Laboratory 3 – Wind turbine noise

Location/meeting point: Basement of Kemicentrum, in front of the elevator

Background

As wind turbines become more common in Europe, the importance of controlling the noise emissions from turbines become more important. The acceptance of wind power is dependent on minimising the number of people disturbed by the installations. One common cause of disturbance is the low frequency noise emissions and it is therefore important to have a good knowledge on the measurement of the noise emanating from wind turbine installations and of the evaluation of the measurements.

The measurement and analysis of wind turbine noise emissions is regulated through the IEC61400-11 standard. The standard precisely describes the measurement method. It regulates among other things, the sensors applied, the placement of the sensors and how to analyse the data. Focus is on sound power, 3rd octave bands and tonalities. All data have to be measured at what is called wind bins. The measurements have to be performed at various wind speeds which in turn mean that the setup is dependent on environmental conditions as well as on the topography. All taken together, a measurement campaign can take long time and be quite costly.

Purpose

The main purpose of this assignment is to investigate the method described in IEC61400-11 and to apply it on a model of a wind turbine. Since only a model of a wind turbine is used, many of the phenomena present in a real measurement will be absent but the IEC61400-11 protocol shall still be adhered to in as close detail as possible. The following tasks shall also be addressed.

- Measure the wind turbine model in a sufficiently large and quiet room following as closely as possible the IEC61400-11 standard.
- Assess the wind turbine according to the standard.
- Create an Excel sheet to perform the calculations/plots detailed in IEC61400-11.
- Detail any simplifications made and discuss their impact on the measurements.

A copy of the IEC61400-11 standard and any necessary equipment can be borrowed from the supervisors.

Laboratory report

The laboratory report shall be written on computer, printed and stapled. It shall be handed in Juan's or Delphine's tray at the third floor of the *Kemicentrum*, at latest one week after the laboratory exercise have been carried out.

Read the *"Guidelines on how to write a technical report"* (available on the course website) so as to know what it should be included in the final report.

Wind turbine specifications

V112-3.45 MW™ IEC IA
Facts & figures

POWER REGULATION Pitch regulated with variable speed

OPERATING DATA

Rated power	3,450 kW
Cut-in wind speed	3 m/s
Cut-out wind speed	25 m/s
Re cut-in wind speed	23 m/s
Wind class	IEC IA

Standard operating temperature range from -20°C* to +45°C with de-rating above 30°C

*subject to different temperature options

SOUND POWER
(Noise modes dependent on site and country)

ROTOR

Rotor diameter	112 m
Swept area	9,852 m²
Air brake	full blade feathering with 3 pitch cylinders

ELECTRICAL

Frequency	50/60 Hz
Converter	full scale

GEARBOX

Type	two planetary stages and one helical stage

TOWER

Hub height	69 m (IEC IA) and 94 m (IEC IA)

NACELLE DIMENSIONS

Height for transport	3.4 m
Height installed (incl. CoolerTop®)	6.9 m
Length	12.8 m
Width	4.2 m

HUB DIMENSIONS

Max. transport height	3.8 m
Max. transport width	3.8 m
Max. transport length	5.5 m

BLADE DIMENSIONS

Length	54.7 m
Max. chord	4 m

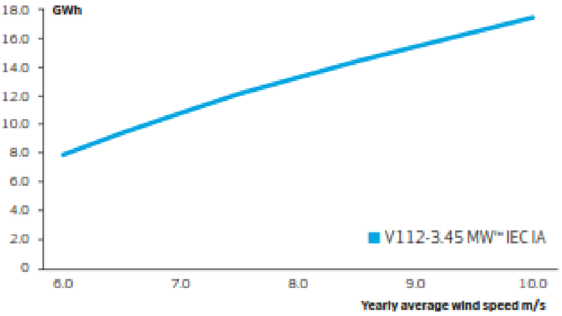
Max. weight per unit for transportation	70 metric tonnes

TURBINE OPTIONS

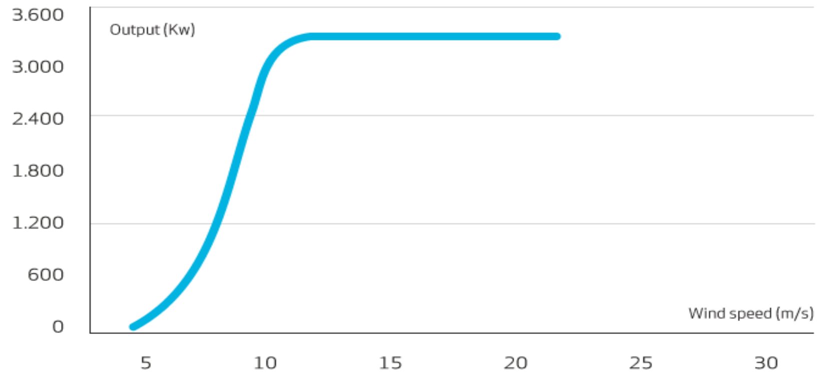
- Power Mode (site specific)
- Condition Monitoring System
- Service Personnel Lift
- Vestas Ice Detection
- Vestas De-Icing
- Low Temperature Operation to - 30°C
- Fire Suppression

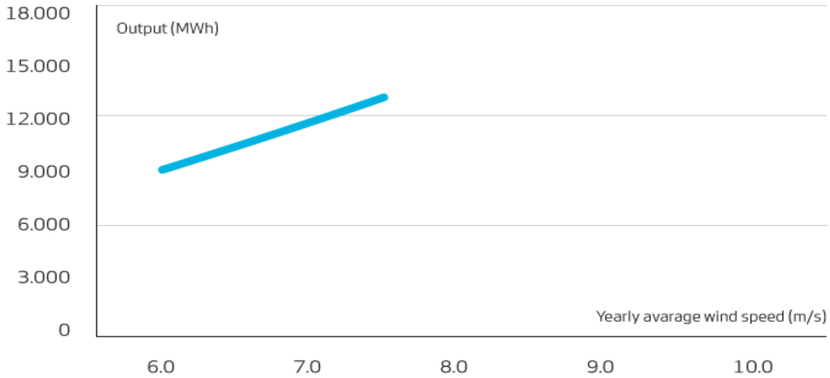
- Shadow detection
- Increased Cut-In
- Nacelle Hatch for Air Inlet
- Aviation Lights
- Aviation Markings on the Blades
- Obstacle Collision Avoidance System (OCAS™)

ANNUAL ENERGY PRODUCTION



Assumptions
One wind turbine, 100% availability, 0% losses, k factor =2, Standard air density = 1.225, wind speed at hub height



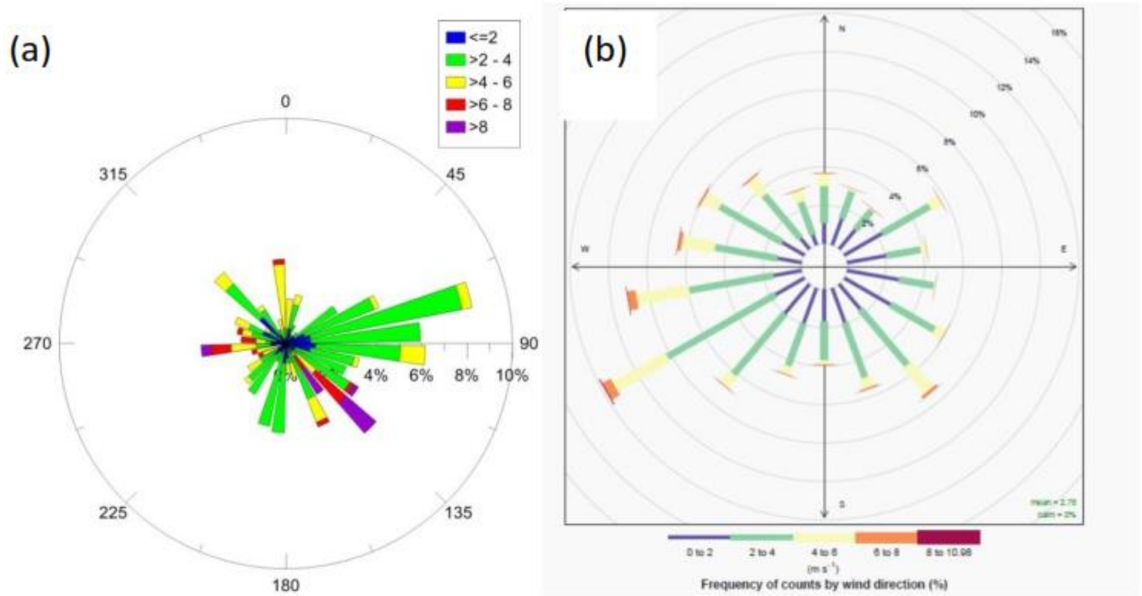


Assumptions
One wind turbine, 100% availability, 0% losses, k factor =2,
Standard air density = 1.225, wind speed at hub height

Wind Turbine Generator (WTG) Classes (IEC 61400-1)

Wind Class/Turbulence	**Annual average wind speed at hub-height (m/s)**	**Extreme 50-year gust in meters/second (miles/hour)**
Ia High wind - Higher Turbulence 18%	10.0	70 (156)
Ib High wind - Lower Turbulence 16%	10.0	70 (156)
IIa Medium wind - Higher Turbulence 18%	8.5	59.5 (133)
IIb Medium wind - Lower Turbulence 16%	8.5	59.5 (133)
IIIa Low wind - Higher Turbulence 18%	7.5	52.5 (117)
IIIb Low wind - Lower Turbulence 16%	7.5	52.5 (117)
IV	6.0	42.0 (94)

Wind rose in Malmö



Figur 6. Vindros för Malmö från oktober 2009 (a), och för perioden oktober 2009 – september 2012 (b).

Standards extracts

See attached document