WEOLIC

WIND MURAL PAINTING

Description

Copenhagen's icon is mermaid and it is said that sirens used to sing their songs to the sailors who came in boats. Now, **Refshaleøen** was a port and as it is known music is energy. So we want to translate the idea of a sea symphony into a visual concept related to Copenhagen's Mermaid, and technology. Then, **renewable energy can be beautiful** and people can also learn about it **to feel enchanted like the sailors with mermaid's songs.** We will create a big light blue wind screen with a form of a wave and sea motif on it named **"WEOLIC".** This name is a summatory of words "**wave**", "**we**" (to include community by putting them as part of the project because everybody will use the energy) and "**eolic**". It will also increase turism as it will become like a second icon of this green city and as an example to a world asking an ecological answer.

Vantage points

According to company MotorWaveGroup, a set of small plastic wind turbines (20 x 26 cm in diameter) coupled to one generator are capable of producing 15 Watts of energy per m2 at wind speeds of 5 meters/second. These turbines are coupled to each other by gear teeth, gathering more m2 of wind per generator. We propose a similar concept but using larger turbines which have a diameter of 1 meter and are coupled in groups of 4 turbines per generator

Technology and list of the primary materials used in our design

The energy-generating system consists on an undulating screen that measures 80 meters long and 30 meters high.

This screen is composed of stainless steel columns as a main structure. Horizontal stainless steel tubes configure a secondary structure, supporting 50 cm radius recycled plastic micro turbines and adding rigidity to the structure. Small electric generators are fixed to this structure as well.

Micro turbines are interconnected vertically by gear teeth, improving the system´s efficiency by allowing to install one generator every 4 turbines.

The energy produced by each generator is driven to transformers located in an engine room buried 1 meter deep under the screen; contained between concrete foundation bases for steel columns. Each column supports 6 sets of 1 generator with 4 microturbines (24 turbines per column)

Estimated annual kWh (kilowatt-hours) generated by our design

Based on data [1] presented by MotorWaveGroup, with wind speeds 5m/second , they predict that 20 turbines (1 square meter of total area) could generate 15 Watts of power.

The calculations to obtain that number (as detailed in [2]) are the following:

Air density at sea level = 1.23 kg/m3

Turbine area = PI x radio^2

Kinetic energy = 0.5 x mass x speed^2

mass /second = speed (m/s) x area (m2) x density (kg/m^3)

Wind Power (Watts) = 0.5 x swept area x air density x speed^3

In the case of 20 turbines of 26 cm in diameter (swept area = 1m^2), the total wind power received by the system would be 4.08 Watts x 20 = **81.6 Watts**

Therefore the efficiency of the system proposed by MotorWaveGroup may be calculated as follows

Efficency = Generated Power / Wind Power

Efficency = 15Watts / 81.6 Watts = **18.3** % in the best case scenario.

There is an upper limit to the efficiency of any wind turbine, known as the Betz limit [3] which is 59 %. No generator could overcome this efficiency.

In our proposal, supposing that the efficiency of our design is similar to the one proposed by MotorWaveGroup and the average wind speed is 5 m/s, we could estimate that the kWh generated could be 23,13 kWh:

Turbine area = PI x (0,5m)^2

Turbines total area = 84 columns x 24 turbines x 0,78m^2 = 1572 m^2

Wind Power per turbine = 0.5 x 0,78 m2 x 1,23 kg/m3 x (5 m/s)^3 = 60 Watts

Total power generated = 60 Watts x 84 columns x 24 turbines x 0,183 efficency

Total power generated = 22135 Watts or **23,13 kWh**

Dimensions

84 columns of 24 turbines (1m in diameter each), with a DC electric generator every 4 turbines.

Environmental impact statement

1. **Availability of the wind resource at the site:**
   Based on the information provided in the bidding documents and retrieved from the web site www.emd.dk/windres/using the Wind Resourse Mapper software we could conclude that the average speed at the site would be an average of 5 meters/second (based on statistics of wind turbines at 25 meters above ground)

2. **Speeds required:**
   Conventional generators require speeds exceeding 10 m/s to generate power efficiently. An alternative for slower speeds is the use of "micro-turbines" whose diameters range between 26 cm and 2 meters and being mechanically coupled together by gears. There by reducing the need for an electric generator for each propeller. This idea was proposed by Lucien Gambarota in Hong Kong, in 2007.

References

[1] http://www.motorwavegroup.com/files/motorwindhkupressconference.pdf

[2] http://www.reuk.co.uk/Calculation-of-Wind-Power.htm,

[3] http://www.reuk.co.uk/Betz-Limit.htm

Other related articles or websites

http://edition.cnn.com/2007/BUSINESS/04/15/ft.gambarota/

http://www.motorwavegroup.com/

http://www.reuk.co.uk/Hong-Kong-Micro-Wind-Turbine-Arrays.htm

Other technical considerations:

The generators would require an electronic system to control the variable output of energy produced by the changing wind conditions. This electronic system would have to stabilize the output voltage in order adequate it to the requirements of the public electric grid. The details of such control system requires a deep technical analisys that is out of the scope of this document