



Figure 2: Example power curve

Level 1: Based upon the generic power curve (Figure 2), use your knowledge of the various regions on the graph to determine the following.

What is the: (a) cut-in wind speed? (b) rated wind speed? (c) and cut-off wind speed?

(a) cut-in wind speed: **$v = 3 \text{ m/s}$**

(b) rated wind speed: **$v = 15 \text{ m/s}$**

(c) and cut-off wind speed: **$v = 25 \text{ m/s}$**

Level 2: The following table contains wind speeds over an 8-hour period:

TIME	WIND SPEED (m/s)
12:00	7
01:00	7
02:00	8
03:00	10
04:00	10
05:00	11
06:00	11
07:00	9

Using Figure 2 for your calculations: What is the average power output for the 8-hour time period? What is the standard deviation of the 8-hour power output dataset? (Power output can be approximated to the nearest 50 kW).

We can approach this problem in the following manner, first we want to find the power output for each hour given the windspeed (power output estimated using Figure 2 for the given wind speeds). This yields us the following table from which we can run our calculations.

TIME	WIND SPEED (m/s)	POWER (kW)
12:00	7	500
01:00	7	500
02:00	8	750
03:00	10	1500
04:00	10	1500
05:00	11	1750
06:00	11	1750
07:00	9	1000

Calculate the hourly average power output by summing all the outputs over 8 hours and dividing by the number of hours (n = 8):

$$\frac{2(500) \text{ kW} + 750 \text{ kW} + 2(1500) \text{ kW} + 2(1750) \text{ kW} + 1000 \text{ kW}}{8} \approx \mathbf{1160 \text{ kW}}$$

The equation for standard deviation is:

$$\sqrt{\frac{\sum_i (x_i - \mu)^2}{n - 1}}$$

Where x_i is the wind speed for each hour, μ is the average wind speed over the time period, and n is the number of data points. Plugging in our average and the number of data points gives:

$$\sqrt{\frac{\sum_i (x_i - 1160)^2}{8 - 1}}$$

The above equation can be computed as follows:

$$\begin{aligned} \sum_i (x_i - 1160)^2 &= (500 - 1160)^2 + (500 - 1160)^2 + (750 - 1160)^2 + (1500 - 1160)^2 + (1500 - 1160)^2 \\ &\quad + (2000 - 1160)^2 + (2000 - 1160)^2 + (1000 - 1160)^2 = 1,992,300 \end{aligned}$$

$$\sqrt{\frac{1,992,300}{8 - 1}} \approx \mathbf{530 \text{ kW}}$$