Energy Audit Summary Report

Audit No. 69

Industrial Catering

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: 2011

(Date of the visit on site: 21.12.2011)

2.1. General information of the company

Sector	industrial catering	
Yearly production	1,6 million of meals (about 800 t)	
Current final energy consumption [MWh] (*)	total	for heating and cooling
- natural gas	1.050	1.050
- electricity	2.350	801

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

2.2. Description of the company

a) Productive process

The company receives ingredients from which warm meals are prepared and then delivered to the final customers.

The most important processes using thermal energy are:

- cooking of pasta and rice
- preparation (cooking) of sauces
- cooking of vegetables in steam
- cooking of soups
- baking in electrical oven
- several minor cooking processes on electrical plates
- ovens for maintenance of temperature.

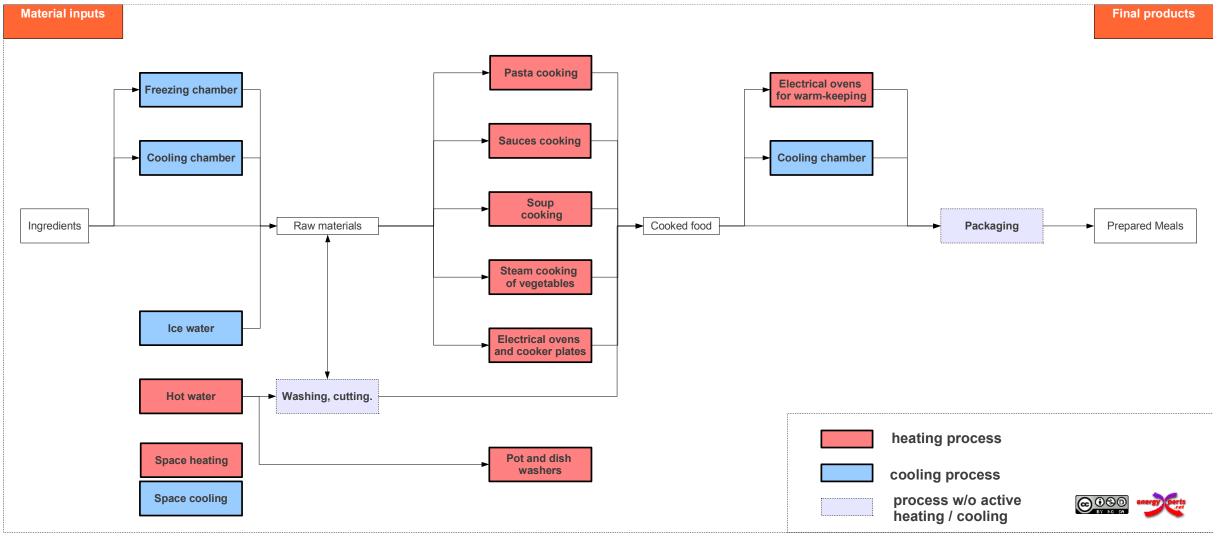

Figure 1. Simplified production flow sheet.

The most heat consuming processes in the company are the hall heating, and, among the different food elaboration processes, the pasta and rice cooking and the different electrical heaters (ovens, cookers).

b) Energy supply system

The heat used in the company is generated in a gas fired steam boiler and in an electrically driven heat pump using ground water as low temperature heat source. Furthermore, low temperature heat is recovered from chillers (mainly de-superheating) and a small solar thermal system is installed for hot water heating.

Cooling is provided at different temperature levels by electrically driven chillers for the cooling chambers and for ice water production. Cooling of the production hall is provided by the same (reversible) heat pump which is used for heating in winter. Heat rejection of chillers is also provided by the ground water circuit.

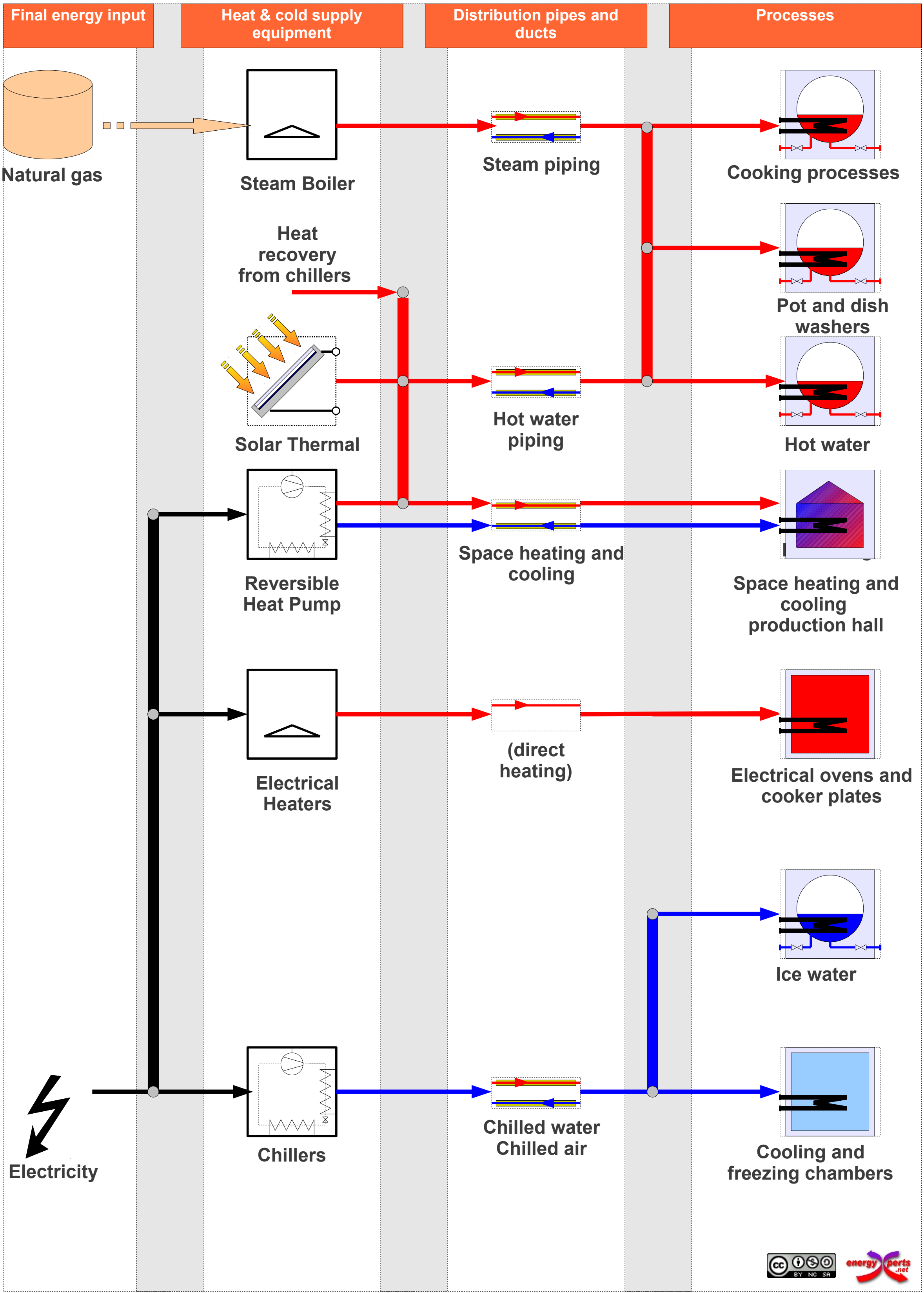

Figure 2. Overview of the heat and cold supply system

2.3. Additional comments

The results of this study are based on assumptions on the distribution of heat demand and supply on different processes and supply equipments which are associated with a rather high level of uncertainty due to lack of more detailed data. Especially high levels of uncertainty are associated with:

- amount of space heating and cooling demand
- heat supplied by heat pump and total (process) heat demand
- average COP of the heat pump (COP = 4 has been 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.

The scope of the EINSTEIN audit is focussed exclusively on the analysis and optimisation of the supply system of heating and cooling. Building optimisation is not included. As In the present case building heating and cooling demand form a significant fraction of the total heating and cooling demand, it was strongly recommended to the company to carry out a study on potential demand reductions in the building itself (building envelope, lighting, reduction of internal gains) and – in case of modifications – adapt the measures proposed in this study to the then reduced heating and cooling demands.

3.1. Proposed alternatives

The technical potential alternatives that have been investigated are listed in Table 1.

Table 1. Overview of the alternative proposals studied

Short Name	Description
RC	recupero di calore_heat recovery (heat recovery from waste water from pasta boiling for water preheating)
RC+COG	RC+Cogenerazione_Cogeneration (gas turbine 200 kWe/375 kWt)
RC+ST	RC+SolareTermicoGrande_RC+SolarThermal 210 kW (installation of 140 kW of evacuated tube collectors in addition to the existing solar plant of 70 kW flat plate collectors)

3.2. Energy performance[1]

Table 2. Comparative study: yearly primary energy consumption.

Alternative	Primary energy consumption	Savings	
	[MWh]	[MWh]	[%]
PRESENT STATE	6.255	---	---
RC	6.185	70	1,12
RC+COG	6.002	253	4,04
RC+ST	6.094	160	2,56

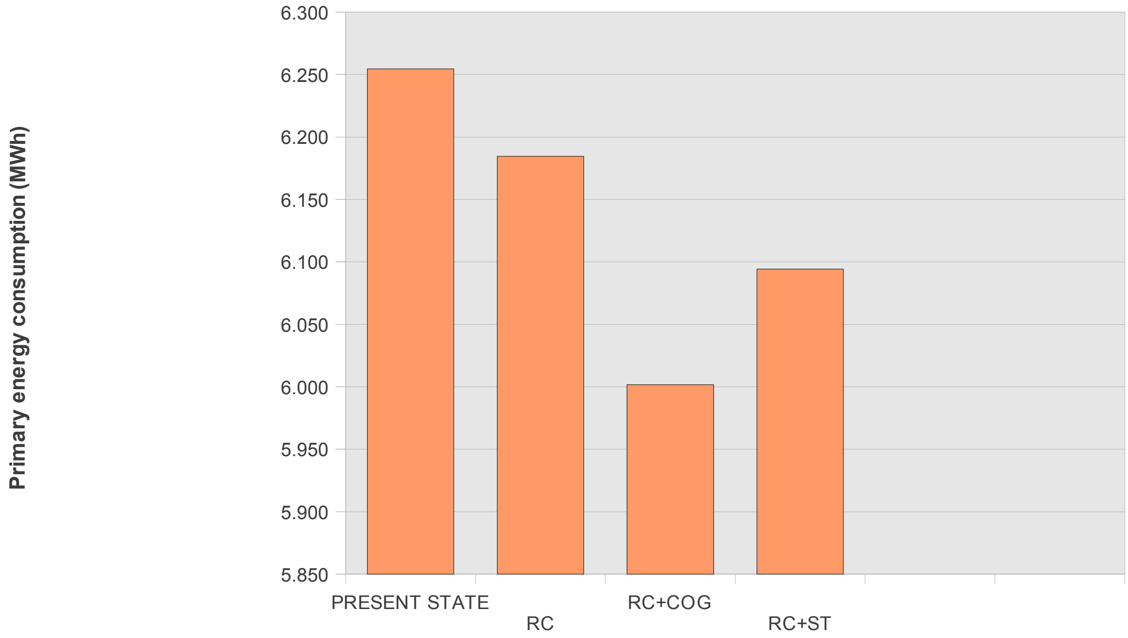

Figure 3. Comparative study: yearly primary energy consumption.

3.3. Economic performance

Table 3. Comparative study: investment costs. No susbsidies considered: the estimated income related to the white certificates trading for the CHP and the tax reduction foreseen for the solar thermal implementation have been included in the economic assessment as non- recurring revenues.

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 natural gas.

Alternative	Total investment [€]	Own investment [€]	Subsidies [€]
PRESENT STATE	---	---	---
RC	3.756	3.756	0
RC+COG	263.756	263.756	0
RC+ST	106.239	106.239	0

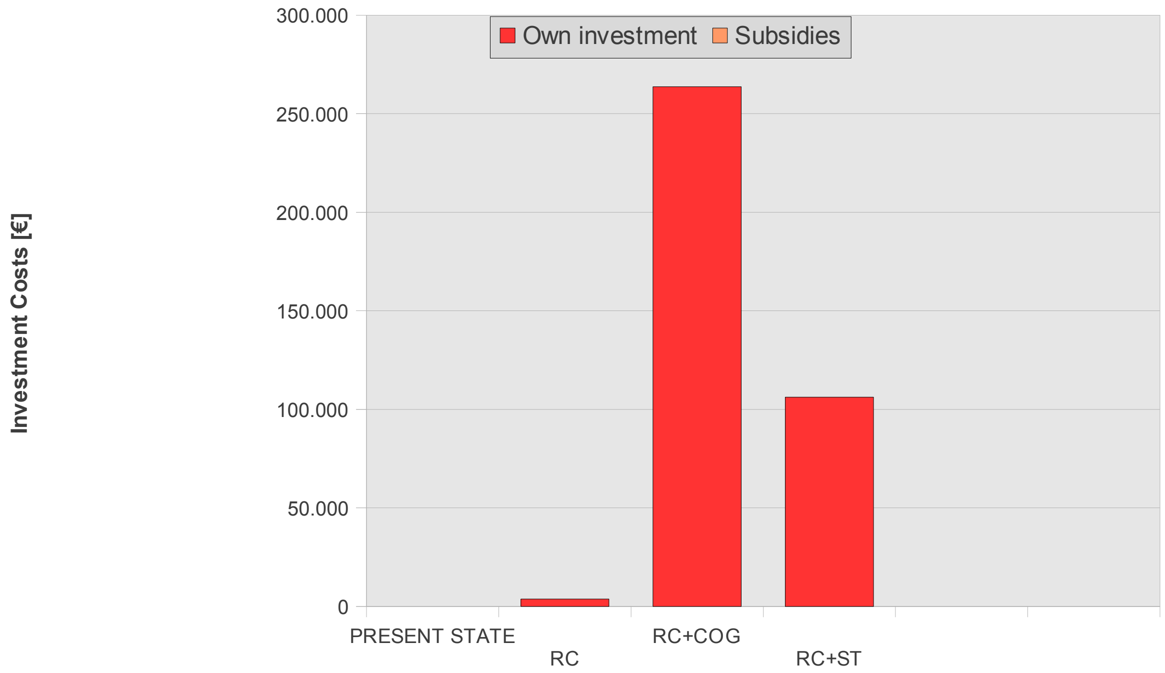

Figure 4. Comparative study: investment costs.

Table 4. Comparative study: annual costs including annuity of initial investment[2]. O&M costs are the additional costs associated to the new equipment. The annual energy costs reported in the table include the fuel and electricity annual costs, and do not include the expected white certificates`revenues for the CHP and the tax reduction foreseen for the solar thermal implementation.

Alternative	Annuity [€]	Energy Cost [€]	O&M [€]	Total [€]
PRESENT STATE	---	439.525	0	439.525
RC	362	435.774	300	436.436
RC+COG	25.411	411.735	20.550	457.696
RC+ST	10.235	430.437	800	441.472

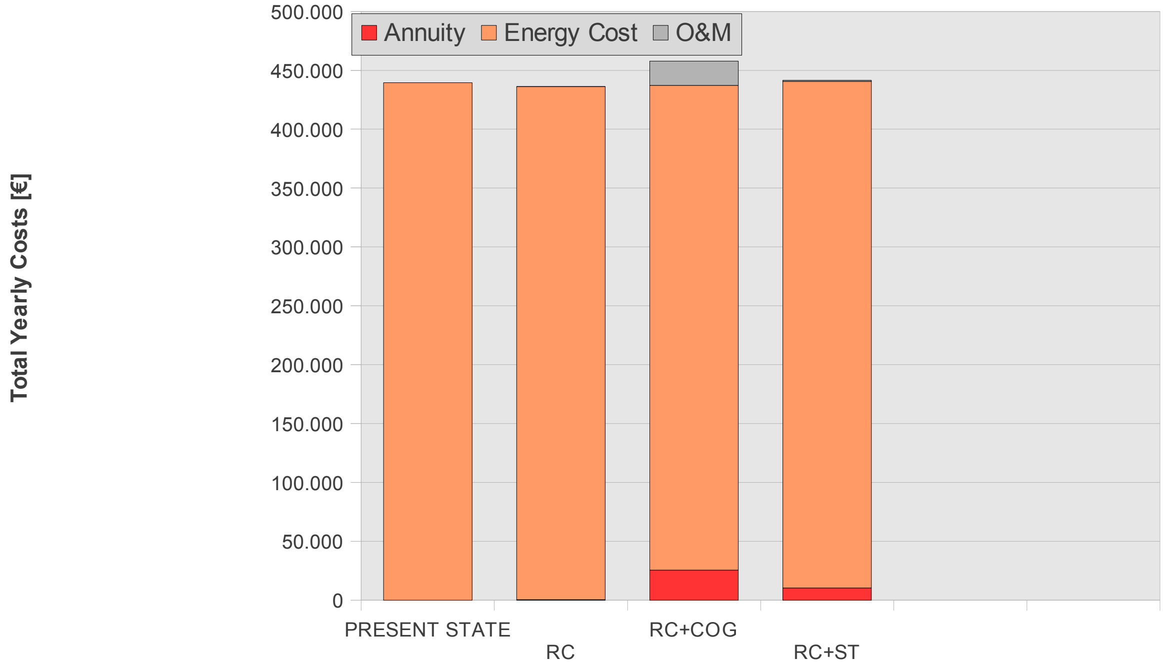

Figure 5. Comparative study: annual costs including annuity of initial investment. Data from Table 4.

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.

4. Selected alternative and conclusions

4.1. Selected alternative

The alternative proposal "RC (heat recovery)" has been proposed, that foresees the installation of a heat recovery system (heat exchanger 12 kW/K + hot water storage tank of 1,76 m^3) for the pasta boiling process.

Combining these measure with a cogeneration plant is not economically feasible (pay-back times > 15 years), and also the alternative RC+ST (increased solar thermal system) would require investment with a pay-back period of more than 8 years.[3]

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

4.1.1. Process optimisation

No process optimisation measure has been proposed, as the amount and detail of available information is not sufficient for this purpose. Nevertheless, several aspects of a possible optimisation potential of the cooking processes could be studied:

- possibility to reduce amounts of water for cooking
- possibility to cover and/or to insulate vessels.

3 This result may change in case that the base parameters used in the analysis change, especially if the COP of the currently used heat pump is lower than the estimated value of COP = 4.

4.1.2. Heat recovery

The proposed heat recovery system uses heat from the waste water of the pasta and rice boiling process for preheating of process water (Table 5). An additional hot water storage of 1,76 m^3 is foreseen for this system. As can be seen from Table 2, heat recovery leads to a saving of 1,1 % of the primary energy consumption.

Table 5. List of heat exchangers proposed.

Heat Exchanger	Power	Heat Source	Heat Sink	Heat transferred	
	[kW]			[MWh]	[%]
HX Heat Pump	79	HeatPumpSummer	SteamDistribution	91	29,93
HX_Chiller_0degC	13	Chiller_0degC	HotWater	69	22,89
HX_Chiller_-18degC	13	Chiller_-18degC	HotWater	69	22,63
HX PastaCooker	**80**	**PastaCooking**	**PastaCooking**	**74**	**24,56**

4.1.3. Heat and Cooling Supply

No additional equipment for heat and cooling supply has been foreseen.

The total and monthly contribution of the new equipment to the total heat supply is shown respectively in Table 6, Figure 6 and Figure 7 while the contribution to the cooling supply is shown in Table 7, Figure 8 and Figure 9.

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

Equipment	USH by equipment	
	[MWh]	[% of Total]
SteamBoiler	884	49,09
HeatPump	697	38,74
SolarThermal	38	2,12
ElectricalHeaters	181	10,05
Total	**1.800**	**100**

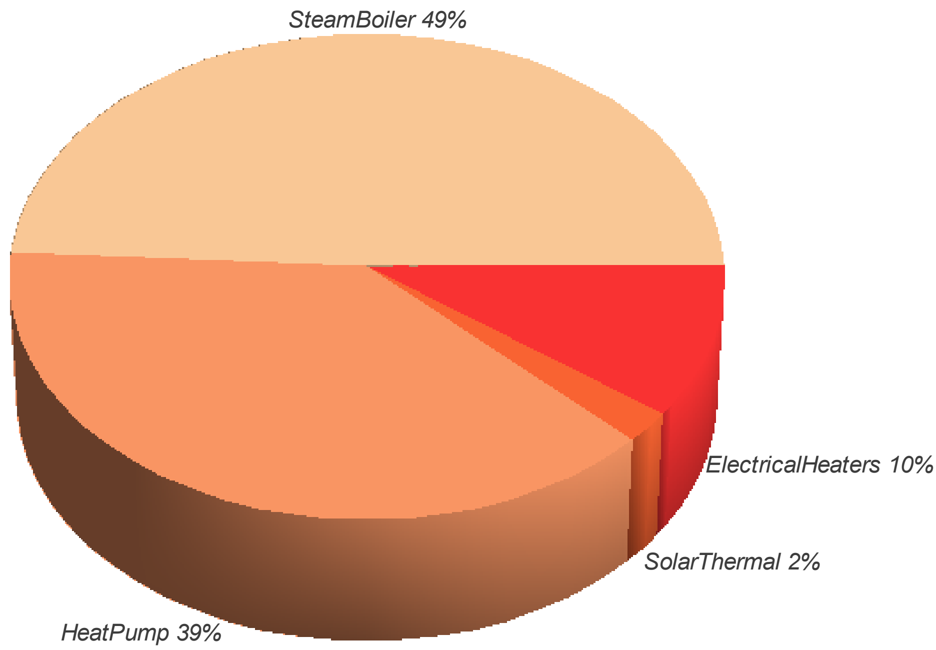

Figure 6. Contribution of the different equipments to the total useful heat supply (USH) in the company.

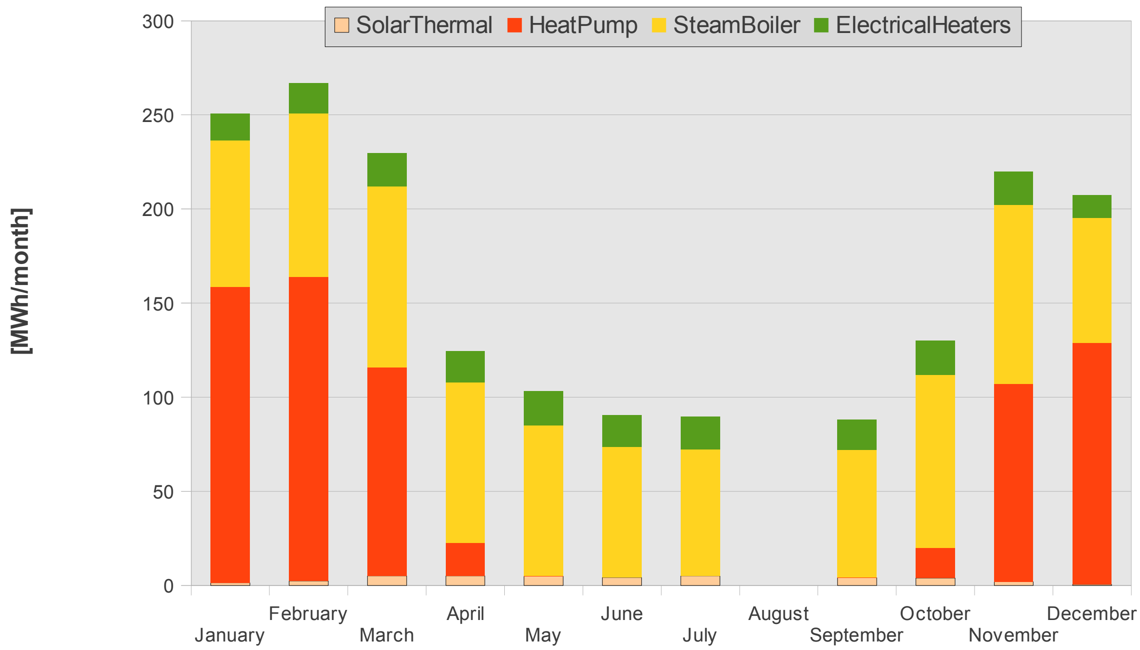

Figure 7. Contribution of the different equipments to the total useful heat supply (USH) per month.

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

Equipment	USC by equipment	
	[MWh]	[% of Total]
Chiller_0degC	511	37,69
Chiller_-18degC	354	26,14
Chiller_-5degC	20	1,50
HeatPumpSummer	470	34,67
Total	**1.356**	**100**

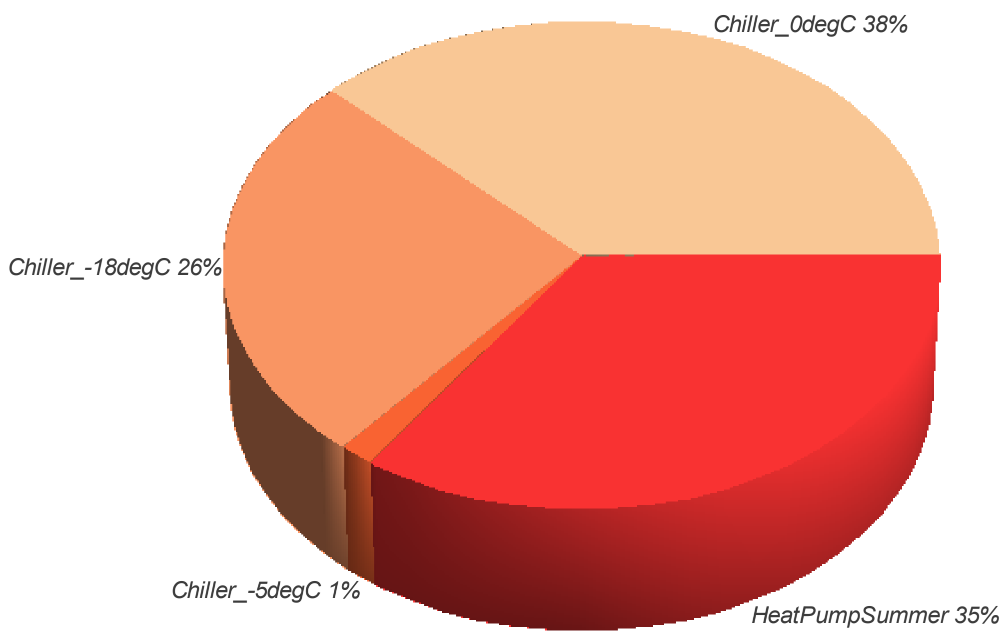

Figure 8. Contribution of the different equipments to the total useful cooling supply (USC)in the company.

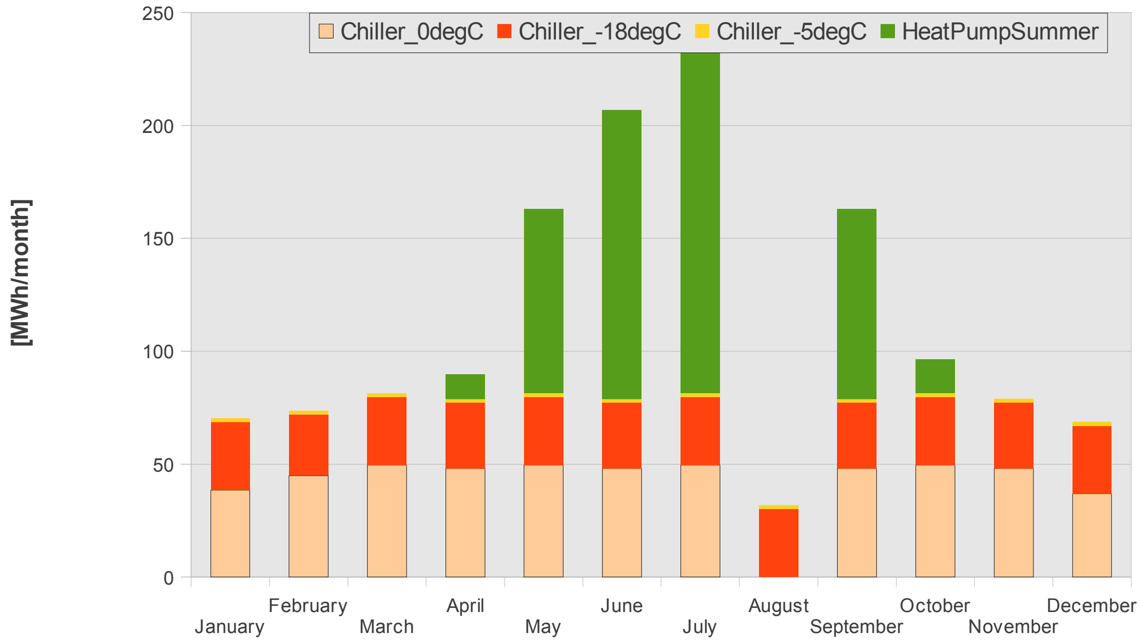

Figure 9. Contribution of the different equipments to the total useful cooling supply (USC) per month.

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

The following measures are proposed:

– heat recovery: use of waste water from pasta cooking for preheating of process water

This measures allow to save 1,1% of the current primary energy consumption and 0,9 % of current energy cost The total required investment is about 3.800 € and the expected pay-back time is 1,1 years.

Other measures such as cogeneration or an increase of the existing solar thermal system may lead to substantially higher energy savings, but have to be reconsidered once a more solid base of data is available.

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*	*6.255*	*6.185*	*1,12%*
- fuels	*MWh*	*1.155*	*1.080*	*6,49%*
- electricity	*MWh*	*5.100*	*5.105*	*-0,10%*
Primary energy saving due to renewable energy	*MWh*	*0*	*0*	-
CO_2 emissions	t/a	*1.297*	*1.280*	*1,23%*
Annual energy system cost (2)	*EUR*	*439.525*	*436.436*	*0,7%*
Total investment costs	*EUR*	-	*3.756*	-
Payback period	*years*	-	*1,1*	-

(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.*