Low Wind Speed Case Study

Arkansas Wind Energy Resource

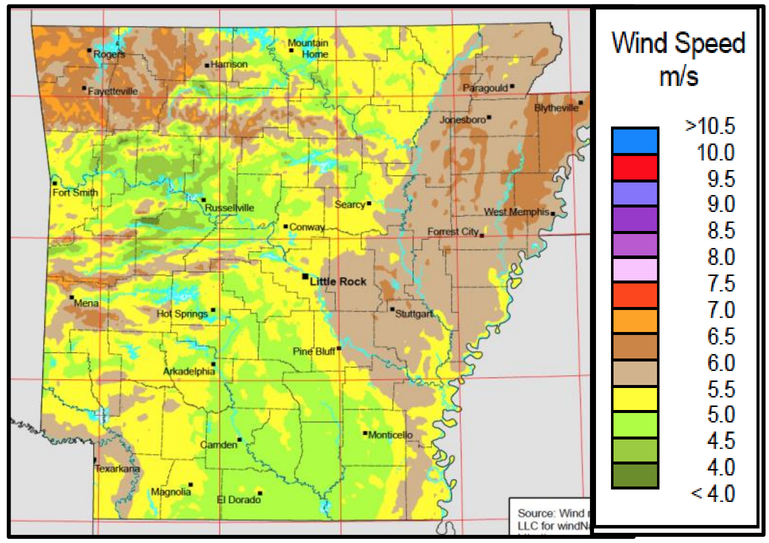
While Arkansas does not currently contain large-scale wind turbines, the state's wind resource potential has been studied. In 2011, AWS Truepower, LLC performed such a study for the Arkansas Economic Development Commission. The year-long study concluded: **"The long-term projected speeds at height of 80 m[eters] and above suggest that commercial wind development in these areas of the State is feasible, in part due to technological advancements in the industry."**

However, the success of a potential wind farm in Arkansas is contrary to the National Renewable Energy Lab's (NREL) popular 80-meter map, which fails to incorporate new turbine technology benefits for low wind speeds areas. This case study compares estimated wind speeds from available wind speed maps, and highlights Arkansas potential to develop wind energy with modern turbine technology.

In 2010, NREL published maps showing state-by-state average annual wind at a height of 80 meters. The image on the right (**Figure 1**) is adapted from NREL's map for Arkansas.

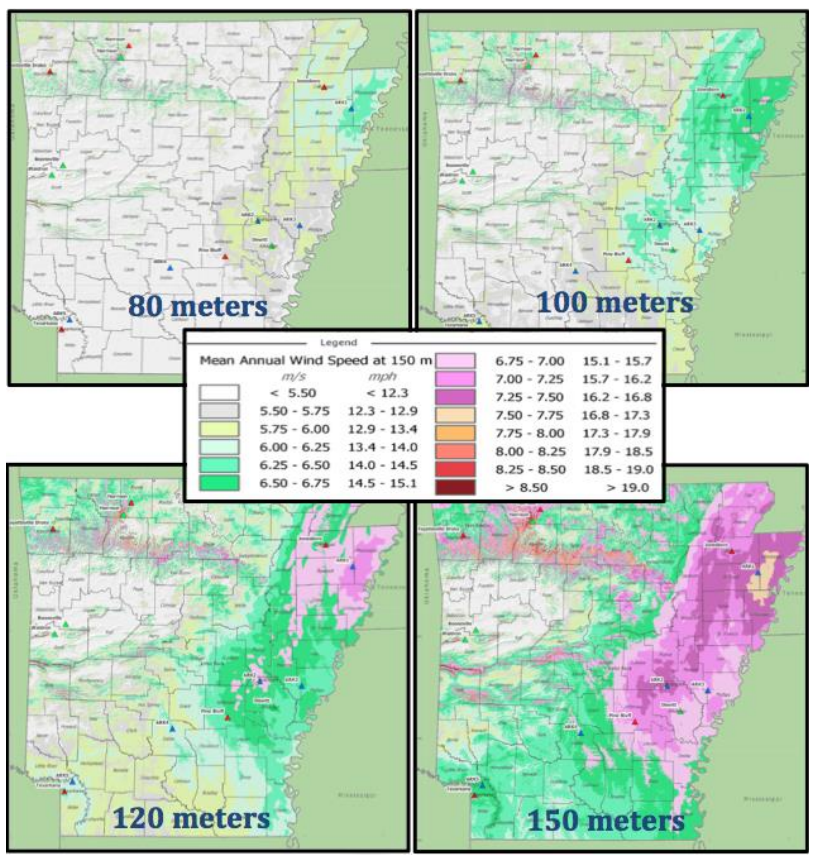
AWS Truepower, LLC identified 5 locations and summarized wind speeds at the end of each month. The information identified from these locations was presented in a final assessment and used to update resource assessment maps in the state (**Figure 2**). According to the study, the long-term wind speeds at 80 meters ranged from 5.25-6.46 meters per second (m/s), similar to wind speeds displayed in the NREL 80 meter map. **At 150 meters, the wind speeds were between 6.56-7.68 m/s, a much higher estimated wind speed compared to NREL's resource map.** As demonstrated, wind speed maps alone cannot predetermine the viability of a wind farm, and specific on-site analysis that factors in modern turbine heights is key to identifying wind energy potential.

Figure 1. Arkansas Average Annual Wind Speeds (80 Meters)



Source: National Renewable Energy Lab 2010

Figure 2. Arkansas Average Annual Wind Speeds at Multiple Heights (80 m, 100 m, 120 m, and 150 m)



Source: AWS Truepower 2012

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Arkansas is traditionally viewed as having a low wind resource, as displayed in the NREL 80 meter map (**Figure 1**). However, newer, taller turbines are opening access to faster and more stable winds higher off the ground. Modern turbines, reaching up to 500 feet (150 meters) make wind energy a viable option in Arkansas. Taller turbines provide higher capacity factors for wind turbines, which increase electricity output and produce lower electricity prices for wind energy.

Figure 3, from the AWS Truepower study, demonstrates the benefits of modern turbine technology. For example, site ARK1, located in northeastern Arkansas, has a projected average wind speed of 6.46 m/s at 80 meters. The NREL 80-meter map (**Figure 1**) suggests a similar average of 6.0-6.5 m/s. Yet, at the same site (ARK1), **taller heights can produce wind speeds of 6.68 m/s at 100 meters, 7.22 m/s at 120 meters, and 7.68 m/s at 150 meters.**

Figure 3. Extrapolation of Climate-Adjusted Speeds to Different Heights

Table 6. Extrapolation of Climate-Adjusted Speeds to Different Heights

Tower Number	Monitoring Height (m)	Climate-Adjusted Speed (m/s)	Effective Wind Shear	Projected 80-m Speed (m/s)	Projected 100-m Speed (m/s)	Projected 120-m Speed (m/s)	Projected 150-m Speed (m/s)
ARK1	76.3	6.31	0.274	6.46	6.87	7.22	7.68
ARK2	70.8	5.67	0.416⁺/0.374⁺⁺	5.97	6.55	7.01	7.62
ARK3	96.1	5.76	0.396*/0.357**	5.36	5.84	6.24	6.75
ARK4	96.4	6.05	0.437*/0.393**	5.58	6.14	6.60	7.20
ARK5	86.3	5.39	0.356	5.25	5.68	6.06	6.56

+Shear applied for 80 m and 100 m hub height wind speed estimates
++Shear reduced by 10% and used to estimate wind speeds at the 120 m and 150 m heights
*Shear applied for 80 m hub height wind speed estimate.
**Shear reduced by 10% and used to estimate wind speeds at heights above top monitoring level.

Source: AWS Truepower 2012

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.**

Two monitoring towers in Arkansas used to collect data on wind speeds. Credit: AWS Truepower, LLC

Conclusions

Wind turbine technology has rapidly evolved over the past five years. New turbine technology is better able to capture low-wind energy resources.

The resource assessment maps, like NREL's 80-meter maps, are often used to initially assess a site for wind farm development. However, these maps alone are not adequate for determining the success of a wind farm, and may underestimate wind speeds in places like Arkansas. 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

AWS Truepower, LLC. "Arkansas Tall Tower Wind Resource Assessment" (May 15, 2012).

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

National Renewable Energy Laboratory (2014). "New National Wind potential estimates for Modern and Near-Future Turbine Technologies."