TEST case study

Juice production company

Developed under the framework of Med TEST II

UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

switchmed

The SwitchMed Programme is funded by the European Union

Juice production company

SECTOR	Food sector
SUBSECTOR:	Juices with different flavors
SIZE	220 full time employees
PRODUCTS	fresh juices and drinks
MARKET	Local and international (10% export)
CERTIFIED MANAGEMENT SYSTEMS	**Before participation in TEST:** • EHS (ISO14001 OHSAS18001); • Food safety (ISO22000, FDA, EFSA, Health Canada) **After participation in TEST:** • ISO 50001: 2011 Certification for Energy Management System.

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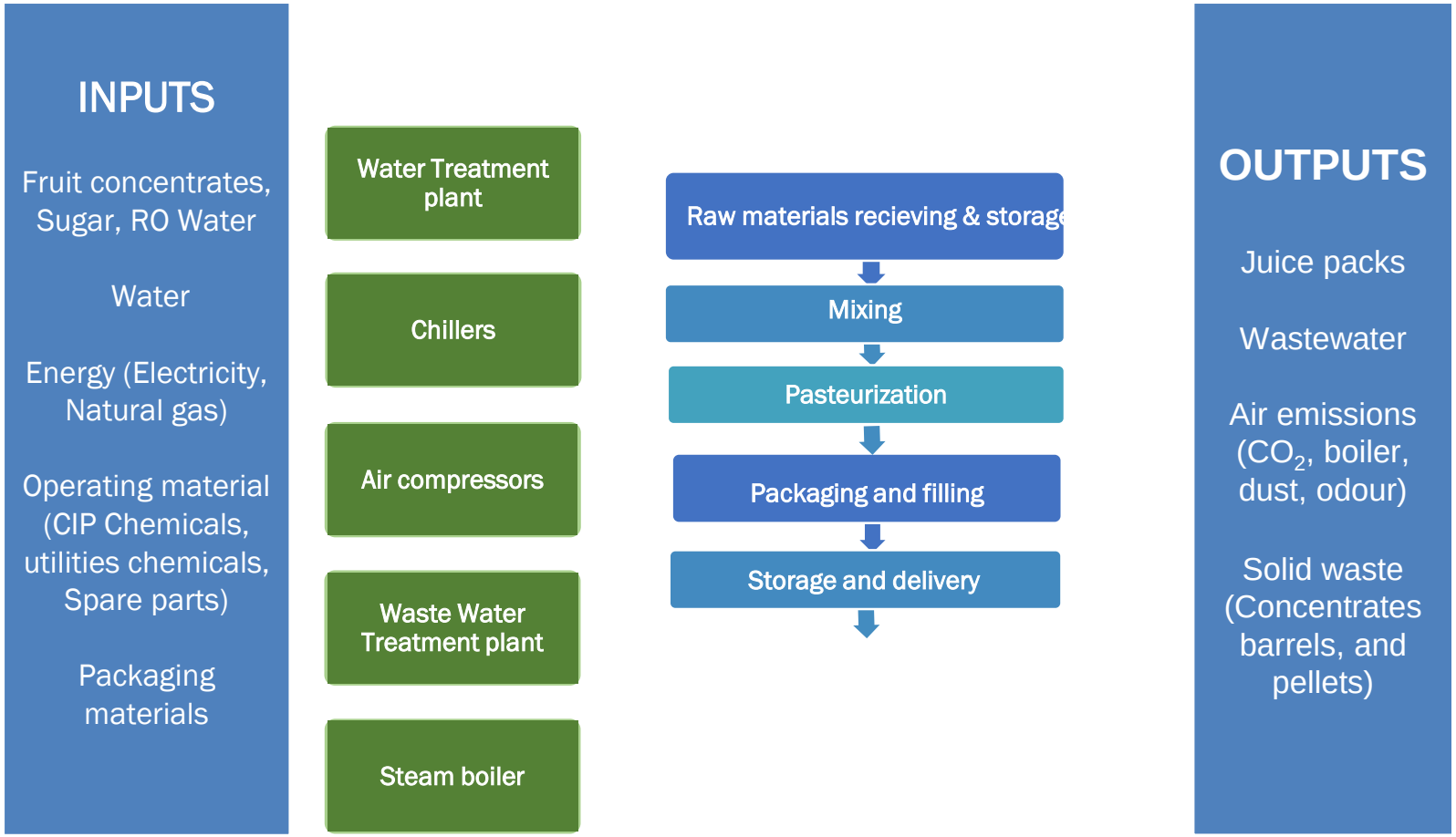
Company Key data

YEAR 2015	Unit	Value
Production: Juices with different flavors	Package/an	652,620
Electricity consumption	kWh/an	16,664,277
Natural Gas Consumption	kWh/year	1,042,052
Water consumption	m^3/an	366,891
CO_2 emission	Ton/an	10,365
BOD_5	Kg/an	N/A
COD	Kg/an	N/A
Total cost of sales	Euro/an	N/A
Total cost of inputs (Purchase value of raw materials, auxiliary materials, packaging energy and water)	Euro/an	N/A
	% vs. cost of sales	N/A
Estimated non-product output	Euro/an	N/A
	% vs. cost of sales	N/A

Initial Assessment observations

- The company, being a member of a large holding, produces fruit juice and nectars from concentrates. Almost 50% of the used concentrates are produced in its sister company, while the remaining part is imported.
- The technology is considered the state of the art as the factory was built in 2009 with the latest technology available at that time.
- The initial walkthrough to the production facility didn’t reveal much room for improvement as the company is fully automated within most of the production processes and no significant losses were visually noted.

Process overview/flowchart

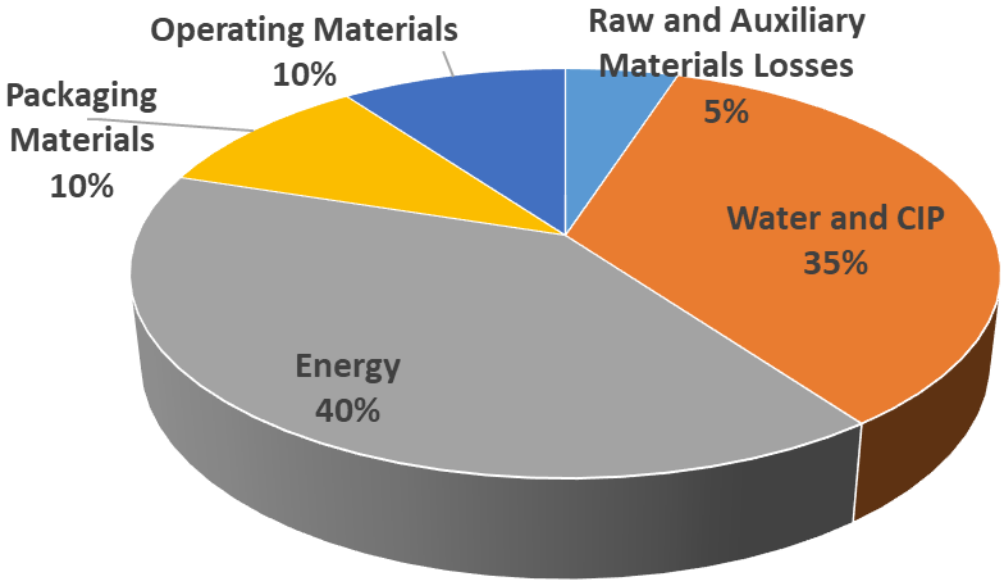


Company Level Benchmarking

Benchmark type	Unit	Company records (2015)	Internal Benchmark
Electricity	$Kwh_{elec}/litre_{juice}$	0.107	0.092
Thermal	$Kwh/\ litre_{juice}$	0.075	0.067
Water consumption	$m^3/litre_{juice}$	0.00088	NA

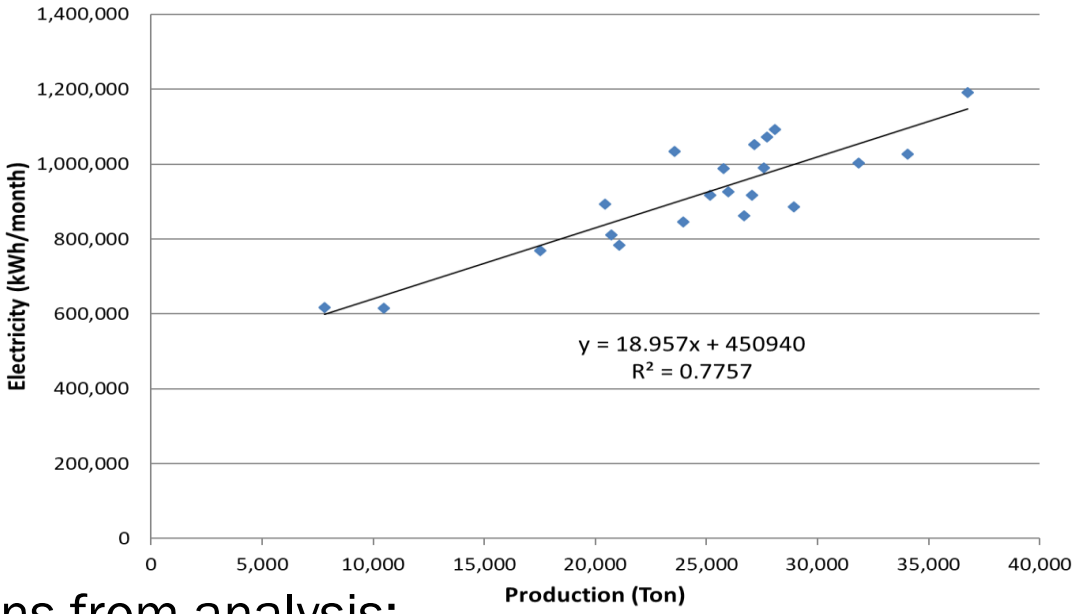
Investigating the International Best Practices for this company was a tedious exercise. Limited data are published on juice production from concentrates. The best practices for use of electricity and thermal energy are therefore based on an internal benchmark calculated as the lowest achieved monthly specific consumption. As the company achieved this figure in one month, it should aim on sustaining the consumption around that figure all year round.

Non-Product output costs



- The company refused to disclose its financial data. This caused delays in starting the TEST process as it starts by defining the priority flows based on the monetary data.
- Therefore, the company team was trained on filling in the MFCA sheet on its own and only the results were shared with service provider in order to secure confidentiality of data.

Company level regression analysis



Observations from analysis:

- Strong correlation between consumption and production levels
- Baseload of 450,940 kWh is on the high side. Most probably due to equipment running continuously especially in the utilities section and during CIP

Priority flows

Priority flows at the company were selected to be:

1 – Energy

2 – Water

This selection and prioritization was based on:

- NPOs cost analysis
- Group's annual target (the objective for 2017 was to reduce 10% of energy, the objective for 2018 is to sustain the energy savings and reduce 10% of water).

Information system - MFCA

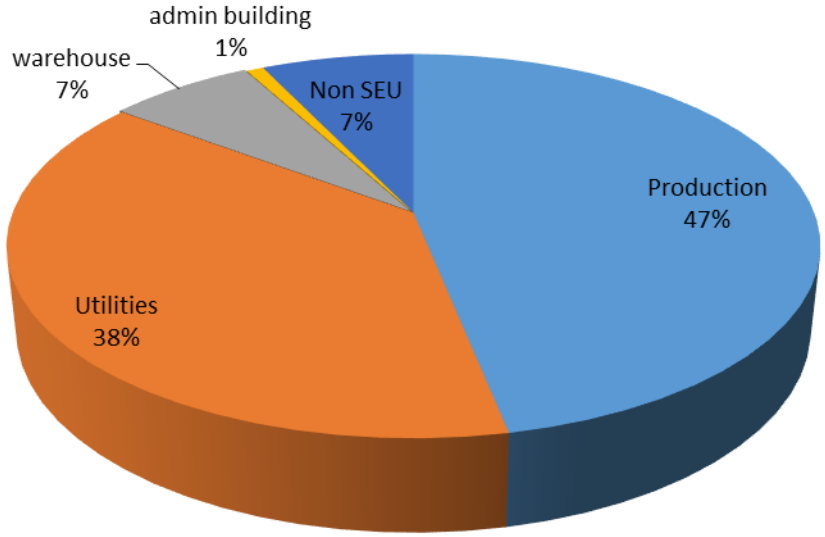
- The company had an Enterprise Resource Planning (ERP) monitoring system already in place. That ERP system facilitated for the I/O analysis smooth data collection at the company level.
- The definition of some flows, such as water, was not correct. The company considered all the water consumption based on the utility invoices as loss. However, reasonable portion of the water consumption goes to the product as raw material.
- Similarly, the company information system included the cost of CIP chemicals within the water utility cost center, rather than considering it an operating material in production process.
- The MFCA analysis revealed that the main priority flow is energy, followed by water.

Information system – Metering system

- The company installed electricity submetering system on the main sections while preparing its Energy Management System. Readings from those submeters were recorded on daily basis, together with the company production. These records facilitated calculation of baselines for specific KPIs.
- Later, during the course of the MEDTEST, the company team installed and started to record water consumption for different sections besides monitoring the electricity use. The company intends to develop baselines for water consumption for each main section.

Energy Focus areas and cause analysis

- Mapping of electricity use breakdown was readily prepared by the company in its preparation to the Energy Management System. This mapping was made based on records from submeters monitoring consumption at different sections of the company.
- The largest two electricity consumers were the production section and the utilities section.
- Baseline for each of the two sections was at the level of OPI developed based on regression analysis.



Energy Focus areas and cause analysis

- Through the MEDTEST project, the largest two sections were further analyzed.
- Within the production line, based on the recommendation form the international expert, the focus area was decided to be the **pasteurization area** (pasteurizers and homogenizers). This represents the section with possible intervention to the operating parameters. Other areas (preparation, mixing, and filing) have limited room for improvement as they are fully automated.
- In the Utilities section, the **ammonia compressors** accounted for 39% of the utilities consumption, followed by the **air compressors** representing 33% of the consumption.

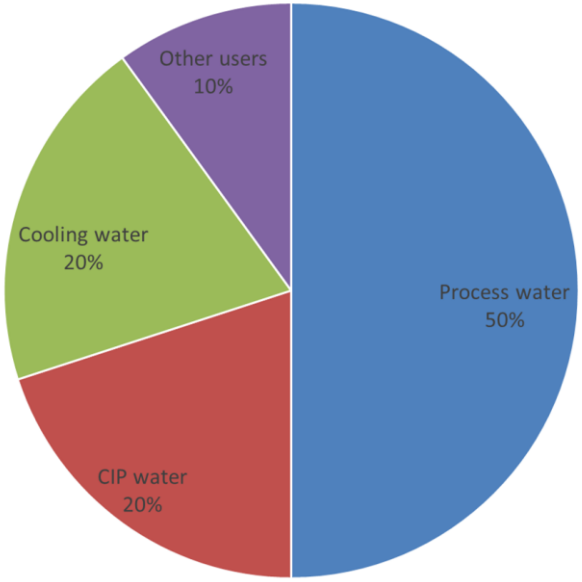
Investigation of Pasteurization Section

In analyzing the pasteurization section; a check list was prepared with the support from the International expert to the possible areas of improvement as:

What	Direct Savings Impact Impact on	Side effect	Data & actions needed	Cost Impact	Work to be done during Implementation
Temperature profiles of Heat treatment	Gas ,Fuel	CO2 emmissions (direct)	A list of ALL pasteurizers/products (template 1)	No cost	Adjust temperature profile
Raise the HR% in Plate heat exchangers	Gas ,Fuel	CO2 emmissions (direct)	(from above)	Low-Medium Cost	Add plates ,cut & weld certain piping
Steam condensates Recovery (valves,steam traps, piping)	Gas ,Fuel ,Water	CO2 emmissions (direct)	Check if there is condensates recovery exists from consumption points back to the bolier room..	Medium-High Cost	
Distribution Piping from Boilers to consumption points.	Gas ,Fuel	CO2 emmissions (direct)	Check if insulaton exists.Check if any "bleeding" of steam occures in the production area.	Medium-High Cost	Insulatie all piping.
F/C & soft starters to all El.motors	Electricity	Lower CO2 emmissions (Indirect)	where agreed block chart of motors so to establish a KWH/Lt ratio as a base line.	Low-Medium Cost	Frequency converters & soft Starters in the MCC panels.
Homogenizers usage	Electricity	Lower CO2 emmissions (Indirect)	List of all existing homogenizers with motor ratings,flow rates, pressures and products type homogenized. (e.g for clear Drinks NO need to homogenize)	No cost -Low cost	If possible to by pass then No Cost.If mot possible to by pass then some piping modification.
Homogenizers usage	Electricity	Lower CO2 emmissions (Indirect)	as above plus hours per shift .shifts per day,days per week, weeks per year	Low-Medium Cost	Some Suppliers of Homogenizers offer "Energy saving kits".These are advanced homogenization heads that succed the same homogenization effect with lower energy consumption.

Water Focus areas and cause analysis

- A breakdown for water consumption was conducted. Results of one month of monitoring submeter data revealed that almost 50% of the water goes into the product. This portion is considered as a Product Output.
- For the NPO portion of water, breakdown revealed that 40% is consumed in CIP process, 40% for cooling purposes (cooling and lubrication water for the equipment), and the remaining 20% is split between washing water and domestic use.
- Thus the focus for improvement should be on the CIP water and on the cooling water.



Cause analysis and option generation for CIP process

- Increase the frequency between CIP cycles - currently the company goes for CIP after 3 days of continuous production while the best practice is to have the CIP every 4 or 5 days only.
- Adjust the production plan to reduce the changeover. As the company has to go for CIP at certain change over between SKUs, the company team has to discuss with the planning department the need to reduce the frequency of changeovers.
- Different alternatives to CIP first rinse. Using product push techniques such as pigging or ice pigging can be adopted to eliminate the need for first rinse.
- Recovery of final rinse to be utilized in first rinse or floor washing.

Causes analysis for RO reject water

- The company Reverse Osmosis (RO) plant rejects around 200 liter/minute representing 25% of the input water, and the useful quantity (RO permeate) is around 600 liter/minute. Measurements for the TDS in the reject showed that the reject is at 700 ppm, which is very low.
- Initial thoughts were targeting different alternatives to reuse the reject water, either through installing another smaller RO plant, or installing a filtration station and sending the reject back with the feedwater to the existing RO.
- Through in depth analysis and by clarifying if there is a real need for RO water in juice industry, it was revealed that most juice producers have simple water treatment plants. The national legislation, with the quality of municipal water (TDS around 300 ppm in feedwater) requires only water softner and a carbon filter to adjust the chlorine in water.

OPI Level Benchmarking

Parameter	Unit	Company records (2015)	International best practice
Pasteurizers Heat Recovery ratio (HRR)	%	91	90%
Pasteurization temp.	Deg. C	95	88
Homogenization pressure	Bar	150	Not needed for clear products
Product reprocessing	% of production	0.5%	0.2%-0.7%
CIP frequency	Hrs of operation	Every 48-72 hrs	Every 96-120 hrs

Developed OPIs revealed that the HRR and product reprocessing are within the best practice range. Thus limited improvement is foreseen in these areas, and were not considered in options generation.

Example of option generation

- Priority flow: Energy, Focus area: Homogenizer section.
  - Problem: Use of homogenizers for all products.
    - Option: Bypass the homogenizer for clear products.

    There was initial rejection from the company team. Its members believed that reducing the pressure within the homogenizer will not allow steady flow of juice through the pasteurizer tubes. Through several trials they appreciated the measure, as is currently the common practice for clear juice.

Example of option generation

- Priority flow: Water, Focus area: CIP
  - Problem: High consumption of water in CIP
    - Option 1: Increase the operating hours before going to CIP
    - Option 2: Collect the final rinse CIP water for reuse as first rinse
    - Option 3: Collect the final rinse CIP water for floor washing
    - Option 4: Use steel ball pigging for first rinse
    - Option 5: Use ice-pigging techniques instead of first rinse

Saving Catalogue – identified projects

	Energy - Pasteurization section
1	Reduce the Pasteurization Temp by 2-3 C for certain products
2	Eliminate the use of Homogenizer for clear products
3	Fix malfunctioning steam traps
	Energy – Light fixtures
4	Replace light fixtures with LED lamps
	Water – RO plant
5	Install a second RO unit
6	Reuse of RO reject in irrigation
7	Replace the RO plant with water softner and carbon filter (new idea, under investigation)
	Water – Cooling water
8	Water recovery from homogenizers and vacuum pumps
9	Replace lubrication of filler chain from water lubrication to dry lubrication (new idea, under investigation with technology provider)

Sample of identified measures on Energy: Eliminate the use of Homogenizer for clear products

Description of the solution	The clear juice (apple, grapes, pineapple,..) represent over 50% of the company's production. Bypassing the homogenizer for the clear juices would save in the electricity bill as well as the frequency of changing the service kit of the homogenizers (2,000 euros/3,000 hrs of operation). As the company has four pasteurizer lines (each with a homogenizer). The capacities of the lines are 7000 l/h, 2 x 15000 l/h, and 25000 l/h. The idea here is to assign one pasteurizer (producing 25,000 Liter/hr) for the clear juices, and thus eliminating the need for its homogenizer (120kW savings).
Economic benefits	Saving will be around 120kW * 24 hr/day * 312 day/year = 898,560 kWh/year Eliminating the service kit for that homogenizer: 24 hr/day*312 days/year /3,000 hrs per kit = 2.5 kits per year. Cost savings: (898,560 kWh/year * 0.039 Euro/kWh) + (2.5 kits/year*2,000 Euro/kit) = 39,595 Euro/year.
Environmental benefits	Reduction in energy consumption by 4.8 kWh/ton With an annual production of 187,200 ton/year = 898,560 kWh/year (5% of the original baseline). CO_2 reduction associated with the energy savings is equivalent to 431 ton/year.

Sample of identified measures on Energy: Eliminate the use of Homogenizer for clear products

Capital investments	Bypassing the homogenizer is a no cost measure. Payback is immediate
Other barriers	Tests shall be conducted on product batch to assure that no quality issues occur (separation of product).

Sample of identified measures on Water: Water recovery from homogenizers and vacuum pumps

Description of the solution	The cooling water for the homogenizer and the vacuum pump is actually drained. With a pump it could be transferred to the cooling tower, reducing the temperature within the mixing with higher flow originally going to the cooling tower, and further reducing the temperature in the cooling tower will allow to reuse the whole quantity.
Economic benefits	Assuming 16 hrs/day operation, 22 days/month, 12 month/year, 4 production lines, and consumption of homogenizer 1 m3/hr, while vacuum pumps 1.5 m3/hr then the total water saving is expected to be: 16 * 22 * 12 * 4* (1 + 1.5) = 42,240 m^3/year With a cost of 0.285 Euro/ m^3 the saved water would be 12,038 Euro/ year
Environmental benefits	Reduce water consumption by 42,240 m^3/ year Reducing the wastewater generated by 42,240 m^3/ year which will reduce the hydraulic load on the final End-of-Pipe.

Sample of identified measures on Water: Water recovery from homogenizers and vacuum pumps

Capital investments	Water pump + water return pipeline ~ 5,000 Euro Payback less than 6 months
Other barriers	The additional cost due to increased load on the cooling tower should be taken into consideration during the full feasibility, together with the running cost for the water pump.

Management system integration

- During the course of the MED TEST II project, the company integrated the Resource Efficient and Cleaner Production (RECP) concept into the existing policy.
- The company received accreditation for ISO 50001:2011 during the course of the project. The data collection for the analysis was much easier than other companies who are not preparing/certified for Energy Management System.

Performance Monitoring

- Following the MED TEST II project implementation, the company's TEST team continued to use the methodology on its own. Realised savings were 18.1% of electricity and 21.2% of natural gas consumption in 2017.
- During 2018, the company team started analysing company water performance aiming to replicate the achievements within the energy flows.

Results

Action	Investment euro	Savings euro /Yr.	PBP Years	Water m^3	Energy MWH	Environmental Impacts
Process optimization	None	66,258	Immediate	---	1,890	1,006 tons CO_2 /year
Steam system optimization	2,400	10,383	0.23		677	
Replacement of light fixtures	26,487	8,040	3.29		209	
Optimization of water use	57,500	26,484	2.17	92,928	---	
TOTAL	86,388 €	111,164 €	0.78 years	92,928	2,775	

Action Plan - Sample

Title of the Measure	Classification (GHK, low-moderate cost, high cost)	Approved by top management						Retained for study	Discarded
		Implemented	Under implementation	Planned (start-end date)	Budget (local currency)	Responsible person	Link to Monitoring system		
Reduce the Pasteurization Temp by 2-3 C for certain products	GHK		X			Production	Natural gas and electricity meters		
Eliminate the use of Homogenizer for clear products	GHK	X				Maintenance + Production	Electricity meter		
Replace light fixtures with LED lamps	low-moderate			x		Eng. Yasser Abbass	Electricity meter		
Fix malfunctioning steam traps	low-moderate	X				Maintenance	Natural gas meter		

Conclusions

- 6 out of 7 RECP measures implemented/under implementation/planned.
- Economic savings 111,164 €/y with an average PBP of 0.78 year
- Total annual Water savings : 25.3%
- Total annual Energy savings : 8.8% (planned), 19.4% (actual)
- ISO 50001 certification (2011 Version)

- Improvment of information system and monitoring plan for timely identification of deterioration in performance
- Additional measures identified by the company team to save water
- Company started in replicating the TEST approach within other group companies
- Elimination of un-necessary processes (homogenizer bypass, potential elimination of RO) shall save on service cost