NEXRAD Wind Farm Impact Zone Maps and the ROC Evaluation Process

The WSR-88D Radar Operations Center (ROC) has learned a lot about wind turbine clutter (WTC) impacts on the WSR-88D network and severe weather operations since 2007 while completing over 1200 case-by-case wind farm impact analyses, interacting with the wind industry, and discussing WTC – radar challenges with weather forecast offices. From the knowledge gained, the ROC developed an "inventory" of WTC impacts by distance, some of which is presented in the notional estimated impact chart in Figure 1.

In 2011, in an effort to concentrate on wind farm proposals with the greatest operational impacts, the ROC updated wind farm evaluation criteria and the associated maps on the Obstruction Evaluation / Airport Airspace Analysis (OE/AAA) preliminary screening tool website (https://oeaaa.faa.gov/oeaaa/external/gisTools/gisAction.jsp?action=showLongRangeRadarToolForm). Previous ROC criteria treated all wind farms equally, regardless of range or number of elevation angles penetrated. If the wind farm was in the radar line of sight (RLOS), the ROC wanted to evaluate it, and we didn't have firm criteria for requesting mitigation.

Under anomalous propagation conditions, wind farms can be detected over 150 km away. Generally, distant wind farms only create WTC in the first elevation scanning angle and only over the wind farm area, resulting in minimal impacts to radar and severe weather operations. However, when wind farms are sited within about 18 km (assuming level terrain) of a WSR-88D, the turbines begin to penetrate higher scanning angles and cause multipath scattering clutter down range of the wind farm. When wind farms are within 3 km of a WSR-88D the wind turbine nacelles can physically block the beam in one or more radials, impacting the entire range of the radar. Finally, turbines within the radar's near field (approximately 1.5 km for the WSR-88D) can potentially cause receiver damage and effect beam formation.

Simply using distance as an evaluation criterion does not account for changes in terrain that could result in a greater number of impacted elevation angles. Therefore the ROC has developed a four-zone scheme that takes terrain and the number of elevation angles impacted into account while "greening" up areas with minimal impact in support of the nation's goal of achieving 20% of electricity produced by wind power by 2030. The four zones, defined below, are: notification, consultation, mitigation and no build. Figure 2 provides a sample of the zones with turbine locations and Base Reflectivity included to show how the new scheme will identify a majority of the areas where turbines will cause an impact on the WSR-88D while allowing the developers to build in areas where the impacts would be minimal.

1. The Notification Zone, green areas on the map, is the area between 36 km and 60 km where a 160-meter tall turbine will only penetrate one elevation angle, or any area beyond 60 km that a 160-meter tall turbine is in the RLOS. Since impacts are typically minimal beyond 36 km and workarounds are available for penetration of only one elevation angle, consultation is optional. However, the ROC would still like to know about the project.

2. The Consultation Zone, yellow areas on the map, is the area between 3 km and 36 km where a 160-meter turbine only penetrates the 1st elevation angle or when a 160-meter tall turbine will penetrate more than one elevation angle between 36 km and 60 km. Due to the increased potential for impact to operations, the ROC requests consultation with the developer to track the project and acquire additional information for a thorough impact analysis.

3. The Mitigation Zone, orange areas on the map, is the area between 3 km and 36 km where a 160-meter turbine would penetrate more than one elevation angle. Wind farms sited within the Mitigation Zone have the potential for moderate to high impacts. Therefore, the ROC will ask to work with the developer to get detailed project information, do a thorough impact analysis, and discuss potential mitigation solutions.

4. The No Build Zone is a 3-km radius red circle around the WSR-88D on the map. The ROC is requesting that developers do not build turbines in the RLOS within 3 km of the radar due to the potential for serious impacts, including turbine nacelles and towers blocking the radar beam, and potential beam formation issues and receiver damage if sited in the radar's near field.

Since the federal government has no land-use authority on private lands, the ROC can only suggest/request developers work to mitigate the potential impacts in advance or not build/relocate planned wind farms.

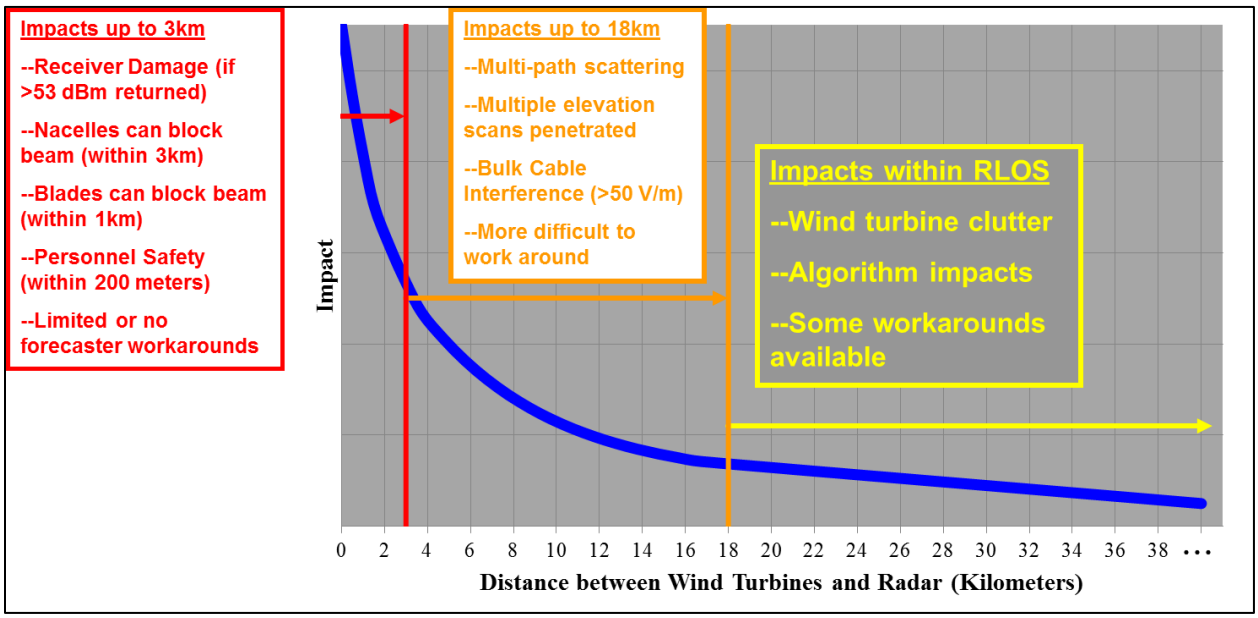

Fig. 1: Notional chart depicting the estimated increased WTC impacts as turbines are sited closer to a WSR-88D. This figure is for flat terrain.

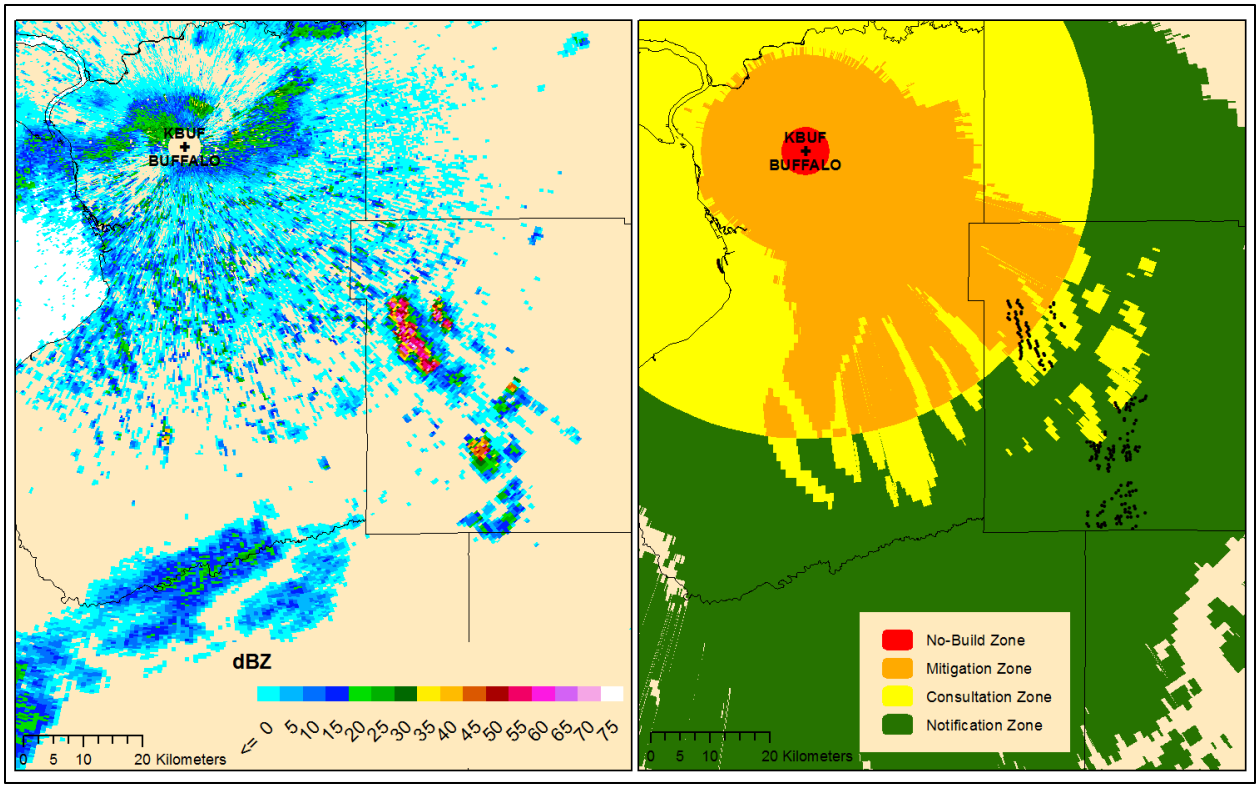

Fig. 2: Graphic of the new evaluation scheme for the Buffalo, NY NEXRAD. Image on the left is Base Reflectivity and the image on the right are the new evaluation zones with OE/AAA built turbines (black dots) overlaid. Note the turbines with the greatest impact are located within the mitigation and consultation zones.