



**K2 WIND POWER PROJECT
WIND TURBINE SPECIFICATIONS REPORT**

**Prepared by:
K2 Wind Ontario Limited Partnership
Suite105, 100 Simcoe Street
Toronto, ON
M5H 3G2**

**In association with:
Stantec Consulting Ltd.;
SENES Consultants Limited; and
AMEC Environment & Infrastructure**

November 2012

TABLE OF CONTENTS

	PAGE
1.0 INTRODUCTION.....	1
1.1 Project Overview	1
1.2 Report Requirements	1
2.0 TECHNICAL SPECIFICATIONS	3
2.1 Siemens SWT-2.3 Wind Turbine	3
2.2 Acoustic Emissions Data	5
3.0 CLOSURE.....	6
4.0 REFERENCES.....	7

LIST OF TABLES

Table 1-1: Wind Turbine Specifications Report Requirements per Ontario Regulation 359/09	2
Table 2-1: Basic Wind Turbine Specifications	3

LIST OF APPENDICES

APPENDIX A: Siemens SWT-2.3 Specifications

1.0 INTRODUCTION

1.1 Project Overview

K2 Wind Ontario Inc., in its capacity as general partner of K2 Wind Ontario Limited Partnership (the Proponent or K2 Wind), is proposing to develop, construct and operate the K2 Wind Power Project (the Project) in the Township of Ashfield-Colborne-Wawanosh (Township of ACW) north of Goderich within the County of Huron, Ontario. The Proponent is a limited partnership formed under the *Limited Partnerships Act* (Ontario), with K2 Wind Ontario Inc. as general partner and CP K2 Holdings Inc. (an affiliate of Capital Power Corporation), Samsung Renewable Energy Inc., and Pattern K2 LP Holdings LP (an affiliate of Pattern Renewable Holdings Canada ULC), as limited partners. The Project would supply approximately 270 megawatts (MW) of electricity to the Ontario power grid. The development of the Project would help the province of Ontario meet its goal of increasing the proportion of electricity generated from renewable sources. The Project is subject to Ontario Regulation 359/09 – Renewable Energy Approvals under Part V.0.1 of the *Environmental Protection Act* (O. Reg. 359/09).

Key Project components would consist of up to 140 wind turbines, electrical collection and communications systems including a transmission line, a transformer station, a substation, an operation and maintenance building, meteorological towers, access roads, and temporary construction and laydown areas.

The Proponent has elected to assess and seek approval for some alternative Project configurations. The Renewable Energy Approval (REA) application process will consider two potential transmission line voltages (138 kV vs. 230 kV), two potential transmission line routes, and several alternate access road and collector line alignments. Final selection of the sites to be used would be based on the results of consultation activities, detailed design / engineering work, and the conditions experienced during construction.

The Proponent retained Stantec Consulting Ltd., SENES Consultants Limited, and AMEC Environment & Infrastructure, a division of AMEC Americas Limited (AMEC) to assist in the preparation of the REA application with input from Timmins Martelle Heritage Consultants Inc., Selde Corporation and Zephyr North Canada.

1.2 Report Requirements

The purpose of the *Wind Turbine Specifications Report* is to provide specific technical information regarding the wind turbines proposed to be used for the Project.

The *Wind Turbine Specifications Report* has been prepared in accordance with Item 14, Table 1 of O. Reg. 359/09 and in consideration of the Ministry of the Environment's (MOE's) guidance document *Technical Guide to Renewable Energy Approvals*.

The following table provides the requirements of the *Wind Turbine Specifications Report* as prescribed in O. Reg. 359/09 and the relevant sections where it can be found within this document.



Table 1-1: Wind Turbine Specifications Report Requirements per Ontario Regulation 359/09

ID	Requirements	Section Number
Provide specifications of each wind turbine, including:		
1.	The make, model, name plate capacity, hub height above grade and rotational speeds.	2.1
2.	The acoustic emissions data, determined and reported in accordance with standard CAN/CSA-C61400-11-07, "Wind Turbine Generator Systems — Part 11: Acoustic Noise Measurement Techniques", dated October 2007, including the overall sound power level, measurement uncertainty value, octave-band sound power levels (linear weighted) and tonality and tonal audibility.	2.2

2.0 TECHNICAL SPECIFICATIONS

2.1 Siemens SWT-2.3 Wind Turbine

The Project includes approximately 140 Siemens SWT-2.3 wind turbines. A summary of the basic specifications of the turbine model is provided in Table 2.1 below. A complete description of the general specifications for this turbine model is found in the manufacturer's brochure provided as [Appendix A](#).

Table 2-1: Basic Wind Turbine Specifications

Basic Wind Turbine Specifications	
Manufacturer	Siemens
Model	SWT-2.3-101
Name plate capacity (MW)	Rated between 1.824 and 2.300 MW
Hub height above grade	99.5 m
Blade length	49 m
Full blade diameter	101 m
Blade sweep area	8,000 m ²
Nominal revolutions (rotational speed)	6-16 rpm
Grid frequency	60 Hz
Sound power nameplate (1.824 MW)	3 m/s – 91.4 dBA; 4 m/s – 95.3 dBA; 5 m/s – 98.1 dBA; 6 m/s – 100.5 dBA; >7 m/s – 101.0 dBA
Sound power nameplate (1.903 MW)	3 m/s – 91.4 dBA; 4 m/s – 95.5 dBA; 5 m/s – 99.0 dBA; 6 m/s – 101.5 dBA; >7 m/s – 102.0 dBA
Sound power nameplate (2.030 MW)	3 m/s – 91.4 dBA; 4 m/s – 95.6 dBA; 5 m/s – 99.8 dBA; 6 m/s – 102.5 dBA; >7 m/s – 103.0 dBA
Sound power nameplate (2.126 MW)	3 m/s – 91.4 dBA; 4 m/s – 95.7 dBA; 5 m/s – 100.3 dBA; 6 m/s – 103.5 dBA; >7 m/s – 104.0 dBA
Sound power nameplate (2.221 MW)	3 m/s – 91.4 dBA; 4 m/s – 95.7 dBA; 5 m/s – 100.5 dBA; 6 m/s – 104.5 dBA; >7 m/s – 105.0 dBA
Sound power (nameplate 2.300 MW)	3 m/s – 91.4 dBA; 4 m/s – 95.7 dBA; 5 m/s – 100.6 dBA; 6 m/s – 105.4 dBA; >7 m/s – 106.0 dBA

Each wind turbine consists of eight key components:

- concrete tower foundation;
- five steel tower sections;
- nacelle (comprised of gearbox, electrical generator, and housing);
- three rotor blades;
- hub (the structure to where the blades attach);
- power convertor;
- padmount transformer at the base of the tower; and
- electrical wiring and grounding.

The tower would be supported by a concrete foundation, approximately 3 m deep, depending upon subsurface conditions. The turbine tower has internal ascent and direct access to the yaw system and nacelle. It is equipped with platforms and internal electric lighting. The tower height for the Siemens SWT-2.3 turbine is 99.5 m.

The tower supports the nacelle which is accessible via a hatch in the floor and houses the main components of the wind turbine including:

- Main bearing;
- Main shaft;
- Gearbox;
- Brake disc;
- Coupling;
- Generator;
- Service crane;
- Yaw ring;
- Yaw gear;
- Nacelle bedplate;
- Oil filter;
- Canopy; and
- Generator fan.

The rotor hub is cast in nodular cast iron and is fitted to the main shaft with a flange connection. The hub is sufficiently large to provide a comfortable working environment for two service technicians during maintenance of the blade roots and pitch bearings from inside the structure.

The Siemens SWT-2.3 turbine uses unique features such as NetConverter[®] power conversion system which allows generator operation at variable speed, frequency and voltage while supplying power at a constant frequency and voltage to the MV transformer. The 101 m rotor supports three blades and a hub. Each blade is constructed of fibreglass reinforced epoxy in Siemens' proprietary IntegralBlade[®] manufacturing process. The blades are 49 m in length. Each blade has its own independent pitching mechanism capable of feathering the blade under any operating condition. The blade pitch arrangement allows for optimization of the power output throughout the operating range, and the blades are feathered during standstill to minimize wind loads.

Electrical wiring includes a 690 V cable which runs down the turbine tower to the padmount transformer located adjacent to the tower base. A padmount transformer, located adjacent to the base of each wind turbine, is required to transform the electricity created in the nacelle to a standard operating power line voltage (i.e. 690 V to 34.5 kV). The converter is also located at the base of the turbine and controls the energy conversion in the generator by feeding power to and from the grid. From the padmount transformer, underground 34.5 kV collector lines would carry the electricity from the turbines to the collector line system.

Turbine tower lighting would be in accordance with Transport Canada Regulations and Standards as described in the *Design and Operations Report*.

2.2 Acoustic Emissions Data

The Siemens SWT-2.3 wind-powered turbines are rated to operate between 1.824 and 2.300 MW. The maximum overall sound power rating of the highest rated turbines (2.300 MW) is 106.0 dBA. Information regarding the acoustic emissions of the turbine, including the overall sound power level, measurement uncertainty value, octave-band sound power levels, and tonality and tonal audibility, is available in the manufacturer specifications provided in Appendix A.

3.0 CLOSURE

K2 Wind Ontario Limited Partnership, in association with Stantec Consulting Ltd., SENES Consultants Limited, and AMEC Environment and Infrastructure, has completed this report for the exclusive use of the Proponent for specific application to the Project. The work has been completed in accordance with Ontario Regulation 359/09, and in consideration of the guidance document *Technical Guide to Renewable Energy Approvals*.

Prepared by:



Kara Hearne

Project Manager
Stantec Consulting Ltd.



Sarah Palmer

Senior Environmental Advisor
Capital Power Corporation
for K2 Wind Ontario Limited Partnership.

4.0 REFERENCES

Ontario Regulation 359/09. Renewable Energy Approvals Under Part V.0.1 of the Act made under the Environmental Protection Act.

Ontario Ministry of the Environment. 2011 & 2012. Technical Guide to Renewable Energy Approvals. Queen's Printer for Ontario. PIBS 8472e.

APPENDIX A:
Siemens SWT-2.3 Specifications

Noise Measurement

SWP Report
N-2304 099-T1

Ejler Kristensen
25.05.2011

Contents

1	Measurement	4
2	Conclusion	4
2.1	Results.....	4
3	Analysis of Sound Power Level	5
3.1	Sound Power Level	5
4	Analyses of Tonality	8
4.1	Info	8
4.1.1	Tonal analysis method	8
4.2	Tonal analysis at 6 m/s	8
4.2.1	Tonality analysis at 117.5 Hz.....	9
4.3	Tonal analysis at 7 m/s	9
4.3.1	Tonality analysis at 118.8 Hz.....	10
4.3.2	Tonality analysis at 495.3 Hz.....	10
4.4	Tonal analysis at 8 m/s	11
4.4.1	Tonality analysis at 517.3 Hz.....	11
4.5	Tonal analysis at 9 m/s	12
4.5.1	Tonality analysis at 517.8 Hz.....	12
4.6	Tonal analysis at 10 m/s	13
4.6.1	Tonality analysis at 519.3 Hz.....	13
	Appendix 1 Non acoustic measurements 10 s average	14
	Appendix 2 Acoustic overall analyzer measurements 10 s average.....	16

Rev. no.	Rev. date	Changes	Resp.
1	25.5.2011	First version	Ejler Kristensen
1A	25.06.2012	Version without site name	Ejler Kristensen/AJJ

1 Measurement

The measurement was performed at turbine xx at xxxxxx Wind farm in Ontario on 16th April 2011 from 14:43 to 18:07 by Ejler Kristensen, Siemens Wind Power. The measurement computer time was synchronized with the turbine computer time.

The turbine type is SWT-2.3-101 with turbine ID no. 230x-xxxx.

The hub height wind speed range from 4.6 m/s - 14.0 m/s measured as 10 sec average with the nacelle anemometer, and the power output from 430 kW - 2300 kW.

10 sec average non acoustic measurements are shown in appendix 1.

The measurement fulfils IEC61400-11:2002 with following exceptions:

- The nacelle anemometer is used for background noise wind speed measurements.

2 Conclusion

A noise measurement has been performed at turbine xx at xxxxxx Wind Farm.

2.1 Results

The results are shown in table 2.1 below:

Wind speed BIN [m/s] - 10 m	5	6	7	8	9	10
LWA [dB re. 1 pW]	101.7	104.4	104.9	105.1	105.6	105.1
Tone average frequency, f [Hz]	-	117.5	118.8	517.3	517.8	519.3
Max. tonality, ΔL_k [dB]	-	-6.7	-5.2	-2.9	-1.5	-0.2
Max. tonal audibility, $\Delta L_{a,k}$ [dB]	-	-4.7	-3.2	-0.6	0.8	2.1

Table 2.1: Results of the measurements

Sound power levels, LWA, of the turbine are below guaranteed values.

The level of tonality in the reference position (near field) is acceptable. The maximum tonality measured in the reference position is -0.2 dB at 519.3 Hz, which corresponds to an audibility of 2.1 dB.

3 Analysis of Sound Power Level

3.1 Sound Power Level

The sound power level, L_{WA} , is calculated according to IEC61400-11:2002.

Figure 3.1 shows measured sound pressure levels. Table 3.1 shows the resulting sound power level without extrapolation of the regression results.

Microphone: Signal 1_130 m ref: [Pa]

Date:	16-04-2011
Engineer:	EJK
Location:	XXXXX in Ontario
Turbine-ID:	T1
Hub Height:	80m
Distance:	130m
Roughness:	0,05m
K-Faktor:	0.7418
V_P/V_Anemo:	1.041

Calibrator with serial type 4231 serial no. 2326419 has been measured to 93,89 dB at Brüel & Kjær – Nærum DK with reference to calibration letter of 25. maj 2011.

The calibrating signal was measured to 93,8 dB at the beginning of the measurement. See appendix 2

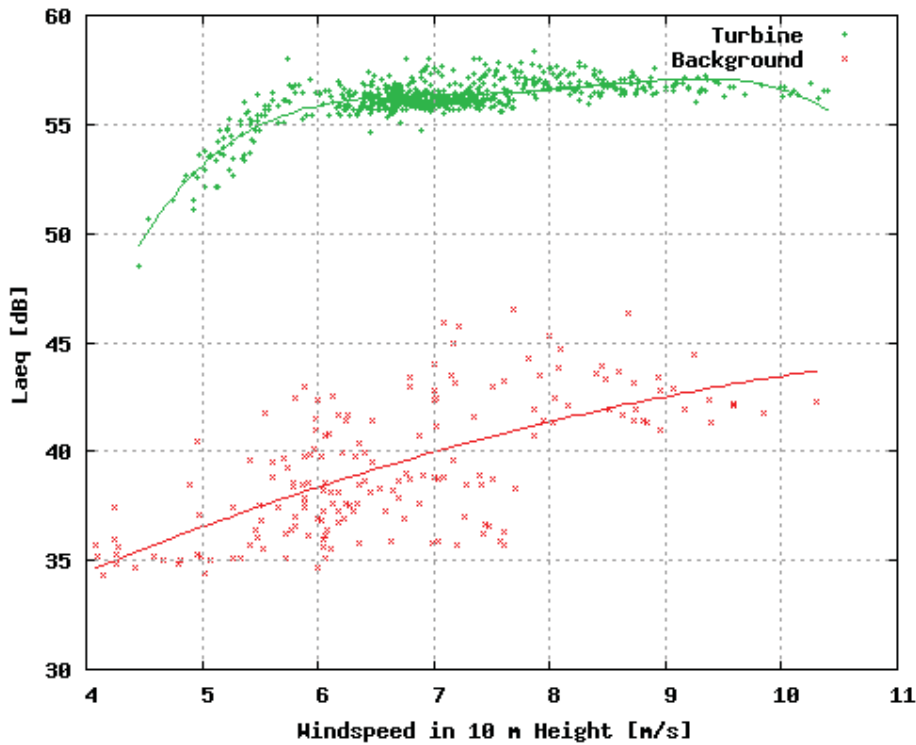


Figure 3.1: Measured background noise and total noise

Windspeed [m/s] 10 m	5	6	7	8	9	10
Averaged 2 PitchBladeB: [deg]	-1,67	-2,52	-1,57	0,9	3,86	7,27
Averaged 5 MainSRpm: [RPM]	13,14	14,44	14,55	15,23	15,55	15,62
Averaged 6 ActPower: [kW]	824,93	1397,41	1885	2259,79	2296,43	2295,79
Averaged 7 AcWindSp: [m/s]	7,1	8,12	9,5	10,73	11,99	13,43
Averaged 8 GenRpm: [RPM]	1190,69	1308,2	1318,88	1379,96	1409,2	1415,96
LAeq total [dB(A) re 20 µPa]	53,1	55,85	56,33	56,58	57,04	56,63
LAeq BG [dB(A) re 20 µPa]	36,52	38,35	39,96	41,35	42,51	43,45
LAeq BG corr. [dB(A) re 20 µPa]	53,01	55,78	56,23	56,44	56,89	56,41
LWA [dB(A) re pW]	101,67	104,44	104,90	105,11	105,55	105,08

*) difference between LAeq total and LAeq BG is between 3 and 6 dB(A)

Table 3.1: Turbine noise

General Calculation Settings and Information

All wind speeds are measured in hub height and are recalculated to 10 m height.

Background Definition

Power [kW]: <20

RPM [1/min]: <20

Total Noise Definition

Power [kW]: >20

RPM [1/min]: >500

Windspeed in 10m Height

Offset: +1.5 m/s

Used Powercurve:

C:\VBA-Pulse\Powercurves\SWT-2 3-101.txt

Status Setting

Status1: Status1 used Powercurve for Calculation

Values which are not used for the calculation

Range Values:

Time		z-Index
	22	
	50	calibrator
	63	
	200	mic moved
	750	
	804	mic moved
	319	
	325	xxxxx at mic.
	384	
	408	mic moved

4 Analyses of Tonality

4.1 Info

Txxx, ID no. 23xx-xxxx.

4.1.1 Tonal analysis method

The tonal analysis presented in this report is performed according to the L70 method as described in IEC 61400-11:2002.

Due to air absorption, different level of masking noise etc. tonal analysis in the reference position is not comparable with tonality analysis in the far field.

Wind speeds in the tonal analysis are given at 10 m height.

4.2 Tonal analysis at 6 m/s

The 2 periods of 1 minute with averaged wind speeds closest to 6 m/s are used for this tonal analysis.

The twelve 10 sec. FFT spectra are shown in Figure 4.1 below.

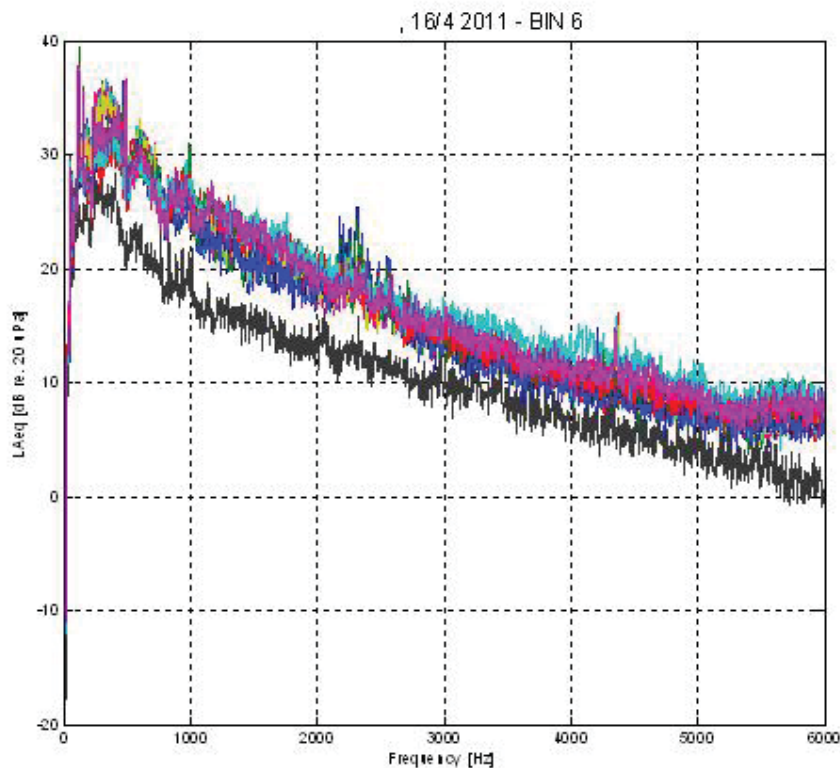


Figure 4.1: The twelve 10 sec FFT spectra used for tonal analysis.

Results are shown below as well as examples of tonality analysis at each frequency.

4.2.1 Tonality analysis at 117.5 Hz

6 m/s	Zidx	fc [Hz]	CB [Hz]	CBmin [Hz]	CBmax [Hz]	L70%	Lpn,avg [dB]	Lpn [dB]	Lpt [dB]	dLtn [dB]	dLak [dB]
1	248		101,0	68,0	168,0					-15,3	
2	249		101,0	68,0	168,0					-15,3	
3	250		101,0	68,0	168,0					-15,3	
4	251		101,0	68,0	168,0					-15,3	
5	252		101,0	68,0	168,0					-15,3	
6	253		101,0	68,0	168,0					-15,3	
7	347		101,0	68,0	168,0					-15,3	
8	348		101,0	68,0	168,0					-15,3	
9	349	118	101,0	68,0	168,0	27,1	28,4	43,6	41,5	-2,2	-0,2
10	350	118	101,0	68,0	168,0	26,3	27,5	42,7	40,4	-2,3	-0,3
11	351	118	101,0	68,0	168,0	26,4	27,7	43,0	40,5	-2,5	-0,5
12	352	116	101,0	66,0	166,0	26,4	27,7	43,0	40,5	-2,5	-0,5

Average frequency 117,5 Hz
Average dLtn -6,7 dB
dLak -4,7 dB

4.3 Tonal analysis at 7 m/s

The 2 periods of 1 minute with averaged wind speeds closest to 7 m/s are used for this tonal analysis.

The twelve 10 sec. FFT spectra are shown in Figure 4.2 below.

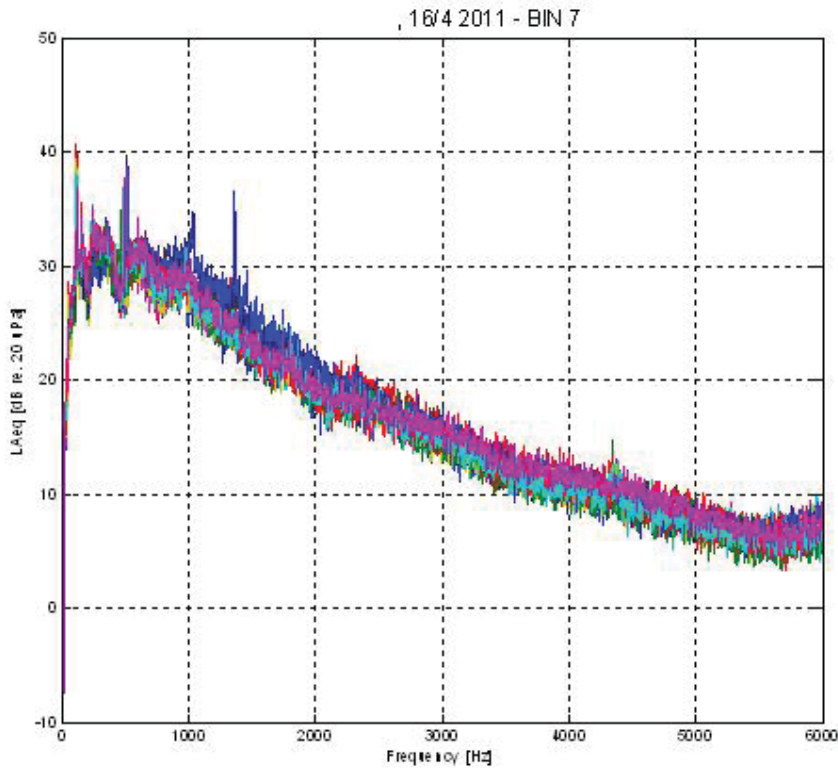


Figure 4.2: The twelve 10 sec FFT spectra used for tonal analysis.

Results are shown below as well as examples of tonality analysis at each frequency.

4.3.1 Tonality analysis at 118.8 Hz

7 m/s	Zidx	fc [Hz]	CB [Hz]	CBmin [Hz]	CBmax [Hz]	L70%	Lpn.avg [dB]	Lpn [dB]	Lpt [dB]	dLtn [dB]	dLak [dB]
1	605	118	101,0	68,0	168,0	26,9	28,1	43,4	39,6	-3,7	-1,7
2	606	116	101,0	66,0	166,0	27,9	29,3	44,5	41,1	-3,4	-1,4
3	607	116	101,0	66,0	166,0	29,5	30,4	45,7	41,2	-4,5	-2,4
4	608	118	101,0	68,0	168,0	27,4	28,6	43,9	37,9	-6,0	-4,0
5	609	118	101,0	68,0	168,0	28,1	29,2	44,5	38,8	-5,7	-3,7
6	610	116	101,0	66,0	166,0	26,5	27,5	42,7	42,0	-0,7	1,3
7	995	124	101,1	74,0	174,0	28,4	29,6	44,9	35,9	-8,9	-6,9
8	996	126	101,1	76,0	176,0	28,6	29,6	44,8	36,1	-8,7	-6,7
9	997	120	101,0	70,0	170,0	28,1	29,3	44,6	36,7	-7,9	-5,9
10	998	118	101,0	68,0	168,0	28,6	30,0	45,3	38,6	-6,7	-4,6
11	999	116	101,0	66,0	166,0	28,3	29,5	44,8	39,3	-5,5	-3,5
12	1000	120	101,0	70,0	170,0	29,2	30,7	46,0	36,9	-9,1	-7,1

Average frequency 118,8 Hz
Average dLtn -5,2 dB
dLak -3,2 dB

4.3.2 Tonality analysis at 495.3 Hz

7 m/s	Zidx	fc [Hz]	CB [Hz]	CBmin [Hz]	CBmax [Hz]	L70%	Lpn.avg [dB]	Lpn [dB]	Lpt [dB]	dLtn [dB]	dLak [dB]
1	605		116,9	436,0	552,0					-15,9	
2	606		116,9	436,0	552,0					-15,9	
3	607		116,9	436,0	552,0					-15,9	
4	608		116,9	436,0	552,0					-15,9	
5	609		116,9	436,0	552,0					-15,9	
6	610		116,9	436,0	552,0					-15,9	
7	995	508	117,8	450,0	566,0	29,1	29,8	45,8	44,6	-1,2	1,1
8	996	516	118,3	458,0	574,0	28,9	29,8	45,7	42,2	-3,5	-1,2
9	997	484	116,2	426,0	542,0	28,3	29,3	45,2	36,3	-8,9	-6,7
10	998	490	116,6	432,0	548,0	28,9	29,9	45,8	37,9	-8,0	-5,7
11	999	480	116,0	424,0	536,0	28,3	29,2	45,0	40,7	-4,4	-2,1
12	1000	494	116,9	436,0	552,0	29,0	30,1	46,0	42,6	-3,4	-1,1

Average frequency 495,3 Hz
Average dLtn -6,9 dB
dLak -4,6 dB

4.4 Tonal analysis at 8 m/s

The 2 periods of 1 minute with averaged wind speeds closest to 8 m/s are used for this tonal analysis.

The twelve 10 sec. FFT spectra are shown in Figure 4.3 below.

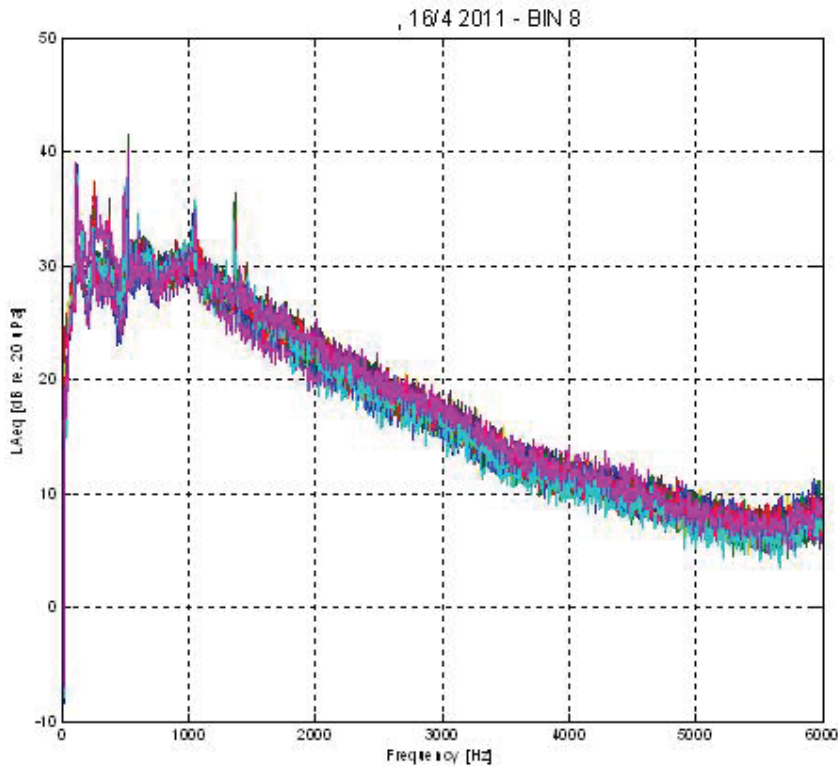


Figure 4.3: The twelve 10 sec FFT spectra used for tonal analysis.

Results are shown below as well as examples of tonality analysis at each frequency.

4.4.1 Tonality analysis at 517.3 Hz

8 m/s	Zidx	fc [Hz]	CB [Hz]	CBmin [Hz]	CBmax [Hz]	L70%	Lpn.avg [dB]	Lpn [dB]	Lpt [dB]	dLtn [dB]	dLak [dB]	
	1	1007	516	118,3	458,0	574,0	26,6	27,8	43,8	41,5	-2,2	0,1
	2	1008	514	118,2	456,0	572,0	28,3	29,3	45,2	39,9	-5,3	-3,0
	3	1009	522	118,7	464,0	580,0	28,6	29,5	45,4	40,4	-5,0	-2,7
	4	1010	504	117,5	446,0	562,0	29,1	30,6	46,6	38,8	-7,7	-5,4
	5	1011		118,5	460,0	576,0					-16,0	
	6	1012	518	118,5	460,0	576,0	27,6	28,9	44,9	35,5	-9,4	-7,1
	7	1115	520	118,6	462,0	578,0	28,4	29,5	45,4	43,3	-2,1	0,2
	8	1116	518	118,5	460,0	576,0	28,0	28,9	44,8	41,3	-3,5	-1,2
	9	1117	516	118,3	458,0	574,0	27,5	28,3	44,3	44,9	0,6	2,9
	10	1118	522	118,7	464,0	580,0	27,8	28,9	44,9	43,0	-1,9	0,5
	11	1119	516	118,3	458,0	574,0	28,2	28,9	44,8	44,9	0,1	2,4
	12	1120	524	118,9	466,0	582,0	27,4	28,5	44,4	43,1	-1,4	1,0

Average frequency 517,3 Hz
Average dLtn -2,9 dB
dLak -0,6 dB

4.5 Tonal analysis at 9 m/s

The 2 periods of 1 minute with averaged wind speeds closest to 9 m/s are used for this tonal analysis.

The twelve 10 sec. FFT spectra are shown in Figure 4.4 below.

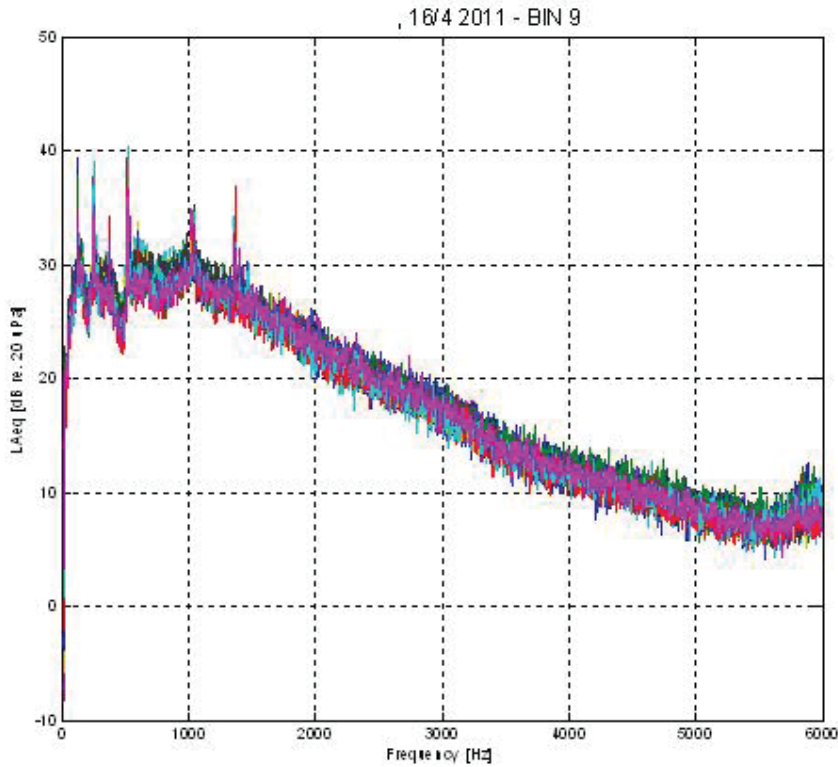


Figure 4.4: The twelve 10 sec FFT spectra used for tonal analysis.

Results are shown below as well as examples of tonality analysis at each frequency.

4.5.1 Tonality analysis at 517.8 Hz

9 m/s	Zidx	fc [Hz]	CB [Hz]	CBmin [Hz]	CBmax [Hz]	L70%	Lpn.avg [dB]	Lpn [dB]	Lpt [dB]	dLtn [dB]	dLak [dB]	
	1	1037	518	118,5	460,0	576,0	26,8	27,9	43,9	42,2	-1,7	0,6
	2	1038	522	118,7	464,0	580,0	27,4	28,3	44,3	41,5	-2,9	-0,5
	3	1039	510	117,9	452,0	568,0	25,8	26,6	42,5	40,5	-2,1	0,2
	4	1040	518	118,5	460,0	576,0	28,4	29,4	45,4	41,0	-4,4	-2,1
	5	1041	512	118,1	454,0	570,0	26,6	27,2	43,2	43,7	0,5	2,8
	6	1042	512	118,1	454,0	570,0	27,6	28,4	44,4	43,3	-1,1	1,2
	7	1061	524	118,9	466,0	582,0	28,2	29,3	45,2	41,1	-4,1	-1,8
	8	1062	528	119,1	470,0	586,0	28,7	27,9	43,9	39,3	-4,6	-2,3
	9	1063	520	118,6	462,0	578,0	26,3	27,3	43,3	41,3	-1,9	0,4
	10	1064	514	118,2	456,0	572,0	25,3	26,6	42,5	43,2	0,7	3,0
	11	1065	522	118,7	464,0	580,0	26,5	27,5	43,5	42,8	-0,6	1,7
	12	1066	514	118,2	456,0	572,0	25,9	26,6	42,5	42,8	0,2	2,5

Average frequency 517,8 Hz
Average dLtn -1,5 dB
dLak 0,8 dB

4.6 Tonal analysis at 10 m/s

The 2 periods of 1 minute with averaged wind speeds closest to 10 m/s are used for this tonal analysis.

The twelve 10 sec. FFT spectra are shown in Figure 4.5 below.

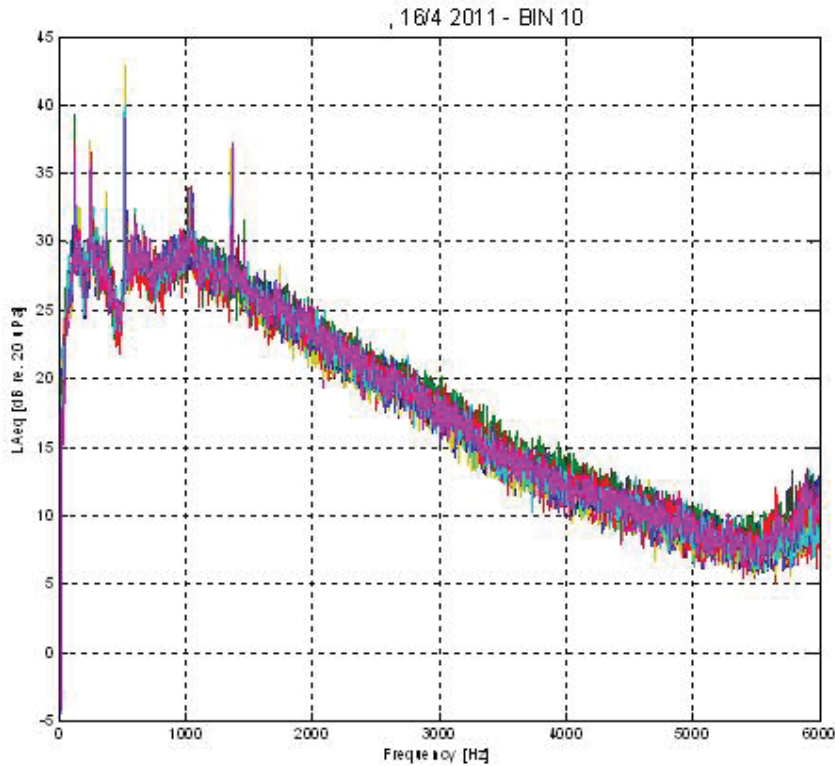


Figure 4.5: The twelve 10 sec FFT spectra used for tonal analysis.

Results are shown below as well as examples of tonality analysis at each frequency.

4.6.1 Tonality analysis at 519.3 Hz

10 m/s	Zidx	fc [Hz]	CB [Hz]	CBmin [Hz]	CBmax [Hz]	L70%	Lpn.avg [dB]	Lpn [dB]	Lpt [dB]	dLtn [dB]	dLak [dB]
1	1031	528	119,1	470,0	586,0	26,8	27,7	43,7	44,3	0,7	3,0
2	1032	518	118,5	460,0	576,0	26,3	27,3	43,3	41,0	-2,3	0,0
3	1033	520	118,6	462,0	578,0	26,3	27,2	43,1	46,1	3,0	5,3
4	1034	518	118,5	460,0	576,0	26,4	27,3	43,3	42,6	-0,6	1,7
5	1035	516	118,3	458,0	574,0	26,6	27,4	43,4	43,7	0,4	2,7
6	1036	516	118,3	458,0	574,0	26,6	27,5	43,4	45,4	1,9	4,2
7	1091	520	118,6	462,0	578,0	26,2	27,3	43,3	41,9	-1,4	1,0
8	1092	520	118,6	462,0	578,0	26,2	26,9	42,9	41,8	-1,1	1,2
9	1093	524	118,9	466,0	582,0	26,3	27,7	43,7	37,3	-6,3	-4,0
10	1094	514	118,2	456,0	572,0	25,6	26,5	42,5	41,2	-1,3	1,0
11	1095	514	118,2	456,0	572,0	26,1	27,1	43,0	42,5	-0,5	1,8
12	1096	524	118,9	466,0	582,0	26,6	27,5	43,5	42,7	-0,8	1,5

Average frequency 519,3 Hz
Average dLtn -0,2 dB
dLak 2,1 dB

Appendix 1 Non acoustic measurements 10 s average

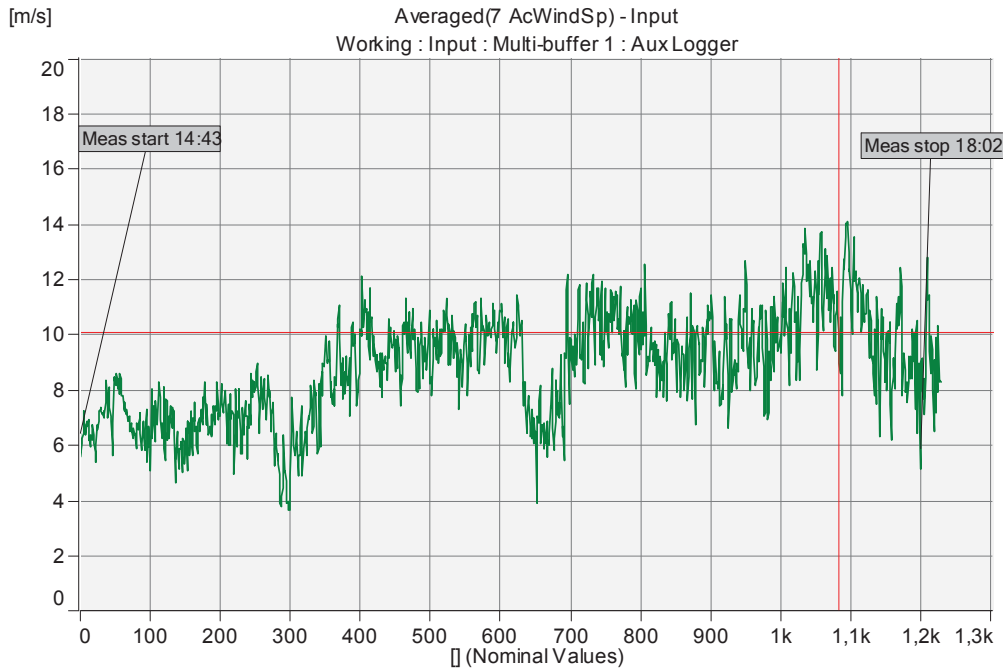


Figure A1.1: Dark green line: Measured 10 s avg. wind speed from the nacelle anemometer.

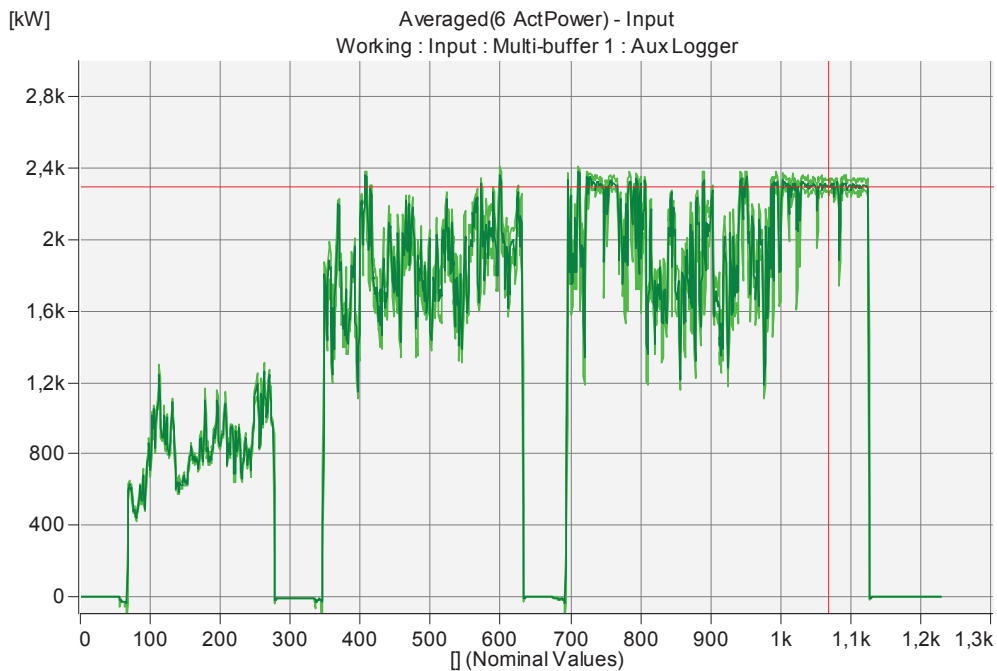


Figure A1.2: Dark green line: Measured 10 s avg. produced power. Light green line shows max instantaneous measurements within the averaging period.

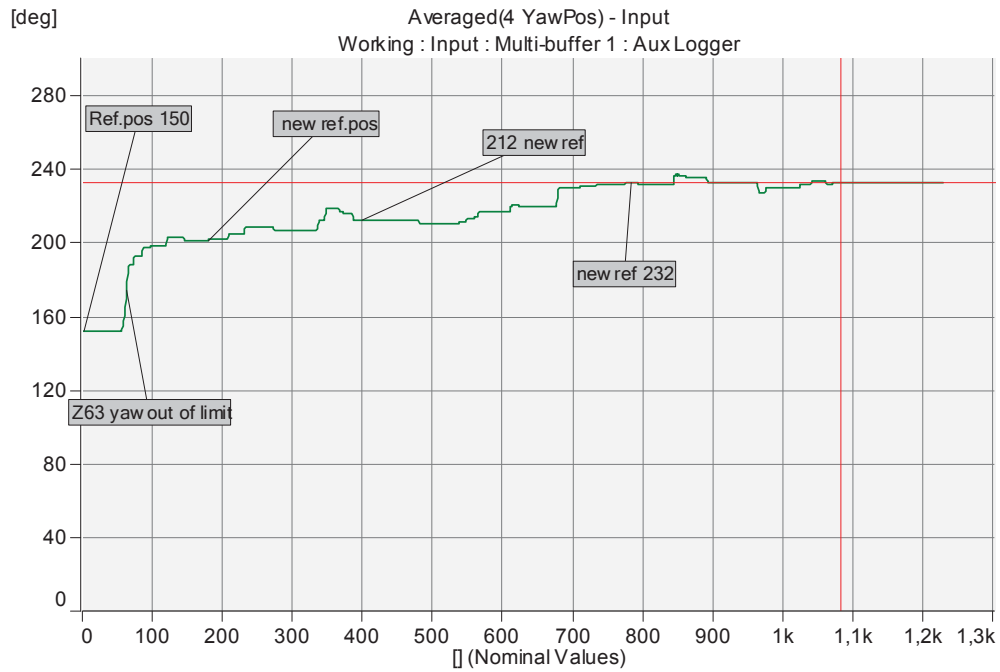


Figure A1.3: Dark green line: Measured 10 s avg. yaw position.

Appendix 2 Acoustic overall analyzer measurements 10 s average

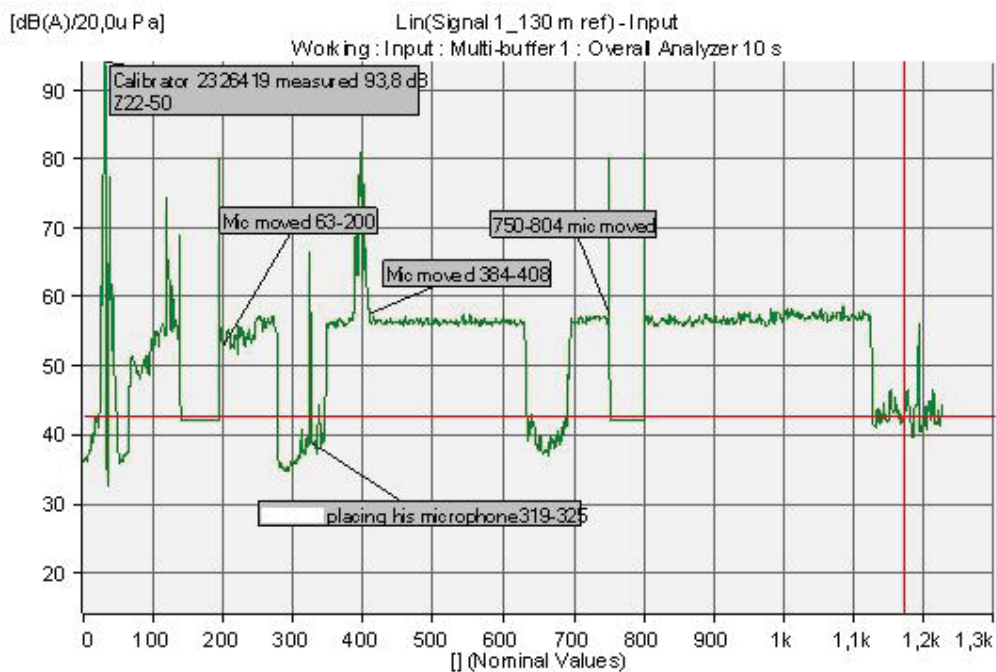


Figure A2.1: Dark green line: Measured 10 s avg. overall analyzer values.



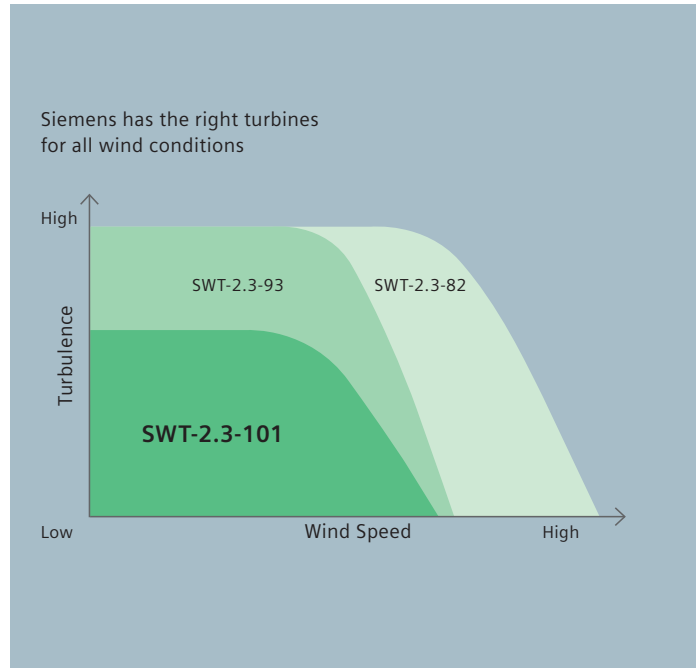
The new standard for moderate wind conditions

Siemens Wind Turbine SWT-2.3-101

Answers for energy.

SIEMENS





Your trusted partner

Siemens has been a major driver of innovation in the wind power industry since the early 1980s when wind turbine technology was still in its infancy.

Technology has changed with the times, but Siemens' commitment to providing its customers with proven wind turbine solutions remains the same.

The combination of robust and reliable turbines, highly efficient solutions for power transmission and distribution and a deep understanding of the entire energy market ensures that Siemens will continue to be a leading supplier.

Siemens' record, when it comes to on-time delivery, is impeccable. Long-lasting customer relationships, based on the successful installation of wind turbines, provide for a sound, sustainable and profitable investment.

Drawing on 140 years of experience in the energy sector, a strong focus on renewables and a global network of highly skilled and trained employees, Siemens has proven itself to be a trustworthy and reliable business partner. And will continue to be in the future.

Harvest more energy from sites with moderate wind conditions

The Siemens SWT-2.3-101 turbine is designed to deliver unparalleled performance and reliability, making it especially suited to areas with moderate wind conditions.

The SWT-2.3-101 turbine offers low energy production costs and joins Siemens' 2.3-MW product family, which has proven availability that is among the highest in the industry. The 101-meter rotor is specifically designed to optimize the energy output in areas with moderate wind conditions. The turbine is also ideal for all types of grid connections in most major markets.

The SWT-2.3-101 is designed to last. The robust and reliable design offers a high yield with low maintenance costs. The turbine is backed by advanced condition monitoring and diagnostics, which constantly examine the turbine. Any change in a turbine's performance is promptly addressed by an experienced after-sales service team either remotely or in the field.

If you desire a better return on investment and superior availability, take a closer look at the SWT-2.3-101 turbine.



Superior performance gives higher yields

Optimum energy at moderate wind conditions

Harvesting more energy

The SWT-2.3-101 wind turbine is designed to increase the energy returns from sites with moderate wind conditions. Advanced blade technology also allows for quieter operation. The B49 blade with a rotor diameter of 101 meters and pitch regulation optimizes power output and increases control over the energy output.

High availability

Currently, the Siemens fleet of 2.3-MW wind turbines sets the industry standard for availability. The SWT-2.3-101 will build on the reputation for reliability that the market has come to expect from a Siemens Wind turbine.

High yield with minimal maintenance

Siemens optimizes the return on investment in its wind turbines through intelligent maintenance that ensures the turbine to deliver high yield with low operational costs.

The rugged structural design, combined with an automatic lubrication system, internal climate control and a generator system without slip rings contributes to exceptional reliability. The innovative design of the SWT-2.3-101 allows for longer service intervals.

Superior grid compliance

The Siemens NetConverter® system is designed for maximum flexibility in the turbine's response to voltage and frequency variations, fault ride-through capability and output adjustment. The advanced wind farm control system provides state-of-the-art fleet management.

Proven track record

Siemens has a proven track record of providing reliable turbines that last. The world's first offshore wind farm in Vindeby, Denmark, was installed in 1991 and is still fully operational. In California, Siemens installed over 1,100 turbines between 1983 and 1990, with 97% still in operation today. Siemens takes its commitment to reliability seriously and prides itself on the long lifespan that its turbines have demonstrated.



No compromise on reliability

SWT-2.3-101: Newest member of the extremely reliable product family

Designed for life

Siemens turbines are designed to last. The robust design of the SWT-2.3-101 allows for trouble-free output throughout the complete lifecycle of the turbine.

The blades are made of fiberglass-reinforced epoxy in Siemens' proprietary IntegralBlade® manufacturing process. The blades are cast in one piece in a closed process, which eliminates the traditional weaknesses found at glue joints in other manufacturers' blades. Like the turbine itself, the blades are designed to last.

Climate control within the turbine protects vital equipment from the outside environment. The turbine also offers controlled-wear strategies for critical components, which results in a further reduction of maintenance costs.

Safety first

Safety is at the heart of all Siemens operations. From production to installation, operation and service, Siemens strives to set the standard in safety.

The fail-to-safe capabilities within a turbine, combined with Siemens' superior lightning protection system, are designed to enhance security for the turbine.

Advanced operations support

Given the logistical challenges associated with servicing wind farms, Siemens has equipped its turbines with a Turbine Condition Monitoring (TCM) system that reduces the need for on-site servicing.

Continuous monitoring of turbines allows for the discovery of small faults before they become major problems.

The TCM system continuously checks the external and internal condition of the wind turbine. Twenty-four hours a day, seven days a week precise measurements are taken of vibrations in the gearbox, the generator and the main shaft bearings. The system instantly detects deviations from normal operating conditions.

Using the knowledge gained from monitoring thousands of turbines over the years, Siemens' experts are exceptionally skilled at analyzing and predicting faults within a turbine. This allows Siemens to proactively plan the service and maintenance of the turbines as each fault can be categorized and prioritized based on the severity of the fault. Siemens can then determine the most appropriate course of action to keep the turbine running at its best.

Technical specifications



Rotor

Diameter	101 m
Swept area	8,000 m ²
Rotor speed	6-16 rpm
Power regulation	Pitch regulation with variable speed

Blades

Type	B49
Length	49 m

Aerodynamic brake

Type	Full-span pitching
Activation	Active, hydraulic

Transmission system

Gearbox type	3-stage planetary/helical
Gearbox ratio	1:91
Gearbox oil filtering	Inline and offline
Gearbox cooling	Separate oil cooler
Oil volume	Approximately 400 l

Mechanical brake

Type	Hydraulic disc brake
------	----------------------

Generator

Type	Asynchronous
Nominal power	2,300 kW
Voltage	690 V
Cooling system	Integrated heat exchanger

Yaw system

Type	Active
------	--------

Monitoring system

SCADA system	WebWPS
Remote control	Full turbine control

Tower

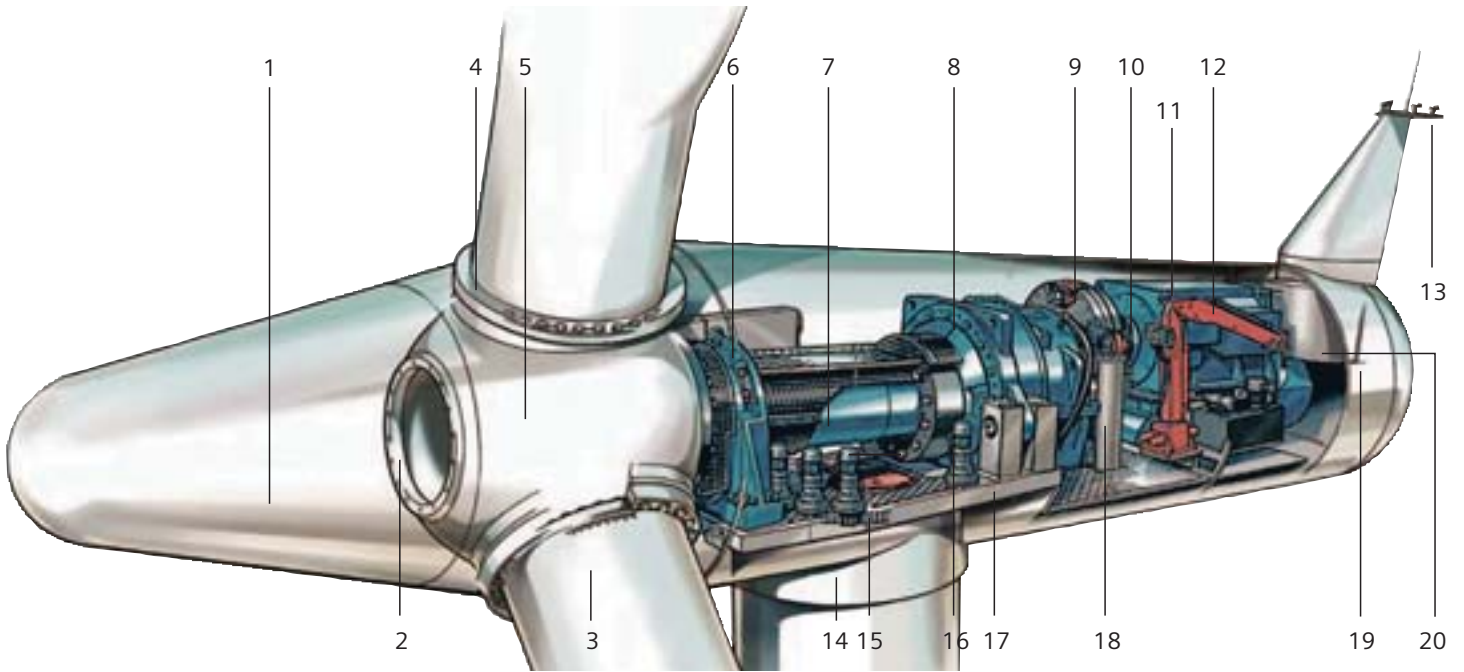
Type	Cylindrical and/or tapered tubular
Hub height	80 m or site-specific

Operational data

Cut-in wind speed	3-4 m/s
Rated power at	12-13 m/s
Cut-out wind speed	25 m/s
Maximum 3 s gust	55 m/s (standard version) 60 m/s (IEC version)

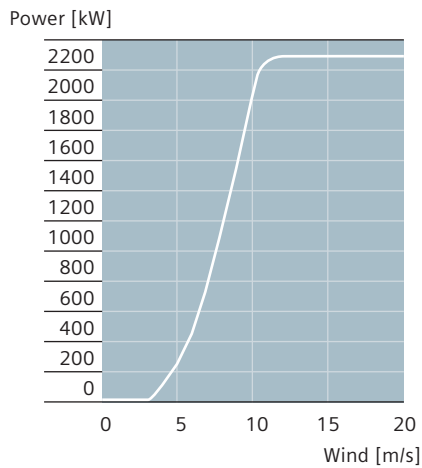
Weights

Rotor	62 tons
Nacelle	82 tons
Tower for 80-m hub height	162 tons



Sales power curve

The calculated power curve data are valid for standard conditions of 15 degrees Celsius air temperature, 1013 hPa air pressure and 1.225 kg/m³ air density, clean rotor blades and horizontal, undisturbed air flow. The calculated curve data are preliminary.



Nacelle arrangement

- | | |
|--------------------|----------------------------|
| 1. Spinner | 10. Coupling |
| 2. Spinner bracket | 11. Generator |
| 3. Blade | 12. Service crane |
| 4. Pitch bearing | 13. Meteorological sensors |
| 5. Rotor hub | 14. Tower |
| 6. Main bearing | 15. Yaw ring |
| 7. Main shaft | 16. Yaw gear |
| 8. Gearbox | 17. Nacelle bedplate |
| 9. Brake disc | 18. Oil filter |
| | 19. Canopy |
| | 20. Generator fan |

Published by and copyright © 2009:
Siemens AG
Energy Sector
Freyeslebenstrasse 1
91058 Erlangen, Germany

Siemens AG
Siemens Wind Power A/S
Borupvej 16
7330 Brande, Denmark
www.siemens.com/wind

For more information, please contact
our Customer Support Center.
Phone: +49 180 524 70 00
Fax: +49 180 524 24 71
(Charges depending on provider)
E-mail: support.energy@siemens.com

Renewable Energy Division
Order No. E50001-W310-A121-X-4A00
Printed in Germany
Dispo 34804, c4bs No. 7491
fb 2225 WS 10095.

Printed on elementary chlorine-free bleached paper.

All rights reserved.
Trademarks mentioned in this document
are the property of Siemens AG, its affiliates,
or their respective owners.

Subject to change without prior notice.
The information in this document contains
general descriptions of the technical options
available, which may not apply in all cases.
The required technical options should therefore
be specified in the contract.

SWT-2.3-101, Max. Power 1824 kW Contract Acoustic Emission, Hub Height 99.5 m

Sound Power Levels

The warranted sound power level is presented with reference to the code IEC 61400-11:2002 with amendment 1 dated 2006-05 based on a hub height of 99.5 m and a roughness length of 0.05 m as described in the IEC code. The sound power levels (L_{WA}) presented are valid for the corresponding wind speeds referenced to a height of 10 m above ground level.

Wind speed [m/s]	3	4	5	6	7	8	9	10	11	12	Up to cut-out
Sound power level	91.4	95.3	98.1	100.5	101.0	101.0	101.0	101.0	101.0	101.0	101.0

Table 1: Noise emission, L_{WA} [dB(A) re 1 pW]

Octave Band

Octave band spectra are tabulated below for 6 and 8 m/s referenced to 10 m height.

Octave band, centre frequency [Hz]	63	125	250	500	1000	2000	4000	8000
Sound power level	83.0	92.1	92.5	92.8	94.3	93.5	87.4	84.0

Table 2: Octave band for 6 m/s, L_{WA} [dB(A) re 1 pW]

Octave band, centre frequency [Hz]	63	125	250	500	1000	2000	4000	8000
Sound power level	81.9	91.3	91.4	94.7	96.1	92.7	87.4	83.7

Table 3: Octave band for 8 m/s, L_{WA} [dB(A) re 1 pW]

SWT-2.3-101, Max. Power 1903 kW Contract Acoustic Emission, Hub Height 99.5 m

Sound Power Levels

The warranted sound power level is presented with reference to the code IEC 61400-11:2002 with amendment 1 dated 2006-05 based on a hub height of 99.5 m and a roughness length of 0.05 m as described in the IEC code. The sound power levels (L_{WA}) presented are valid for the corresponding wind speeds referenced to a height of 10 m above ground level.

Wind speed [m/s]	3	4	5	6	7	8	9	10	11	12	Up to cut-out
Sound power level	91.4	95.5	99.0	101.5	102.0	102.0	102.0	102.0	102.0	102.0	102.0

Table 1: Noise emission, L_{WA} [dB(A) re 1 pW]

Octave Band

Octave band spectra are tabulated below for 6 and 8 m/s referenced to 10 m height.

Octave band, centre frequency [Hz]	63	125	250	500	1000	2000	4000	8000
Sound power level	83.4	93.3	94.5	93.7	94.4	94.7	87.3	83.5

Table 2: Octave band for 6 m/s, L_{WA} [dB(A) re 1 pW]

Octave band, centre frequency [Hz]	63	125	250	500	1000	2000	4000	8000
Sound power level	82.1	91.8	92.5	95.8	97.2	93.7	88.1	84.3

Table 3: Octave band for 8 m/s, L_{WA} [dB(A) re 1 pW]

SWT-2.3-101, Max. Power 2030 kW Contract Acoustic Emission, Hub Height 99.5 m

Sound Power Levels

The warranted sound power level is presented with reference to the code IEC 61400-11:2002 with amendment 1 dated 2006-05 based on a hub height of 99.5 m and a roughness length of 0.05 m as described in the IEC code. The sound power levels (L_{WA}) presented are valid for the corresponding wind speeds referenced to a height of 10 m above ground level.

Wind speed [m/s]	3	4	5	6	7	8	9	10	11	12	Up to cut-out
Sound power level	91.4	95.6	99.8	102.5	103.0	103.0	103.0	103.0	103.0	103.0	103.0

Table 1: Noise emission, L_{WA} [dB(A) re 1 pW]

Octave Band

Octave band spectra are tabulated below for 6 and 8 m/s referenced to 10 m height.

Octave band, centre frequency [Hz]	63	125	250	500	1000	2000	4000	8000
Sound power level	83.1	93.7	95.5	95.5	95.7	95.4	87.4	83.2

Table 2: Octave band for 6 m/s, L_{WA} [dB(A) re 1 pW]

Octave band, centre frequency [Hz]	63	125	250	500	1000	2000	4000	8000
Sound power level	82.2	92.2	93.7	97.2	98.2	94.7	88.6	84.8

Table 3: Octave band for 8 m/s, L_{WA} [dB(A) re 1 pW]

SWT-2.3-101, Max. Power 2126 kW Contract Acoustic Emission, Hub Height 99.5 m

Sound Power Levels

The warranted sound power level is presented with reference to the code IEC 61400-11:2002 with amendment 1 dated 2006-05 based on a hub height of 99.5 m and a roughness length of 0.05 m as described in the IEC code. The sound power levels (L_{WA}) presented are valid for the corresponding wind speeds referenced to a height of 10 m above ground level.

Wind speed [m/s]	3	4	5	6	7	8	9	10	11	12	Up to cut-out
Sound power level	91.4	95.7	100.3	103.5	104.0	104.0	104.0	104.0	104.0	104.0	104.0

Table 1: Noise emission, L_{WA} [dB(A) re 1 pW]

Octave Band

Octave band spectra are tabulated below for 6 and 8 m/s referenced to 10 m height.

Octave band, centre frequency [Hz]	63	125	250	500	1000	2000	4000	8000
Sound power level	82.6	93.6	96.1	97.3	97.4	96.0	87.9	83.5

Table 2: Octave band for 6 m/s, L_{WA} [dB(A) re 1 pW]

Octave band, centre frequency [Hz]	63	125	250	500	1000	2000	4000	8000
Sound power level	82.2	92.5	94.8	98.5	99.1	95.5	89.0	85.1

Table 3: Octave band for 8 m/s, L_{WA} [dB(A) re 1 pW]

SWT-2.3-101, Max. Power 2221 kW Contract Acoustic Emission, Hub Height 99.5 m

Sound Power Levels

The warranted sound power level is presented with reference to the code IEC 61400-11:2002 with amendment 1 dated 2006-05 based on a hub height of 99.5 m and a roughness length of 0.05 m as described in the IEC code. The sound power levels (L_{WA}) presented are valid for the corresponding wind speeds referenced to a height of 10 m above ground level.

Wind speed [m/s]	3	4	5	6	7	8	9	10	11	12	Up to cut-out
Sound power level	91.4	95.7	100.5	104.5	105.0	105.0	105.0	105.0	105.0	105.0	105.0

Table 1: Noise emission, L_{WA} [dB(A) re 1 pW]

Octave Band

Octave band spectra are tabulated below for 6 and 8 m/s referenced to 10 m height.

Octave band, centre frequency [Hz]	63	125	250	500	1000	2000	4000	8000
Sound power level	82.1	93.3	96.5	99.0	99.1	96.6	88.8	84.4

Table 2: Octave band for 6 m/s, L_{WA} [dB(A) re 1 pW]

Octave band, centre frequency [Hz]	63	125	250	500	1000	2000	4000	8000
Sound power level	82.4	93.0	96.0	99.8	100.1	96.5	89.6	85.7

Table 3: Octave band for 8 m/s, L_{WA} [dB(A) re 1 pW]

SWT-2.3-101

Contract Acoustic Emission, Hub Height 99.5 m

Sound Power Levels

The warranted sound power level is presented with reference to the code IEC 61400-11:2002 with amendment 1 dated 2006-05 based on a hub height of 99.5 m and a roughness length of 0.05 m as described in the IEC code. The sound power levels (L_{WA}) presented are valid for the corresponding wind speeds referenced to a height of 10 m above ground level.

Wind speed [m/s]	3	4	5	6	7	8	9	10	11	12	Up to cut-out
Sound power level	91.4	95.7	100.6	105.4	106.0	106.0	106.0	106.0	106.0	106.0	106.0

Table 1: Noise emission, L_{WA} [dB(A) re 1 pW]

Octave Band

Octave band spectra are tabulated below for 6 and 8 m/s referenced to 10 m height.

Octave band, centre frequency [Hz]	63	125	250	500	1000	2000	4000	8000
Sound power level	81.4	92.6	96.7	100.3	100.5	97.1	89.7	85.4

Table 2: Octave band for 6 m/s, L_{WA} [dB(A) re 1 pW]

Octave band, centre frequency [Hz]	63	125	250	500	1000	2000	4000	8000
Sound power level	82.5	93.4	97.1	101.1	101.1	97.4	90.2	86.2

Table 3: Octave band for 8 m/s, L_{WA} [dB(A) re 1 pW]