



## ***2009-2010 Ohio Anemometer Loan Program (ALP) December 2009 Monthly Summary Report***

***Grant No. 08-01***

Prepared for:

Ohio Department of Development, Ohio Energy Office  
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Ashtabula Port Authority  
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and

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### **1. Site Status**

Data collection continues for the two recipients of the 2009-2010 Ohio Anemometer Loan Program. There have been no data recovery issues for the month of December.

Preliminary results for the month of December 2009 are summarized in Section 2. A short summary of the study to date can be found in Section 3. Specifications for the 2009-2010 ALP sites are included in Appendices A & B (Site Specification Logs).

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### 2. Monthly Data Analysis Summary

Preliminary wind data collected at the ALP sites during the month of December 2009 are summarized below in Tables 1 and 2, and Figures 1 through 4. The data in this section have not been filtered for icing or tower shading.

**Table 1: Ashtabula Port Authority Summary of Monthly Average Wind Speed, Power Density and Turbulent Intensity.**

Channel	Height (feet)	Height (meters)	Boom Orientation (degrees)	Monthly Average Wind Speed (mph)	Monthly Average Wind Speed (m/s)	Cubic Average Wind Speed (mph)	Cubic Average Wind Speed (m/s)	Monthly Wind Power Density (W/m <sup>2</sup> )	Monthly Turbulent Intensity
1	98	29.9	135	11.8	5.3	14.2	6.4	162.7	0.22
2	98	29.9	315	12.0	5.4	14.6	6.5	174.8	0.22
3	131	39.9	135	13.1	5.8	15.8	7.1	223.5	0.20
4	131	39.9	315	13.1	5.8	16.0	7.1	229.4	0.20
5	164	50.0	135	14.2	6.3	17.1	7.7	282.6	0.18
6	164	50.0	315	14.3	6.4	17.2	7.7	286.4	0.17
<b>Shear Exponent</b>	<b>Channels</b>	<b>Exponent from Average of Wind Shear Column</b>	<b>Exponent from Average Wind Speed</b>						
Exp1	1 to 3	0.3830	0.3638						
Exp2	3 to 5	0.3546	0.3563						
Exp3	2 to 4	0.2580	0.2921						
Exp4	4 to 6	0.4736	0.3875						

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**Table 2: Pettisville Summary of Monthly Average Wind Speed, Power Density and Turbulent Intensity.**

Channel	Height (feet)	Height (meters)	Boom Orientation (degrees)	Monthly Average Wind Speed (mph)	Monthly Average Wind Speed (m/s)	Cubic Average Wind Speed (mph)	Cubic Average Wind Speed (m/s)	Monthly Wind Power Density (W/m <sup>2</sup> )	Monthly Turbulent Intensity
1	102	31.1	180	12.0	5.4	14.7	6.6	178.9	0.15
2	102	31.1	332	12.2	5.4	14.8	6.6	184.4	0.15
3	131	39.9	180	12.9	5.8	15.6	7.0	212.7	0.14
4	131	39.9	332	12.9	5.8	15.5	6.9	211.5	0.13
5	164	50.0	180	13.7	6.1	16.4	7.3	246.8	0.13
6	164	50.0	332	13.5	6.0	16.3	7.3	241.5	0.13
<b>Shear Exponent</b>	<b>Channels</b>	<b>Exponent from Average of Wind Shear Column</b>	<b>Exponent from Average Wind Speed</b>						
Exp1	1 to 3	0.3553	0.2837						
Exp2	3 to 5	0.2867	0.2645						
Exp3	2 to 4	0.2854	0.2313						
Exp4	4 to 6	0.2047	0.2095						

Figure 1: Ashtabula Port Authority Daily Average Wind Speeds for December 2009

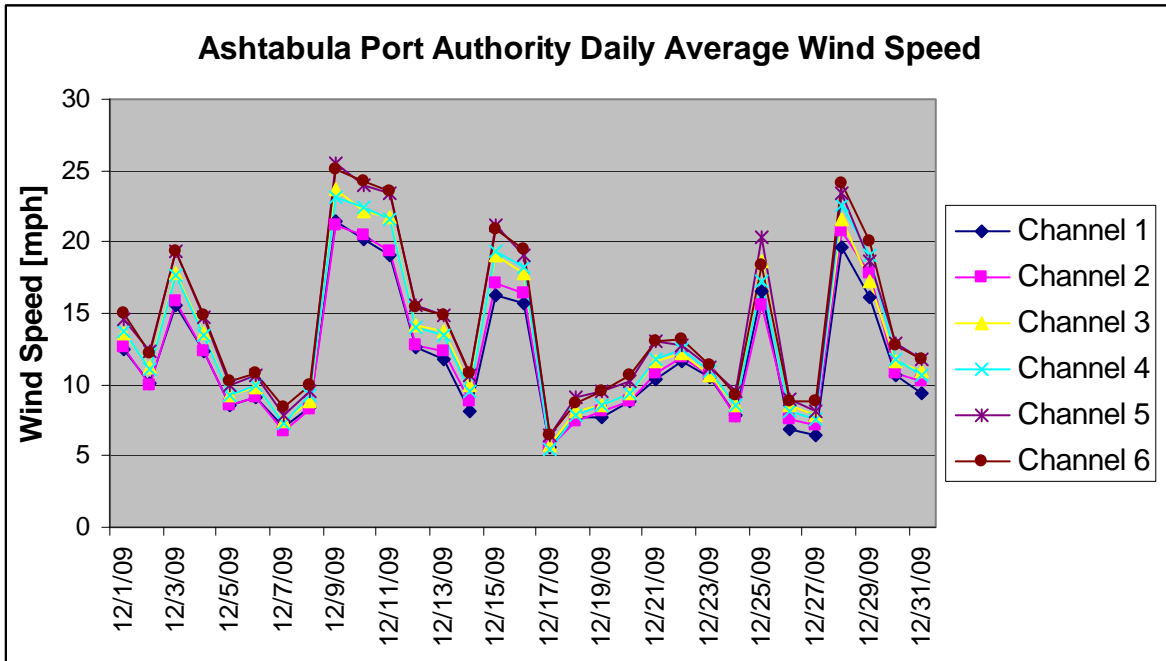


Figure 2: Ashtabula Port Authority Daily Average Wind Power Density for December 2009

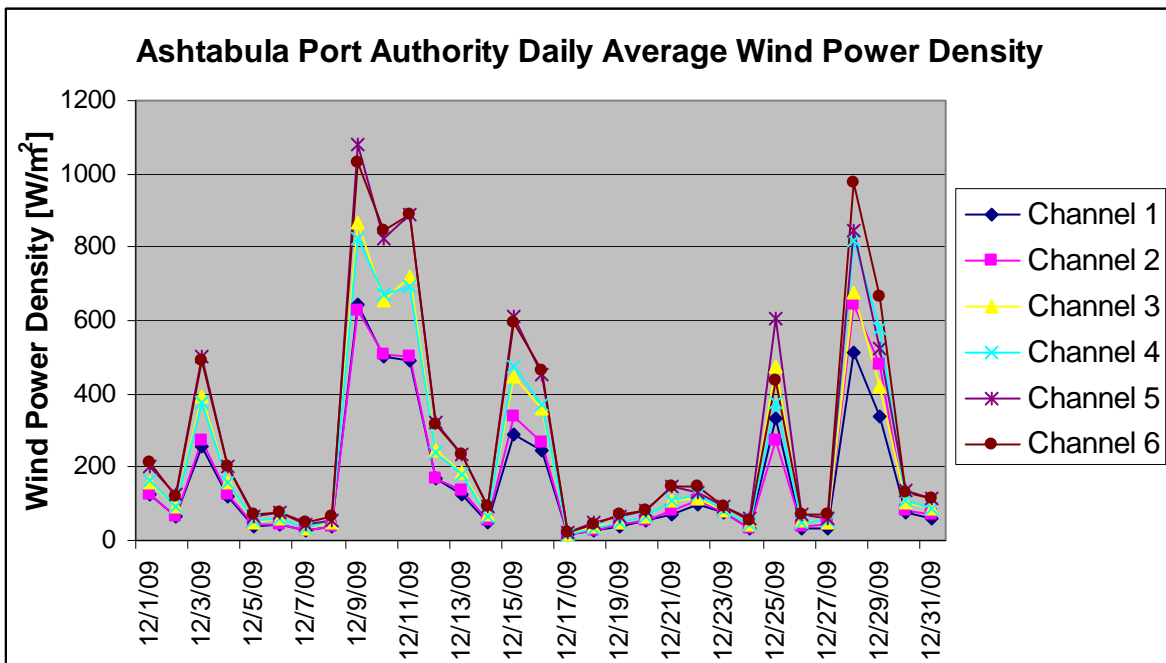


Figure 3: Pettisville Daily Average Wind Speeds for December 2009

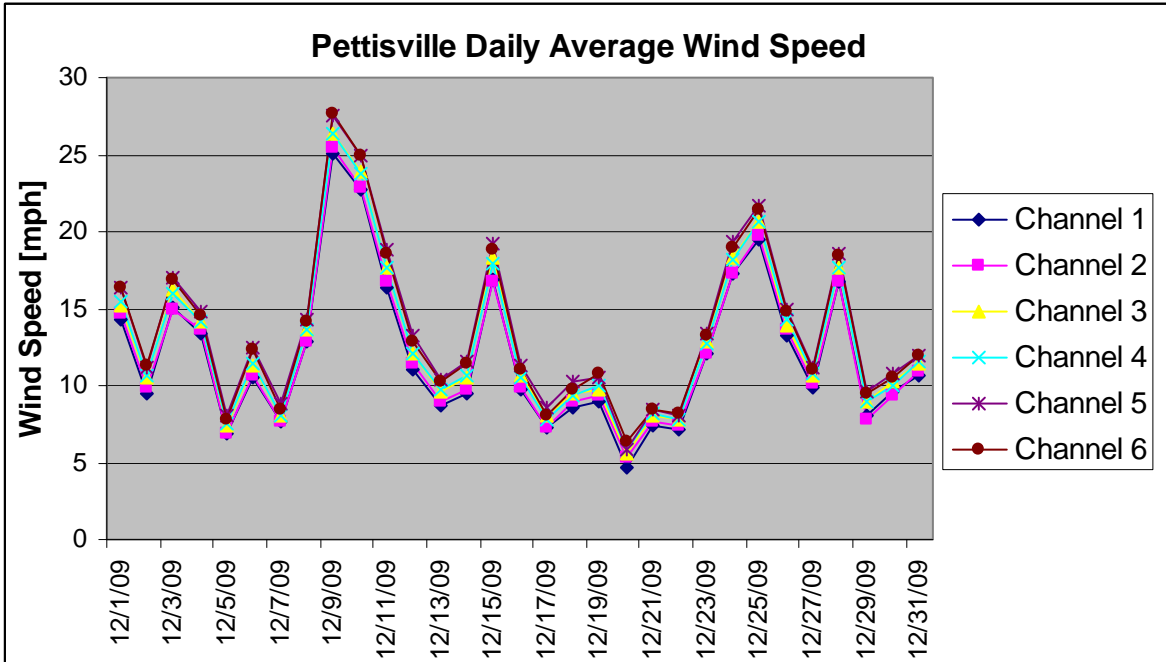
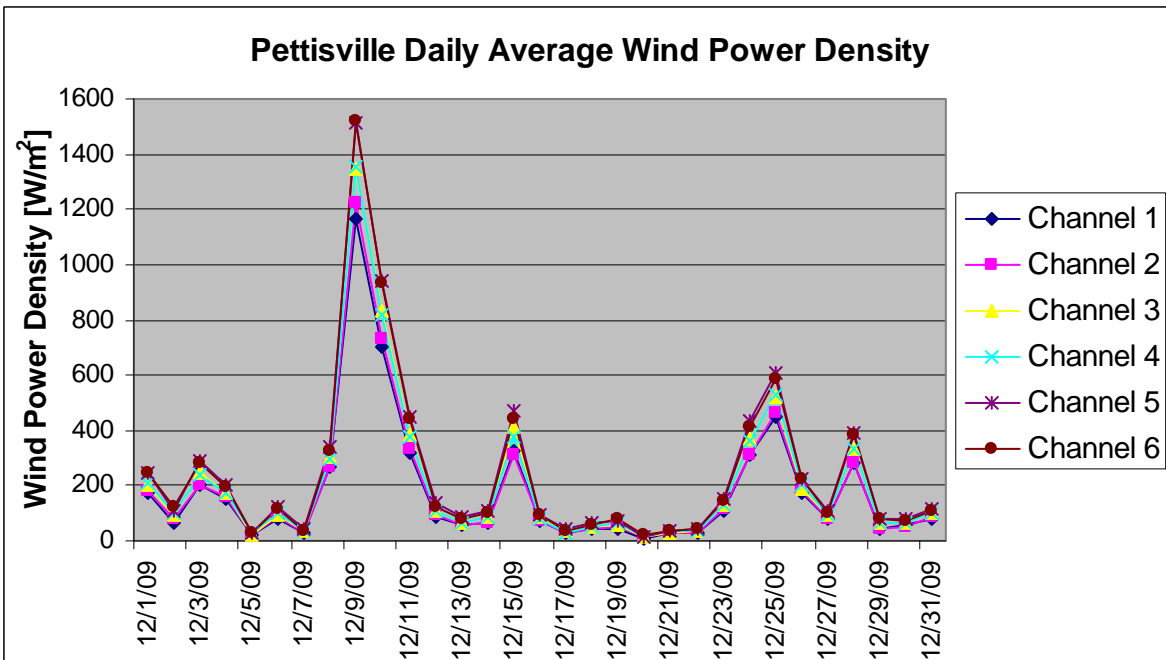


Figure 4: Pettisville Daily Average Wind Power Density for December 2009



### 3. Data Analysis Summary (study to date)

Figures 3 and 4 display monthly average wind speed data and monthly average wind power density data for the study to date. Thus far, the site at the Ashtabula Water Treatment Plant has reported higher monthly average wind speeds than the site at Pettisville. Wind speeds and wind power density values increased for both sites from September to October. Note that since both sites were commissioned in September, the monthly averages calculated for September did not include data for the whole month, and may not be representative of the entire month.

Wind speeds increased at the Ashtabula site from October to November; however, wind speeds at the Pettisville site decreased during the same time period. Wind power density values decreased for both sites from October to November. Since monthly average wind speeds increased and temperatures decreased (therefore air density increased) at the Ashtabula site from October to November, wind power density should have increased during this time period, as air density and wind speed are the only variables in the calculation of wind power density. The general equation used to calculate power density is:

$$\text{power density} = \frac{1}{2} \times \rho V^3$$

Here  $\rho$  is the air density, and  $V$  is the wind velocity. In our model, air density was calculated as a function of the temperature at the site, the elevation of the site and the channel height of the specific anemometer in question:

$$\rho = (353.05 / (273 + \text{temperature})) * e^{(-0.034 * ((\text{elevation} + \text{channelheight}) / (273 + \text{temperature})))}$$

Here, temperature is the site temperature in Celsius, elevation is the site elevation in meters, channel height is the height in meters above ground of the anemometer in question, and  $\rho$  is the air density in  $\text{kg/m}^3$ . In this case, the discrepancy of a decreasing wind power density when wind speed is increasing is due to the fact that the wind power density equation cubes the wind speed, thus, it more heavily weights higher wind speeds. Though the average wind speed was greater during November at the Ashtabula site, there was one extremely high wind day on October 7, 2009 (50 meter daily average wind speed of 29.4 mph!), that skewed the monthly wind power density average for October and caused it to be higher than the November average.

Average monthly wind speed and wind power density values increased for both sites from November to December 2009. We expect this increasing trend to continue through January 2010.

Figure 3: Monthly Average Wind Speeds (Data Filtered for Icing and Tower Shading)

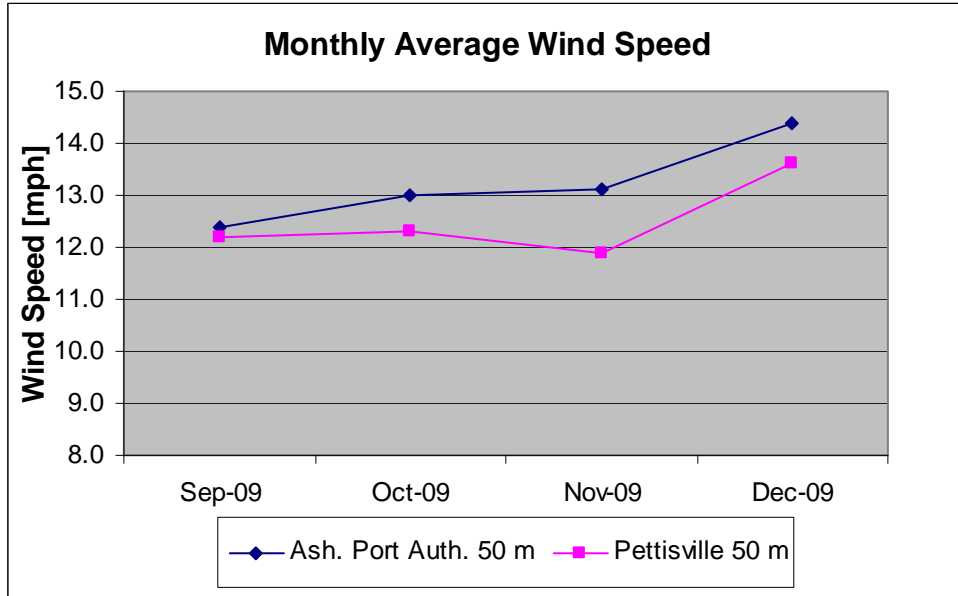
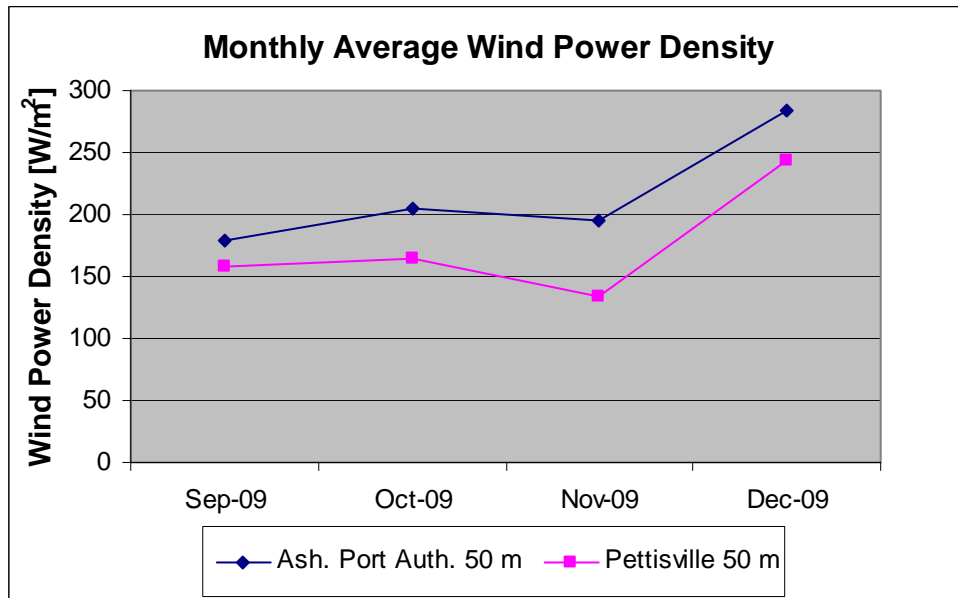


Figure 4: Monthly Average Wind Power Density (Data Filtered for Icing and Tower Shading)



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### APPENDIX A: SITE SPECIFICATION LOG – ASHTABULA PORT AUTHORITY

#### SITE

Site Name: Ashtabula Port Authority  
 Installation Date: September 7, 2009  
 Tower Owner: Ohio Department of Development (ALP)  
 Site Location (description): Tower located on grassy field on the southeast corner of the Ashtabula Water Treatment Plant property (303 Woodland Ave.). Tower is located approx. 205 feet due north of E. 5<sup>th</sup> St., and approx. 445 feet west of Parkgate Ave. (GPS coordinates): N 41° 54.112'; W 80° 47.162'  
 Ground Elevation: 625 ft  
 Prevailing Wind Direction: WSW (from OPSB Interactive Wind Resource Map)  
 Site Sponsor Contacts: Alicia McFarland, 440-992-7154 (Office), 440-813-3076 (Cell), [amcfarland@cityofashtabula.com](mailto:amcfarland@cityofashtabula.com)  
 Michael Mearini, 440-964-3030, 440-228-9217, [michaelm@cityofashtabula.com](mailto:michaelm@cityofashtabula.com)  
 Logger Lock Combination: 356

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#### TOWER

FCC Tower Registration: None (50m XHD NRG Tall Tower) Tower ground assembly orientation: 0°; boom offsets: anemometers 135° & 315°; vanes 0°  
 Height of structure: 197 ft  
 Nominal Boom Heights: 30m, 40m, 50m

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#### INSTRUMENTATION

**Data Logger:** NRG Symphonie, Serial Number 8064; Site Number 1234

#### Sensors:

Logger Channel	Instrument	Serial Number	Slope (mph)	Offset (mph)	Height (ft)	Boom Azimuth (degrees)	Deadband Azimuth (degrees)
1	NRG Max 40 Anemometer	15580	1.698	0.76	98	135	
2	NRG Max 40 Anemometer	15581	1.700	0.85	98	315	
3	NRG Max 40 Anemometer	15582	1.702	0.76	131	135	
4	NRG Max 40 Anemometer	15583	1.700	0.76	131	315	
5	NRG Max 40 Anemometer	15584	1.698	0.85	164	135	
6	NRG Max 40 Anemometer	15585	1.698	0.81	164	315	
7	NRG 200P Vane	None	0.351	0	134	360	360
8	NRG 200P Vane	None	0.351	0	161	360	360
9							
10	NRG Temp Sensor	None	0.244	-123.5	9	360	360

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### INCIDENT LOG:

August 20, 2009: Tower surveying and anchor installation completed. Shifted tower layout to extend N-S anchors for additional stability. Confirmed location of underground utilities along access drive (west of anchors) with Ashtabula Wastewater Treatment Plant and City of Ashtabula personnel. Tested two anchors in west quadrant using TRG dynamometer and small back hoe (3,500 lbs. of force); no pull-out was observed. Excavated 5 ft. x 5 ft. x 2 ft. deep area for base plate to meet engineer's specifications. Lined hole with geotechnical fabric and filled with 4.89 tons of #304 crushed stone. Compacted stone with TRG backhoe. (The Renaissance Group [TRG] & Green Energy Ohio [GEO]).

August 22, 2009: TRG pull-tested the six anchors in the south and west quadrants to 7,000 lbs. using TRG dynamometer and backhoe provided by Ashtabula Port Authority; no pull-out was observed. Based on soil conditions observed during anchor installation activities, the anchors in the north and east quadrants were not tested (TRG).

August 26, 2009: NRG 50 meter MET tower decommissioned from Cuyahoga County Fairgrounds in Berea, OH (TRG & GEO). Tower transported to Ashtabula by TRG.

August 27, 2009: Began tower layout and assembly activities, including sensor prep & testing, boom attachment and logger programming (TRG & GEO).

September 7, 2009: Tower, boom, and instrument assembly completed. Tower raised & straightened and guy wires tightened (TRG). Data collection for anemometers and vanes begins (TRG).

September 8, 2009: Temperature sensor installed and operating correctly.

September 28, 2009: Logger time clock reset from 10:40 to 11:40 to reflect correct time.

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### APPENDIX B: SITE SPECIFICATION LOG – PETTISVILLE

#### SITE

Site Name: Pettisville  
 Installation Date: September 17, 2009  
 Tower Owner: Ohio Department of Development (ALP)  
 Site Location (description): Tower located on Dean Genter's property (3902 County Rd. 19 Archbold, OH 43502-9761) in an alfalfa field situated immediately south of Oak Drive and Pettisville School. Tower is located approx. 750 feet south of County Rd. D, and approx. 900 feet east of County Rd. 19 (GPS coordinates): N 41° 31.613'; W 84° 13.561'  
 Ground Elevation: 755 ft  
 Prevailing Wind Direction: WSW (from OPSB Interactive Wind Resource Map)  
 Site Sponsor Contacts: Steve Switzer, 419-446-2705 (Office), 419.306.4168 (Cell), [pville\\_s@nwoca.org](mailto:pville_s@nwoca.org)  
 Donna Meller, 419-966-2702 (Cell), [pet\\_aca\\_dm@nwoca.org](mailto:pet_aca_dm@nwoca.org)  
 John Poulson, 419-572-6403 (Cell), [pet\\_aca\\_jp@nwoca.org](mailto:pet_aca_jp@nwoca.org)  
 Paul Bishop, 419-446-2705 x 208, [pet\\_aca\\_pb@nwoca.org](mailto:pet_aca_pb@nwoca.org)  
 Logger Lock Combination: 127

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#### TOWER

FCC Tower Registration: None (50m XHD NRG Tall Tower) Tower ground assembly orientation: 45°; boom offsets: anemometers 180° & 332°; vanes 0°  
 Height of structure: 197 ft  
 Nominal Boom Heights: 31m, 40m, 50m

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#### INSTRUMENTATION

**Data Logger:** NRG Symphonie, Serial Number 8065; Site Number 1235

#### Sensors:

Logger Channel	Instrument	Serial Number	Slope (mph)	Offset (mph)	Height (ft)	Boom Azimuth (degrees)	Deadband Azimuth (degrees)
1	NRG Max 40 Anemometer	15571	1.700	0.78	102	180	
2	NRG Max 40 Anemometer	15572	1.696	0.89	102	332	
3	NRG Max 40 Anemometer	15573	1.702	0.76	131	180	
4	NRG Max 40 Anemometer	15574	1.698	0.72	131	332	
5	NRG Max 40 Anemometer	15578	1.702	0.83	164	180	
6	NRG Max 40 Anemometer	15579	1.693	0.76	164	332	
7	NRG 200P Vane	None	0.351	0	134	360	360
8	NRG 200P Vane	None	0.351	0	161	360	360
9							
10	NRG Temp Sensor	None	0.244	-123.5	9	360	360

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### INCIDENT LOG:

September 16, 2009: Tower, boom, and instrument assembly completed (Wind Energy Services & Green Energy Ohio); could not raise tower due to unsafe windy conditions (crosswind > 10 mph).

September 17, 2009: Commissioned tower at Pettisville Schools (Wind Energy Services). Vanes and temp sensor wired incorrectly (white in positive; red in signal).

September 18, 2009: Instructed site sponsor John Poulson to correct wiring of vanes and temp sensor; red in positive; white in signal.