FINAL REPORT

DOE Field Verification Program for Small Wind Turbines

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NY/NJ DISTRIBUTED WIND POWER FIELD VERIFICATION PROJECT

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Executive Summary

Since the available funds for this project have been exhausted, the DOE has instructed AWS to cease quarterly reporting as of 2 July 2003. This report summarizes the overall performance of the four turbines installed under this program and is submitted to the DOE as a Final Report. All host sites have been notified that the maintenance, monitoring and reporting of their sites has terminated as of 2 July 2003. Discussions are underway with the Long Island Power Authority to provide funding for the continued maintenance and reporting of the Southampton College and Town of Brookhaven turbines.

During the course of this study, AWS found three out of the four turbines installed to perform in accordance with the manufacturer's projections. AWS worked with the manufacturer in solving the underperformance issue of the third turbine. Additionally, AWS found the data recovery rates and turbine availability to be exceptional for each of the turbines.

Background

AWS is one of five companies to receive a grant under the US Department of Energy's Small Wind Turbine Field Verification Program. As part of the NY/NJ Distributed Wind Power Field Verification Project, AWS installed four 10 kW Bergey Excel S wind turbines. Host sites for the program include Liberty Science Center in Jersey City, NJ which hosts over 2 million visitors each year, Southampton College Campus of Long Island University, the Town of Brookhaven Town Hall in Farmingville, NY, and a farm located in Webster, NY. AWS' responsibilities included system design, specification, procurement, permitting, construction, operation and maintenance (O&M), performance monitoring, and training host personnel in the conduct of operation, maintenance and monitoring activities after the conclusion of the three-year program.

Webster, NY

This first turbine installed under this program was a 10 kW Bergey Excel-S mounted on a 120 ft guyed lattice tower located at the Bechtold residence in Webster NY. Offshore Services of Rhode Island installed this turbine in June of 2001 with assistance from AWS Scientific staff. The average annual wind resource measured at this site is about 5.2 m/s (11.6 mph) and the installed cost of this system was approximately $56,000.

The siting process for this turbine began during the summer of 2000. The property, which is located close to the shores of Lake Ontario, has great exposure to the prevailing wind and was home to an existing 2.5 kW turbine on a 100-foot guyed lattice tower. The site is reasonably close to electrical service for interconnection and is a good distance from property lines and dwellings. Additionally, this site provided easy access for the crane. A 120-foot guyed lattice tower was specified for this site to maximize the turbine's exposure to the prevailing wind and increase annual energy production.

Being that the landowner held a permit for an existing 2.5 kW turbine on a 100-foot tower, it was initially thought that a new building permit would not be required for this installation. However, it was later determined that the local authority would require a new permit as this was a larger turbine on a taller tower. Thus, in attempt to acquire the necessary building permit, the landowner attended planning board meetings and public hearings during the winter of 2000-2001. Concerns regarding noise emissions, aesthetics, avian mortality and safety were raised by the planning board. The landowner successfully navigated these meetings by educating the planning board and the public as to the positive attributes of wind energy. Statistics and literature from the American Wind Energy Association were used as evidence to dispute any erroneous information and concerns. A building permit was issued for this installation in the spring of 2001.

The foundation installation for this project began in July 2000. Both the foundation and electrical work were subcontracted to a local contractor and the installation of this turbine installation began in late-May 2001. The installation took approximately two and a half days to complete. During this installation, the weather and soil conditions were favorable.

Lessons Learned

Permitting was shown to be the biggest obstacle for this turbine. Requesting a preliminary meeting with the local authority to determine what information will be required is key. Prior to any public meetings it is best to be well versed in all aspects of small wind energy systems. Bring with informational handouts that address the typical concerns regarding wind energy systems. These concerns are often regarding noise emissions, aesthetics, birds, radio frequency interference, safety and ice shed.

Liberty Science Center, NJ

The Liberty Science Center wind turbine is a 10 kW Bergey Excel-S mounted on a 120 ft self-supporting tower. Offshore Services of Rhode Island installed this turbine in April of 2001 with assistance from AWS Scientific staff. The average annual wind resource at this site, as projected by the New Jersey State Wind Map, is about 4.5 m/s (10 mph). This turbine was co-funded by the Department of Energy and the Liberty Science Center. The installed cost of this system was approximately $80,000.

The siting process for the Liberty Science Center wind turbine began in the summer of 2000. The site has a reasonable exposure to the prevailing wind and is about 350 feet from the point of interconnection. The proximity of the site to a road allowed for easy crane access. A 120 ft self-supporting tower was specified to minimize any land use conflicts resulting from turbine's guy wires.

The foundation installation for this project began in February of 2001. The foundation and electrical work were subcontracted to local union contractors. The foundation took about four days to complete and a few weeks to cure. It is worth noting that the foundation for a self-supporting tower is much bigger than what is typically used for guyed lattice towers and results in higher material and labor costs.

Southampton, NY

The Southampton College wind turbine, located in Southampton NY, is a 10 kW Bergey Excel-S mounted on a 100 ft self-supporting lattice tower. Offshore Services of Rhode Island installed this turbine in May of 2002 with assistance from AWS Scientific staff. The average annual wind resource measured at this site is 5.1 m/s (11.4 mph). This wind resource allowed the turbine to generate roughly 9,500 kWh during its first year in operation. This project was co-funded by the Department of Energy and the Long Island Power Authority (LIPA). The installed cost of this system was approximately $78,000.

The siting process for the Southampton College wind turbine began in the spring of 2001. The site, which is located on the college campus, has good exposure to the prevailing wind and is about 300 feet from the college dormitories. The dormitories also served as the electrical service interconnection point. The topography of this site and its close proximity to a service road provided easy access for the crane. A 100 ft self-supporting tower was specified to minimize the turbine's aesthetic impact and to avoid any land use conflicts.

The permitting for this site was contracted to Inter-Science, a local environmental consultant. This process took approximately 12 months to complete. The local authority required the submittal of detailed site plans, a Professional Engineer stamped analysis of the tower and foundation design and general information regarding wind energy systems. Additionally, the local authority was provided with photo-simulations of the proposed site illustrating its impact upon the local aesthetics.

The foundation installation for this project began in April of 2002. Both the foundation and electrical work were subcontracted to a local civil contractor. The foundation took about four days to complete and a few weeks to cure. It is worth noting that the foundation for a self-supporting tower is much bigger than what is typically used for guyed lattice towers and results in higher material and labor costs.

This turbine was connected to the LIPA utility grid. LIPA, which co-funded this project, provided an inter-tie protective relay. Inter-tie protective relays are commonly required by utilities as an additional safety measure when interconnecting distributed generation equipment. Additionally, LIPA requested an electric service disconnect be installed on the outside wall of the dormitories.

Lessons Learned

For budgetary and planning purposes, it is important to investigate the permitting process thoroughly and early in the process. In this instance, permits were granted one year after the applications were filed. For many, a lengthy process such as this can be both expensive and time consuming.

The power-processing unit used for this installation is now recognized by the New York State Public Service Commission as ‘Type Tested’ and approved for interconnection. This means that Bergey Excel installations similar to the Southampton turbine are no longer required to use an inter-tie protective relay.

Another lesson learned from this site is that modern wind turbines produce very little sound and can peacefully operate near dwellings. This is evident by the siting of this turbine near the college’s dormitory complex. To date, there have been no complaints by students regarding noise from this turbine.

Brookhaven Town Hall, Farmingville, NY

The Town of Brookhaven’s wind turbine is a 10 kW Bergey Excel-S mounted on a 90 ft monopole tower. Offshore Services of Rhode Island installed this turbine in April of 2003 with assistance from AWS Scientific staff. The average annual wind resource at this site, as projected by the New York State Wind Map, is about 5.1 m/s (11.4 mph). This wind resource will allow the turbine to generate roughly 10,500 kWh each year. This turbine was co-funded by the Department of Energy and the Long Island Power Authority. The installed cost of this system was approximately $75,000.

The siting process for the Town of Brookhaven wind turbine began in the summer of 2002. The wind turbine site is located at the Brookhaven Town Hall. The site has a reasonable exposure to the prevailing wind and is about 50 feet from the point of interconnection. The proximity of the site to a road allowed for easy crane access. A 90 ft monopole tower was specified to minimize the turbine's aesthetic impact and to avoid any land use conflicts resulting from guy wires.

As this turbine was installed on Town of Brookhaven property, the Town reviewed technical information about the wind turbine, tower and interconnection equipment and issued its own permits for this installation.

The foundation installation for this project began in March of 2003. The foundation and electrical work were subcontracted to local union contractors. The foundation took about four days to complete and a few weeks to cure. It is worth noting that the foundation for a monopole tower is much bigger than what is typically used for guyed lattice towers and results in higher material and labor costs.

This turbine was connected to the Long Island Power Authority (LIPA) utility grid. The Town of Brookhaven constructed a shed 50 feet from the base of the turbine to house the electrical interconnection equipment. LIPA reviewed the technical information regarding electrical interconnection equipment specified for this installation. Based upon the technical information and LIPA's previous experience with the Southampton College wind turbine, interconnection approval was granted. LIPA also provided an inter-tie protective relay, which is commonly required by utilities as an additional safety measure when interconnecting distributed generation systems.

Lessons Learned

The equipment used for this installation is now recognized by the New York State Public Service Commission (PSC) as 'type tested' and is approved for standardized interconnection in New York State. This means that all Bergey Excel installations using type tested equipment in PSC governed territory are no longer required to use an inter-tie protective relay. This can reduce the installed cost significantly.

Turbine Performance

The following table shows the comparative quarterly output of each turbine for the duration of the monitoring period.

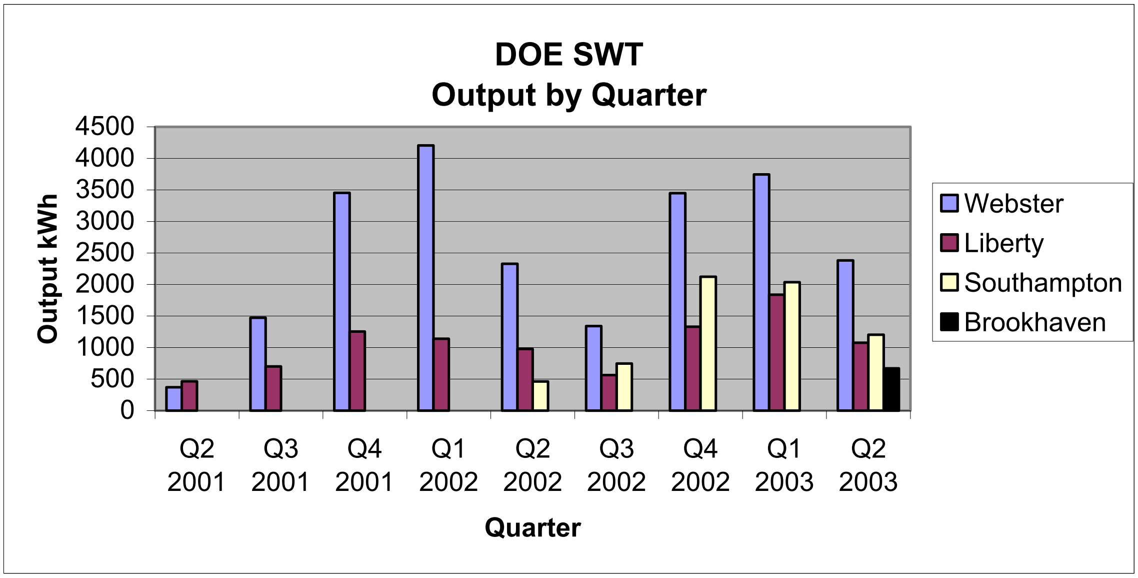

Table 1.

Webster

The Webster NY turbine was in-service for a total of 18,730 hours during the monitoring period that began on 1 June 2001 and ended on 30 June 2003. The wind system achieved a cumulative wind turbine availability of 96.5% with 1,492 hours of turbine down time. Total energy production recorded during the monitoring period was 22,753 kWh for a cumulative capacity factor of 13.1%. The average 37-meter hub height wind speed for the Webster site during the monitoring period was 5.2 meters per second. Additionally, the maximum ten-minute average output recorded during the period was 10.2 kW during a concurrent ten-minute average wind speed of 13.9 meters per second at 30-meters. The Webster turbine continually performed in accordance with, or slightly above, the manufacturer's power curve. A photo of the Webster turbine is shown in Figure 1.

Figure 1.
Turbine installation in Webster, NY

Liberty Science Center

The turbine at Liberty Science Center in Jersey City, NJ was in-service for a total of 19,164 hours during the monitoring period that began on 22 April 2001 and ended on 30 June 2003. The wind system achieved a cumulative wind turbine availability of 98.2% with 1,125 hours of turbine down time. Total energy production recorded during the monitoring period was 9,349 kWh for a cumulative capacity factor of 4.7%. The average 37-meter hub height wind speed for the Liberty site during the monitoring period was 4.3 meters per second. Additionally, the maximum ten-minute average output recorded during the period was 7.6 kW during a concurrent ten-minute average wind speed of 12.6 meters per second at 30-meters. The Liberty Science Center turbine continually performed in accordance with the manufacturer's power curve. A photo of the Liberty Science Center turbine is shown in Figure 2.

Figure 2.
Turbine installation at Liberty Science Center, Jersey City, NJ

Southampton College

The turbine at Southampton College in Southampton, NY was in-service for a total of 9,830 hours during the monitoring period that began on 17 May 2002 and ended on 30 June 2003. The wind system achieved a cumulative wind turbine availability of 98.9% with 48.1 hours of turbine down time. Total energy production recorded during the monitoring period was 6,569 kWh for a cumulative capacity factor of 6.4%. The average 30-meter hub height wind speed for the Southampton site during the monitoring period was 5.1 meters per second. Additionally, the maximum ten-minute average output recorded during the period was 7.1 kW during a concurrent ten-minute average wind speed of 19.1 meters per second at 24-meters. The Southampton College turbine continually under-performed compared to the manufacturer's power curve. In response to this under-performance issue, a representative from Bergey Windpower conducted a turbine blade change on 27 March 2003. Based upon data collected after the blade change, it appears that the blade change had no effect upon turbine performance. Data collected at other Bergey sites has revealed that the under-performance issue is most likely caused by poor blade design. AWS will work with Bergey to resolve the Southampton College underperformance issue at a later date. A photo of the Southampton College turbine is shown in Figure 3.

Figure 3.
Turbine installation at Southampton College, Southampton, NY

Town of Brookhaven

The Town of Brookhaven wind turbine was in-service for a total of 2,128 hours during the monitoring period that began on 3 April 2003 and ended on 30 June 2003. The wind system achieved a cumulative wind turbine availability of 98.5% with 31 hours of turbine down time. Total energy production recorded during the monitoring period was 670 kWh for a cumulative capacity factor of 3.1%. The average 27-meter hub height wind speed for the Brookhaven site during the monitoring period was 4.0 meters per second. Additionally, the maximum ten-minute average output recorded during the period was 4.4 kW during a concurrent ten-minute average wind speed of 9.2 meters per second at 20-meters. During the monitoring period, the Brookhaven turbine performed slightly below the manufacturer's power curve. A photo of the Brookhaven turbine is shown in figure 4.

Figure 4.
Town of Brookhaven, NY Turbine Installation

Conclusions and Recommendations

AWS has provided all host sites with information regarding the scheduled maintenance of their turbines and the contact information of a qualified maintenance technician located within 3 hours of their site. Additionally, the data acquisition systems deployed for this program will remain on site should future monitoring become necessary.

During the course of this project, there were many valuable lessons learned. For budgetary and planning purposes, it is critical to investigate the permitting process thoroughly and early in the process. Prospective turbine owners would do well to consult their neighbors and community early and often during the planning stages of their projects. For many, a lengthy regulatory process can be both expensive and time consuming. Additionally, prospective turbine owners should fully investigate the costs and regulatory requirements of subcontracting various parts of the installation.

Prospective turbine owners would also do well to monitor the performance of their turbines. During the course of this study, underperformance issues were discovered and characterized directly as a result of the data acquisition system employed. The data collected facilitated the troubleshooting of the issue and allowed the manufacturer to consider the appropriate solution.