Experimental Test Site for Small Wind Turbines of Narbonne

Test Report n°002 version 1 of Oct. 16 2005

Bornay Inclin 1500 Wind Turbine – Grid Connected

Manufacturer	BORNAY (Spain)
Reference	INCLIN 1500
Rotor shaft	horizontal
Number of blades	2
Rotor diameter	2.86 m
Mechanical regulation type	tilting
Nominal output	1500 W at 12 m/s
Grid connection	DMI inverter
Tower type	guyed tubular
Importer	KRUG SARL – 11300 LIMOUX

Bornay Inclin 1500 installed at the Narbonne experimental test site

ADEME Agence de l'Environnement et de la Maîtrise de l'Energie Délégation Régionale Languedoc-Roussillon — la Région Languedoc Roussillon — EDF — Parc naturel régional de la Narbonnaise en Méditerranée — Ville de Narbonne Carrefour de l'Europe du Sud

Summary

1 Manufacturer Data

INCLIN 1500

Aerogeneradores · Windturbines

El Aerogenerador Inclin 1500, es el introductor del alternador de imanes de neodimio, con una potencia nominal de 1500 W, equipado con un rotor bipala con sistema de frenado automático por inclinación, y alternador trifásico de imanes de neodimio.

El Inclin 1500 es un equipo robusto, dedicado a todo tipo de usos, como repetidores de telecomunicaciones, y todos aquellos lugares de pequeños consumos como pueden ser refugios, viviendas, balizas de señalización, pequeñas granjas y un sinfín de aplicaciones.

El Inclin 1500 puede ser instalado sobre cualquier tipo de torre capaz de soportar una presión lateral de 400 Kg. y su mantenimiento se limita a una revisión anual de toda la tornillería, así como el engrase de las partes móviles.

El Inclin 1500 está protegido contra la corrosión y fabricado con materiales de gran calidad. Las partes exteriores han sido fabricadas en fibra de vidrio

El Inclin 1500 tiene una garantía de dos (2) años.

The Inclin 1500 windturbine, was the first of the Inclin neo windturbines, with a nominal power of 1500 W is equipped with a two blades rotor, automatic brake system by tilt up and neodymium permanent magnet alternator.

The Inclin 1500 is a robust windturbine, dedicated to all kind of uses like telecommunications, Cabins, Homes, Small farms Signs and some other small uses.

The Inclin 1500 can be installed in all kind of tower capable to support a lateral pressure of 400 Kgr, and the maintenance is limited to one annual revision.

The Inclin 1500 is protected against corrosion and made with durable materials. All the external parts are made with fiberglass.

The Inclin 1500 have a warranty of two (2) years.

Aplicaciones:
- Carga de baterías.
- Bombeo de agua.
- Consumos domésticos.

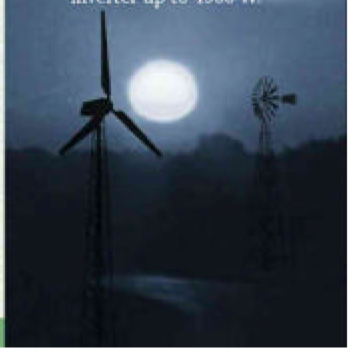
Instalaciones típicas:
- Refugios.
- Alumbrado.
- Viviendas.
- Pequeñas granjas.
- Balizas de señalización

Recomendaciones de instalación:
- 8-12 Paneles 75 W.
- Regulador de 150 Amp.
- Batería 600-1000 Ah 24 V
- Inversor hasta 2400 W.

Applications:
- Battery Charging.
- Water pump systems.
- Domestic consumes.

Typical uses:
- Cabins.
- Lighting
- Homes.
- Small farms.
- Signs.

Installation recommendations:
- 8-12 PV Panels 75 W.
- 150 Amp. regulator
- 600-1000 Ah. battery 24 V
- Inverter up to 4500 W.



Bornay AEROGENERADORES

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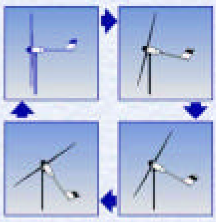
INCLIN 1500

Especificaciones · Specifications

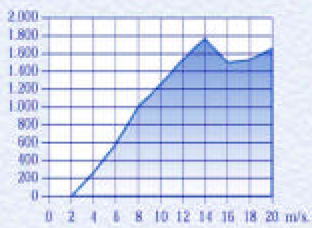
DATOS TÉCNICOS / TECHNICAL DATA

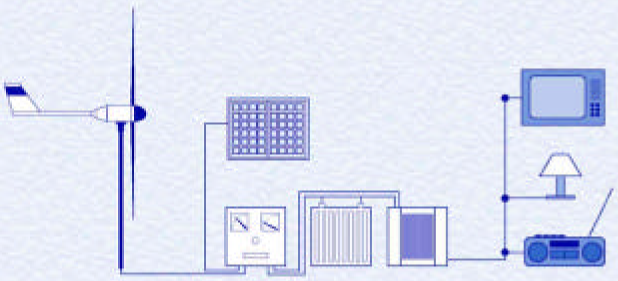
ROTOR		**ROTOR**
Nº de hélices	2	Number of blades
Diámetro	2,86 mts.	Diameter
Material	Fibra de vidrio / carbono / Carbon / glass fibers	Material
SISTEMA ELÉCTRICO		**ELECTRICAL SYSTEM**
Tipo	Alternador trifásico de imanes permanentes Three phases permanent magnet alternator	Type
Imanes	Neodimio / Neodymium	Magnets
Pot. nominal	1500 w	Nominal power
Voltaje	24, 48, 120, 220 v.	Voltage
Regulador	150 Amp. = 24, 48 v	Regulator
OPCIONAL		**OPTIONAL**
	Híbrido: freno y resistencia agua / Hybrid: brake and heat water resistance	
FUNCIONAMIENTO: Velocidad del viento		**PERFORMANCE:** Windspeed
Para arranque	3,5 m/s.	For turn on
Para Pot. nominal	12 m/s.	For nominal power
Para frenado automático	14 m/s.	For automatic brake
Peso	42 Kg.	Weight
Embalaje	1 caja de cartón - 41 x 37 x 71 cm. - 1 carton box 1 caja de cartón - 152 x 26,5 x 6 cm. - 1 carton box	Packets

SISTEMA DE FRENADO / BRAKE SYSTEM



CURVA DE POTENCIA / POWER OUTPUT





Vendedor / Dealer

2 Objectives

The Experimental Test Site for Small Wind Turbines of Narbonne is intended to observe the behaviour and the performances of small wind turbines with a rotor diameter smaller or equal to 7 meters (or generated power smaller than approximately 10kVA) proposed to the test within the framework of a voluntary program by a manufacturer or an official distributor.

The following points are studied:

- evaluation of operation, safety, quality, reliability and integrity of the wind turbine and associated systems, according to the protocol of measurements defined in this document and approaching as far as possible to the rules and procedures of the IEC WT01 and IEC61400-2 standards
- measurements of the power curve and production of electrical energy of the machine according to the wind resource, and according to the protocol of measurements defined in this document and approaching as far as possible to the IEC61400-12 standard
- measurements of noise levels at audio frequencies (acoustic noise) near the wind turbines
- evaluation of the quality of the electrical current produced, according to a protocol of measurements of grid disturbances defined by EDF R&D Department
- measurements of environmental conditions at the test site (speed, direction and turbulence of the wind, temperature, pressure and relative humidity)
- appreciation of the visual impact (investigation carried out with visitors of the experimental test site)

The recording and the process of the measurements were carried out on the test site during the period of operation of the equipment installed.

3 Installations

The test site is equipped:

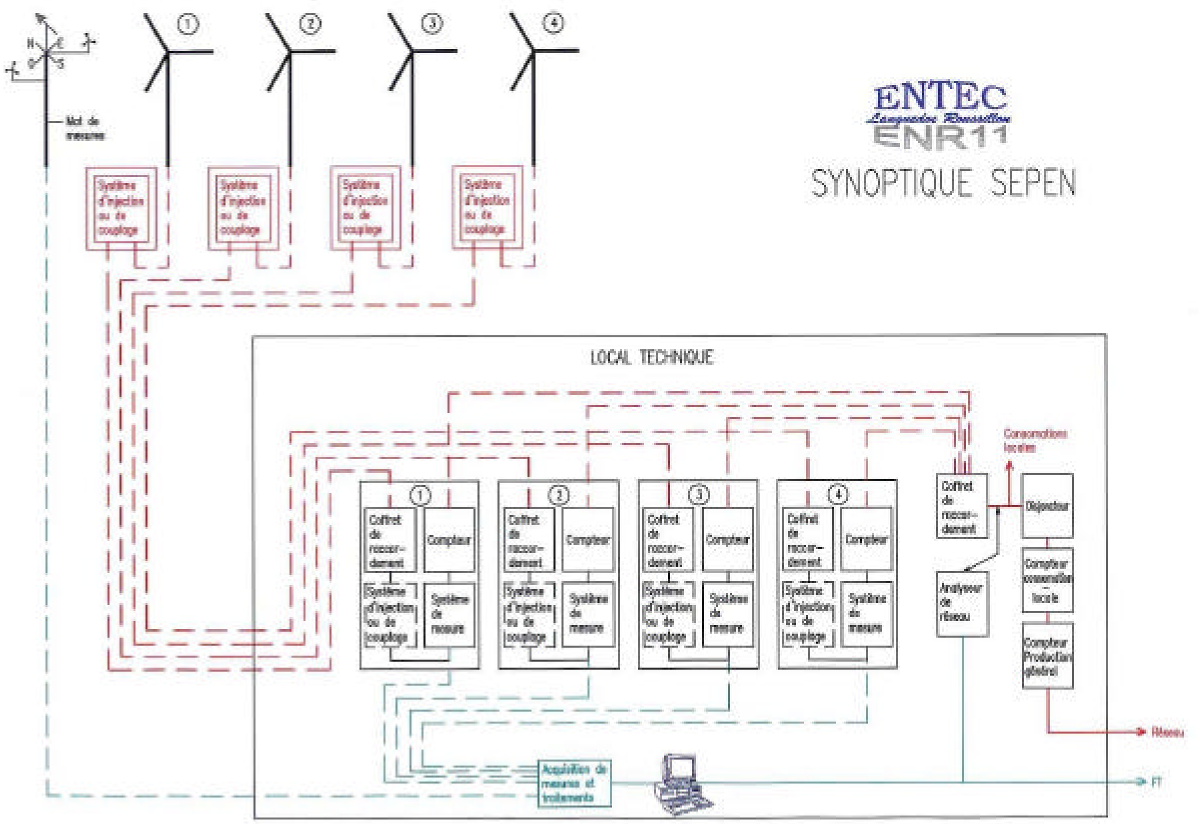
- with a technical building where are gathered:
    - equipment to accesses the grid for each wind turbine, with room reserved for the installation of the manufacturer grid connection equipment for each machine
    - safety equipments and energy meters:

    - safety equipment to disconnect the sources of energy in the event of disturbance on the grid
    - meters for generated and consumed energy
    - measurement of the grid disturbances (LEM QWave parameterized according to NF-EN-50160 standard)

  - equipments for power measurement:
    - power measurement transducers (single-phase or three-phase current balanced or not, Lumel N10A)
    - acquisition of current information by current transformers
    - output of power information by analog signal 4-20mA
    - visualization of the grid parameters (tension, current, frequency, active and reactive power …)

  - equipments for measurement of environmental parameters:
    - ambient temperature transducer (Prosensor 700PT100)
    - atmospheric pressure transducer (NRG BP20)
    - relative humidity transducer (NRG RH5)
    - insulating transducers (Phoenix Contact MCR-C-UI-UI-DCI)

  - equipments for data recording
    - dedicated desktop PC computer
    - USB data logger (IOTech Personal DAQ/56 and PDQ2 extension)
    - remote access by ADSL modem on telephone line

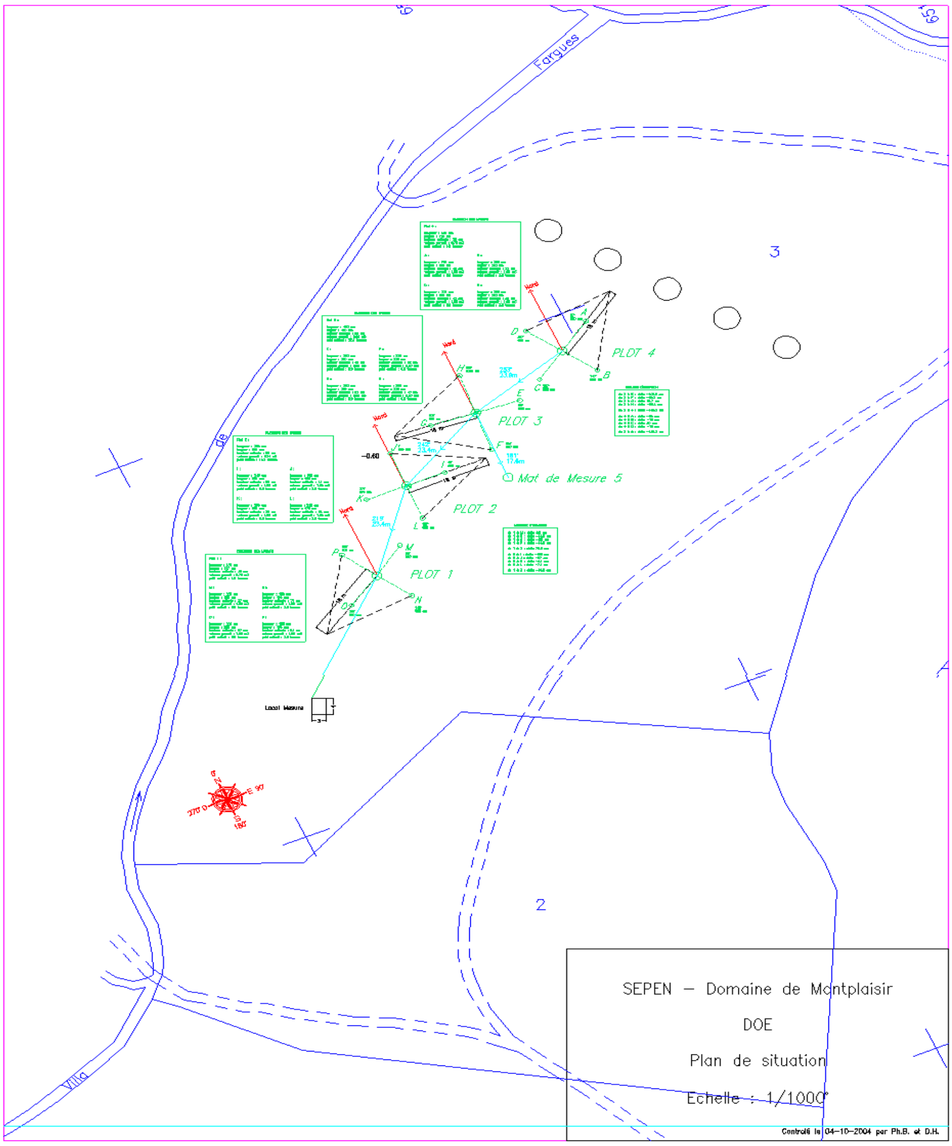


- with 4 positions for installations for the wind turbines:

  - 1 concrete base which can accept a wind turbine with a 7m rotor diameter maximum (approximately 10kVA), the wind turbine can be installed on guyed or free standing tower with a maximum height of 18m

- o 1 concrete base which can accept a wind turbine with a 5m rotor diameter maximum (approximately 5kVA), the wind turbine can be installed on guyed or free standing tower with a maximum height of 18m
- o 2 concrete bases which can accept a wind turbine with a 5m rotor diameter maximum (approximately 5kVA), the wind turbine can be installed on guyed tower only with a maximum height of 18m
- o each concrete base is intended to receive a mechanical adaptation plate for each tower from each manufacturer

- of a 20m guyed measurement tower, equipped with:
  - o 3 anemometers placed at 16, 18 and 20m (NRG # 40H including 1 calibrated)
  - o wind vanes placed at 16 and 20m (NRG # 200P)
  - o 5 signal transducers with 4-20mA output (Lumel P120 and P12U)
- equipment for noise measurement (on site only during the noise measurement campaigns)



Unless otherwise specified for a particular test, the tests will follow the following procedures:

- recording of all the data each second
- statistical processing on 1mn (average, standard deviation, min and max values)
- data recording in a computer file
- periodic visual inspection of the test site (any anomaly will be recorded and reported)
- in the event of change of equipment (measurement equipment or equipment under test) the test will be re-started
- data recorded under particular operating conditions (heavy rain, snow, ice…) will be validated in a special data base, the criteria of selection of the data will be specified in the measurement report
- throughout the measurement campaign, the data will be checked periodically to ensure the quality and the repetitiveness of the results
- a logbook will be maintained up to date on all the important events which have occurred during the measurement period
- all the data recorded during the periods of unavailability of the equipment under test will be ignored

Reports:

- each test will be concluded by a report

4 Test site environmental data

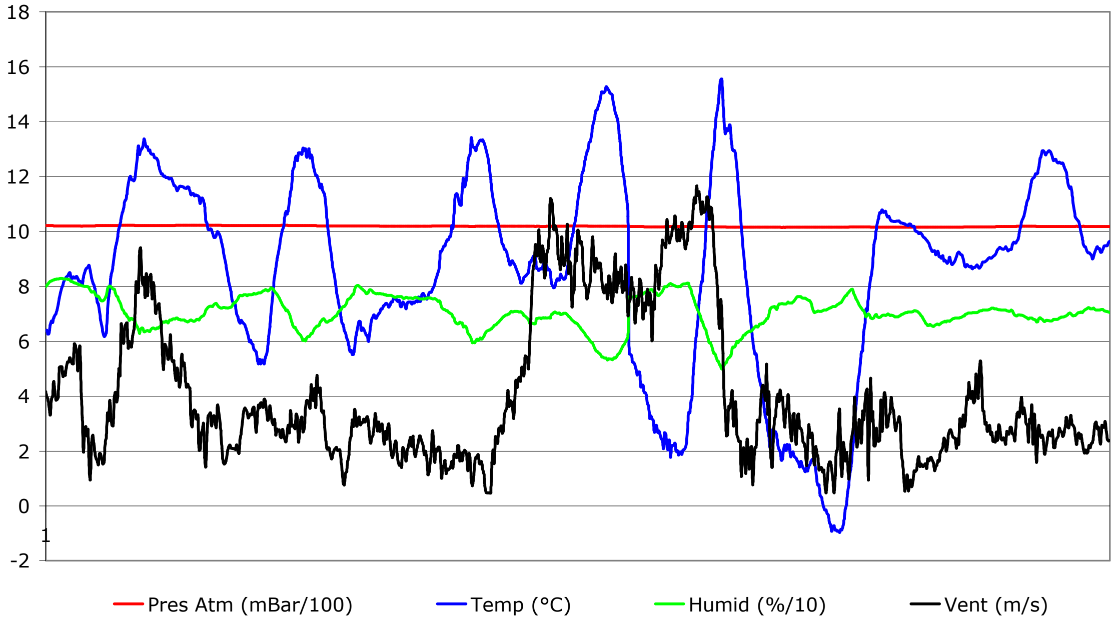
	Temperature (°C)	Relative humidity (%)	Atmospheric pressure (mbar)
Measurement campaign from December 2004 to Mars 2005			
Maximum	18,6	83	1029
Average	6,9	67	1012
Minimum	- 6,3	33	988
Measurement campaign from May to September 2005			
Maximum	38,8	-	1019
Average	22,9	-	1010
Minimum	9,5	-	999

	Wind speed at 19m (m/s)		Wind speed at 15m (m/s)
Measurement campaign from December 2004 to Mars 2005			
Instantaneous gust	30,5	-	30,2
Maximum	24,3	-	22,9
Average	7,1	-	6,0
Average standard deviation	1,0	-	1,5

	Wind speed at 20m (m/s)	Wind speed at 18m (m/s)	Wind speed at 16m (m/s)
Measurement campaign from May to September 2005			
Instantaneous gust	24,9	25,9	26,4
Maximum	17,7	17,4	16,8
Average	5,6	5,7	5,6
Average standard deviation	1,1	1,1	1,1

Example of environmental data – week from 10 to 16 January 2005

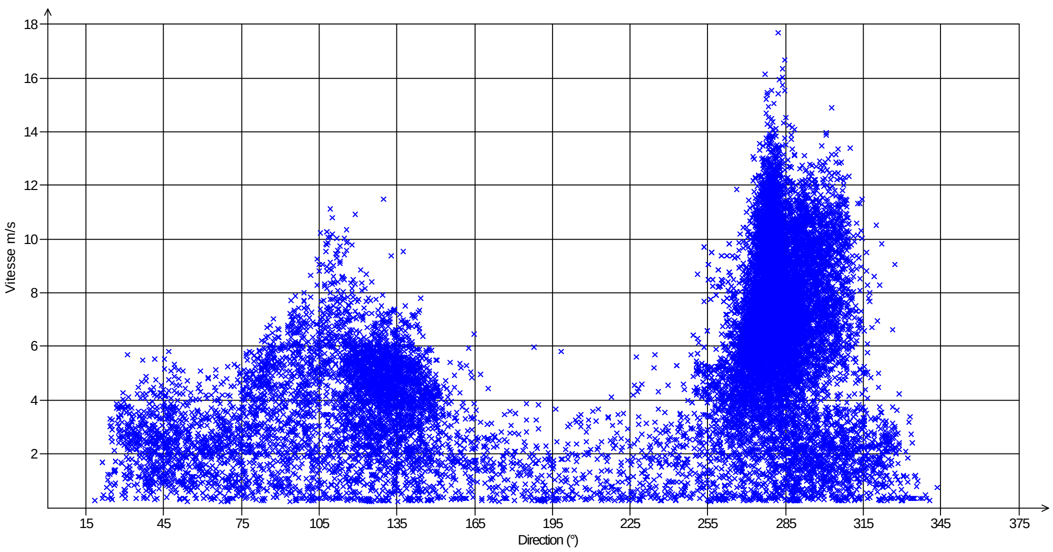
Exemple de Données Météo - Semaine du 10 au 16 Janvier 2005



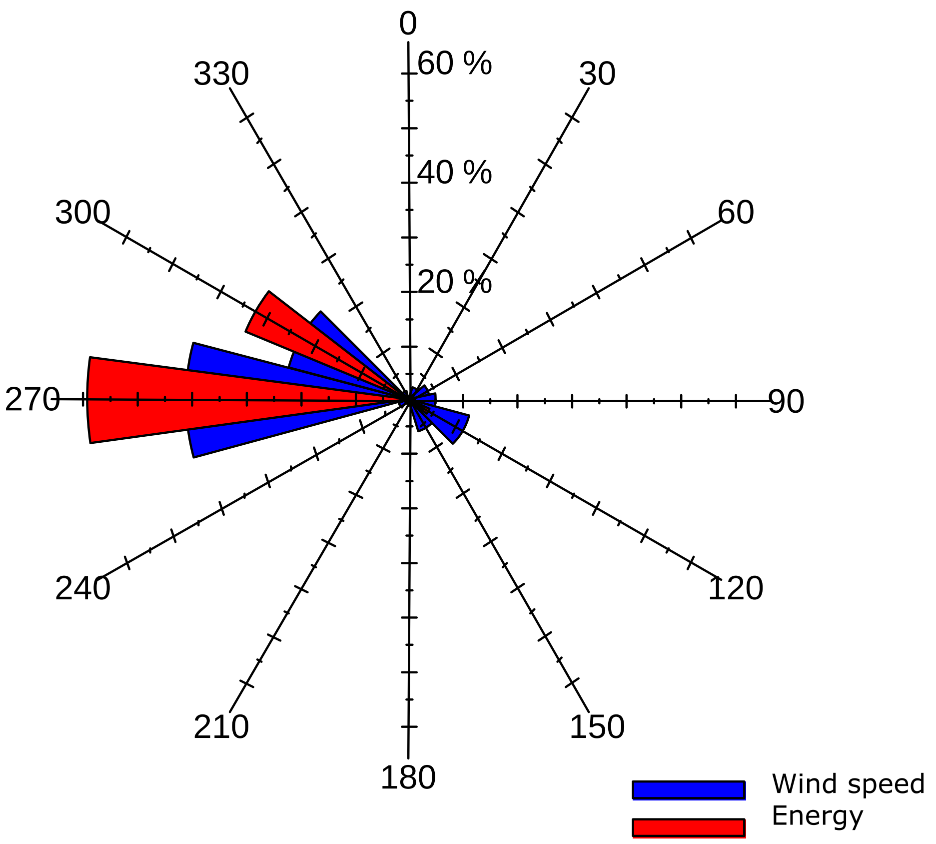
Atmospheric pressure Temperature Humidity Wind speed

Average wind speed per direction

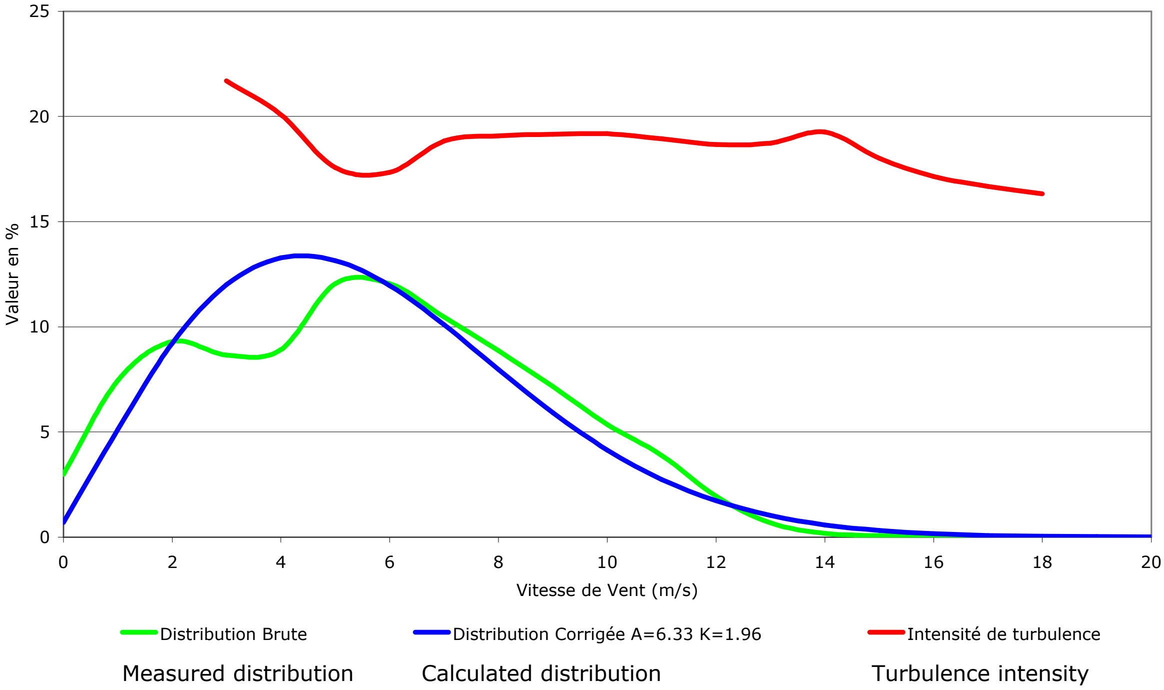
Décomposition par secteur : V1 / D1



Wind speed and energy distribution



Wind speed distribution and turbulence intensity at 20m



5 Operation and safety tests

- tests objectives
    - to check that the wind turbine shows a operational behaviour in conformity with its design
    - to check that provisions related to people safety are correctly put in practice
    - to test that the control and protection systems are functioning with satisfaction
    - to check the good dynamic behaviour of the wind turbine with at least 1.8 times the wind speed corresponding to its nominal power output (data from manufacturer)

- operation and safety tests
    - observation of yawing at various wind speeds
        - yawing is satisfactory, straight and is well amortized (without jolts nor vibrations) whatever the wind speed when the grid connection inverter is working properly (see below)
        - it appears a massive and brutal yaw rotation (the nacelle can make 2 turns on itself) at the time of the short-circuit of the machine generator by the grid connection inverter, in the event of grid loss or over power generation problems (inverter fault)
        - this abnormal operation is probably at the origin of the loss of the tail
    - start-up and stop test sequences following the protocols recommended by the manufacturer
        - the start-up sequence is automatic and controlled by the grid connection inverter, no possibility of manual intervention
        - connection to the grid by the inverter with power electronics is flexible and without mechanical jolts
        - stop sequence is by short-circuiting the stator windings of the synchronous generator in the event of grid loss
        - this system is brutal and generates a massive rotation of the nacelle
    - checking of the generated power compared to the manufacturer data
        - the measured generated power is appreciably lower than the data given by the manufacturer (approximately 600W at 9m/s for 1000W announced) even with integrating the efficiency of the grid connection inverter
        - this fact may not be attributed only to the wind turbine, the behaviour of the grid connection inverter could also be blamed

  - at low to medium wind speeds the grid connection inverter is working perfectly and this until an active power generated on the grid of approximately 600W
  - at stronger wind speed and beyond 600W, the grid connection inverter brutally put the machine stator windings in short-circuit after an operation of several minutes
  - it seems that under these conditions, internal thermal protections of the grid connection inverter enter in action to protect the power electronic components
  - when wind speeds are strong and steady, this behaviour generated:
    - the loss of the tail, probably because of too important moments of inertia
    - destruction of the stator windings of the synchronous generator of the wind turbine
  - this behaviour is illustrated by the points close to zero, beyond 10m/s, on the power curve
  - during the tests the distributor replaced the grid connection inverter without solving the problem
  - the tests were stopped after the destruction of the stator windings of the synchronous generator of the wind turbine
  - the cut-in wind speed of the machine is in conformity with the manufacturer data (approximately 3m/s)
  - see the power curves for more details

- checking of the rotor speed limitation

  - during strong winds, the rotor speed limitation per tilting action functions correctly, but generates a noticeable rise in the noise level generated by the machine
  - during strong winds, the limitation of generated power per tilting action does not seem to be compatible with the power that can be absorbed the grid connection inverter

- simulations of grid loss network (micro cut and normal cut)

  - to see comments above

- simulation of load loss (wind turbine disconnected from the grid)

  - to see comments above

- test of preventions against not authorized parameters system changes

  - no possibility of manual intervention on the parameters of the grid connection inverter
  - the metal box of the inverter is closed with screws, without display nor keys for adjustments

- checks of equipment and safety procedures (mechanical, electrical) for installation and maintenance
    - mechanical parts of the tower, nothing to report
    - remember to safely assemble the elements of the nacelle, a bolt of the nacelle cover has been found on the ground

- checking of the grounding system and lightning protection
    - it is essential to electrically connect to the ground all the mechanical parts of the tower
    - it is essential to install lightning surge protection devices at the grid connection interface

6 Reliability tests

- test objectives
    - to check structural integrity and temporal deterioration of the system, the components or the materials (cracks, deformations, wears…)
    - to check the quality of environmental protections (corrosion, paintings and joints …)
    - to check the dynamic behaviour of the wind turbine and its grid connection system over the test period

- reliability test
    - operation not very reliable during the test period
        - availability lower than 90% over the test period
        - major failures of the grid connection inverter leading to the destruction of the synchronous generator during the test period
        - December 2004: inverter break down
        - January 2005:
            - inverter replaced
            - loss of the tail vane, replaced
        - May 2005: synchronous generator break down (stator windings burned)
    - production for at least 1500 hours at unspecified wind speed
        - test not validated

- production lasting at least 250 hours at higher or equal wind speed of 1.2 times the wind speed corresponding to the nominal power output (data manufacturer data)
    - test not validated
- production lasting at least 25 hours at higher or equal wind speed of 1.8 times the wind speed corresponding to the nominal power output (data manufacturer data)
    - test not validated
- measured energy higher than 80% of expected energy (according to data manufacturer)
    - test not validated

7 Power curve measurement

- the data were recorded uninterrupted, with a sampling rate of one second:
    - wind speed at 16, 18 and 20m
    - wind direction at 16 and 20m
    - temperature on the ground
    - atmospheric pressure on the ground
    - relative humidity on the ground
    - active power at grid connection point (technical building)

- the data are sorted out by:
    - validated values compared to the sensor range
    - plausible values compared to the considered site
    - incomplete series on the 1mn measurement averaging period (60 data)
    - values outside the validated wind direction sector

To calculate validated wind direction sector for the measurement of each machine, it is necessary to take into account the neighbouring obstacles, which can be: another wind turbine, trees, measurements mast … The IEC61400-12 standard gives a calculation defining the disturbed sectors by neighbouring wind turbines according to their diameter and hub height.

Disturbed sector: $a = 2\text{Arctan}(2D_n/L_n + 0.25)$

Where Dn is the diameter of the neighbouring machine
Ln is the distance between the 2 machines

This formula has been applied for each wind turbine tower position, the following table summarizes the characteristics of the obstacles taken into account, and the limits of the disturbed sectors calculated.

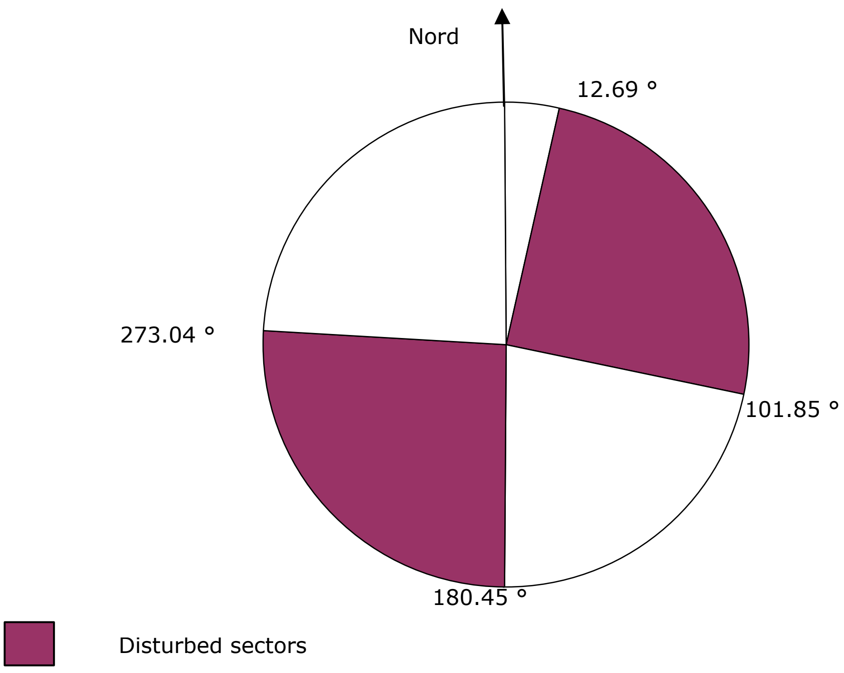
The height and the width of the obstacles other than the close machines (trees) not having been measured, the calculation was not applied for these obstacles. However, the final selected disturbed sectors are rather strongly penalizing, since they include in fact all the disturbed sectors of each machine, as represented on the following diagram.

One can notice that, compared to the Northern direction, the 2 large disturbed sectors correspond to the alignment of the 4 towers. The machines were installed so that they are facing undisturbed prevailing winds (wind of the North-West and wind of south-east).

The data processing software eliminates all the data with wind direction inside one of the 2 disturbed sectors.

Site	Obstacle	Diameter Dn	Distance Ln	Angle	Lower limit	Higher limit
1	Site 2	2.9 m	23.4 m	52.6°	12.7°	65.3°
1	trees	not calculated	not calculated	not calculated	not calculated	not calculated
2	Site 1	6.4 m	23.4 m	77.1°	180.5°	257.6°
2	Site 3	1.4 m	23.4 m	40.3°	41.8°	82.2°
3	Site 2	2.9 m	23.4 m	52.6°	215.7°	268.3°
3	Site 4	3.6 m	23.9 m	57.7 °	44.1°	101.9°
4	Site 3	1.4 m	23.9 m	40.1°	233°	273°
4	trees	not calculated	not calculated	not calculated	not calculated	not calculated

Summary table of the characteristics of the obstacles for the calculation of the disturbed sectors.

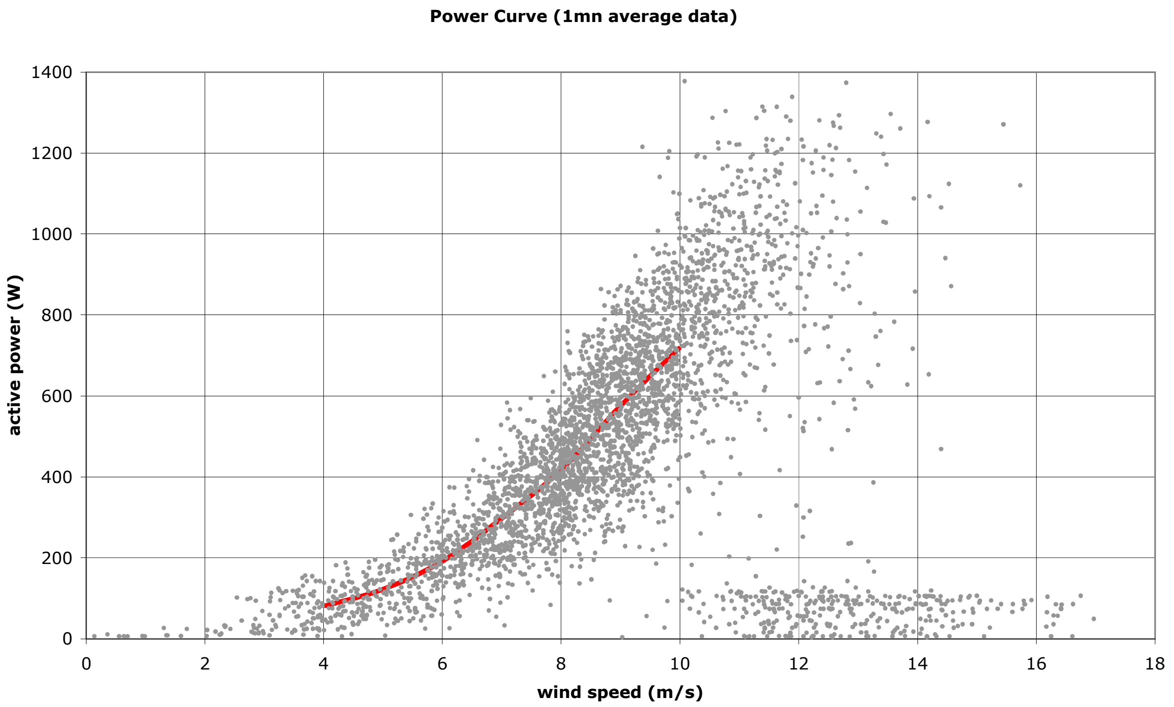


- the data are processed to extract the following information by 1mn steps:
    - average value
    - standard deviation
    - maximum value
    - minimum value

- the data are corrected according to the wind gradient

- the series are normalized for the average air density measured on the test site

- the power curve:
    - the normalized power curve is established according to the bin method (see standard IEC61400-12 §5.2)
    - the 0.5m/s bins are contiguous and aligned on the multiple of 0.5m/s
    - for each bin one records:
        - the number and values of the normalized wind speeds (representing the 1mn normalized averages)
        - the number and values of normalized active power (representing the 1mn normalized averages)
    - for each bin one calculates:
        - the total average the wind speed on the interval (total number of values divided by their number)
        - the total average of the power on the interval (total number of the values divided by their number)



8 Acoustic noise measurements

- See report in appendix

9 Measurements of power quality

- General data

The impedance of the electrical supply network at the point of injection is to be determined.

Measurements carried out correspond to the standard EN 50160 (Characteristics of the power provided by the public distribution network). The object of this standard is to provide and describe the values characterizing the supply voltage provided such as:
  - the frequency,
  - the voltage amplitude,
  - the form of the wave,
  - the symmetry of the three-phase voltages.

- Results

The period of operation were random and of short duration.

During the sequences of production, no disturbance was recorded in comparison with the standard EN 50160.

10 Appendix

- Report of acoustic noise measurements
  Dated June 23, 2005
  By Mr. Philippe Zuliani
  Noise Measurement Consultant

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Montplaisir

"Small Wind Turbine Test Site"

Acoustic Noise Measurements

Date: June 23, 2005

Summary

Objectives

Our intervention aims at specifying the acoustic impact of wind turbine on the environment. The selected site is the small wind turbine test site of Montplaisir in Narbonne.

Principle

The site of Montplaisir comprises 4 positions which receive 4 small wind turbines simultaneously. The figure in the following pages specifies the relative position of the towers of the wind turbines.

The analysis of this noise impact is done with reference to the French law text of April 18, 1995, decree 95-408 "Limitation of the neighbourhood noises". It fixes values of emergence not to be exceeded: 5 dB (A) during day time (7am to 10pm) and 3 dB (A) during night time (10pm to 7am). Emergence being the difference in noise levels recorded when the machine is operating (ambient noise) and when the machine is not operating (residual noise).

For each tower, or for each wind turbine installed on the towers, we considered 4 measurement points (points numbered 1, 3, 5, 7) respectively located at distances of 5m, 10m, 20m and 35m of the tower.

For each one of these points we recorded the ambient noise and the residual noise, and by calculating the difference between the 2, we determined emergence.

The records, of either ambient noise or residual noise for one point of analysis, consisted in carrying out five records of 10sec during one period of 5mn.
These measurements of 10sec are carried out through an analysis in frequency whose base is the third of octave.

The study is carried out tower after tower. With only one wind turbine functioning at the site at any one time, we measured its four characteristic points, the ambient noise, then we stopped the wind turbine to measure for these four points the level of residual noise. This procedure has been repeated for the three other wind turbines.

With these noise measurements are associated wind speed measurements recorded with an anemometer placed on a metrological mast located at the centre of the site.

In order to be able to appreciate the variability of the sound level of the wind turbines, we proceeded to 3 series of measurement at 3 different times (different days). By measurement campaign we define a characterization of all measurement points of the site for ambient noise and residual noise, at a given day.

Measurements

Equipment used

- Real time noise analyzer CESVA, standard RC-401.

Measurement campaign

Three wind turbines were operating.

The table below specifies the characteristics of these sites, indicating:

- the type of wind turbine
- the position of each tower
- series of measurements carried out, characterized by their date

Wind turbine	Mast	Series of measurement		
		1st February 2005	4 Mars 2005	May 31, 2005
Bornay 1500	2	done	done	unavailable

The results are presented in the appendices.

Analysis

The three campaigns correspond to three wind configurations: if the wind came systematically North West, its strength fluctuated. At the time of the first campaign, we can regard it as very strong (between 15 and 25m/s). During the second campaign, it was medium to strong (between 10 and 20m/s). During the third campaign, we can estimate it as being low to medium (between 5 and 15m/s).

The strength of the wind has an immediate impact on the perceived residual noise, depending on the neighbouring highway circulation, but especially depending on the surrounding vegetation (presence of pine trees and vegetation of the scrubland type).

We see that the residual noise varies from 66dBA to 52dBA, in general the residual noise is more important on the peak (position 1 and 3) that on the slope of the test site (positions 5 and 7).

We can conclude that the fairly dense presence of vegetation conditions noise levels, this is far from being negligible, reaching values higher than 60dBA, varying in an important way according to the wind speed.

Moreover the noise spectrum is very specific, with a maximum energy around the 1000Hz octave.

Bornay Inclin 1500

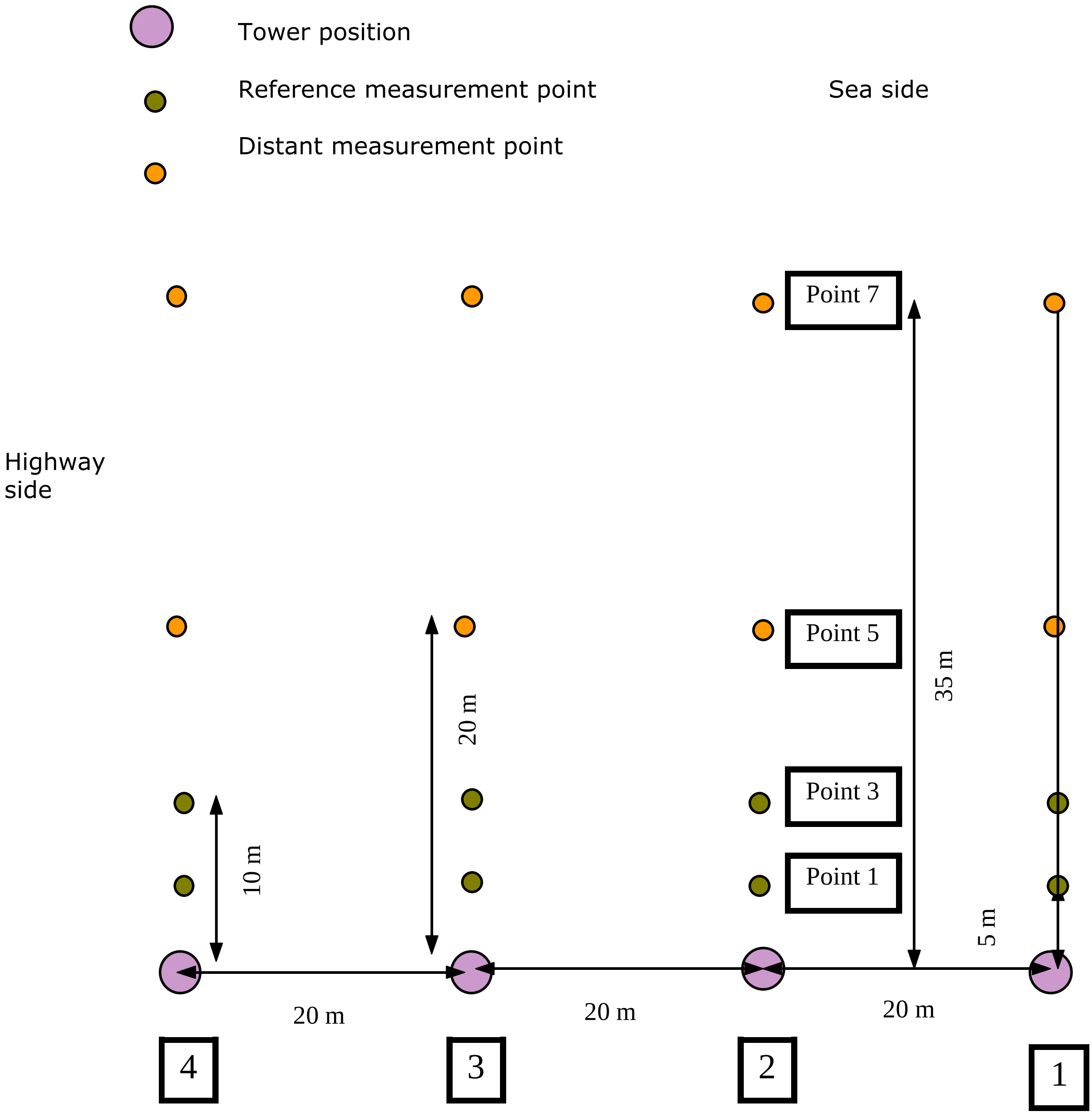
This wind turbine is the subject of a specific study: after a high rotation speed for a short period, it stops and thus does not to produce any more noise. This way of operation does not correspond to a normal use.

During the operation time, the wind turbine can generate some very important emergences at sizeable distances: Point 7 (36m), first campaign, emergence of 14dBA.

This type of operation is thus to be banned for this type of wind turbine.

Conclusion

This first series of measurement made it possible to validate the metrological protocol. This type of investigation makes it possible to practically apprehend the sound emission of wind turbines within the framework of their environmental impact.



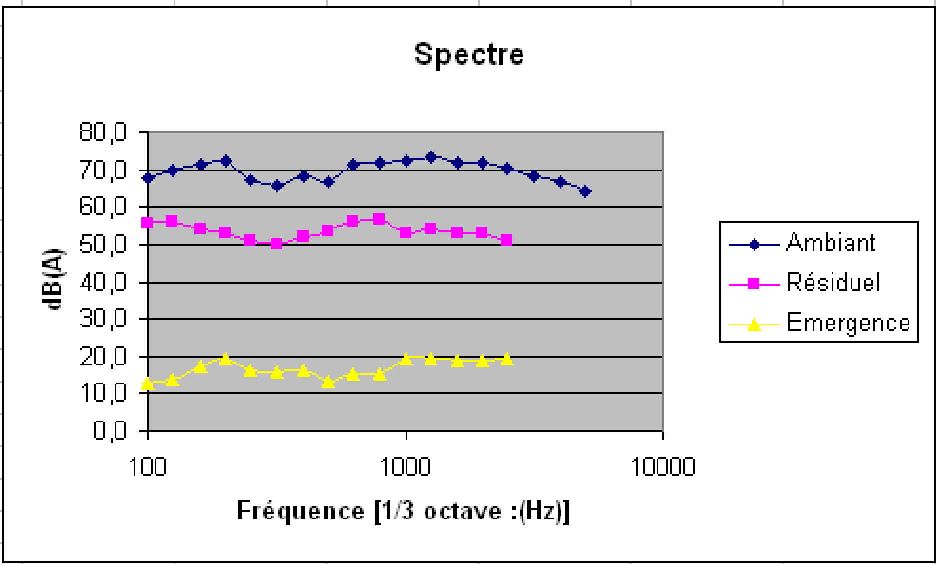
Measurement Point Positions

Characterization of the noise level of the Bornay Inclin 1500 wind turbine

Tower 2

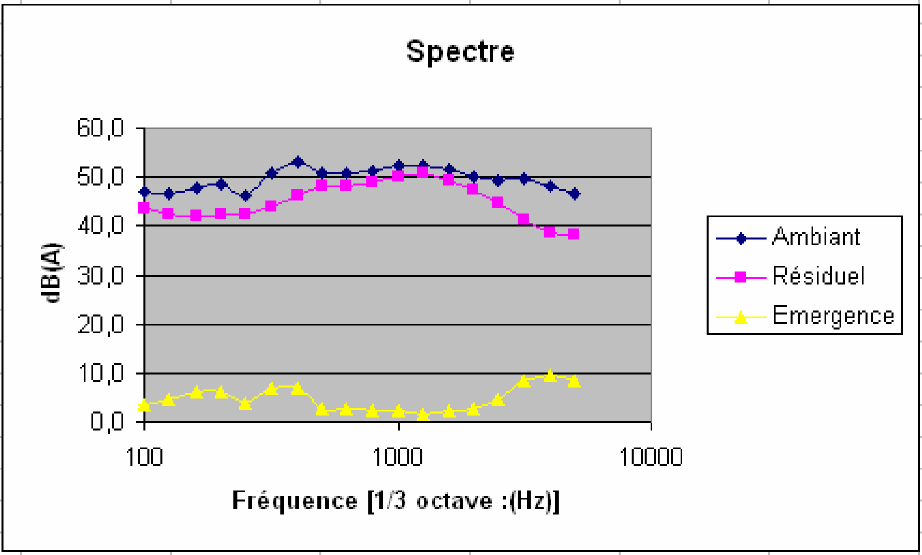
Point 1

Date :	01/02/2005	Campagne	1



1/3 Octave	Ambiant	Résiduel	Emergence
100	68,0	55,4	12,6
125	69,8	55,8	14,0
160	71,1	53,9	17,2
200	72,4	52,9	19,5
250	67,3	51,0	16,3
315	65,6	50,0	15,6
400	68,3	52,0	16,3
500	66,9	53,7	13,2
630	71,2	56,1	15,1
800	71,8	56,4	15,4
1000	72,4	53,2	19,2
1250	73,4	54,1	19,3
1600	72,1	53,2	18,9
2000	71,7	53,1	18,6
2500	70,3	50,8	19,5

Date :	04/03/2005	Campagne	2



1/3 Octave	Ambiant	Résiduel	Emergence
100	47,2	43,7	3,5
125	46,8	42,3	4,5
160	47,9	41,9	6,0
200	48,4	42,4	6,0
250	46,4	42,5	3,9
315	50,8	43,9	6,9
400	53,0	46,1	6,9
500	50,9	48,3	2,7
630	50,7	48,2	2,5
800	51,2	49,0	2,2
1000	52,4	50,1	2,3
1250	52,5	51,0	1,5
1600	51,7	49,4	2,3
2000	49,9	47,3	2,6
2500	49,3	44,7	4,6
3150	49,8	41,2	8,6
4000	48,3	38,7	9,6
5000	46,8	38,4	8,4
Global	63,0	59,3	3,7

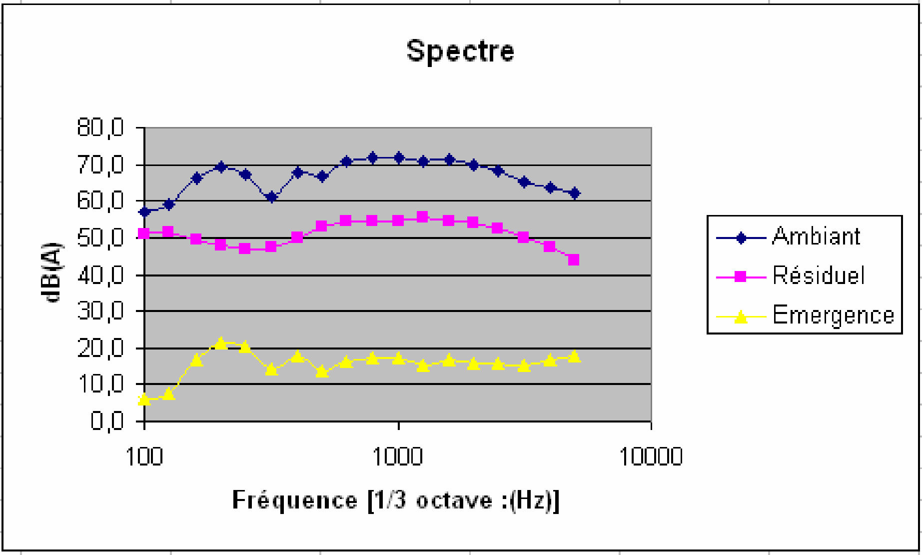
Vent m/s	10	10,4

Characterization of the noise level of the Bornay Inclin 1500 wind turbine

Tower 2

Point 3

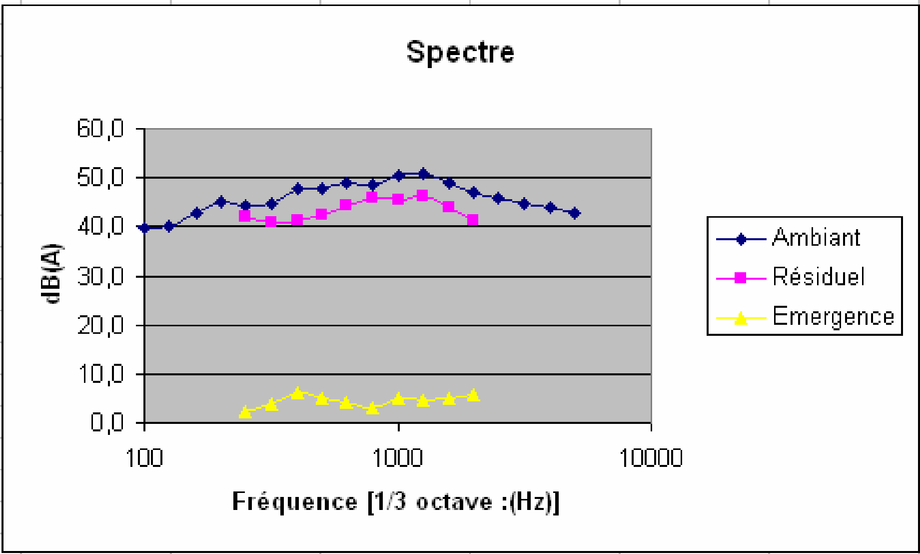
Date :	01/02/2005	Campagne	1



1/3 Octave	Ambiant	Résiduel	Emergence
100	57,1	50,8	6,3
125	59,2	51,7	7,5
160	66,4	49,6	16,8
200	69,4	47,8	21,6
250	67,2	47,0	20,2
315	61,3	47,2	14,1
400	67,6	49,9	17,7
500	66,6	52,8	13,8
630	70,6	54,5	16,1
800	71,8	54,7	17,1
1000	71,6	54,3	17,3
1250	70,6	55,3	15,3
1600	71,1	54,4	16,7
2000	69,7	53,9	15,9
2500	68,2	52,5	15,8
3150	65,3	49,9	15,4
4000	63,9	47,3	16,6
5000	62,1	44,0	18,1
Global	80,8	64,9	15,9

Vent m/s	AV	AV

Date :	04/03/2005	Campagne	2



1/3 Octave	Ambiant	Résiduel	Emergence
100	39,7	0,0	0,0
125	40,1	0,0	0,0
160	42,9	0,0	0,0
200	45,0	0,0	0,0
250	44,3	42,0	2,3
315	44,7	40,8	3,9
400	47,6	41,4	6,2
500	47,8	42,6	5,2
630	48,8	44,4	4,4
800	48,6	45,7	2,9
1000	50,5	45,6	4,9
1250	50,9	46,2	4,7
1600	49,0	44,1	4,9
2000	47,0	41,3	5,7
2500	46,0	0,0	0,0
3150	44,6	0,0	0,0
4000	43,9	0,0	0,0
5000	42,9	0,0	0,0
Global	59,5	54,5	5,0

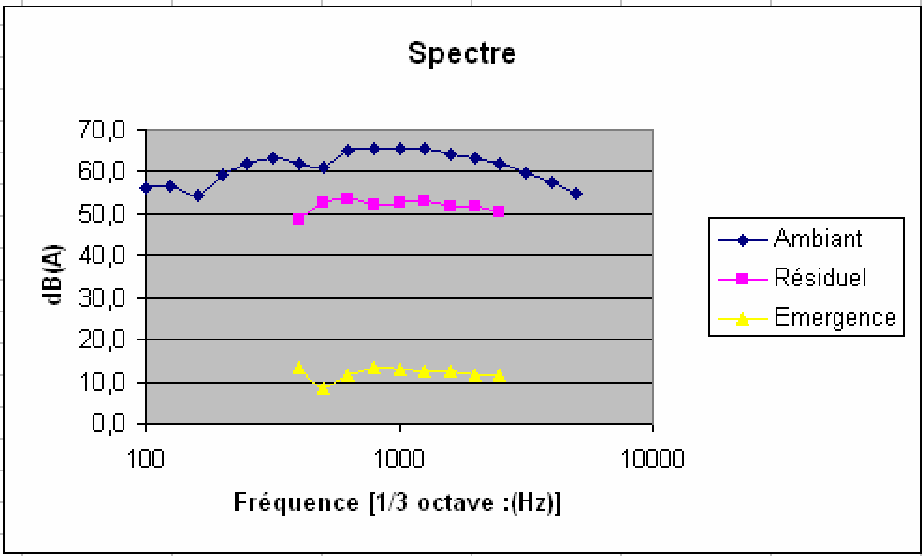
Vent m/s	12,2	10,1

Characterization of the noise level of the Bornay Inclin 1500 wind turbine

Tower 2

Point 5

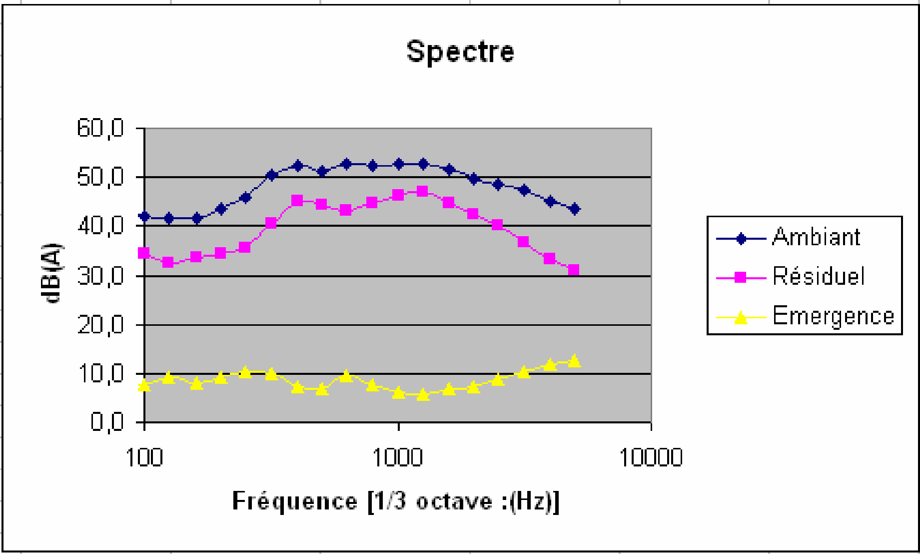
Date :	01/02/2005	Campagne	1



1/3 Octave	Ambiant	Résiduel	Emergence
100	56,4	0,0	0,0
125	56,5	0,0	0,0
160	54,4	0,0	0,0
200	59,1	0,0	0,0
250	61,8	0,0	0,0
315	63,1	0,0	0,0
400	62,0	48,8	13,3
500	61,2	52,6	8,6
630	65,1	53,5	11,6
800	65,4	52,1	13,3
1000	65,5	52,6	12,9
1250	65,5	53,0	12,5
1600	64,4	51,9	12,5
2000	63,2	51,8	11,4
2500	62,1	50,5	11,7
3150	59,9	0,0	0,0
4000	57,4	0,0	0,0
5000	55,0	0,0	0,0
Global	75,0	61,6	13,4

Vent m/s	AV	AV

Date :	04/03/2005	Campagne	2



1/3 Octave	Ambiant	Résiduel	Emergence
100	42,0	34,4	7,5
125	41,8	32,5	9,3
160	41,5	33,6	7,9
200	43,5	34,3	9,2
250	45,8	35,4	10,4
315	50,5	40,6	9,9
400	52,5	45,1	7,5
500	51,1	44,4	6,7
630	52,7	43,1	9,6
800	52,5	44,8	7,7
1000	52,6	46,4	6,2
1250	52,8	47,0	5,8
1600	51,6	44,6	7,0
2000	49,8	42,5	7,3
2500	48,7	40,0	8,7
3150	47,2	36,8	10,5
4000	45,0	33,1	11,9
5000	43,7	31,0	12,7
Global	62,4	54,8	7,6

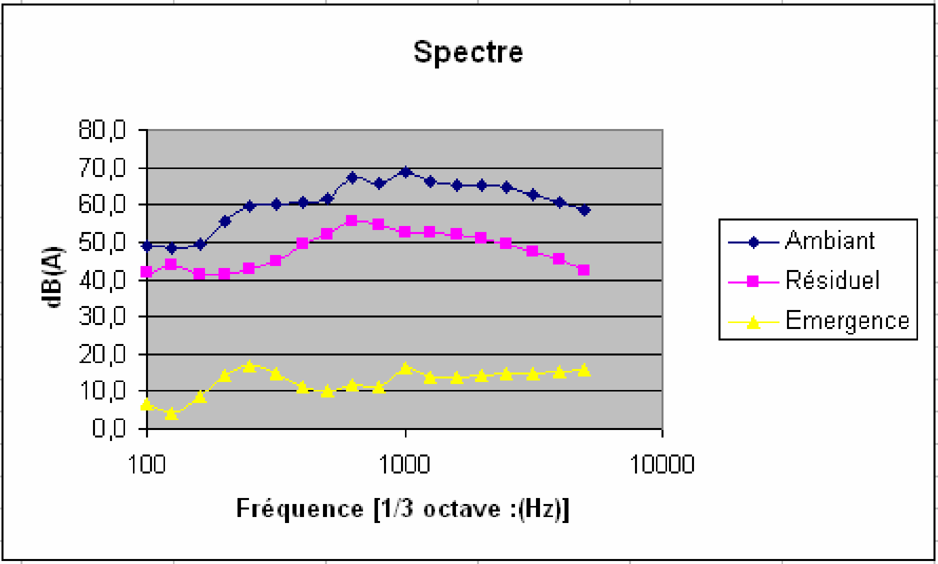
Vent m/s	AV	AV

Characterization of the noise level of the Bornay Inclin 1500 wind turbine

Tower 2

Point 7

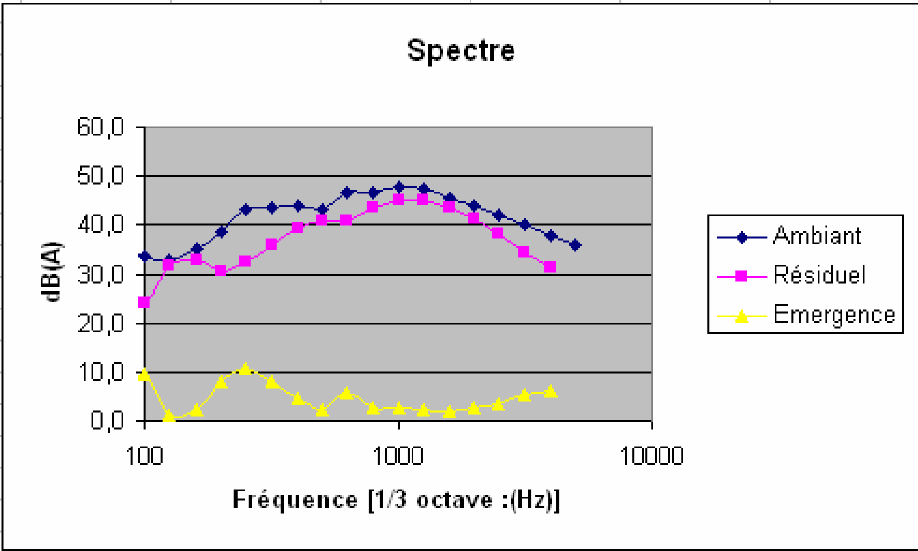
Date :	01/02/2005	Campagne	1



1/3 Octave	Ambiant	Résiduel	Emergence
100	48,7	42,0	6,7
125	48,3	44,1	4,2
160	49,6	41,1	8,5
200	55,4	41,2	14,2
250	59,4	42,8	16,6
315	59,9	44,9	15,0
400	60,6	49,3	11,3
500	61,9	51,8	10,1
630	67,1	55,4	11,7
800	65,7	54,6	11,1
1000	68,7	52,5	16,2
1250	66,4	52,7	13,7
1600	65,4	51,7	13,7
2000	65,2	50,8	14,4
2500	64,5	49,7	14,8
3150	62,6	47,6	15,0
4000	60,7	45,2	15,5
5000	58,4	42,5	15,9
Global	76,1	62,7	13,4

Vent m/s	AV	AV

Date :	04/03/2005	**Campagne**	2



1/3 Octave	Ambiant	Résiduel	Emergence
100	33,5	23,9	9,6
125	32,9	31,8	1,1
160	35,3	33,0	2,2
200	38,6	30,6	8,0
250	43,1	32,4	10,7
315	43,6	35,8	7,9
400	44,1	39,5	4,5
500	43,2	40,8	2,4
630	46,5	41,0	5,6
800	46,6	43,7	2,9
1000	48,0	45,1	2,8
1250	47,3	44,9	2,4
1600	45,3	43,4	1,9
2000	43,9	41,4	2,6
2500	41,9	38,3	3,6
3150	40,0	34,6	5,4
4000	37,7	31,5	6,2
5000	35,9	0,0	0,0
Global	56,1	52,6	3,5

Vent m/s	11,4	10,5