Schweizerische Eidgenossenschaft
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Swiss Agency for Development and Cooperation SDC

IIEC International Institute for Energy Conservation

eds MEGHRAJ BASE

Building Integrated Wind Turbine

Source: CTCN

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' or 'Vertical Axis 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 aesthetics, vertical axis wind turbines (VAWTs) became increasingly popular for integrated building applications. Furthermore, VAWTs are also quieter (resulting in less noise nuisance) than HAWTs during operation.

Vertical Axis Wind Turbines generators (200 W-10kW) can be used as stand-alone systems or as grid connected systems, and both can be paired with other energy conversion systems, such as photovoltaics. With a height from 2 to 10 meters, small wind turbines can be placed on rooftops, on streets or in gardens, they have relatively little visual impact and are able to produce energy even from modest wind flows. In addition to that, small wind turbines may also be coupled to street lighting systems (smart lighting).

'Building-Integrated Wind Turbines' Players in India

1. Windstream Energy Technologies
2. Spitzen Energy
3. Avant Garde Innovation Pvt. Ltd.

Although vertical axis wind turbines can have different shapes, they can be divided in two main groups: the Savonius turbines (1929) working primarily on the aerodynamic drag principle and the Darrieus turbines (1931) were operating on the principle of lift. On the market there are now innovative models, which take advantages of the features of both. **Savonius Wind Turbine** is a drag type turbine, commonly used when high reliability is required in many things such as ventilation and anemometers. Because they are a drag type turbine, they are less efficient than the common HAWT. Savonius are excellent in areas of turbulent wind and can self-start at low wind speeds (See figure below).

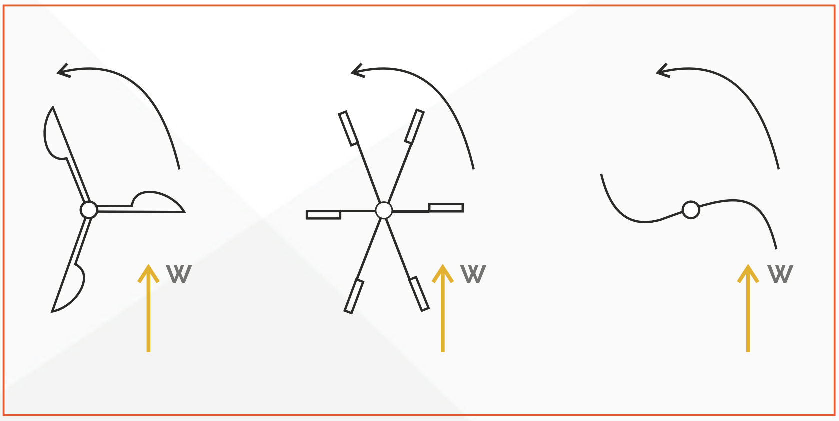

Figure 1: Savonius Wind Turbines

Darrieus wind turbines are commonly called "Eggbeater" turbines, because they look like a giant eggbeater. They have good efficiency but produce large torque ripple and cyclic stress on the shaft, which contributes to poor reliability. They also generally require some external power source, or an additional Savonius rotor, to start turning because of the extremely low starting torque. Torque ripple is reduced by using three or more blades, resulting in a higher solidity of the rotor. Solidity is measured by blade area over the rotor area. Newer Darrieus type turbines are not held up by wires but have an external superstructure connected to the top bearing. Darrieus turbines can either have circular or straight wings (the latter called H-blade Darrieus); a further development has a helicoidal winged design called Gorlov, after its inventor, and it is more efficient (See figure below).

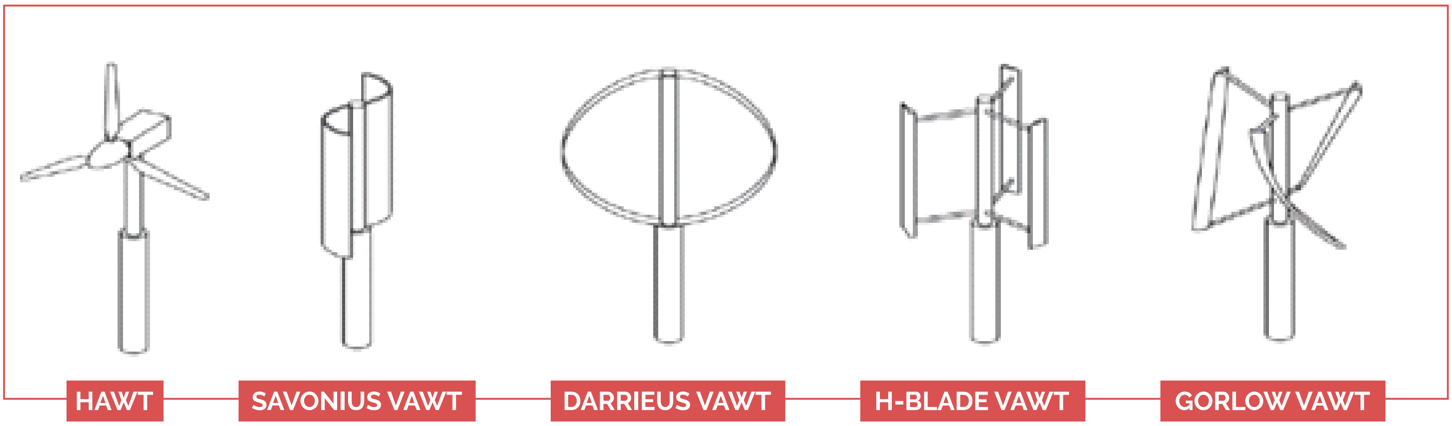

Figure 2: Different types of wind turbine

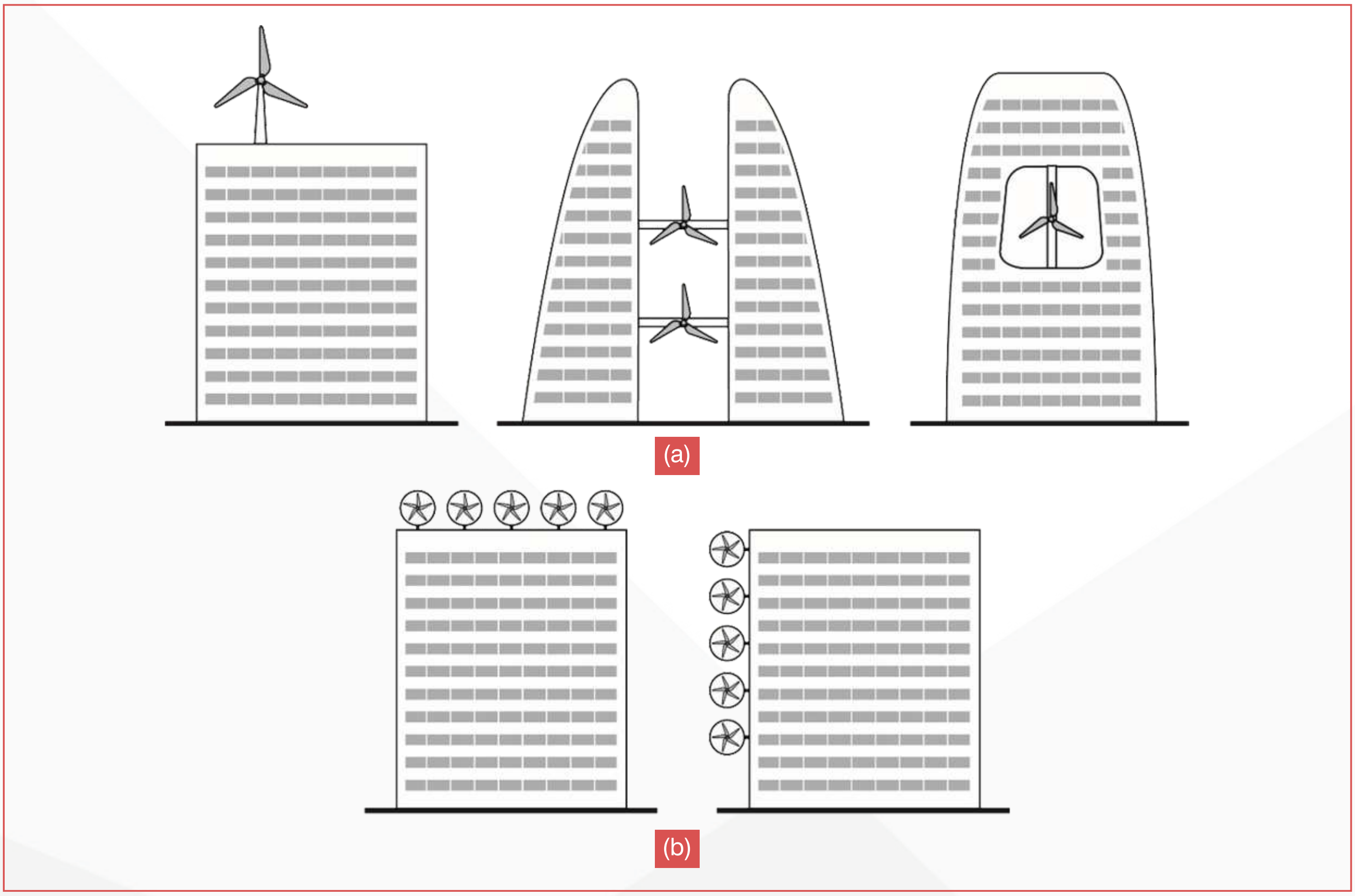

Figure 3: Building-integrated wind turbine system using wind turbines: (a) three possible installation locations of large-size wind turbines; and (b) two possible installation locations of small-size wind turbines.

Financial requirements and costs

Financial requirements for the implementation of building integrated wind turbines include investment and maintenance costs. Investment cost covers not only the products and their installation, but also feasibility studies and system design related activities. One of the most critical activities is to analyse (for existing buildings) and predict (for new buildings during design stage) the wind conditions on and around the building to determine the feasibility and location for installation.

The cost components of wind turbines vary depending on the type, capacity rating, and local availability. Return on investment depends greatly on the actual wind conditions and performance onsite, and partially on the incentive level of feed-in tariff and local electricity pricing.

Building Integrated Wind Turbine Application and Potential End Use

Technology	Output energy	Application	Specific requirement
Building integrated wind turbine	Electricity	Offset Building electricity consumption & Export to Grid	Unobstructed open area (Rooftop or ground)

Source: Saur energy

Advantages of building integrated wind turbine technologies:

- 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.
- **Solar-wind hybrid systems combine two of the fastest growing renewable energy technologies.** Such a concept has emerged due to the complementary nature of solar and wind. Solar, due to its dependence on sunlight can produce power only during the day, probably from 8 am – 6 pm. The Wind, on the other hand, starts blowing during late evenings and reaches its peak during the nights. Due to this inherent nature of wind and solar, **power production can be leveled out all throughout the day with a solar-wind hybrid.**
- 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.

Solar Mill

WindStream Technologies, Inc. was established in 2008 with the goal of designing, prototyping and manufacturing affordable and scalable renewable energy technologies for a global marketplace. The Company has developed and tested the first-of-its-kind, integrated, hybrid energy solution and is now marketing and selling SolarMills® to a worldwide customer base.

WindStream Technologies' engineers have designed a unique set of vertical axis wind turbines, added the highest quality solar panels, and a patented system of integrated electronics, to create a hybrid device with the highest energy density in the market.

Hybrid Plant INSTALLATION ON Directorate of Fisheries OFFICE Kavaratti Lakshadweep

Plant Details:

I. System: 20kW (15 kW Solar + 5 kW wind) Off grid
II. Model: (SM 10-48P) with 240V 400Ah T-GEL Battery
III. Load: 14 kW office loads for 8 hours of operation.

These are designed to power the building which requires continuous electricity for storing the collected fish.

The table below gives the information on the amount charged per KWH for various categories.

(20kW) Hybrid Renewable Energy Off-Grid system	
Cost of System in INR	2,715,500.00
Generation per day in kWH	65
Unit rate in INR	22.5
Savings Per Month in INR	36563
Cost Savings per Annum	438750
Return on Investment	6.2 years