

HOW TO GUIDE

OPTIMIZE in energyPRO



energyPRO

Preface

energyPRO is a Windows-based modeling software package for combined techno-economic analysis and optimisation of complex energy projects with a combined supply of electricity and thermal energy from multiple different energy producing units.

The unique programming in energyPRO optimises the operations of the plant including energy storage (heat, fuel, cold and electrical storages) against technical and financial parameters to provide a detailed specification for the provision of the defined energy demands, including heating, cooling and electricity use.

energyPRO also provides the user with a detailed financial plan in a standard format accepted by international banks and funding institutions. The software enables the user to calculate and produce a report for the emissions by the proposed project.

energyPRO is very user-friendly and is the most advanced and flexible software package for making a combined technical and economic analysis of multi-dimensional energy projects.

For further information concerning the applications of energyPRO please visit www.emd.dk.

Terms of application

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1. Introduction

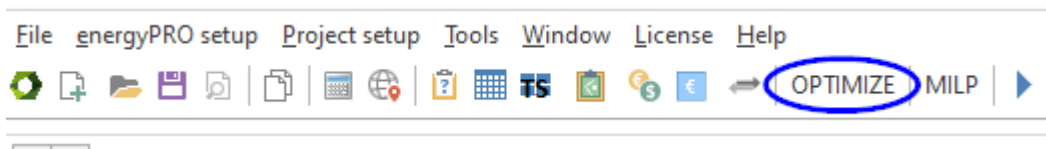
With the OPTIMIZE module in energyPRO, you can make a sizing optimization of any new energy conversion unit or storage you would like include in your model.

Intuitive user interface where you select the assets, planning period, specific investments, expected lifetime and interest rate.

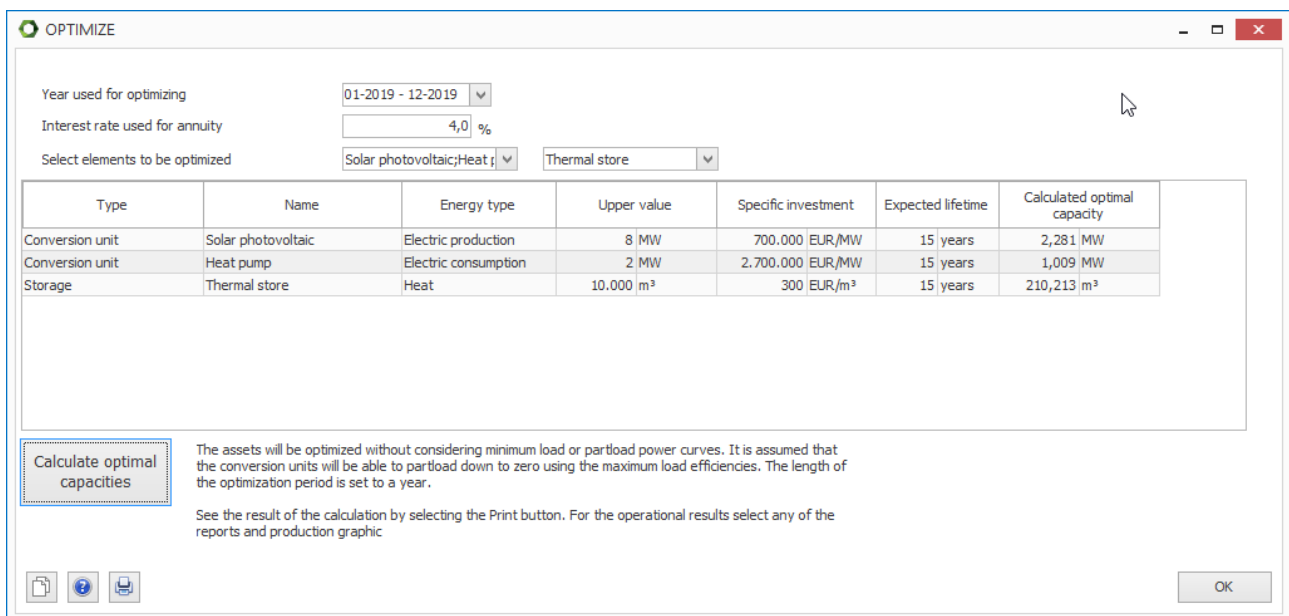
Based on the inputs energyPRO calculates an annuity cost. This annuity cost is connected to the size of the asset and energyPRO will find the optimal size and operation based on the annuity cost, operational cost and income and technical conditions such as demands and transmission restrictions.

2. OPTIMIZE window

When having a valid OPTIMIZE license, you can access the OPTIMIZE form in the toolbar. Beside having a valid OPTIMIZE license, you shall use the MILP solver.



When clicking on OPTIMIZE the OPTIMIZE window appears.



You start by defining the year used for the sizing optimization. When being in DESIGN, this will be equal to your planning period. If you are in FINANCE or ACCOUNTS and your planning period is more years, you can select which year to use for the optimization. If you have development in demand, prices, etc. the result of the sizing optimization might change depending on which year you select.

The interest rate is used for the calculation of the annuity, see section 4.1 .

Next, you select the elements you would like to optimize the size of. You can either select energy conversion units or storage units and you can select multiple elements.

The selected elements appear in the table. In the column **Energy type**, you select between the different energy types the energy conversion unit is consuming or producing.

In the **Upper value** column, you specify the largest possible capacity of the given energy type when calculating the optimal size. For storages the value is not used. Here, you can have an optimal storage larger than the value set in the upper value column.

The **Specific investment** contains the investment per MW, kW, m3 or whatever measuring unit the energy type is specified in.

In the **expected lifetime** column, you set the expected lifetime of the element. Together with the specific investment and interest rate this is used for calculating the annuity, see section 4.1 .

When having set the inputs, you press the “Calculate Optimal capacities” button. energyPRO makes an annual calculation, where the annuities of the selected elements are included.

The calculated values will appear in the **Calculated optimal capacity** column.

This can be an iterative process. Maybe the specific investment can be more precise, when knowing in which range the optimal capacity is.

Maybe you will need to extend the Max. solution time in the MILP settings, if you have warning that the solution time has been exceeded. With an optimization period of a year the calculation will take longer time.

3. Reports

Selecting the Report button will reveal a report with a summary of the inputs and the calculated capacities and corresponding investments.

Finally, a summary table with operational income and cost together with the annuities presents the operational income.

OPTIMIZE**Inputs**

Year used for optimizing: 01-2019 - 12-2019

Interest rate used for annuity: 4%

Type	Name	Energy type	Upper value	Specific investment	Expected lifetime
Conversion unit	Solar photovoltaic	Electric production	8 MW	700000 EUR/MW	15 years
Conversion unit	Heat pump	Electric consumption	2 MW	2700000 EUR/MW	15 years
Storage	Thermal store	Heat	10000 m ³	300 EUR/m ³	15 years

Results

Name	Calculated optimal capacity	Investment
Solar photovoltaic	2,281 MW	1.596.700 EUR
Heat pump	1,009 MW	2.724.300 EUR
Thermal store	210,213 m ³	63.064 EUR

Net Operation income including annuities (EUR)	
Revenues	12.914
Operating Expenditures	-1.152.855
Annuity, Solar photovoltaic	-143.809
Annuity, Heat pump	-245.027
Annuity, Thermal store	-5.872
Operational income including annuities	-1.534.249

All the usual reports are available as well.

4. Methods

4.1 Annuity

The sizing optimization in energyPRO is done by adding independent variables for the capacities of the selected elements. A linear cost is multiplied with these independent variables.

The linear cost is calculated as an annuity of the investment based on the interest rate and expected lifetime.

$$\text{Annuity} = \text{SpecificInvest} * \text{Capacity} * \frac{i}{1 - (1 + i)^{-n}}$$

Where i is interest rate and n is expected lifetime.

4.2 Upper value

The upper value of the energy type is used to limit the interval in which the optimal capacity is looked for. The full load capacity of the energy conversion unit is used to define the relationship between the energy types of the energy conversion unit.

4.3 Optimization period

The optimization period is set to year regardless of the setting in the projects.

4.4 Part load and minimum load

Since the full load capacity of the energy conversion unit is an independent variable, it is not possible to have part load power curves and minimum load.

5. Limitations

The size optimization only works with the MILP solver.

The energy conversion unit is allowed to part load down to zero with the efficiencies of the full load power curve. Any part load power curves will be ignored including minimum load.

The planning period is one year even if you have more years in the project's planning period. The optimization period is also a year, even if you have monthly optimization in the project settings.

It is not possible to optimize fuel storages, user defined thermal storages or hydro station storage.