

Exercise 2.3

Example solutions

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Using the set of mean wind speed data provided and the power curves of the 600 kW (50m diameter), 1.3 MW (55m diameter), MW and 2 MW (80m diameter) wind turbines estimate the annual energy produced by each wind turbine.

Data – Hourly mean wind velocity data at 3 heights – 15m, 40m and 50m (***Ex 2_1 Data.xlsx***)

Power Data for the three wind turbine data – (***Turbines power data.xlsx***)

Approach –

- Since the three turbines have the hub heights to be 61.5m, 55m and 50m, the average wind velocity data at 50m height is selected as reference data u_r .
- The power law is used to move the wind speed data into the corresponding hub heights.

$$u = u_r \left(\frac{z}{z_r} \right)^{1/7}$$

- Histograms created with 1m/s bins to calculate the occurrence of each wind velocity bin; 1m/s to 25m/s.



Annual Energy Produced(at 6m/s) = Yearly Occurance×Power Produced(at 6m/s) (kWh/year)

- Yearly occurrence is referred from the histogram data and the Power Produced at each velocity bin is refereed from the relevant Turbine Power data.

Therefore,

$$\textbf{\textit{Total Annual Energy Produced}} = \frac{\sum_{i=1}^{25} \textbf{\textit{Annual Energy Produced}}_i}{1000} \textbf{ MWh.}$$

For 2MW Wind Turbine,

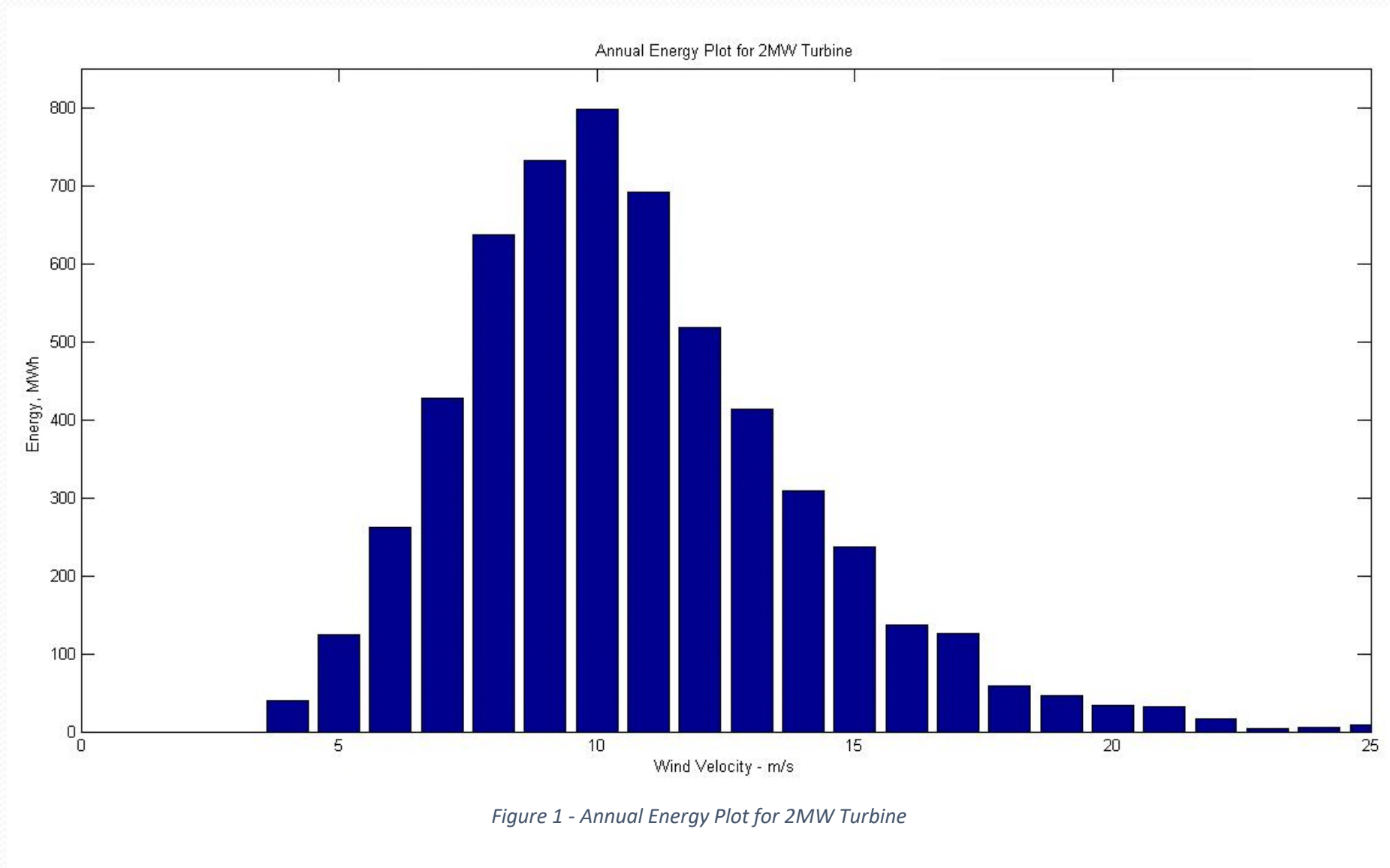
$$\textbf{\textit{Total Annual Energy Produced}} = 5653.5 \textbf{ MWh}$$

For 1.3MW Wind Turbine,

$$\textbf{\textit{Total Annual Energy Produced}} = 2347.6 \textbf{ MWh}$$

For 600kW Wind Turbine,

$$\textbf{\textit{Total Annual Energy Produced}} = 1990.7 \textbf{ MWh}$$



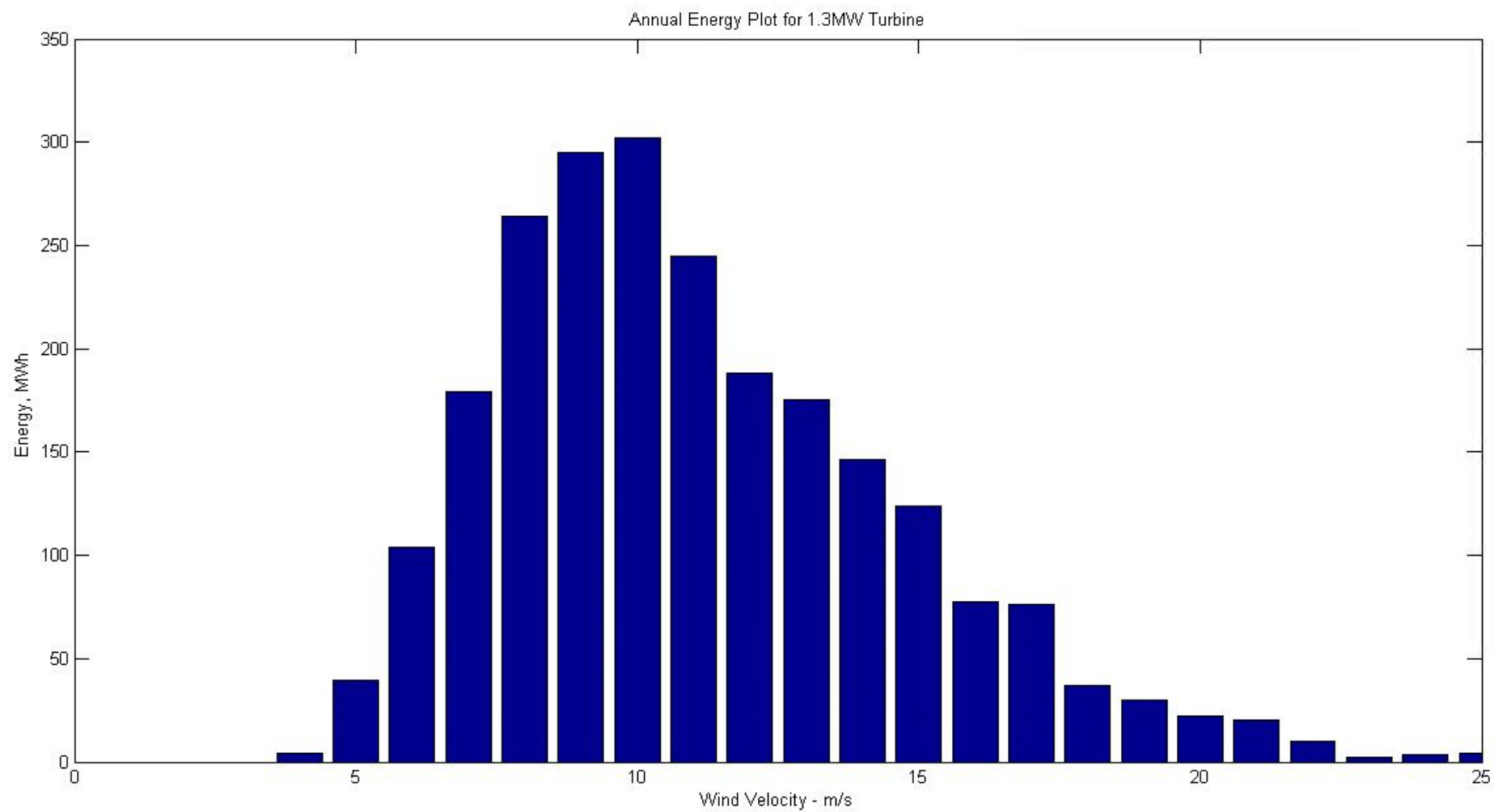


Figure 2 - Annual Energy Plot for 1.3 MW Turbine

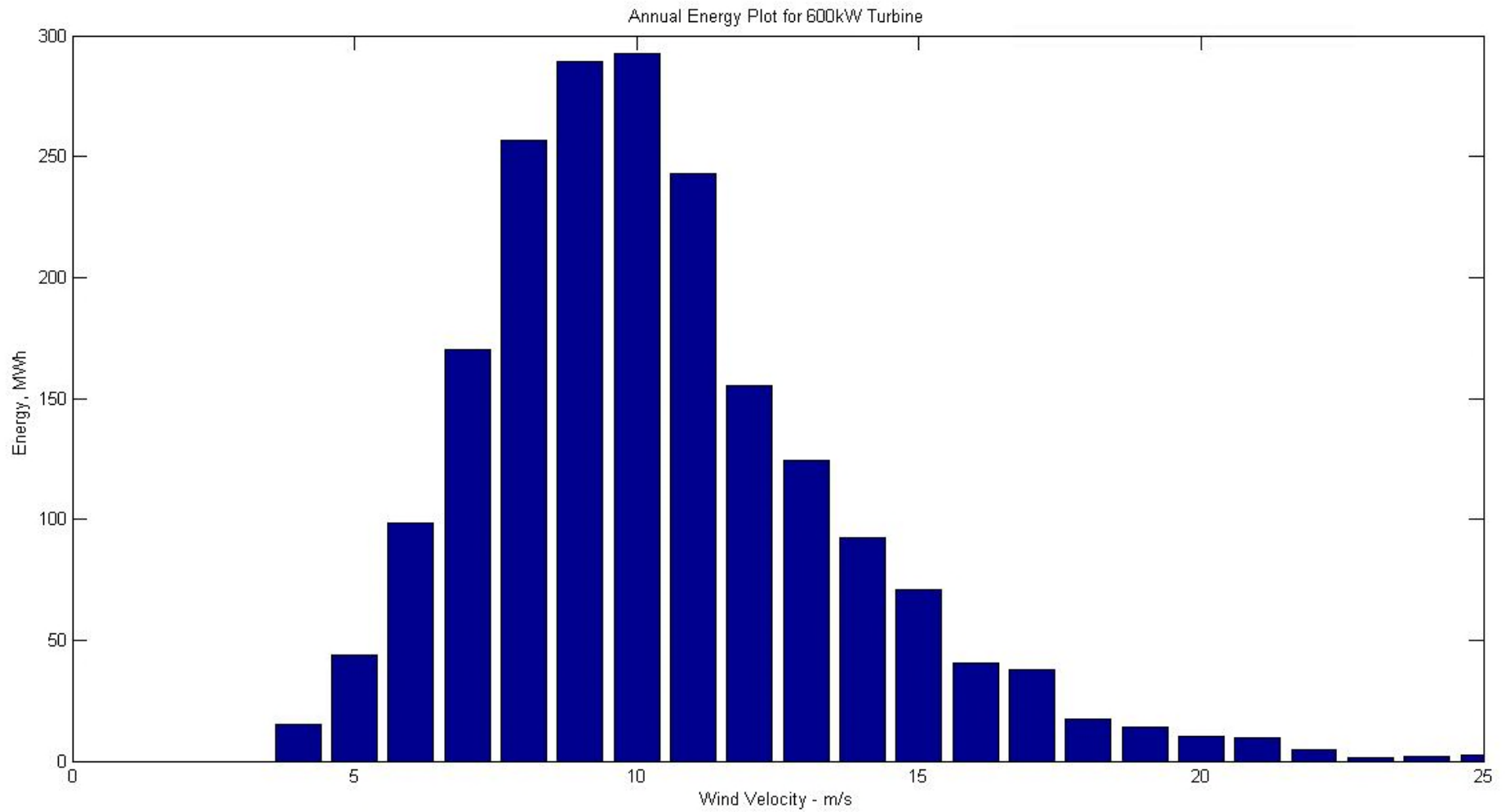


Figure 3 - Annual Energy Plot for 600kW Turbine