



7870 Olentangy River Road, Suite
304
Columbus, OH 43235
ph. 614.985.6131; fax 614.888.9716

July 30, 2010

Via E-Mail: chrisriddle@ameritech.net

Mr. Chris Riddle
Environmental Specialist
Ohio Lake Erie Commission
One Maritime Plaza, 4th Floor
Toledo, Ohio 43604-1866

RE: Final Report for Great Lakes Tall Tower Wind Monitoring Project – Lake Erie Project
Lake Erie Protection Fund Award – SG 362-09

Dear Mr. Riddle:

Enclosed please find Green Energy Ohio's (GEO) final report for the Lake Erie Protection Fund Award – SG 362-09. Included as an attachment to this report is GEO's technical Wind Resource Assessment Report which summarizes the findings of our 12-month wind monitoring study conducted in Lorain, Ohio. This project, titled the "Great Lakes Tall Tower Wind Monitoring Project" was funded by grants from the Ohio Lake Erie Commission and the U.S. Department of Energy (via the Wisconsin Public Service Commission). Also enclosed is an Abstract.

GEO is grateful for the financial support received by the Ohio Lake Erie Commission – without it, this project would not have been financially feasible.

The Final Accounting Report will be provided under separate cover.

Please contact me at 216-789-5248 or Kemp@greenenergyohio.org if you have any questions or need additional information.

Sincerely,

A handwritten signature in blue ink that reads "Kemp E. Jaycox".

Kemp E. Jaycox
Wind Program Manager

Enclosures (3)



7870 Olentangy River Road, Suite 304
Columbus, OH 43235
ph. 614.985.6131; fax 614.888.9716
www.greenenergyohio.org

ABSTRACT

To: Mr. Chris Riddle, Environmental Specialist, Ohio Lake Erie Commission

From: Kemp Jaycox, Wind Program Manager, Green Energy Ohio

Date: July 30, 2010

**Re: Great Lakes Tall Tower Wind Monitoring Project – Lake Erie Project
Lake Erie Protection Fund Award – SG 362-09**

In April 2009, Green Energy Ohio (GEO) received a grant from the Ohio Lake Erie Commission to supplement a grant from the U.S. Department of Energy for the Great Lakes Tall Tower Wind Monitoring Project. The goals of this project were to evaluate the near-shore wind resource, compare the resource to data taken previously by GEO offshore at the Cleveland Water Intake Crib, and to help spur in-lake or near-lakeshore wind development near the monitoring site. Measurements were collected at approximately 51, 73 and 93 meters (168, 238 and 305 feet, respectively) above the ground surface using a communication tower at the FirstEnergy Power Plant in Lorain. Data were collected and analyzed between May 19, 2009 and May 31, 2010.

Results show the Lorain site is categorized as a class 1 wind site based on a 51 m yearly wind speed average of 10.7 mph (4.8 m/s) and a yearly average wind power density of 109.9 Watts/m². Wooded areas and plant buildings surrounding the tower affected wind speeds. Comparison to a long term reference site showed that the monitoring period was a low wind speed period; a normalized 51 m annual average wind speed of 11.8 mph (5.3 m/s) was calculated, which still classifies the site as a class 1 wind site. Data from the Lorain site were much lower than data collected offshore at the Crib, as expected. When compared to other near-shore and inland locations measured by GEO, the Lorain wind speeds were similar or lower.

While the wind data from this Project were not as high as we expected given the tower is located 0.5-mile from Lake Erie, the Project still provided important data at wind turbine hub heights that was previously lacking for this part of the state. The results should not deter developers from planning wind projects in Lorain County. Instead, these results provided a reminder that wind energy projects need to be sited properly to be economically successful. Based on wind resource maps for Ohio, there likely are other more open locations in Lorain County and along Lake Erie that would be more suitable for wind energy projects than in the immediate vicinity of the monitoring site for this project.



*Great Lakes Tall Tower Wind Monitoring Project
Lake Erie Project
Final Report
Lake Erie Protection Fund Award – SG 362-09*

Prepared for:

Ohio Lake Erie Commission
One Maritime Plaza, 4th Floor
Toledo, OH 43604

Prepared by:

Green Energy Ohio
Emily Sautter, Wind Program Coordinator
Kemp Jaycox, Wind Program Manager
7870 Olentangy River Road, Suite 304
Columbus, OH 43235

July 30, 2010

Executive Summary

Green Energy Ohio (GEO) received a grant from the U.S. Department of Energy (DOE) in November 2008 to conduct a wind resource assessment study on an existing tall communication tower. The grant was part of the Great Lakes Tall Tower Wind Monitoring Project and included one study near Lake Erie and one study near Lake Michigan. GEO applied for and received a grant from the Ohio Lake Erie Commission in April 2009 as part of the Lake Erie Protection Fund to supplement the DOE grant budget. Without the Lake Erie Commission grant, the project would not have been feasible.

The goals of the project were to evaluate the near-shore wind resource, compare the resource to data taken previously by GEO offshore at the Cleveland Water Intake Crib, and to help spur in-lake or near-lakeshore wind development near the monitoring site. To accomplish these goals, wind monitoring equipment was installed on a 104-meter (342-foot) microwave communication tower at the FirstEnergy Power Plant in Lorain, Ohio. Measurements were collected at approximately 51, 73 and 93 meters (168, 238 and 305 feet, respectively) above the ground surface. Data were collected and analyzed between May 19, 2009 and May 31, 2010.

The project involved many steps and stakeholders in order to find a suitable tower to meet the DOE grant requirements, get permission from the tower owner to lease space, install the wind monitoring equipment, and collect and analyze the data. Several lessons were learned throughout the project. This report documents these activities and outcomes. A separate technical report was created by GEO to summarize the wind data collected and analyzed from the site and is provided as Attachment A.

The report also provides an overview of the wind energy industry in Ohio to provide context for the importance of this study and other wind resource assessment initiatives. Ohio currently generates approximately 90% of its electricity by combusting coal, which leads to significant air, water and land pollution, and contributes to climate change. Furthermore, billions of dollars are spent each year importing coal from nearby states¹. Having a more diverse energy portfolio is good for our economy, our political stability and the environment, especially when clean, renewable sources such as wind and solar are added to our energy mix. With a unique combination of policies and incentives, as well as Ohio's strategic position in the wind supply chain, the wind industry in Ohio is helping provide a boost to Ohio's economy.

¹ U.S. Energy Information Administration.

Green Energy Ohio

GEO is a statewide non-profit organization whose mission is to promote environmentally and economically sustainable energy policies and practices. In addition to our education and outreach initiatives, we provide consulting services for the wind industry including wind resource assessment and wind turbine feasibility studies. GEO manages the Ohio Anemometer Loan Program and has conducted wind resource assessment studies at over 20 locations throughout Ohio through our Monitoring Ohio Wind Program. Data and reports from our studies are added to our Public Wind Database for developers, consultants, property owners and others to access to evaluate the local wind resource. Our studies help Ohio businesses, schools, hospitals, port authorities and other non-profit and public entities with making important decisions about investing in and proceeding with wind turbine development projects.

One of GEO's first studies occurred in 1999-2000 near Bowling Green and led to the state's first utility-scale wind turbines located southwest of the City of Bowling Green. Another important study took place during 2005-2007 offshore at the Cleveland Water Intake Crib. Data from the Crib study were used in 2009 by a consultant (juwi/JW Great Lakes Wind) who determined it is technically feasible to install wind turbines in Lake Erie. In 2010, the Lake Erie Energy Development Corporation (LEEDCo) was formed and is working to initiate a 20 MW offshore pilot project and promote Cleveland as a manufacturing, assembly and installation hub for offshore projects. Several of GEO's monitoring sites received grants from the American Recovery and Reinvestment Act in December 2009 and are proceeding with commercial-scale wind turbine development projects.

One of the goals of this Project in Lorain was to provide wind data for an area of the state that until now had little to no wind data at utility-scale wind turbine hub heights (70 to 100 meters). The Project was also intended to help spur in-lake or near-lakeshore wind development near the monitoring site.

Wind Energy Industry in Ohio²

Wind power is the fastest growing source of electric power in the U.S. today. Ohio has been slow to follow this trend, but with the passage of the Advanced Energy Portfolio Standard (AEPS) on May 1, 2008 (Senate Bill 221), wind power development in Ohio is likely to increase significantly. SB 221 requires the state's four investor-owned utilities to generate 12.5% of their electricity from renewable sources such as wind, solar, biomass, etc. by the year 2025. Given that Ohio is a very large consumer of electricity, a significant amount of electricity needs to be generated from renewable sources to meet SB 221 requirements. A carve out was created to ensure solar power projects have a market in Ohio; however, wind power projects will likely generate the majority of electricity to meet SB 221 requirements.

The initial six years of operation at Ohio's first utility scale wind farm, located near Bowling Green, as well as single turbine installations at businesses and schools, have proven that wind power projects can be successful in Ohio. With the passage of Ohio's AEPS, over 15 wind developers are working throughout Ohio to develop projects. In March 2010, the first three utility-scale wind farms were approved by the Ohio Power Siting Board (OPSB). Construction for these projects will likely begin in late 2010 to early 2011. Four additional

² This section is intended to provide context for the importance of this study and other wind resource assessment initiatives being conducted throughout Ohio.

projects are pending approval from OPSB. Once on-line, these projects will generate over 1,100 MW of electricity, enough to power approximately 240,000 average size residences.

The OPSB has jurisdiction over any wind project 5 MW or greater. Comprised of representatives from several state agencies, the OPSB is intended to streamline the siting process for wind developers. Projects smaller than 5 MW are subject to local zoning approval.

With Ohio's economy reeling from the recent recession, the decline of the automotive industry and the loss of hundreds of thousands of manufacturing jobs, the wind energy industry serves as an opportunity to create thousands of much-needed jobs. These jobs include manufacturing jobs for turbine parts and components and construction jobs for installation projects. Other sectors of the economy that are benefitting include developers and consultants who design, plan and manage projects, technicians who will service and maintain turbines over the long term, and local restaurant, hotel and business owners who benefit temporarily during construction activities.

Ohio is a major supply chain state for the wind industry. As of May 2010, there are approximately 175 manufacturing businesses in Ohio that are actively making various wind turbine parts and components. The Great Lakes Wind Network, based in Cleveland, matches Original Equipment Manufacturers with suppliers throughout Ohio and the world to ensure parts and components can be made and assembled in a timely and cost effective manner in order to keep turbine orders on time and within budget.

Making sure there are enough skilled technicians who can properly service and maintain the 39,000 plus turbines that are currently operating is critical. Lorain County Community College graduated its first class of technicians in May 2010. Other Ohio schools are rushing to add wind energy to their curriculum to train the next technicians, engineers and other wind energy professionals.

Financially, the Ohio Department of Development plays an important role by offering grants for wind turbines installed at residential and commercial properties. Coupled with the federal 30% tax credit, many incentives are available to make wind power projects financially feasible.

In summary, Ohio plays a critical role in the wind industry by serving as a major supply chain state, while state policies and incentives are providing a supportive framework to foster the development of wind power projects within the state.

Project History

In 2005, GEO partnered with three other states, Wisconsin, Indiana and Michigan, to conduct a "Coastal Tall Towers Wind Monitoring Project" using a grant from the U.S. DOE. Unfortunately, the grant money was held up in Wisconsin for 2.5 years and staff turnover at the Public Service Commission (PSC) complicated getting the money released. From 2007-2008, GEO worked to resurrect the grant money. By this time, Indiana and Wisconsin were no longer interested in conducting the studies; though the grant money remained at the Wisconsin PSC. Finally by fall of 2008, the grant money was released to GEO and an organization in Michigan. Unfortunately, GEO's original allocation was cut in half. Therefore, GEO began its efforts to find additional grant monies to make the project financially feasible and a find usable tower to lease at a nominal rate.

Summary of Activities

The following tasks were completed during the Project. More detailed summaries were provided in previous quarterly reports submitted to the Ohio Lake Erie Commission and the Wisconsin PSC.

- Searched for suitable towers that met DOE grant requirements (i.e., at least 100 meters tall and located within 0.5 mile of Lake Erie). The tower had to have space available for GEO's wind monitoring equipment and the tower owner had to be willing to lease space for a nominal fee (January 2008 through April 2009)
- Lease agreement signed with tower owner First Telecom Services (3/20/09).
- Structural analysis of tower performed by Paul J. Ford & Company (4/2/09).
- Matching grant obtained from Ohio Lake Erie Commission (April 2009).
- Applied for second matching grant from Lorain County Community College (April 2009); grant request denied.
- Requested matching funds from City of Lorain, Lorain County and two Lorain County wind industry businesses; requests denied due to lack of funding in their budgets as a result of the economic recession.
- 18-foot booms fabricated by Advance Design Industries, Inc. (May 2009).
- Discussed equipment installation and mounting hardware requirements with Tri County Tower (April-May 2009).
- Equipment preparation, calibration and ordering (April-May 2009).
- Monitoring equipment installed on tower in Lorain by Tri County Tower & GEO (5/18 & 5/19/09).
- Data collection and analysis (May 2009 through May 2010).
- Quarterly reports summarizing wind data analysis prepared and submitted to OLEC, Wisconsin PSC and other project stakeholders.
- Equipment removed from tower by Tri County Tower (6/8/10).
- Anemometers shipped to OTECH laboratory for post-calibration.
- Year-long data analysis conducted and final reports prepared for OLEC, Wisconsin PSC and other project stakeholders (June and July 2010).

Deliverables / Outcomes

The following deliverables were generated for this project and were provided previously under separate cover to OLEC and Wisconsin PSC.

- Structural analysis report by Paul J. Ford & Company – The report analyzed the tower's equipment load before the study and provided an opinion regarding whether or not the tower could physically support the addition of the wind monitoring equipment.
- Photos of installation activities and the area surrounding the tower.
- Site Specification Log – This document contained information about the site, property owner, tower location, and the type, serial numbers and orientation of sensors. The log was also used to document any data issues or repairs made during the study.
- Quarterly reports – These reports summarized data analyzed for the referenced time period (e.g., average wind speed, power density, wind shear and turbulent intensity).

- Final summary report – The technical report summarized data collected for the entire study period and provided projected energy production estimates using various wind turbine models (see Attachment A). GEO also created this non-technical report for OLEC.
- Public Wind Database – The technical report and wind data from this Project will be added to GEO's Public Wind Database.

Data from GEO's studies have been used by AWS Truepower and the National Renewable Energy Laboratory (NREL) to validate Ohio's wind maps. These maps serve as a critical resource for individuals, businesses and developers to evaluate the local wind resource prior to proceeding with an actual wind monitoring study or wind turbine installation. Data collected from this study will be shared with AWS, NREL and other key stakeholders. The data will also be added to GEO's public wind database, the only public wind database in Ohio. Wind developers and interested stakeholders can obtain copies of the data and reports for this project and over 20 other test sites in Ohio.

Data collected during this study was compared to data that GEO collected off-shore at the Cleveland Water Intake Crib from 2005-2007, as well as other near-shore and inland locations and a long term reference site. Such data provided insight into how the wind resource changes from on-lake to on-shore, as well as, how the wind resource for the study period compares to several decades of wind data collected at much lower heights. The long term goal of the project is to support wind energy and sustainable economic development efforts in northern Ohio, particularly in Lorain County and other near-shore areas of Lake Erie.

The success of our project was partially based on the total percentage of data recovered (98.1%³), how well the data correlated with the long term reference site (R^2 value of 0.73⁴), and if the data suggest that the local wind resource is strong enough to support a wind turbine development project⁵.

Challenges / Lessons Learned

GEO staff practiced being patient and persistent *many* times throughout this Project, especially given the delays with getting the DOE grant money released. Finding a tower at least 100 meters tall and located within 0.5 mile of Lake Erie whose owner was willing to provide tower space gratis or for a nominal charge was also a major challenge. Many tower owners were unwilling to work with GEO and/or were not interested in spending their time helping an organization that would provide them with little to no rent income.

GEO spent a lot of time in 2008 trying to secure a tower in Oregon, Ohio after the City of Oregon expressed a strong interest to participate in the project and provided some funds to help offset tower commissioning expenses. At the request of the tower owner, GEO paid for a structural analysis study and spent countless hours working with a representative of the tower owner. After that individual left the company and GEO had already invested a great deal of time and money, the tower owner decided not to allow GEO space on the tower. The donation was returned to the City of Oregon.

³ All data losses during this project resulted from icing events.

⁴ Empirical studies have shown that an R^2 value ≥ 0.70 is indicative of a sufficient fit for using the reference site for normalization of data to a historical trend

⁵ Refer to the Conclusions section for additional comments.

Using contacts in Lorain County, we were able to secure the use of the tower at the FirstEnergy plant in Lorain. However, it took six months to negotiate a lease agreement with the tower owner, First Telecom Services, while we had budgeted for the process to take two months.

The tower in Lorain met the DOE requirements but was not ideal for other reasons: the presence of large microwave dishes and associated equipment forced us to invest in longer booms to mount our monitoring equipment (we had planned to use 12-foot booms from our equipment inventory). Furthermore, the tower is surrounded by wooded areas, FirstEnergy plant buildings and a vacant Ford plant. These obstructions affected wind speeds and resulted in high turbulent intensity values. Higher turbulent intensity results in more stress on turbine components and less efficient energy conversion. Furthermore, the wind speeds measured and normalized for the site (10.7 to 11.8 mph at a height of 51 m) were found to be lower than those predicted by the Ohio Wind Resource Map (12.3 to 13.4 mph and a wind power density of 200 to 300 Watts/m² at 50 m).

GEO attempted to obtain additional funds to supplement the Project's budget but unfortunately our efforts were not successful. The economic recession made asking for money very difficult, especially at a time when municipalities were trying to minimize staff layoffs. Because of our budget challenges, GEO took steps to be resourceful including providing monitoring equipment and cables that were used during previous studies. In hind sight, we should have invested in new anemometers to avoid the Dry Friction Whip issue that affected two of our sensors (refer to the technical report for more information).

In the future, GEO will budget more time for finding an ideal monitoring location, negotiating a lease agreement with the tower owner, and addressing other due diligence issues prior to installing wind monitoring equipment on an existing tower. GEO will also continue to work with and rely on our GEO members and key contacts to initiate and complete wind projects throughout the state. While being resourceful for this project was a necessity, GEO hopes economic conditions will improve thereby making it easier for similar studies to be conducted in other parts of the state in order to support wind energy development efforts.

Conclusions

While the wind data from this Project was not as high as we expected, the Project still provided important data at wind turbine hub heights that was previously lacking in this area of the state. The results should not deter developers from planning wind projects in Lorain County. Instead, these results provided a reminder that wind energy projects need to be sighted properly to be economically successful. Based on wind resource maps for Ohio, there are other more open locations in Lorain County and along Lake Erie that would be more suitable for wind energy projects than in the immediate vicinity of the monitoring site for this project. Wind energy has a bright future in Ohio even though our wind resource is moderate compared to other states.

Attachment A: GEO's Wind Resource Assessment Report