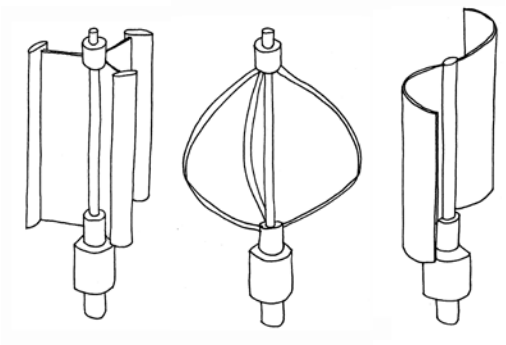
Wind Systems

A growing amount of renewable electricity is being harnessed from the wind. Australia has an abundant supply of wind resources, which, if utilised adequately, can save significant greenhouse gas emissions. This fact sheet provides an overview of installing and using wind systems.

AUSWEA and University of Newcastle



New developments in wind turbines include noiseless vertical axis turbines.

INSTALLING DOMESTIC WIND SYSTEMS

Domestic wind generators (also called turbines) are usually used in stand alone power systems and are designed to charge a battery bank.

Domestic wind generators are usually sized in the range of 300W up to 5kW but in some instances they could include a 10kW or 20kW turbine.

Conventional wind turbines have the turbine axis in the horizontal plane, but a number of innovative designs are being developed employing a vertical axis turbine, and some with more aerodynamic features or shrouded blades to improve the performance of small horizontal axis machines.

These changes are aimed at reducing noise and providing a better output under turbulent wind conditions likely to be experienced around buildings. Test results are promising and some commercial models are making it to the installation stage. The remainder of this fact sheet relates to the commercial horizontal axis wind generation.

The main body of the wind generator comprises a set of blades, the alternator and the tail section. The power of the wind makes the blades turn. The blades are connected to the rotor inside the alternator which turns and generates electrical power. The tail ensures that the wind generator is facing directly into the wind.

Wind speed increases as the height above the ground increases.

Output of a wind generator is dependent on the amount of wind but can also vary from one manufacturer to another.

To help appreciate what you can expect from a wind generator the following table shows the daily AC load in watt hours (Wh) that can be met by a 1000 Watt wind generator at various average wind speeds.

Inverter and battery efficiency have been taken into account in accordance with design guidelines. A household electricity usage of 5,000kWh per year equates to about 13.5kWh per day.

Care should be taken in determining the wind resource of your site.

AVERAGE WIND SPEED METRES/SEC	DAILY AC LOAD THAT CAN BE SUPPLIED BY SOMA 1000 (Wh)
3	690
4	2,142
5	3,060
6	5,585
7	7,650
8	9,180
9	10,863
10	12,470

As a rule of thumb, a wind generator should be installed no closer to an obstacle than at least ten times its height, and on the down wind side. The preferred distance is twenty times the height.

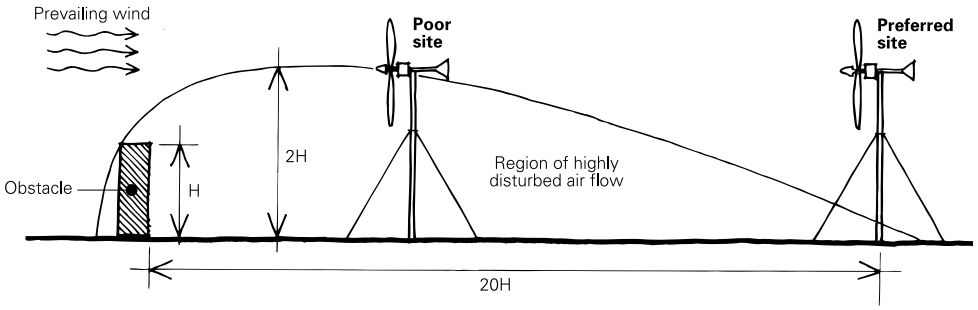
Wind speed increases as the height above the ground increases, so the wind generator should be installed on the highest tower that is practical and cost effective for your site. The typical tower used in domestic wind generator systems is between 10-20m tall.

SITING AND INSTALLATION

Wind generators need ‘clean’ wind to operate. Clean wind is where the wind is constant from the one direction and is not being made turbulent by near-by obstacles. The clean wind is required to overcome the starting torque (that is the starting resistance) of the wind generator.

Wind can be affected by terrain like hills, trees and nearby buildings or structures. Some areas of Australia receive seasonal wind and may only receive winds in winter while in coastal regions on the east and west coasts the prevailing wind will be summer sea breezes.

Most manufacturers will provide figures on the ‘cut-in’ wind speed. This is the speed of the wind (generally measured in metres/second) at which the starting torque is overcome and the wind generator begins to turn and generate power. In areas with frequent light winds, a low cut-in speed is an important feature for



maximum output. Manufacturers provide a rated output of a wind generator at a specified wind speed. Not all manufacturers rate their units at the same wind speed.

In Australia there is very little wind monitoring undertaken, so the system designer will have very limited wind data to use to design the system. Designers will use their own experience, knowledge and relevant information obtained from the manufacturer when determining the anticipated output of the wind generator system.

To overcome the power loss in the cables, the wind generator needs to be located as close as possible to the battery bank. If the preferred site is distant from the house, the batteries and inverter could be located near the wind generator and the power transmitted as 240V AC to minimise cable losses. Alternatively the generation voltage can be higher and then transformed down to battery voltage if the batteries are installed near the house. Higher voltage transmission means lower losses.

Wind generators can produce some running noise in high winds. The noise can come from the blades, gear-box, brush gear or wind whistling past the tower, pole or guy wires. The noise may not be loud but may be noticeable to you or close neighbours. The background noise of the wind itself usually covers the sound of the blades. Always ensure that there are no objections to the low level noise produced.

TURBINE CONTROLS

As the wind speed increases the wind generator will spin faster. If wind speed continues to increase the generator may ultimately be destroyed. All wind generators therefore have a wind 'cut out' speed at which the unit will employ some form of overspeed control to either stop the unit generating power or govern the rotational speed to produce constant power.

The two most common forms of overspeed control are mechanical braking and feathering.

In mechanical braking, a brake, similar to those found in many cars, is applied as a result of the centrifugal forces developed when the unit approaches the cut out speed. If the unit is operating in an area where the average speed is close to the cut out speed, braking might happen frequently and the brakes will wear out rapidly.

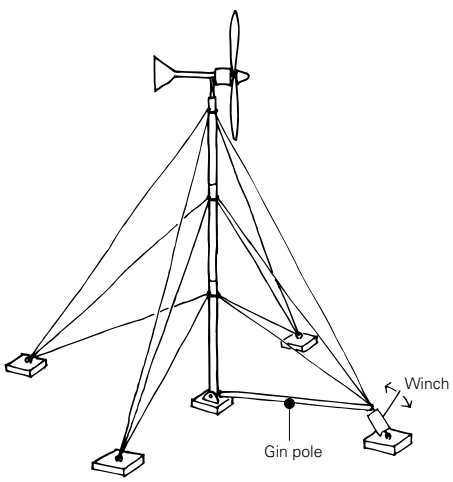
Feathering can occur in two ways: either by rotating the individual blades to reduce their angle into the wind, thereby reducing rotor speed; or turning the whole unit out of the wind.

Wind generators are always producing power when turning. If the batteries are fully charged the excess power is redirected into a dummy load, usually an electrical element. The dummy load can get very hot and should be positioned where it will not be touched accidentally.

TOWER DESIGN AND INSTALLATION

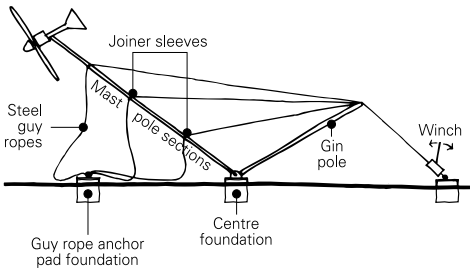
Wind turbines require regular maintenance and the tower needs to be designed to allow access for servicing mechanical components, such as bearings.

The typical tower is designed so that it can be lowered and raised by tilting the tower with a gin pole and winch.



Courtesy of Geoff Stapleton

If a tilt tower and gin pole is used there must be sufficient area around the wind tower for it to be lowered. If it is 20m tall you will need at least 20m area for lowering the tower. If a vehicle is used to raise and lower the tower it also needs room to manoeuvre.



ENERGY USE

Tilt towers are guyed, so although the tower might only be constructed from 100mm pipe, the guying of the tower will have a footprint of 20 x 20m for a 19.5m tower. The guy wire tensions will need to be checked regularly.

The tower and the guy wires will usually require concrete footings. These footings must be designed in accordance with the wind loadings for the particular site.

Wind generators and the accompanying system, being mounted on top of metal towers, are very susceptible to lightning strikes. Lightning arresters should be installed in the system to protect electronic components from the effects of lightning strikes.

ADDITIONAL READING

Contact your State / Territory government or local council for further information on renewable energy, including what rebates are available.
www.gov.au

ReNew, *Small Wind Turbine Buyers Guide*, Issue 100
www.renew.org.au

Peter F and Robotham T (2004), *Wind Power: Plan your own wind power system*, Alternative Technology Association.

Gipe P (2004) Wind Power: *Renewable Energy for Home, Farm, and Business*, Chelsea Green Publishing Company, Vermont USA.
www.wind-works.org/books/wind_power2004_home.html

Alternative Technology Association, *The Viability of Domestic Wind Turbines for Urban Melbourne*
www.ata.org.au/home-page-items/ata-report-launch-the-viability-of-domestic-wind-turbines-for-urban-melbourne/

Principal authors:
Geoff Stapleton
Geoff Milne

Contributing author:
Chris Riedy