



# *Florida Power & Light Company*

*Wind Results from the St. Lucie Project Site*

# Executive Summary

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## *Overview:*

WindLogics performed an analysis for Florida Power & Light Company to characterize the wind resource at the St. Lucie site for purposes of energy production.

The wind resource assessment analysis was based on five (5) years (2002-2006) of hourly meteorological data collected from an on-site measurement tower (38,788 data points, 88.6% data recovery). Further work was done to create a “Net Capacity Factor (NCF) Workbook” based on data from 2006 to calculate annual energy production.

All data were rigorously quality-checked and analyzed according to WindLogics’ standard procedures. The results are summarized below and in the tables and graphs on the following slides.

## *Wind Speeds:*

At 80 meters\* or 262.46 feet above ground level (AGL) the annual average wind speeds were 6.18 meters per second (m/s) or 13.82 miles per hour (mph).

At 60 meters\* or 196.85 feet AGL the annual average wind speeds were 5.65 m/s or 12.64 mph.

At 10 meters\* or 32.80 feet AGL the annual average wind speeds were 3.35 m/s or 7.49 mph.

\* See Appendix A for hub-height extrapolation method

# *Executive Summary (cont.)*

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The wind directions were generally from the east-southeast on an annual average.

## *Energy Calculations:*

Energy calculations performed by WindLogics were based on the Siemens 2.3 MW Turbine (Model SWT-2.3-82 VS), utilizing the manufacturer's published power curve (DOC ID: PG-R3-10-0000-0094-01, HST / 29.10.2006).

The estimated expected gross annual energy production is 4,016 megawatt-hours (MWh) per year, per turbine, for a gross capacity factor of 19.9%, (capacity factor is defined as the energy produced as a percentage of the rated capacity of the turbine).

The estimated expected net annual energy production is 3,495 MWh per year, per turbine, for a net capacity factor of 17.9%. Standard energy loss assumptions (turbine availability, electrical line resistance, etc.) were used in the gross-to-net energy calculations.

It is the opinion of WindLogics, based on the available data, that an estimated 21,594 MWh per year (for an installation of 6 turbines) of energy could be produced at the St. Lucie site in a safe, efficient and reliable manner.

\* See Appendix A for hub-height extrapolation method

# Wind Speeds at 80m\*, 60m and 10m

80m (or 262.46 feet)  
Extrapolated\*

Month	m/s	mph
January	6.44	14.41
February	6.51	14.56
March	6.91	15.46
April	6.90	15.43
May	6.29	14.07
June	5.27	11.79
July	4.88	10.92
August	4.81	10.76
September	5.90	13.20
October	6.10	13.65
November	7.37	16.49
December	7.19	16.08
Annual Average	6.18	13.82

60m (or 196.85 feet)

Month	m/s	mph
January	5.81	13.00
February	5.90	13.20
March	6.32	14.14
April	6.33	14.16
May	5.80	12.97
June	4.88	10.92
July	4.50	10.07
August	4.43	9.91
September	5.40	12.08
October	5.59	12.50
November	6.69	14.97
December	6.50	14.54
Annual Average	5.65	12.64

10m (or 32.80 feet)

Month	m/s	mph
January	3.13	7.00
February	3.30	7.38
March	3.73	8.34
April	3.80	8.50
May	3.58	8.01
June	3.11	6.96
July	2.79	6.24
August	2.72	6.08
September	3.21	7.18
October	3.42	7.65
November	3.83	8.57
December	3.56	7.96
Annual Average	3.35	7.49

**Note:** Monthly and annual averages are calculated from hourly data. Thus, the annual average is not the average of the monthly average values.

\* See Appendix A for hub-height extrapolation method

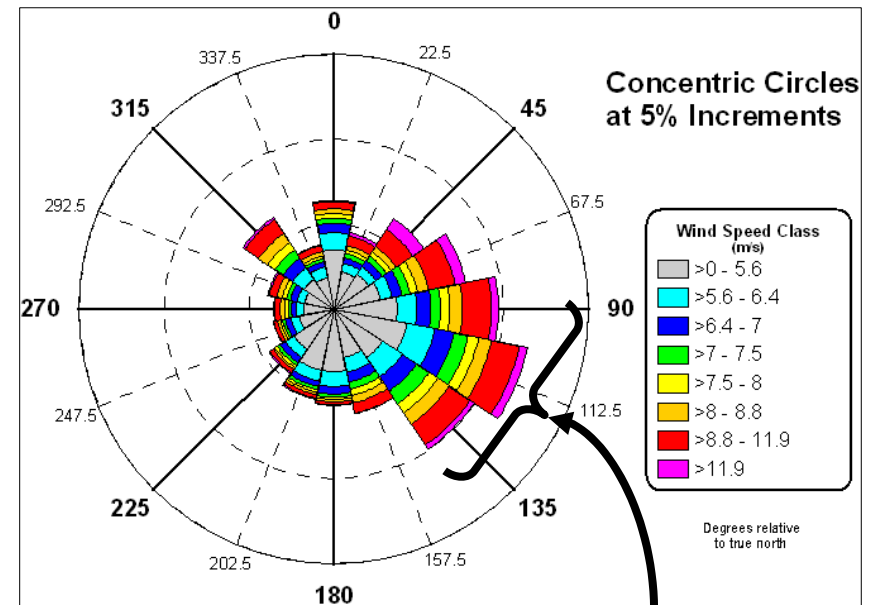
# What is a "Wind Rose"?

A "Wind Rose" is a meteorological diagram depicting the distribution of wind direction and speed at a specific location over a period of time.

The diagram shows the percentage of time the wind is blowing from each compass direction (0 – 360 degrees). Zero degrees (or due north) is at the top of the diagram. 90 degrees is due east and so on. The rings or "concentric circles" are depicted in 5% increments.

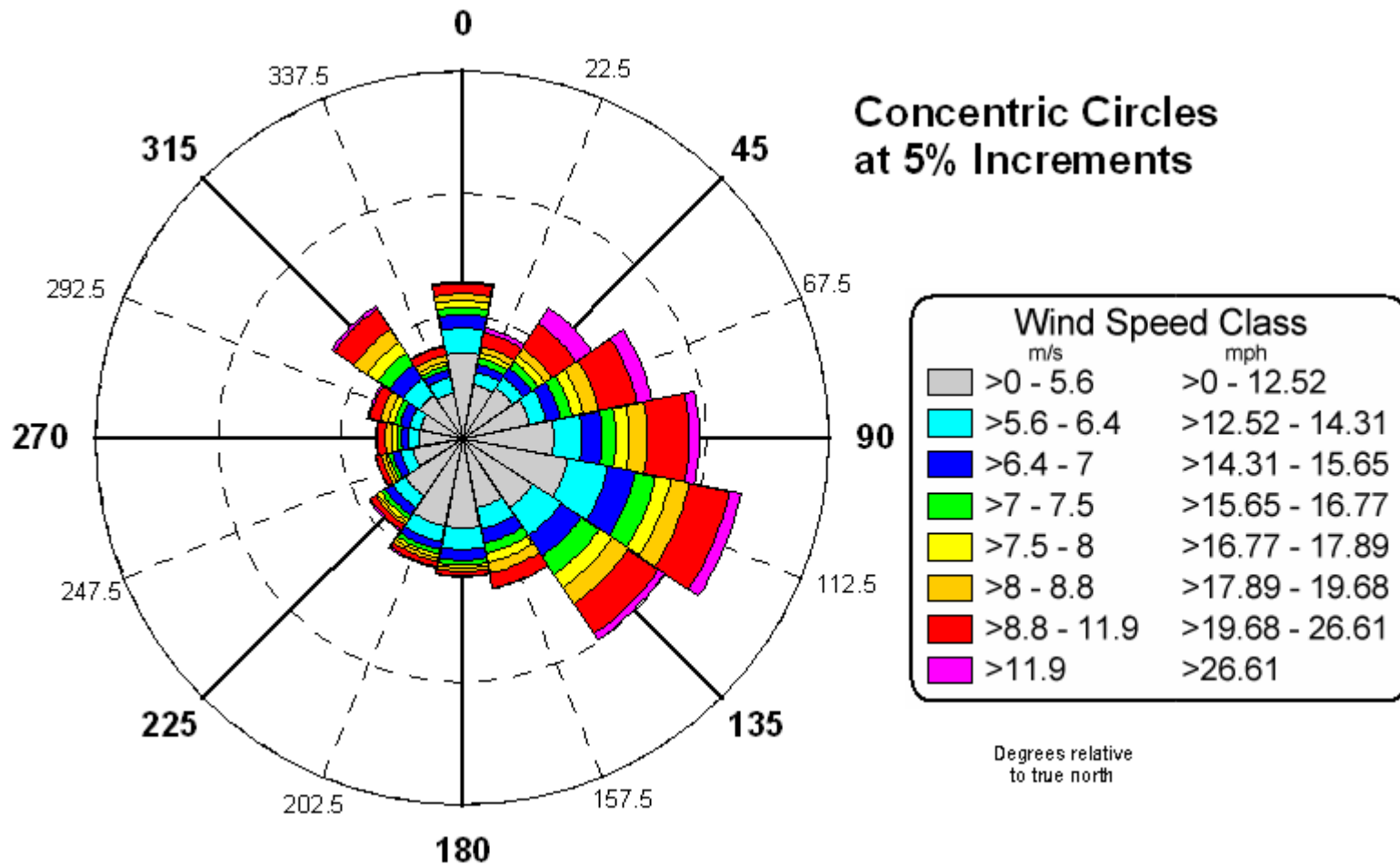
The colors show the wind speeds that occur (gray is low wind – red and purple are high winds, etc.).

The analysis of wind direction is useful in determining optimal wind turbine layouts.



In this example, most of the wind blows from the east and south east directions.

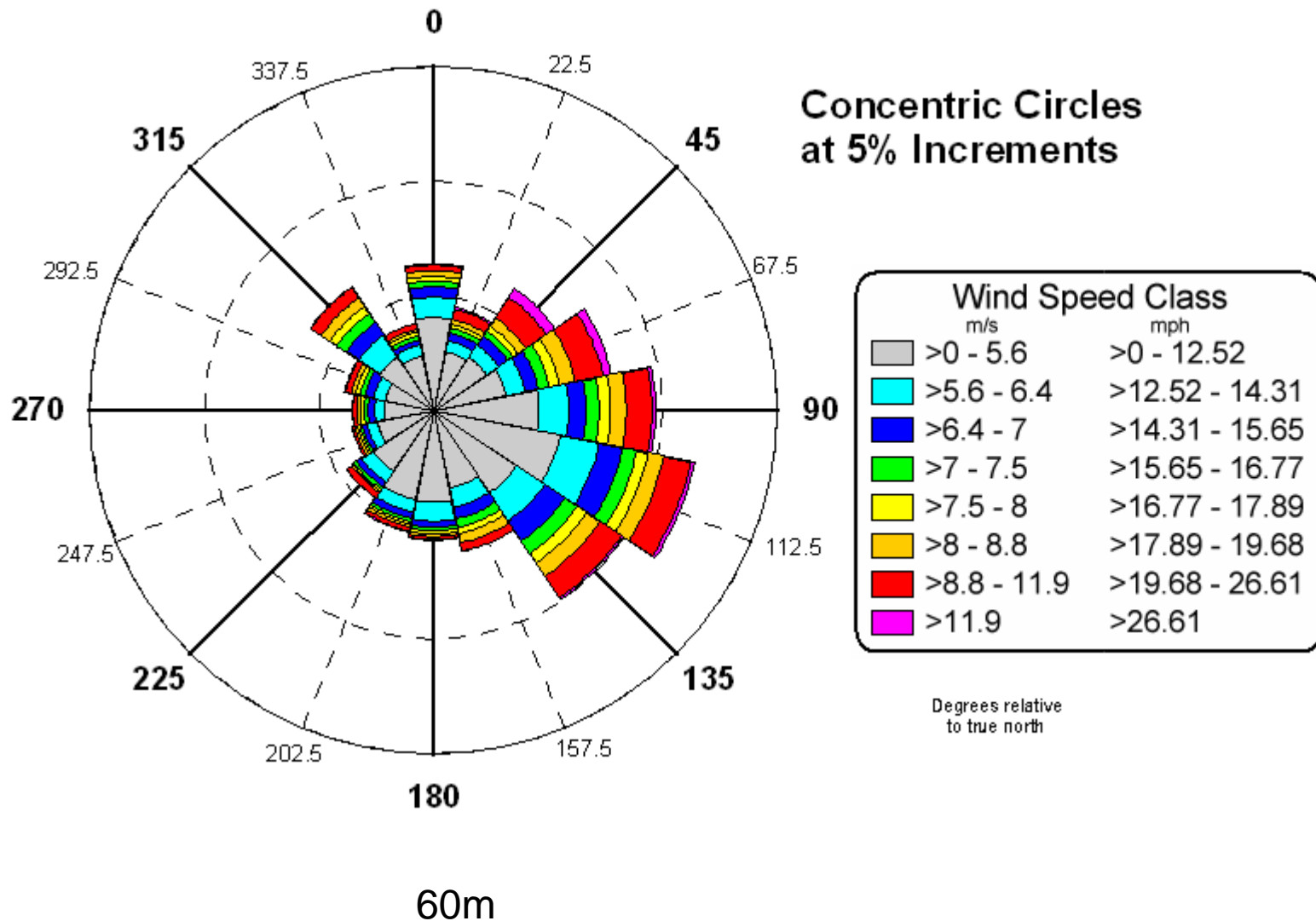
# Wind Rose at 80m\* (262.46 feet) AGL



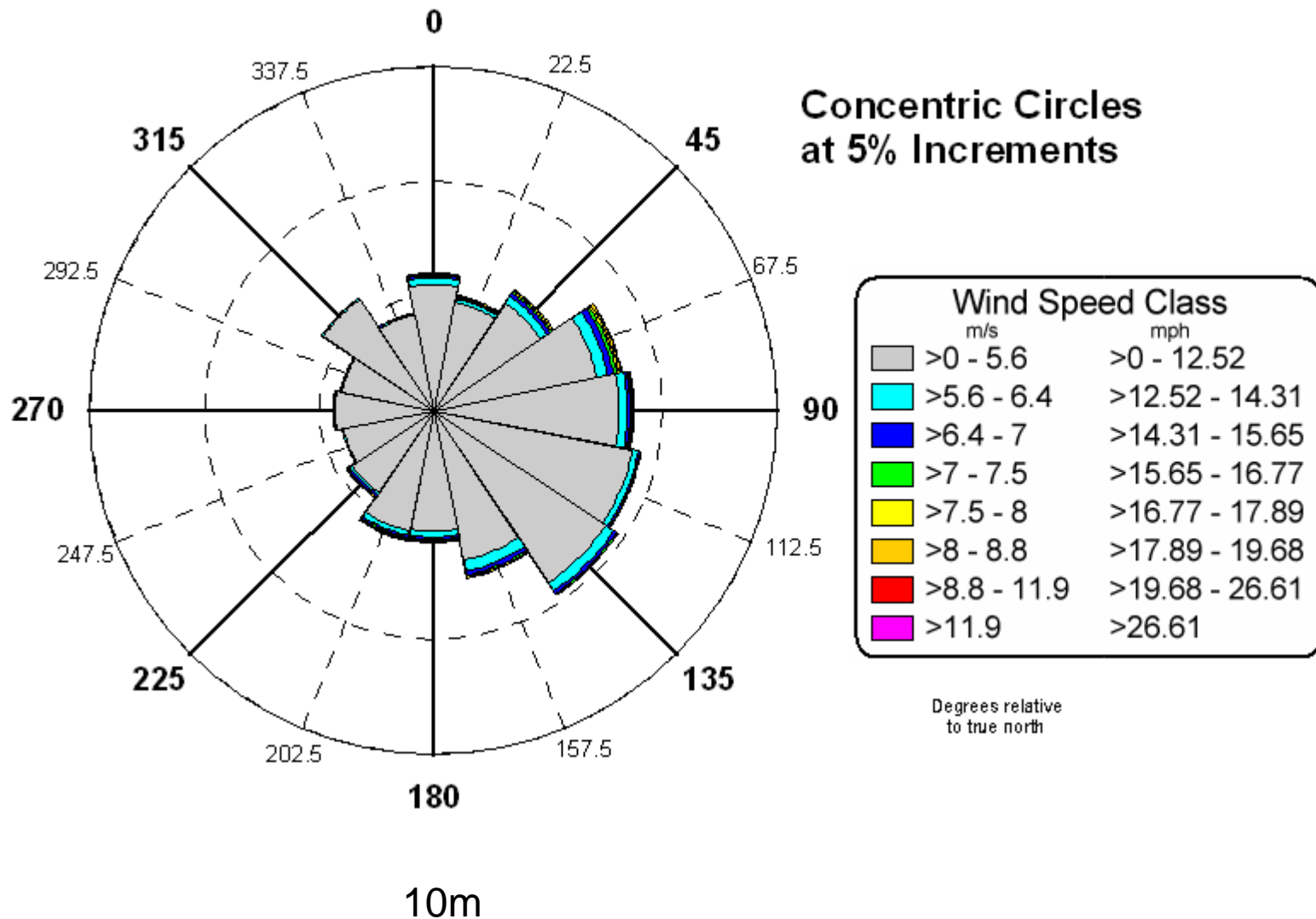
80m Extrapolated\*

\* See Appendix A for hub-height extrapolation method

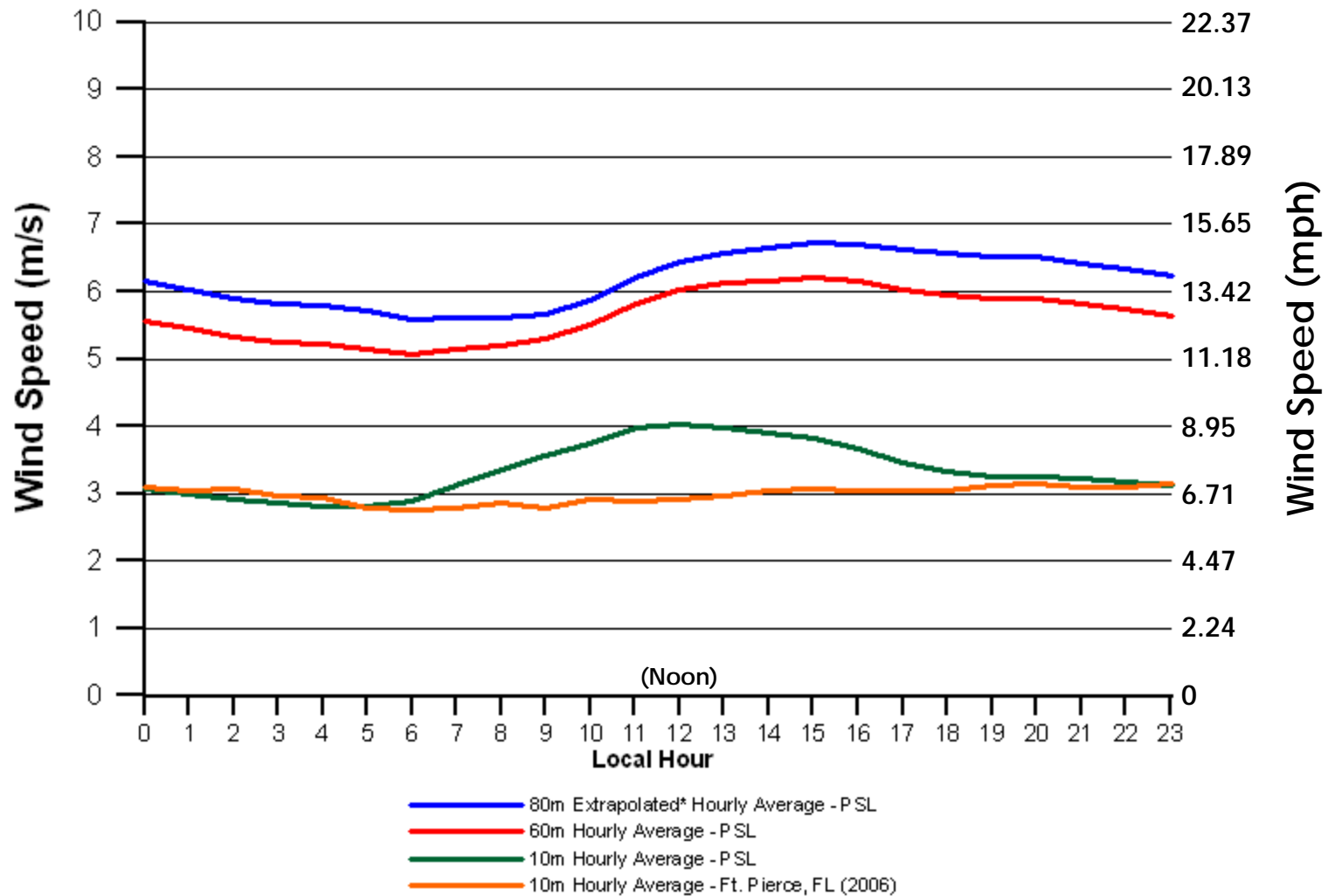
# Wind Rose at 60m (196.85 feet) AGL



# Wind Rose at 10m (32.80 feet) AGL



# Hourly Wind Speeds at 80m\*, 60m and 10m



\* See Appendix A for hub-height extrapolation method

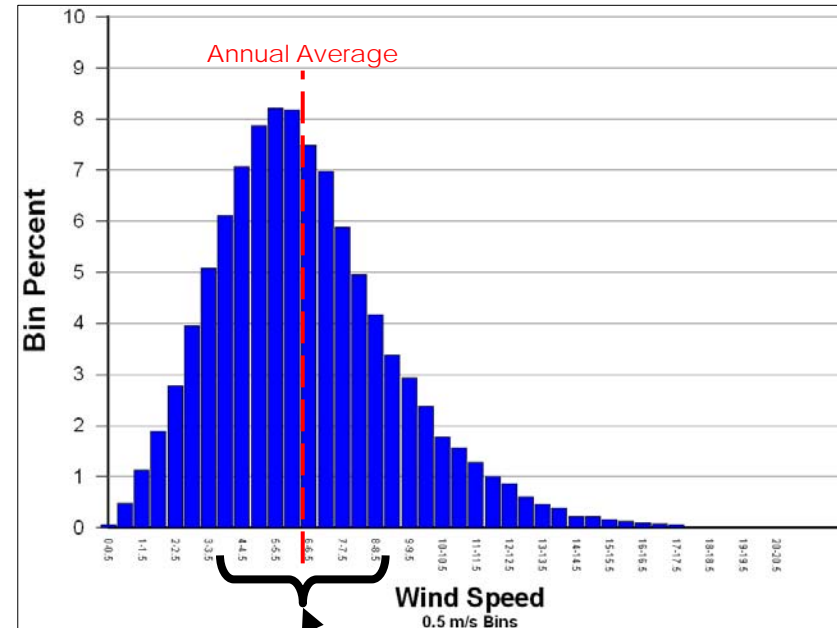
# What is a Wind Speed Histogram?

A “Wind Speed Histogram” is a method of depicting the distribution of wind speeds.

The bar graph shows the percentage of time the wind is blowing at a certain speed. The speeds are grouped into “bins” representing one half meter per second each (approx. 1.1 mph).

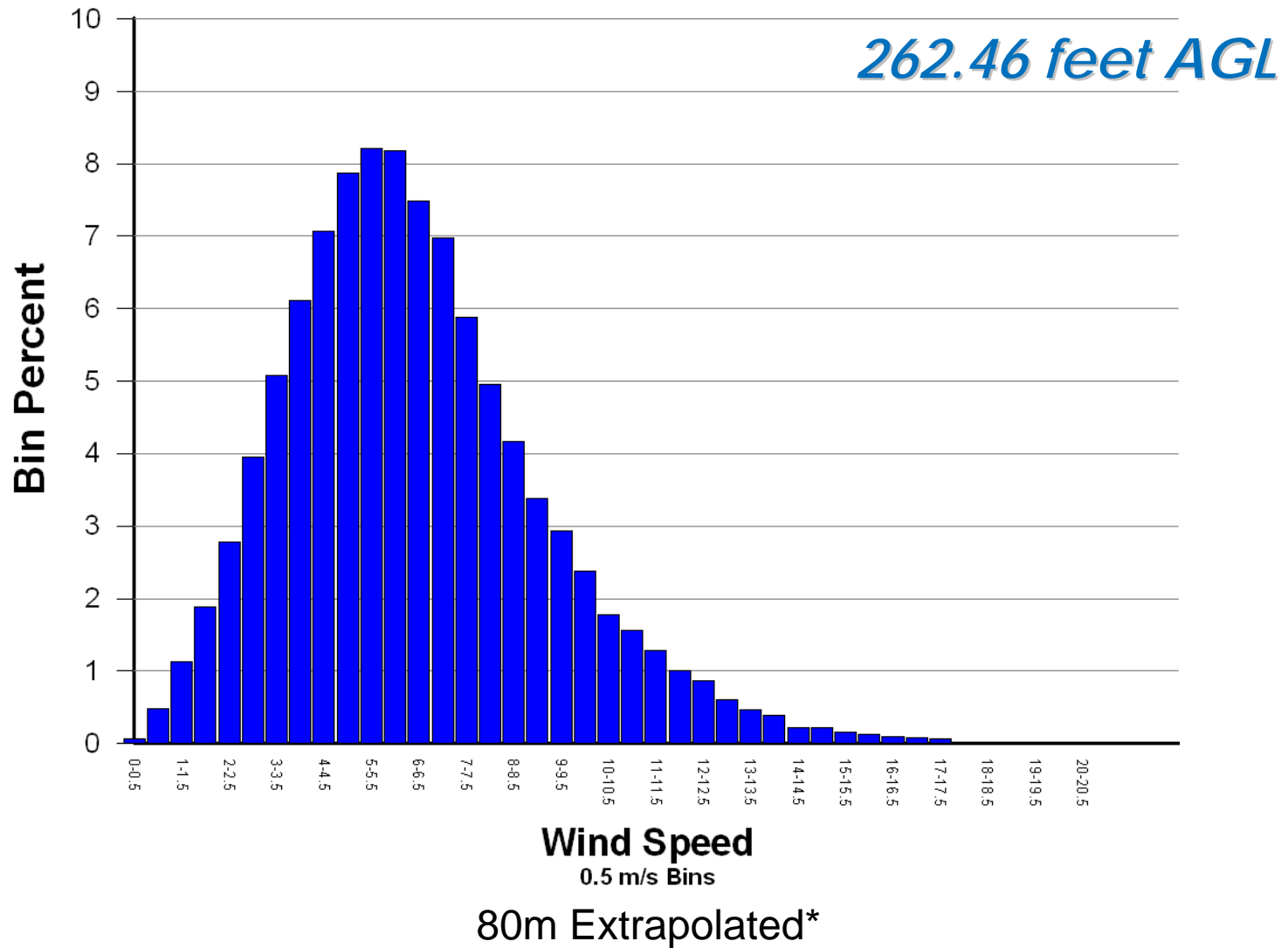
The taller the bar, the greater the percent of time the wind is blowing that speed.

Taller bars to the right of the graph indicate better wind turbine performance more of the time.



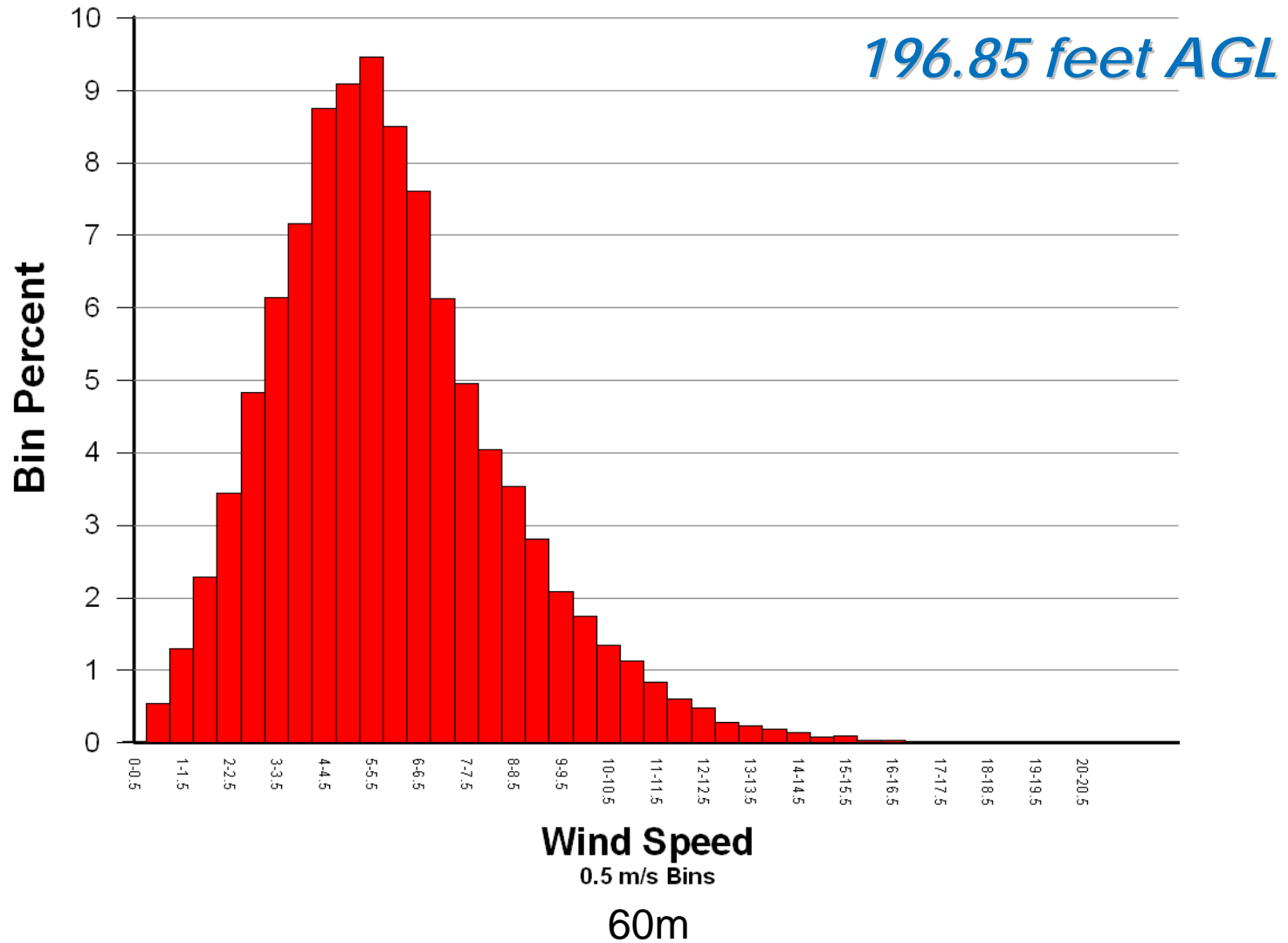
In this example, the wind speeds are distributed fairly evenly around the annual average of 6.18 meters per second (m/s) or 13.82 miles per hour (mph) at turbine height.

# Wind Speed Histogram at 80m\*

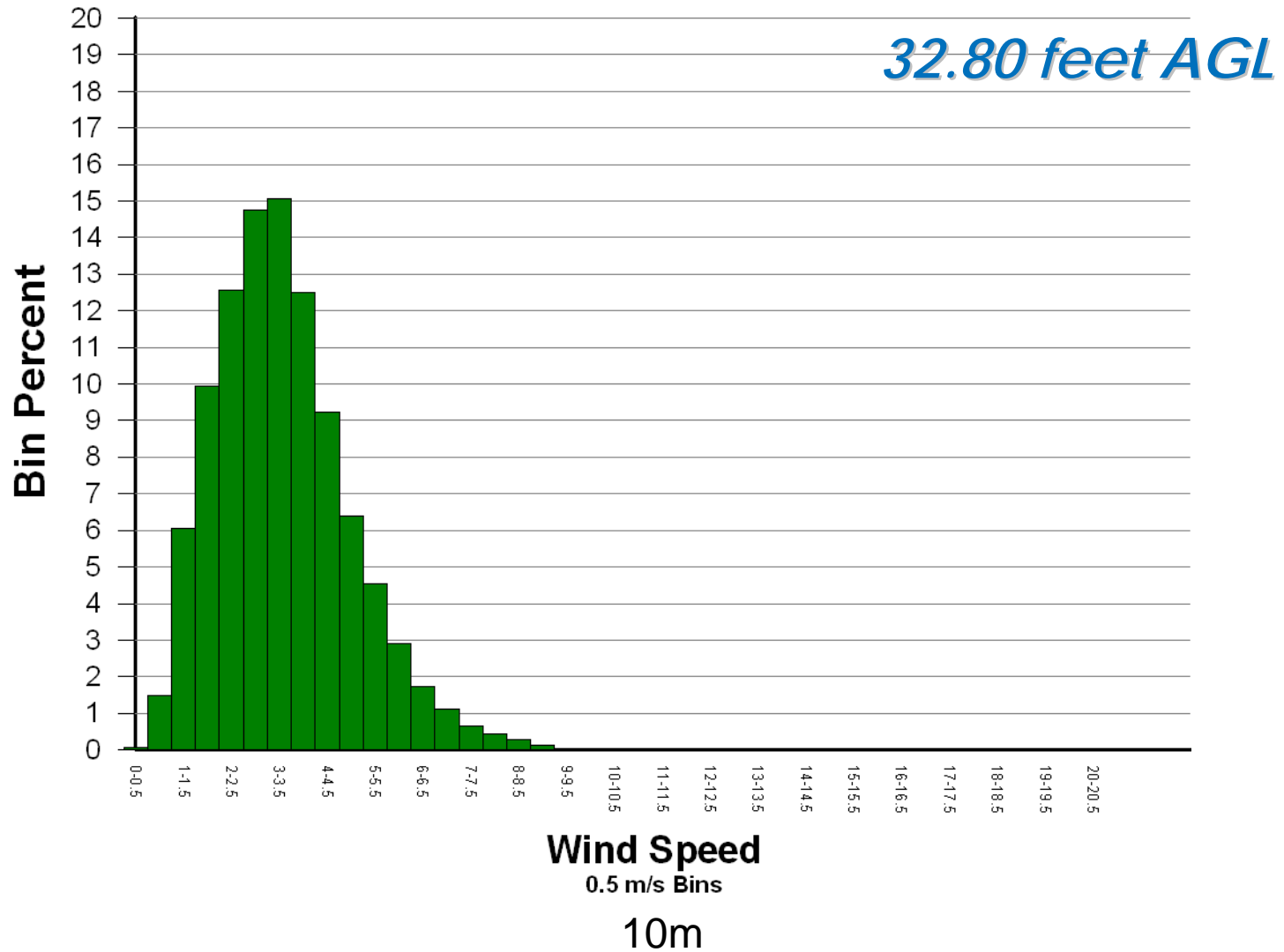


\* See Appendix A for hub-height extrapolation method

# Wind Speed Histogram at 60m



# Wind Speed Histogram at 10m



## Appendix A: Calculating Hub-height Wind Speeds

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The *power-law* equation is used to extrapolate wind speeds from measurement heights to hub height.

The power-law equation takes the form:

$$V_{80} = V_{60} \cdot \left( \frac{80m}{60m} \right)^{\alpha}$$

Where:

- $V_{80}$  is the estimated hub-height wind speed at 80 meters (80m)
- $V_{60}$  is the measured wind speed at 60 meters (60m)
- $\alpha$  (alpha) is the *shear coefficient* calculated using this equation between 60 meters and 10 meters - on an hourly basis for this study

Please refer to Appendix B for references and more information regarding power-law extrapolation.

# Appendix B: References

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Wind resource assessment references, including power-law extrapolation method information:

- Manwell, J.F. et al. *Wind Energy Explained*. John Wiley & Sons. June 2002.
- Bailey, B.H., S.L. McDonald, D.W. Bernadett, M.J. Markus, K.V. Elsholz, 1997. *Wind Resource Assessment Handbook: Fundamentals for Conducting a Successful Monitoring Program* (<http://www.nrel.gov/wind/pdfs/22223.pdf>), AWS Scientific, Inc., Albany, NY.
- Elliott, D.L., C.G. Holladay, W.R. Barchet, H.P. Foote, and W.F. Sandusky, 1986. *Wind Energy Resource Atlas of the United States* (<http://rredc.nrel.gov/wind/pubs/atlas/>), Pacific Northwest Laboratory, Richland, WA.