TEST case study

Water and beverages company

Developed under the framework of Med TEST II

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

switchmed

The SwitchMed Programme is funded by the European Union

Water and beverages company

SECTOR	Agri-foodstuffs
SUBSECTOR	Water and beverages
SIZE	400 employees
PRODUCTS	Mineral water, flavoured mineral water and soda packaged in glass and PET containers of various sizes
MARKET	Local, national
CERTIFIED MANAGEMENT SYSTEMS	ISO 22000 in process

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Company key data

Reason to join TEST project

Aware of the pureness and health benefits of its naturally sparkling spring water, the company has committed to efficient resource management to sustainably protect its water, from the source to the consumer.

YEAR 2016	Unit	Value
Production	litres/year	88,000,000
Electricity consumption	kWh/year	10,048,791
Gas consumption	m^3/year	2,304,587
Gas oil consumption	kg/year	527,850
Water consumption	m^3/year	148,000
CO_2 emissions	tonnes/year	16,746
BOD5	kg/year	7,320
COD	kg/year	31,980
Total cost of sales	€/year	7,532,457
Total cost of inputs (purchase value of raw materials, auxiliary materials, packaging energy and water)	€/year	4,160,819
	% vs. cost of sales	55.2
Estimated non-product output	€/year	545,989
	% vs. cost of sales	7.25

Process overview/flowchart

INPUTS

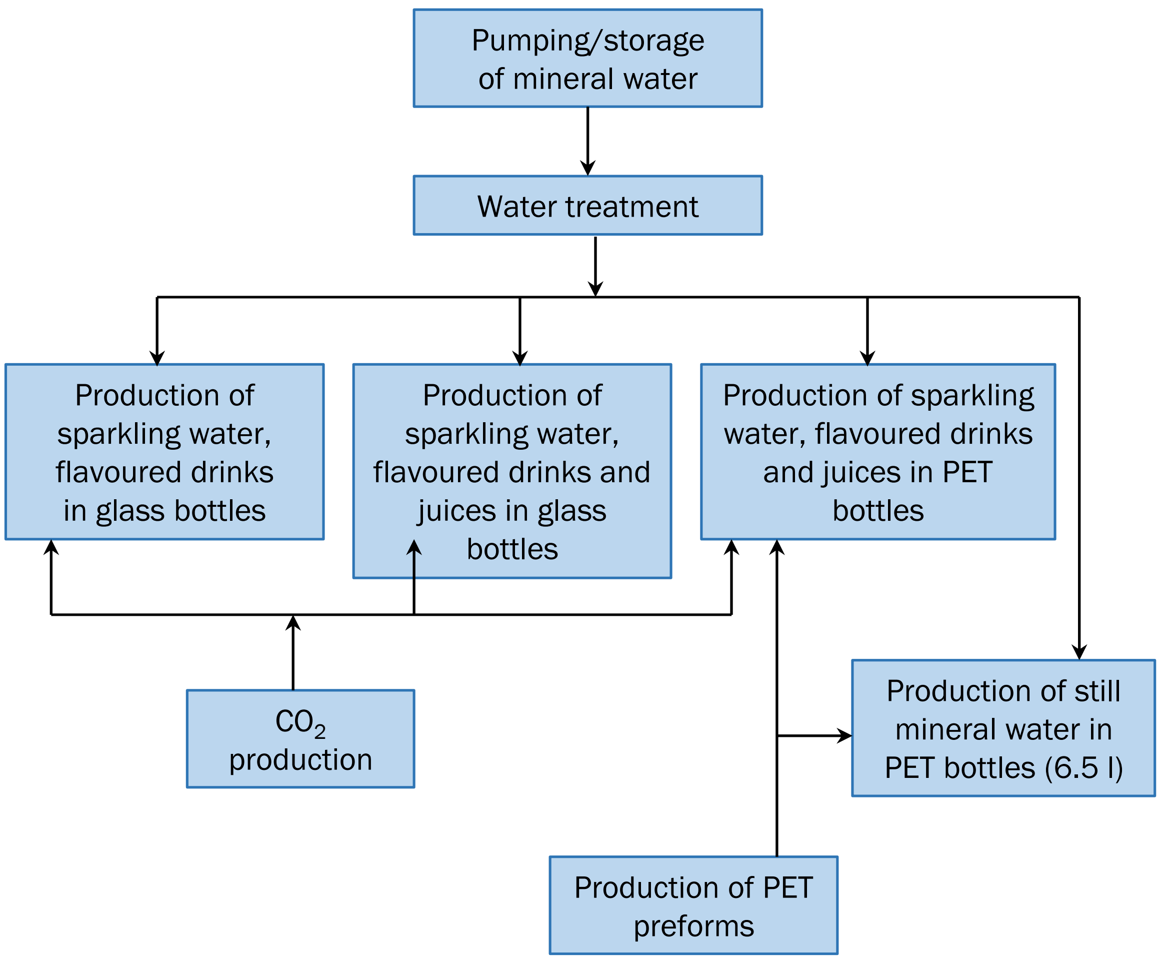
Sugar
Flavouring
Colouring
Pulp

PE film
PET preforms
Labels
Bottle tops

Refined salt pastilles
Lab products
HNO_3; NaOH
Cleaning products
Glues; lubricants

Electricity
Gas
Gas oil

Water



OUTPUTS

Products: sparkling mineral water; still water; flavoured drinks; juices

Waste water

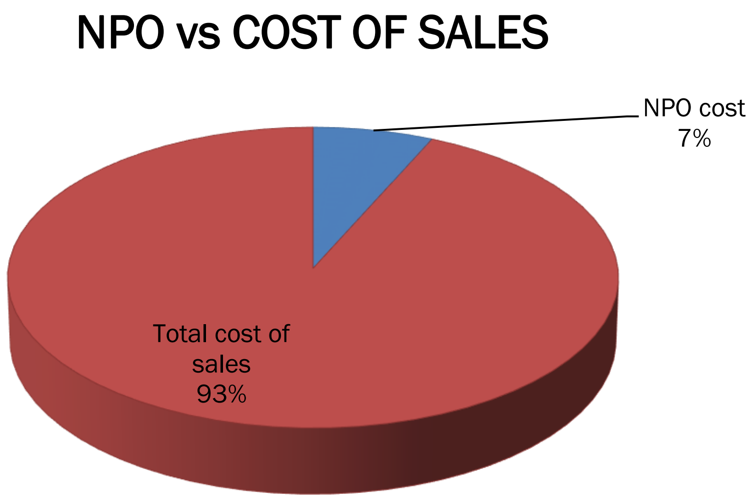
Air emissions: CO_2; NOx; SOx; H_2O

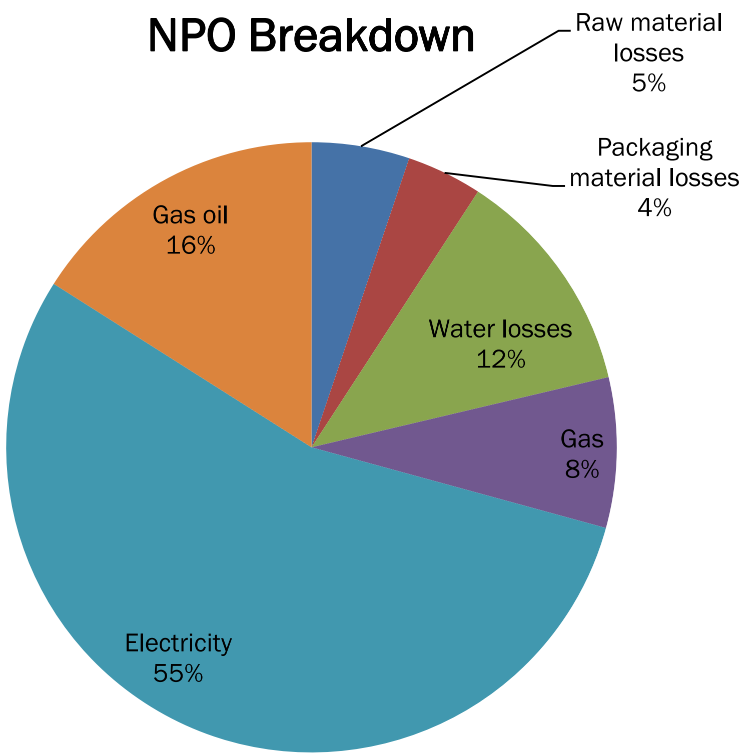
Waste:
Used packaging
Non-compliant products
Used lubricants

Benchmarking

Benchmark type	Unit	Company	Best practice
Energy	$kWh_{elec+ heat} / L_{product}$	0.485	0.058 - 0.341
Water	$L / L_{product}$	1.70	1.15
Waste water	$L / L_{packaged\ product}$	0.68	N/A
CO_2 emissions	$kg\ CO_2/m^3_{product}$	190	N/A
BOD5	$kg/m^3_{product}$	0.085	N/A
COD	$kg/m^3_{product}$	0.36	N/A

Non-product output costs





Approximately 13% of input cost (7.2% of turnover) in 2015 was lost due to losses in raw materials, packaging, operating materials and water as well as for energy requirements.

Priority flows

The priority flows selected are:

Energy:

- ✓ It represents 79% of NPO costs
- ✓ A considerable reduction is possible as the comparison with best practices revealed that there was an overconsumption of around 142%
- ✓ A considerable reduction of GHG emissions is possible

Water:

- ✓ In comparison with the best practices of the sector, a potential reduction of 48% is possible
- ✓ The company's concern with preserving the source of mineral water

Priority flows

Packaging material losses (PET):

✓ They represent 4% of NPO costs

Raw material losses (sugar):

✓ They represent 5% of NPO costs

✓ They lead to an increase in the pollution flow (COD) in waste water

Information system – MFCA

- ## Key findings:

✓ The non-product output costs are a considerable expense in relation to the turnover.

✓ Comparative analysis with international best practices made it possible to quantify the potential for improvement and revealed that energy consumption can be greatly improved.

- ## Experience with I/O analysis

I/O analysis makes it possible to quantify non-product outputs in physical terms, and to finance and quickly identify the priority flows.

- ## Recommendations

Integrate MFCA analysis as a management accounting tool.

Information system – Metering

Recommendations:

1. Install flow measurement devices to record the quantities of water used at each workshop.

2. Improvement of waste quantification system:

- Daily weighing of packaging materials (plastic film, PET, tops, caps etc.)

Focus areas and cause analysis

The breakdown of NPO costs for priority flows on the different cost centres made it possible to identify the focus areas:

Priority flows	Focus areas
Water	Production of still mineral water in PET bottles (6.5 L)
Energy	Production of sparkling water, flavoured drinks and juices in glass and PET bottles Utilities
Raw material (sugar)	Production of sparkling water, flavoured drinks and juices in glass and PET bottles
Packaging materials (PET)	Injection of preforms

Focus areas and cause analysis

	Cost centres (production process, key services, etc.)							
	Total €	CO_2 production	Production of mineral water (6.5 litres)	Production of flavoured and sparkling mineral water, and juices in glass bottles	Production of flavoured sparkling mineral water in glass bottles	Production of flavoured and sparkling mineral water, and juices in PET bottles	Production of preforms	Utilities
NPO COSTS	**545,989**							
1. Raw materials	28,312			2,449		11,955		
% of NPO	100%							
2. Packaging materials	21,828						13,908	
% of NPO	100%							
3. Water	66,175		49,409	3,603		13,163		
% of NPO	100%							
4. Energy	429,674	73,323	29,888	47,821		158,406	32,877	87,360
% of NPO	100%	17.06%	6.95%	11.13%		36.87%	7.65%	20.33%

Focus areas and cause analysis

Priority flows	Focus areas	Sources	Primary and secondary causes
Water	Production of still mineral water in PET bottles (6.5 L)	• Unit, mineral water line 6.5 L • CIP line	• Poor machine design • Use of mineral water for CIP
Raw material (sugar)	Production of sparkling water, flavoured drinks and juices in glass and PET bottles	• Syrup preparation phase • Intermixing on two production lines for flavoured water, juices (glass, PET)	• No saturation in CO_2 due to the saturation temperature which is not low enough • Difference in Brix between the set value of the machine and the laboratory analysis • Brown-out of electric current • Syrup residue in ***low-BRIX pipes*** at the end of production
Packaging materials (PET)	Injection of preforms	• Injection of PET preforms at 180°C • Transformation of resin 300°C	• Power cuts (+3h) • Brown-out of electric current • Machinery malfunction (pneumatic or mechanical elements, automatons…) • Improper use

Focus areas and cause analysis

Priority flows	Focus areas	Sources	Primary and secondary causes
Electric power	Production line Utilities	• Transformers • Air compressors • Cooling units	• Several transformers operate at low load • Compensation batteries are insufficient • The 40-bar compressors are connected in parallel but only two are operated by a sequencer • Utility supply line with an authorised maximum demand which is 3,000 kW too high in relation to real needs
Thermal energy	Utilities	• Steam boilers • Sterilisation and cleaning procedures (CIP) • Instrumentation and regulation	• Type of fuel used for steam boilers • Water supply for boilers 90% open • Steam leaks through distribution manifolds and valves • Thermal surface losses from machinery (valves, flanges, steam collectors etc.) • Excessive need for steam pressure and distribution manifolds

Savings catalogue – Identified projects

	Energy
1	Check the current series of compensation batteries and reinforce them to increase their power factor
2	Integrate the third 40-bar compressor into the sequencer
3	Examine with utility company the possibility to remove the second supply line or reduce its authorised maximum demand to 500 kW
4	Review the connection of the transformers operating at low load
5	Substitute gas oil with natural gas as a fuel for the boiler
6	Renovate the feed water de-aerator for the boiler
7	Apply thermal insulation (ducts, flanges, collectors) and reduce steam leaks
8	Ensure the return of condensate
9	Install a boiler economiser

Savings catalogue – Identified projects

	Raw materials
10	Increase the capacity of the cooling units from 460 to 1,100 kW to increase saturation in CO_2
11	Install scrapers on the production ducts for flavoured water, juice (glass and PET) to reduce syrup residue in low-BRIX pipes
12	Optimise the filling level of PET bottles
	Packaging materials
13	Install a 782-kVA inverter for the injection and command of the PET grain machine (bottles and preforms) to prevent power cuts and brown-outs
14	Train personnel on the PET grain injection machine to reduce and eliminate improper use of the machine
15	Optimise the current 6.5L PET bottle line with a particular attention on steps involving capping and handles
	Water
16	Optimise mineral water consumption in the CIP of the 6.5L line
17	New investment in the 6.5L line to increase production capacity and solve problems related to this line

Best Practice 1:

Switch to natural gas instead of gas oil as a fuel for the boiler – Energy

Description of the solution	The company uses gas oil to fuel its boilers. However, the company is connected to the natural gas network which it uses to operate its CO_2 production unit. The improvement measure consists in using natural gas instead of gas oil as a fuel for the boiler. This requires replacing the boiler's current burner with a combined natural gas / gas oil burner, connecting the boiler to the internal natural gas network, and increasing the available capacity of natural gas to 10,000,000 kcal/h.
Economic benefits	Natural gas costs 0.022 €/m^3, whereas gas oil costs 0.15 €/litre. For a thermal energy consumption of 5,958,918 kWh/year, changing fuel will result in savings amounting to 56,358 €/year.
Environmental benefits	• For an emissions factor of 0.202 tonnes of CO_2/MWh for natural gas, and of 0.267 tonnes of CO_2/MWh for gas oil, based on an average consumption of 5,958,918 kWh/year, the switch will result in a reduction in greenhouse gas emissions of 387 tonnes of CO_2/year. • Risk reduction of soil pollution by gas oil during transfer and storage.
Capital investments	Investment: 18,739 € / Pay-back period: 0.33 years
Other barriers	No technical barriers, no negative impact on the quality of the products

Best Practice 2:
Return of hot condensate towards the boiler – Energy

Description of the solution	The diagnostics of the steam circuits revealed that there is no return of condensate from machinery, such as sterilising apparatus, juice and drinks preparation line, glass washers and PET washers to the boiler. This open circuit design results in an overconsumption of energy, water, and chemical products for boiler feed-water treatment. The improvement measure consists in ensuring the return of hot condensate towards the boiler's feed tank. This means installing a return circuit of approximately 50 m of insulated piping with two centrifugal pumps, flanges and valves.
Economic benefits	• The financial savings resulting from energy savings represent 2,738 €year • The financial savings resulting from the reduction in water consumption and treatment are estimated to be 1,499 €/year • Total savings: 4,237 €/year
Environmental benefits	• Estimated energy savings of 1,179 MWh/year • For an emissions factor of 0.21 tonnes of CO_2/MWh for natural gas, this means a reduction in GHG emissions of 246 TE-CO_2/year • The savings in water consumption corresponding to 21% of yearly production of steam are estimated to be 1,518 m^3/year
Capital investments	Investment of 2,998 € with a pay-back period of 0.71 years
Other barriers	No technical barriers, no negative impact on the quality of the products

Best Practice 3:

Integrate the third 40-bar compressor into the sequencer – Energy

Description of the solution	The unit is equipped with three 40-bar compressors: two 190 kW compressors wired in parallel with a sequencer, and a third 220 kW compressor still not integrated into the sequencer. This configuration leads to an overconsumption of energy, as start-ups occur more frequently with the third compressor. In order to optimise the use of these three compressors, we suggest integrating the third compressor into the sequencer. Thus, depending on demand, the sequencer will turn on one, two or three compressors simultaneously. Once it has been integrated into the sequencer, we estimate that the down-time of the third compressor will be extended by two hours per day which represents considerable energy savings.
Economic benefits	In the scope of reducing operating time of the third compressor by 2h/day, annual energy savings will amount to 160,600 kWh. Annual financial savings = 3,250 €
Environmental benefits	Annual energy savings of more than 160 MWh Reduction of CO_2 emissions = Energy savings * Emissions factor = 160 MWh * 0.670 tonnes CO_2/MWh = 107.2 TE-CO_2/year
Capital investments	Investment: Investment of 2,507 € with a pay-back period of 0.69 years
Other barriers	No technical barriers, no negative impact on the quality of the products

Management system integration

- Integration of the RECP into the current environmental management system
- Integration of the MFCA as an additional management accounting tool

Performance Monitoring

The follow-up of expected savings using improvement measures is carried out on the basis of the following indicators:

For the reduction of energy consumption:

- Energy consumption (electric + thermal) / litre of product

For the reduction of raw materials consumption:

- Controlling the process: kg of sugar / kg of finished product
- Controlling the injection machine: kg PET / kg finished product

For the reduction of spring water consumption:

- Litres of spring water / litre of finished product

Results

Measure	Investment (euros)	Savings (euros /yr)	PBP (years)	Water and raw materials /yr	Energy (MWh/yr)	Environmental impacts /yr
Increase the capacity of cooling units for saturation in CO_2	50,000	77,968	0.6	100 m^3 of water 1.5 t of RM	–	910 t CO_2 33,118 m^3 of waste water
Optimisation of CIP	–	9,417	Immediate	7,500 m^3 of water	–	
New 6.5-litre mineral water production line	192,857	22,420	8.5	24,000 m^3 of water	–	
Energy efficiency	58,571	72,066	0.8	1,518 m^3 of water	2,265	
TOTAL	**301,428**	**181,871**	**1.7**	**33,118 m^3 of water 1.5 t of RM**	**2,265**	

Conclusion

- **14 of the 17 suggested improvement measures were considered by the company for implementation or further study.**
- **The potential savings amount to €181,871 with a pay-back period of 1.7 years.**
- **Total annual water savings: 22.4%**
- **Total annual energy savings: 5.6%**
- **Total annual raw material savings: 0.06%**

- Non-product output costs reduced by 33.7%
- CO_2 emissions reduced by 13.5%