



QUICK GUIDE TO OPTIMIZE V2

Purpose:


Efficient optimization of wind farm layouts regarding: Annual Energy Production (AEP), Levelized Costs of Energy (LCOE) or Net Present Value (NPV). Layouts can be subject to several constraints including: site area, turbine spacing, turbine component lifetime, and noise level at noise sensitive areas.

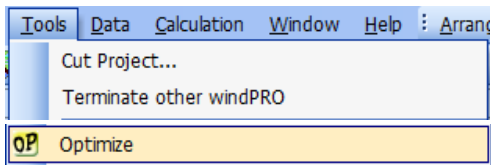
The optimizer is flexible and can be used to compare optimized layouts for different park sizes, turbine models, as well as different optimization strategies.

Outline of Guide:

1. Start 'OPTIMIZE V2' session
2. Basic setup - 'Add Site'
3. Set turbine properties - 'Add WTG'
4. Setup & run optimization - 'Add Sizes & Runs'
5. Result & convergence of 'Run'
6. Compare multiple 'Runs'

1. START 'OPTIMIZE V2' SESSION

To start a new Optimization session open **Optimize** directly in the tool bar icon  or from the dropdown **Tools** menu.



This will open the **Session list**. To open an existing session simply double click it, to start a new session, click **New**. Change the name by clicking the Name field. Click **Open** to open selected session or double click it. Currently only **Irregular pattern** is available.

| Name | Session type | Create date | Last Edit Date |
|------------------|-------------------|---------------------|---------------------|
| My first session | Irregular pattern | 03/01/2022 14:47:43 | 03/01/2022 14:49:57 |
| New Session | Irregular pattern | 03/01/2022 14:50:12 | 03/01/2022 14:50:12 |

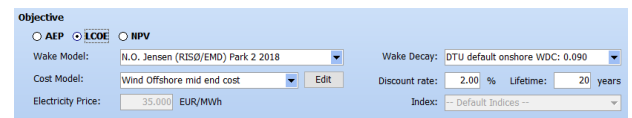
Buttons: New, Delete, Clone, Open, Close

2. BASIC SETUP - 'ADD SITE'

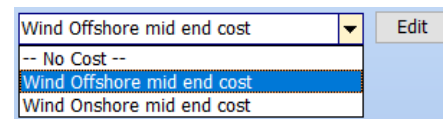
First step in an optimization is to setup the **Site** properties. Per default the first **Site** is already added. The green highlights will guide you to through the required setup items. First, define the resource file by clicking **Browse** and selecting the file.



Second step, define the **Objective** of the optimization - what do you want to optimize for the project? 'Annual energy Production' (**AEP**), 'Levelized cost of Energy' (**LCOE**) or 'Net Present Value' (**NPV**). No matter the objective you must define the **Wake Decay** constant for the **PARK2** wake model, which is currently the only supported wake option.



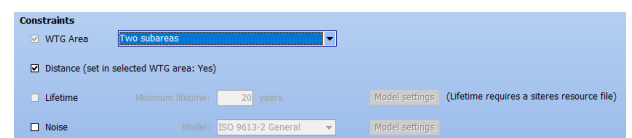
For LCOE and NPV you need to setup a **Cost Model**. You can select a predefined default model from the list or click **Edit** to establish a customized cost model.



For NPV you also need to define the **Electricity Price**.

Electricity Price: 35.000 EUR/MWh

Third step, define the **Constraints** required for the site and optimized layouts. A **WTG Area** object is always needed to define the areal constraints and must be fully covered by the resource file. **Distance** constraints may have been set in the WTG area (for each sub-area) and these can be activated with the Distance check box.



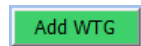
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Constraints on WTG component **Lifetime** and **Noise** level at sensitive areas may also be selected. These have individual model settings and require further inputs later.

Final step, optionally define required **Connection point(s)** for road/grid by selecting Control point objects. **Existing WTGs** can also be defined, which will add wake effects, but not contribute to the AEP. For Noise constraint the noise sensitive points (NSAs) must be selected from the list of objects via **Select**.

| | | |
|---|--------|-------------|
| Connection points: (Optional grid/road) | Select | Selected: 0 |
| Existing WTGs: | Select | Selected: 0 |
| Noise sensitive areas: | Select | Selected: 0 |

We are now ready to proceed to add and setup a wind turbine model (WTG). Click **Add WTG** to proceed.



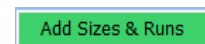
3. SET TURBINE PROPERTIES - 'ADD WTG'

Select **WTG Type** and model, the **Hub Height** and the relevant **Power curve/Mode**.

| | |
|-----------------------|-------------------------|
| WTG & Mode | |
| WTG Type: | <input type="text"/> |
| Hub Height: | <input type="text"/> |
| Power curve/Mode: | <input type="text"/> |
| Lifetime/Loads | |
| Design Standard: | IEC61400-1 ed. 3 (2010) |
| WTG Design Class: | IA |
| Load Response Model: | EMD Generic RD>=160m |
| 8/8 sensors selected. | |
| Noise Data | |
| Noise Data | <input type="text"/> |

For activated noise and lifetime constraints you will also need to define the data to use for those constraint calculations.

You can now proceed to setup the park sizes and optimization details. Click **Add Sizes & Runs**.



4. SETUP & RUN OPTIMIZATION - 'ADD SIZES & RUNS'

First inspect the summary table of the WTG area, showing the minimum and maximum number of WTGs setup for each subarea. Is everything as intended? If not,

now is the time to close the Optimizer and adjust the settings in the WTG area object.

| WTG Area | Min Turbines | Max Turbines |
|------------|--------------|--------------|
| Sub-area | 10 | 15 |
| Sub-area 2 | 5 | 15 |

There are three modes of creating a good start layout:

Interval - Per default **the optimizer will establish a run for the maximum size of layout as defined by the WTG Area object**. However, you can select a range of park sizes to optimize **from min to max number of WTGs**. It must fulfill the requirements defined in the WTG area. Any minimum number in sub areas will be respected by the optimizer per area.

User layout – here you can specify your own starting layout (User Layout) by selecting manually created WTG objects.

Fill max - ask the optimizer to fill as many turbines as possible into the WTG Area.

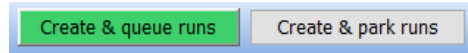
Using the Interval mode, we can now select the optimization strategy from the three available options: **Smart**, **Random** or **Custom**. **Smart** is the best option in most cases, as it generates a superior start model already accounting for the objective and will be much closer to converged.

Smart Random Custom
Realizations: 1
Limit to grid points
Allow invalid start model
Max runtime: 15,0 min

Random is a good alternative when strict constraints are imposed. In this case 'Allow invalid start' model must be activated (only possible for Random). 'Realizations' is simply the number of random optimizations you want to start, i.e. how many dice throws? **Custom** opens for fully flexible settings in the lower part of the window.

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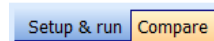
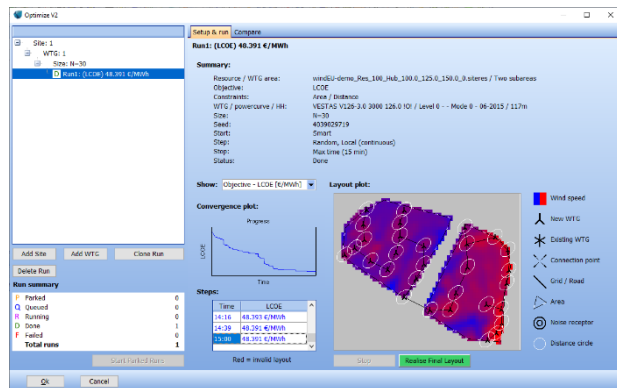
Limit to grid points will default to the appropriate setting given the resolution of the chosen resource file. Set **Max runtime** according to your time available - larger park sizes generally may take longer to fully converge. When ready click **Create & queue runs**.



5. RESULT & CONVERGENCE OF 'RUN'

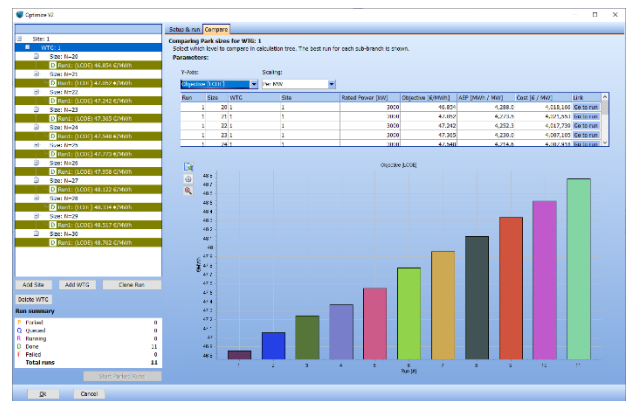
During the course of the optimization, you can track how the WTGs are initially placed and how they 'step' around. A 'step' is taken each time an improvement has been found. You can also see how the objective changes during the optimization in the **Convergence plot** and **Steps** list. For LCOE or NPV you can also select to see evolution of AEP or Cost in the Convergence plot and Steps list. In general, the objective will level out when converged.

Note: The Smart model may generate such good start models that no further convergence is possible and the convergence plot is just a straight line.

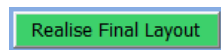


This could be e.g. results for different WTGs for a site or different sizes for a WTG or different runs for a size.

Simply select the level for which you want to compare. **Select the Site to compare the WTGs** it contains, **select a WTG to compare the sizes** it contains or **select a size to compare its runs**. If comparing e.g. WTGs the best run (best objective) for each WTG regardless of size is automatically picked and highlighted in the tree. Similarly for the other levels of comparison.



If you are satisfied with the result of the optimization run you can 'realize' the optimized layout as WTG objects in a new layer by pressing **Realize Final Layout**.



You can navigate the tree on the left to add new sites with alternative resource files, a different objective or other constraints. Or you can add other WTG models for the same site to compare their performance. You can also try different optimization 'strategies' for the same park size.

6. COMPARE MULTIPLE 'RUNS'

The **Compare** tab allows you to compare multiple runs.