ME 417
Design of Alternative Energy Systems

Project 2 Design of a Wind Power System
Due Monday, February 28, 2011

The Air In Motion (AIM) Administration for the state of Iowa has hired the engineering firm of Bénard and Somerton (aka BS Engineering) to provide preliminary designs for wind power systems in the state. Two or three associates of the firm have been assigned to investigate two or three different sites in the state. Each associate will perform the design analysis for a single site. The team will use the Iowa Energy Center Wind Turbine Output Calculator located at

http://www.energy.iastate.edu/Renewable/wind/windstudy-index.htm

The sites are to be in different counties in the state of Iowa. A design analysis should be done at each site for two power systems. One system should have a operating of power 1500 kW, while the other system should have an operating power of 65 kW.

For each site and power system, the design team will undertake a design study to determine

- turbine type
- the optimal tower height

The following turbines shall be considered for the two power systems:

1500 kW Power System
Nordtank 1500/64 (rotor diameter of 60 m)
GE Wind 1.5s (rotor diameter of 77 m)
NEG Micon NM72C/1500 (rotor diameter of 82 m)

65 kW Power System
Vestas V15 65 kW (rotor diameter of 18 m)
Nordtank 65 (rotor diameter of 20 m)
Windmatic 15S (rotor diameter of 11 m)

The objective function used in the design study will be the predicted cost of the electricity in $/(kW⋅hr). The team will want to compare the results of the design studies at the sites chosen.

The following parameter values should be used in the design analysis:

- Site: High Exposed Unobstructed Crop Land
- Loss Factor: 12%
- Maximum Rotor Height: 100 m
- Interest Rate: 8%
- System Life: 30 years
In determination the objective function, the following factors must be included:

- **Cost of Tower:** \((0.1 \times \text{rotor diameter in m})^2 \times (0.3 \times \text{tower height in m}) \times 500\)
- **Cost of Generator:** \(35 \times \text{(turbine power in kW)} \div (A/P,i,N)\)
- **Cost of Blades and Rotor:** \(6 \times \text{(rotor diameter in m)}^3\)

The cost of the power produced in $/(kW \cdot \text{hr}) is then:

\[
\text{Power Cost} = \frac{(\text{capital costs} \times (A/P,i,N) \div \text{(annual energy produced)})}{(1+i)^N} \left( \frac{1}{1+i} \right)
\]

where

\[
(A/P,i,N) = \frac{i(1+i)^N}{(1+i)^N - 1}
\]

The team is required to submit a technical memo that documents their work. It is suggested that this documentation might include graphs of power cost versus tower height for all six turbines at all sites. The memo should also include a final design decision for each power system at each site.

**Getting Started**

- Each team member selects a site.
- Using the Iowa Energy Center Wind Turbine Output Calculator, determine the annual power output for the different turbines at different tower heights.
- Develop a cost calculator spreadsheet using the cost equations provided
- Determine the energy cost for each turbine at different tower heights.
- Using the cost of energy, determine which turbine is “best” for each power system.
# ME 417

## Design of Alternative Energy Systems

### Project Grade Evaluation

#### Project 3 Design of a Wind Power System

Student Names: ____________________________________________________________

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<th>Topic</th>
<th>Assigned Score Site #1 65 kW</th>
<th>Assigned Score Site #1 1.5 MW</th>
<th>Assigned Score Site #2 65 kW</th>
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