Energy Audit Summary Report
AEE INTEC
Audit no. 54 – BUL09

10th of May 2012

Supported by INTELLIGENT ENERGY EUROPE

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AUDIT no. 54 - BUL09

1. Data of the auditor

1.1. Contact data of the auditor

Jürgen Fluch, Matthäus Hubmann

Number of audits preformed: 17

Date of the audit: 15.04.2012

Duration of the audit: 4 weeks

AEE INTEC, Gleisdorf, Austria

2. Introduction

2.1. Objectives

The main objectives of this audit were to verify and check the potential energy savings.

3. Status Quo: processes, distribution, energy supply

The reference data and information are taken of the year 2010.

3.1. General information of the company

Sector	Aluminium Parts Manufacturer
Products	Aluminium Parts for cars
No. of employees	550 employees
Current primary energy consumption	3,572 [MWh/a]

3.2. Flow sheet of the whole manufacturing side

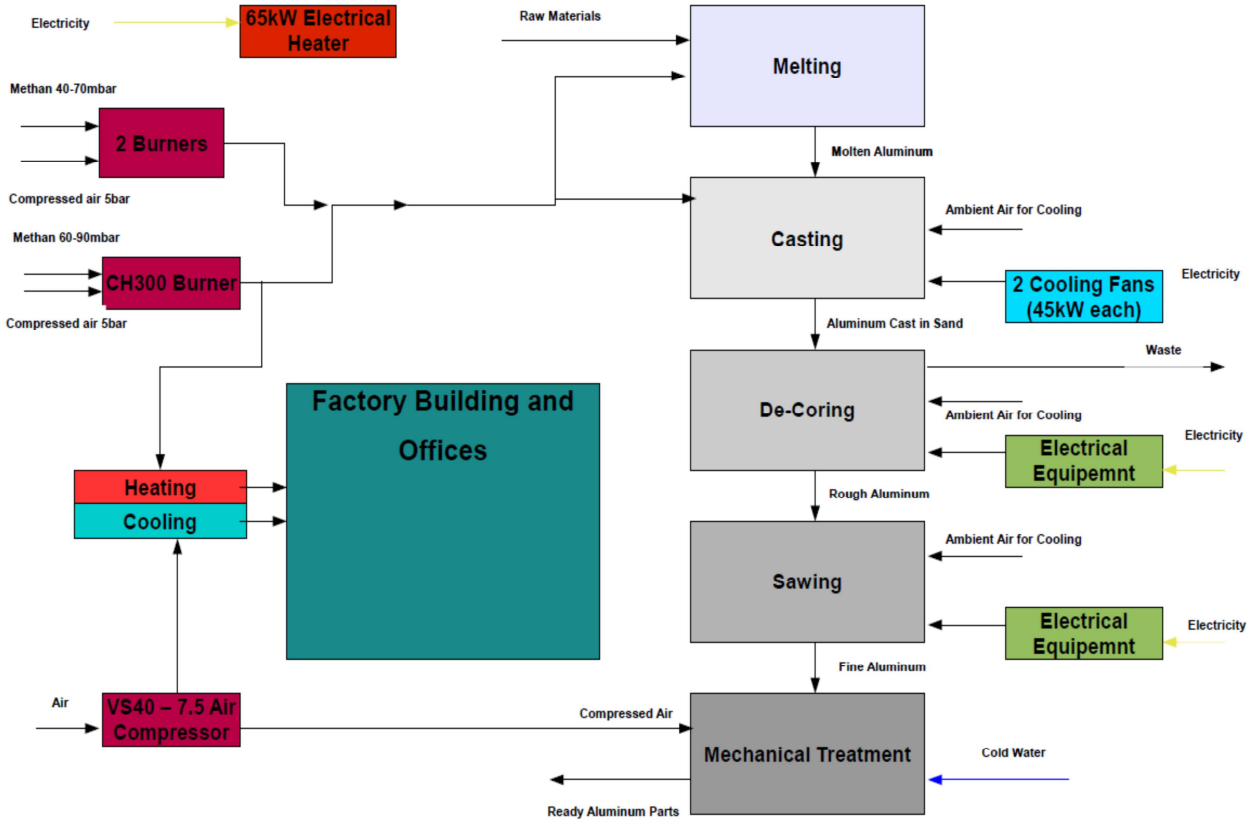

Figure 1: Flow sheet of the factory

3.3. Description of the existing system

- **Energy Supply:**

The factory is mainly consuming energy for the different metal treatment processes (melting, casting, etc…), in addition to the heating of the buildings. In addition it has electrical consumption for cooling in summer and ventilation purposes.

Table 1: Primary energy consumption (PEC) and primary energy consumption for thermal use (PET)

Energy type (fuels / electricity)	PEC		PET	
	[MWh]	[% of Total]	[MWh]	[% of Total]
Total fuels	2,357	65.99	2,357	65.99
Total electricity	1,215	34.01	1,215	34.01
Total (fuels + electricity)	**3,572**	**100.00**	**3,572**	**100.00**

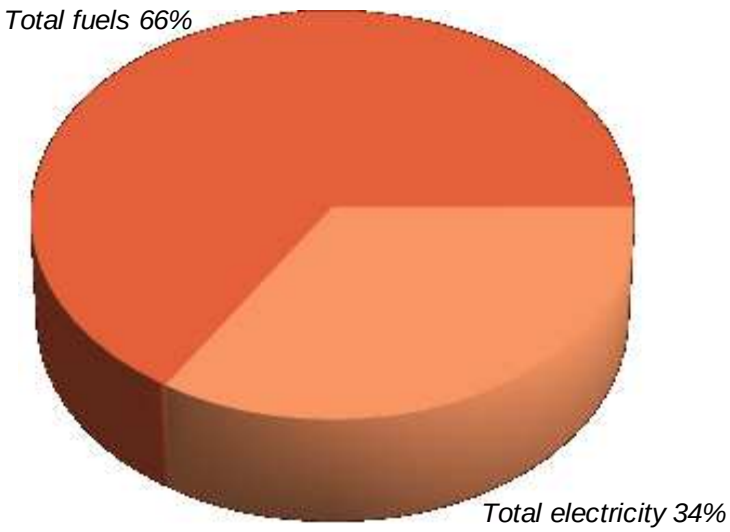

Figure 2: distribution of PEC by fuel type

Table 2: Final energy consumption (FEC) and Final energy consumption for thermal use (FET)

Fuel type	FEC		FET	
	[MWh]	[% of Total]	[MWh]	[% of Total]
Natural gas	2,143	84.11	2,143	84.11
Electricity	405	15.89	405	15.89
Total	2,548	100.00	2,548	100.00

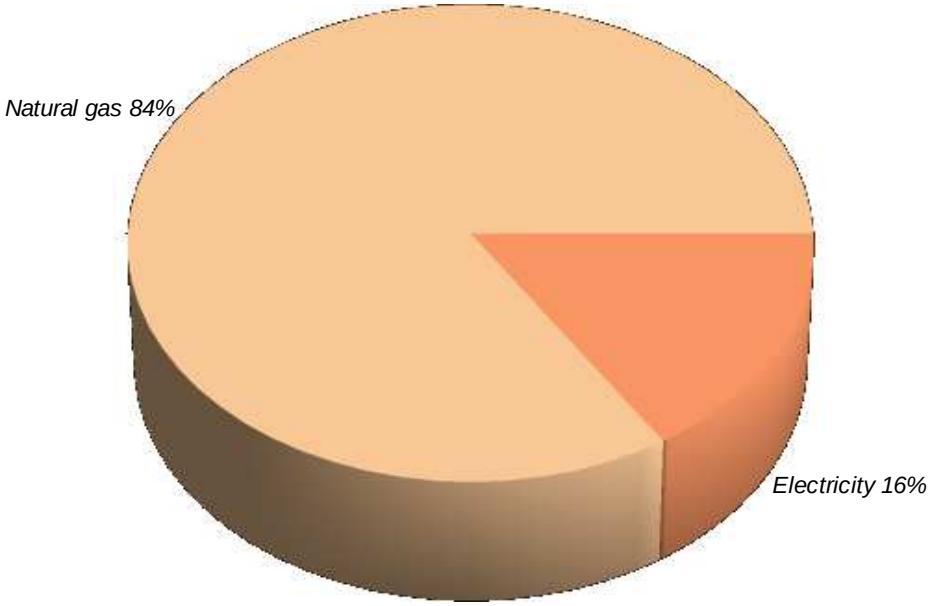

Figure 3: Total final energy consumption for thermal use (FET)

Table 3: Final energy consumption for thermal use (FET) by equipment

Equipment	Fuel type	FET by equipment	
		[MWh]	[% of Total]
burner (melting)	Natural gas	416	16.31
burner (casting)	Natural gas	67	2.64
supporting furnance	Electricity	270	10.60
heating	Natural gas	1,444	56.66
hot water boiler	Natural gas	216	8.49
cooling fans	Electricity	127	4.98
cooling	Electricity	8	0.31
Total		**2,548**	**100.00**

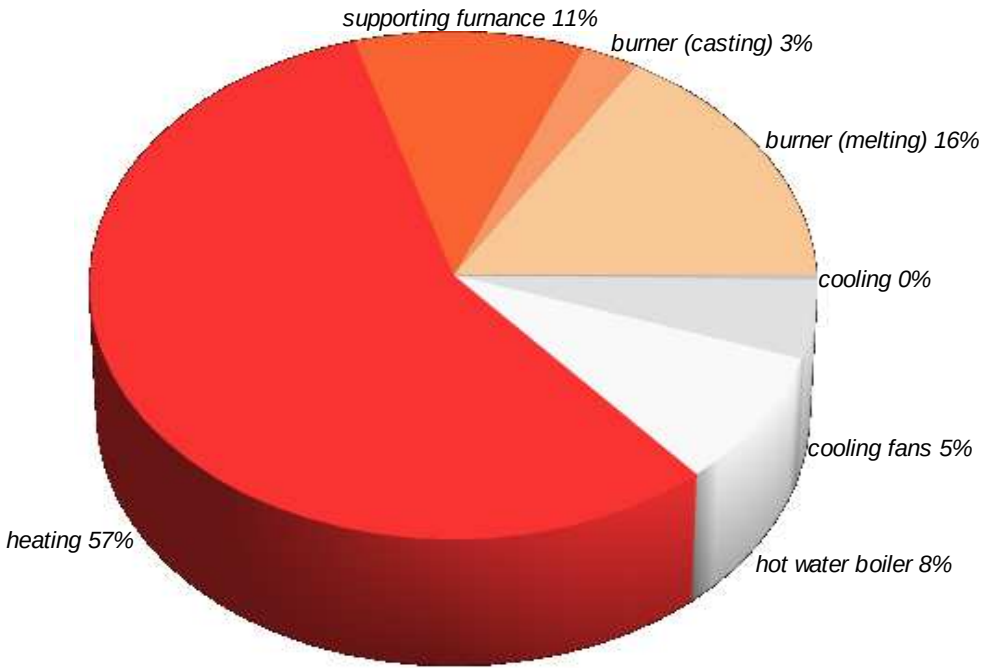

Figure 4: Final energy consumption for thermal use (FET) by equipment

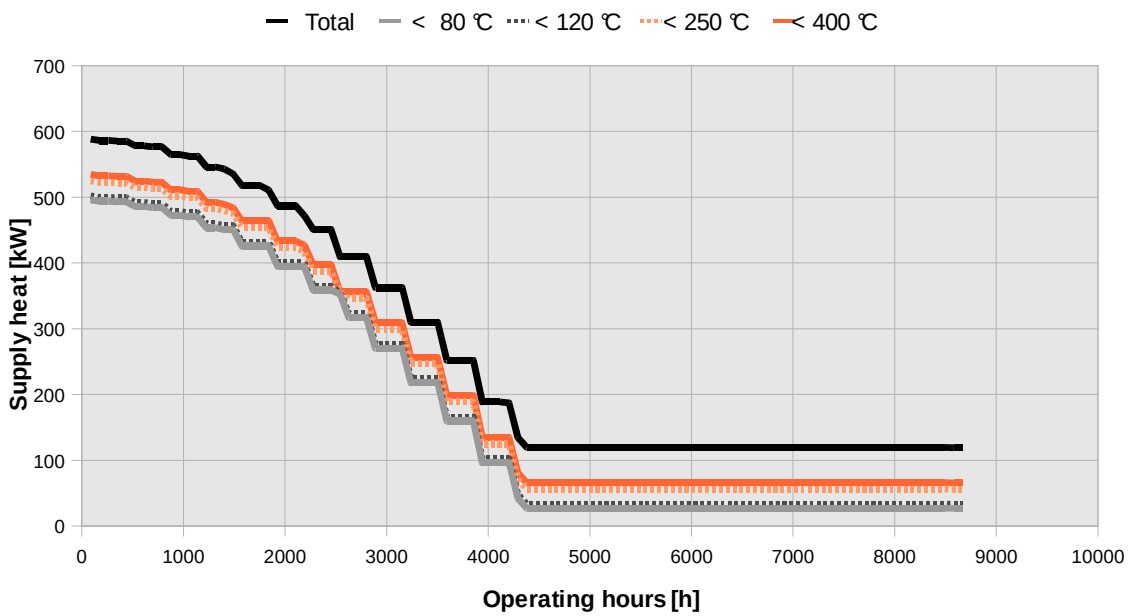

Figure 5: Distribution of supply heat by temperature levels and annual operating hours. Present state.

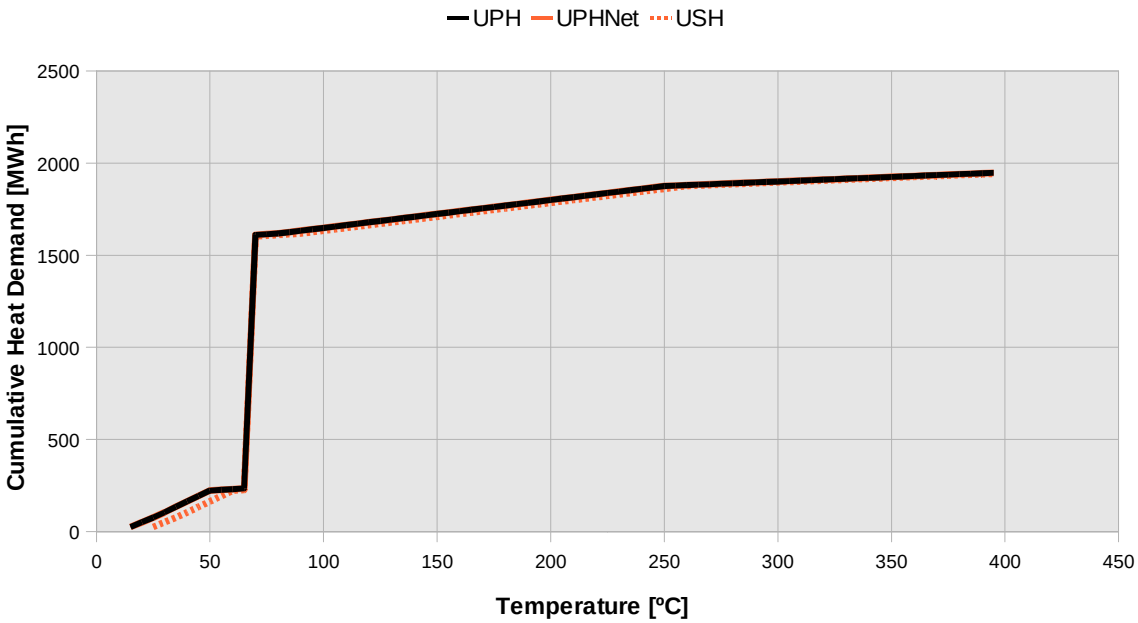

Figure 6: Distribution of the heat demand by temperature levels

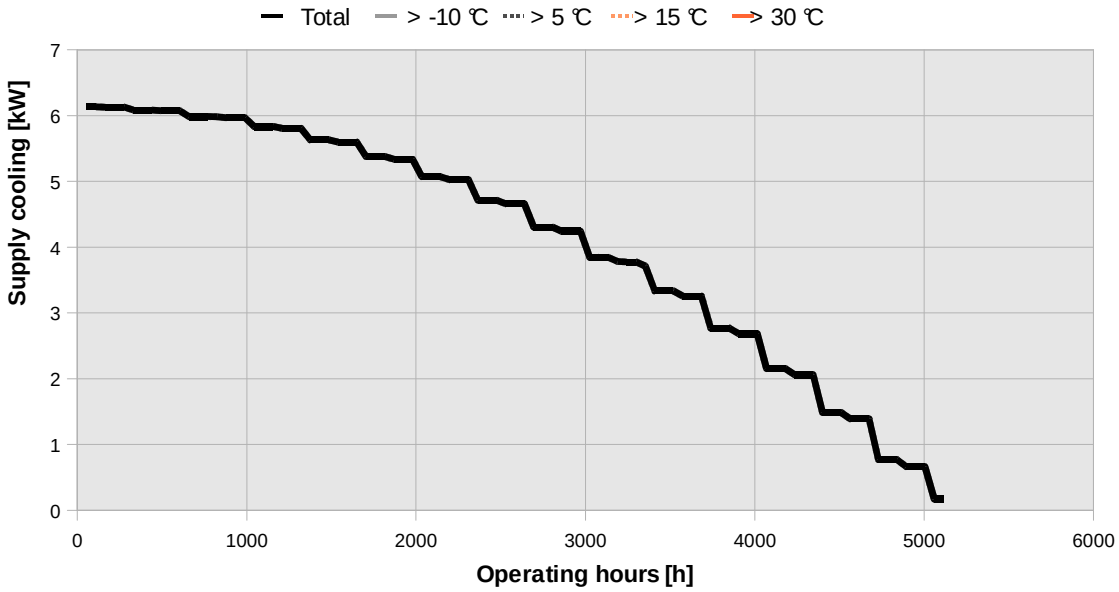

Figure 7: Distribution of supply cooling by temperature levels and annual operating hours. Present state.

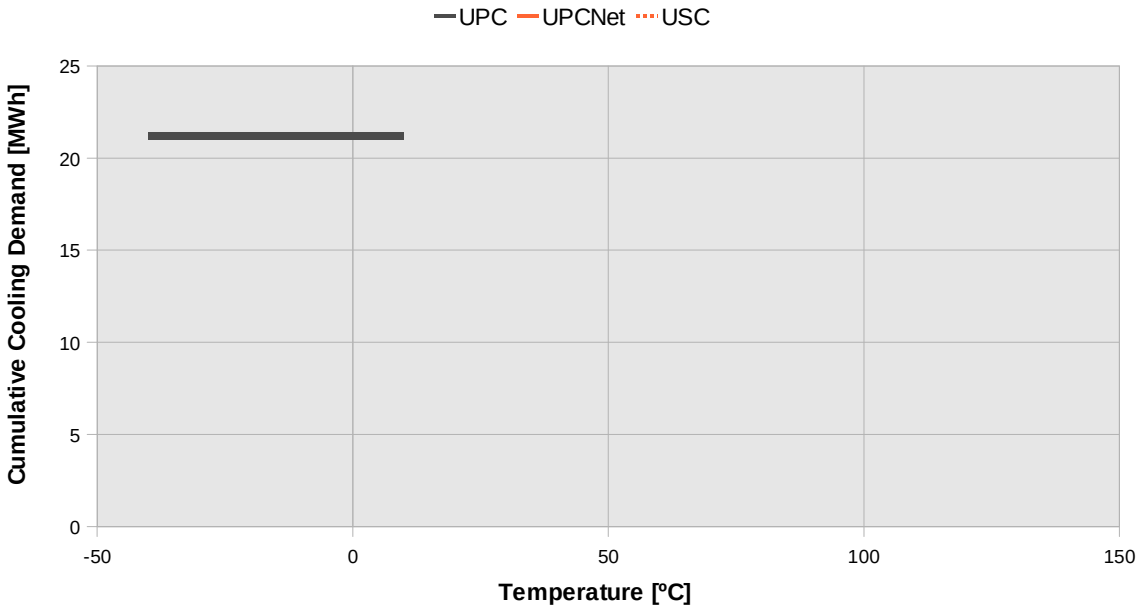

Figure 8: Distribution of the cooling demand by temperature levels

Table 4: Useful supply heat (USH) by equipment. Present state.

Equipment	USH by equipment	
	[MWh]	[% of Total]
burner (melting)	374	15.53
burner (casting)	61	2.51
supporting furnance	270	11.22
heating	1,372	56.93
hot water boiler	206	8.54
cooling fans	127	5.27
Total	**2,409**	**100.00**

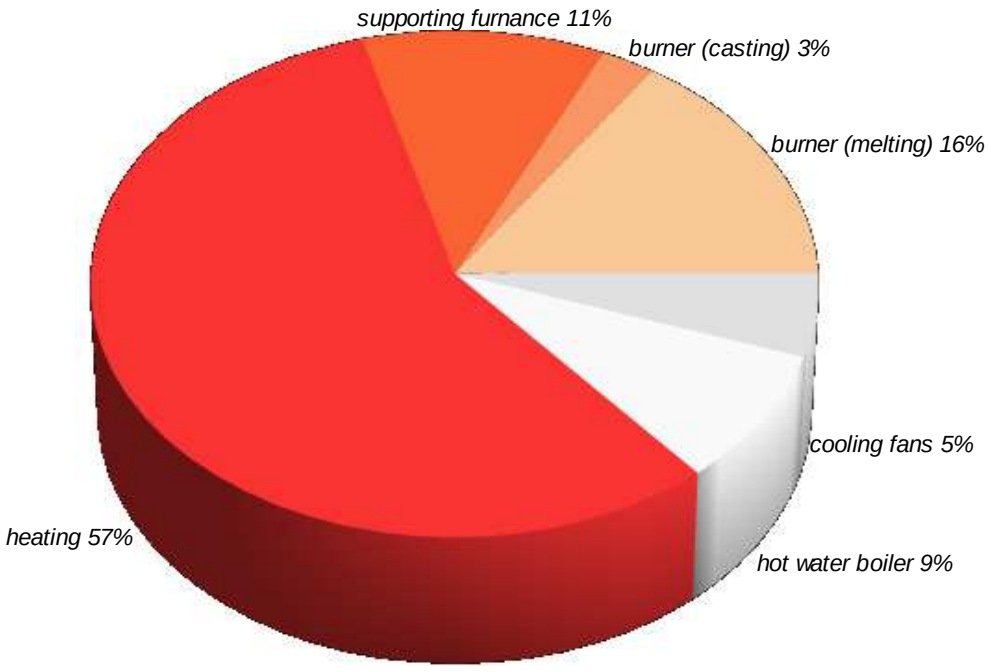

Figure 9: Useful supply heat (USH) by equipment. Present state

Table 5: Useful process heat demand (UPH) by process. Present state.

Process	Total	Circulation	Maintenance	Start-up
	[MWh]	[MWh]	[MWh]	[MWh]
production building_HW	206	206	0	0
production building_heating	1,289	0	1,289	0
administrative building_heating	82	0	82	0
melting	374	374	0	0
casting	61	61	0	0
supporting furnance	270	0	270	0
cooling fans	127	127	0	0
Total	**2,409**			

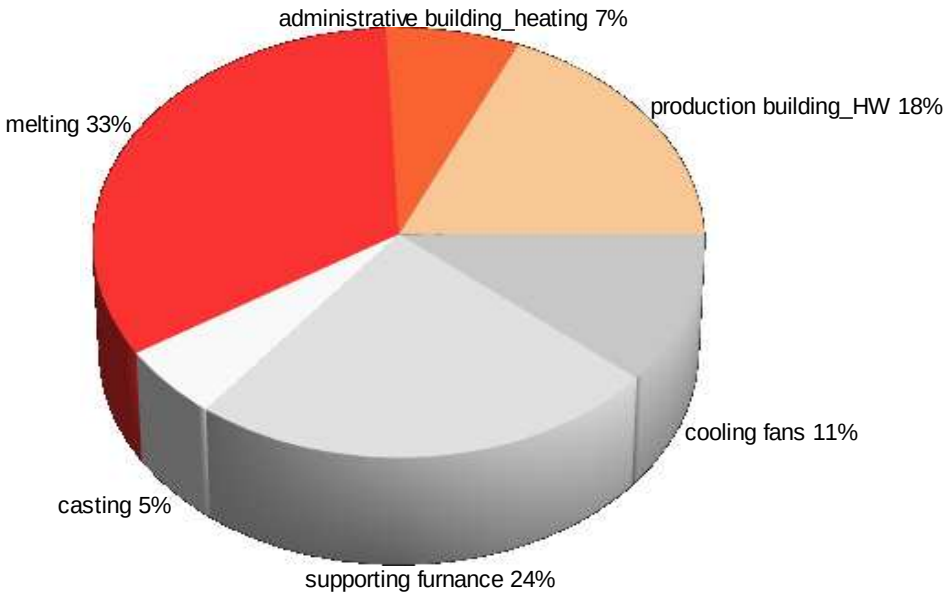

Figure 10: Useful process heat (UPH) by process

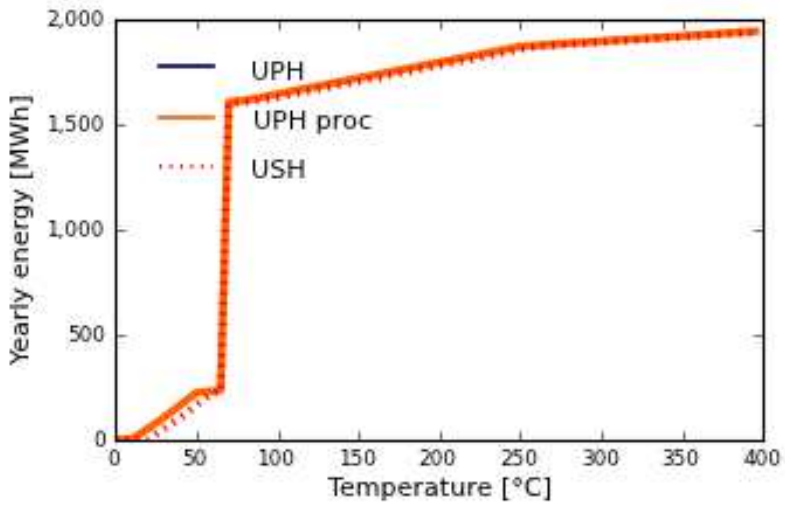

Figure 11: Distribution of heat demand (UPH) and supply (USH) by process temperatures

Table 6: Useful supply cooling (USC) by equipment. Present state.

Equipment	USC by equipment	
	[MWh]	[% of Total]
cooling	21	100.00
Total	**21**	**100.00**

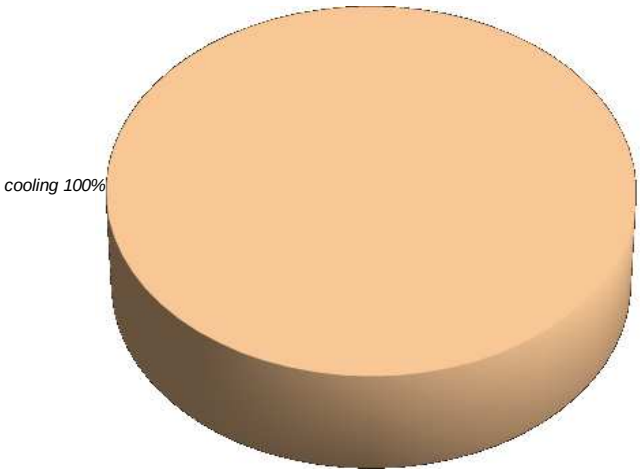

Figure 12: Useful supply cooling (USC) by equipment. Present state.

Table 7: Useful process cooling demand (UPC) by process. Present state.

Process	Total	Circulation	Maintenance
	[MWh]	[MWh]	[MWh]
administrative building_cooling	1	0	1
production building_cooling	20	0	20
Total	**21**		

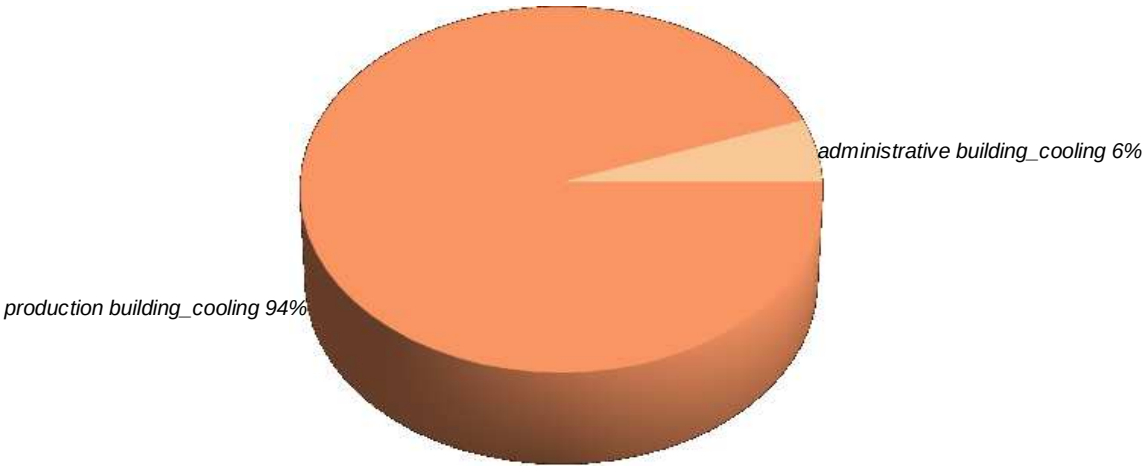

Figure 13: Useful process cooling (UPC) by process

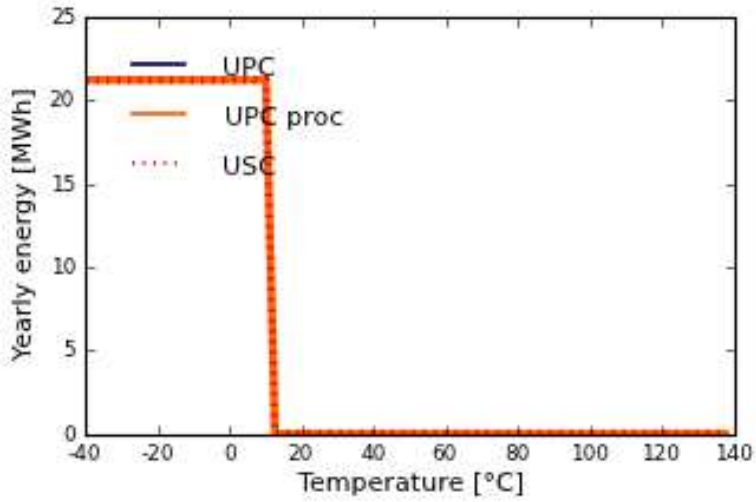

Figure 14: Distribution of cooling demand (UPC) and supply (USC) by process temperatures

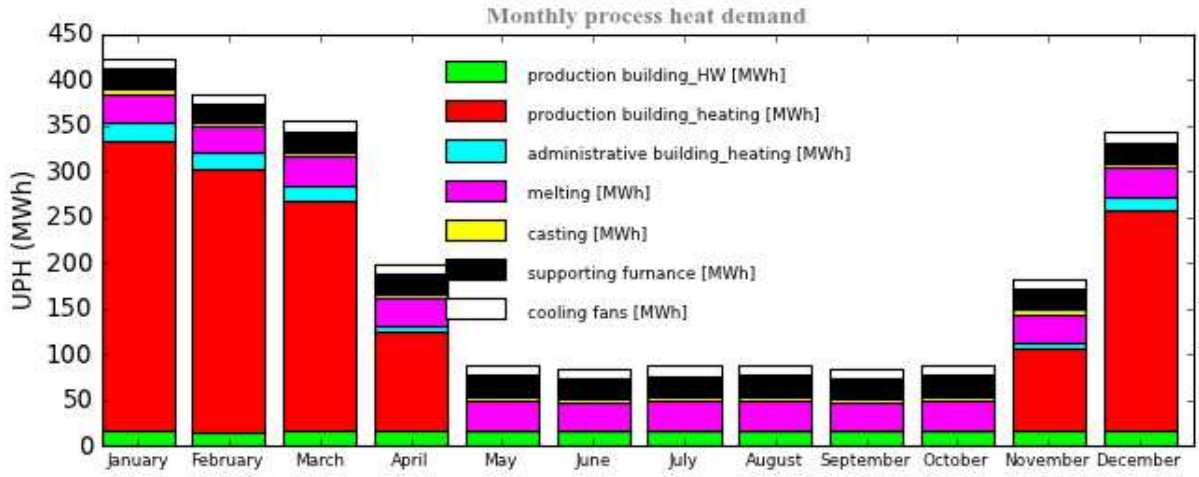

Figure 15: Distribution of useful process heat demand per month

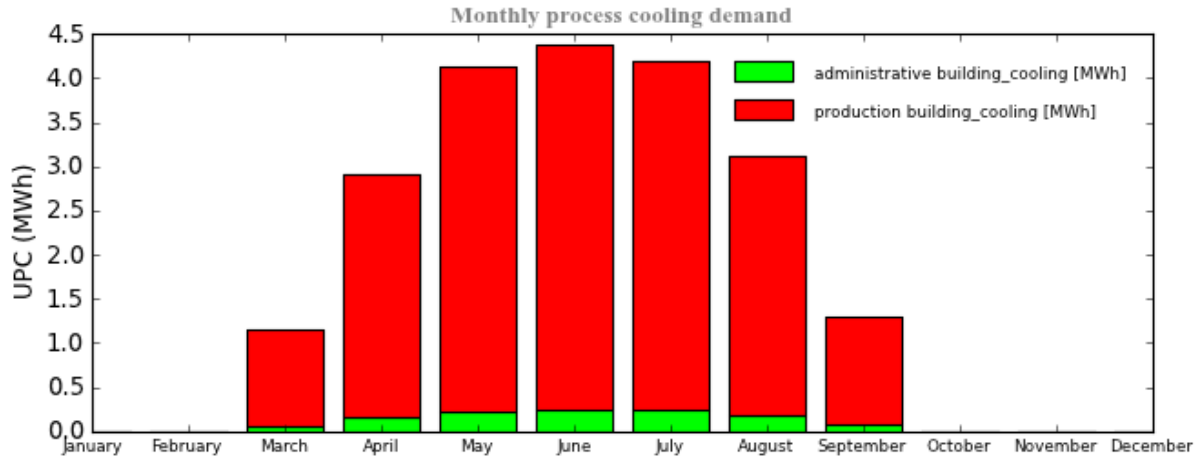

Figure 16: Distribution of useful process cooling demand per month

3.4. General

- The target room temperature during winter is 22 °C for the administrative building and also for the production building.
- The hot water demand was estimated to be 12.1 m³ per day.

4. Comparative study

4.1. Proposed alternatives

There are five proposals made in this study. In the first proposal a solar thermal system is installed using flat plate collectors. The second proposal is a new boiler with 350kW. The third proposal focuses on the installation of an HR compressor (based on the present state). The fourth proposal discusses the installation of a new boiler (200kW) in addition to an HR compressor. The fifth is an HR compressor and a solar thermal system.

Table 8: Overview of the alternative proposals studied

Short Name	Description
solar HW	based on present state the installation of a solar thermal system is proposed
new boiler (350kW)	based on present state a new boiler is proposed
HR compressor	based on present state the heat recovery from the waste heat of the air compressor is suggested
HR + new boiler (200kW)	based on present state the heat recovery from the waste heat of the air compressor and the installation of a new boiler is suggested
HR + solar HW and heating	based on present state the heat recovery from the waste heat of the air compressor and the installation of a solar thermal system is suggested

4.1.1. Heat Supply

- **Solar HW (FPC):**

Collector type:	FPC (flat plate collectors)
Installed capacity:	863.8 kW
Installed collector area:	2685.8 m²
Solar buffer storage volume:	61.7 m³
Solar fraction:	94.1 %
Annual energy yield:	223.98 kWh/kWa

Table 9: Heat and cooling supply equipment and contribution to total heat and cooling supply

Equipment	Nominal capacity	Contribution to total heat and cooling supply	
	[kW]	[MWh]	[%]
Solar thermal system	864	193	8.03
burner (melting)	90	374	15.53
burner (casting)	30	61	2.51
supporting furnance	65	270	11.22
heating	500	1,372	56.93
hot water boiler	100	12	0.50
cooling fans	89	127	5.27
cooling	50	21	100.00
Total	**1,788**	**2,430**	**200**

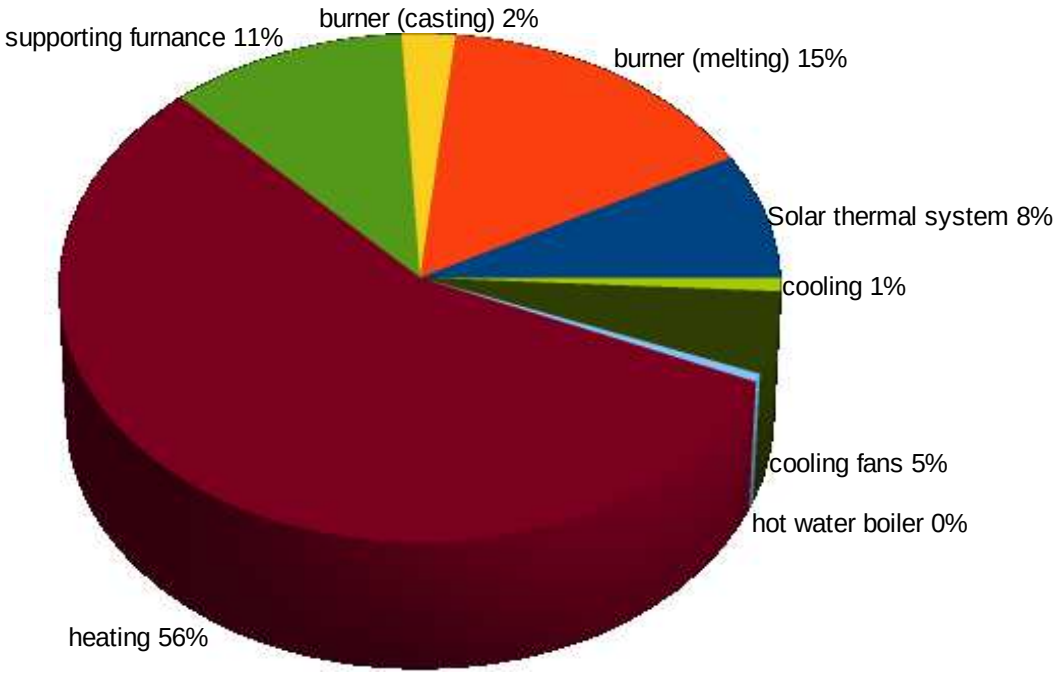

Figure 17: Contribution of each equipment to the total useful heat and useful cooling supply (USH & USC).

- graphic: heat demand covered by solar thermal system:

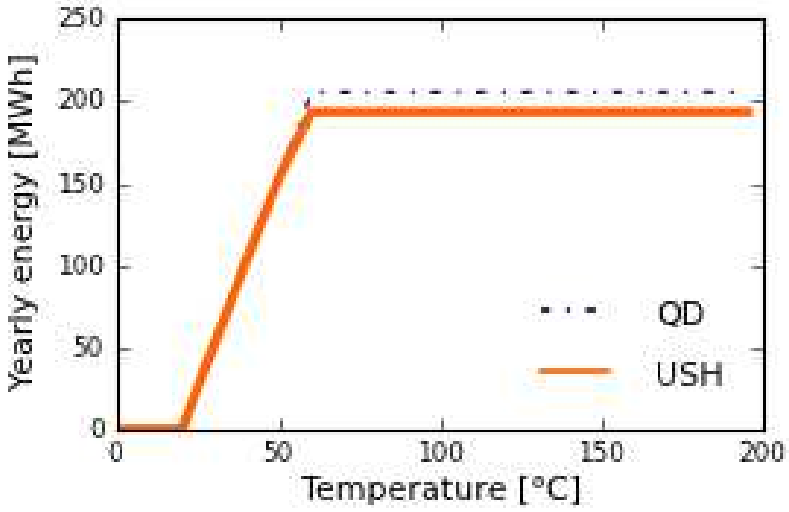

Figure 18: Heat demand and solar contribution

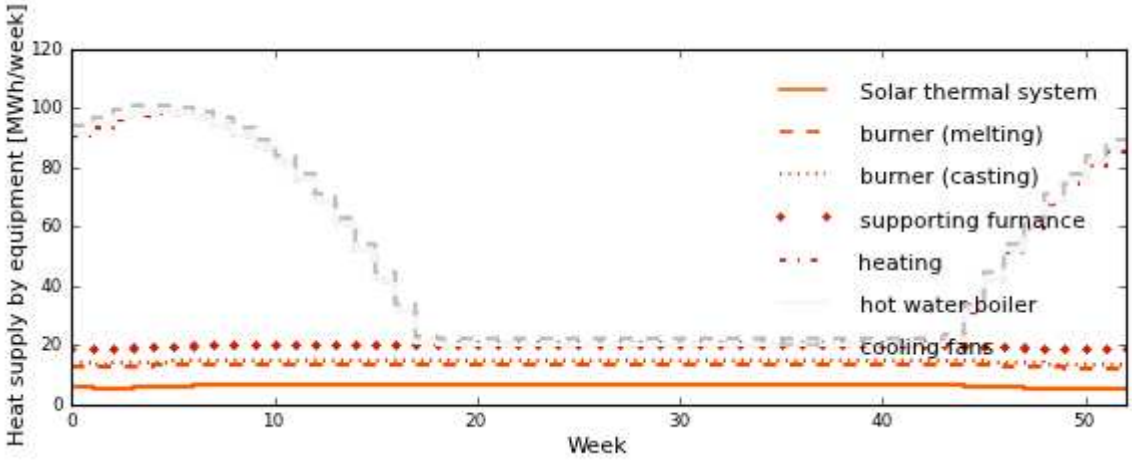

Figure 19: Weekly heat supply by equipment

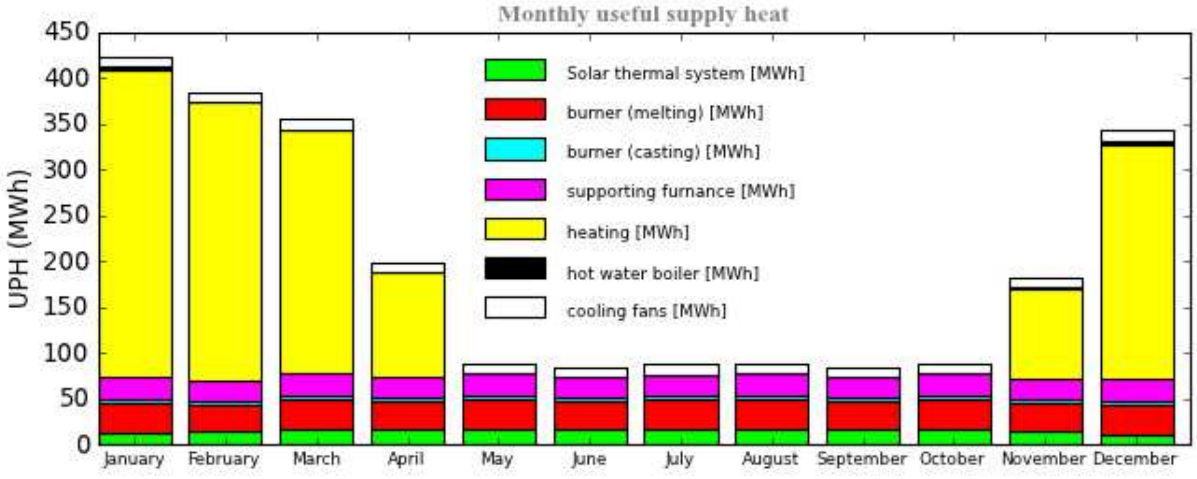

Figure 20: Distribution of useful process heat supply per month

- **New Boiler (350kW):**

Type of boiler	condensing boiler
Nominal power	350 kW
Thermal efficiency	1.13
Operating hours	8,760 h

Table 10: Heat and cooling supply equipment and contribution to total heat and cooling supply

Equipment	Nominal capacity [kW]	Contribution to total heat and cooling supply [MWh]	[%]
New boiler 1	350	1,349	56.00
burner (melting)	90	374	15.53
burner (casting)	30	61	2.51
supporting furnance	65	270	11.22
heating	500	217	8.99
hot water boiler	100	12	0.48
cooling fans	89	127	5.27
cooling	50	21	100.00
Total	**1,274**	**2,430**	**200**

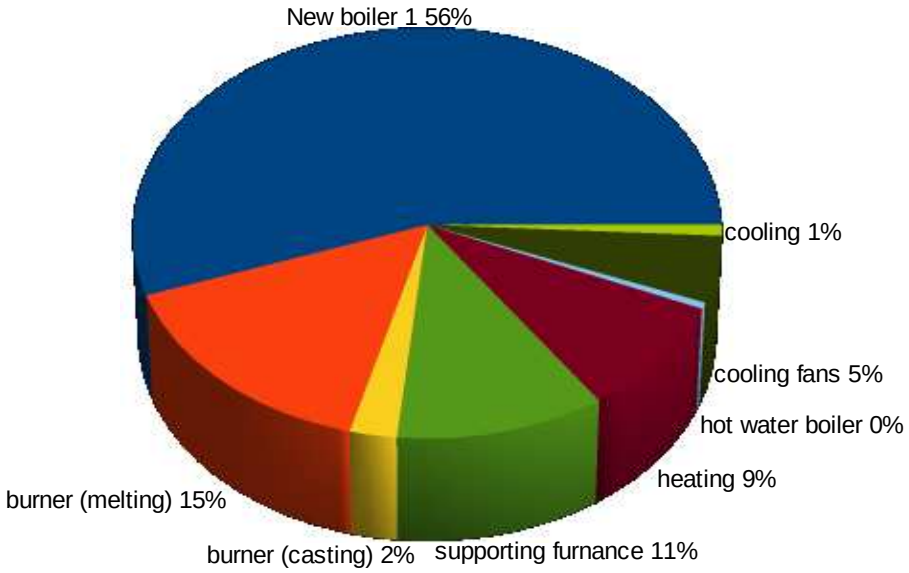

Figure 21: Contribution of each equipment to the total useful heat and useful cooling supply (USH & USC).

- graphic: heat demand covered by new boiler:

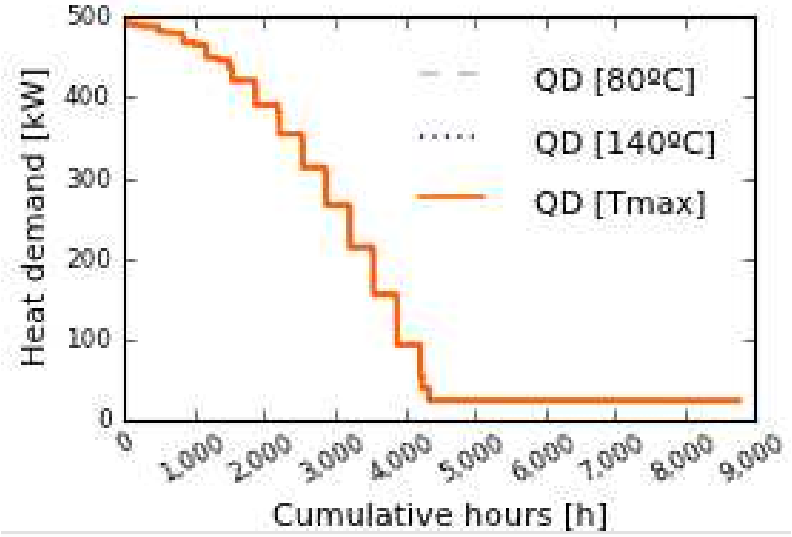

Figure 22: Heat demand covered by new boiler

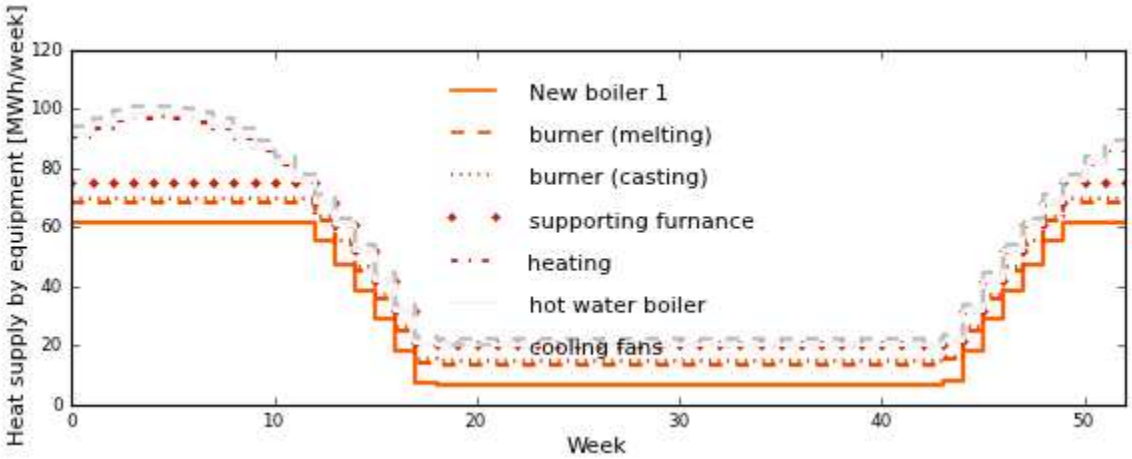

Figure 23: Weekly heat supply by equipment

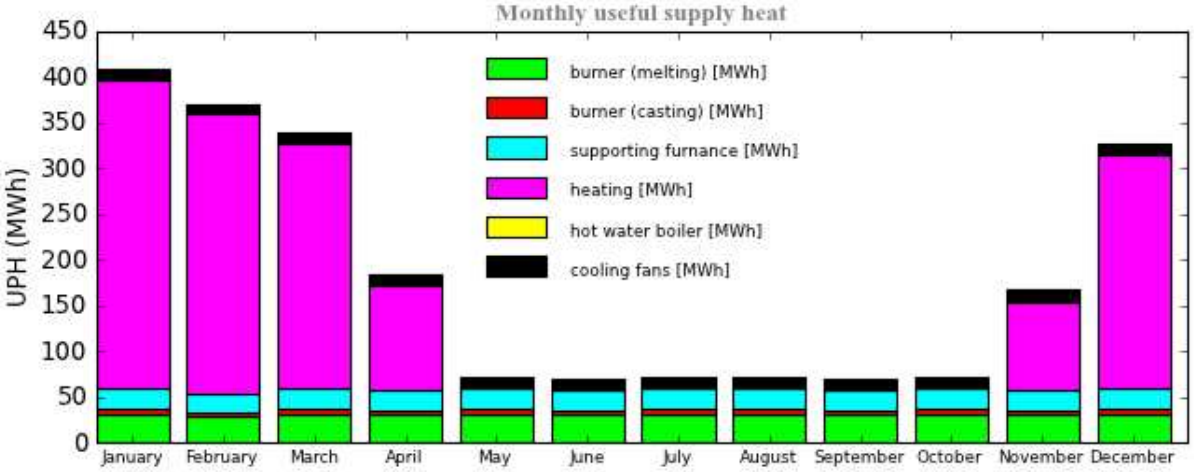

Figure 24: Distribution of useful process heat supply per month

- **HR compressor (HX waste heat):**

Type	finned tubes (liquid-air)
Nominal heat transfer	30 kW
UA value of HX	30kW/K
Area	9m²
Thermal mass of storage	1.02 kW/K

Table 11: Heat and cooling supply equipment and contribution to total heat and cooling supply

Equipment	Nominal capacity	Contribution to total heat and cooling supply	
	[kW]	[MWh]	[%]
burner (melting)	90	374	16.78
burner (casting)	30	61	2.72
supporting furnance	65	270	12.12
heating	500	1,372	61.53
hot water boiler	100	26	1.15
cooling fans	89	127	5.70
cooling	50	21	100.00
Total	**924**	**2,250**	**200**

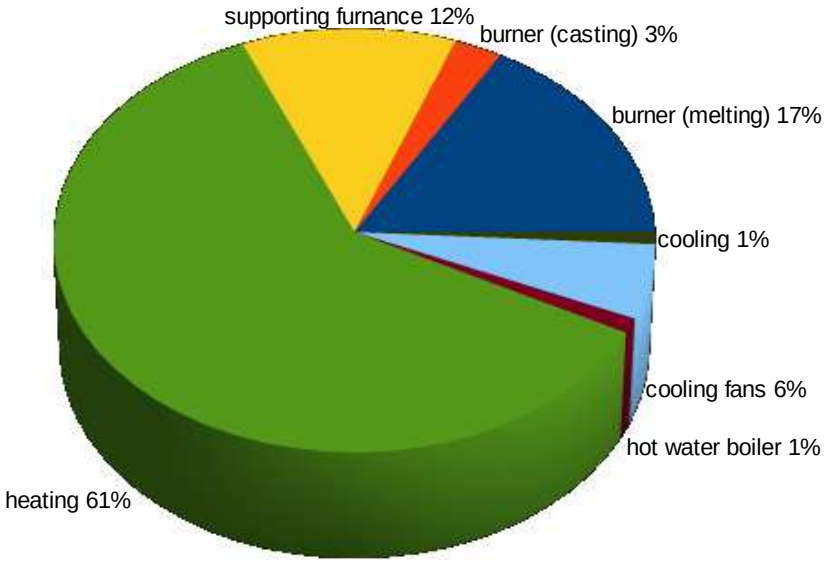

Figure 25: Contribution of each equipment to the total useful heat and useful cooling supply (USH & USC).

- graphic: performance curves of HX:

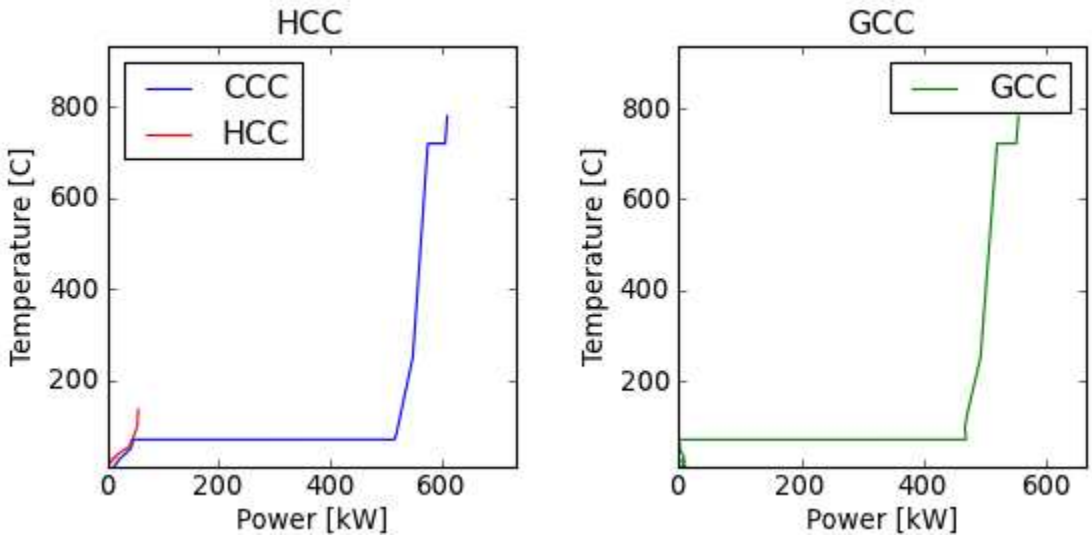

Figure 26: Performance curves of HX

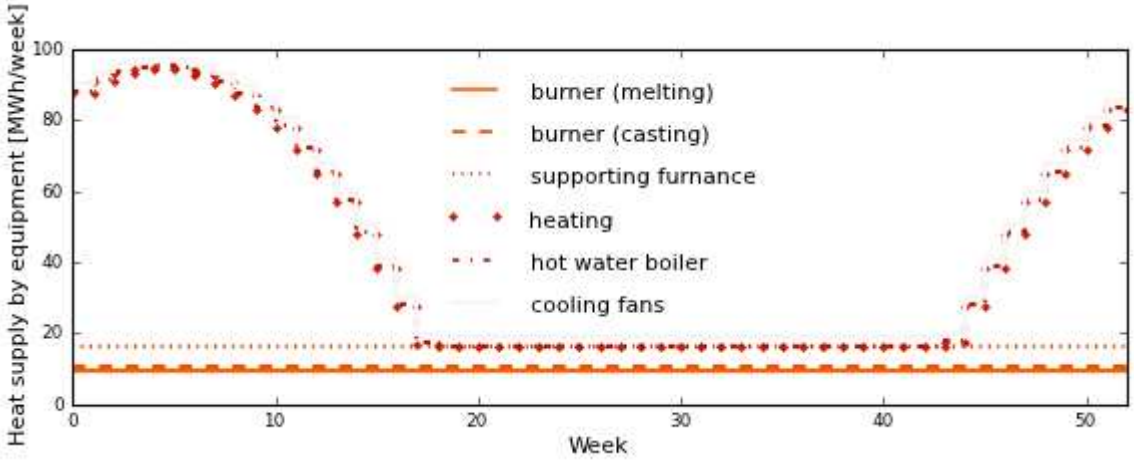

Figure 27: Weekly heat supply by equipment

- **HR compressor (HX waste heat) + new boiler (200kW):**

Type of boiler	condensing boiler
Nominal power	200 kW
Thermal efficiency	1.13
Operating hours	8,760 h

Table 12: Heat and cooling supply equipment and contribution to total heat and cooling supply

Equipment	Nominal capacity	Contribution to total heat and cooling supply	
	[kW]	[MWh]	[%]
New boiler 3	200	793	35.59
burner (melting)	90	374	16.78
burner (casting)	30	61	2.72
supporting furnance	65	270	12.12
heating	500	600	26.90
hot water boiler	100	4	0.20
cooling fans	89	127	5.70
cooling	50	21	100.00
Total	**1,124**	**2,250**	**200**

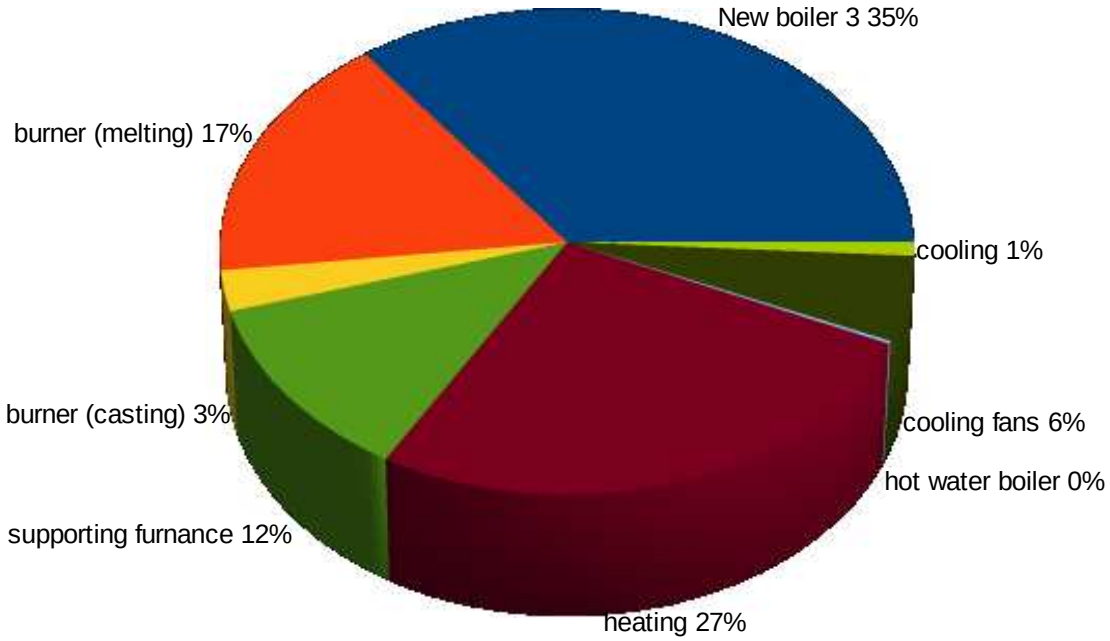

Figure 28: Contribution of each equipment to the total useful heat and useful cooling supply (USH & USC).

- graphic: heat demand covered by new boiler:

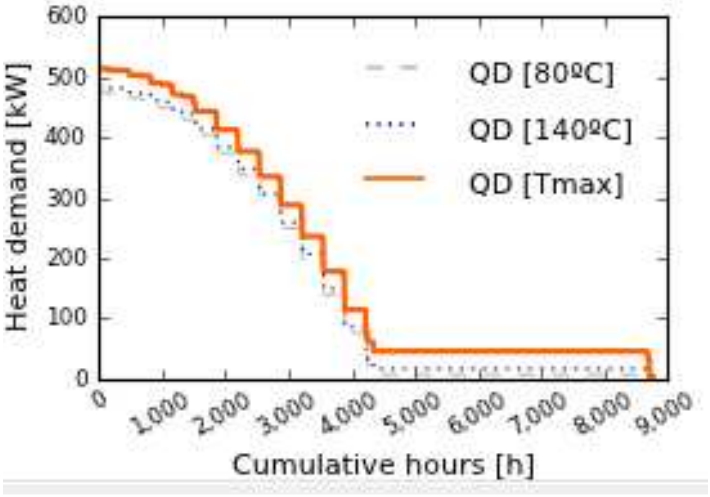

Figure 29: Heat demand covered by new boiler

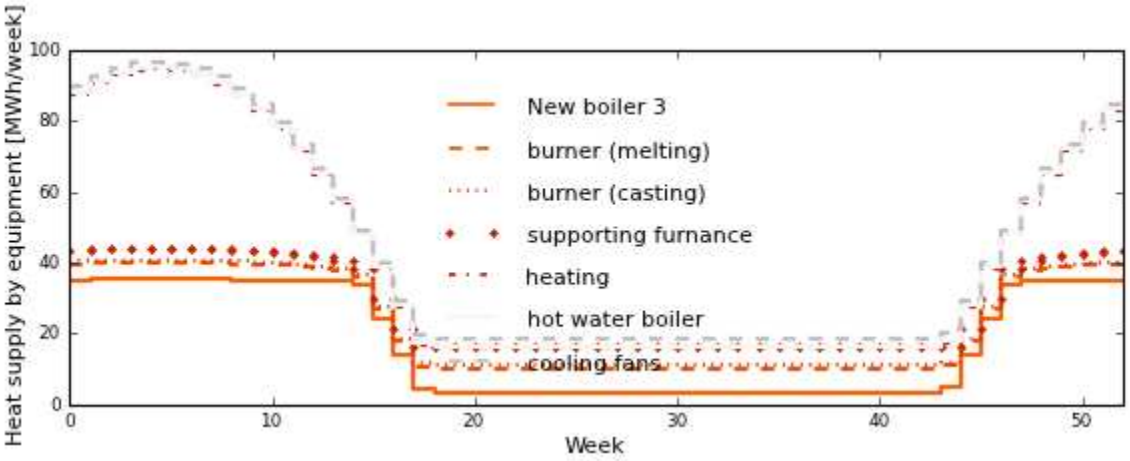

Figure 30: Weekly heat supply by equipment

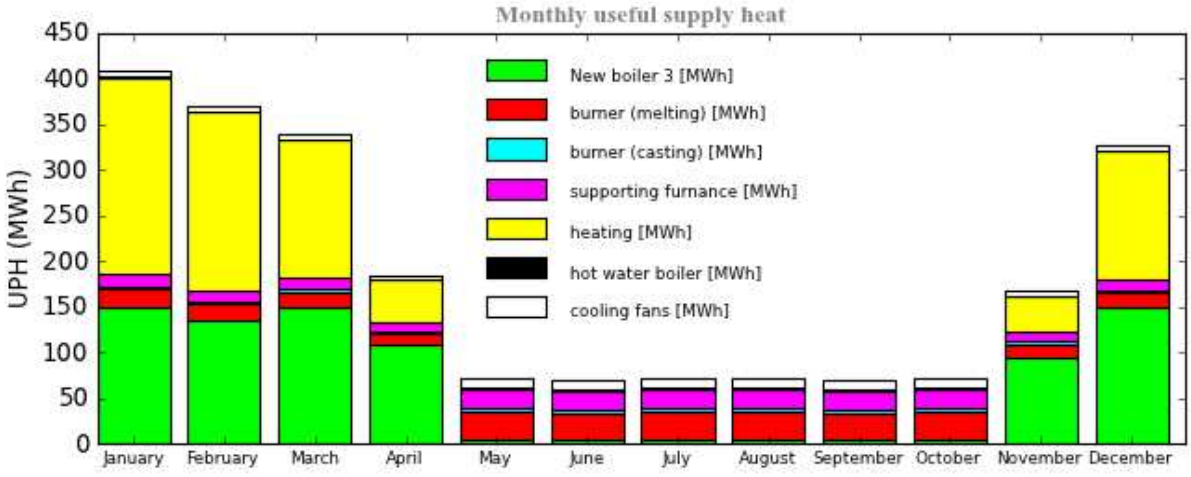

Figure 31: Distribution of useful process heat supply per month

- **HR compressor (HX waste heat) + solar HW and heating**

Collector type:	FPC (flat plate collectors)
Installed capacity:	196.7 kW
Installed collector area:	611.6 m²
Solar buffer storage volume:	14.05 m³
Solar fraction:	3.68 %
Annual energy yield:	300.03 kWh/kWa

Table 13: Heat and cooling supply equipment and contribution to total heat and cooling supply

Equipment	Nominal capacity	Contribution to total heat and cooling supply	
	[kW]	[MWh]	[%]
Solar thermal system	197	59	2.65
burner (melting)	90	357	16.02
burner (casting)	30	58	2.59
supporting furnance	65	258	11.57
heating	500	1,352	60.65
hot water boiler	100	24	1.09
cooling fans	89	121	5.44
cooling	50	21	100.00
Total	**1,121**	**2,250**	**200**

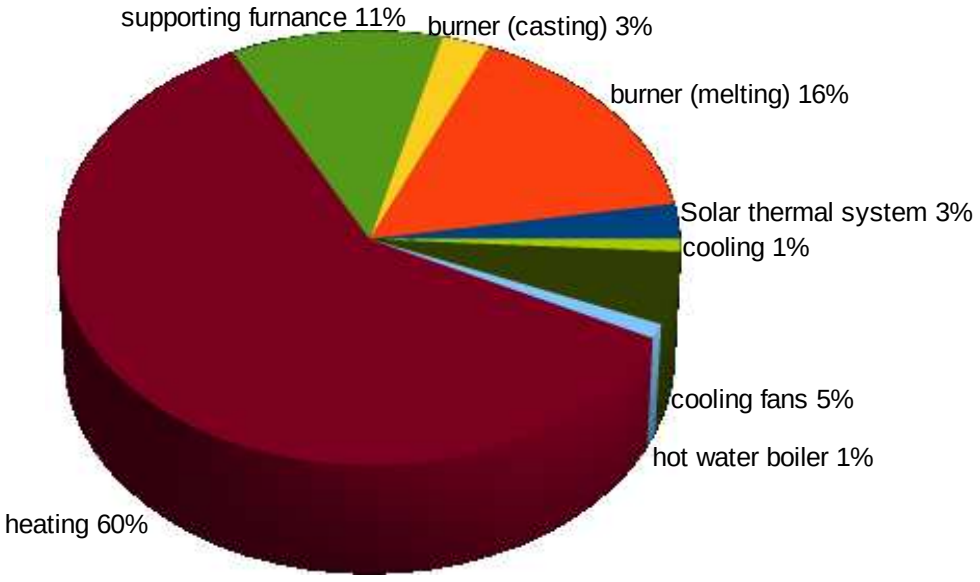

Figure 32: Contribution of each equipment to the total useful heat and useful cooling supply (USH & USC).

- graphic: heat demand covered by solar thermal system:

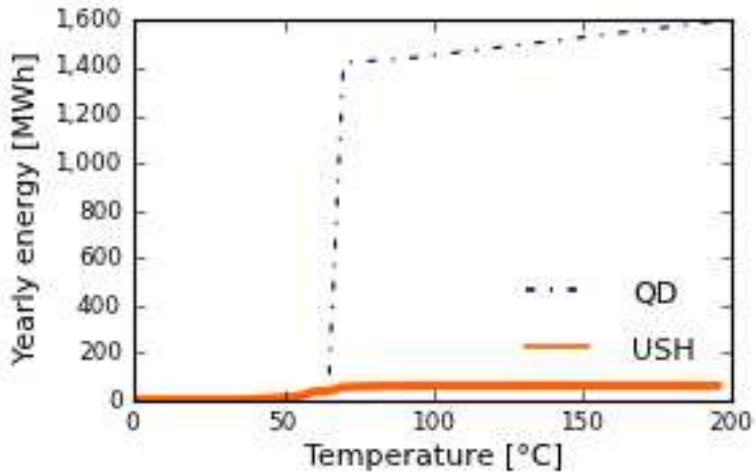

Figure 33: Heat demand covered by solar system

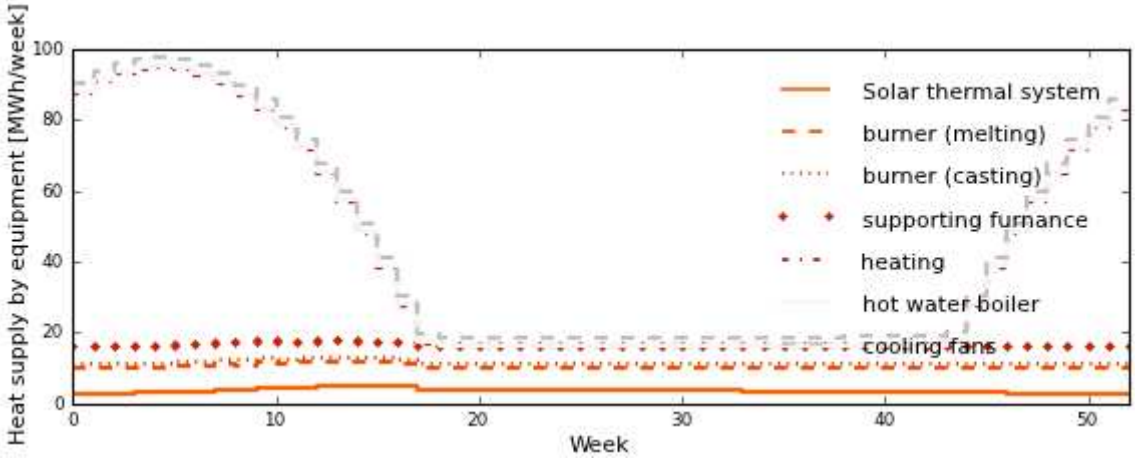

Figure 34: Weekly heat supply by equipment

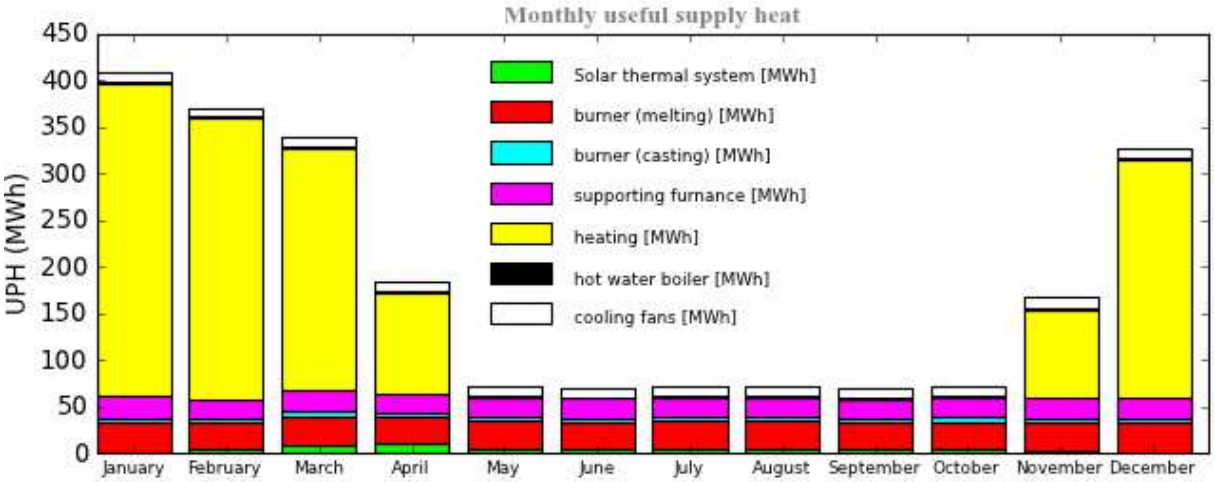

Figure 35: Distribution of useful process heat supply per month

- Primary energy consumption (PEC)

Table 14: primary energy consumption and savings

Alternative	Primary energy consumption	Savings	
	[MWh]	[MWh]	[%]
Present State (checked)	3,572	---	---
solar HW	3,347	225	6.29
new boiler (350kW)	3,353	219	6.14
HR compressor	3,357	215	6.01
HR + new boiler (200kW)	3,232	340	9.52
HR + solar HW and heating	3,256	316	8.85

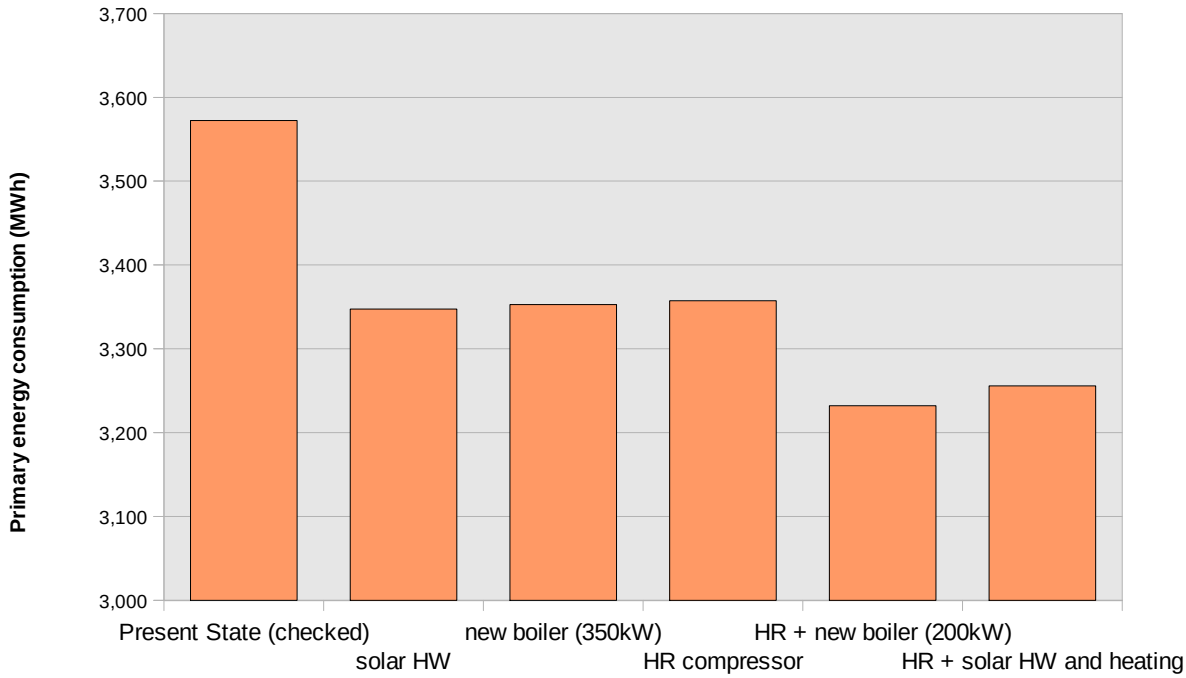

Figure 36: Comparison of alternatives: primary energy consumption

- Useful process and supply heat (UPH and USH)

  Due to the fact that the processes were not changed, the useful process heat and the supply heat stayed the same.

Table 15: Useful process and supply heat: present state and alternative proposals.

Alternative	Useful process heat (UPH)	Savings UPH	Useful supply heat (USH)	Savings USH
	[MWh]	[MWh]	[MWh]	[MWh]
Present State (checked)	2,409	---	2,409	---
solar HW	2,409	0	2,409	0
new boiler (350kW)	2,409	0	2,409	0
HR compressor	2,409	0	2,229	180
HR + new boiler (200kW)	2,409	0	2,229	180
HR + solar HW and heating	2,409	0	2,229	180

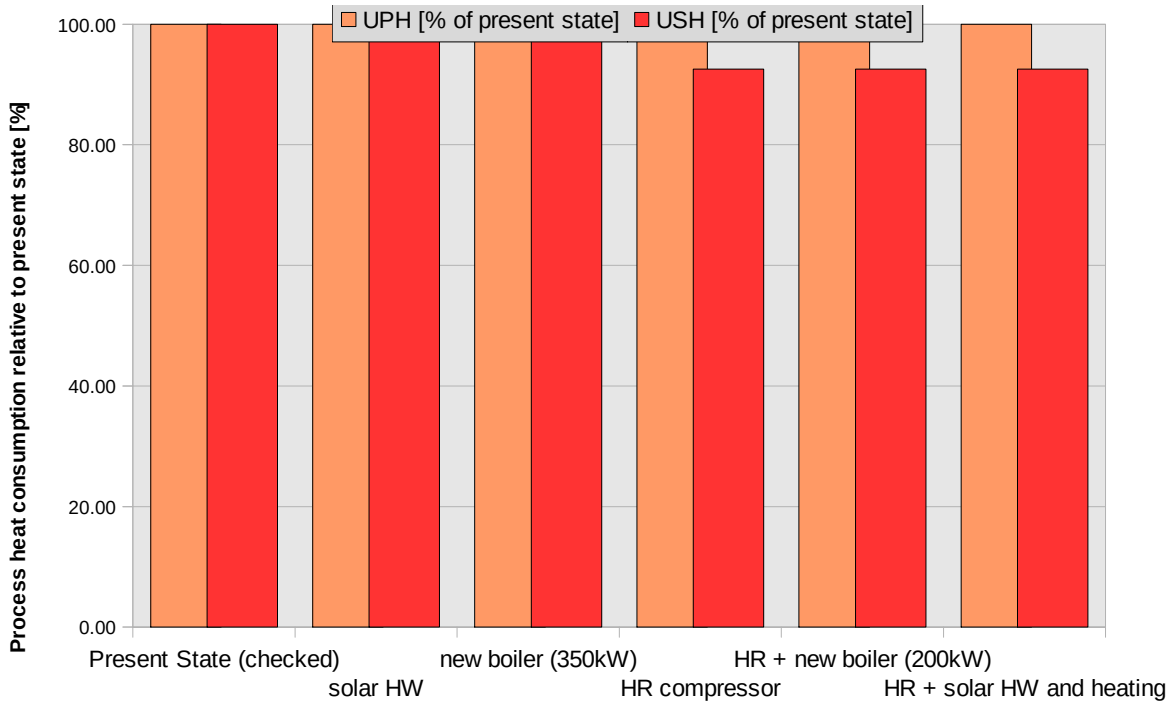

Figure 37: Comparison of alternatives: useful process heat supply

- Environmental impact

Table 16: CO2 production and CO2 savings per year

Alternative	Production of CO2	Water consumption
	[t]	[m³]
Present State (checked)	738.23	0.00
solar HW	687.20	0.00
new boiler (350kW)	686.57	0.00
HR compressor	689.80	0.00
HR + new boiler (200kW)	660.06	0.00
HR + solar HW and heating	669.98	0.00

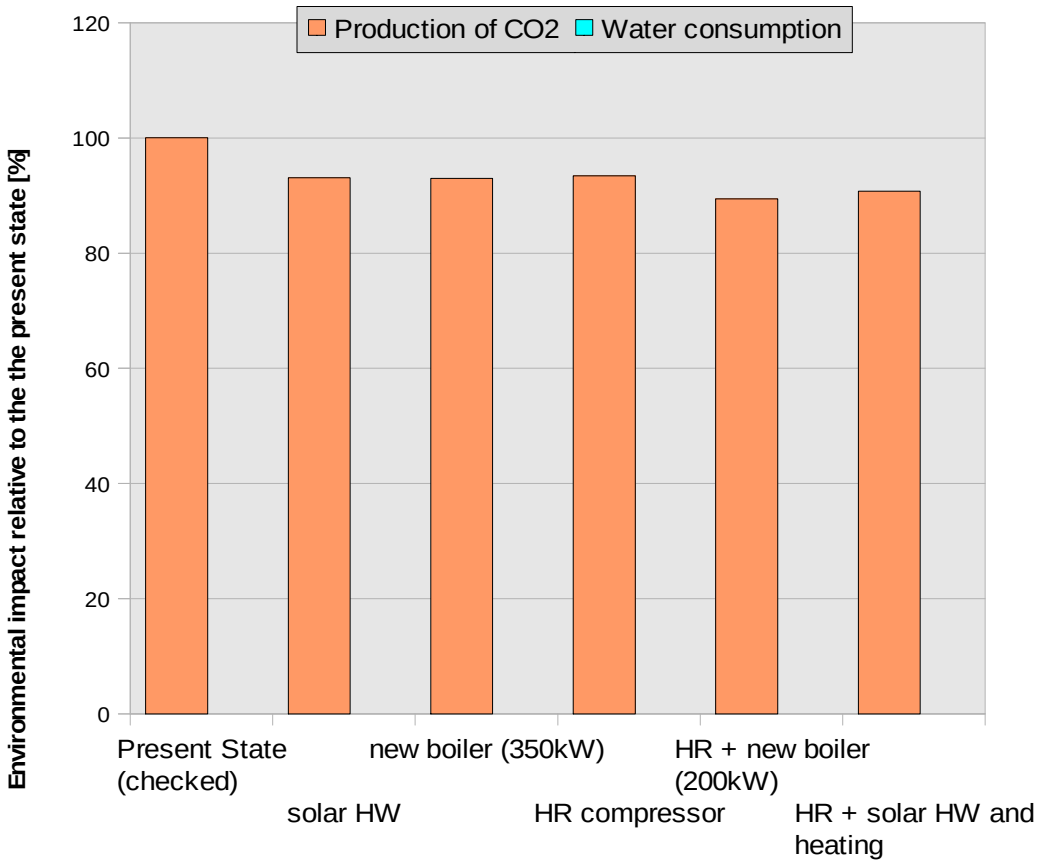

Figure 38: Comparison of alternatives: environmental impact

Table 17: Investment costs and subsidies of the proposals

Alternative	Total investment [€]	Own investment [€]	Subsidies [€]
Present State (checked)	---	---	---
solar HW	493,600	345,520	148,080
new boiler (350kW)	45,500	45,500	0
HR compressor	8,500	8,500	0
HR + new boiler (200kW)	38,500	38,500	0
HR + solar HW and heating	129,400	90,580	38,820

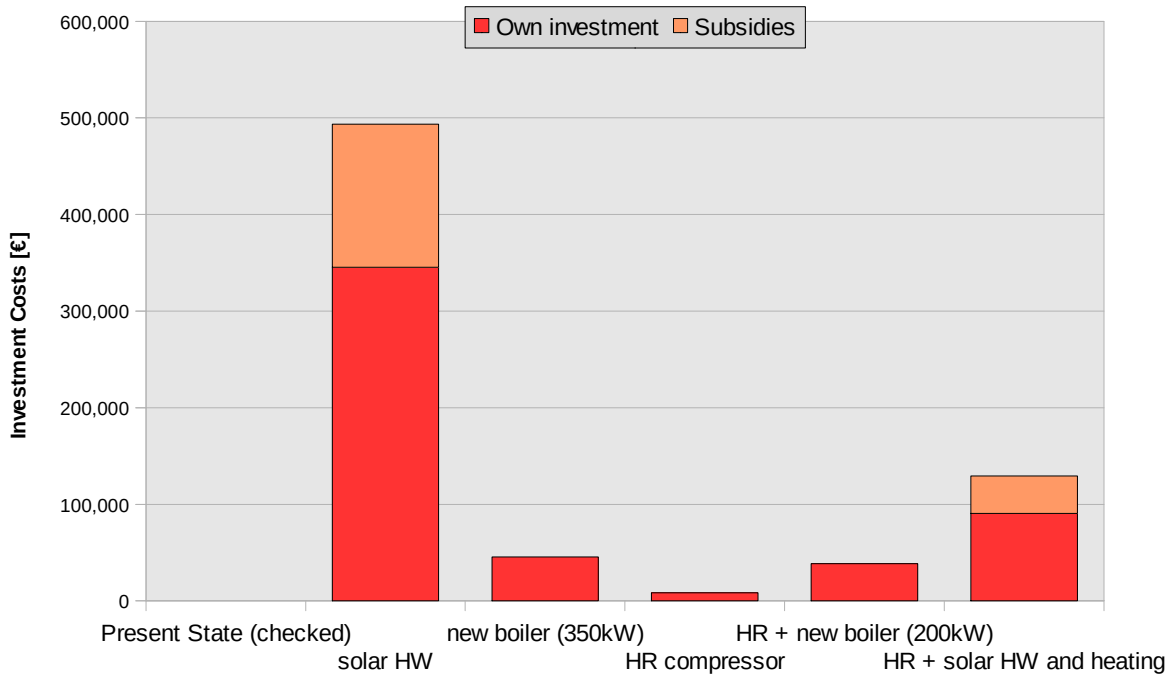

Figure 39: Comparison of alternatives investment cost

5. Selected alternative(s) and conclusions

5.1. Selected alternative

The selected alternative that has been chosen is the "HR Compressor".

5.1.1. Process optimisation (written proposals)

None

5.1.2. Heat Supply

HR compressor (HX waste heat):

Type	finned tubes (liquid-air)
Nominal heat transfer	30 kW
UA value of HX	30kW/K
Area	9 m²
Thermal mass of storage	1.02 kW/K

Table 18: Heat and cooling supply equipment and contribution to total heat and cooling supply

Equipment	Nominal capacity	Contribution to total heat and cooling supply	
	[kW]	[MWh]	[%]
burner (melting)	90	374	16.78
burner (casting)	30	61	2.72
supporting furnance	65	270	12.12
heating	500	1,372	61.53
hot water boiler	100	26	1.15
cooling fans	89	127	5.70
cooling	50	21	100.00
Total	**924**	**2,250**	**200**

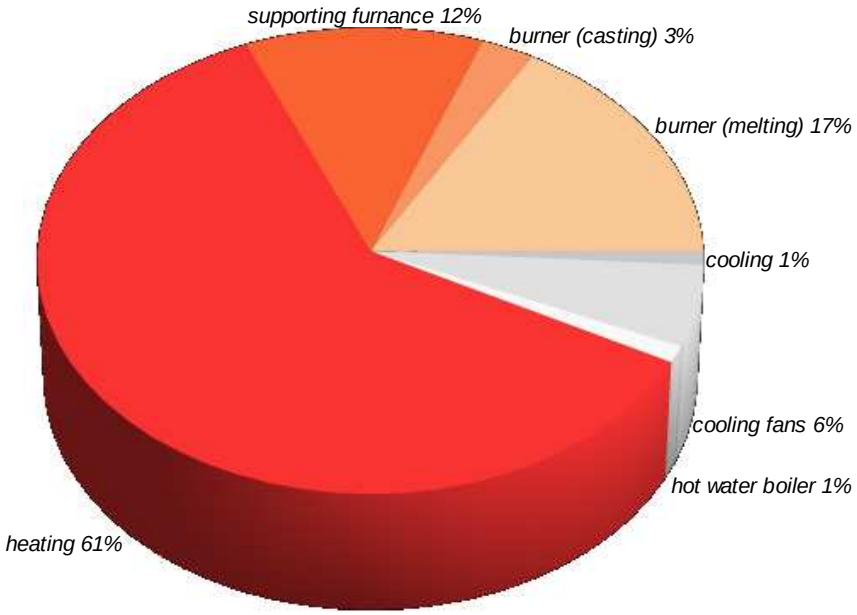

Figure 40: Contribution of each equipment to the total useful heat and useful cooling supply (USH & USC).

5.1.3. Energy Consumption

Table 19: Total primary energy consumption (PEC) and primary energy consumption for thermal use (PET)

Energy type (fuels / electricity)	PEC		PET	
	[MWh]	[% of Total]	[MWh]	[% of Total]
Total fuels	2,149	64.01	2,149	64.01
Total electricity	1,208	35.99	1,208	35.99
Total (fuels + electricity)	**3,357**	**100.00**	**3,357**	**100.00**

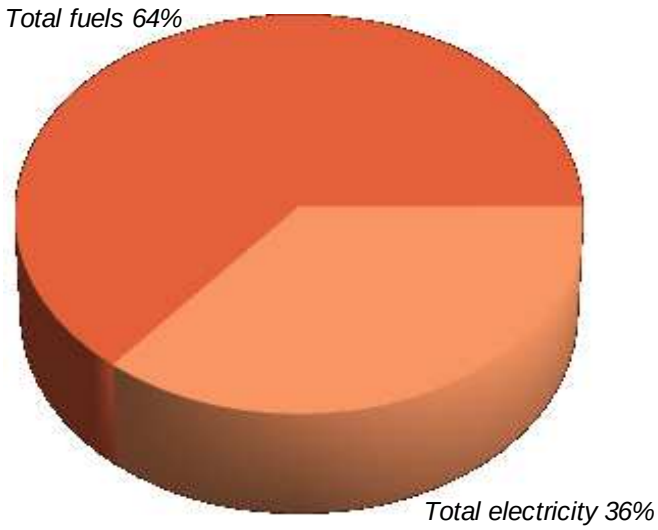

Figure 41: Distribution of PEC by fuel type

Table 20: Total final energy consumption (FEC) and final energy for thermal use (FET). Proposed final solution.

Fuel type	FEC		FET	
	[MWh]	[% of Total]	[MWh]	[% of Total]
Natural gas	1,954	82.91	1,954	82.91
Electricity	403	17.09	403	17.09
Total	2,356	100.00	2,356	100.00

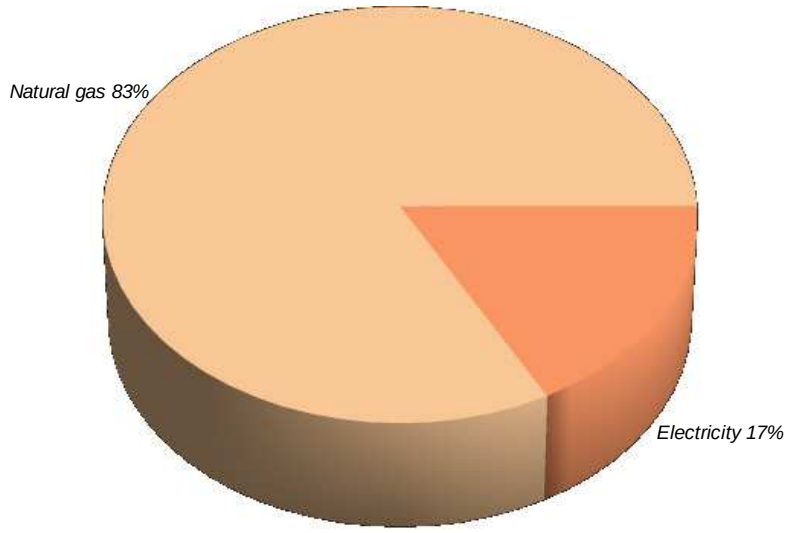

Figure 42: Total final energy consumption (FEC). Proposed final solution.

Table 21 : Final energy consumption for thermal use (FET) by equipment. Proposed final solution.

Equipment	Fuel type	FET by equipment	
		[MWh]	[% of Total]
burner (melting)	Natural gas	416	17.64
burner (casting)	Natural gas	67	2.86
supporting furnance	Electricity	270	11.47
heating	Natural gas	1,444	61.27
hot water boiler	Natural gas	27	1.15
cooling fans	Electricity	127	5.39
cooling	Electricity	6	0.24
Total		**2,356**	**100**

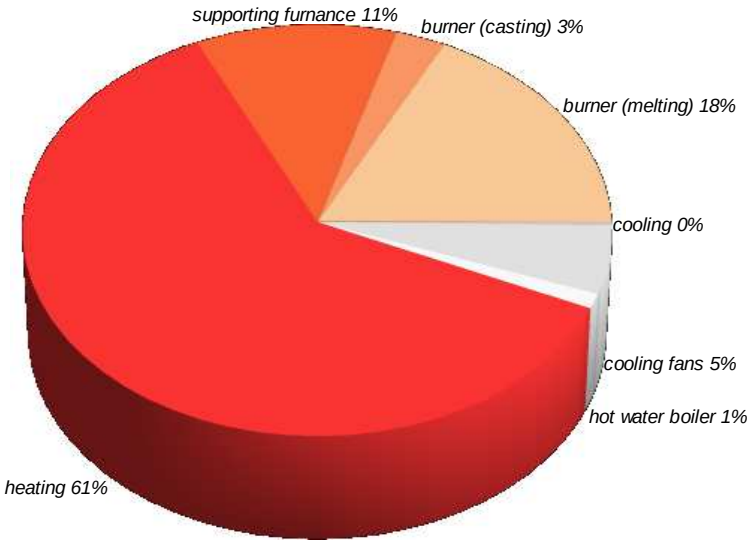

Figure 43: Final energy consumption for thermal use (FET) by equipment

Table 22 : Useful supply heat (USH) by equipment. Proposed final solution.

Equipment	USH by equipment	
	[MWh]	[% of Total]
burner (melting)	374	16.78
burner (casting)	61	2.72
supporting furnance	270	12.12
heating	1,372	61.53
hot water boiler	26	1.15
cooling fans	127	5.70
Total	**2,229**	**100**

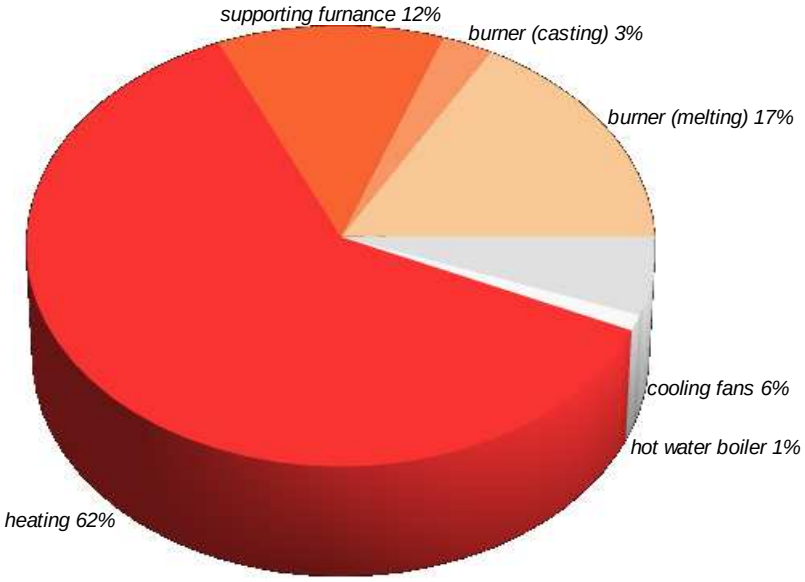

Figure 44: Useful supply heat (USH) by equipment. Proposed final solution

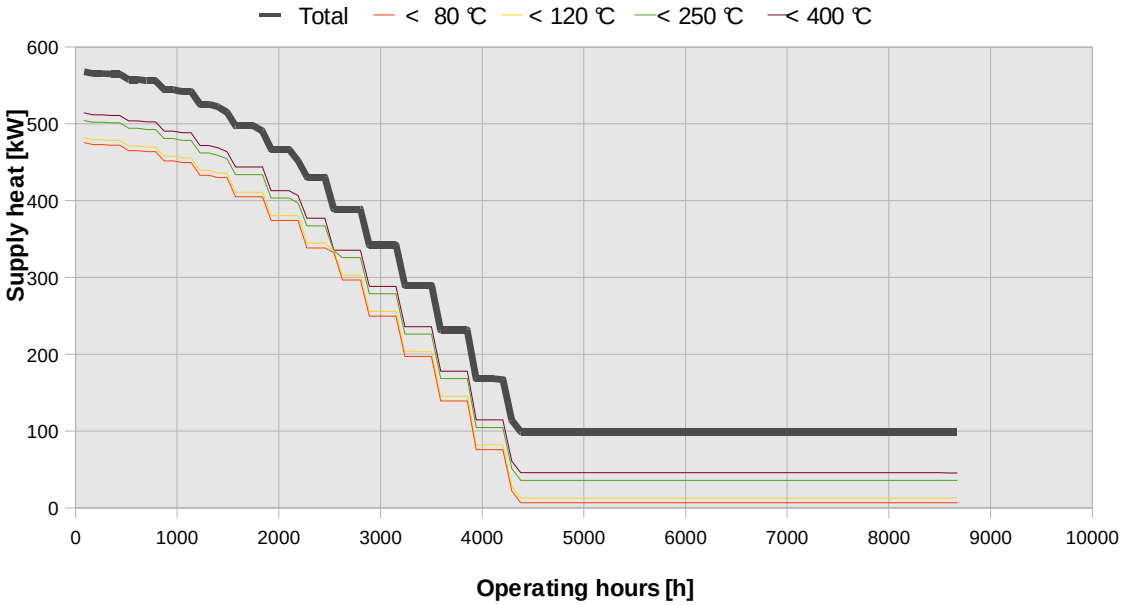

Figure 45: Distribution of supply heat by temperature levels and annual operating hours. Proposed final solution.

5.2. Comparative study and conclusions

5.2.1. Energy and environmental analysis

In the proposed alternative around 7 % of the CO_2 pollution can be saved.

5.2.2. Economic analysis

The payback period of about 9 years has to be checked concerning the investment costs and due to the possible change of these figures the payback

period will change in dependency. The calculations are based on costs and subsidies of 30% for the solar thermal plant of the investment costs and have to be revised. Investment and installing cost are based on actual cost in Austria and not Bulgaria.

Table 23: Savings of the proposed alternative in comparison to the present state

		Present state	Alternative	Saving	[% savings]
Total primary energy consumption (1)					
- total	[MWh]	3572	3,357	215	6%
- fuels	[MWh]	2357	2,149	208	9%
- electricity	[MWh]	1215	1,208	7	1%
Primary energy saving due to renewable energy	[MWh]				
CO2 emissions	[t/a]	738.23	689.8	48.43	7%
Annual energy system cost (2)	[EUR]	57,872	57,227	645	1%
Total investment costs	[EUR]		8,500		
Payback period (3)	[years]		9		

(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) Supposing 30% of funding of total investment (subsidies or equivalent other support mechanisms)

5.2.3. Conclusions and outlook

- As the calculations of the hot water consumption are based on assumptions and the yearly overall energy consumptions, these figures and data have to be revised and adapted to the actual figures.
- In order to gain savings as high as calculated, the calculations have to be adapted to the actual thermal efficiency of the new boiler as the computed savings are based on the highest number
- Based on the available data and measurements performed the energy consumption split to the processes and equipment so that they could be calculated by EINSTEN and the results are well comparable to the present state of the company. For the economic aspects some further calculations will be necessary as final investment costs are based on first estimations.