PCWG Tool: Analysis and Dataset File Structure

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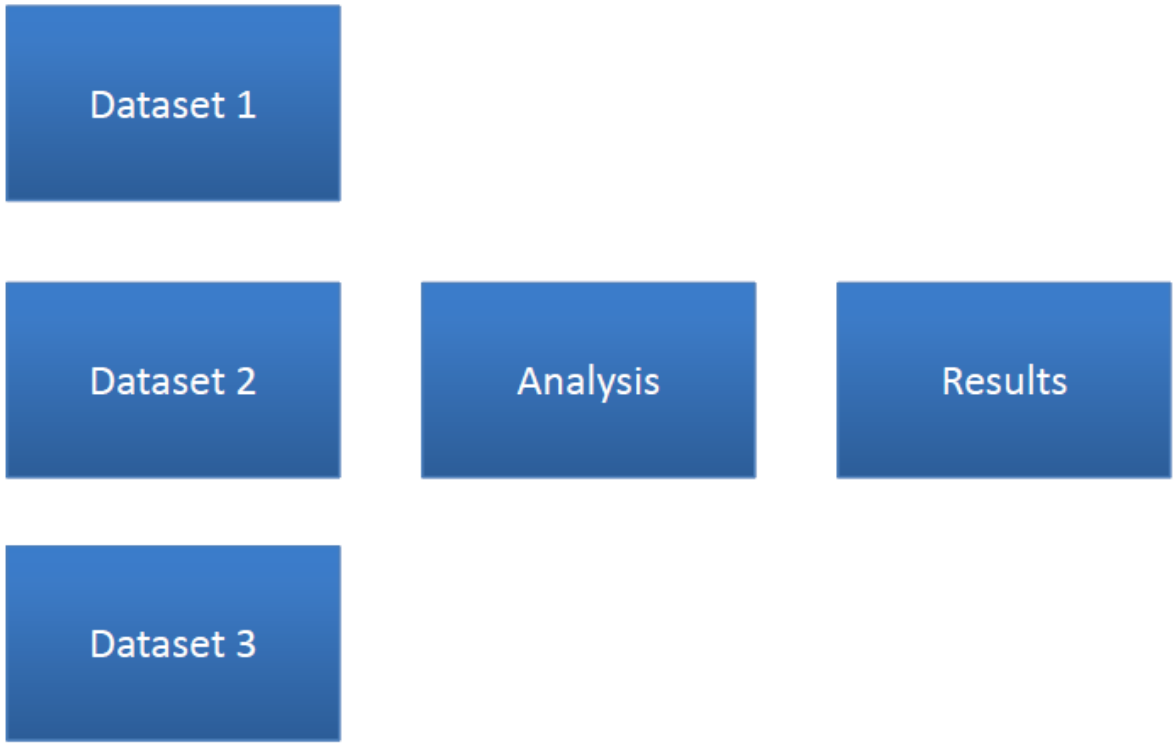
Presentation Contents

- This presentation details the structure of PCWG Tool Analysis and Dataset configuration files
- Configuration files are written in XML format (eXtensible Markup Language)
- Configuration files can also be edited with the PCWG Tool GUI (note: some advanced features currently only supported by editing xml directly)

Key PCWG Tool Concept: Dataset and Analysis

The PCWG analysis tool is designed to logically separate input data from the analysis performed on them. This allows the same **Analysis** to be performed on multiple **Datasets**.



The PCWG tool generates a combined set of results from one or more datasets.

Note: a dataset is the data associated with a single power performance test and consists of power turbine data plus mast data and/or LiDAR data.

File Structure and GUI (1)

The PCWG Tool file structure is xml based. This means that settings can either be edited via the GUI or by directly editing the underlying files.

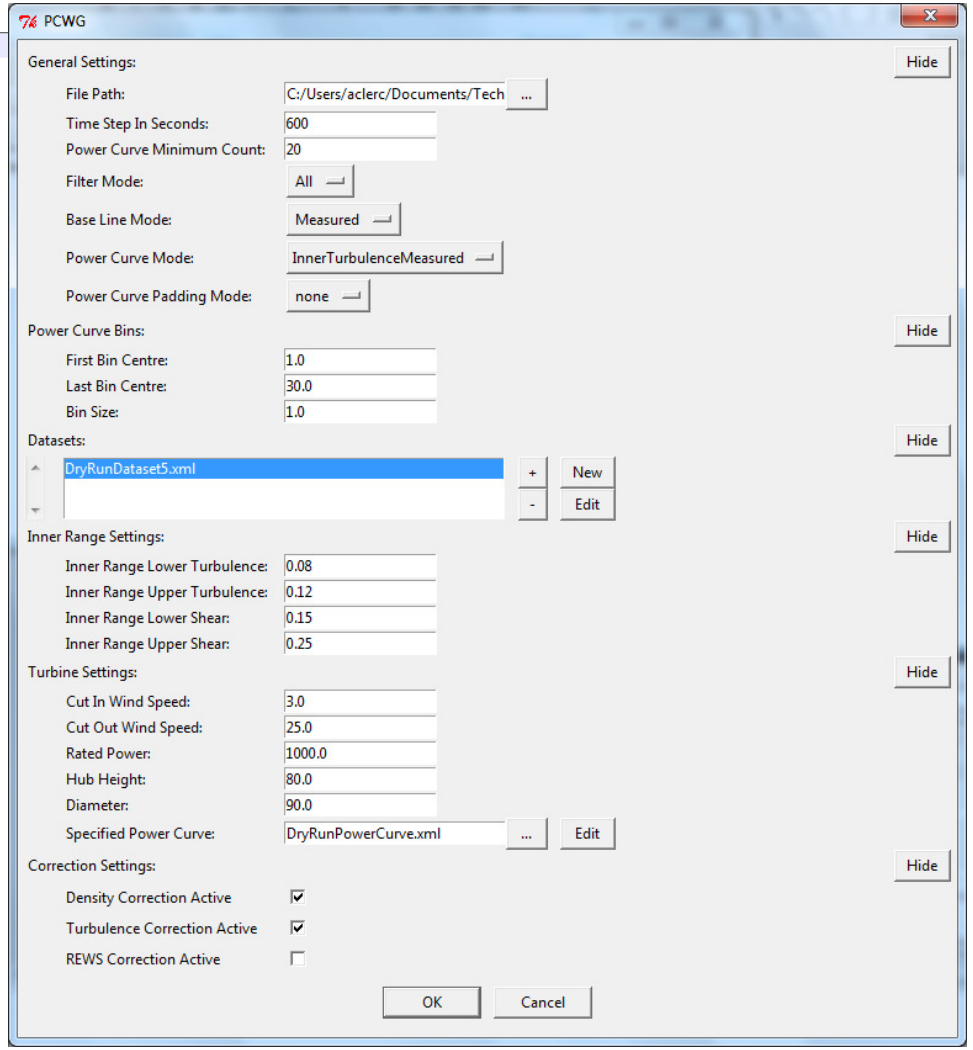
GUI

Dataset.dat	Time series data file in Comma Separated or Tab Separated Format.
Dataset.xml	Xml based file which configures the data in Dataset.dat
Analysis.xml	Xml based file which defines the analysis to be performed.

For a useful and free xml editor visit http://notepad-plus-plus.org

File Structure and GUI (2)

```
<?xml version="1.0" ?>
<Configuration xmlns="http://www.pcwg.org">
    <TimeStepInSeconds>600</TimeStepInSeconds>
    <PowerCurveMinimumCount>20</PowerCurveMinimumCount>
    <FilterMode>All</FilterMode>
    <BaseLineMode>Measured</BaseLineMode>
    <PowerCurveMode>InnerTurbulenceMeasured</PowerCurveMode>
    <PowerCurvePaddingMode>none</PowerCurvePaddingMode>
    <PowerCurveBins>
        <FirstBinCentre>1.000000</FirstBinCentre>
        <LastBinCentre>30.000000</LastBinCentre>
        <BinSize>1.000000</BinSize>
    </PowerCurveBins>
    <Datasets>
        <Dataset>DryRunDataset5.xml</Dataset>
    </Datasets>
    <InnerRange>
        <InnerRangeLowerTurbulence>0.080000</InnerRangeLowerTurbulence>
        <InnerRangeUpperTurbulence>0.120000</InnerRangeUpperTurbulence>
        <InnerRangeLowerShear>0.150000</InnerRangeLowerShear>
        <InnerRangeUpperShear>0.250000</InnerRangeUpperShear>
    </InnerRange>
    <Turbine>
        <CutInWindSpeed>3.000000</CutInWindSpeed>
        <CutOutWindSpeed>25.000000</CutOutWindSpeed>
        <RatedPower>1000.000000</RatedPower>
        <HubHeight>80.000000</HubHeight>
        <Diameter>90.000000</Diameter>
        <SpecifiedPowerCurve>DryRunPowerCurve.xml</SpecifiedPowerCurve>
    </Turbine>
    <DensityCorrection>
        <Active>1</Active>
    </DensityCorrection>
    <TurbulenceRenormalisation>
        <Active>1</Active>
    </TurbulenceRenormalisation>
    <RotorEquivalentWindSpeed>
        <Active>0</Active>
    </RotorEquivalentWindSpeed>
</Configuration>
```



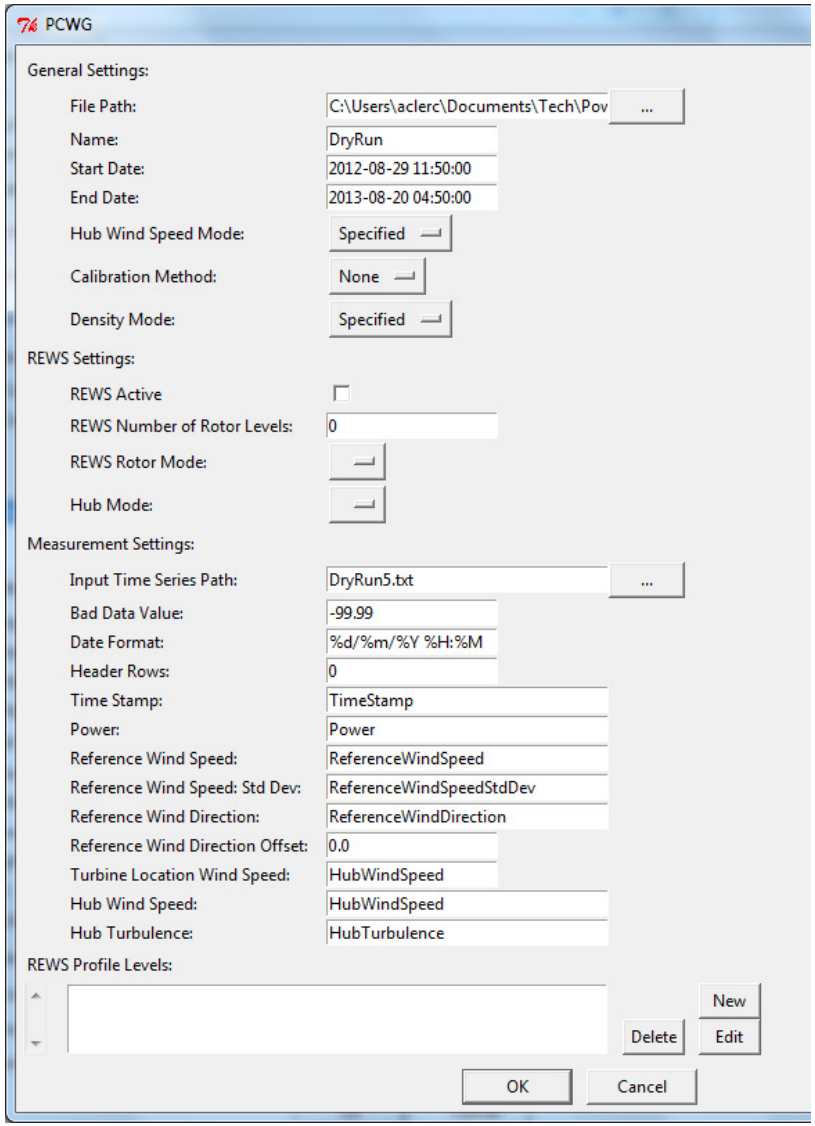
Analysis xml Config File

Analysis GUI Editor

File Structure and GUI (3)

```xml
<?xml version="1.0" ?>
<Configuration xmlns="http://www.pcwg.org">
    <Name>DryRun</Name>
    <StartDate>2012-08-29 11:50:00</StartDate>
    <EndDate>2013-08-20 04:50:00</EndDate>
    <HubWindSpeedMode>Specified</HubWindSpeedMode>
    <CalibrationMethod>None</CalibrationMethod>
    <DensityMode>Specified</DensityMode>
    <Measurements>
        <InputTimeSeriesPath>DryRun5.txt</InputTimeSeriesPath>
        <BadDataValue>-99.990000</BadDataValue>
        <DateFormat>%d/%m/%Y %H:%M</DateFormat>
        <HeaderRows>0</HeaderRows>
        <TimeStamp>TimeStamp</TimeStamp>
        <Power>Power</Power>
        <ReferenceWindSpeed>ReferenceWindSpeed</ReferenceWindSpeed>
        <ReferenceWindSpeedStdDev>ReferenceWindSpeedStdDev</ReferenceWindSpeedStdDev>
        <ReferenceWindDirection>ReferenceWindDirection</ReferenceWindDirection>
        <ReferenceWindDirectionOffset>0.000000</ReferenceWindDirectionOffset>
        <TurbineLocationWindSpeed>HubWindSpeed</TurbineLocationWindSpeed>
        <HubWindSpeed>HubWindSpeed</HubWindSpeed>
        <HubTurbulence>HubTurbulence</HubTurbulence>
        <ShearMeasurements/>
        <ProfileLevels/>
    </Measurements>
    <Filters/>
    <Exclusions/>
</Configuration>
```

Dataset xml Config File

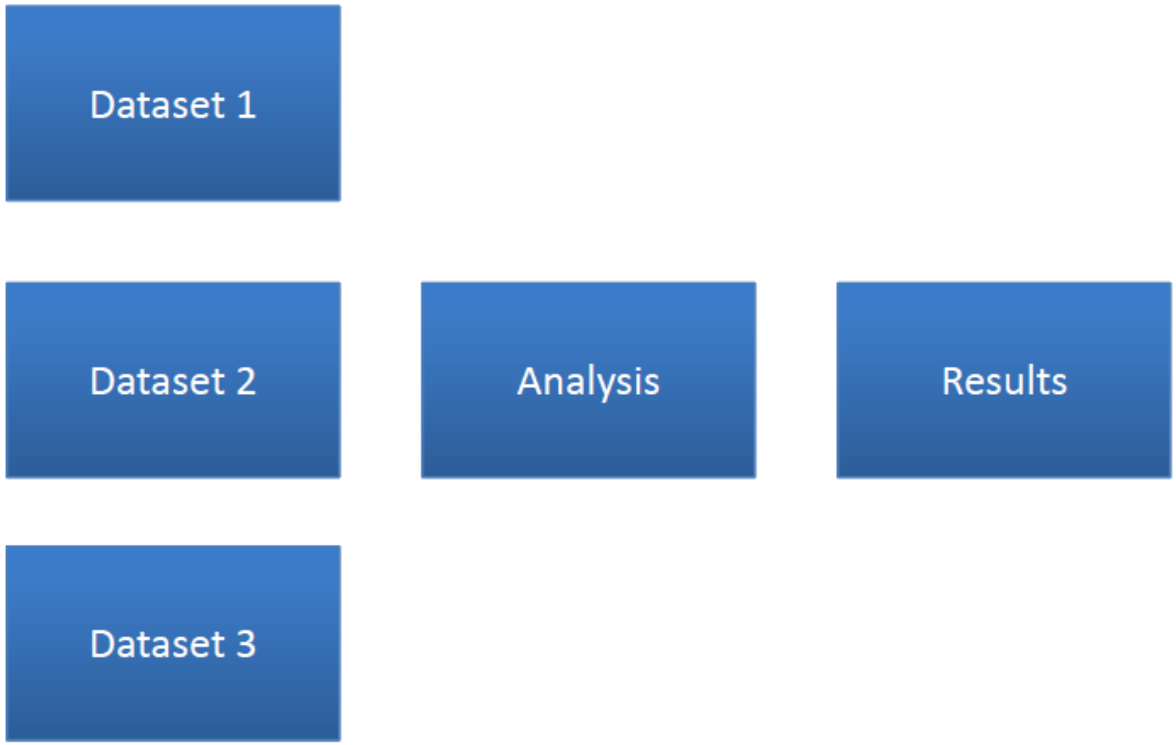


Dataset GUI Editor

Analysis Configuration xml structure

Key PCWG Tool Concept: Dataset and Analysis

The PCWG analysis tool is designed to logically separate input data from the analysis performed on them. This allows the same **Analysis** to be performed on multiple **Datasets**.



The PCWG tool generates a combined set of results from one or more datasets.

Note: a dataset is the data associated with a single power performance test and consists of power turbine data plus mast data and/or LiDAR data.

Analysis Config File Structure

```
2  <Configuration xmlns="http://www.pcwg.org">
```

All config settings sit within the Configuration node

```
40 </Configuration>
```

Analysis Config File Structure

Datasets:
List of datasets which are to be analysed. At least 1 dataset configuration file must be specified.

```
14    <Datasets>
15        <Dataset>DryRunDataset5.xml</Dataset>
16    </Datasets>
```

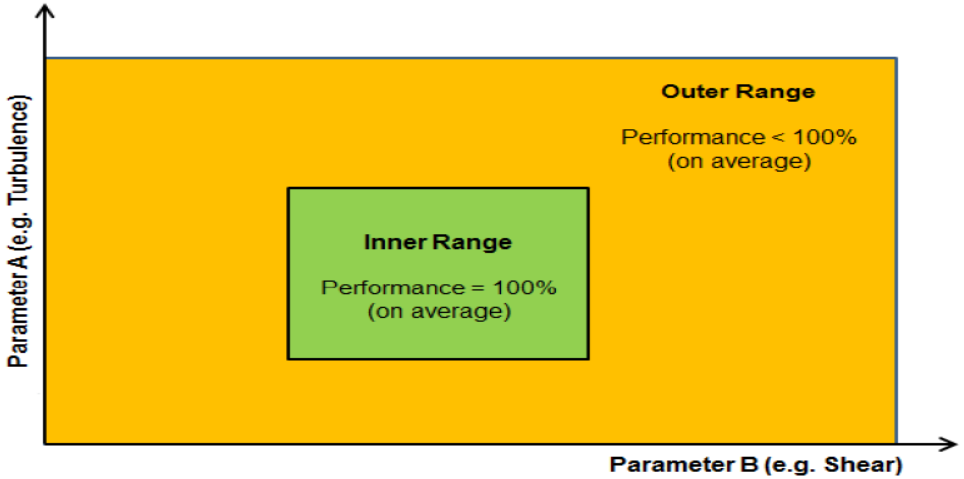
Note if multiple datasets are specified, the tool combines them in to a single dataset before analysis and reporting. Therefore it is recommended that the datasets have similar instrumentation.

Basic turbine properties are defined in the Analysis File so the turbine type should be the same for all datasets

Analysis Config File Structure

InnerRange:
Defines the inner Shear and TI range

```
<InnerRange>
    <InnerRangeLowerTurbulence>0.080000</
    <InnerRangeUpperTurbulence>0.120000</
    <InnerRangeLowerShear>0.150000</Inner
    <InnerRangeUpperShear>0.250000</Inner
</InnerRange>
```



Analysis Config File Structure

FilterMode:
Typically **All**. Used to filter the data set based on Shear and/or TI

```
4    <FilterMode>All</FilterMode>
```

FilterMode options are:

- **All**: use all data
- **Inner**: use TI and Shear Inner Range
- **InnerTurb**: use TI Inner Range
- **InnerShear**: use Shear Inner Range
- **Outer**: use TI and Shear Outer Range
- **OuterTurb**: use TI Outer Range
- **OuterShear**: use Shear Outer Range
- **LowShearLowTurbulence**
- **LowShearHighTurbulence**
- **LowShearLowTurbulence**
- **LowShearHighTurbulence**

Analysis Config File Structure

PowerCurveMode:
Used to calculate baseline power curve (for power deviation matrices)

```
6    <PowerCurveMode>InnerTurbulenceMeasured</
```

PowerCurveMode options are:

- **Specified**: Power curve read from file
- **AllMeasured**: Power curve based on all data
- **InnerMeasured**: Power curve based on Shear and TI Inner Range data
- **InnerTurbulenceMeasured**: Power curve based on TI Inner Range data
- **OuterMeasured**: Power curve based on Shear and TI Outer Range data
- **OuterTurbulenceMeasured**: Power curve based on TI Outer Range data

Analysis Config File Structure

BaseLineMode:
Used to calculate a baseline energy yield (for benchmark tests)

```
5    <BaseLineMode>Measured</BaseLineMode>
```

BaseLineMode options are:

- **Hub**: Baseline energy is calculated from hub wind speed and a power curve (specified by PowerCurveMode)
- **Measured**: Baseline energy is the sum of actual energy in the dataset

Analysis Config File Structure

Turbine:
Defines properties of the turbine

```
23  ---><Turbine>
24  ------><CutInWindSpeed>3.000000</CutInWindSpeed>
25  ------><CutOutWindSpeed>25.000000</CutOutWindSpeed>
26  ------><RatedPower>1000.000000</RatedPower>
27  ------><HubHeight>80.000000</HubHeight>
28  ------><Diameter>90.000000</Diameter>
29  ------><SpecifiedPowerCurve>DryRunPowerCurve.xml</S
30  ---></Turbine>
```

- REWS calculation requires turbine geometry
- 0% TI power curve calculation requires rated power and turbine geometry
- **Specified Power Curve:** used as the base line power curve if PowerCurveMode = Specified

Analysis Config File Structure

Correction Activation Nodes:
Activate various corrections to wind speed and power

```
31  <DensityCorrection>
32      <Active>1</Active>
33  </DensityCorrection>
34  <TurbulenceRenormalisation>
35      <Active>1</Active>
36  </TurbulenceRenormalisation>
37  <RotorEquivalentWindSpeed>
38      <Active>0</Active>
39  </RotorEquivalentWindSpeed>
```

- **Density Correction:** Calculate Density Corrected Wind Speed according to IEC 61400-12-1
- **Turbulence Renormalisation:** TI correction consistent with PCWG round robin exercises and IEC 61400-12-1
- **Rotor Equivalent Wind Speed:** REWS correction consistent with PCWG round robin exercises and IEC 61400-12-1

Analysis Config File Structure

PowerCurveBins:
Defines the measured power curve wind speed bins

```
<PowerCurveBins>
    <FirstBinCentre>1.000000</FirstBinCentre>
    <LastBinCentre>30.000000</LastBinCentre>
    <BinSize>1.000000</BinSize>
```

Nodes within **PowerCurveBins** are:

- **FirstBinCentre**: Centre of first wind speed bin, default 1.0 m/s
- **LastBinCentre**: Centre of last wind speed bin, default 30.0 m/s
- **BinSize**: Width of each wind speed bin, default 1.0 m/s

Analysis Config File Structure

PowerCurveMinimumCount:
Minimum data count required to calculate a power curve bin.

```
8    <PowerCurveMinimumCount>20</Powe
```

A measured power will not be reported for bins which do not meet the data count requirement

Wind Speed	Measured Power	Data Count
18	2001.1	33
19		19
20	1999.0	20

Analysis Config File Structure

PowerCurvePaddingMode:
Used to fill in missing high wind speed bins in the measured power curve

```
7    <PowerCurvePaddingMode>none</Power
```

PowerCurvePaddingMode options are:

- **Linear**: Linear interpolation between filled in bins, horizontal extrapolation otherwise
- **Specified**: Specified power curve (from file) used to fill in the measured power curve
- **Observed**: Last measured power bin used to fill in missing bins (horizontal extrapolation)
- **Max**: Max measured power bin used to fill in missing bins

Dataset Configuration xml structure

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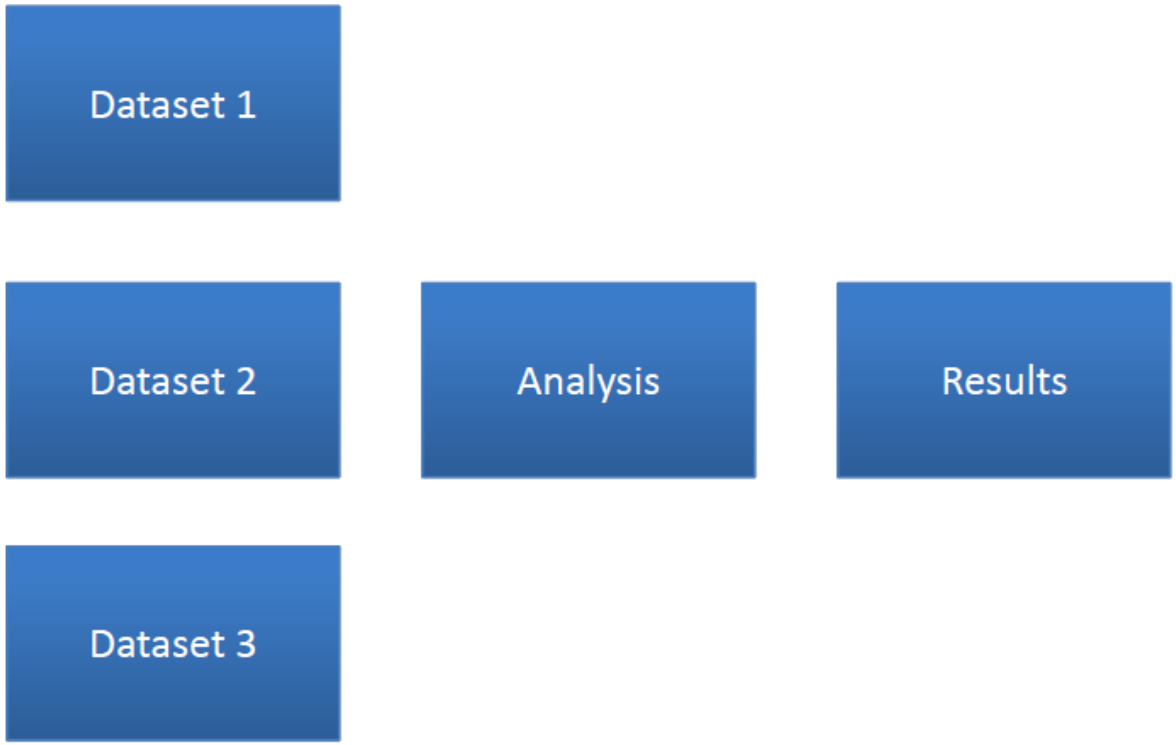

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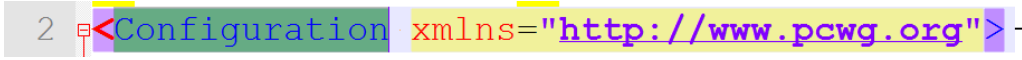
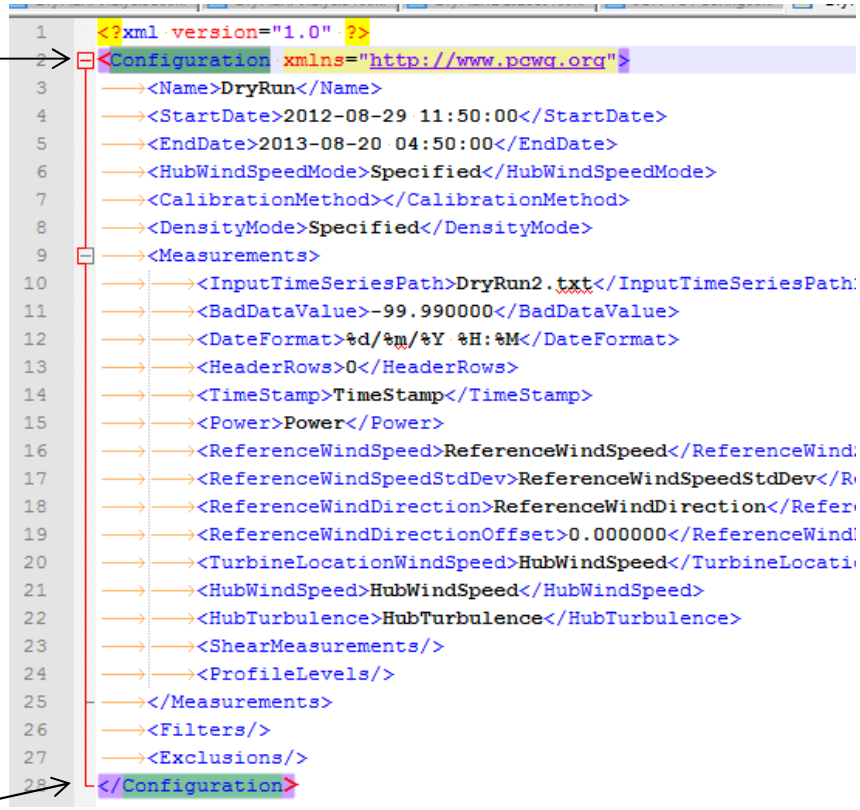
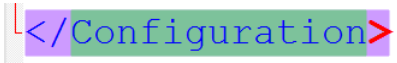
Dataset Config File Structure





All config settings sit within the Configuration node



Dataset Config File Structure

Name:
Name of the data set

```
3    <Name>DryRun</Name>
```

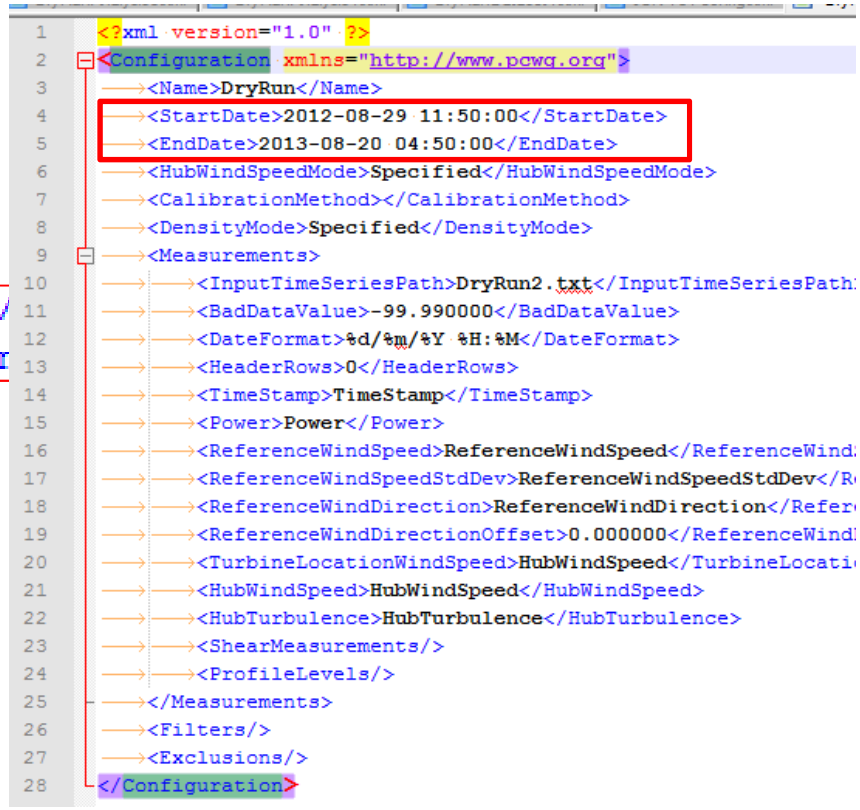
```
1   <?xml version="1.0" ?>
2   <Configuration xmlns="http://www.pcwg.org">
3       <Name>DryRun</Name>
4       <StartDate>2012-08-29 11:50:00</StartDate>
5       <EndDate>2013-08-20 04:50:00</EndDate>
6       <HubWindSpeedMode>Specified</HubWindSpeedMode>
7       <CalibrationMethod></CalibrationMethod>
8       <DensityMode>Specified</DensityMode>
9       <Measurements>
10          <InputTimeSeriesPath>DryRun2.txt</InputTimeSeriesPath
11          <BadDataValue>-99.990000</BadDataValue>
12          <DateFormat>%d/%m/%Y %H:%M</DateFormat>
13          <HeaderRows>0</HeaderRows>
14          <TimeStamp>TimeStamp</TimeStamp>
15          <Power>Power</Power>
16          <ReferenceWindSpeed>ReferenceWindSpeed</ReferenceWind
17          <ReferenceWindSpeedStdDev>ReferenceWindSpeedStdDev</R
18          <ReferenceWindDirection>ReferenceWindDirection</Refer
19          <ReferenceWindDirectionOffset>0.000000</ReferenceWind
20          <TurbineLocationWindSpeed>HubWindSpeed</TurbineLocati
21          <HubWindSpeed>HubWindSpeed</HubWindSpeed>
22          <HubTurbulence>HubTurbulence</HubTurbulence>
23          <ShearMeasurements/>
24          <ProfileLevels/>
25      </Measurements>
26      <Filters/>
27      <Exclusions/>
28  </Configuration>
```

Dataset Config File Structure

Start and End Date:
Optional. Defines the first and last time stamp to be analysed

```
4    <StartDate>2012-08-29 11:50:00</
5    <EndDate>2013-08-20 04:50:00</Er
```

Note this is a special case of Exclusions, which allow specific time periods of the data to be filtered (more on this later)



Dataset Config File Structure

TimeStepInSeconds:
Typically 600 (10 minutes). Used to convert kW to MWh.

```
3    <TimeStepInSeconds>600</TimeStepInSeconds>
```

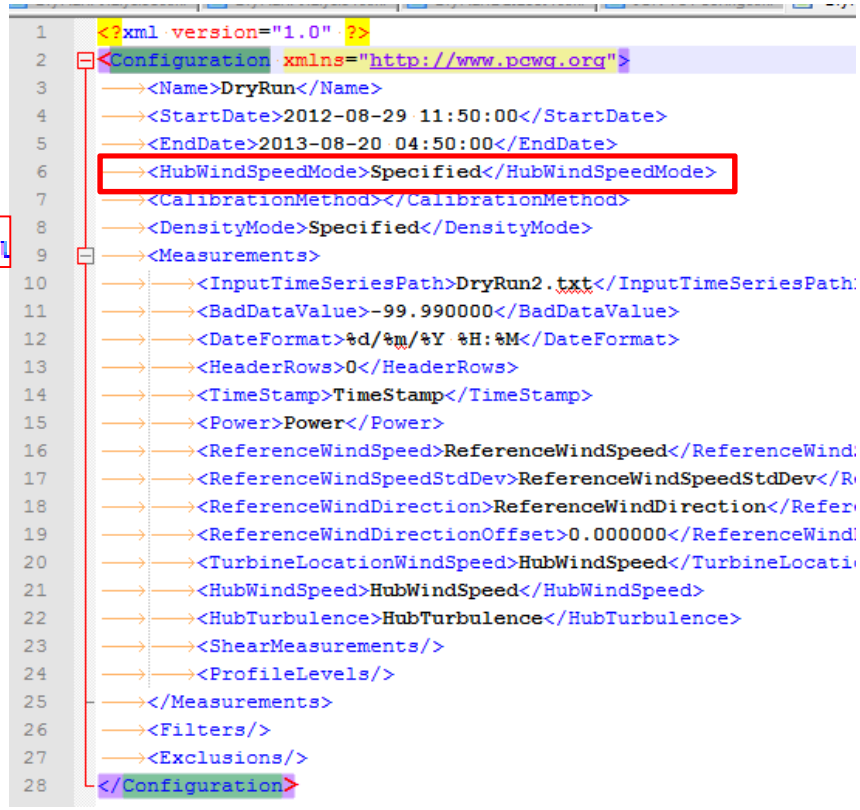
When multiple data sets are analysed at once,
TimeStepInSeconds must be the same for all data sets

Dataset Config File Structure

HubWindSpeedMode:
Method to determine wind speed at turbine hub height

```
6    <HubWindSpeedMode>Specified</Hu
```

- **Calculated:** calculate hub wind speed from reference wind speed and site calibration
- **Specified:** read hub wind speed from the input time series
- **None:** equivalent to Specified



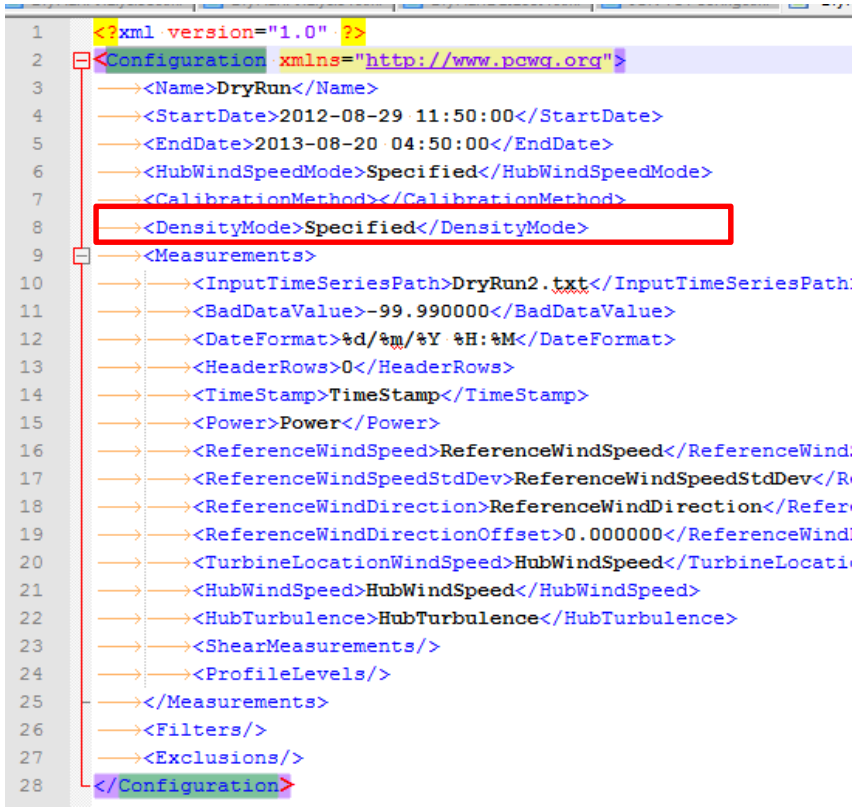
Dataset Config File Structure

DensityMode:
Name of the data set

```
8    <DensityMode>Specified</Density
```

Options in GUI:

- **Calculated:** calculate density from temperature and pressure
- **Specified:** read density directly from input time series
- **None:** No density



Measurements

The Measurements node describes the contents of the input data file

```
14    <ns1:Measurements>
```

```
1   <?xml version="1.0" ?>
2   <Configuration xmlns="http://www.pcwg.org">
3       <Name>DryRun</Name>
4       <StartDate>2012-08-29 11:50:00</StartDate>
5       <EndDate>2013-08-20 04:50:00</EndDate>
6       <HubWindSpeedMode>Specified</HubWindSpeedMode>
7       <CalibrationMethod></CalibrationMethod>
8       <DensityMode>Specified</DensityMode>
9       <Measurements>
10          <InputTimeSeriesPath>DryRun2.txt</InputTimeSeriesPath
11          <BadDataValue>-99.990000</BadDataValue>
12          <DateFormat>%d/%m/%Y %H:%M</DateFormat>
13          <HeaderRows>0</HeaderRows>
14          <TimeStamp>TimeStamp</TimeStamp>
15          <Power>Power</Power>
16          <ReferenceWindSpeed>ReferenceWindSpeed</ReferenceWind
17          <ReferenceWindSpeedStdDev>ReferenceWindSpeedStdDev</R
18          <ReferenceWindDirection>ReferenceWindDirection</Refer
19          <ReferenceWindDirectionOffset>0.000000</ReferenceWind
20          <TurbineLocationWindSpeed>HubWindSpeed</TurbineLocati
21          <HubWindSpeed>HubWindSpeed</HubWindSpeed>
22          <HubTurbulence>HubTurbulence</HubTurbulence>
23          <ShearMeasurements/>
24          <ProfileLevels/>
25      </Measurements>
26      <Filters/>
27      <Exclusions/>
28  </Configuration>
```

Measurements

InputTimeSeriesPath:
Identifies the input data file. This can be csv or tab separated.

```
<InputTimeSeriesPath>DryRun2.txt</In
```

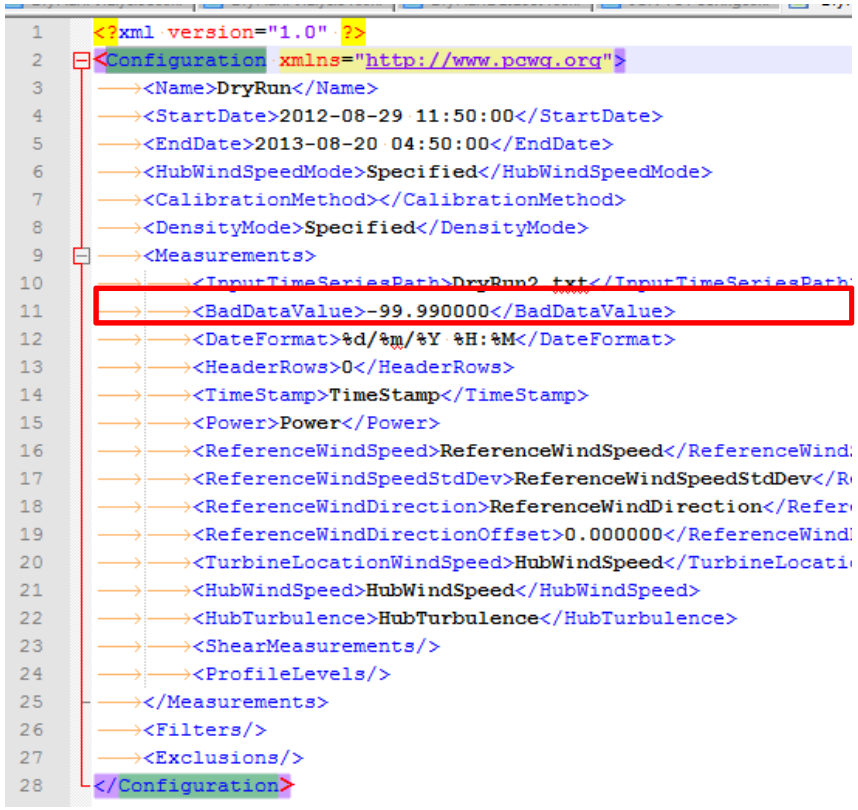
TimeStamp	Power	ReferenceWindDirection	Density	ReferenceWindSpee
29/8/2012 13:30	841.6530397	130	1.229544059	10.63537484	1.544049384	1
29/8/2012 13:40	632.8862526	99	1.231356466	9.449451787	1.050402636	9
29/8/2012 14:00	266.9697117	116	1.228385035	6.843022013	0.626663943	6
29/8/2012 14:30	378.9063434	85	1.201910095	7.903026818	0.717340117	7
29/8/2012 14:40	298.4273468	142	1.204267418	7.076111476	0.694863346	6
29/8/2012 14:50	356.2446574	105	1.225554939	7.67866622	0.731989235	7
29/8/2012 15:10	278.834147	316	1.210217046	6.940579395	0.709735683	7
29/8/2012 15:20	398.4477145	328	1.197010478	7.285855028	0.651707523	7
29/8/2012 15:30	271.1492249	203	1.213025988	6.881744956	0.685807436	7
29/8/2012 16:20	374.0686352	299	1.221412213	6.838636358	0.75045522	6
29/8/2012 16:30	428.8797349	199	1.229326878	7.642919558	0.673154149	7
29/8/2012 17:20	693.7623411	299	1.20693028	8.875768812	0.885750336	8
29/8/2012 17:30	825.7046348	221	1.192475931	10.22730038	1.155188889	1
29/8/2012 17:40	700.0211578	143	1.190595393	9.765084245	1.15625671	1
29/8/2012 18:00	720.4817599	85	1.228873203	9.753640599	1.077858324	9
29/8/2012 18:10	680.2797543	149	1.226839898	9.845629495	1.012179528	9
29/8/2012 19:00	760.8013565	249	1.218103451	9.765247579	0.933879504	9
29/8/2012 19:10	644.3067957	181	1.185809549	9.602528856	0.916291821	9
29/8/2012 19:20	670.3477743	24	1.222253238	8.81025957	0.825898081	9

```
<?xml version="1.0" ?>
<Configuration xmlns="http://www.pcwg.org">
    <Name>DryRun</Name>
    <StartDate>2012-08-29 11:50:00</StartDate>
    <EndDate>2013-08-20 04:50:00</EndDate>
    <HubWindSpeedMode>Specified</HubWindSpeedMode>
    <CalibrationMethod></CalibrationMethod>
    <DensityMode>Specified</DensityMode>
    <Measurements>
        <InputTimeSeriesPath>DryRun2.txt</InputTimeSeriesPath
        <BadDataValue>-99.990000</BadDataValue>
        <DateFormat>%d/%m/%Y %H:%M</DateFormat>
        <HeaderRows>0</HeaderRows>
        <TimeStamp>TimeStamp</TimeStamp>
        <Power>Power</Power>
        <ReferenceWindSpeed>ReferenceWindSpeed</ReferenceWind
        <ReferenceWindSpeedStdDev>ReferenceWindSpeedStdDev</R
        <ReferenceWindDirection>ReferenceWindDirection</Refer
        <ReferenceWindDirectionOffset>0.000000</ReferenceWind
        <TurbineLocationWindSpeed>HubWindSpeed</TurbineLocati
        <HubWindSpeed>HubWindSpeed</HubWindSpeed>
        <HubTurbulence>HubTurbulence</HubTurbulence>
        <ShearMeasurements/>
        <ProfileLevels/>
    </Measurements>
    <Filters/>
    <Exclusions/>
</Configuration>
```

Measurements

BadDataValue:
The value indicating bad/missing data. Typically -99.99 or NA

```
<BadDataValue>-99.990000</BadDataVal
```



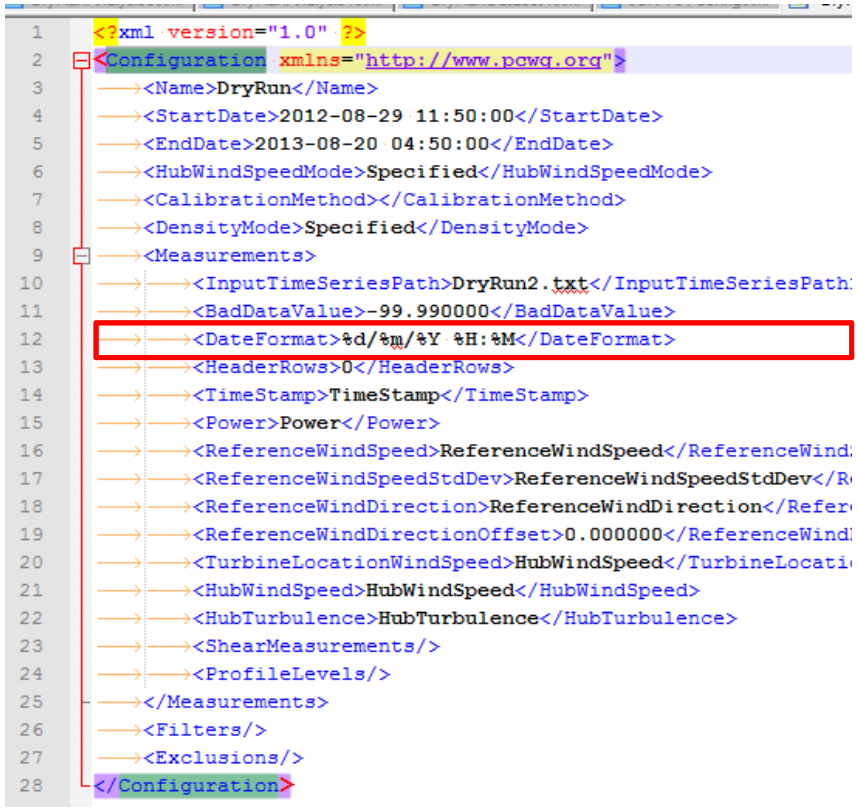
Measurements

DateFormat:
Format of time stamps in data file

```
<DateFormat>%d/%m/%Y %H:%M</DateForm
```

Example time formats

- %Y-%m-%d %H:%M:%S
  - e.g. 2015-03-14 9:26:53
- %d/%m/%Y %H:%M
  - e.g. 14/3/2015 9:26
- %m/%d/%y %H:%M
  - e.g. 3/14/15 9:26



The PCWG Tool uses C standard date time formats, for more information on date time formatting see:
https://docs.python.org/2/library/time.html

Measurements

HeaderRows:
Number of rows to skip before reading data. **Does not include column names.**

```
<HeaderRows>0</HeaderRows>
```

```
1  TimeStamp ⟶ Power ⟶
2  29/8/2012 13:30 841.
3  29/8/2012 13:40 632.
4  29/8/2012 14:00 266.
```

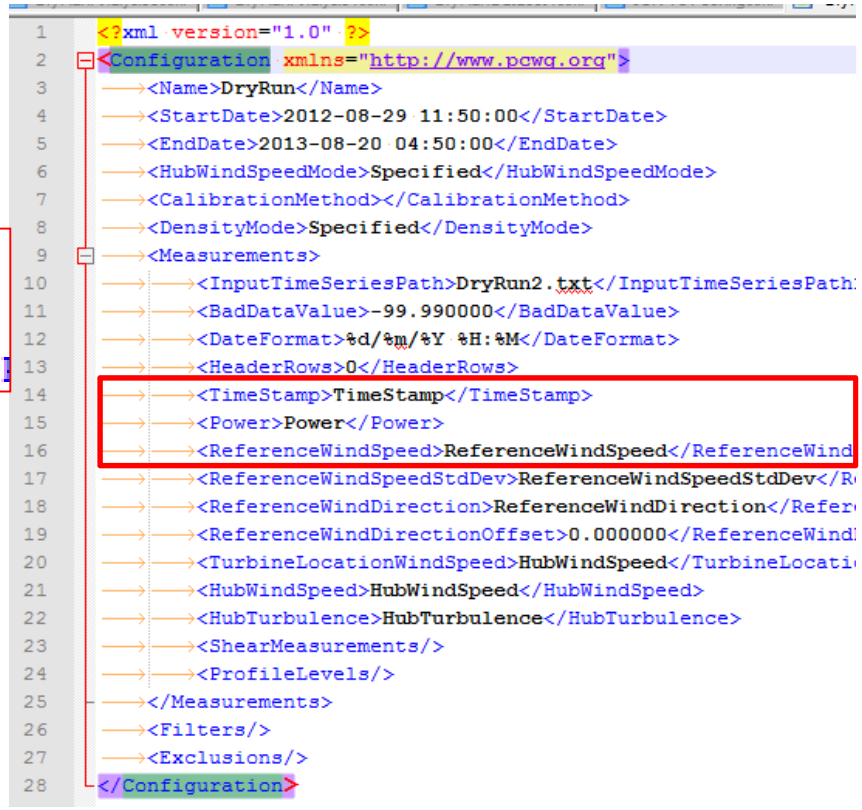
For HeaderRows = 0, column names are on row 1 and data begins on row 2

```
1  <?xml version="1.0" ?>
2  <Configuration xmlns="http://www.pcwg.org">
3      <Name>DryRun</Name>
4      <StartDate>2012-08-29 11:50:00</StartDate>
5      <EndDate>2013-08-20 04:50:00</EndDate>
6      <HubWindSpeedMode>Specified</HubWindSpeedMode>
7      <CalibrationMethod></CalibrationMethod>
8      <DensityMode>Specified</DensityMode>
9      <Measurements>
10         <InputTimeSeriesPath>DryRun2.txt</InputTimeSeriesPath
11         <BadDataValue>-99.990000</BadDataValue>
12         <DateFormat>%d/%m/%Y %H:%M</DateFormat>
13         <HeaderRows>0</HeaderRows>
14         <TimeStamp>TimeStamp</TimeStamp>
15         <Power>Power</Power>
16         <ReferenceWindSpeed>ReferenceWindSpeed</ReferenceWind
17         <ReferenceWindSpeedStdDev>ReferenceWindSpeedStdDev</R
18         <ReferenceWindDirection>ReferenceWindDirection</Refer
19         <ReferenceWindDirectionOffset>0.000000</ReferenceWind
20         <TurbineLocationWindSpeed>HubWindSpeed</TurbineLocati
21         <HubWindSpeed>HubWindSpeed</HubWindSpeed>
22         <HubTurbulence>HubTurbulence</HubTurbulence>
23         <ShearMeasurements/>
24         <ProfileLevels/>
25     </Measurements>
26     <Filters/>
27     <Exclusions/>
28 </Configuration>
```

Measurements

Data column definitions:
Relate dataset fields to the names of columns in the data file

```
<TimeStamp>TimeStamp</TimeStamp>
<Power>Power</Power>
<ReferenceWindSpeed>ReferenceWindSpeed</
```



```
1  <?xml version="1.0" ?>
2  <Configuration xmlns="http://www.pcwg.org">
3      <Name>DryRun</Name>
4      <StartDate>2012-08-29 11:50:00</StartDate>
5      <EndDate>2013-08-20 04:50:00</EndDate>
6      <HubWindSpeedMode>Specified</HubWindSpeedMode>
7      <CalibrationMethod></CalibrationMethod>
8      <DensityMode>Specified</DensityMode>
9      <Measurements>
10         <InputTimeSeriesPath>DryRun2.txt</InputTimeSeriesPath
11         <BadDataValue>-99.990000</BadDataValue>
12         <DateFormat>%d/%m/%Y %H:%M</DateFormat>
13         <HeaderRows>0</HeaderRows>
14         <TimeStamp>TimeStamp</TimeStamp>
15         <Power>Power</Power>
16         <ReferenceWindSpeed>ReferenceWindSpeed</ReferenceWind
17         <ReferenceWindSpeedStdDev>ReferenceWindSpeedStdDev</R
18         <ReferenceWindDirection>ReferenceWindDirection</Refer
19         <ReferenceWindDirectionOffset>0.000000</ReferenceWind
20         <TurbineLocationWindSpeed>HubWindSpeed</TurbineLocati
21         <HubWindSpeed>HubWindSpeed</HubWindSpeed>
22         <HubTurbulence>HubTurbulence</HubTurbulence>
23         <ShearMeasurements/>
24         <ProfileLevels/>
25     </Measurements>
26     <Filters/>
27     <Exclusions/>
28 </Configuration>
```

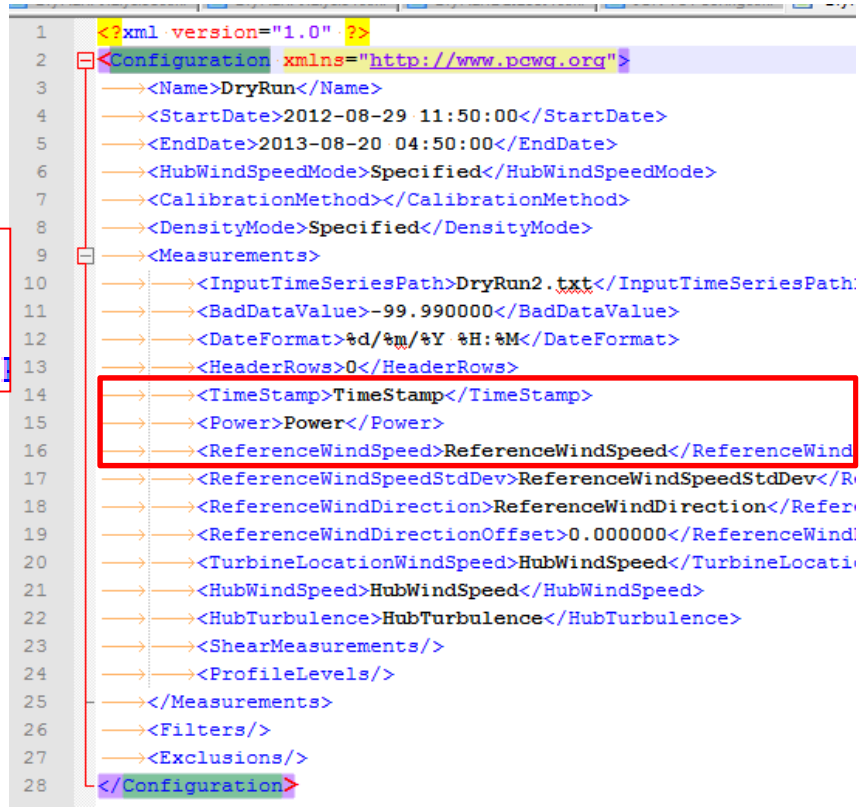
In many PCWG worked examples the data file column names are the same as the names of dataset fields (example above). For data files from the real world this is not usually the case (example below).

```
<TimeStamp>DateTime</TimeStamp>
<Power>m740LOZybr046PowerTransducerMean_(195/630324/010/1,0m)</Power>
<ReferenceWindSpeed>m640LOZybr096AnemometerMean_(12102674,75.43m,331deg)</Re
```

Measurements

Data column definitions:
Relate dataset fields to the names of columns in the data file

```
<TimeStamp>TimeStamp</TimeStamp>
<Power>Power</Power>
<ReferenceWindSpeed>ReferenceWindSpeed</
```



Fields supported in the GUI:

- Time Stamp
- Power
- Hub Wind Speed and Turbulence
- Reference Wind Speed and StDev
- Reference Wind Direction
- Reference Wind Direction Offset
  - Constant offset for the tool to apply, e.g. to correct from Magnetic N to Grid N
- Turbine Location Wind Speed (can be used to calculate site calibration)

Measurements

Fields supported in the GUI (continued):

- Shear Measurements
- Arbitrarily many REWS Profile levels. Example from Dataset 1:

```
<UpperWindSpeed>Mast - 89.1m Wind Speed Mean</UpperWindSpeed>
<UpperWindSpeedHeight>89.100000</UpperWindSpeedHeight>
<ProfileLevels>
    <ProfileLevel>
        <Height>52.500000</Height>
        <ProfileWindSpeed>LiDAR - 52.5m Wind Speed Mean</ProfileWindSpeed>
        <ProfileWindDirection>LiDAR - 52.5m Wind Direction Mean</ProfileWindDirection>
    </ProfileLevel>
    <ProfileLevel>
        <Height>67.500000</Height>
        <ProfileWindSpeed>LiDAR - 67.5m Wind Speed Mean</ProfileWindSpeed>
        <ProfileWindDirection>LiDAR - 67.5m Wind Direction Mean</ProfileWindDirection>
    </ProfileLevel>
    <ProfileLevel>
        <Height>77.500000</Height>
        <ProfileWindSpeed>LiDAR - 77.5m Wind Speed Mean</ProfileWindSpeed>
        <ProfileWindDirection>LiDAR - 77.5m Wind Direction Mean</ProfileWindDirection>
    </ProfileLevel>
    <ProfileLevel>
        <Height>137.500000</Height>
```

Measurements

REWS node:
Defines how to calculate REWS and hub height wind speed from Profile Levels

```
 8    <RotorEquivalentWindSpeed>
 9        <NumberOfRotorLevels>9</NumberOfRotorLevels>
10        <RotorMode>ProfileLevels</RotorMode>
11        <HubMode>PiecewiseExponent</HubMode>
12    </RotorEquivalentWindSpeed>
```

- **NumberOfRotorLevels:** number of levels to use in calculation, generally equal to number of Profile Levels
- **RotorMode**: how to assign profile measurements to rotor areas (levels)
  - **ProfileLevels:** Levels are defined according to measurement heights. This can result in unevenly spaced levels if measurement heights are irregular.
  - **EvenlySpacedLevels:** Levels are interpolated to be evenly spaced. Requires odd number of profile measurements so that the central level represents the hub.
- **Hub Mode:** method to calculate wind speed at hub height from profile
  - **Interpolated:** Linear interpolation
  - **Piecewise Exponent:** Interpolation assuming power law profile

Exclusions

- **Exclusions** can be defined to filter out specific time periods of a dataset:

```
<ns1:Exclusions>
<!-- site cal is from 09/11/12 13:20 12/01/13 04:10-->
<!-- PP test is from 18 October 2013 00:00 to 20 December 2013 08:00-->
    <!-- start of site cal period-->
    <ns1:Exclusion>
        <ns1:ExclusionStartDate>2000</ns1:ExclusionStartDate>
        <ns1:ExclusionEndDate>2012-11-09 13:20</ns1:ExclusionEndDate>
        <ns1:ExclusionActive>1</ns1:ExclusionActive>
    </ns1:Exclusion>
    <!-- end of site cal period to start of PP test-->
    <ns1:Exclusion>
        <ns1:ExclusionStartDate>2013-01-12 04:10</ns1:ExclusionStartDate>
        <ns1:ExclusionEndDate>2013-10-18 00:00</ns1:ExclusionEndDate>
        <ns1:ExclusionActive>1</ns1:ExclusionActive>
    </ns1:Exclusion>
    <!-- end of PP test-->
    <ns1:Exclusion>
        <ns1:ExclusionStartDate>2013-12-18 12:00</ns1:ExclusionStartDate>
        <ns1:ExclusionEndDate>2020-12-20 08:00</ns1:ExclusionEndDate>
        <ns1:ExclusionActive>1</ns1:ExclusionActive>
    </ns1:Exclusion>
</ns1:Exclusions>
```

Filters

- Dataset filters can be defined in the Filters node (currently not supported in the GUI)

- Each Filter must have:
  - Data Column
  - Filter Type (Above, Below or Between)
  - Inclusive (if 1, remove data equal to the Filter Value)
  - Filter Value
  - Active (1 for active, 0 to disable)

```
99
100   <ns1:Filters>
101     <ns1:Filter>
102       <ns1:DataColumn>Density Corrected Hub Wind Speed
103       <ns1:FilterType>Below</ns1:FilterType>
104       <ns1:Inclusive>0</ns1:Inclusive>
105       <ns1:FilterValue>3</ns1:FilterValue>
106       <ns1:Active>1</ns1:Active>
107     </ns1:Filter>
108     <ns1:Filter>
109       <ns1:DataColumn>Density Corrected Hub Wind Speed
110       <ns1:FilterType>Above</ns1:FilterType>
111       <ns1:Inclusive>0</ns1:Inclusive>
112       <ns1:FilterValue>30</ns1:FilterValue>
113       <ns1:Active>1</ns1:Active>
114     </ns1:Filter>
115     <ns1:Filter>
116       <ns1:DataColumn>m649LOZybr039WindvaneMean_(54083
117       <ns1:FilterType>Below</ns1:FilterType>
118       <ns1:Inclusive>0</ns1:Inclusive>
119       <ns1:FilterValue>190</ns1:FilterValue>
120       <ns1:Active>1</ns1:Active>
121     </ns1:Filter>
122     <ns1:Filter>
123       <ns1:DataColumn>m649LOZybr039WindvaneMean_(54083
124       <ns1:FilterType>Above</ns1:FilterType>
125       <ns1:Inclusive>1</ns1:Inclusive>
126       <ns1:FilterValue>240</ns1:FilterValue>
127       <ns1:Active>1</ns1:Active>
128     </ns1:Filter>
```

Filters

- If using Between, two FilterValues are required. This is specified as a comma separated list

```
<!-- 4 [Inflow Angle] >= -2 and [Inflow Angle] < 2 - Reference
    <ns1:DataColumn>m658LOZybr085WindvaneMean_(0104092980_inflow,76.9m,225deg)</
    <ns1:FilterType>Between</ns1:FilterType>
    <ns1:Inclusive>0</ns1:Inclusive>
    <ns1:FilterValue>2.0,358.0</ns1:FilterValue>
    <ns1:Active>0</ns1:Active>
</ns1:CalibrationFilter>
```

Filters

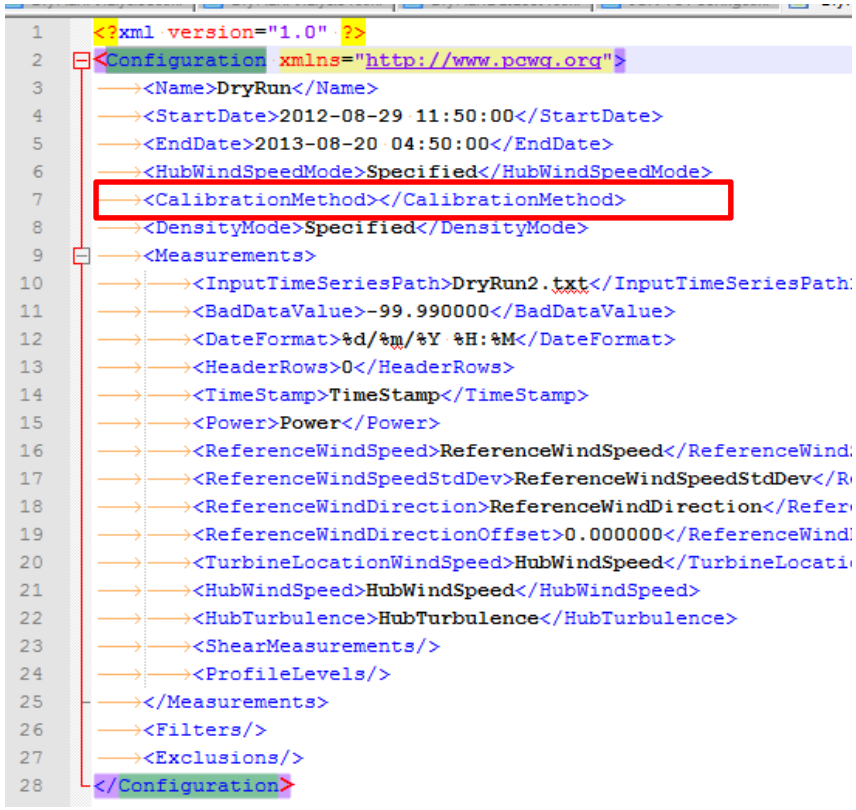
- A filter can contain a Relationship node which allows multiple filters (defined in Clause nodes) to be combined using the AND or OR operation (Conjunction)

```
<ns1:Filter>
    <ns1:Active>1</ns1:Active>
    <ns1:Relationship>
        <ns1:Conjunction>OR</ns1:Conjunction>
        <ns1:Clause>
            <ns1:DataColumn>m758LOZybr029ScadaAvailabilityMax_(Tbn_Connected_To_Grid,1m)</ns1:DataColumn>
            <ns1:FilterType>Below</ns1:FilterType>
            <ns1:Inclusive>0</ns1:Inclusive>
            <ns1:FilterValue>600</ns1:FilterValue>
        </ns1:Clause>
        <ns1:Clause>
            <ns1:DataColumn>m758LOZybr029ScadaAvailabilityMax_(Tbn_Connected_To_Grid,1m)</ns1:DataColumn>
            <ns1:FilterType>Above</ns1:FilterType>
            <ns1:Inclusive>1</ns1:Inclusive>
            <ns1:FilterValue>601</ns1:FilterValue>
        </ns1:Clause>
    </ns1:Relationship>
</ns1:Filter>
```

Site Calibration

CalibrationMethod:
Method of site wind speed calibration

```
7    <CalibrationMethod></Calibrati
```



Options in GUI:

- **Specified:** read calibration from Dataset config file
- **LeastSquares:** Perform least squares fit of turbine wind speed to reference wind speed
- **None:** No calibration

Also supported:

- RatioOfMeans
- York

Site Calibration

- A site calibration can be calculated if Reference Wind Speed and Turbine Location Wind Speed are available in the file. The Calibration node contains:
  - Number of Sectors: typically 36
  - Center of First Sector: generally 5 or 0
  - Calibration Start and End Date (special case Exclusion)
  - Calibration Filters: collection of filters which have the same format as the Filters node

```
192    <ns1:Calibration>
193        <ns1:NumberOfSectors>36</ns1:NumberOfSectors>
194        <ns1:CenterOfFirstSector>5</ns1:CenterOfFirstSector>
195        <ns1:CalibrationStartDate>2014-02-27T10:10:00</ns1:CalibrationStartDate>
196        <ns1:CalibrationEndDate>2014-06-06T02:50:00</ns1:CalibrationEndDate>
197        <ns1:CalibrationFilters>
```

Site Calibration

- Alternatively the calibration results can be specified directly in a CalibrationDirections node, in this case Calibration Method must be set to Specified

```
271  <ns1:Calibration>
272      <ns1:NumberOfSectors>36</ns1:NumberOfSectors>
273      <ns1:CalibrationDirections>
274          <ns1:CalibrationDirection>
275              <ns1:Direction>0</ns1:Direction>
276              <ns1:Slope>1.022</ns1:Slope>
277              <ns1:Offset>0.079</ns1:Offset>
278              <ns1:Active>1</ns1:Active>
279          </ns1:CalibrationDirection>
280          <ns1:CalibrationDirection>
281              <ns1:Direction>10</ns1:Direction>
282              <ns1:Slope>1.021</ns1:Slope>
283              <ns1:Offset>0.088</ns1:Offset>
284              <ns1:Active>1</ns1:Active>
285          </ns1:CalibrationDirection>
```

Summary

- Analysis file structure defines:
  - What dataset(s) will be analysed
  - What baseline the data will be compared to
  - Inner range
  - Turbine details
  - Power curve analysis method e.g. binning, corrections (Density, TI, REWS)

- Dataset file structure defines:
  - Measurements (description of input file)
  - Exclusions
  - Filters
  - Site Calibration

Any Questions?