MICRO WIND

Wind turbines convert kinetic energy from the wind into mechanical energy and then into usable electrical energy. Large wind turbines are suitable for wind farms in rural areas and for offshore locations. Micro wind is the term used to describe a turbine of 20 kW or less according to the BWEA (British Wind Energy Association) [173].

To generate power in areas close to buildings and people, two characteristics of urban wind need to be considered: the lower mean annual wind speed compared with rural areas, and the more turbulent flow [174]. Many studies of wind generation in urban environments have recorded a lack of wind resource available at the desired location despite a reported mean annual wind speed which would have been sufficient. This is partly because of the huge variation in wind resource from site to site, and partly because most of the turbines used in the studies were mounted either on the ground or on residential roofs which are close in height to other obstacles blocking the wind's path [175]. Therefore to take full advantage of the wind resource available, wind turbines should be mounted as high as possible, such as on the roofs of central business district (CBD) office buildings, and each potential site should be properly evaluated prior to installation.

In summary, to get the best power output in an urban area, the evaluation should cover:

- the wind resource in that area,
- choice of site,
- turbine choice.
- Additionally, to mount turbines on CBD buildings, the evaluation should also cover:
- wind loads,
- size of the turbines themselves, to ensure the desired building will be able to withstand the turbines on the roof.

Selected Micro Wind Technology

The desirable choice for a micro wind turbine is one which can be roof-mounted, performs well in turbulence, and has passed stringent safety and performance standards. An example of a such a micro wind turbine is the Quiet Revolution turbine (qr5), because these have been proven in the field, are roof top mounted, designed for turbulence and to operate with minimal vibration, as well as being the only vertical axis micro wind turbine which has been approved for the Microgeneration Certification Scheme (MCS). [176]

The qr5 turbine is a 6 kW peak power rated Vertical Axis Wind Turbine (VAWT) with a helical blade design. There ar approximately 150 of these turbines currently operational in the UK, the Netherlands, Germany and Australia. [177] The power curve below shows that the peak output occurs at 16 m/s and the energy curve

shows the relationship between annual delivered energy and annual mean wind speed .[177]

Micro Wind Installation Process

Rooftop qr5 installation is relatively simple, with turbines installed in the 'mast down' position without the need for additional support structures. Installation and maintenance activities require a clear and level working platform. With a generally smaller plan area than a Horizontal Axis Wind Turbine (HAWT), VAWTs are favourable in the context of rooftop mounts in CBD areas, although many HAWT turbines have been successfully installed on rooftops.

Electronics and control equipment can be wall-mounted in the building plant room or floor-mounted externally in a weatherproof cabinet. The space requirement for control panels and the grid metering board is relatively minor. Grid connection involves installation by an approved electrician and the use of an approved inverter as minimum requirements in Victoria. A three-phase grid connection is required, and electronics and control equipment must be located within 85 m of the turbine.

FIGURE 3.47

Vertical-axis wind turbines in Melbourne's Docklands. [Hassel]

Micro Wind Benefits

- Wind Turbine systems generate electricity that can be consumed on-site
- Allows for greater energy generation than solar photovoltaic on buildings with a good wind resource
- Is a visible sustainability measure, which could be used by a company to promote their green credentials
- Wind turbines operate day and night, whenever it is windy

Electricity Demand-Reduction Potential of Micro Wind

Demand reduction potential is heavily dependent on the mean annual wind speed at the site, because the power output from a wind turbine is a function of the cube of the average wind speed. In other words, if wind speed doubles, the power output increases eight times [177].

Figure 3.48 shows that annual delivered energy at mean annual wind speeds below 5 m/s is 4 MWh or less which is not enough to power a ten-person office. On a wind site with a mean annual wind speed between 5 m/s and 8 m/s, the qr5 will generate up to 15 MWh/annum. This is equivalent to the electrical needs of a 20- to 30-person office (ie for lights, computers, servers, printers, faxes and phones) [177].

Demand reduction potential also depends on the efficiency of the turbine in converting mechanical energy into electrical. Recent advances in the design of the qr5 quiet revolution turbine have already improved the efficiency (see Figure

3.49 for comparison), and projections for the next decade are for further efficiency improvements up to 25% [178].

Micro Wind Implementation Recommendations

To properly assess the wind resource at each potential site this report considered an entire 3D model of the wind resource in the area and surrounds. Where the wind resource was found to be sufficient, a wind load analysis was undertaken to see how many turbines can fit onto the building with an adequate safety margin. This process was undertaken using the Melbourne CBD area, demonstrating that there is potential for substantial wind power from CBD buildings. The modelling is discussed in detail in Part 5, Section 3.2 "Executive Summary of CBD Wind Project" and in Appendix 3.

This analysis concluded that there was enough wind resource on suitable buildings to accommodate 269 turbines in the Melbourne CBD area generating 2.3 GWh of energy per annum. However it is the view of this report that the relatively lower cost of solar PV makes micro wind a less attractive option and therefore the report considers micro wind to only be financially viable in a limited number of cases.

Micro Wind Costs

The cost estimates below were derived from discussions with Maxim Renewables, the distributor for qr5 turbines in Australia. Installation of other micro wind

turbines would lead to different costs, but Table 3.24 is indicative of the expected costs for the installation of any turbines with a similar power output.

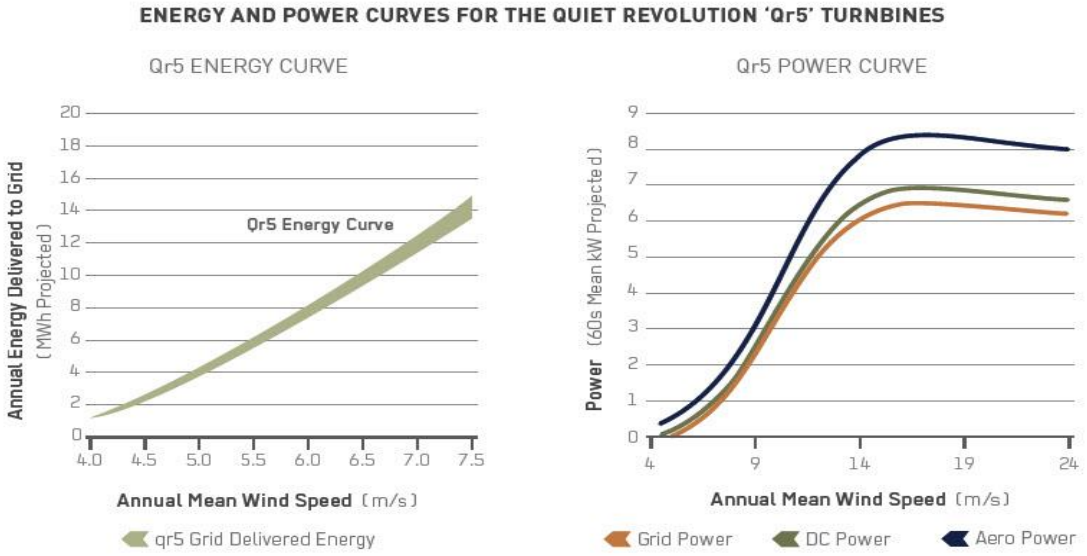

FIGURE 3.48

Power and Energy Graphs for Quiet revolution turbines

The average installation cost is currently about $10,000 per turbine, with the actual cost heavily dependent on installation type. However significant economies of scale are available by installing multiple turbines at a particular location. Based on initial CFD and structural analysis, a single building will incorporate seven turbines on average, resulting in an estimated cost of $4,000 per turbine. Where such placement of turbines on top of load bearing columns is not possible, steel grillages may be used to support the incorporation of multiple turbines on an existing roof.

Micro Wind Product Development

Historically, noise levels are a key concern associated with wind turbines operating in population centres. However, the qr5 turbine generates low noise, owing to the low tip speed ratio (because the turbine tips are relatively close to the axis of rotation). A number of independent studies have established that background noise levels in urban environments typically reach rates equal to or greater than turbine noise levels.

FIGURE 3.49

Quiet Revolution turbines [Quiet Revolution]

TABLE 3.24

Projected turbine unit costs (AUD) for large-scale rollout

	Unit Cost	Installation Cost	Installation Cost with Grillage	Total Cost (w/o Grillage)	Total Cost (with Grillage)	Annual Maintenance Cost
Current retail price, single unit	$36,500	$10,000	$18,000	$46,500	$54,500	$625

Price for 250-500 units	$27,000	$4000	$12,000	$31,000	$39,000	$625
Price for 500-1000 units	$25,000	$4000	$12,000	$29,000	$37,000	$625

Source: http://decarboni.se/publications/zero-carbon-australia-buildings-plan/8-onsite-electricity-generation