Energy Audit Summary Report

Audit No. 57

C.I.B. S.r.l

Conservatori Alimentari Brevettati

Sona (Verona), Italy

Plastics Industry

Food packaging

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

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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: 13-06-2010)

2.1. General information of the company

Company, location	C.I.B. S.r.l., Sona (verona), Italy	
Sector	Food packaging	
Products	Plastic food containers	
Yearly production	1.000 t/a	
No. of employees	16	
Current final energy consumption [MWh] (*)	total	for heating and cooling
- gas oil	103	103
- electricity	1.040	653

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

(a)

(b)

(c)

Figure 1. (a) Plastic beads (raw material); (b) plastic sheets (intermediate product) ; (c) sample of plastic food containers (final products)

2.2. Description of the company

a) Productive process

The first step of the food containers production is the extrusion of the thermoplastic raw material. The beads of HIPS (High Impact Polystyrene) are gravity fed into the barrel of the extruder. A rotating screw forces the plastic grains forward into the barrel. The temperature gradually increases up to the desired melt temperature (above 200 ºC) from the rear (where the plastic enters) to the front thanks to the heat supplied by electrical heaters. Extra heat is contributed by the friction taking place inside the barrel. The temperature regulation is done through air ventilation.

For sheeting, the next production step, the cooling is achieved by pulling plastics through a set of cooling rolls.

The post-extrusion process for the plastic sheet stock generated is the thermoforming, where the sheets are heated until soft and formed into different shapes via a mould which is actively cooled down to be maintained at a constant temperature.

Space heating of offices and of the production hall generates an additional heat demand in wintertime.

Figure 2. Extruders

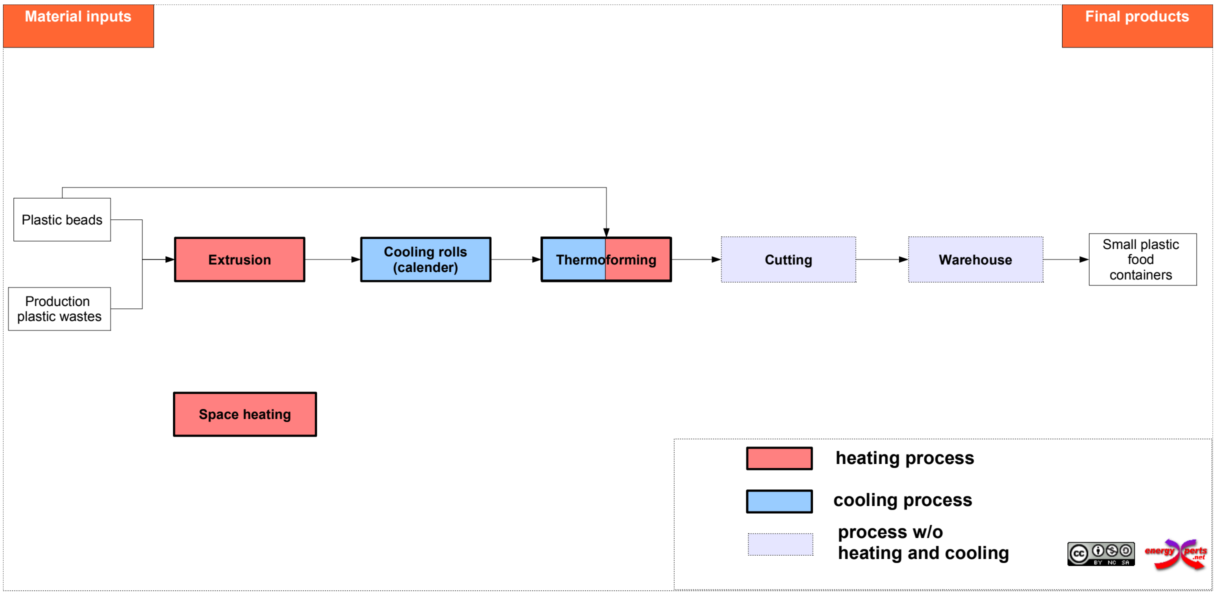

Figure 3. Simplified production flow sheet

The most energy consuming process resulted to be the thermoforming where the plastic sheets have to be heated up till the softening point while the moulds are cooled down to ambient temperature.

b) Energy supply system

The thermal energy necessary for the extrusion and for the thermoforming is provided by electrical heaters. Two heat pumps and a gas oil boiler are used to heat respectively the offices and the production hall in wintertime.

The process chilled water is supplied by two air cooled electrically driven chillers.

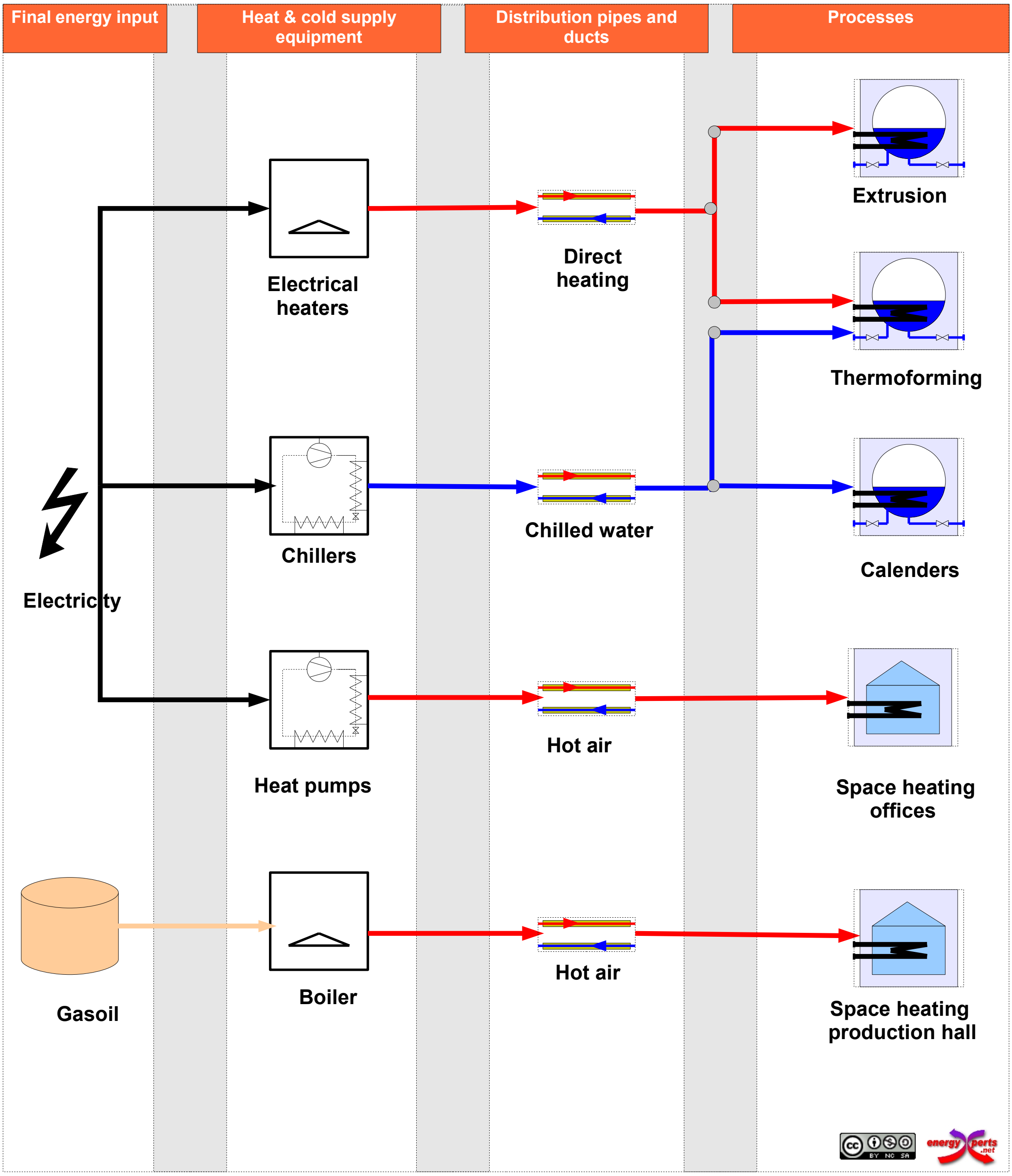

Figure 4. Overview of the heat and cold supply system

2.3. Additional comments

Peculiarities of the company

- No connection to the natural gas distribution network. No biomass locally available.
- No heating demand at low temperature apart from space heating in wintertime.
- Electrical heaters not replaceable due to the process (equipment) requirements.

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 4 of them are first shortly described and then the results of the comparative study are presented.

3.1. Proposed alternatives

The 4 technical potential alternatives that have been investigated are listed in Table 1. The study highlighted that due to different type of constraints the potential for energy saving is limited.

Table 1. Overview of the alternative proposals studied . HR = Heat Recovery

Short Name	Description
HR cooling rolls	Heat recovery from the post-extrusion rolls (source) for space heating (sink).
HR chillers	Recovery of the heat rejected by chillers (source) for space heating (sink).
HR rolls+chillers	Heat recovery from the post-extrusion rolls and the heat rejected by chillers (sources) for space heating (sink).
HR + Cooling tower	- Heat recovery from the post-extrusion rolls and the heat rejected by chillers (sources) for space heating (sink). - Cooling tower (dry) as cooling supply system for the post-extrusion rools. Nominal cooling power: 40 kW

3.2. Energy performance[1]

Table 2. Comparative study: yearly primary energy consumption.

Alternative	Primary energy consumption	Savings	
	[MWh]	[MWh]	[%]
Present State (checked)	2.371	---	---
HR cooling rolls	2.334	37	1,57
HR chillers	2.326	46	1,92
HR rolls+chillers	2.307	64	2,70
HR+Cooling tower	2.304	67	2,82

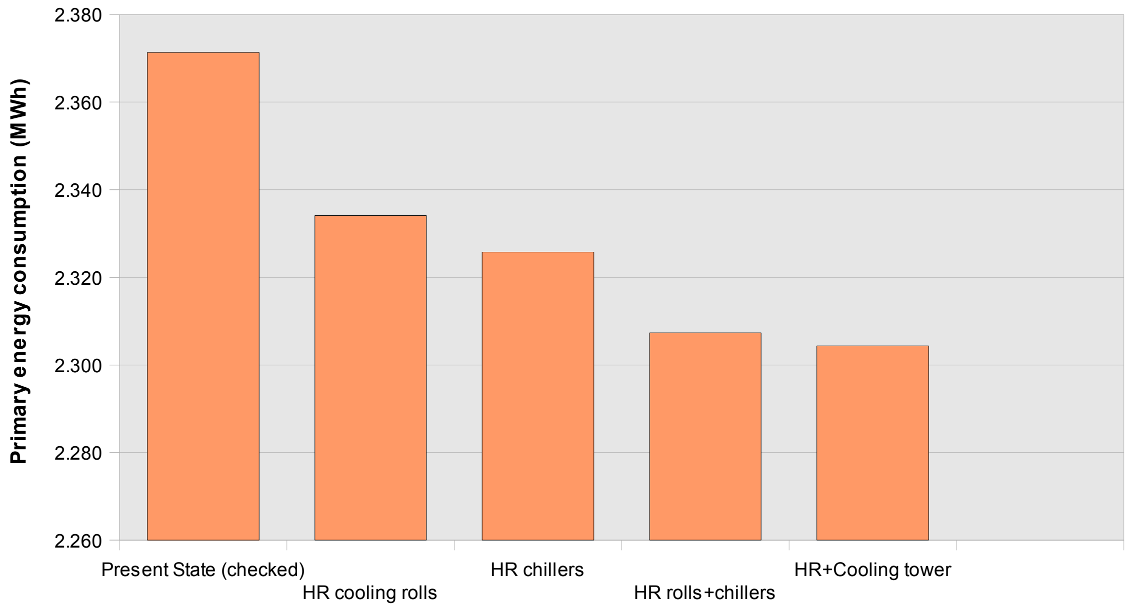

Figure 5. Comparative study: yearly primary energy consumption.

1 The factors for conversion of final energy (for fuels in terms of LCV) to primary energy used in this study are 2,17 for electricity and 1,1 for gasoil.

3.3. Economic performance

Table 3. Comparative study: investment costs.

Alternative	Total investment [€]	Subsidies [€]
Present State (checked)	---	---
HR cooling rolls	12.000	0
HR chillers	8.000	0
HR rolls+chillers	20.000	0
HR+Cooling tower	29.000	0

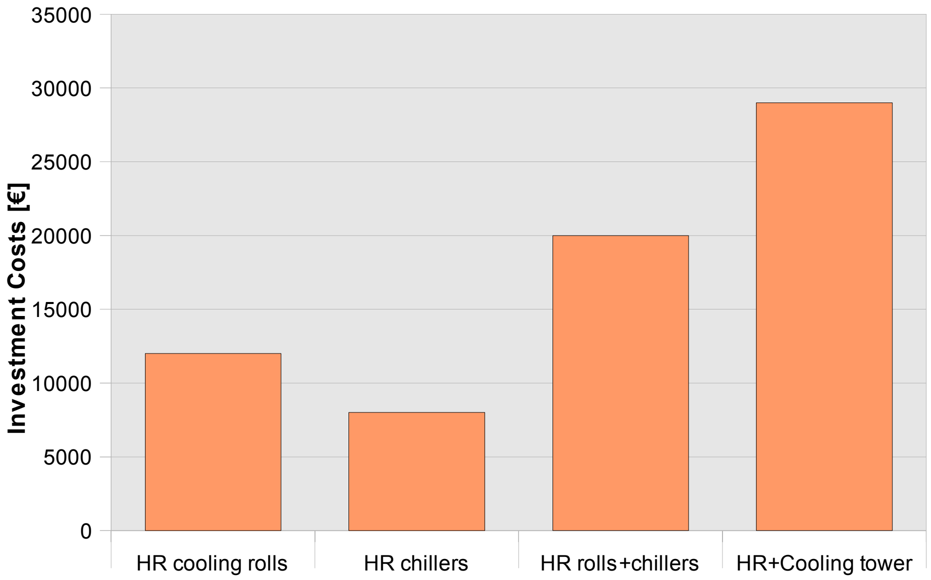

Figure 6. Comparative study: investment costs.

Table 4. Comparative study: annual costs including annuity of initial investment[2]. O&M costs are the additional costs associated to the new systems.

Alternative	Annuity [€]	Energy Cost [€]	O&M [€]	Total [€]
Present State (checked)	---	160.111	0	160.111
HR cooling rolls	1.156	156.321	350	157.827
HR chillers	771	153.210	0	153.980
HR rolls+chillers	1.927	151.649	350	153.926
HR+Cooling tower	2.794	152.018	710	155.522

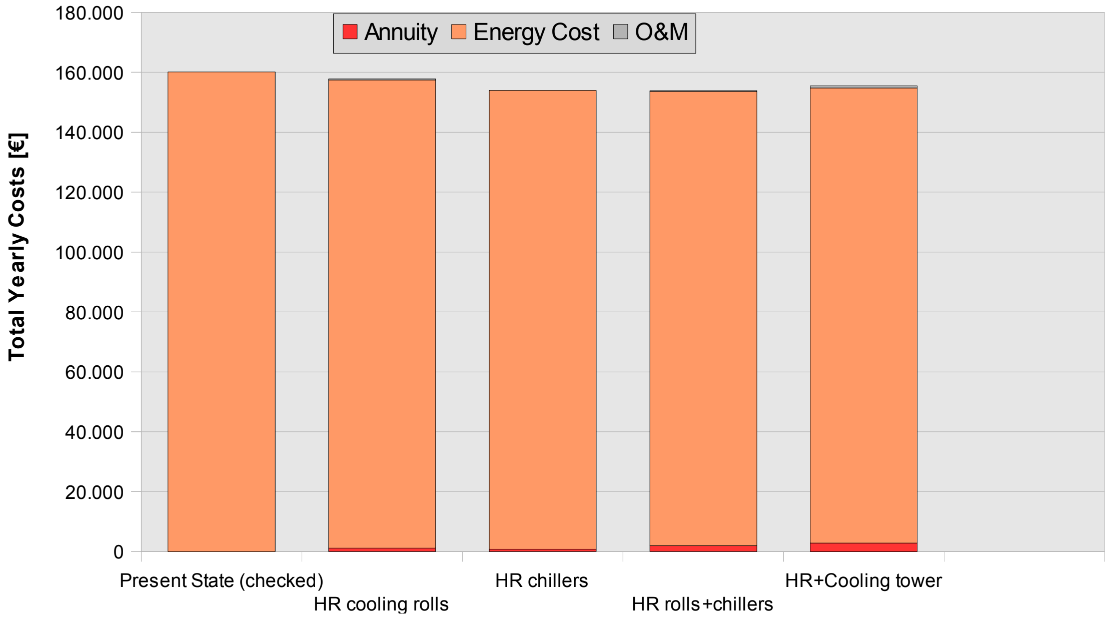

Figure 7. Comparative study: annual costs including annuity of initial investment.

4. Selected alternative and conclusions

4.1. Selected alternative

The alternative proposal "Heat recovery from the post-extrusion rolls and from the heat rejected by chillers for space heating" (HR rolls + chillers) includes two different interventions aiming at reducing the actual fuel consumption via heat recovery. It has been

2 Annuity of initial investment: 9,63 % of yearly payments, calculated based on 8 % nominal interest for external financing, 3 % general inflation rate and 15 years of economic depreciation period.

considered the best option among those analysed because it shows the best overall energy saving potential in relation to the economic performance.

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

4.1.1. Process optimisation

Not investigated.

4.1.2. Heat recovery

The proposed alternative includes two heat recovery interventions:

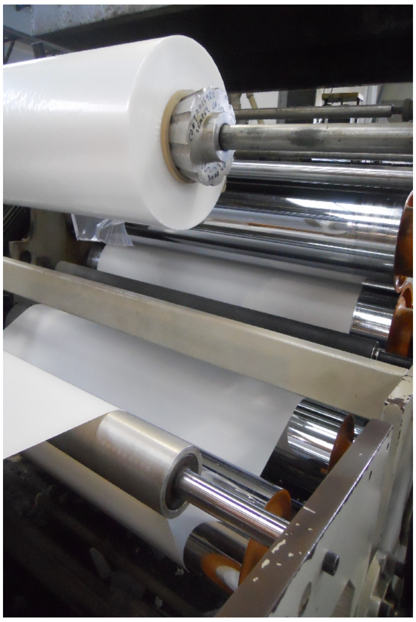

Figure 8. Cooling rolls

– the use of the cooling water of the post-extrusion rolls for space heating via heat exchanger (see Table 5);

– the direct use of the heat rejected by the air cooled chillers for space heating (recoverable heat: 49 MWh)

which together reduce the fuel consumption to 20%.

Even though this result is partially affected by an increase of the electrical consumption due to a lower efficiency of the chillers in the new operating conditions[3], heat recovery leads to an overall primary energy saving of 2,7 % .

Table 5. List of heat exchangers proposed.

Heat Exchanger	Power	Heat Source	Heat Sink	Heat transferred
	[kW]			[MWh]
HX 1	11	Post-extrusion cooling rolls	Production hall_space heating	23

4.1.3. Heat and Cooling Supply

The total and monthly contribution of the existing equipments to the total heat supply (611 MWh) is shown respectively in Table 6, Figure 9 and Figure 10 while the contribution to the cooling supply (344 MWh) is shown in Table 7.

Table 6. Contribution of the different equipments to the total useful heat supply (USH) in the company. Selected alternative.

Equipment	USH by equipment	
	[MWh]	[% of Total]
Heaters extruders	90	14,67
Heaters thermoforming	493	80,67
Hot air boiler	18	3,02
Heat pumps	10	1,64
Total	**611**	**100**

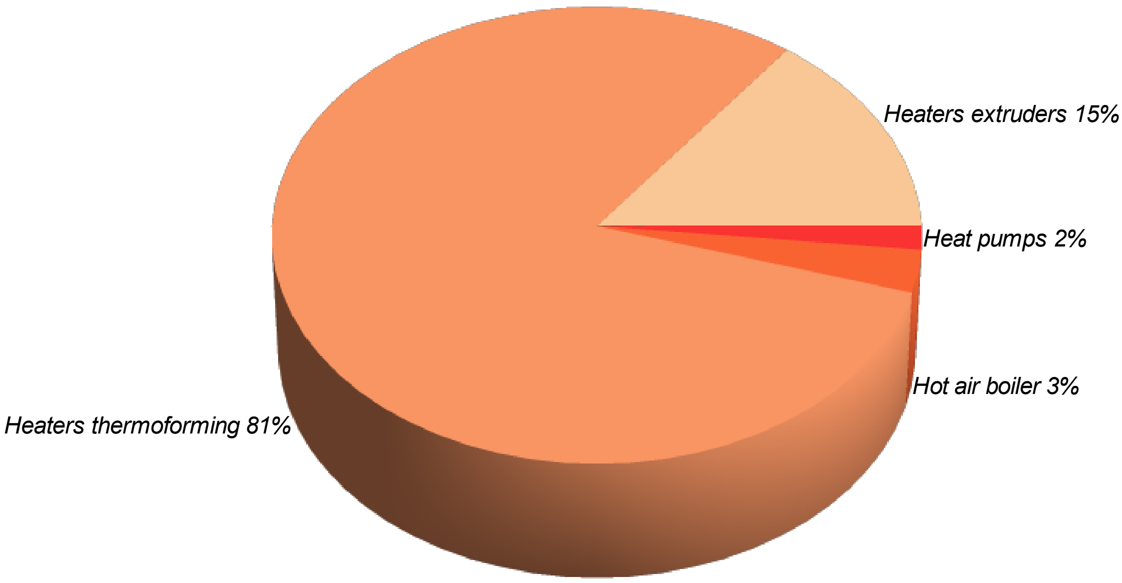

Figure 9. Contribution of the different equipments to the total useful heat supply (USH) in the company.

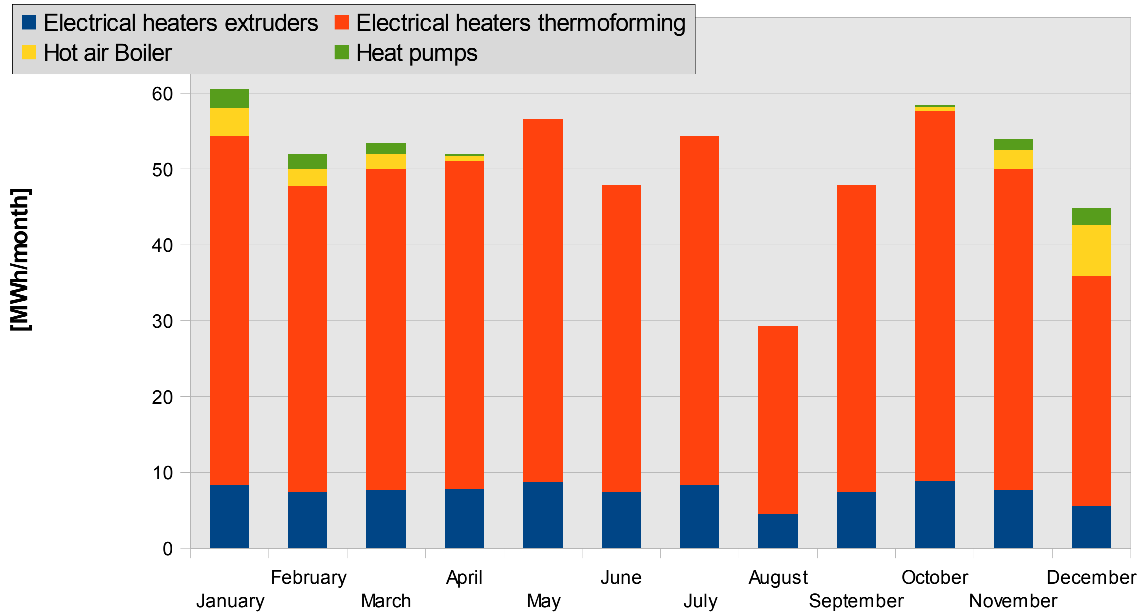

Figure 10. Contribution of the different equipments to the total useful heat supply (USH) per month.

Table 7. Contribution of the different equipments to the total useful cooling upply (USC) in the company. Selected alternative.

Equipment	USC by equipment	
	[MWh]	[% of Total]
Fans extruders	20	5,81
Compression Chillers	324	94,19
Total	**344**	**100**

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

With respect to the actual state, it has been proposed to use the heating capacity of the cooling rolls system and the heat rejected by the air cooled compression chillers to reduce the fuel consumption for space heating in wintertime.

These measures together allow to save 2,7 % of the current total primary energy consumption and around 5% of the current energy cost. The estimated investment is 20.000 € and the expected pay-back time is lower than 3 years.

The relative size of potential energy savings in this industry is rather small, due to the fact that in this case the possibility of an energetic optimisation of extrusion and thermoforming (the main energy consuming processes) has been not investigated. However, for this scope, more detailed information on the production equipments would have been necessary.

Table 8. 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*	*2.371*	*2.307*	*2,70%*
- fuels	*MWh*	*113*	*23*	*79,75%*
- electricity	*MWh*	*2.258*	*2.284*	*-1,16%*
Primary energy saving due to renewable energy	*MWh*	*0*	*0*	-
CO_2 emissions	t/a	*484*	*468*	*3,14%*
Annual energy system cost (2)	*EUR*	*160.111*	*153.926*	*3,86%*
Total investment costs (3)	*EUR*	-	*20.000*	-
Payback period	*years*	-	*2,6*	-

(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) indicative, since strongly dependent on the implementation strategy.

Also solar thermal for space heating and process cooling (coupled with a thermally driven chiller) has been analysed in the framework of this study. Even though this option showed the greatest primary energy saving potential, it has been not further investigated since, under the current conditions, it resulted to be not economically feasible.