Offshore CREYAP Part 2:
Scope of Work, Inputs and Deliverables

Introduction

This document outlines the scope of work for the Offshore CREYAP Part 2 resource and energy yield comparison exercise. It describes the inputs that are provided in the data pack and the results that the participants should produce and submit to EWEA.

Results should be provided using the *Offshore CREYAP 2 Output Template* provided in the data pack.

The exercise is based on the operating Barrow offshore wind farm (see Figure 1), which consists of 30 Vestas V90 3-MW turbines. Using the wind data provided, participants will derive the net energy yield for Barrow, accounting for wind speed variations over time and across the site, and for wake effects.

Since the power and thrust curves for the turbines are known, this exercise is supposed to provide a realistic prediction of the actual Barrow wind farm energy yield. It is intended not only as a comparative exercise using publically-available information about the wind farm, but also as a bench mark exercise gauging how well the industry can predict actual offshore wind farm productions.

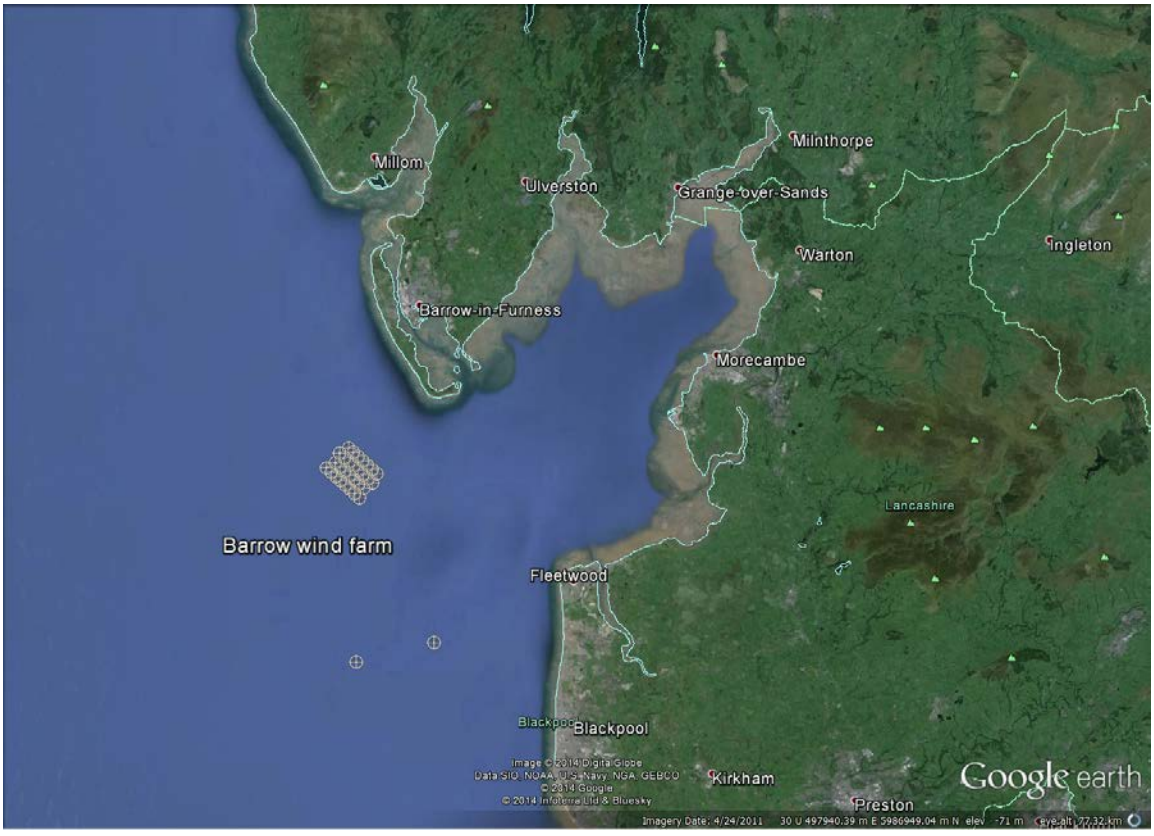

Figure 1: Location of the operational Barrow wind farm in the Irish Sea. The two markers south of the wind farm show the locations of two met. masts at Shell Flat Sandbank. Image from Google Earth Pro (2014).

Input Data

This section describes the data that are provided in the *Offshore CREYAP 2 Data Pack*. Participants should use only this data for their analysis, unless stated otherwise in the instructions.

Site Wind Data

13 months of data measured at the 80-m Shell Flat met. mast are provided, including anemometers at 82, 80, 70 and 50 m HAT and wind vanes at 80 and 50 m HAT (Crown Estate). Data from a 50-m mast nearby are also available. It shall be assumed that the anemometers are fully IEC-compliant and require no bias corrections. The two meteorological masts are described in the document *10_6121_001_GLA_O_R_002 Shell Flats Installation and Commissioning Report B1.pdf*.

The data include wind speed, standard deviation and direction in 10-minute bins. North reference is True North; the site metric coordinate system is UTM Zone 30N, WGS84. Instrument heights are referenced to Highest Astronomical Tide (HAT), which is 5.3 m above mean sea level (MSL).

Reference Wind Data

In order to derive a long-term wind speed prediction, as well as predictions for other periods, 16 years of hourly wind speed and direction data from the MERRA database have been provided for the closest grid point to the Shell Flat 80-m mast, covering the period 01/01/1998 to 31/12/2013. The MERRA data is for a height of 50 m above mean sea level at the location 54.0 degrees North, 3.332 degrees West (WGS 1984). The north reference is True North.

Temperature and Pressure Data

13 months of temperature and pressure data measured at the Shell Flat masts are provided, in order to calculate the air density.

Wind Farm Data

The following data are provided for the Barrow wind farm; see *Barrow layout.xlsx* and *PC and Ct.xlsx*:

- Turbine layout coordinates
- Turbine power and thrust curves
- Turbine hub height and rotor diameter

Net Yield Loss Factors

Loss factors to include in the calculation of the net energy yield are provided in the table below. These loss factors are not derived from the actual wind farm and are used here for calculations only.

Loss Factor Component	Value
Turbine Availability	95.0%
Accessibility	99.0%
Balance of Plant Availability	99.0%
Grid Availability	99.9%
Electrical Efficiency	98.5%
Turbine Performance Degradation	99.5%
High Wind Speed Hysteresis	99.5%

Required Outputs

The participants are asked to derive the following results for comparison. An output template is provided for the reporting of these results: *Offshore CREYAP 2 Output Template.xlsx*.

Long-term Site Climate

The long-term wind climate at Shell Flat should be derived. There are no significant wake losses from neighbouring wind farms in the time period covered by the wind farm data. The following outputs should be produced:

- Observed mean wind speed at 82 m (HAT) at the 80-m Shell Flat mast location
- Long-term mean wind speed at 82 m (HAT) at the 80-m Shell Flat mast location
- Uncertainty on the ten-year mean wind speed
- Long-term frequency distributions of wind speed and direction
- Measured mean turbulence as a function of wind speed and direction
- Long-term mean wind speed at 75 m (MSL) at the 80-m Shell Flat mast location
- Mean site air density at wind turbine hub height (75 m MSL)

Conditions at Barrow Turbine Locations

- Long-term, mean free-stream wind speed at hub height at all Barrow turbine locations, by extrapolating from the mast location.

Barrow Energy Yield

The energy yield for Barrow should be derived, ignoring any wake effects from neighbouring wind farms. Both **1-year** (for the 12-month period 2008-02 to 2009-01) and **long-term** values (10 y) should be given. The following outputs should be produced:

- A hub-height *Reference Yield*, which is the predicted long term energy yield (Shell Flat mast) without accounting for wake effects or wind speed variation across the site.
- The total predicted array (wake) efficiency for Barrow
- A wind farm *Gross Yield*, which is the predicted energy yield including the effects of wakes from Barrow turbines and wind speed variation across the site.
- The Gross Yield and array (wake) efficiency for each individual turbine
- A breakdown of the Gross Yield binned into 12 direction sectors, each of width 30 degrees.
- A P50 *Net Yield,* which is the predicted yield after accounting for wake effects, wind speed variations across the site, and the loss factors given in Table 1.
- Total uncertainty on the Net Yield and the resulting P90 estimate, along with uncertainty estimates for each of a number of main uncertainty components.

Notes on Expected Methodology

Participants are expected to derive a long-term wind speed and directional distribution at the 80-m Shell Flat mast using the MERRA data provided in an MCP approach or similar. Air density and turbulence intensity should be based on site-measured data only and should be vertically extrapolated to turbine hub heights where applicable. Extrapolation of wind speeds in the vertical and across the wind farm area should be performed using a method of the participant's choice.

Other offshore wind farms may exist in this area of the Irish Sea, some operational and some in planning. However, wake effects from all of these wind farms should be ignored for the purposes of this exercise. It shall be assumed that the wind data provided represents the free-stream conditions at the Shell Flat met. masts.

For all tasks, participants will be asked for a brief description of the methodology used.

Notes on participating teams

Participants are finally asked to provide information about their team and company regarding:

- Number of persons in team
- Number of years in wind power industry
- Type of company
- Approximate number of wind farm projects
- Education as wind energy master or similar
- Continuing education courses in wind energy
- Courses in software tools and models used
- In-house training in wind and yield assessments
- Participation in previous CREYAP exercises

More information is provided in the output template.

Contents of data pack

The data pack is a single ZIP archive containing the following files:

- Barrow layout.xlsx
- Datalogger signal list for 80m mast.xlsx
- Datalogger signal list for 50m mast.xlsx
- MERRA_W03.332_N54.000.xlsx
- Offshore CREYAP 2 - Instructions.pdf
- Offshore CREYAP 2 - Output Template.xlsx
- PC and Ct.xlsx
- Shell_Flats_1_80mHAT.xlsx
- Shell_Flats_2_50mHAT.xlsx

Terms and conditions

This document describes the data pack and instructions for the Offshore CREYAP 2 exercise. All data and information may be copyrighted and should only be used for this Offshore CREYAP 2 exercise. Participants must agree to specific terms and conditions when downloading the data pack from EWEA's web site.

Acknowledgements

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