

Wind Power GeoPlanner™

Government RADAR Systems Analysis

Antrim Wind Energy Project



**Prepared on Behalf of
Eolian Renewable
Energy LLC**

January 13, 2016





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1. Introduction

Comsearch was contracted by Eolian Renewable Energy LLC to determine if there would be any significant degradation to the operational coverage of Government RADAR systems located near the proposed Antrim Wind Energy Project in Hillsborough County, New Hampshire. Figure 1a and 1b show the location of the Antrim Wind Energy project area and wind turbines, respectively. Table 1 lists all of the wind turbines within the Antrim Project and their geographic coordinates.

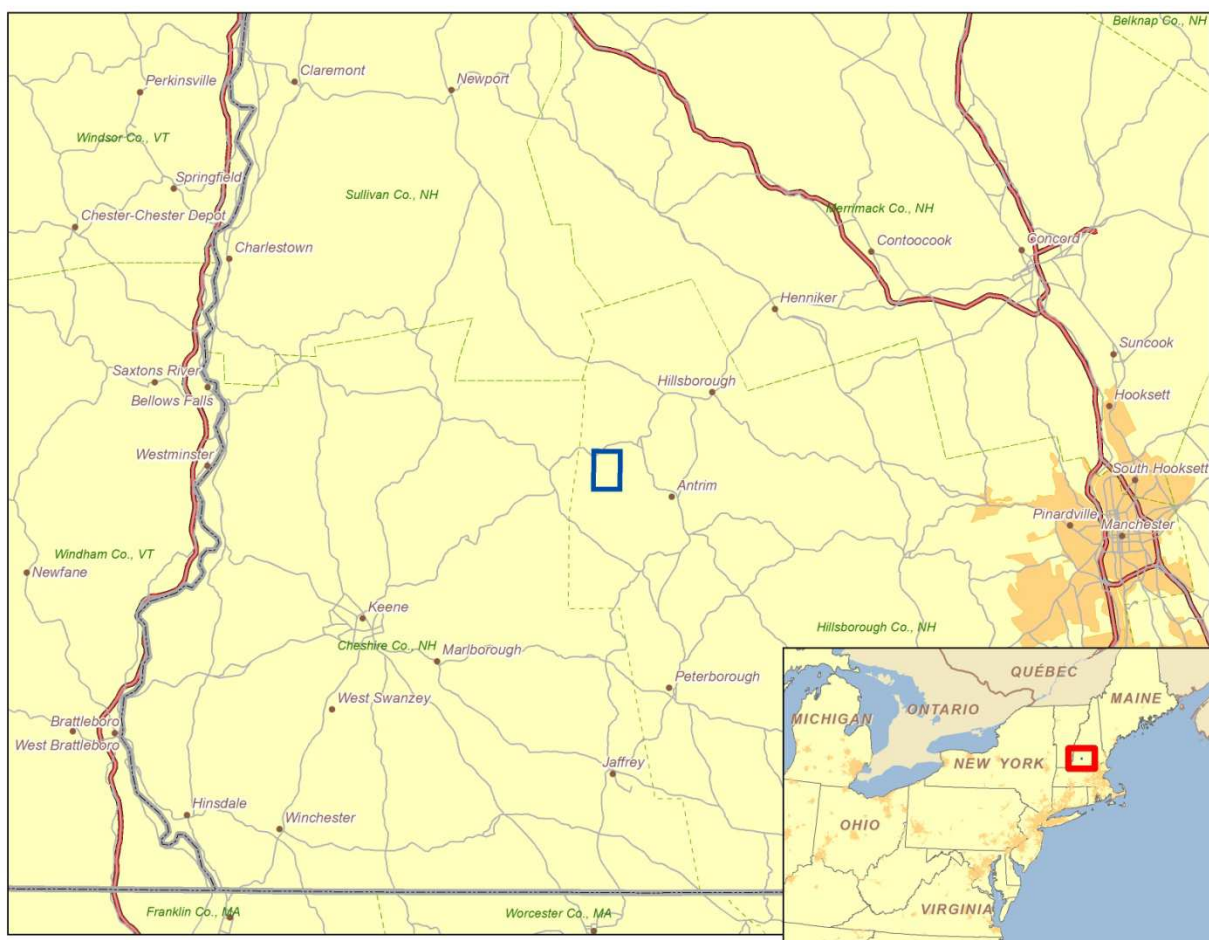


Figure 1a: Antrim Wind Energy Project Area

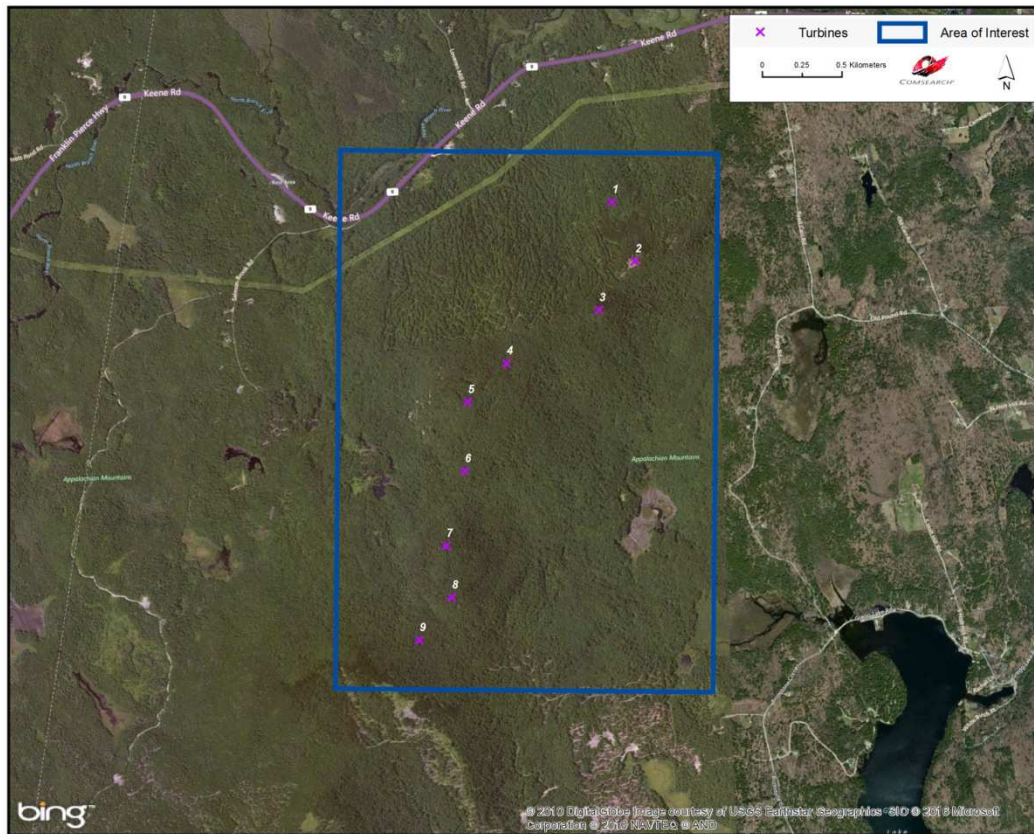


Figure 1b: Antrim Wind Energy Project Area

Turbine ID	Latitude (NAD83)	Longitude (NAD83)
1	43.06757543	-72.00784753
2	43.06415693	-72.00622973
3	43.06146974	-72.00913447
4	43.05864667	-72.01643969
5	43.05653910	-72.01953051
6	43.05263123	-72.01997279
7	43.04842239	-72.02160036
8	43.04550318	-72.02132236
9	43.04315637	-72.02394361

Table 1: Wind Turbine Coordinates for the Antrim Wind Energy Project

2. Summary of Screening Results

There are three types of radar systems that Comsearch examined as part of this analysis: Department of Defense (DoD) military systems, Federal Aviation Administration (FAA) long range radar systems, and National Weather Service (NWS) NEXRAD WSR-88D systems.

Comsearch used the DoD RADAR screening tool to determine whether potential coverage issues were anticipated for the above systems. The geographical coordinates for the center point of the Antrim Wind Energy project area ($43^{\circ}3'23.56''N$, $72^{\circ}1'10.52''W$) were used as an input parameter for the screening tool. The results of the screening showed that there were no potential issues with the Department of Defense (DoD) military operations and National Weather Service (NWS) NEXRAD WSR-88D systems. There is potential impact to the FAA long range radar systems. In support of these findings, three figures and statements were captured from the DoD screening tool and are presented below.

Figure 2 shows the screening results for the DoD military system which is basically a sectional aeronautical chart centered on the wind project area.

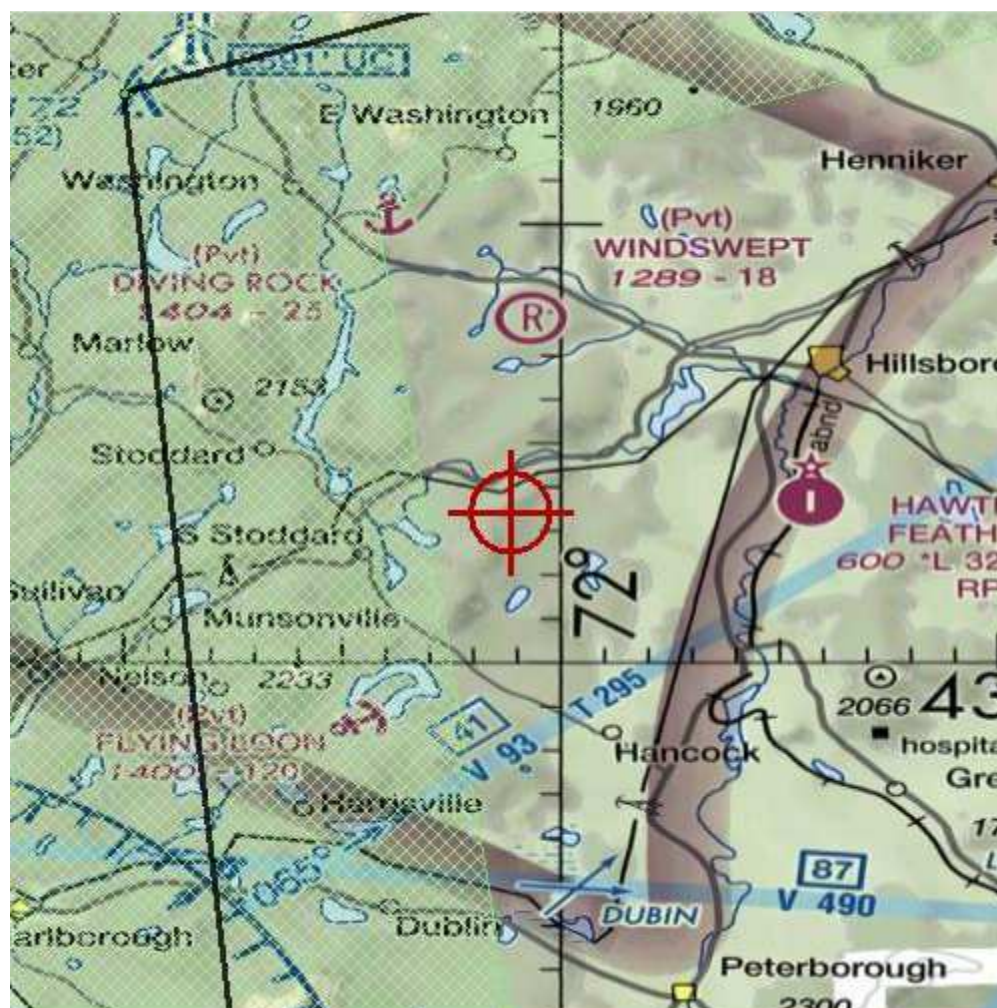


Figure 2: Screening Tool Diagram for DoD Military Systems



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According to the DoD screening tool, there are no likely impacts to military airspace. The following contacts were provided for confirmation and documentation if required:

- David Brentzel (404) 562-4211
USAF Regional Environmental Coordinator
- US Navy Representative, FAA Eastern Service Area (404) 305-6908
USN Regional Environmental Coordinator
- LTC Jeffrey Martuscelli (404) 305-6915
USA Regional Environmental Coordinator
- US Marine Corps Representative, FAA Eastern Service Area (404) 305-6907
USMC Regional Environmental Coordinator

Formal project approval is granted as a result of the FAA review of the Form 7460-1 that is required for each individual wind turbine to be installed in the project. No issues are anticipated based on the preliminary screening tool results.

Figure 3 shows the screening results for the NEXRAD weather service systems. The screening tool map shows that the Antrim Wind Energy project will be located in the “green” area of the NEXRAD systems located around the project area. The “green” designation signifies that no obstruction to the radar line-of-sight (RLOS) is predicted for the surrounding radar systems. Since NEXRAD can detect wind turbines occasionally at great distances, NOAA would like to know the location of all wind farm projects so that corrupted radar data can be flagged. All information regarding the wind project can be sent directly to NOAA at wind.energy.matters@noaa.gov or through the NTIA.

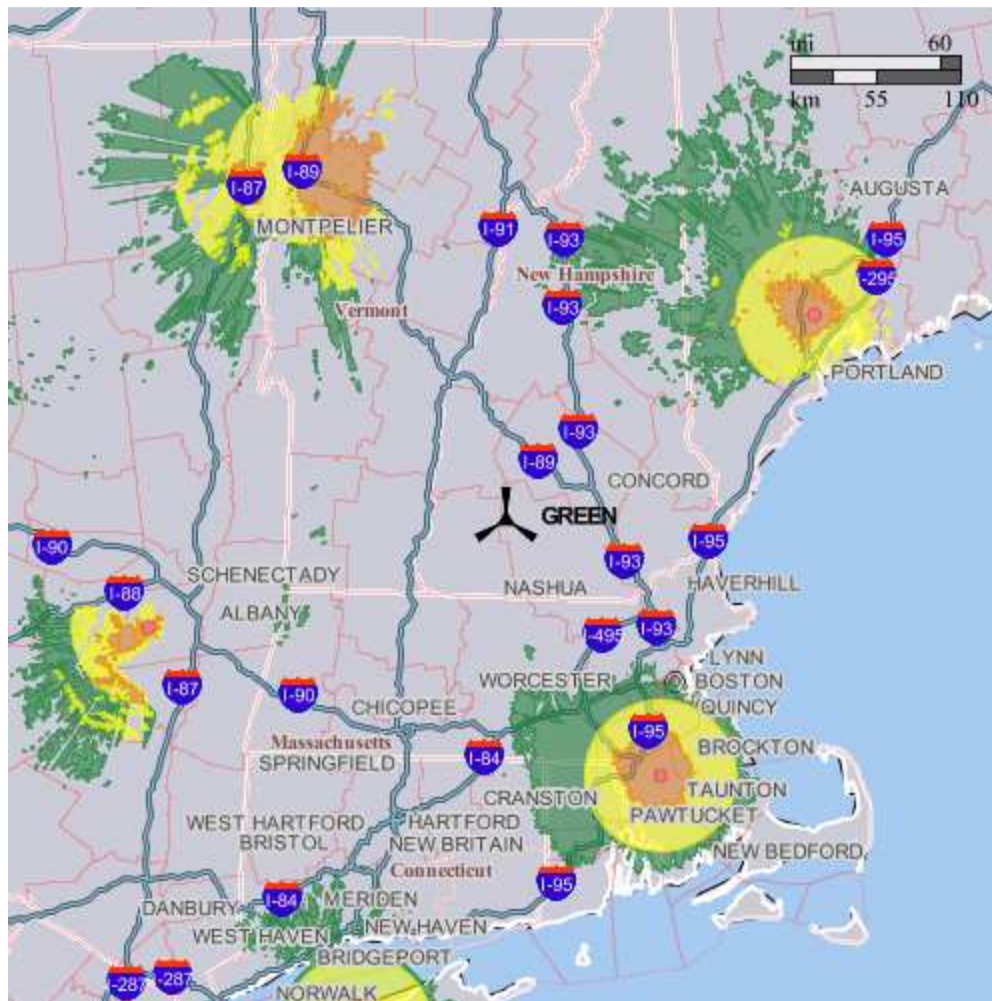


Figure 3: Screening Tool Diagram for Weather Service RADAR Coverage

Figure 4 shows the screening results for the FAA long range radar system. According to the map diagram, there are four FAA radar systems in the surrounding area, and based on the wind project location, potential impacts to the radar coverage exist. Hence, the screening tool returned the “yellow” designation for the Atrim Wind Energy Project as shown in Figure 4.

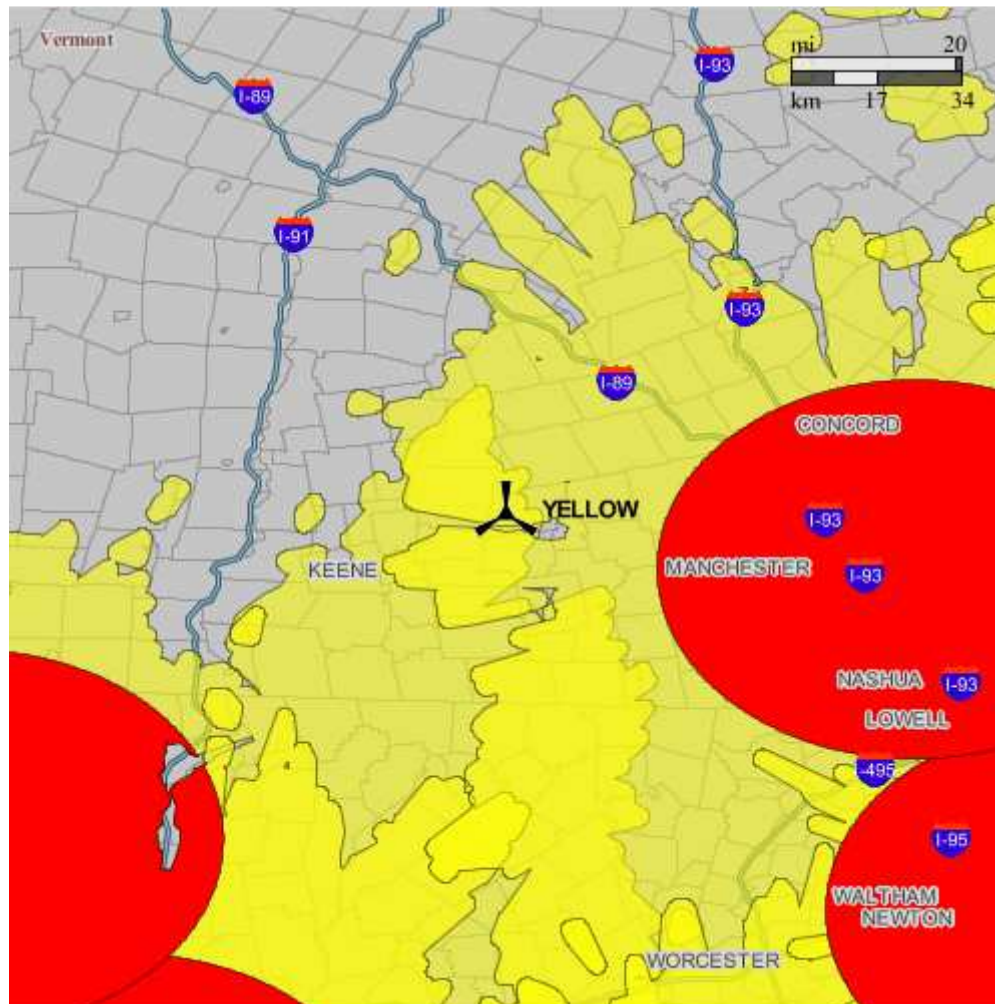


Figure 4: Screening Tool Diagram for FAA Long Range Radar Coverage



3. Analysis

To determine the potential impact of the proposed wind turbines on the FAA radar systems around the Antrim wind energy project, the line-of-sight (LOS) distance between a given radar and wind turbine is calculated. If the physical separation distance between a radar and wind turbine is within the LOS distance, then the wind turbine would have the potential to obstruct coverage and produce false targets for that particular radar. Otherwise, the wind turbine would be located over the horizon and beyond line-of-sight. The separation distance between a radar and wind turbine is based on their geographical coordinates, whereas the LOS distance is determined based on the sum of the horizon distances associated with a particular radar antenna and wind turbine.

The distance to the horizon for a radar antenna is a function of its height and is given by:

$$D_1 = (2 \cdot H_R)^{1/2} \quad (\text{Equation 1})$$

Where:

- D_1 = Distance from radar to horizon in miles
- H_R = Height of radar antenna above sea level in feet

Likewise, the distance to the horizon for a wind turbine is a function of the maximum height reached by the tip of the rotating blade and is given by:

$$D_2 = (2 \cdot H_{WT})^{1/2} \quad (\text{Equation 2})$$

$$H_{WT} = (H_h + R/2) \quad (\text{Equation 3})$$

Where:

- D_2 = Distance from wind turbine to horizon in miles
- H_{WT} = Max height of wind turbine blade tip above sea level in feet
- H_h = Hub height in feet
- R = Rotor diameter in feet

The LOS distance, in miles, is simply the sum of horizon distances as follows:

$$D_{LOS} = (D_1 + D_2) \quad (\text{Equation 4})$$

From Equation 2 and Equation 3, the horizon distance for each wind turbine is determined, and the results are shown in Table 3. If the geographical coordinates and heights for each FAA radar is provided, then their corresponding horizon distance as well as LOS distance can be calculated using Equation 1 and Equation 4, respectively.



Turbine ID	Latitude (NAD83)	Longitude (NAD83)	Ground Elevation (ft)	Hub Height (ft)	Rotor Diameter (ft)	H _{WT} (ft)	D ₂ (mi)
1	43.06757543	-72.00784753	1,431	303.5	370.7	1,920	62.0
2	43.06415693	-72.00622973	1,739	303.5	370.7	2,228	66.7
3	43.06146974	-72.00913447	1,756	303.5	370.7	2,245	67.0
4	43.05864667	-72.01643969	1,686	303.5	370.7	2,175	65.9
5	43.0565391	-72.01953051	1,727	303.5	370.7	2,215	66.6
6	43.05263123	-72.01997279	1,504	303.5	370.7	1,993	63.1
7	43.04842239	-72.02160036	1,679	303.5	370.7	2,168	65.8
8	43.04550318	-72.02132236	1,700	303.5	370.7	2,189	66.2
9	43.04315637	-72.02394361	1,663	260.8	370.7	2,109	64.9

Table 2: Wind Turbine Dimensions and Overall Height Above Sea Level

4. Conclusions

Potential issues involving military operations in the same area as the Antrim Winds Energy Project were examined. Based on the DoD screening tool, no issues were identified.

Similarly, no issues were identified with the Weather Service's NEXRAD Radar Systems. The Weather Service can be informed of the project through the NTIA notification process.

Antrim Wind Energy LLC submitted Form 7460-1 for each of the nine proposed wind turbines to address the DoD screening tool findings involving long range radars and inform the FAA of the wind project. After conducting an aeronautical study concerning the wind turbines, the FAA issued a response to each of the form submissions with a "Determination of No Hazard to Air Navigation" for all nine wind turbines. A copy of the FAA response letters can be found in the Appendix section of this report.

5. Contact

For questions or information regarding the Government RADAR System Analysis report, please contact:

Contact person: Denise Finney
 Title: Account Manager
 Company: Comsearch
 Address: 19700 Janelia Farm Blvd., Ashburn, VA 20147
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 Fax: 703-726-5595
 Email: dfinney@comsearch.com
 Web site: www.comsearch.com



Appendix

**SEE APPENDIX 2E of AWE's
Application for a Certificate of Site and
Facility**