## Low Wind Speed Case Study

# Buffalo Mountain Wind Farm

The Buffalo Mountain Wind Farm is the Southeast's first and currently only wind farm. Located near Oak Ridge, Tennessee, the Tennessee Valley Authority (TVA) began this project in 2000 with three turbines. In 2004, wind farm development company Invenergy expanded the project to include fifteen additional turbines. The electricity from the 27-megawatt (MW) project belongs to TVA. **The Buffalo Mountain Wind Farm has been successful, producing enough energy to power 3,400 homes a year.** However, the success of this wind farm is contrary to the data that is publicly available via wind speed maps, which underestimate the onsite wind speeds. This case study compares estimated wind speeds from the National Renewable Energy Lab's (NREL) popular 80-meter wind speed maps with available information about the Buffalo Mountain Wind Farm.

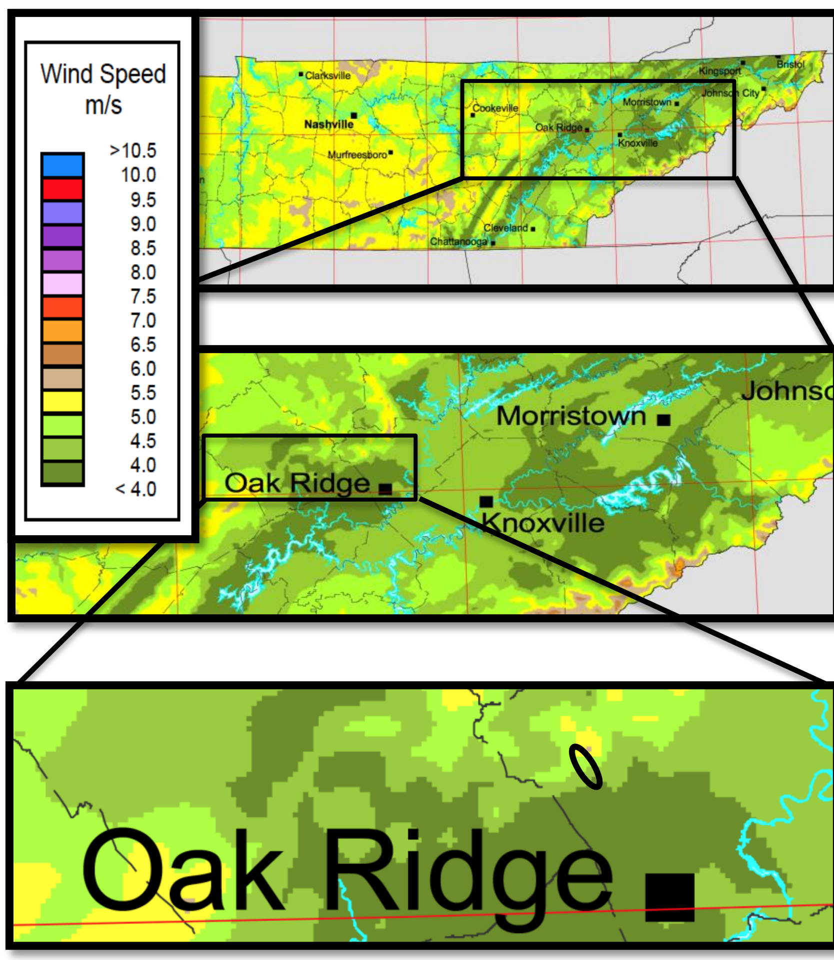
In April 2002, TVA conducted an environmental assessment for the Buffalo Mountain Wind Farm expansion that included collected wind speed data onsite. **According to TVA, average monthly wind speeds at a height of 50 meters ranged from a low of 4.4 meters per second (m/s) to a high of 7.8 m/s. That assessment may suggest average annual wind speeds of around 6 m/s at Buffalo Mountain.**

In 2010, NREL published maps showing state-by-state average annual wind at a height of 80 meters. The images on the right (**Figure 1**) are adapted from NREL's map for Tennessee. The Buffalo Mountain Wind Farm is represented by the black oval in the bottom image. **This map inaccurately represents the Buffalo Mountain Wind Farm site average annual wind speeds in the 4.0-5.0 m/s range.** While difficult to gauge, this is the most accurate prediction that can be made by this resource.

**As demonstrated, wind speed maps alone cannot predetermine the viability of a wind farm.**

*Credit: NREL (Buffalo Mountain Wind Project, Tennessee)*

**Figure 1. Tennessee Average Annual Wind Speeds (80 Meters)**




*Source: National Renewable Energy Lab 2010*

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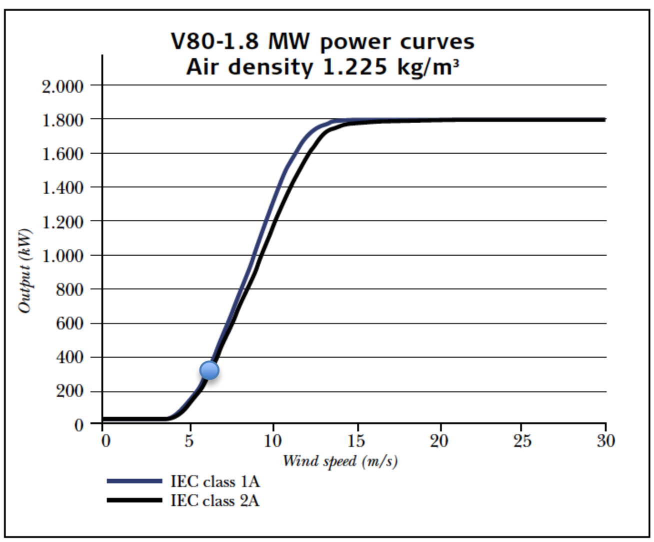
With conflicting average wind speed estimates from the NREL map and the TVA environmental assessment, additional information is necessary. Fortunately, data exists from the Buffalo Mountain Wind Farm and the specific turbine model used on site. Actual wind speeds can be deduced using these two data sources.

In 2012, the Buffalo Mountain Wind Farm generated approximately 48,000 megawatt hours of electricity from the fifteen turbines constructed by Invenergy. Each turbine is rated for a maximum output of 1.8 megawatts per hour, indicating that the wind farm achieved a 20% capacity factor. Therefore, each wind turbine's average hourly output was approximately 360 kilowatts (20% of 1.8 megawatts).

Wind turbine manufacturers provide estimates of energy output based on various wind speeds in a graph known as a power curve. In 2004, fifteen V80-1.8 wind turbines (manufactured by Vestas) expanded the Buffalo Mountain Wind Farm. **Based on the V80-1.8 power curve, the Buffalo Mountain Wind Farm site may achieve 6 m/s average wind speeds (see Figure 2).**

**Figure 2. Vestas V80-1.8 Power Curve**




*Source: Vestas V80-1.8 Factsheet*

## How important is wind speed?

Electricity generation from a wind turbine is not linear; in other words, a doubling of wind speed does not double electricity generation. A 1 m/s increase in average wind speed has a greater effect on electricity generation between a wind turbine's "cut-in" wind speed (when the turbine begins to spin) and its "nominal" wind speed (when it reaches maximum production). **A 1 m/s increase in average wind speed can substantially increase electricity generation at a wind farm.**

Using the NREL estimate of 4.0-5.0 m/s, the Buffalo Mountain Wind Farm should only achieve a capacity factor of approximately 5-10%. **Actual output at the Buffalo Mountain Wind Farm is at least double what would be expected using the NREL map with the estimated wind speed.**

## Conclusions

The NREL resource assessment maps are often used to initially assess a site for wind farm development. However, these maps alone are not adequate for determining wind farm success and may underestimate wind speeds in places like the Southeastern United States. The Buffalo Mountain Wind Farm achieves a greater energy output than can be estimated by the NREL resource assessment map, since it assesses such a large area. Other areas that could be characterized as "low wind speed," according to the resource assessment maps, may have similar pockets of good wind speed that may be ideal for consideration of wind power development, especially as newer wind turbine technology achieves greater efficiency.

## Sources

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National Renewable Energy Laboratory (2010). Tennessee Annual Average Wind Speed at 80 m.

Tennessee Valley Authority (April 2002). "Chapter 3, Affected Environment," *20-MW Windfarm and Associated Energy Storage Facility Environmental Assessment.*

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