University of Cyprus
Department of Electrical and Computer Engineering

PSM LAB

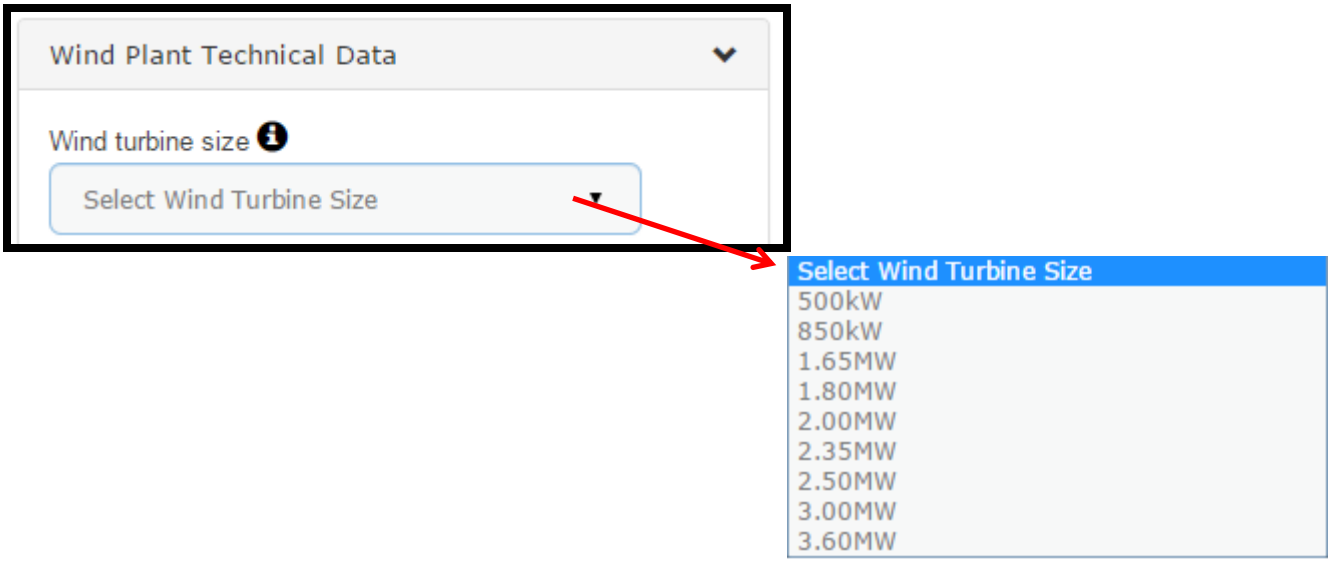
Wind Plant's Transformer Evaluation Tool: Guide Memo

This Memo will guide you through the steps necessary to input a set of data as well as explaining the embedded output options.

Input Data

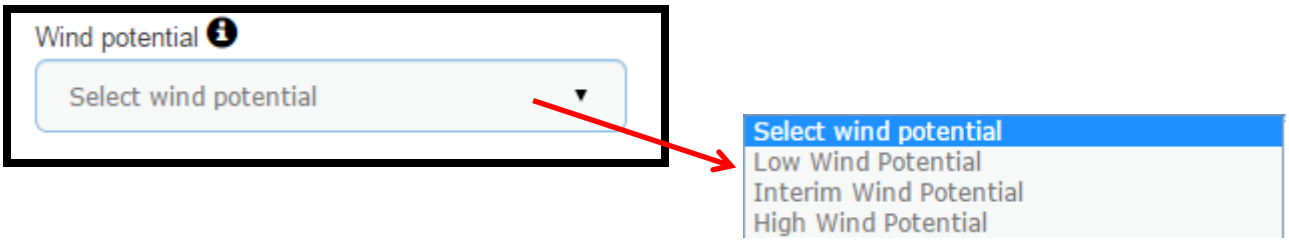
Wind Plant Technical Data

On the ***Wind Turbine Size*** option select the rated size of the wind turbines found in a Wind plant. The list provides options for some commercially available wind turbines.

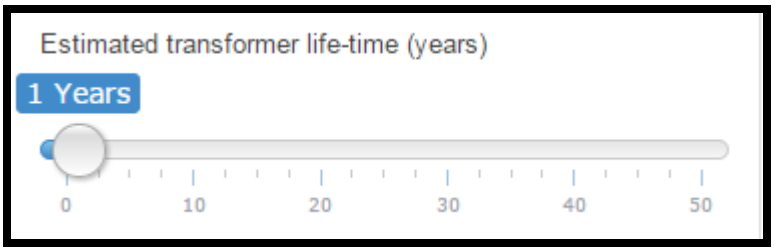


For the ***Number of Wind Turbines*** option insert the number of wind turbines in the plant. The number of wind turbines should only be an integer number.

For the ***Wind Potential*** select the wind potential likely to be available plant's location. (For Example Low = average wind speed ≤2.5m/s, Interim = average wind speed 2.5m ≤*u*≤5m/s, High = average wind speed ≥7m/s).

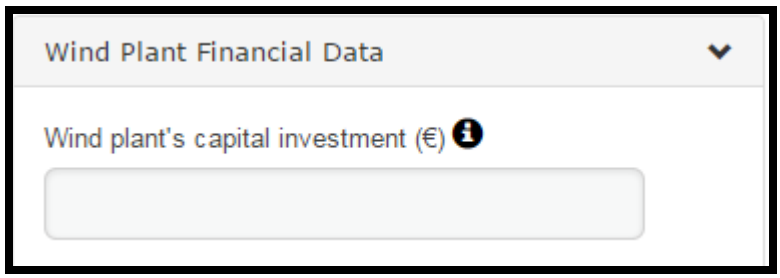


For the ***Estimated Transformer Life-Time*** insert the expected duration of the power transformer operation in years.

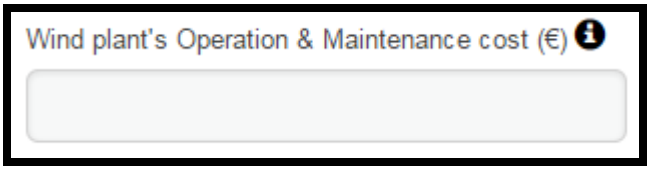


Wind Plant Financial Data

On the ***Wind Plant's Capital Investment*** option insert the initial capital expenditure for the wind plant in €.



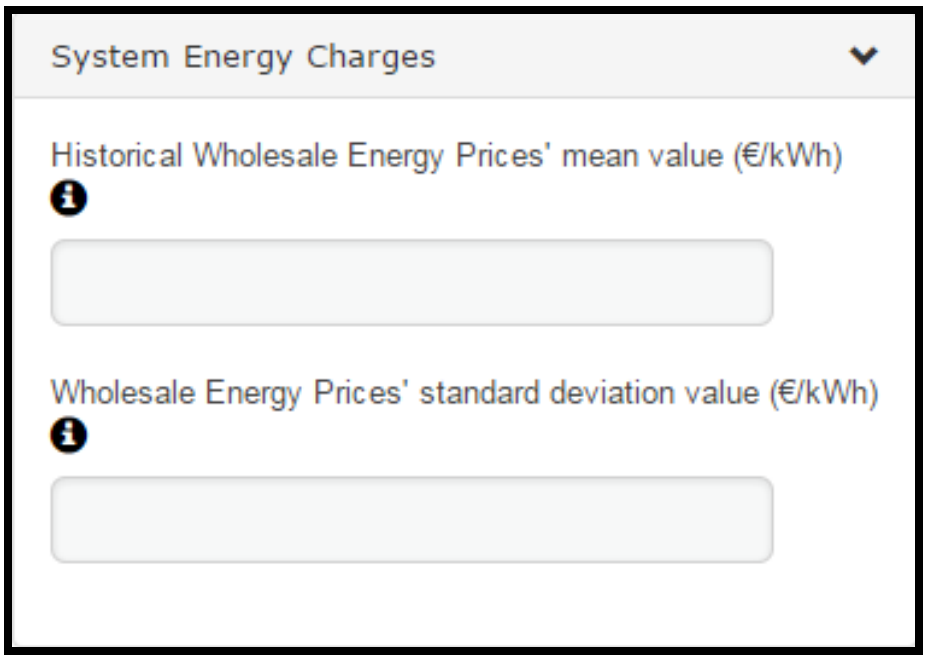
For the ***Wind Plant's Operation and Maintenance Cost*** option insert the annual expected expenditure for plant's operation and maintenance in €.



For the ***Nominal Discount Rate*** option choose the interest rate (in %) that will be used in the discounted cash flow (DCF) analysis to determine the present value of future cash flows.
For the ***Inflation Rate*** option choose the annual expected inflation rate (in %) during the evaluation lifetime.

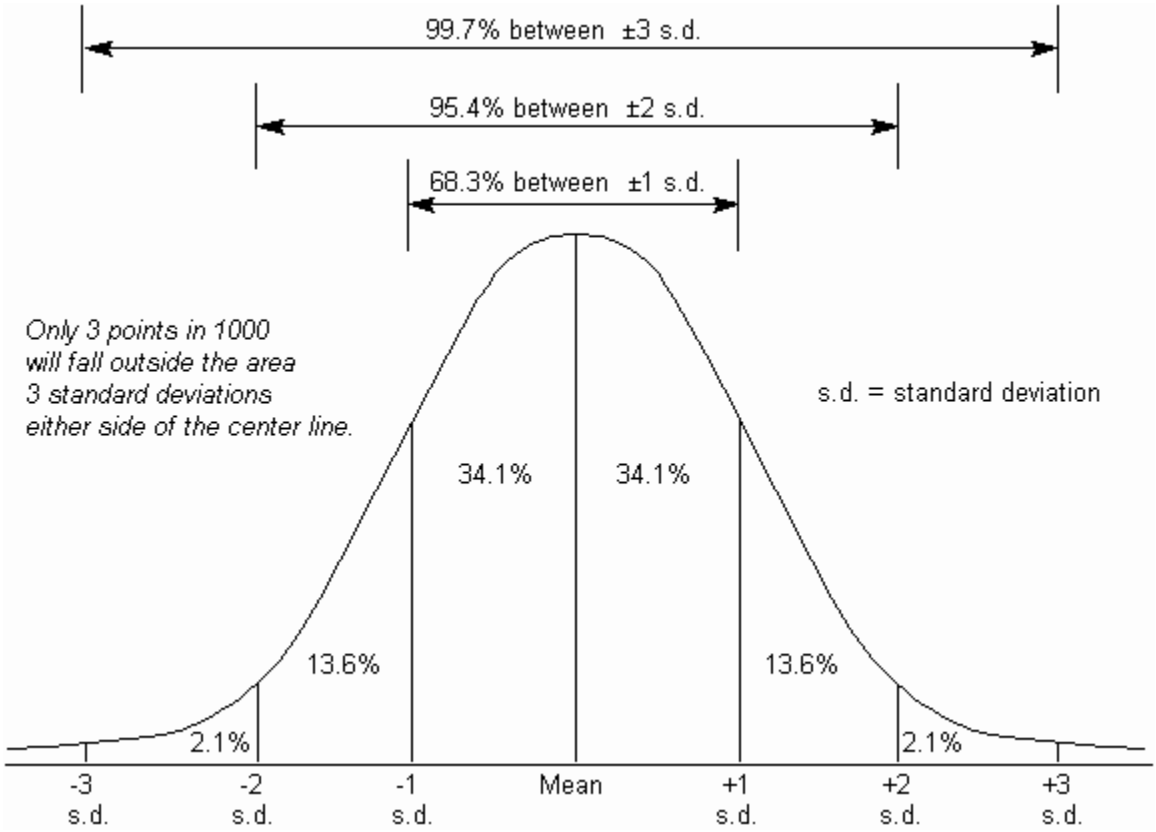
System Energy Charges

For the ***Historical Wholesale Energy Price's Mean Value*** option insert the mean value of the probability density function derived from the available historical wholesale energy prices in €/kWh.
For the ***Historical Wholesale Energy Price's Standard Deviation Value*** option insert the standard deviation of the wholesale energy prices resulting from the statistical treatment of the available historical data of wholesale energy prices in €/kWh.



****Example:**

The available historical wholesale energy prices may be modeled by a normal distribution as shown:

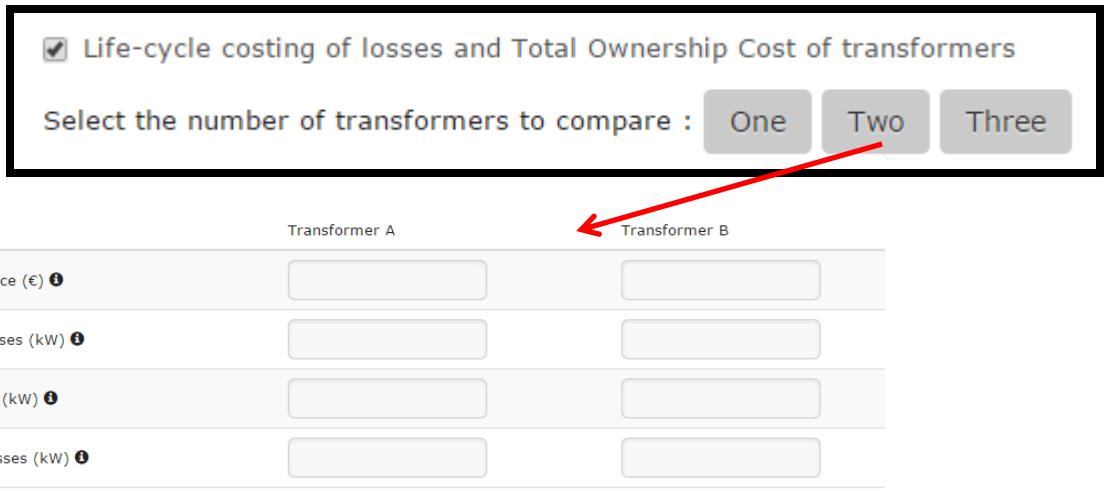


Mean: Mean value of normal distribution
s.d.: Standard Deviation of normal distribution

- ***Historical Wholesale Energy Price's Mean Value:*** Mean Value of the normal distribution shown.
- ***Historical Wholesale Energy Price's Standard Deviation Value:*** s.d. (+1) of the normal distribution shown.

*Optional: Transformer Total Ownership Cost

If you wish to calculate the ***Total Ownership Cost (TOC)*** of transformers you should select the option displayed. If this is the case, the required number of transformers to be compared should be selected. The tool provides the ability to compare up to three transformers.



You should then insert the data provided by the manufacturer of all the transformers to be compared. The data should be inserted as follows:
For the ***Purchase Price*** option insert the capital expenditure to buy the equivalent transformer in €, as provided by manufacturer.

For the ***No-Load Losses*** option insert the guaranteed fixed transformer losses due to core energisation, in kW. This is provided by transformer's manufacturer.

For the ***Load Losses*** option insert the guaranteed variable transformer losses due to loading of transformer, in kW. This is provided by transformer's manufacturer.

For the ***Auxiliary Losses*** option insert the guaranteed transformer losses due to power lost by the operation of transformer's cooling units, in kW. This is provided by transformer's manufacturer.

Output Results

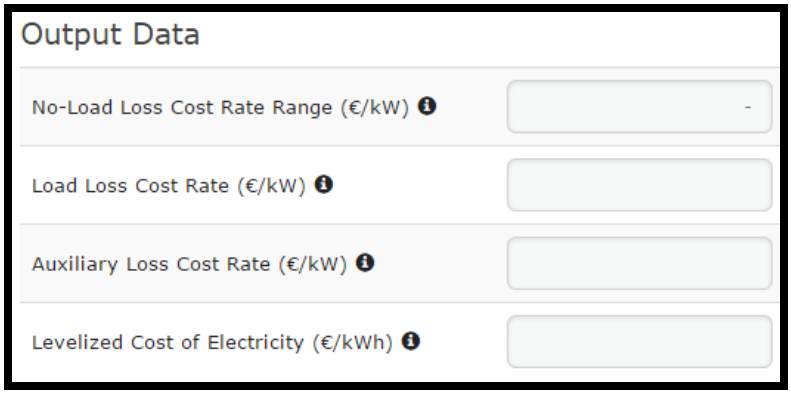
The output results are displayed in a table format and, if the optional transformer Total Ownership Cost check-box is selected, graphically. The Table provides the calculated loss cost rates for transformer no-load, load and auxiliary losses. In addition, the Wind plant specific Levelized Cost of Electricity is illustrated. The graph illustrates the probabilistic **Total Ownership Cost distribution** of the transformers. The distribution is illustrated in terms of a ***statistical box-plot***.

***No-Load Losses Cost Rate Range (€/kW)*:** The range at which no-load loss costs are capitalized or converted to present value. This is dependent on the historical wholesale energy prices and the wind plant's Levelized Cost of Electricity

Load Loss Cost Rate (€/kW): Factor that capitalizes or converts load loss costs to present value. This is dependent on the wind plant's Levelized Cost of Electricity.

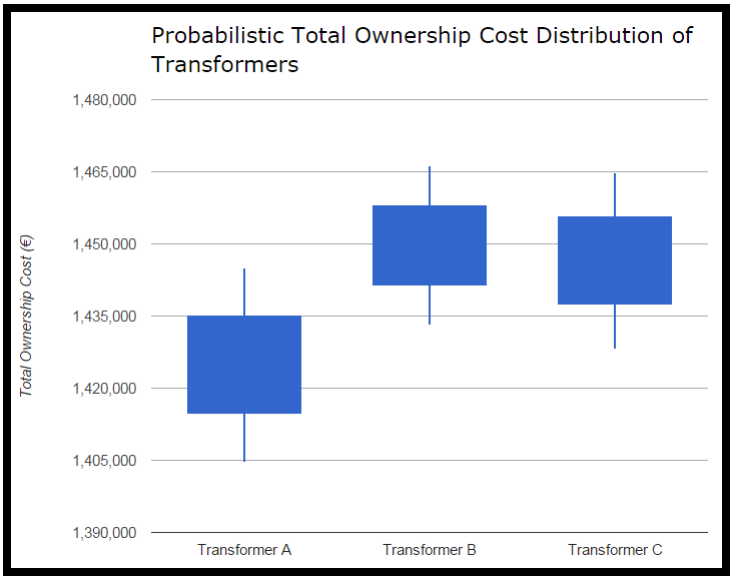
Auxiliary Loss Cost Rate (€/kW): Factor that capitalizes or converts auxiliary load loss costs to present value. This is dependent on the wind plant's Levelized Cost of Electricity.

Levelized Cost of Electricity (€/kWh): It is an economic assessment, in per kWh cost, to build and operate a power-generating asset over its lifetime divided by the total power output of the asset over that lifetime

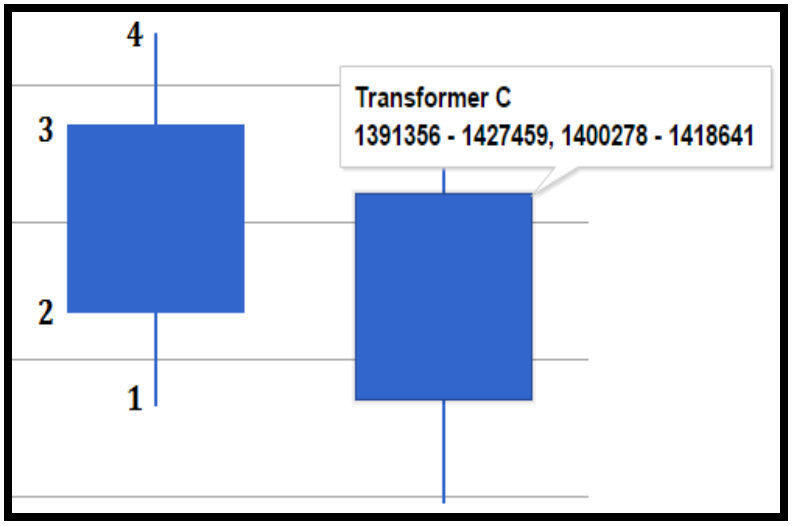


Optional:

Example for three transformers probabilistic TOC evaluation:

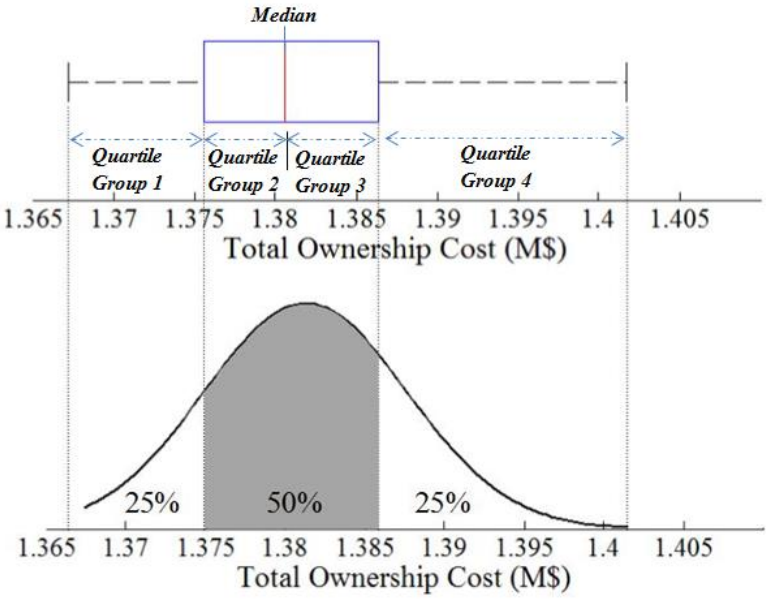


The graph provides relevant information, for each statistical box plot distribution. The first set of limit provides the range of prices from point 1 to point 4 (see side figure). The second set of limit provides the range of prices from point 2 to point 3 (see side figure).



1 – 4: €1391356 – €1427459
2 – 3: €1400278 – €1418641

Correlation of a statistical box-plot to normal distribution (explanation):



For Further Details:

http://ieeexplore.ieee.org/xpl/articleDetails.jsp?arnumber=6940295&sortType%3Dasc_p_Sequence%26filter%3DAND(p_Publication_Number%3A61)%26rowsPerPage%3D100