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ICC-SWCC™

SUMMARY REPORT SWCC-18-02

Manufacturer: Hi VAWT Technology Corporation
 (Represented in USA by Colite Technologies)

Wind Turbine Model: DS3000 (240 VAC, 1-phase, 60 Hz)

Certification Number: SWCC-18-02



The above-identified Small Wind Turbine is certified under the ICC–SWCC Small Wind Turbine Certification Program to be in conformance with the AWEA *Small Wind Turbine Performance and Safety Standard* (AWEA 9.1–2009). For the ICC-SWCC Certificate visit: www.smallwindcertification.org.

This report summarizes the results of testing and certification of the Hi-VAWT Technology Corp. DS3000 turbine in accordance with AWEA Standard 9.1-2009. The DS3000 is a 3-blade, vertical axis wind turbine with a combination Darrieus-Savonius rotor with a 3.66 m effective diameter¹ and swept area of 10.6 m². All testing was performed by TUV-NEL on a turbine system utilizing a WT23000 grid-tie inverter and an 8.4 m (28') monopole tower at NEL's Myres Hill test site within the Whitelee Forest area above Eaglesham, south of Glasgow, Scotland.

Power Performance testing was performed from 12 February 2010 to 22 March 2010. Duration testing was performed from 12 February 2010 to 15 September 2010. Safety and Function testing was performed from 12 February 2010 to 15 September 2010 (data collected during Performance and Duration testing). Acoustic testing was performed during March 2010 and August 2010.

1. Turbine Ratings

The DS3000 performance testing was conducted in accordance with Section 2 of AWEA Standard 9.1-2009. The resulting turbine ratings, tabulated graphical Annual Energy Production (AEP), and graphical and tabulated power curve are given below.

AWEA Rated Annual Energy @ 5 m/s	2,460 kWh
AWEA Rated Sound Level	42.3 dB(A)
AWEA Rated Power @ 11 m/s	1.4 kW
Peak Power @ 10.5 m/s	1.4 kW

¹ Per IEC 61400-12-1 Ed. 1 clause 5.1, in the case of a vertical axis wind turbine, D is equivalently defined as $2\sqrt{A/\pi}$, where A is the swept area of the rotor.

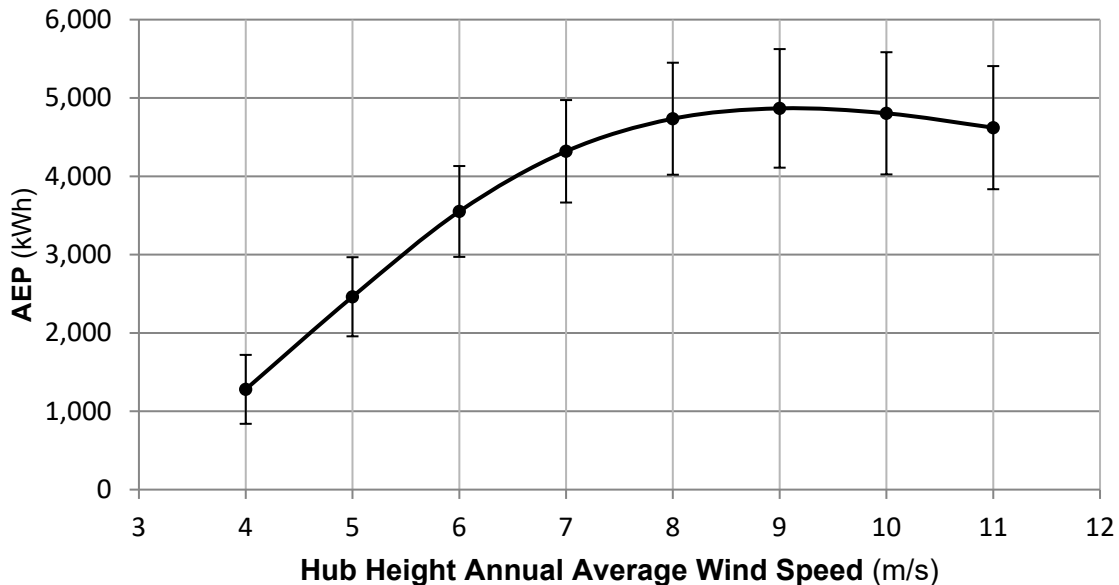
2. Tabulated Annual Energy Production (AEP)

Database A; corrected to a sea level air density of 1.225 kg/m³

Hub Height Annual Average Wind Speed (m/s)	AEP Measured (kWh)	Standard Uncertainty in AEP (kWh)	Standard Uncertainty in AEP (%)	AEP Extrapolated (kWh)
4	1,280	440	34.3%	1,280
5	2,462	505	20.5%	2,462
6	3,551	580	16.3%	3,551
7	4,319	654	15.1%	4,319
8	4,735	715	15.1%	4,735
9	4,867	757	15.6%	4,867
10	4,804	780	16.3%	4,804
11	4,621	786	17.0%	4,621

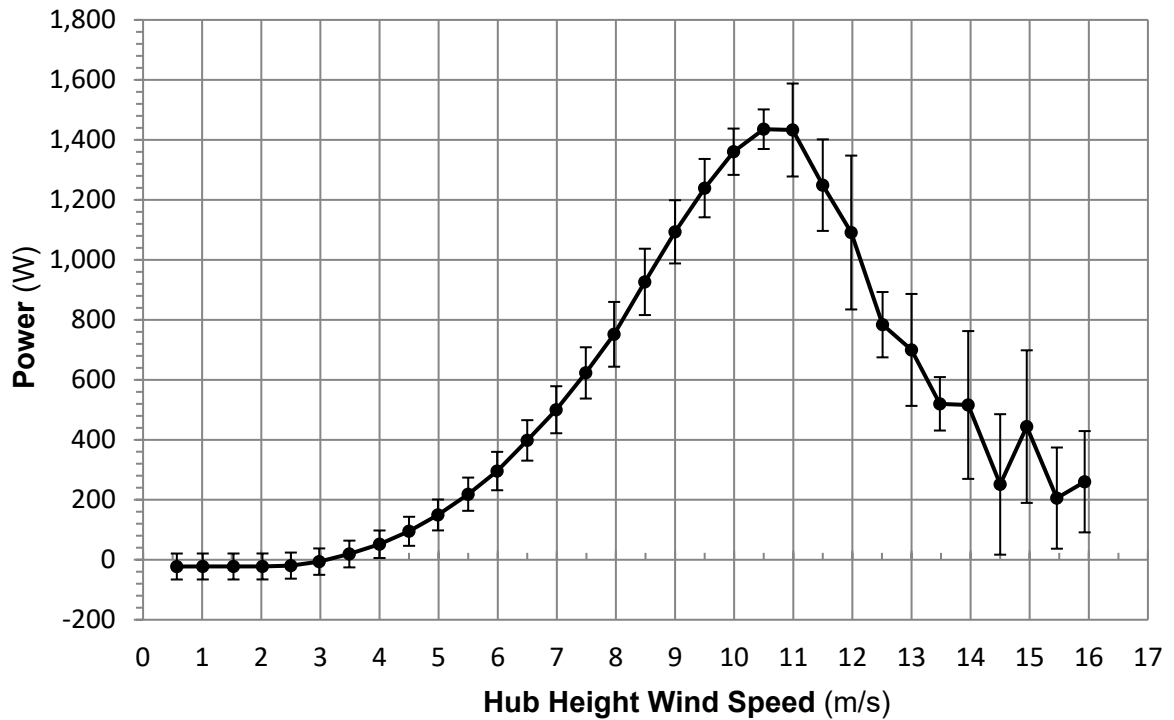
3. Annual Energy Production Curve

Estimated Annual Energy Production
with Standard Uncertainty
AEP-measured, database A, swept area = 10.6 m²
DS3000
Reference air density: 1.225 kg/m³



4. Power Curve

DS3000 Power Curve
 with Combined Standard Uncertainty
 Database A, swept area = 10.6 m²
 Reference air density: 1.225 kg/m³



5. Tabulated Power Curve

Database A Corrected to a sea level air density of 1.225 kg/m ³					Category A	Category B	Combined
Bin	Hub Height Wind Speed	Power Output	C _p	1-minute samples	Standard Uncertainty, S _i	Standard Uncertainty, U _i	Standard Uncertainty, C _i
	<i>m/s</i>	<i>kW</i>			<i>kW</i>	<i>kW</i>	<i>W</i>
1	0.57	-22.5	-19.3	295	0.0	43.5	43.5
2	1.01	-22.4	-3.4	633	0.0	43.3	43.3
3	1.53	-22.4	-1.0	1253	0.0	43.3	43.3
4	2.02	-22.3	-0.4	1604	0.0	43.3	43.3
5	2.50	-19.5	-0.2	2093	0.1	43.3	43.3
6	2.98	-6.2	0.0	1761	0.3	43.5	43.5
7	3.49	19.2	0.1	1449	0.5	44.0	44.0
8	4.00	51.8	0.1	1190	0.8	44.6	44.6
9	4.50	94.9	0.2	1237	0.9	45.9	45.9
10	4.99	149.4	0.2	1154	1.3	48.4	48.4
11	5.50	218.6	0.2	912	1.8	51.5	51.5
12	5.99	295.8	0.2	772	2.3	55.3	55.4
13	6.50	398.0	0.2	696	3.0	63.9	64.0
14	6.99	500.2	0.2	733	3.2	67.4	67.5

15	7.49	623.0	0.2	685	3.9	78.3	78.4
16	7.97	751.7	0.2	609	4.5	85.3	85.5
17	8.49	926.5	0.2	524	6.2	107.8	108.0
18	9.00	1093.4	0.2	477	8.6	110.2	110.6
19	9.50	1239.1	0.2	432	15.7	104.3	105.4
20	9.99	1360.5	0.2	364	24.4	94.2	97.3
21	10.50	1435.6	0.2	340	35.6	68.5	77.2
22	10.99	1432.9	0.2	295	48.1	45.2	66.0
23	11.50	1249.1	0.1	293	57.1	144.1	155.0
24	11.98	1091.1	0.1	257	66.1	137.5	152.6
25	12.51	783.8	0.1	222	67.2	247.5	256.5
26	13.00	699.7	0.0	192	68.0	85.0	108.9
27	13.48	520.0	0.0	136	72.0	172.2	186.6
28	13.96	516.1	0.0	98	77.6	43.7	89.1
29	14.50	251.2	0.0	68	68.0	236.9	246.4
30	14.95	444.0	0.0	45	95.0	214.0	234.2
31	15.46	205.6	0.0	28	37.7	236.5	254.4
32	15.93	260.2	0.0	14	151.5	74.3	168.7

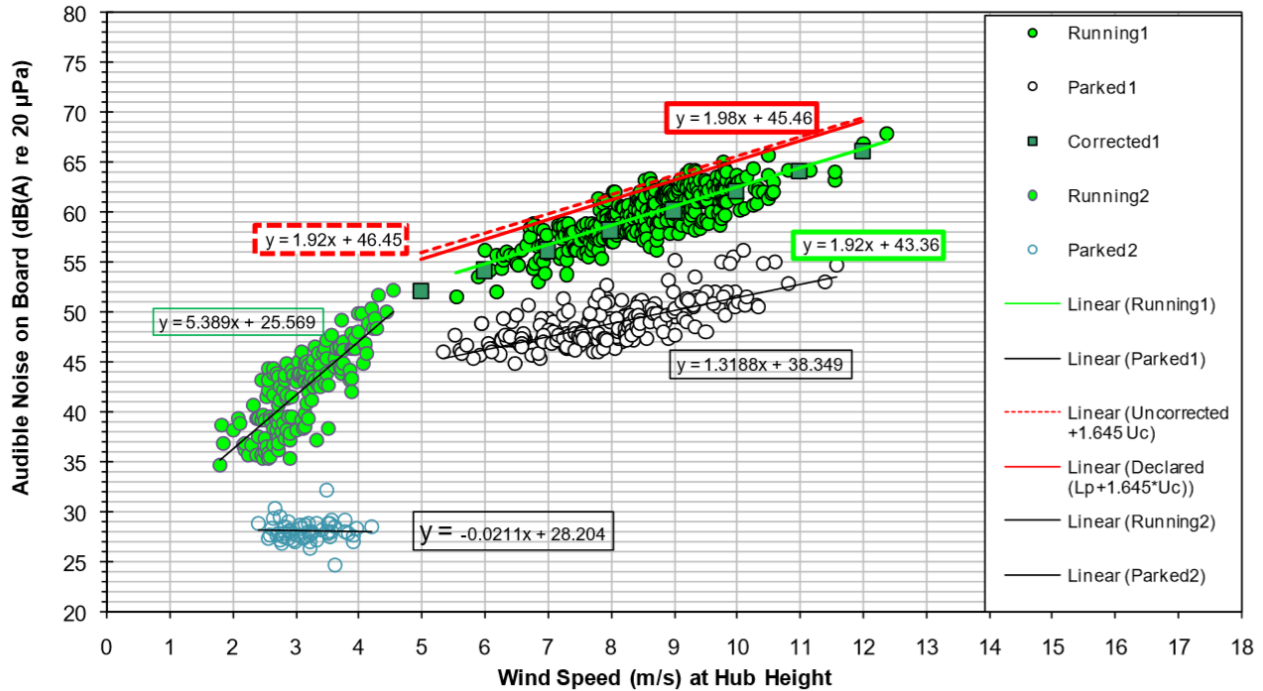
6. Tabulated Acoustic Data

The DS3000 was tested in accordance with Section 3 of AWEA Standard 9.1-2009. The tabulated sound pressure and sound power levels are provided for specific wind speed bins.

Wind Speed at 10m Height <i>m/s</i>	Background Corrected Sound Pressure Level <i>dB(A)</i>	Apparent Sound Power Level <i>dB(A)</i>	Combined Uncertainty <i>dB(A)</i>
6	54.9	82.7	2.0
7	56.8	83.4	2.0
8	58.7	85.4	2.0
9	60.6	87.3	2.0
10	62.6	89.2	2.0
11	64.5	91.1	2.0

The background corrected sound pressure levels at integer wind speeds were found using $[y = 1.92x + 43.36]$. Linear interpolation resulted in a sound power level of 88.8 dB(A) at 9.8 m/s. At the 60 m observer distance, this provides an AWEA Rated Sound Level of 42.3 dBA.

7. Graphical Acoustic Data (excerpt from NEL report 2010/351 issue 3)



Audible noise (sound pressure measured at the ground board) as a function of wind speed

8. Duration Testing

As a result of the particular wind distribution that occurred during the Duration Test period, it was not possible to demonstrate IEC Class III wind conditions. The DS3000 successfully completed a Duration Test for an IEC Class IV Small Wind Turbine with an Operational Time Fraction of 90 %. The average turbulence intensity (1-minute averaging) at 15 m/s (33.6 mph) was 13%. The highest recorded instantaneous wind speed was 26.4 m/s (59.1 mph).

9. Mechanical Strength Analysis

The mechanical strength analysis was found to be in conformance with IEC 61400-2 as modified by AWEA Standard 9.1 – 2009 for an IEC Class III small wind turbine. Design calculations include utilization of the simple load model equations for vertical axis wind turbines developed by the Institute of Nuclear Energy Research, Atomic Energy Council of Republic of China.

10. Safety and Function testing

Safety and Function testing was found to be in conformance with sections 4.3 and 4.4 of AWEA Standard 9.1 – 2009.

11. Manufacturer Tower Design Requirements (ICC-SWCC is not responsible for any errors in the document below, which is provided by the manufacturer).

Mechanical Connections

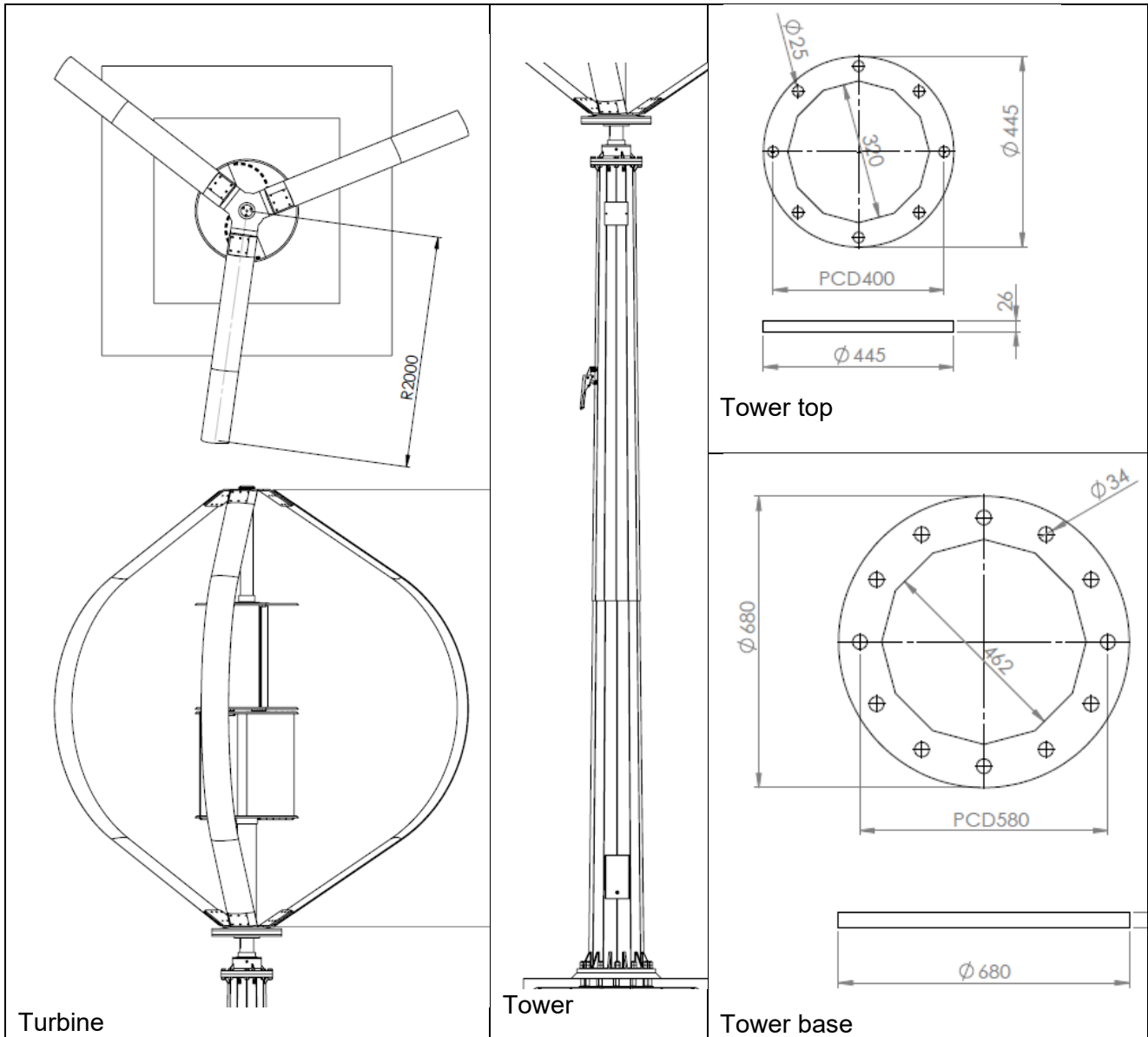


Figure above shows the DS-3000 mechanical connection layout. Tower top connection shall be made using eight M22 bolts in circular arrangement.

Electrical Connections

Electrical wiring requirements for a DS-3000 installation can be found in the installation manual.

Minimum blade/tower clearance

Blades from VAWT won't have clearance problem with tower. All blades are naturally located above the tower.

Maximum tower top loads

The maximum tower top loads calculated for the DS-3000 wind turbine from load case H of the design evaluation report of DS-3000.

Turbine weight	7357.5 N (750 kg)
Shear force at tower top (Wind loads at 52.5 m/s wind speed)	5372.5 N
Overturning bending moment (Wind loads)	12316.5 N.m

Maximum allowable tower top deflection

The maximum allowed tower top deflection at V_{e50} is 2.5% of the tower height (0.175 m for 7 m height tower).