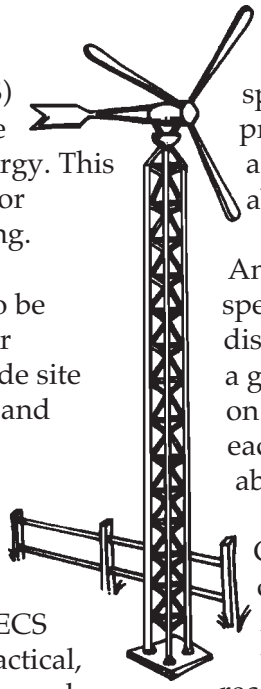
BUILDING IN ALASKA

EEM-01352

Windpower

Factsheet

Richard D. Seifert
Energy and Housing Specialist



Wind energy conversion systems (WECS) convert the kinetic energy of a renewable resource – wind – to mechanical energy. This energy can be used as electric power or for direct applications such as water pumping.

Several important considerations need to be applied to use successful wind energy for home power. These considerations include site evaluation, proper choice of equipment, and energy conservation.

Site Evaluation

Average wind speed is the critical factor used in determining the economic effectiveness of wind machines. For a WECS system that generates electricity to be practical, you will need an average monthly wind speed of 8 to 14 miles per hour (mph) at your site. The amount of power available in the wind is proportional to the cube of the wind speed, an important fact to consider when siting wind turbines. Underestimating the average wind speed 20% means that a site could actually produce 73% more energy. Overestimating a site's wind speed by 20% could produce about half the expected power.

An anemometer is used to measure wind speed. A basic anemometer measures the distance a column of air moves over a site in a given period of time and registers the count on a digital meter. Daily readings, totaled each month for at least four months (preferably a year) are advisable.

Government weather stations in your area can provide average monthly wind speed figures for a whole year. Contact at least three weather stations and compare your records to theirs. By comparing monthly averages you can find the ratio between your monthly wind speed and the average monthly wind speeds. This ratio helps you determine the average wind speed at your site during each month of the year.

UNIVERSITY OF ALASKA FAIRBANKS
College of Rural Alaska
Cooperative Extension Service

417/8-77/RDS/1200 Reprinted September 2003

You need to know the highest wind speed gusts that are likely at your site because the wind generator and tower must be built to withstand violent winds. Your local weather station can supply data on storm winds and gusts. Use the same ratio determined above to customize those figures to your site; multiply this new highest gust estimate by 1.33 (a "gust constant"). Your wind generator and tower support must be designed to handle this amount of gusting for safety and insurance purposes.

Equipment

Combine the efficiencies of both rotor and generator to determine system efficiency. Today's best turbines can convert about 40% of the wind's energy to mechanical energy. With a typical generator efficiency of about 85%, the WECS can achieve a maximum overall efficiency of about 35%. This conversion compares favorably with other energy technologies. Typical commercially available photovoltaic modules have efficiencies of less than 15%; conventional power plants have 30% to 40% thermal efficiency.

A wind generator's rated output is usually for sea level air density. Higher altitudes have lower air density and require higher wind speeds to achieve a given output. Temperatures also have some effect on output. The density ratio altitude (DRA) chart below shows the real output of a wind generator at your site's altitude. Find the DRA figure nearest your site's altitude and multiply it by the rated output of the wind generator you are considering to determine actual output.

Altitude Above Sea Level	DRA (60°F)
Sea Level	1.000
2,500 feet	1.000
5,000 feet	0.912
7,500 feet	0.756
10,000 feet	0.687

Any wind generator should be equipped with a blocking diode and proper voltage regulator to provide battery protection. The diode will prevent the generator from becoming a motor that would deplete the batteries when there is no wind.

AC or DC

The electricity generated by a wind turbine may be

1. Converted to alternating current (AC) and used without storage,
2. Stored in batteries and later used as direct current (DC) or alternating current, or
3. Tied into an existing utility grid through the use of an induction generator.

To use standard AC appliances you must either tie in to a utility or convert the DC produced by the generator to AC with an inverter.

System Sizing

The amount of electricity required is the basis for deciding the size wind generator you need. Power requirements may change during the year, so the demand estimate should be made on a monthly or seasonal basis. This estimate can be compared with wind speeds, which also vary seasonally, to determine the match between expected energy supply and demand. Electrical demand is usually greater during the winter than the summer for most Alaska users.

Decide what appliances will be used and how long they will be turned on to determine demand estimates. Also determine the maximum rate of electricity required, or how many electrical devices will be on at the same time.

Review your electrical needs and decide how much you can reduce them without giving up too much convenience. Using other energy sources to heat water, cook and refrigerate, will reduce your electrical needs and save money.

Proper Tower Placement

Wind turbine location is very important. Wind speeds can vary 30% or more between sites only 100 feet apart in areas of rolling hills or tree cover. Figures 1 and 2 show the effects of terrain and height on the percentage of maximum wind speed available.

The wind turbine should be mounted on a tower 30 to 80 feet high to take maximum advantage of the wind. Roof mounting is not recommended because blade vibrations can be felt through the entire house. The rule of thumb

is to have the tower height at least 20 feet higher than any potential obstacle within a range of 500 feet. Remember that an increase of only 1 mph wind speed can give a 33% increase in power.

The wind tower should generally be located within 100 feet of the house or battery storage system because of the potential voltage drop in transmission lines.

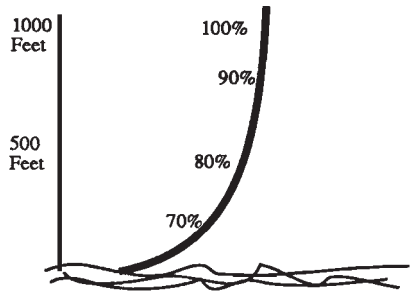


Figure 1. Height Over Smooth Terrain Vs. Percentage of Maximum Wind Speed

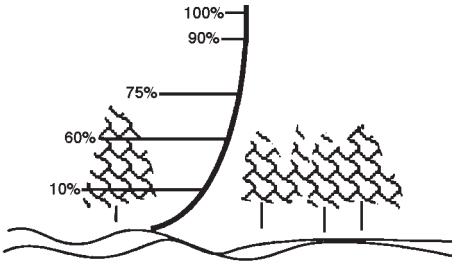


Figure 2. Height Over Rough Terrain Vs Percentage of Maximum Wind Speed

Energy Conservation

1. Tower and foundation costs can be significant. It is often worthwhile to build 100-foot towers because of higher winds at higher elevations. A higher more expensive tower results in increased power output of the system and reduces backup power costs. This makes it possible to use a smaller and less expensive wind generator to get the same amount of power.
2. The model wind generator you choose will affect the cost of power generated. Larger, more expensive WECS cost more initially, but will provide lower cost per kWh. Alternatively, smaller units (less than 4 kW) are more proven and more likely to last longer.
3. A larger battery bank will allow for longer periods of low wind without the need of a back-up system.
4. An inverter allows you to convert wind power to AC and use more conventional appliances and wiring. Weigh the expense of the inverter versus efficiency, possibility of both AC and DC circuits, and the appliances involved.
5. Consider utility intertie. Determine rates at which your local utility is willing to buy and sell power. This rate will help figure the economics of tie-in versus using the utility as a back up source only – or not at all. Check with your local utility or the Alaska Public Utility Commission Tariff Section to establish pay back rates.

For more information contact:
Energy Resource & Information Center (ERIC)
520 E. 34th Avenue
Anchorage, AK 99503
(907) 564-9170 or 1-800-478-INFO (4636)

Energy Efficiency and Renewable Energy Clearinghouse (EREC)
U.S. Department of Energy
P.O. Box 3048
Merrifield, VA 22116
800-523-2929

For a map of wind energy distribution in Alaska, see the publication Wind *Energy Resource Atlas, Volume 1, Alaska,* PNL-3195, in ERA-10, UC-60. Available from Environment and Natural Resources Data Center, University of Alaska, 707 A Street, Anchorage, AK 99501, or from N.T.I.S., U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22151.

Wind Power Related Webpages

http://www.windpower.dk
is the Danish turbine manufacturers page. It's the best wind site I've seen, has both technical and policy stuff.

http://www.dewi.de
is the German wind institute with links to most of the German companies.

http://www.uni-muenster.de/Energie/wind/markt/mkt-a-e.html
Try variations on this URL as there is quite a lot of interesting stuff at the site.

http://www.OrgVE.dk/
is the Danish renewable energy organization.

http://www.econet.org/awea/
http://www.bwea.com/
are the American and British Wind Energy Association home pages, respectively.

http://www.inforse.dk
is the international network for sustainable energy and should have some relevant information and interesting links.

http://www.dti.gov/NewReview/
has back issues of a UK government magazine on general UK renewable energy news.

http://www.wpm.co.nz
is the wind power monthly magazine electronic edition from New Zealand.

http://www.nationalwind.org/pubs/pubs.htm
At this site is the full text of "Wind Permitting Handbook" developed by the siting sub-committee of the National Wind Coordinating Committee. Useful if you want to go bigtime and provide utility power.

Reviewed by Virginia Moore, Energy Consultant and Educator, Anchorage, Alaska, and Richard Seifert, Extension Energy and Housing Specialist, Cooperative Extension Service, University of Alaska Fairbanks.

Visit the Cooperative Extension Service web site at
www.uaf.edu/coop-ext