QUICK GUIDE – PARK WITH SCALER AND MEASURED WIND DATA

Purpose:

This quick guide shows you how to calculate expected Annual Energy Production (AEP) as time-step calculations based on local wind measurements.

Here, PARK calculates in time steps (e.g. 10 min) using measured data, with the SCALER extrapolating the measurements to each turbine position. The SCALER can handle multiple measurement heights and mast positions, and individual displacement heights by sector for individual masts and turbines. The SCALER transfer functions are obtained from WAsP, WASP-CFD or FLOWRES (generalized format open for all model providers) calculations, and include speed up and veering. Also, measured turbulence can be transformed to turbine positions.

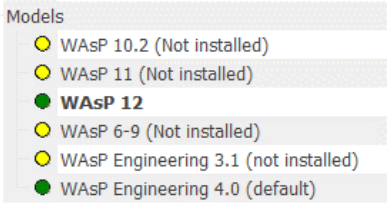
In this guide we assume you are familiar with the basic use of windPRO, like the creation of objects and how to import data into Meteo objects.

Outline of Guide:

1. **License and version requirements**
2. **Setup input and data input in PARK**
3. **Calculation**
4. **Results of PARK calculation**
5. **Additional Scaler options**

1. LICENSE AND VERSION REQUIREMENTS

WindPRO 4.1 or above, with license to the module PARK and METEO. Also, WAsP (11 or above) must be installed.



2. SETUP AND DATA INPUT IN PARK

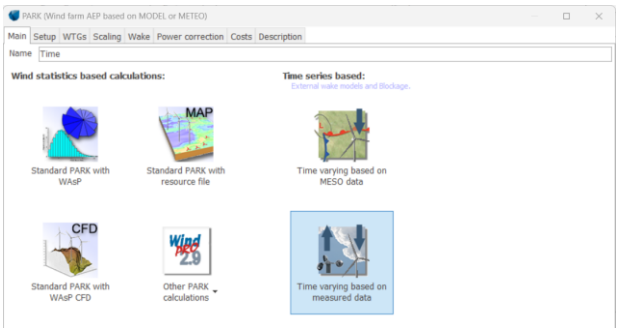
Establish the site measured wind data in Meteo Objects.

If not already established in the project:

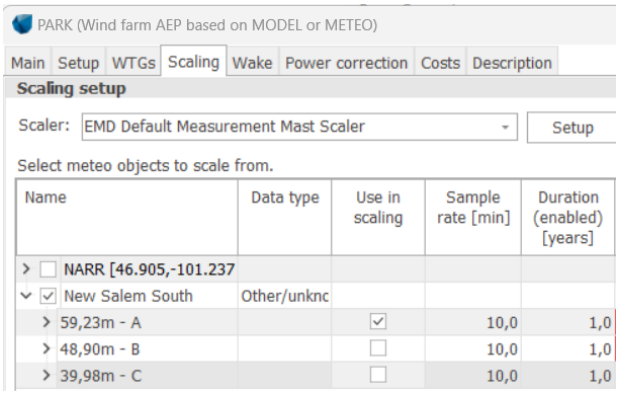
- Insert the WTG objects to simulate.
- Establish roughness and elevation data and make a site data object linking these together.

3. CALCULATION

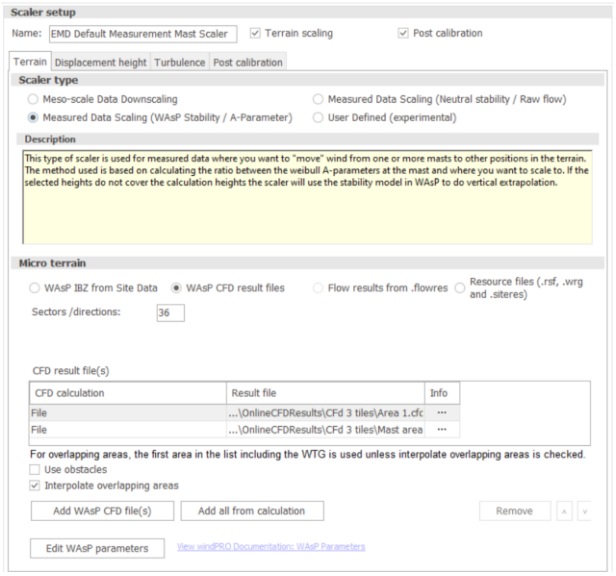
Upon starting PARK, choose the Time-varying calculation based on measured data.



After choosing the turbines for calculation in the **WTG** tab, go to **Scaling**. Here, select the wind data to be used. The model chosen later in the Scaler will be able to interpolate, if the hub height is between measurement heights, or to extrapolate, if it is above.



Now choose the "EMD Default Measurement Mast Scaler", and access its Setup.



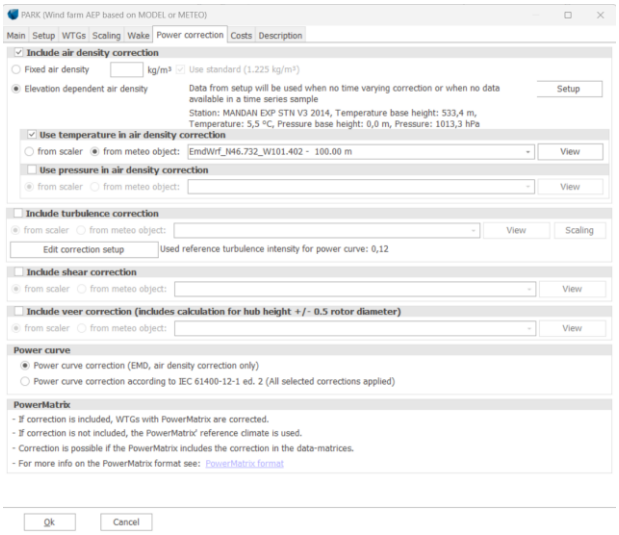
Make sure the correct Site Data Object is chosen – or if WAsP-CFD, .flowres, .rsf or .siteres files should be used as the model. The number of sectors can be chosen as well (only if you're not using CFD results). This affects how many sectorwise transfer functions shall be calculated and, later, when scaling each time record from the time series. Normally, 12 is recommended. The use of 36 can, in some special cases, improve accuracy, but it requires very good data, e.g., a very high accuracy of the measured direction. Close the Setup with Ok.

More advanced options will be described later.

In the **Wake** tab**,** a list of wake models is available. The recommended one is the N.O. Jensen PARK2 (2018), which is default. In this model, the critical parameter is the Wake Decay Constant (WDC), whose default value for onshore sites is set as default (0.090). The WDC should be otherwise chosen based on ambient turbulence. If this is not available, different terrain types are listed together with their roughness class (RC) and length (z0) to help the user choose.

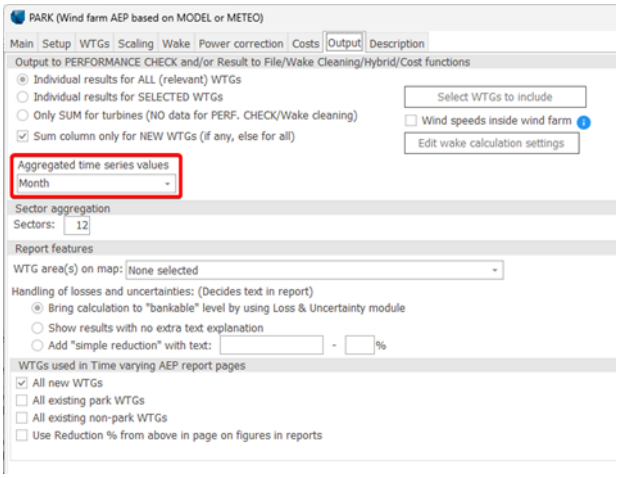
There are more **Advanced** options. If turbulence is available for the entire calculation period, the WDC can be controlled by turbulence in each time step – this is the easy and "safe" choice. For very large wind farms (+5 rows), deep-array model corrections are available.

Finally, the **Power curve correction** is entered. The recommendation here is only to activate the temperature correction, since this gives a more precise month by month calculation.



If there is no temperature data in the measurements, it is possible to get temperature from mesoscale data out of models such as EMD-WRF, where an interpolation will be made in the hourly data to establish 10' data. The other corrections are more for "experimental use". In general, these do not affect the AEP result significantly.

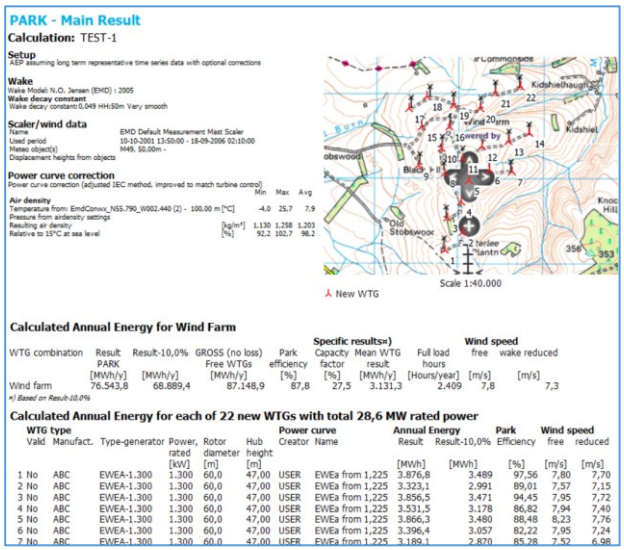
Under **Output** tab, note especially the "Aggregate" options. By default, this is set to Month, partly to save memory. If there is a need for e.g. 10' values (for use in PERFORMANCE CHECK or for some detailed calculations in LOSS & UNCERTAINTY), this must be changed to "None".



Under Report features, the old default of adding a simple 10% reduction to roughly account for losses can be switched to *Bring calculation to "bankable" level*.

Now run the calculation.

4. RESULTS OF PARK CALCULATION



PARK - Main Result

Calculation: TEST-1

Setup
AEP assuming long term representative time series data with optional corrections

Wake
Wake Model: N.O. Jensen (EMD) : 2005
Wake decay constant
Wake decay constant:0,049 HH:50m Very smooth

Scaler/wind data
Name: EMD Default Measurement Mast Scaler
Used period: 10-10-2001 13:50:00 - 18-09-2006 02:10:00
Meteo object(s): H49, 50.00m -
Displacement heights from objects

Power curve correction
Power curve correction (adjusted IEC method, improved to match turbine control)

Air density
Temperature from: EmdConwx_NSS.790_W002.440 (2) - 100.00 m [°C]
Pressure from airdensity settings
Resulting air density [kg/m³]
Relative to 15°C at sea level [%]

	Min	Max	Avg
	-4,0	25,7	7,9
	1.130	1.258	1.203
	92,2	102,7	98,2

Calculated Annual Energy for Wind Farm

WTG combination	Result PARK [MWh/y]	Result-10,0% [MWh/y]	GROSS (no loss) Free WTGs [MWh/y]	Park efficiency [%]	Specific results*) Capacity factor [%]	Mean WTG result [MWh/y]	Full load hours [Hours/year]	Wind speed free [m/s]	wake reduced [m/s]
Wind farm	76.543,8	68.889,4	87.148,9	87,8	27,5	3.131,3	2.409	7,8	7,3

*) Based on Result-10,0%

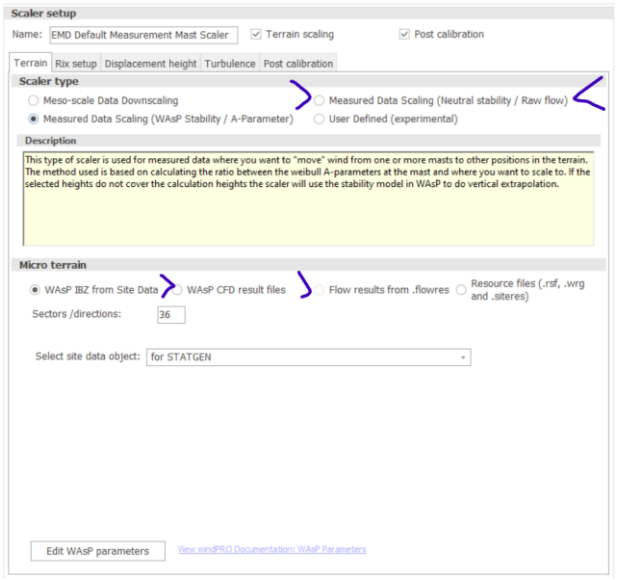
Calculated Annual Energy for each of 22 new WTGs with total 28,6 MW rated power

	WTG type Valid	Manufact.	Type-generator	Power, rated [kW]	Rotor diameter [m]	Hub height [m]	Power curve Creator	Name	Annual Energy Result [MWh]	Result-10,0% [MWh]	Park Efficiency [%]	Wind speed free [m/s]	reduced [m/s]
1	No	ABC	EWEA-1.300	1.300	60,0	47,00	USER	EWEa from 1,225	3.876,8	3.489	97,56	7,80	7,70
2	No	ABC	EWEA-1.300	1.300	60,0	47,00	USER	EWEa from 1,225	3.323,1	2.991	89,01	7,57	7,15
3	No	ABC	EWEA-1.300	1.300	60,0	47,00	USER	EWEa from 1,225	3.856,5	3.471	94,45	7,95	7,72
4	No	ABC	EWEA-1.300	1.300	60,0	47,00	USER	EWEa from 1,225	3.531,5	3.178	86,82	7,94	7,40
5	No	ABC	EWEA-1.300	1.300	60,0	47,00	USER	EWEa from 1,225	3.866,3	3.480	88,48	8,23	7,76
6	No	ABC	EWEA-1.300	1.300	60,0	47,00	USER	EWEa from 1,225	3.396,4	3.057	82,22	7,95	7,24
7	No	ABC	EWEA-1.300	1.300	60,0	47,00	USER	EWEa from 1,225	3.189,1	2.870	85,28	7,52	6,98

The standard report document provides the calculation assumptions and gives the expected AEP as the average for the period calculated. There will automatically be compensation for data recovery, and, optionally, season unbiasing can be chosen. Note that free as well as wake-reduced wind speeds are shown.

The strongest feature when calculating in time steps is the very detailed validation options offered. With the "result to file" output, the result in time can be taken into Excel for further processing or analyses.

5. ADDITIONAL SCALER OPTIONS



Scaler setup

Name: EMD Default Measurement Mast Scaler | Terrain scaling | Post calibration

Terrain | Rix setup | Displacement height | Turbulence | Post calibration

Scaler type

- Meso-scale Data Downscaling
- Measured Data Scaling (Neutral stability / Raw flow)
- Measured Data Scaling (WAsP Stability / A-Parameter)
- User Defined (experimental)

Description

This type of scaler is used for measured data where you want to "move" wind from one or more masts to other positions in the terrain. The method used is based on calculating the ratio between the weibull A-parameters at the mast and where you want to scale to. If the selected heights do not cover the calculation heights the scaler will use the stability model in WAsP to do vertical extrapolation.

Micro terrain

- WAsP IBZ from Site Data
- WAsP CFD result files
- Flow results from .flowres
- Resource files (.rsf, .wrg and .siteres)

Sectors /directions: 36

Select site data object: for STATGEN

Edit WAsP parameters | View windPRO Documentation: WAsP Parameters

Using the Scaler on local measurements offers additional choices.

- One is to use the "Neutral stability/Raw flow" as alternative to the "WAsP Stability/A Parameter": no atmospheric stability is applied, and a neutral atmosphere is assumed.
- The other is to use WAsP-CFD result files or FLOWRES files (from other CFD providers).