Appendix 14. Energy mapping user guide

Under the Energy Efficiency Incentive Scheme for Energy Intensive Industries in Vietnam

1 Introduction

A careful mapping and understanding of the energy usage in an industrial company is a crucial baseline in project development.

However, in numerous international projects it has been observed that energy auditors face severe challenges in such important work, partly because the work is not very well structured and well defined in terms of outputs, and partly because energy auditors are reluctant to build conclusions on other than detailed and precisely measured data.

With this background, this guide aims to establish a well-defined mapping methodology, that delivers clear outputs phase by phase and supports and instructs energy auditors on specific activities to be carried out.

The guide consists of an energy mapping template in Excel format which is accompanied by the present user guide which describes how to set-up such a mapping in practice and how to utilize the results for developing projects. The data and process flow within the energy mapping template are only for illustrative purposes and do not represent actual data from an actual production site.

Figure 1 shows a flow chart of the overall energy mapping process which can be used to keep track of the steps in the energy mapping process. It also highlights the iterative process of setting up the energy balance, where the mapping degree is used as an indicator for when to move on to analyse the results. This simplified approach can save auditors a lot of time on carrying out many very time-consuming measuring programs on all equipment and instead focuses on first getting a full overview of the actual energy demands based on available information and assumptions. This enables the auditor to prioritize the more time-consuming analyses and measuring programs on the processes and equipment that is initially shown to have the greatest saving potentials. Having set up energy- and mass balances for a process will often also be a necessary step for identifying which parameters to measure.

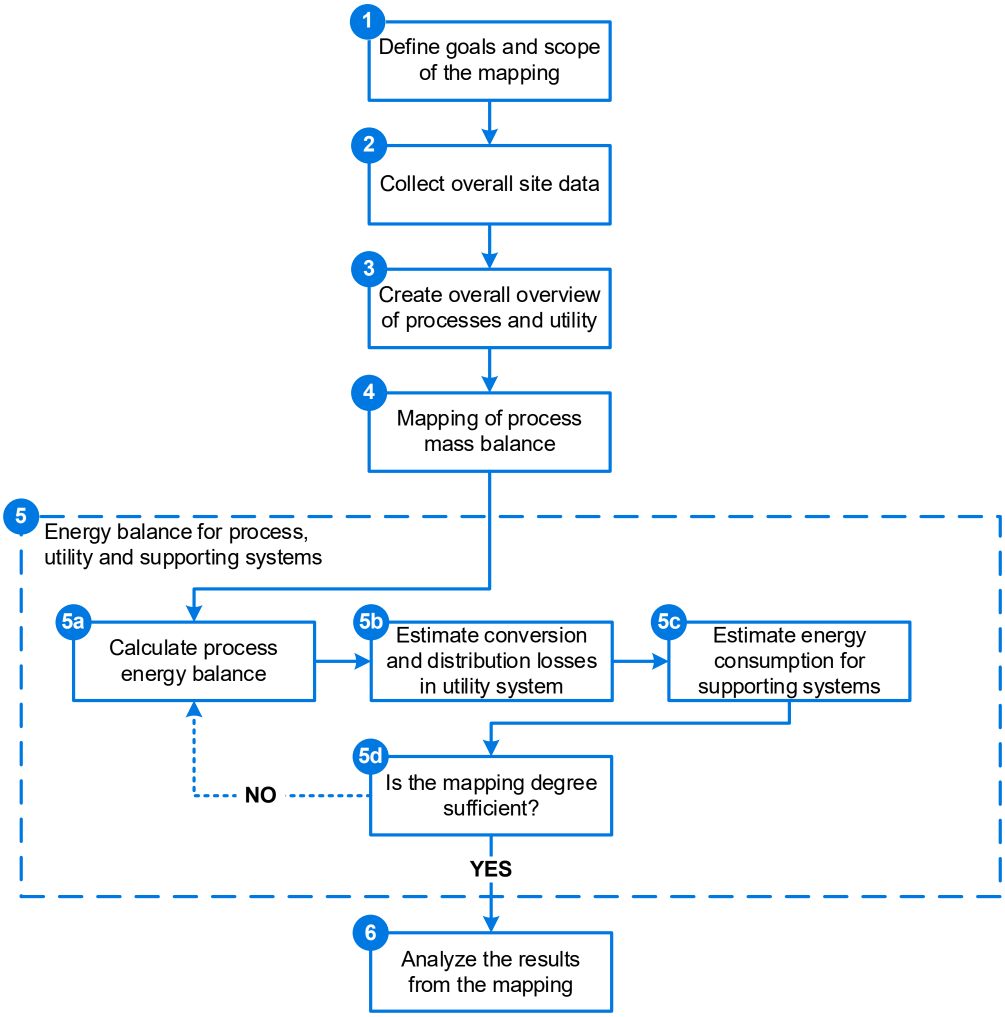

Figure 1: Flow chart of the energy mapping process

2 Defining a scope and goal

This first step of the energy mapping is to clearly define a scope and purpose for the energy mapping. Depending on the size of the company and timeline for the energy mapping and the overall strategy of the company which is being mapped, the scope and goals of the mapping could vary. The following questions should therefore be considered before starting the energy mapping:

- Is the goal to map the entire facility or should the mapping focus on certain areas?
  - Geographic areas?

    - Certain production areas of higher interest?
- What level of detail can be achieved with the given timeline for the energy mapping?
- What is the main driver for conducting the energy mapping?
    - Is it only to achieve a detailed overview of the energy consumption?
    - Is it economical? Should the model be prepared to handle economic evaluations?
    - Is it environmental? Should the model be prepared to handle CO_2 savings as well?

3 Overall site data

When the scope is defined, the next step of the energy mapping is to get an overview of the overall site data. This data should be easily available at most sites. The overall site data covers all purchased primary energy consumption and the amount of production output. In addition to the outputs the main inputs (i.e. raw materials) to the production process should also be achieved at this step. In the Energy mapping template, an example of such overall data collection is shown in the sheet "Yearly data".

This sheet will function as an input sheet for the mass balance and utility mapping sheets later on. Therefore, all unit conversions should be carried out in this sheet to avoid unnecessary calculations in the later sheets. It is important to secure consistency of the units within all data types. For time, energy and mass, the recommended units are:

1. Time: Year
2. Mass: Tons
3. Energy: kWh

Being consistent about all units will ease further work and comparisons.

The overall site data should be collected as soon as possible and many times even before an actual site visit, in order to give a better understanding of the size of the production company and their overall energy demands.

Yearly data

Energy Data	**Year**	
Purchased Electricity	20.000.000	kWh/y
Purchased Natural Gas Steam boiler	20.000.000	kWh/y
Purchased Coal	18.000.000	kWh/y
Total Purchased Energy	**58.000.000**	**kWh/y**
Production data		
Material X	160.000	Ton/y
Material Y	20.000	Ton/y
Material Z	40.000	Ton/y
Material W	5.000	Ton/y
Material V	10.000	Ton/y
Material Q	15.000	Ton/y
Total Raw materials	**250.000**	**Ton/y**
Additives production line 1	10.000	Ton/y
Additives production line 2	-	Ton/y
Total Additives	**10.000**	Ton/y
Final product data		
Final product 1	100.000	Ton/y
Final product 2	80.000	Ton/y
Total final product	**180.000**	**Ton/y**

Figure 2: Overview of collection of overall site data. See sheet "Yearly data" in the Excel template.

Creating an overview of process, utilities and supporting systems

Once the overall site data has been gathered and goals and scope have been defined, an overall overview of the production processes, utilities and supporting systems should be created. These are essentially the first drafts of what will become the mass flow balance and utility mapping in the Excel template.

The overviews should be made on the basis of screenshots, flow diagrams, previous audits, production trends, site walks, etc. This first overview can also be carried out on paper or a drawing program such as Visio to then later be carried over to the Excel spreadsheets. An example of a simple Visio sketch of the example from the Excel template is shown in Figure 3.

For the production processes the goal is to create a basic overview of the entire production flow at the site. At this step, the focus is to include all processes in the right order in relation to each other, but not necessarily to get numbers on inputs and outputs of each step. Every process should be labelled and each process stream should be numbered to keep a good overview of the system. The production flows are mapped in the sheet "Mass flow balance" in the Excel template.

In addition to creating an overview of the production processes, an overview of the utility structures at the site should also be prepared. Once again focus at this stage is more to qualitatively achieve the full overview rather than quantifying losses and efficiencies. This should be done for all utility systems at the site (i.e. heating, cooling, compressed air, etc.). The utility structures are mapped in the sheet "Utility mapping" in the Excel template.

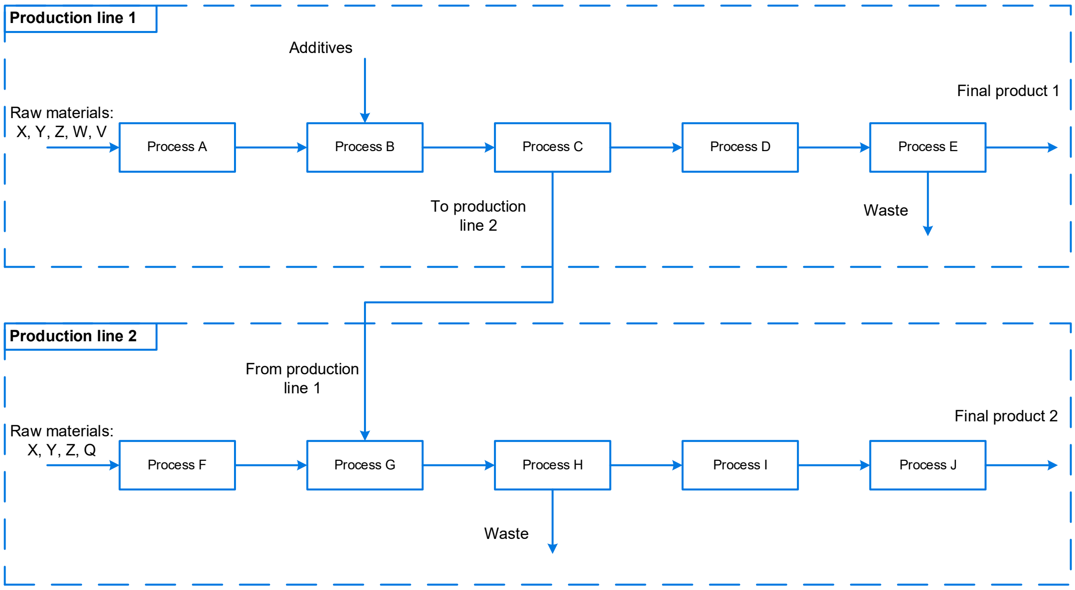

Figure 3: Simple Process flow overview of the template example.

4 Process mass balance

The next step is to set up the process mass balance based on the previously created process flow diagram. This is shown in Figure 4 below and is done in the "Mass flow balance" sheet in the mapping template. Each process step is indicated by a box. The example shows a site with two different production lines that are creating two different products from a list of raw materials. Each production line consists of 5 processes with varying inputs of additives and energy. It is also seen that a biproduct from production line 1 is used directly in production line 2. To carry out the mass balance the following steps should be followed:

1. The yearly data for raw materials are imported from the "Yearly data" sheet.
2. For each process it is evaluated whether there is any addition or extraction of material.
3. If any product or additive is added or removed during a process, data should either be collected from the company if possible or it should be estimated.
   a. Estimation can often be done by consulting the operating personnel at the site.
   b. For some processes calculating the mass balance could require more information about the product. In the energy mapping template such an example is given for production line 2, where the mass balance is set up from knowing the Dry Matter percentage between process steps.

c. This process can require a more detailed understanding of the process than the auditor has and it can therefore be an advantage to involve operational or production personnel with extensive knowledge on the process in this step.

4. All streams with additions or removal of product are numbered.

   a. It is important remember to include waste streams since these might become interesting for later analysis.

5. It is important to keep progressing with the energy mapping and not get stuck in trying to achieve a value in a very detailed way that takes too long at this stage. If the uncertainty of a value is deemed very high this should be noted by the energy auditor as a potential focus point for later analysis.

6. When all processes have been mapped, the calculated amount of final product can be compared to the actual data for final production. This can be used to indicate if there are significant errors in the mass balance.

   a. In addition to this, a check should also be done for each production line on all incoming materials and outgoing products, making sure it equals out (In the Excel template this is carried out in cells T25 and T52 for the two production lines respectively).

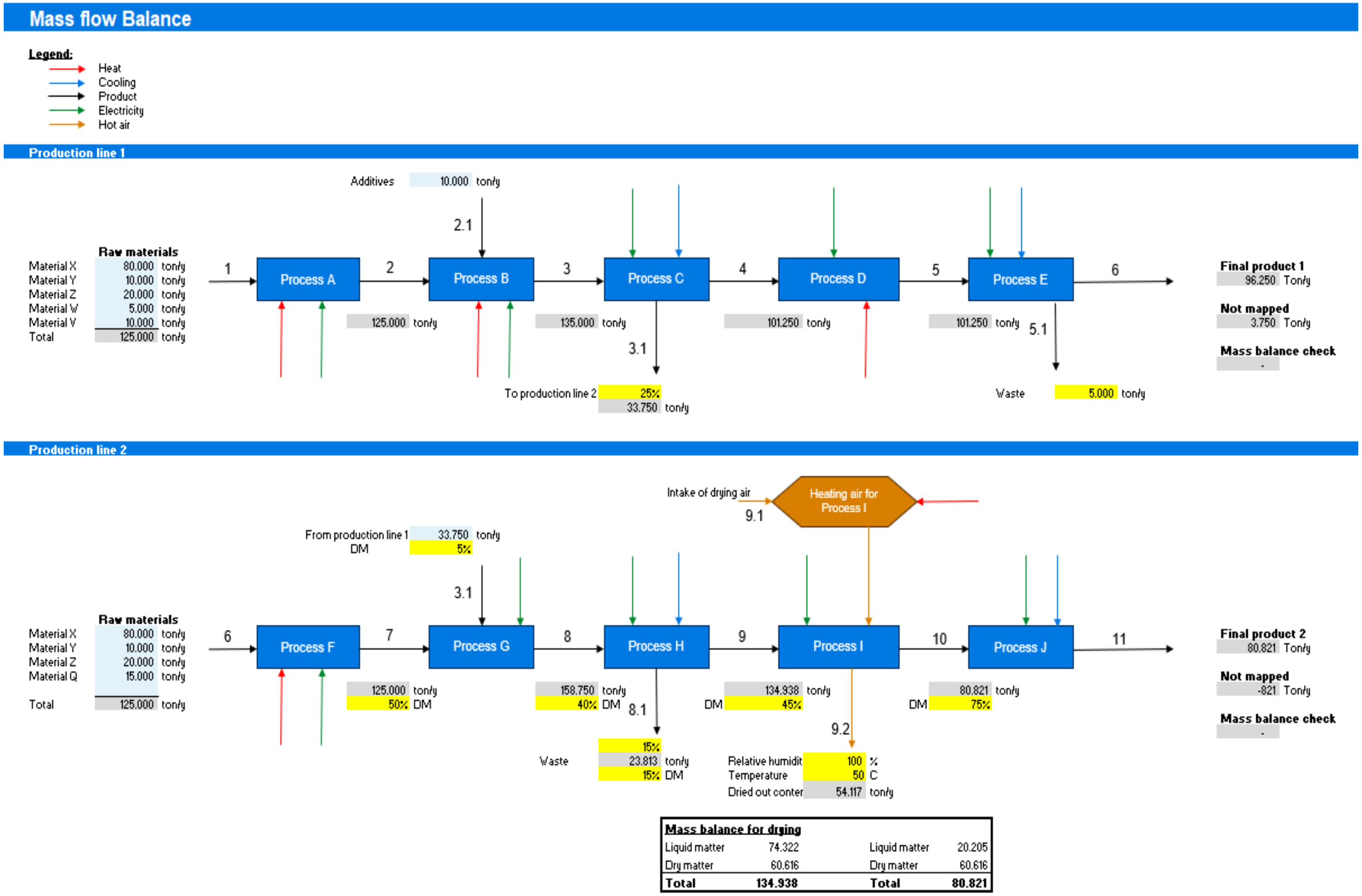

Figure 4: Overview of the process mass flow balance. See sheet "Mass flow balance" in Excel template.

5 Energy balance for process, utility and supporting systems

In addition to the mass flow balance, energy balances for process, utility and supporting systems should be set up. The goal is to set up tables for each utility type where all the energy consumers are listed. This is shown in Figure 5 and can be seen in sheet “Process mapping” in the Excel template. Starting with the process energy balances the recommended approach is described below:

1. The first step is to evaluate the energy inputs for each process on a qualitative level, considering both the thermal and electrical energy consumption. This is most easily done by drawing ingoing energy flows on the previously created mass balance. This can also be seen in Figure 4.
2. After this, the specific energy consumption in each process step should be calculated. Each process is listed in the respective energy consumption tables and some basic information on “Section”, “Media” and “Stream No.” is noted for easy reference later.
3. For thermal energy mapping additional information on the process stream might be required. In any case temperature information is needed and, in some cases, pressure and heat capacity or enthalpy could also be needed. The mapping itself can be carried out with three different approaches (examples of all three approaches are given in the Excel template):

   - **Flow**: With the flow approach, the energy demand is calculated with the following equation. This approach is based on information of the mass flow and temperature difference over a specific unit.

$$(T_{out} - T_{in})\ [K]\ \times\ c_p\ \left[\frac{kJ}{kg * K}\right] \times \dot{m}_{in}\ \left[\frac{ton}{year}\right] \times 1000\ \left[\frac{kg}{ton}\right] \times \frac{1}{3600}\left[\frac{h}{s}\right] = \dot{Q}\ \left[\frac{kWh}{year}\right]$$

   - **KPI**: With the KPI approach, the energy demand is calculated based on a KPI for the specific unit, if such information exists.

$$KPI\ \left[\frac{kWh}{ton}\right] \times \dot{m}\ \left[\frac{ton}{year}\right] = \dot{Q}\ \left[\frac{kWh}{year}\right]$$

   - **Measurement**: With measurement approach, the energy demand from a component will be measured over a period of time and the measured value will be extrapolated to a yearly consumption. It can also be that the energy consumption for a given process is logged by the production company.

4. It is important to keep in mind that the potential energy content of the process waste streams should also be mapped during the thermal energy mapping.

5. For the electrical energy mapping, the electricity consumption of the process equipment is calculated. This calculation can also be based on three different approaches (examples of all three are once again shown in the Excel template):

   - **Power**: with the power approach then the electricity demand is calculated by the knowledge of the power capacity, the operating hours and a load estimate.

$$\gamma[-] \times t\,[h] \times p[kW] = \dot{P}_{unit}\left[\frac{kWh}{year}\right]$$

t = annual operational time in hours [h]

γ = Load factor

p = effect in kW [kW]

   - **KPI**: This approach is the same as for the thermal part.

$$[KPI]\left[\frac{kWh}{ton}\right] \times \dot{m}\left[\frac{ton}{year}\right] = \dot{P}_{unit}\left[\frac{kWh}{year}\right]$$

   - **Measured**: This approach is the same as for the thermal part.

$$\dot{P}_{unit}\left[\frac{kWh}{year}\right] = measured$$

6. The template is set up with conditional formatting to indicate the largest consumers in each energy type. Cell E6 can furthermore be utilized to define a threshold for Significant Energy Users. This can vary depending on the size of the facility and the number of process streams.

7. In column CO to MK a temperature analysis is set up for analyzing results in the later stage.

8. Once again it is important to keep progressing with the energy mapping and not get stuck in trying to achieve a value in a very detailed way that takes too long at this stage. If the uncertainty of a value is deemed very high this should be noted by the energy auditor as a potential focus point for later analysis

9. The tables in the Excel template are set up to be able to handle up to 100 processes within each category. Most of these are hidden to keep a better overview. For a guide on how to unhide a number of rows Appendix 0 should be reviewed.

Process Mapping

NB: See Appendix in User guide for help on how to add additional rows to the tables

Definition of Significant Energy User:	15%

Heating consumption															
Section	Proces	Medium	Stream no	Utility system	Temp. In	Temp. Out	Mass flow	Dry matter	Cp	KPI	Flow approach	KPI approach	Measurement	Total	Share of total
					°C	°C	t/yr	%	kJ/KgK	kWh/ton	kWh	kWh	kWh	kWh	
Production line 1	Process A	Product	1	Steam	20	50	125.000	5,0%	4,06		4.228.440			4.228.440	14,6%
Production line 1	Process B	Product	2	Steam	50	100	135.000	5,0%	4,08	100,00		13.500.000		13.500.000	46,6%
Production line 1	Process D	Product	4	Hot water	45	50	101.250	5,0%	4,07				800.000	800.000	2,8%
Production line 2	Process F	Product	6	Steam	20	60	125.000	50,0%	3,00		4.168.389			4.168.389	14,4%
Production line 2	Heating air for Process I	Product	9.1	Steam	20	80	134.938	44,9%	3,17	40,00		5.397.500		5.397.500	18,6%
Support system 1	Support system 1	Water	11	Hot water	20	50	26.000	0,0%	4,18		905.667			905.667	3,1%
									4,18					-	0,0%
									4,18					-	0,0%
									4,18					-	0,0%
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									4,18					-	0,0%
									4,18					-	0,0%
									4,18					-	0,0%
									4,18					-	0,0%
	TOTAL										9.302.496	18.897.500	800.000	**28.999.996**	100%

Cooling consumption															
Section	Proces	Medium	Stream no	Utility system	Temp. In	Temp. Out	Mass flow	Dry matter	Cp	KPI	Flow approach	KPI approach	Measurement	Total	Share of total
					°C	°C	t/yr	%	kJ/KgK	kWh/ton	kWh	kWh	kWh	kWh	
Production line 1	Process C	Product	3	Glycol	75	20	135.000	5,0%	4,07		8.386.860			8.386.860	37,7%
Production line 1	Process E	Product	5	Glycol	30	12	101.250	5,0%	4,05	30,00		3.037.500		3.037.500	13,6%
Production line 2	Process H	Product	8	Glycol	55	15	158.750	5,0%	4,06				9.000.000	9.000.000	40,4%
Production line 2	Process J	Product	10	Glycol	50	15	80.821	75,0%	2,35		1.845.256			1.845.256	8,3%
									4,18					-	0,0%
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									4,18					-	0,0%
									4,18					-	0,0%
									4,18					-	0,0%
									4,18					-	0,0%
	TOTAL										10.232.115	3.037.500	9.000.000	**22.269.615**	100%

Waste heat potential															
Section	Proces	Medium	Stream no		Temp. In	Temp. Out	Mass flow	Dry matter	Cp	KPI	Flow approach	KPI approach	Measurement	Total	Share of total
					°C	°C	t/yr	%	kJ/KgK	kWh/ton	kWh	kWh	kWh	kWh	
Production line 1	Process E	Product	5.1		50	20	5.000	0,0%	4,18		174.167			174.167	6,4%
Production line 2	Process H	Product	8.1		40	20	23.813	0,0%	4,18		552.979			552.979	20,3%
Production line 2	Process I	Air	9.2		50	20	54.117	0,0%	1,01				2.000.000	2.000.000	73,3%
									4,18					-	0,0%
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									4,18					-	0,0%
									4,18					-	0,0%
									4,18					-	0,0%
	TOTAL										727.146	-	2.000.000	**2.727.146**	100%

Electricity consumption													
Section	Proces	Medium	Stream no	Effect	Operation hours	Mass flow	Load factor	KPI	Flow approach	KPI approach	Measurement	Total	Share of total
				kW	h/y	t/yr	%	kWh/ton	kWh	kWh	kWh	kWh	
Production line 1	Process A	Product	1	500	6.500	125.000	90,0%		2.925.000			2.925.000	24,8%
Production line 1	Process B	Product	2	300	6.500	135.000	50,0%	8,00		1.080.000		1.080.000	9,1%
Production line 1	Process C	Product	3	100	7.000	135.000	60,0%		420.000			420.000	3,6%
Production line 1	Process D	Product	4	300	6.500	101.250	70,0%	3,00		303.750		303.750	2,6%
Production line 1	Process E	Product	5	50	7.000	135.000	75,0%				400.000	400.000	3,4%
Production line 2	Process F	Product	6	400	6.500	125.000	90,0%		2.340.000			2.340.000	19,8%
Production line 2	Process G	Product	7	400	6.500	125.000	50,0%	20,00		2.500.000		2.500.000	21,2%
Production line 2	Process H	Product	8	200	7.000	158.750	60,0%		840.000			840.000	7,1%
Production line 2	Process I	Product	9	300	6.500	134.938	70,0%	3,00		404.813		404.813	3,4%
Production line 2	Process J	Product	10	50	7.000	80.821	75,0%				600.000	600.000	5,1%
												-	0,0%
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												-	0,0%
												-	0,0%
												-	0,0%
												-	0,0%
												-	0,0%
	TOTAL								6.525.000	4.288.563	1.000.000	**11.813.563**	100%

Figure 5: Overview of the process energy mapping. See sheet "Process mapping" in Excel template.

When the process level energy balances are set-up, the utility level energy balance can be set-up. The utility mapping covers all the utility systems that support the process energy demand. The utility systems can be boilers, coolers, chillers, air compressors, wastewater etc. The scope is to cover the purchased energy, conversion of energy, distribution of energy and finally the process energy. An example is shown in Figure 6 and can furthermore be seen in the Excel template. This system consists of two steam boilers using coal and natural gas to supply the main heating consumption, while a small hot water boiler and waste heat from air compressors is used in a 60°C system to supply hot water for supporting systems and one low temperature heating process. Cooling is supplied by one central chiller. The Excel template is prepared to handle up to three heating and cooling systems respectively. If more systems are present, the later results will have to be expanded by the user. The utility mapping can be carried out by the following steps:

1. All purchased energy is imported into the "Purchased" column
2. All major utility equipment is added to the "Conversion" column e.g. in the example the system consists of two steam boilers, chillers and air compressors.
3. For each type of equipment, the efficiency is estimated, and energy losses are calculated.
   - In the example losses are estimated for the boilers and air compressors
   - For chillers a Coefficient-of-Performance (COP) and known electricity consumption is used to estimate the amount of cooling that is produced. The COP value is not always known by the site in which case it might have to be estimated based on an assessment of the present equipment.
4. Next, the distribution losses are estimated in the "Distribution" column based on an overall assessment of the distribution system (level of maintenance, insulation, steam traps etc.)
5. Then the utility is connected to the end-users in the "Consumption" column.
6. Finally, the overall mapping degree can be calculated. As shown in Figure 1 in the beginning, the mapping degree is now used to evaluate whether the mapping is done to a sufficient degree or whether an extra iteration is required to.
   - If the mapping degree is deemed too low the energy balances are reevaluated.
   - If the mapping degree is deemed sufficient the auditor can move on to setting up and analyzing the results.

- The sufficient level can vary a lot depending on the size of the facility and level of detail. Based on international experience a mapping degree of at least 90% is most often considered sufficient. However, no matter the degree it is very important to critically reflect on the reasons why it is not exact and what the potential consequences can be.

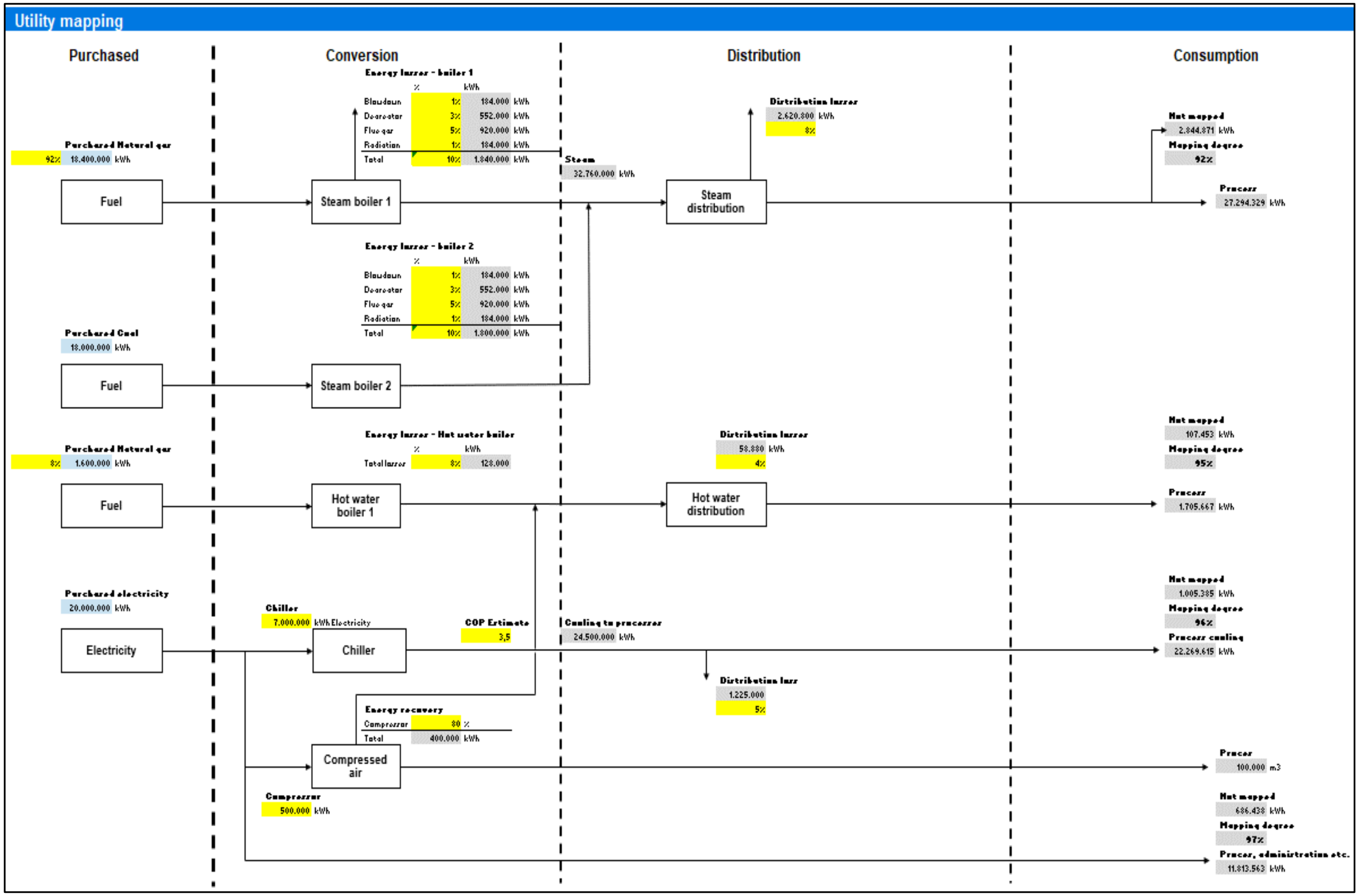


Figure 6: Overview of the utility mapping. See Excel template sheet "Utility mapping".

In addition to process and utility level energy balances, many production facilities also have several supporting systems. These systems are also required to be mapped, to get the full overview of energy consumption at a site. Examples could be, Cleaning-In-Place, washers (containers, boxes, bottles etc.), ventilation, packaging units etc. Since these will not be visible in the process flow, a separate sheet in the Excel template is kept for handling of these systems "Supporting systems". In the Excel template oe example is given which is shown in Figure 7 below. In this example steam is used for heating up water for a washing machine at the site. This energy consumption is also carried over to the process mapping overview tables.

Supporting systems

Support system 1

An example of a common support system could be a washing machine. An example of such calculation is given below:

Supply water temperature	Forward temperature to washer	Weekly water consumption	Annual water consumption	Specific heat
[C]	[C]	[m3/week]	[m3/y]	[kJ/kgK]
20	50	500	26.000	4,18

Energy consumption for support system 1

905.667 **kWh**

Stream 11

Temperature levels

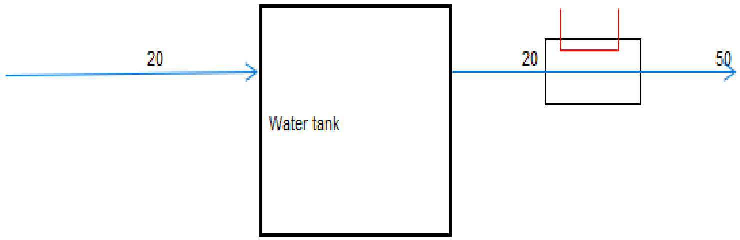


Figure 7: Overview of the supporting systems. See the sheet "Supporting systems" in the Excel template

6 Analyzing and understanding the results

When a sufficient mapping degree is achieved, the next step is to set up the results in an easily understandable way. To use the energy mapping properly it is important to consider how to present the results and how to use the results efficiently develop energy saving projects. It is emphasized that the development of projects should start by understanding the energy consumption of the processes before moving on to the utility systems. A full understanding of the actual energy service or purpose of using energy in the specific processes is therefore required.

To easily get a full overview of the entire facility pie charts and bar charts are made for each utility type at the site. As an example, an overview of the heating consumption for the given example is shown in
Figure *8*. These plots provide a good overview of the distribution of heat consumption for the entire site and make it easy to identify the main energy consumers at the site. In the example these are only created on site level, but for larger sites they can also be created on a production line level or section level, to have an even more detailed overview of where the energy is consumed. The overviews are created for each utility system at the site.

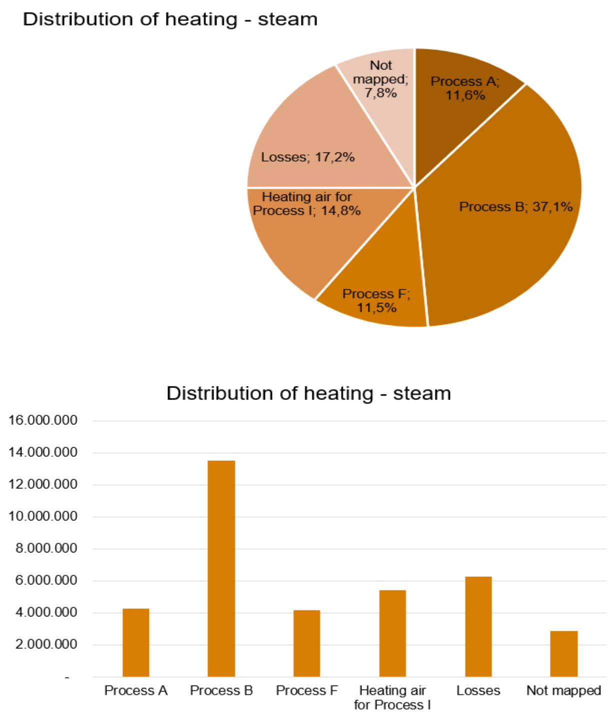


Figure 8: Charts for presenting the results of overall heat consumption. See Excel template sheet "Result Overview".

In addition to the overall overviews, it is often also useful to connect the consumption to temperature. This can help assess the potential for heat recovery and integration of, for example heat pumps. The graphs help give a good overview of what temperature levels the heating is utilized at. An example from the template is shown in

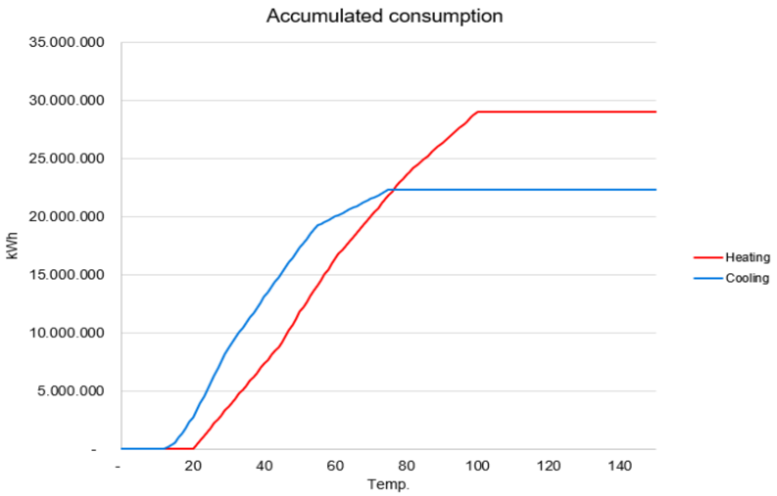


Figure 9. Conclusions from these plots could for example be that:

- 80% of the heating is used for processes below 80°C (about 23 GWh) and all heating is below 100°C.
    - Can hot water be used instead of steam?
    - Any good heat sources for heat pumps?
- 20% of the cooling is used above 50°C (about 4 GWh).
    - Are there any potentials for heat recovery?

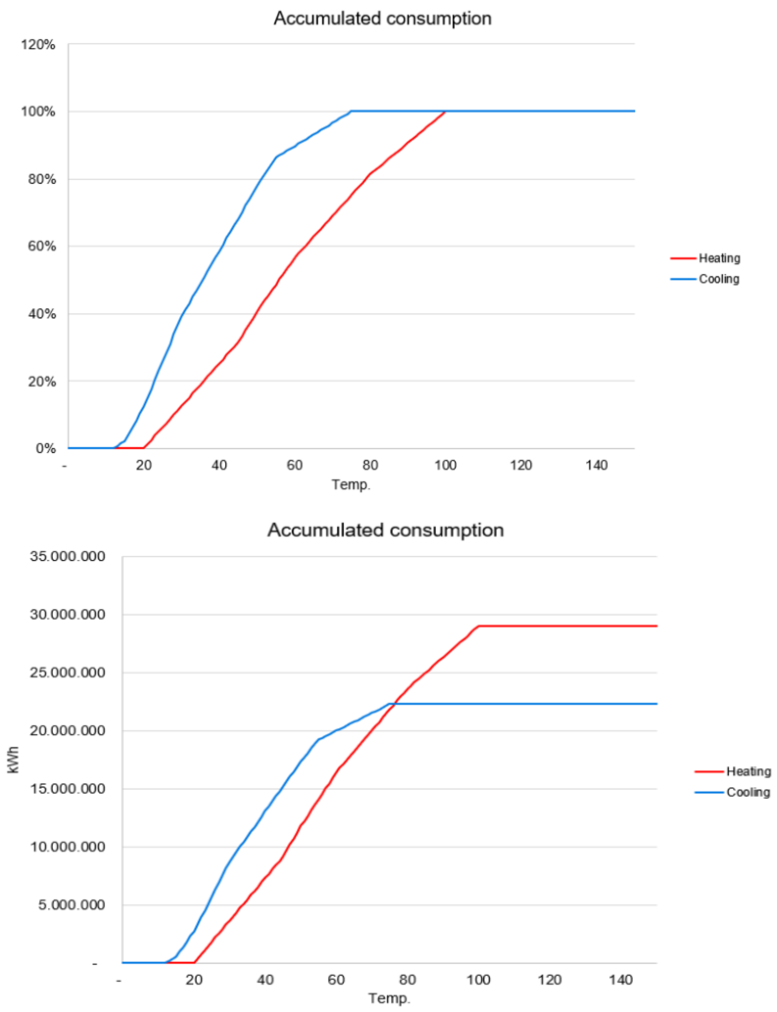


Figure 9: Accumulated thermal energy consumption. See Excel template sheet "Result Overview".

To gain a better overview of the relations between heating and cooling temperature levels, composite curves can be plotted for each. This is shown for the Excel template and in Figure 10 below, where the mapped waste heat streams have also been added. This analysis shows the amount of energy that is consumed at each degree of temperature. It can therefore be used to identify heat recovery potentials. The graph has four distinct areas.

- Orange area: theoretically minimum required heating utility
- Blue area: theoretically minimum required cooling utility
- Yellow area: Available waste heat from the processes

- Overlapping grey area: maximum potential for direct heat recovery between processes

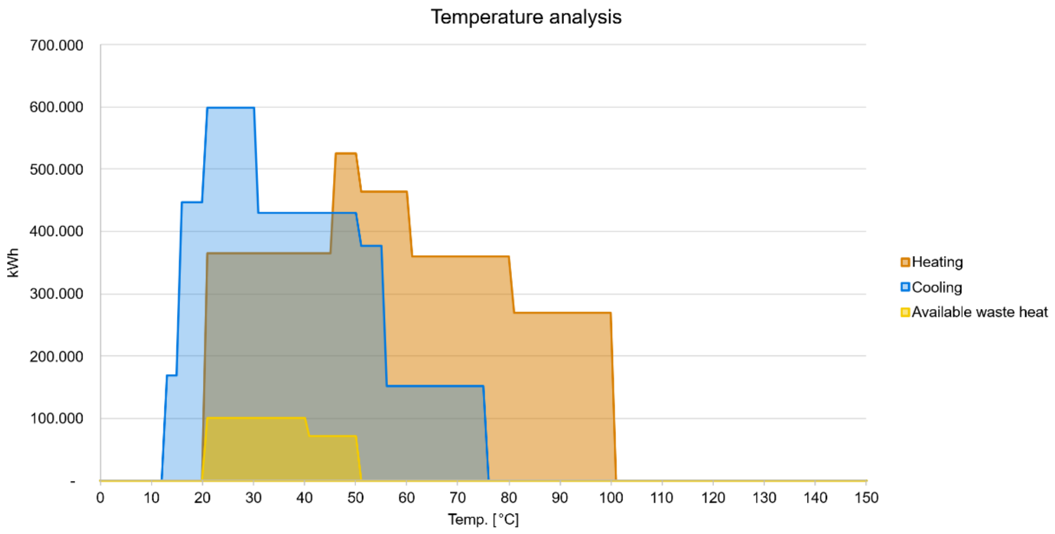


Figure 10: Example of a temperature analysis. See Excel template sheet "Result Overview".

In the example from the Excel template, it is seen that there is a high potential for implementing heat recovery between 20-75°C. Next step is to identify processes from the “Process mapping” tables with overlapping temperature requirements. In this example it can be seen that Process C for example can be matched with Process A and F:

Table 2: Potential heat recovery opportunities

Process	Temperature in [°C]	Temperature out [°C]	Energy consumption [MWh]
Process A	20	50	4.228
Process F	20	60	4.168
Process C	75	20	8.387

In terms of energy these streams almost match exactly, however, it will not be possible to cool Process C all the way to 20°C. A pinch temperature should therefore be introduced to reflect the physical limitations. Assuming a pinch temperature of 5°C, this means that process C can be cooled to 25°C and that 7.627 MWh can be recovered for heating. Cooling and heating utility will therefore still have to be used in both ends.

It should be noted that the above exercise is fully theoretical. In the real world there are many more elements to consider when analysing the heat recovery potentials such as:

- **Matching operation times**: Are the processes running at the same time or are they batch controlled? Do we need a buffer tank?
- **Geographical location**: How far away are the processes from each other? Do the potential energy savings justify the piping investments?

It is therefore necessary to make a techno-economical analysis, estimating full investment costs and calculating payback times.

Once the energy consumption has been optimized, the utility system should be evaluated. From the utility mapping sheet, it should be evaluated whether the energy losses from the equipment can be minimized or recovered. In the Excel template, it is seen that waste heat from air compressors is already utilized in a 60°C hot water system. However, no heat is recovered from the chillers. There is a possibility to install an oil cooler or de-superheater on the chillers to supply more energy to the 60°C system. A lot of heat is also lost in the condensers of the chillers which could potentially be upgraded to higher temperatures with a heat pump. For the boilers it is seen that both boilers have an estimated flue gas loss of 5%. Recovering this in an economizer should therefore also be considered.

7 Appendix

Adding additional rows in Process mapping tables

The following describes how to practically add extra rows to the Excel template. Each Process mapping table contains 100 rows of which most are left empty for the user to fill in if required. To add rows for the energy mapping the following steps should be followed:

1. Click on the “+” sign to the left of the table to open up the empty rows:

Heating consumption

	Section	Proces	Medium	Stream no	Utility system	Temp. In °C	Temp. Out °C	Mass flow t/yr	Dry matter %	Cp kJ/KgK	KPI kWh/ton	Flow approach kWh	KPI approach kWh	Measurement kWh	Total kWh	Share of total
11	Production line 1	Process A	Product	1	Steam	20	50	125.000	5,0%	4,06		4.228.440			4.228.440	14,6%
12	Production line 1	Process B	Product	2	Steam	50	100	135.000	5,0%	4,08	100,00		13.500.000		13.500.000	46,6%
13	Production line 1	Process D	Product	4	Hot water	45	50	101.250	5,0%	4,07				800.000	800.000	2,8%
14	Production line 2	Process F	Product	6	Steam	20	60	125.000	50,0%	3,00		4.168.389			4.168.389	14,4%
15	Production line 2	Heating air for Process I	Product	9.1	Steam	20	80	134.938	44,9%	3,17	40,00		5.397.500		5.397.500	18,6%
16	Support system 1	Support system 1	Water	11	Hot water	20	50	26.000	0,0%	4,18		905.667			905.667	3,1%
17										4,18					-	0,0%
18										4,18					-	0,0%
19										4,18					-	0,0%
20										4,18					-	0,0%
111		TOTAL										9.302.496	18.897.500	800.000	28.999.996	100%

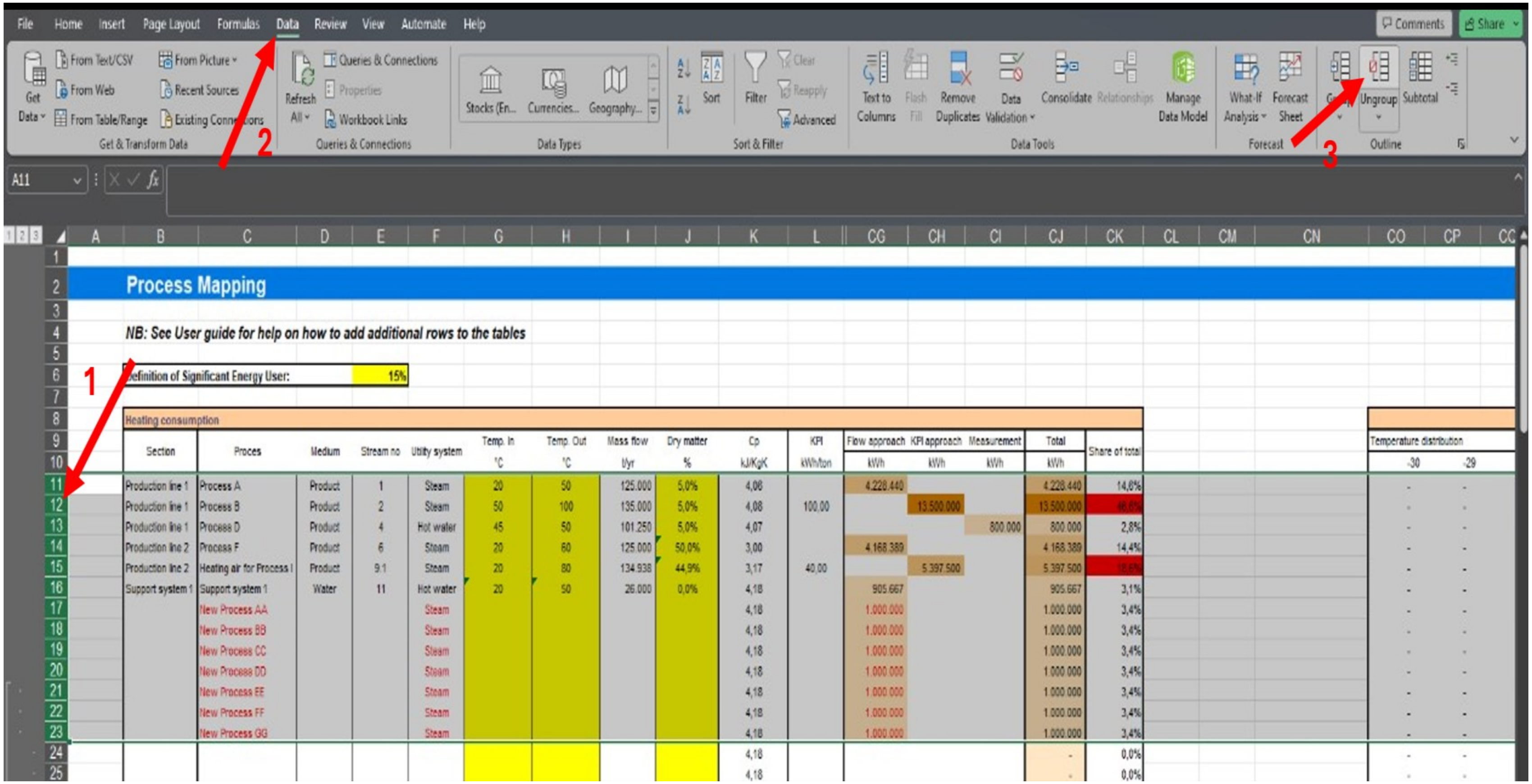
Cooling consumption

	Section	Proces	Medium	Stream no	Utility system	Temp. In °C	Temp. Out °C	Mass flow t/yr	Dry matter %	Cp kJ/KgK	KPI kWh/ton	Flow approach kWh	KPI approach kWh	Measurement kWh	Total kWh	Share of total
117	Production line 1	Process C	Product	3	Chillers	75	20	135.000	5,0%	4,07		8.386.860			8.386.860	37,7%
118	Production line 1	Process E	Product	5	Chillers	30	12	101.250	5,0%	4,05	30,00		3.037.500		3.037.500	13,6%
119	Production line 2	Process H	Product	8	Chillers	55	15	158.750	5,0%	4,06				9.000.000	9.000.000	40,4%
120	Production line 2	Process J	Product	10	Chillers	50	15	80.821	75,0%	2,35		1.845.256			1.845.256	8,3%
121										4,18					-	0,0%
122										4,18					-	0,0%
123										4,18					-	0,0%
124										4,18					-	0,0%
125										4,18					-	0,0%
126										4,18					-	0,0%
217		TOTAL										10.232.115	3.037.500	9.000.000	22.269.615	100%

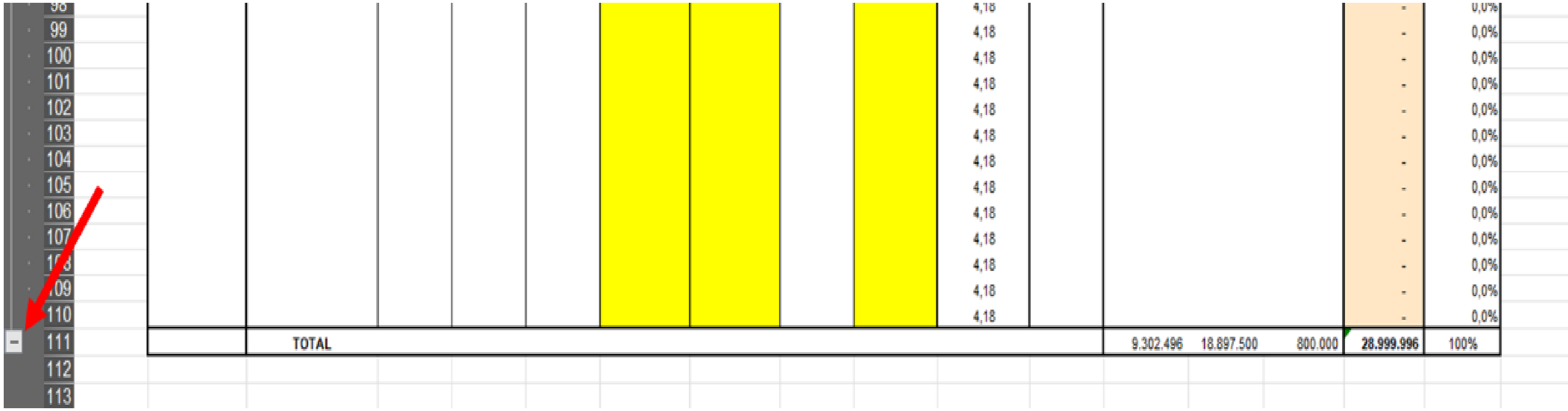
2. Add the new processes to the table:

	Heating consumption								
9	Section	Proces	Medium	Stream no	Utility system	Temp. In	Temp. Out	Mass flow	Dry matter
10						°C	°C	t/yr	%
11	Production line 1	Process A	Product	1	Steam	20	50	125.000	5,0%
12	Production line 1	Process B	Product	2	Steam	50	100	135.000	5,0%
13	Production line 1	Process D	Product	4	Hot water	45	50	101.250	5,0%
14	Production line 2	Process F	Product	6	Steam	20	60	125.000	50,0%
15	Production line 2	Heating air for Process I	Product	9.1	Steam	20	80	134.938	44,9%
16	Support system 1	Support system 1	Water	11	Hot water	20	50	26.000	0,0%
17		New Process AA							
18		New Process BB							
19		New Process CC							
20		New Process DD							
21		New Process EE							
22		New Process FF							
23		New Process GG							
24									
25									
26									
27									
28									

3. When the new processes have been added, all the rows that have been filled out are marked. From the top ribbon navigate to “Data”, and click the “Ungroup” button to the right side:



4. All the filled-out rows are now ungrouped and the remaining empty rows can be hidden again by scrolling to the bottom of the table and clicking the “-“ sign to the left:

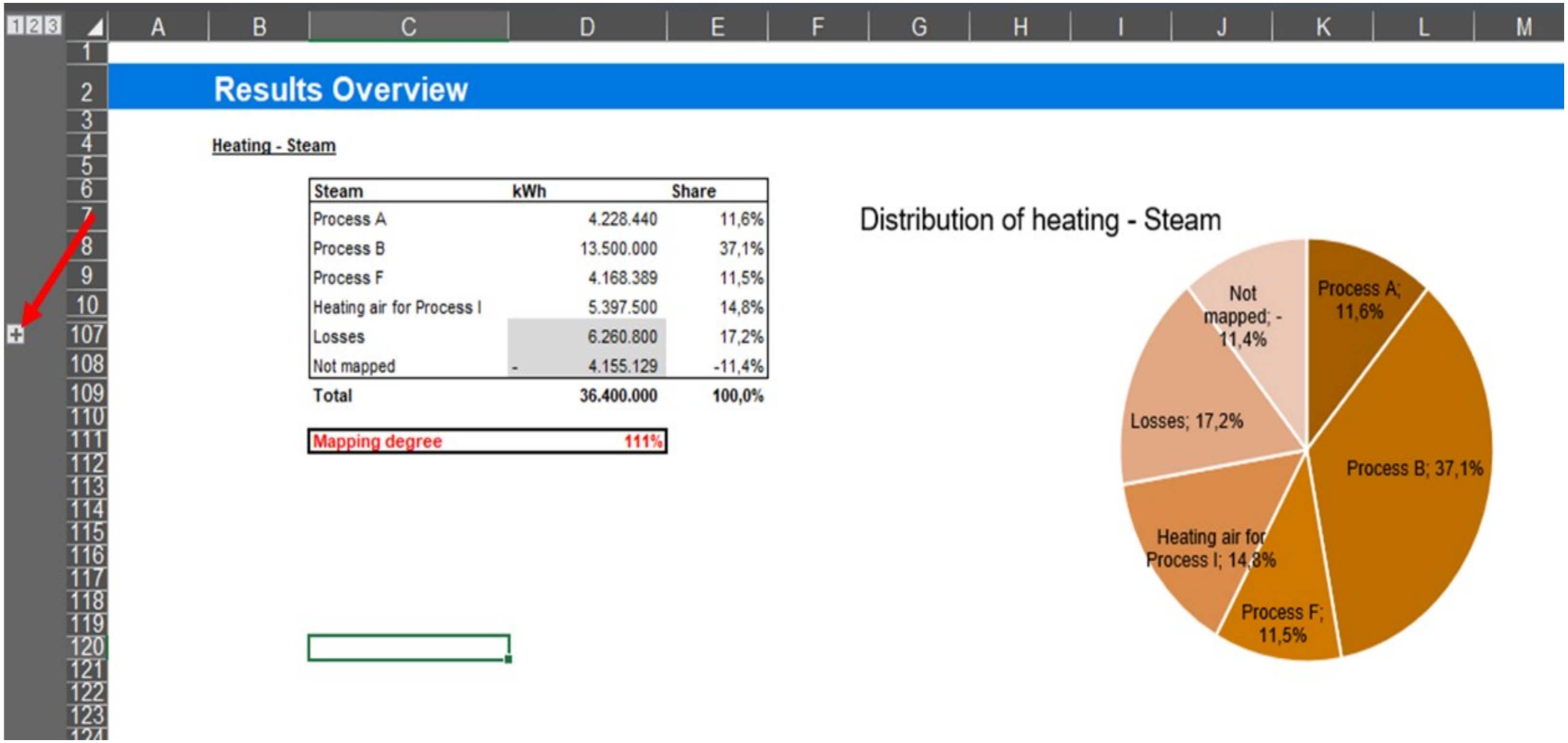


5. You are now left with a table containing all the new processes:

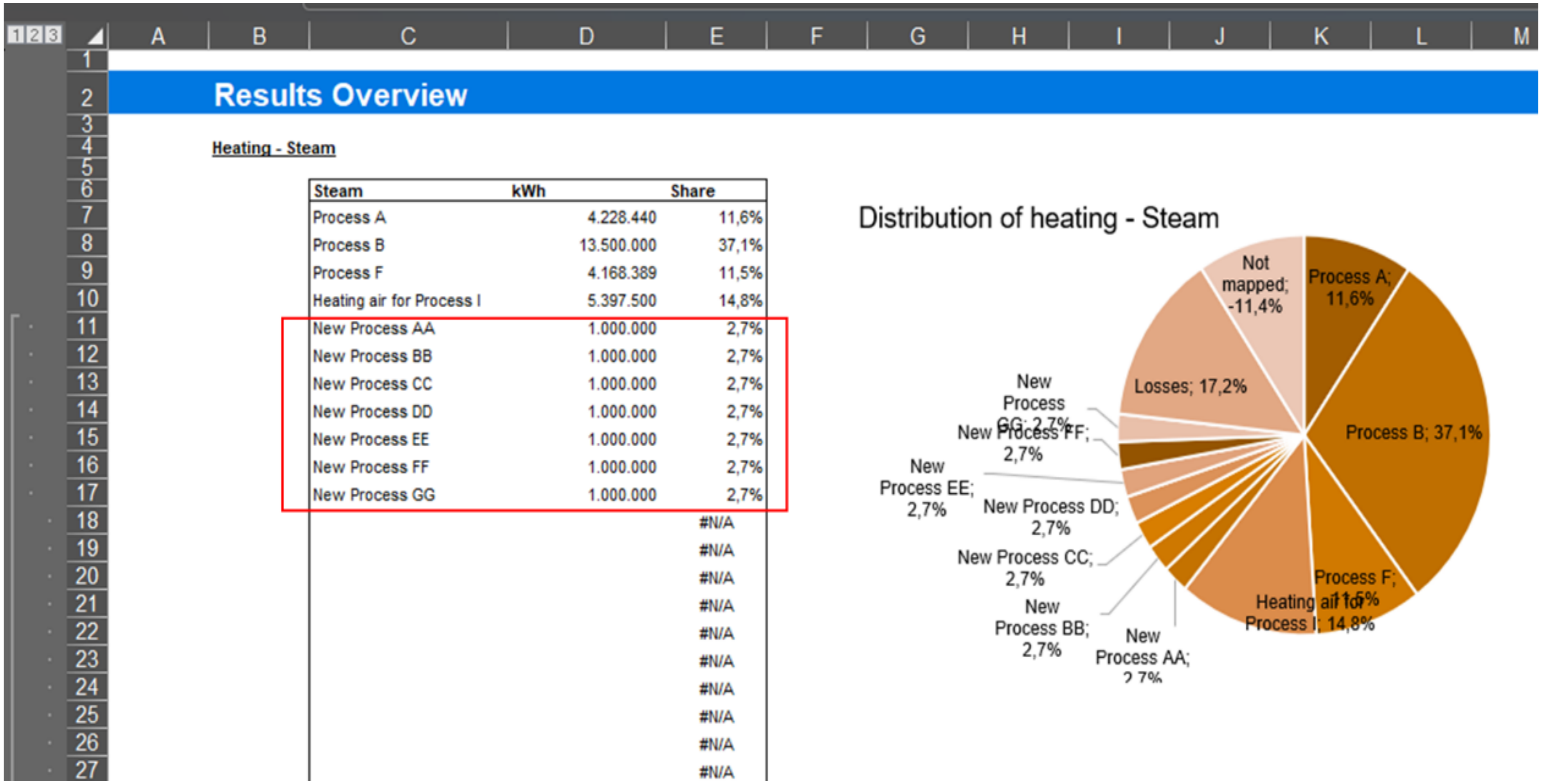
Row	Section	Proces	Medium	Stream no	Utility system	Temp. In °C	Temp. Out °C	Mass flow t/yr	Dry matter %	Cp kJ/KgK	KPI kWh/ton	Flow approach kWh	KPI approach kWh	Measurement kWh	Total kWh	Share of total
8	Heating consumption															
11	Production line 1	Process A	Product	1	Steam	20	50	125.000	5,0%	4,06		4.228.440			4.228.440	14,6%
12	Production line 1	Process B	Product	2	Steam	50	100	135.000	5,0%	4,08	100,00		13.500.000		13.500.000	46,6%
13	Production line 1	Process D	Product	4	Hot water	45	50	101.250	5,0%	4,07				800.000	800.000	2,8%
14	Production line 2	Process F	Product	6	Steam	20	60	125.000	50,0%	3,00		4.168.389			4.168.389	14,4%
15	Production line 2	Heating air for Process I	Product	9.1	Steam	20	80	134.938	44,9%	3,17	40,00		5.397.500		5.397.500	18,6%
16	Support system 1	Support system 1	Water	11	Hot water	20	50	26.000	0,0%	4,18		905.667			905.667	3,1%
17		New Process AA			Steam					4,18		1.000.000			1.000.000	3,4%
18		New Process BB			Steam					4,18		1.000.000			1.000.000	3,4%
19		New Process CC			Steam					4,18		1.000.000			1.000.000	3,4%
20		New Process DD			Steam					4,18		1.000.000			1.000.000	3,4%
21		New Process EE			Steam					4,18		1.000.000			1.000.000	3,4%
22		New Process FF			Steam					4,18		1.000.000			1.000.000	3,4%
23		New Process GG			Steam					4,18		1.000.000			1.000.000	3,4%
111		TOTAL										9.302.496	18.897.500	800.000	28.999.996	100%
112																

Next, the same procedure should be carried out in the “Result Overview” sheet. The formulas in the tables update automatically, but to make the plots show the correct values the new processes have to be unhidden.

1. Click on the “+” sign to the left of the table to open up the empty rows:



2. Scroll up to the top of the table and check that the new processes have been imported correctly:



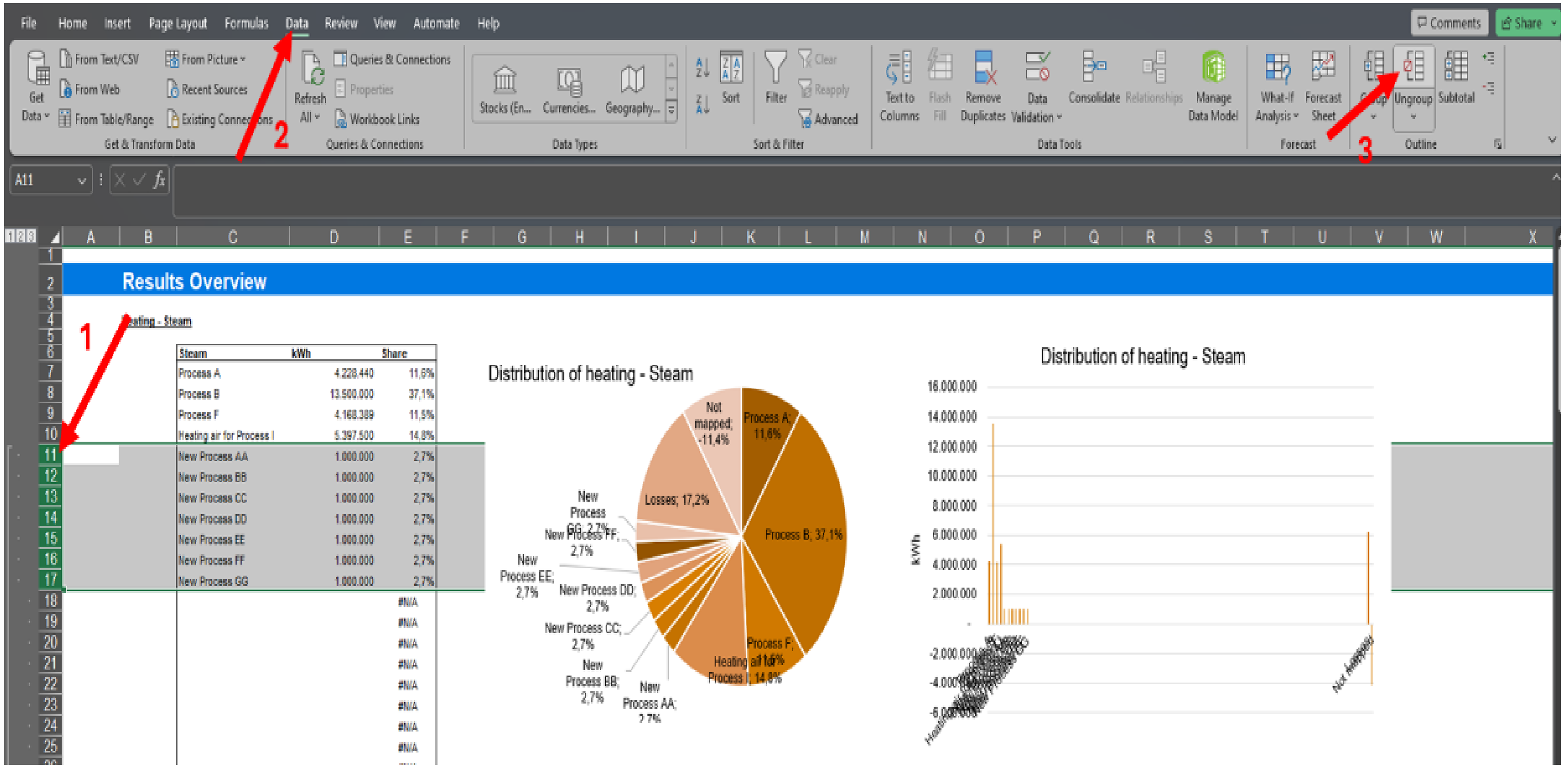
Results Overview

Heating - Steam

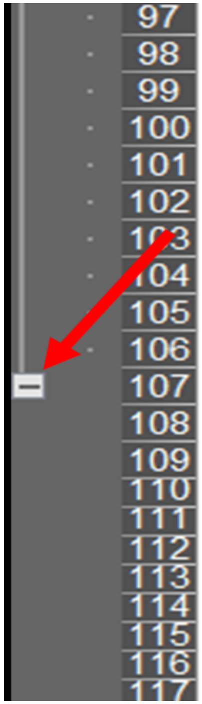
Steam	kWh	Share
Process A	4.228.440	11,6%
Process B	13.500.000	37,1%
Process F	4.168.389	11,5%
Heating air for Process I	5.397.500	14,8%
New Process AA	1.000.000	2,7%
New Process BB	1.000.000	2,7%
New Process CC	1.000.000	2,7%
New Process DD	1.000.000	2,7%
New Process EE	1.000.000	2,7%
New Process FF	1.000.000	2,7%
New Process GG	1.000.000	2,7%
		#N/A
		#N/A
		#N/A
		#N/A
		#N/A
		#N/A
		#N/A
		#N/A
		#N/A
		#N/A

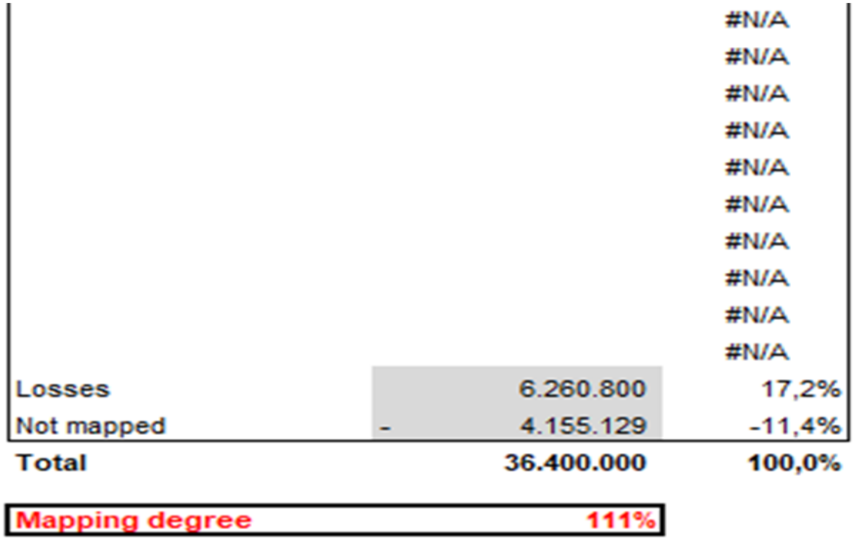
3. Similar as for the process mapping – mark all the new process rows. From the top ribbon navigate to “Data”, and click the “Ungroup” button to the right side.

(NB: The bar chart will show all the unhidden empty cells during this step, but will become normal once the empty cells are hidden again.)



4. All the filled-out rows are now ungrouped and the remaining empty rows can be hidden again by scrolling to the bottom of the table and clicking the “-“ sign to the left:





		#N/A
		#N/A
		#N/A
		#N/A
		#N/A
		#N/A
		#N/A
		#N/A
		#N/A
		#N/A
Losses	6.260.800	17,2%
Not mapped	- 4.155.129	-11,4%
Total	**36.400.000**	**100,0%**
Mapping degree	111%	

5. You are now left with a table containing all the new processes. This can be repeated for the remaining utility systems where processes have been added to the tables.

Results Overview

Heating - Steam

Steam	kWh	Share
Process A	4.228.440	11,6%
Process B	13.500.000	37,1%
Process F	4.168.389	11,5%
Heating air for Process I	5.397.500	14,8%
New Process AA	1.000.000	2,7%
New Process BB	1.000.000	2,7%
New Process CC	1.000.000	2,7%
New Process DD	1.000.000	2,7%
New Process EE	1.000.000	2,7%
New Process FF	1.000.000	2,7%
New Process GG	1.000.000	2,7%
Losses	6.260.800	17,2%
Not mapped	- 4.155.129	-11,4%
Total	36.400.000	100,0%

Mapping degree	111%