Building integrated wind energy system

Building integrated wind energy system

Wind turbine technologies, used in wind home systems in particular, contribute to social development by improving the quality of life to villagers in remote islands and rural areas, similar to that of solar home systems. These benefits include:

Building integrated wind turbines offer opportunities for local economic development, including:

Wind energy technologies can be classified into two categories - macro wind turbines that are installed for large-scale energy generation such as wind farms, and micro wind turbines used for local electricity production. Micro wind turbines are suitable for application at the building scale and are called "building-integrated wind turbines". The main components of a wind turbine include blades, rotor, gearbox and generator. Small wind turbines were originally designed with a horizontal axis, also known as HAWTs. To reduce the need for a high tower, and for aesthetic reasons, vertical axis wind turbines (VAWTs) become increasingly popular for integrated building applications. Furthermore, VAWTs are also quieter (resulting in less noise nuisance) than HAWTs during operation.

Wind turbines can be grid-connected or off-grid. Off-grid systems require battery storage to store surplus electricity, thereby providing a more stable electricity supply. Their application is most suitable for rural and remote areas, such as remote villages and small isolated islands, where grid power is not available. Conventionally, grid-connected systems require power converters to convert the generated DC electricity to AC electricity to be compatible with power grid and AC-electricity-based appliances. As technologies improve, modern wind turbines can also directly generate AC power.

Recent developments in building integrated wind turbine technologies involve improving reliability, improving efficiency at low wind speeds and lowering capital cost. Wind turbine blades are now designed with lightweight materials and aerodynamic principles, so that they are sensitive to small air movements. Furthermore, the use of permanent magnet generators, based on rare earth permanent magnets, results in lightweight and compact systems that allow low cut-in wind speeds. In this way, electricity can be generated with wind speeds as low as a few metres per second.

To be more attractive for integrating into buildings, micro wind turbines are also being designed to be more visually attractive, without compromising their performance. Another objective is to reduce/eliminate noise associated with blade rotation and gearbox/generator noise. This can be achieved by using low-noise blade designs, vibration isolators to reduce sound and sound absorbing materials around the gearbox and generator. Lastly, simplifying wind turbine components/systems also adds to the attractiveness of wind turbine application and reduces maintenance costs. Efforts in this area include the integration of inverters into the nacelle (rotor hub) (EWEA, 2009).

Lastly, to lower the product costs, advanced blade manufacturing methods, such as injection moulding, compression moulding and reaction injection moulding, are being applied to reduce labour and increase manufacturing quality.

In terms of applications, development of wind home systems (WHSs), based on the idea of solar home systems is a growing trend. A typical wind home system comprises a micro wind turbine, a battery, and various DC electrical appliances. Research shows that in coastal island areas with frequent windy conditions (e.g., Kutubdia and St Martin islands in Bangladesh), the application of WHSs is more cost effective compared with solar home systems (Khadem, 2006).

Micro VAWTs are often installed at locations with frequent windy conditions. Prior to installation of a wind turbine, it is important to collect wind data in the immediate vicinity of a building or installation site. Based on the wind data, a suitable type of wind turbine and suitable location can be determined to maximise the electricity generation. One important criterion is to match ambient wind conditions with a wind turbine"s cut-in wind speed, rated wind speed and cut-out wind speed.

Prior to installation of wind turbine(s), especially in a large number, on an existing building rooftop, it is important to ensure the roof structure is strong enough to hold the additional loads. These include the weight of the wind turbine(s) and vibration from wind turbine operation. Vibration absorbent technology should be applied in order to prevent damage to building structure and to reduce interior noise in the building. As wind turbines are usually installed on the high point of the building, prevention measures from lighting damage should be in place. Accessibility for maintenance should also be planned for.

Figure 2: Integrating micro wind turbines to the built environment in urban setting

In addition to the above incentivising policies, local building and construction authorities should regulate the installation of building integrated wind turbines in the following aspects: