

## Step 1.4: Bakery MFCA exercise

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### **Environmental and Material Flow Cost Accounting - Case Study of a Guglhupf Bakery**

The Guglhupf Bakery case study illustrates the main steps for setting up an input-output mass balance, estimating the loss percentages for non-product output (NPO), forming the initial process flow chart, and understanding the structure of the environmental cost assessment template. It is not intended to replace an oral presentation on the principles Material Flow Cost Accounting (MFCA), but is designed as an exercise after the lecture on definitions and the general methodology. The data is based on experiences with several bakeries, but is not a real case study, as several cost items were included for demonstration purposes. As such, the distribution of costs by cost categories cannot be used as a benchmark for further analysis.

The intention when developing the case study was to use an example of a technical process that would be understood by people all over the world with little knowledge in accounting or engineering. Baking a cake is a production process that is commonly understood. Guglhupf, which is the name of a famous Austrian cake, was chosen as a good demonstration of this task.

The starting point of any assessment should be the list of accounts or trial balance of the previous business year, as several data and inventory changes are often recorded only annually.

#### ***Input-Output balance on the company level***

##### Step 1:

Think about your favourite cake! Do you know the recipe? List the inputs and outputs (no values, just the types of inputs and outputs) of a company that produces your favourite cake, e.g. Guglhupf for Austria.

##### Step 2:

Use the assessment sheet, shown in table 1, to record your inputs, and outputs for the bakery as a whole (company system boundary).

In this assessment, it is important to stick to the system boundary of the legal unit for the first assessment and work with proper accounting information and not try to do the first assessment for a smaller system boundary, like a production line only.

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<b>INPUTS</b>	<b>OUTPUTS</b>
<b>Raw materials</b>	<b>Products</b>
	<b>By-products</b>
	<b>Waste</b>
	<i>Waste for recycling</i>
<b>Auxiliary materials</b>	
	<i>Non hazardous waste</i>
<b>Packaging</b>	
	<i>Hazardous waste</i>
<b>Operating materials</b>	
	<b>Waste water</b>
<b>Energy</b>	<b>Air emissions</b>
<b>Water</b>	

**Table 1: Input-output assessment sheet**

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### Step 3:

Compare your listings to the case study in table 2. Remember, that there are several possible answers, as companies are different.

Remember that auxiliary materials become part of the product, but by definition operating materials are not part of the product.

For packaging, it is necessary to distinguish between the packaging of the input materials and the packaging materials used for the product. Packaging of input materials becomes waste on site or can be returned to the supplier. If, when the inputs are weighed, the packaging is part of the weight, then it is normally not recorded separately under inputs. Packaging for our product is recorded on the input side. In many countries, there is good data available in companies on product packaging since it is subject to a license fee.

Materials which are used several times in a loop system, e.g. refilled glass bottles or pallets, the amounts purchased to replace discarded amounts are recorded, with the amount purchased in the year used for the MFCA assessment as an input, as it is assumed that this input will be identical to the discarded amounts on the output side.

Equipment and machines which are used over several years are normally not included in the mass balance. In our case, this could be the refrigerator for the raw materials, the mixer, and the baking oven. When they become output, it is often recorded on a separate line (e.g. waste from disposal due to reconstruction). Tax accounting laws often stipulate a certain threshold, e.g. 400 Euros, to distinguish between equipment that can be expensed in the first year (e.g. small tools) and would thus appear as an input for MFCA, or equipment at higher value and in use for several years, which has to be depreciated over their expected life time.

In general, cake bakeries do not produce by-products. However, potential by-products include selling any excess waste heat from the baking room. Use of the eggshells in gardening, or of the cake crumbs as bird feed are instead examples of recycling because the company is not able to sell them. The borderline between a by-product and a waste for recycling is vague and depends on market prices. By definition, by-products generate earnings, while waste goes to a recycling or disposal or free of charge.

**Question:** What is the difference between materials purchased and materials used for production in accounting? Which ones should be recorded in the mass balance?

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INPUT	Amount in kilogramm	Amount in money	OUTPUT	Amount in kilogramm
<b>Raw materials</b>			<b>Products</b>	
Flour			Cakes	
Sugar				
Eggs			<b>By-products</b>	
Butter			Excess heat	
Rasins				
Nuts			<b>Waste</b>	
Lemons			<i>Waste for recycling</i>	
<b>Auxiliary materials</b>			Glass bottles (rum)	
Baking powder			Paper	
Salt			Organic waste	
Rum			Plastic	
Cocoa				
			<i>Non hazardous waste</i>	
<b>Packaging</b>			Dirt and sweepings	
Wooden boxes			Broken bowls	
Wrapping paper				
Packthread				
Labels			<i>Hazardous waste</i>	
			Broken refrigerator	
<b>Operating materials</b>			Light bulbs	
Cleaning materials				
Disinfectant			<b>Wastewater</b>	
Softening agent			Amount in m3	
Machine oil			Organic emissions	
Maintenance materials				
Buttering brush			<b>Air Emissions</b>	
(Plastic bowls, if below a certain price treshold)			CO	
(Mixer, if below a certain price treshold)			CO <sub>2</sub>	
			SO <sub>2</sub>	
<b>Energy</b>			NO <sub>x</sub>	
Electricity				
Gas			<b>Noise</b>	
			Maximum at night	
<b>Water</b>			Maximum on site	
Ground water				
Municipal water				
Rain water				

**Table 2: Input-output chart for the bakery**

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Ideally, the mass balance in volumes (kilograms) balances out to zero.

It is therefore necessary to account for materials actually used for production, not materials purchased and put in the incoming store. Materials purchased include all inputs to the site by delivery notice. However, the materials actually used for production may be significantly different due to inventory changes. Depending on the company, these materials are assessed by separate records of the materials withdrawn from stock for production, by measurements during the process stages, or by simply recording inventory losses. For the mass balance, ideally the materials used for production should be used as these are related to actual production. The materials lost from stock should be recorded in a separate line, if data is available, as the measures needed to reduce these amounts are different from solutions addressing the material losses from the technical processes (material deterioration, spoilage and sometimes even theft, instead of losses and scrap).

Water and energy should be listed but not aggregated. The water and energy balance are calculated separately, if needed.

The total annual amounts of money spent for materials used for production and volumes available should be listed in the first assessment. The mass balance can become tricky when there are several processes involving water. The goal is not to be perfect in the initial assessment, but to gain an understanding of the dimensions of material flows and the quality of the existing information system that records them. It is therefore important to make sure that the data entered is consistently recorded in kilograms, not in pieces, m<sup>2</sup>, bottles and other units that do not allow for aggregation.

A very common recommendation for improving the information system relates to the opening of new accounts for the different material inputs and a clear definition which material numbers are to be posted to which accounts in order to make aggregation possible.

Another common recommendation is the purchase of a scale for the incoming store, to allow calculating actual consumption, to recalculate units in to kilograms and to monitor maximum shelf weight, which is a legal requirement in many countries.

The monetary values for treating the output, e.g. the costs for disposal, are not recorded in the mass balance input-output scheme, but in a separate page of the excel sheet related to the MFCA cost assessment. This explains why there is no column for the amount in money for the output side. The excel file will be explained in depth later.

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### Step 4:

Estimate the percentages for product output (PO) and non-product output (NPO) for all the inputs to the bakery.

INPUT	Product output in %	NPO in %
Raw materials		
Auxiliary materials		
Packaging		
Operating materials		
Energy		
Water		

**Table 3: Estimation of the share of product and non product output**

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### Step 5:

Compare your result with the suggested solution.

INPUT	Non-product output in percentage
<b>Raw materials</b>	
	If no data is available, it may be reasonable to estimate a total NPO percentage for all raw materials together, e.g. at 5%. Data recording, information systems and quality management for the main inputs and processes should then be gradually improved.
<b>Auxiliary materials</b>	The people responsible for production often have good estimates. For auxiliary materials, the loss percentage normally is lower than for raw materials, e.g. 1% for the bakery, and perhaps 2% for the rum, as a lot remains in the glass bowl together with the raisins.
<b>Packaging</b>	Experience says 1-5% as long as you do not have better data.
<b>Operating materials</b>	Per definition 100% NPO
<b>Energy</b>	Per definition 100% NPO
<b>Water</b>	Depending on product and processes, 100% NPO for the bakery

**Table 4: Input-output assessment sheet – divided into product output and NPO**

### ***Production steps and supporting processes***

#### Step 6:

Develop a production flow chart for the bakery. Define the typical processes and separate them into the main steps used for production and additional supporting processes. Main process steps are those directly related with the cake production, e.g. mixing the raw materials, beating the egg whites or baking in the oven. Supportive processes are not directly related with the cake baking, e.g. logistics, marketing, administration, wastewater treatment. Consider the related material inputs and outputs and production facilities, which could be installed as cost centres in larger organisations.

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INPUT	Main process steps/cost centres	Additional supportive processes or cost centers	OUTPUT

*Table 5: Assessment sheet for the process flow chart*



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### Step 7:

Compare your results with the proposed solution.

INPUT	Main process	Additional processes	OUTPUT
Materials purchased		Incoming store	Materials used for production
Electricity Cooling agent		Refrigeration	Air emissions
Materials used for production	Preparation of materials		Packaging waste of input materials
Egg white Electricity	Beating the egg white		Beaten egg white Dirty bowl
Egg yolks, flour, sugar, etc. Electricity	Mixer		Cake dough Dirty bowl Organic waste
Oil for the baking pan	Baking pan filling station		Cake ready for oven Dirty bowls
Gas	Oven		Baked cake CO <sub>2</sub> , NO <sub>x</sub> emissions Waste Heat
Dirty bowls and pans Cleaning agents Water		Cleaning room	Clean bowls Wastewater
Packaging Materials electriciy		Packaging room	Packed cake Non hazardous waste
Chemicals Cake for testing		Quality assessment	Hazardous waste Organic waste
Electricity Marketing and office materials		Sales room	Non hazardous waste CO <sub>2</sub> emissions
Maintenance materials and tools		Maintenance	Non hazardous waste Hazardous waste
Electricity Wood pellets Gas		Energy Management  Energy conversion with combined block and steam production as well as the compressed air system for cooling	Fossil and biogenic CO <sub>2</sub>
Wastewater from production processes		Waste and wastewater management  Wastewater treatment plant	Pretreated water to municipality
Waste from the different production steps/cost centres		Waste collection centre	Waste to licensed supplier
Office materials		Administration	Waste
		etc.	

**Table 6: Process flow chart for the bakery**

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### ***Working with the excel file***

The Excel file for the MFCA Excel tool consists of the following sheets:

- I/O balance
- Process flow chart
- NPOs Cost Breakdown
- NPOs Cost Summary

For an assessment, information is first added to the sheet “I/O Balance”. Use Tables 2, 3 and 4 to do this. All the cost categories are already set. Once the total annual costs have been recorded in Column G of the sheet “I-O Balance”, these will transfer automatically to column B in the sheet “NPO cost detail”. The columns “source of information” in the “I/O Balance” sheet is intended to ensure the same cost centres and accounts are used in the following years without having to spend a lot of time finding them again. It is also practical to document the type of calculation used to acquire a certain figure.

It is recommended to directly record recommendations for improvement and additional comments (e.g. in column I of the worksheet “I/O Balance”).

The development of an easy process flow chart, separated into main and additional processes, as described above, is the next step. Use Table 6 for this.

From there, a distribution of total NPO costs can be done to the different process steps (the core of material flow cost accounting). Likewise, if available, the NPOs in volumes can be distributed to production steps.

The sheet “NPOs cost breakdown” includes a control function, which ensures that the value in the *costs in €* column is identical to that in *sum*. An error will result if this is not the case. The values are only identical if all costs in the *costs in €* column are assigned to a medium.

The columns in the sheet for “NPOs Cost Breakdown” for the production steps can be modified directly in the sheet or inserted into a separate sheet for the process steps and linked.

The sum of the costs of all the categories in the “NPOs Cost Breakdown” worksheet is automatically transferred to the “NPOs Cost Summary” worksheet in order to provide an overview and a better presentation layout.

In general, it is possible to add lines into the sheets. But please note: If columns or rows are added or deleted, then the same needs to be done for the other sheets, if information is linked.

The worksheet “I-O Balance”, done on the company system level, allows the definition of the priority flows, while the worksheet “NPOs Cost Breakdown”, with the distribution of costs to process steps and cost centres, allows the definition of focus areas for further investigation.