



QUICK GUIDE TO OPTIMIZE

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 constraints, turbine spacing constraints, turbine component lifetime constraints, maximum wake loss constraints, and noise constraints. 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' 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' SESSION

Open **OPTIMIZE** directly from the Energy tab to start a new Optimization session. It is still possible to use the classical optimizer by clicking the dropdown and selecting **OPTIMIZE Classic**. The recommendation is to select **OPTIMIZE** for the new optimizer.



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. **Layout - Irregular pattern** and **Curtailement - Noise** are available, click the former for the layout optimization.

Optimize - Session list			
Name	Session type	Create date	Last Edit Date
New Session	Irregular pattern	26/09/2022 09.23.00	26/09/2022 09.23.00

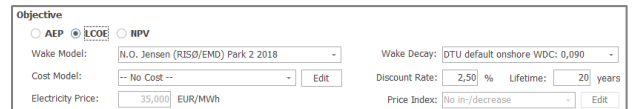
Buttons: New, Delete, Clone

2. BASIC SETUP - 'ADD SITE'

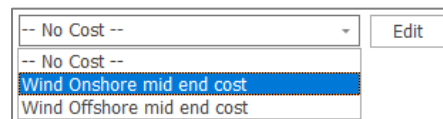
First step in an optimization is to setup the **Site** properties. Per default the first **Site** is already added. The green highlights will guide you to through the required setup items. First, define the resource file by clicking **Browse** and selecting the file.



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**.



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 **Maximum Wake Loss**, **Lifetime** and **Noise** level at sensitive areas may also be selected. The latter 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**.

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

Add WTG

3. SET TURBINE PROPERTIES - 'ADD WTG'

Select **WTG Type** and model, the **Hub Height** and the **Power curve/Mode**. The **Hub Height** must lie between the lowest and highest height of the resource grid.

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**.

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.

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 the optimum.

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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.

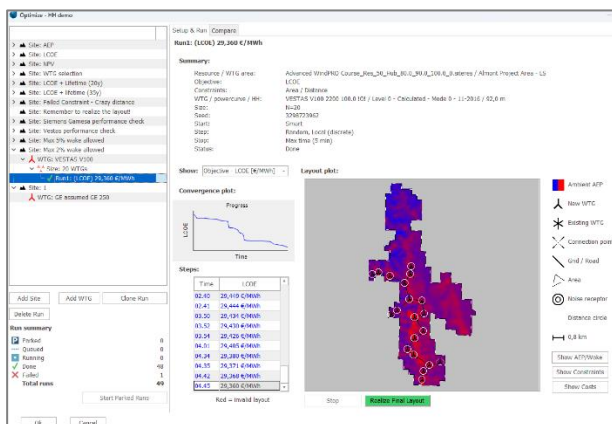
Limit to grid points forces WTG positions to be at grid points of the associated resource file. Set **Max runtime** according to your time available - larger park sizes generally may take longer to fully converge. When ready click **Create & queue runs**.



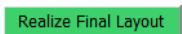
5. RESULT & CONVERGENCE OF 'RUN'

During the course of the optimization, you can track how the WTGs are initially placed and how they explore the neighbourhood for better solutions. 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.



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**.

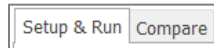


You can navigate the tree on the left to add new sites with alternative resource files, a different objective, or

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.



This could be either results for different WTGs for a site, 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.

