DOE/Golden Field Office • NREL • National Wind Technology Center

FIELD VERIFICATION PROGRAM FOR SMALL WIND TURBINES

May 2001 QUARTERLY REPORT July–September 2000
3rd Quarter, Issue #2

Field Verification Program Overview

The Field Verification Program (FVP) reports the quarterly status and activities of its five recipients: Windward Engineering; Endless Energy Corporation; Siyeh Development Corporation; Offshore Service, Ltd.; and AWS Scientific, Inc. Electronic documentation can be found on the Field Verification Program Web site at http://www.nrel.gov/wind/field_verification_program.html. One goal of the FVP is to provide U.S. manufacturers with opportunities to verify performance and reliability of their small (0.3–100 kW) wind turbines (SWT). To accomplish this goal, recipients are required to purchase, install, and test a SWT at the National Renewable Energy Laboratory's (NREL's) National Wind Technology Center (NWTC) for safety, performance, noise, and duration. The five recipients are using one of three manufacturer's turbines: Whisper H40, AOC 15/50, or Bergey Excel-S/E 10 kW (Table 1). Windward Engineering is currently testing their Whisper H40 at the NWTC (see profile below). The NWTC already owned an AOC; therefore, Endless Energy Corporation was not obligated to purchase and install another turbine for testing. This turbine is currently undergoing testing at the NWTC, and more information will be provided in future issues of the FVP Quarterly Report. For the quarter ending September 30, 2000, the Bergey Excel-S/E 10 kW has not begun testing at the NWTC due to complications with the Trace GridTek 10-kW inverter. Three recipients will be using Bergey turbines, but AWS Scientific, Inc. purchased and installed the turbine at the NWTC for testing.

The second goal of the FVP is to evaluate the applicability and effectiveness of SWTs that serve a range of distributed power needs in various regions of the United States, under diverse ownership and operating scenarios. To accomplish this goal, recipients are required to install their turbine(s) at a host site(s) (Table 1). Each of the five FVP recipients are at different points in the process. Some recipients have their turbine(s) installed at the host site(s) and are collecting data. Other recipients are negotiating with school boards, attending town meetings, preparing budgets, ordering parts, waiting on parts, installing the system, or are in the process of finding alternate host sites. Observing this process, can be helpful to those interested in purchasing and installing their own systems. These quarterly reports document the hurdles of organizations in the wind energy field. Individuals or organizations can learn from the process that these five recipients are experiencing. For example, each county in the United States has its own guidelines, which either accelerate or hinder progress in siting and installing a turbine at a host site. Readers can follow the progress of the five recipients from siting, zoning, attending public meetings, ordering hardware, installing the system, troubleshooting and maintaining the system, and monitoring and reporting data. For more information about wind energy and installing a wind turbine, see the Wind Powering America Web site at http://www.eren.doe.gov/windpoweringamerica/.

Whisper Installation at the National Wind Technology Center

Dean Davis and Andres Gianfelice from Windward Engineering installed the Whisper H40 on a 30-foot, tilt-down tower at the NWTC in December 1999. Windward Engineering staff built an adapter to fit over the existing foundation at the site and completed the electrical wiring from the turbine to the down-tower junction box. The site shed houses the data acquisition system and instrumentation, the Trace SW4024 inverter, and connections to the single-phase utility line. A 24-volt battery bank is located outside the shed in a battery box.

After installation and prior to certification testing, staff commission the system to ensure proper installation and operation. Then, NWTC researchers follow International Electrotechnical Commission (IEC) standards to test the turbine for duration, power performance, and noise. They also conduct a system safety and function test based on the manufacturer's owners manual.

Above: Final installation of Whisper H40 at the NWTC.

Below from left: Andres Gianfelice, Windward Engineering; Trudy Forsyth, NREL; Dean Davis, Windward Engineering finish the installation of the Whisper H40 at the NWTC.

Host Sites

The five recipient organizations manage 13 sites. Figure 1 and Table 1 show the names of the organizations and contacts, locations, turbine types, and applications.

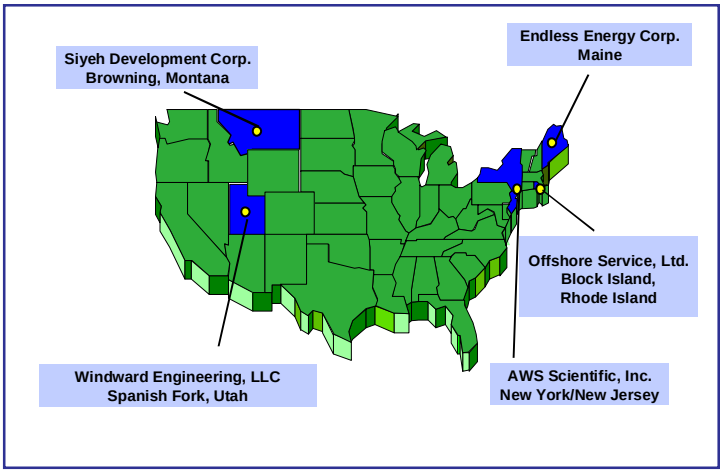


Figure 1. DOE Field Verification Program turbine locations

Table 1. Field Verification Program Locations and Participating Organizations

Organization/Contact	SWT #	Turbine Location	Quantity/Type of Turbine	Application
Windward Engineering 4661 Holly Lane Salt Lake City, UT 84117 Contact: Craig Hansen/Dean Davis	Turbine #1	Spanish Fork , Utah	One Whisper H40 (previously named Whisper 900)	Grid Connected
Endless Energy Corporation 57 Ryder Road Yarmouth, ME 04096 Contact: Harley C. Lee/Michael Boice	Turbine #1	Allen Blueberry Plant, Orland, Maine	One AOC 15/50	Grid Connected
	Turbine #2	Monhegan Island, Rockland, Maine	One AOC 15/50	Grid Connected
Siyeh Development Corporation P. O. Box 1989 Browning, MT 59417 Contact: Dennis Fitzpatrick	Turbines #1-4	Waste Water Treatment Facility, Browning, Montana	Four Bergey Excel-S/E 10 kW	Pumping and Purification
Offshore Service, Ltd. P. O. Box 457 Block Island, RI 02807 Contact: Henry G. duPont	Turbine #1	Block Island Goose and Garden Greenhouse, Block Island, Rhode Island	One Bergey Excel-S/E 10 kW	Residential Consumption
	Turbine #2	TBD	One Bergey Excel-S/E 10 kW	Residential Consumption
	Turbine #3	TBD	One Bergey Excel-S/E 10 kW	Residential Consumption
	Turbine #4	TBD	One Bergey Excel-S/E 10 kW	Residential Consumption
	Turbine #5	Jonathan & Jo-An Evans Residence Block Island, Rhode Island	One Bergey Excel-S/E 10 kW	Residential Consumption
AWS Scientific, Inc. 251 Fuller Road CESTM, Suite B220 Albany, NY 12203-3656 Contact: Bob Putnam/Dan Bernadett	Turbine #1	Webster, New York	One Bergey Excel-S/E 10 kW	Distributed Generation
	Turbine #2	Liberty Science Center Jersey City, New Jersey	One Bergey Excel-S/E 10 kW	Distributed Generation
	Turbine #3	Environmental Education Center Babylon, New York	One Bergey Excel-S/E 10 kW	Distributed Generation
	Turbine #4	Peconic Land Trust's North Fork Stewardship Center Long Island, New York	One Bergey Excel-S/E 10 kW	Distributed Generation

Third Quarter Status and Statistics Summary

Windward Engineering, LLC

Windward Engineering is a wind engineering organization located in Spanish Fork, Utah. Staff are testing a Whisper H40 (previously named Whisper 900), which is connected to the Spanish Fork City Utility grid at an existing wind energy test site (Figure 2). Another Whisper H40 has been tested at the NWTC since February 2000. Windward Engineering will collect data required under the cooperative agreement and, in addition, will create a computer model to predict the furling behavior of the Whisper H40.

Figure2. Whisper H40 at the host site, Spanish Fork, Utah

Spanish Fork, Utah

For the period ending September 30, 2000, the Whisper H40 turbine in Spanish Fork, Utah, ran normally with complete data acquisition systems operational. The test site produced 482 kWh under an average quarterly wind speed of 6.5 m/s. Since the turbine was commissioned in February 2000, the turbine has produced a total of 889 kWh. Seventy-seven percent of the energy produced has been sold to the grid.

The following tables and figures contain the test results of the Whisper H40 at the site in Spanish Fork, Utah. Table 2 shows the quarterly project summary through September 30, 2000. Note that the Windward Engineering tables and figures report the measured power data. Power curves are not corrected to sea-level air density. All wind speeds reported are the average of the two values measured by the primary anemometer (at hub height plus the rotor radius) and the secondary anemometer (at hub height minus the rotor radius).

Table 2. Project Summary

Quarterly Summary								
SWT #	kWh Total	kWh/m^2	Capacity Factor****	Unavailable Hours*	Turbine Availability	Max. Watt**	Concurrent Wind Speed***(m/s)	Ave. Wind Speed at Hub Height (m/s)
1	482	134.9	24%	5.3	100%	621.7	11.8	6.50

* Unavailable hours events are shown in Table 3 and include data from the DAS system and from the site operation log

** Maximum power is the peak 10-minute-average output

*** The concurrent wind speed is a 10-minute-average wind speed

**** Rated output is 900 watt

The turbine operated with 100% turbine availability and 99.76% system availability. The downtime was related to instrumentation and there were no faults in the turbine system. See Table 3 for the detailed downtime summary.

Table 3. Downtime Summary by Type for Whisper H40

Category	Hours	Lost Energy KWh	Remarks
Fault: Wind Turbine			
Fault: Inverter			
O&M			
Turbine measurements (related to modeling)			
Ground Testing (related to modeling)			
Instrumentation installation or calibration	5.3	0.0	Replace instrumentation power supply, calibrate yaw & furl sensors
DAS disable			
Host site system disable			
Battery over voltage			
Blown fuse			
Brake cooling cycle			
Inverter faults			
Unknown			
Others			
Total	5.3	0.0	

Figures 3 and 4 show the results from measured values for the Windward Engineering testing for the period of July – September 2000. Figure 3 shows the wind distribution for the test site, and Figure 4 shows the resulting power curve from that period of time. Note that the power curve has not been corrected for air density.

Figure 3. Distribution of Quarterly Average Wind Speed (Spanish Fork, Utah, Test Site)

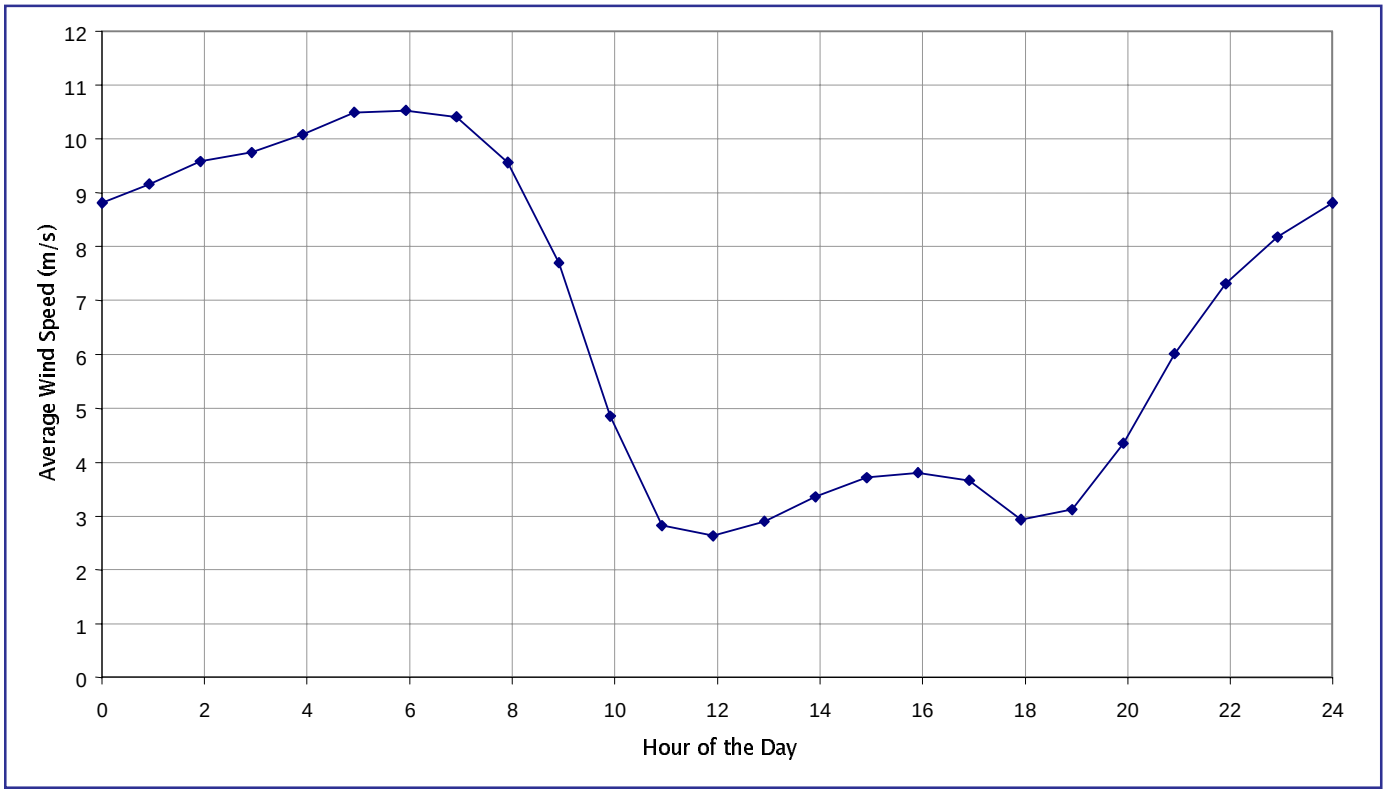
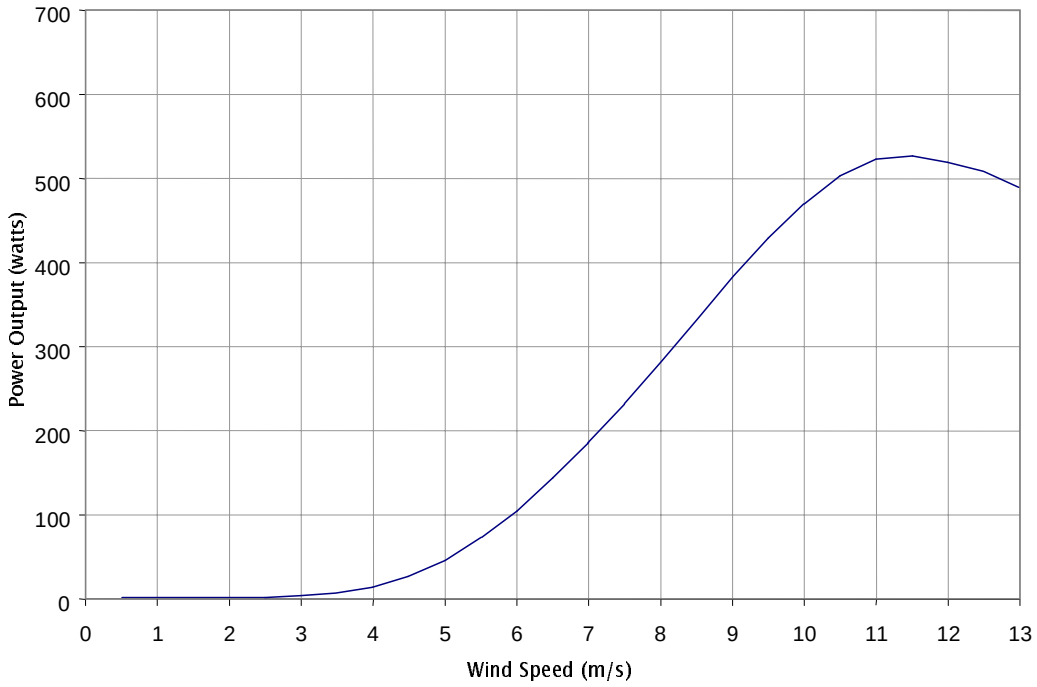


Figure 4. World Power Technologies, Whisper H40 Wind Turbine Power Curve



Wind Speed (m/s)	Power (watts)
0.5	2
1.0	2
1.5	2
2.0	2
2.5	2
3.0	4
3.5	7
4.0	14
4.5	27
5.0	45
5.5	73
6.0	105
6.5	144
7.0	186
7.5	232
8.0	282
8.5	333
9.0	383
9.5	429
10.0	470
10.5	504
11.0	523
11.5	527
12.0	519
12.5	509
13.0	490

Endless Energy Corporation

Endless Energy Corporation (EEC) will install two AOC 15/50 turbines along the windy Maine coast for several commercial power customers. The goals of the project are to verify the performance of the turbine under harsh coastal conditions and to create a model for commercially competitive wind power installations in small, distributed settings. The project will benefit from the convergence of essential factors for successful wind-powered generation: windy, buildable locations; the use of well-engineered wind turbines; the existence of the necessary regulatory scheme and power markets for financial success.

Allen Blueberry Plant, Orland, Maine

During this quarter, EEC assembled a 100-foot Rohn tower and received the controller system, which was installed by a locally contracted electrician. EEC received the turbine blades, but there have been delays in receiving other necessary turbine components. These delays have pushed the estimated date for complete installation to the fourth quarter. In the meantime, EEC's engineer finalized the details for data collection and contacted Kotzebue Electric to learn of their experiences with the supervisory control and data acquisition (SCADA) systems on similar turbines. In addition, EEC, Central Maine Power (the utility company), and Atlantic Orient Company (the turbine vendor) have been negotiating to resolve a concern of voltage and frequency control systems before the turbine is connected to the grid.

Monhegan Island, Rockland, Maine

The school board of an elementary school, which is under construction in Deer Island, Maine, decided to pursue the project after a successful presentation by EEC. EEC and the board agreed on a turbine location and terms of site lease and power purchase agreements. As construction on the school progressed and the need to finalize wind turbine construction details grew, delays from Atlantic Orient Corporation on EEC's Allen Blueberry Plant made it impossible for EEC to commit to a time frame suitable to the desires of the school board. EEC was not able to guarantee a completion date based on experience in attempting to install the Allen Blueberry Plant turbine, which is behind schedule.

Siyeh Development Corporation

Siyeh Development Corporation (of the Blackfeet Indian tribe), in conjunction with the Town of Browning, Montana; Bergey Windpower; the Indian Health Service; the Blackfeet Indian Housing Authority; and Glacier Electric Cooperative will partner to install four Bergey turbines at Browning's Waste Water Treatment Facility. These project partners represent a broad base of experience and interests ranging from local government and utility functions to state-of-the-art wind turbine systems engineering. It is believed that the project will assist in the improvement of the community waste water treatment system and promote a cohesive and integrated experience base for future wind power development.

Waste Water Treatment Facility, Browning, Montana

During this quarter, there was communication between Siyeh and NREL for assistance in installing the data acquisition system (DAS). The DAS was not installed this quarter, but Siyeh anticipates that it will be installed in the fourth quarter with assistance from NREL and the town of Browning. Siyeh found a problem with the furling mechanism on turbine #4 and has had problems with the Trace inverter. Siyeh is currently working with Trace on the second retrofit.

Siyeh's reimbursement of costs remained suspended by the Department of Energy during the third quarter while an acceptable plan was developed for the successful completion of the project. This quarter, a Memorandum of Agreement (MOA) was executed between Siyeh and the town of Browning. This MOA was presented to the Department of Energy for review, along with a proposed budget that would be used for future work on the project.

Offshore Services, Ltd.

Offshore Services will install five Bergey Excel wind turbines on Block Island, Rhode Island, to evaluate the effectiveness of wind power at five different locations with different types of ownership structure in a harsh marine environment. In addition, Block Island Power Company has a number of circuits that experience low voltage at the ends of the distribution system during peak demand periods. Some of these turbines will be placed at the end of the distribution system to measure the effect of adding distributed power sources.

Offshore Services, Ltd.

Block Island Goose and Garden Greenhouse, Block Island, Rhode Island

Offshore commissioned a Bergey 10 kW Excel/R last quarter for DC battery charging, which replaced a Bergey 0.85-kW turbine. The sensors, data logger, and data recovery and analysis software are all working properly. General operation of the turbine, battery, and inverter system is favorable. People visiting the commercial greenhouse facility have shown some interest in the turbine installation but most visitors and customers do not seem to notice the difference in the size and sound of the new, larger wind turbine. A poll of the neighboring property owners brought a favorable or indifferent response. No neighbor complaints have been filed with the town building official with regard to the turbine aesthetics or noise.

The new wind turbine installation produces more power than the old wind turbine and the increased battery storage capacity (130 kWh compared to 30 kWh) helps the facility get through periods of light wind. However, if there is no wind for more than 3 days, it is necessary to operate the 6.5-kW gasoline-fueled generator for battery charging. Offshore's preliminary experience is that in periods of light winds, they need to operate the generator for charging (an 8-hour battery charge cycle or about 50 kWh) only once a week, instead of once every 2-3 days. A preliminary estimate of generator fuel savings per month during the summer is about $110, or 48 gallons saved each month at $2.30 per gallon.

The turbine has provided excellent power availability. Offshore has had no operational problems except for the following two incidents. First, in thunderstorms, a 1.5-amp buss-type fuse on the turbine's DC voltage controller blew, which interrupted power until it was replaced. The fuse replacement was easy, but there was no way to know that the fuse had blown except to verify turbine power output after a thunderstorm. Second, Offshore has had a few brief periods of power interruption during a severe thunderstorm when they intentionally shut off the inverters to avoid possible lightning damage to the system. This power interruption did not affect the turbine output, but caused a brief interruption in signal output from the AC-powered Ohio Semitronics (OSI) power transducer channel from the wind turbine, causing a brief (half-hour) loss of data. No other channels of data were affected (such as the meteorological).

Offshore has leased a Ford Electric Ranger pickup truck (Figure 5) that is being charged as needed with the energy from the Bergey wind turbine. The operation of the electric vehicle has increased the power use of the Goose and Garden Facility from 300 to 600 kWh a month. Offshore is finding that the Ford Ranger electric vehicle, with a battery size of 23 kWh, needs to be charged once every 3 days or once every 60 miles of travel. This vehicle allows the wind power/battery/generator system to be used more efficiently because vehicle charging can be deferred to windy days when excess wind energy would be dumped after the facility battery is full. Thus, the 23-kWh vehicle batteries can be used to help store energy between wind events, thereby increasing the capacity of the facility main battery. A log of the truck usage, including battery-charging data, has been maintained. An effort to better show the relationship between the availability of the wind resource and the need for generator battery charging and vehicle usage will be made by establishing a generator operating log.

Figure 5. This Ford Ranger electric vehicle is charged with excess wind energy from a Bergey Excel 10-kW wind turbine.

Jonathan & Jo-An Evans Residence, Block Island, Rhode Island

The turbine was commissioned on August 23, 2000. The data-monitoring equipment was commissioned with nominal performance from the meteorological sensors, but the power transponder equipment has noise--perhaps electromagnetic interference from the proximity of the Trace inverter. Offshore will move the OSI current transformer and transducer away from the source of the interference.

This site, which meets all the local requirements for wind turbine permitting, is in a residential neighborhood. Neighbors are within 250 to 400 feet. These neighbors objected to the legal issuance of the turbine's building permit before it was installed and subsequent to its operation after it was commissioned. The neighbors have found allies in a local newspaper and electric utility (the Block Island Power Company), which does not support private renewable energy projects and has been soliciting others to oppose the Evans wind turbine installation. The Power Company distributed the telephone number of the Department of Energy's Golden Field Office and encouraged Power Company customers to call DOE and complain. However, neighbors 500 to 600 feet away have called to say that they rarely hear the Evans wind turbine and that it does not bother them.

Offshore Services, Ltd.

During this period, Offshore Services identified three alternate sites to those originally proposed.

Alternate Site 1, Block Island, Rhode Island

Offshore has a hotel owner on Block Island interested in being a host site. The property has a 25-room hotel with a bar and a restaurant and uses approximately 3000 kWh a month year round. Block Island is currently in the process of adding new zoning and noise ordinances, which will allow neighbor input before permitting. Offshore is waiting for the new requirements. Previously, the site would have met all local provisions for the granting of a building permit without zoning approval. If Offshore gets the permit, it will need to have the proposed site approved by DOE. If the site is approved by DOE, the wind turbine will be placed on the corner of the hotel parking lot. The wind turbine will provide the owner with more economical energy, since the facility will use most of the generated energy from the wind turbine, considering its large loads. The remaining power will be sold back to the power company. The wind turbine has been received and is stored on site. The tower is ordered, and all of the supporting equipment (i.e., data loggers and wind data sensors) for the operation and data collection phases of the project were received.

Alternate Site 2, New Shoreham, Rhode Island

The town of New Shoreham is one of the proposed municipal sites originally proposed to DOE as a host site. The town council met and recommended the town's new Coast Guard Station facility due to its remote location. The station was recently acquired from the Department of Transportation. A zoning application was submitted for public hearing on August 28, 2000, but the application was subsequently withdrawn by the town when it became apparent that a neighborhood group was in opposition to a wind turbine at the Coast Guard Station. Offshore is pursuing an alternate site.

Alternate Site 3, New Shoreham, Rhode Island

Last quarter, Offshore received preliminary approval from the school board of Block Island School in New Shoreham, subject to the school architect finding a location that would complement the school's multi-million dollar physical plant upgrade. The school board held subsequent public hearings on the proposed project and determined that there was opposition from the board of the medical center, which is near the school. The school board, which was preparing for a public referendum on their controversial multi-million dollar physical plant improvements, did not want to jeopardize the improvements by participating in the wind turbine project. Offshore is pursuing alternate sites.

AWS Scientific, Inc.

AWS Scientific will install, operate, maintain, and monitor the performance of one Bergey Excel at each of its four sites. These four sites are geographically diverse and are characterized by challenging weather extremes. These projects will demonstrate the use of wind for distributed power needs for grid-connected generation under diverse ownership scenarios. The wind turbine testing at the NWTC has been delayed due to Trace GridTek 10-kW inverter problems.

Webster, New York

AWS completed the tower foundation for this site in July and expects to receive the Bergey Excel 10-kW wind turbine and tower in November for installation that month. The state of New York required AWS to obtain an additional certification beyond UL listing (Underwriters Laboratory's, Inc.) for the Trace GridTek 10-kW inverter, called New York State Standard Interconnection Requirements (SIR). As of the end of September, the testing was still underway.

Liberty Science Center, Jersey City, New Jersey

AWS scheduled the installation of a tower foundation in November, pending the final approval of the Site Plan from the New Jersey Department of Environmental Protection (NJ DEP). AWS has received the tower, expects delivery of the turbine in the fourth quarter, and expects installation in the first quarter of 2001. In addition, DOE's policy requires recipients to comply with the National Environmental Policy Act. In doing so, AWS had a soil sample taken in July 2000. It showed very low levels of contaminant to a depth of 3.5 feet. AWS has proposed an excavation plan.

Environmental Education Center, Babylon, New York

AWS continues to work with the town of Babylon to put a professional and technical services agreement in place to address any permitting and approval issues.

Peconic Land Trust's North Fork Stewardship Center, Long Island, New York

AWS visited the North Fork Stewardship Center and continues to work with the Peconic Land Trust to put a professional and technical services agreement in place to address any permitting and approval issues.

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visit http://www.nrel.gov/wind/

For more information on renewable energy,
contact Energy Efficiency and Renewable Energy Clearinghouse (EREC)
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