Feasibility of A Ball State Wind Turbine

Luke Pentecost
Advisor: Dr. Eric Hedin
Department of Physics & Astronomy, Ball State University
Ball State PHYS 483

Introduction

The original question asked for this research; is it feasible for ball state to invest in a wind turbine. That question itself is the basis behind this research.

• The data used in this research spans two years.
• From February 26, 2013, to February 25, 2015
• Differing turbine heights, power curves, and prices all affect the feasibility of a turbine.
• Analysis of the differing turbines allows to optimally choose which the best turbine.
• The feasibility in this study was ultimately determined by how many years to pay off the turbine.

Apparatus & Experimental Details

For this experiment a specific environment is needed:

• The environment needed for a turbine should be away from larger buildings and most commercial settings as to avoid turbulence.
• For the wind data to be collected the data must be obtained from an area that is high enough to get pure wind data.
• Wind data in this experiment was collected from a 15m pole.
• That data can then be applied for these turbines:

The Turbines Considered

Turbine 1: VESTAS 126 – 3.3MW IEC IIA – 137m Tower
Turbine 2: GE – 2.5MW – 139m Tower
Turbine 3: Nordex – N117/2500kW – 91m Tower
Turbine 4: Repower – 3.2MW – 114 – 143m Tower
Turbine 5: GAMESA – G52 – 850kW 65m Tower

Equations

1. \[ \frac{m_i}{h} = \left( \frac{\text{data value}}{\text{time period}} \right) \times 0.857 \times 0.725 \]
2. \[ \text{Wind Speed at Hub Height} = \left( \frac{\text{Hub Height}}{\text{recorded data}} \right) \times \text{Environmental Constant} \times \text{Wind Speed} \]
3. \[ \text{kWh/Year} = \text{Power for wind speed} \times \text{Hours at wind speed} \times \text{Maintenance cost per lifetime} = \text{Cost of Turbine} \times 0.02 
\]
4. \[ \text{Cost of Turbine} = \# \text{of MW of Turbine} \times 1,000,000 \]
5. \[ \text{Total Turbine Cost} = \text{Cost of Turbine} \times 0.02 \]
6. \[ \text{Years to pay off} = \frac{\text{Total Power Produced [MW h/year]}}{\text{Cost of Electricity [\$/kWh]}} \]

Results & Conclusion

In the table below, the results show how the different turbines would fare in the conditions at Cooper Farm. By the criteria of a turbine taking the least amount of time Turbine 4 would most fit that criteria, although Turbine 1 produces the most energy. The smallest and least expensive turbine, Turbine 5, is not a feasible option. The results show that just because a turbine gives the most energy does not mean it is most feasible.

Sources