

Equipment

Massachusetts Anemometer Loan Program

Location: MA

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<http://www.ceere.org/rerl/projects/support/weps.html>

The Wind Energy Predevelopment Support Program (WEPS), which is part of the Massachusetts Anemometer Loan Program, facilitates the introduction of more wind energy in the Commonwealth of Massachusetts, on the community, farm, and small-business scale.

The program will provide assistance at all stages of pre-development, including wind resource monitoring, site evaluation, permitting, request for proposal development and bid evaluation.

The program is directed at persons and groups including: towns, individuals, small businesses, farms, nonprofit organizations, and public agencies. Please see the web site for more information.

Make your own measuring devices

Using electronic sensors, micro-controllers, and memory devices, students can build data-loggers that can attach to anemometers, solar cells, and flow-meters helping to build a picture of local renewable resources. Prices of individual components are far below packaged devices, affordable for any classroom. Free software is available to program the micro-controllers.

You can combine GPS trackers with movable devices to geocode data.

HOBO Data-Loggers

<http://www.onsetcomp.com/products/>

Companies like Onset Computers (of Bourne, MA) offer weather stations, logging equipment for those stations, and stand-alone loggers with which students can keep track of wind, rain, and sunlight.

Pendulum loggers are hand-held, waterproof devices that can be left outside for months, taking measurements at intervals between once-per-second and once-per-eighteen-hours.

Inspeed Anemometers and Software

<http://inspeed.com/>

Inspeed is a small company started by a Massachusetts engineer to provide low-cost cup anemometers for "home use, portable applications, weather and storm spotting, wind energy applications, and all sorts of wind-related sports." They also make vanes and hardware and software for data-logging. Students can attach an anemometer to a serial port of a windows computer to use Inspeed's software "Windware" or new "WindWorks," or make their own logging circuit, or attach to a cheap bicycle computer.

Please use our links page to find more.

Measuring and Logging Systems: <http://energyteachers.org/Links.php?LinkTopicSelect=36>

Equipment and Materials Shopping: <http://energyteachers.org/Links.php?LinkTopicSelect=54>

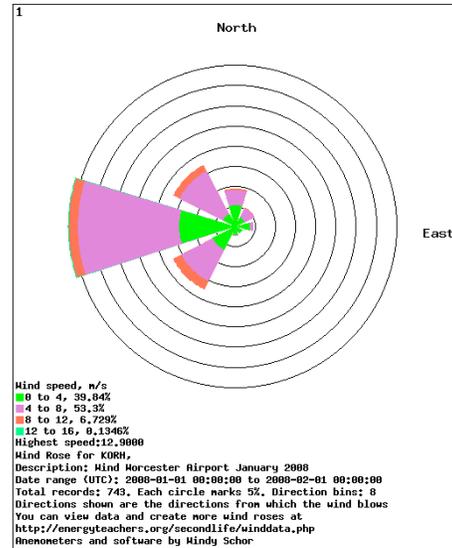
Data and Analysis tools

Wind Roses at EnergyTeachers.org

<http://energyteachers.org/secondlife/winddata.php>

Schools can send their wind data to EnergyTeachers.org, of unlimited size, and make sophisticated analyses of the wind resource with graphs that include a treasure of information in a single picture. Students can also analyze data from meteorological stations across the country.

A wind rose shows how frequently winds blow in a range of directions, and how frequently in a range of speeds. The rose at right shows that wind at the airport in Worcester, in January 2008, usually blew to the E, and the the wind most often blew 4-8 m/s. Seven percent of the time, winds blew towards E, NE, SE, and S at speeds between 8-12 m/s.



Watts on Schools

The Watts on Schools program installed solar panels on several schools in Texas, Louisiana, and Arkansas. Data is available from the panels includes time of day, irradiance, ambient temperature, wind speed, power output, and efficiency, about 30 times a day:

<http://www.wattsonschoools.com/data.htm>

Since 2007, WOS has been using Soltrex for data services, which means raw data is more difficult to acquire, but analysis now includes comparison to model predictions and instant graphs.

SOLTREX

<http://www.soltrex.com/>

Very commonly used in Massachusetts, this is a web-based data visualizer for energy systems, showing power outputs and weather conditions. You can use their graphs, or download data to do analyses such as correlations.

RETScreen

<http://www.etscreen.net/ang/home.php>

Complex modeling software for renewable systems, using real, precise data from manufacturers and meteorological agencies.

MY NASA DATA

<http://mynasadata.larc.nasa.gov>

Access data inferred from satellite observations. Students can enter a date and a location (latitude and longitude) and make a local map comparing insolation on that day. In the

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"advanced" mode, students can download time series of data such as "Daily Surface All-sky SW [short wave, visible] Downward Flux."

A lesson plan for measuring sunlight using a cheap solar cell and a multimeter.

FirstLook

FirstLook uses Google Maps to show average wind speed. Registered users can access speed data.

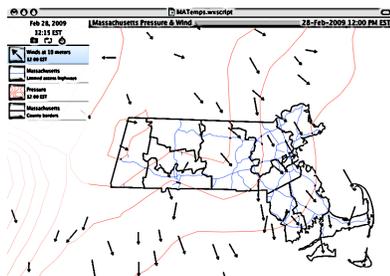
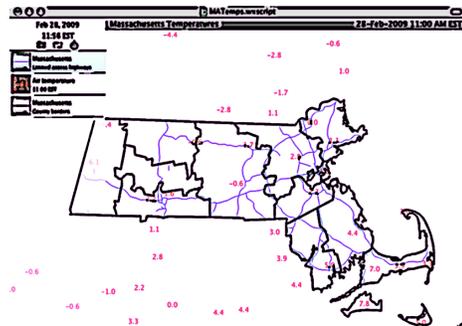
<http://firstlook.3tiergroup.com/>

WeatherScope

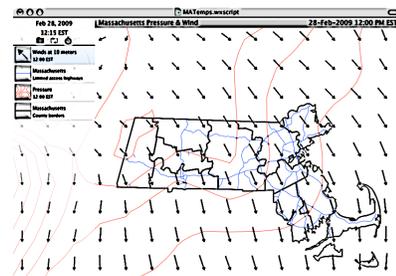
<http://climate.ok.gov/>

<http://www.mesonet.org/>

The Oklahoma Climatological Survey aggregates weather data from around the country, which you can access using WeatherScope, a Mac/Windows program that allows users to map weather data, and graph data from Oklahoma sensors. Maps can be animated, show gradients, iso-lines, or observed numbers/vectors. The program can archive gigabytes of weather data on the client computer, for in-depth studies and analysis.



Vectors like wind velocity can be shown as discrete observations, or interpolated to a grid of vectors.

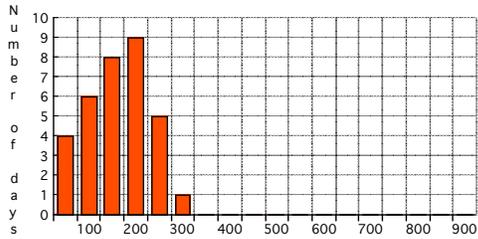


UMass Amherst Renewable Energy Research Lab

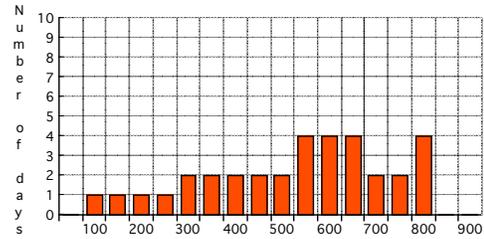
http://www.ceere.org/rerl/rerl_resourcedata.html

RERL provides FTP access to (vintage) sets of wind-data for locations in and around Massachusetts.

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Langleys per day, 1970-76, January, Geneva Station



Langleys per day, 1970-76, June, Geneva Station

Inspiration

Energy Seeds

<http://energyseeds.com/2007/06/28/getting-solar-for-your-school/>

Here's a story of a teacher who found it easy to obtain a solar PV system for his small school in California. The teacher had his students help him write the application for a grant from the utility company.

South Dakota's Wind for Schools

<http://wac.sdwind.org/wfs>

The Wind Application Center in South Dakota promotes wind energy. In the Wind for Schools project, they are installing demonstration turbines at schools across the state. A partnership between the Public Utilities Commission, SD State U., and individual school districts.

Wind Energy Center, UMass Amherst Renewable Energy Research Lab

Education-savvy contact:

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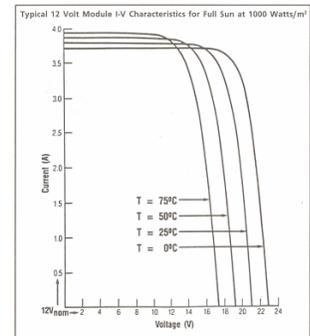
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Pat Quinlan gave a workshop for teachers Feb 25, 2009, in association with the Museum Institute for Teaching Science, where he discussed his current projects in RE research and educational work.

Mr. Quinlan works with educators and young students, on design-build projects and investigations.



Temperature has an effect on power output of PV modules.

EnergyTeachers.org Links section

Browse our Links section for hundreds of annotated, hierarchically organized links:

<http://energyteachers.org/Links.php>

Activities

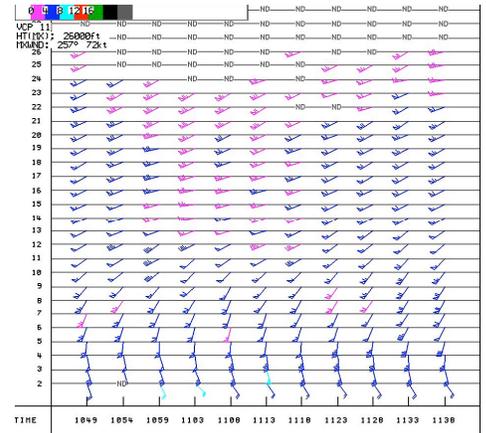
Measuring Wind

Measuring Light

Gathering meteorological data online

Measuring and extrapolating height-profiles of wind

Atmospheric wind speed goes to zero as the height above ground measured goes to zero. Anemometers at different heights on a tower can help determine how high a turbine should be elevated to be above turbulence and friction caused by ground and objects. Wind shear is a term for differences in wind speed at nearby heights.



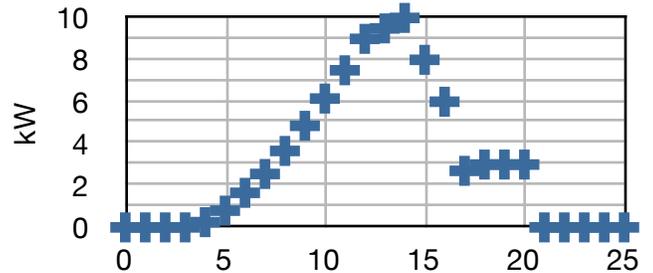
Time series of height profile of wind every 1000m, 5 min. Note higher winds more consistent.

Convolving meteorological data with solar hot water efficiency charts

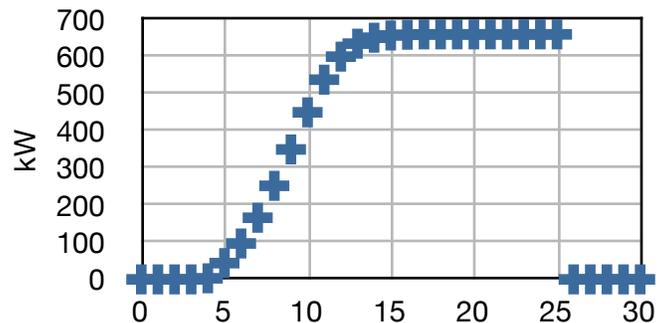
Convolving wind data with power curves

In a wind turbine, the power converted is not linearly proportional to the wind speed, and there is a cut-in speed below which no power will be generated, and a cut-out speed above which the turbine quits generating power. Therefore, if students simply take a variable wind speed averaged over a long period and look up the power output at that speed, the calculated output will not be the same as what the real output would be. Students can make a better estimation by multiplying power output by bins of wind speed on the power curve with the amount of time the wind spends in those bins.

Bergey BWC Excel-S kW v. m/s



Vestas V-47 660, kW v. m/s



Convolving insolation data with PV specifications

Using maps of data

Where is the best place in your area to site a wind turbine? How does insolation in the mountains compare to the seashore?

Modeling

<http://www.nrel.gov/rredc/pvwatts/>

The National Renewable Energy Laboratory offers two versions of its software to predict PV system performance in locations you choose.

Curriculum Sources

KidWind

<http://www.kidwind.org/>

The very successful program of wind education in America. Kits and lesson plans help students learn about engineering and wind power

Wind Wisdom

<http://www.nesea.org/k-12/cleanenergyforacleanenvironment/windwisdom/>

The Northeast Sustainable Energy Association, headquartered in Greenfield, MA, offers a learning unit and certificates in Wind Wisdom. Secondary school students learn about wind technology, environmental and economic issues, see wind turbines in action, and develop their own presentations to younger students.

Too many more to list here. Please go to:

<http://energyteachers.org/Links.php?LinkTopicSelect=52>

Pursuits for interested students

College programs in renewable energy

- Wind energy course at Greenfield Community College to begin 2009-2010.
- Technician-level certificate-based courses at UMass Wind Energy Center.

Please see EnergyTeachers.org Links for many more opportunities for college and training:

<http://energyteachers.org/Links.php?LinkTopicSelect=46>

Field Trips

Please use our field trip guide, and contribute comments and new sites to it. 1300 school in Massachusetts received the guide in book form in 2007. Ask the principal or librarian if they remember where they put it. You can also access the guide, and use it to find sites nearest you:

<http://energyteachers.org/fieldtripguide.php>