – 7.0 ¢/kWh.

---

[23] See: U.S. Department of Energy, Wind and Hydropower Technologies Program. (November 2004). *Wind Energy Multi Year Program Plan 2005–2010*. http://www.eere.energy.gov/windandhydro/.

[24] It should also be noted that traditional fossil fuels and energy technologies have been afforded a variety of financial incentives and subsidies. See for example: Renner, Michael, 2004, "Moving Toward a Less Consumptive Society," in *State of the World 2004*, Washington, DC: Worldwatch Institute; Chapter 5; Roodman, David Malin, 1998, *The Natural Wealth of Nations: Harnessing the Market for the Environment*, New York: Norton; and, Scheer, Hermann, 2002, *The Solar Economy*, Sterling, VA: Earthscan, pp. 149-153.

5. Benefits of Offshore Wind

The most important benefit of siting wind generators offshore is the exposure to higher velocity and steadier winds. Winds close to the earth's surface are generally faster and steadier over large bodies of water than they are over land masses; with their more varied terrain, ground cover, and buildings that effectively break up the wind. The higher wind speeds and steadier winds will be the main driver of offshore wind development. The wind speed at turbine hub-height is generally greater over large water bodies than over land because stronger winds from aloft mix down towards the surface more efficiently over water than over land, because water bodies have lower and more uniform surface roughness than land.[25] As discussed previously, the more electricity generated per wind turbine, given the very large percentage of fixed capital investment, the cheaper the per-kWh cost of delivered energy. Because wind power varies with the cube of the wind speed, small differences in wind speeds can make large differences in how much electricity is generated.

With offshore wind turbines, it could be that less attention will need to be devoted to noise reduction, which adds significant costs to onshore wind turbines.[26] Far enough offshore, aesthetic concerns about large turbines might also be significantly mitigated. A corollary is that offshore wind development could be capable of displacing development on land, reducing conflicts over aesthetics, competing land uses, and other issues. However, siting offshore does not completely eliminate aesthetic concerns, as is demonstrated by early experience with the Cape Wind project (see page 23).

Additionally, turbine and component size might not be limited offshore the same way they are on land. Wind generator turbine, blade, and towers are already nearing the maximum sizes that can be transported and delivered via land-based transportation systems. However, with offshore turbines, marine shipping and handling equipment could erect today's largest, multi-megawatt turbines (see p. 12).[27]

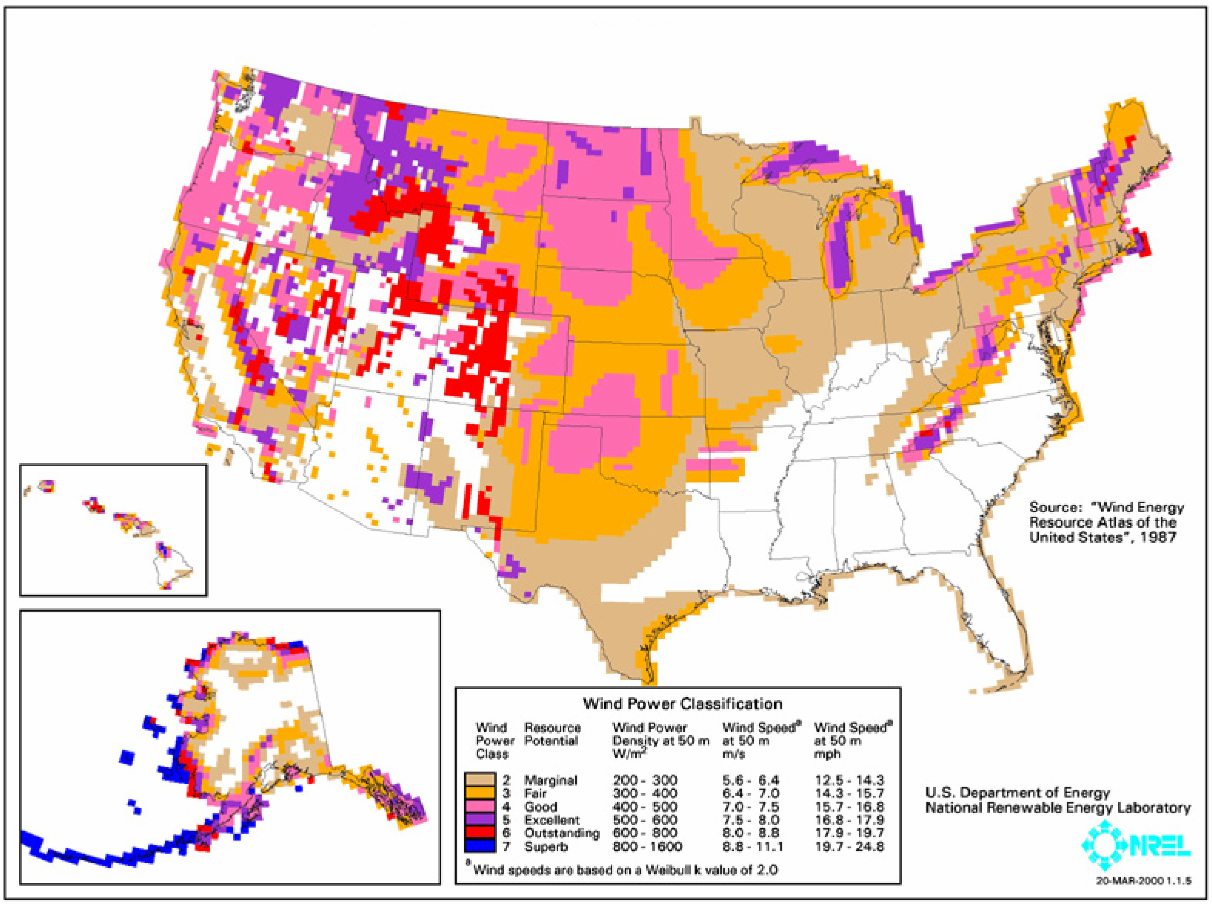
The greatest land-based wind resources in the U.S. are in the Great Plains – from North Dakota to northern Texas (see Figure 1). Those resources, however, are generally far away from major population centers and long distances from the existing electric transmission grid, needed to deliver the power from generators to loads. Offshore wind is generally closer to coastal population centers (as is the case in the Great Lakes region). About 26 million people live in coastal counties bordering the Great Lakes, for example.[28] By contrast, about 31.5 million people live in the entire Great Plains region, including 22 million in all of Texas.[29]

---

[25] Personal communications, 9/7/2004, Marc Schwartz, National Renewable Energy Laboratory.
[26] Musial, Walter and Butterfield, Sandy. (2004, June). *Future for Offshore Wind Energy in the United States*. National Renewable Energy Laboratory; NREL/CP-500-36313, http://www.nrel.gov/docs/fy04osti/36313.pdf.
[27] Ibid.
[28] National Oceanic and Atmospheric Administration. *Population and Development in Coastal Areas* (Web page). http://spo.nos.noaa.gov/projects/population/population.html.
[29] U.S. Census Bureau data for 2000.

From the Michigan Wind Resource Map (see Figure 2), the National Renewable Energy Laboratory (NREL) calculated estimates of Michigan's offshore wind generating capacity. The estimates represent only offshore areas within about 20 km (11 nautical miles) of the shoreline. In keeping with standard practices used for estimating wind capacity in the Atlantic and Pacific oceans, all areas within five nautical miles of the coastline and known protected areas (such as underwater parks) were completely excluded from consideration and 2/3 of the remaining area was excluded.[30] After these exclusions were made, NREL estimated 44,228 MW of offshore wind capacity in Michigan waters for areas with Class 4 or better wind resources (see Table 2).[31]

Figure 1: United States Wind Resource Map



Source: National Renewable Energy Laboratory, http://www.eere.energy.gov/windandhydro/windpoweringamerica/wind_maps_none.asp. For more recent, detailed wind maps developed for many states, see: http://www.eere.energy.gov/windandhydro/windpoweringamerica/wind_maps.asp.

---

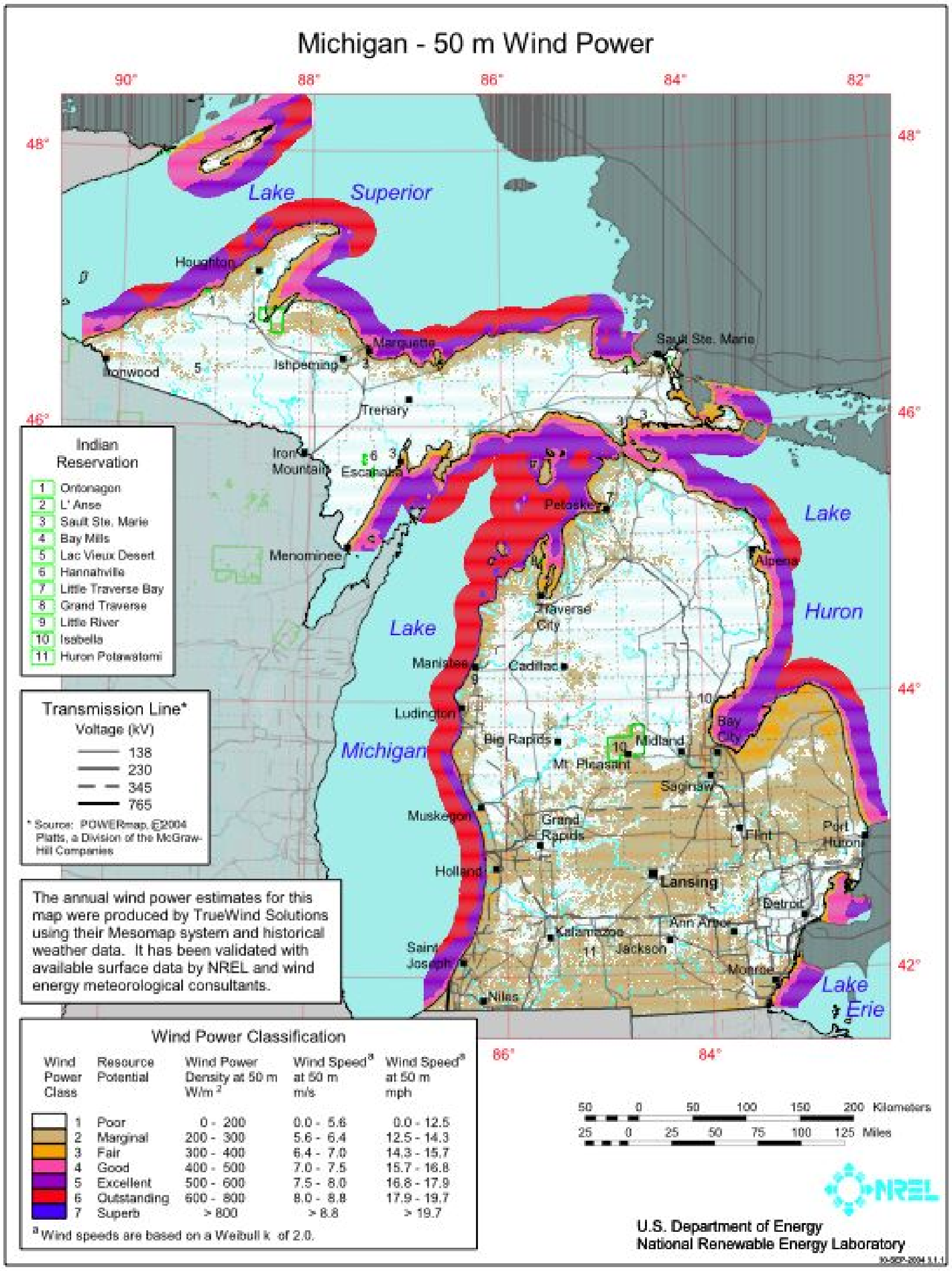
[30] It should be noted, however, that these estimates do not incorporate any explicit exclusions based on water depth. In the future, more comprehensive assessments should be undertaken, which incorporate exclusions based on relevant water depths and other considerations. See Recommendation 1 on page 24.
[31] To put this resource in perspective, Michigan's statewide peak electric power demand is presently on the order of about half of this amount, and statewide total installed capacity is about 29,000 MW. See footnote 10.

Table 2: Estimated Michigan Offshore Wind Power Potential

Lake	Wind Power Class	Area (km^2)	Potential (MW)	Cumulative Potential (MW) by Lake
Lake Michigan	4	175.2	292	
	5	1,862.4	3,104	
	6	6,955.4	11,592	
	7	4.1	7	14,995
Lake St. Clair	4	143.0	238	
	5	239.7	399	638
Lake Erie	4	27.2	45	
	5	446.4	744	789
Lake Huron	4	339.7	566	
	5	4,417.8	7,363	
	6	1,753.2	2,922	10,851
Lake Superior	4	1,583.6	2,639	
	5	4,038.7	6,731	
	6	4,586.4	7,644	17,014
Total		**26,572.6**	**44,288**	**44,288**

Source: Personal communication, November 2004, Donna Heimiller, National Renewable Energy Laboratory.

Figure 2: Michigan Wind Resource Map



Source: Michigan Wind Resource Maps, www.michigan.gov/cis/0,1607,7-154-25676_25774-101765--,00.html.
Note: The bluish-purple (Class 5) and red (Class 6) colors indicate the highest average wind speeds, and these areas are exclusively offshore. This map represents offshore resources for only the first approximately 11 nautical miles from Michigan's shores. It is safe to assume that similarly high wind speeds, Class 5 and 6, exist all the way across the Great Lakes.

6. Technical Considerations for Offshore Wind

Resource Variability and Storage

One of the major technical challenges for wind generation is that winds are both intermittent and variable, and in Michigan there is not a great deal of correlation between when the wind blows and electricity demands.[32] For electric power systems to rely much on wind generation, dispatchable capacity[33] will be needed as a backup power source for times when winds die down. The steadier and more predictable the winds are, however, the more capacity value can be credited to wind generators.[34, 35] Thus, offshore resources with their steadier and higher speed winds may prove significantly more valuable, to producers and utility managers alike. Figure 3 and Figure 4 help to demonstrate some of these important differences in wind power, measured at the Lake Michigan shoreline, near Muskegon, and at nearby inland locations that are, respectively, 5 km and 20 km from shore. Preliminary data from the few available offshore wind monitoring stations in the Great Lakes indicate both higher average wind power density and steadier winds offshore.

Another viable option for increasing the value of wind generation is to combine it with some form of energy storage. In West Michigan, the 1800 MW Ludington pumped storage facility presents a unique capability for electric power storage. At least in theory, it could be possible to use wind power to pump water uphill into the Ludington reservoir during times when wind generation would not be particularly valuable to the electric grid; effectively storing electricity in the form of hydroelectric potential that could be dispatched as needed when the capacity is more valuable. Another option being explored with growing interest is the possibility of using wind-generated electricity through the electrolysis of fresh water, to produce hydrogen and store

---

[32] Michigan's peak power demands generally occur in the hottest, most humid days each summer, when air conditioners are working hardest. Such heat wave events are generally correlated with low wind power availability. Thus, adding significant quantities of wind generation may do little to reduce the need for peak generating capacity in Michigan, unless wind power can be associated with some form of energy storage. See footnote 14, p. 5.

[33] Electric generating sources are considered to be "dispatchable" if they can be made subject to operator control, to determine when power will be produced.

[34] Recently, analytical methods for determining appropriate capacity credits for wind generation have been researched by staff at the National Renewable Energy Laboratory. Methods have been developed for calculating the generation equivalent of a conventional electric generating unit (such as a natural gas-fired peaking unit) that would deliver the same risk level as a variable-output unit (such as a wind generator). Performing such calculations, electric system planners can determine what is called the effective load carrying capability (ELCC) of a wind generator. See Milligan, Michael. (2002, March). *Modeling Utility Scale Wind Power Plants Part 2: Capacity Credits*, NREL/TP-500-29701; http://www.nrel.gov/docs/fy02osti/29701.pdf.

[35] It is also generally true that the larger the geographic area covered by wind farms, the more predictable will be total wind production. See Möller, Bernd. (2002, October). "Geographically determined interactions of DG and power transmission in Denmark," in *Proceedings*, Second International Symposium on Distributed Generation: Power System and Market Aspects, Stockholm, Sweden, Session 8.

it for later use. However, it should be emphasized that practical, economical hydrogen generation and storage technologies may still be many years away from commercial viability.[36],[37]

Turbines

The size of modern wind generators and associated components is of considerable importance. The blades of GE's 3.6 MW turbine are 104 meters in diameter.[38] To put that in perspective, the wingspan of a Boeing 747 jet airplane is only 65 meters. Enercon's 4.5 MW prototype weighs 440 tons and its blade and rotor diameter measures 112 meters.[39]

The increasing size poses serious challenges for traditional land transportation. The limiting factors for shipping turbines are the size of the tower and blades and the weight of the nacelle components. Towers are usually manufactured in sections and assembled on site, but tower section diameters for land-based delivery are already being limited by the clearance under highway bridges.[40] Most onshore turbines are shipped by road. Rail is seldom used. For offshore wind projects it is envisioned that most large components will be built or assembled very close to shore, at manufacturing facilities in port cities, and shipped by water.

Michigan's central location, access to shipping lanes in the Great Lakes, and industrial base make the state a prime candidate for becoming an important manufacturing center for wind turbines, blades, towers, foundations, generators, and associated hardware; especially for the next generations of large offshore machines. According to a recent report issued by the Renewable Energy Policy Project (REPP), a Washington, DC, think-tank, Michigan ranks fourth in the nation behind California, Ohio and Texas in potential for wind equipment manufacturing. The REPP report estimates that companies capable of participating in the wind equipment manufacturing industry already employ 66,000 Michigan workers, and another 8,500 new jobs could be created in Michigan if the industry expands here.[41, 42]

---

[36] See U.S. Department of Energy Electrolysis–Utility Integration Workshop, Broomfield, CO, September 22-23, 2004, *Proceedings*, http://www.eere.energy.gov/hydrogenandfuelcells/wkshp_electrolysis.html, and Electrolysis Production of Hydrogen from Wind and Hydropower Workshop, Washington, DC, September 9-10, 2003, *Proceedings*, http://www.eere.energy.gov/hydrogenandfuelcells/wkshp_wind_hydro.html. See also DTE Energy, November 2004, *Hydrogen: The Next Step* (DVD: EM-986).

[37] See http://www.baldeaglepower.org. Bald Eagle plans to generate hydrogen from wind by electrolysis, and then ship the hydrogen to shore.

[38] http://www.gepower.com/prod_serv/products/wind_turbines/en/36mw/index.htm.

[39] http://www.enercon.de/en/e112.htm.

[40] Personal communication, November 2004, Walter Musial, National Wind Technology Center, National Renewable Energy Laboratory.

[41] Sterzinger, George and Svrcek, Matt. (2004, September). *Wind Turbine Development: Location of Manufacturing Activity*. Renewable Energy Policy Project; www.repp.org/articles/static/1/binaries/WindLocator.pdf.

[42] Policies designed to support in-state markets for wind equipment may be a necessary prerequisite, however, to attracting such development to Michigan. The MREP Economic Impacts Committee is exploring the potential for increased in-state renewable energy manufacturing and related economic impacts. A preliminary report is being incorporated into the 2004 MREP Annual Report (in press). See www.michigan.gov/mrep.

Figure 3: Sample Measurements of Average Wind Power Density by Month at Great Lakes Shoreline and Nearby Michigan Onshore Locations

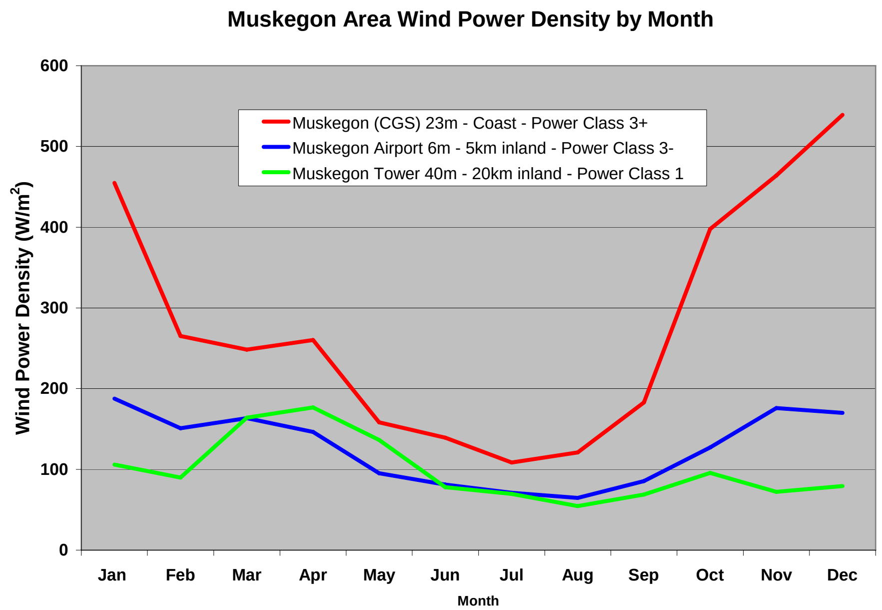
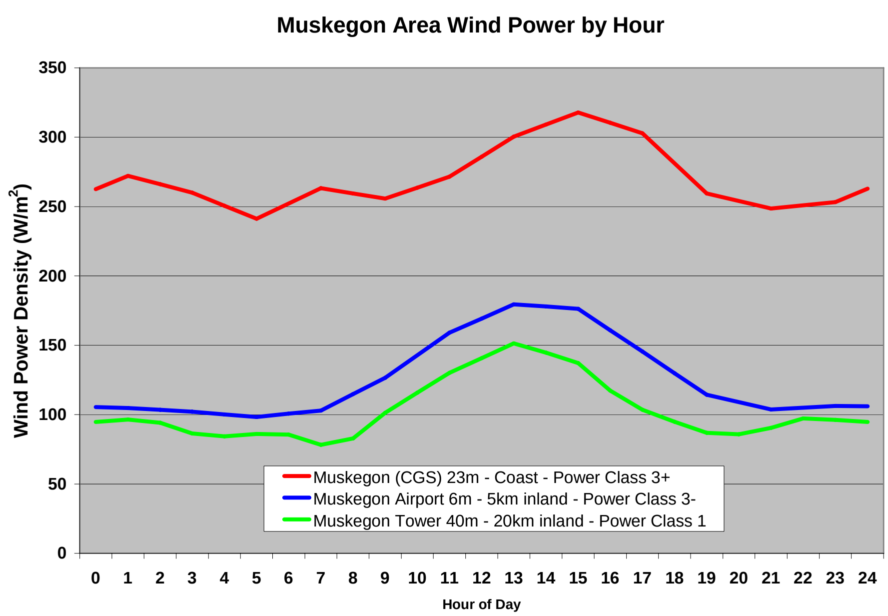


Figure 4: Sample Measurements of Average Wind Power Density by Hour at Great Lakes Shoreline and Nearby Michigan Onshore Locations



Other states are already working to attract wind manufacturers. European companies recently built manufacturing plants in Illinois and North Dakota and new factories were recently announced for Pennsylvania, Vermont, and Wisconsin.[43] GE, the largest U.S. manufacturer of wind turbines, makes its turbines in Tehachapi, CA, and its turbine blades in Pensacola, FL.[44]

Foundations

There are several different support options currently being explored for offshore wind turbines. They range from buoy designs to steel pilings (monopiles) to floating pontoons (see Figure 5). Their application and use depends on site depth and distance from shore.

It should be emphasized, however, that turbine siting in water depths over 50 meters is still in a conceptual phase. Furthermore, systems cannot be permitted, let alone built and operated, without obtaining insurance coverage against potential hazards including environmental impacts. Insurance companies have thus far approved coverage only for certain foundation types and for placement in rather shallow water. More research, development and demonstration work is likely to be needed before insurers will be ready to cover applications in deeper waters and using what may be as yet unproven foundation types.[45]

To date, foundation engineering requirements generally have been determined by wave height in the North Sea and pack ice in the Baltic Sea.[20] Both of these issues are expected to present significant technical challenges for sites in the Great Lakes, too. Data from buoys in Lake Michigan and Lake Superior show most wave heights reaching maximums of six to seven meters, respectively.[46] In addition, concerns have been raised about the durability of turbines, blades, and foundations that would be exposed to freshwater freeze and thaw cycles in the Great Lakes. Experience with pack ice in the Baltic Sea and consistently cold temperatures at land-based wind farms in North Dakota and Minnesota can be expected to provide some guidance, though, about suitable approaches for designs and engineering needed to meet these concerns.

---

[43] Gamesa Corp., the Spanish wind turbine manufacturing company, will base its manufacturing facility for wind turbine blades in Ebensburg, PA. The plant will create an estimated 236 permanent manufacturing jobs. See http://state.pa.us/papower/cwp/view.asp?Q=439981&A=11.

Northern Power Systems is expanding manufacturing facilities, in Barre, VT, and plans to hire at least 35 new technicians, drafters, and engineers. They will first build NorthWind 100 wind turbines and fabricate industrial power systems. See www.northernpower.com/company/whats-new/press-releases.html. [continued on next page]

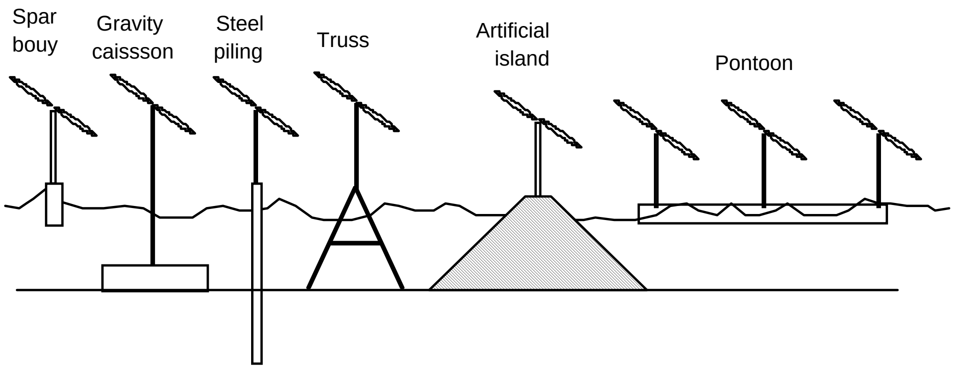
Global Energy Systems has been established in Stevens Point, WI, with the help of a Wisconsin Focus on Energy grant. They will employ about 100 people, including 75 skilled laborers, to fabricate wind turbine components such as towers, flanges, gearboxes, bedplates, and hubs. See www.focusonenergy.com/portal.jsp?pageId=603&#7393.

[44] American Wind Energy Association. (1998, December 18). *Wind Powers America* (Press Release). Washington, DC: American Wind Energy Association, www.awea.org/news/wpa3.html.

[45] Personal communications with Bob Link, Permits Compliance Officer for Winergy, LLC, March 2005.

[46] National Oceanic and Atmospheric Administration, National Data Bouy Center, Great Lakes Historical Marine Data; http://www.ndbc.noaa.gov/Maps/great_lakes_hist.shtml and *Significant Wave Height Data, April 1980 – November 2001*, Lake Michigan, Bouy 45007, http://www.ndbc.noaa.gov/images/climplot/45007_wh.jpg and Lake Superior, Bouy 45004, http://www.ndbc.noaa.gov/images/climplot/45004_wh.jpg.

Figure 5: Wind Turbine Foundation Types[47]



Cables and Grid Hookups

Underwater, marine cables would connect offshore wind farms to the mainland electrical grid. Undersea cabling is a well-established technology. Underwater cables are often buried in shallow trenches dug into the lake bottom, to reduce the risk of damage from fishing equipment, boat anchors, and the like.

There are well-established technologies and standards for interconnections with electric grids. For example, the offshore wind farm at Horns Rev, Denmark, interconnects at the wind farm site via a 36 kV cable and a step-up transformer that increases the current to 150 kV for transmission to land, where it interconnects with the national grid. As with any electric generator, for interconnections to be both feasible and economical, offshore wind generators must be located in reasonable proximity to adequate distribution or transmission lines.

Maintenance

Because severe weather conditions can prevent service personnel from approaching and accessing wind turbines, high availability is important for offshore wind turbines. Developers are learning to optimize preventive maintenance programs for all wind farms, including remote offshore locations.[48] Remote monitoring of wind towers and generators for early problem detection is rapidly becoming standard operating procedure for utility scale wind farms. The size of large offshore wind turbines makes it cost-effective to install extra sensors on each piece of equipment and continuously analyze minute variations in vibrations, which can signal wear. For

[47] Ram, Bonnie, Energetics Corp. (2004, October 5). *Offshore Wind Developments*, Presentation to MREP and Michigan Wind Working Group; http://www.michigan.gov/eoworkshops. See also http://home.planet.nl/~windsh/offshore.html, for a directory of wind farms using various types of foundations.
[48] Danish Wind Site; http://www.windpower.org.

example, at Horns Rev, the control center is connected via fiber-optic cable to sensors at each wind turbine.[49]

Deep Water Wind Turbine Development

There are several benefits to installing wind turbines in deeper water. First, there are larger geographic areas with greater resource potential and higher average wind speeds. The middle of a lake is furthest from the influence of the more stable atmospheric layers over the land. Therefore, the winds over deeper waters are likely to be as strong or even stronger than over shallower waters closer to shore. In addition, installing wind turbines farther from shore may mitigate concerns about visual impacts.[50] But, installing wind turbines in deeper water presents a number of technical challenges. Weather conditions could be even more extreme, and depending on water depth such installations could surpass the limits of currently available monopile tower technology.[51]

Even in Northern Europe, where there is the most experience with and rapid growth of offshore wind development, there remains some uncertainty regarding installations of deepwater platforms. Considerable research and development is still needed before floating supports can be considered practical. Also, transmitting power long distances to shore will necessitate higher construction costs and increase line losses between the generators and loads. Installing cables on or under the lake bottom also introduces numerous environmental uncertainties, which are itemized on page 17. Furthermore, offshore wind farm siting will have to be considerate of navigation routes for both freighters and recreational boaters.

Maps incorporating bathymetric data for the Great Lakes are being compiled by the National Oceanic and Atmospheric Administration. The maps show water depths like topographical maps show changes in terrestrial elevation: Contour lines and color codes mark water depths. Combining the data from bathymetric and wind resource maps can be expected to quickly identify the most promising locations to consider for siting offshore wind facilities.[52] Figure 6 shows bathymetric data for Lake Michigan.

---

[49] Ibid.

[50] Turbines will recede from view because of their greater distance from on-shore viewers, and also because of the curvature of the earth. However, a 70-meter tower would have to be nearly 20 miles offshore to be completely out of view, below the horizon. See U.S. Army Corps of Engineers, New England District, November 9, 2004, *Cape Wind Energy Project Draft Environmental Impact Statement*, http://www.nae.usace.army.mil/projects/ma/ccwf/deis.htm, Figure 3-35: Generic Seascape to Represent Existing Water Views At Shoreline Locations; Figures 3-53 through 3-65: Potential Views from various locations; Figure 5.10-3: Simulated Day time Views; and Figure 5.10-4: Simulated Night time Views. See also, Wind Energy in Nantucket Sound, Fact Sheets: *Turbine View in Perspective*, http://www.cleanpowernow.org.

[51] A monopile is essentially a large steel tube. For wind generator installations in appropriate geological formations, monopiles can are effectively driven 10-20 meters deep, into the lakebed, to form the foundation for a tower.

[52] For instance, bathymetric data for the Atlantic and Pacific Oceans helps explain why most U.S. offshore wind energy exploration has been focused on the East Coast. The West Coast has much steeper drop-offs closer to shore, which will likely necessitate much more difficult and expensive foundation construction.

7. Environmental Considerations of Offshore Wind

Although the State of Michigan possesses significant offshore wind resources, and wind energy could provide a clean, renewable alternative to – or a supplement for – coal and other fossil fuels, offshore wind projects present numerous potential environmental and social concerns. With respect to biodiversity, there is some concern that installing offshore turbines, transmission lines, and associated cables and other required infrastructure could adversely impact marine habitat and fisheries.

Specific environmental concerns include electromagnetic fields generated by turbines and underwater cables, noise associated with installation and operation, and fragmentation and possible degradation of habitat. Marine biologists are concerned that electromagnetic fields near the generators and cables might disrupt navigation of some fish and mammalian species that use the earth's magnetic field for navigation. Disruption to or interference with navigation during migration to breeding grounds would be of particular concern. Also, noise during installation and operation could trouble or possibly even displace marine life, especially any life forms that may be sensitive to the low-frequency sounds produced during operation.[53] Another concern is that the foundations for large wind farms with many installed turbines might pose an obstacle, something like a maze, to traveling or feeding fish. If it turned out such disturbances were significant enough, marine habitat could actually be fragmented by offshore wind farm installations. Similarly, habitat for small fish and invertebrates could be degraded, depending on foundation construction methods and materials used, and how cables are laid or buried.[54]

Offshore wind could also pose a threat to avian species, in or migrating through the Great Lakes region. In addition to direct collisions with blades or towers, wind turbine installation could cause habitat fragmentation and disrupt migratory pathways.[55] While it may prove impossible to avoid 100 percent of all bird kills, it is well understood that the impact can be greatly reduced by choosing sites away from migratory pathways and important nesting and feeding areas. Another concern is that offshore projects could degrade lakebed and coastal areas, as well as marine archaeology. Depending on the geology of the lakes and various areas deserving of special protections, there may be many areas where offshore projects must not be permitted.

In addition, as tower heights and blade length have increased, air traffic safety concerns have to be addressed. The Federal Aviation Administration has already developed siting requirements and required warning lights for all towers that are installed near airport flight paths. Finally, there are other widely publicized citizen concerns about wind system siting, regarding aesthetic impacts, noise, and possible disturbances of radio and TV reception.

[53] There has been little research yet on this aspect of offshore wind construction and operation. A study of a Danish site indicated that noise did not seem to have much effect on Dolphins. See Horns Rev Offshore Wind Farm Environmental Reports, at http://www.hornsrev.dk/Engelsk/default_ie.htm. See also Vella, Gero, 2002, *Offshore Wind: The EnvironmentalImplications*, http://www.utilitiesproject.com/documents.asp?d_ID=880, and Safewind.Info, 2003, *Frequently Asked Questions: Do Offshore Wind Farms Harm Marine Wildlife?*, http://www.safewind.info/wind_FAQ_final.htm.
[54] Ibid.
[55] Ibid.

8. Regulatory Considerations for Offshore Wind

There are numerous factors determining which regulations apply to a specific project. Among these factors are: (1) project size and location; (2) potential impacts on sensitive marine and land areas and avian and marine species; (3) grid connection; and (4) relevant state and national boundaries.

The State of Michigan is responsible for maintaining and protecting the bottomlands and waters of the Great Lakes for the use and enjoyment of all its citizens. Michigan holds title to the Great Lakes from the ordinary high water mark along its shoreline to the boundaries with its neighboring states and Canada. This is the case with all Great Lakes States, with the exception of a 4.5-mile zone around Isle Royale in Lake Superior, which is controlled by the federal government by virtue of the entire island being a national park.

9. Learning from Offshore Wind Energy Proposals in Other States

Michigan has an important opportunity to learn from the experiences of other offshore wind energy developers. Several offshore wind projects are in operation in Europe and many projects are under consideration here in the United States (see Table 4). By examining these offshore wind projects, Michigan will be in a better position to manage the technical, regulatory, environmental and social issues that arise.

In 2001, Cape Wind Associates, LLC (Cape Wind) became the first developer in the United States to apply to the Army Corps of Engineers for the necessary environmental permits to site an offshore wind energy project. The wind park is proposed for Horseshoe Shoal, five miles off Massachusetts' Cape Cod shore. Plans include up to 130 turbines, spread over 24 square miles and generating a maximum output of 420 MW.[56] The developer claims that during average winds the turbines will supply 3/4 of the Cape's and surrounding islands' power needs.[57] According to Cape Wind, the project will cost more than $800 million and will provide jobs and other economic benefits to Rhode Island and Southeastern Massachusetts.

The project took a major stride forward in November 2004 with the release of a mostly favorable Draft Environmental Impact Statement (DEIS) by the Army Corps of Engineers. The report, three years in the making, says the project would do little or no harm to fish, birds, or the surrounding seafloor, and would not decrease local property values.[58] In addition, the report

[56] Cape Wind development Web site. http://www.capewind.org.
[57] Ibid.
[58] The DEIS report publication launched a public comment period, which was extended to February 24, 2005. After comments are reviewed, significant new issues will be investigated and the EIS will be modified as needed. The final EIS, containing the Corps' responses to comments received on the DEIS will be published and distributed. The Corps indicates, "The decision to issue a permit will be based on an evaluation of the probable impact of the proposed activity on the public interest" (U.S. Army Corps of Engineers, New England District, *Public Notice*, File No. NAE-2004-338-1, November 9, 2004). See http://www.nae.usace.army.mil.

states navigation would not become more hazardous under normal weather conditions and the project would improve public health by generating energy without emitting pollutants.[59]

While considerable progress has been made with respect to the Cape Wind project, including completion of the DEIS and the installation of a meteorological tower, the project has faced several hurdles.[60]

While several environmental organizations support the Cape Wind project, including Greenpeace, Sierra Club, and the Union of Concerned Scientists, many landowners support the legal challenges based on concerns about potential negative impacts on the ocean floor and marine and avian life, as well as concerns about the installations interfering with ocean views. Thus, the often quoted public reaction to energy facility siting, "not in my backyard" (NIMBY), has a new variation, "not near my beach". Overall, the Cape Wind project has suffered from a lack of political support. An April 2004 report by the U.S. Commission on Ocean Policy called for sweeping new federal regulations, to govern developments that many fear, if left unchecked, will encroach on shorelines. U.S. Senator John Warner (R-VA), Chairman of the Senate Armed Services Committee, introduced but then later withdrew a proposed amendment to a defense spending bill, that would prohibit offshore wind projects from moving forward until Congress establishes new requirements and regulations for them. It is reported that Senator Warner's family owns property with a view that might be affected by the Cape Wind project.[61]

There are several take-aways from the Cape Wind project that Michigan should consider. One is that view-sheds are important. Some residents have compared the siting of the Cape Wind project to the siting of a wind energy project in Yellowstone National Park, arguing that Nantucket Sound has national historic and scenic relevance. One can certainly imagine similar arguments made by Michiganders. Technology that allows for siting in deeper waters further from shore could reduce or possibly even eliminate such aesthetic concerns and would also have the added benefit of allowing generator placement where there are higher average wind speeds. Technologies for siting wind turbines in deep water still must be tested, however (see p. 16).

As projects are pursued, community involvement is critical. Cape Wind's developers, in conjunction with the Massachusetts Technology Collaborative, undertook an extensive stakeholder process. More than 40 key individuals participated in this dialogue, representing the interests of the Cape and islands as well as non-governmental organizations, state and federal agencies, and elected officials.[62] The objective of the process was not necessarily to achieve

---

[59] Daley, Beth. (2004, November 8). "Report Sees Few Drawbacks On Wind Farm". *Boston Globe.*
[60] A lawsuit filed by the Alliance to Protect Nantucket Sound challenged the U.S. Army Corp of Engineers' decision to permit the meteorological tower. Another, brought by Ten Taxpayer Citizens Group, challenged the construction of the meteorological tower on the grounds that Cape Wind did not obtain the necessary permits under state law. See Dennehy, Kevin, February 15, 2005, "Court rules in favor of data tower," and Leaning, John, November 26, 2004, "Cape group appeals wind farm case,"*Cape Cod Times;* http://www.capecodonline.com/special/windfarm/.
[61] See Motavalli, Jim, October 12, 2004, "Commentary: Fresh Air for Cape Wind," *E Magazine*; http://www.emagazine.com/view/?2086.
[62] Cape & Islands Offshore Wind Stakeholder Process, from Massachusetts Technology Collaborative; http://www.mtpc.org/offshore/index.htm.

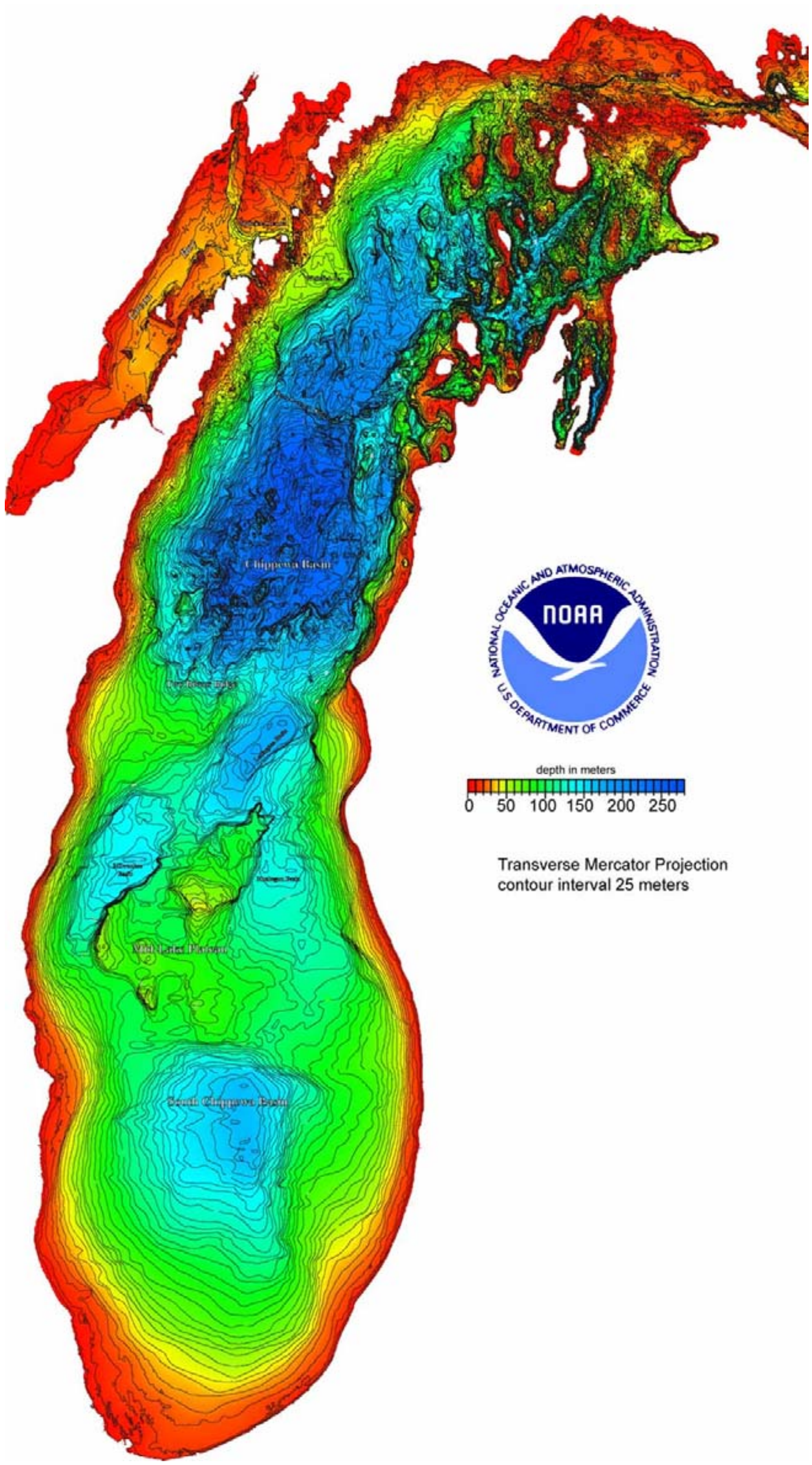
consensus but to help decision makers and average citizens participate in the permitting process in an informed manner. Early participation from the public, and processes that seek the establishment of shared objectives and common interests, will be important to the siting of offshore wind energy in Michigan.[63]

Across the Atlantic, European developers of offshore wind energy have benefited from greater political support for renewable energy. The lesson for Michigan and the other Great Lakes states and provinces is that sound energy policies provide the necessary political framework for developing offshore energy projects. Because of this support, developers in Europe have faced fewer legal challenges.[64] Governments in Europe have also helped developers by establishing "zones for development", based on resource potential and other considerations such as access to the grid. Finally, European projects have showed that financial support for demonstration projects is critical because such projects speed up the initial research stages and regulatory approval processes.[65]

---

[63] As Michigan project developers can already attest, these lessons regarding local objections and the difficulty of achieving consensus apply to the siting of practically all large scale energy infrastructure projects, on land or water.
[64] Ram, Bonnie, Energetics Corp. (2004, October 5). *Offshore Wind Developments*, Presentation to MREP and Michigan Wind Working Group. See http://www.michigan.gov/eoworkshops.
[65] Ibid.

Figure 6: Bathymetry of Lake Michigan



Source: National Oceanic and Atmospheric Administration, www.ngdc.noaa.gov/mgg/greatlakes/greatlakes.html.

Table 3: Selected Federal Regulations

Legislative Authority	Major Program/Permit	Lead Agencies
Rivers and Harbors Act – Section 10	Prohibits the obstruction or alteration of navigable water of the U.S without a permit	U.S. Army Corps of Engineers (District Office)
National Environmental Policy Act (NEPA)	Requires submission of an environmental review for all major federal actions that may significantly affect the quality of the human environment	U.S. Army Corps of Engineers (District) President's Council on Environmental Quality
Coastal Zone Management Act	Requires determination of consistency with the coastal program of the affected state	NOAA State Coastal Zone Management Agencies
Navigation and Navigable Waters	Navigation aid permit (markings and lighting)	U.S. Coast Guard
Navigational Hazard to Air Traffic	Determination of the safe use of airspace from construction start (lighting)	U.S. Federal Aviation Administration (Regional Administrator)
Migratory Bird Treaty Act	Requires determination of no "taking" or harming of birds	Fish and Wildlife Service Migratory Bird Conservation Commission
National Historic Preservation Act	Consultation on the protection of historic resources — places, properties, shipwrecks	Department of the Interior State Historic Preservation Offices
Magnuson-Stevens Fishery Conservation & Management Act	Conserves & manages fish stocks to a 200-mile fishery conservation zone & designates essential fish habitat	National Marine Fisheries Service
National Marine Sanctuary Act (Title III)	Designates marine protected areas	National Ocean Service (NOAA)
Endangered Species Act	Consultation on action that may jeopardize threatened & endangered (listed) species or adversely modify critical habitat	Fish & Wildlife Service National Marine Fisheries Service
Marine Mammal Protection Act	Prohibits or strictly limits the direct of indirect taking or harassment (Permits may be sought for "incidental take")	Fish & Wildlife National Marine Fisheries Service
Submerged Lands Act	Grants a lease for public lands held in trust by the government	Minerals Management Service (Does not apply in Great Lakes)
Outer Continental Shelf Lands Act	Manages the OCS with leasing rights for minerals production. Also covers artificial islands, installations, and other devices located on the seabed	Minerals Management Service (Does not apply in Great Lakes)
Clean Water Act	Regulates discharges of pollutants into the waters of the United States	U.S. Environmental Protection Agency
Estuary Protection Act	Conserves estuarine areas	Fish and Wildlife Service

Source: Ram, Bonnie, Energetics Corp. (2004, October 5). *Offshore Wind Developments*, Presentation to MREP and Michigan Wind Working Group. See www.michigan.gov/eoworkshops.

Table 4: Proposed U.S. Offshore Wind Projects

Applicant	Project Location	Applications Filed[2]	Status
Cape Wind[1] http://www.capewind.org	Nantucket Sound	Nov. 2001	Waiting for final EIS
Bald Eagle Power[1] http://www.baldeaglepower.org	Off New York State, in federal waters.	May 2002	Adapting application based on new plans for hydrogen production
Florida Power and Light http://www.fplenergy.com	Long Island Sound	Not yet filed	See also http://www.lipower.org/cei/wind.rfp.html
Greenlight	Lake Erie	May 2003	On hold
Winergy[1,3] http://www.winergyllc.com	Baltimore District,[4] 2 sites in federal waters	Not yet filed	In pre-application process
Winergy[1]	New England District, 2 in federal waters, 1 in state waters	May 2003	Public hearings completed. Applicant put on hold.
Winergy[1]	New York District, 5 in state waters, 1 in federal waters	July 2001[5]	Pre-application meeting completed. Expect to have public notice of application by May 2005 for a new site.
Winergy[1]	Norfolk (VA) District, 1 in state waters	July 2003	Finished public hearings in August 2003. Expect to reapply for new site, based on public hearing input and comment, in May 2005.
Winergy[1]	Philadelphia District, 5 in federal waters	Not yet filed	In pre-application process

Source: Initial listing from Ram, Bonnie, Energetics Corp. (2004, October 5). *Offshore Wind Developments*, Presentation to MREP and Michigan Wind Working Group. See www.michigan.gov/eoworkshops.

Note:
[1] Information updated based on personal communications with Applicants, March 2005.
[2] Month application was filed with U.S. Army Corp of Engineers.
[3] Winergy has planned a development in New Jersey waters. NJ Acting Governor Richard Codey established by Executive Order, 12/23/04, a 15-month moratorium on offshore wind development, until completion of a cost-benefit study. Also, legislation introduced in New Jersey, in January 2005, would impose a 7-year moratorium on offshore development. See http://www.state.nj.us/cgi-bin/governor/njnewsline/view_article.pl?id=2286 and http://www.njleg.state.nj.us/2004/Bills/S2500/2174_I1.HTM.
[4] Districts refer to U.S. Army Corps of Engineers District offices.
[5] New York and California are "designated states," which means their state agencies have been designated, by the Army Corps of Engineers, to handle the application process.

10. Recommendations for Michigan

1. **Resource Assessment:** Michigan stakeholders should identify some specific geographic areas for further study. This identification will combine detailed data from the best information about all "exclusions" (e.g., water depths, wind speeds, marine and avian wildlife habitat, fisheries, recreation including boating, commercial navigation, archeological sites, etc.) to identify a few small areas for study, and invite proposals for meteorology. Completing this project will require the temporary placement of 50-70 meter, or perhaps event taller, towers at one or more promising sites. Wind project financiers require 12-24 months of wind data before making a commitment to a wind project. Engineering studies should also be performed of the impacts and specific challenges of various options for installing wind tower foundations in or over the lakebeds of the Great Lakes.

2. **Interstate Coordination:** The State should coordinate efforts with other Great Lakes states' regulatory and other interested agencies.[66] As a preliminary step, Michigan's Wind Working Group is encouraged to develop a list of the appropriate contacts in the other Great Lakes states and Canadian provinces.

3. **Stakeholder Outreach:** Michigan should begin to facilitate discussions between wind developers, recreation and sporting groups, communities, and other parties that may be affected by offshore wind development.

4. **Permit Streamlining**: With fewer overlapping jurisdictions than for land-based wind projects, offshore permitting should, in theory, be simpler. The State should work to put together a one-stop shop for developers interested in further investigating the possibilities of Michigan offshore wind development.

   Attempting to specify all of the required permitting guidelines and procedural details for siting offshore wind generators is premature. However, establishing a process for siting structures needed to obtain meteorological data, and then carefully monitoring their effects, will provide a great deal of information that will ultimately prove useful in developing generator siting guidelines and procedures.

5. **Turbine and Equipment Manufacturing**: With Michigan's easy access to water transport and large installed industrial base, our state is positioned to become a major manufacturing center for wind turbines and related components, especially offshore turbines too large for overland transport. The State should make a concerted effort to attract turbine and other wind equipment manufacturing by European- and US-based

[66] Interest has already been expressed by state agencies in Wisconsin and Ohio. Plans are already underway to host a wind energy conference in Michigan in fall 2005. For more information, contact the Michigan Wind Working Group (see http://www.michigan.gov/eorenew).

turbine makers. Based on preliminary indications from wind turbine manufacturers, state policies to increase wind energy sales, such as a renewable portfolio standard, may be a prerequisite for Michigan to compete successfully for the attraction of wind energy manufacturing.[67]

[67] See footnotes 41, 42 and 43, p. 12.