

ANNEXE E

COURBES D'ÉMISSION ACOUSTIQUE DES ÉOLIENNES

CONSIDÉRÉES

**Estimated
Sound Power Level
of the
ENERCON E-92
Operational Mode I
(Data Sheet)**

Imprint

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Revision

Revision: 1.1

Department: ENERCON GmbH / Site Assessment

Glossary

WEC means an ENERCON wind energy converter.

WECs means more than one ENERCON wind energy converter.

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Estimated Sound Power Level for the E-92 with 2.3 MW rated power

in relation to standardized wind speed v_s at 10 m height					
hub height v_s in 10 m height	85	98 m	104 m	108 m	138 m
5 m/s	99,5 dB(A)	99,9 dB(A)	100,0 dB(A)	100,1 dB(A)	100,5 dB(A)
6 m/s	102,0 dB(A)	102,2 dB(A)	102,2 dB(A)	102,3 dB(A)	102,6 dB(A)
7 m/s	103,3 dB(A)	103,4 dB(A)	103,5 dB(A)	103,5 dB(A)	103,7 dB(A)
8 m/s	104,2 dB(A)	104,4 dB(A)	104,4 dB(A)	104,5 dB(A)	104,7 dB(A)
9 m/s	105,0 dB(A)	105,0 dB(A)	105,0 dB(A)	105,0 dB(A)	105,0 dB(A)
10 m/s	105,0 dB(A)	105,0 dB(A)	105,0 dB(A)	105,0 dB(A)	105,0 dB(A)
95% rated power	105,0 dB(A)	105,0 dB(A)	105,0 dB(A)	105,0 dB(A)	105,0 dB(A)

in relation to wind speed at hub height									
wind speed at hub height (m/s)	7	8	9	10	11	12	13	14	15
Sound Power Level [dB(A)]	99,5	101,4	102,5	103,6	104,1	104,6	105,0	105,0	105,0

- The relation between the estimated sound power level and the standardized wind speed v_s in 10 m height as shown above is valid on the premise of a logarithmic wind profile with a roughness length of 0.05 m. The relation between the estimated sound power level and the wind speed at hub height applies for all hub heights. During the sound measurements the wind speeds are derived from the power output and the power curve of the WEC.
- A tonal audibility of $\Delta L_{A,k} \leq 2$ dB can be expected over the whole operational range (valid in the near vicinity of the turbine according to IEC 61400-11 ed. 2).
- The estimated sound power level values given in the table are valid for the **Operational Mode I**. The respective power curve is the calculated power curve E-92 dated November 2011 (Rev. 1.x).
- Due to the typical measurement uncertainties, if the sound power level is measured according to one of the accepted methods the measured values can differ from the values shown in this document in the range of ± 1 dB.

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Accepted measurement methods are:

- a) IEC 61400-11 ed. 2 („Wind turbine generator systems – Part 11: Acoustic noise measurement techniques; Second edition, 2002-12”), and
- b) the FGW-Guidelines („Technische Richtlinie für Windenergieanlagen – Teil 1: Bestimmung der Schallemissionswerte”, published by the association “Fördergesellschaft für Windenergie e.V.”, 18th revision).

If the difference between total noise and background noise during a measurement is less than 6 dB a higher uncertainty must be considered.

5. For noise-sensitive sites it is possible to operate the E-92 with reduced rotational speed and reduced rated power during night time. The sound power levels resulting from such operational mode can be provided in a separate document upon request.
6. The sound power level of a wind turbine depends on several factors such as but not limited to regular maintenance and day-to-day operation in compliance with the manufacturer's operating instructions. Therefore, this data sheet can not, and is not intended to, constitute an express or implied warranty towards the customer that the E-92 WEC will meet the exact sound power level values as shown in this document at any project specific site.

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Sound Power Level of the ENERCON E-92 Reduced Modes (Data Sheet)

Imprint

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Revision

Revision: 1.1

Department: ENERCON GmbH / Site Assessment

Glossary

WEC means an ENERCON wind energy converter.

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Sound Power Level for the E-92 with reduced rated power

Sound Power Levels for the E-92 with reduced rated power					
	$P_{N,red}=2000 \text{ kW}$ $n_{N,red}=$	$P_{N,red}=1600 \text{ kW}$ $n_{N,red}=$	$P_{N,red}=1400 \text{ kW}$ $n_{N,red}=$	$P_{N,red}=1200 \text{ kW}$ $n_{N,red}=$	$P_{N,red}=1000 \text{ kW}$ $n_{N,red}=$
95% rated power	104,0 dB(A)	103,5 dB(A)	103,0 dB(A)	102,5 dB(A)	100,0 dB(A)

 Measured value at
95% rated power

- The respective SPL is given for 95% $P_{N,red}$ and is therefore valid for all hub heights.
- A tonal audibility of $\Delta L_{a,k} < 2 \text{ dB}$ can be expected over the whole operational range (valid in the near vicinity of the turbine according to IEC 61 400 -11 ed. 2).
- The sound power level values given in the table are valid for the respective reduced Modes (defined via the reduced rated power $P_{N,red}$ and the reduced rated rotational speed $n_{N,red}$).
- The power curves for the respective reduced modes are given in a separate document which can be made available upon request.
- The values displayed in the tables above are based on official and internal measurements of the sound power level. If official measured values are available they are given in this document as a reference (in italic print). The extracts of the official measurements can be made available upon request. The values given in the measurement extracts do not replace the values given in this document. All measurements have been carried out according to the recommended German and international standards and guidelines as defined in the measurement reports, respectively.
- Due to the typical measurement uncertainties, if the sound power level is measured according to one of the accepted methods the measured values can differ from the values shown in this document in the range of +/- 1 dB.
Accepted measurement methods are:
 a) IEC 61400-11 ed. 2 („Wind turbine generator systems – Part 11: Acoustic noise measurement techniques; Second edition, 2002-12”), and
 b) the FGW-Guidelines („Technische Richtlinie für Windenergieanlagen – Teil 1: Bestimmung der Schallemissionswerte”, published by the association “Fördergesellschaft für Windenergie e.V.”, 18th revision).
 If the difference between total noise and background noise during a measurement is less than 6 dB a higher uncertainty must be considered.
- Estimated Sound Power values for further reduced modes can be provided upon request.
- The sound power level of a wind turbine depends on several factors such as but not limited to regular maintenance and day-to-day operation in compliance with the manufacturer's operating instructions. Therefore, this data sheet can not, and is not intended to, constitute an express or implied warranty towards the customer that the E-92 WEC will meet the exact sound power level values as shown in this document at any project specific site.

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Revision /date:	1.1 June 2012		

**Preliminary
Power Curve &
Sound Power Level
REpower MM100
[50Hz/2MW]**

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Applicable documents

The documents referred to in the table below are included for information only. Reference to them in this product description does not make them part of the contract.

Title	Document no.

* If the products referred to in the table above are to be included within the project, the relevant product descriptions in their current version will be amended to the contract.

List of abbreviations and units

Abbreviation/Unit	Description
cp	Power coefficient
ct	Thrust coefficient
IEC	International Electrotechnical Commission
WEC	Wind Energy Converter

1 Introduction

This document shows the guaranteed power curve and sound power level of the REpower MM100 and the corresponding guarantee and measurement conditions.

2 Conditions for guarantee and measurement of power curve and sound power level

2.1 General information

Rotor diameter:	100.0 m
Air density:	1.225 kg/m ³
Cut in wind speed:	approx. 3.0 m/s
Cut out wind speed:	22.0 m/s
Wind speed at hub height:	10 minutes mean values
Blades:	clean, no ice/snow formation

2.2 Conditions for power curve guarantee and measurement

Verification according to IEC 61400-12-1: 2005^{1,2}

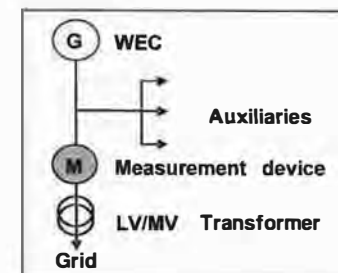
Turbulence intensity:	6 to 12 %
Terrain:	not complex according to IEC 61400-12-1: 2005 ¹
Vertical wind shear coefficient (measured between hub height and hub height minus rotor diameter divided by 2):	≤ 0.3
Air density at location (10 minutes mean value):	≥ 1.13 kg/m ³
Temperature range:	acc. to related Standard Conditions of use
Anemometer type:	Thies First Class/ Thies First Class Advanced
Voltage level for measurement:	690 V (50Hz)

¹ For obstacle assessment according to 61400-12-1: 2005 Annex A 2 the following condition applies:

To determine significant obstacles the procedure "Power Performance Measurement Procedure – Version 5, December 2009" chapter 3.9 has to be followed.

In addition no obstacles with a height greater than 1/3 of the distance between the ground and the lower blade tip shall exist in the measurement sector within 0-4 rotor diameters of the WEC or met mast.

² Valid for active power set points



Arrangement of a measuring unit for the power curve measurement of a REpower MM100

2.3 Conditions for sound power level guarantee and measurement

Verification according to IEC 61400-11: 2002 + A1: 2006³

Roughness length (average peak):	0.05 m
----------------------------------	--------

³ Method 1, as outlined in section 7.3 of the IEC standard 61400-11

3 Guaranteed electrical power curve and guaranteed sound power level⁴

The sound power level guaranteed by REpower includes an uncertainty of approx. 1 dB(A). REpower warrants that there is no tonal audibility > 0 dB.⁵

3.1 Guarantees according to IEC for wind speed at hub height

Wind speed v [m/s] ⁶	Power P [kW] ⁷	Sound power level L_{WA} [dB(A)] ⁸	Thrust coefficient ct [-]	Power coefficient cp [-]
3.0	20	-	1.01	0.154
4.0	102	-	0.85	0.331
5.0	239	-	0.80	0.397
6.0	452	98.8	0.80	0.435
7.0	746	102.5	0.80	0.452
8.0	1126	103.7	0.78	0.457
9.0	1559	104.4	0.71	0.444
10.0	1901	104.8	0.59	0.395
11.0	2000	104.8	0.45	0.312
12.0	2000	104.8	0.34	0.241
13.0	2000	104.8	0.25	0.189
14.0	2000	104.8	0.20	0.151
15.0	2000	104.8	0.16	0.123
16.0	2000	104.8	0.13	0.101
17.0	2000	104.8	0.11	0.085
18.0	2000	104.8	0.09	0.071
19.0	2000	104.8	0.08	0.061
20.0	2000	104.8	0.07	0.052
21.0	2000	104.8	0.06	0.045
22.0	2000	104.8	0.05	0.039

⁴ Valid for unrestricted operation only. During sound reduced operation different power and sound levels are effective.

⁵ Valid for $V_{10} \geq 6$ m/s.

⁶ A cut-out at 22 m/s as a 10 min average is equivalent to a 100 s average cut-out at 24 m/s.

⁷ Guaranteed on 690 V voltage level (for 50Hz).

⁸ Sound power level at hub height.

3.2 Sound power level guarantee according to IEC for wind speed at 10 m height

HH	v_{10} [m/s]	4.0	5.0	6.0	7.0	8.0	9.0	10.0
98.0 - 100.0 m	L_{WA} [dB(A)]	97.8	102.7	104.2	104.8	104.8	104.8	104.8

All sound power levels above are based on wind speeds of v_{10} at 10 m height. The data of the noise level are based on the requirements of the IEC 61400-11: 2002 + A1: 2006.

The calculation of the wind speed in 10 m height is based on a roughness length of 0.05 m.

**Power Curve &
Sound Power Level
Sound Management I
99.5 dB (A)
[MM100/50Hz]**

Preliminary Version

*Preliminary Power Curve & Sound Power Level
Sound Management I 99.5 dB(A) [MM100/50Hz]
Do not use as appendix to contract*

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Applicable documents

The documents referred to in the table below are included for information only. Reference to them in this product description does not make them part of the contract.

Title	Document no.
Product Description Sound Management I	PD-2.5-WT.PO.01-D-*

* If the products referred to in the table above are to be included within the project, the relevant product descriptions in their current version will be amended to the contract.

List of abbreviations and units

Abbreviation/Unit	Description
cp	Power coefficient
ct	Thrust coefficient
IEC	International Electrotechnical Commission
TI	Turbulence intensity
WEC	Wind Energy Converter

1 Introduction

This document is intended to provide information only and therefore acts only as a preliminary non-committal guide. All values mentioned below can be subject to change based on subsequent calculations or measurements. No rights and obligations of any nature whatever can be derived from the general information given in this document. REpower is not responsible for any claims in conjunction with this information

This document shows the preliminary power curve and the preliminary sound power level of the *REpower Sound Management I 99.5 dB (A) [MM100/50Hz]* and the corresponding guarantee and measurement conditions.

2 Conditions for guarantee and measurement of power curve and sound power level

2.1 General information

Rotor diameter:	100.0 m
Air density:	1.00, 1.02, 1.04, 1.06, 1.08, 1.10, 1.12, 1.14, 1.16, 1.18, 1.20, 1.22, 1.24, 1.26, 1.225, 1.27 kg/m ³
Cut in wind speed:	approx. 3.0 m/s
Cut out wind speed:	22.0 m/s
Wind speed at hub height:	10 minutes mean values
Blades:	clean, no ice/snow formation

2.2 Conditions for power curve guarantee and measurement

Verification according to IEC 61400-12-1: 2005^{1,2}

Turbulence intensity:	$6\% \leq T_i \leq 12\%$, $12\% < T_i \leq 18\%$
Terrain:	not complex according to IEC 61400-12-1: 2005 ¹

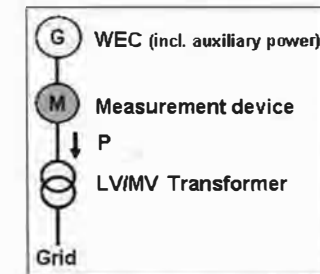
¹ For obstacle assessment according to 61400-12-1: 2005 Annex A.2 the following condition applies:

To determine significant obstacles the procedure "Power Performance Measurement Procedure – Version 5, December 2009" chapter 3.9 has to be followed.

In addition no obstacles with a height greater than 1/3 of the distance between the ground and the lower blade tip shall exist in the measurement sector within 0-4 rotor diameters of the WEC or met mast.

² Valid for active power set points.

Vertical wind shear coefficient (measured between hub height and hub height minus rotor diameter divided by 2):	≤ 0.3
Air density at location (10 minutes mean value):	$\geq 1.13 \text{ kg/m}^3$
Temperature range:	acc. to related Standard Conditions of Use
Anemometer type:	Thies First Class/ Thies First Class Advanced
Voltage level for measurement:	690 V (50Hz)



Arrangement of a measuring unit for the power curve measurement of a *REpower MM100*

2.3 Conditions for sound power level guarantee and measurement

Verification according to IEC 61400-11: 2002 + A1: 2006³

Roughness length (average peak):	0.05 m
----------------------------------	--------

³ Method 1, as outlined in section 7.3 of the IEC standard 61400-11

3 Preliminary electrical power curve and sound power level⁴

The sound power level guaranteed by REpower includes an uncertainty of approx. 1 dB (A).

REpower warrants that there is no tonal audibility > 0 dB.⁵

3.1 Guarantees acc. to IEC for wind speed at hub height dependent on the turbulence intensities

Wind speed v [m/s] ⁶	Power P [kW] at turbulence intensities $6\% \leq T \leq 12\%$ ⁷	Power P [kW] at turbulence intensities $12\% < T \leq 18\%$ ⁷	Sound power level L_{WA} [dB(A)] ⁸	Thrust coefficient c_t [-] at turbulence intensities $6\% \leq T \leq 18\%$	Power coefficient c_p [-] at turbulence intensities $6\% \leq T \leq 12\%$	Power coefficient c_p [-] at turbulence intensities $12\% < T \leq 18\%$
3.0	20	22	-	1.01	0.154	0.169
4.0	102	104	-	0.85	0.331	0.338
5.0	239	242	-	0.80	0.397	0.402
6.0	452	458	98.8	0.80	0.435	0.441
7.0	725	726	99.5	0.75	0.439	0.440
8.0	1013	1009	99.5	0.63	0.411	0.409
9.0	1235	1181	99.5	0.52	0.352	0.337
10.0	1330	1292	99.5	0.38	0.276	0.268
11.0	1330	1323	99.5	0.28	0.208	0.207
12.0	1330	1330	99.5	0.22	0.160	0.160
13.0	1330	1330	99.5	0.16	0.126	0.126
14.0	1330	1330	99.5	0.13	0.101	0.101
15.0	1330	1330	99.5	0.10	0.082	0.082
16.0	1330	1330	99.5	0.09	0.067	0.067
17.0	1330	1330	99.5	0.07	0.056	0.056
18.0	1330	1330	99.5	0.06	0.047	0.047
19.0	1330	1330	99.5	0.05	0.040	0.040
20.0	1330	1330	99.5	0.05	0.035	0.035
21.0	1330	1330	99.5	0.04	0.030	0.030
22.0	1330	1330	99.5	0.04	0.026	0.026

Table 1: Values are related to an air density of 1.225 kg/m³.

⁴ Valid for Sound Management I 99.5 dB (A) only, During sound reduced operation different power and sound levels are effective.

⁵ Valid for $V_{10} \geq 6$ m/s.

⁶ A cut-out at 22 m/s as a 10 min average is equivalent to a 100 s average cut-out at 24 m/s.

⁷ Guaranteed on 690 V voltage level (for 50Hz)

⁸ Sound power level at hub height

3.2 Guarantees acc. to IEC for wind speed at hub height dependent on air densities

Wind speed v [m/s]	Air density [kg/m ³]															
	1.00	1.02	1.04	1.06	1.08	1.10	1.12	1.14	1.16	1.18	1.20	1.22	1.24	1.26	1.27	
	Power P [kW]															
3.0	11	12	13	14	14	15	16	17	18	18	19	20	21	21	22	
4.0	77	80	82	84	86	88	91	93	95	97	99	101	104	106	107	
5.0	189	193	198	202	207	211	215	220	224	229	233	238	242	247	249	
6.0	361	369	377	385	394	402	410	418	426	434	442	450	458	466	470	
7.0	585	598	610	623	635	648	660	673	685	698	710	722	735	747	754	
8.0	823	841	858	875	892	909	926	942	959	976	993	1009	1025	1041	1049	
9.0	1049	1069	1090	1111	1128	1146	1163	1178	1193	1209	1220	1232	1244	1257	1264	
10.0	1236	1251	1265	1280	1289	1297	1306	1311	1317	1322	1326	1329	1330	1330	1330	
11.0	1321	1324	1327	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	
12.0	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	
13.0 – Cut out	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	

Table 2: Values are related to a turbulence intensity of $6\% \leq T \leq 12\%$.

3.3 Guarantees acc. to IEC for wind speed at hub height dependent on air densities

Wind speed v [m/s]	Air density [kg/m ³]														
	1.00	1.02	1.04	1.06	1.08	1.10	1.12	1.14	1.16	1.18	1.20	1.22	1.24	1.26	1.27
	Power P [kW]														
3.0	14	15	16	16	17	18	19	20	20	21	22	22	23	24	25
4.0	78	80	82	84	87	89	91	93	95	97	101	104	105	107	107
5.0	189	194	198	203	207	212	216	221	225	230	235	240	244	248	250
6.0	366	374	382	390	398	407	415	423	431	439	448	456	464	472	476
7.0	592	604	617	629	642	655	667	680	692	705	714	724	738	753	761
8.0	827	844	861	878	895	912	929	945	960	976	991	1005	1019	1033	1040
9.0	1011	1030	1049	1067	1084	1100	1116	1129	1142	1155	1166	1178	1188	1198	1203
10.0	1197	1210	1223	1236	1245	1254	1262	1269	1275	1282	1286	1291	1295	1299	1301
11.0	1282	1289	1295	1302	1305	1309	1313	1315	1317	1319	1321	1323	1325	1326	1327
12.0	1307	1310	1313	1316	1318	1320	1322	1323	1325	1326	1327	1328	1329	1330	1330
13.0 – Cut out	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330

Table 3: Values are related to a turbulence intensity of 12%<Ti≤18%.

3.4 Sound power level guarantee according to IEC for wind speed at 10 m height

HH	v ₁₀ [m/s]	4.0	5.0	6.0	7.0	8.0	9.0	10.0
98.0 - 100.0 m	L _{WA} [dB(A)]	97.8	99.5	99.5	99.5	99.5	99.5	99.5

All sound power levels above are based on wind speeds of v₁₀ at 10 m height. The data of the noise level are based on the requirements of the IEC 61400-11: 2002 + A1: 2006. The calculation of the wind speed in 10 m height is based on a roughness length of 0.05 m.

**Power Curve &
Sound Power Level
Sound Management I
101.5 dB (A)
[MM100/50Hz]
Preliminary Version**

Preliminary Power Curve & Sound Power Level
Sound Management I 101.5 dB(A) [MM100/50Hz]
Do not use as appendix to contract

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Applicable documents

The documents referred to in the table below are included for information only. Reference to them in this product description does not make them part of the contract.

Title	Document no.
Product Description Sound Management I	PD-2.5-WT.PO.01-D-*

* If the products referred to in the table above are to be included within the project, the relevant product descriptions in their current version will be amended to the contract.

List of abbreviations and units

Abbreviation/Unit	Description
cp	Power coefficient
ct	Thrust coefficient
IEC	International Electrotechnical Commission
Ti	Turbulence intensity
WEC	Wind Energy Converter

1 Introduction

This document is intended to provide information only and therefore acts only as a preliminary non-committal guide. All values mentioned below can be subject to change based on subsequent calculations or measurements. No rights and obligations of any nature whatever can be derived from the general information given in this document. REpower is not responsible for any claims in conjunction with this information

This document shows the preliminary power curve and the preliminary sound power level of the *REpower Sound Management I 101.5 dB (A) [MM100/50Hz]* and the corresponding guarantee and measurement conditions.

2 Conditions for guarantee and measurement of power curve and sound power level

2.1 General information

Rotor diameter:	100.0 m
Air density:	1.00, 1.02, 1.04, 1.06, 1.08, 1.10, 1.12, 1.14, 1.16, 1.18, 1.20, 1.22, 1.24, 1.26, 1.225, 1.27 kg/m³
Cut in wind speed:	approx. 3.0 m/s
Cut out wind speed:	22.0 m/s
Wind speed at hub height:	10 minutes mean values
Blades:	clean, no ice/snow formation

2.2 Conditions for power curve guarantee and measurement

Verification according to IEC 61400-12-1: 2005^{1,2}

Turbulence intensity:	$6\% \leq T_i \leq 12\%$, $12\% < T_i \leq 18\%$
Terrain:	not complex according to IEC 61400-12-1: 2005 ¹

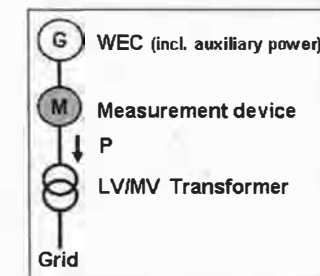
¹ For obstacle assessment according to 61400-12-1: 2005 Annex A.2 the following condition applies:

To determine significant obstacles the procedure "Power Performance Measurement Procedure – Version 5, December 2009" chapter 3.9 has to be followed.

In addition no obstacles with a height greater than 1/3 of the distance between the ground and the lower blade tip shall exist in the measurement sector within 0-4 rotor diameters of the WEC or met mast.

² Valid for active power set points

Vertical wind shear coefficient (measured between hub height and hub height minus rotor diameter divided by 2):	≤ 0.3
Air density at location (10 minutes mean value):	$\geq 1.13 \text{ kg/m}^3$
Temperature range:	acc. to related Standard Conditions of Use
Anemometer type:	Thies First Class/ Thies First Class Advanced
Voltage level for measurement:	690 V (50Hz)



Arrangement of a measuring unit for the power curve measurement of a *REpower MM100*

2.3 Conditions for sound power level guarantee and measurement

Verification according to IEC 61400-11: 2002 + A1: 2006³

Roughness length (average peak):	0.05 m
----------------------------------	--------

³ Method 1, as outlined in section 7.3 of the IEC standard 61400-11

3 Preliminary electrical power curve and sound power level⁴

The sound power level guaranteed by REpower includes an uncertainty of approx. 1 dB (A).
REpower warrants that there is no tonal audibility > 0 dB.⁵

3.1 Guarantees acc. to IEC for wind speed at hub height dependent on the turbulence intensities

Wind speed v [m/s] ⁶	Power P [kW] at turbulence intensities $6\% \leq T_i \leq 12\%$ ⁷	Power P [kW] at turbulence intensities $12\% < T_i \leq 18\%$ ⁷	Sound power level L_{WA} [dB(A)] ⁸	Thrust coefficient c_t [-] at turbulence intensities $6\% \leq T_i \leq 18\%$	Power coefficient c_p [-] at turbulence intensities $6\% \leq T_i \leq 12\%$	Power coefficient c_p [-] at turbulence intensities $12\% < T_i \leq 18\%$
3.0	20	22	-	1.01	0.154	0.169
4.0	102	104	-	0.85	0.331	0.338
5.0	239	242	-	0.80	0.397	0.402
6.0	452	458	98.8	0.80	0.435	0.441
7.0	746	766	101.5	0.80	0.452	0.464
8.0	1078	1082	101.5	0.76	0.437	0.439
9.0	1374	1314	101.5	0.66	0.392	0.375
10.0	1532	1485	101.5	0.53	0.318	0.309
11.0	1550	1536	101.5	0.39	0.242	0.240
12.0	1550	1546	101.5	0.30	0.186	0.186
13.0	1550	1550	101.5	0.19	0.147	0.147
14.0	1550	1550	101.5	0.15	0.117	0.117
15.0	1550	1550	101.5	0.12	0.095	0.095
16.0	1550	1550	101.5	0.10	0.079	0.079
17.0	1550	1550	101.5	0.09	0.066	0.066
18.0	1550	1550	101.5	0.07	0.055	0.055
19.0	1550	1550	101.5	0.06	0.047	0.047
20.0	1550	1550	101.5	0.06	0.040	0.040
21.0	1550	1550	101.5	0.05	0.035	0.035
22.0	1550	1550	101.5	0.04	0.030	0.030

Table 1: Values are related to an air density of 1.225 kg/m³.

⁴ Valid for Sound Management I 101.5 dB (A) only. During sound reduced operation different power and sound levels are effective.

⁵ Valid for $V_{10} \geq 6$ m/s.

⁶ A cut-out at 22 m/s as a 10 min average is equivalent to a 100 s average cut-out at 24 m/s.

⁷ Guaranteed on 690 V voltage level (for 50Hz)

⁸ Sound power level at hub height

3.2 Guarantees acc. to IEC for wind speed at hub height dependent on air densities

Wind speed v [m/s]	Air density [kg/m ³]															
	1.00	1.02	1.04	1.06	1.08	1.10	1.12	1.14	1.16	1.18	1.20	1.22	1.24	1.26	1.27	
Power P [kW]																
3.0	11	12	13	14	14	15	16	17	18	18	19	20	21	21	22	
4.0	77	80	82	84	86	88	91	93	95	97	99	101	104	106	107	
5.0	189	193	198	202	207	211	215	220	224	229	233	238	242	247	249	
6.0	361	369	377	385	394	402	410	418	426	434	442	450	458	466	470	
7.0	602	615	628	640	653	666	679	692	705	717	730	743	756	768	775	
8.0	876	894	912	930	948	966	984	1002	1020	1038	1056	1073	1091	1109	1118	
9.0	1158	1180	1202	1224	1245	1266	1287	1306	1324	1342	1356	1370	1388	1408	1418	
10.0	1421	1436	1451	1467	1484	1500	1517	1525	1534	1542	1537	1533	1538	1546	1550	
11.0	1535	1540	1544	1548	1549	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	
12.0	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	
13.0 – Cut out	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	

Table 2: Values are related to a turbulence intensity of $6\% \leq T_i \leq 12\%$.

3.3 Guarantees acc. to IEC for wind speed at hub height dependent on air densities

	Air density [kg/m³]														
	1.00	1.02	1.04	1.06	1.08	1.10	1.12	1.14	1.16	1.18	1.20	1.22	1.24	1.26	1.27
Wind speed v [m/s]	Power P [kW]														
3.0	14	15	16	16	17	18	19	20	20	21	22	22	23	24	25
4.0	78	80	82	84	87	89	91	93	95	97	101	104	105	107	107
5.0	189	194	198	203	207	212	216	221	225	230	235	240	244	248	250
6.0	366	374	382	390	398	407	415	423	431	439	448	456	464	472	476
7.0	618	631	644	657	671	684	697	710	723	736	749	762	775	789	795
8.0	885	903	922	940	958	976	994	1011	1028	1045	1062	1078	1094	1110	1118
9.0	1121	1141	1161	1181	1199	1218	1236	1251	1267	1282	1296	1310	1323	1336	1342
10.0	1374	1388	1402	1416	1426	1436	1446	1455	1463	1471	1477	1484	1489	1494	1497
11.0	1488	1494	1501	1508	1512	1517	1521	1524	1527	1530	1533	1535	1537	1539	1540
12.0	1520	1523	1526	1529	1531	1534	1536	1538	1540	1542	1544	1545	1547	1548	1549
13.0	1548	1549	1549	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550
14.0 – Cut out	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550

Table 3: Values are related to a turbulence intensity of 12% < Ti ≤ 18%.

3.4 Sound power level guarantee according to IEC for wind speed at 10 m height

HH	v ₁₀ [m/s]	4.0	5.0	6.0	7.0	8.0	9.0	10.0
98.0 - 100.0 m	L _{WA} [dB(A)]	97.8	101.5	101.5	101.5	101.5	101.5	101.5

All sound power levels above are based on wind speeds of v₁₀ at 10 m height. The data of the noise level are based on the requirements of the IEC 61400-11: 2002 + A1: 2006. The calculation of the wind speed in 10 m height is based on a roughness length of 0.05 m.

**Power Curve &
Sound Power Level
Sound Management I
103.0 dB (A)
[MM100/50Hz]
Preliminary Version**

Preliminary Power Curve & Sound Power Level
Sound Management I 103.0 dB(A) [MM100/50Hz]
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Applicable documents

The documents referred to in the table below are included for information only. Reference to them in this product description does not make them part of the contract.

Title	Document no.
Product Description Sound Management I	PD-2.5-WT.PO.01-D-*

13. If the products referred to in the table above are to be included within the project, the relevant product descriptions in their current version will be amended to the contract.

List of abbreviations and units

Abbreviation/Unit	Description
cp	Power coefficient
ct	Thrust coefficient
IEC	International Electrotechnical Commission
TI	Turbulence intensity
WEC	Wind Energy Converter

1 Introduction

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This document shows the preliminary power curve and the preliminary sound power level of the *REpower Sound Management I 103.0 dB (A) [MM100/50Hz]* and the corresponding guarantee and measurement conditions:

2 Conditions for guarantee and measurement of power curve and sound power level

2.1 General information

Rotor diameter:	100.0 m
Air density:	1.00, 1.02, 1.04, 1.06, 1.08, 1.10, 1.12, 1.14, 1.16, 1.18, 1.20, 1.22, 1.24, 1.26, 1.225, 1.27 kg/m ³
Cut in wind speed:	approx. 3.0 m/s
Cut out wind speed:	22.0 m/s
Wind speed at hub height:	10 minutes mean values
Blades:	clean, no ice/snow formation

2.2 Conditions for power curve guarantee and measurement

Verification according to IEC 61400-12-1: 2005^{1,2}

Turbulence intensity:	$6\% \leq T_i \leq 12\%$, $12\% < T_i \leq 18\%$
Terrain:	not complex according to IEC 61400-12-1: 2005 ¹

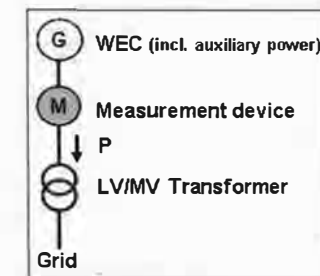
¹ For obstacle assessment according to 61400-12-1: 2005 Annex A.2 the following condition applies:

To determine significant obstacles the procedure "Power Performance Measurement Procedure – Version 5, December 2009" chapter 3.9 has to be followed.

In addition no obstacles with a height greater than 1/3 of the distance between the ground and the lower blade tip shall exist in the measurement sector within 0-4 rotor diameters of the WEC or met mast.

² Valid for active power set points.

Vertical wind shear coefficient (measured between hub height and hub height minus rotor diameter divided by 2):	≤ 0.3
Air density at location (10 minutes mean value):	$\geq 1.13 \text{ kg/m}^3$
Temperature range:	acc. To related Standard Conditions of Use
Anemometer type:	Thies First Class/ Thies First Class Advanced
Voltage level for measurement:	690 V (50Hz)



Arrangement of a measuring unit for the power curve measurement of a *REpower MM100*

2.3 Conditions for sound power level guarantee and measurement

Verification according to IEC 61400-11: 2002 + A1: 2006³

Roughness length (average peak):	0.05 m
----------------------------------	--------

³ Method 1, as outlined in section 7.3 of the IEC standard 61400-11

3 Preliminary electrical power curve and sound power level⁴

The sound power level guaranteed by REpower includes an uncertainty of approx. 1 dB (A).
REpower warrants that there is no tonal audibility > 0 dB.⁵

3.1 Guarantees acc. to IEC for wind speed at hub height dependent on the turbulence intensities

Wind speed v [m/s] ⁶	Power P [kW] at turbulence intensities $6\% \leq Ti \leq 12\%$ ⁷	Power P [kW] at turbulence intensities $12\% < Ti \leq 18\%$ ⁷	Sound power level L_{WA} [dB(A)] ⁸	Thrust coefficient c_t [-] at turbulence intensities $6\% \leq Ti \leq 18\%$	Power coefficient c_p [-] at turbulence intensities $6\% \leq Ti \leq 12\%$	Power coefficient c_p [-] at turbulence intensities $12\% < Ti \leq 18\%$
3.0	20	22	-	1.01	0.154	0.169
4.0	102	104	-	0.85	0.331	0.338
5.0	239	242	-	0.80	0.397	0.402
6.0	452	458	98.8	0.80	0.435	0.441
7.0	746	766	102.5	0.80	0.452	0.464
8.0	1101	1120	103.0	0.76	0.447	0.455
9.0	1478	1416	103.0	0.66	0.421	0.404
10.0	1752	1691	103.0	0.53	0.364	0.351
11.0	1825	1787	103.0	0.39	0.285	0.279
12.0	1825	1809	103.0	0.30	0.219	0.218
13.0	1825	1825	103.0	0.21	0.173	0.173
14.0	1825	1825	103.0	0.17	0.138	0.138
15.0	1825	1825	103.0	0.14	0.112	0.112
16.0	1825	1825	103.0	0.12	0.093	0.093
17.0	1825	1825	103.0	0.10	0.077	0.077
18.0	1825	1825	103.0	0.08	0.065	0.065
19.0	1825	1825	103.0	0.07	0.055	0.055
20.0	1825	1825	103.0	0.06	0.047	0.047
21.0	1825	1825	103.0	0.05	0.041	0.041
22.0	1825	1825	103.0	0.05	0.036	0.036

Table 1: Values are related to an air density of 1.225 kg/m³.

⁴ Valid for Sound Management I 103.0 dB (A) only. During sound reduced operation different power and sound levels are effective.

⁵ Valid for $V_{10} \geq 6$ m/s.

⁶ A cut-out at 22 m/s as a 10 min average is equivalent to a 100 s average cut-out at 24 m/s.

⁷ Guaranteed on 690 V voltage level (for 50Hz)

⁸ Sound power level at hub height

3.2 Guarantees acc. to IEC for wind speed at hub height dependent on air densities

Wind speed v [m/s]	Air density [kg/m ³]															
	1.00	1.02	1.04	1.06	1.08	1.10	1.12	1.14	1.16	1.18	1.20	1.22	1.24	1.26	1.27	
Power P [kW]	11	12	13	14	14	15	16	17	18	18	19	20	21	21	22	
3.0	77	80	82	84	86	88	91	93	95	97	99	101	104	106	107	
4.0	189	193	198	202	207	211	215	220	224	229	233	238	242	247	249	
5.0	361	369	377	385	394	402	410	418	426	434	442	450	458	466	470	
6.0	602	615	628	640	653	666	679	692	705	717	730	743	756	768	775	
7.0	895	914	932	951	969	987	1006	1024	1042	1061	1079	1097	1115	1134	1143	
8.0	1217	1242	1266	1291	1315	1339	1364	1366	1408	1431	1452	1473	1493	1513	1522	
9.0	1551	1575	1600	1624	1643	1663	1682	1697	1712	1726	1738	1750	1759	1769	1774	
10.0	1764	1774	1783	1793	1799	1805	1811	1815	1819	1823	1824	1825	1825	1825	1825	
11.0	1819	1821	1823	1825	1825	1825	1825	1825	1825	1825	1825	1825	1825	1825	1825	
12.0	1819	1821	1823	1825	1825	1825	1825	1825	1825	1825	1825	1825	1825	1825	1825	
13.0 – Cut out	1825	1825	1825	1825	1825	1825	1825	1825	1825	1825	1825	1825	1825	1825	1825	

Table 2: Values are related to a turbulence intensity of $6\% \leq Ti \leq 12\%$.

3.3 Guarantees acc. to IEC for wind speed at hub height dependent on air densities

		Air density [kg/m³]														
		1.00	1.02	1.04	1.06	1.08	1.10	1.12	1.14	1.16	1.18	1.20	1.22	1.24	1.26	1.27
Wind speed v [m/s]	Power P [kW]															
3.0	14	15	16	16	17	18	19	20	20	21	22	22	23	24	25	
4.0	78	80	82	84	87	89	91	93	95	97	101	104	105	107	107	
5.0	189	194	198	203	207	212	216	221	225	230	235	240	244	248	250	
6.0	366	374	382	390	398	407	415	423	431	439	448	456	464	472	476	
7.0	618	631	644	657	671	684	697	710	723	736	749	762	775	789	795	
8.0	909	928	947	966	984	1003	1022	1041	1059	1078	1097	1116	1134	1152	1161	
9.0	1183	1204	1226	1248	1269	1290	1311	1332	1352	1373	1392	1411	1430	1448	1457	
10.0	1518	1538	1558	1577	1594	1610	1627	1640	1653	1666	1677	1688	1698	1707	1712	
11.0	1699	1711	1723	1735	1743	1751	1759	1765	1771	1777	1781	1785	1789	1793	1795	
12.0	1768	1773	1778	1784	1787	1791	1795	1798	1801	1803	1806	1808	1810	1812	1814	
13.0	1808	1812	1815	1819	1822	1825	1828	1827	1826	1825	1825	1825	1825	1825	1825	
14.0 – Cut	1825	1825	1825	1825	1825	1825	1825	1825	1825	1825	1825	1825	1825	1825	1825	

Table 3: Values are related to a turbulence intensity of 12%<Ti≤18%.

3.4 Sound power level guarantee according to IEC for wind speed at 10 m height

HH	v ₁₀ [m/s]	4.0	5.0	6.0	7.0	8.0	9.0	10.0
98.0 - 100.0 m	L _{WA} [dB(A)]	97.8	102.7	103.0	103.0	103.0	103.0	103.0

All sound power levels above are based on wind speeds of v₁₀ at 10 m height. The data of the noise level are based on the requirements of the IEC 61400-11: 2002 + A1: 2006. The calculation of the wind speed in 10 m height is based on a roughness length of 0.05 m.

**Power Curve &
Sound Power Level
REpower 3.2M114
[3.2M/114/50Hz]**

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Applicable Documents

The following documents are mentioned within this document without being subject matter of this product description.

Title	Document no.

* Depending on the project specific selection of REpower products the respective documents will appear in each case as separate amendments of the contract in their actual version.

List of Abbreviations and Units

Abbreviation/Unit	Description
cP	Power coefficient
cT	Thrust coefficient
FGW	Fördergesellschaft Windenergie e.V.
IEC	International Electrotechnical Commission
WEC	Wind Energy Converter (equal to Wind Turbine Generator System [WTGS])

1 Introduction

This document shows the guaranteed power curve and sound power level of the *REpower 3.2M114* and the corresponding guarantee and measurement conditions.

2 Conditions for guarantee and measurement of power curve and sound power level

2.1 General information

Rotor diameter:	114.0 m
Air density:	1.225 kg/m ³
Cut in wind speed:	approx. 3.0 m/s
Cut out wind speed:	22.0 m/s
Wind speed at hub height:	10 minutes mean values
Blades:	clean, no ice/snow formation

2.2 Conditions for power curve guarantee and measurement

Verification according to IEC 61400-12-1: 2005^{1,2}

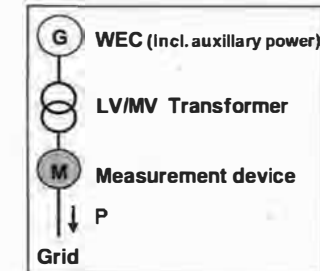
Turbulence intensity:	6 to 12 %
Terrain:	not complex according to IEC 61400-12-1: 2005 ¹
Vertical wind shear coefficient (measured between hub height and hub height minus rotor diameter divided by 2):	≤ 0.3
Air density at location (10 minutes mean value):	≥ 1.13 kg/m ³
Temperature range:	acc. to related Standard Conditions of use
Anemometer type:	Thies First Class/ Thies First Class Advanced
Voltage level for measurement:	660 V / 950V V (50Hz)

¹ For obstacle assessment according to 61400-12-1: 2005 Annex A.2 the following condition applies:

To determine significant obstacles the procedure "Power Performance Measurement Procedure – Version 5, December 2009" chapter 3.9 has to be followed.

In addition no obstacles with a height greater than 1/3 of the distance between the ground and the lower blade tip shall exist in the measurement sector within 0.4 rotor diameters of the WEC or met mast.

² Valid for active power set points



Arrangement of a measuring unit for the power curve measurement of a *REpower 3.2M114*

2.3 Conditions for sound power level guarantee and measurement

Verification according to IEC 61400-11: 2002 + A1: 2006³

Roughness length (average peak): 0.05 m

³ Method 1, as outlined in section 7.3 of the IEC standard 61400-11

3 Guaranteed electrical power curve and sound power level⁴

The sound power level guaranteed by REpower includes a measurement uncertainty of approx. 1 dB(A). REpower warrants that there is no tonal audibility > 0 dB⁵.

The guaranteed electrical power curve of the REpower 3.2M114 is applicable at the medium-voltage side of the transformer and includes the transformer losses.

Wind speed	Power	Sound power level	Thrust coefficient	Power coefficient
v [m/s] ⁶	P [kW]	$L_{WA}[dB(A)]$ ⁷	c_T [-]	c_P [-]
3	18	-	1.05	0.107
4	144	-	0.85	0.360
5	319	-	0.80	0.408
6	590	99.4	0.80	0.437
7	969	102.2	0.80	0.452
8	1460	104.7	0.80	0.456
9	2017	105.2	0.72	0.443
10	2576	105.2	0.64	0.412
11	3009	105.2	0.57	0.362
12	3170	104.9	0.40	0.293
13	3170	104.8	0.30	0.231
14	3170	104.8	0.24	0.185
15	3170	104.8	0.19	0.150
16	3170	104.8	0.16	0.124
17	3170	104.8	0.13	0.103
18	3170	104.8	0.11	0.087
19	3170	104.8	0.10	0.074
20	3170	104.8	0.08	0.063
21	3170	104.8	0.07	0.055
22	3170	104.8	0.06	0.048

⁴ Valid for unrestricted operation only. During sound reduced operation modes different power and sound levels are effective.

⁵ Valid for $V_{10} \geq 6$ m/s

⁶ Wind speed at hub height

⁷ Sound power level at hub height

3.1 Sound Power Level according to IEC for different Hub Heights

HH*	V_{10}^8 [m/s]	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0
91-93m	L_{WA}^9 [dB(A)]	98.4	102.5	105.0	105.2	105.1	104.8	104.8	104.8
120-123m	L_{WA}^9 [dB(A)]	99.1	103.1	105.1	105.2	105.0	104.8	104.8	104.8
140-143m	L_{WA}^9 [dB(A)]	99.4	103.5	105.2	105.2	104.9	104.8	104.8	104.8

* Hub height depending on foundation design

All sound power levels above are based on wind speeds of v_{10} at 10 m height. The data of the noise level are based on the requirements of the IEC 61400-11 : 2002 + A1 : 2006
The calculation of the wind speed in 10m height is based on a roughness length of 0.05m.

3.2 Sound Power Level according to FGW Guideline at 95% of rated power

The sound power level measured according to the "Technische Richtlinie für Windenergieanlagen Teil 1: Rev. 18 der FGW" at 95% of the rated power is independent of the hub height:

$$L_{WA, 95\%} = 105.2 \text{ dB(A)}$$

⁸ Wind speed in a height of 10 meters

⁹ Sound power level at hub height

4 Calculated electrical power curve (for information only)

The calculated electrical power curve of the REpower 3.2M114 is a theoretical one which is applicable at the low-voltage side of the transformer and does not include the transformer losses. It has been derived from the guaranteed electrical power curve in chapter 2 using typical operation conditions of the electrical system. The calculated electrical power curve is for informative purposes only and is not content of the guaranteed electrical power curve.

The values of the calculated electrical power curve are a non-binding additional information. No rights or duties for REpower Systems SE result from the values given in this chapter. Legal claims against REpower Systems SE for any costs incurred and/or damages suffered (including direct, indirect, consequential damage or damages, as well as loss of income or profits) caused by the use or non-use of the information offered here or the use of erroneous or incomplete information are excluded.

Wind speed	Power	Thrust coefficient	Power coefficient
$v \text{ [m/s]}^{10}$	$P \text{ [kW]}$	$c_T \text{ [-]}$	$c_P \text{ [-]}$
3	27	1.05	0.160
4	151	0.85	0.377
5	327	0.80	0.418
6	598	0.80	0.443
7	978	0.80	0.456
8	1471	0.80	0.460
9	2031	0.72	0.446
10	2594	0.64	0.415
11	3033	0.57	0.364
12	3200	0.40	0.296
13	3200	0.30	0.233
14	3200	0.24	0.187
15	3200	0.19	0.152
16	3200	0.16	0.125
17	3200	0.13	0.104
18	3200	0.11	0.088
19	3200	0.10	0.075
20	3200	0.08	0.064
21	3200	0.07	0.055
22	3200	0.06	0.048

¹⁰ Wind speed at hub height

**Power Curve &
Sound Power Level
Sound Management I
99.5 dB(A)
[3.2M114/50Hz]
Preliminary Version**

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Applicable Documents

The documents referred to in the table below are included for information only. Reference to them in this product description does not make them part of the contract.

Titel	Dokumenten-Nr.
Product Description Sound Management I	PD-2.5-WT.PO.01-D-*

* If the products referred to in the table above are to be included within the project, the relevant product descriptions in their current version will be amended to the contract.

List of Abbreviations and Units

Abbreviation/Unit	Description
cp	Power coefficient
ct	Thrust coefficient
FGW	Fördergesellschaft Windenergie e.V.
IEC	International Electrotechnical Commission
WEC	Wind Energy Converter

1 Introduction

This document is intended to provide information only and therefore acts only as a preliminary non-committal guide. All values mentioned below can be subject to change based on subsequent calculations or measurements. No rights and obligations of any nature whatever can be derived from the general information given in this document. REpower is not responsible for any claims in conjunction with this information

This document shows the preliminary power curve and the preliminary sound power level of the *REpower Sound Management I 99.5 dB(A) [3.2M114/50Hz]* and the corresponding guarantee and measurement conditions.

2 Conditions for guarantee and measurement of power curve and sound power level

2.1 General information

Rotor diameter:	approx. 114 m
Air density:	1.225 kg/m ³
Cut in wind speed:	3.0 m/s
Cut out wind speed:	22 m/s
Wind speed at hub height:	10 minutes mean values
Blades:	clean, no ice/snow formation

2.2 Conditions for power curve guarantee and measurement

Verification according to IEC 61400-12-1: 2005^{1,2}

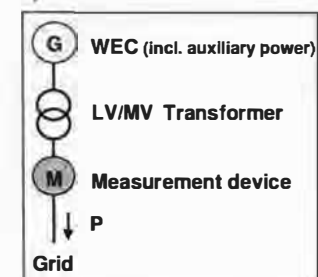
Turbulence intensity:	6 to 12 %
Terrain:	not complex according to IEC 61400-12-1: 2005 ¹
Vertical wind shear coefficient (measured between hub height and hub height minus rotor diameter divided by 2):	≤ 0.3

¹ For obstacle assessment according to 61400-12-1: 2005 Annex A.2 the following condition applies:

No obstacles with a height greater than 1/3 of the distance between the ground and the lower blade tip shall exist in the measurement sector within 0-4 rotor diameters of the wind turbine or met mast.

² Valid for active power set points

Air density at location (10 minutes mean value):	≥ 1.13kg/m ³
Temperature range:	≤ 35 °C
Anemometer type:	Thies First Class / Thies First Class Advanced
Voltage level for measurement:	660 V / 950V (50 Hz)



Arrangement of a measuring unit for the power curve measurement of a *REpower 3.2M114*

2.3 Conditions for sound power level guarantee and measurement

Verification according to IEC 61400-11: 2002 + A1: 2006³

Roughness length (average peak):	0.05 m
----------------------------------	--------

³ Method 1, as outlined in section 7.3 of the IEC standard 61400-11

3 Preliminary electrical power curve and sound power level⁴

The sound power level guaranteed by REpower includes a measurement uncertainty of approx. 1 dB(A). REpower warrants that there is no tonal audibility > 0 dB⁵.

3.1 Sound power level according to IEC for wind speed at hub height

Wind speed v [m/s]	Power P [kW] ⁶	Sound power level L_{WA} [dB(A)] ⁷	Thrust coefficient ct [-]	Power coefficient cp [-]
3.0	18	-	1.046	0.107
4.0	144	-	0.848	0.360
5.0	319	-	0.799	0.408
6.0	569	-	0.773	0.421
7.0	903	99.0	0.694	0.421
8.0	1215	99.2	0.580	0.380
9.0	1492	99.5	0.475	0.327
10.0	1760	99.5	0.399	0.282
11.0	2000	99.5	0.399	0.240
12.0	2100	99.4	0.269	0.194
13.0	2100	99.1	0.207	0.153
14.0	2100	98.9	0.164	0.122
15.0	2100	98.9	0.132	0.100
16.0	2100	98.9	0.108	0.082
17.0	2100	98.9	0.091	0.068
18.0	2100	98.9	0.076	0.058
19.0	2100	98.9	0.067	0.049
20.0	2100	98.9	0.057	0.042
21.0	2100	98.9	0.051	0.036
22.0	2100	98.9	0.044	0.032

⁴ Valid for Sound Management I 99.5 dB(A) only. During other operation modes different power and sound levels are effective.

⁵ Valid for $V_{10} \geq 6$ m/s

⁶ Guarantee for the medium-voltage side of the transformer including the transformer losses.

⁷ Sound power level at hub height

3.2 Sound power level according to IEC for wind speed at 10 m height

HH	v_{10} [m/s]	5.0	6.0	7.0	8.0	9.0	10.0	11.0
91 - 93 m	L_{WA} [dB(A)]	99,0	99,3	99,5	99,4	99,2	98,9	98,9
120 - 123 m	L_{WA} [dB(A)]	99,0	99,4	99,5	99,4	99,0	98,9	98,9

All sound power levels above are based on wind speeds of v_{10} at 10 m height. The data of the noise level are based on the requirements of the IEC 61400-11: 2002 + A1: 2006.

The calculation of the wind speed in 10m height is based on a roughness length of 0.05m.

3.3 Sound Power Level according to FGW Guideline at 95% of rated power

The sound power level measured according to the "Technische Richtlinie für Windenergieanlagen Teil 1: Rev. 18 der FGW" at 95% of the rated power is independent of the hub height:

$$L_{WA, 95\%} = 99.5 \text{ dB(A)}$$

**Power Curve &
Sound Power Level
Sound Management II
Type C
[3.2M114/50Hz]
Preliminary Version**

Preliminary Power Curve & Sound Power Level
Sound Management II Type C [3.2M114/50Hz]

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Applicable Documents

The documents referred to in the table below are included for information only. Reference to them in this product description does not make them part of the contract.

Titel	Dokumenten-Nr.
Product Description Sound Management II	PD-2.5-WT.PO.02-D-*

* If the products referred to in the table above are to be included within the project, the relevant product descriptions in their current version will be amended to the contract.

List of Abbreviation and Units

Abbreviation/Unit	Description
cp	Power coefficient
ct	Thrust coefficient
FGW	Fördergesellschaft Windenergie e.V.
IEC	International Electrotechnical Commission
WEC	Wind Energy Converter

1 Introduction

This document is intended to provide information only and therefore acts only as a preliminary non-committal guide. All values mentioned below can be subject to change based on subsequent calculations or measurements. No rights and obligations of any nature whatever can be derived from the general information given in this document. REpower is not responsible for any claims in conjunction with this information

This document shows the preliminary power curve and the preliminary sound power level of the *REpower Sound Management II Type C [3.2M114/50Hz]* and the corresponding guarantee and measurement conditions.

2 Conditions for guarantee and measurement of power curve and sound power level

2.1 General information

Rotor diameter:	approx. 114 m
Air density:	1.225 kg/m ³
Cut in wind speed:	ca. 3.0 m/s
Cut out wind speed:	22 m/s
Wind speed at hub height:	10 minutes mean values
Blades:	clean, no ice/snow formation

2.2 Conditions for power curve guarantee and measurement

Verification according to IEC 61400-12-1: 2005^{1,2}

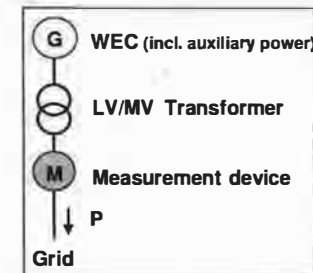
Turbulence intensity:	6 to 12 %
Terrain:	not complex according to IEC 61400-12-1: 2005 ¹
Vertical wind shear coefficient (measured between hub height and hub height minus rotor diameter divided by 2):	≤ 0.3
Air density at location (10 minutes mean value):	≥ 1.13kg/m ³

¹ For obstacle assessment according to 61400-12-1: 2005 Annex A.2 the following condition applies:

No obstacles with a height greater than 1/3 of the distance between the ground and the lower blade tip shall exist in the measurement sector within 0-4 rotor diameters of the wind turbine or met mast.

² Valid for active power set points

Temperature range:	≤ 35 °C
Anemometer type:	Thies First Class / Thies First Class Advanced
Voltage level for measurement:	660 V / 950V (50 Hz)



Arrangement of a measuring unit for the power curve measurement of a *REpower 3.2M114*

2.3 Conditions for sound power level guarantee and measurement

Verification according to IEC 61400-11: 2002 + A1: 2006³

Roughness length (average peak):	0.05 m
----------------------------------	--------

³ Method 1, as outlined in section 7.3 of the IEC standard 61400-11

3 Preliminary electrical power curve and sound power level⁴

The sound power level guaranteed by REpower includes a measurement uncertainty of approx. 1 dB(A). REpower warrants that there is no tonal audibility > 1 dB⁵.

3.1 Sound power level according to IEC for wind speed at hub height

Wind speed v [m/s]	Power P [kW] ⁶	Sound power level L_{WA} [dB(A)] ⁷	Thrust coefficient ct [-]	Power coefficient cp [-]
3.0	18	-	1.046	0.107
4.0	144	-	0.848	0.360
5.0	309	-	0.744	0.395
6.0	537	95.1	0.663	0.398
7.0	811	96.6	0.588	0.378
8.0	1129	97.9	0.526	0.353
9.0	1583	100.2	0.515	0.347
10.0	2226	104.0	0.527	0.356
11.0	2799	105.2	0.485	0.336
12.0	2989	105.2	0.377	0.277
13.0	3000	104.8	0.286	0.218
14.0	3000	104.8	0.224	0.175
15.0	3000	104.8	0.181	0.142
16.0	3000	104.8	0.148	0.117
17.0	3000	104.8	0.124	0.098
18.0	3000	104.8	0.105	0.082
19.0	3000	104.8	0.090	0.070
20.0	3000	104.8	0.077	0.060
21.0	3000	104.8	0.065	0.052
22.0	3000	104.8	0.060	0.045

⁴ Valid for Sound Management II Type C only. During other operation modes different power and sound levels are effective.

⁵ Valid for $V_{10} \geq 6$ m/s

⁶ Guarantee for the medium-voltage side of the transformer including the transformer losses.

⁷ Sound power level at hub height

3.2 Sound power level according to IEC for wind speed at 10 m height

HH	v_{10} [m/s]	5.0	6.0	7.0	8.0	9.0	10.0	11.0
91 - 93 m	L_{WA} [dB(A)]	96.7	98.8	103.7	105.2	104.8	104.8	104.8
120 - 123 m	L_{WA} [dB(A)]	97.1	99.7	105.1	105.2	104.8	104.8	104.8

All sound power levels above are based on wind speeds of v_{10} at 10 m height. The data of the noise level are based on the requirements of the IEC 61400-11:2002 + A1:2006.

The calculation of the wind speed in 10m height is based on a roughness length of 0.05m.

**Power Curve &
Sound Power Level
REpower 3.4M104**

[3.4M/104/50Hz]

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Applicable Documents

The following documents are mentioned within this document without being subject matter of this product description.

Title	Document no.

* Depending on the project specific selection of REpower products the respective documents will appear in each case as separate amendments of the contract in their actual version.

List of Abbreviations and Units

Abbreviation/Unit	Description
cP	Power coefficient
cT	Thrust coefficient
FGW	Fördergesellschaft Windenergie e.V.
IEC	International Electrotechnical Commission
WEC	Wind Energy Converter (equal to Wind Turbine Generator System [WTGS])

1 Introduction

This document shows the guaranteed power curve and sound power level of the *REpower 3.4M104* and the corresponding guarantee and measurement conditions.

2 Conditions for guarantee and measurement of power curve and sound power level

2.1 General information

Rotor diameter:	104 m
Air density:	1.225 kg/m ³
Cut in wind speed:	3.5 m/s
Cut out wind speed:	25.0 m/s
Wind speed at hub height:	10 minute mean values
Blades:	clean, no ice/snow formation

2.2 Conditions for power curve guarantee and measurement

Verification according to IEC 61400-12-1: 2005^{1,2}

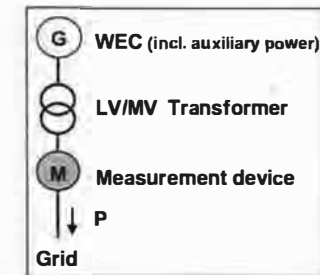
Turbulence intensity:	6 to 12 %
Terrain:	not complex according to IEC 61400-12-1: 2005 ¹
Vertical wind shear coefficient (measured between hub height and hub height minus rotor diameter divided by 2):	≤ 0.3
Air density at location (10 minutes mean value):	≥ 1.13 kg/m ³
Temperature range:	acc. to related Standard Conditions of use
Anemometer type:	Thies First Class/ Thies First Class Advanced
Voltage level for measurement:	660 V / 950V V (50Hz)

¹ For obstacle assessment according to 61400-12-1: 2005 Annex A.2 the following condition applies:

To determine significant obstacles the procedure "Power Performance Measurement Procedure – Version 5, December 2009" chapter 3.9 has to be followed.

In addition no obstacles with a height greater than 1/3 of the distance between the ground and the lower blade tip shall exist in the measurement sector within 0-4 rotor diameters of the WEC or met mast.

² Valid for active power set points



Arrangement of a measuring unit for the power curve measurement of a *REpower 3.4M104*

2.3 Conditions for sound power level guarantee and measurement

Verification according to IEC 61400-11: 2002 + A1: 2006³

Roughness length (average peak): 0.05 m

³ Method 1, as outlined in section 7.3 of the IEC standard 61400-11



3 Guaranteed electrical power curve and sound power level⁴

The sound power level guaranteed by REpower includes a measurement uncertainty of approx. 1 dB(A). REpower warrants that there is no tonal audibility > 0 dB⁵.

The guaranteed electrical power curve of the REpower 3.4M104 is applicable at the medium-voltage side of the transformer and includes the transformer losses

Wind speed v [m/s] ⁶	Power P [kW]	Sound Power Level L_{WA} [dB(A)] ⁷	Thrust coefficient c_T [-]	Power coefficient c_P [-]
3.5	28	-	1.10	0.125
4	87	-	0.91	0.261
5	246	-	0.79	0.378
6	471	-	0.76	0.419
7	783	100.2	0.76	0.439
8	1209	102.9	0.76	0.454
9	1733	104.6	0.76	0.457
10	2293	105.4	0.71	0.441
11	2839	105.6	0.66	0.410
12	3269	105.3	0.57	0.364
13	3340	105.0	0.40	0.292
14	3370	104.8	0.31	0.236
15	3370	104.8	0.25	0.192
16	3370	104.8	0.20	0.158
17	3370	104.8	0.17	0.132
18	3370	104.8	0.14	0.111
19	3370	104.8	0.12	0.094
20	3370	104.8	0.11	0.081
21	3370	104.8	0.09	0.070
22	3370	104.8	0.08	0.061
23	3370	104.8	0.07	0.053
24	3370	104.8	0.06	0.047
25	3370	104.8	0.06	0.041

⁴ Valid for unrestricted operation only. During sound reduced operation modes different power and sound levels are effective.

⁵ Valid for $V_{10} \geq 8$ m/s

⁶ Wind speed at hub height

⁷ Sound power level at hub height



3.1 Sound Power Level according to IEC for different Hub Heights

HH*	V_{10} ⁶ [m/s]	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0
78-80m	L_{WA} ⁹ [dB(A)]	100.1	103.7	105.3	105.6	105.1	104.8	104.8	104.8
96.5-100m	L_{WA} ⁹ [dB(A)]	100.7	104.2	105.4	105.5	105.0	104.8	104.8	104.8
125-128 m	L_{WA} ⁹ [dB(A)]	101.3	104.5	105.6	105.3	104.9	104.8	104.8	104.8

* Hub height depending on foundation design

All sound power levels above are based on wind speeds of v_{10} at 10 m height. The data of the noise level are based on the requirements of the IEC 61400-11 : 2002 + A1 : 2006
The calculation of the wind speed in 10m height is based on a roughness length of 0.05m.

3.2 Sound Power Level according to FGW Guideline at 95% of rated power

The sound power level measured according to the "Technische Richtlinie für Windenergieanlagen Teil 1: Rev. 18 der FGW" at 95% of the rated power is independent of the hub height:

$$L_{WA, 95\%} = 105.6 \text{ dB(A)}$$

⁶ Wind speed in a height of 10 meters

⁹ Sound power level at hub height

4 Calculated electrical power curve (for information only)

The calculated electrical power curve of the REpower 3.4M104 is a theoretical one which is applicable at the low-voltage side of the transformer and does not include the transformer losses. It has been derived from the guaranteed electrical power curve in chapter 2 using typical operation conditions of the electrical system. The calculated electrical power curve is for informative purposes only and is not content of the guaranteed electrical power curve.

The values of the calculated electrical power curve are a non-binding additional information. No rights or duties for REpower Systems SE result from the values given in this chapter. Legal claims against REpower Systems SE for any costs incurred and/or damages suffered (including direct, indirect, consequential damage or damages, as well as loss of income or profits) caused by the use or non-use of the information offered here or the use of erroneous or incomplete information are excluded.

Wind speed	Power	Thrust coefficient	Power coefficient
$v \text{ [m/s]}^{10}$	$P \text{ [kW]}$	$c_T \text{ [-]}$	$c_P \text{ [-]}$
3.5	37	1.10	0.167
4	94	0.91	0.282
5	253	0.79	0.390
6	479	0.76	0.426
7	791	0.76	0.443
8	1219	0.76	0.458
9	1745	0.76	0.460
10	2309	0.71	0.444
11	2860	0.66	0.413
12	3295	0.57	0.366
13	3370	0.40	0.295
14	3400	0.31	0.238
15	3400	0.25	0.194
16	3400	0.20	0.160
17	3400	0.17	0.133
18	3400	0.14	0.112
19	3400	0.12	0.095
20	3400	0.11	0.082
21	3400	0.09	0.071
22	3400	0.08	0.061
23	3400	0.07	0.054
24	3400	0.06	0.047
25	3400	0.06	0.042

¹⁰ Wind speed at hub height

**Power Curve &
Sound Power Level
Sound Management I
100.0 dB(A)
[3.4M104/50Hz]**

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Applicable Documents

The documents referred to in the table below are included for information only. Reference to them in this product description does not make them part of the contract.

Titel	Dokumenten-Nr.
Product Description Sound Management I	PD-2.5-WT.PO.01-D-*

* If the products referred to in the table above are to be included within the project, the relevant product descriptions in their current version will be amended to the contract.

List of Abbreviation and Units

Abbreviation/Unit	Description
cp	Power coefficient
ct	Thrust coefficient
FGW	Fördergesellschaft Windenergie e.V.
IEC	International Electrotechnical Commission
WEC	Wind Energy Converter

1 Introduction

This document shows the guaranteed power curve and sound power level of the *REpower Sound Management I 100.0 dB(A) [3.4M104/50Hz]* and the corresponding guarantee and measurement conditions.

2 Conditions for guarantee and measurement of power curve and sound power level

2.1 General information

Rotor diameter:	104 m
Air density:	1.225 kg/m ³
Cut in wind speed:	ca. 3.5 m/s
Cut out wind speed:	25 m/s
Wind speed at hub height:	10 minutes mean values
Blades:	clean, no ice/snow formation

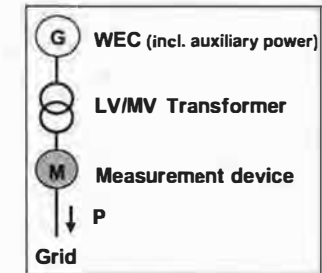
2.2 Conditions for power curve guarantee and measurement

Verification according to IEC 61400-12-1: 2005¹

Turbulence intensity:	6 to 12 %
Terrain:	not complex according to IEC 61400-12-1: 2005 ¹
Vertical wind shear coefficient (measured between hub height and hub height minus rotor diameter divided by 2):	≤ 0.2
Air density at location (10 minutes mean value):	≥ 1.13kg/m ³
Temperature range:	≤ 35 °C
Power factor:	cos phi ~ 1
Anemometer type:	Thies First Class
Voltage level for measurement:	660 V / 950V (50 Hz)

¹ For obstacle assessment according to 61400-12-1: 2005 Annex A.2 the following condition applies:

No obstacles with a height greater than 1/3 of the distance between the ground and the lower blade tip shall exist in the measurement sector within 0-4 rotor diameters of the wind turbine or met mast.



Arrangement of a measuring unit for the power curve measurement of a *REpower 3.4M104*

2.3 Conditions for sound power level guarantee and measurement

Verification according to IEC 61400-11: 2002 + A1: 2006²

Roughness length (average peak):	0.05 m
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² Method 1, as outlined in section 7.3 of the IEC standard 61400-11

3 Guaranteed electrical power curve and guaranteed sound power level³

The sound power level guaranteed by REpower includes a measurement uncertainty of approx. 1 dB(A). REpower warrants that there is no tonal audibility > 0 dB.

3.1 Sound power level according to IEC for wind speed at hub height

Wind speed v [m/s]	Power P [kW] ⁴	Sound power level L _{WA} [dB(A)] ⁵	Thrust coefficient ct[-]	Power coefficient cp [-]
3.5	28		1.056	0.125
4.0	87		0.956	0.261
5.0	246		0.819	0.378
6.0	465		0.780	0.414
7.0	745	100.0	0.768	0.417
8.0	1121	100.0	0.712	0.421
9.0	1513	100.0	0.631	0.399
10.0	1849	100.0	0.539	0.355
11.0	2050	100.0	0.443	0.296
12.0	2050	100.0	0.350	0.228
13.0	2050	100.0	0.265	0.179
14.0	2050	100.0	0.207	0.144
15.0	2050	100.0	0.167	0.117
16.0	2050	100.0	0.137	0.096
17.0	2050	100.0	0.114	0.080
18.0	2050	100.0	0.097	0.068
19.0	2050	100.0	0.084	0.057
20.0	2050	100.0	0.072	0.049
21.0	2050	100.0	0.063	0.043
22.0	2050	100.0	0.055	0.037
23.0	2050	100.0	0.045	0.032
24.0	2050	100.0	0.042	0.029
25.0	2050	100.0	0.039	0.025

³ Valid for Sound Management I 100.0 dB(A) only. During other operation modes different power and sound levels are effective.

⁴ Guarantee for the medium-voltage side of the transformer including the transformer losses.

3.2 Sound power level according to IEC for wind speed at 10 m height

HH	v ₁₀ [m/s]	5.0	6.0	7.0	8.0	9.0	10.0
78 – 80 m	L _{WA} ⁵ [dB(A)]	100.0	100.0	100.0	100.0	100.0	100.0
98 – 100 m	L _{WA} ⁵ [dB(A)]	100.0	100.0	100.0	100.0	100.0	100.0
128 m	L _{WA} ⁵ [dB(A)]	100.0	100.0	100.0	100.0	100.0	100.0

All sound power levels above are based on wind speeds of v₁₀ at 10 m height. The data of the noise level are based on the requirements of the IEC 61400-11: 2002 + A1: 2006.

The calculation of the wind speed in 10m height is based on a roughness length of 0.05m.

⁵ Sound power level at hub height