

WFO Fact Sheet

Potential Wind Farm Impacts on WSR-88D Radars and Users

- **WSR-88D Background**
 - Deployment of 159 Weather Surveillance Radar-1988, Doppler (WSR-88D) systems completed in 1997
 - Provides weather radar data to support NOAA's National Weather Service (NWS) forecast and warning mission, the National Airspace System, DoD operations, and external users (e.g., industry, local government, the public)
 - Operates continuously in pre-programmed scans 0.5° - 19.5° elevation; transmits at a peak power of 750 KW
 - Provides reflectivity and Doppler information; estimates precipitation accumulations; detects severe storm characteristics, such as tornadoes, hail, and high winds; and sends alerts to forecasters

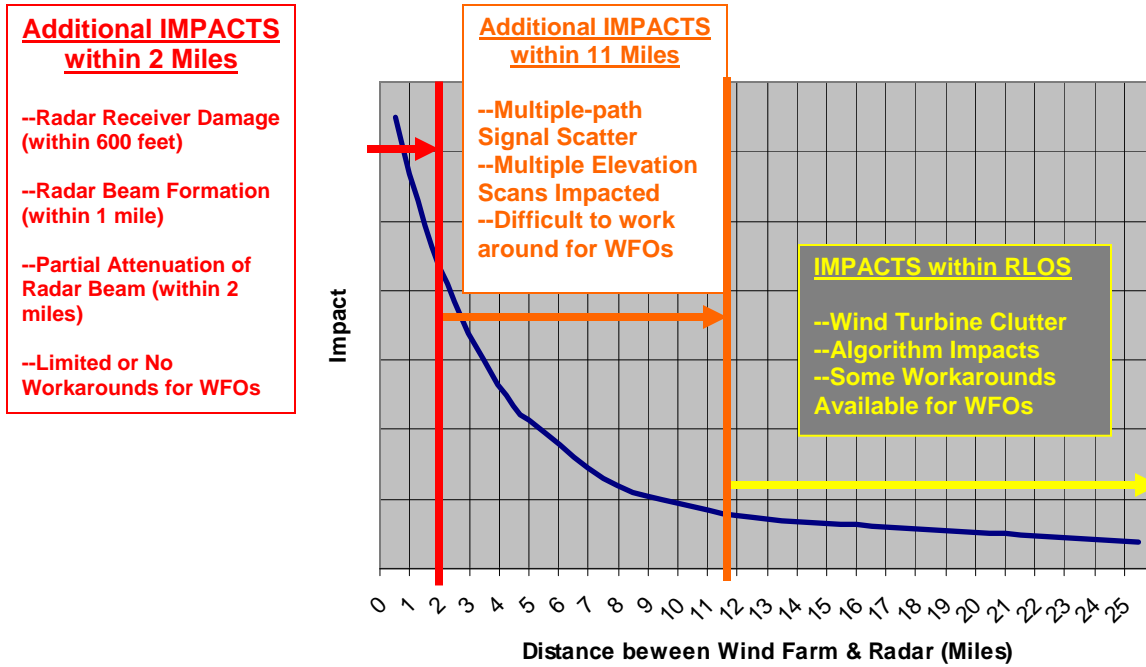
- **How Wind Turbines Can Interact with the WSR-88D**
 - Depending on distance between the wind turbines and the radar, and if the turbines are in the radar's main beam
 - Turbine blades, nacelles and towers are very reflective and produce strong echoes that can sometimes be indistinguishable from weather echoes
 - Radar is unable to filter/remove wind turbine clutter/radar echoes from rotating turbine blades
 - Weather targets are usually moving, so radar is programmed to remove non-moving targets only
 - Result: radar can filter echoes from the motionless turbine towers and nacelles, but not the moving blades
 - Turbines beyond ~18 km/11 mi (assuming level terrain) typically produce unfilterable clutter directly over the wind farm and only in the first elevation scan at 0.5 degrees
 - Towers/turbines within ~18 km/11 mi can also cause false radar echoes 10's of miles down range and begin to impact the radar's higher scanning angles due to multiple-bounce/multiple-pathing
 - Towers/turbines within ~3 km/2 mi can partially block the radar beam affecting weather detection through entire range of radar (up to 300 km/186 mi) beyond the turbines, and at several scanning angles
 - Wind turbine clutter can negatively impact the performance of meteorological algorithms
 - Impacts not fully understood yet; vary from site to site

- **Potential Impacts of Wind Energy Projects on WSR-88D Data and Users**
 - At distances greater than ~18 km/11 mi
 - NWS forecasters can "work around" most of the data impacts during their forecast and warning operations
 - Data users need to learn to distinguish wind farm data characteristics – similar to interpreting bird, insect, ground clutter signatures on radar
 - At distances less than ~18 km/11 mi, the impacts on data increase rapidly with decreasing distance and NWS forecasters have fewer "work arounds" available to analyze the data which can impact timely forecasts and weather warnings
 - At distances less than 3 km/2 mi, the impacts to the data are significant with few "work arounds" available to forecasters, and the risk of delayed or incorrect weather warnings is increased

- **NWS/Radar Operations Center Actions to Lessen Wind Farm Impacts on WSR-88Ds**
 - Educate wind energy industry and public of potential wind farm impacts on weather radars
 - Reach out to individual developers early in their planning process to provide:
 - Case-by-case analysis of potential wind farm impacts on radar data and forecast/weather warning operations; over 550 individual analyses completed
 - One-on-one discussions on how to mitigate potential turbine impacts; over 40 conference calls to date
 - Fund studies of radar-based solutions to reduce impact of the turbine's spinning blades on radar data
 - Share information and techniques within the NWS on how to "work around" wind turbine impacts

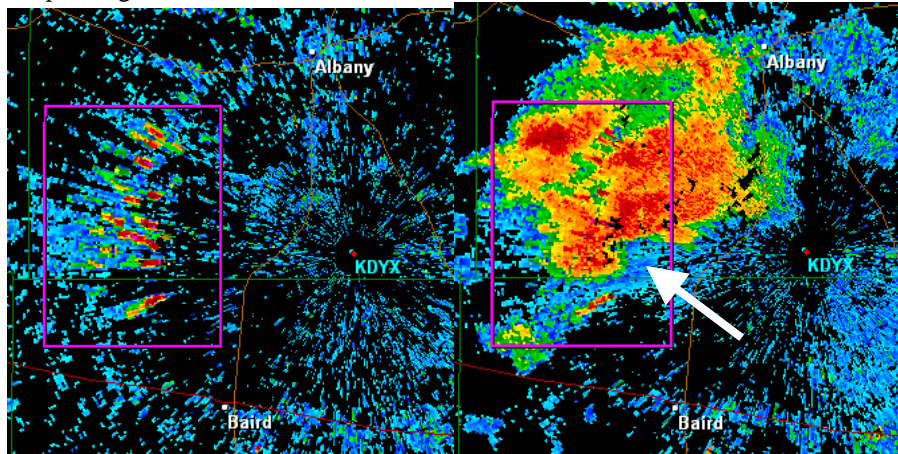
- **Additional Information**
 - NOAA's NWS supports renewable wind energy projects and wants to work with the wind energy industry to ensure there is no significant impact on weather warning operations
 - The federal government does not have land use authority on private land, where most wind farms built
 - Examples of wind turbine impacts on WSR-88D data are on the back of this page
 - Wind turbine-radar interaction information available at: http://www.roc.noaa.gov/windfarm/windfarm_index.asp

ESTIMATED POTENTIAL WIND TURBINE IMPACT ON WARNING OPERATIONS

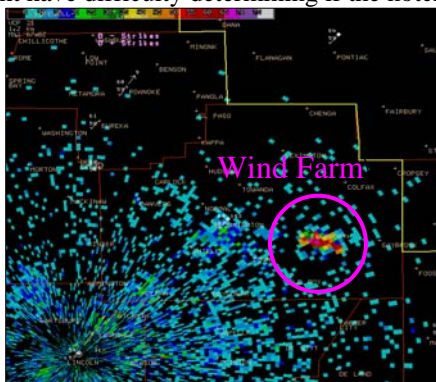


This graph shows how wind turbine impacts vary with distance from the radar. The impacts (blue line) curve upward (increase), as turbines are sited closer to the radar. Impacts increase quickly very close to the radar. Two key distances are 11 miles and 2 miles. These distances delineate where additional impacts generally begin (assuming a level terrain). The actual distances these impacts can occur vary by many miles depending on terrain and weather conditions.

IMAGERY EXAMPLES



Thunderstorms develop over a wind farm (purple rectangle) 11–19 miles west of Dyess AFB, TX WSR-88D. Left image--thunderstorms have not yet developed, high reflectivity values (red) due to wind turbines alone. Right image--storm has developed to where a distinct notch structure, indicative of severe weather, formed. Since turbine and weather echoes are intermingled, forecasters might have difficulty determining if the notch is an artifact of the mixed echoes, or a real severe weather signature.



Most wind turbine clutter has low/no impact on WFO operations if the turbines are beyond ~11 mi (18km) and not in radar line of sight. In the image at left, a wind farm (within purple circle) appears to be an isolated shower. However, the weather was clear and weather forecasters, once they know where the wind farm is; have little difficulty identifying this echo as non-weather clutter. The wind farm is 25 miles from the radar.