Wind Farms and the WSR-88D -- An Update

Wind Energy Industry Update

It's time for an update on the wind energy industry, on some changes in the ROC evaluation of radar impacts, and on the ROC efforts to raise the visibility of the potential impacts of wind farms on Doppler weather radars. Although 2010 was a down year for the wind industry overall (Figure 1), the ROC continues to receive and evaluate a steady stream of proposed wind farm notifications. As soon as the economy revives, wind farm installations will likely resume at a rapid pace, spurred by federal tax incentives and states' renewable energy mandates. Only ~3% of the Nation's current total electric supply is from wind power, and the federal goal is to reach 20% from wind power by 2030 (See July 2008 DOE Report: 20 % Wind Power by 2030, Increasing Wind Energy's Contribution to U.S. Electricity Supply). Thus, most of the wind farm construction is yet to occur.

The distribution of wind farms is not uniform across the country (Figure 2). The Great Plains states from Texas to North Dakota, and to a lesser extent the Great Lakes area, have vast wind resources and plenty of available land on which to build wind farms. The number of wind farms developed near WSR-88Ds is likely to increase, especially in those two geographic areas. Therefore, it is no surprise that states like Texas, Iowa, Illinois, Colorado and Minnesota are among the top ten states with installed wind energy capacity.

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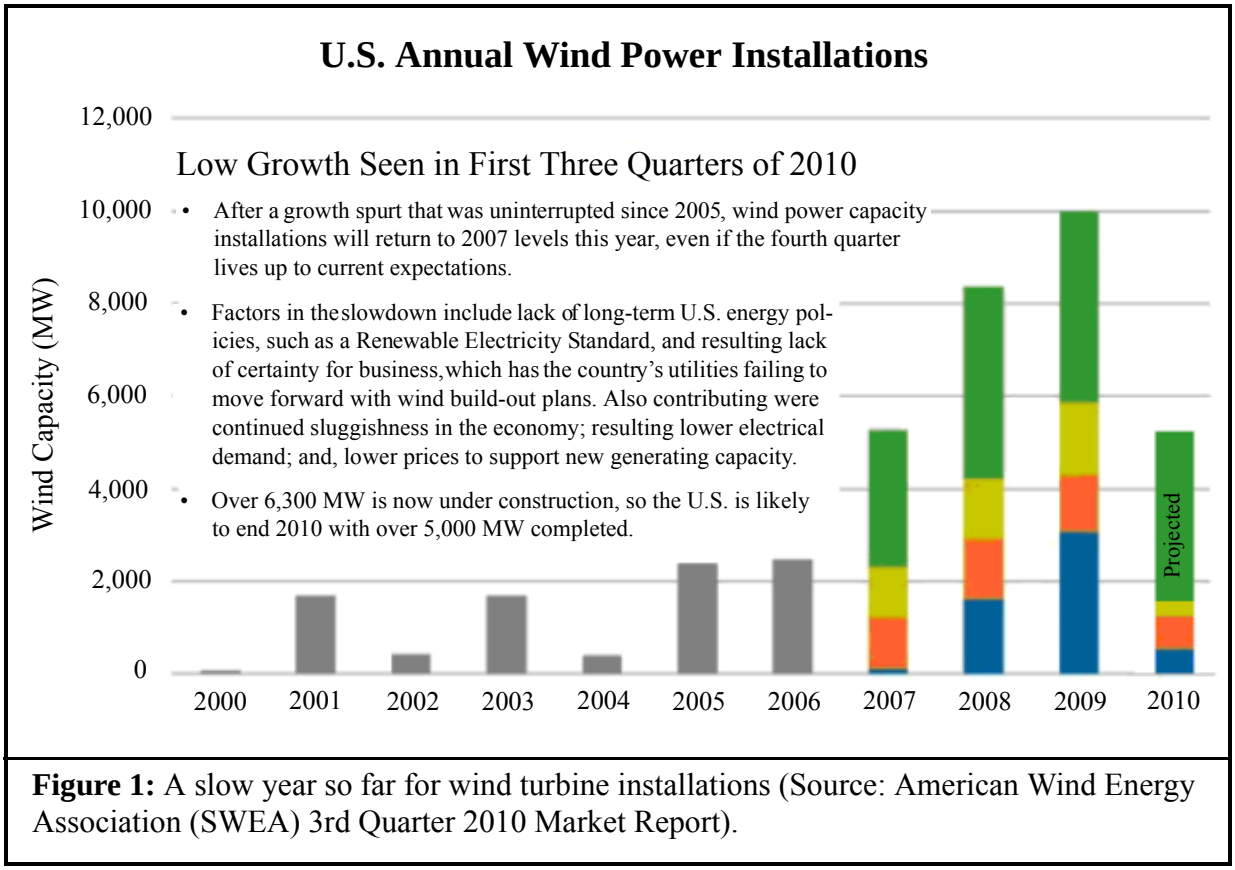

Figure 1: A slow year so far for wind turbine installations (Source: American Wind Energy Association (SWEA) 3rd Quarter 2010 Market Report).

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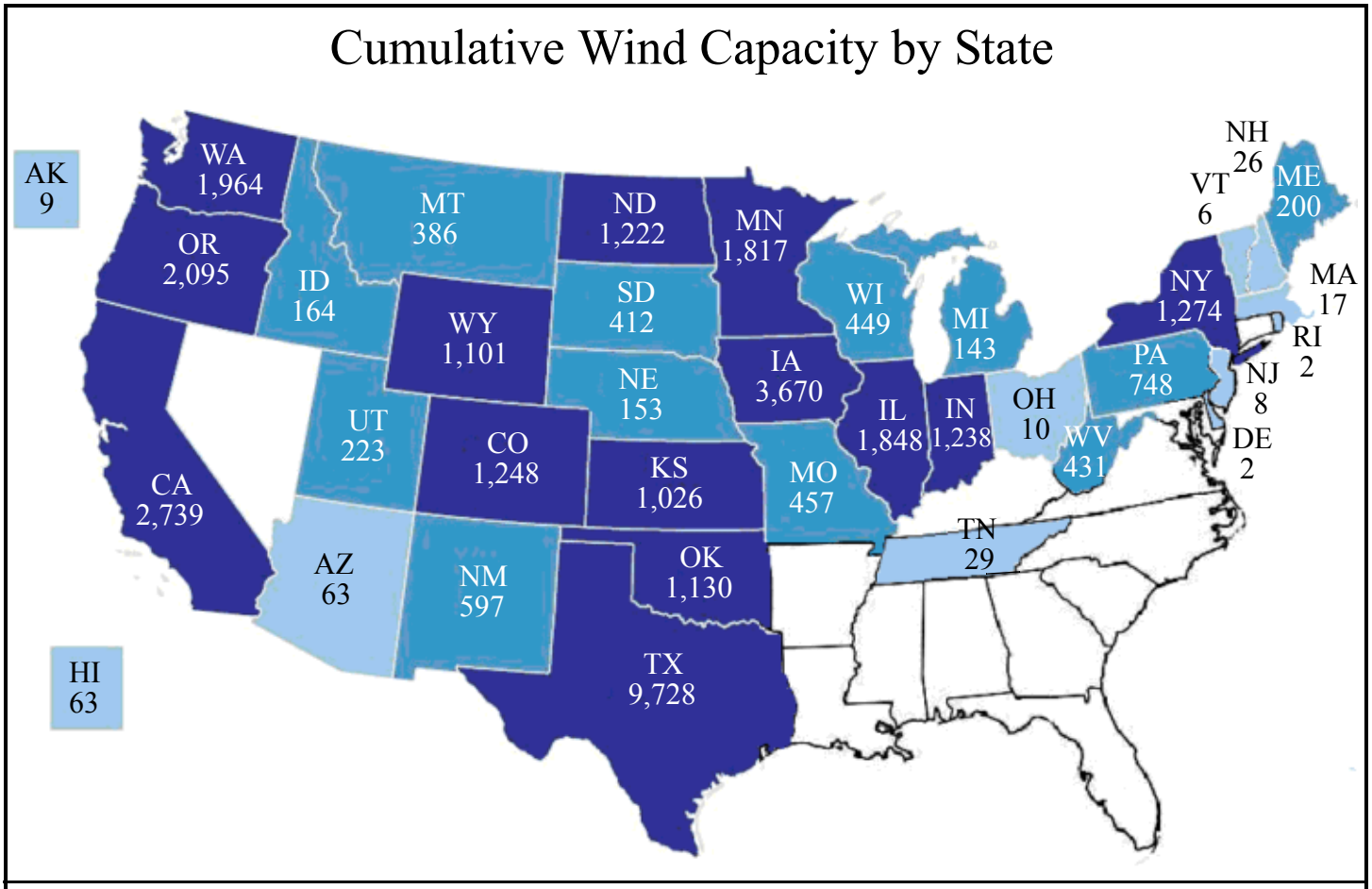

Figure 2: Installed wind power capacity (MW) through 3rd quarter 2010. (Source: American Wind Energy Association (AWEA) 3rd Quarter 2010 Market Report)

ROC Changing How it Evaluates Wind Turbine Impacts

Operating wind farms can be "seen" by the WSR-88D at varying distances, depending on atmospheric conditions, the intervening terrain, and the height of turbines relative to the height of the WSR-88D antenna. When atmospheric conditions cause super-refraction of the radar beam, wind farms can sometimes be seen over 150 km from the radar. The reflectivity patterns from these wind farms can occasionally look just like showers or thunderstorms. Typically, they disappear in the second or third elevation scan. In most of these situations, forecasters can "work around" the influences without impacting severe weather forecast/warning operations, just as they do for other clutter issues, such as those caused by anomalous propagation, terrain blockage, migratory birds, etc.

Wind farms that are much closer to the radar, approximately 18 to 30km, are frequently in the radar's line of sight (assuming standard atmospheric conditions) and "visible" in the radar data.

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Wind farms sited within 18km may begin to cause additional impacts, including contamination of data in multiple elevation scans, and contamination of data beyond the wind farm area due to multi-path scattering of the radar beam. Within 3km more serious impacts can occur that afect the radar data through its entire range. For example, the ROC and other published work have estimated that the large hubs of turbines, which can be as large as 12 meters across, can significantly block (25%) the radar beam if sited within 3km of the radar antenna, and completely block it within 1km of the radar. Figure 3 is a generalized graph depicting these impacts versus distance. One can think of the yellow, orange, and red areas as signifying low, moderate, and high impact. The distances of impacts in this graph assume level terrain and a utility-scale turbine (blade tips that commonly reach at least 130 meters high). The actual distance in which impacts occur varies with terrain.

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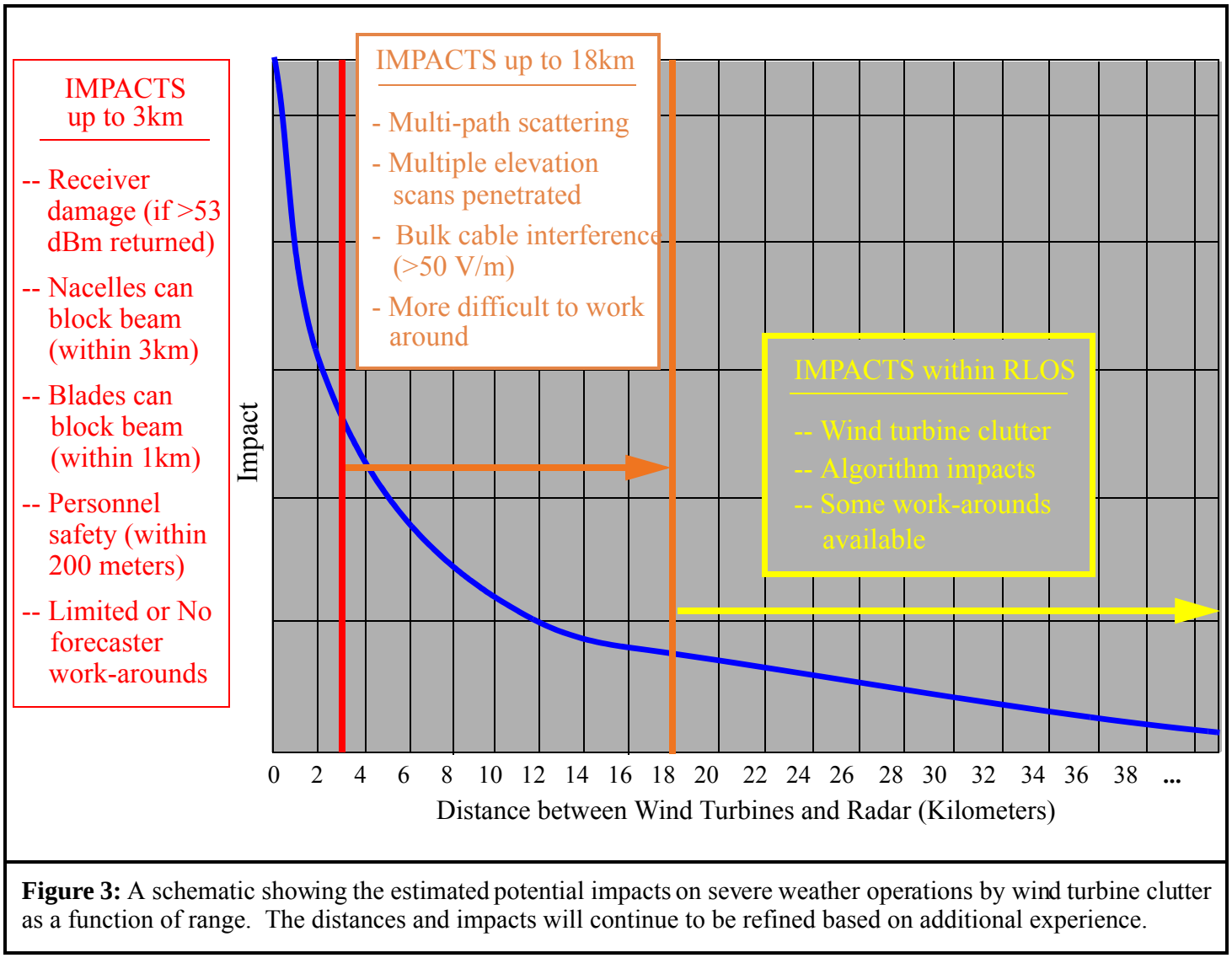

Figure 3: A schematic showing the estimated potential impacts on severe weather operations by wind turbine clutter as a function of range. The distances and impacts will continue to be refined based on additional experience.

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Lately, the ROC has been placing greater emphasis on working with developers proposing wind farms with the potential for high and moderate impacts (i.e., within 3km and within 18km of a WSR-88D). Those developers proposing wind farms within 3km - and there have been a handful of them - get serious attention. The ROC has stopped proactively working with developers whose wind farms would "only" cause clutter in the first elevation scan and are beyond approximately 18km, since the impacts are not as significant and work-arounds are available.

Currently, the closest wind farm to a WSR-88D is 4km from the Ft Drum, NY WSR-88D. That wind farm causes significant clutter from multipath scattering out to 50km from the radar over approximately 120 degrees of azimuth and impacts the 3 lowest elevation scans (through 1.5 degrees). The ROC has received and evaluated several proposals for wind farms closer than 3km from a WSR-88D, but none have been built yet. When the ROC receives a proposal that would be very close to a WSR-88D, we make an effort to engage the developer to ensure they understand the potential impacts on the radar and operations. Since the federal government has no land-use authority over private land, changes to the siting plan is voluntary. Thus, ensuring early contact with developers when their investment in project planning is relatively low is very desirable.

In the past year there has been increasing attention paid by congress to the wind farm-radar issue, as some large wind farm projects have run into objections from federal agencies. In the long run, this is good news because additional resources will be needed to study and develop solutions to wind turbine interference on radars. Visibility of the problem at the congressional level may help obtain the necessary resources and early wind farm planning notification from developers.

ROC Initiatives

The ROC has several on-going and planned initiatives to help WFOs work-around wind turbine clutter impacts.

First, new AWIPS GIS (geographical information system) files will soon be available on the NOAA1 server for WFOs/RFCs to download and use as overlays of wind farm locations. Two types of files will be available - polygons of wind farm locations based on long-accumulation radar-QPE (quantitative precipitation estimation) data (developed by NSSL) and individual "as built" turbine locations from the FAA. The FAA maintains a database of all structures taller than 200 ft as part of their mission to evaluate the potential for such structures to pose a hazard to aviation safety. These GIS wind-farm overlays will be particularly useful for distant wind farms that intermittently appear in the radar data.

Second, the Warning Decision Training Branch (WDTB) has released a Commerce Learning Center course providing initial training on identifying wind farms on radar products, some mitigation strategies, and ROC outreach efforts. NWS Forecasters can access this course in the LMS (and bypass the search requirement) by clicking the following link: Login for National Weather Service LearnCenter. NWS partners and others can access the course at the following link: National Weather Service - Warning Decision Training Branch.

The ROC also continues to leverage the efforts of other federal agencies, such as DOD/ DHS/ and FAA, who also have wind turbine generated radar interference issues. For example, the DHS has a large 3-D wind-turbine impact modeling effort

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underway for air surveillance and weather radars. This contract is expected to be awarded soon.

The ROC is working with a couple WFOs and wind farm developers to explore the possibility of "operational curtailment" of wind turbines under certain severe weather potential situations. A draft Letter of Intent is being reviewed by these wind farm developers.

The ROC Needs Your Help

The ROC needs the support of field offices in order to better define the impacts of wind turbines on the WSR-88D and operations, and to convincingly make the case for those impacts. The ROC needs to be informed if sites are already dealing with wind turbine clutter and encountering cases that impact their forecasts and/or warning operations. WFOs may want to document wind turbine clutter impacts for their particular radar with the goal of developing a "climatology" of the clutter (how often it occurs, under what conditions, products affected, etc.) The ROC is interested in collecting significant impact cases (missed or delayed weather warnings) from around the country to better understand the interaction between wind turbines and the WSR-88D, and if warranted, make a case for action by policy makers. A clearer picture of the impacts may also help the development of a formal policy for working with the wind energy industry and avoid over-reacting or under-reacting to this issue. While NOAA supports renewable energy production, we must preserve our ability to issue accurate and timely severe weather warnings and forecasts using radar data.

Also, if it is learned that a proposed wind farm would be located close to a WSR-88D, please notify the wind farm team at the ROC by sending an email to wind.energy.matters@noaa.gov. We will follow-up.

For more information, please visit previous *NEXRAD Now* articles and/or the Wind Farm Interaction section on the ROC web site to learn more about the wind turbine clutter issue (Radar Operations Center - WindFarm Index). Several posters, papers and briefings have been posted on this web page.

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NEXRAD Now is an informational publication of the WSR-88D Radar Operations Center (ROC).

We encourage our readers to submit articles for publication. Please email all articles and comments to:

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All previous issues of NEXRAD Now can be viewed on the ROC Home Page at:

http://www.roc.noaa.gov/WSR88D/NNOW/NNOW.aspx

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