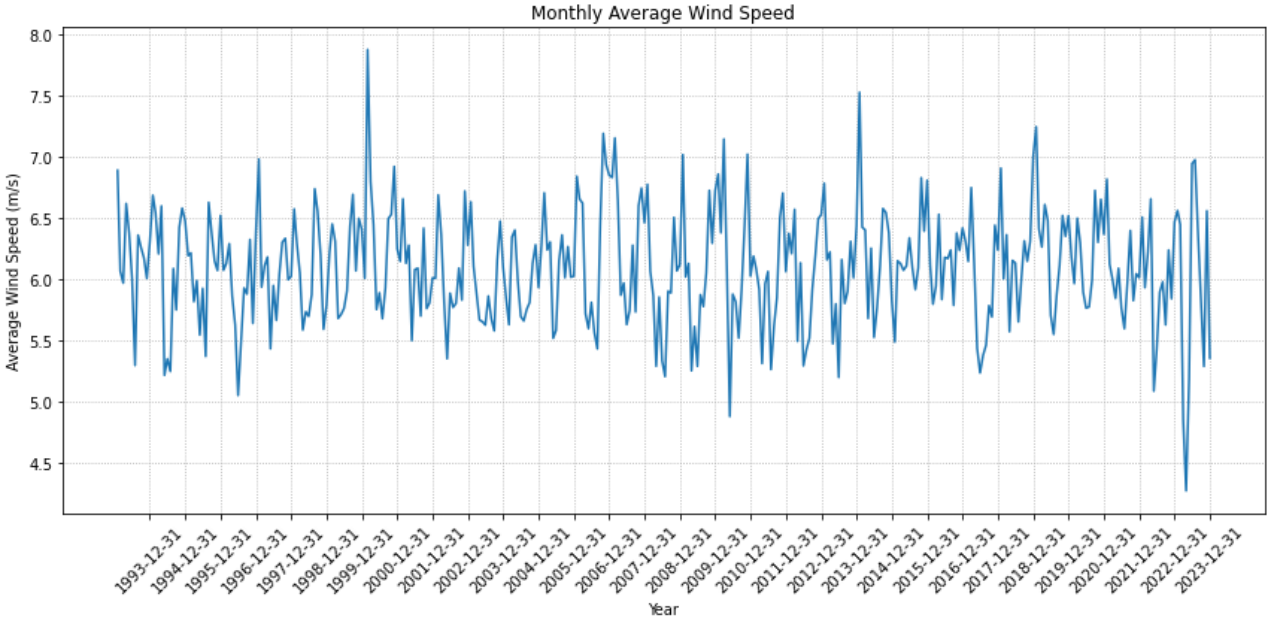
Examine and visualise wind speed data:

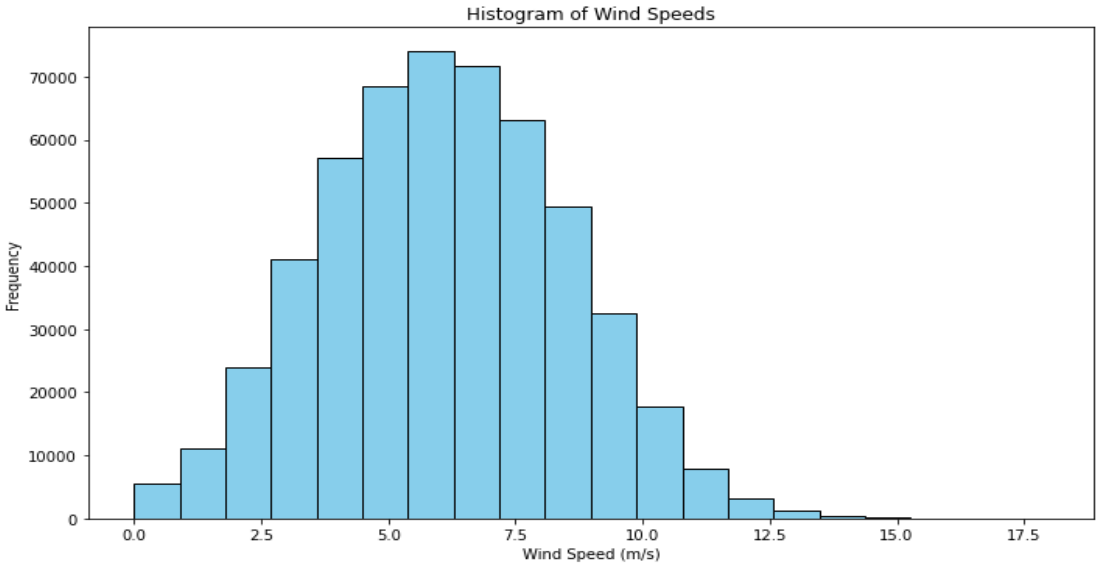
- Assess the variability in wind speeds and describe the patterns observed.

Explanation:

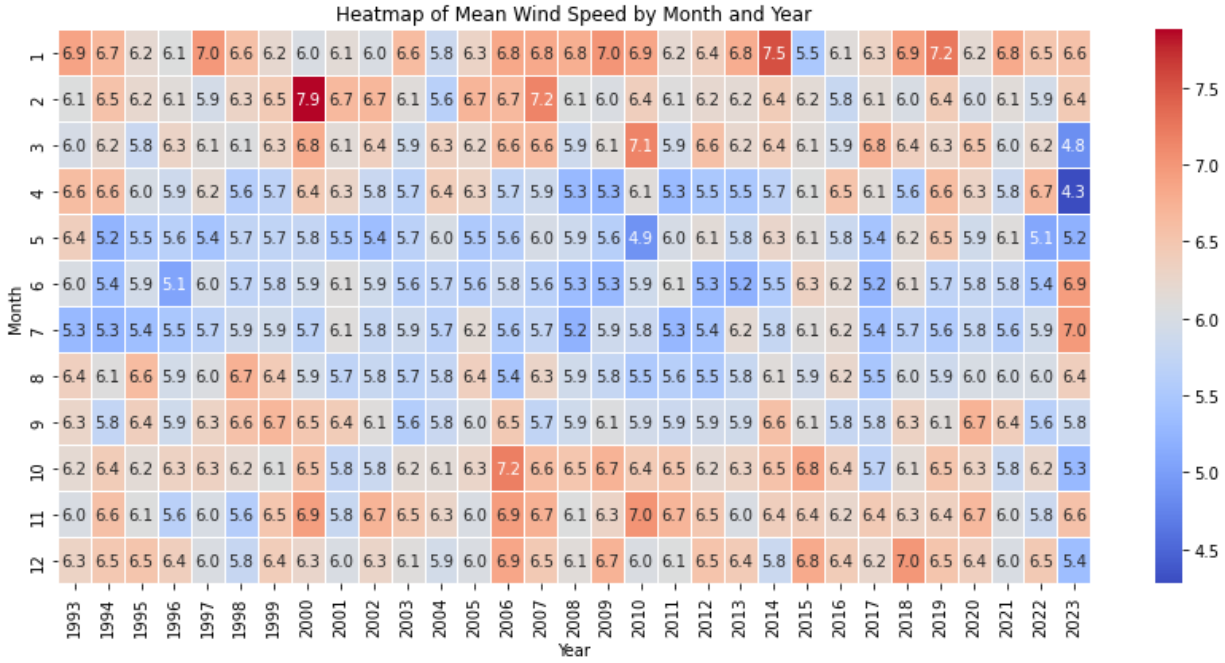
Monthly average wind speed data reveals clear seasonality and long-term trends. Wind patterns in recent years differ significantly from 20 years ago, with wind speeds dropping below 4.5 m/s in 2022.



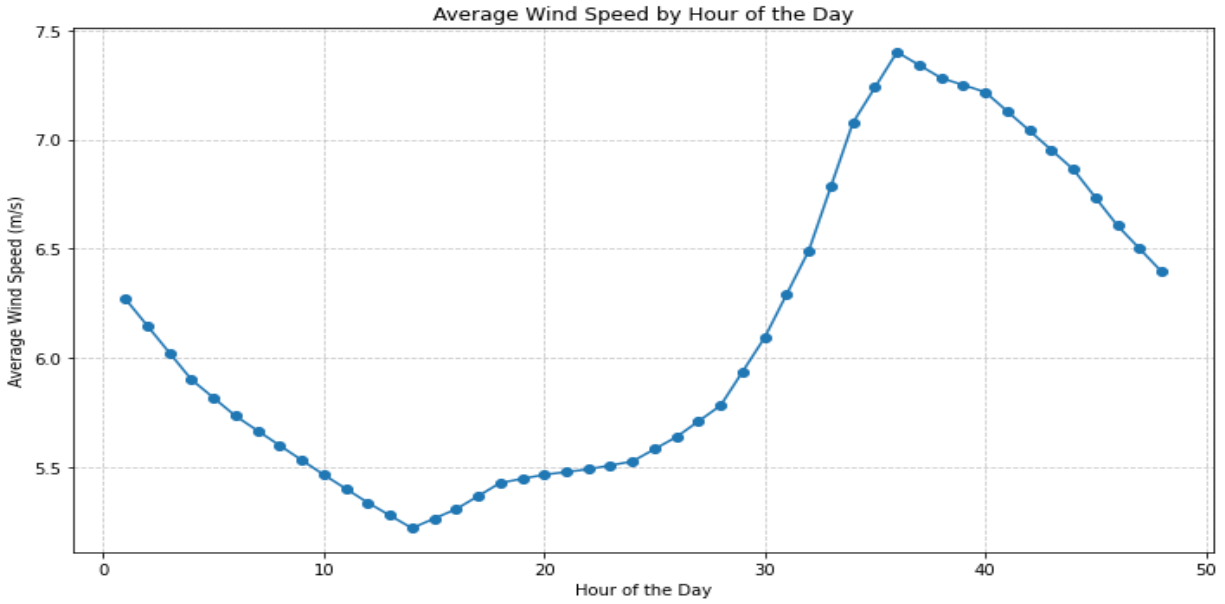
Average: 6.1 m/s, std 2.4 m/s, max: 18 m/s



Wind speed is low during May, June, July months, and high other months.



Average wind speed is high during evening and low during morning.



Trend shows evidence of long-term variability, likely influenced by environmental or climatic changes.

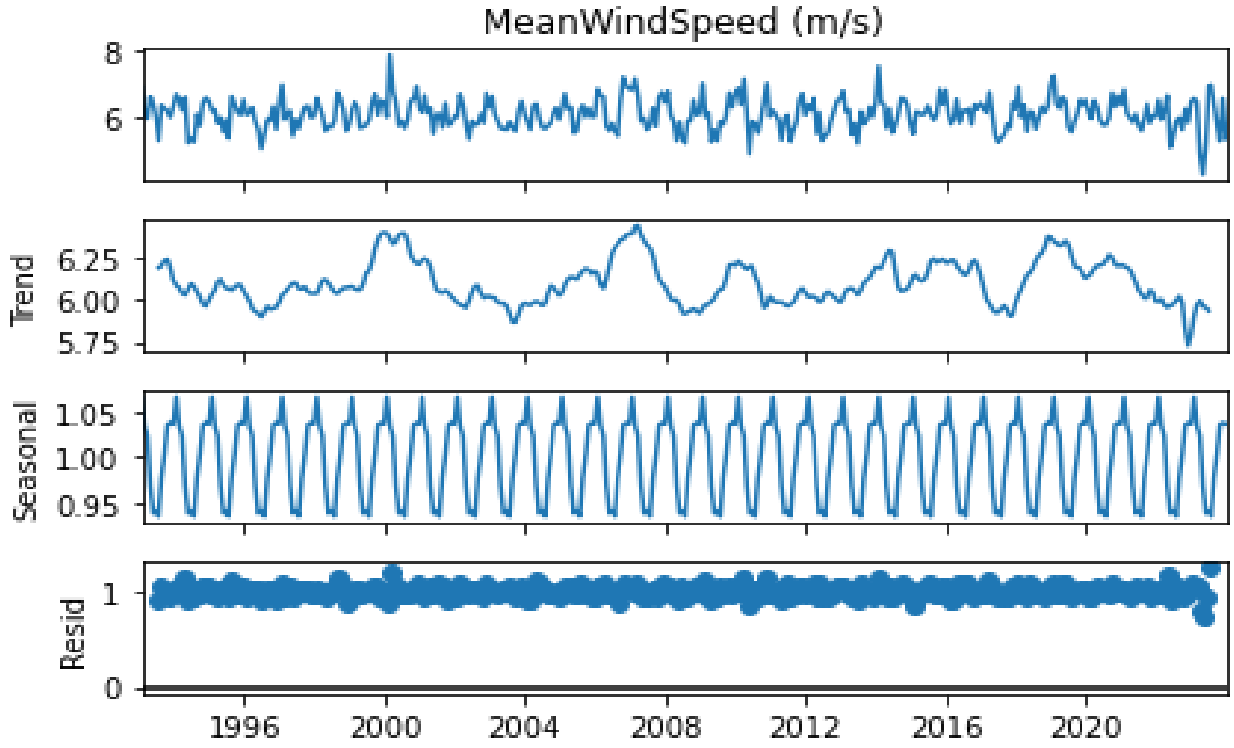
- Wind speeds were declining and increasing over in the early years (1992–2007).
- A gradual rise is seen from 1997 to around 2015, followed by a decreasing trend in recent years.
- Trend Indicates overall cycles or periods of increase and decrease.

Seasonality is pronounced and consistent, indicating predictable cycles in wind behaviour.

- Clear seasonal behaviour is visible with consistent peaks and troughs over time.
- Seasonality suggests recurring increases and decreases in wind speeds during specific months. This is evident from the heatmap, which shows lower wind speeds during May, June, and July, and higher wind speeds in other months.

The dataset's **residuals** indicate that while much of the variability is captured by the trend and seasonality, there are still unexplained factors that could be noise or additional external drivers.

- The residuals appear cantered around zero, showing no strong bias, except recent 2 years.
- Irregular fluctuations suggest external or random factors influencing wind speed.



Conclusion: Wind speed trends show a recent decline, but clear seasonality persists, with predictable high and low periods. These patterns can be leveraged for developing time series models (e.g., ARIMA or SARIMA) to forecast wind speeds and optimise energy generation.

Provide insights for the energy market:

- Identify key observations from the wind speed data that could be relevant for a company selling energy to the spot market, such as fluctuations, trends, or any potential impact on energy generation and supply stability.

Explanation:

Seasonal Optimisation:

The historical data shows higher average wind speeds in evening hours and during specific months (outside of May, June, and July). This indicates that wind power generation is more reliable and profitable in these periods. For example, during high wind speed months, energy production can be maximised to capitalise on favourable market prices.

Predictive Modelling:

Using time series forecasting models, such as ARIMA or SARIMA, wind speeds can be predicted for specific times of the day and days of the week. This information can be used to estimate power generation and align energy output with spot market demand and pricing trends.

Example:
Suppose historical data reveals that wind speeds are highest during September evenings. The company could:

- Schedule turbine maintenance during low wind speed months (e.g., May–July) to avoid production disruptions.
- Use forecasted wind speeds to predict energy output for September evenings and bid accordingly in the spot market to maximise revenue