HOW TO GUIDE

The INTERFACE-module in energyPRO

- XML-call of energyPRO

energyPRO

EMD International A/S
www.emd.dk

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

EMD International A/S, July 2022

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1. Introduction

With the INTERFACE-module you can specify changes in a specific energyPRO project file by use of XML-files. Next, you tell energyPRO to read the XML file, perform a calculation and save specific reports as files. Typically, Excel is used to generate the XML file.

2. Examples of what the INTERFACE can be used for

The INTERFACE module can be useful in several different situations.

2.1 Using INTERFACE to simulate alternatives with a single energyPRO project file

In case you have a heating system with natural gas fired boilers and want to install a solar collector. You want to investigate the impact of two different collector types, three different collector areas and two different storage capacities. Including a reference scenario this altogether amounts to 13 calculations. Typically, it would need 13 different energyPRO project files to simulate this but by using INTERFACE, you can do this using only one project file. You create the XML file, start energyPRO by XML and perform the 13 calculations and have the results presented in report files.

Another great advantage of this feature is if you need to change prices, time series or similar, you do not need to go through all 13 project files. You only have to change it in your single project file, and perform a new set of calculations using the INTERFACE.

2.2 Updating values in several energyPRO projects with INTERFACE

With INTERFACE it is possible to quickly update time series in a large number of project files. If you have a number of plants and need to update e.g. the spot price time series, it can be done easily using the new INTERFACE in energyPRO.

2.3 Daily operation with INTERFACE

You can easily feed your energyPRO project continually with actual values of prices, prognoses and demands and have energyPRO make suggestions of operation for the coming days using INTERFACE.
Please note that this option is only possible if you also purchase an energyTRADE license.

3. Using INTERFACE with an EXCEL spreadsheet

3.1 Typical setup

Typically, (Microsoft EXCEL) spreadsheets are used for setting up the system. In the screenshot below, six scenarios are specified as shown on **Error! Reference source not found.**.

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	A	B	C	D
1				
2				
3				
4	Modifying input (input section)			
5				
6	Start run number	1	Run Calculations	
7	End run number	6		
8	Input ID	Energy Conversion Unit	Storage	
9	Data element	Solar	Storage Volume	
10	Sub data element	Total Area		
11	COMPARE, name of alternative			
12	Parameter name (corresponding to name in the energyPRO model)	Solar collector	Thermal store	
13	Fuel name			
14	Time series file type			
15	File field delimiter			
16	Data element index			
17	3	40000	5000	0
18	Present calculation:↗			
19	Run	Parameter 1	Parameter 2	Parameter 3
20	1	20000	5000	
21	2	30000	5000	
22	3	40000	5000	
23	4	20000	10000	
24	5	30000	10000	
25	6	40000	10000	
26				

Figure 3-1: Six scenarios defined in the “Input” sheet

To make the use of INTERFACE as easy as possible, EMD has prepared a generic spreadsheet, which automates the generation of xml file and call of energyPRO.

For a template to be commissioned, free of charge, please contact EMD International A/S and a spreadsheet will be sent to you. It can also be found and downloaded on our homepage.

By using macros in the spreadsheet, an XML-file is generated and energyPRO is called with a command like this:
energyPRO.exe /XMLMod input.xml

Once the XML-file is generated, there is also the option of reading the XML-file from energyPRO as shown on **Error! Reference source not found.**:

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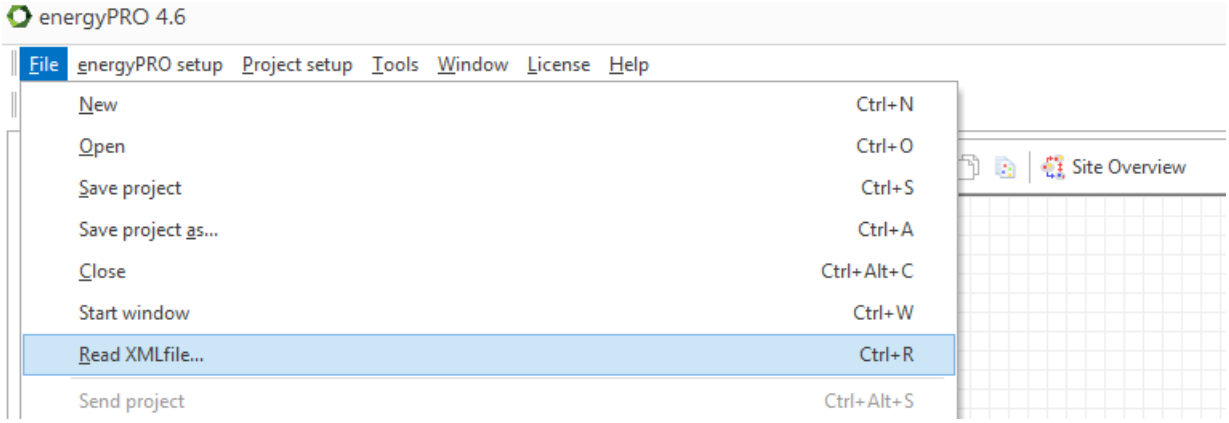

Figure 3-2: Reading the XML-file from energyPRO

3.2 Head Sheet

In the following chapters, the use of the spreadsheet issued be EMD will be explained in more detail.

The spreadsheet has five sheets:

- Head
- Input
- Output
- Key figures
- Evaluation

For detailed information on the different settings see section 3.6 .

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The Head sheet looks like this:

	A	B	C
1		*20211109*	
2			
3			
4	General project information (Head section)		
5			
6	Path, energyPRO:	c:\Program Files\EMD\Build\energyPRO4.exe	Check energyPRO
7	Project file, xml file and reports in same path as spreadsheet:	yes	Update paths
8	Name, project file:		Find project file
9	Path, project file:	Y:\Development\energyPRO\INTERFACE\	
10	Path, xml file:	Y:\Development\energyPRO\INTERFACE\	
11	Path, report files:	Y:\Development\energyPRO\INTERFACE\	
12	Name, xml file:	input	
13	Calculate:	True	
14	Spool:	True	
15	Save:	True	☑ Include run number in name
16	SaveAs:		
17	Logging info and error messages	OnlyLogging	
18	Path, log files	Y:\Development\energyPRO\INTERFACE\	
19	Date	17.12.2021	
20	Version	1	
21	Language of Evaluation reports	English	
22	Currency format	#,##0.00 €	

Figure 3-3: The Head sheet

"Path, energyPRO" shall contain the path and energyPRO exe filename. You can press the "Check energyPRO" button, to have the path verified.

When setting "Project file, xml file and reports in same path as spreadsheet" to Yes, the paths of the project file, xml file and report files will be set to the same as the path of the spreadsheet, when making xml files and calculations. Clicking the "Update paths" button, the paths are updated at once.

All other settings are explained in detail in section 4.

3.3 Input Sheet

The Input sheet looks like this:

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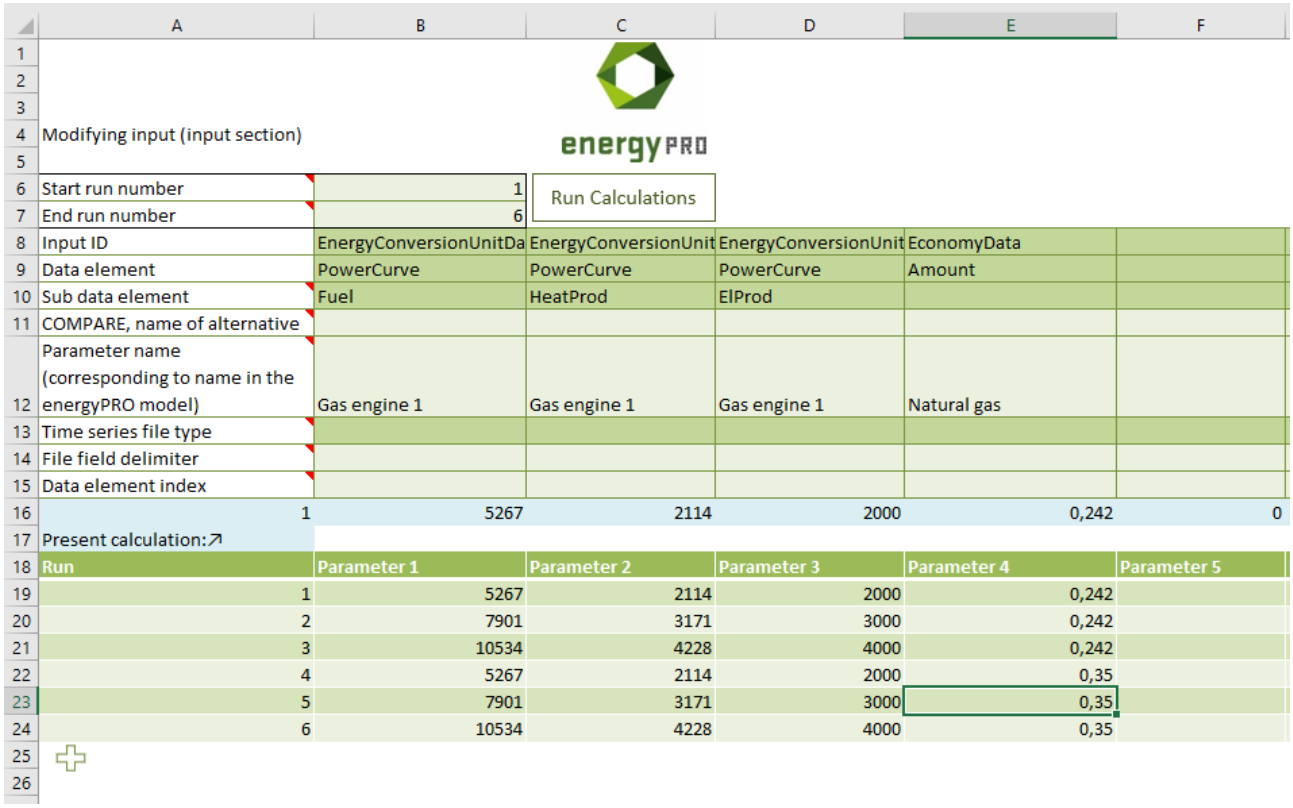

	A	B	C	D	E	F
1						
2						
3						
4	Modifying input (input section)					
5						
6	Start run number	1	Run Calculations			
7	End run number	6				
8	Input ID	EnergyConversionUnitDa	EnergyConversionUnit	EnergyConversionUnit	EconomyData	
9	Data element	PowerCurve	PowerCurve	PowerCurve	Amount	
10	Sub data element	Fuel	HeatProd	ElProd		
11	COMPARE, name of alternative					
12	Parameter name (corresponding to name in the energyPRO model)	Gas engine 1	Gas engine 1	Gas engine 1	Natural gas	
13	Time series file type					
14	File field delimiter					
15	Data element index					
16	1	5267	2114	2000	0,242	0
17	Present calculation:↗					
18	Run	Parameter 1	Parameter 2	Parameter 3	Parameter 4	Parameter 5
19	1	5267	2114	2000	0,242	
20	2	7901	3171	3000	0,242	
21	3	10534	4228	4000	0,242	
22	4	5267	2114	2000	0,35	
23	5	7901	3171	3000	0,35	
24	6	10534	4228	4000	0,35	
25						
26						

Figure 3-4: The Input sheet

On the input sheet, you set the input data you would like to change.

In the row Input ID you have a dropdown list, with the options available.

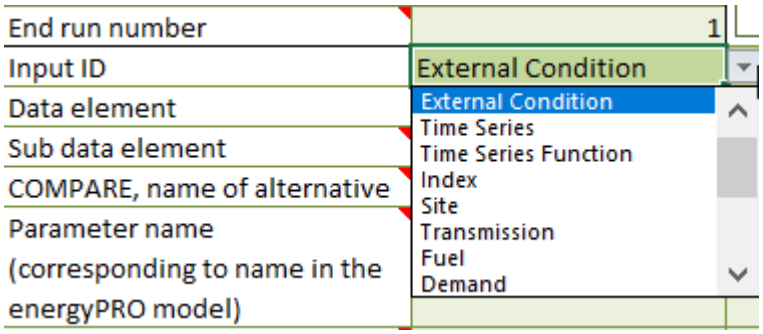

Figure 3-5: Dropdown list, Input ID

The Data element contains a dropdown list, which items depends on the selected Input ID:

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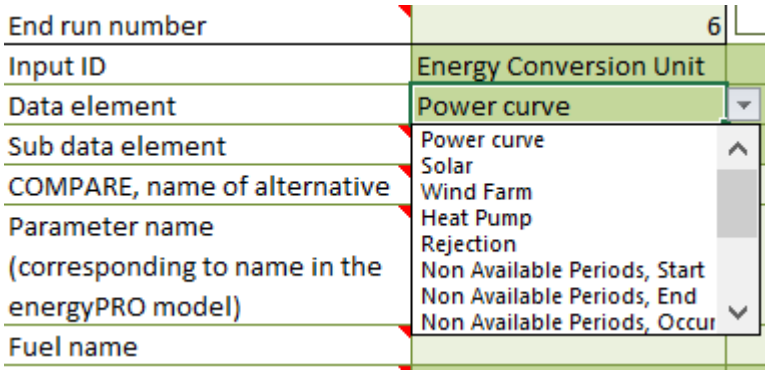

Figure 3-6: Dropdown list, Data element

Next row, Sub data element, is only relevant if Input ID is Energy Conversion Unit and Data element is PowerCurve, SolarUnit or WindFarm. Depending on the selected item in Data element, the Sub data element contains a different dropdown list:

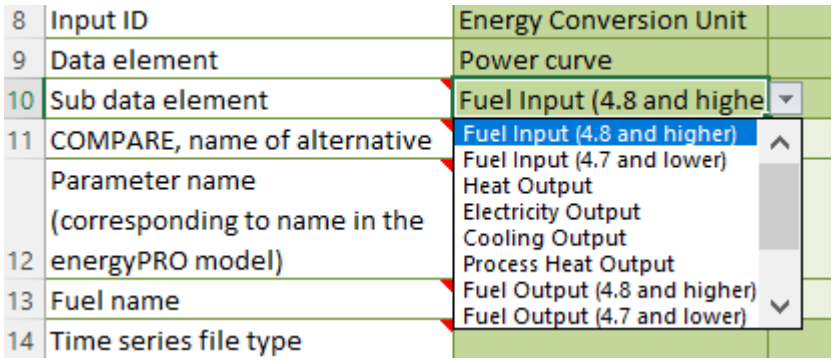

Figure 3-7: Dropdown list, Sub data element

Regarding the latest changes in energyPRO version 4.8, it is necessary to distinguish in this menu regarding the different versions. So please check, which version of energyPRO you are currently using.

If the project file is a COMPARE calculation, you shall include the name of the alternative. If left empty, the change will be made in the reference.

The Parameter name shall correspond to the name of an element in the project file. This is important, otherwise the xml call won't find the correct parameter.

The row with Time series file type, when Input ID is TimeSeriesData or DemandData, where the demand is defined as time series. The different types are:

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Input ID	Time Series
Data element	Time Series
Sub data element	
COMPARE, name of alternative	
Parameter name (corresponding to name in the energyPRO model)	Temperature
Fuel name	
Time series file type	
File field delimiter	
Data element index	3

txt
csv
epw
xml

Figure 3-8: Time series file type

The File field delimiter is only relevant when time series file type is csv or txt.

Data element index is only relevant when having Energy Conversion Unit as Input ID and Non Availability periods as Data element.

In the Run table the values for each run and parameter is set. In this example, altogether six runs are defined, that is a combination of three sizes of Gas engine 1 and two Natural gas prices.

	A	B	C	D	E
4	Modifying input (input section)		energyPRO		
5					
6	Start run number	1	Run Calculations		
7	End run number	6			
8	Input ID	Energy Conversion Unit	Energy Conversion Uni	Energy Conversion Uni	Economy
9	Data element	Power curve	Power curve	Power curve	Price Per Unit
10	Sub data element	Fuel Input (4.8 and highe	Heat Output	Electricity Output	
11	COMPARE, name of alternative				
12	Parameter name (corresponding to name in the energyPRO model)	Gas engine 1	Gas engine 1	Gas engine 1	Natural gas
13	Fuel name				
14	Time series file type				
15	File field delimiter				
16	Data element index				
17	3	10534	4228	4000	0,242
18	Present calculation:↗				
19	Run	Parameter 1	Parameter 2	Parameter 3	Parameter 4
20	1	5267	2114	2000	0,242
21	2	7901	3171	3000	0,242
22	3	10534	4228	4000	0,242
23	4	5267	2114	2000	0,35
24	5	7901	3171	3000	0,35
25	6	10534	4228	4000	0,35
26					
27					

Figure 3-9: Six runs

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3.4 Output Sheet

At the Output sheet you specify, which reports you would like to have generated and saved as files.

	A	B	C	D	E
1					
2					
3					
4	Requested reports (output section)				
5					
6	Output Report Type	Text report	Text report	Graphic report	
7	Report ID	EnergyConversionAnnual	OperationIncome	ProductionGraphic	
8	COMPARE, name of alternative				
9	Report name	energy conversion	Operation income	Production graphic	
10	Report extension	csv	csv	jpg	
11	Report delimiter	;	;		
12	Report decimal separator				
13	Report Resolution				
14	Report start date			01-01-2020	
15	Report end date			08-01-2020	

Figure 3-10: Output sheet

As Output Report Type, you can select between two types:

Output Report Type	Text report
Report ID	Energy Conversion Annual
COMPARE, name of alternative	
Report name	

Figure 3-11: Report type

Depending on the report type, you can select between the predefined reports in energyPRO:

Output Report Type	Text report	Text report
Report ID	Energy Conversion Annual	eration Income
COMPARE, name of alternative		
Report name		
Report year		
Report extension		
Report delimiter		
Report decimal separator	,	,
Report Resolution		
Report start date		
Report end date		

Energy Conversion Annual
Energy Conversion Monthly
Energy Conversion Summary
Environment Monthly
Environment Summary
Production Plan
Cash Flow Monthly
Cash Flow Summary

Figure 3-12: Report ID

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If the project file is a COMPARE calculation, you shall include the name of the alternative. If left empty, it will be the reference.

You define the report name freely, but the number of the run is added to the filename.

If you have a FINANCE or ACCOUNT calculation, you can specify the year of the report, 1 is the first year.

Output Report Type	Text report
Report ID	Energy Conversion Annual
COMPARE, name of alternative	
Report name	Energy Conversion
Report year	6
Report extension	txt
Report delimiter	;
Report decimal separator	,
Report Resolution	
Report start date	
Report end date	

Figure 3-13: Report year

With a text report, you can choose between three extensions:

Output Report Type	Text report
Report ID	Energy Conversion Annual
COMPARE, name of alternative	
Report name	Energy Conversion
Report year	6
Report extension	txt
Report delimiter	txt / csv / pdf
Report decimal separator	
Report Resolution	
Report start date	
Report end date	

Figure 3-14: File extension

If choosing txt or csv the report file can be imported into e.g. spreadsheet for further processing. Also when txt or csv you shall set the report delimiter, typically ";" or ",".

The Report start date and end date is for the Production, graphic report, where the dates are used for setting the period to be shown on Production, graphic.

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Output Report Type	Text report	Text report	Graphic report
Report ID	Energy Conversion Annual	Operation Income	Production Graphic
COMPARE, name of alternative			
Report name	Energy Conversion	Operation Income	Production graphic
Report year	6		
Report extension	txt	csv	jpg
Report delimiter	;	;	
Report decimal separator	,	,	
Report Resolution			
Report start date			01.01.2020
Report end date			08.01.2020

Figure 3-15: Start and end date, Production, graphic.

3.5 Key figures

On this sheet, you can collate any figure, you want from the reports. In the screenshot below, the annual heat production from each gas engine are selected as key figures together with the annual operation income.

Collate key figures

energyPRO

Report #	Energy Conversion	Operation Income
row	15	49
item	3	8

07.01.2022 14:22

Run	Annual heat production, gas boilers	Annual operation income	Co
1	16.877,60	-35.149.535,00	
2	18.784,40	-34.410.619,00	
3	22.438,30	-33.774.620,00	
4	16.877,60	-35.149.535,00	
5	18.784,40	-34.410.619,00	
6	22.438,30	-33.774.620,00	

Figure 3-16: Key figures

The row and item values are found by opening on of the selected reports:

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	A	B	C	D	E
1	Danish cogeneration plant with more sites_REGION module				
2					
3	energyPRO 4.8.139				
4	07.01.2022 14:13				
5					
6	Energy conversion, annual				
7					
8	Calculated period:	01.2020 - 12.2020			
9	The Rindum central				
10					
11	Heat production:				
12		Solid Energy HP		26830,9	MWh/year
13		Engine		51180,7	MWh/year
14		Electric boiler		2112	MWh/year
15		Gas boilers		16877,6	MWh/year
16		Gesamt		0	MWh/year

Figure 3-17: Finding row and item

The annual heat production of Gas engine 1 is found in row 15 and column D. Column D is equal to item 3 (column A is equal to item 0).

3.6 Evaluation

On this sheet it is possible to evaluate and compare the values from reports created by energyPRO optimization using the INTERFACE tool in a more intuitive and flexible way as it can be done in the key figures tab. After running the calculation from the Input sheet, the reports can be loaded in, and different parameters and values can be compared. This is especially helpful when larger numbers of variants must be considered, or sensitivity analysis must be carried out.

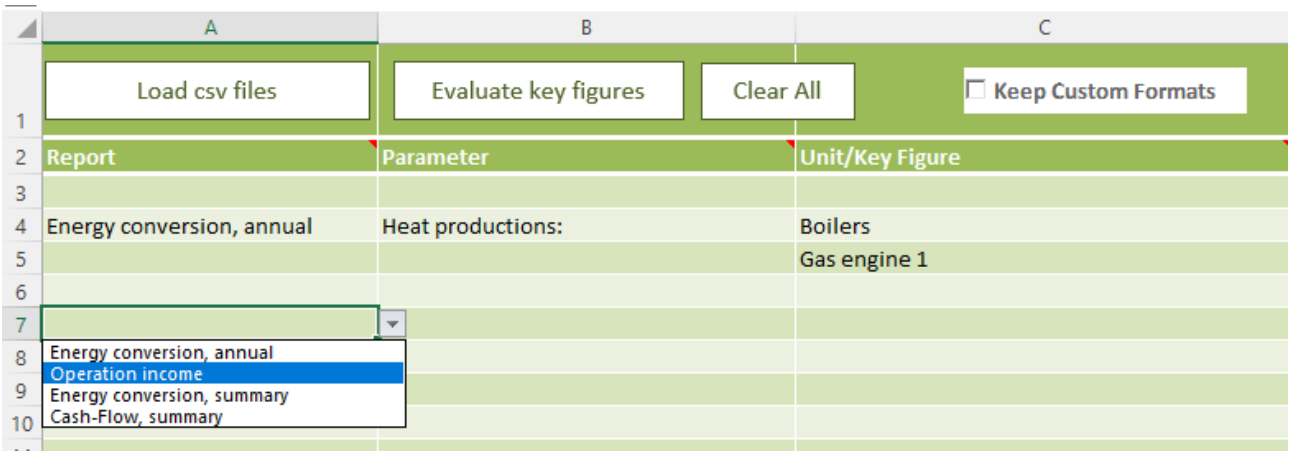

Figure 3-18: Evaluation

3.6.1 Using the Evaluation tool

First, input parameters and the number of runs must be defined in the input tab, see section 3.3

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It is necessary to specify the output as CSV-format in the “Output” tab of the spreadsheet. The Reports, that currently can be evaluated, are:

- Energy conversion, annual
- Energy conversion, summary
- Operation income
- Cash flow, summary

The calculation can be started in the “Input” tab and energyPRO will simulate the specified number of runs. For this tool to work properly the excel file must be placed in the same file as the energyPRO project and the generated reports.

When all runs have been executed, the corresponding reports should be found in the selected folder. If that is the case, the button “Load csv files” will generate another excel file including all reports in one.

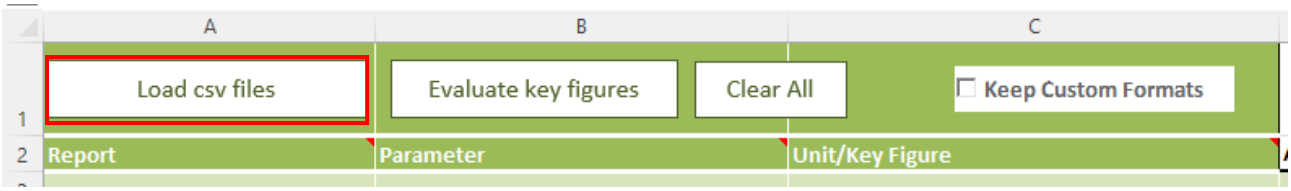

Figure 3-19: Load csv files

Every unit, key figure or value from the selected reports can be evaluated. To do that, the names of the values must be specified in the column “Unit/key figure”, see Figure 3-20. It is important that the spelling is equivalent to the value in the report. The according parameters vary in the different reports and are usually found in column B. They can be chosen from a dropdown menu or entered manually. Before evaluation, the spreadsheet can look like shown in Figure 3-20.

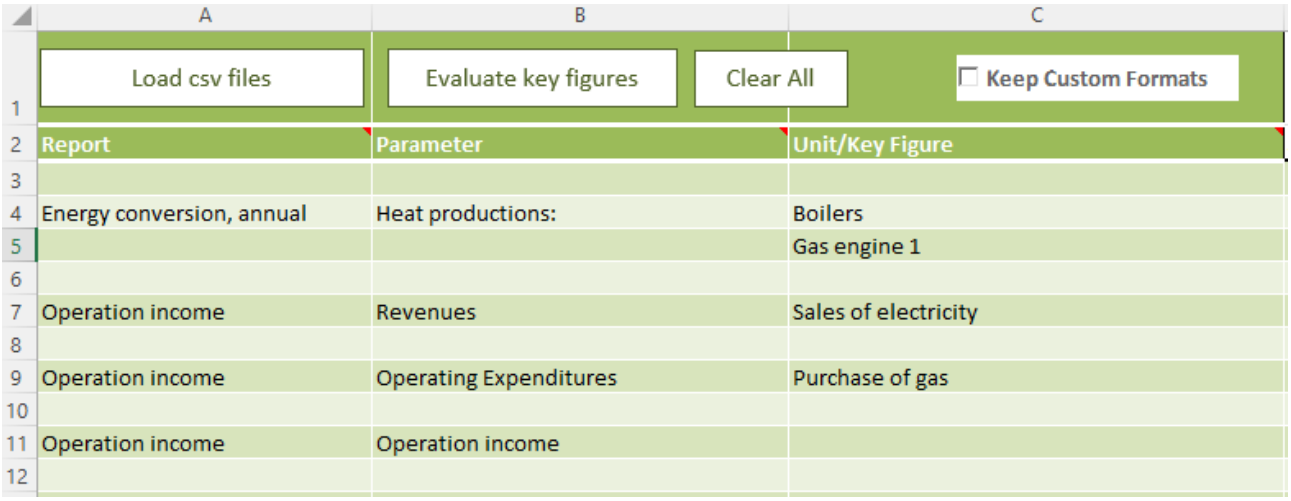

Figure 3-20: Key figures to be evaluated

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The button "*Evaluate key figures*" will start the macro and go through all reports and find the specified key figures. The values from all loaded reports will be put in the table on the right-hand side of the spreadsheet. This display makes it easy to compare many alternatives and makes it also possible to include the results in further calculations in the spreadsheet.

2	Report	Parameter	Unit/Key Figure	Report 0001	Report 0002	Report 0003
3						
4	Energy conversion, annual	Heat productions:	Gas Boilers	23544,4	22993	22438,3
5			Engine	52045,9	48801,4	46556
6			Solid Energy HP	28611,8	27836,9	26830,9
7						
8	Operation income	Revenues	Sale of electricity	15.407.774,00 €	14.504.701,00 €	13.852.081,00 €
9						
10	Operation income	Operating Expenditures	Purchase of gas	16.976.809,00 €	16.037.518,00 €	15.364.973,00 €
11						
12	Operation income	Operation income		-36.678.512,00 €	-35.089.271,00 €	-33.774.620,00 €

Figure 3-21: Results of an evaluation comparing three different variants and six values

Going from column "G" onward, it is possible to insert additional columns as well. This can be helpful for further, manual evaluation or structuring the results with measuring units, etc.

The column "*Additional input*" has multiple functionalities. When evaluating *Energy conversion, annual* or O*peration income* reports, the standard column ("D") from which the result is taken, can be changed. For example, results will be taken from column "B" instead when "B" is entered. It is also needed when analysing several years in a project. In that column it is specified from which year the data in the reports should be extracted. The year should be labelled as "YYYY", as shown in Figure 3-22. If empty, the first year will be taken.

Report	Parameter	Unit/Key Figure	Additional Input
Energy conversion, annual	Heat productions:	Gas Boilers	
		Engine	
		Solid Energy HP	
Operation income	Revenues	Sale of electricity	2022
Operation income	Operating Expenditures	Purchase of gas	
Operation income	Operation income		

Figure 3-22: Extract a certain year from the reports

With the Button "Clear all", the whole sheet can be cleared for a new evaluation. When formatting has been done, the formats can be saved by ticking the box "Keep Custom Formats". This is also relevant when starting a new evaluation, because otherwise all values and formats on the right-hand side of the spreadsheet will be deleted as well.

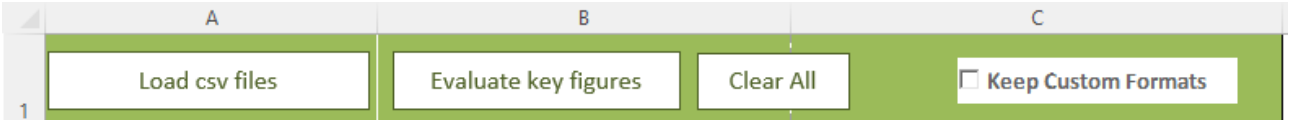

Figure 3-23: Menue bar in "Evaluation" sheet

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4. Overall setup of the XML-file

The XML-file has three main areas:

- Head
- Input data
- Output

In the Head section, you specify among other things the energyPRO project file, which is to be modified. In the Input data section is specified the inputs of the project file you want to modify.

Finally, in the Output section you specify which reports you want to save as files.

Every element in the XML-file has the following syntax:
<Element>value</Element>

The value can be a fixed number or a string, but can also be another element.

4.1 Head section

The head section is defined by the following syntax:
<Head>
Elements
</Head>

In the Head section, the following elements are available.

4.1.1 energyPRO DataFile

This element is mandatory. Here is specified the name of the project file which shall be modified. The path of file shall be included.

Example:
<energyPRODataFile>c:\energyPRO data\English\Project examples\Two CHPs on the German spot market.epp</energyPRODataFile>

4.1.2 Save

This element can be either TRUE or FALSE. If true, the energyPRO project file is saved with changed parameters. Otherwise, the project file is left unchanged after the calculation.

If this element is omitted the project file is left unchanged.

Example:
<Save>FALSE</Save>

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4.1.3 SaveAs

If the element “Save” is set to TRUE, and you want to save the project file under a different name you use this element. If this element is omitted the project file is saved with its original file name. The file will be saved in the same folder as the original project file.

Example:
<SaveAs>NewName.epp</SaveAs>

It is possible to save the project file in a sub folder by including the subfolder in the string:
<SaveAs>SavedAsFolder\NewName.epp</SaveAs>

4.1.4 Include run number in name

Next to the Save and SaveAs you can enable “Include run number in name”. This will include the number of the run in the Save or SaveAs project file name.

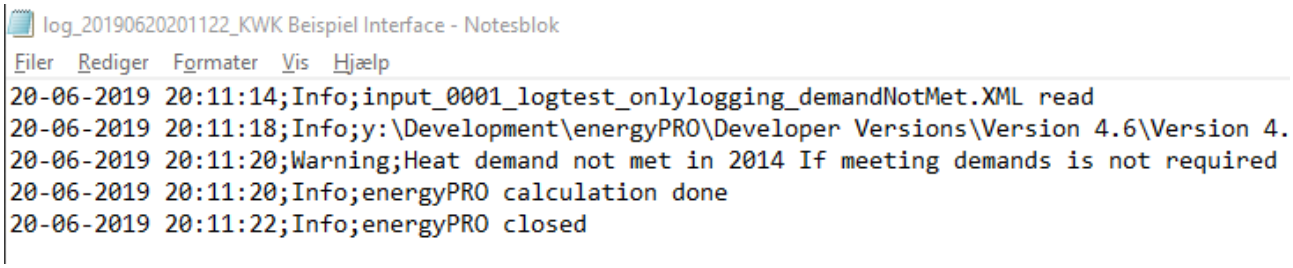
4.1.5 Logging info and error messages

When it comes to viewing and logging of warnings and error messages, you have three options:

- Nologging
- LoggingAndOnScreenMessages
- OnlyLogging

Selecting Nologging, messages appearing during the calculations will appear on screen.
Selecting LoggingAndOnScreenMessages, messages will appear on screen and a log file with the generated.
Selecting OnlyLogging, a log file will be generated and no messages will appear on screen.

The log file will be named “Log” followed by a date and time stamp and finally the name of the energyPRO file. The screenshot below shows an example:



4.1.6 Spool

This element can either be TRUE or FALSE. If true, energyPRO is kept open looking for a new XML-file. If false, energyPRO is closed down after the calculation. Omitted element is equal to False.
Example:
<Spool>TRUE</Spool>

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4.1.7 SpoolPath

If Spool is set to TRUE, the SpoolPath has to be set. This is the path in which energyPRO looks for new XML input files.
Example:
<SpoolPath>c:\INTERFACE\input</SpoolPath>

4.1.8 Calculate

This element can either be TRUE or FALSE. In some situations the task is just to update the same values in a number of project files, without actually making a calculation. Omitted element is equal to True.
Example:
<Calculate>True</Calculate>

4.1.9 Date

This element is just for internal use, it has no impact on the energyPRO calculation.
Example:
<Date>01-01-2014</Date>

4.1.10 Version

This element is just for internal use, it has no impact on the energyPRO calculation.
Example:
<Version>1.2</Version>

4.2 Input Data section

In the Input data section is specified the inputs of the project file you want to modify.
The input data section has the following syntax:

<InputDataElements>
Input Data Element
</InputDataElements>

Each input data element typically has this setup (example with area of solar collector):

<InputDataElement>
<BaseID>EnergyConversionUnitData</BaseID>
<DataName>Solar Collector</DataName>
<DataElementName>SolarUnit.TotalArea</DataElementName>
<DataElementValue>2000</DataElementValue>
</InputDataElement>

The BaseID is a unique identifier.
The DataName shall correspond to a similar element name in the energyPRO project file.
The DataElementName is depending on the BaseID. Typically, for each BaseID there are a number of Data element names available.
The DataElementValue is the value to be changed in the energyPRO project file.

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4.2.1 BaseID

Each input data element needs a unique identifier, identifying the type of element.
Instead of using the BaseID element for the unique identifier it is possible to include the unique identifier in the DataElementName. With the above example it looks like this:
<DataElementName> EnergyConversionUnitData.SolarUnit.TotalArea</DataElementName>

4.2.2 ProjectIdentificationData

In ProjectIdentificationData three Data Element Names are editable by XML.

4.2.2.1 ID.Strings

With ID.Strings you can add a text in the Project identification text box in the Project Identification window. This text will also appear in most of the reports, when saved as pdf.
Example:

```
<InputDataElement>
    <BaseID>ProjectIdentificationData</BaseID>
    <DataElementName>ID.Strings</DataElementName>
    <DataElementValue>Solar collector area: 2000</DataElementValue>
</InputDataElement>
```

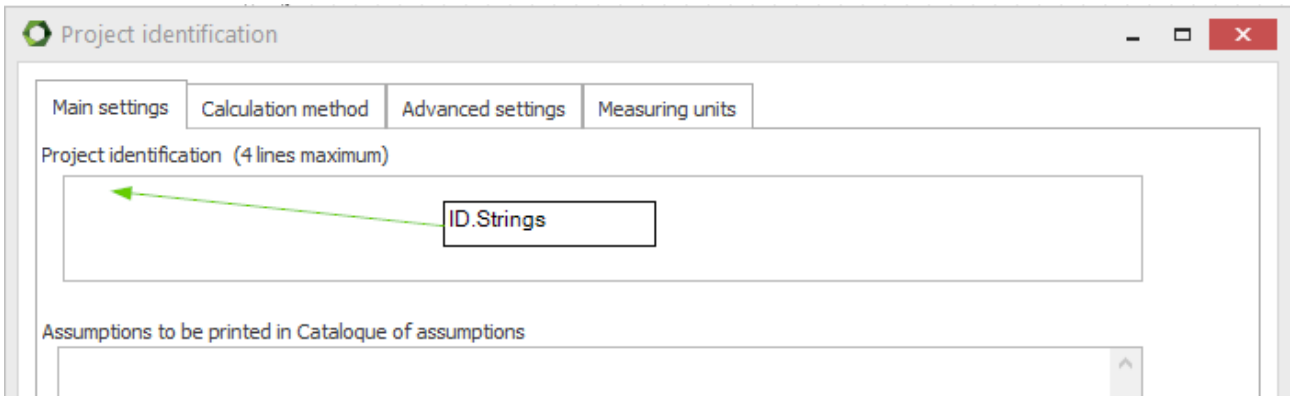

Figure 4-1 Project identification, ID.strings

4.2.2.2 CalcPeriodLengthMinutes

With this option, the length of calculation step can be set. The value can be any of the following: 10, 12, 15, 20, 30 and 60 minutes.
Example:

```
<InputDataElement>
    <BaseID>ProjectIdentificationData</BaseID>
    <DataElementName>CalcPeriodLengthMinutes</DataElementName>
    <DataElementValue>30</DataElementValue>
</InputDataElement>
```

4.2.2.3 OptimizationPeriodLength

In energyPRO the length of optimization period is typically 1 month, but can also be 1 year. In INTERFACE the data element value is “oplMonth” or “oplYear”.

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Example:

<InputDataElement>
<BaseID>ProjectIdentificationData</BaseID>
<DataElementName>OptimizationPeriodLength</DataElementName>
<DataElementValue>oplMonth</DataElementValue>
</InputDataElement>

4.2.2.4 ExtendTSDays

You can extend time series before and after planning period with a number of days. By INTERFACE you use thi ExtendTSDays setting.

Example:

<InputDataElement>
<BaseID>ProjectIdentificationData</BaseID> <!--Project Identification-->
<DataElementName>ExtendTSDays</DataElementName> <!--Extend TS, in days-->
<DataElementValue>3</DataElementValue>
</InputDataElement>

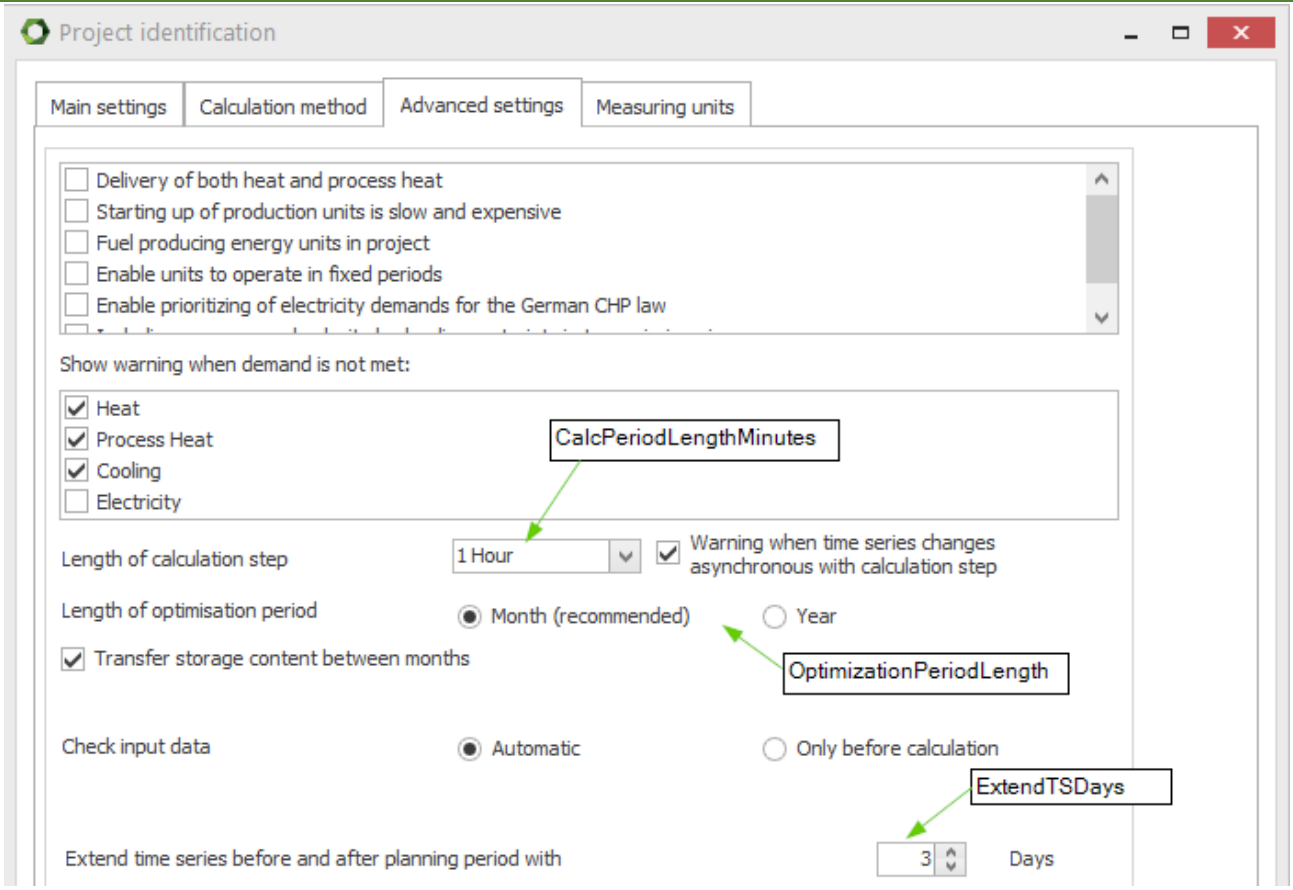

Figure 4-2 Project Identification, Length of calculation step, optimisation period and extending time series

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4.2.2.5 UseMilpSolver

In Project identification you set whether to use a MILP solver or not. The value shall be True or False.

Example:

<InputDataElement>
<BaseID>ProjectIdentificationData</BaseID> <!--Project Identification-->
<DataElementName>UseMilpSolver</DataElementName> <!--Use MILP Solver-->
<DataElementValue>True</DataElementValue>
</InputDataElement>

4.2.2.6 MilpCbcRatio

The MilpCbcRatio is setting the wanted precision or gap of the calculation. This value is also used when using other solvers than CBC.

Example:

<InputDataElement>
<BaseID>ProjectIdentificationData</BaseID> <!--Project Identification-->
<DataElementName>MilpCbcRatio</DataElementName> <!--MILP wanted precision-->
<DataElementValue>0.02</DataElementValue>
</InputDataElement>

4.2.2.7 MilpMaxSec

The MilpMaxSec is the max calculation time in MILP before stopping the calculation. If the wanted precision is not achieved within the max calculation time, the calculation is stopped, and the result achieved at that point is used.

Example:

<InputDataElement>
<BaseID>ProjectIdentificationData</BaseID> <!--Project Identification-->
<DataElementName>MilpMaxSec</DataElementName> <!--MILP Max solution time-->
<DataElementValue>200</DataElementValue>
</InputDataElement>

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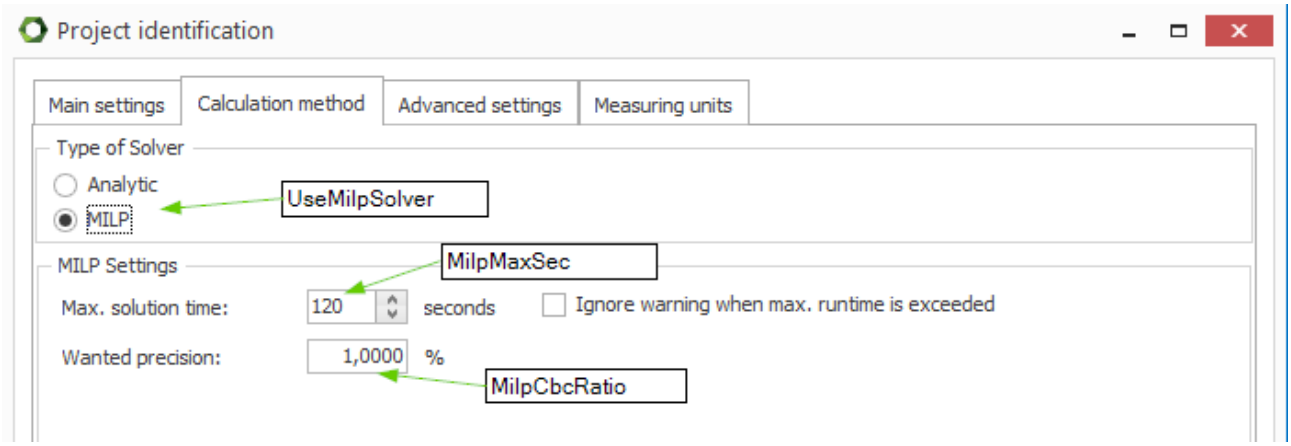

Figure 4-3 Project Identification, MILP settings

4.2.3 ExternalConditionData

In external conditions you can specify the start and end date of the calculation period. Notice that the dates are set in an element called DataElementTimeValue.

4.2.3.1 CalcStart

Sets the start of the calculation.

4.2.3.2 CalcEnd

Sets the end of the calculation.

Example:

```
<InputDataElement>
    <BaseID>ExternalConditionData</BaseID>
    <DataElementName>CalcEnd</DataElementName>
    <DataElementTimeValue>01-01-2014</DataElementTimeValue>
</InputDataElement>
```


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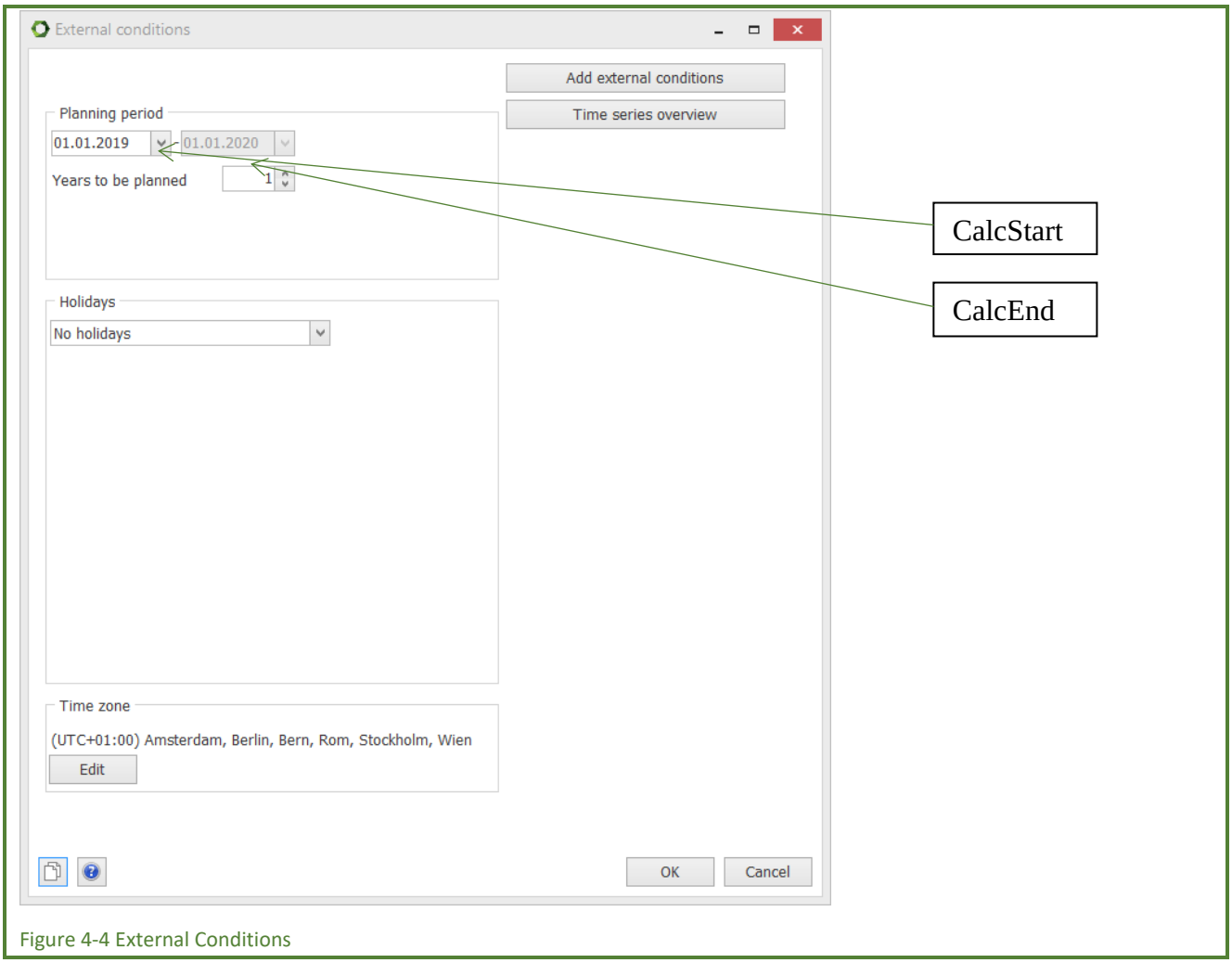

Figure 4-4 External Conditions

4.2.4 TimeSeriesData

In Time series, the whole time series can be replaced by an external file containing a time series (TimeSeriesfileName).

The files can be of the following types (TimeSeriesFileType):

- txt
- csv
- epw
- xml

epw is the energyPRO file format for time series. When the file type is txt or csv it is necessary to specify a field delimiter (DataDelimiter).

Example:

<InputDataElement>

<BaseID>TimeSeriesData</BaseID>

<DataName>Elspot</DataName>

<DataElementName>weatherdata.TimeSeries</DataElementName>

<DataDelimiter>;</DataDelimiter>

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<TimeSeriesFileName>c:\INTERFACE\Elspot2011.csv</TimeSeriesFileName>
<TimeSeriesFileType>csv</TimeSeriesFileType>
</InputDataElement>

With the time series, you also have the options of changing the following data elements:

- Time series is in Daylight Saving Time (IsInDaylightSaving) (True/False)
- Location, latitude (Latitude) (number)
- Location, longitude (Longitude) (number)
- Developing over the years (DevelopingFlag) (True/False)

Example:

<InputDataElement>
<BaseID>TimeSeriesData</BaseID>
<DataName>Elspot</DataName>
<DataElementName>IsInDaylightSaving</DataElementName>
<DataElementValue>False</DataElementValue>
</InputDataElement>

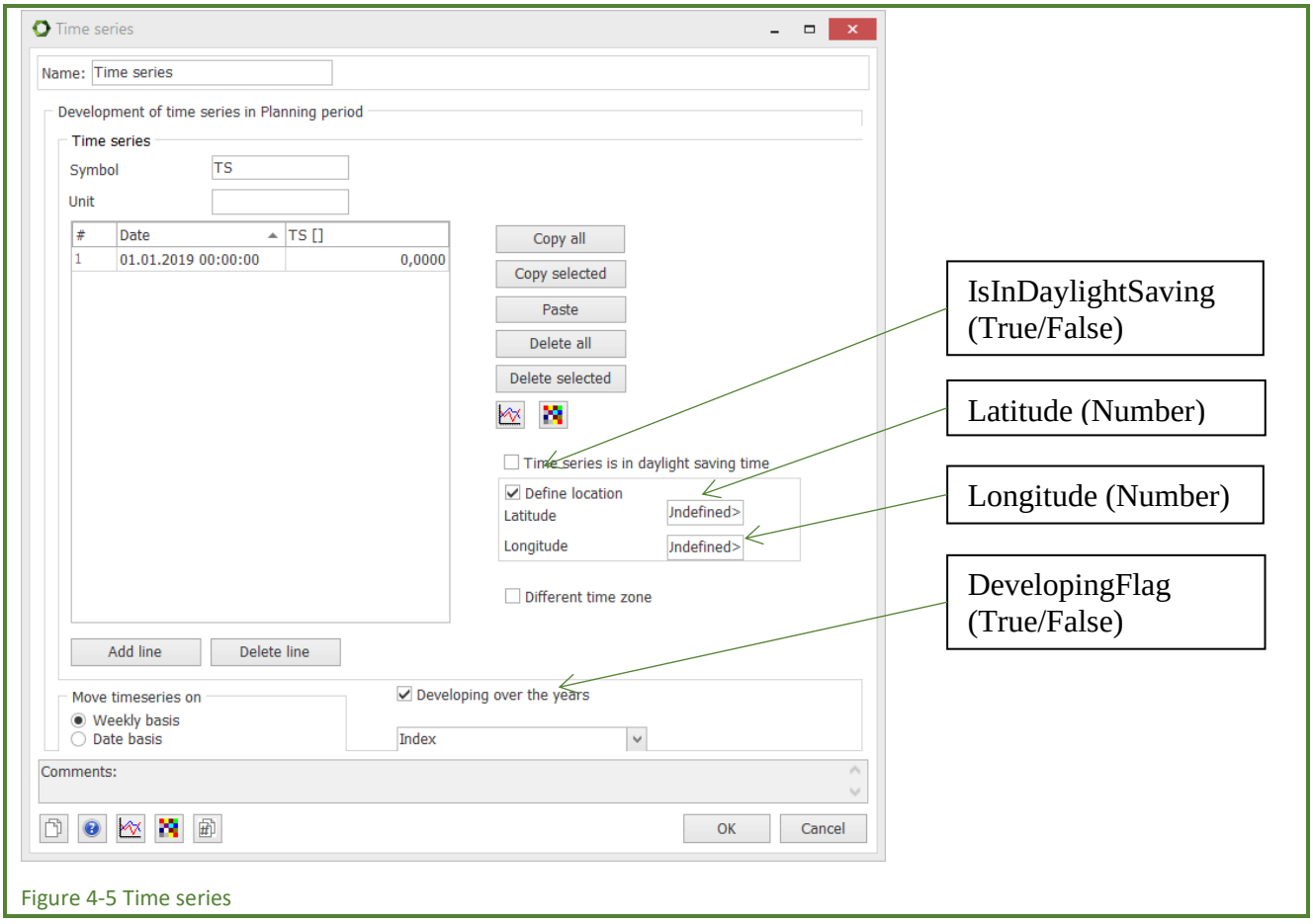

Figure 4-5 Time series

4.2.5 TimeSeriesFunctionData

In TimeSeriesFunctionData you can alter the following data elements:

- Function (FuncFormular) (string)
- Unit (WeatherUnit) (string)

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- Location, latitude (Latitude) (number)
- Location, longitude (Longitude) (number)

Example:

<InputDataElement>
<BaseID>TimeSeriesFunctionData</BaseID>
<DataElementName>FuncFormular</DataElementName>
<DataName>Prognosis for Elspot</DataName>
*<DataElementValue>Spot(_-7)*1.1</DataElementValue>*
</InputDataElement>

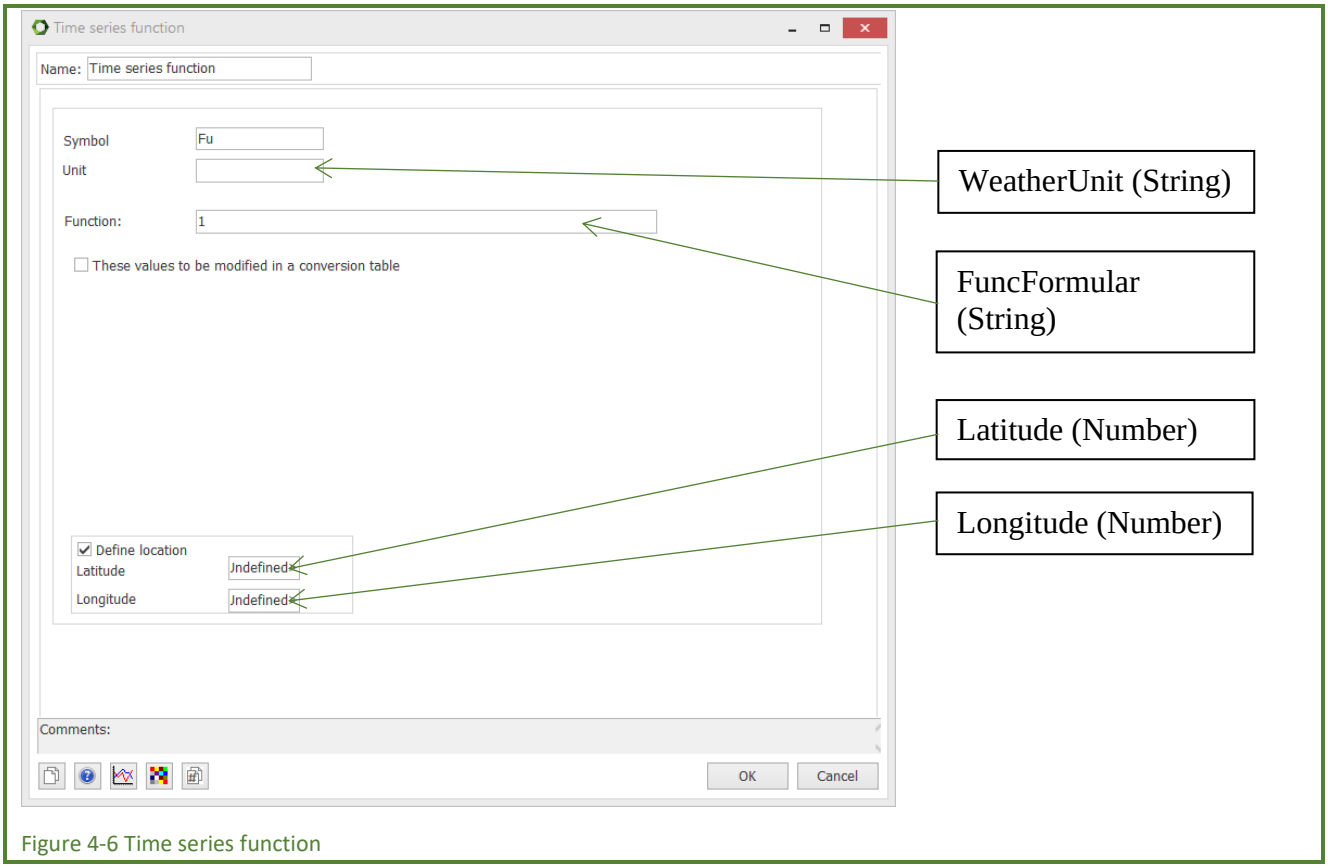

Figure 4-6 Time series function

4.2.6 IndexData

In IndexData you can alter the index values by referring to an external file containing a time series (TimeSeriesfileName).

When having Constant annual increase, the file needs to contain only one time stamp and one value.

The files can be of the following types (TimeSeriesFileType):

- txt
- csv

It is necessary to specify a field delimiter (DataDelimiter).

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Example:

<InputDataElement>
<BaseID>IndexData</BaseID>
<DataElementName>Indexdata.TimeSeries</DataElementName>
<DataName>Inflation</DataName>
<DataDelimiter>;</DataDelimiter>
<TimeSeriesFileName>c:\INTERFACE\Inflation prognosis.csv</TimeSeriesFileName>
<TimeSeriesFileType>csv</TimeSeriesFileType>
</InputDataElement>

4.2.7 SiteData

When having enabled "Including pressure and velocity hydraulic constraints in transmission pipes" in project identification, you can in SiteData set these two temperatures:

- RequiredSupplyTempMin
- DeliveredReturnTempMin

Example:

<InputDataElement>
<BaseID>SiteData</BaseID> <!--Site-->
<DataElementName>RequiredSupplyTempMin</DataElementName> <!--Minimum Required Heat Supply Temperature-->
<DataName>Site1</DataName>
*<DataElementValue>MB(_)*1,2</DataElementValue>*
</InputDataElement>

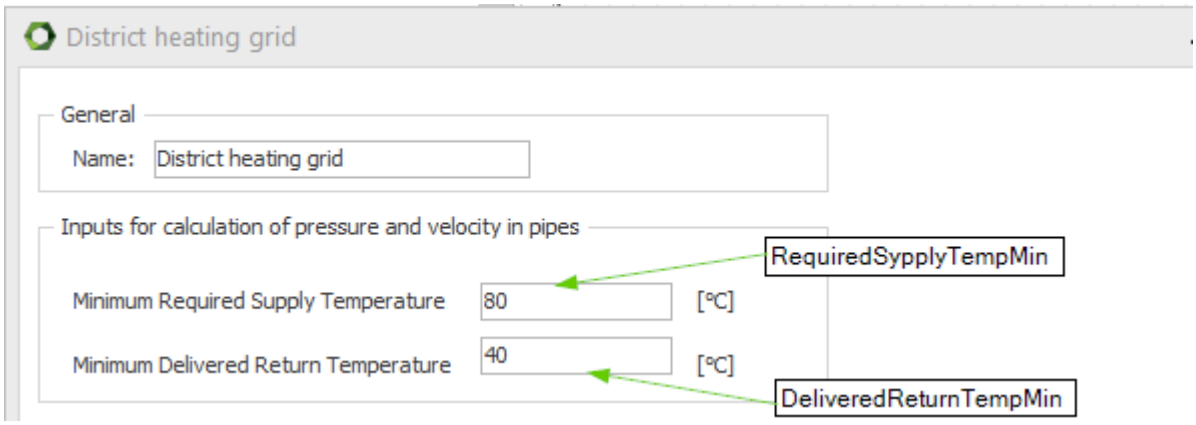

Figure 4-7 Supply and Return temperatures on site

4.2.8 TransmissionData

With TransmissionData you have the options of changing the following data elements:

- Site A can transmit to B (SiteAtoB) (True/False)
- Site B can transmit to A (SiteBtoA) (True/False)

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- Capacity (Capacity) (number)
- Loss (Loss) (number)
- Non Availability Periods (NonAvailableTimes)
- Operation restricted to period from (OperationalFrom)
- Operation restricted to period to (OperationalTo)

Example:

<InputDataElement>
<BaseID>TransmissionData</BaseID>
<DataElementName>Capacity</DataElementName>
<DataName>Transmission line</DataName>
<DataElementValue>25</DataElementValue>
</InputDataElement>

For details on Non Availability periods, please look in the section regarding EnergyConversionUnitData.

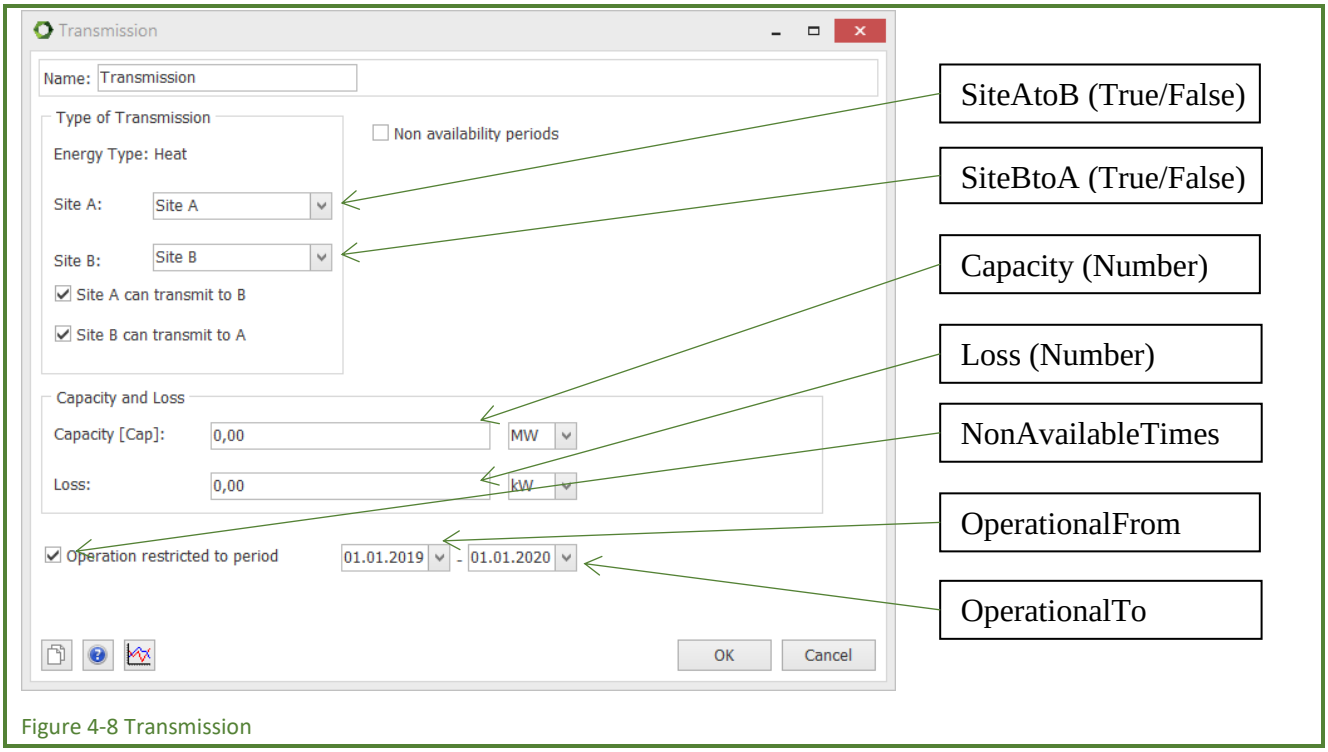

Figure 4-8 Transmission

4.2.8.1 Hydraulic settings

When having enabled “Including pressure and velocity hydraulic constraints in transmission pipes” in project identification, you can in Transmissions set these values:

- LengthOfTransmission
- InternalDiameter
- PipeRoughness

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- SpecificHeatLoss
- MaxVelocity
- MaxPressureGradient
- GroundTempEx

Example:

<InputDataElement>
<BaseID>TransmissionData</BaseID> <!--Transmission-->
<DataElementName>LengthOfTransmission</DataElementName> <!--Length of Transmission-->
<DataName>Transmission 1</DataName>
<DataElementValue>1000</DataElementValue>
</InputDataElement>

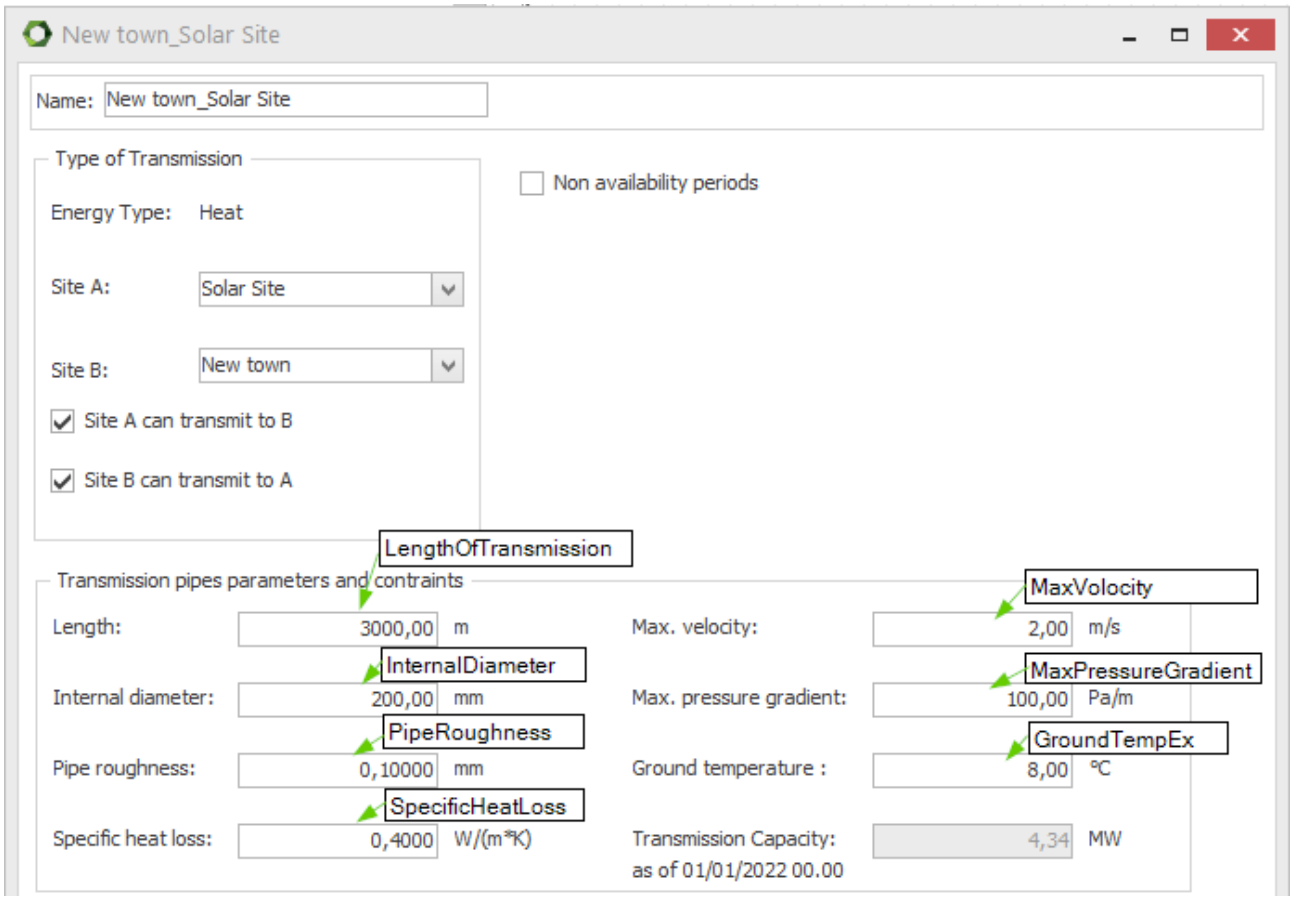

Figure 4-9 Hydraulic settings on transmission

4.2.9 FuelData

When it comes to fuel the following elements (DataElementNames) can be changed by INTERFACE:

- Heat value (ThermalValue)
- Unit (UnitName)
- Fuel storage capacity (FuelStorage)
- Fuel storage content at beginning of calculation (FuelContentPrimo)

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- Fuel storage content at end of calculation (FuelContentUltimo)

Example:

<InputDataElement>
<BaseID>FuelData</BaseID>
<DataName>Natural gas</DataName>
<DataElementName>FuelContentPrimo</DataElementName>
<DataElementValue>17</DataElementValue>
</InputDataElement>

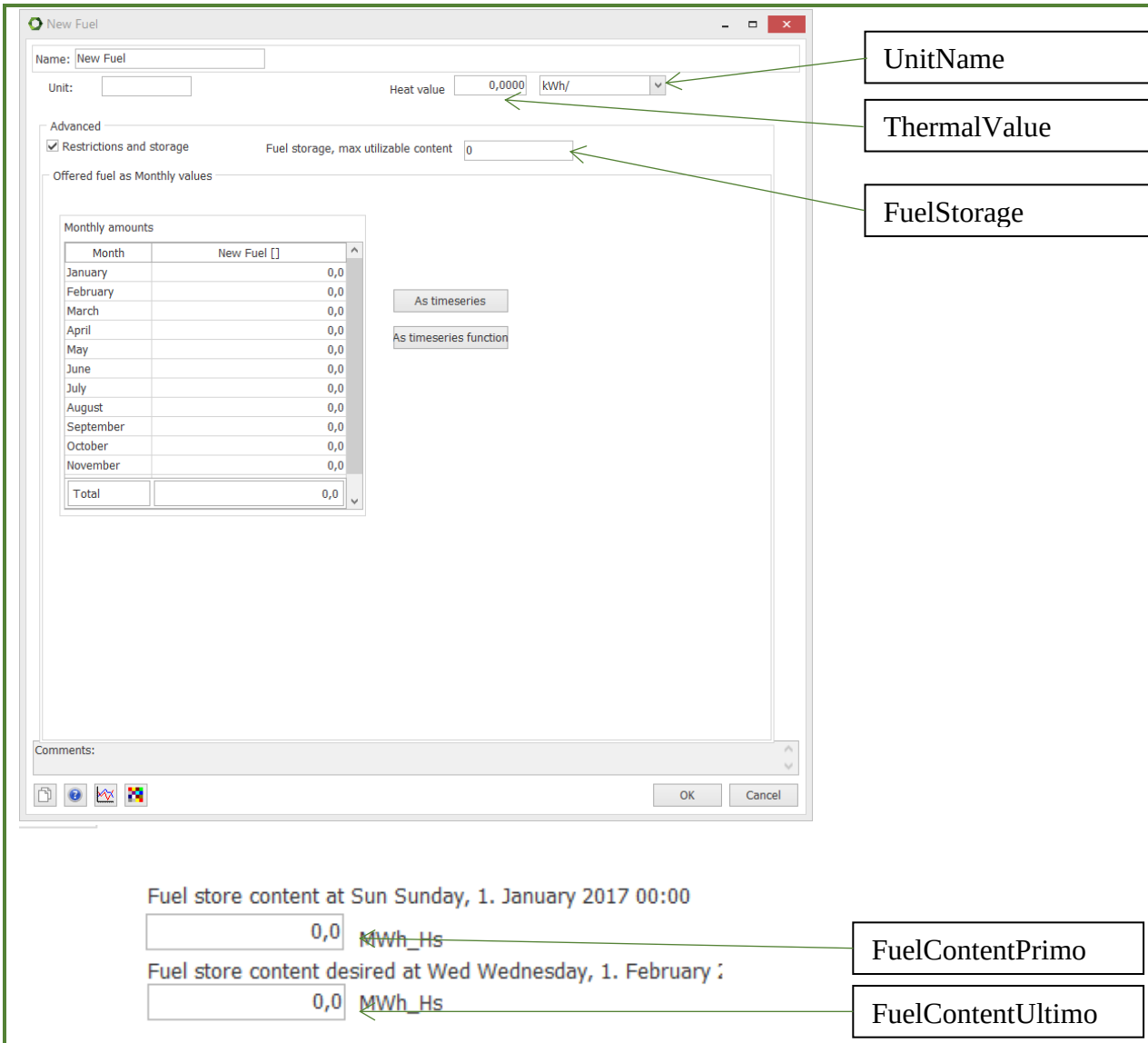

Figure 4-10 Fuel

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4.2.10 DemandData

In a demand the following elements (DataElementNames) can be changed by INTERFACE:

- Annual demand (Demand)
- Symbol for ambient temperatures (OutDoorTempSymbol)
- Reference temperature (ReferenceTemperature)
- Dependent fraction (WeatherDepFraction)
- Restricted season for dependent demand from (WeatherDepSeasonFrom)
- Restricted season for dependent demand to (WeatherDepSeasonTo)
- Fixed profile of demand (FixedProfile)
- Restricted period of connection from (DemandFrom)
- Restricted period of connection to (DemandTo)
- Connected to Site (SiteID)
- Demand as time series (Weatherdata.TimeSeries)

For the elements concerning dates DataElementTimeValue is used. For Demand as time series TimeSeriesFileName is used. For the other DataElementValue is used.
For Demand as time series the element follows the same context as TimeSeriesData.
Example:

```
<InputDataElement>
    <BaseID>DemandData</BaseID>
    <DataName>Heat Demand</DataName>
    <DataElementName>Demand</DataElementName>
    <DataElementValue>27500</DataElementValue>
</InputDataElement>
```

For Fixed profile of demand, the profile can be changed by referring to a file.
Example:

```
<InputDataElement>
    <BaseID>DemandData</BaseID>
    <DataElementName>.FixedProfile</DataElementName>
    <DataName>Weekly profile</DataName>
    <TimeSeriesFileType>csv</TimeSeriesFileType>
    <TimeSeriesFileName>C:\INTERFACE\WeeklyProfile.csv</TimeSeriesFileName>
</InputDataElement>
```

Below is an example of a file with a weekly profile:

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```
#Locale en-gb
Monday;06:00;4
Monday;20:00;2
Tuesday;05:00;5
Tuesday;21:00;3
Wednesday;04:00;6
Wednesday;19:00;4
Thursday;03:00;7
Thursday;19:30;2,5
Friday;05:30;8
Friday;18:00;2
Saturday;08:00;4
Sunday;23:00;2
```

The first line defines the format of the date and time stamp. If not included, the computer setting will be assumed. If having a daily profile, the weekday is omitted.

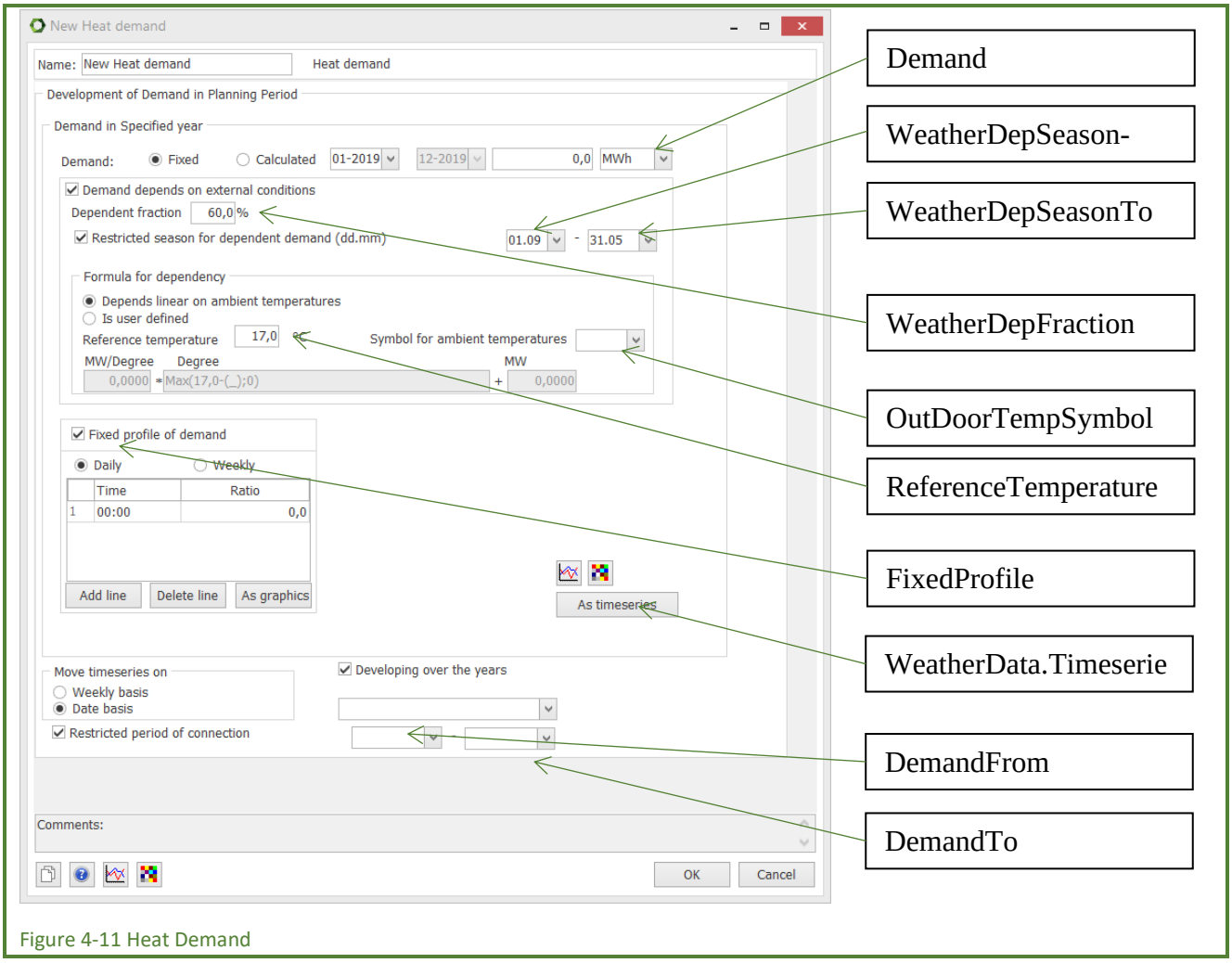

Figure 4-11 Heat Demand

4.2.11 EnergyConversionUnitData

Depending on the type of energy conversion unit, there are different elements.
The following elements are common for all the energy conversion units:

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- Non availability periods (NonAvailableTimes)
- Operation restricted to period from (OperationalFrom)
- Operation restricted to period to (OperationalTo)

Examples:
Start of first non availability period

```
<InputDataElement>
    <BaseID>EnergyConversionUnitData</BaseID>
    <DataName>Engine 1</DataName>
    <DataElementName>NonAvailableTimes.StartTime</DataElementName>
    <DataElementIndex>0</DataElementIndex>
    <DataElementTimeValue>01-01-2012 12:00</DataElementTimeValue>
</InputDataElement>
```

End of first non availability period

```
<InputDataElement>
    <BaseID> EnergyConversionUnitData</BaseID>
    <DataName>Engine 1</DataName>
    <DataElementName>NonAvailableTimes.EndTime</DataElementName>
    <DataElementIndex>0</DataElementIndex>
    <DataElementTimeValue>02-01-2012 17:00</DataElementTimeValue>
</InputDataElement>
```

The occurrence of each non available period is set by NonAvailableTimes.Occurrence:

```
<InputDataElement>
    <BaseID> EnergyConversionUnitData</BaseID>
    <DataName>Engine 1</DataName>
    <DataElementName>NonAvailableTimes.Occurrence</DataElementName>
    <DataElementIndex>0</DataElementIndex>
    <DataElementValue>yearly</DataElementValue>
</InputDataElement>
```

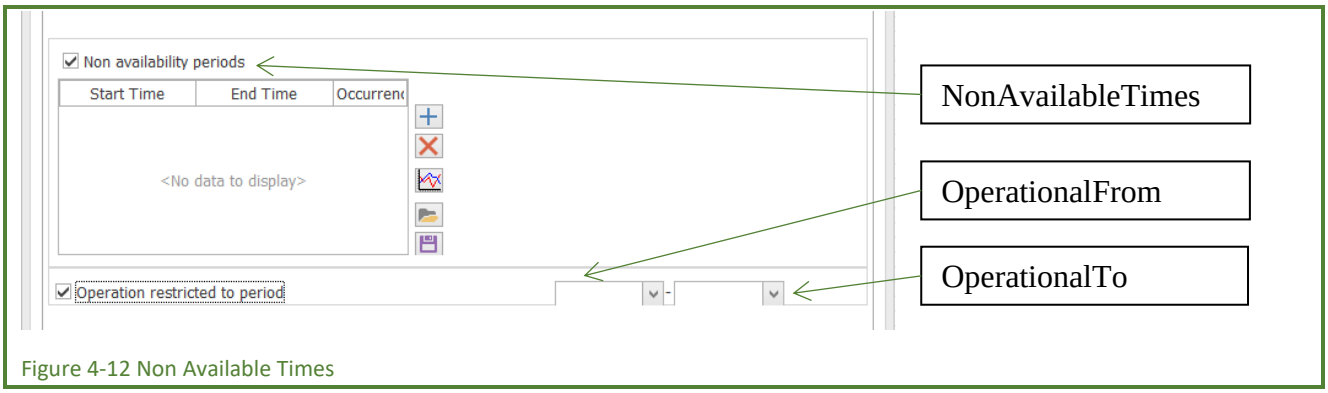

Figure 4-12 Non Available Times

The following settings are valid for Occurrence:

- Once
- Yearly

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- Monthly
- Weekly
- daily

You can have more non-operation periods. By the element DataElementIndex you specify which period you will edit. The first period has the index 0.

For all types of energy conversion units except wind turbines, solar collectors and photovoltaic there is access to the following element:

- Power curves (PowerCurve)
- Starting up period (StartUpPeriod)
- Shutting down period (ShutDownPeriod)
- Min. Operation time (MinimumOperationTime)

With PowerCurve there is access to the following elements:

- Cooling (CoolProd)
- Elec. Consump. (ElCon)
- Elec. Power (ElProd)
- Fuel input (4.8 and higher) (EtypeInput.Value)
- Fuel input (4.7 and lower) (Fuel)
- Fuel output (4.8 and higher) (EtypeOutput.Value)
- Fuel output (4.7 and lower) (FuelProd)
- Heat Consump. (HeatCon)
- Heat (HeatProd)
- Proc. Heat consump. (ProcHeatCon)
- Process Heat (ProcHeatProd)

Example:

```
<InputDataElement>
    <BaseID>EnergyConversionUnitData</BaseID>
    <DataName>Engine 1</DataName>
    <DataElementName>PowerCurve.Fuel</DataElementName>
    <DataElementValue>3669</DataElementValue>
</InputDataElement>
```

If the power curve is a formula, the data element name shall have an “EX” attached:

```
<InputDataElement>
    <BaseID>EnergyConversionUnitData</BaseID>
    <DataName>Engine 1</DataName>
    <DataElementName>PowerCurve.FuelEX</DataElementName>
    <DataElementValue>3669</DataElementValue>
</InputDataElement>
```


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When using fuel input or output in energyPRO 4.8 or higher, the setting is a bit different. There is not dot between PowerCurve and EtypeInput and the name of the fuel shall be specified as well.

<InputDataElement>
<BaseID>EnergyConversionUnitData</BaseID> <!--Energy Conversion Unit-->
<DataElementName>PowerCurveEtypeInput.Value</DataElementName> <!--Power curve.Fuel Input (4.8 and higher)-->
<DataName>Gas engine 1</DataName>
<DataElementEnergyType>Natural gas</DataElementEnergyType>
<DataElementValue>3669</DataElementValue>
</InputDataElement>

The following energy conversion unit types have special elements:

- Solar Collector and Photovoltaic (SolarUnit)
- Wind Farm (WindFarm)
- Heat Pump (HeatPump)

Solar collector and Photovoltaic have some elements in common:

- Inclination (InclinationEX)
- Orientation (OrientationEX)

But they also have a number of elements valid for each of them. The following elements are valid for the Solar Collector:

- Total area of collectors (TotalArea)
- Start efficiency (N0)
- Loss coefficient 1 (K0)
- Loss coefficient 2 (K1)
- Incidence Angle Modifier Coefficient (IncidenceAngleMod50)
- Incidence angle modifier at 50 degree (IncidenceAngleModCoef)
- Temperature on Demand Side (TempOnDemandSide) (True/False)
- Temperature from solar collector (ForwardTemperature) (number)
- Temperature to solar collector (ReturnTemperature) (number)
- Losses in pipes in collector field in percentage of production (PercentLossInPipes)
- Number of rows (NumberOfRows)
- Inclination, ground (InclinationGround)
- Distance between rows (DistanceBetweenRows)
- Orientation of ground (OrientationGround)
- Height, units (SolarUnitHeight)

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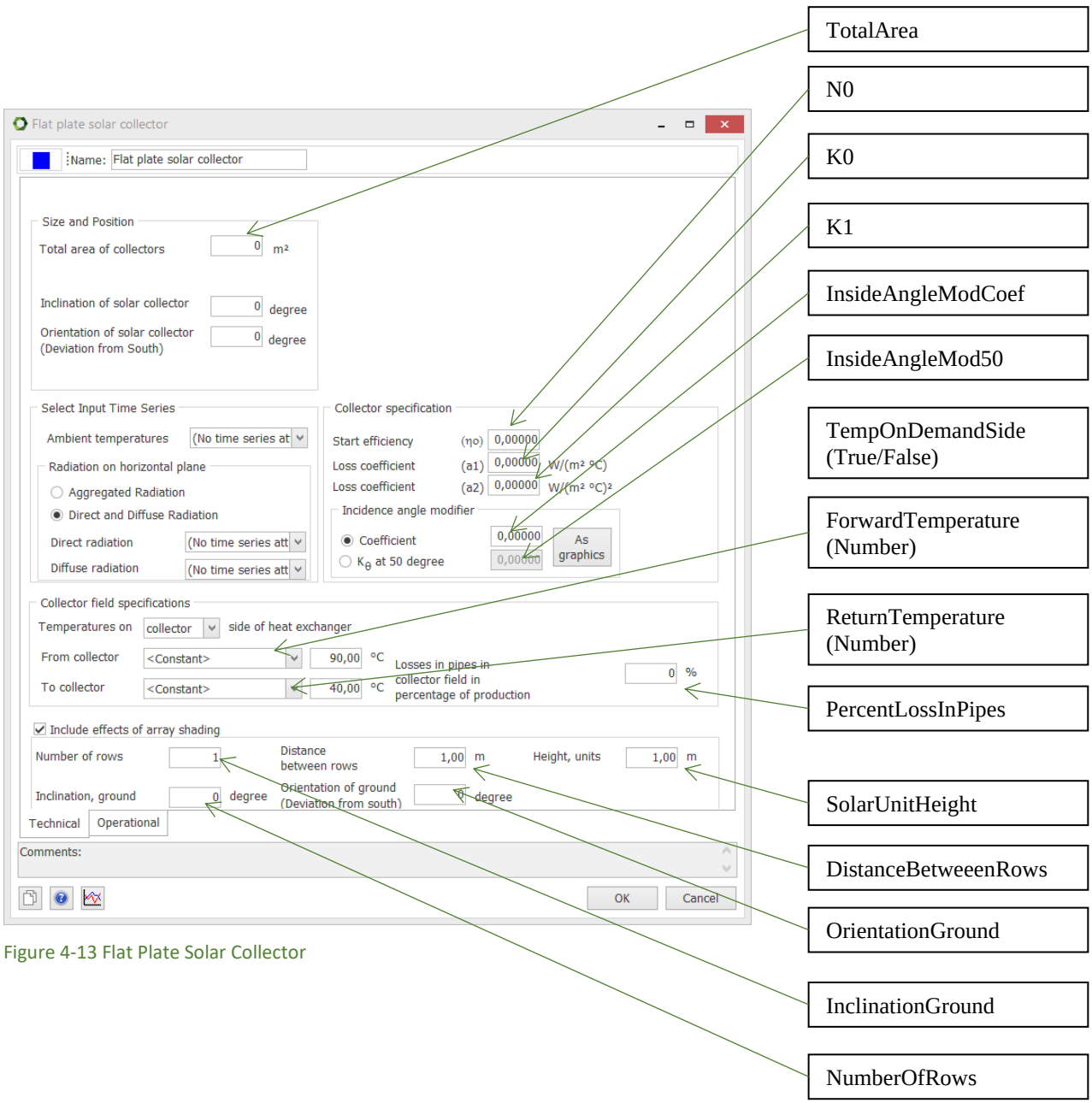

Figure 4-13 Flat Plate Solar Collector

And for the Photovoltaic there are the following elements:

- Installed capacity (InstalledElecCapacity)
- Maximum power (PMaxEX)
- Temperature coefficient of power (TempCoeffPowerEX)
- NOCT (NOCTEX)
- Aggregated losses (PowerLossesEX)

Example:

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<InputDataElement>

<BaseID>EnergyConversionUnitData</BaseID>

<DataName>Solar Collector</DataName>

<DataElementName>SolarUnit.TotalArea</DataElementName>

<DataElementValue>9000</DataElementValue>

</InputDataElement>

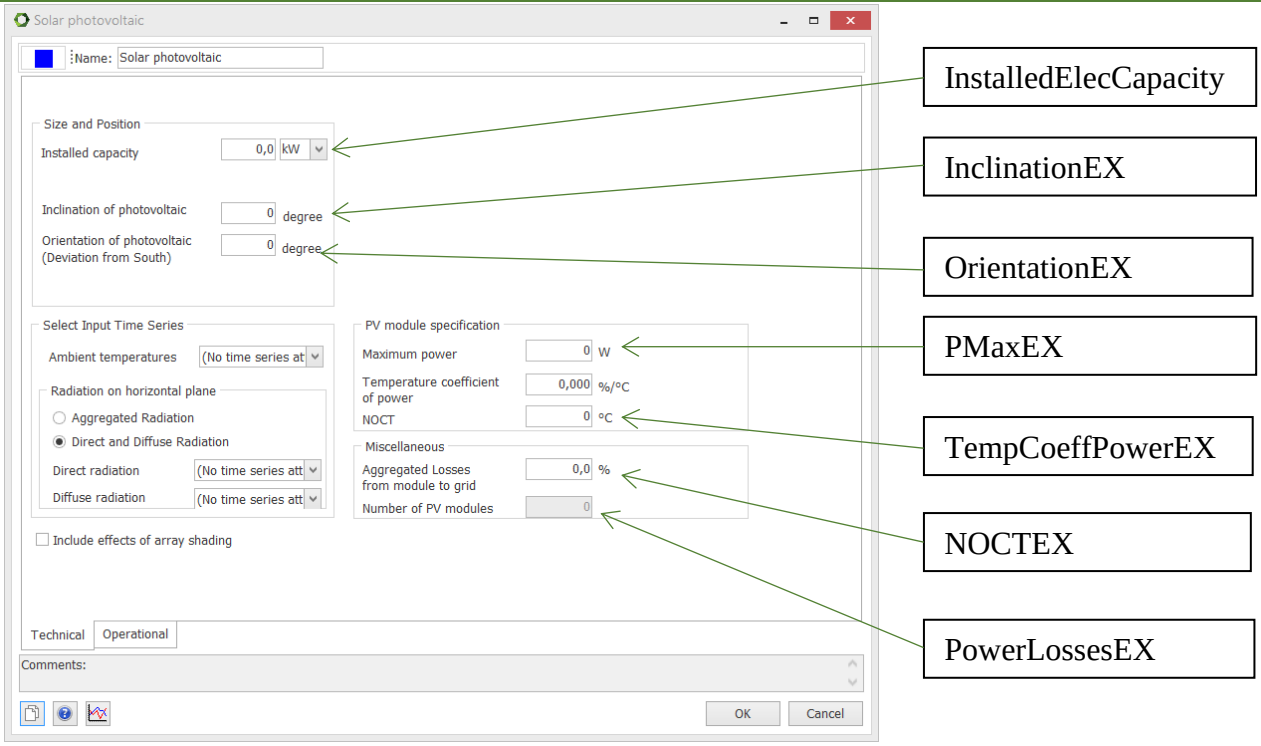

Figure 4-14 Solar Photovoltaik

For the energy conversion unit type 'Wind Farm' the following elements are available:

- Annual production (AnnualProduction)
- Wind time series (WindTSID)
- Measured height (MeasureHeight)
- Hub height (HubHeight)
- Hellman exponent (HellmannExp)
- Power curve (Conversiontable)

Example:

<InputDataElement>

<BaseID>EnergyConversionUnitData</BaseID>

<DataName>Wind turbine</DataName>

<DataElementName>WindFarm.HubHeight</DataElementName>

<DataElementValue>60</DataElementValue>

</InputDataElement>

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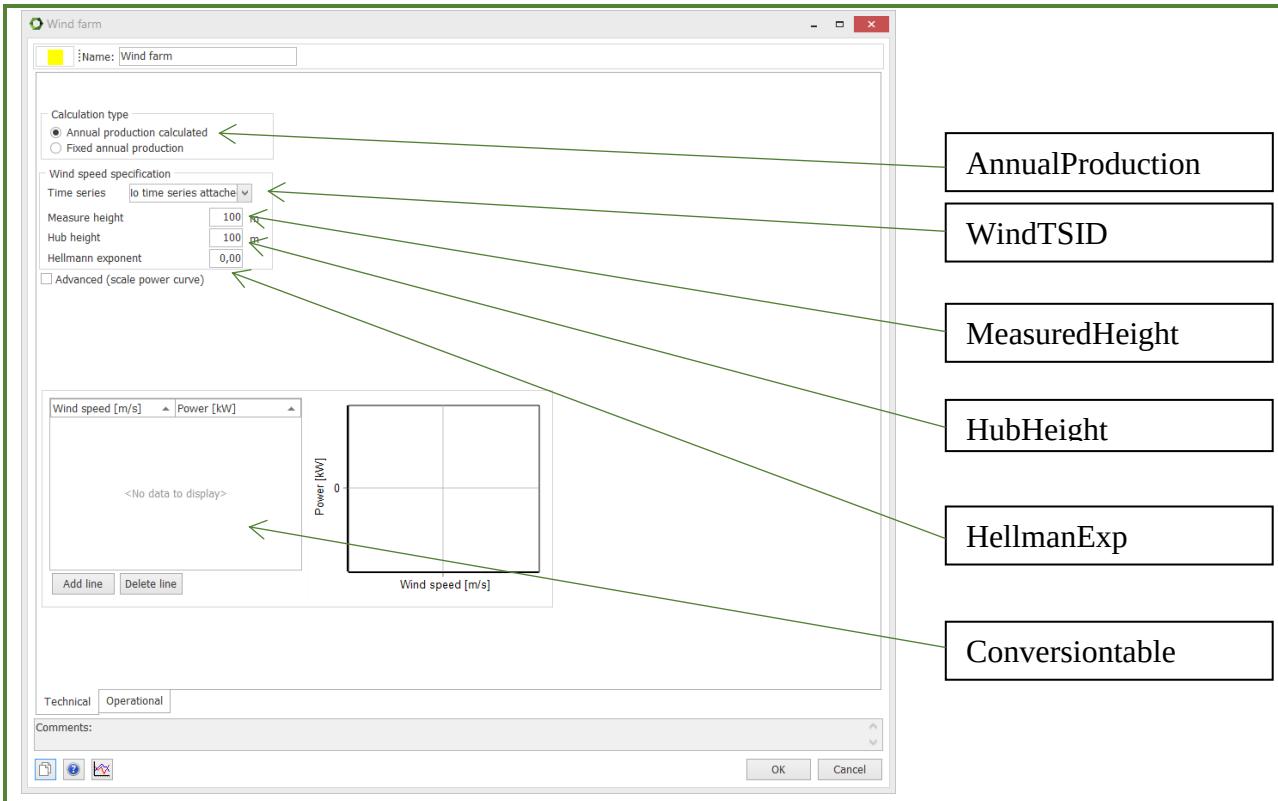

Figure 4-15 Wind Farm

For “Heat Pump” the following elements are available:

- Electrical Capacity (ElectricalCapacity)
- Min. electrical load (MinElecCapacity)
- Heat pump COP (COP)
- Heated from (HeatedFrom)
- Heated to (HeatedTo)
- Cooled from (CooledFrom)
- Cooled to (CooledTo)
- Heat output restricted to (MaxHeatCapacity)
- Heated from actual temperatures (HeatedFromExprStr)
- Heated to actual temperatures (HeatedToExprStr)
- Cooled from actual temperatures (CooledFromExprStr)
- Cooled to actual temperatures (CooledToExprStr)
- Cut off when Cooled from is below (CutOffWhenCooled)

```
<InputDataElement>
    <BaseID>EnergyConversionUnitData</BaseID>
    <DataElementName>HeatPump.ElectricalCapacity</DataElementName>
    <DataName>Heat Pump</DataName>
    <DataElementValue>1.5</DataElementValue>
</InputDataElement>
```


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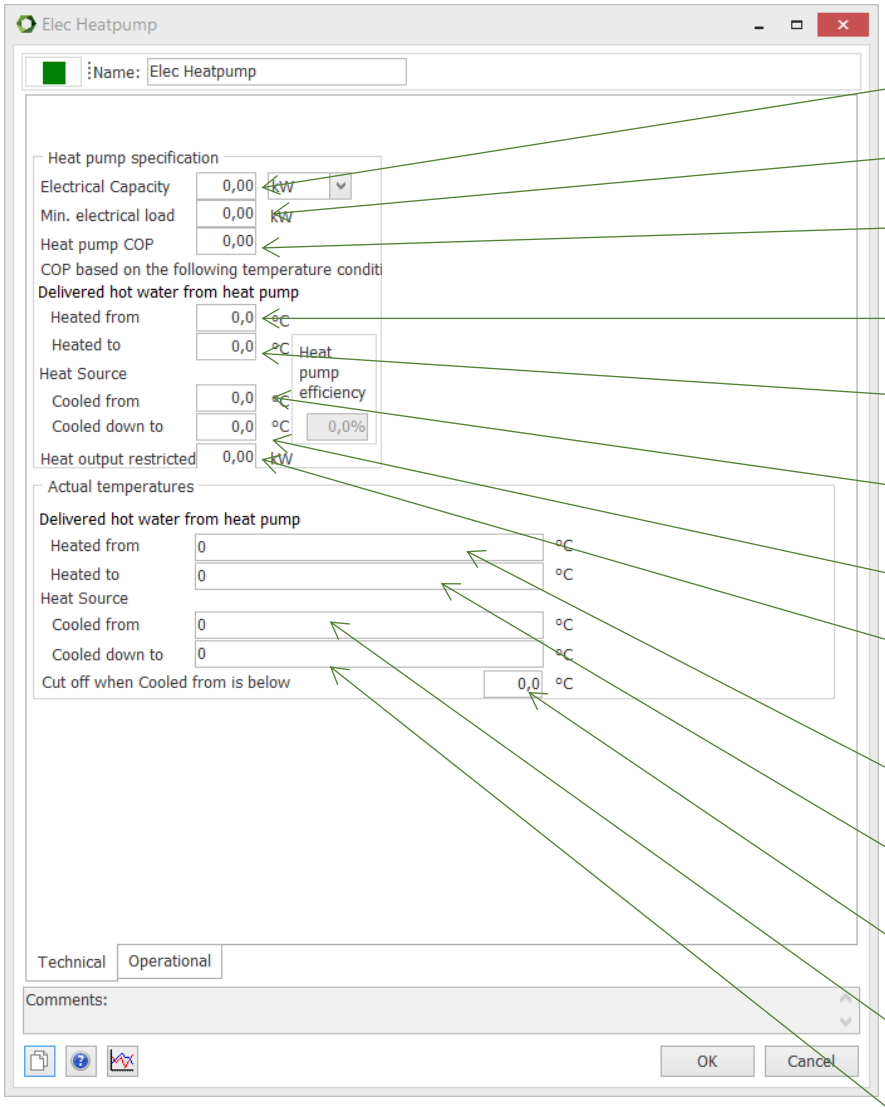

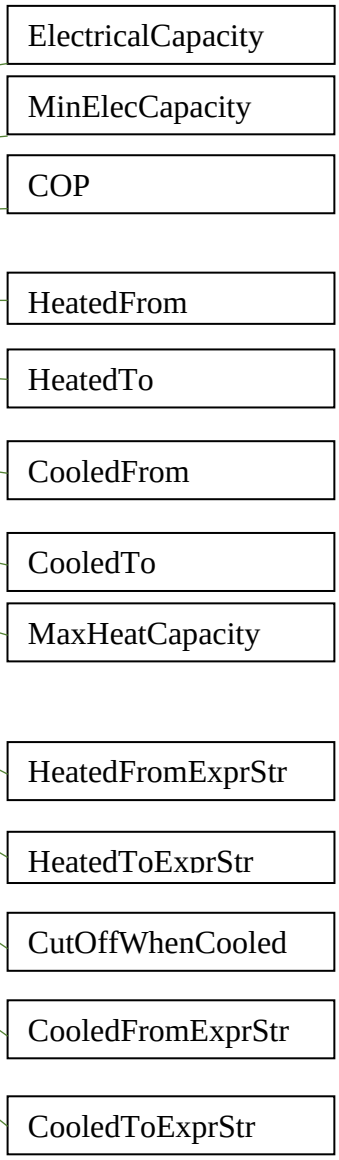

Figure 4-16 Electric Heatpump

4.2.12 Storage

With Storage, you have access to the following types of storages:

- Thermal storage
- Cold storage
- Hydro pumping station
- Battery
- E-cars

With Thermal and Cold storage, you have access to the following data elements:

- Volume of storage (StorageVolume)
- Temperature at top of storage (TempTop)
- Temperature at bottom of storage (TempBottom)

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- Utilization (StorageUtilization)
- Minimum storage content in percentage (MinStorageCapPct)
- Storage Height (StorageHeight)
- Insulation Thickness (InsulationThickness)
- Thermal Conductivity (ThermalConductivity)
- Ambient Temperature (AmbientTemperature)

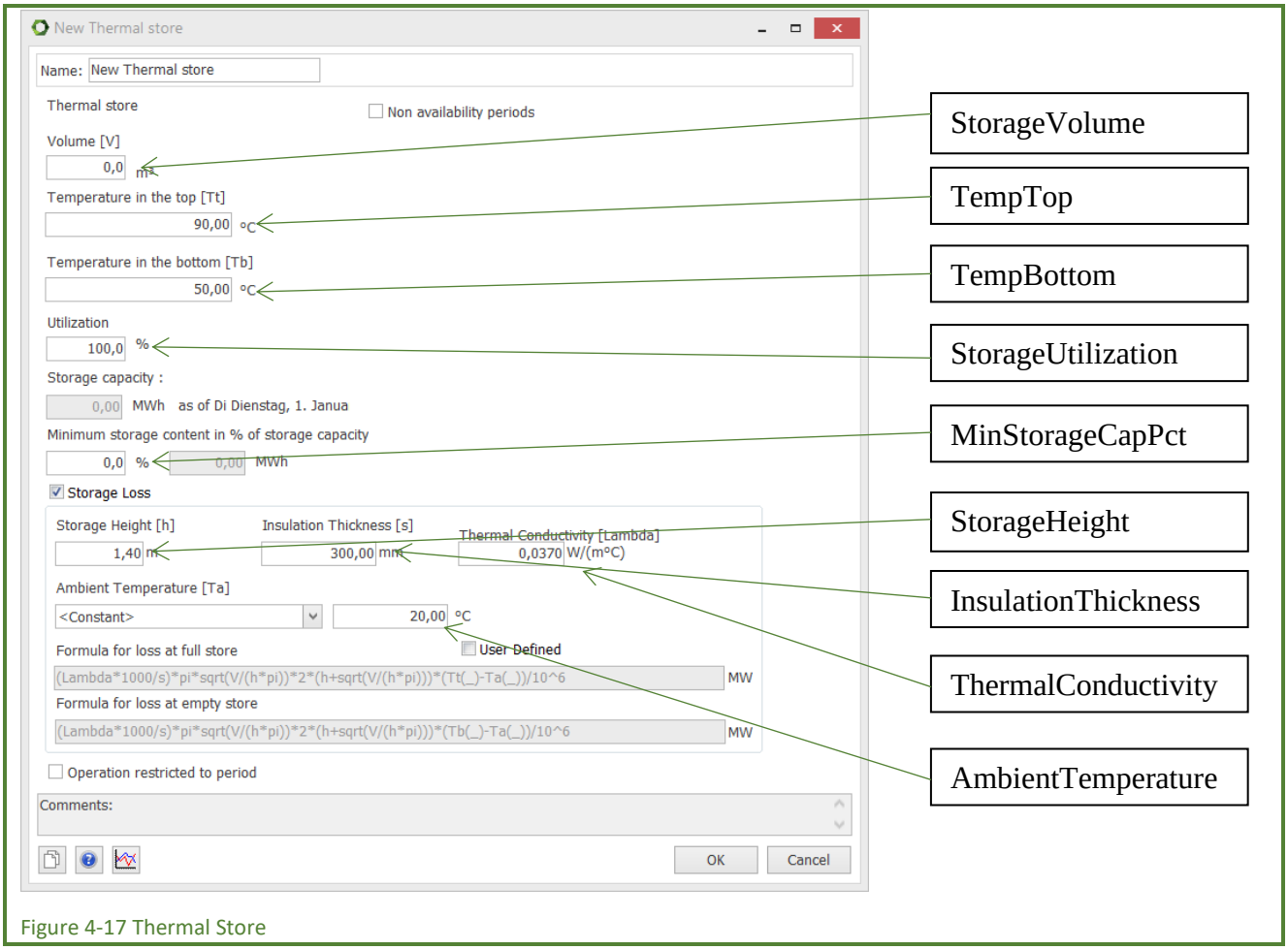

Figure 4-17 Thermal Store

With Hydro pumping station, you have access to the following data elements:

- Height difference (HeightDiff)
- Water reservoir max (WaterReservoirMax)
- Pumping Power Capacity (PumpPowerCapacity)
- Pumping Power Efficiency (PumpPowerEfficiency)
- Producing Power Capacity (PumpProdCapacity)
- Producing Power Efficiency (PumpProdEfficiency)
- Utilization (StorageUtilization)

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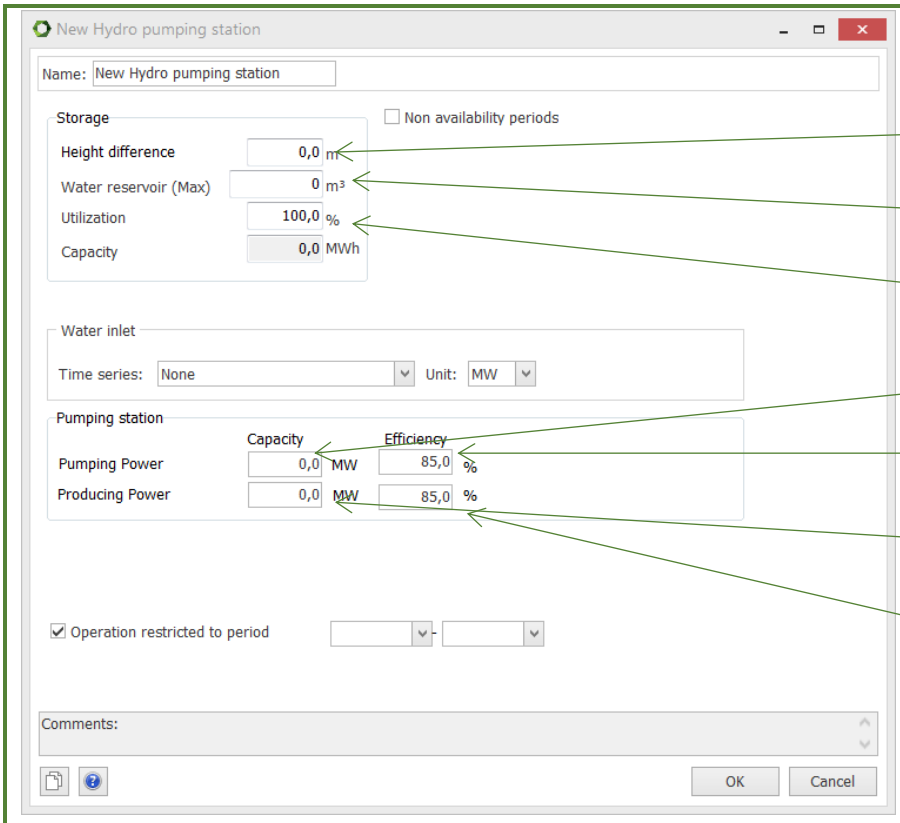

Figure 4-18 Hydro Pumping Station

With Battery and E-cars, you have access to the following data elements:

- Max Capacity, battery (MaxBatteryCapacity)
- Max Capacity, e-car battery (ECarsCapacity)
- Charging Power Capacity (InletCapacity)
- Discharging Power Capacity (OutletCapacity)
- Charging Power Efficiency (InletEfficiency)
- Discharging Power Efficiency (OutletEfficiency)
- Utilization, only Battery (StorageUtilization)

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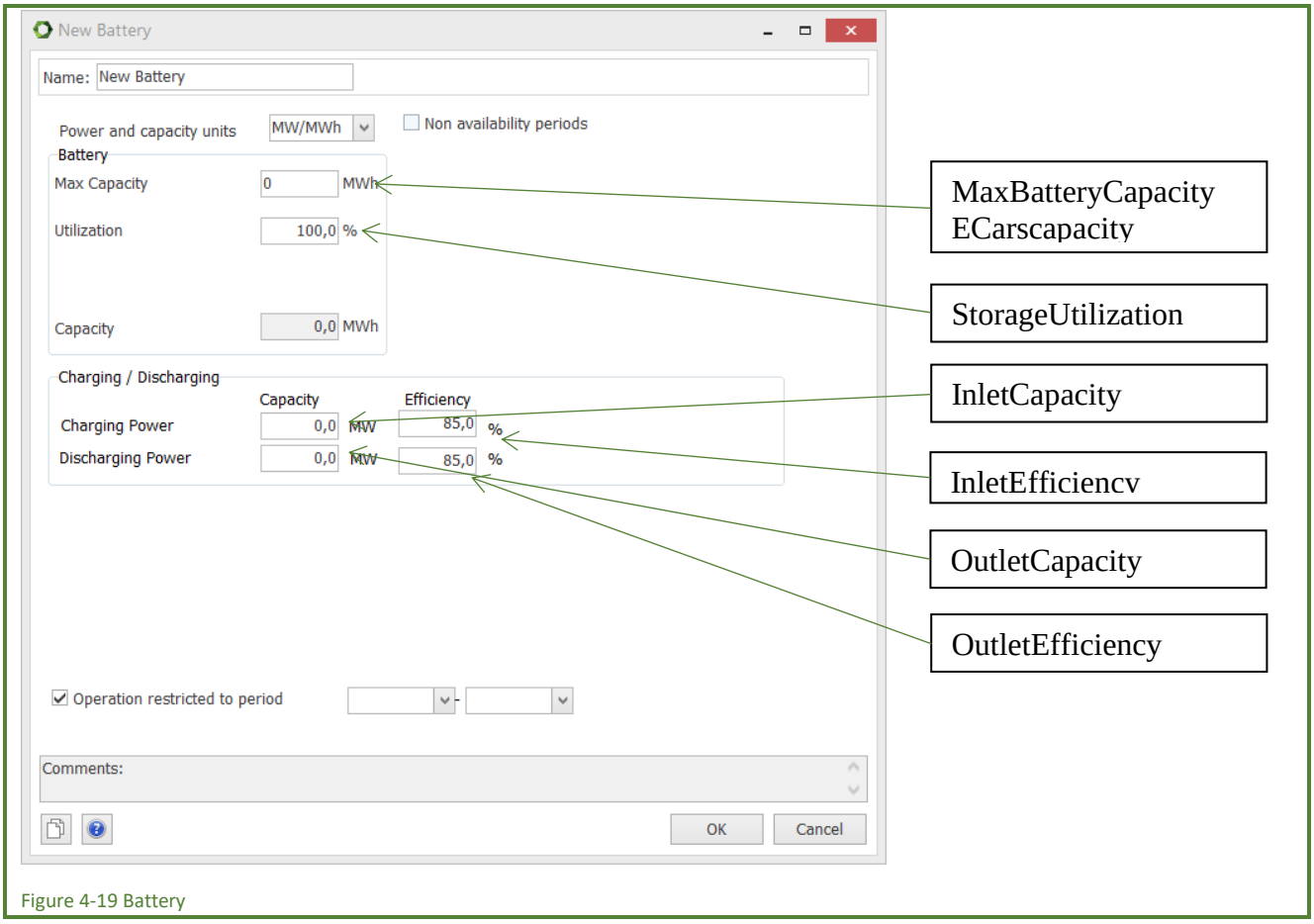

Figure 4-19 Battery

Example:

<InputDataElement>

<BaseID>StorageData</BaseID>

<DataName>Thermal store</DataName>

<DataElementName>StorageVolume</DataElementName>

<DataElementValue>230</DataElementValue>

</InputDataElement>

When having the energyTRADE-module it is also possible to set the storage content at the beginning and at the end of the calculation.

4.2.13 Environment

In the environment, the Amount per Unit (Amount) is available for changes.

Example:

<InputDataElement>

<BaseID>EmissionData</BaseID>

<DataName>Natural gas</DataName>

<DataElementName>Amount</DataElementName>

<DataElementValue>2.25</DataElementValue>

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</InputDataElement>

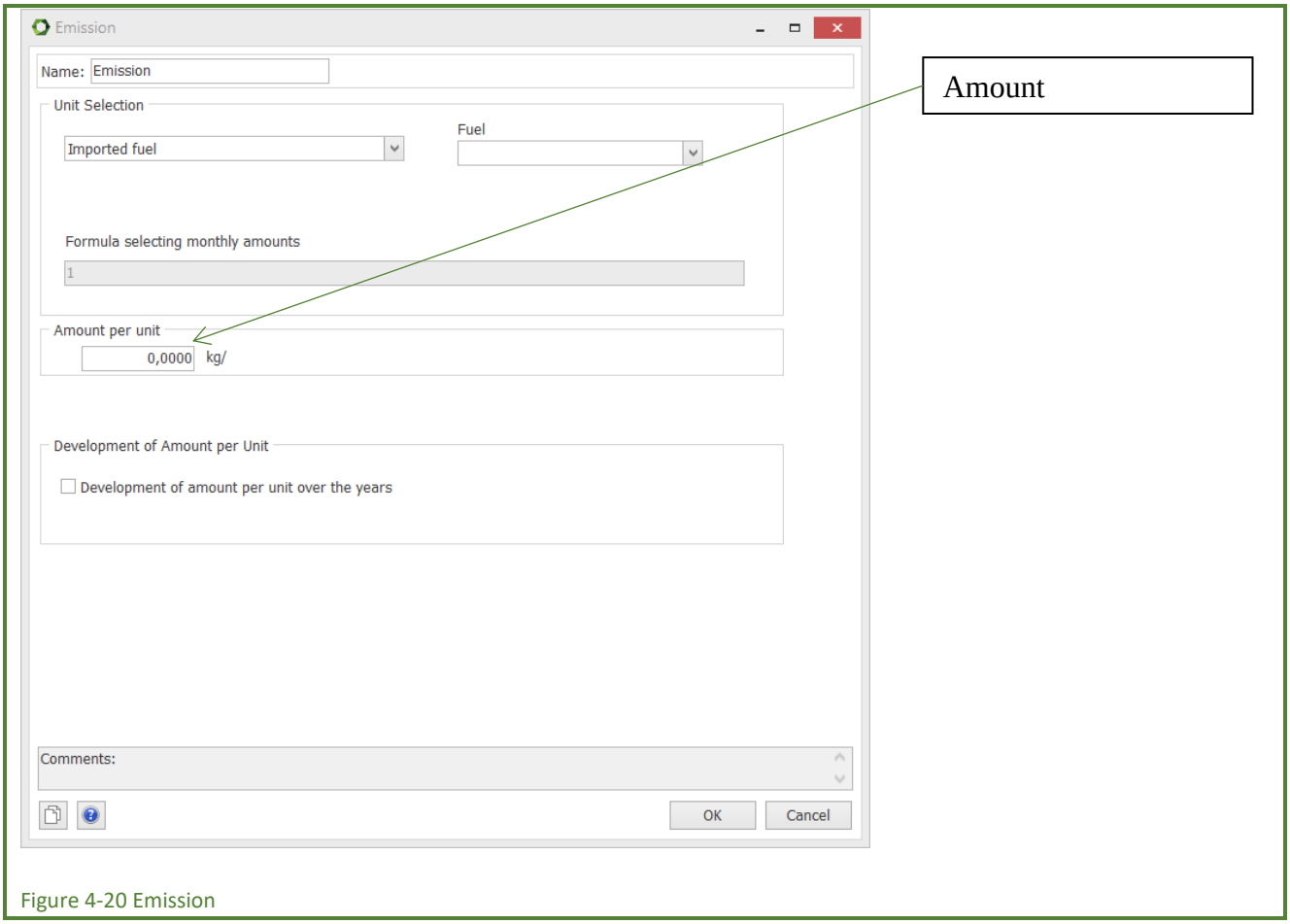

Figure 4-20 Emission

4.2.14 Economy

In the economy, the payments in Revenues and Operation expenditures can be altered. The Price per Unit (Amount) is available for changes.

If you have more payments with the same name, you shall include the name of the payment group, like this: “Operation and Maintenance.Engine 1”.

Further, it is possible to change the Nominal discount rate, when operating in Finance or Accounts (NominalDiscountRate).

Example:

<InputDataElement>
<BaseID>EconomyData</BaseID>
<DataName>Fuel cost</DataName>
<DataElementName>Amount</DataElementName>
<DataElementValue>0.5</DataElementValue>
</InputDataElement>

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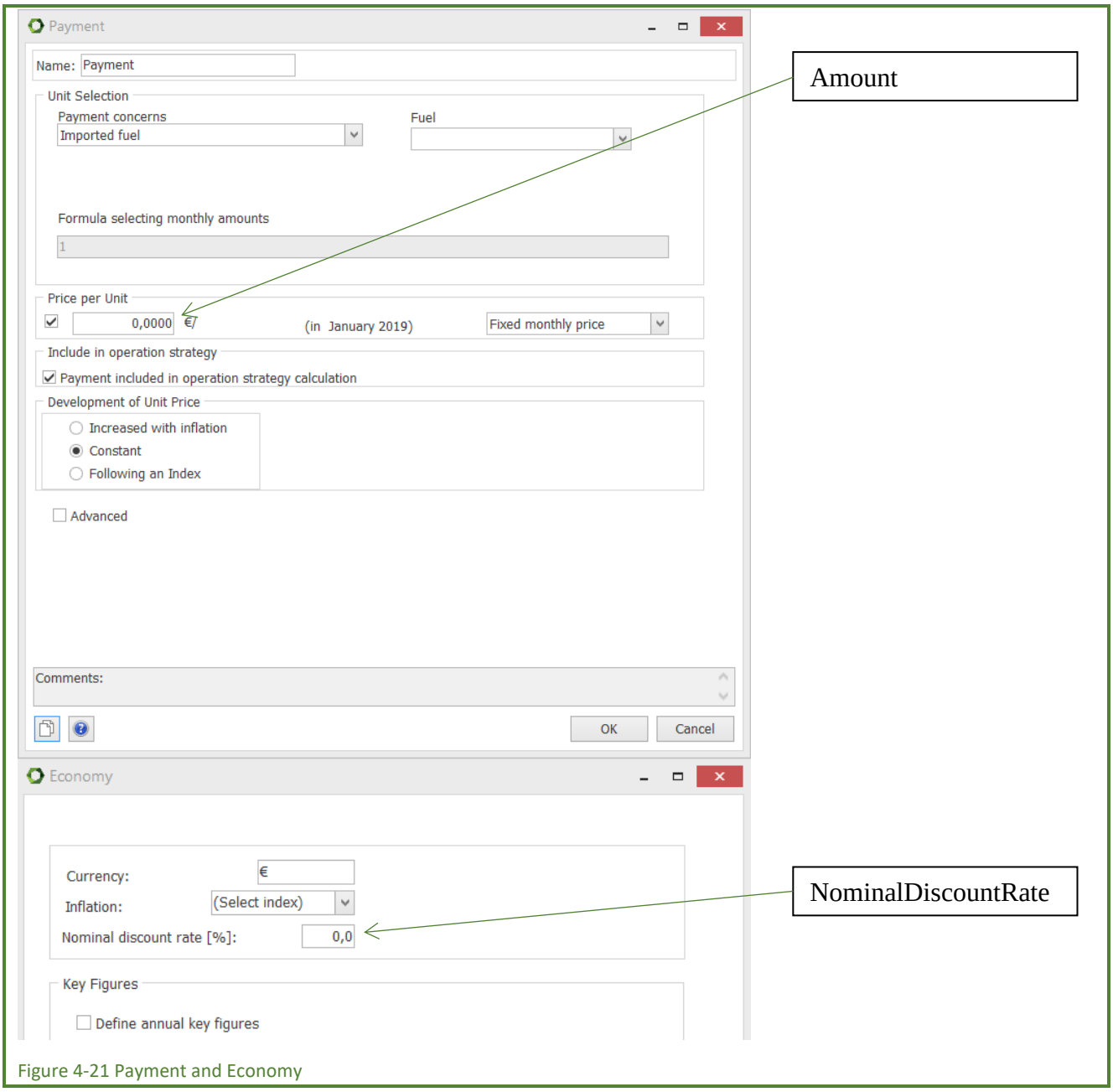

Figure 4-21 Payment and Economy

4.2.15 Financing

When it comes to financing, you have the option of changing the following values:

- Annual Interest (AnnualInterest)
- Loan Period Years (LoanPeriodYears)
- Loan Period Months (LoanPeriodMonths)

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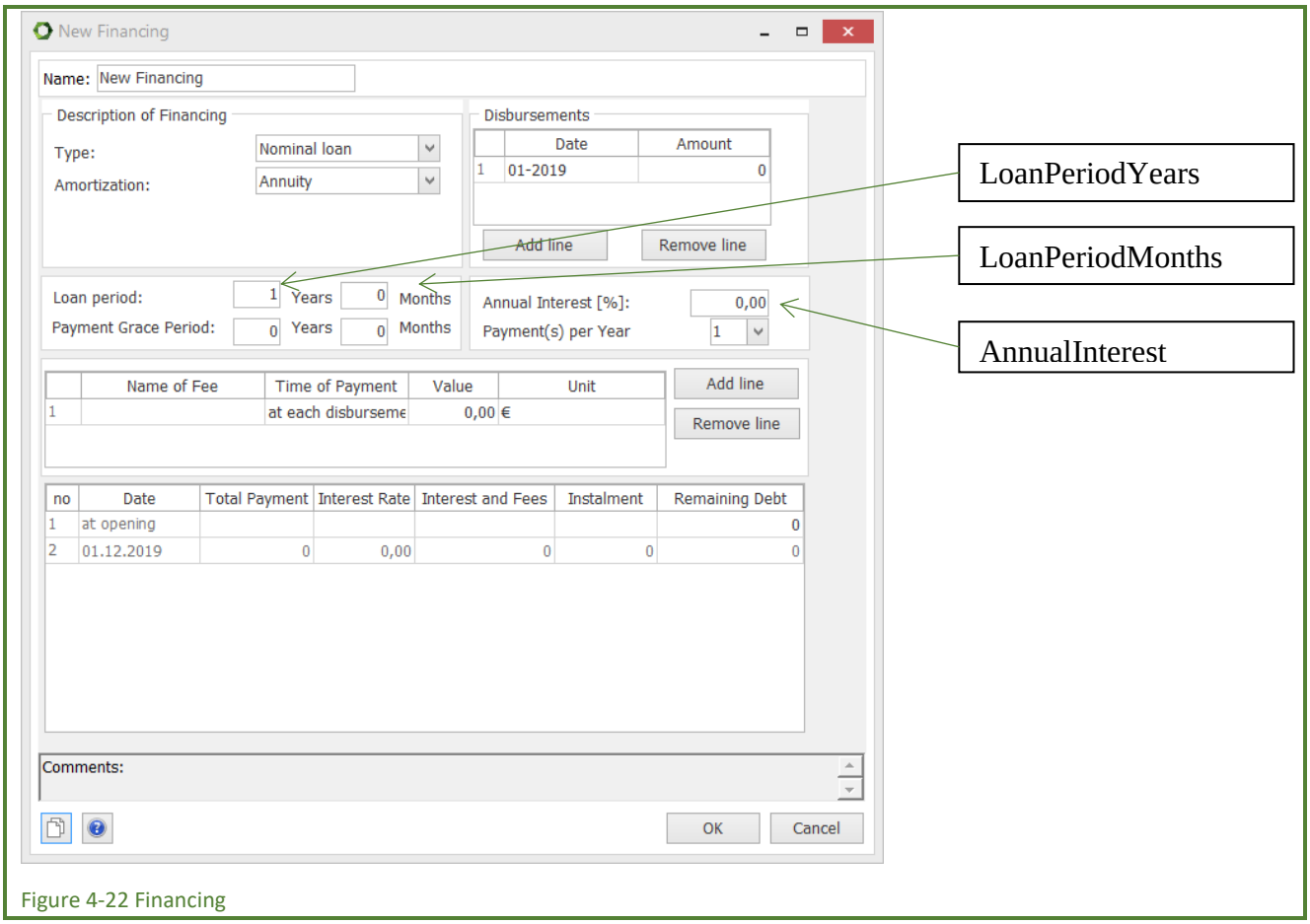

Figure 4-22 Financing

4.2.16 Taxation

When it comes to taxation, you have the option of changing the following values:

- Tax rate (TaxRate)
- Loss carried forward (LossCarriedForward)

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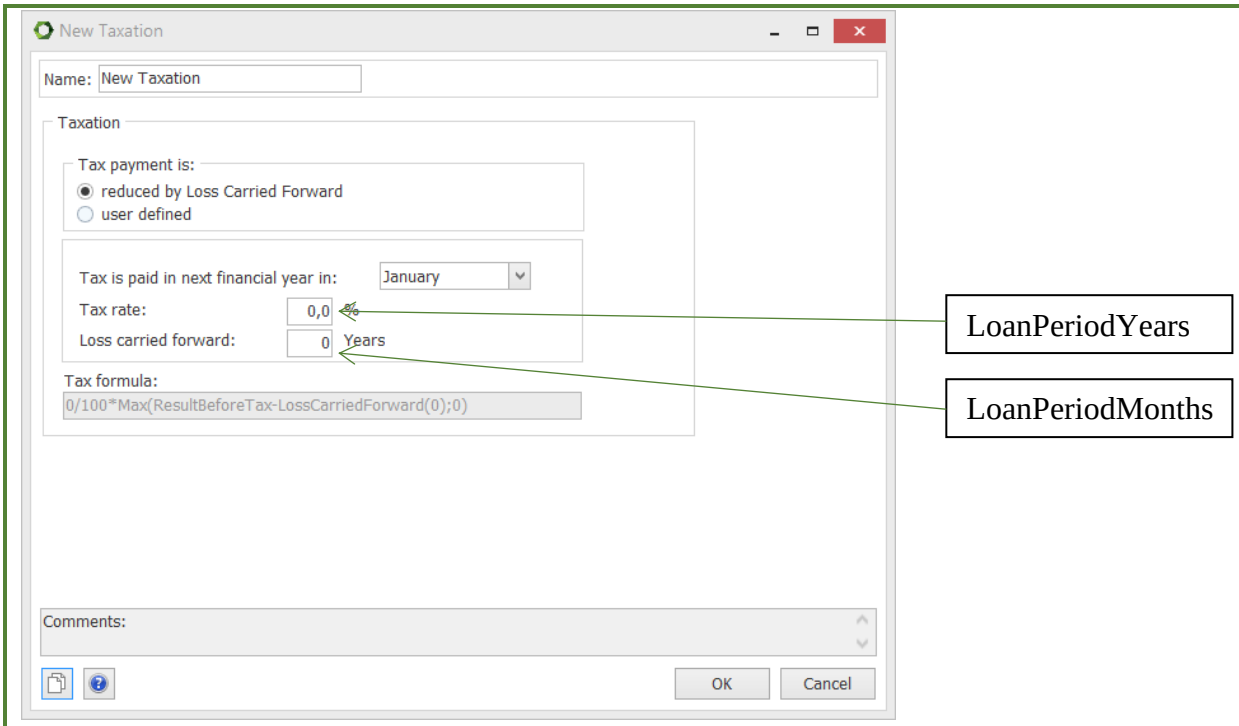

Figure 4-23 Taxation

4.3 Output Data section

In the Output data section is specified the results you want to extract.

The output data section has the following syntax:

<OutputDataElements>

Output Data Element

</OutputDataElements>

An output data element can either be a text report or a graphic report.

4.3.1 Text reports

This is a typical example of a text report:

<OutputDataElement>

<ReportID>EnergyConversionAnnual</ReportID>

<ReportFileName>c:\Energy conversion, annual.txt</ReportFileName>

<ReportDelimiter>;</ReportDelimiter>

<ReportDecimalSeparator>.</ReportDecimalSeparator>

<ReportYear>6</ReportYear>

<AltName>Reference</AltName>

<ReportFileType>txt</ReportFileType>

</OutputDataElement>

For the ReportID the following elements are available.

- EnergyConversionAnnual

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- EnergyConversionMonthly
- EnergyConversionSummary
- Environment
- ProductionPlan
- CashFlowMonthly
- CashFlowSummary
- OperationIncome
- FinancialKeyFigures
- IncomeStatement
- IncomeStatementSummary
- BalanceSheet
- BalanceSheetSummary
- CatalogueTechnicalAssumptions
- CatalogueEconomicAssumptions
- OperationStrategyCalculation
- ProjectReports
- ToolsCopyEnergyConversion

The ReportFileName shall be included in the path.
The ReportDelimiter is the sign for splitting up the values.
The ReportDecimalSeparator is the sign for the decimal separator. If omitted, the setting of the Windows system is used.
The ReportYear is the year of the report if making a FINANCE or ACCOUNT calculation. 1 is the first year. If omitted, the first year is selected.
AltName is the name of the alternative if having a COMPARE project. If omitted, the reference is selected.

ReportFileType can be:

- txt
- csv
- pdf

For the report ToolsCopyEnergyConversion, which in energyPRO is equal to Tools, Export energy conversion, it is possible also to set the resolution, by using this syntax:

<ReportResolution>Hour</ReportResolution>

The resolution can have the following values:

- Year
- Month
- Day
- Hour
- Step

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Where Step is the calculation step defined in Project identification.

Files of the txt and csv types can be opened in e.g. a spreadsheet while pdf files show the report as it looks in energyPRO.

4.3.2 Graphic reports

This is a typical example of a graphic report:

<OutputDataElement>
<ReportID>DurationCurveHeatDemand</ReportID>
<ReportFileName>c:\Duration Curve.jpg</ReportFileName>
<ReportFileType>jpg</ReportFileType>
</OutputDataElement>

As report file type only jpg can be specified.
For the production, graphic report the period can be specified:
<ReportStartDate>01-08-2010</ReportStartDate>
<ReportEndDate>08-08-2010</ReportEndDate>

The following reportIDs are available:

- ProductionGraphic
- TransmissionGraphic
- DurationCurveHeatDemand
- DurationCurveProcessHeatDemand
- DurationCurveElectricityDemand
- DurationCurveCoolingDemand
- CashFlowGraphic
- GraphicalLayout

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