GLGH-4285 11 08105 258-S-0001-B

Extract from Test Report GLGH-4285 11 08105 258-A-0002-B
"Power Performance Measurement on an Ennera Windera S wind turbine in Kaiser-Wilhelm-Koog, Germany, according to IEC 61400-12-1 and BWEA"

Wind Turbine:

Manufacturer:	Ennera Energy and Mobility, S.L.
Type:	Windera S
Serial number:	I.H4.A-000011
Rotor diameter:	4.36 m
Hub height:	12.5 m
Rated power:	3.2 kW
Wind speed (cut-in…rated…cut-out):	3.0...11.0...25.0 m/s
Rated rotor speed:	225 rpm
Blade type:	ATV
Power control:	stall

Measurements:
The measurements were carried out according to „IEC-61400-12-1: Wind turbines – Part 12-1: Power performance measurements of electricity producing wind turbines", First Edition, December 2005 as well as the quality management guide of GL Garrad Hassan Deutschland GmbH and the BWEA Small Wind Turbine Performance and Safety Standard, 2008-02-29 .

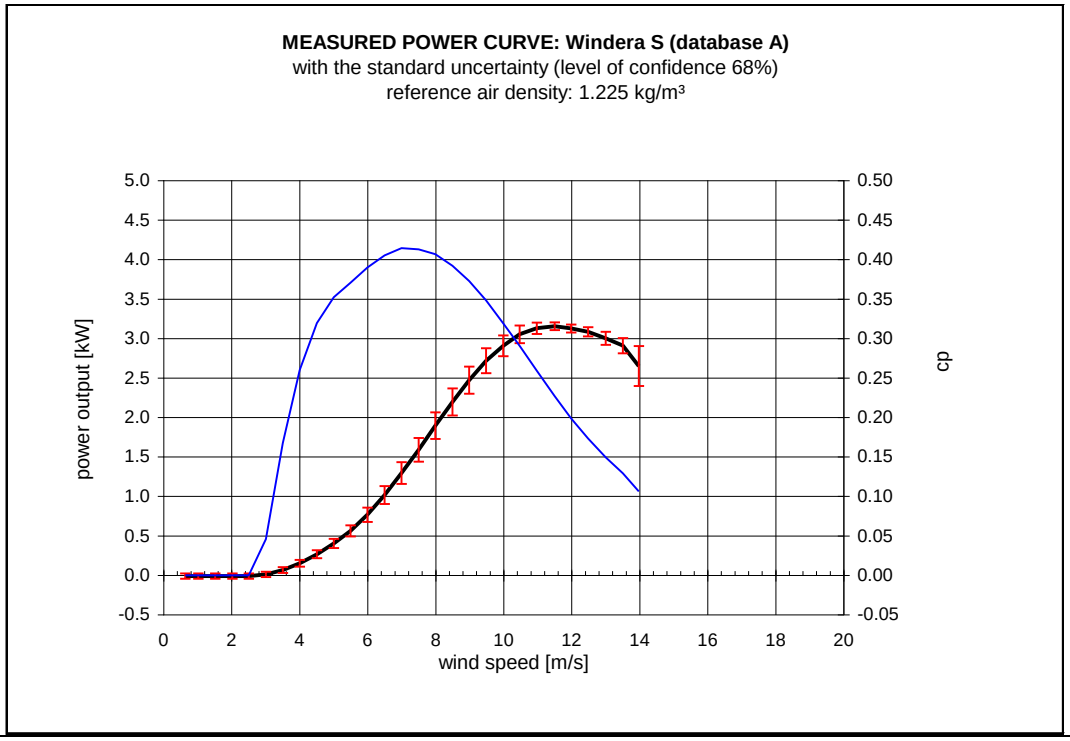
Deviations to IEC 61400-12-1 or the quality management guide of GLGH Deutschland GmbH:

- The anemometers were mounted in a height of 12.05 m, which is slightly below the allowed range of hub height ±2.5% (12.1875...12.8125 m).
- The wind vane has not been calibrated.
- According to GLGH quality management system a recalibration of the temperature sensor should have been done. According to IEC 61400-12-1 this is not mandatory.

Scope of measurements:

- Period: 2013-11-05 to 2013-12-19
- Evaluated wind direction sectors: 144°…235° and 272°…14°
- Wind speed measurements were carried out with a Thies First Class Advanced anemometer at 12.05 m.
- Accuracy of anemometer calibration: ±0.1 m/s in the range of 4 to 16 m/s
- Measured power was normalized to reference air density = 1.225 kg/m³
- Accuracy class of power measuring devices: current transformer = 0.5, power transducer = 0.5

The complete procedure is documented in the report no. GLGH-4285 11 08105 258-A-0002-B



MEASURED POWER CURVE: Windera S (database A) coverage factor (assuming normal distributions): k=1							
reference air density: 1.225 kg/m³ cut-out windspeed: 25 m/s					category A	category B	combined (expanded) uncertainty
bin no.	hub height wind speed [m/s]	power output [kW]	cp values	no. of data sets (1 min. avg.)	standard uncertainty [kW]	standard uncertainty [kW]	[kW]
1	0.64	-0.010	-	168	0.000	0.034	0.034
2	1.02	-0.010	-	663	0.000	0.034	0.034
3	1.51	-0.010	-	1116	0.000	0.034	0.034
4	2.02	-0.010	-	1487	0.000	0.034	0.034
5	2.50	-0.009	-	2148	0.000	0.034	0.034
6	3.01	0.011	0.046	2304	0.001	0.034	0.034
7	3.51	0.066	0.168	2663	0.001	0.037	0.037
8	4.00	0.152	0.260	3002	0.001	0.042	0.042
9	4.50	0.267	0.319	3379	0.001	0.050	0.050
10	5.00	0.404	0.352	3607	0.001	0.058	0.058
11	5.50	0.563	0.371	3556	0.002	0.070	0.070
12	5.99	0.768	0.390	3476	0.002	0.091	0.091
13	6.50	1.015	0.405	3102	0.003	0.113	0.113
14	6.99	1.295	0.415	2659	0.003	0.137	0.137
15	7.50	1.590	0.413	2272	0.004	0.150	0.150
16	7.99	1.896	0.407	1774	0.004	0.169	0.169
17	8.49	2.197	0.392	1420	0.005	0.171	0.171
18	8.98	2.472	0.373	1006	0.005	0.171	0.171
19	9.48	2.718	0.348	681	0.006	0.158	0.158
20	9.99	2.907	0.319	347	0.008	0.131	0.131
21	10.47	3.054	0.291	209	0.007	0.112	0.112
22	10.97	3.129	0.259	147	0.006	0.070	0.071
23	11.50	3.155	0.227	145	0.006	0.049	0.049
24	11.98	3.127	0.199	93	0.008	0.050	0.051
25	12.48	3.085	0.174	66	0.012	0.056	0.058
26	13.00	3.003	0.150	31	0.022	0.080	0.083
27	13.50	2.909	0.129	21	0.032	0.092	0.097
28	13.97	2.651	0.106	13	0.038	0.251	0.253

The marked line is relevant according to BWEA Reference Power

ESTIMATED ANNUAL ENERGY PRODUCTION (AEP) (database A)				
extrapolation of the power curve between the highest measured wind speed and the cut-out wind speed with the average power at highest measured wind speed			WT:	Windera S
			cut-out wind speed:	25 m/s
			reference air density:	1.225 kg/m³
			coverage factor k:	1
hub height annual average wind speed (Rayleigh) [m/s]	AEP-measured (measured power curve) [MWh]	Expanded uncertainty of AEP-measured [MWh]	[%]	AEP-extrapolated (extrapolated power curve) [MWh]
4.0	3.379	0.510	15.09	3.380
5.0	6.179	0.645	10.43	6.229
6.0	8.816	0.732	8.30	9.143
7.0	10.708 *	0.768	7.17	11.722
8.0	11.726 *	0.766	6.53	13.830
9.0	12.025 *	0.738	6.13	15.467
10.0	11.830 *	0.695	5.88	16.668
11.0	11.336 *	0.647	5.70	17.472

values marked with *: power curve incomplete acc. to IEC criteria for database

The marked line is relevant according to BWEA Reference Annual Energy

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