STEP 1 CASE STUDY

USING TEST TO OPTIMIZE ENERGY FLOWS IN A TEXTILE COMPANY

The experience of optimizing energy use in TEST is illustrated here with a textile company (denim washing) operating in Tunisia. The company has a production regime based on three shifts (3x8h) for 6/7 days (under normal production conditions), with an annual hourly production rate of 6,912 hours.

STEP 1.4: ENERGY AS PRIORITY FLOW

Following the MFCA analysis that identified energy as the most important priority flow, an energy audit was performed.

The energy audit was conducted by the national energy expert in close collaboration with the company team. This resulted in a transfer of knowledge which strengthened the company's internal capacities. Among other tools, the expert used the Energy Mapping tool provided in the TEST toolkit, which has been adapted to the Tunisian energy context. Data from the company energy bills from the year 2014 were recorded as shown in table 1.

ENERGY SOURCE	TOTAL CON-SUMPTION	TOTAL COST IN EUR	AVERAGE ELECTRICITY TARIF	POWER FACTOR COS (PHI)	KPI FOR ENERGY EFFI-CIENCY	CO_2 EMISSIONS /YEAR
Electricity	2,156,984 kWh	139,587	0.07 EUR / kWh	0,92	1.00 kWh/pair of jeans produced	1,404 tonnes
Gas	14,644,463 kWh_{th}	242,629	0.01 EUR / kWh		6.62 kWh_{th} /pair of jeans produced	3,992 tonnes

TABLE 1: company data (energy bills) and baselines of company performance, at project's start

The total annual energy (electricity and gas) consumed by the company in 2014 was around 16.8 GWh for a production of 2,234,823 pair of jeans, i.e., with an energy consumption indicator of 7.62 kWh/pair of jeans produced. The distribution of the energy consumption between gas and electricity was 74% and 26%, respectively.

STEP 1.5: IDENTIFICATION OF FOCUS AREAS / SIGNIFICANT ENERGY USERS

After analysing the company's overall energy consumption, the project team proceeded with the identification of the sources of energy consumption for priority energy flows, and the distribution of consumption to the main cost centres and significant energy uses as illustrated in figure 1.

For this purpose, measuring instruments including an infrared thermography control camera, power system analyzers, a combustion analyzer, a lux meter, and electrical and thermal measurement equipment were used.

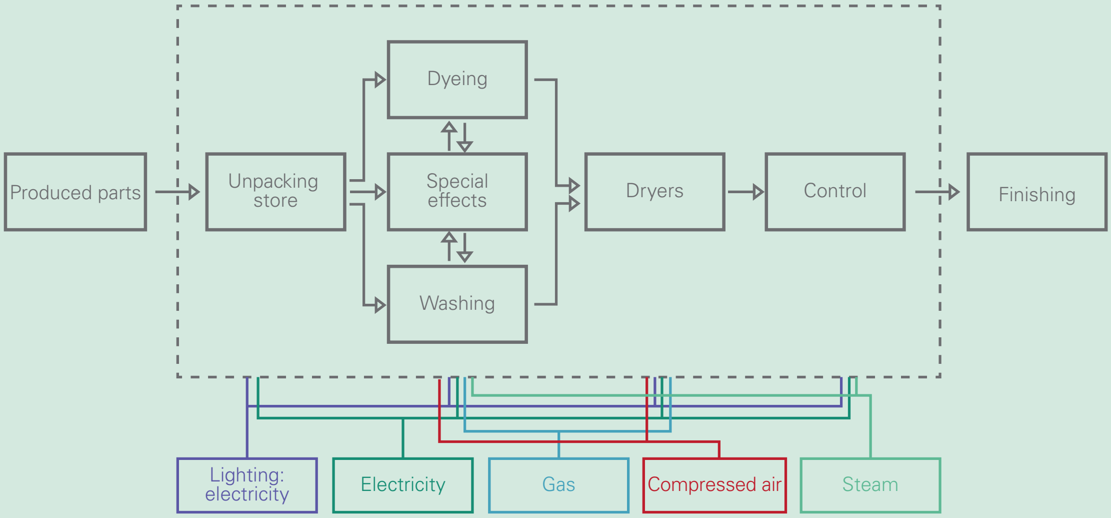
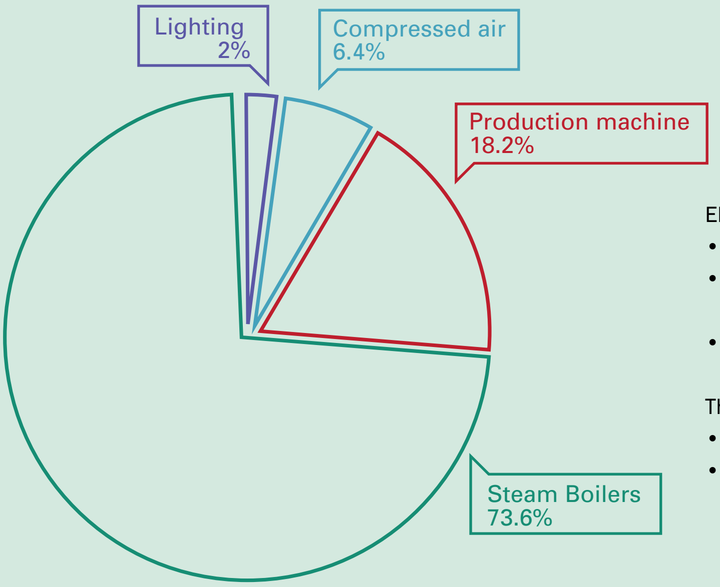


FIGURE 1: Process flow chart and energy flows in a Denim washing plant

Significant energy uses (as defined by the ISO 50001 standard) are those uses that represent a significant consumption in relation to the total consumption and/or represent a significant energy savings potential in line with the criteria for selection of focus area in the TEST approach and methodology.

The energy balance and the identified focus areas / significant energy uses, subject to an in-depth diagnosis and energy measurement, are listed in the figure 2.



Electricity:

- Production equipment
- Air compressors and equipment consuming compressed air
- Lighting

Thermal energy:

- Boilers
- Equipment consuming steam

Distribution of total annual consumption in 2014

FIGURE 2: Energy balance and identified focus areas.
Energy consuming equipment has been considered a high priority, with special focus on consumption of steam. Lighting was also included as a focus area due to an obvious potential for improvement.

STEP 1.6: ANALYSIS OF THE CAUSES OF ENERGY INEFFICIENCY

The following causes of inefficiency were detected:

- The analysis of the maximum power demand during 2014, as indicated on the invoices, revealed that the standard model contract with the electricity company is not suitable for the production regime and results in an additional cost on the order of 6.4%.
- The steam distribution circuit is not subject to preventive maintenance, resulting in leaks in the thermal insulation of auxiliary connections (valves and flanges).
- The analysis of the electrical measurements on the different equipment with variable speed drives revealed a very high overall rate of the current harmonics (205% higher than the 10% threshold), resulting in the creation of a harmonic pollution at the electrical network level. This situation has led to breakdowns and damage to the electronic cards of these pieces of equipment, and losses in material and energy.
- Energy losses due to leaks on the network and on the machines consuming compressed air were identified during the plant's annual suspension period. These losses are estimated at 376,659 kWh/year and a value of 27,119 €/year.
- During the inspection of the lighting system, it was found that the ferromagnetic ballasts of the old T8 neon tubes were still connected and that they were double feeding the new T5 tubes. This configuration generates an additional consumption of 10 W per neon tube.
- During the detailed analysis, it was noticed that the idle running of some production equipment resulted in an unjustified waste of energy.

STEP 1.7: IDENTIFICATION OF THE ENERGY SAVING MEASURES

Addressing identified causes of inefficiency, a menu of energy saving options was developed, assessed and validated by the company, as follows:

- Change of contract type with the electricity company and change to an hourly scheduling contract with the following subscribed power levels:

PRIME (EUR)	REDUCED (KW)	WINTER PEAK (KW)	EVENING (KW)	SUMMER PEAK (KW)	DAY (KW)
2,400	700	600	600	800	800

This action generates monetary gains on the order of 6.4% on the electricity bill.

- Lighting system repair by the elimination of the ferromagnetic ballasts of the old T8 neon tubes. The energy gains that are guaranteed by this action are 25,790 kWh, and around 16.9 t of CO_2 emissions are avoided.
- Repair of the compressed air leaks should generate estimated annual energy gains of around 323,269 kWh (i.e., around 23,277 €) and around 210 t of CO_2 emissions are avoided.
- Thermal insulation of the valves and flanges of the steam circuit. The annual energy gains of this measure were estimated at around 86,205 kWh, and 57.4 t of CO_2 emissions was estimated to be avoided.
- Boiler combustion control to eliminate the incorrect setting of excess air. This action generates annual savings of around 170,997 kWh and reduces CO_2 emissions by around 11.4 t.

- Treatment of the electrical harmonics by the acquisition and installation of passive harmonic filters on each variable speed drive of the production machines. In addition to the protection of electrical equipment against the harmful effects of harmonic currents, this measure generates annual savings of around 12,365 kWh, a reduced amount of CO_2 emissions in the range of 8 t, and a reduction in annual maintenance costs of around 23,078 €.

- Finally, it was recommended to improve the energy performance of the production equipment by strengthening preventive maintenance procedures as well as production procedures, and through technical assistance to improve productivity in the various workshops and on the workstations.

CONCLUSION

All the identified and validated measures were included in the TEST action plan. Expected gains due to the implementation of improvement measures in terms of energy savings were estimated at 618,628 kWh/year equivalent to a reduction of 304.1 t CO_2/year. Moreover, a financial gain of 66,686 €/year is expected to be achieved against an investment of about 50,000 €, resulting in a payback period of nine months.

The good project results that led to substantial gains in terms of energy efficiency, have motivated the company management to consider establishing an energy management system according to ISO 50001. With the application of the Energy Mapping tool and the diagnosis performed with it, several elements of an energy management system are already in place, including the analysis of energy consumption (overall and of the different end uses), the identification of significant energy uses, and the potential for improving the energy performance.