Wind Resource Site Assessment:

A Guide to Selecting Monitoring Equipment

Introduction

The interest in harnessing wind energy is growing in the U.S. and around the world. Several trends and events are now converging that support such interest: a desire to lessen dependency on petroleum products; rising energy prices; and a recognition that environmentally-sustainable building management practices can be both environmentally responsible and cost-saving. Building owners and managers can take steps toward the U.S. Green Building Council's LEED Certification, and can take advantage of federal and state tax incentives that will help save money in the long run.

Whether the focus of a wind project is to supply power for greenhouses on a farm, or install turbines for larger-scale commercial energy supply, proper turbine siting is crucial for optimal performance and return on investment despite the scale of the project.

Once a site is determined to be an appropriate candidate for a wind turbine (through consultation of local and regional wind resource maps, meteorological data, and existing studies), a thorough, onsite wind assessment must be carried out that measures wind speed and direction at heights appropriate for the project and at locations suitable to represent the project. While appropriate permits and permissions are being obtained for the test site or sites, you will need to select monitoring equipment.

The intent of this paper is to provide project managers working on small- to moderate-scale wind energy projects with information about how data loggers fit into wind resource site assessment. This paper examines sensor, data logger, and communications options, with advice on what to look for in selecting such equipment. Then, you'll find information about equipment mounting hardware to help ensure optimal performance during your project's monitoring period. This information will help simplify the equipment-selection process, and help you save time and money for your site assessment project.

Sensors and Data Loggers

The main components of a site's wind resource assessment are wind speed and wind direction sensors that plug into a data logger, all of which are mounted on an appropriately-sized tower. Knowing a bit about sensors and loggers will help you choose the right devices for your budget and ensure you collect data reliably and accurately.

Sensors

Sensors for a wind assessment project are often mounted tens of meters off the ground, and must measure environmental parameters accurately and consistently for at least a year, across all the seasons. In addition to doing their job of measuring wind parameters, sensors must withstand rain, snow, ice and humidity.

When evaluating sensors, check the manufacturer's specifications regarding:

- Operating temperature - What happens during freezing temperatures?
- Response time - Will short gusts be recorded?
- Connection to logger and deployment - Is there any wiring required, or does the sensor simply plug into the logger?
- Durability - What are the sensor components made of? Are the moving parts strong?
- Accuracy
- Resolution
- Expected lifetime - For how long will the sensor operate?

Here are some factors to consider for each type of sensor:

Anemometer

Wind speed is the most important measurement in your assessment. Cup-style anemometers are the most common for wind power projects, and consist of several cups which rotate around a vertical shaft.

The anemometer should be sturdy enough to withstand sustained winds and wind gusts of up to at least 100 mph, depending on your location. Keep in mind that wind speed increases with vertical distance from the ground. Check into the manufacturer's specifications for:

- Maximum wind speed
- Starting threshold
- Response time - Often referred to as distance constant, this describes how responsive the anemometer is to changes in wind speed.
- Materials - shaft, cup and bearings
- Expected lifetime

Ideally, anemometers are placed at three locations on a tower: the proposed turbine's hub height, the height of the highest blade tip, and the height of the lowest blade tip. Often, however, towers are used that are shorter than the proposed turbine hub; there are numerical models that allow the input of data from lower heights to be applied. Budgetary restrictions may also limit data collection. In any case, it is a good idea to mount two anemometers at each tower height for data replication or in case of sensor failure.

Wind Direction

Wind vanes are often part of the anemometer unit, but may also be available as stand-alone devices. Most important is to check the resolution of the vane; make sure the data output is in small enough units for you to use it effectively in your assessment. Also consider:

- Maximum wind speed - Is the vane designed to withstand typical and maximum wind speeds at your site?
- Materials - What are the fins and shaft constructed of?
- Expected lifetime

Data Logger

All data logging systems for measuring wind parameters consist of multiple sensors that connect to a data logger, which records and stores all data at prescribed time intervals. When evaluating data loggers, keep simplicity and flexibility in mind as you consider the following:

- Housing - The logger will be outside for a year or more, so check if the enclosure is strong and weatherproof enough to withstand wind, rain and curious animals, and that the electronic components will stay dry.
- Data channels - There is usually a limit to the number of sensors that can be plugged into a logger. Does the logger have enough data input channels? Can more be added?
- Power - If there is a battery, will it last the full duration of your study? If not, how easily can new batteries be swapped in? Will the data be safe during a power outage? Check about solar and rechargeable battery options, as well. Specific power options may be recommended for certain data download options.
- Configuration - Some sensors require programming for deployment, while others simply plug in and are immediately recognized by the logger. Can you configure sensors in the field with or without a laptop, or do you need to set everything up in the office beforehand?
- Flexibility - You may decide to add other sensors sometime during the monitoring process, or at a future date for another application. Can the logger accept a wide variety of sensor inputs, including third-party sensors?
- Cable length limitations - Towers can be very tall, and you must ensure that the logger can handle all the cables necessary to reach the sensors. In some cases, you may need to use multiple loggers.

Today's data logging systems include a wide variety of data retrieval options, from cellular remote communications to onsite laptop computer download. The next section describes the different options available.

Data Communications Options: Remote Communications vs. Manual Download

There are several options for downloading data from your wind resource monitoring system, and they essentially break down into two categories: manual download and remote communications. Each has its strengths, and you'll be better prepared to assess them if you first consider the following:

- Monitoring period - How often would you like to download data? You'll be monitoring wind parameters at the site for a year or more, and how often would you like to check in? How many parties are interested in the data?
- Maintenance - How often will you do routine maintenance checks to be sure that the logger, sensors and tower are in good working condition and repair? Such checks require staff and travel time.
- Location - Where is the station located? Is it in a vandalism-prone area, many miles from roads, or right on the edge of the project owner's property?
- Budget - What is your budget? Some communications options are more costly than others at the outset, but may save money in labor and travel costs over the life of the project.
- Future applications - Will you reuse the equipment for future wind resource assessment projects?

Manual Onsite Download with a Data Shuttle or Laptop

Data shuttles are small, hand-held devices that plug into a data logger and retrieve data. They are usually designed for field conditions, and are simple to operate, often involving a single-button download. Alternatively, you can use a laptop computer equipped with the appropriate software and interface cable.

This is often the most inexpensive option, though it does have some limitations. Technicians must visit the logger to download data, and there may be no way to know about malfunctions until data has been examined.

Remote Data Download: Cellular and WiFi-based Communications

Remote communications allow for real time Internet-based access to data. Rather than going out into the field, the user simply logs onto a website to view and download data, thus saving time and money on travel and labor, and minimizing the chance of data gaps due to equipment failure.

Operators can easily and frequently monitor sensor and battery status, or make adjustments to logging intervals, right over the Internet. With these systems, it is easy to check that sensors and loggers are working properly, and cellular phone and email alarm notifications can be sent when sensor parameters are out of a set range, if equipment fails, or if battery power is low. The sooner you know about a system malfunction, the faster you can get out to the site, fix the problem, and continue collecting uninterrupted data.

Two data communications systems available today are cellular and WiFi. Cellular systems require a cellular data contract, and the logging system must be within provider range. With WiFi, data

transfer is accomplished via WiFi network or WiFi router connected to the Internet. There is no need to pay for cellular service, but your installation does have to be within range of a WiFi router (repeaters and booster can extend range). Users can set notification alarms that transmit to cell phones and email addresses with either system.

Mounting Tips For Data Logging Systems

In addition to the sensors and data logger, you will need to select hardware and other accessories for mounting and connecting the devices, and ensure system components are installed properly. Once it's up and running, animals, weather conditions, and vandals may act upon your monitoring system, and periodic field visits and/or logger alarms are required in order to ensure smooth operation.

You will need to attach your sensors and logger securely to your chosen tower in a fashion that allows for optimal data collection. Sensor manufacturers usually provide a selection of hardware options; before you consider spending money and time to design or make your own, check around to see what's available. In most cases, equipment should be mounted on sturdy metal arms and brackets, with several anchor points.

You should consult the manufacturer's recommendations for placement distances, but here are some factors you'll have to consider:

Sensors

- Mount anemometers and vanes far enough away from the tower structure and other sensors to avoid interference. Each sensor should have its own individual boom that holds the sensor well away from the tower. Consult your manufacturer for details.
- Temperature and humidity sensors require solar radiation shields.
- Ensure that sensors are designed to shed water and operate in freezing conditions.

Cables

- Sensors connect to the logger via cables, so order enough of the proper length to reach from sensors to logger.
- Wrap cables along the tower from the sensors to the logger, and secure them with UV-resistant tape or ties. Allow enough slack in chafe-prone areas.

Logger

- Make sure the logger is securely housed inside a weatherproof, locked, tamper-resistant structure.
- Mount it high enough so that animals cannot reach it from the ground, and close up gaps to deter birds.
- Make sure enclosure is properly sealed, carefully following the manufacturer's instructions.
- Mount the solar panel, if applicable, ensuring it will receive adequate sunlight throughout the day and through the seasons.

Again, your sensor, logger and tower manufacturers will have detailed guidance specific to the equipment you have selected.

Conclusion

Site-specific wind resource assessment is one of the most time-consuming and important steps of a wind energy project. This guide has hopefully helped to make you aware of the data-collection and communications options available to you so that you can make the best choice for your site, project and budget.

About Onset

Onset is the world's leading supplier of data loggers. The company's HOBO data logger and weather station products are used around the world in a broad range of monitoring applications, from verifying the performance of green buildings and renewable energy systems to agricultural and coastal research. Based on Cape Cod, Massachusetts, Onset has sold more than one million data loggers since the company's founding in 1981. Visit Onset on the web at http://www.onsetcomp.com.

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