Nursery & Garden Industry

Wind Power opportunities for the Australian Nursery Industry

Introduction

Wind power is an alternative and renewable electrical energy source suitable to areas of Australia with average wind speeds above 5m/s. Wind turbines can have a shorter payback period and higher return on investment than solar power in areas with high average winds speeds and low wind turbulence.

Basic Principles

Wind turbines convert the kinetic energy of wind into electrical energy. The theoretical maximum conversion efficiency of kinetic energy to electrical energy is approximately 70%; however, current commercial designs attain a maximum conversion efficiency of around 45%.

Figure 1: Vertical axis wind turbine (VAWT). Reproduced from http://www.greenwindsolar.com

Electricity generation offers the opportunity to either offset or replace the electricity used within your nursery operation and significantly reduce or even eliminate electricity costs to your business.

Modern wind turbine designs work on the principle of lift rather than drag. The turbine blades and horizontal-axis wind turbines (HAWT) rotate at a higher tip speed than the wind velocity due to the principle of lift; this allows lift based designs to extract energy more efficiently from the wind than drag based designs such as some vertical-axis wind turbines (VAWT).

Figure 2: Horizontal axis wind turbine (HAWT). Reproduced from http://www.two-west.com/hawt_03.php

Types and Components

The two types of modern wind turbine designs are HAWT (Horizontal-axis Wind Turbine) and VAWT (Vertical-axis Wind Turbine). VAWT turbines are more suitable for the domestic market as they are quieter and more efficient in turbulent winds associated with built up areas. VAWT turbines are also designed to operate in lower mean wind velocities, require less or no gearing, and can be easily installed (GWS Technologies 2010). Globally, VAWT design is rarely used for large or small scale wind power generation as they are much less cost effective when compared to HAWT designs (Fink 2005). HAWT turbines range in size from under 100W to 7.6MW, and are extensively used across the world (including Australia) for grid connect and isolated energy generation. HAWT turbines are therefore the most popular type of wind turbine due to their cost effective, efficient and proven design over the life of the turbine. The rest of this information sheet will only consider HAWT's for this reason.

Functional components required for a wind generator system

1. **Turbine Blades:** Convert kinetic wind energy into mechanical rotation. Blade furl (bend) under high wind velocities to protect the turbine from spinning too fast in gale force winds.
2. **Drive Train:** Transfers energy from blades to the alternator at a suitable rotational speed, the bearings may require lubrication or replacing at intervals set by the manufacturer.
3. **Turbine Alternator:** Converts rotational mechanical energy into electrical energy, usually three phase rectified into direct current. The motors are usually permanent magnet motors, with voltage increasing with wind speed.
4. **Dummy Load:** Used as a safety device in high wind conditions and when there is no electrical load on the turbine. The dummy load sinks the power generated from the wind turbine and acts as a break.
5. **Nacelle:** The housing for the drive train and the permanent magnet motor.
6. **Tower:** Used to raise and support the turbine into a higher velocity, lower turbulence air stream. Towers for wind turbines are usually cable tensioned (guyed) tower or freestanding tubular towers.
7. **Charge Controller:** The charge controller converts the raw power at a varying voltage from the wind generator to a constant voltage. A good controller will have a Maximum Power Point Tracker (MPPT) to extract the greatest power possible.
8. **Energy Storage:** Energy can be stored in battery banks for non-grid connected systems; however, battery banks add considerable cost to any renewable energy system and require ongoing maintenance and have a limited life. Grid connected systems effectively use the grid as a limitless storage battery.
9. **Inverter:** Converts the power from the charge controller into useful AC voltages. Grid connect inverters cost more, but are a much more cost effective solution when compared to battery storage when grid connection is possible.
10. **Transmission Cables:** If the power from the wind turbine requires transmission over any real distance from the wind turbine, this should be done after the inverter stage in order to reduce power transmission losses.

Figure 3: Guyed pole tower. Reproduced from http://www.colgantoolmaking.com.au

Wind turbines under 10kW are usually used in small rural, semi-rural and small scale isolated applications. Each of the above components needs to be accounted for in the design and budgeting of your wind energy system. Many varied wind turbine models are available for use in Australia– some of which are included in the links below.

Power rating vs. cost is not necessarily a good indicator of value for money as each turbine model and design will have its own unique power vs. wind velocity curve. In fact any one turbine may be proven to outperform another of equal power rating over the course of a year when installed at the same location. A useful way to estimate the potential for wind power for a particular location is to use an online wind power calculator: i.e., the NGIA wind power calculator (NCEA 2010).

Advantages/Disadvantages

Advantages of wind power include;

- Small foot print required for freestanding tower designs
- Greenhouse gas reduction
- Good return on investment over the life of the wind turbine for locations with high mean wind speeds
- Renewable Energy Certificates (RECs) are available for wind power
- High net feed-in tariffs for grid connect systems are available in most states of Australia
- 20+ years lifespan for reputable wind turbine models
- Hedging against future energy tariff increases

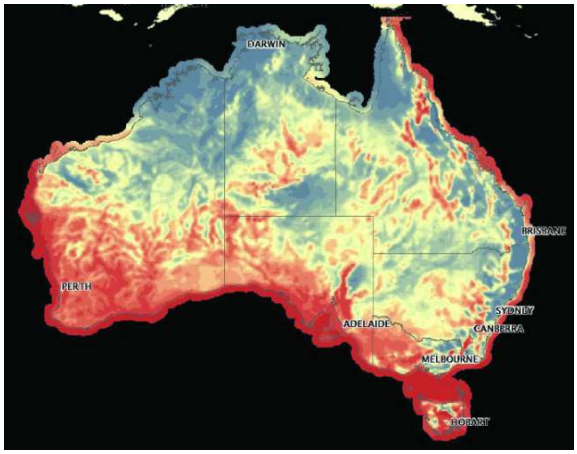

Figure 4: Wind Map of Australia, red areas depict zones ideal for wind power generation. Reproduced from http://ramblingsdc.net/Australia/WindPPotential.html

Disadvantages of wind power;

- Relatively few regions in Australia have average wind velocities which warrant wind power
- Potential for visual and noise pollution (subject to turbine design)
- Towers may be prone to lighting strike and may require lightning arresting in the design
- Larger area required for cable tensioned tower design
- High capital investment for wind turbine components and installation

Basic Installation Issues

Wind power is highly subject to the specific location of interest. To allow for an accurate financial assessment of any particular wind power installation, site specific wind averages are required. Mean wind velocity can be obtained from local weather stations or from Australian wind maps. This data can be used for preliminary analysis, however the average wind velocity may be much lower and turbulence excessive at the site due to obstructions such as trees and buildings. If local wind maps indicate a wind velocity adequate for wind power generation, it is important to perform a specific site analysis by recording the prospective sites wind speeds over a full year with an anemometer (Webb 2007). Anemometers are a cost effective instrument that are readily available and will

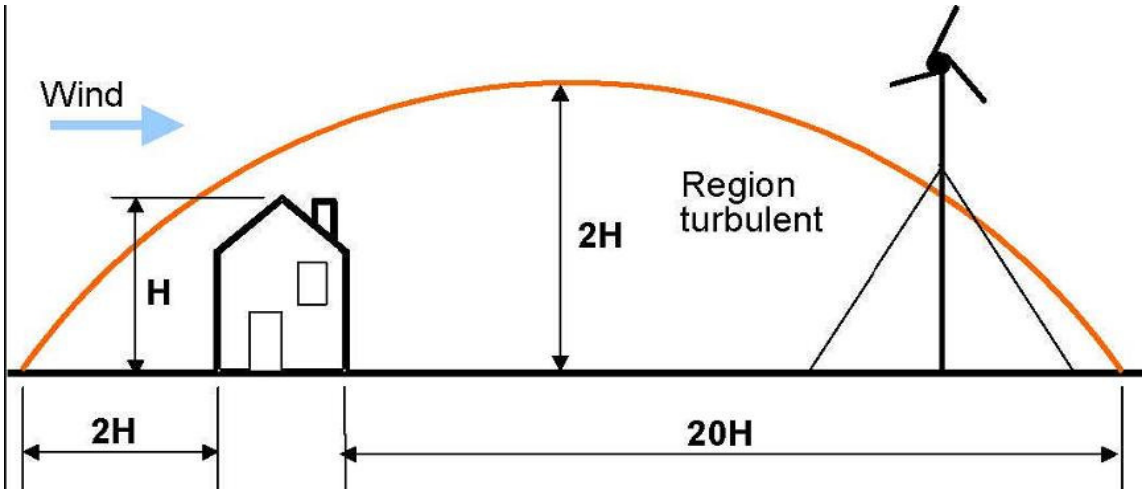

Figure 5: Wind turbulence. Reproduced from http://www.greenthinking.co.uk

prevent a potentially poor investment; one example is the Power Predictor Anemometer kit http://www2.powerpredictor.com/.

A suitable site for a wind turbine not only requires 5 m/s (or greater) average wind velocities, but also a site that is not in a turbulence zone as per Figure 5 (above). Turbulence will reduce the life of a wind turbine, and reduce its annual power production.

There are four aspects to tower selection: height, design, cost of material, and cost of installation.

The two major design options are cable tensioned (guyed) tower or free standing pole designs. For smaller turbines the guyed tower has lower costs than a freestanding pole; however, a free standing pole has a very small footprint and may be more aesthetically appealing. A wind turbine mounted on a guyed tower can be erected without a crane. Once installed it is important to check the guy wire tension on a regular basis.

Lightning is attracted to tall steel structures, and can pose as a major threat to the electrical components of a wind generator. Wind turbine manufacturers can build safety measures into a turbine design, and other external measures can be added. One measure is setting up a lightning rod connected to earth higher than the turbine, but this may attract extra lightning (Webb 2007).

Wind Power Links

Calculators

http://www.reuk.co.uk/Calculate-kWh-Generated-by-Wind-Turbine.htm

http://www2.powerpredictor.com/

http://guidedtour.windpower.org/en/tour/wres/pow/index.htm

http://www.energyefficientchoices.com/resources/wind-power-system-sizing-calculator.html

Resources

http://www.csiro.au/resources/pf16q.html

http://www.advocacypanel.com.au/documents/Applic246Windturbineviablity.pdf

http://www.cleanenergy.qld.gov.au/queensland_wind_map_.cfm

http://www.yourhome.gov.au/technical/fs68.html

http://www.otherpower.com/windbasics2.html

http://ramblingsdc.net/Australia/WindPPotential.html

Suppliers

http://www.energymatters.com.au/

http://www.todae.com.au/Products/windturbinegenerators/

http://www.solaronline.com.au/wind-turbines

References

Webb, A 2007, *The Viability of Domestic Wind Turbines for Urban Melbourne*, Alternative Technology Association Melbourne, viewed 17 November 2010, http://www.advocacypanel.com.au/documents/Applic246Windturbinevia blity.pdf

About Wind Energy 2010, GWS Technologies Inc, viewed 24 November 2010, http://www.greenwindsolar.com/about_wind_energy.php

Fink, D. 2005, *Small Wind Turbine Basic*, Part 2, viewed 24 November 2010, http://www.otherpower.com/windbasics2.html

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YOUR NGIA

NGIA is the peak industry body for the Australian nursery and garden industry and is responsible for overseeing the national development of this diverse and essential industry. Our vision is for a unified Australian nursery and garden industry that is productive, profitable and sustainable.

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