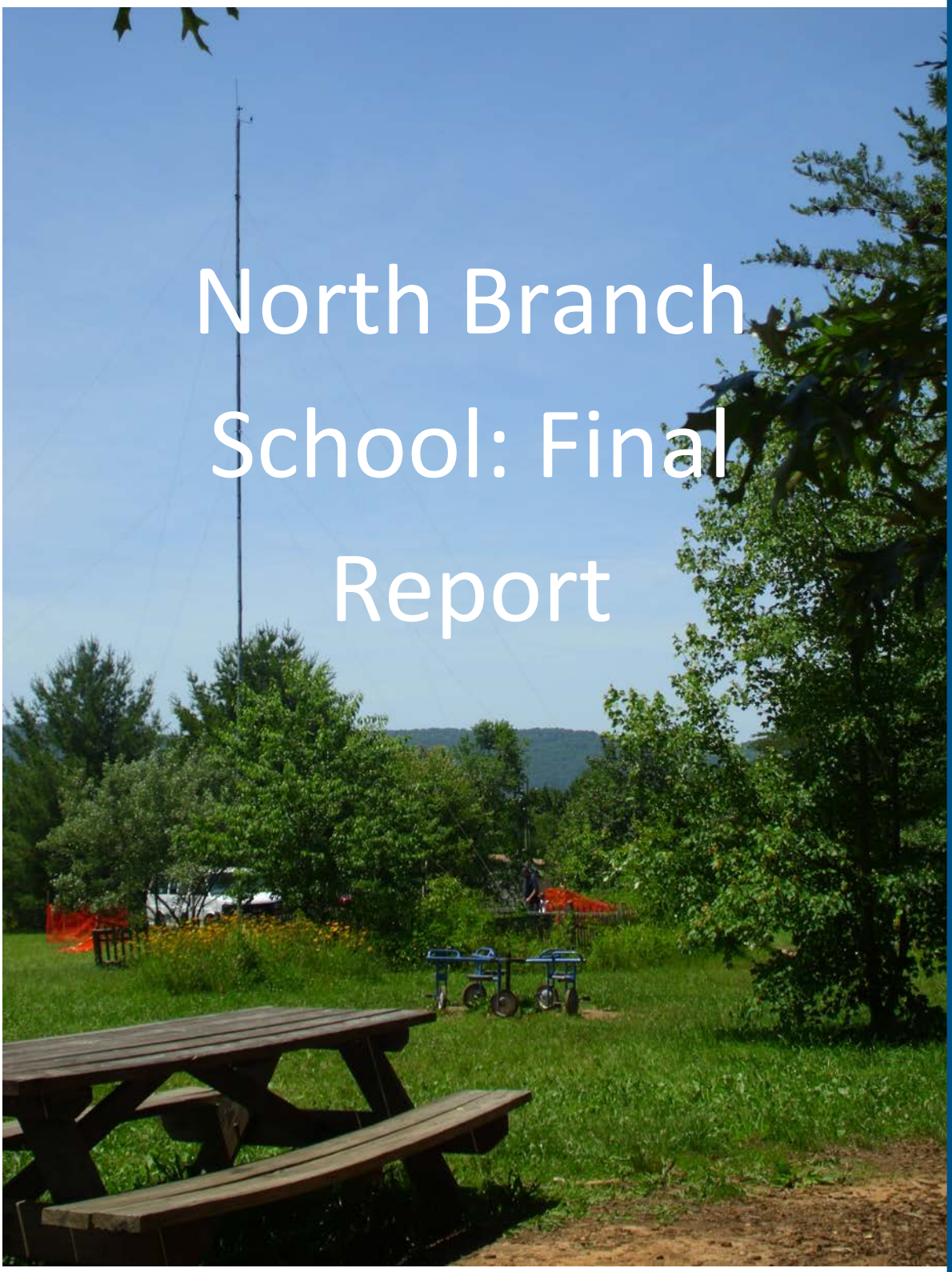

North Branch School: Final Report

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Project Summary

As part of Virginia's State-Based Anemometer Loan Program, an anemometer was placed at North Branch Middle School to assess the area's wind energy potential. Wind speed and direction were measured from June 6 2011 through July 4 2012. The annual average wind speed during the monitoring period (66ft [20m] above ground level) was recorded to be 4.1 mph (1.9m/s). Wind power density was calculated to be around 17.4 W/m^2. The site is a **Class 1** wind site and is therefore considered **marginal** for a wind project. Wind turbines with low cut-in speeds of around 6mph for any noticeable energy production. The strongest months were January and February, whereas the winds were strongest in the afternoon.

A link to the data can be found online at http://wind.jmu.edu/education/partners.html

Project Location

The monitoring equipment was installed on North Branch School grounds at an elevation of 800 ft. The site is located on *N 37.998995; W 78.822918*

Monitoring Equipment

The 20-meter NRG-NOW Systems – Wind Explorer kit includes

- one tower
- one NRG Symphonie data logger with shelter box
- one #40 Maximum anemometer
- one #200P wind direction vane
- sensor cabling
- lightning rod with copper rod
- one MMC card

Results

Average annual wind speed	4.1mph
Average annual wind power density	17.4W/m^2 (Class 1 – very poor)
Month with greatest wind resource	February 2012
Average wind speed during month with greatest resource	5.8mph
Month with least wind resource	September 2011
Average wind speed during month with least wind resource	2.32mph
Percentage of year Skystream 3.7 turbine active	17.1%
Number of days a year Skystream 3.7 active	62.3 days
Number of hours a year Skysteam 3.7 active	1494 hours
Average annual power output	578kWh/year

Time Series

Figure 1 shows the wind speed readings for every ten-minute average from June 2011 through June 2012, represented by the blue line. This time series was compared to the cut-in wind speed of the Skystream 3.7 wind turbine, which is the minimum wind speed required for the Skystream to operate. During the year, **only 13.8% of all recorded data** was above this minimum speed, and this can easily be seen in Figure 1. Therefore, a Skystream 3.7 would not be a viable machine to deploy at the North Branch School.

Alternatively, the school may want to explore other options, including turbines with a lower cut-in wind speed. A wind turbine with a cut-in wind speed of **7mph** would be operational for around **17.5% of the year**, equivalent to **64 days a year**. A wind turbine with a cut-in wind speed of **6mph** would be operational for **23.6%** of the year, equivalent **to 86.2 days** a year.

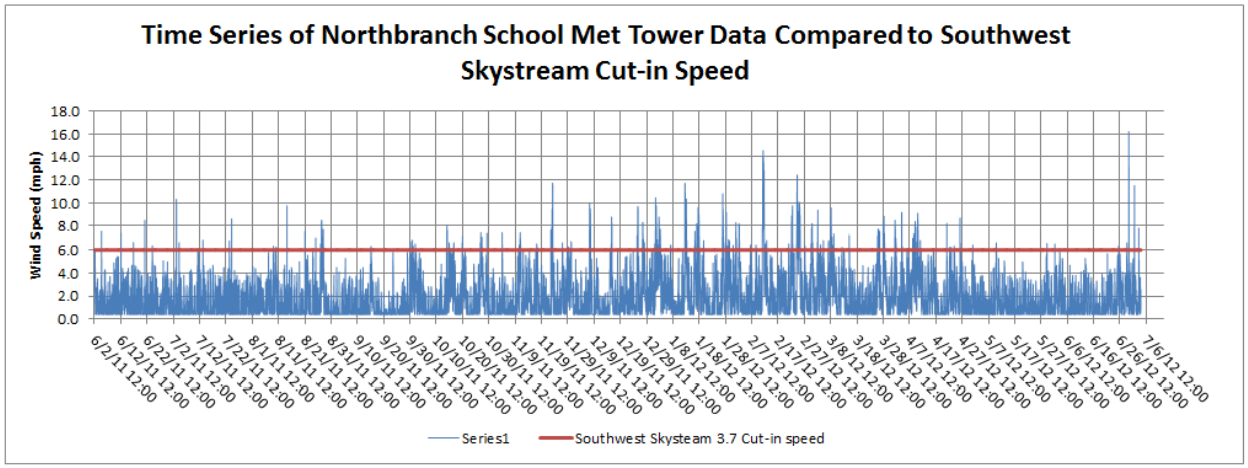

Figure 1 – Wind speed readings throughout the year (blue) compared to cut-in wind speed for the Skystream 3.7 turbine (red)

Monthly Variation

Figure 2 shows the average monthly wind speeds (blue line) for each month throughout the recorded time period. The strongest months were **January and February**, with the highest average wind speeds at around **5.8mph**. The average power density calculated for these two months were significantly higher at **41.2W/m^2 and 51.1W/m^2** respectively. The wind resource is significantly lower from late spring through autumn, where the average power density was less than **15W/m^2**.

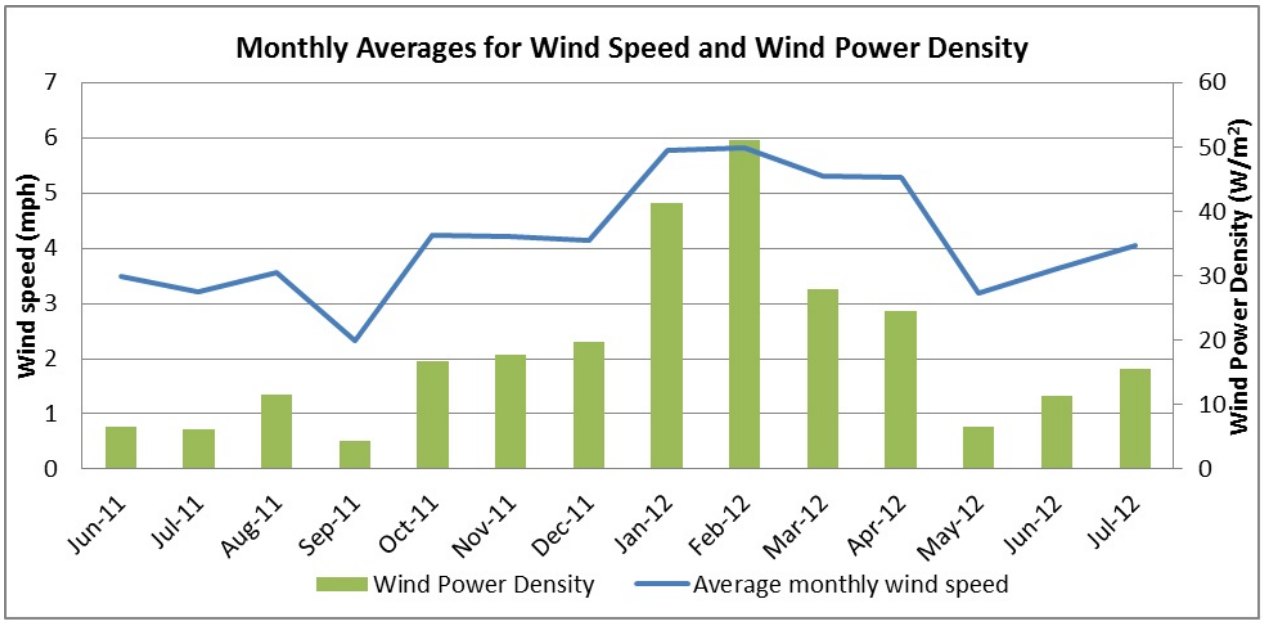

Figure 2 – Monthly average wind speeds and power densities throughout the year

Diurnal Variation

Figure 3 shows how wind speeds varied over the past year on an hourly basis. Stronger winds are more prevalent during the **afternoon and early evening** hours, but start to decrease at sunset. The slowest winds occur after midnight until around sunrise.

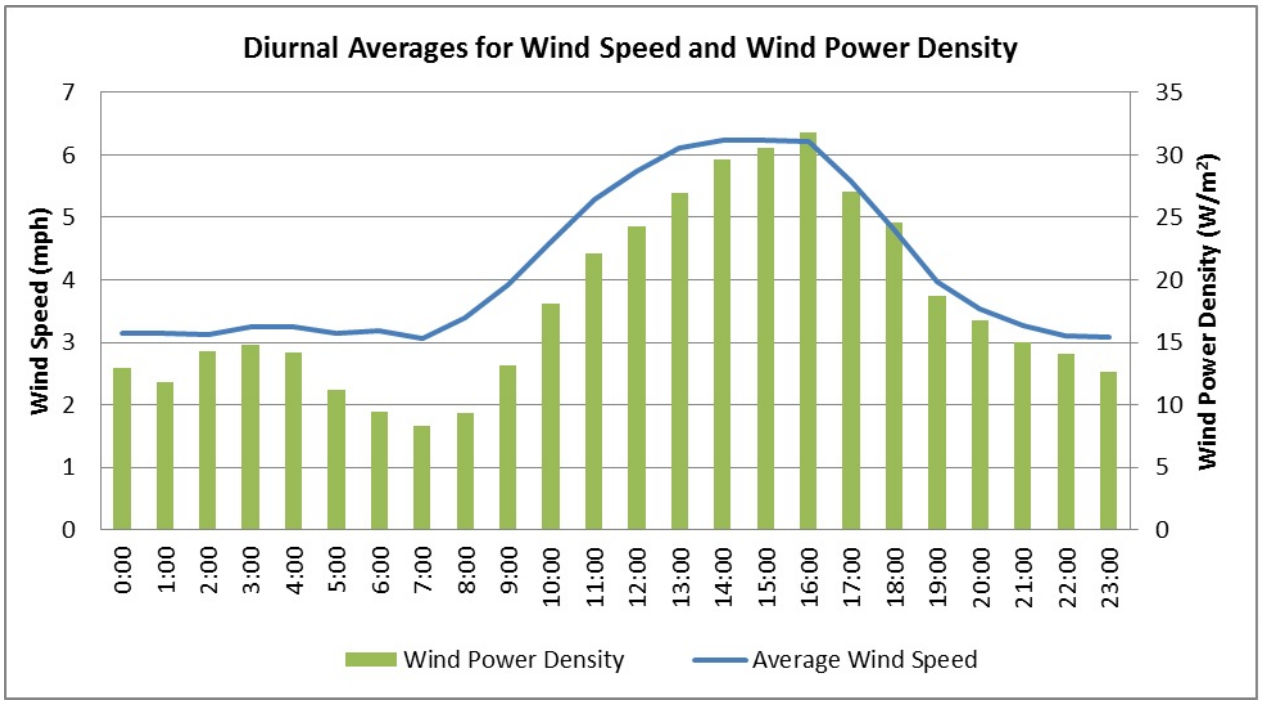

Figure 3 – Average hourly wind speeds and directions throughout the year with the associated power densities

Wind Speed Histograms

Figure 4 shows the occurrence in the number of hours that each wind speed occurs and compares this distribution to the Skystream 3.7. Typically, the wind speed distribution at a site has a high peak at lower wind speeds, and a tailing off at higher wind speeds, also called a **Weibull distribution**. For the North Branch site, the most **common** wind speed range was between **1-1.5mph**, with almost **2000 hours** a year. Figure 4 clearly shows that both the peak and average winds speeds are far below the Skystream cut-in wind speed, again highlighting the fact that this turbine is unsuitable for North Branch School.

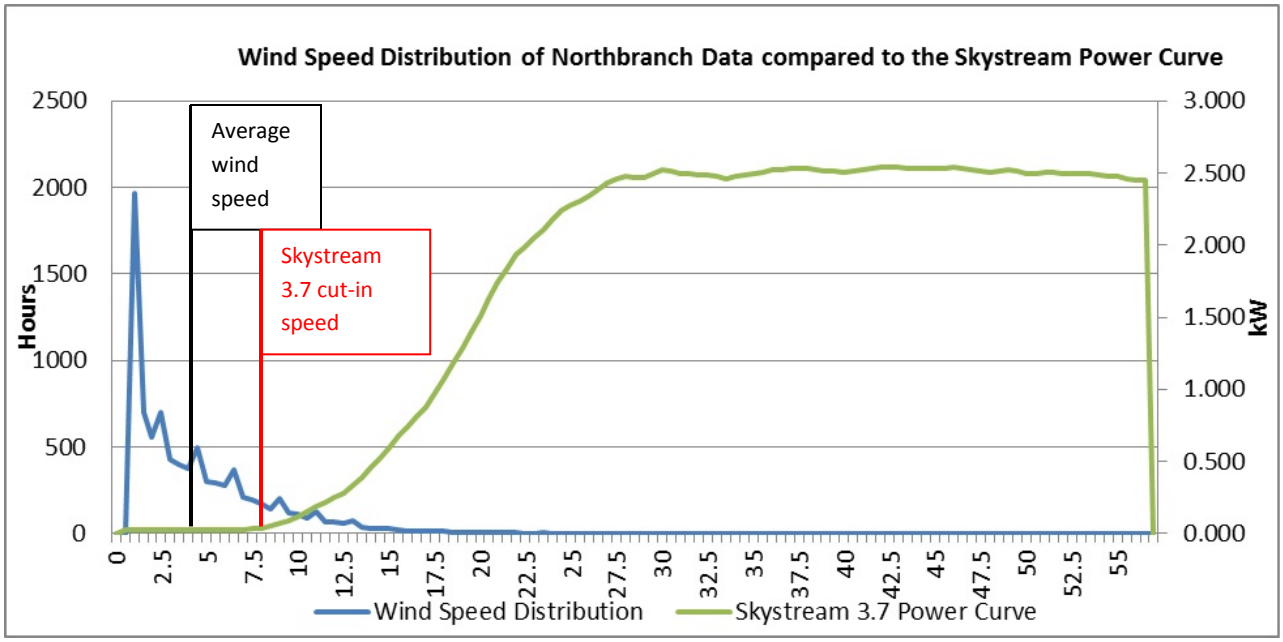

Figure 4 – Wind speed frequency distribution over the year by number of hours compared to the Skystream 3.7 power curve

Wind Rose

Figure 5 shows a wind rose, and it indicates where the majority of the winds are coming from, and at what speeds. For the North Branch school, the prevalent wind directions are south to southwesterly, with very little north to northeasterly winds throughout the year.

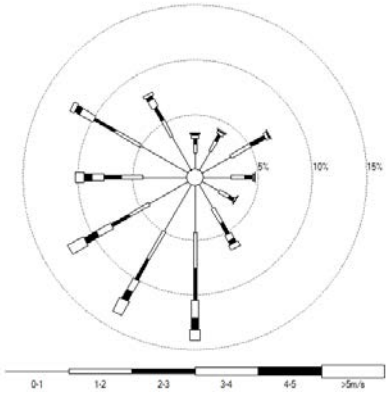

Figure 5 – Wind rose displaying wind direction frequency

Recommendations

While the wind resource at North Branch School is likely not sufficient for a Skystream 3.7 wind turbine, there are other turbines in the market, including the BWC XL.1 1kW turbine, and the ARE 110 2.5kW turbine, with cut-in speeds at around 6mph. All three turbines can be seen in Figure 6. A demonstration model turbine may be used to demonstrate how a wind turbine works in the classroom. Additionally, the wind data collected over the past year will be a useful learning tool in the classroom. Remy Pangle is currently developing classroom material to assist teachers.

Finally, the annual Kid Wind Challenge provides the perfect opportunity for students to learn all about wind by researching and designing their own turbines. We highly recommend any interested students to participate in the 2013 Challenge.

Figure 6 - (from left to right) The Skystream 3.7, BWC XL.1 1kW, and the ARE 110 2.5 kw machine

Storm of Friday, June 29 2012

On Friday, June 29 2012, a big storm passed through most of Virginia, including the North Branch school area. Data readings throughout that day are provided in Figure 6. The storm passed through the North Branch area at around 8:00pm through around 11:00pm, where a massive increase in the wind speed is seen during this time period. However, the high wind speeds observed would not have been a risk to any wind turbines in the area. After the storm passed, wind levels dropped to the regular values by midnight.

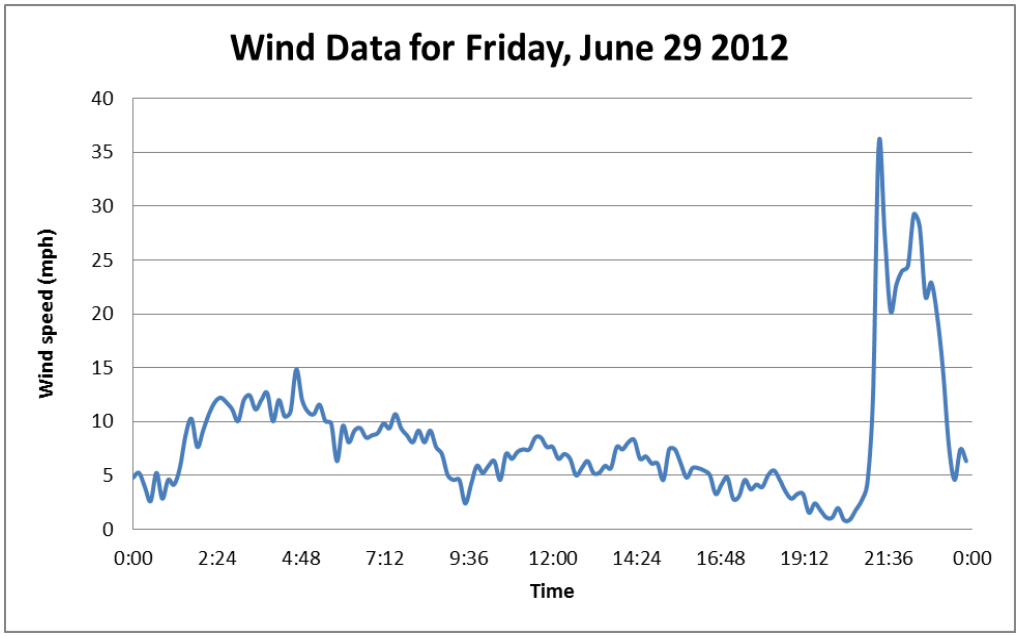

Figure 6 - Wind data for Friday, June 29 2012