Energy Audit Summary Report

Audit No. 22 - FR03

Manufacture of cosmetics

energyXperts.NET
Berlin (Germany) / Barcelona (Spain)

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CHAMBRE DE COMMERCE
ET D'INDUSTRIE DE LA DRÔME

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1. Contact data of the auditors

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2. Description of the company (status quo)

Reference year of data/information: 2010

(Date of the visit on site: 09-05-2011)

2.1. General information of the company

Sector	Cosmetics	
Products	Cosmetics	
Yearly production	57,7 tons	
No. of employees	75	
Current final energy consumption [MWh] (*)	total	for heating and cooling
- natural gas	151	151
- electricity	209	45

(*) fuel consumption in terms of MWh lower calorific value (LCV)

(a) (b)

Figure 1. (a) Production (b) Storage

2.2. Description of the company

a) Productive process

The company receives the cosmetic components and processes them to produce the different cosmetic products. The products can be divided into different groups: emulsions (about 1/3 oil, 2/3 water), gels (2/3 oil, 1/3 water) and fats (3/3 oil). Water is pretreated in an osmosis tank. Different products are mixed according to the receipt. They are heated up to temperatures between 40 and 85ºC and they are maintained at particular temperatures during some time. At the end, the mixture is cooled down to ambient temperature.

Furthermore, hot water is required for different activities: Water for sanitary uses (55ºC), water from osmosis to clean small materials and water from osmosis to clean the Dumek (an electrical reactor).

The different areas of the building are heated in winter and cooled in summer. The target temperature is 22ºC the whole year. There is a small cold chamber at 4ºC to store some products.

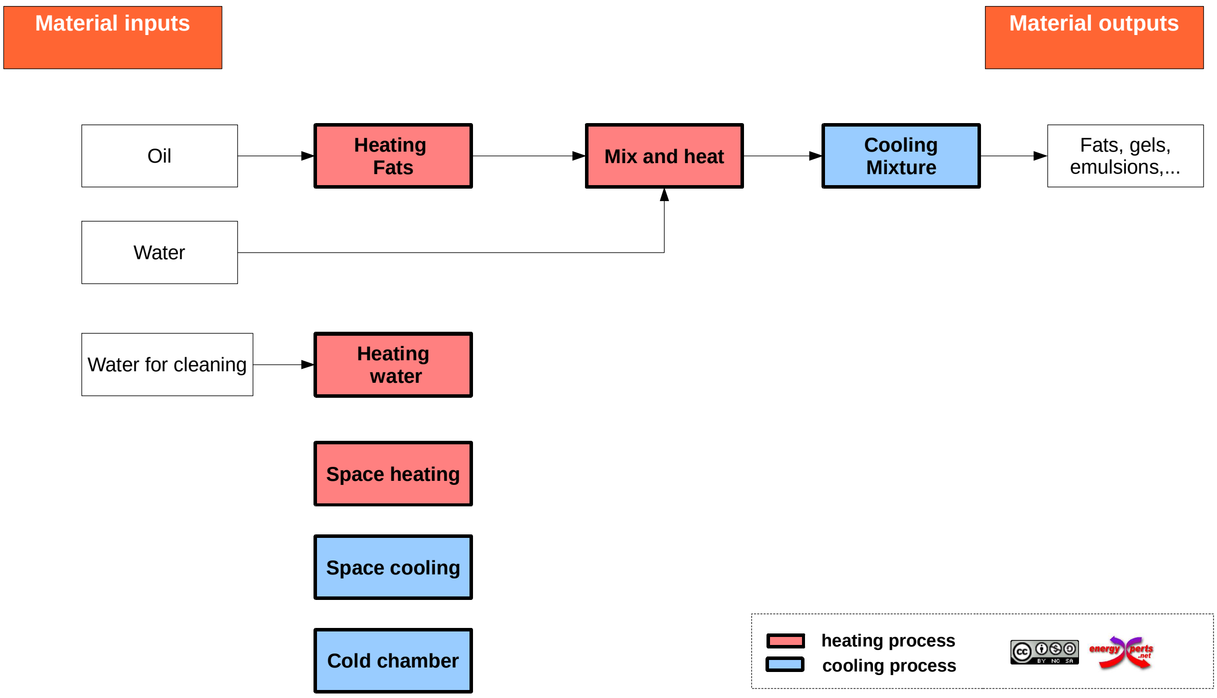

Figure 2. Simplified production flow sheet

The most heat consuming processes in the company are the production of hot water for sanitary uses and space heating. The most cold consuming process is space cooling for the atéliers.

b) Energy supply system

Processes are heated up electrically in two reactors: "dumek" for water and mixtures and "fondoirs" for oil. Water to clean small materials is heated electrically in the "Ballon". Water to clean the Dumek is generated in another electrical boiler. Water at 55ºC for domestic uses (kitchen, cleaning) etc. is generated in a natural gas fired hot water boiler.

Hot water at 65ºC for space heating is generated in the same hot water boiler mentioned above. Cold water at 7ºC for space cooling is produced in an electrical chiller. The area "Bureau récreation" is heated and cooled by an electrically driven heat pump. The cold storage is cooled by a separated chiller. An additional small chiller is furthermore used to cool the processes with a water-glycol circuit at 7ºC.

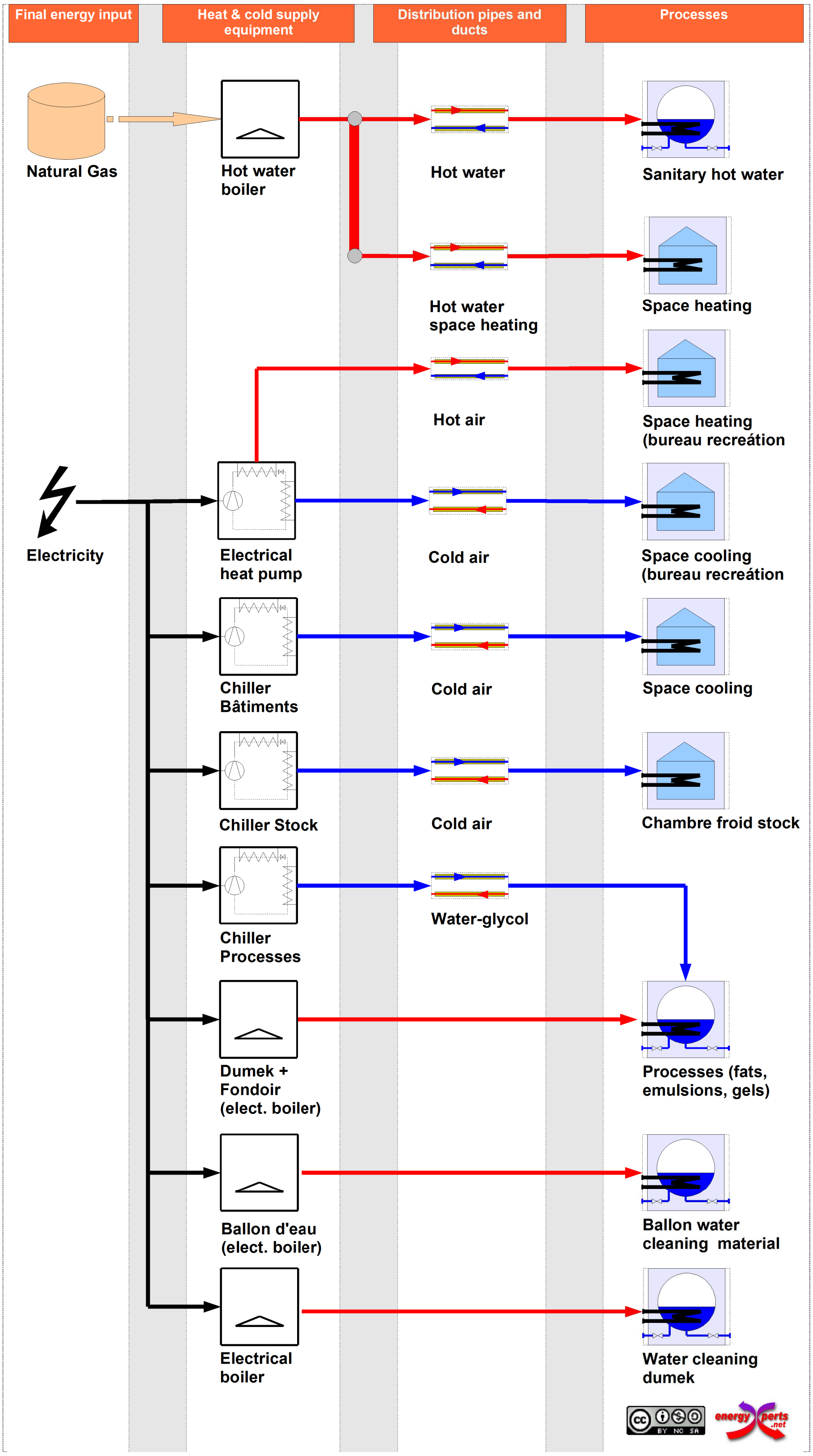

Figure 3. Overview of the heat and cold supply system

2.3. Additional comments

Specific assumptions

The results of this study are based on specific assumptions which should be further assessed in the framework of the follow-up actions for the implementation of the proposed measures.

Table 1. Assumptions

Description	Value estimate	Justification
Specific heat demand of space heating	40 kWh /m2year	Limited by the total gas consumption and the heat demand to generate hot water
Specific cooling demand of space cooling	50 kWh /m2year	Limited by the power of the chillers
Temperature of return of the condensate entering in the boiler	40ºC	Temperature to process/space heating is 60ºC. A ΔT=20 K is assumed.

3. Comparative study of alternative proposals

A comparative study of several technically feasible alternative proposals for energy saving has been carried out. In the following sections the alternatives are first shortly described and then the results of the comparative study are presented.

3.1. Proposed alternatives

The technical potential alternatives that have been investigated are listed in Table 2.

Table 2. Overview of the alternative proposals studied

Short Name	Description
Heat recovery	Heat exchanger 0,2 kW to use exhaust gas of boiler to pre-heat water
Cogeneration	Cogenerative engine 32 kW thermal /17 kW electrical for heat supply (space heating and hot water)
Trigeneration	Cogenerative engine 32 kW thermal /17 kW coupled to an absorption chiller (5kW) for heat and cold supply
Solar thermal	Solar thermal (Flat Plate Collector) 20 kW to generate hot water

3.2. Energy performance[1]

Table 3. Comparative study: yearly primary energy consumption.

Alternative	Primary energy consumption	Savings	
	[MWh]	[MWh]	[%]
Present state	857	---	---
Heat recovery	849	7	0,84
Cogeneration (*)	728	128	15,00
Trigeneration (*)	721	136	15,83
Solar thermal	832	25	2,86

(*) In systems with a CHP, the excess of electricity generated in the engine, which is sold to the grid, is counted as a negative consumption.

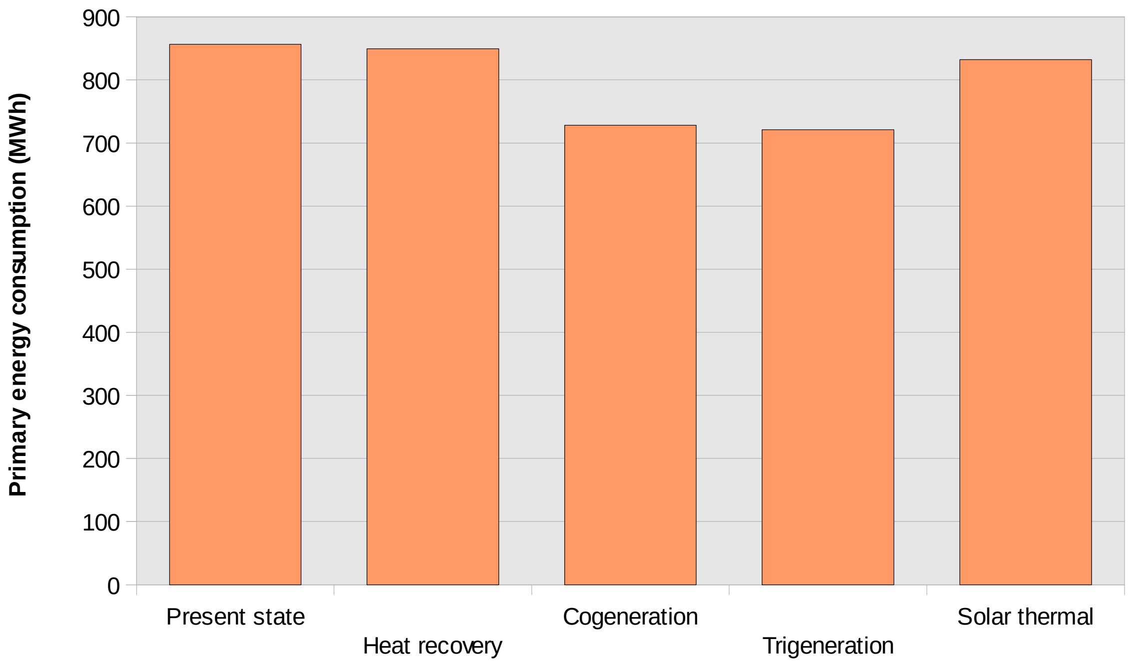

Figure 4. Comparative study: yearly primary energy consumption.

1 The factors for conversion of final energy (for fuels in terms of LCV) to primary energy used in this study are 3,3 for electricity and 1,1 for natural gas.

3.3. Economic performance

Table 4. Comparative study: investment costs. Assumed co-funding: 30 % for solar thermal systems and 10% for the rest of technologies.

Alternative	Total investment [€]	Own investment [€]	Subsidies [€]
Presen state	---	---	---
Heat recovery	560	504	56
Cogeneration	25,500	22,950	2,550
Trigeneration	33,500	30,150	3,350
Solar thermal	13,455	9,419	4,037

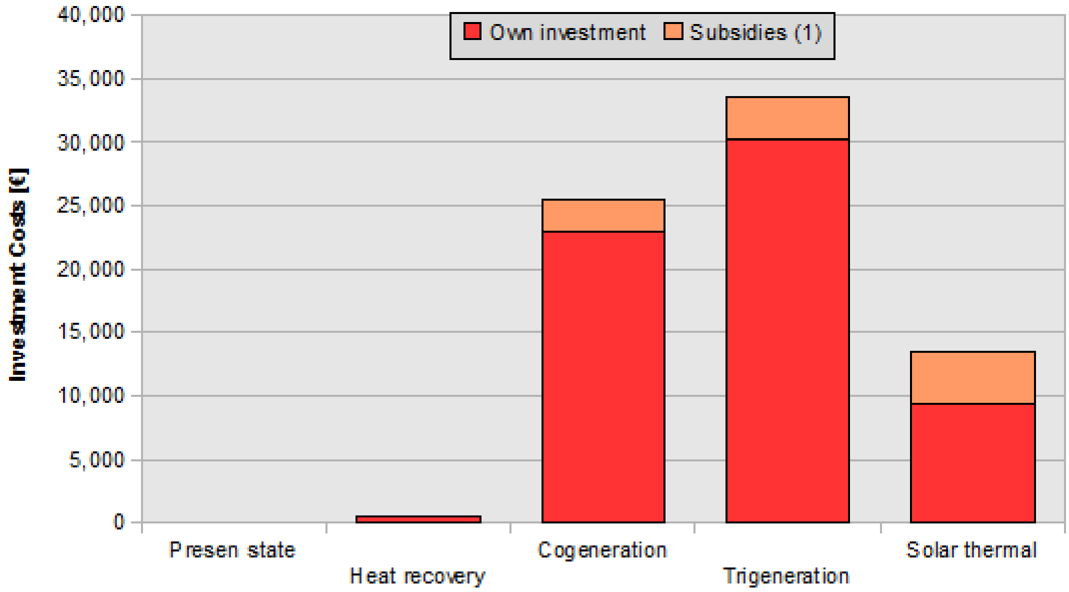

Figure 5. Comparative study: investment costs. Assumed co-funding: 30 % for solar thermal systems and 10% for the rest of technologies.

Table 5. Comparative study: annual costs including annuity of initial investment[2]. The energy cost for CHP includes also the feed-in-tariff revenue for the CHP electricity. O&M costs include the O&M equipments costs and the annual costs for cooling water.

Alternative	Annuity [€]	Energy cost [€]	O&M [€]
Present state	---	28,085	0
Heat recovery	58	27,792	50
Cogeneration (*)	2,626	23,115	867
Trigeneration (*)	3,449	22,873	1,211
Solar thermal	1,385	27,191	250

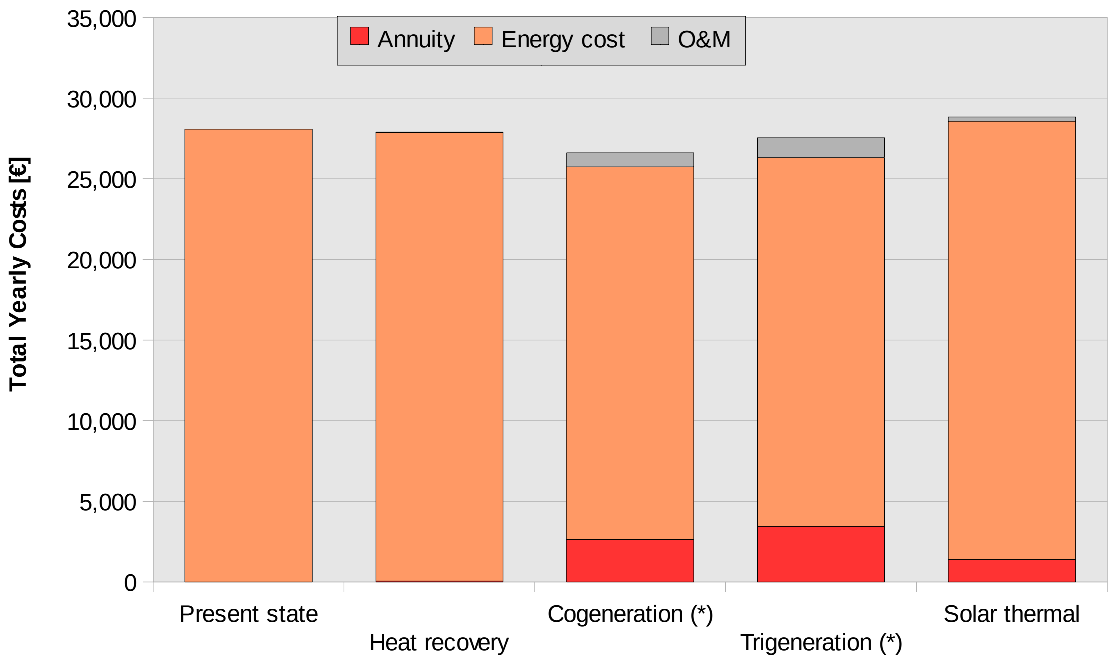

Figure 6. Comparative study: annual costs including annuity of initial investment. The energy cost for CHP includes also the feed-in-tariff revenue for the CHP electricity. O&M costs include the O&M equipments.

2 Annuity of initial investment: 10,3 % of yearly payments, calculated based on 8 % nominal interest for external financing, 2 % general inflation rate and 15 years of economic depreciation period.

4. Selected alternative and conclusions

4.1. Selected alternative

The alternative proposal "CHPe 32kW" consisting of a cogenerative engine of 17 kW_e /32 kW_{th} has been considered the best option among the previously analysed due to the following facts:

- high potential of both primary energy and energy cost savings
- the solar thermal system (flat plate collector) of 20 kW has been discarded due to the long pay-back period
- the trigeneration system (chp engine of 32 kW coupled to an absorption chiller 5 kW) does not save significantly more energy than the chp by itself, so that the additional investment does not seem to be justified.

In the following sections, the selected alternative is described in detail.

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4.1.1. Process optimisation

Since the main heat and cooling demand processes are the space heating, space cooling and hot water, no possible process optimization has been considered.

(a)

(b)

Figure 7. (a) Natural gas fired boiler for hot water and space heating. (b) Electrical heating

4.1.2. Heat recovery

Heat recovery has been excluded due to the low potential.

4.1.3. Heat and Cold Supply

In the new system proposed a cogeneration plant (engine) is added to the heat supply system. The CHP plant can feed heat into the existing hot water network using the exhaust gas (113ºC approx) and the cooling water (95ºC approx).

The technical specifications of the new CHP turbine are given in Table 6.

Table 6. Technical specifications of the new CHP gas turbine.

Parameter	Units	Technical data
Type of equipment	-	CHP engine
Nominal power (heat or cold output)	kW	32,00
Fuel type	-	Natural gas
Fuel consumption (nominal)	kg/h	4,30
Electricity power input	kW	17,00
Electrical power generated (CHP)	-	0,32

The contribution of the new equipments to the total heat supply (173 MWh) is shown in Table 7 while the contribution to the cooling supply (108 MWh) is shown in Table 8.

Equipment	USH by equipment	
	[MWh]	[% of Total]
Hot water boiler	28	15,88
Electrical boiler cleaning Dumek	5	2,78
Ballon	0	0,07
Dumek and fondoir	5	3,11
Heat pump	22	12,74
New CHP	113	65,43
Total	**173**	**100**

Table 7. Contribution of the different equipments to the total useful heat supply (USH) in the company.

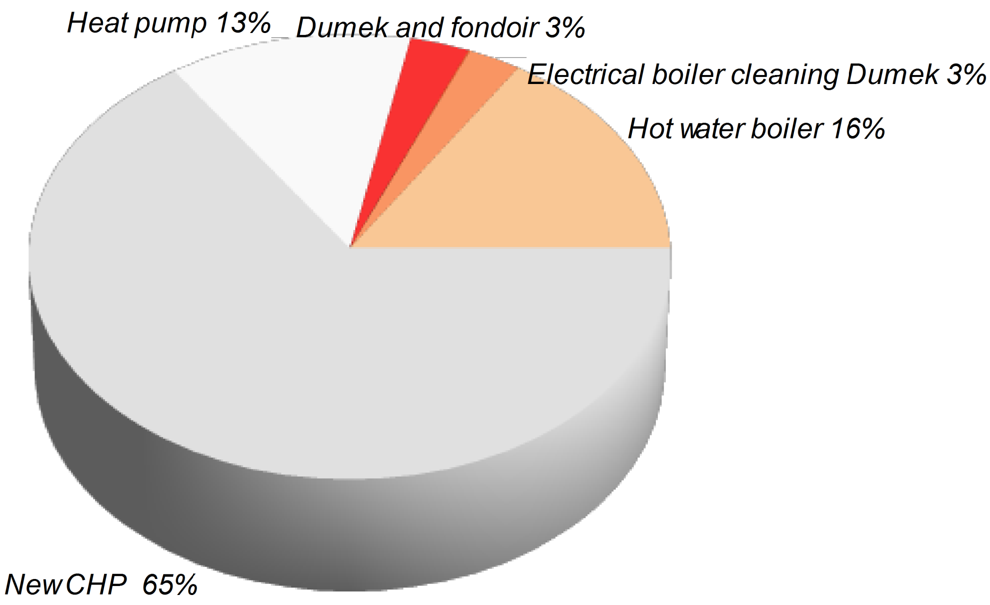

Figure 8. Contribution of the different equipments to the total useful heat supply (USH) in the company.

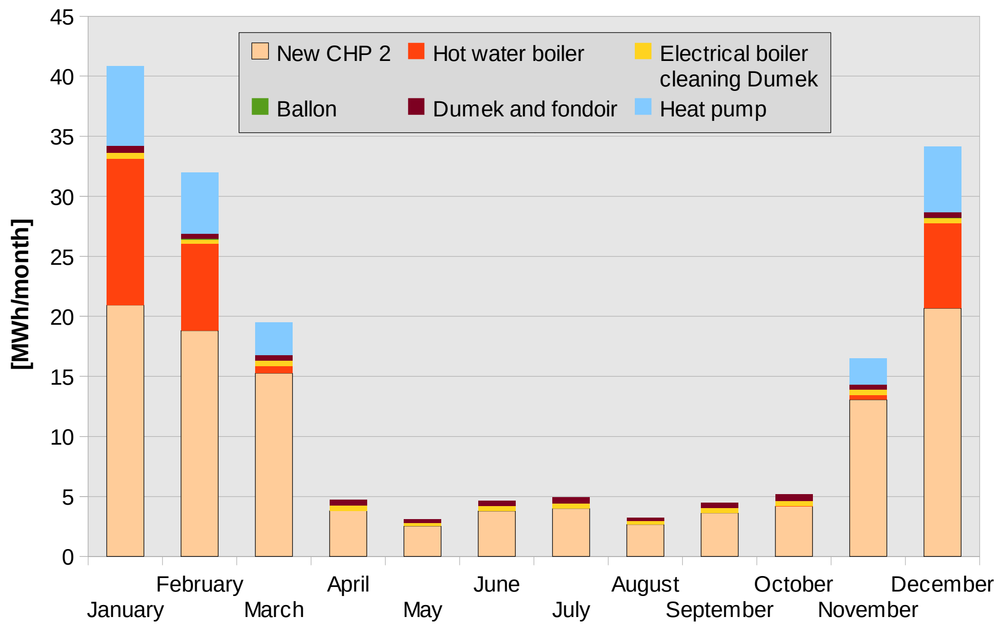

Figure 9. Monthly distribution of the heat supply by equipment.

Table 8. Contribution of the different equipments to the total useful cooling supply (USC) in the company.

Equipment	USC by equipment	
	[MWh]	[% of Total]
Group glacée process	3	2,63
Group froid chambre froid	0	0,42
Group glacée space cooling	95	87,54
Heat pump	10	9,41
Total	**108**	**100**

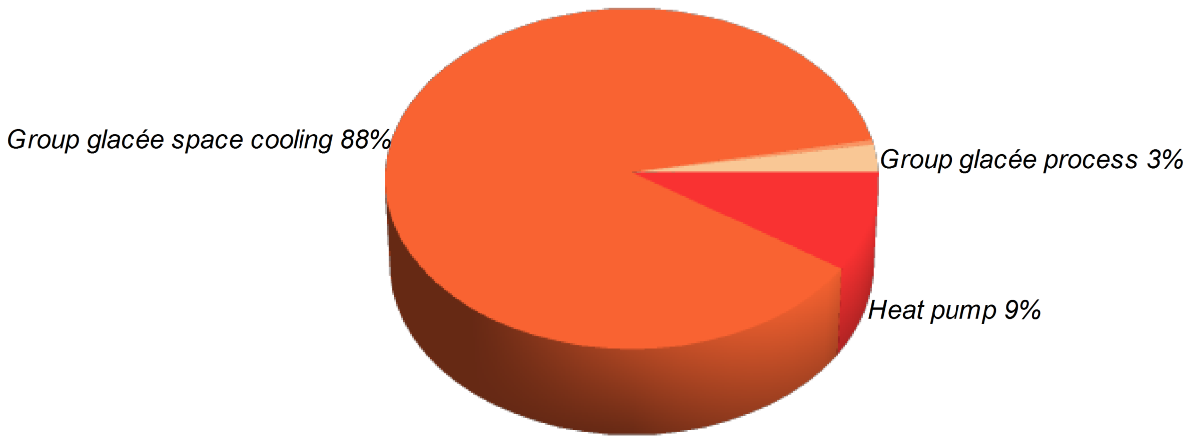

Figure 10. Contribution of the different equipments to the total useful cooling supply (USC) in the company.

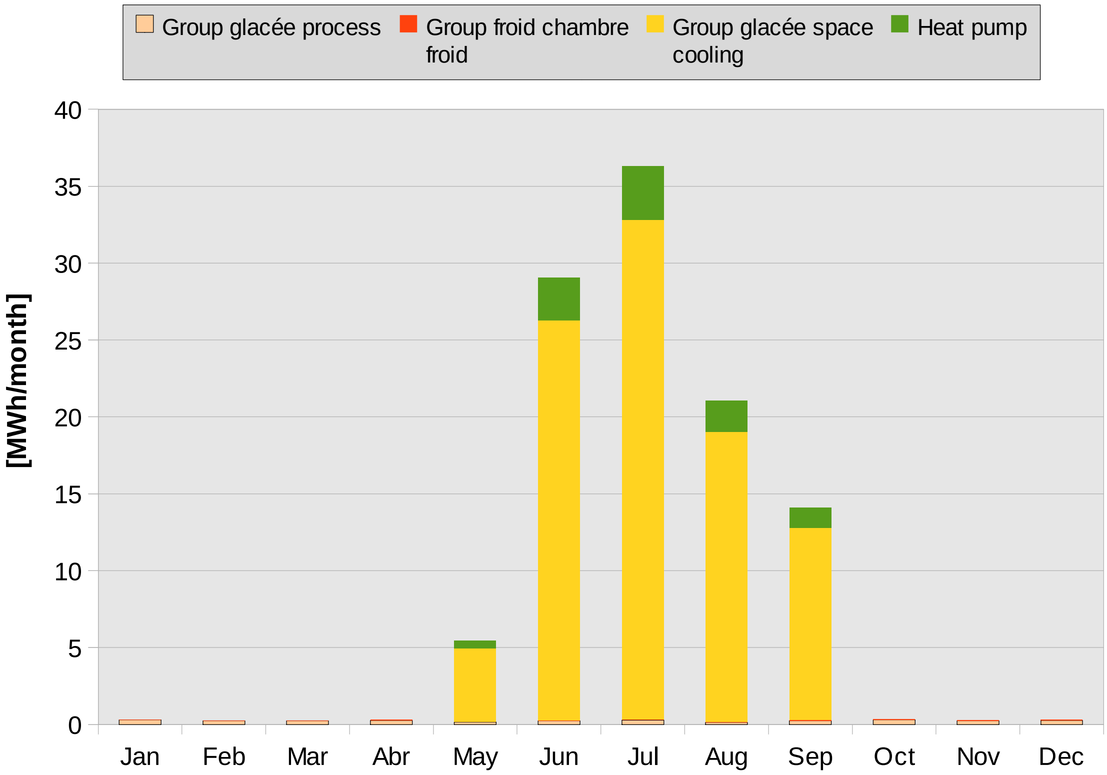

Figure 11. Monthly distribution of the cooling supply by equipment.

4.2. Summary: saving potential with respect to present state and economic performance

The following measures are proposed:

- cogeneration (engine) for covering the base load of the heat demand

This measure allows a saving of 15% of current primary energy consumption (including primary energy for non-thermal uses. Regarding primary energy for thermal uses, 17,7% is saved) and 5,26% of current energy costs (including cost of energy, operation and maintenance costs and amortization). The required investment cost is 25.500 € with a payback period of 6,3 years (taking into account subsidies).

Table 9. Comparison of the present state and the proposed alternative: saving potential and economic performance.

	U.M.	Present state	Alternative	Saving [%]
Total primary energy consumption (1)				
- total	*[MWh]*	*857*	*728*	*15,05*
- fuels	*[MWh]*	*166*	*288*	*-73,49*
- electricity	*[MWh]*	*691*	*440*	*36,32*
Primary energy saving due to renewable energy	*[MWh]*	*0*	*0*	*0*
CO_2 emissions	*[tons/a]*	*59*	*79*	*-33,9*
Annual energy system cost (2)	*[EUR]*	*28.085*	*26.607*	*5,26*
Total investment costs (3)	*[EUR]*	*-*	*25.500*	*-*
Payback period (4)	*[years]*	*-*	*6,3*	*-*

(1) including primary energy consumption for non-thermal uses

(2) including energy cost (fuel and electricity bills), operation and maintenance costs and annuity of total investment.

(3) total investment excluding subsidies.

(4) supposing 10% of funding of total investment (subsidies or equivalent other support mechanisms)