New National Wind Potential Estimates for Modern and Near-Future Turbine Technologies

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Areas of New Potential Turbine Deployment

Acceleration in turbine technology in the past ~5 years has created much higher capacity factors using much larger rotors per MW. Assuming the same capacity factor threshold, the results of applying modern turbine technology to the same wind data results in large increases in raw area that may be suitable for deployment. The figures below illustrate the magnitude of this change. NREL's contribution to this poster was funded by the Wind and Water Power Program, Office of Energy Efficiency and Renewable Energy of the U.S. Department of Energy under Contract No. DE-AC02-05CH11231.

Figure 1. This image shows areas with a Gross Capacity Factor (GCF) of > 30% assuming a 2-MW 80-m rotor turbine at an 80-m hub height. These estimates were used in the original 2008 *20% Wind by 2030* U.S. Department of Energy (DOE)/NREL report assuming the aforementioned technology for all locations and wind regimes.

Figure 1

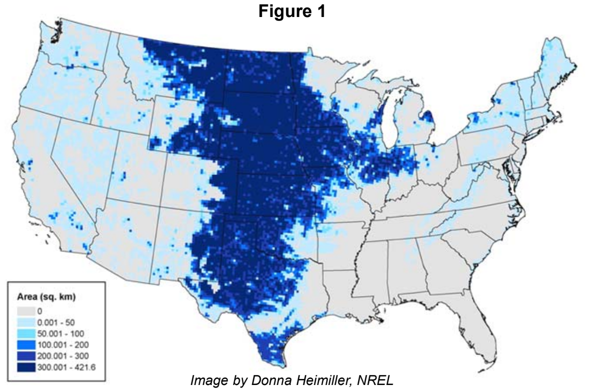

Image by Donna Heimiller, NREL

Figure 2

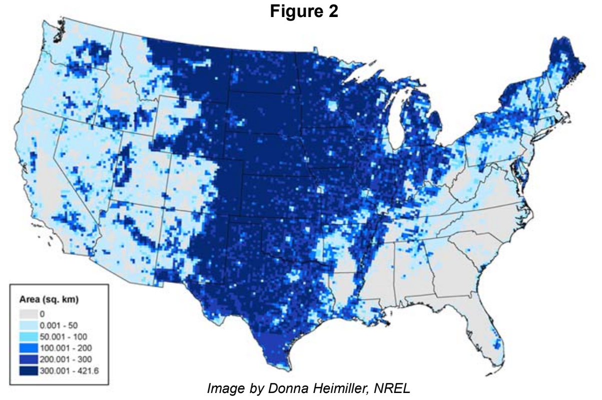

Image by Donna Heimiller, NREL

Figure 2. This image shows new areas with GCF > 30% assuming modern GE 1.6–100, 82.5, and 77-m rotors depending on the altitude-adjusted annual average wind speed. The shading shows raw developable area at a resolution of roughly 400 km^2 with the intensity of shading being proportional to the density of developable area within each cell.

Capacity factor is not necessarily the appropriate measure of project viability, but these images serve as an illustration of the new areas that may be more cost effective for wind energy deployment as turbine technology accelerates or energy prices increase. The wind industry has already begun deploying utility-scale projects, which utilize large rotors, at sites with hub-height annual average wind speeds as low as 6.0 m/s. Newer machines with even larger rotors are currently being deployed cost effectively at lower wind speed sites. As areas of higher wind resource are developed and constraints such as transmission capacity decrease the total potential developable area at higher wind speed sites, lower wind speed sites will become more attractive for development. Turbine technology is likely to follow this trend, but much development is needed to lower the costs of taller towers and longer blades.

Figure 3

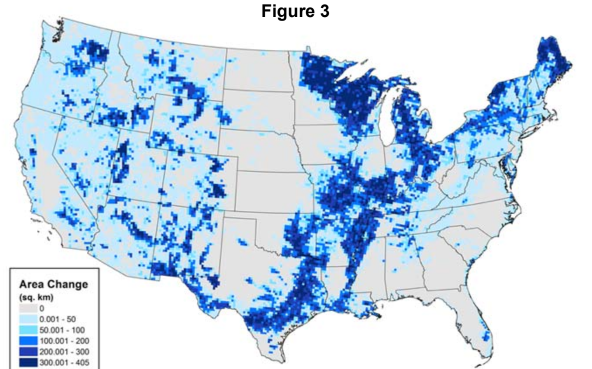

Image by Donna Heimiller, NREL

Figure 3 shows new areas with a GCF of > 30% when compared with previous NREL estimates. Total new potential in deployable area has a 50.6% increase over previous estimates. The total new capacity potential is 3,907 GW of installed capacity assuming 3 MW/km^2. Machines with taller hub heights and larger rotors specifically designed for lower average and appropriate extreme wind speeds may increase this overall potential. The shading shows raw developable area at a resolution of roughly 400 km^2 with the intensity of shading being proportional to the density of developable area within each cell.

Siting Considerations, New Dataset Advantages, and the Need for Outreach

Figure 3. Buffalo Mountain Wind Farm near Oak Ridge, Tennessee, the only operating commercial wind farm in the southeastern United States. *Photo by Owen Roberts, NREL*

- **Siting considerations for new areas:**
  - There is a high potential for turbines to be deployed in states and communities where wind has never been considered or discussed on a utility scale.
  - The potential for interactions with new species of wildlife is likely and will necessitate new siting considerations.
  - The current Federal Aviation Administration's permitting process for turbine tip heights greater than 500 feet is currently limiting tower turbine heights in the United States and uncertainty in approval times is a driving factor behind the use of shorter towers.
- **Key dataset improvements:**
  - The approach used to generate the data herein utilizes hourly wind speed data to compute hourly turbine production for each 200-m cell. This increases the accuracy of the model used to determine the levelized cost of energy (LCOE) of new potential projects.
  - The new data process uses modern large rotor machines selected for each International Electrotechnical Commission wind regime using altitude-adjusted wind speed to compute annual energy production.
- **Future and ongoing analysis:**
  - NREL to release new CF maps and capacity curves for each state to engage stakeholders
  - This data is being utilized in the upcoming DOE wind vision study to reflect the increased potential in lower wind speed regimes
  - Ongoing research will be conducted to reduce LCOE specifically through taller hub heights.
- **Other advantages for deployment:**
  - This new potential for deploying wind in previously undevelopable areas lessens the requirement for additional transmission for deployments of equivalent LCOE by allowing siting of wind projects closer to load centers.

The Southeast Region: An Example

The total potential for the southeastern states using sites with a > 40% CF is 134 GW of installed capacity (Louisiana: > 50GW; Missouri and Tennessee: > 25 GW) with the assumptions from Figure 1 for hub height and the capacity factor from Figure 4. These estimates assume 2.6 MW per square kilometer; machines with larger rotors specifically designed for lower average and extreme wind speeds may increase this potential. The uncertainty in the data at 140 m above ground level is high as few validation points exist currently. However, wind project development in some of these areas is ongoing as proposed projects near construction.

Figure 4

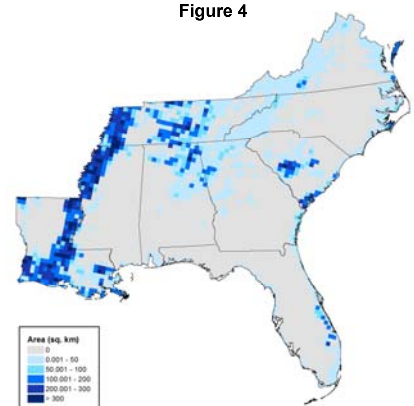

Image by Donna Heimiller, NREL

Figure 4 shows areas with a GCF of > 40% (net capacity factor ~34% with15% losses) assuming Nordex N117-2.4 at 140 m hub height. The taller hub heights in this assumption are mainly due to many areas in the region having very high wind shear, which increases the cost effectiveness of taller towers and the available wind resource.

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