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.

Courtesy of Eraring Energy

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.

Although wind generators produce AC power similar to the grid, there are currently no guidelines for interconnecting small domestic sized wind generators directly to the grid. They may only be connected via an inverter.

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.

A typical 1 kW turbine will cost approximately $5,000 and the tower around $2,000 – $3,000. For a guide to the cost of components for the rest of the system [See Batteries and Inverters].

Courtesy of AUSWEA and University of Newcastle

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.

The wind generator produces alternating voltage and current, and these are rectified to provide DC at the correct voltage to charge batteries. This process is similar to charging the battery in a car.

The rectifier can either be mounted with the generator on top of the tower or in a separate control cubicle. The majority of wind generators in Australia have the rectifier installed within the generator so that only DC cables are connected to the generator. The cables are installed within the tower.

In some wind generators the cables are continuous between the generator and the battery bank. As the turbine turns to face the wind the cables running down inside the tower will twist. In most cases they will twist clockwise as much as anti-clockwise, but sometimes the turbine must be manually rotated to unwind the cables.

Other wind generators use a series of slip rings to make the electrical contact between the generator and the cables leading down the tower. In this case the turbine can rotate to face any direction without twisting the cables, but the slip rings will wear and eventually need replacing.

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 SOMA 1000 Watt wind generator at various average wind speeds.

Inverter and battery efficiency have been taken into account in accordance with SEIA design guidelines. A household electricity usage of 5,000 kWh per year equates to about 13,500 Wh per day.

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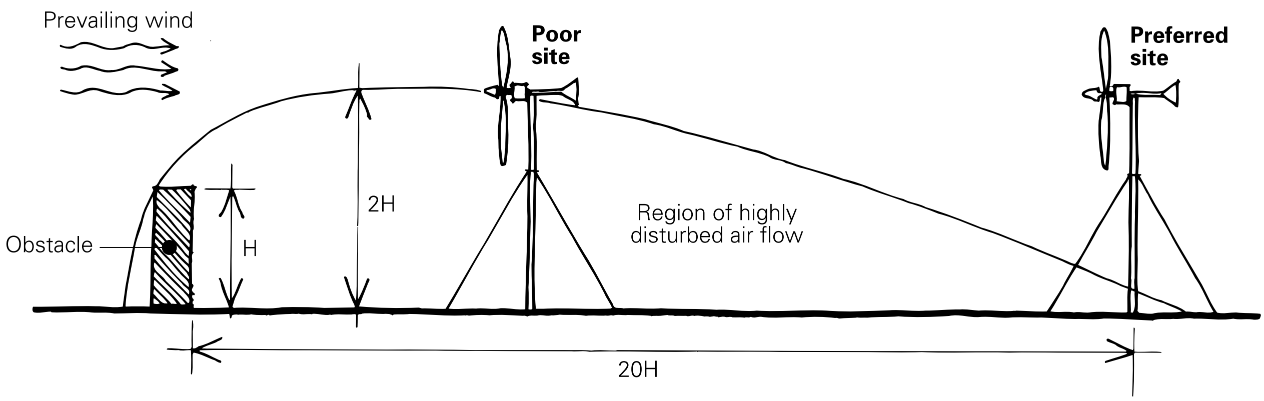


Average Wind Speed Metres/sec	Daily AC Load that can be supplied by SOMA 1000 (Wh)
3	690
4	2,142
5	3,060
6	5,585
7	7,650
8	9,180
9	10,863
10	12,470

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 ten metres and twenty metres 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 240 V 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 be noisy when running 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. Beyond a couple of hundred metres, 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.


Courtesy of Geoff Stapleton

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.

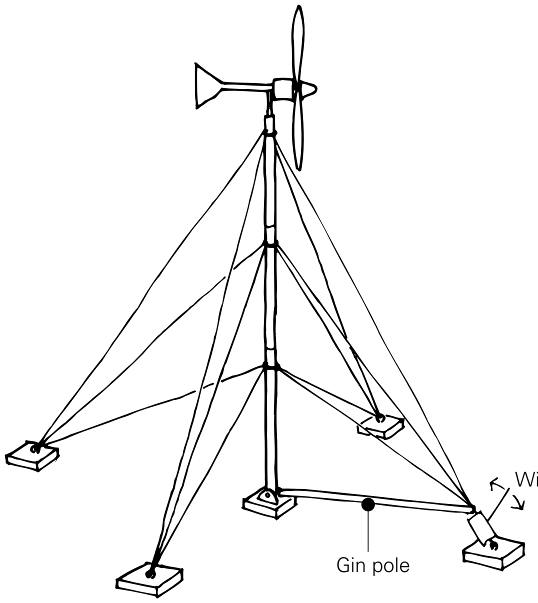
In mechanical braking, a brake, similar to those found in many cars, is applied as a result of the centrifugal forces developed when the unit approaches the cut out speed. If the unit is operating in an area where the average speed is close to the cut out speed, braking might happen frequently and the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

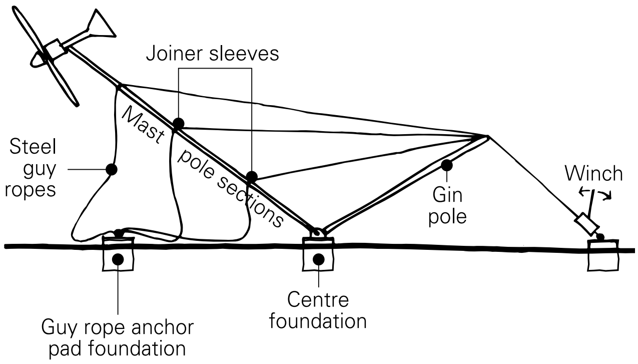
Feathering can occur in two ways: either by rotating the individual blades to reduce their angle into the wind, thereby reducing rotor speed; or turning the whole unit out of the wind.

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 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.

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 twenty metres tall you will need at least twenty metres area for lowering the tower. If a vehicle is used to raise and lower the tower it also needs room to manoeuvre.

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 twenty metres by twenty metres for a 19.5 metre tower. The guy wire tensions will need to be checked regularly.

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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.

Cattle, horses, etc. should be denied access to the tower as they may damage themselves or the tower/generator if they collide with the guy wires or tower. Large animals scratching themselves on towers have had devastating consequences.

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 KEY REFERENCES
Australian Renewable Energy Website, http://renewable.greenhouse.gov.au
Australian Wind Energy Association (AusWEA) website, http://www.auswea.com.au
Sustainable Energy Industry Association website, http://www.seia.com.a

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