Environmental and Material Flow Cost Accounting

Case Study of a Guglhupf Bakery

This case study shows the main steps in the assessment of an input-output mass balance, how to estimate loss percentages for non-product output, how to put together an initial process flow chart, and the structure of the environmental cost assessment template. It is not intended to replace an oral presentation, but designed as an exercise during a lecture for students in the 3rd to 6th semester who still have little experience with accounting and technical production processes.

Materials balance

Step 1:

List the inputs and outputs (no values, just the types) of a company that produces cakes (Guglhupf).

Step 2:

Use the assessment sheet (table 1) to record your inputs and outputs and consider additional ones.

INPUT	OUTPUT
Raw materials	**Products**
	By-products
Auxiliary materials	
	Waste
	Waste for recycling
Packaging	
	Municipal waste
Operating materials	*Hazardous waste*
	Waste water
	Air emissions
	CO
Energy	CO_2
	SO_2
	NO_x
	Noise
	Maximum during night
Water	Maximum on site

Table 1: Input-output assessment sheet

Step 3:

Compare your data to the case study. 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 input materials and packaging materials for the product. The former becomes waste on site or can be returned to the supplier and is normally not recorded separately under inputs. The latter is recorded on the input side.

Permanent equipment that has been in use for several years is normally not included in the mass balance. In our case, this would 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).

As a rule, cake bakeries do not produce by-products, that is products sold that are not the main scope of business. But one could imagine selling the excess capacity of the solar power plant and the waste heat from the baking room.

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

INPUT	Amount in kilogramm	Amount in euro	OUTPUT	Amount in kilogramm
Raw materials			**Products**	
Flour			Cakes	
Sugar				
Eggs			**By-products**	
Butter			Excess heat	
Rasins				
Nuts			**Waste**	
Lemons			*Waste for recycling*	
Auxiliary materials			Glas bottles (rum)	
Baking powder			Paper	
Salt			Organic waste	
Rum			Plastic	
Cocoa				
			Solid waste	
Packaging			Dirt and sweepings	
Wooden boxes			Broken bowls	
Wrapping paper				
Packthread				
Labels			*Hazardous waste*	
			Broken refrigerator	
Operating materials				
Cleaning materials				
Desinfectant			**Waste water**	
Softening agent			Amount in m3	
Maschine oil			Organic emissions	
Baking pan				
Buttering brush			**Air Emissions**	
Plastic bowls			CO	
Mixer			CO_2	
			SO_2	
Energy			NO_x	
Electricity				
Gas			**Noise**	
			Maximum at night	
Water			Maximum on site	
Ground wasser				
Municipal water				
Rain wasser				

Table 2: Input-output chart for the bakery

Ideally, the mass balance comes out to zero. Water and energy should be only listed, not aggregated. The mass balance can become tricky when there are several processes involving water. But 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 most important to make sure that the data entered is consistently recorded in kilograms, not in pieces, m2, bottles and other units that don't allow for aggregation.

Common recommendations for improving information systems include the opening of new accounts for the different material inputs and clearly defining which material numbers are to be posted to which accounts to make aggregation possible.

The 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 are related to actual production. The materials lost from stock should be recorded separately, as the measures needed to reduce these amounts are different from the material used during the technical processes (material deterioration, spoilage and sometimes theft, instead of leakages and scrap).

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 percent
Raw materials	
Auxiliary materials	
Packaging	
Operating materials	
Energy	
Water	

Table 3: Estimating non-product output

Step 5: Compare your result with the suggested solution.

INPUT	Non-product output in percentage
Raw materials	
	If no data is available, it may be reasonable to estimate total NPO percentage for all raw materials for the initial assessment, e.g. at 5%. Information systems and quality management for the main inputs and processes should then be gradually improved.
Auxiliary materials	The people responsible for production can often offer good estimates. For auxiliary materials the loss percentage normally is lower, e.g. 1% for the bakery, and perhaps 2% for the rum, as a lot remains in the glass bowl with the raisins.
Packaging	Experience says 1-5% as long as we don't have better data.
Operating materials	Per defininition 100% NPO
Energy	Per defininition 100% NPO
Water	Depending on product and processes, 100% NPO for the bakery

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

Step 6: Develop a production flow chart for the bakery: What are the typical processes, separated into the main steps for production and additional processes? Consider the related material inputs and outputs and production facilities, which could be installed as cost centres in larger organisations.

INPUT	Main process steps	Additional processes	OUTPUT

Table 5: Assessment sheet for process flow chart

Step 7: Compare your results with the proposed solution.

INPUT	Main process	Additional processes	OUTPUT
Materials purchased	Incoming stores		Materials used for production
Electricity Cooling agent	Refrigerator		Air emissions
Materials used for production	Preparation of materials and tools		Packaging waste of input materials
Egg white Electricity	Beating the egg white		Beaten egg white Dirty bowl
Egg yolks, flour, sugar, etc.	Mixer		Cake dough
Electricity			Packaging waste of input materials Dirty bowls
			Organic waste
Oil for the baking pan Gas	Baking pan filling station Oven		Cake ready for oven Dirty bowls Baked cake Dirty pan
Dirty bowls and pans Cleaning agents Water Cake Packaging materials	Cleaning room Packaging room	 Quality assessment	Clean bowls and pans Waste water Organic waste Packaged cake
Electricity	Sales room		Solid waste
 Electricity Wood pellets, gas		Energy Management, comprising Energy conversion with combined block and steam production as well as the compressed air system for cooling	 Fossil and biogenic sediment, CO2
Waste water from production processes Solid waste from the different production steps/cost centres		Waste water treatment plant Waste collection centre	Pretreated water to municipality Waste to licensed supplier
Office materials		Administration	Waste
		etc.	

Table 6: Process flow chart for the bakery

Environmental Costs

The IFAC environmental cost assessment scheme was transferred into an Excel file that is available for download at **www.ioew.at/ioew/index.html** under “Publications”.

The Excel file for the environmental cost assessment consists of three sheets – *detail, sum, and structure*. Information is only added to the *detail* sheet. All the cost categories are already set. The environmental media can be modified if necessary. Please note: If columns are added or deleted, then the same needs to be done for the other two sheets.

For costs that are incurred for equipment (1.1), it is practical to simultaneously collect data on maintenance (1.2), personnel (1.3), and material costs (3.1-3.5). All collected data should be assigned to the correct environmental medium.

The *accounts* column is intended to ensure the same cost centres and accounts are used for years to come 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 possible to add lines into the sheet, just ensure that the automatic excel calculations are maintained.

The sheet 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 sum of the costs of all the categories in the *detail* sheet is transferred to the *sum* sheet to provide an overview and a better presentation layout. The *structure* sheet merely calculates the costs in percentages to show the most relevant environmental costs.

Environmental media / Environmental cost categories	Air and climate	Waste water	Waste	Soil and ground water	Noise and vibration	Biodiversity and landscaping	Radiation	Other purpose	Total
1a. Material costs of products									
1.1. Raw materials									37.2%
1.2. Auxiliary materials									1.8%
1.3. Packaging materials									8.3%
1.4. Operating materials									4.4%
1.5. Water									7.4%
1.6. Energy									26.0%
1.7. Production costs of NPO									14.9%
Total material costs of products									**100.0%**
1. Material costs of non-product-output	**21.9%**	**3.5%**	**20.3%**						**45.7%**
1.1. Raw materials 5% NPO		2.5%							2.5%
1.2. Auxiliary Materials 1-2% NPO		0.0%							0.0%
1.3. Packaging materials			0.1%						0.1%
1.4. Operating materials	0.6%	1.0%	1.9%						3.6%
1.5. Water			6.1%						6.1%
1.6. Energy	21.3%								21.3%
1.7. Production costs of NPO			12.2%						12.2%
2. Waste and emission treatment costs		**7.9%**	**14.6%**	**9.1%**	**7.3%**	**1.8%**			**40.7%**
2.1. Depreciation		0.6%	1.8%		1.2%				3.6%
2.2. Operating materials									
2.3. Water and energy									
2.4. Internal personal costs		4.9%	9.1%						14.0%
2.5. External services		1.2%		3.0%	6.1%				10.3%
2.6. Taxes, fees and permits		1.2%	3.6%						4.9%
2.7. Penalties				6.1%					6.1%
2.8. Insurance									
2.9. Clean up and compensation						1.8%			1.8%
3. Prevention and other environmental management costs	**1.4%**				**0.3%**			**13.1%**	**14.8%**
3.1. Depreciation	1.2%				0.3%				1.5%
3.2. Operating materials, water and energy									
3.3. Internal personnel								7.9%	7.9%

costs									
3.4. External services								4.9%	4.9%
3.5. Other costs	0.2%							0.3%	0.5%
4. Research and development costs	**6.1%**								**6.1%**
Total environment-related costs (1. + 2. + 3. + 4.)	**29.4%**	**11.4%**	**34.9%**	**9.1%**	**7.6%**	**1.8%**		**13.1%**	**107.3%**
6. Environmental earnings									
6.1. Other earnings									
6.2. Subsidies and investment grants	-3.0%							-4.3%	-7.3%
Total environment-related earnings	**-3.0%**							**-4.3%**	**-7.3%**
Total environment-related costs minus earnings	**26.3%**	**11.4%**	**34.9%**	**9.1%**	**7.6%**	**1.8%**		**8.8%**	**100.0%**

Table 7: Environmental costs percentage distribution