The Happy Beer Factory

Exercise 1: Identifying inputs and outputs at company system boundary

The Happy Beer Factory has started a RECP assessment with support from external advisors. A first meeting to identify input and output resource flows at the company was held with the RECP company team. The team consists of the operation manager (team leader), the production chief, an accounting officer, the warehouse manager, and the quality system manager. During the meeting, the process flow was outlined, identifying resources going in and out by significant process steps, which will be confirmed after a more detailed walkthrough by the advisors. Then, all materials and energy sources were identified at the company system boundary as the current company's information system currently records them. Team members from production, accounting, and warehouse areas were requested to bring to the meeting information on records and invoices for the last year. When necessary, some information was collected in each office. The team concluded on the following process overview and provided the following data (all data are collected for one year period)

Production process (major steps)
(Using tab 3 of RT2-Data collection template)

Inputs	Operations (production process sequence)	Outputs	Remarks
Malt	Brewing malt and mills (Grinding, Mashing and Purification)	Spent grains	
Brewing Water		Dust	
Cleaning agents		Heat	
Energy		Waste water	All wastewater stream to the treatment plant
Hop	Preparation of Wort (boiling and cool down)	Hops waste	
Water		Brewing residue (spent grains)	
Cleaning agents, detergents		Heat	
Energy		Wastewater	
Refrigerants			
Yeast	Fermentation/Maduration	yeast surplus	
Sterile Air		Wasted beer	
CO2			
Refrigerant		Carbon dioxide	
Water		wastewater	
Energy			
Water,	Filtration (Separation of yeast and proteins)	Wastewater	
Energy,		Filtrate	
Carbonic Acid,		Auxiliary materials	
Cleaning agents,		Carbon dioxide	
Disinfectants,			
Refrigerant, Auxiliary materials			
Water,	Botteling and barrel filling	Wastewater	
Energy		Sludge	
Carbonic Acid,		Solid waste	
Cleaning agents		Heat	
Desinfectants		Residue	
Packaging materials (bottles, labels, caps, trays)		Bottled wasted beer	

Inputs:

The accounting department indicates the following costs as recorded in different accounts for the last year. Amounts have been obtained from the resource planning system that is held by the production and maintenance areas.

Resource	EUR	Account number	Amount (ton)
Malt	1000,000	5100	4,000
Hop	120,000	5101	500
Burst rice	120,200	5102	200
Auxiliary materials	12,150	5110	100
CO2 purchase	100,000	5111	--
Bottle beer caps	80,000	5301	--
Labels	100,00	5310	--
Label glue	15,000	5330	--
Beer plastic boxes (only new purchase to replace damaged boxes[1])	30,000	5320	--
6-Bottle trays	160,000	5340	--
Bottles	45,000	5341	--
Pallets	14,200	5350	--
Cleaning agents	190,000	5400	210
Refrigerant	40,000	5401	50
Neutralization agent	35,000	5402	250
Filtering agents	20,000	5403	30
Laboratory material	20,000	5404	1
Lubricants	11,000	5405	1
Tools and maintenance supply	5,000	5500	--

For water, electricity, and fuels the following information was crosschecked with accounting department and invoices to obtain amounts:

Resource	EUR	Account number / sources	Amount
Water (from public supply in hl)	50,000	5650 /invoices	1000,000
Electricity (kWh)	275,000	5600 / invoices	2,700,000
Heating oil (extra light) in Liter	200,000	5601 / invoices	700
Fuel (in liter)	21,300	5602/invoices	300
Diesel (in liter)	200,000	5603/invoices	370,000

The company has also its own wells extracting **1300,000 hl of water annually**. This is recorded by a flow meter installed at the outlet of the water treatment system. There is no cost associated to this amount of water. Water obtained from public supply is used for cleaning, sanitation, heating and cooling processes, whilst water extracted from company's wells is treated for beer production.

[1] Boxes are returnable from customer points.

Based on the experience of the production and quality system managers, the following known drops in production have been identified for the main inputs:

- 20 % of Malt and Hop do not become final product (estimated losses)
- 15 % of burst rice is estimated as loss
- 2% of auxiliary material is accepted as losses.
- Estimated packaging material losses:
    - 5 % of bottle caps beer
    - 7 % of labels and glue
    - 3% of beer bottles.
- Beer boxes are returnable. The input amount represents the annual replacement of damaged boxes that end up as waste. 95 % of this new purchase will end up as waste.

Outputs:

The total beer production registered is **260,000 hl** in the studied period. The total production cost is estimated at EUR 4MM, according to the finance department. Some residues are sold as by-products for external composting with agricultural purposes. The information available for the studied period is as follows:

- Brewing residue: EUR 3,500 as revenue for 280 tons reported.
- Wet draff: EUR 35,000 as revenue for 5,500 tons reported.
- 240 tons of semi-solid mineral silt is also delivered free of charge with the previous residues for agricultural composting.

The quality system manager reported the following outputs:

- Several packaging waste from the warehouse is handed over for external recycling process: 430 tons.
- Other non-hazardous waste is just disposed through the public service: 20 tons

The following hazardous waste are monitored:

- Total hazardous waste: 7 tons
- Waste oil: 0.1 tons

There were no waste management costs reported in the accounting records.

Wastewater entering the wastewater system amounts 96,200 m^3 according to the metering system. Operation costs for the wastewater treatment system are not recorded separately.

Group # 1: Use the Input/Output Analysis table (***4. I-O Analysis***) of the “RT2 - Data collection template” to organize this information and take notes on main observation and conclusions[2].

Note: By convention in material flow cost accounting standard, energy is always accounted as non-product-output cost, as well as all other materials that do not end up as finished product. In addition, all revenues figures in the output sides should be identified with negative sign.

[2] For practice purpose, density of beer will not be taken into account in this exercise to convert volume to weight. Please use the same value as water to introduce values in tons in the input and output table.

Exercise 2: Key performance indicators and benchmarking:

First, read the overview described in Exercise 1, and then continue with this section.

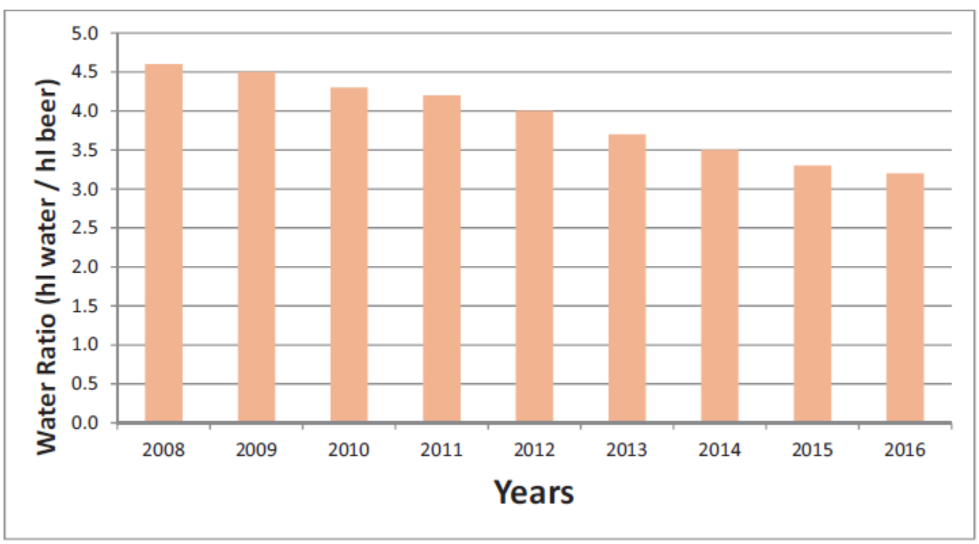
The study "*Water and Wastewater Management in the Malt Brewing Industry*"[3] classifies the brewing industry according to beer production: (1) large breweries amounts to over 6,000,000 barrels (704,087 m3) per annum, (2) medium between 15,000 to 6,000,000 barrels, and (3) small is less than 15,000 barrels (17,602 m3) per annum (Brewers Association, 2013).

The study methodology included a review of the current literature, an assessment of industry reports and a questionnaire survey undertaken among medium and small breweries. The following indicators are extracted from this study to compare performance and identify overall potential for resource efficiency in the Happy Beer Factory.

Water consumption

In the brewing industry, water is used for beer production and for cleaning, sanitation, heating and cooling processes. The malt brewing industry is classified under the food and beverage category and generates three forms of waste streams, namely: solid waste (from raw material inputs and packaging), liquid waste (wastewater from various processes) and gaseous waste. The two dominant waste streams that influence wastewater generation management are solids and liquids.

The next figure shows that the water efficiency in beer production improved between 2008 and 2013, **from 4.6 hl water/hl beer in 2008 to 3.7 hl water/hl beer in 2013**. From 2014 to 2016 the breweries managed to reduce water consumption from **3.5 hl water/hl beer to 3.2 hl water/hl beer**. This figures where achieved because breweries employ new processes and they changed their behavior to reduce water consumption whilst achieving the same high quality of product.



[3] Source: "Water and Wastewater Management in the Malt Brewing Industry". Water Resources Competency Area, Natural Resources and the Environment, CSIR, Pretoria, South Africa. 2016.

Solid waste generation

Table 6 Typical breakdown of solid waste for medium scale breweries

Solid Waste	Range	Measurement unit
Spent grains	440-1080	kg per brew
Surplus yeast	96-288	kg per brew
Kieselguhr (Diatomaceous earth)	3.2-72	kg per brew

* A single brew ranges between 2000 litres to 3000 litres.

Energy consumption[4]:

The brewing industry utilizes energy in different processes, and uses considered include: heating, cooling, packaging, and transportation of materials and products in the plants.

Table 7
Energy and water consumption.

Outputs per unit of product	Unit	Benchmark
Energy[a]		
Heat	MJ/hL	85–120
Electricity	kWh/hL	7.5–11.5
Total Energy	MJ/hL	100–160
Water[a]		
Water consumption		4–7

[a] Input and output figures for large German breweries (capacity over 1 million hL beer). Source: EC, 2006.

Group # 2:

Use tab ***5. KPI*** of the **"RT2 - Data collection template"** to identify the key performance indicators that can be relevant for this company.

- List the indicators needed and identify the measurements units - columns A and B
- Calculate those for which the information is available from the overview provided in Exercise 1 – column C.
- Select the benchmarking indicator that can be used – columns D and E
- Identify % of potential improvement based on comparing current KPI and benchmarking indicators – Column F.

[4] Source: Journal of Cleaner Production (2012) "The brewing industry and environmental challenges". Abass A. Olajire. Industrial and Environmental Chemistry Unit, Department of Pure and Applied Chemistry, Ladoke Akintola University of Technology, Ogbomoso, Oyo, Nigeria.