

Averages: Still Flawed

What is the “best” location to place a wind turbine on your island?

A homework problem, after viewing *Averages: Still Flawed* and *Flaws of Averages*

NOTE: The problem solutions are available to teachers upon email request to MIT BLOSSOMS, <blossoms@mit.edu>

Part 1

Imagine that you live on an island and that you are in charge of placing a wind turbine on or near the island to generate electricity. There are three proposed locations for the wind turbine:

- A) Ridge: On a ridge at the highest point on the island
- B) Coastline: On the coastline of the island
- C) Offshore: Out in the ocean, a short distance from the island

For each of these locations, you are given the **daily** average wind speed as follows:

- A) Ridge: 11 meters per second
- B) Coastline: 9 meters per second
- C) Offshore: 10 meters per second

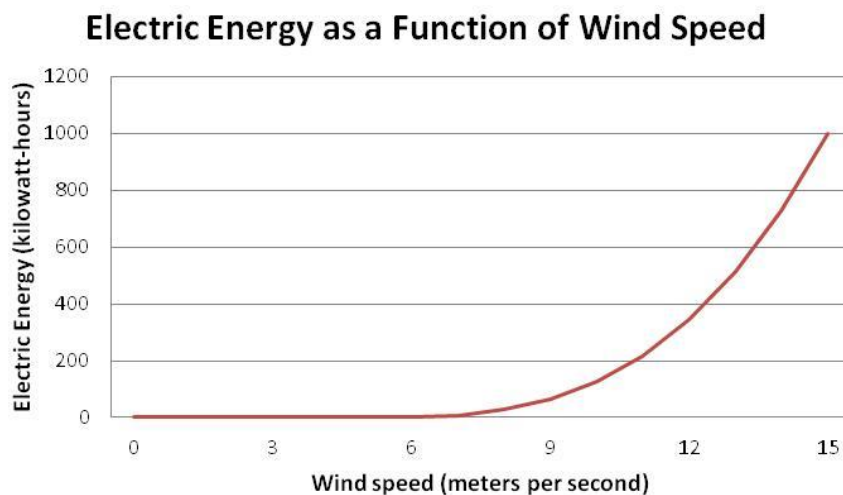
Is this enough information? Should you place the wind turbine on the ridge? Why or why not?

Part 2

One missing piece of information from Part 1 is determining how much electric energy (in kilowatt-hours) is generated at varying wind speeds (in meters per second). A simplified form of this function is:

$$\text{Electric energy} = k * (\text{wind speed} - 5)^3$$

In words, this function states that the electric energy generated by a wind turbine is proportional to the cube of the wind speed minus 5 meters per second. A plot of this function when $k = 1$ is included below.



With this information, a colleague tells you that the **hourly** average electric energy produced at each location must be the following:

- A) Ridge: 216 kilowatt-hours, which is $(11-5)^3$
- B) Coastline: 64 kilowatt-hours, which is $(9-5)^3$
- C) Offshore: 125 kilowatt-hours, which is $(10-5)^3$

Do you believe your colleague? Why or why not? If not, is there a flaw of averages that your colleague is making?

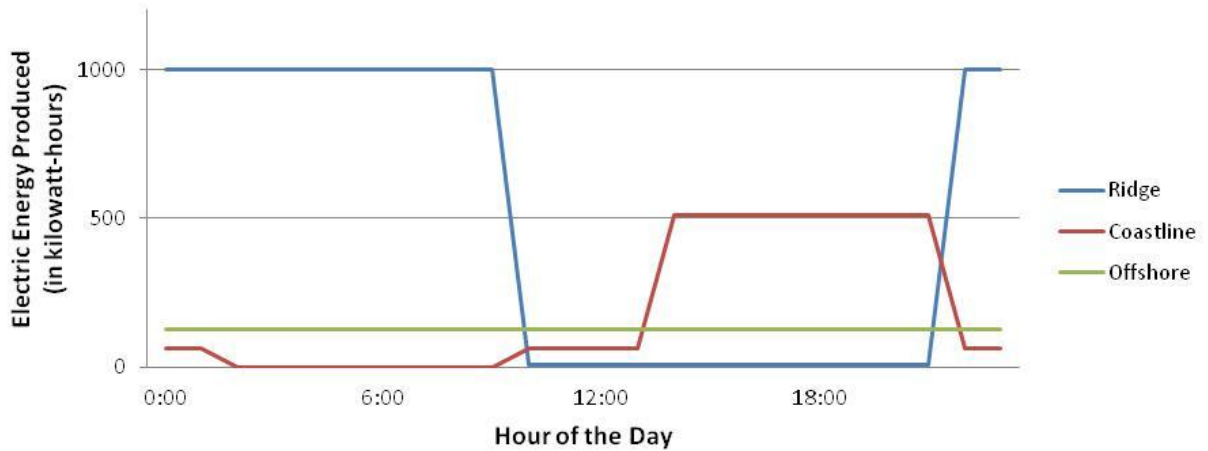
Part 3

After asking the right people, the following table of information was provided to you with **hourly** average wind speeds for each location. As you can see, the **hourly** electric energy produced differs from your colleague's prediction.

Hour Beginning at:	Windspeed (in meters per second)			Electric Energy Produced (in kilowatt-hours)		
	Ridge	Coastline	Offshore	Ridge	Coastline	Offshore
0:00	15	9	10	1000	64	125
1:00	15	9	10	1000	64	125
2:00	15	5	10	1000	0	125
3:00	15	5	10	1000	0	125
4:00	15	5	10	1000	0	125
5:00	15	5	10	1000	0	125
6:00	15	5	10	1000	0	125
7:00	15	5	10	1000	0	125
8:00	15	5	10	1000	0	125
9:00	15	5	10	1000	0	125
10:00	7	9	10	8	64	125
11:00	7	9	10	8	64	125
12:00	7	9	10	8	64	125
13:00	7	9	10	8	64	125
14:00	7	13	10	8	512	125
15:00	7	13	10	8	512	125
16:00	7	13	10	8	512	125
17:00	7	13	10	8	512	125
18:00	7	13	10	8	512	125
19:00	7	13	10	8	512	125
20:00	7	13	10	8	512	125
21:00	7	13	10	8	512	125
22:00	15	9	10	1000	64	125
23:00	15	9	10	1000	64	125
Daily Average:	11	9	10	504	192	125

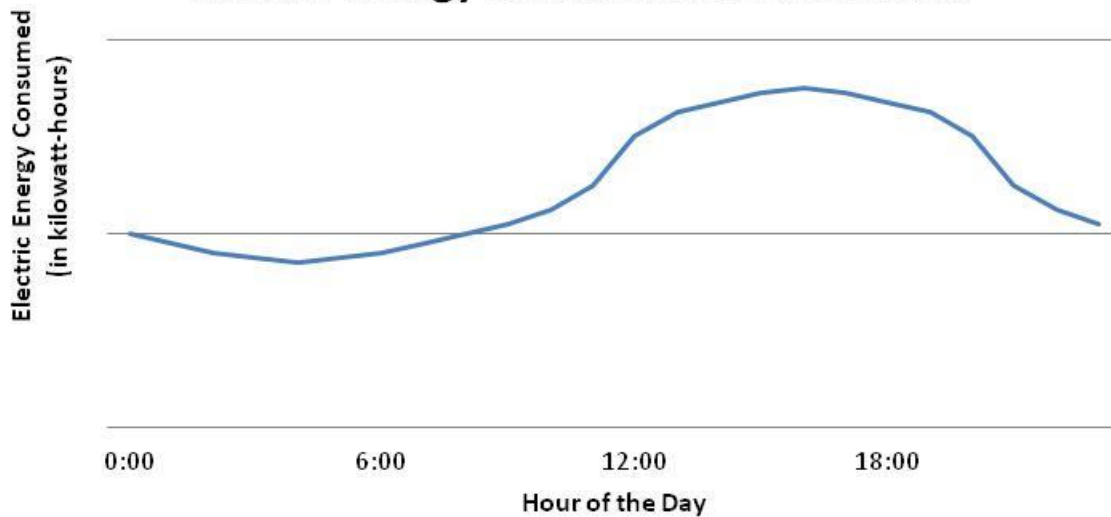
For easier visualization, here is the same information about the **hourly** electric energy produced:

Hourly Electric Energy Produced at Different Island Locations



There’s one final piece of information you may need. On the island, the usual electric energy used by the residents and businesses on the island looks like this:

Electric Energy Consumed on the Island



Given all of this information, which location do you believe is the “best” location for the wind turbine to be placed?