


# Summary Details for Performance, Duration and Acoustic Measurements for Skystream 3,7 Wind Generator

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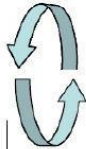
## UK MCS Certification Summary



APPROVED PRODUCT

MCS

BRE GLOBAL LISTED



BWEA small wind turbine standard, 2008

Certified by BRE

Reference Annual Energy	3416	kWh
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Annual average wind speed of 5 m/s (11 mph). Your performance may vary

Reference No. WT0043/01 & WT0043/02

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## NOTICE

These report summaries are results from third party testing of the Skystream 3,7 wind generator in accordance to the UK MCS product certification. Tests were performed in accordance to the BWEA (British Wind Energy Association) small wind Standard. This standard is based on the IEC-61400-2, 61400-11 and 61400-12.

### **Declaration of certified Wind turbines**

The Skystream 3,7 wind generator currently produced and tested is fully representative of the wind generator tested by Germanischer Lloyd. No significant changes have been made to the original design. Any Skystream 3,7 wind turbine produced after January 1, 2010 meets the UK MCS certification requirements and any machine sold into the UK will be affixed with the "MCS Approved Product" label.

Sincerely,

A handwritten signature in black ink, appearing to read 'd/le', positioned below the 'Sincerely,' text.

Andrew Kruse  
Executive VP of Business Development

# ONE - POWER PERFORMANCE

**Power Curve-** The following tables demonstrate the power performance results at sea level air density for the Skystream wind generator in accordance to IEC 61400-12-1.

## Power Curve according IEC 61400-12-1 and Measnet

responsible: Dipl.-Ing. Axel Sachse  
 checked: Dipl.-Ing. Mike Lüdde  
 Report: final  
 site: TASWT KWK  
 wind turbine type: Skystream 3.7  
 anemometer: Vector  
 no. of raw data: 107425  
 database: 87563  
 date: 2009-05-11  
 normalisation according to IEC to reference air density = 1.225 kg/m³

Filter  
 period: 14.11.2008 - 22.03.2009  
 sector: 278° to 70°; 133° to 232°  
 0% failure  
 100% availability  
 0% to 100% turbulence intensity  
 Database A

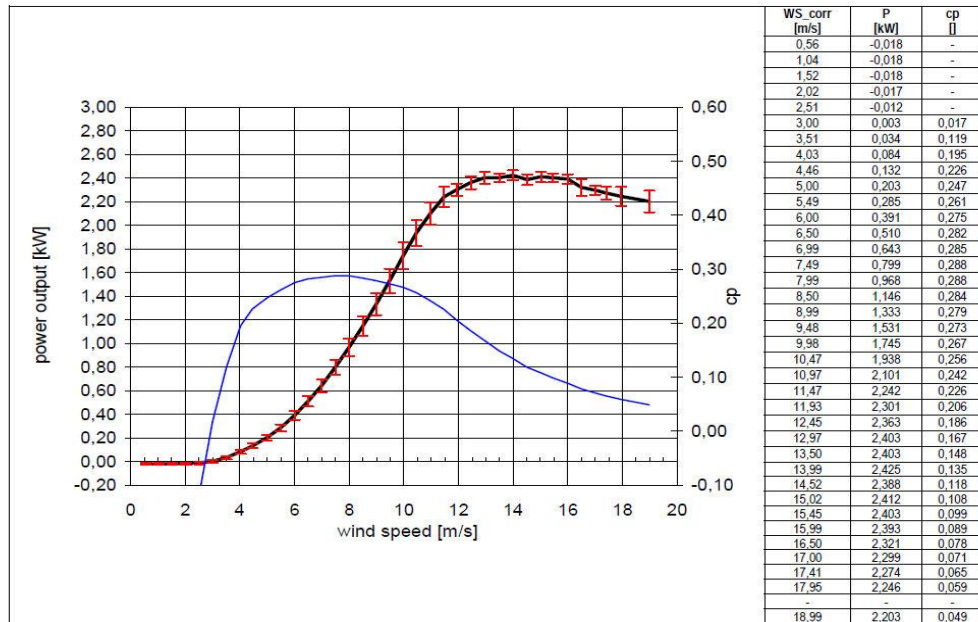
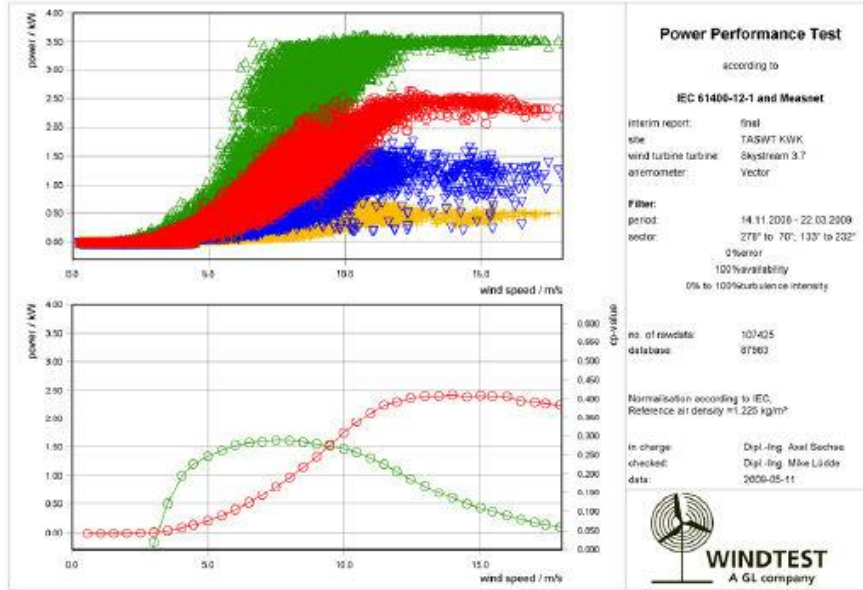


bin	from		no. of data	ws mean		P mean corr.	cp	P		P dev.	ws dev.	turb. intensity
	ws [m/s]	ws [m/s]		acta [m/s]	beta [m/s]			min. [MW]	max. [MW]			
1	0.00	0.75	465	0.56	-0.018	-15.405	-0.020	-0.016	0.001	0.136	12.120	
2	0.75	1.25	1204	1.04	-0.018	-2.391	-0.019	-0.012	0.001	0.141	8.585	
3	1.25	1.75	2082	1.52	-0.018	-0.773	-0.020	-0.001	0.001	0.147	7.800	
4	1.75	2.25	3471	2.02	-0.017	-0.311	-0.019	0.021	0.004	0.144	8.021	
5	2.25	2.75	5236	2.51	-0.012	-0.118	-0.020	0.075	0.009	0.143	7.903	
6	2.75	3.25	6353	3.00	0.003	0.017	-0.020	0.129	0.020	0.143	8.256	
7	3.25	3.75	6485	3.51	0.034	0.119	-0.019	0.248	0.031	0.144	8.688	
8	3.75	4.25	9502	4.03	0.084	0.195	-0.019	0.315	0.040	0.141	9.050	
9	4.25	4.75	9778	4.46	0.132	0.228	-0.019	0.530	0.044	0.138	9.407	
10	4.75	5.25	6018	5.00	0.203	0.247	0.070	0.660	0.055	0.143	9.485	
11	5.25	5.75	5407	5.49	0.285	0.261	0.059	0.887	0.076	0.145	9.672	
12	5.75	6.25	4924	6.00	0.391	0.275	0.070	1.177	0.101	0.144	10.044	
13	6.25	6.75	4519	6.50	0.510	0.282	0.265	1.334	0.124	0.145	10.114	
14	6.75	7.25	4570	6.89	0.643	0.285	0.278	1.619	0.148	0.145	9.950	
15	7.25	7.75	4194	7.49	0.789	0.288	0.384	1.818	0.183	0.147	10.000	
16	7.75	8.25	3534	7.99	0.968	0.288	0.514	1.942	0.173	0.145	9.952	
17	8.25	8.75	3053	8.50	1.145	0.284	0.669	2.181	0.176	0.145	9.745	
18	8.75	9.25	2543	8.99	1.333	0.279	0.642	2.312	0.169	0.144	9.640	
19	9.25	9.75	1685	9.45	1.531	0.273	0.829	2.428	0.171	0.144	8.413	
20	9.75	10.25	959	9.98	1.745	0.267	1.149	2.512	0.175	0.148	9.444	
21	10.25	10.75	583	10.47	1.938	0.258	1.415	2.383	0.155	0.141	9.453	
22	10.75	11.25	335	10.97	2.101	0.242	1.416	2.516	0.152	0.145	9.733	
23	11.25	11.75	182	11.47	2.242	0.228	1.826	2.507	0.118	0.140	9.756	
24	11.75	12.25	105	11.93	2.301	0.206	1.948	2.529	0.108	0.135	9.751	
25	12.25	12.75	47	12.45	2.263	0.186	1.947	2.629	0.141	0.147	9.578	
26	12.75	13.25	27	12.97	2.403	0.167	2.129	2.559	0.111	0.140	10.402	
27	13.25	13.75	25	13.50	2.403	0.148	2.210	2.493	0.073	0.160	10.513	
28	13.75	14.25	33	13.99	2.425	0.135	2.180	2.523	0.062	0.150	10.548	
29	14.25	14.75	37	14.52	2.389	0.118	2.118	2.535	0.102	0.151	11.647	
30	14.75	15.25	36	15.02	2.412	0.108	2.063	2.520	0.082	0.148	11.203	
31	15.25	15.75	32	15.45	2.403	0.099	2.240	2.515	0.063	0.127	11.292	
32	15.75	16.25	14	15.99	2.393	0.089	2.269	2.488	0.063	0.181	10.354	
33	16.25	16.75	12	16.50	2.321	0.078	2.170	2.417	0.085	0.150	11.254	
34	16.75	17.25	8	17.00	2.299	0.071	2.254	2.324	0.023	0.115	9.908	
35	17.25	17.75	3	17.41	2.274	0.065	2.196	2.315	0.068	0.071	9.318	
36	17.75	18.25	2	17.95	2.246	0.059	2.177	2.316	0.098	0.149	7.834	
37	18.25	18.75	-	-	-	-	-	-	-	-	-	
38	18.75	19.25	2	18.99	2.203	0.049	2.137	2.269	0.094	0.156	9.662	
39	19.25	19.75	-	-	-	-	-	-	-	-	-	
40	19.75	20.25	-	-	-	-	-	-	-	-	-	
41	20.25	20.75	-	-	-	-	-	-	-	-	-	
42	20.75	21.25	-	-	-	-	-	-	-	-	-	
43	21.25	21.75	-	-	-	-	-	-	-	-	-	
44	21.75	22.25	-	-	-	-	-	-	-	-	-	
45	22.25	22.75	-	-	-	-	-	-	-	-	-	

The valid datasets stated in the graphs below are normalized to sea level air density, referring to ISO standard atmosphere (1.225kg/m<sup>3</sup>). The Average of the measured air density (during periods of valid data collection) is 1.262 kg/m<sup>3</sup>, which is within the range.

Power performance measurement of the Skystream 3.7 at Kaiser-Wilhelm-Koog, Germany according to IEC 61400-12-1 and BWEA

report WT 7650/09  
2009-11-02



BWEA Results:

<b>BWEA Reference Power (Watts)</b>	2101
<b>Cut-in Wind Speed (m/s)</b>	3,0 m/s
<b>Maximum Power (Watts)</b>	2425

**Estimated Annual energy production** – This data is extrapolated between the highest measured wind speed and the cut-out wind speed using a K factor of K=2

<b>BWEA Reference Annual Energy Production (kWh)</b>	3416
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<b>ESTIMATED ANNUAL ENERGY PRODUCTION (AEP)</b>				
<b>(database A)</b>				
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:	IEC Test
			cut-out wind speed:	m/s
			reference air density:	1,225 kg/m <sup>3</sup>
			coverage factor k:	1
hub height annual average wind speed (Rayleigh) [m/s]	AEP-measured (measured power curve) [MWh]	Expanded uncertainty of AEP-measured		AEP-extrapolated (extrapolated power curve) [MWh]
		[MWh]	[%]	
4,0	1,736	0,208	11,980	1,736
5,0	3,416	0,295	8,626	3,416
6,0	5,349	0,368	6,883	5,349
7,0	7,207	0,418	5,798	7,207
8,0	8,737	0,447	5,116	8,737
9,0	9,814	0,462	4,709	9,814
10,0	10,439	0,469	4,497	10,439
11,0	10,683	0,473	4,427	10,683

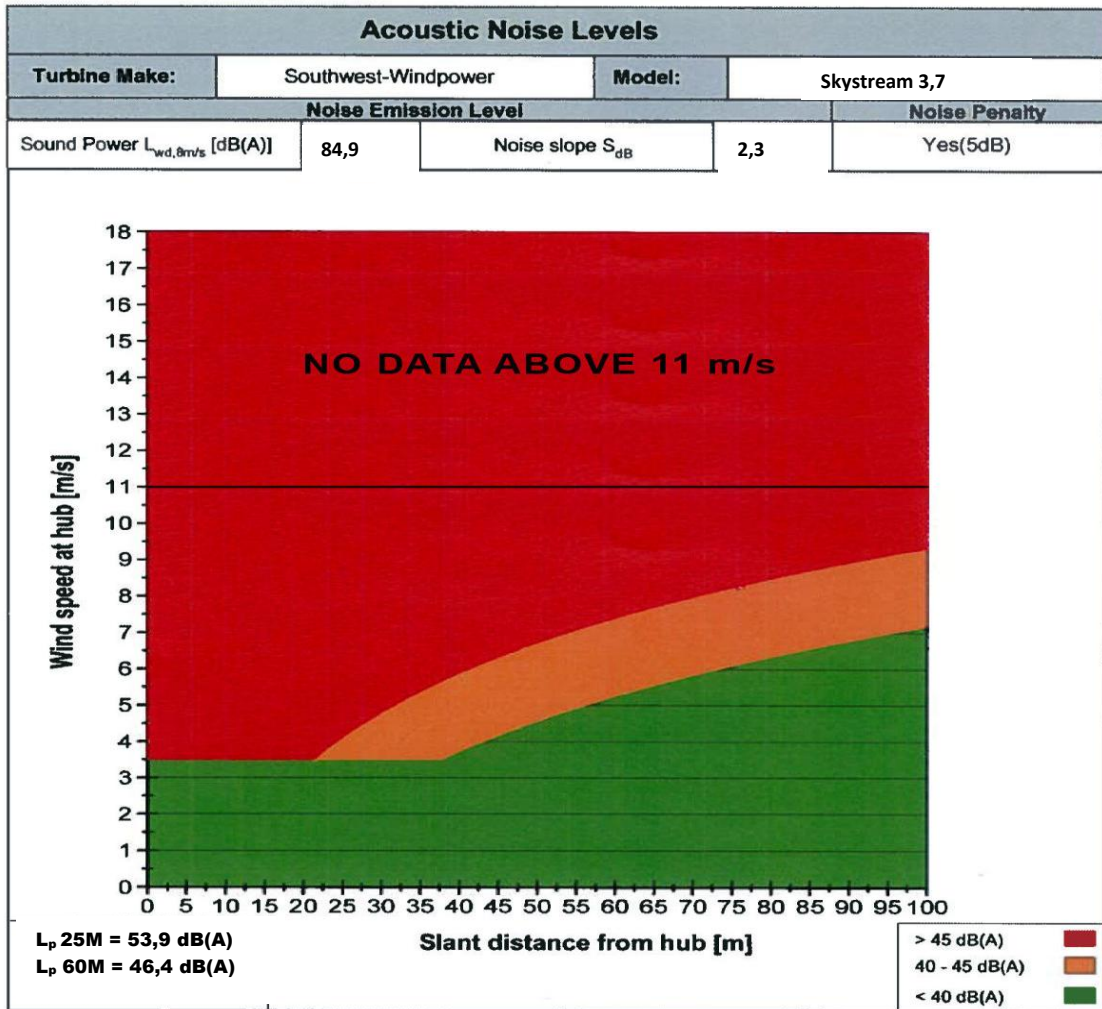
values marked with \*: power curve incomplete acc. to IEC criteria for database

**NOTE: Performance Measurements** – The power transducer that measured the energy that Skystream produced during the test was located at the base of the tower directly next to a cabinet. This cabinet is where the grid connection is realized. The BWEA standard calls for a requirement that a minimum of “eight rotor diameters” separate the base of the tower from the power transducer. This distance is approximately 96’ Using a 4mm<sup>2</sup> (12 AWG) wire, which is specified in Appendix A of the European owner’s manual, the line loss would be less than 2% which is considered negligible.

## TWO – ACOUSTICS

### Acoustics Emission

The acoustics label for the Skystream 3,7 is indicated below. All measurements and analyses of the sound power level and tonality described in this report were made on the basis of the IEC-61400-11 Ed. 2,1 and the BWEA standard for small wind turbines.



The BWEA Reference Sound Levels at 25m and 60M at 8 m/s hub height wind speed are:

$$L_{p,25m} = 53,9 \text{ dB(A)}$$

$$L_{p,60m} = 46,4 \text{ dB(A)}$$

## THREE – DURATION

### Duration Testing

The turbine was observed during the visits at wind speeds between approximately 5 and 12 m/s for approximately 1,5 hours. During these observations no abnormal behavior was observed. Personnel have also reported no that noticeable oscillations had occurred during the test period.

Test start time: January 29 - 2007

Test end time: March 31 - 2008

Tower: 10-meter mono-pole

	TEST REQUIREMENT	RESULTS	PASS/FAIL
Operation	Minimum of 6 months operation	14 months	Pass
	2500 hours of power production at any wind velocity	3350 hours	Pass
	Power production at $1,2 * V_{ave}$ ( $1,2 * 8,5$ m/s = 10,2 m/s) (Min 250 hours)	473 hours	Pass
	Power production at $1,8 * V_{ave}$ ( $1,8 * 8,5$ m/s = 15,3 m/s) (Min 25 hours)	26,5 hours	Pass
Reliability	Operational time fraction of at least 90%	90,8%	Pass
	No major failure of the wind turbine occurred during test	Wind turbine was operational at end of test	Pass

The RF Radio Frequency (RF) board which communicates data from the wind turbine to a computer failed during the test. Because it was not material to the performance and operation of the wind turbine it was not considered material. The RF board was referred as a “RV-Board” in the duration report.

### REFERENCE REPORTS:

- 1) **Power & Performance Test:** Report WT 7650/09 Tested near Wilhelm-Koog/Germany at the Windtest laboratory – November 2009
  
- 2) **Acoustics Test:** Report WT 7727/09 – Tested near Kaiser-Wilhelm-Koog/Germany at the Windtest laboratory – December 2009
  
- 3) **Duration Test:** Report WT 6534/08 – Tested in Bushland, Texas at the USDA laboratories – observed by Windtest - May 2008

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