Integrating Wind Turbines in Skyscrapers

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Energy Crisis in the UAE

It is no secret that the world is suffering from an energy crisis as fossil fuels and natural resources are near depletion. Renewable source of energy have been receiving increased attention over recent years.

If we consider the UAE:

- Oil resources will deplete in the next 40-70 years [1]
- Due to the UAE's fast growth by 2020, it will be capable of generating only half of the energy needed to meet growing demand
- Alternatives required: Renewable energy sources

The skyscrapers in the UAE cannot be left unnoticed. Every year, new towers are rising and the population is increasing.

- Utilizing the existing towers to generate energy for the residents
- Integrating modified wind turbines
- High-rise buildings are the most suitable for wind turbine integration [2]

Barriers to Implementation

Size of the Turbine

- Adding weight/load to the overall structure will increase the risks of failure in the foundations

Low Efficiency in Operation

- Work input is significantly larger than work output, therefore, resulting in wasted energy

Noise & Vibration Generated

- Since the turbines are Installed in residential towers, noise will cause inconvenience to the residents

Installation

- Positioning of the wind turbine to achieve the maximum work input and estimating the additional loading the structure will have to bear.

Maintenance

- Sustaining the wind turbine against operational and environmental hazards, in order to extend life span of components.

Solutions

An increase in the size of the turbine will result in an increase in installation cost and an increase in noise level. However, bigger turbines generate more power.

Introduction of Flodesign Turbines

- Balance between power and size.

The unique "jet engine-like" design is smaller in size and height allowing easier installation.

Figure 1. Size and design of turbine [3]

- Another advantage of using the Flodesign is the high efficiency of the turbine.
- The Flodesign substantially improves the turbine's efficiency resulting in up to three times more energy output per unit of swept area.

Use of Helical gears

- Helical gears are a different type of gears designed in such a way that they minimize the power lost in a certain gear system.

Figure 2. Helical gear [4]

Installation on rooftops

- Conventional wind turbines are mainly installed between two towers, as in the example of the twin towers in Bahrain.
- Installing on rooftops will minimize the noise levels.

Loading

- Factor of safety must be taken into account
- Analysing the data for the loading effect, checking safety standards and consequently decide on installation.

Employing Nanotechnology

- Oiling the wind turbine's components with nano-lubricates to reduce friction levels.
- Applying nano-coats to protect the surface of blade against harsh environmental effects.

Evaluation

Flodesign is more efficient than the conventional wind turbines since it uses a combination of smaller blades in such a way to form a vortex as air passes through vents slots. Table 1 displays the cost analysis comparison between the use of the conventional wind turbines versus the Flodesign.

Table 1. Rotor costs for Conventional and Flodesign turbines

Specification	Conventional turbines	Flodesign turbines
Weight (tons)	19.5	2.67
Cost ($/kg)	27	200
Total rotor cost ($)	526,500	413,400

Like all renewable sources of energy, initial costs are high; however, in the long run, revenues will outweigh costs and energy will be generated at relatively low costs.

Nanomaterials help reduce friction levels, which decrease wear and tear, hence extended components' lifespan. While nanocoats protect against dust-filled UAE environment though nanomaterial's structural properties.

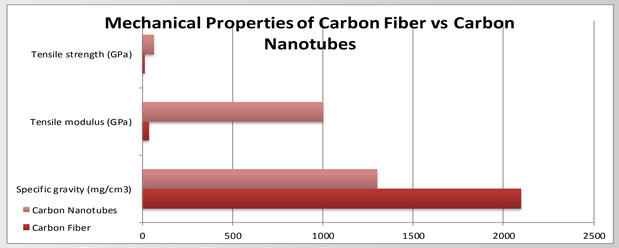

Figure 2. Carbon Fiber vs Carbon Nanotubes

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