Comparative Resource & Energy Yield Assessment Procedures Part II

Description of Input Data and Model Outputs

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Revision History

Issue	Date	Author	Nature And Location Of Change
01	15 Jan 2013	Euan C George	First created
02	1 Feb 2013	Euan C George	Minor amendments applied
03	6 Feb 2013	Euan C George	Minor amendments applied
04	19 Aug 2013	Euan C George	Updated following participant feedback

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1.0 FOREWORD

Following the closing date for submissions for the CREYAP II exercise, comments were fed back from two participants regarding the reliability of the processed MERRA data supplied within the data pack. An investigation by RES confirmed that the processed MERRA data contained an error and has subsequently also called the ground-based reference data supplied in the same data pack into question.

The investigation found an anomaly within the processed MERRA data at this particular location which, coupled with a suspect period of data from the ground-based reference station, resulted in both datasets yielding similar prediction results. As a result, the error remained undetected. Outcomes of the investigation by RES are available via the EWEA website[1].

This amended data pack has been made available for participants of CREYAP II who wish to resubmit results. The scope of the assessment has been reduced to allow users to perform a simplified analysis. Updated results will be presented at the AWEA Wind Resource & Project Energy Assessment Seminar in December 2013.

2.0 ANALYSIS REQUIRED FOR RESUBMISSION OF RESULTS

The scope of the revised data pack has been reduced such that participants are invited to predict the wind farm performance for the **production period only** (see Figure 1). That is, the elements of analysis set out in Section 3.0 of this report should be predicted for the period **July 2007 - June 2012 only**. This allows for a direct comparison of results with production data, and removes any ambiguity related to the choice of historic period. Further guidance and assumptions for the exercise are set out in Section 3.0.

Results will be compared with production data for the period specified above. Production data will be corrected for an availability of 96.8%, but will not be corrected for windiness.

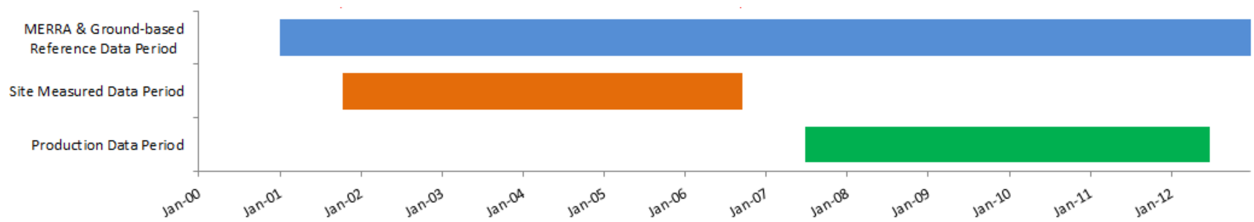

Figure 1 - Reference, Site Measured and Production Data Periods

Reference Data Period	01/01/2001 - 31/12/2012
Site Measured Data Period	10/10/2001 - 18/09/2006
Production Data Period	01/07/2007 - 30/06/2012

Please note that the reference data supplied in this data pack supersedes those which were supplied in the original data pack. All other model inputs remain unchanged. For more information regarding the model inputs and outputs, see Section 3.0.

[1] Results of RES investigation available on the EWEA Website

3.0 INTRODUCTION

This document outlines the input data provided as well as the required results format of the Comparative Resource and Energy Yield Assessment Procedures (CREYAP) Part II exercise, in which parties are invited to carry out a wind speed and energy yield prediction for a wind farm project with the aim of comparing results of different industry standard models and approaches. Participants' results will be independently compared and contrasted with one another, as well as against real wind farm performance data.

This exercise builds on the CREYAP exercise performed for the 2011 EWEA Wind Resource Assessment Technology Workshop. The CREYAP Pt I exercise invited participants to analyse and report, amongst other information, the measured wind climate and net energy yield for a 14 turbine wind farm. Inputs included site measured data, terrain and layout data, and a range of simplified assumptions that were to be applied. Participants' results were independently collated and compared on a relative basis.

The CREYAP Pt II exercise builds on the previous exercise by providing a wider range of inputs, including roughness and obstacle information, a choice of reference data, and a comprehensive site assessment measurement campaign designed to improve the spatial resolution of the site measured data. In addition to this, participants' results will be independently analysed and compared with wind farm production data from the site analysed in this case study. To enable the comparison to be undertaken the production period estimate of actual performance of the wind farm has been derived from production data taken from July 2007 to June 2012 and normalised to an overall availability (turbine, grid, & balance of plant) of 96.8%.

It should be noted that all digital data supplied with this package are under licence and once used for the purposes of this study should be deleted and not used for any other purpose.

4.0 INPUT DATA DESCRIPTION

The following data are provided for the resource assessment comparison (Aug 2013 release):

1) Files "*Wind Data - M49.xlsx*" & "*Wind Data - M50 M51 M52 M53 M54 M55.xlsx*" contain quality controlled measured mean wind speed, standard deviation of wind speed and direction data from the site wind speed resource assessment masts on a 10-minute time base. Measurement heights are specified in these files, whilst boom orientations for anemometers on all masts can be considered to be south-west. Wind speeds have been measured using Class I, MEASNET calibrated, high quality industry standard anemometers with IEC standard compliant mounting arrangements. The data come with calibration factors applied and directional data are relative to Ordnance Survey of GB Datum GB1936 (OS) grid North. A drawing of the mast locations can be seen in Figure 2.

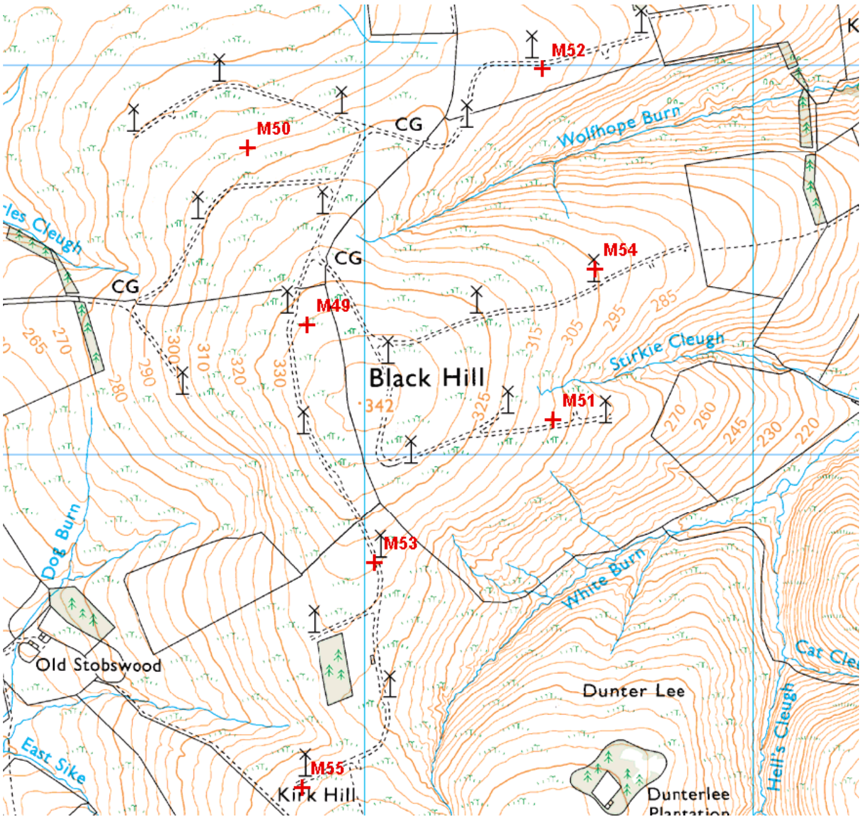

Figure 2 - Mast Locations

The measurement campaign at this site involved the deployment of M49 as the primary site assessment mast for the period of October 2001 to September 2006. For the period of October 2001 to March 2002, two site assessment masts were deployed on short measurement campaigns at six locations around the site, providing an increased spatial resolution of site measured data. The measurement periods for each mast are displayed in Figure 3.

It should be assumed that a total of 0.24% of the available data at M49 has been lost due to icing. All remaining masts have not lost any data as a result of icing.

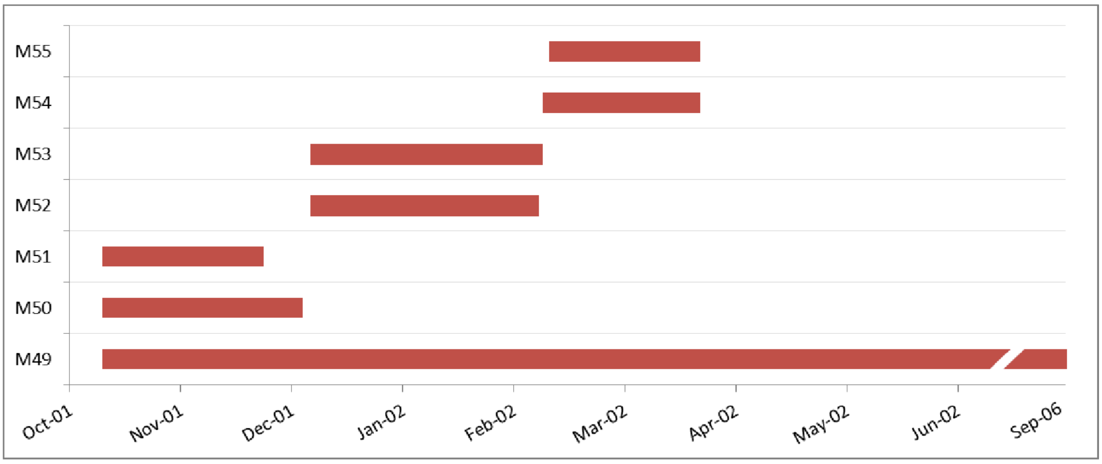

Figure 3 - Site Assessment Measurement Campaign

2) Files "*Reference Station (Ground Based).xlsx*" & "*Reference Station (MERRA).xlsx*" contain wind speed and direction data from two reference data sources. The former file contains data from a ground based measurement system, while the latter file contains reanalysis data.

   "*Reference Station (Ground Based).xlsx*" provides concurrent hourly wind speed and direction data on the worksheet, "*Hourly Means*". Concurrent and production period data are provided in the form of monthly mean wind speed data on the worksheet, "*Monthly Mean Wind Speed*", and frequency distributions on the worksheet "*Frequency Distribution*". Wind speeds are in knots, measured at 10 m AGL, and directional data are relative to True North.

   "*Reference Station (MERRA).xlsx*" provides concurrent hourly wind speed and direction data on the worksheet, "*Hourly Means*". Wind speeds are in m/s, simulated at a height of 50 m AGL, and directional data are relative to True North.

   Participants are invited to use one or both of the reference data sources, whichever is most suitable.

3) File "*Masts & Turbines Info.xlsx*" contains the grid coordinates of the site wind speed resource assessment mast locations as well as the wind turbines of the project layout. Grid coordinates are in the OS coordinate system. File "*Turbine and Mast Layout drawing.pdf*" shows the turbine and mast locations on an OS topographic background map.

4) A power and thrust coefficient curve as well as further parameters for a typical 1.3 MW wind turbine are provided in file "*Masts & Turbines Info.xls*". The power and thrust data are valid for an air density of 1.10 kg/m^3. For the purpose of this assessment, the mean site air density shall be assumed to be 1.208 kg/m^3 at 2 m AGL at M49. The turbines have a hub height of 47 m, and rotor diameter of 62 m.

5) A digital terrain model (DTM) is provided in file "*Digital Terrain Model.xyz*" in the OS coordinate system, located within the folder "*Terrain & Roughness Data*". This is 50 m gridded height data with the Easting [m], Northing [m] and elevation [m] data provided in xyz text file format for the site and the surrounding area.

6) Roughness contours and obstacle characteristics have been supplied as a shape file, "*Roughness Contours.shp*" in the folder "*Terrain & Roughness Data*". Roughness length values (Z_0) for the roughness contours, as well as obstacle height (H) and porosity (P) information can be found in "*Roughness Contours Drawing.pdf*". All other areas shall be assumed uniform with a roughness length of 0.03 m.

7) A 690V/33kV transformer is installed at the base of each turbine. The on-site cabling system collects the power produced at each turbine and connects to the site substation located close to turbine T21, where the point of metering is located. There is no grid transformer associated with the project. Based on an empirical assessment of similar schemes without grid transformers the electrical loss figure shall be assumed to be 1.2%.

8) For the purpose of this test, the total plant availability (turbine, grid, & balance of plant) should be assumed to be 96.8%.

5.0 MODEL OUTPUTS

The following model outputs shall be estimated and reported in the model output report template file "*Results.xls*" (fill in cells coloured in yellow with modelling results):

1) The production period predicted wind speed frequency distribution of hours per year as a function of wind speed and direction. This should be reported at the top anemometer height of 50.0 m as well as the turbine hub height of 47.0 m. For convenience of comparison this table should be presented at wind speed bins centred on 0.5 m/s, 1.5 m/s etc. up to 49.5 m/s (data valid at centre of bins) and wind direction bins centred on 0 degrees, 30 degrees, etc up to 330 degrees relative to OS grid North (data valid at centre of bins). The estimated mean turbulence intensities at 50.0 m and 47.0 m need to be provided as well.

2) The production period predicted energy yield of the wind farm project and details of the calculation. This includes:

    a. Reference (or ideal) yield in GWh/year, before topographic and wake effects and any other losses. This is equivalent to a yield where all turbines see the wind distribution at the mast, sheared to hub height.

    b. The topographic effect, i.e. the % change in energy yield from (a) due to terrain variation and roughness.

    c. Gross yield in GWh/year, including the topographic effect but before wakes or any other losses. (This is (a) adjusted for topo effects (b)).

    d. The wake effect, i.e. the % change in energy yield from (c) due to wind turbine wake effects.

    e. Potential energy yield, including wake and topographic effects but before any other losses are applied. (This is (c) adjusted for wake effects (d)).

    f. Potential to Net loss factors such as, availabilities, electrical efficiency, turbine performance etc as detailed in the results template, as a % loss of energy.

    g. The Net energy yield in GWh/year, which is the long term predicted annual average energy yield at the point of metering. (This is (e) adjusted for additional losses (f)).

3) The estimated uncertainty of the production period predicted net energy yield, including a breakdown of the individual uncertainty components that have been estimated or assumed. **It should be noted that since the required prediction period is that of the past production period, both the historic and inter-annual variation uncertainty components should be set to zero (since the reference data available extends throughout the production period).**

4) A breakdown of the individual contribution of each turbine to the predicted energy yield of the wind farm, as a % of the total production as well as modelled wake and topographic effects per turbine.

5) Details of how the results have been derived, in particular on how the wind speed prediction has been carried out (e.g. MCP and what technique), if measured or modelled wind shear was used, details of the flow model, details of the wake model (which wake model, details of wake combination, wake meandering, wake added turbulence), etc.

When reporting your results, please be as specific and precise as possible since this will help us in the comparisons.