Newport News, Va
Max Media at Hampton Roads Tall Tower

Project Summary

As part of Virginia's State Based Anemometer Loan Program an existing 420 foot guyed lattice radio tower was outfitted with measurement sensors on property owned by Max Media of Hampton Roads, LLC. The tower was outfitted with six anemometers, three wind vanes, and a temperature sensor. Wind speed, wind direction, and temperature were recorded for 15 months from August 27, 2006 through December 6, 2007. The annual average wind speed during the monitoring period 97 m (318 ft above ground level) was recorded to be 6.33 m/s (14.2 mph) with a wind power density of 270 W/m^2.

Project Location

The monitoring equipment was installed on property owned by Max Media of Hampton Roads at an elevation of 3 m. The tower is located at N 36°57.792' W 076°24.703'.

Figure 1: Close-up Google satellite image of the tower.

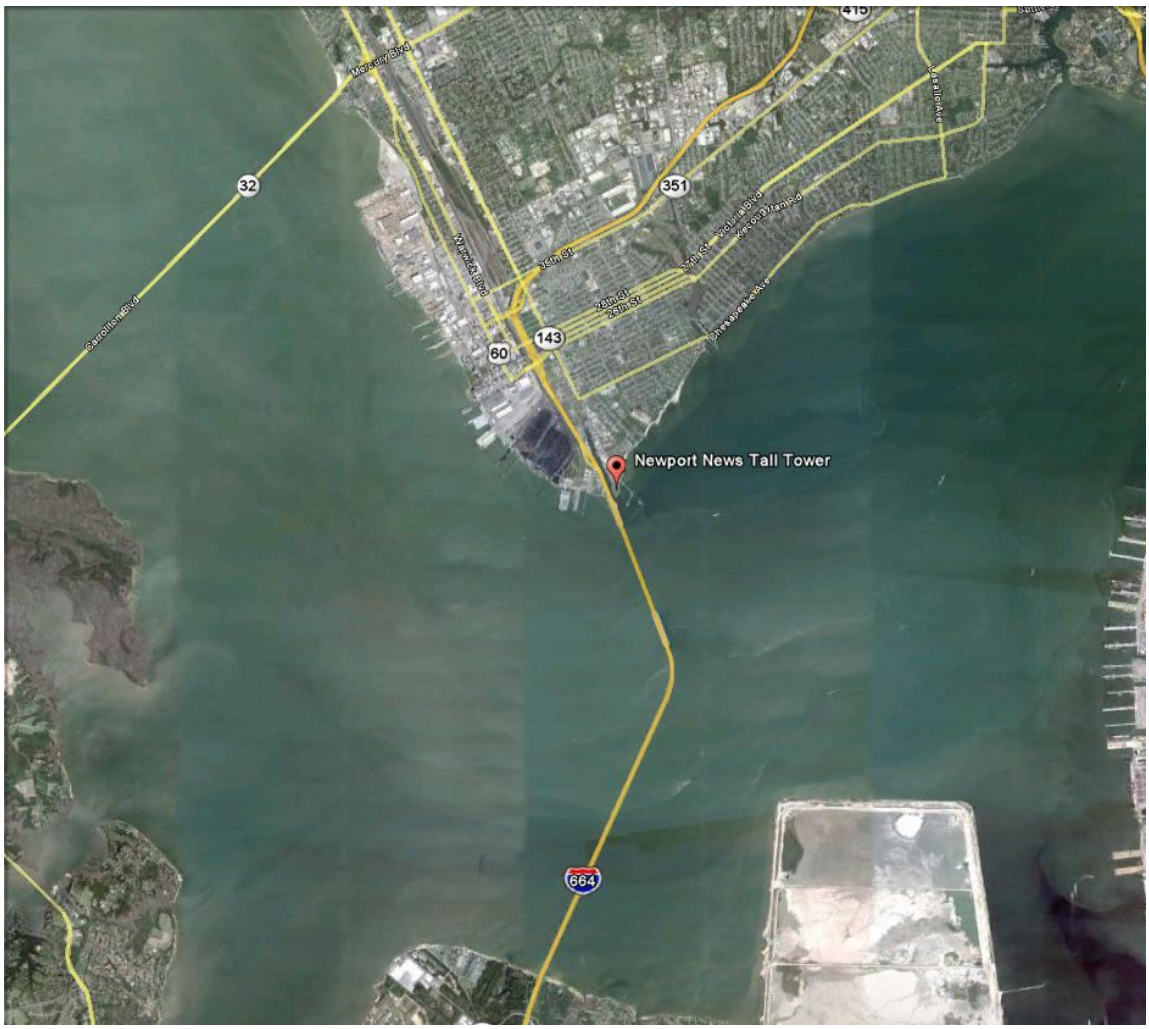

Figure 2: Distant Google satellite image of tower site.

Monitoring Equipment

The tower was outfitted with one Symphonie Data Logger with shelter box, six #40C anemometers, two #200P wind vanes, and one #110S temperature sensor. The anemometers and wind vanes were placed at three different heights. Two anemometers and one wind vane were placed at 97 meters, two anemometers and one wind vane were placed at 85 meters, and the final two anemometers and wind vane were placed at 51 meters. The temperature sensor was attached at 2.1 meters. At each anemometer height the anemometers were oriented at 30 and 150 degree from magnetic north. All 3 wind vanes were oriented at 30 degrees from magnetic north.

Virginia State Wind Map Predictions

Annual Average Wind Speed (30m)	**6.23 m/s (13.9 mph)**
Annual Average Wind Speed (50m)	**6.63 m/s (14.8 mph)**
Annual Average Wind Speed (70m)	**6.92 m/s (15.5 mph)**
Annual Average Wind Speed (100m)	**7.24 m/s (16.2 mph)**
Wind Power Density (50m)	**369 W/m^2**

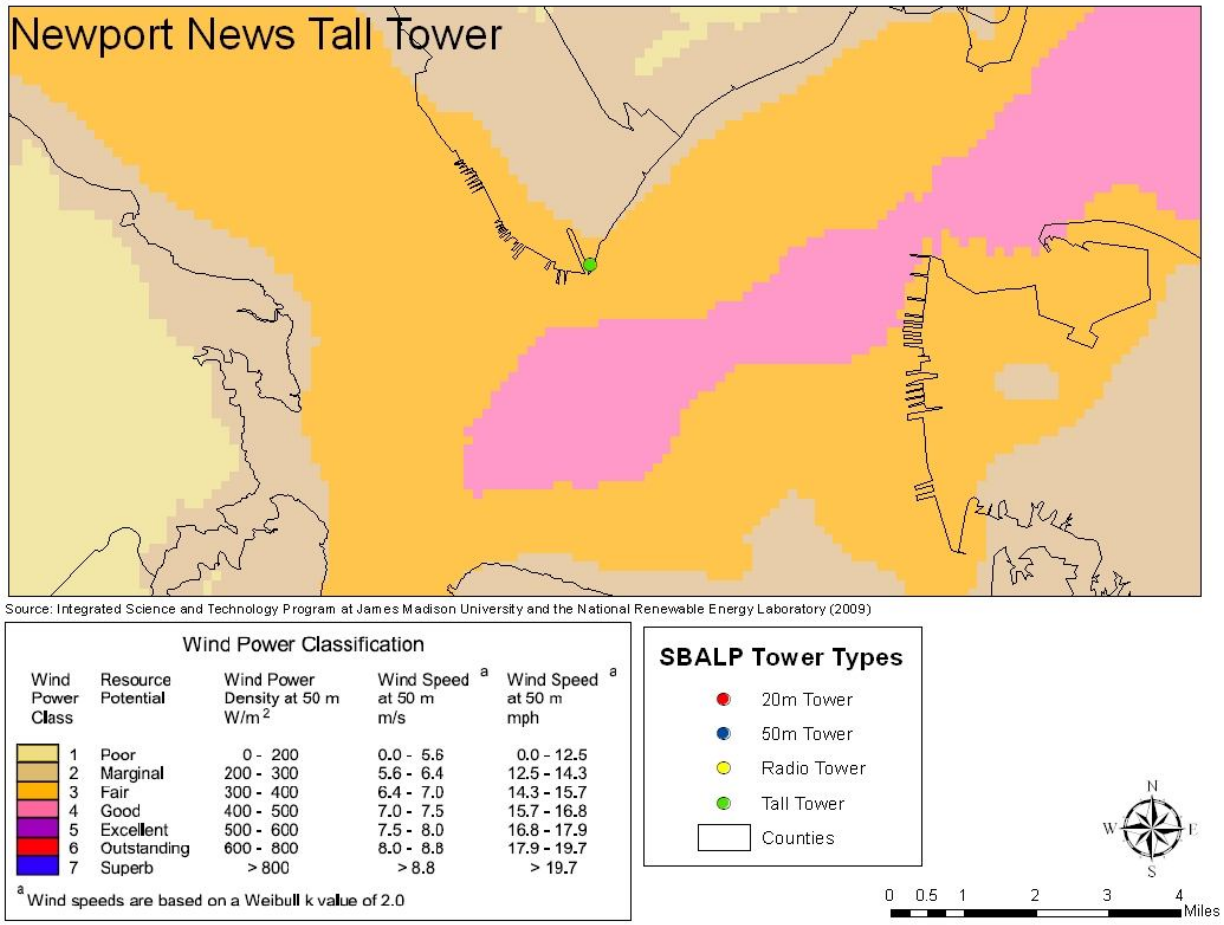

Figure 3: View of the Newport News tower site as seen on the Virginia State Wind Map.

Data Summary

Wind Speed

Average Annual Wind Speed (97m)	**6.33 m/s (14.2 mph)**
Average Annual Wind Speed (85m)	**6.15 m/s (13.8 mph)**
Average Annual Wind Speed (51m)	**5.69 m/s (12.7 mph)**

Wind Power Density

Average Annual Wind Density (97m)	**270 W/m^2**
Average Annual Wind Density (85m)	**254 W/m^2**
Average Annual Wind Density (51m)	**204 W/m^2**

Data Gaps and Measurement Sensor Issues

A significant data gap occurs for the Channel 1 anemometer (97 m A). This anemometer does not seem to have been functioning during the initial stages of the data collection period from August 27, 2006 to October 31, 2006. Beginning on November 1, 2006 anemometer readings from this channel began reading normally. Fortunately the data collection period continued on through December 6, 2007 so data for the months of August through October is still present from collection in 2007.

An issue was also discovered regarding the wind vane sensors installed on the tower. The wind vanes located at the 97 meter and 85 meter heights did not function properly. The wind vane at 97 meters gave readings of 7 – 45º during data collection period with the majority of the time the sensor showed a reading of 7 – 8º. The wind vane located at 85 meters gave a constant reading of 0º throughout the data collection period. The wind vane located at 51 meters seems to have functioned properly during the data collection period.

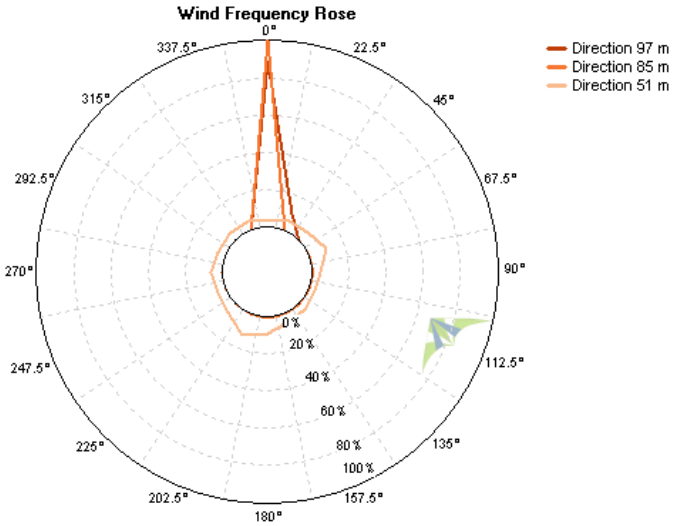

Figure 4: Wind frequency rose displaying data for all three installed wind vane sensors on the Newport News Tower.

Monthly Variation

Table 1 displays the average wind speed for each month throughout the data acquisition period for each installed anemometer. The dark line in the Figure 5 represents the annual average wind speed recorded at the highest anemometer height. Above average months occur during winter and spring months while below average months occur in summer and fall months.

Table 1: Monthly Wind Speeds for Newport News Tall Tower

Month	97 m A	97 m B	85 m A	85 m B	51 m A	51 m B
January	7.40	7.43	7.15	7.06	6.56	6.36
February	6.55	6.94	6.37	6.66	5.87	6.00
March	7.37	7.31	7.22	7.05	6.67	6.43
April	6.80	7.03	6.67	6.78	6.17	6.17
May	6.74	6.55	6.62	6.41	6.27	6.01
June	5.68	5.53	5.56	5.33	5.29	5.00
July	5.46	5.22	5.38	5.09	5.19	4.86
August	4.84	4.64	4.72	4.53	4.62	4.36
September	5.72	5.55	5.49	5.47	5.30	5.14
October	5.60	6.14	6.00	5.94	5.57	5.41
November	6.54	6.43	6.18	6.13	5.61	5.41
December	7.14	7.23	6.89	6.87	6.20	6.15
Annual Avg.	6.32	6.33	6.19	6.11	5.78	5.61
Combined Avg.	**6.33**		**6.15**		**5.69**	

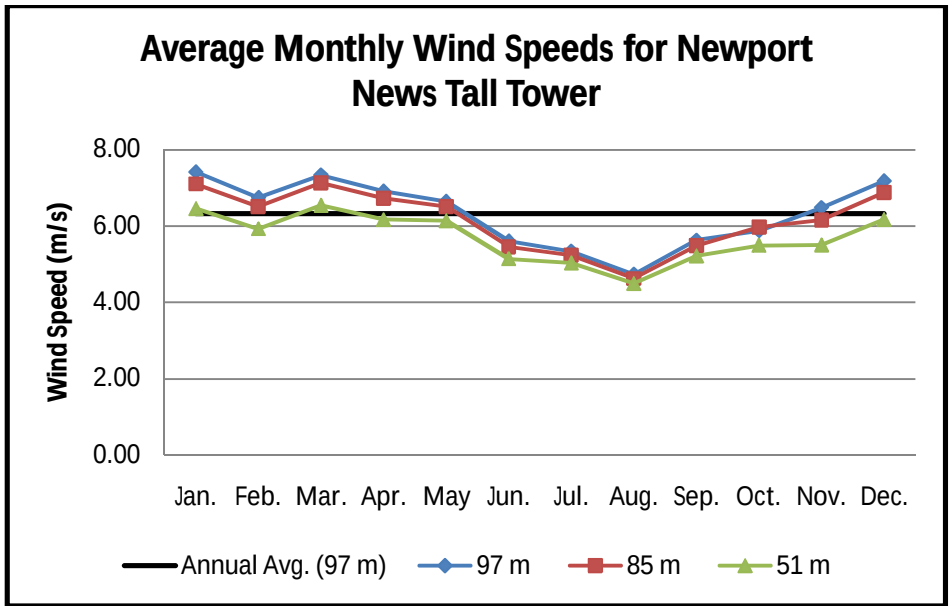

Figure 5: Average monthly wind speeds for the three installed anemometer heights.

Correlation to Long Term Data

Figure 6 displays the monthly averages for the Newport News tower plotted against historical weather data for the years 2007 through 2009. The historical data was acquired from the National Oceanic and Atmospheric Administration National Climatic Data Center for the Dominion Terminal DOMV2 at an elevation of 2 meters. This weather terminal is located at 36.967º N, 76.417º W approximately 0.4 miles northwest of the Newport News tower site. The data collected from Newport News matches the expected seasonal variation and is similar to the seasonal variation displayed by data acquired from the Dominion Terminal.

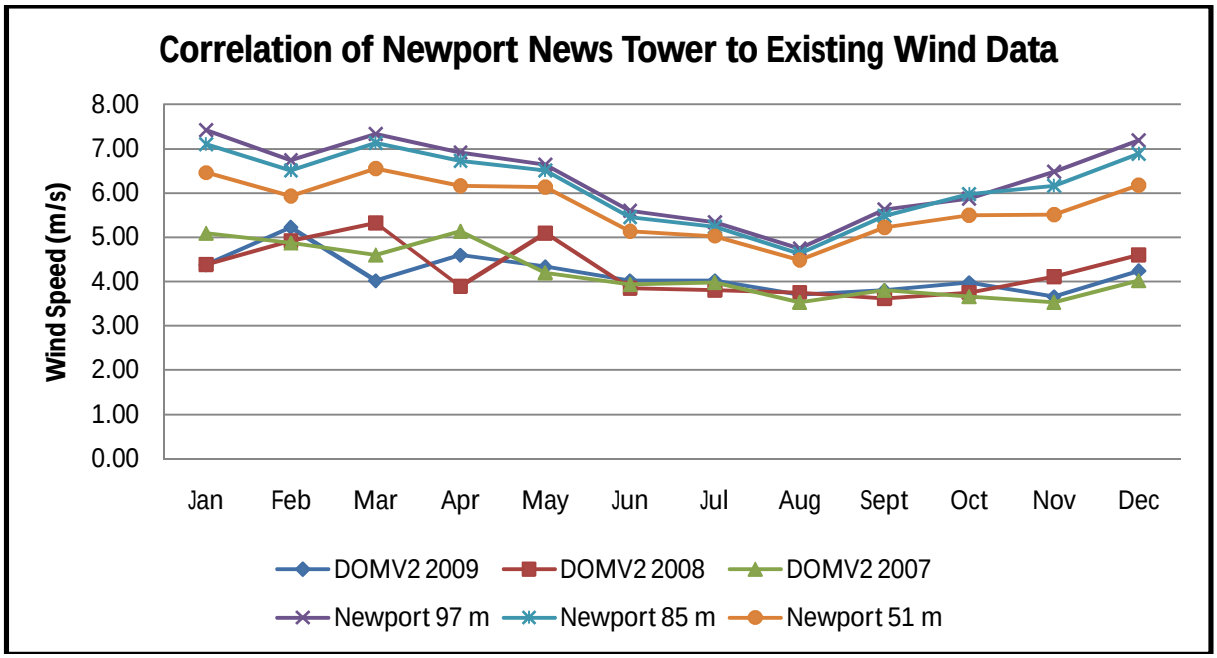

Figure 6: Monthly wind speed averages for Newport News compared to wind speed averages from Dominion Terminal DOMV2.

Wind Shear

Wind shear describes the change in wind velocity with respect to height at a give location. Trees, buildings, and other various obstructions can slow the flow of wind closer to the ground increasing the shear at the site. The Newport News location exhibits a moderate level of shear with a wind shear exponent of 0.172.

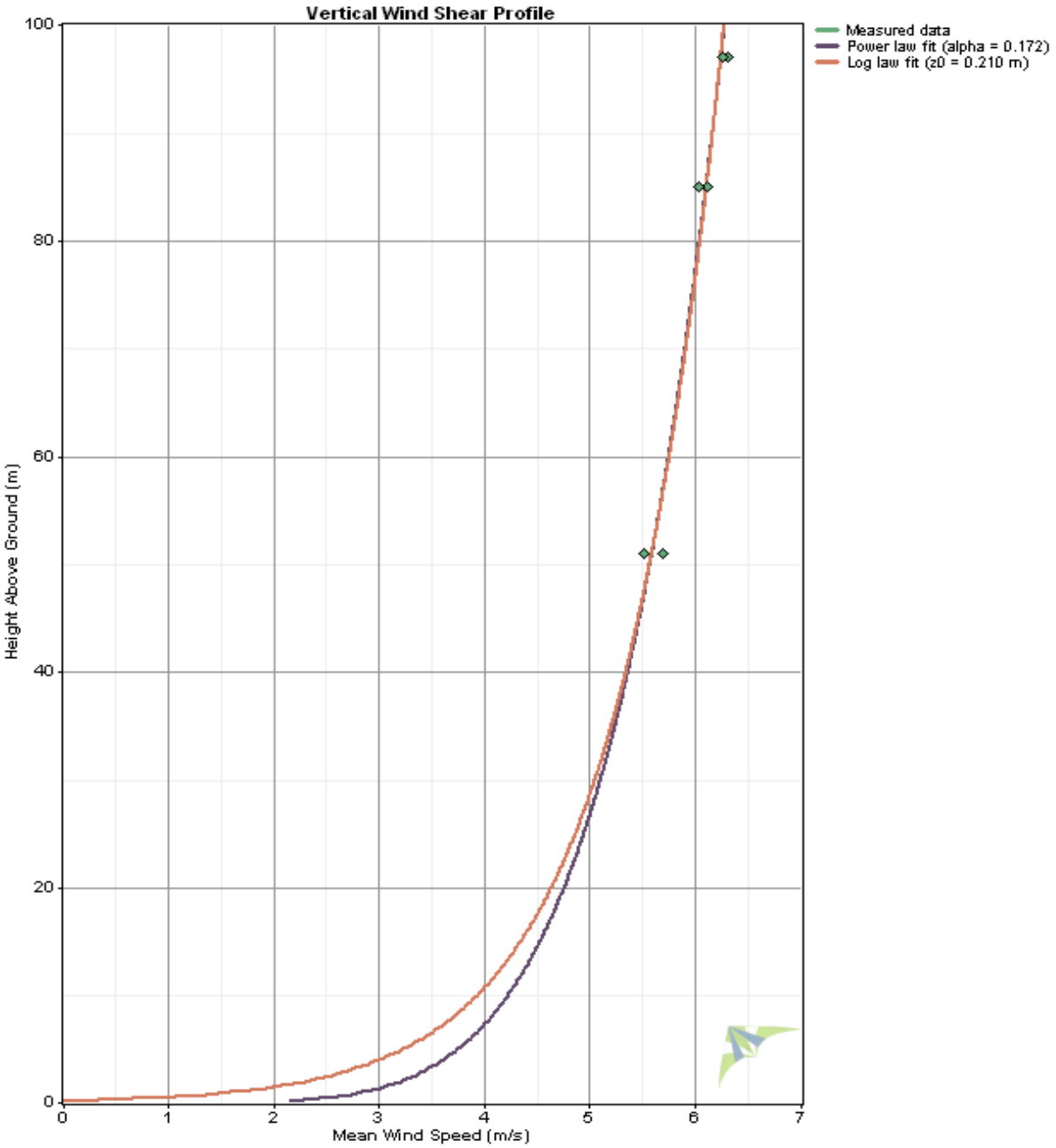

Figure 7: Displays the wind shear profile for the Newport News tower site.

Frequency Wind Rose

Figure 7 displays a frequency wind rose showing what percentage of time the wind blows from 16 compass point directions during the data acquisition period. This rose shows that wind blows most frequently from the southwest but also significantly blows from the northeast though less frequently.

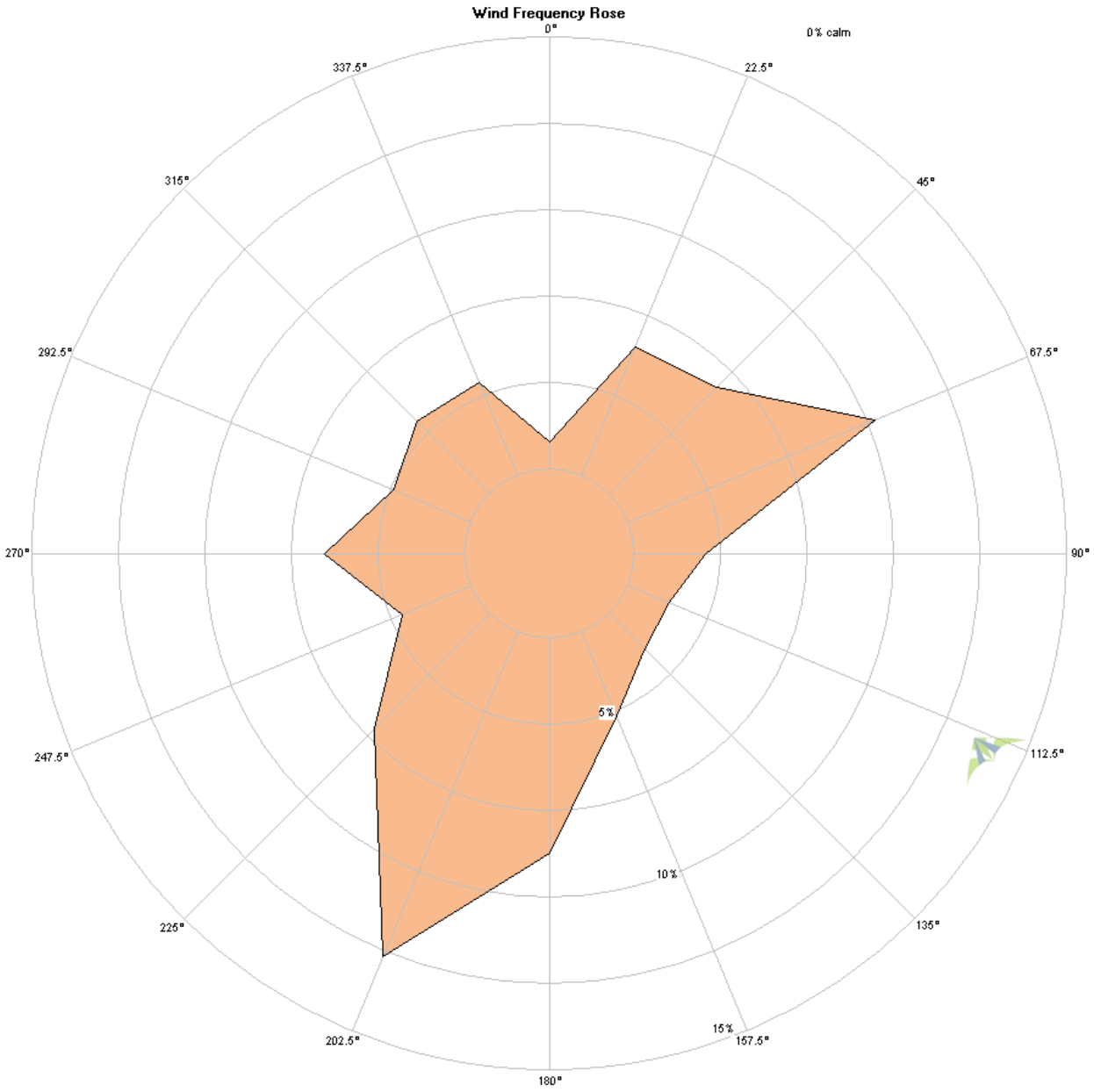

Figure 8: Wind rose displaying wind direction frequency at 51 m.

Wind Speed Occurrence by Direction

Figure 8 – 10 show the average wind speed by 16 compass point directions at 97, 85, and 51 meters. The strongest winds come from western and southwestern directions as well as some significant winds from the northeast. Figure 7 shows that winds coming from the west are some of the stronger winds the tower experiences. However, as shown in Figure 7, winds from the west blow much less frequently then from the southwest or northeast.

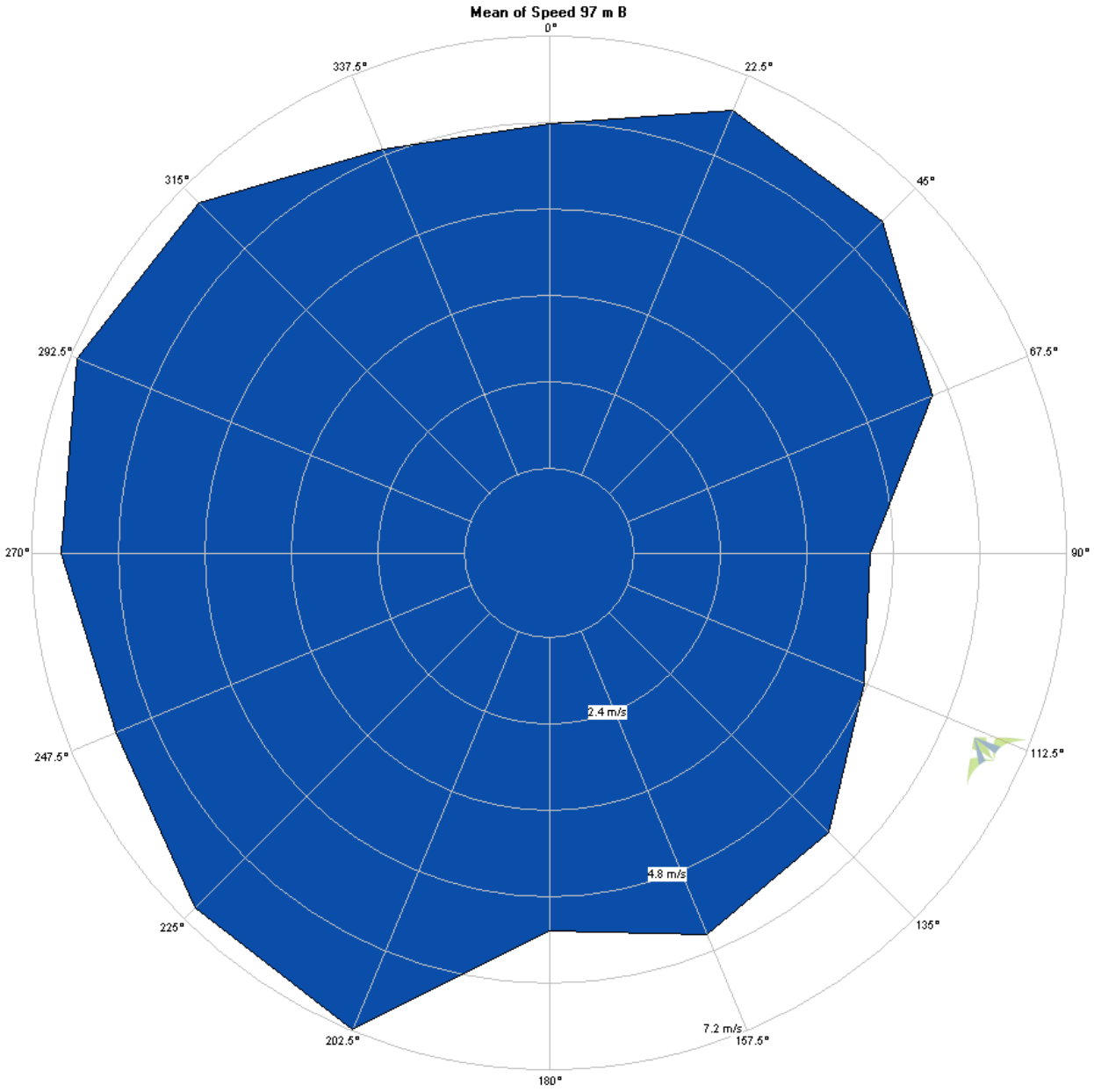

Figure 9: Wind rose displaying mean value wind speeds by direction at 97 meters.

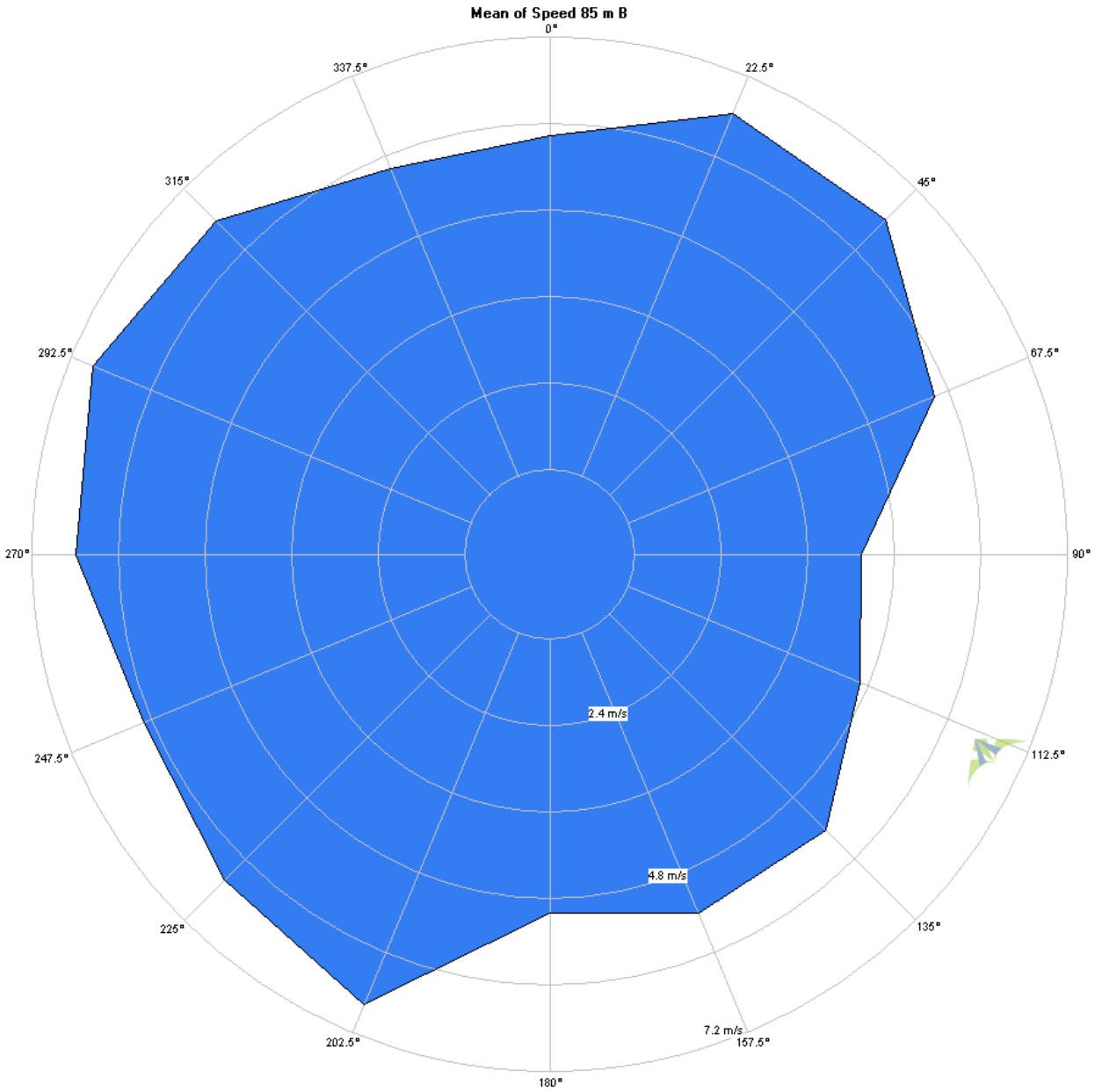

Figure 10: Wind rose displaying mean value wind speeds by direction at 85 meters.

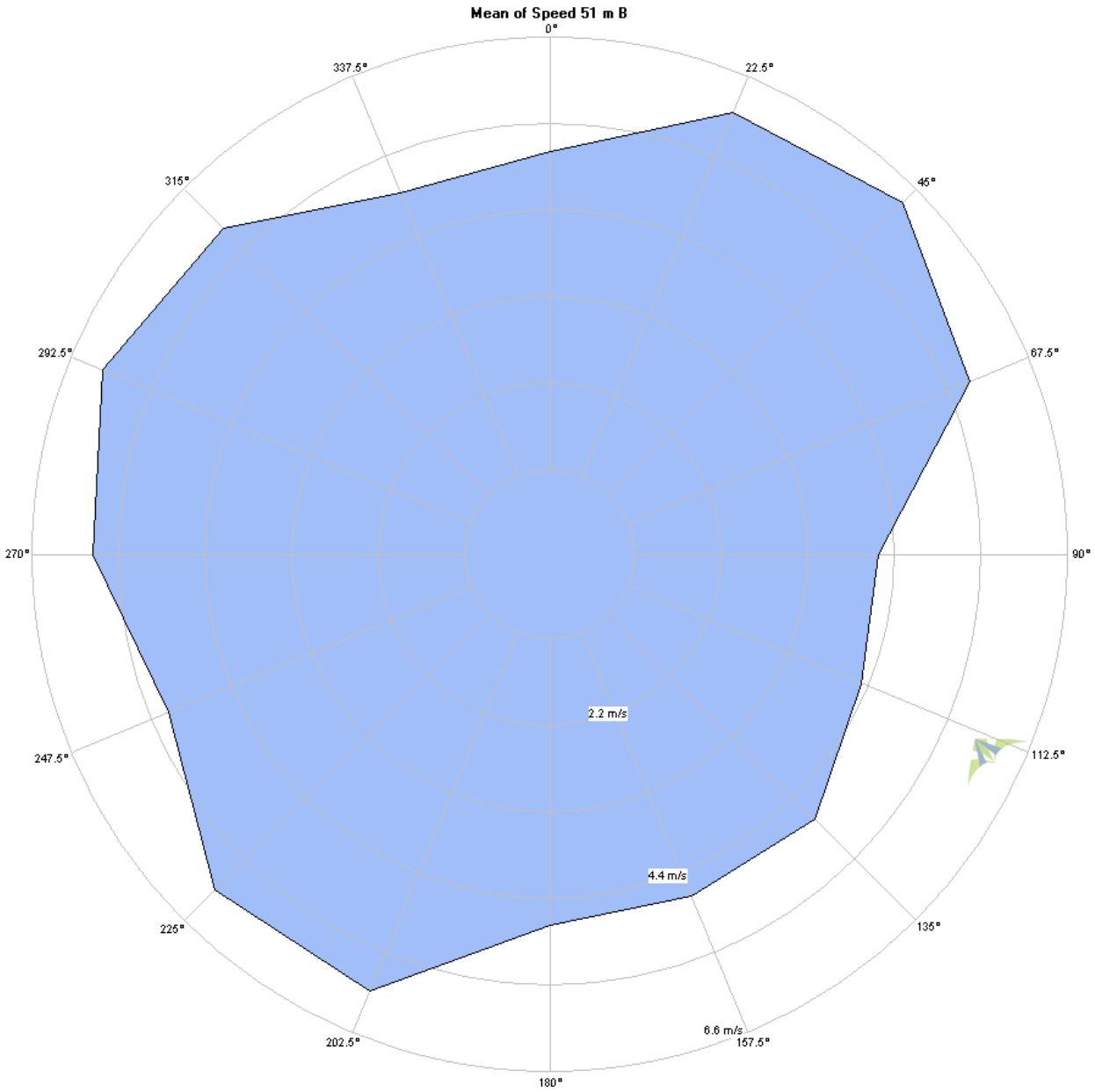

Figure 11: Wind rose displaying mean value wind speeds by direction at 51 meters.

Energy Rose

Figures 11 – 13 each display a wind energy rose that shows the percentage of energy available from 16 compass point directions at 97, 85, and 51 meters. The winds that will provide the most significant amount of usable energy come from the southwest. Some generation will also occur from winds coming from the west and the northeast, but to a lesser degree.

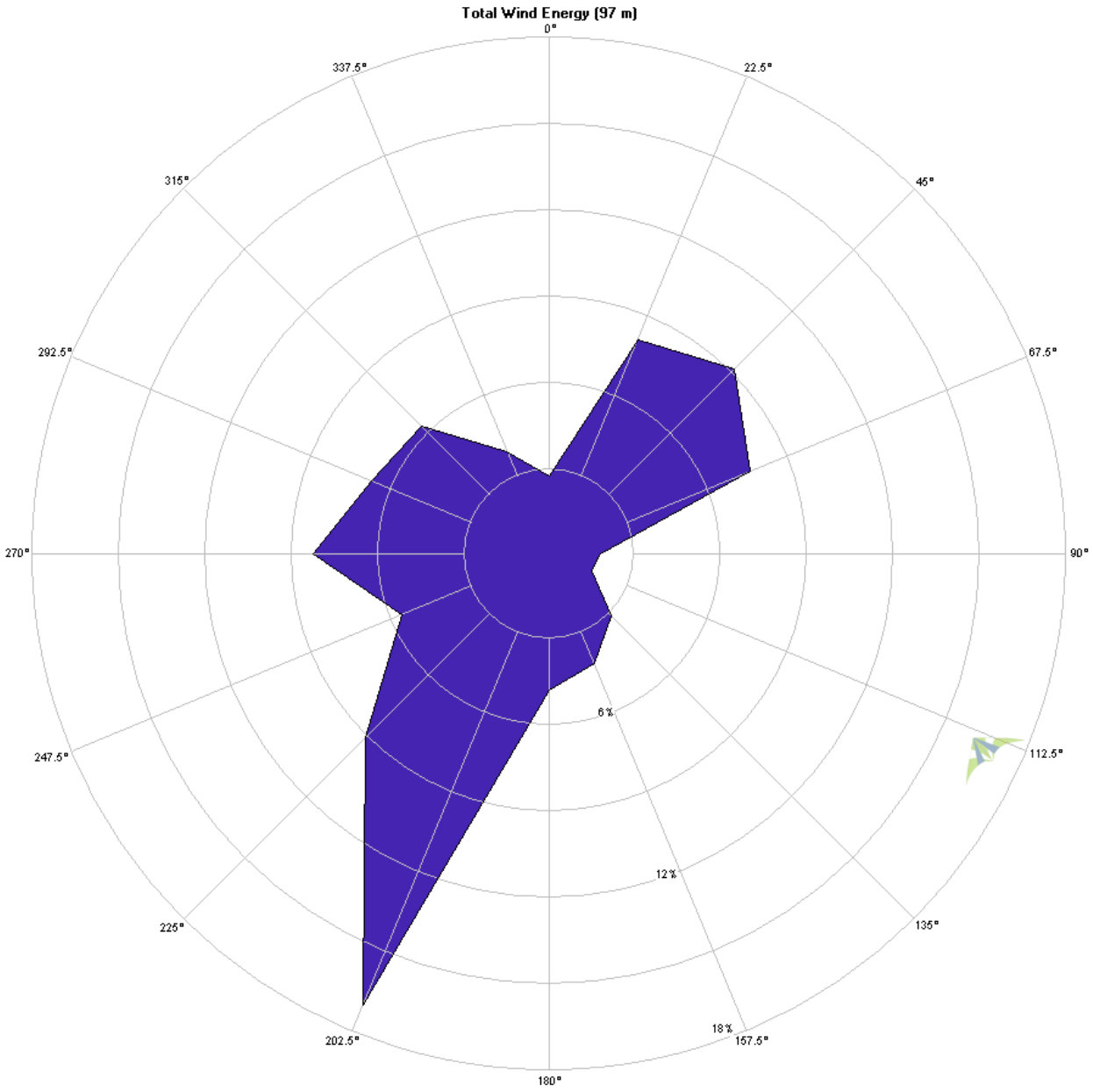

Figure 12: Wind rose displaying the percentage of total energy by direction at 97 meters.

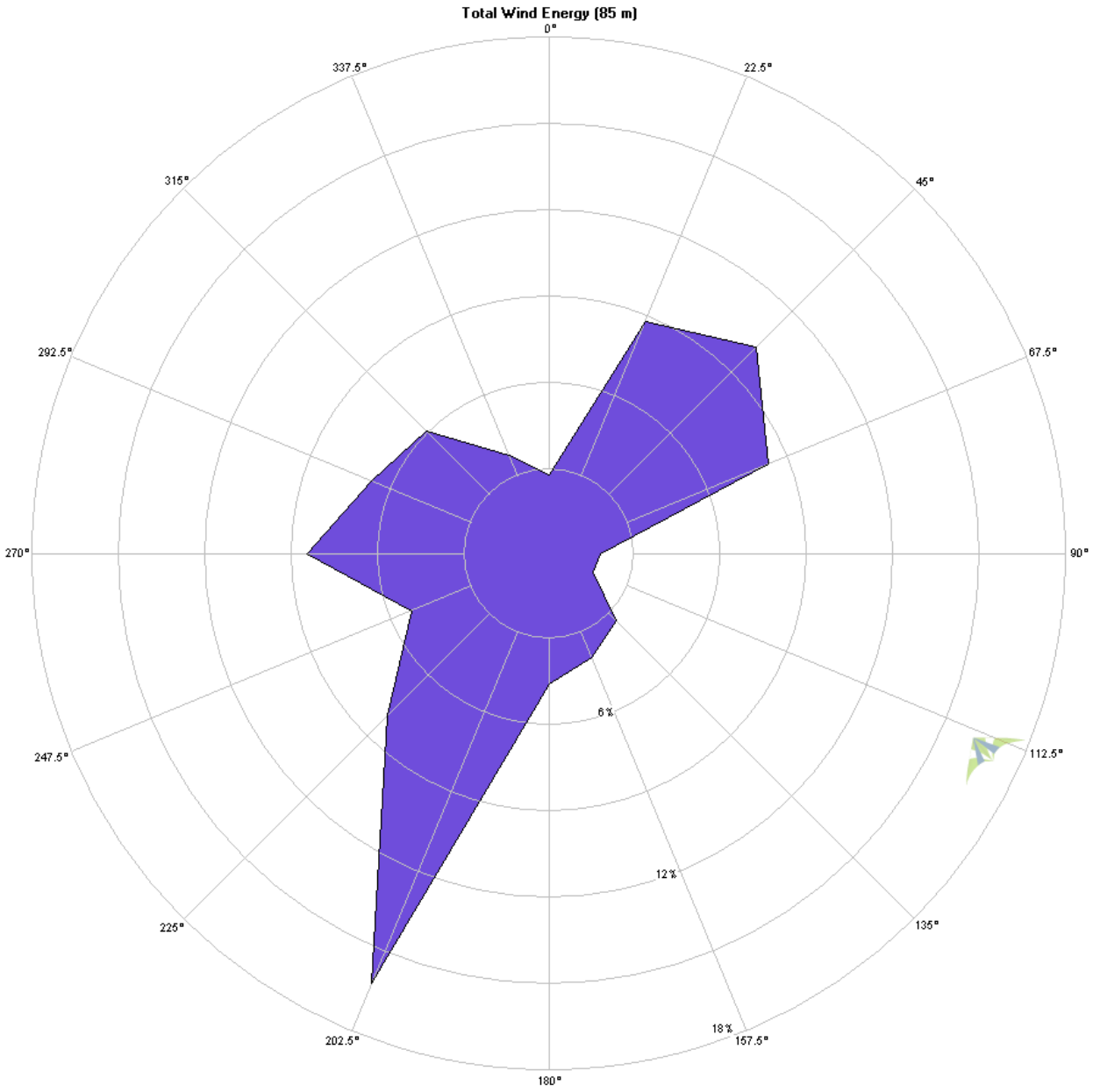

Figure 13: Wind rose displaying the percentage of total energy by direction at 85 meters.

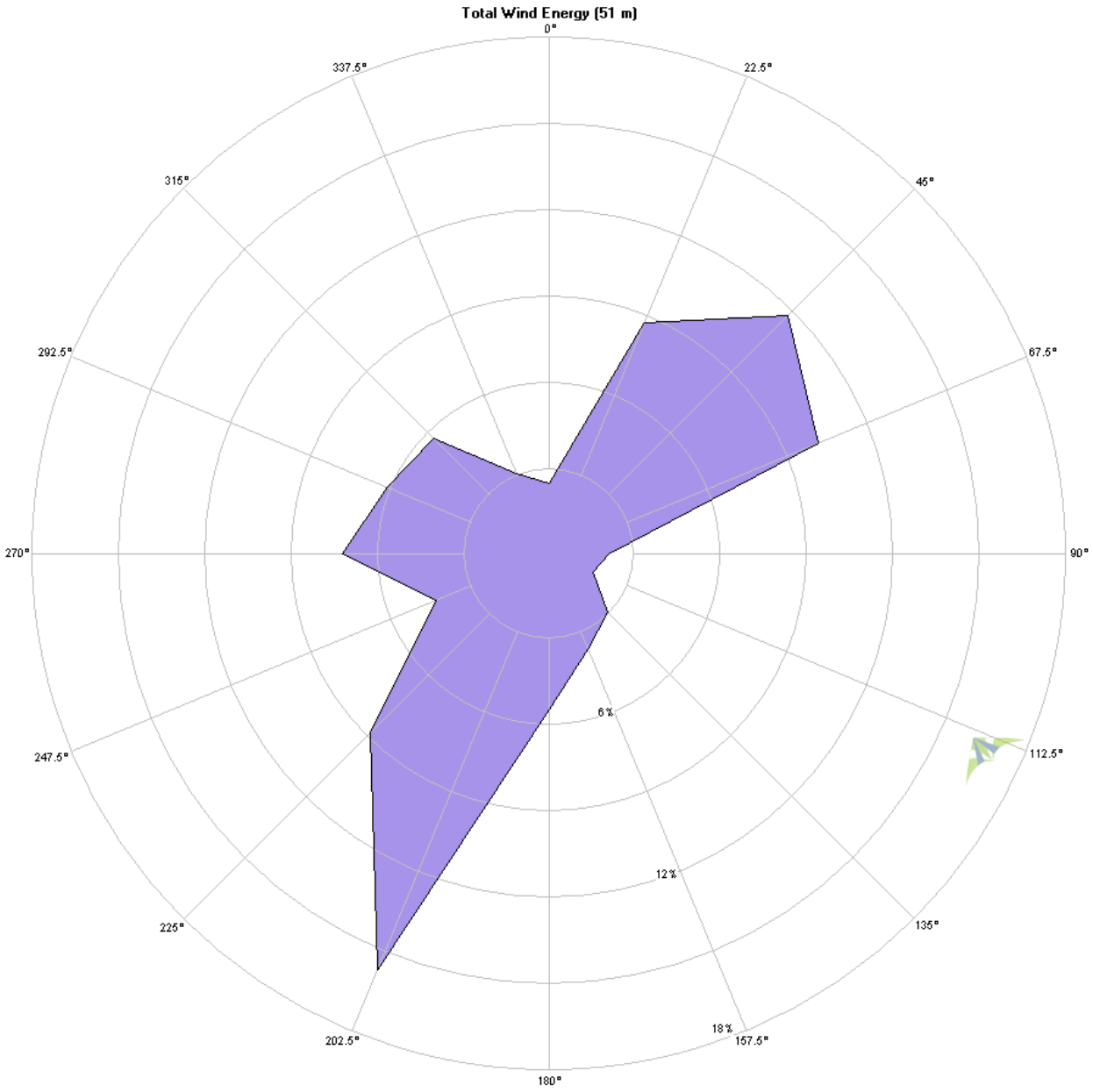

Figure 14: Wind rose displaying the percentage of total energy by direction at 51 meters.