Feasibility of A Ball State Wind Turbine

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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] $$?\ \frac{mi}{h} = \left(\left(\frac{data\ value}{time\ period}\right) \times 0.857\right) + 0.725$$

[2] $$Wind\ Speed\ at\ Hub\ Height = \left(\frac{Hub\ Height}{Height\ of\ recorded\ data}\right)^{Environmental\ Constant} \times Wind\ Speed$$

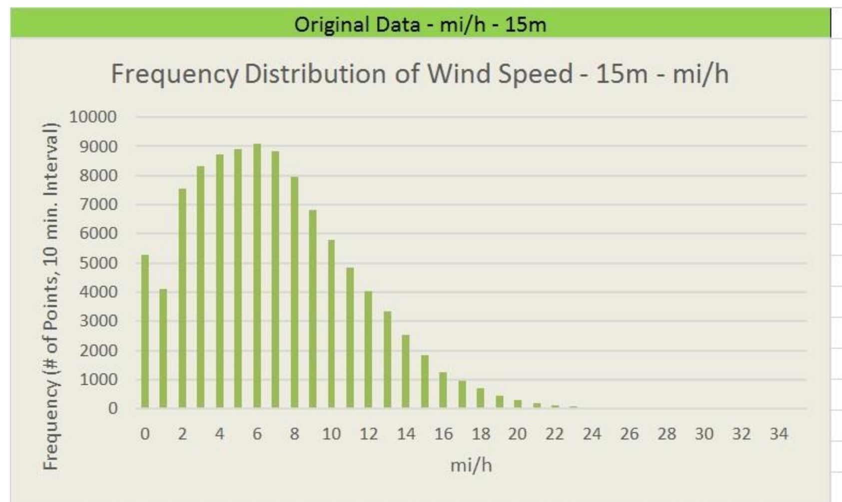
[3] $$\frac{kWh}{year} = Power\ for\ wind\ speed \times \frac{Hours}{year}\ at\ wind\ speed$$

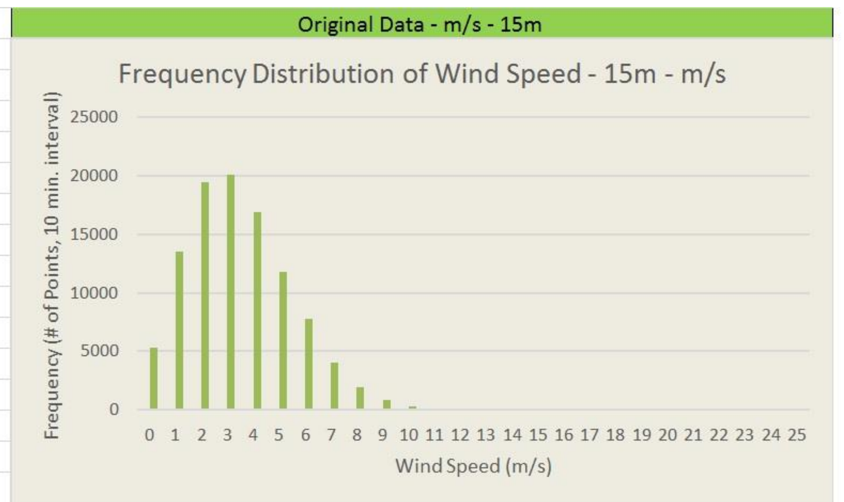
[4] $$Maintence\ cost\ per\ lifetime = Cost\ of\ Turbine \times 0.02$$

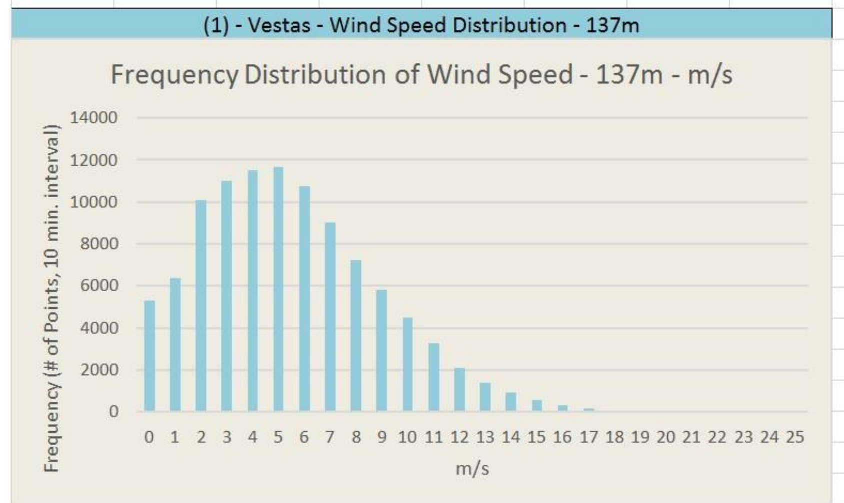
[5] $$Cost\ of\ Turbine = \#\ of\ MW\ of\ Turbine \times 1{,}000{,}000$$

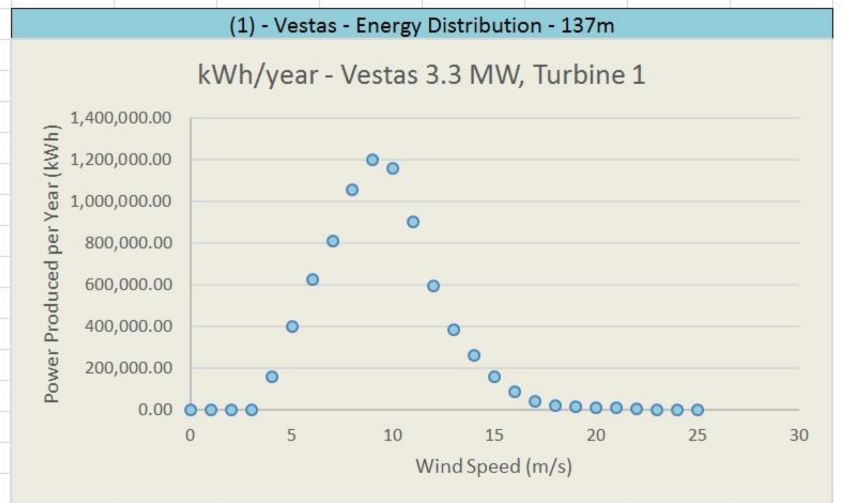
[6] $$Years\ to\ payoff = \frac{\frac{Total\ Turbine\ Cost}{Total\ Power\ Produced}\left[\frac{\$}{kW\ h/y\ ear}\right]}{Cost\ of\ Electricity\ \left[\frac{\$}{kWh}\right]}$$

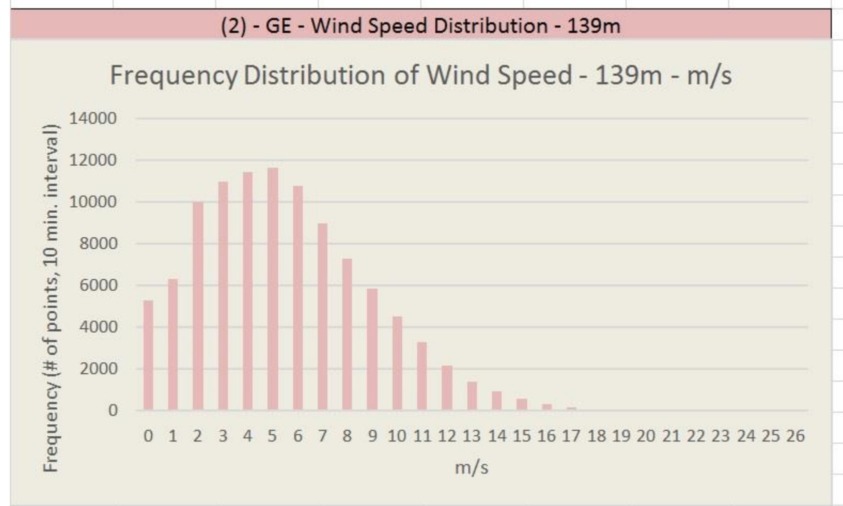
Graphs For Turbines, Wind Speed Distribution and Energy Distribution

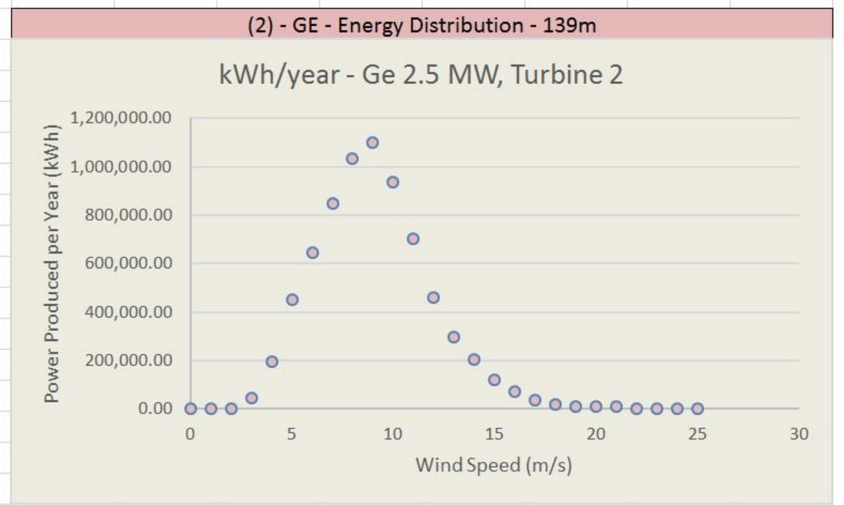


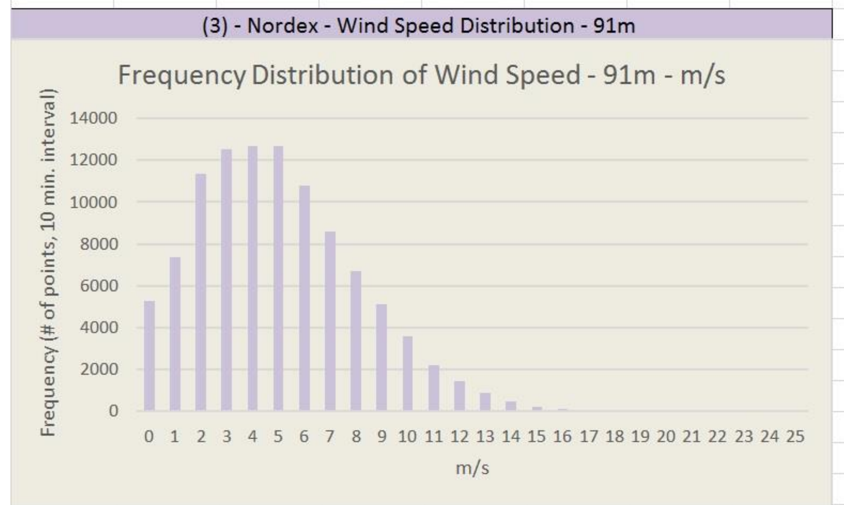


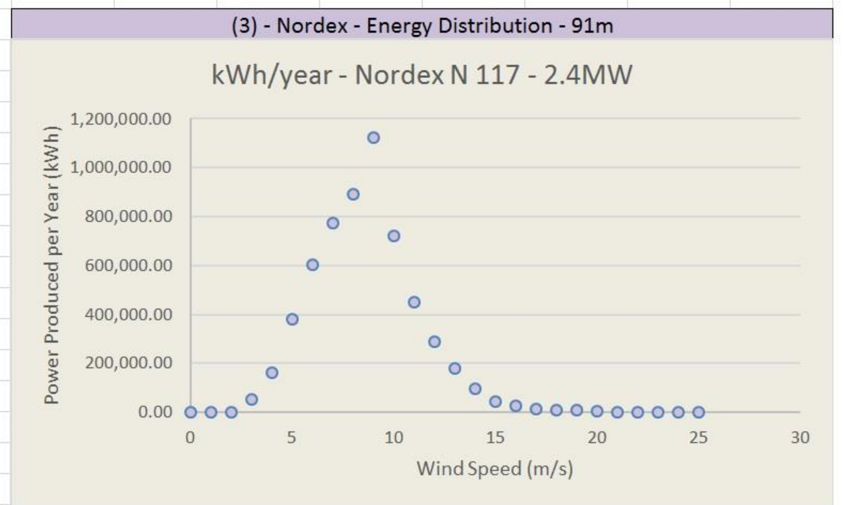


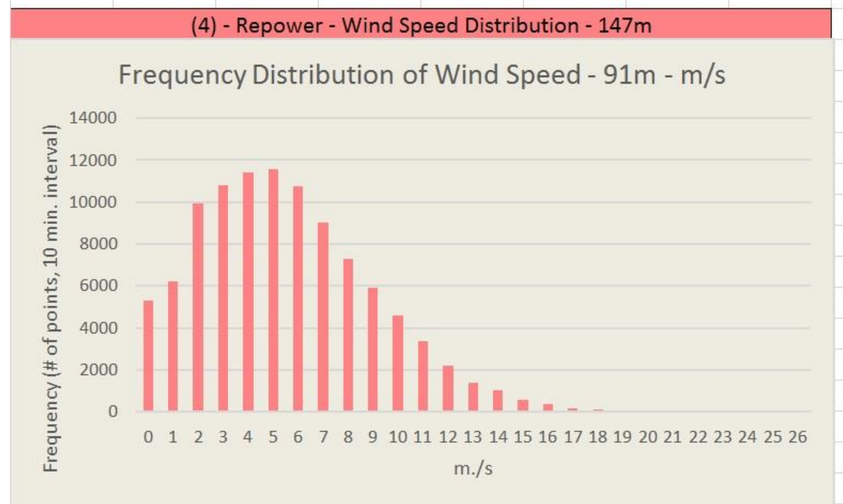


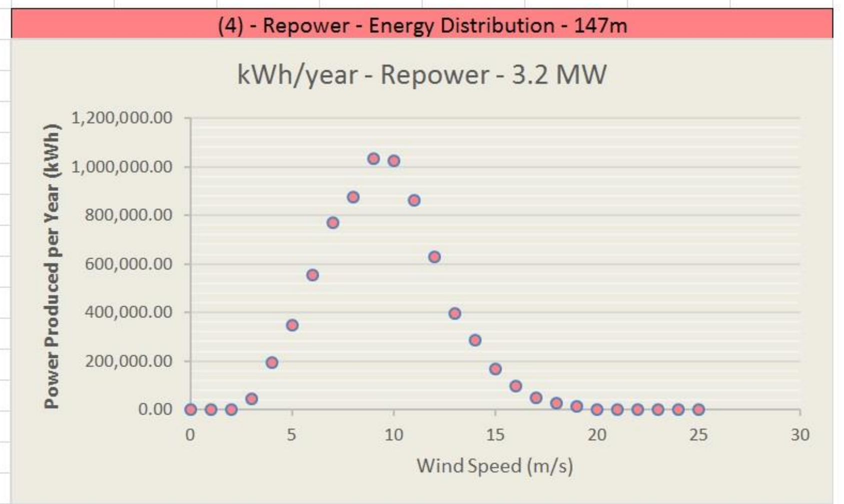


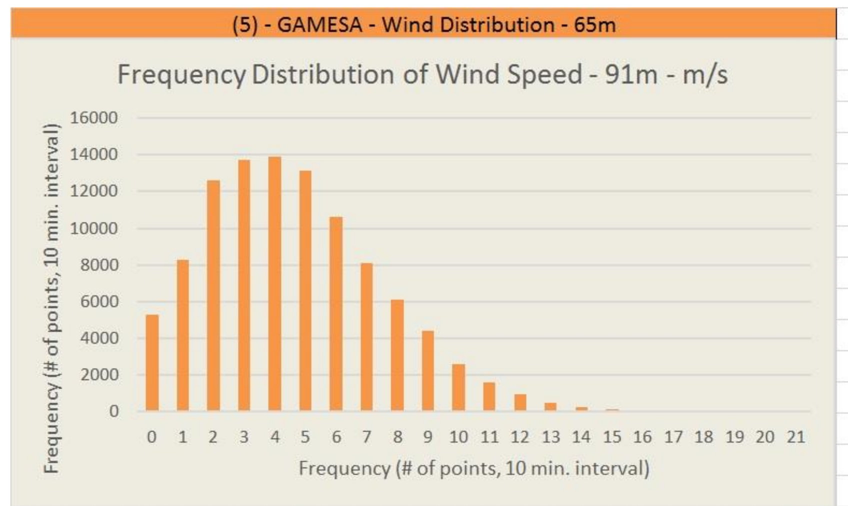


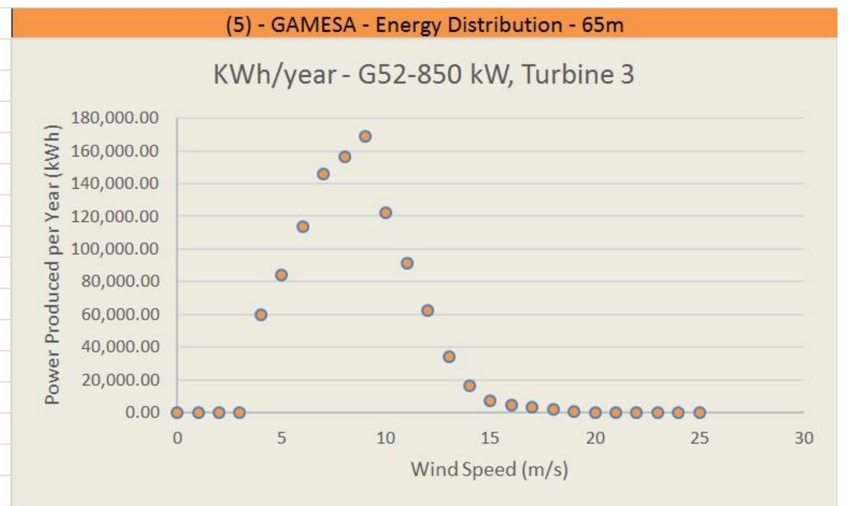












Results & Conclusion

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.

Monetary Value			
Turbine	MW of Turbine	Cost of Turbine	Instillation Cost
1	3.3	3,366,000	500,000
2	2.5	2,550,000	500,000
3	2.4	2,448,000	500,000
4	3.2	3,264,000	500,000
5	0.85	867,000	250,000
Maintenance cost of life-time	Total Cost of Turbine	Total Power in a year (kWh/yr)	$/kWhr/year
66,000	3,932,000	7,917,526	0.497
50,000	3,100,000	7,192,548	0.431
48,000	2,996,000	5,827,897	0.514
64,000	3,828,000	7,374,531	0.519
17,000	1,134,000	1,074,734	1.055
Years to pay off	Money Saved by using turbine per year (After payoff)	Money saved after life time	Power consumed on campus annually
9.9	395,876	3,985,526	111,000,000
8.6	359,627	4,092,548	
10.3	291,395	2,831,897	
10.4	368,727	3,546,531	
21.1	53,737	-59,266	
Percent of cost of maintenance for lifetime	Life time of Wind Turbine	Cost of Wind Turbine Estimated by US per MW	Cost of Electricity ($/kWh)
0.02	20 year life time	1,000,000	0.05

Sources

[1] Wizelius, T. (2007). *Developing wind power projects*. London: Earthscan.