Energy Audit Summary Report

Audit No. 72

Food Industry

Bakery

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: 09 – 05 – 2012)

2.1. General information of the company

Sector	Food (bakery)	
Products	Piadina and other bread products	
Yearly production	820 t	
Current final energy consumption [MWh] (*)	total	for heating and cooling
- natural gas	718	718
- electricity	134	33

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

2.2. Description of the company

a) Productive process

The company produces piadina bread (90% of the production) and other bread products.

Concerning the production steps, in the early morning flour is extracted from the silos and pumped to the kneading vessels where it is mixed with chilled water and other ingredients in order to obtain the dough of the piadina and of other bread products.
The dough is then formed and temporary stored before being baked either in a plate oven (piadina) or in rotary ovens (other products). Before packaging, only piadina is actively cooled down.

Offices and the production hall are equipped with space heating and air conditioning systems.

The most energy consuming processes in the company are the baking and cooling down of the piadina breads.

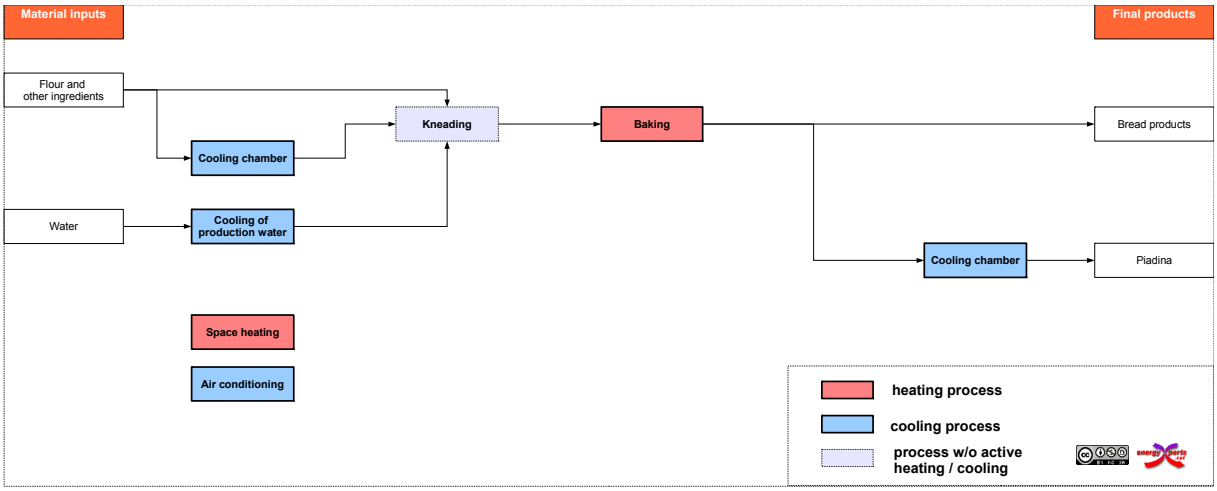

Figure 1. Simplified production flow sheet

b) Energy supply system

All ovens are equipped with natural gas fired burners.

In wintertime, an additional hot water boiler supplies heat to the offices space heating circuit (radiators) while the off - gases of the piadina oven are recoved to heat the renovation air inflow in the production hall.

Cooling is mainly provided by several electrically driven chillers (air cooled).

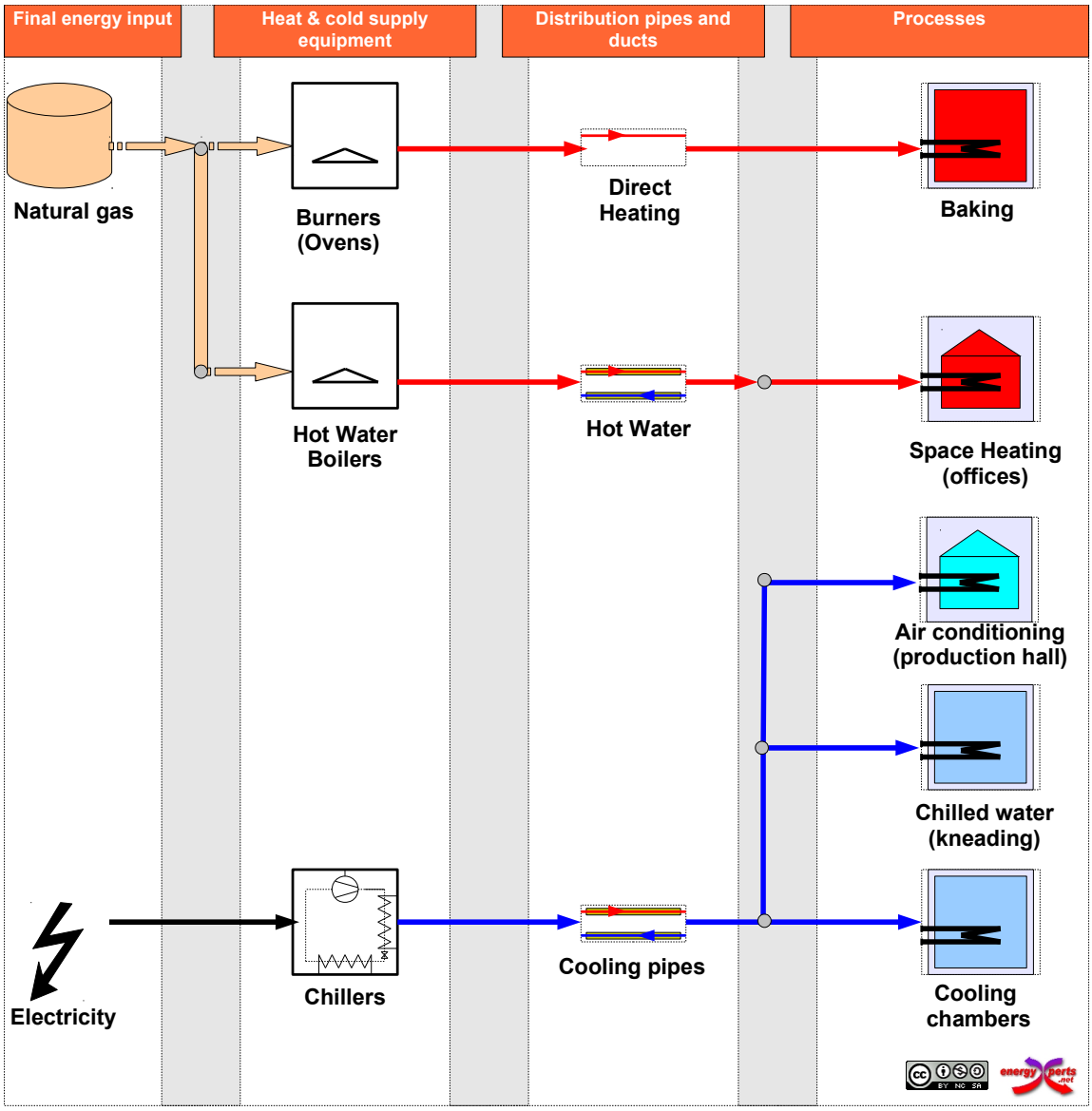

Figure 2. Overview of the heat and cold supply system

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

Table 1. Overview of the alternative proposals studied

Short Name	Description
PO Baking Piadina (PO BP)	Process optimization baking piadina (by reduction of thermal losses in the oven)
PO Cooling Piadina (PO CP)	Process optimization cooling chamber piadina (by dividing the process in two phases – at high and low temperature – and by increasing the free cooling contribution)
PO Baking + Cooling Piadina (PO)	Combination of the measures proposed in PO Baking Piadina and PO Cooling Piadina.
PO +Thermal Chiller (PO + TC)	Combination of the measures proposed in PO Baking Piadina and PO Cooling Piadina + New thermal chiller fed by the offgases of the piadina oven. Thermal nom. power: 12 kW.

3.2. Energy performance[1]

Table 2. Comparative study: yearly primary energy consumption.

Alternative	Primary energy consumption	Savings	
	[MWh]	[MWh]	[%]
Present State	1.080	---	---
PO Baking Piadina	977	103	9,54
PO Cooling Piadina	1.047	33	3,05
PO Baking + Cooling Piadina	944	136	12,59
PO + Thermal Chiller	934	146	13,52

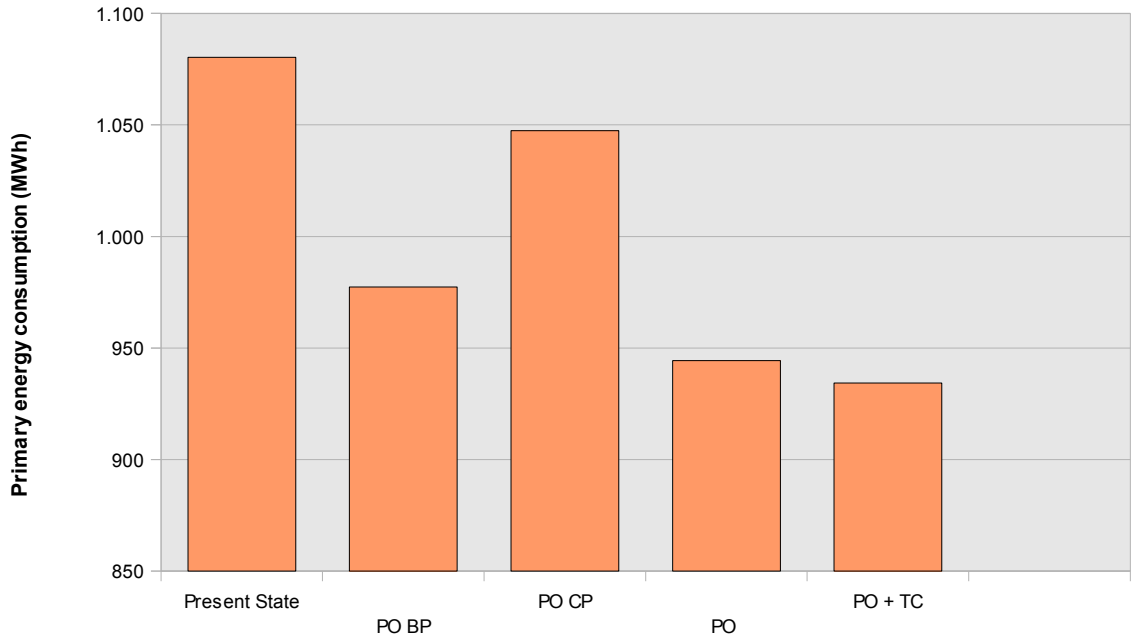

Figure 3. Comparative study: yearly primary energy consumption.

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 natural gas.

3.3. Economic performance

Table 3. Comparative study: investment costs. Investment costs for the baking and cooling optimisation are provided on a purely indicative basis. Investment costs for the cooling process optimisation account for the control strategy improvement only. No susbsidies considered.

Alternative	Total investment [€]	Subsidies [€]
Present State	---	---
PO Baking Piadina	20.000	0
PO Cooling Piadina	5.000	0
PO Baking + Cooling Piadina	25.000	0
PO + Thermal chiller	34.600	0

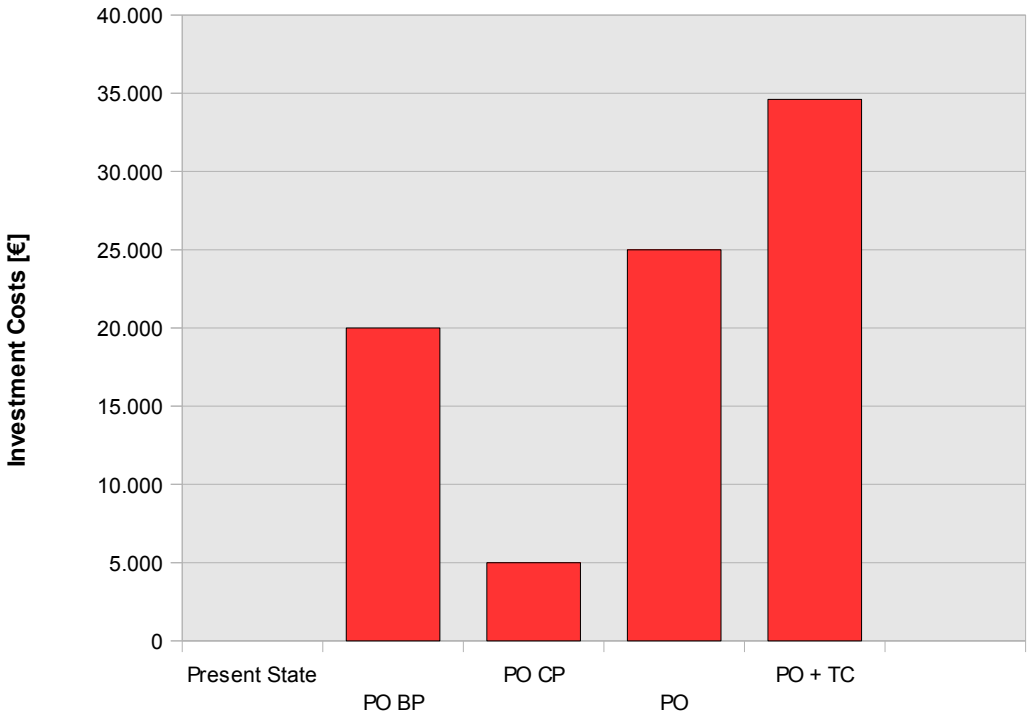

Figure 4. Comparative study: investment costs.

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

Alternative	Annuity [€]	Energy Cost [€]	O&M [€]	Total [€]
Present State	---	59.322	0	59.322
PO Baking Piadina	1.927	54.538	0	56.465
PO Cooling Piadina	482	56.981	0	57.462
PO Baking + Cooling Piadina	2.409	52.197	0	54.605
PO +Thermal Chiller	3.333	51.434	380	55.148

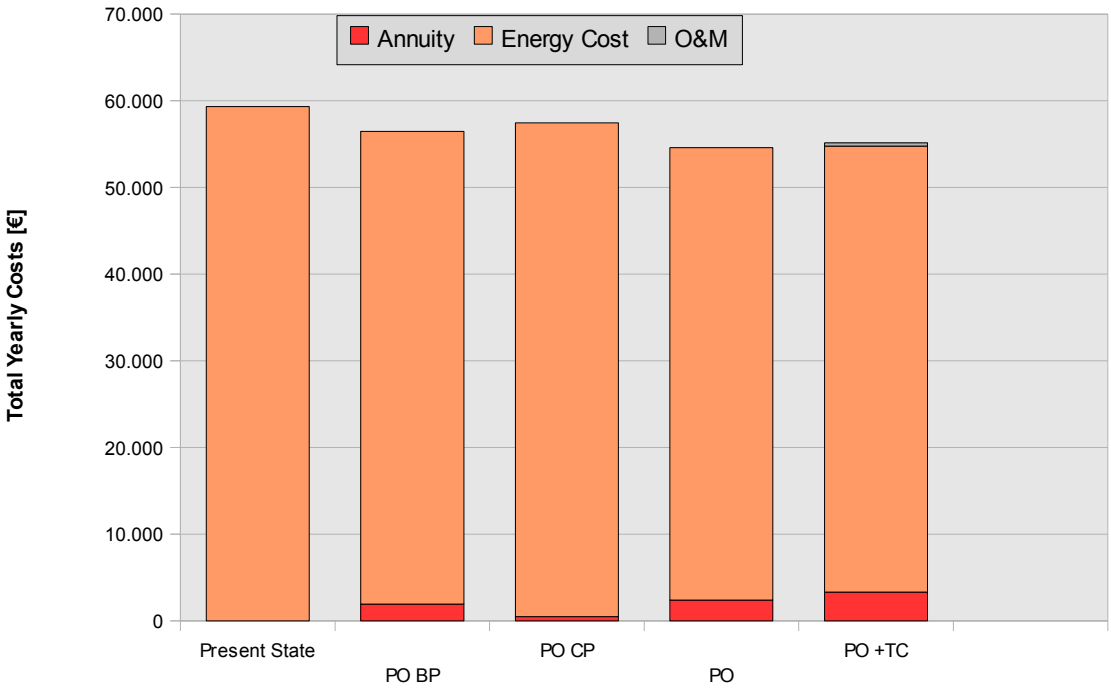

Figure 5. Comparative study: annual costs including annuity of initial investment.

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 "PO Baking and Cooling Piadina" that combines the energy optimisation of the piadina baking and cooling processes has been considered the best option because it shows the biggest energy saving potential in relation to the economic performances.

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

4.1.1. Process optimisation

The proposed energy saving alternative combines the following two process optimisation interventions:

- the improvement of the energy efficiency of the baking process by reducing the thermal losses in the plate oven, currenlty not insulated,
- splitting the piadina cooling process (currently from 90 ºC down to ambient temperature) in two temperature steps, in order to allow a better exploitation of the free cooling (suitable for the first cooling step, at higher temperature) and to reduce the electricity consumption of the existing chillers.

As can be seen from Table 2, this measure leads to a primary energy saving of 12,5% of which 9,5% is due to the baking process improvement (resulting in a fuel consumption reduction), and the residual 3% to the cooling optimisation (resulting in a electricity consumption reduction).

4.1.2. Heat recovery

No additional heat exchangers foreseen.

4.1.3. Heat and Cooling Supply

No additional equipments have been proposed with respect to the existing heating and cooling supply systems.

Table 5. Heat and cooling existing supply equipments. Selected alternative.

Equipment	Type	Contribution to total h
		[MWh]
Boiler	hot water boiler	21
BakingOvenPiadina	burner (direct heating)	529
NewBakingOven	burner (indirect heating)	36
OldBakingOvens	burner (indirect heating)	12
Chiller_KneadingWater	compression chiller (air cooled)	1
GroundWater	ground water	1
Chillers_Production	compression chiller (air cooled)	34
Chiller_Warehouse	compression chiller (air cooled)	19
Chiller_CoolingChamber	compression chiller (air cooled)	13

The total and monthly contribution of the existingt equipments to the total heat supply (598 MWh) is shown respectively in Table 6, Figure 6 and Figure 7 while the contribution to the cooling supply (67 MWh) 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]
Boiler	21	3,51
BakingOvenPiadina	529	88,45
NewBakingOven	36	6,08
OldBakingOvens	12	1,95
Total	**598**	**100**

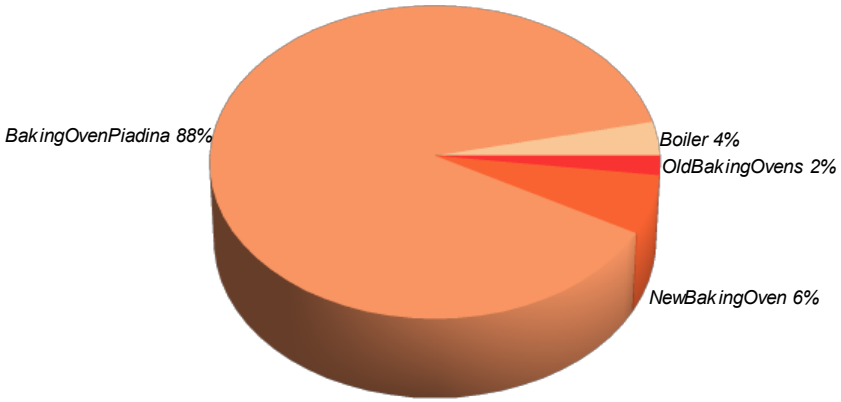

Figure 6. Contribution of the different equipments to the total useful heat supply (USH) in the company.

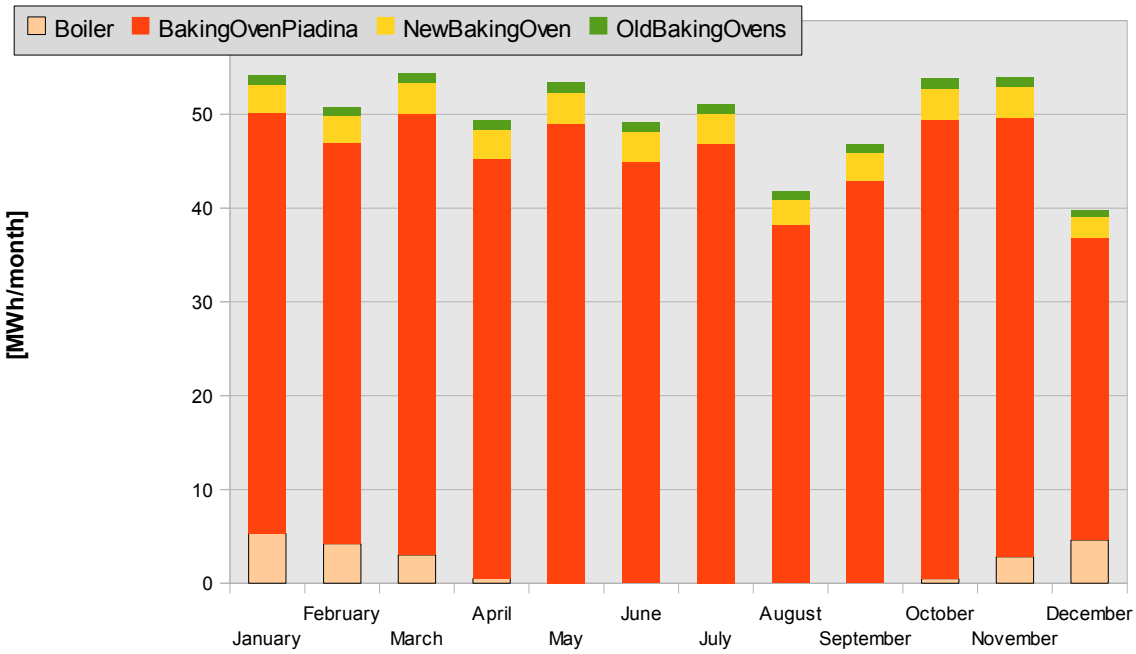

Figure 7. Contribution of the different equipments to the total useful heat supply (USH) per month.

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_KneadingWater	1	0,93
GroundWater	1	1,03
Chiller_Production	34	50,26
Chiller_Warehouse	19	28,00
Chiller_CoolingChamber	13	19,77
Total	**67**	**100**

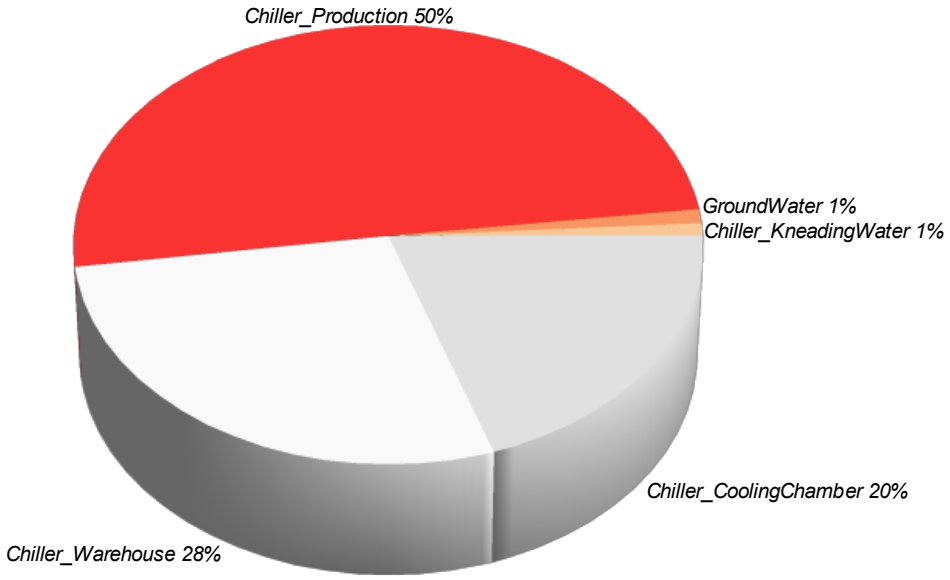

Figure 8. Contribution of the different equipments to the total useful cooling supply (USC)in the company.

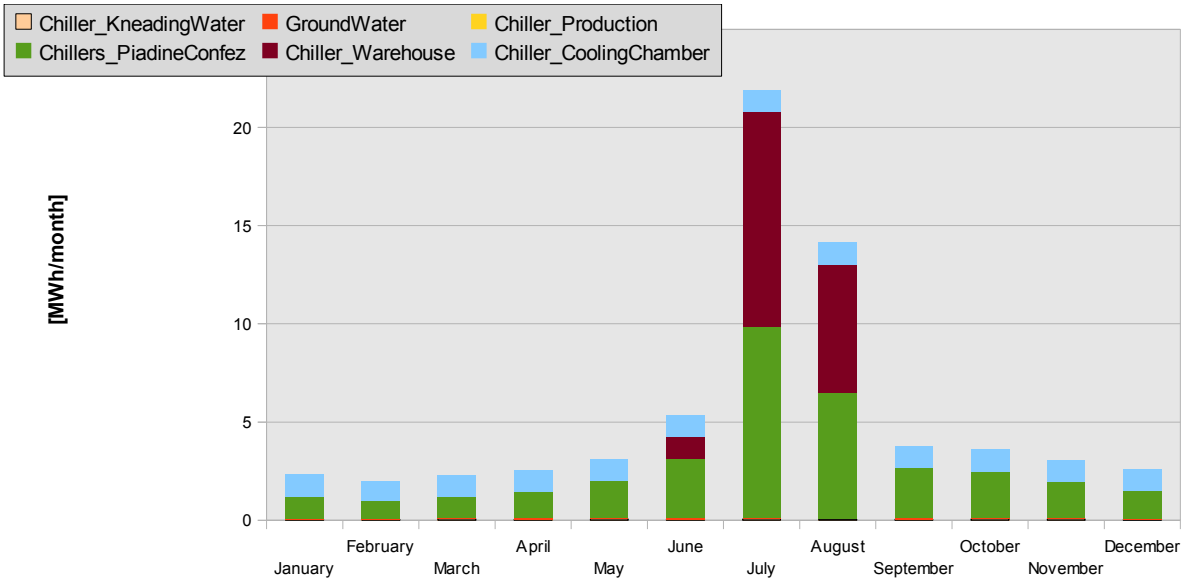

Figure 9. Contribution of the different equipments to the total useful cooling supply (USC) per month.

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

The following measures are proposed:

- Optimisation baking process: improvement of the baking process by reducing the thermal losses in the plate oven, currenlty not insulated
- Optimisation cooling process: splitting the piadina cooling process in two temperature steps, in order to allow a better exploitation of the free cooling.

These measures allow to save 12,59 % of the current primary energy consumption and 12% of the current energy cost. The total estimated investment is 25.000 € (3) and the expected pay-back is 3,7 years.

The technical and economical feasibility of a thermally driven chiller fed by the off-gases of the oven after the baking optimisation should be further investigated in order to achieve higher savings.

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*	*1.080*	*944*	*12,59%*
- fuels	*MWh*	*790*	*675*	*14,58%*
- electricity	*MWh*	*290*	*269*	*7,18%*
Primary energy saving due to renewable energy	*MWh*	*0*	*0*	-
CO_2 *emissions*	t/a	*238*	*208*	*12,75%*
Annual energy system cost (2)	*EUR*	*59.322*	*54.605*	*7,95%*
Total investment costs (3)	*EUR*	*0*	*25.000*	-
Payback period	*years*	-	*3,7*	-

(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) investment costs are provided on a purely indicative basis. Investment costs for the cooling process optimisation account for the control strategy improvement only. No subsidies considered.