Offshore CREYAP Part 1: Scope of Work, Inputs and Deliverables

Introduction

This document outlines the scope of work for the Offshore CREYAP Part 1 energy yield comparison exercise. It describes the inputs that are provided in the data pack and the results that participants should produce.

Results should be provided using the Offshore CREYAP Output Template.xlsx provided in the data pack and the completed output spread sheet should be emailed to Tim Robinson, EWEA: techworkshops@ewea.org by **30 September 2013**. Each participant will be sent a reference code that will be used to refer to their submission in case of queries and in the presentation of the results of the comparison exercise at EWEA OFFSHORE 2013, Frankfurt, on 21 November 2013. In this way EWEA will keep the identity of each participant anonymous.

The exercise is based on the under-construction Gwynt y Mor offshore wind farm (see Figure 1), which will consist of 160 Siemens 3.6MW turbines. Using wind data provided, participants will derive the net energy yield for Gwynt y Mor, accounting for wind speed variation across the site and wake effects.

Since the exact power and thrust curve for the turbines is unknown, this exercise is not an accurate prediction of the actual Gwynt y Mor energy yield. It is intended purely as a comparative exercise using publically-available information about the wind farm.

A secondary exercise is also included, in which participants are asked to derive the predicted wake impact of Gwynt y Mor upon the operational North Hoyle offshore wind farm. This will facilitate a comparison of inter-farm wake models.

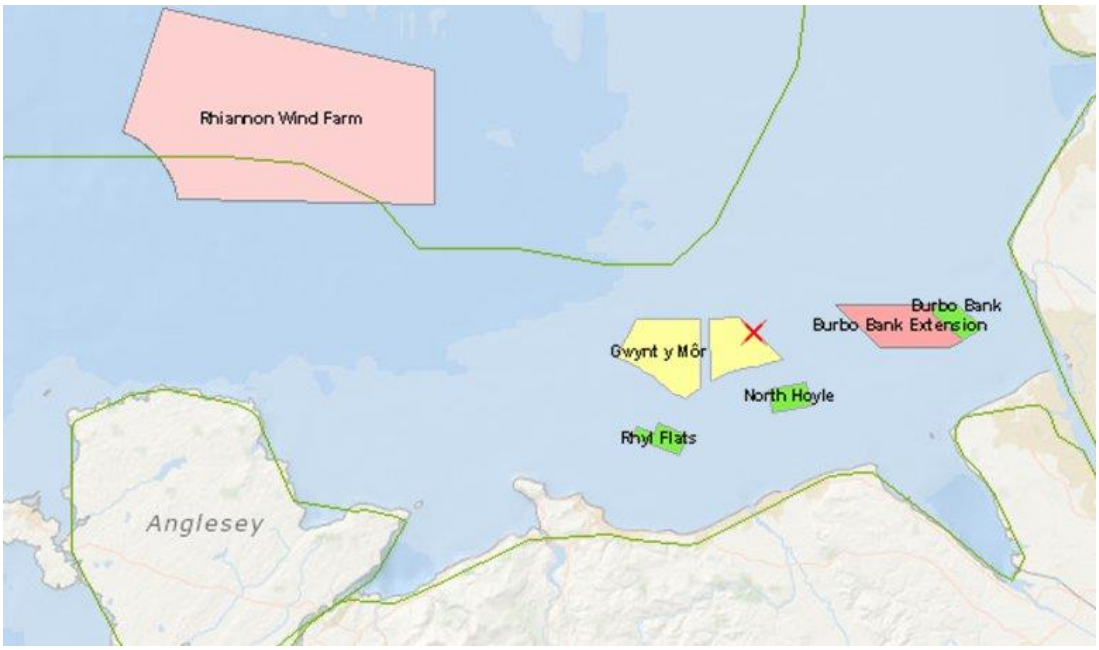

Figure 1: Location of planned (red), under-construction (yellow) and operational (red) wind farms near Gwynt y Mor. The red cross shows the approximate location of the Gwynt y Mor met mast in the eastern half of the project area. Image taken from www.4coffshore.com.

Input Data

This section describes the data that are provided in the data pack. Participants should use only this data for their analysis.

Site Wind Data

2.5 years of data measured at the Gwynt y Mor met mast are provided, including one anemometer (at 85m AMSL) and one wind vane (at 82m AMSL). **The data have been fully quality-controlled and mast effects have been removed.** Therefore, participants should use the wind data exactly as provided with no modifications or corrections. It shall be assumed that the anemometer is fully IEC-compliant and requires no bias corrections.

The data includes wind speed, standard deviation and direction in 10-minute bins. The north reference is Grid North, the coordinate system is UTM 1984 Zone 30N.

A mean wind shear power-law exponent of **0.10** should be used to vertically extrapolate wind speeds where required.

Reference Wind Data

In order to derive a long-term wind speed prediction, 11 years of hourly wind speed and direction data from the MERRA database have been provided for the closest point to the Gwynt y Mor mast, covering the period 01/01/2002 to 31/05/2013. The MERRA data is for a height of 50m above mean sea level at the location 53.5 degrees North, 3.33 degrees West (WGS 1984). The north reference is True North.

Temperature and Pressure Data

1.5 years of temperature and pressure data measured at the Gwynt y Mor mast at a height of 20m are provided, in order to calculate the air density.

Wind Farm Data

The following data are provided for both the Gwynt y Mor and North Hoyle wind farms, based on publically-available information:

- Turbine layout coordinates
- Turbine power and thrust curves
- Turbine hub height and rotor diameter
- High wind speed cut-out and restart speeds
- Turbine rotational speeds (maximum and minimum)

Net Yield Loss Factors

Loss factors to include in the calculation of the net energy yield are provided in Table 1 below. *These are generic loss factors only and are not specific to Gwynt y Mor.*

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

Table 1: Loss factors for calculation of the net energy yield

The loss due to high wind speed hysteresis should be derived by the participants as part of the energy yield calculation.

Required Outputs

The participants are asked to derive the following results for comparison. An output template is provided for the reporting of these results.

Long Term Site Climate

The long term wind climate at Gwynt y Mor should be derived. **Participants should ignore the effects of any nearby wind farms that were operational during the measurement period**; the data should be treated as if these wind farms did not exist. The following outputs should be produced:

- Long term mean wind speed at the Gwynt y Mor mast location, at measurement height
- Uncertainty on the ten-year mean wind speed
- Long term frequency distribution of wind speed and direction
- Measured mean turbulence as a function of wind speed and direction
- Mean site air density at measurement height

Conditions at Gwynt y Mor Turbine Locations

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

Gwynt y Mor Energy Yield

The energy yield for Gwynt y Mor should be derived, **ignoring any wake effects from neighbouring wind farms**. The following outputs should be produced:

- A hub height *Reference Yield*, which is the predicted long term energy yield without accounting for wake effects or wind speed variation across the site.
- The total predicted array (wake) efficiency for Gwynt y Mor
- A wind farm *Gross Yield*, which is the predicted energy yield including the effects of wakes from Gwynt y Mor turbines and wind speed variation across the site.

- The Gross Yield 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 energy yield after accounting for the loss factors given in Table 1.
- Total uncertainty on the Net Yield and the resulting P90 estimate, along with a list of uncertainty components

Effect of Gwynt y Mor upon North Hoyle

- The predicted total Gross Energy Yield for North Hoyle **excluding** the effect of Gwynt y Mor and ignoring all other nearby wind farms, including the effects of internal wakes and wind speed variation across the site.
- The predicted total Gross Energy Yield for North Hoyle **including** the wake effects from Gwynt y Mor

Loss due to Export System Constraint

As a final task, participants are asked to calculate the annual Net Energy Yield for Gwynt y Mor assuming that the capacity of the export system was constrained to a constant 500MW. The resulting yield shall be presented along with a percentage loss caused by the export constraint.

Notes on Expected Methodology

Participants are expected to derive a long term wind speed and directional distribution at the Gwynt y Mor mast using the MERRA data provided in a MCP approach. 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 across the wind farm area and between the two wind farms should be performed using a method of the participant's choice. Commonly, a mesoscale model would be used.

Other offshore wind farms 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 Gwynt y Mor met mast.

The final task of estimating the loss due to export system constraint is included because it is a common feature of offshore wind farms. The methodology used for this calculation is the choice of the participant, but it is recommended that relevant losses (especially turbine unavailability) are taken into account.

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

If you have any questions regarding the exercise or your submission please contact:

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