

Guidance on setup of datasets in PCWG Tool

This document provides support in importing power curve test datasets into the PCWG Tool and specifying settings required for the PCWG Sharing Initiative.

Pre-requisites

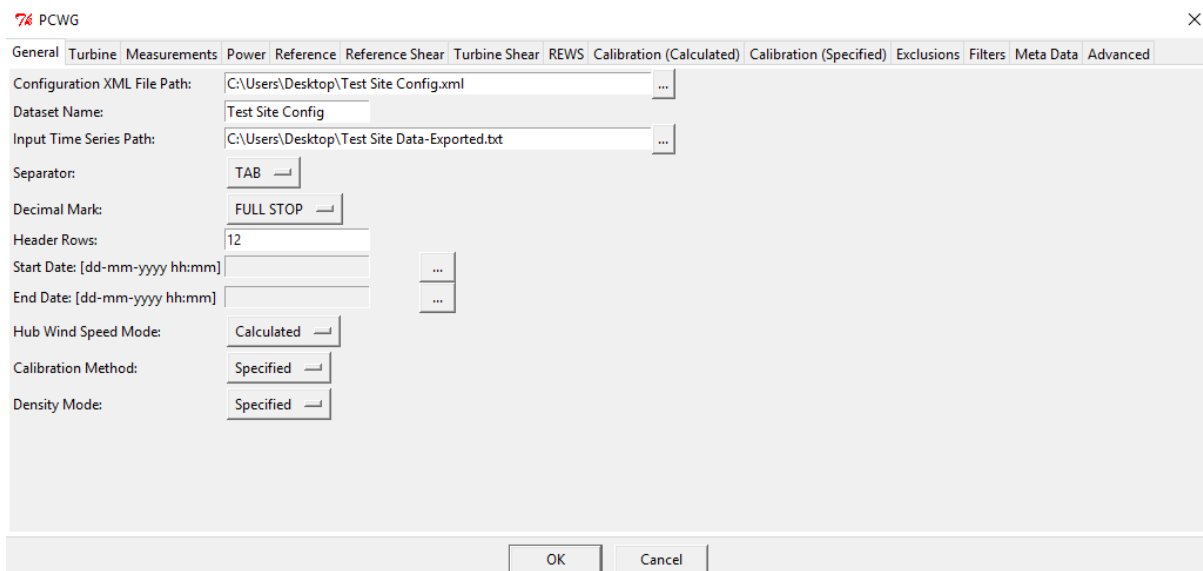
For a dataset to be applicable for the PCWG Sharing Initiative, it must have these attributes:

- Mean wind speed and direction, and standard deviation of wind speed, at hub height recorded at a met mast which is between 2.5D and 4D from the turbine location.
- In the case of terrain which is not flat, a site calibration performed between the reference measurement and the turbine location before the turbine was constructed.
- At least two wind speed measurement heights at the reference location for calculation of shear experienced by the turbine. Even more valuable is a LiDAR or SoDAR co-located with the mast measuring up to the upper tip of the turbine.
- Turbine power output from a SCADA system or recorded by a power curve test logger which is synchronised with the wind data measurements. The turbine should be in **normal operation** during the periods included, and **not subject to curtailment** due to grid constraints or other reasons.
- Credible air temperature and pressure measurements recorded at the turbine or met mast, for air density calculation.
- The turbine should be free from wakes from adjacent turbines for a significant part of the site wind rose. Similarly, the reference measurement should be free of wakes from the test turbine and adjacent turbine for the wind directions included in the analysis.

Procedure

The following procedure can be used when adding a dataset into a portfolio of sites for submission to the PCWG Sharing Initiative.

1. Start in the **General** Tab. Choose a path and filename for the Configuration XML file which will store all the setup information which you specify below when you eventually click the **OK** button. Enter your name for your dataset – note that this name will **not** be contained in submissions to the sharing initiative.



The screenshot shows the 'General' tab of the PCWG tool's configuration window. The window title is '76 PCWG'. The tabs at the top are: General, Turbine, Measurements, Power, Reference, Reference Shear, Turbine Shear, REWS, Calibration (Calculated), Calibration (Specified), Exclusions, Filters, Meta Data, and Advanced. The 'General' tab is active. The configuration fields are as follows:

| | |
|--------------------------------|--|
| Configuration XML File Path: | C:\Users\Desktop\Test Site Config.xml |
| Dataset Name: | Test Site Config |
| Input Time Series Path: | C:\Users\Desktop\Test Site Data-Exported.txt |
| Separator: | TAB |
| Decimal Mark: | FULL STOP |
| Header Rows: | 12 |
| Start Date: [dd-mm-yyyy hh:mm] | ... |
| End Date: [dd-mm-yyyy hh:mm] | ... |
| Hub Wind Speed Mode: | Calculated |
| Calibration Method: | Specified |
| Density Mode: | Specified |

At the bottom of the window are 'OK' and 'Cancel' buttons.

2. Locate the text file which contains your dataset, which should contain a row of column names. The text file could be exported from Windographer or Excel, for instance, or other software.

You can choose to skip a number of header rows before the column names and what character delimits the columns in your file. You can also restrict the analysis to a specified date range. Missing data can simply be left as blanks in the text file.

Your file will likely consist of the following columns:

- **Timestamp.** Needs to run sequentially through the file.
- **Hub height mean wind speed (m/s).** For the calculation of predicted power.
- **Turbine power (kW).** Actual power recorded from the turbine.
- **Standard deviation wind speed (m/s).** From the same sensor as the hub height mean wind speed for TI calculation.
- **Additional mean wind speeds (m/s).** At least two measurement heights for shear calculation, or at multiple heights up to tip height (if from a LiDAR or SoDAR device) to define REWS.
- **Wind direction (deg).** *If using a text file exported from Windographer, note that the degree symbol (°) is not accepted by the PCWG Tool and should be removed manually from the text file.*
- **Air density (kg/m³).** Temperature (degC) and pressure (mbar) fields can be provided, or density provided directly.
- **Inflow angle (deg, positive angles indicate upward inflow).** Provided by processing of 3D wind data from ultrasonic anemometers.

If your analysis involves a period of measurement for a site calibration, before the turbine was installed, additional columns can be included for the wind data at the turbine location during this period. The columns for the reference data measurement need to be consistent between the site calibration period and the turbine testing period.

Essentially, all the time series data used in the analysis will need to be contained in this one single text file.

3. Choose the scenario which represents your dataset:

- For a flat site, or when you already have a column in the text file where a site calibration has been applied to the turbine location, set **Hub Wind Speed Mode** to **Specified** and **Calibration Method** to **None**. You won't then need to specify any inputs in the **Reference** tab. **In this scenario, you need to provide TI as a column directly – the tool won't calculate TI from a mean and standard deviation.**
- If you already have a table of site calibrations by direction from your reference location to the turbine, then set **Hub Wind Speed Mode** to **Calculated** and **Calibration Method** to **Specified**.
- If a period of your time series covers the site calibration from your reference to turbine location, then set **Hub Wind Speed Mode** to **Calculated** and **Calibration Method** to **Least Squares**.

- Choose how air density will be defined. If you have a column in your text file for air density (in kg/m^3) then set **Density Mode** to **Specified**. If you have separate columns for temperature (in degC) and pressure (in mbar) then set **Density Mode** to **Calculated**.
- Inputs required in the **Turbine** tab are straightforward. **Rated Power** should be given in kW. **Tilt** is only needed if an inflow angle column is available in the dataset.

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| General | Turbine | Measurements | Power | Reference | Reference Shear | Turbine Shear | REWS | Calibration (Calculated) | Calibration (Specified) | Exclusions | Filters | Meta Data | Advanced |
|---------------------|---------|--------------|-------|-----------|-----------------|---------------|------|--------------------------|-------------------------|------------|---------|-----------|----------|
| Cut In Wind Speed: | 3.0 | | | | | | | | | | | | |
| Cut Out Wind Speed: | 25.0 | | | | | | | | | | | | |
| Rated Power: | 2300.0 | | | | | | | | | | | | |
| Hub Height: | 78.3 | | | | | | | | | | | | |
| Diameter: | 93.0 | | | | | | | | | | | | |
| Tilt: | | | | | | | | | | | | | |

- In the **Measurements** tab and the **Reference** tab, specify column names as required by the options selected for **Hub Wind Speed Mode**, **Calibration Method** and **Density Mode** – guidance is provided by the tool.

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General Turbine Measurements Power Reference Reference Shear Turbine Shear REWS Calibration (Calculated) Calibration (Specified) Exclusions Filters Meta Data Advanced

Time Step In Seconds: 600

Bad Data Value: -99.990000

Date Format: %Y-%m-%d %H:%M:%S

Time Stamp: Date/Time

Turbine Location Wind Speed: . Not Required

Hub Wind Speed: . Not required for calculated hub wind speed mode

Hub Turbulence: . Not required for calculated hub wind speed mode

Temperature: . Not required when density mode is set to specified

Pressure: . Not required when density mode is set to specified

Density: AirDensity

Inflow Angle: . Not required

OK Cancel

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General Turbine Measurements Power Reference Reference Shear Turbine Shear REWS Calibration (Calculated) Calibration (Specified) Exclusions Filters Meta Data Advanced

Reference Wind Speed: WindSpeed_83m [m/s]

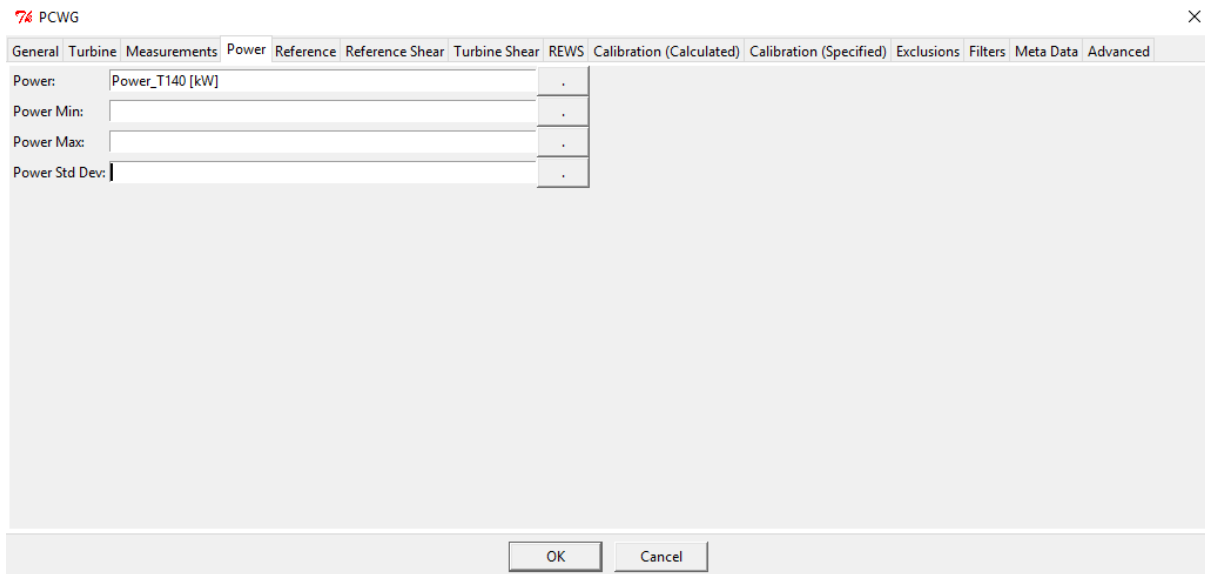
Reference Wind Speed Std Dev: WindSpeed_83m_stddev [m/s]

Reference Wind Direction: Direction []

Reference Wind Direction Offset: 0.0

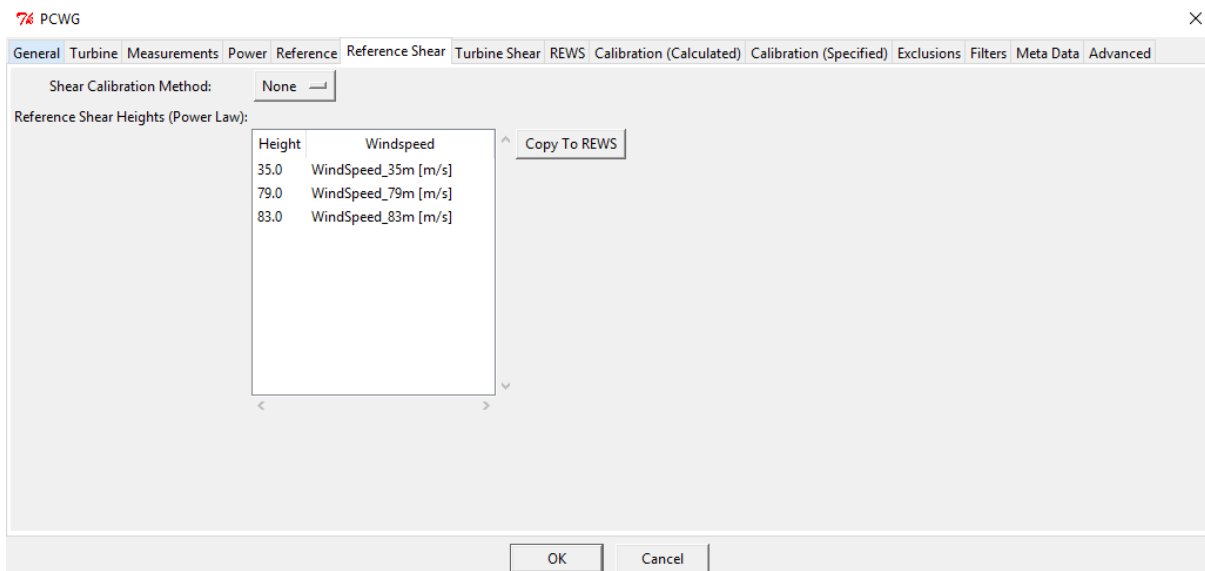
OK Cancel

- Only a mean turbine power is required in the **Power** tab – the min, max and standard deviation are not used in the current sharing initiative.



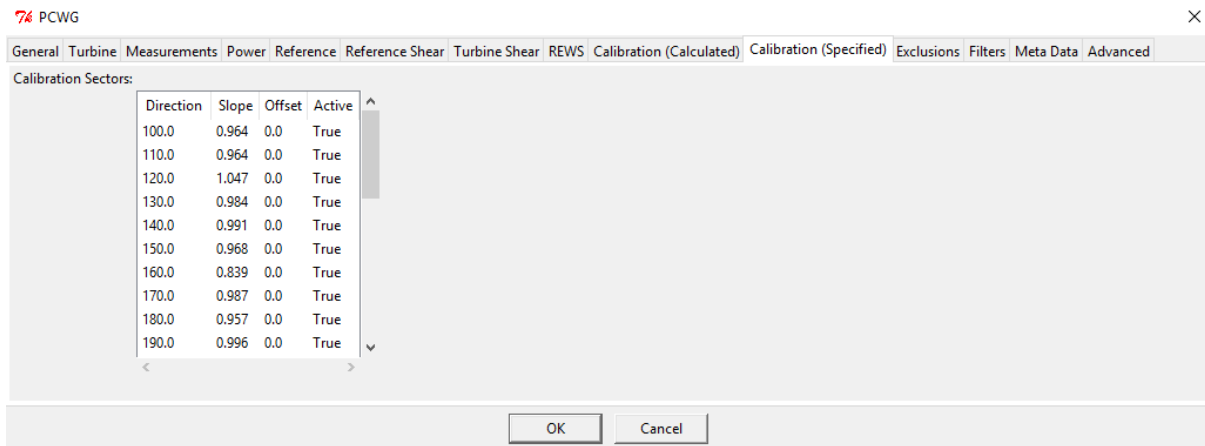
- Specify column names and measurement heights for the shear measurement at the reference location in the **Power** tab. Right-click in table to add a new entry. If this shear measurement is provided by a LiDAR or SoDAR, these entries can then be automatically copied to the **REWS** tab by clicking the button.

If the site calibration also involved a shear measurement at the turbine location, the relevant columns can be specified in the **Turbine Shear** tab. These will be related to the shear recorded at the reference location during that site calibration period.



- If a site calibration period is included in your time series, specify this period in the **Calibration (Calculated)** tab and specify any filtering on data which is required during this period. Note that any data captured by the filter are **excluded** from the calculation. The **Inclusive** indicator refers to whether a filter is considered as “greater than” (exclusive filter) or “equal to or greater than” (inclusive filter), as an example.

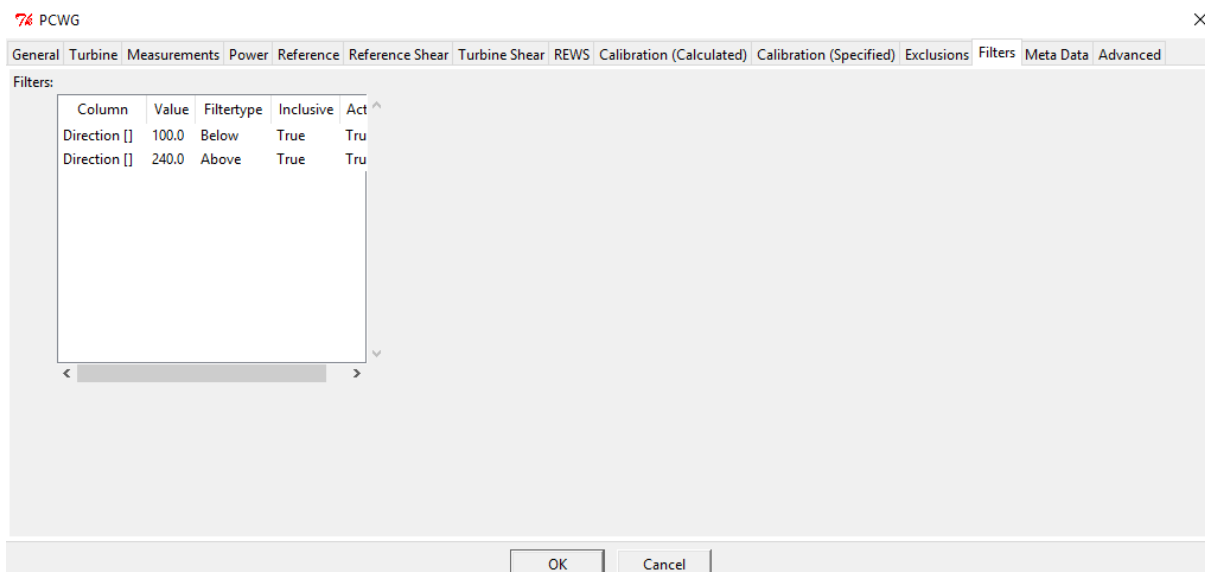
If you already have a table of calibrations, then these are entered in the **Calibration (Specified)** tab. 10-degree bin widths are assumed and the directions entered are the centre of each bin. If this tab is used, then any 10-degree sectors which are not included in the table are excluded from the power curve analysis.



- Specify any time periods which should be removed from the analysis in the **Exclusions** tab and any filters which should be applied in the **Filters** tab. As in point 8, any data captured by the filters are **excluded** from the analysis.

Ensure that wind directions where A) the test turbine is wake-affected by adjacent turbines, and B) the reference measurement is wake-affected by the test turbine and adjacent turbines, are excluded from the analysis.

Filtering on a turbine status flag could be used to ensure that only timestamps with periods of **normal, uncurtailed operation** are included in the analysis.



11. Finally, include any metadata which you can in the **Meta Data** tab. This will allow the analysis of your power curve test data to be categorised but will fully maintain the anonymity of your data.

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General | Turbine | Measurements | Power | Reference | Reference Shear | Turbine Shear | REWS | Calibration (Calculated) | Calibration (Specified) | Exclusions | Filters | **Meta Data** | Advanced

Data Type: Mast

Outline Site Classification: Complex

Outline Forestry Classification: Forested

IEC Terrain Classification:

Latitude: 53

Longitude: -4

Continent: Europe

Country: United Kingdom

Elevation Above Sea Level: 300

Measurement Compliance: IEC 61400-12-1 (2006) Compliant

Anemometry Type: Cups

Anemometry Heating: Unheated

Turbulence Measurement Type: Cups

Power Measurement Type: SCADA

OK Cancel