NOISE CURTAILMENT OPTIMIZATION

Purpose:

This quick guide shows how to generate optimal noise curtailment strategies for a wind farm. The turbine positions and noise receptors are fixed, but their operation modes can be changed in various dimensions (time, wind speed, wind direction, temperature etc.).

The goal is to maximize AEP, while respecting noise constraints.

Outline of Guide:

1. REQUIREMENTS

The noise optimization procedure requires an activated license to OPTIMIZE and either DECIBEL or NORD2000.

The WTGs to be optimized must contain information about available operation modes, including noise and power curves. Some turbine models in windPRO Wind Turbine Catalogue already include this information, while others don't. You can always add your own list of operation modes by creating a "Power & Noise pair" or "PowerMatrix" (see BASIS manual 2.6.4.4 and 2.6.4.5)

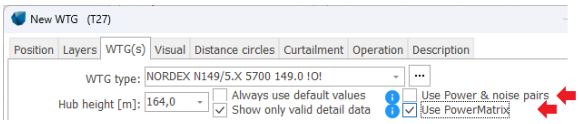
If no "Power & Noise pairs" or "PowerMatrix" is defined for all WTGs, then no curtailment optimization is possible.

2. PREPARING DATA

Turbine information

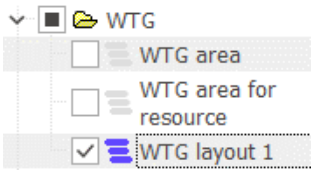
In this quick guide we assume you already have a fixed layout of WTG objects:

Every WTG object must have noise data and power curve defined as "Power & noise pairs" or "PowerMatrix":



This makes it possible for the Curtailment Optimizer to know which operation modes are available for optimization for each WTG.

The curtailment strategy will be applied to all turbines in a layer, so make sure to group the turbines in appropriate layers.

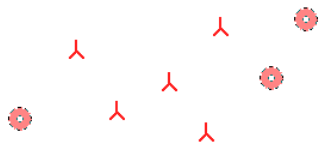


Wind data

To quantify the production loss the Curtailment Optimizer needs information on wind speed either through a resource map or a Meteo Object.

Noise sensitive areas

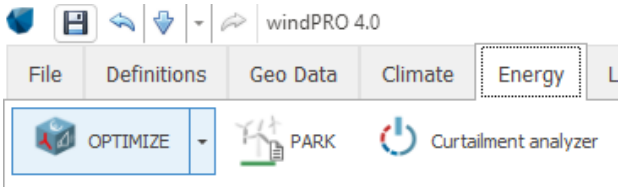
In this quick guide it is assumed that the noise receptors (NSA objects) have already been defined:



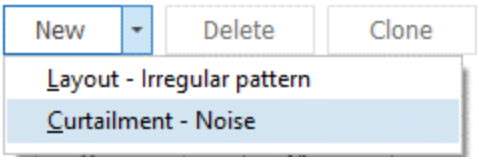
The noise demands defined on each receptor will be used and respected in the curtailment optimization.

3. SETTING UP THE OPTIMIZATION

Open the Optimizer module from the Energy tab:



Click New and select "Curtailment – Noise":

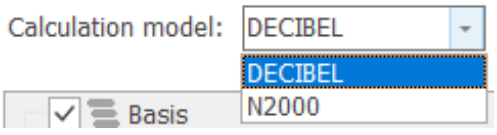


The Curtailment Optimizer is organized in a tree structure:

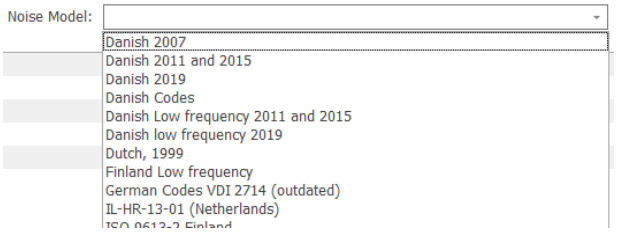
Site	1. Define noise calculation model 2. Select noise sensitive areas to respect 3. Define energy calculation model
Layout	4. Select which fixed layout to optimize
Strategy	5. Define which dimensions the optimization is allowed to use to generate a curtailment strategy. 6. Evaluate results and apply strategy to WTG objects.

Defining the Site

Select calculation model (DECIBEL or NORD2000):

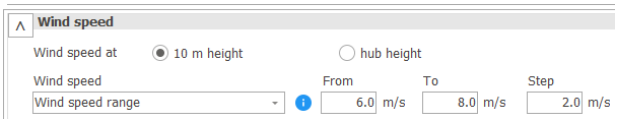


Next, select noise standard (ISO, German, Dutch, Danish, Swedish etc.):

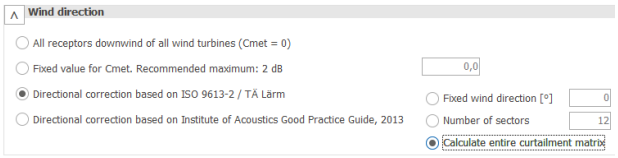


Depending on the flexibility of the noise model you can choose to edit some or all noise model parameters:

For instance, if the you wish to optimize the curtailment strategy by wind speed, then you need to define the which range of wind speeds to include:

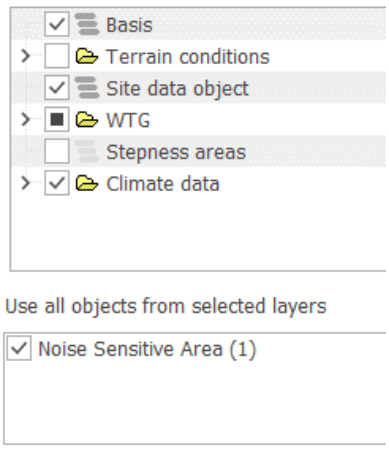


And/or how wind direction will be considered:



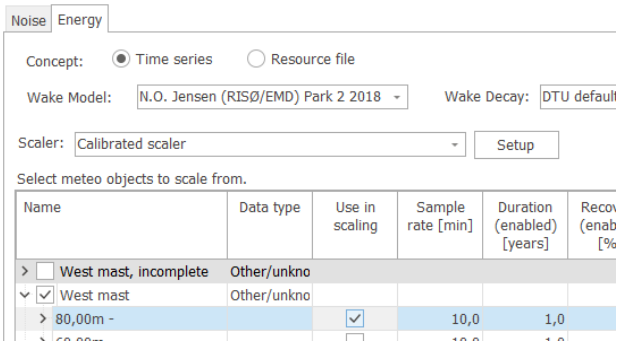
Click Ok in the Edit model parameters window.

Next, select the NSA objects to be included in the optimization:



The last step in the Site setup is to go to the "Energy" tab, and select a time series and Scaler for evaluating the production loss due to changes in operation modes:

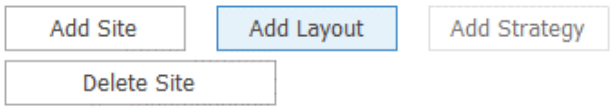
Quick Guide – Curtailment Optimizer



(Alternatively, select Resource map if you already have one)

Selecting the turbines to optimize

Click "Add Layout", in the left side of the window:

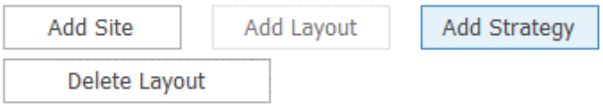


Select the layer with WTGs to be included in the curtailment optimization:

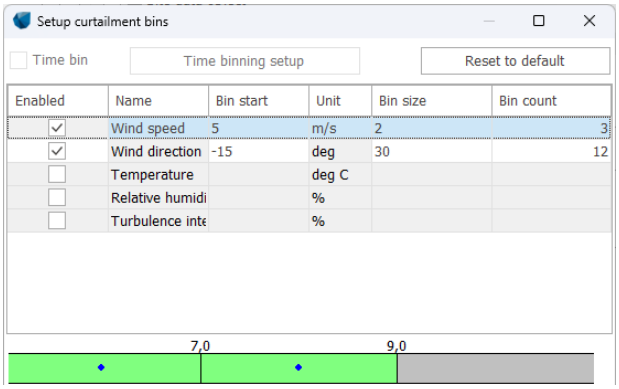
All WTG objects located in this layer will then be included in the optimization.

Defining the optimization strategy

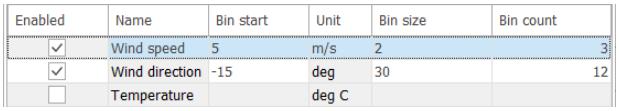
Next, click Add Strategy:



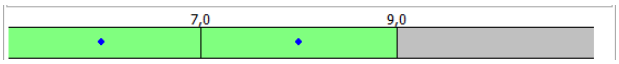
Here, you get an overview of the dimensions the Curtailment Optimizer will use to generate a curtailment strategy:



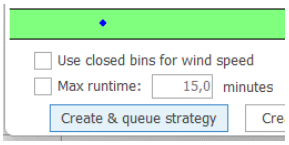
In case you wish to reduce the complexity of the optimation, it is possible to disable dimensions and to reduce the number of bins, the start value and size of each.:



The bottom graphic shows the wind speed ranges which the selected noise calculation will be evaluated against:



To start the calculation, click Create & queue strategy:



Now the Optimizer will run for seconds, minutes or hours depending on the number of turbines, receptors, dimensions and bins.

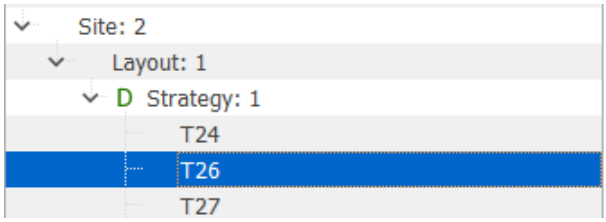
Analyzing the results

The results of the curtailment optimization will appear for all turbines:

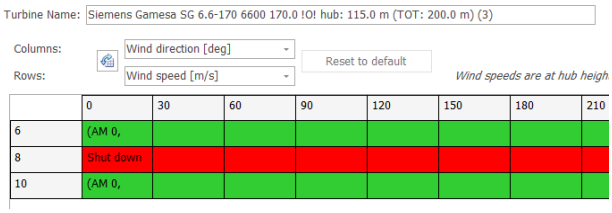
Status: Done

WTG	AEP Loss [MWh]	Loss [%]	Curtailed AEP [M\
Siemens Gamesa SG 6.6-170 6600	-137.5	-0.7	20,249.8
Siemens Gamesa SG 6.6-170 6600	-62.4	-0.3	21,108.2
Siemens Gamesa SG 6.6-170 6600	5,115.4	27.6	13,419.0
Siemens Gamesa SG 6.6-170 6600	-103.8	-0.5	20,120.9
Siemens Gamesa SG 6.6-170 6600	-219.9	-1.1	19,654.9
TOTAL	4,591.8	4.6	94,552.8

You can dive into the results of the individual turbines using the tree in the left side of the window:

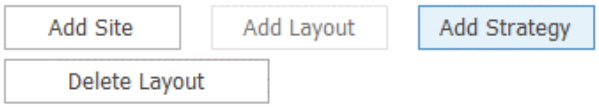


For each turbine you will see a matrix showing which operation mode the turbine will operate in for the selected dimensions:

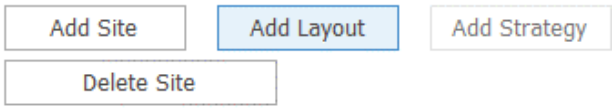


Above, the turbine shuts down in all directions at 8 m/s, while operating in mode AM 0 for all other directions and wind speeds.

You can always repeat the calculation with different dimensions by adding an additional strategy:

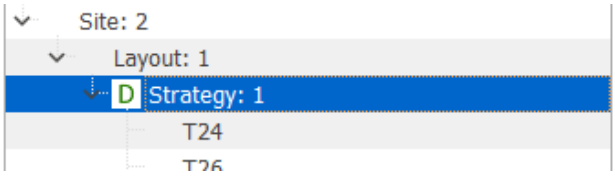


You can also repeat the calculation with a different set of turbines by adding a different Layout:

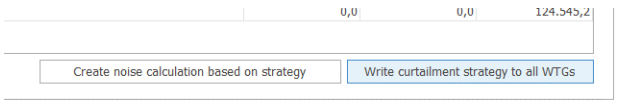


Realizing the results

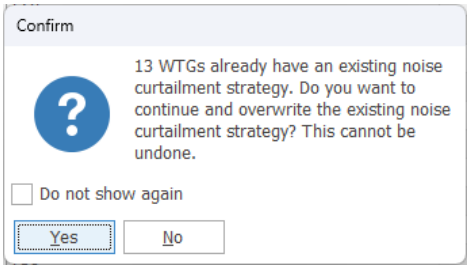
Once you are satisfied with the optimization results go to the Strategy layer:



And click the “Write curtailment strategy to all WTGs”



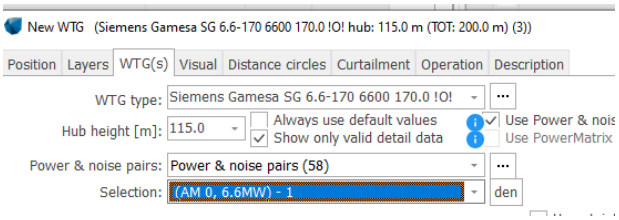
You will be asked to confirm the overwriting of any existing curtailment strategies:



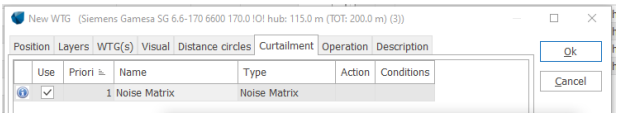
In this case, say yes.

Close the Curtailment Optimizer and open one of the WTG objects which was included in the optimization.

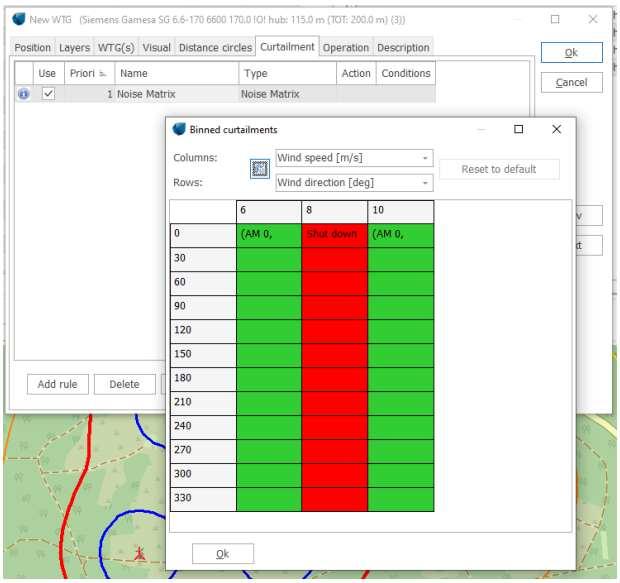
You will see that the selection for normal operation remains the same as before the optimization:



But a curtailment rule called “Noise Matrix” has now been added to the list of curtailments:



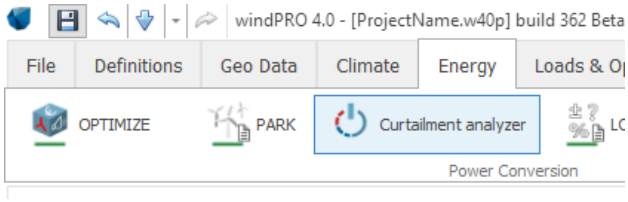
If you double click this line, you can see the noise curtailment matrix for different dimensions:



If you delete or change this rule, then the entire optimized strategy for the other WTGs will no longer be valid. Their Noise Curtailment Matrices will therefore also be cleared!

4. REVIEW THE CURTAILMENTS IN THE CURTAILMENT ANALYZER

It is possible to review, turbine by turbine, all the curtailments applied to a layer. Simply open the Energy Tab and select "Curtailment analyser":



5. FAQ

Can I combine an optimized noise strategy with other curtailments?

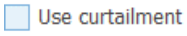
Yes, it is possible to combine the optimized noise curtailments with any other (existing or new) curtailments, such as wind sector management, bat/ bird curtailments etc.

The losses will be subsequently attributed depending on the priority.

Can I use the curtailment strategy in other calculations?

Yes, the operation strategies created by the optimizer can be used directly in PARK, DECIBEL and NORD2000.

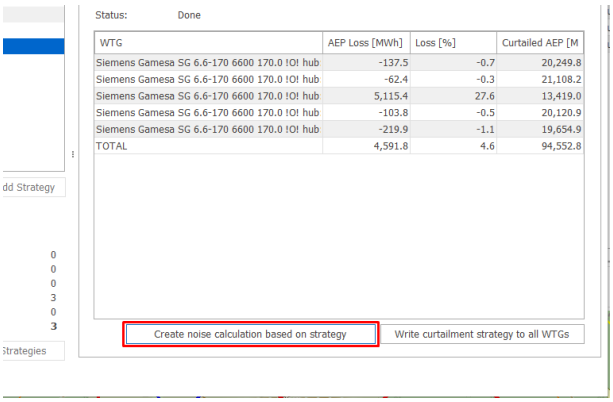
In Time Varying PARK, simply check the Use curtailments checkbox:



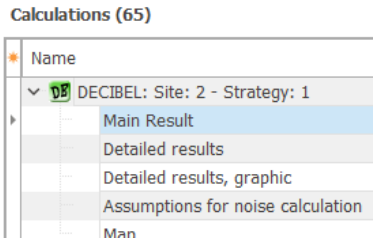
What about proving that the noise curtailment strategy actually works, protecting the neighbours from excessive noise?

An easy way to ensure that the resulting noise calculation uses the same assumptions and input as the optimizer is to let the Curtailment Optimizer output a DECIBEL or NORD2000 report:

Open the Curtailment Optimizer again and go to the desired strategy. There, click the button *Create noise calculation based on strategy*:



This will create a noise calculation (DECIBEL or NORD2000) in the calculation list:



This calculation will use the exact same model parameters as the Curtailment Optimizer.

Now, run the generated DECIBEL/NORD2000 calculation from the calculation list (we're assuming you have already saved the curtailment strategy in the WTG Objects as shown before).

The result on the map shows the case of the loudest period, indicating that the NSA in the North is unaffected (well, the optimizer also had to fully shut down the nearby WTG…):