Wind Energy

Introduction

Wind turbines harness the wind to produce electrical power. A turbine consists of generator that is equipped with fan blades and placed at the top of a tall tower. The tower must be tall enough to harness the wind at a greater velocity while avoiding obstacles such as trees, hills, and buildings. As the turbine rotates in the wind, the generator produces electrical power. A single wind turbine can range in size from a few kW for residential applications to more than 5 MW.

For someone to justify construction of a turbine, it is recommended to have a minimum of one year of wind data to determine the feasibility of the location of interest. Rowan University currently has an Anemometer Loan Program whose purpose is to help potential customers collect one years worth of data at no cost to them. More information about this program is available at http://www.rowan.edu/cleanenergy. With the data collected from the anemometer and making use of past electric bills, customers receive a report summarizing the potential for a wind turbine on their site. This report contains suggested sizes of turbines that would work for the particular customer and it discusses the possibilities for purchasing turbines. Also, this report contains a detailed explanation of a payback period analysis for the installation of a turbine at the customer's site.

Performance and Cost

The most ideal places for wind turbines are areas that have consistent strong winds. Wind turbine are located in areas with strong winds. It is best for these areas to have an annual capacity factors (which is the actually power output of the turbine divided by the theoretical output) ranging from 20% to over 40% [1]. The life expectancy of a wind turbine is around 20 years. During this time, maintenance may be required on the turbine. Figure 1 shows wind speed vs. power output for some popular turbines. The cost of wind energy is determined by the initial cost of the wind turbine installation, the interest rate on the money invested, and the amount of energy produced. Large-scale wind farms can be installed for about $1,000/kW, while small-scale wind turbine units cost up to $3,000/kW.[2]

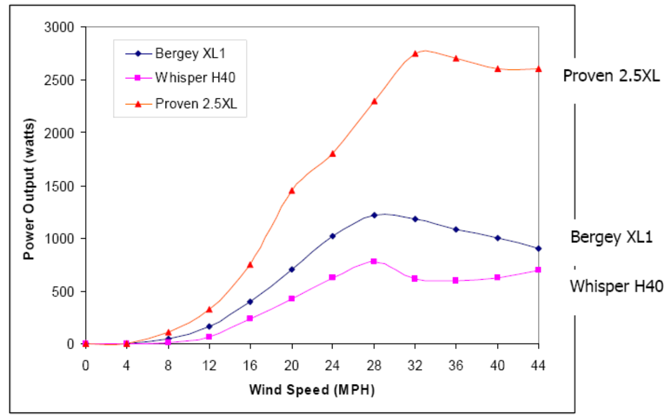

Figure 1: Power Output vs. Wind Speed

In areas with strong winds, the costs of generating electricity ranges between $0.03/kWh and $0.06/kWh. [2] These costs include the wind production federal tax credits of 1.7 cents/kWh for the first ten years of operation. A typical 10 kW home wind turbine system will cost $25,000 - $35,000 to purchase and install. If placed in windy areas (Average wind speeds for Newark and Atlantic City are 9.8 and 10.2 mph, respectively[3]), it will produce between 10,000 to 18,000 kWh per year.[2] This turbine typically has a blade diameter of about 20-25 feet and sits on a tower about 100 feet tall. Homes sitting on a one-acre parcel could probably accommodate such a turbine, depending on local zoning restrictions. In remote areas, generating electricity with diesel generators can range from $0.25/kWh to $1.00/kWh. [2] So in areas with good wind, wind-generated electricity is clearly cost effective.

Strengths & Weaknesses

Power generated from wind farms can be inexpensive when compared to other traditional power production methods. Typical costs of wind power are between $0.03/kWh and $0.06/kWh [2]. Wind turbines do not produce any harmful emissions or require any fuel product for operation. Minimal space is required for a turbine farm and the land below each turbine can be used for animal grazing or farming.

A disadvantage of wind turbines is what some people would call an aesthetic problem created when placing them in areas of high population density. Aesthetic and neighborhood codes could discourage or even prohibit the use of wind turbines to supply energy to individual homes. A map of New Jersey zoning regulations is shown in Figure 2 below.

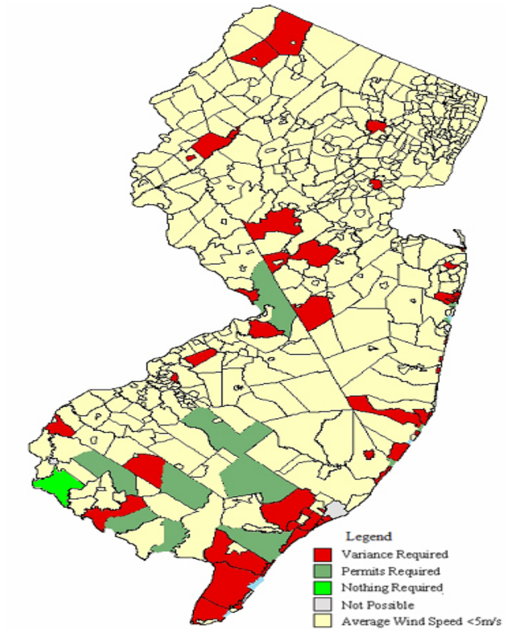

Figure 2: Zoning Regulations Obtained from Municipalities

Growth

To date, the total U.S. wind energy capacity (installed) is 10,492 MW.[5] In New Jersey, the Jersey-Atlantic Wind Farm in Atlantic City has a rated power of 7.5 MW which could produce enough energy to power more than 2,500 homes every year!

Case Study

In order to fully grasp the advantage of using wind power, let's look at a hypothetical situation. Consider the total initial cost of a 5 kW residential system and a 50 kW commercial system:

Residential 5 kW system = $15,000 - $6,000 after rebates

Commercial 50 kW system = $100,000 - $70,000 after rebates

Let's assume the cost of electricity to be 10 cents per kWh and the annual output from the residential and commercial systems at a 14 mph site to be 10,000 kWh and 100,000 kWh, respectively. The annual energy-cost savings from both systems would be:

Residential $0.10/kWh x 10,000 kWh = $1,000

Commercial $0.10/kWh x 100,000 kWh = $10,000

So the residential payback period would be:

$6,000/$1,000 = 6 years

And the commercial payback period would be:

$70,000/$10,000 = 7 years

References

Figures and Tables

Figure 1: Wind Speed vs. Power Output of 3 Turbines

From Arquin, M. (2006) http://www.kidwind.org/pdfiles/Wind%20Power%20Curvesv3.pdf

Figure 2: Zoning Regulations

From Rowan Clean Energy Team (2006)

End Notes

[1] California Energy Comission (2006) http://www.energy.ca.gov/distgen/equipment/wind/wind.html

[2] U.S. DOE Office of Renewable Resources and Alternate Energy (2006) http://www1.eere.energy.gov/windandhydro/wind_technologies.html

[3] NCDC Average Wind Speeds (2006) http://www.ncdc.noaa.gov/oa/climate/online/ccd/avgwind.html

[4] American Wind Energy Association U.S. Projects (2006) http://www.awea.org/projects/

Additional Information

Information on Several Wind Turbines

http://www.kidwind.org/pdfiles/XL1.Spec.pdf (1 kW class)

http://www.kidwind.org/pdfiles/Excel.Spec.Frt.pdf (10 kW class) http://www.kidwind.org/pdfiles/proven.pdf (0.6 to 15 kW class)