WIND STUDY | Wind Study is intended for grades 5-8 and 8-11
Questions posted on: Monday   Answers posted on: Friday
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2021Q9   (BINNING, EXTRAPOLATION)

For this weeks' Wind Study, we recommend revisiting our Science Shorts video about wind instrumentation, specifically anemometers, posted on 2/5/2021.

To conduct a wind resource assessment, One Energy uses data near the potential project site. This data comes from a wind instrument, such as an anemometer. In a prior Wind Study, posted on 2/1/2021, we applied a power curve to calculate energy production at a given wind speed. In that example, the manufacturer's power curve was presented in 0.5 m/s increments – but real wind speeds aren't reported in these increments. One Energy rounds and sorts real wind speeds into *bins* in 0.5 m/s increments so that the power curve can be applied. Each bin is centered on a wind speed, meaning that the 5.0 m/s bin includes data points between 4.75 – 5.25 m/s.

Level 1: A portion of anemometer data is shown below.

TIME STAMP	WIND SPEED (m/s)
14:00	9.353
15:00	9.174
16:00	9.363
17:00	8.884
18:00	7.166
19:00	5.794
20:00	5.471
21:00	5.352
22:00	5.311
23:00	7.410
0:00	6.950
1:00	7.288
2:00	5.989
3:00	5.363

How many data points would be in each of the following bins?

BIN (m/s)	# OF DATA POINTS
5.0	
5.5	
6.0	
6.5	
7.0	
7.5	
8.0	
8.5	
9.0	
9.5	

Level 2: Anemometers aren't typically installed at the hub height of a wind turbine. In order to calculate the most accurate energy production estimate, the measured wind speeds need to be extrapolated to hub height. Extrapolating to hub height is done using the wind profile power law, which assumes that wind speeds increase logarithmically using the following equation:

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$$v_2 = v_1 \left(\frac{z_2}{z_1}\right)^{\alpha}$$

where v_2 is the wind speed in m/s at height z_2 (m), v_1 is the measured wind speed in m/s at reference height z_1 (m), and α is the dimensionless wind shear parameter. The wind shear parameter describes the variation in wind speed over the given height range, and can vary with time of day and season, among other factors. If the data in the Level One question was measured at a height of 50m and the value of α is 0.2, what is the 80 m hub height wind speed for the first time stamp?

Wind instrumentation devices at the North Findlay Wind Campus.