Energy Audit Summary Report

AEE INTEC

Audit no. 30 – SVK01

Euro Dabo

16th of April 2012

Supported by INTELLIGENT ENERGY EUROPE

This energy audit has been carried out with cofunding of the European Commission (EACI) in the Framework of the EU funded project EINSTEIN-II (ProjectNo. IEE/09/702/SI2.558239)

AUDIT no. 30 – SVK01

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: 26.03.2012

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 2011.

3.1. General information of the company

Sector	plastic products
Products	expanded polystyrene
No. of employees	30 employees
Current primary energy consumption	56,865 [MWh/a]

3.2. Flow sheet of the whole manufacturing side

3.3.

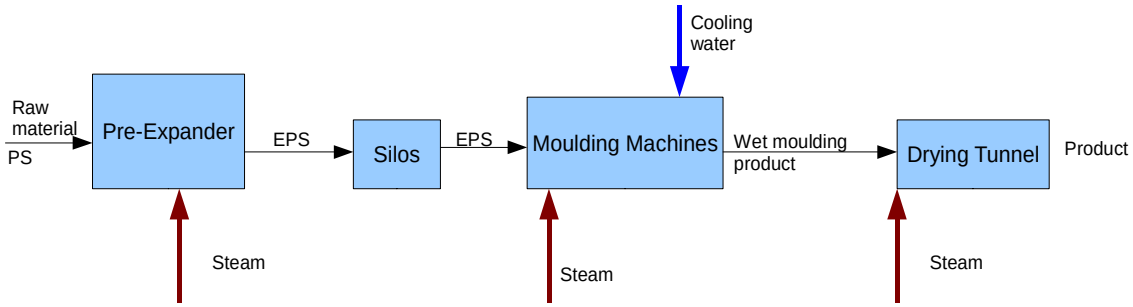

Figure 1: Flow sheet of the factory; explanation: PS … polystyrene, EPS … expanded polystyrene

3.4. Description of the existing system

- **Energy Supply:**

The factory is mainly consuming energy for the pre-expansion, the moulding machines and the drying tunnel, in addition to the heating of the buildings.

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	13,121	23.07	13,121	98.76
Total electricity	43,744	76.93	165	1.24
Total (fuels + electricity)	**56,865**	**100.00**	**13,286**	**100.00**

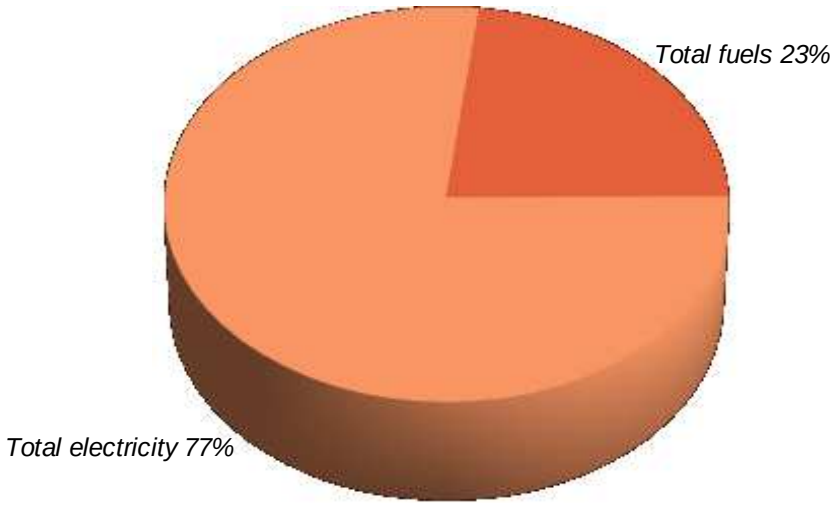

Figure 2: distribution of PEC by fuel type

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 II	11,928	45.00	11,928	99.54
Electricity	14,581	55.00	55	0.46
Total	26,509	100.00	11,983	100.00

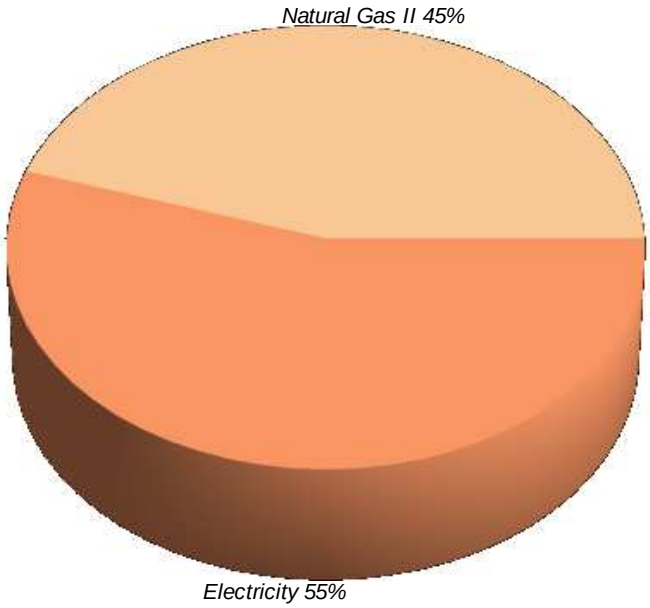

Figure 3: Total final energy consumption for thermal use (FET)

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

		[MWh]	[% of Total]
LOOS steam boiler 1	Natural Gas II	5,936	45.86
LOOS steam boiler 2	Natural Gas II	5,934	45.84
Viessmann 1	Natural Gas II	509	3.93
Viessmann 2	Natural Gas II	509	3.93
cooling tower 1	Electricity	9	0.07
cooling tower 2	Electricity	46	0.36
Total		**12,943**	**100.00**

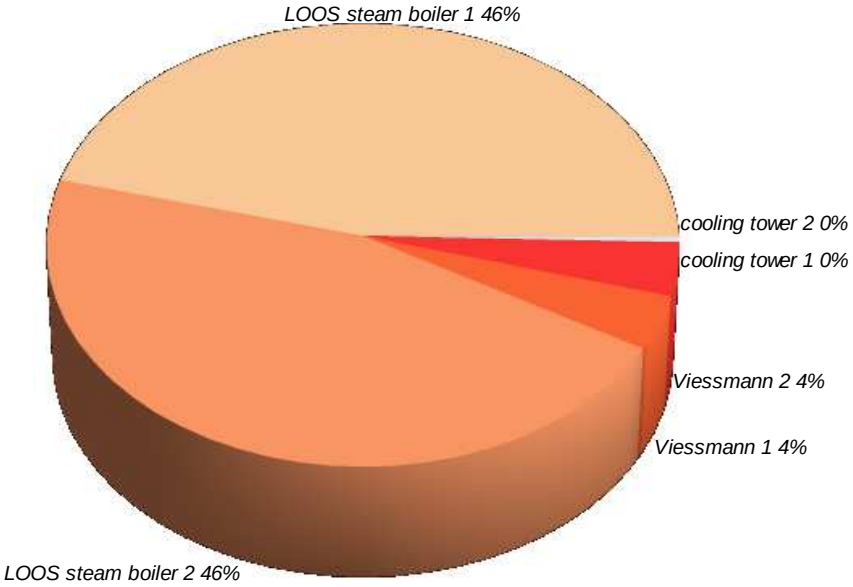

Figure 4: Final energy consumption for thermal use (FET) by equipment

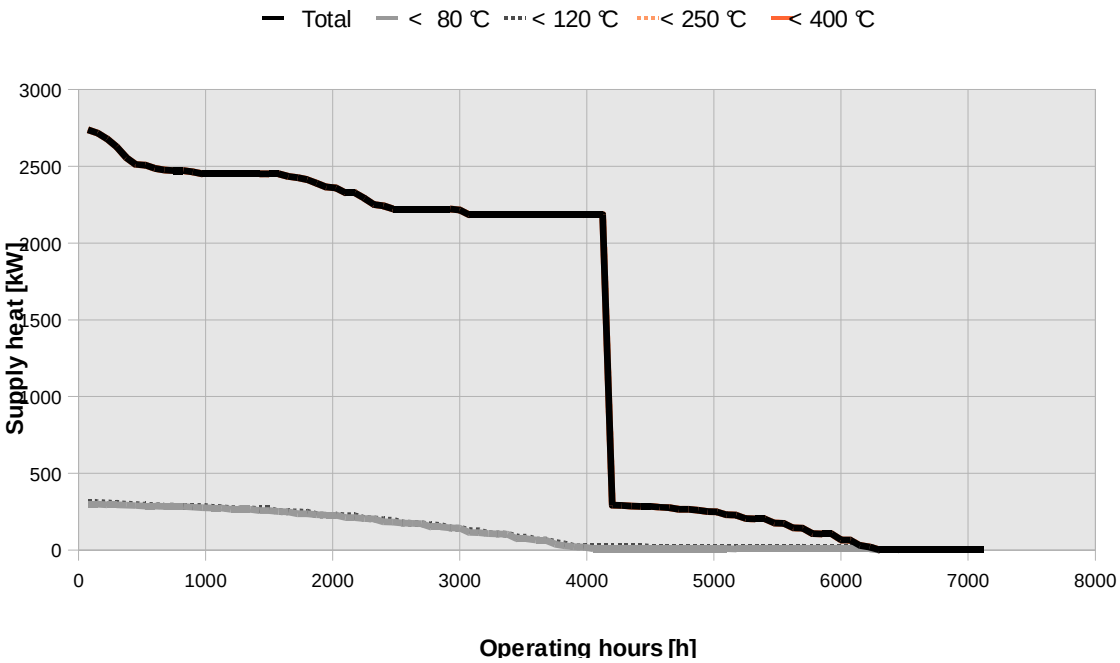

Figure 5: Distribution of supply heat by temperature levels and annual operating hours. Present state.

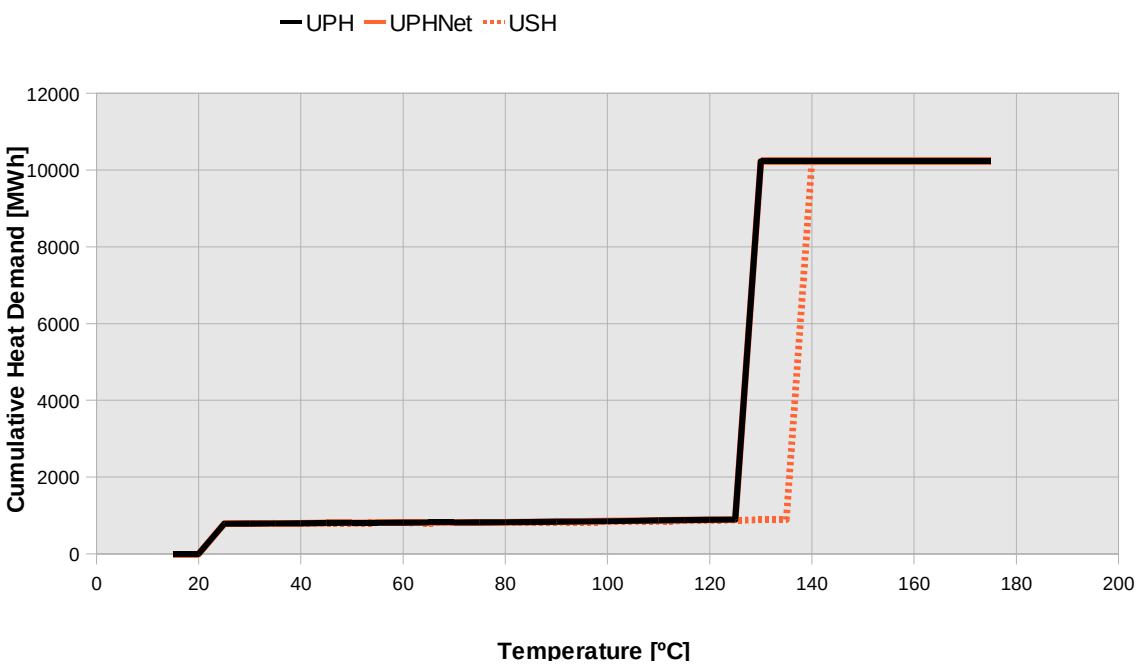

Figure 6: Distribution of the heat demand by temperature levels

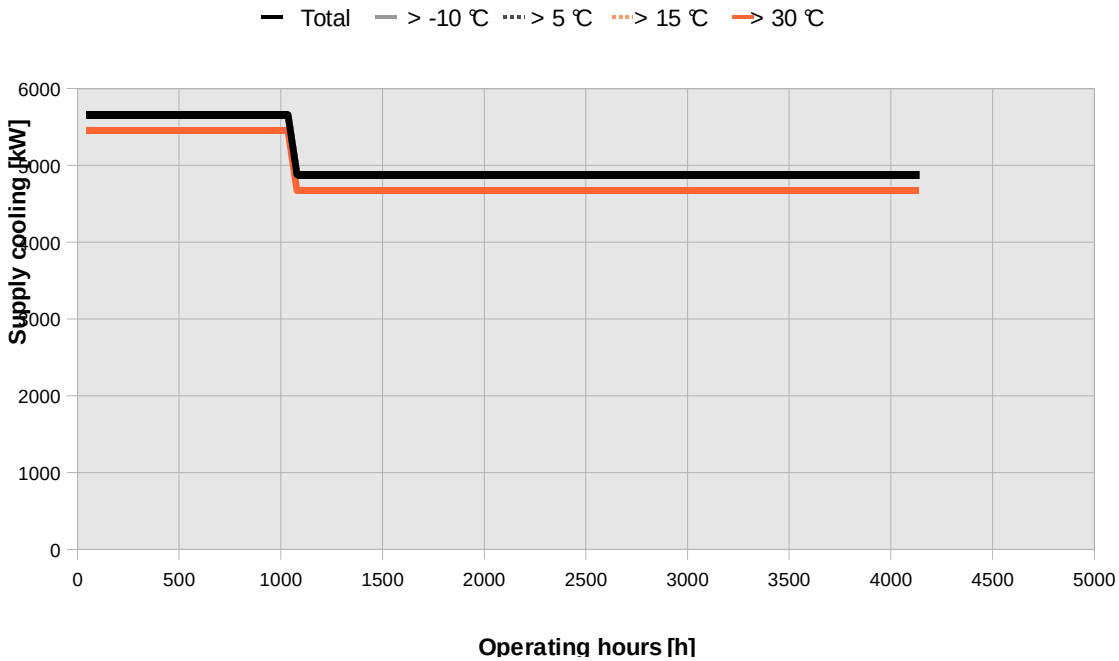

Figure 7: Distribution of supply cooling by temperature levels and annual operating hours. Present state.

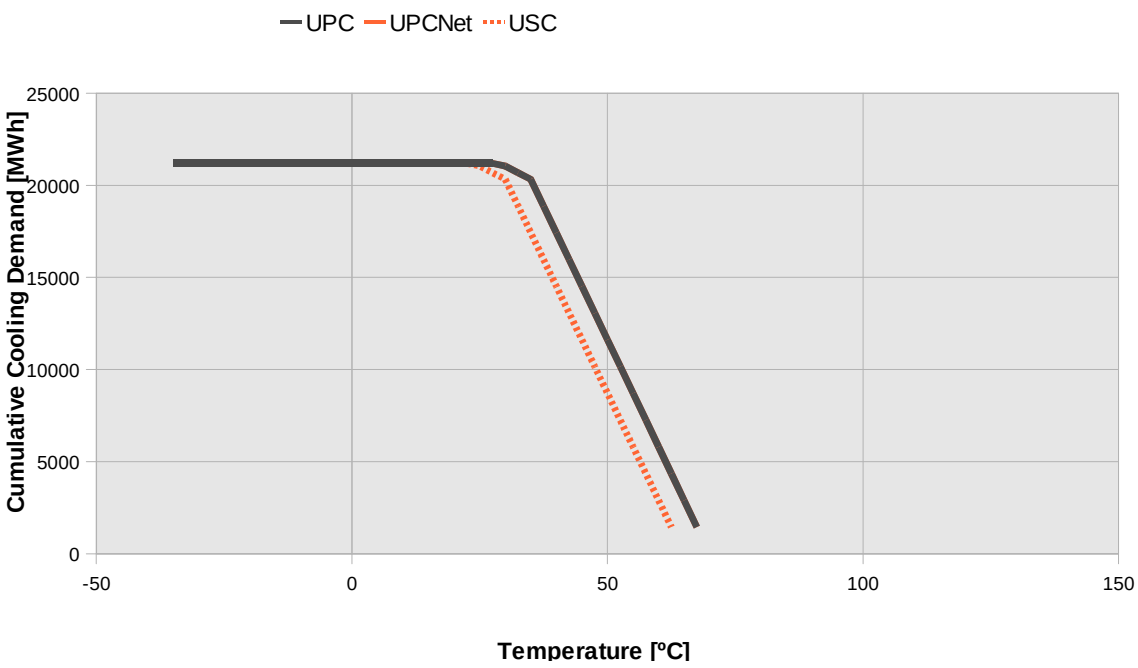

Figure 8: Distribution of the cooling demand by temperature levels

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

Equipment	USH by equipment	
	[MWh]	[% of Total]
LOOS steam boiler 1	4,716	46.00
LOOS steam boiler 2	4,714	45.98
Viessmann 1	411	4.01
Viessmann 2	411	4.01
Total	**10,253**	**100.00**

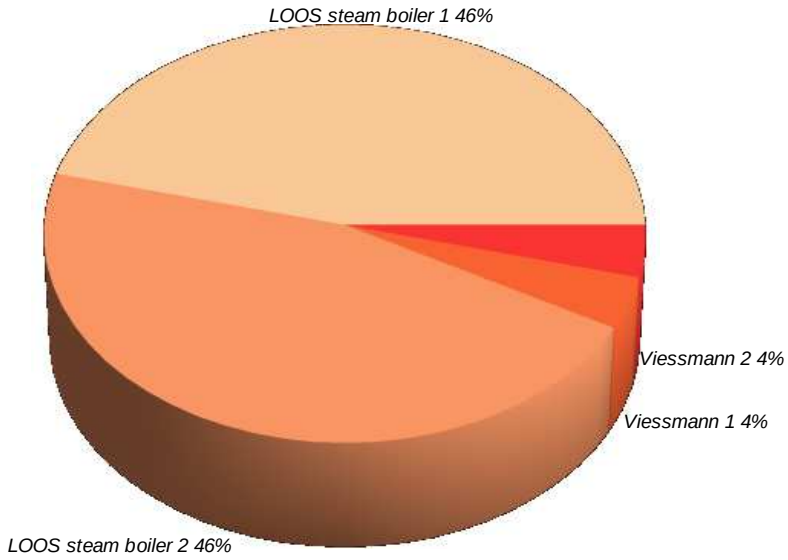

Figure 9: Useful supply heat (USH) by equipment. Present state

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

Process	Total	Circulation	Maintenance	Start-up
	[MWh]	[MWh]	[MWh]	[MWh]
expanding	1,934	62	1,872	0
forming	5,989	30	5,959	0
drying	1,509	21	1,489	0
main building_HW	12	12	0	0
main building_heating	781	0	781	0
cooling tower waste heat	0	0	0	0
Total	**10,225**			

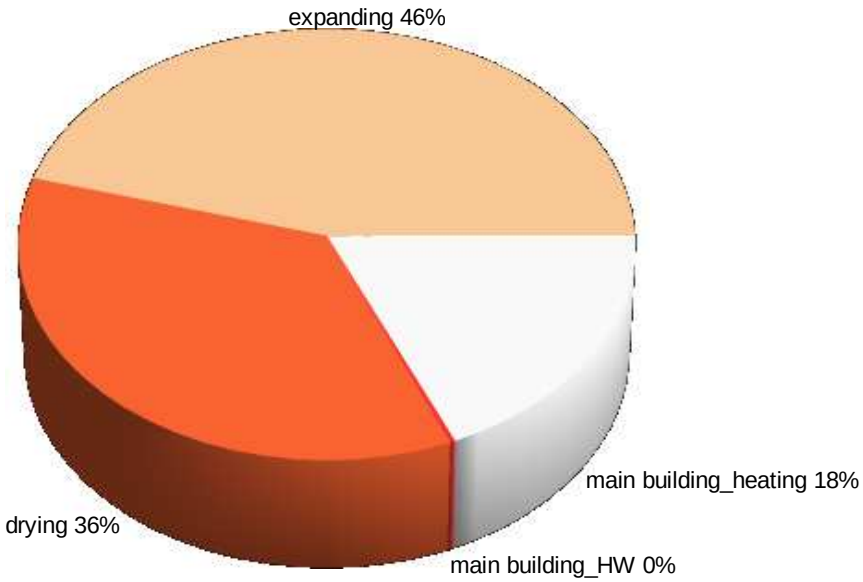

Figure 10: Useful process heat (UPH) by process

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

Equipment	USC by equipment	
	[MWh]	[% of Total]
cooling tower 1	869	4.10
cooling tower 2	20,317	95.90
Total	**21,187**	**100.00**

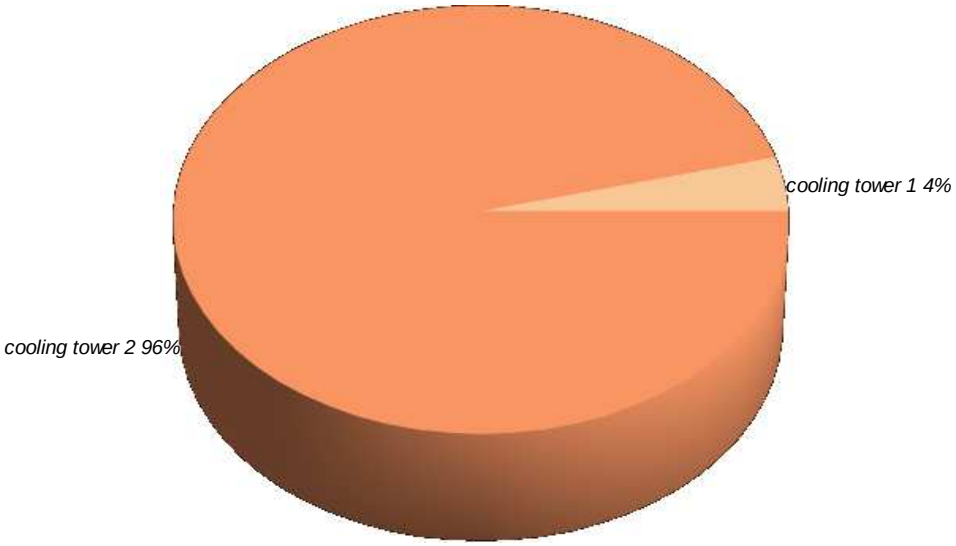

Figure 11: Useful supply cooling (USC) by equipment. Present state.

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

Process	Total	Circulation	Maintenance
	[MWh]	[MWh]	[MWh]
cooling tower 1	869	869	0
forming	20,317	20,317	0
Total	**21,187**		

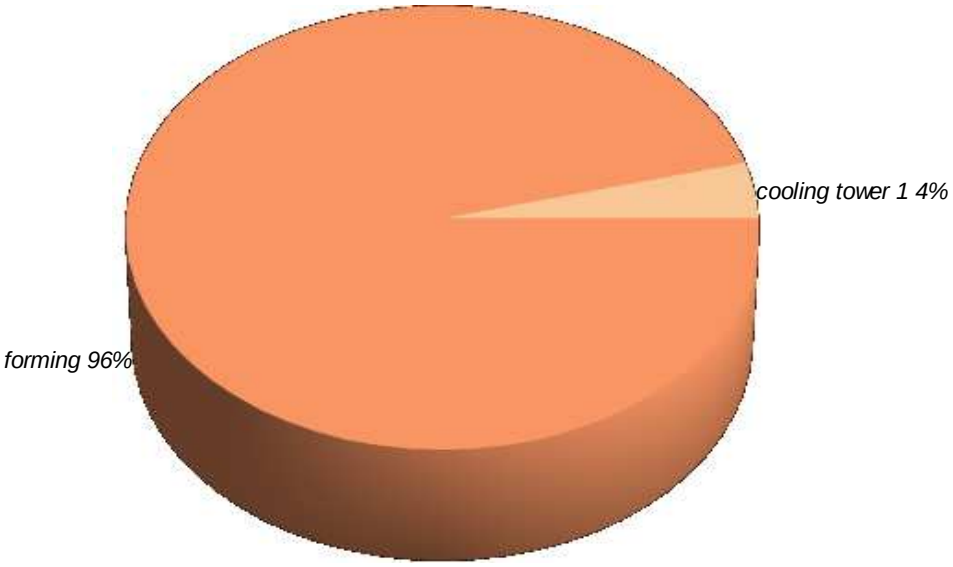

Figure 12: Useful process cooling (UPC) by process

3.5. General

- The target room temperature during winter is 25 °C for the production hall and offices.
- The hot water demand was estimated to be 0.7 m³ per day.

4. Comparative study

4.1. Proposed alternatives

There are five proposals made in this study. In the first proposal is a new steam boiler. The second proposal is a new hot water boiler. The third proposal is a heat recovery compressor. The fourth proposal is a solar system. The fifth proposal is a CHP plant.

Table 8: Overview of the alternative proposals studied

Short Name	Description
new steam boiler	based on present state a new steam boiler was suggested
new hot water boiler	based on present state a new hot water boiler was suggested
heat recovery compressor	based on present state the use of the waste heat of the compressors was suggested
solar	based on present state the installation of a solar thermal plant was suggested
CHP	based on present state the installation of a CHP (combined heat and power) plant was suggested

4.1.1. Heat Supply

- **New Steam Boiler:**

Type of boiler	steam boiler
Nominal power	2,734 kW
Thermal efficiency	0.93
Operating hours	4,176 h

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]	[%]
New boiler 1	2,734	9,432	92.24
LOOS steam boiler 1	2,736	0	0.00
LOOS steam boiler 2	2,736	0	0.00
Viessmann 1	217	690	6.75
Viessmann 2	217	103	1.00
cooling tower 1	210	551	2.78
cooling tower 2	4,884	19,276	97.22
Total	**13,734**	**30,052**	**200**

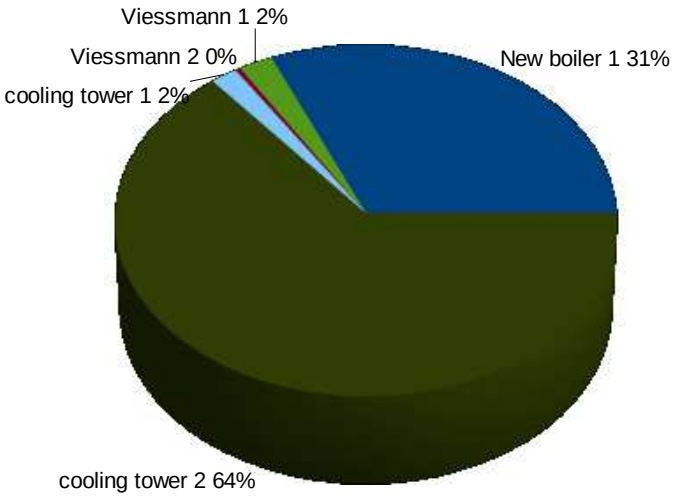

Figure 13: Contribution of each equipment to the total useful heat and useful cooling supply (USH & USC).

- graphic: heat demand covered by new steam boiler:

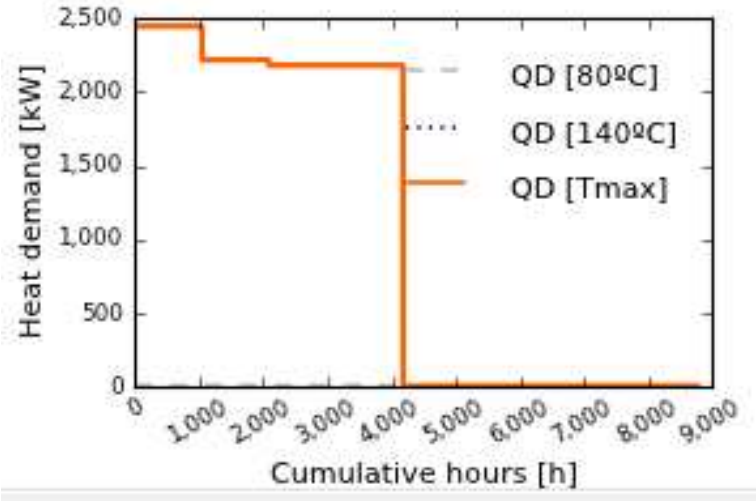

Figure 14: Heat demand and boiler contribution

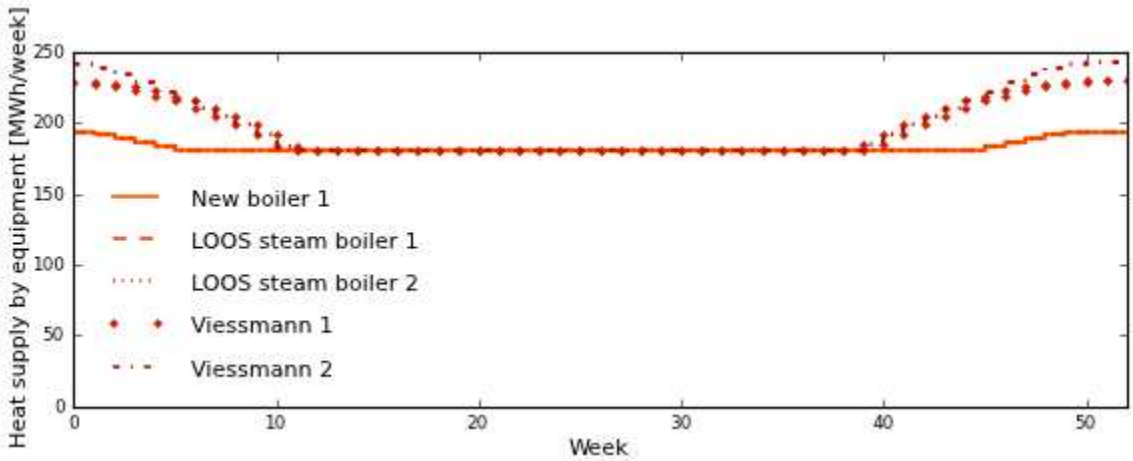

Figure 15: Weekly heat supply by equipment

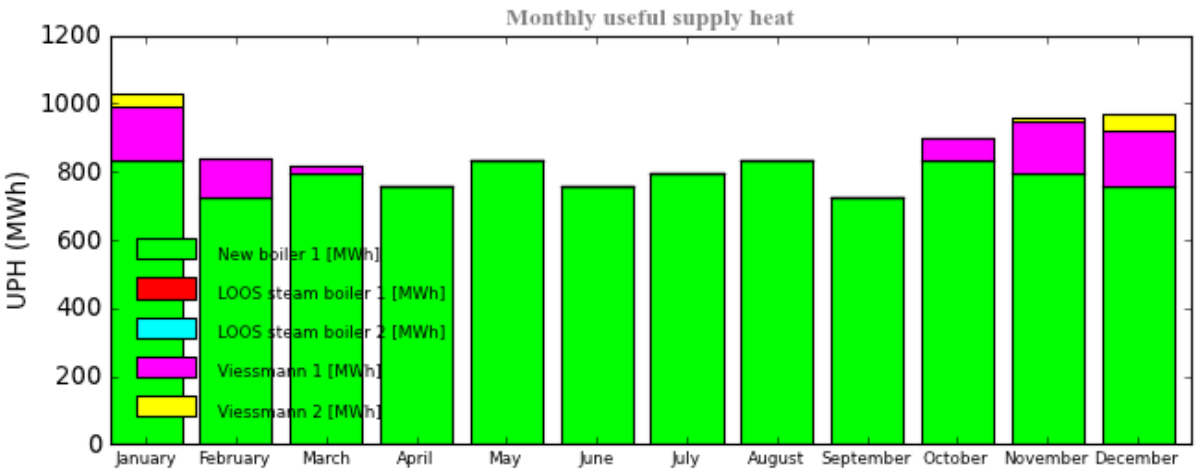

Figure 16: Distribution of useful process heat supply per month

- **New Hot Water Boiler:**

Type of boiler	condensing boiler
Nominal power	300 kW
Thermal efficiency	1.1
Operating hours	7,168 h

Table 10: 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 2	300	793	7.76
LOOS steam boiler 1	2,736	9,432	92.24
LOOS steam boiler 2	2,736	0	0.00
Viessmann 1	217	0	0.00
Viessmann 2	217	0	0.00
cooling tower 1	210	551	2.78
cooling tower 2	4,884	19,276	97.22
Total	**11,300**	**30,052**	**200**

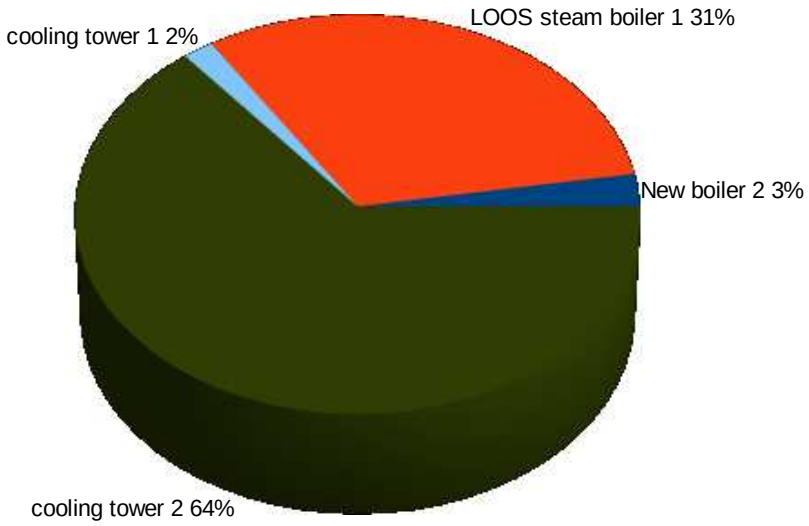

Figure 17: Contribution of each equipment to the total useful heat and useful cooling supply (USH & USC).

- graphic: heat demand covered by new boiler:

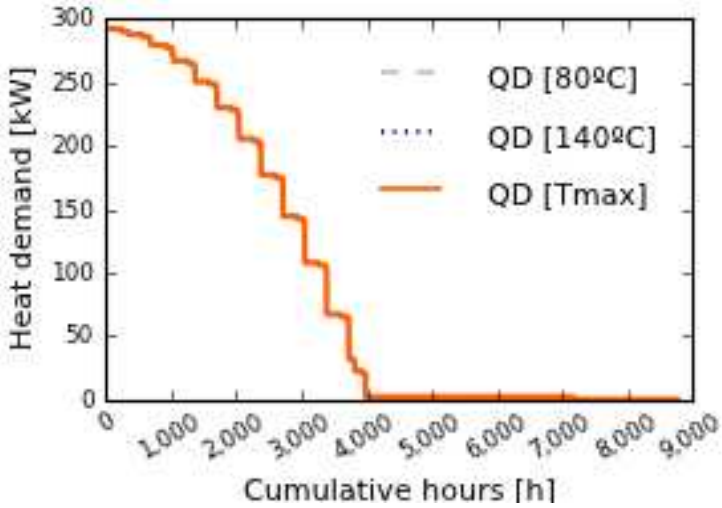

Figure 18: Heat demand covered by new boiler

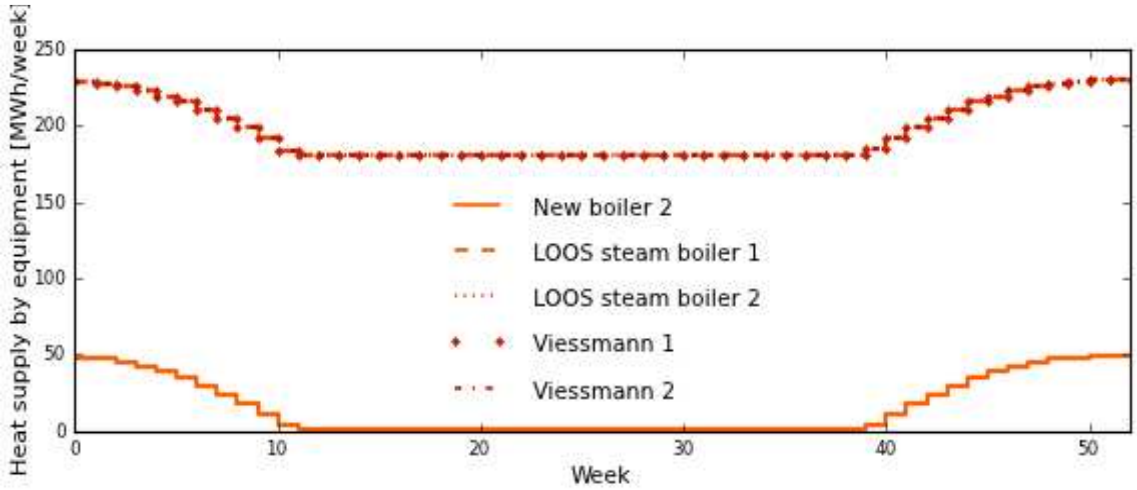

Figure 19: Weekly heat supply by equipment

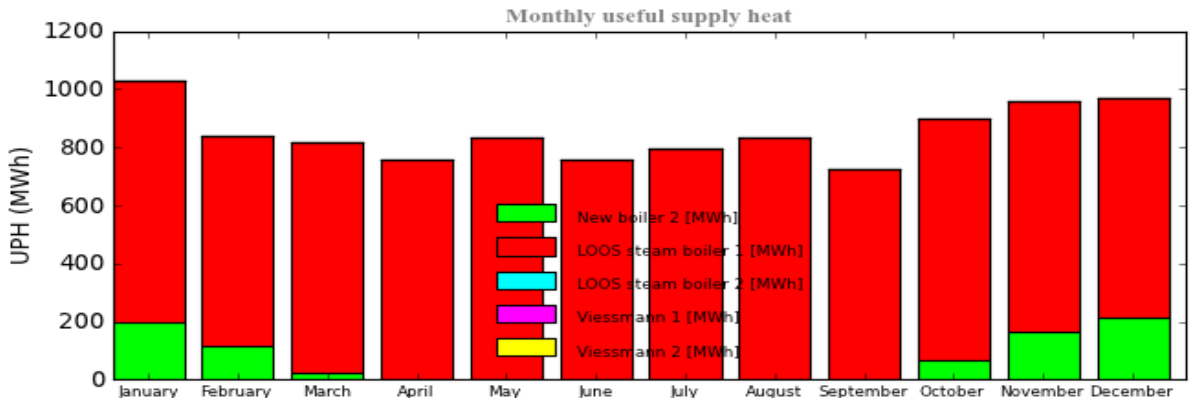

Figure 20: Distribution of useful process heat supply per month

- **HR compressor:**

  Heat exchanger type — plate HX (liquid-liquid)

  Nominal heat transfer — 80 kW

  In the following the Pinch Analysis is shown. The heat exchanger design of this alternative is presented and the remaining energy demand curve, as well as the remaining energy availability curves are displayed.

Table 11: Heat exchangers and amount of recovered energy

Heat Exchanger	Power	Heat Source	Heat Sink	Amount of recovered energy	
	[kW]			[MWh]	[%]
compressor waste heat	2	KAESER air compressors	main building_HW	7	100.00
Total	2			**7.44**	**100**

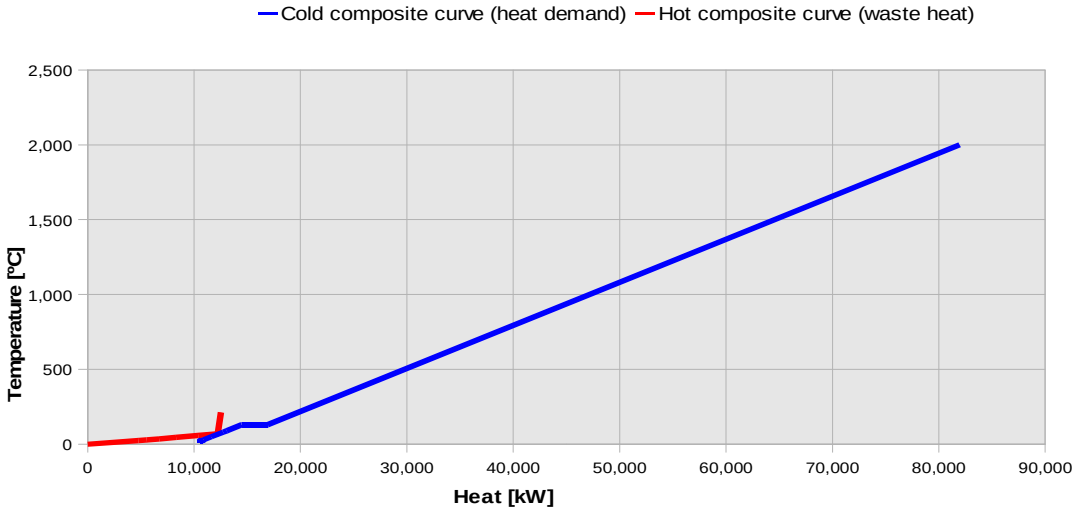

Figure 21: Pinch Analysis - Composite Curves

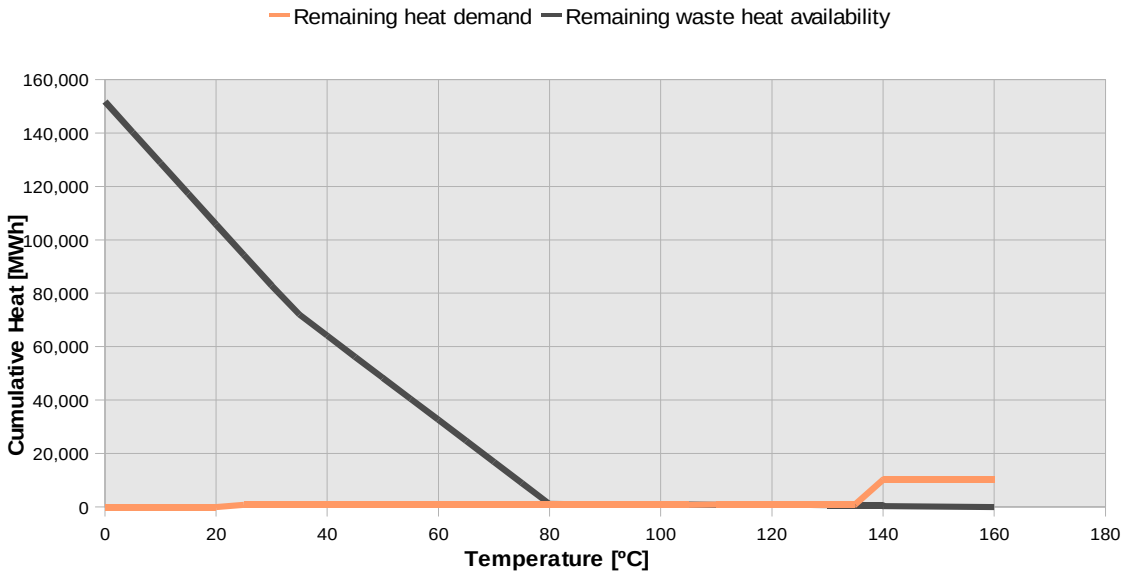

Figure 22: Pinch Analysis – Remaining yearly energy demand and energy availability

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]	[%]
LOOS steam boiler 1	2,736	9,432	92.31
LOOS steam boiler 2	2,736	0	0.00
Viessmann 1	217	685	6.70
Viessmann 2	217	101	0.99
cooling tower 1	210	551	2.78
cooling tower 2	4,884	19,276	97.22
Total	**11,000**	**30,045**	**200**

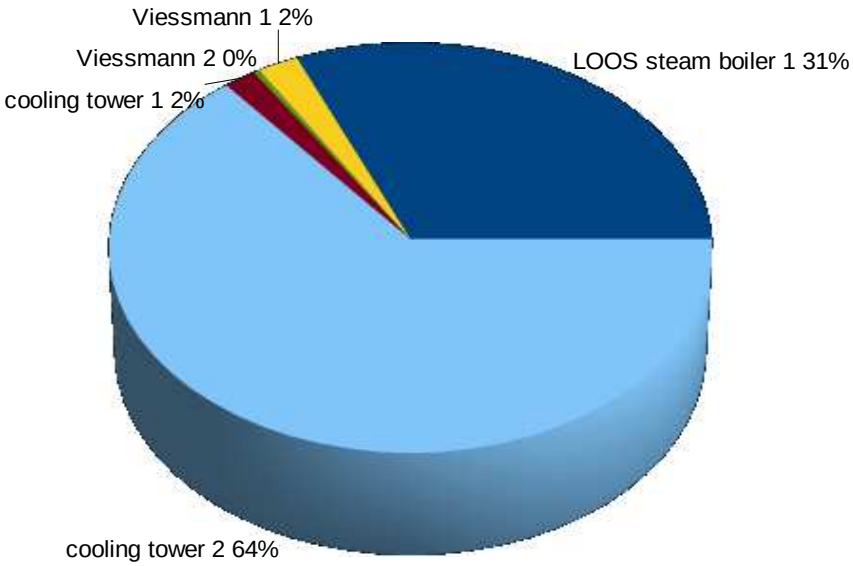

Figure 23: Contribution of each equipment to the total useful heat and useful cooling supply (USH & USC).

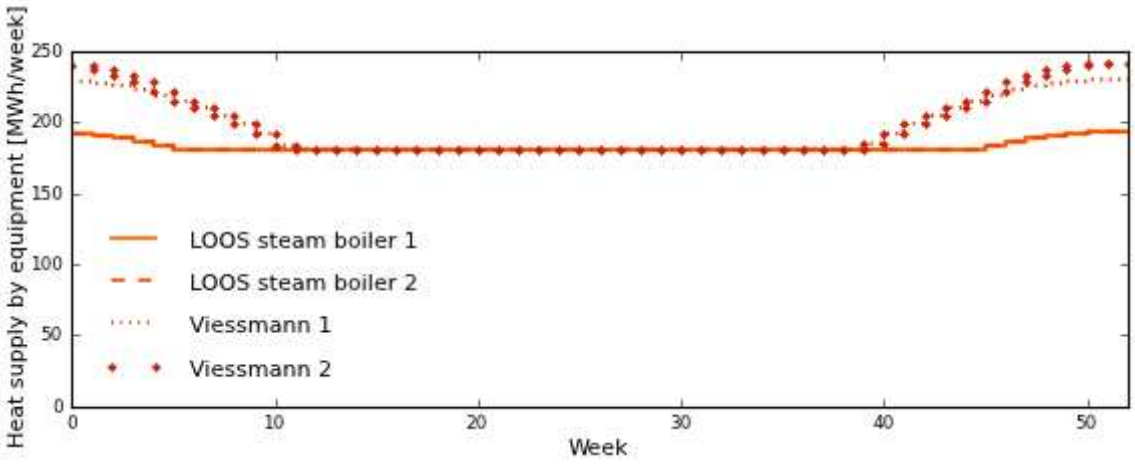

Figure 24: Weekly heat supply by equipment

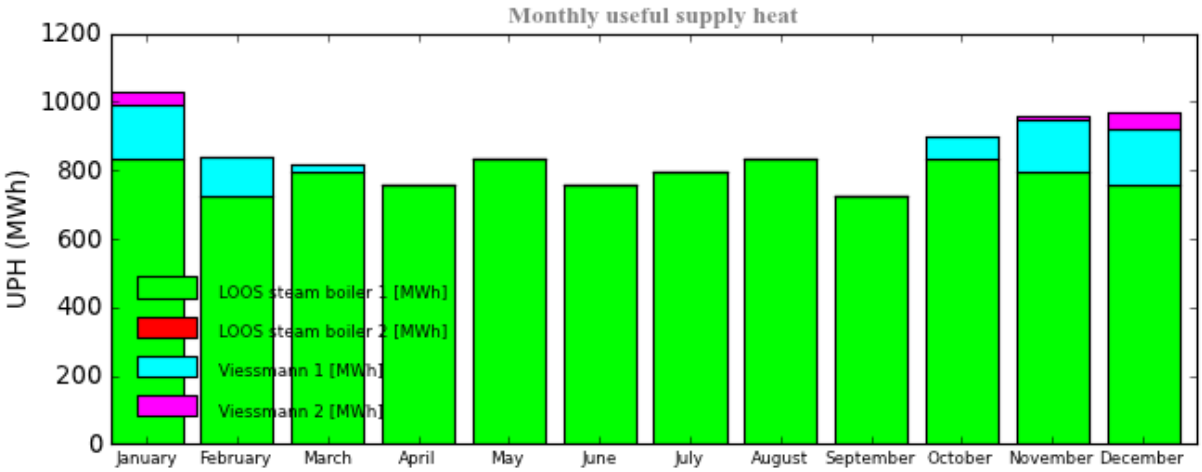

Figure 25: Distribution of useful process heat supply per month

- **Solar (FPC):**

Collector type:	FPC (flat plate collectors)
Installed capacity:	65.8 kW
Installed collector area:	213.85 m²
Solar buffer storage volume:	4.7 m³
Solar fraction:	1.86 %
Annual energy yield:	224.57 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	66	15	0.14
LOOS steam boiler 1	2,736	9,432	92.24
LOOS steam boiler 2	2,736	0	0.00
Viessmann 1	217	678	6.63
Viessmann 2	217	100	0.98
cooling tower 1	210	551	2.78
cooling tower 2	4,884	19,276	97.22
Total	**11,066**	**30,052**	**200**

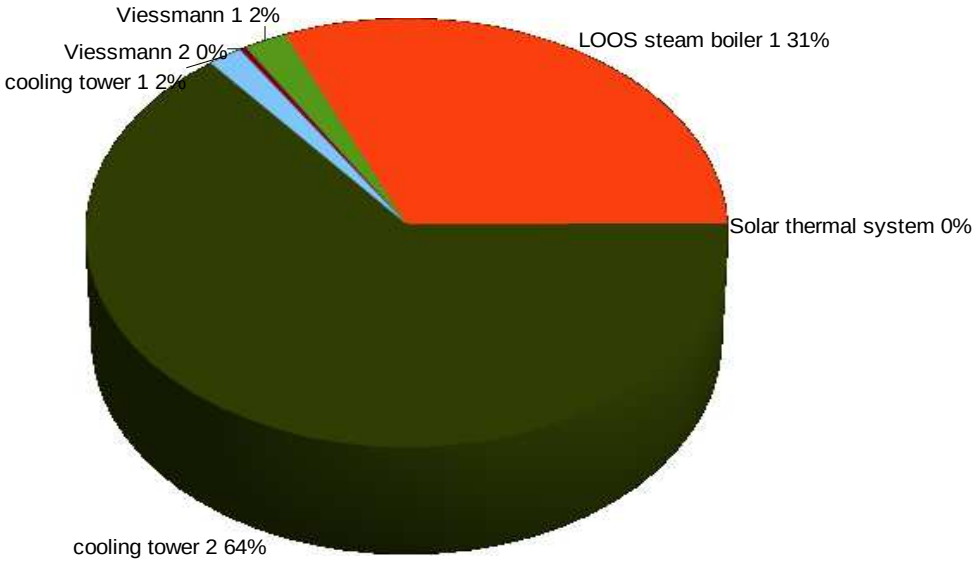

Figure 26: Contribution of each equipment to the total useful heat and useful cooling supply (USH & USC).

- graphic: heat demand covered by solar thermal system:

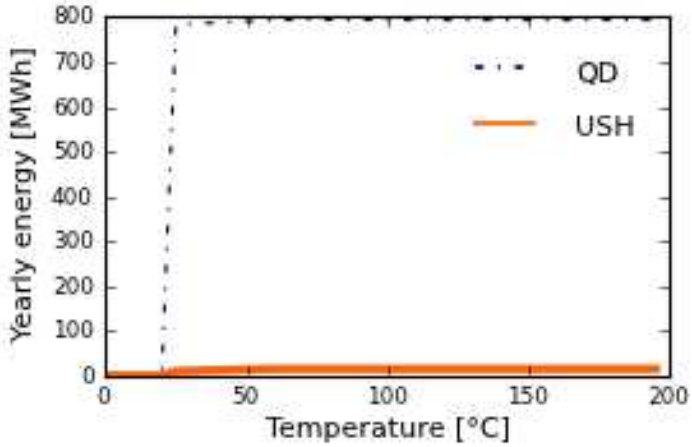

Figure 27: Heat demand covered by solar system

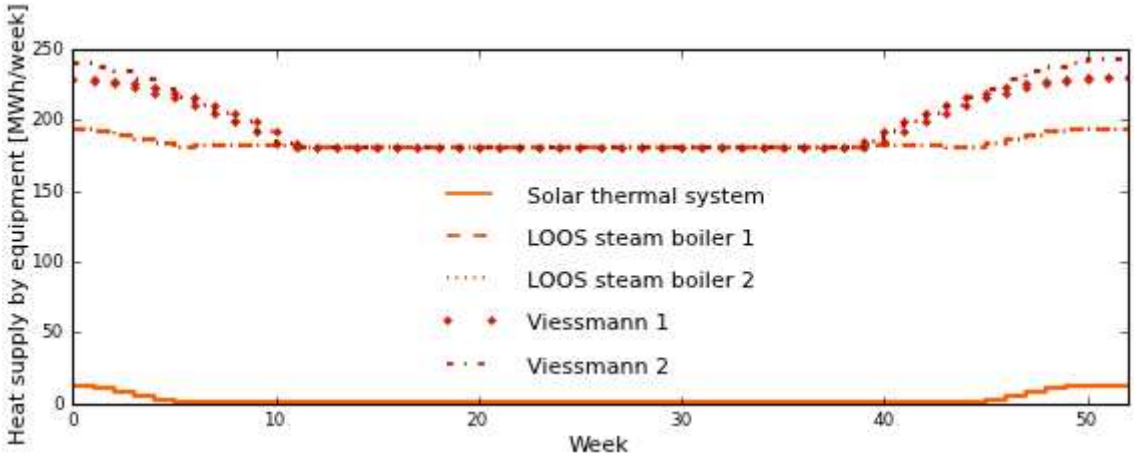

Figure 28: Weekly heat supply by equipment

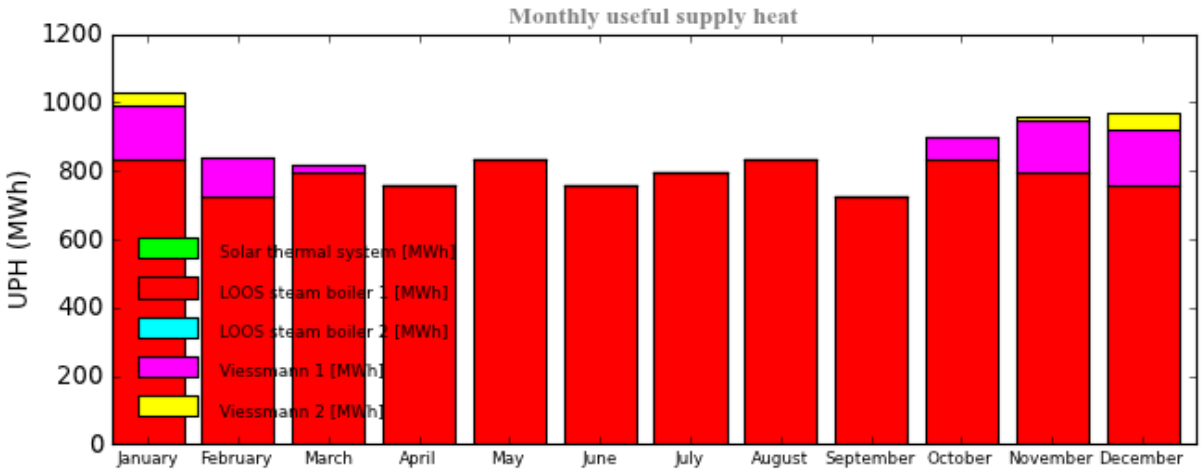

Figure 29: Distribution of useful process heat supply per month

- **CHP:**

Type	CHP engine
Nominal thermal power	50 kW
Nominal electric power	93 kW
Thermal efficiency	0.52
Electrical efficiency	0.28
Operating hours	6,443 h

Table 14: 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 CHP 1	93	407	3.98
LOOS steam boiler 1	2,736	9,217	90.14
LOOS steam boiler 2	2,736	0	0.00
Viessmann 1	217	561	5.48
Viessmann 2	217	40	0.40
cooling tower 1	210	551	2.78
cooling tower 2	4,884	19,276	97.22
Total	**11,093**	**30,052**	**200**

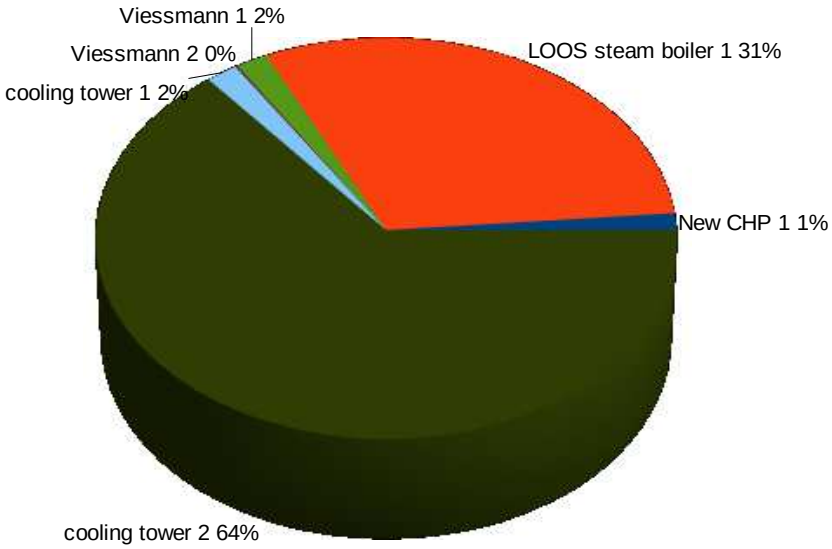

Figure 30: Contribution of each equipment to the total useful heat and useful cooling supply (USH & USC).

- graphic: heat demand covered by CHP:

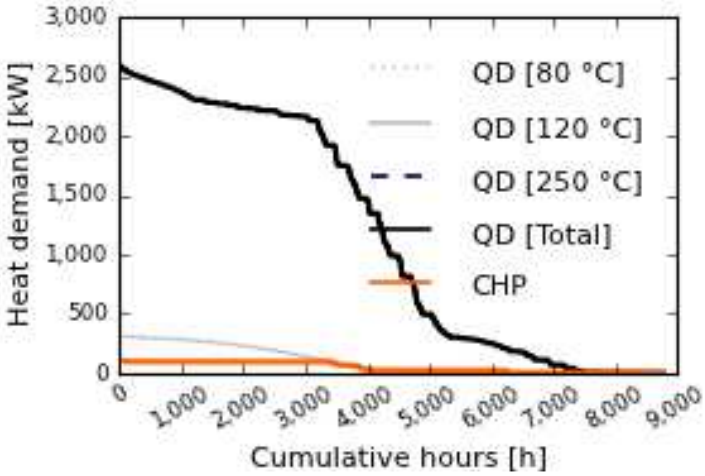

Figure 31: Heat demand covered by CHP

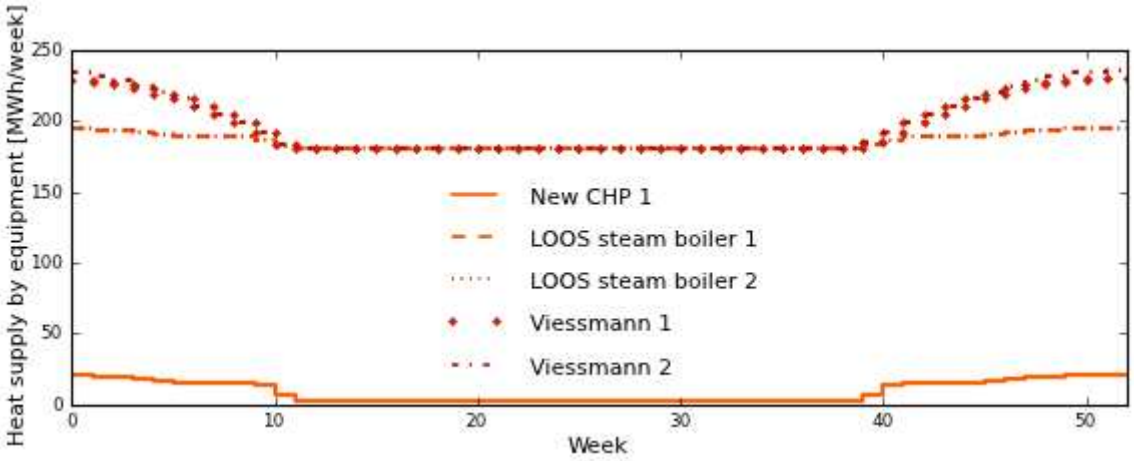

Figure 32:Weekly heat supply by equipment

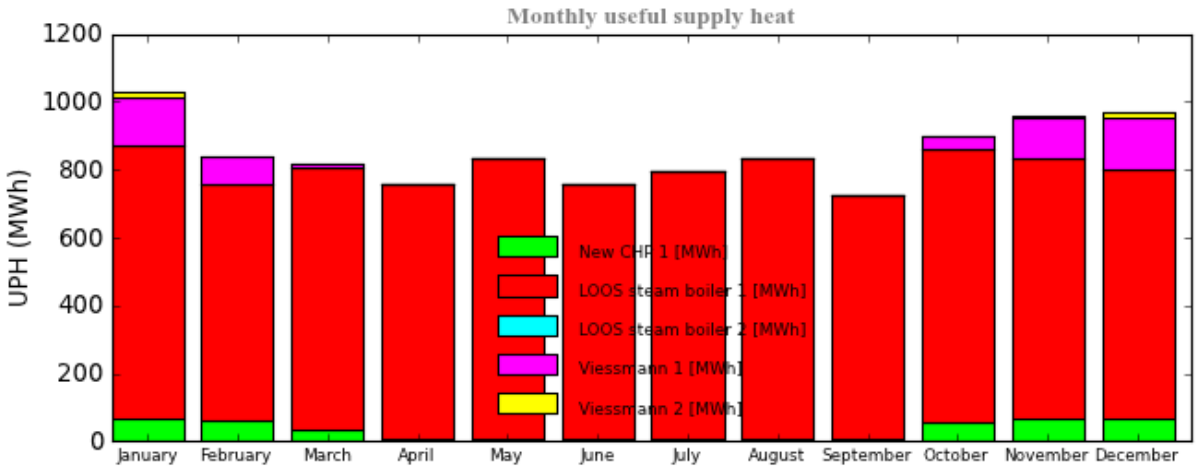

Figure 33: Distribution of useful process heat supply per month

- Primary energy consumption (PEC)

Table 15: primary energy consumption and savings

Alternative	Primary energy consumption	Savings	
	[MWh]	[MWh]	[%]
Present State (checked)	56,865	---	---
new steam boiler	56,101	763	1.34
new hot water boiler	56,722	142	0.25
heat recovery compressor	56,839	26	0.04
solar	56,831	34	0.06
CHP	56,554	311	0.55

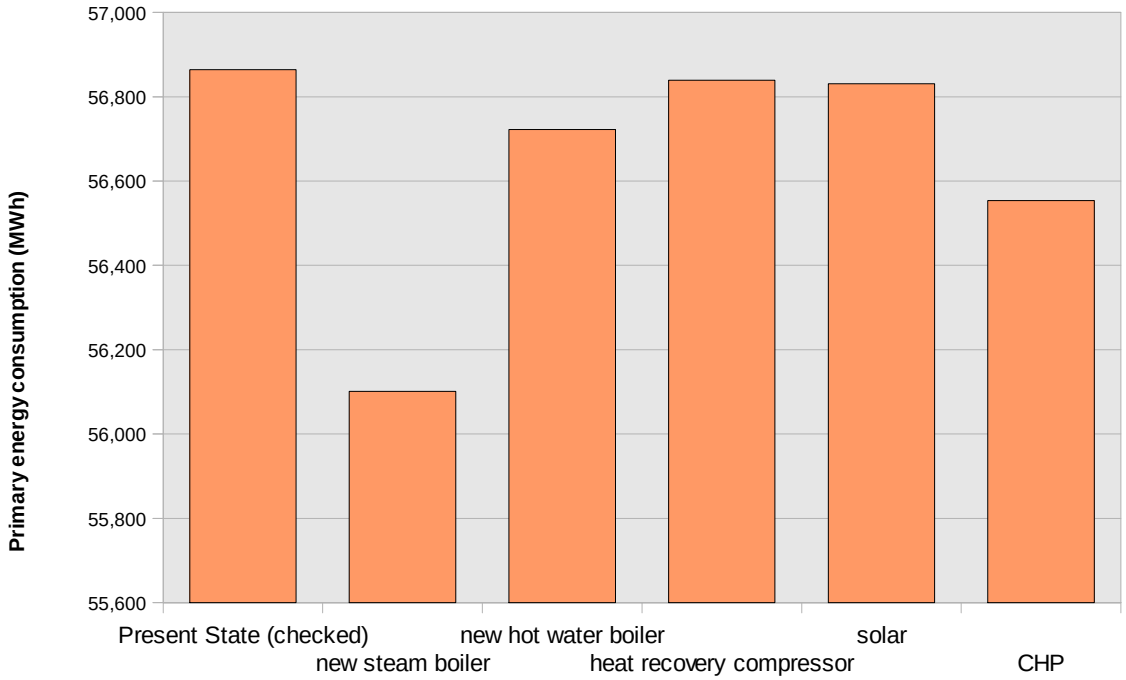

Figure 34: Comparison of alternatives: primary energy consumption

- 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 16: 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)	10,225	---	10,356	---
new steam boiler	10,225	0	10,225	130
new hot water boiler	10,225	0	10,225	130
heat recovery compressor	10,225	0	10,218	138
solar	10,225	0	10,225	130
CHP	10,225	0	10,225	130

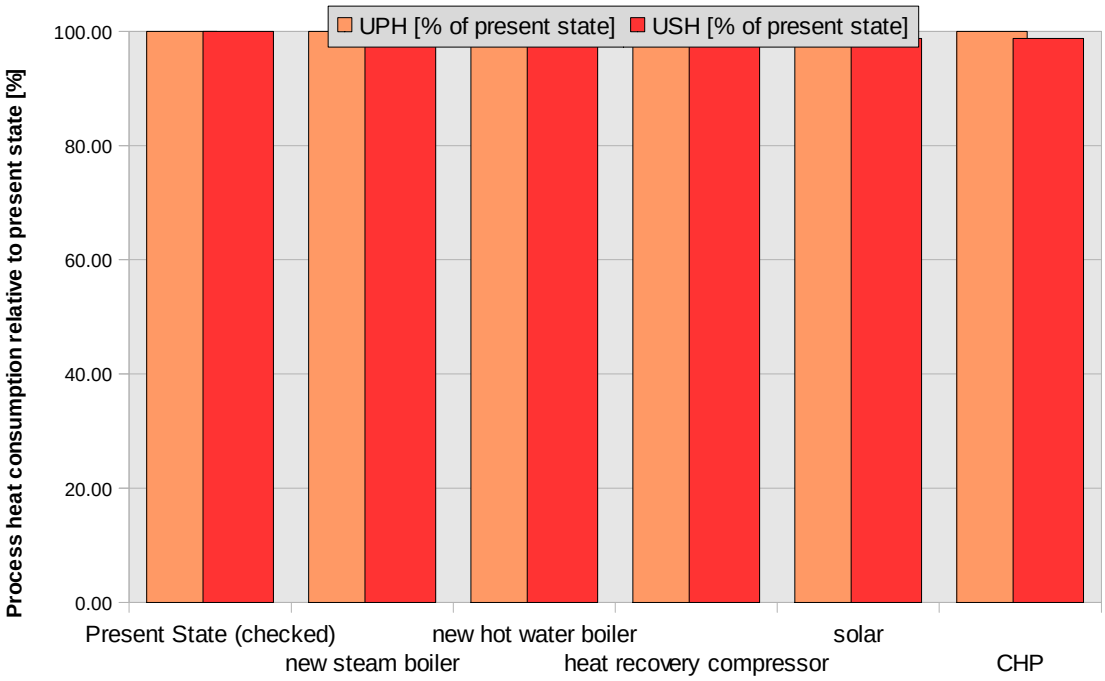

Figure 35: Comparison of alternatives: useful process heat supply

- Environmental impact

Table 17: CO2 production and CO2 savings per year

Alternative	Production of CO2	Water consumption
	[t]	[m³]
Present State (checked)	10,272.64	0.00
new steam boiler	10,082.05	0.00
new hot water boiler	10,240.31	0.00
heat recovery compressor	10,268.09	0.00
solar	10,266.23	0.00
CHP	10,243.77	0.00

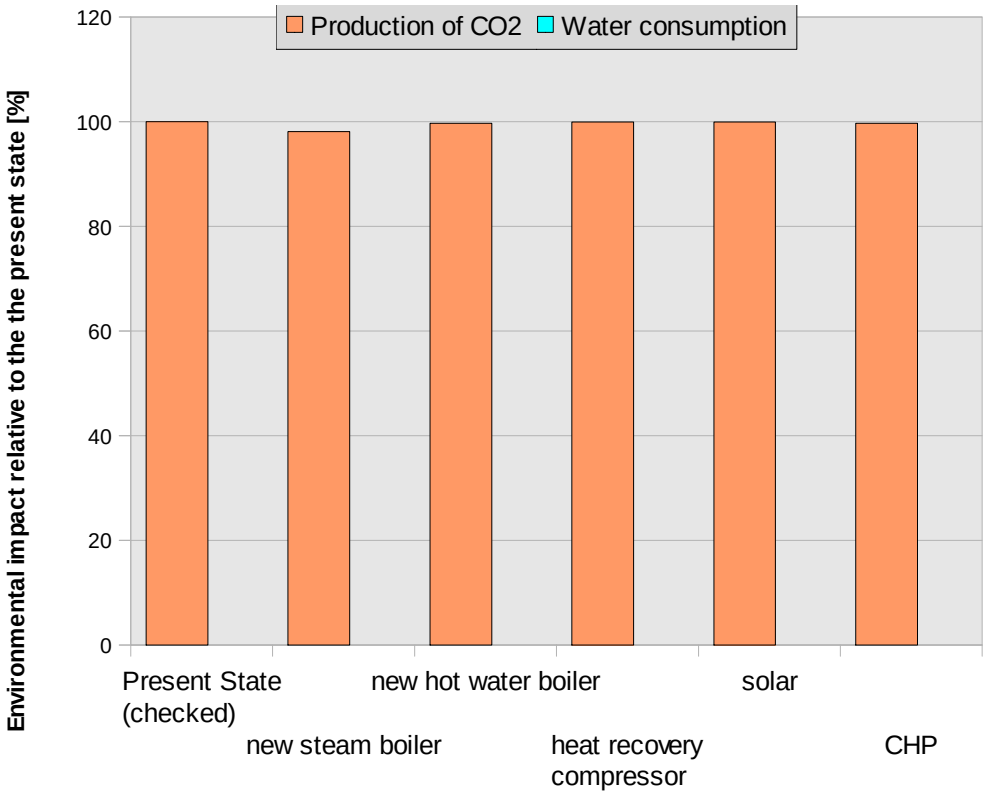

Figure 36: Comparison of alternatives: environmental impact

Table 18: Investment costs and subsidies of the proposals

Alternative	Total investment [€]	Own investment [€]	Subsidies [€]
Present State (checked)	---	---	---
new steam boiler	136,700	136,700	0
new hot water boiler	21,000	21,000	0
heat recovery compressor	12,000	12,000	0
solar	42,300	29,610	12,690
CHP	90,000	90,000	0

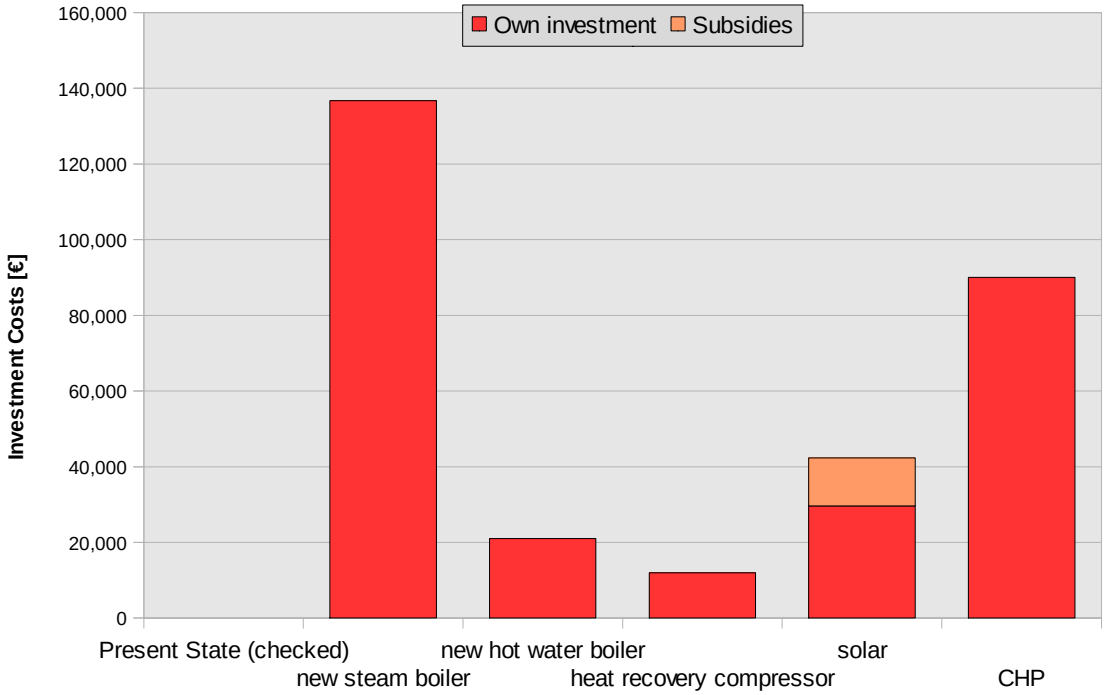

Figure 37: Comparison of alternatives investment cost

5. Selected alternative(s) and conclusions

5.1. Selected alternative

The selected alternative that has been chosen is the "New Steam Boiler".

5.1.1. Process optimisation (written proposals)

None

5.1.2. Heat Supply

New Steam Boiler:

Type of boiler	steam boiler
Nominal power	2,734 kW
Thermal efficiency	0.93
Operating hours	4,176 h

Table 19: 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 1	2,734	9,432	92.24
LOOS steam boiler 1	2,736	0	0.00
LOOS steam boiler 2	2,736	0	0.00
Viessmann 1	217	690	6.75
Viessmann 2	217	103	1.00
cooling tower 1	210	551	2.78
cooling tower 2	4,884	19,276	97.22
Total	**13,734**	**30,052**	**200**

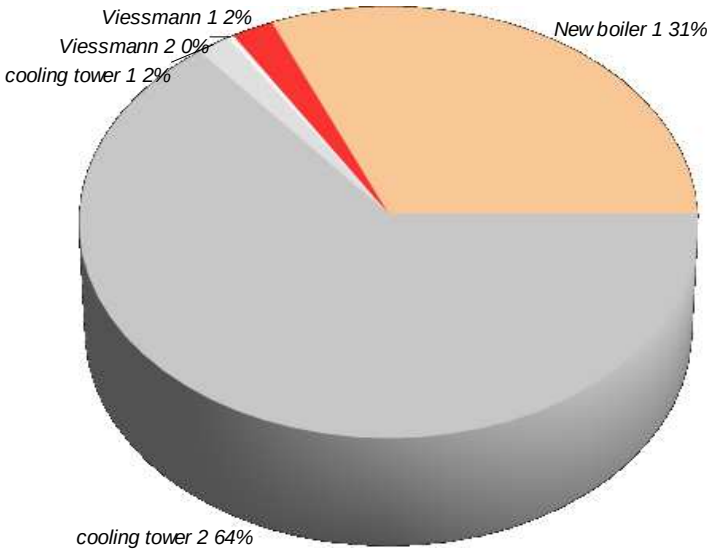

Figure 38: Contribution of each equipment to the total useful heat and useful cooling supply (USH & USC).

5.1.3. Energy Consumption

Table 20: 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	12,075	21.52	12,075	96.40
Total electricity	44,027	78.48	451	3.60
Total (fuels + electricity)	**56,101**	**100.00**	**12,526**	**100.00**

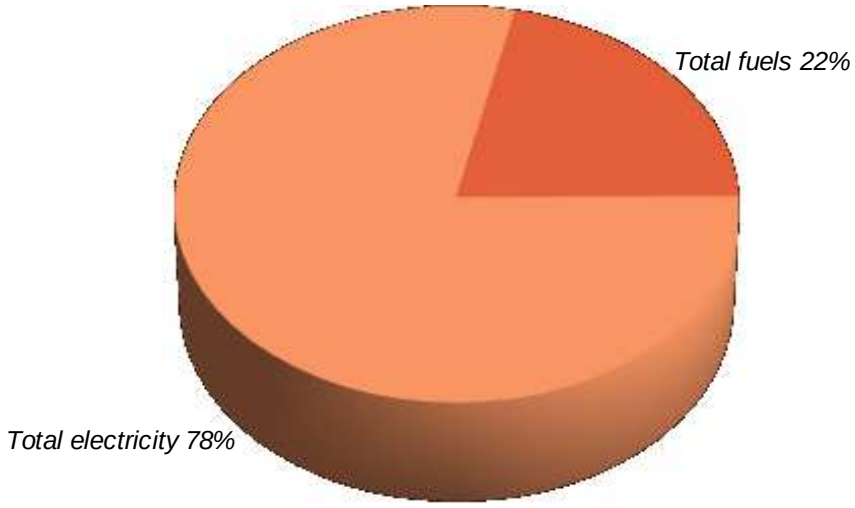

Figure 39: Distribution of PEC by fuel type

Table 21: 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 II	10,977	42.79	10,977	98.65
Electricity	14,676	57.21	150	1.35
Total	25,653	100.00	11,128	100.00

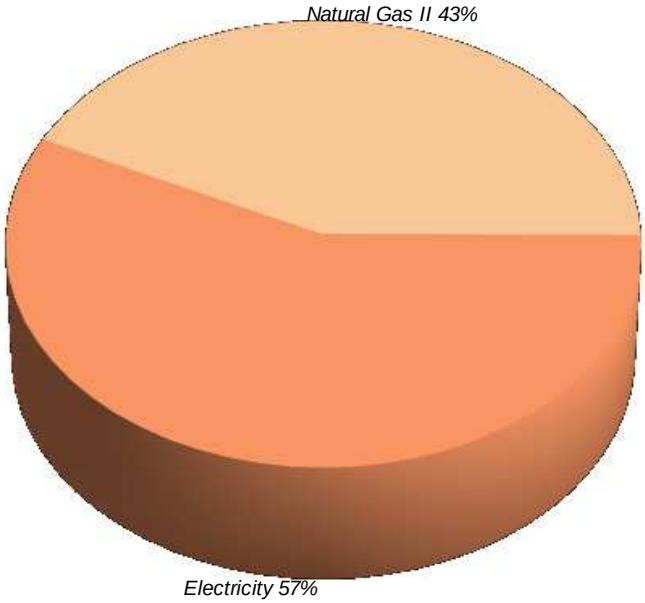

Figure 40: Total final energy consumption (FEC). Proposed final solution.

Table 22 : Final energy consumption for thermal use (FET) by equipment. Proposed final solution.

Equipment	Fuel type	FET by equipment	
		[MWh]	[% of Total]
LOOS steam boiler 1	Natural Gas II	0	0.00
LOOS steam boiler 2	Natural Gas II	0	0.00
Viessmann 1	Natural Gas II	727	6.53
Viessmann 2	Natural Gas II	108	0.97
cooling tower 1	Electricity	6	0.05
cooling tower 2	Electricity	43	0.39
New boiler 1	Natural Gas II	10,243	92.05
Total		**11,128**	**100**

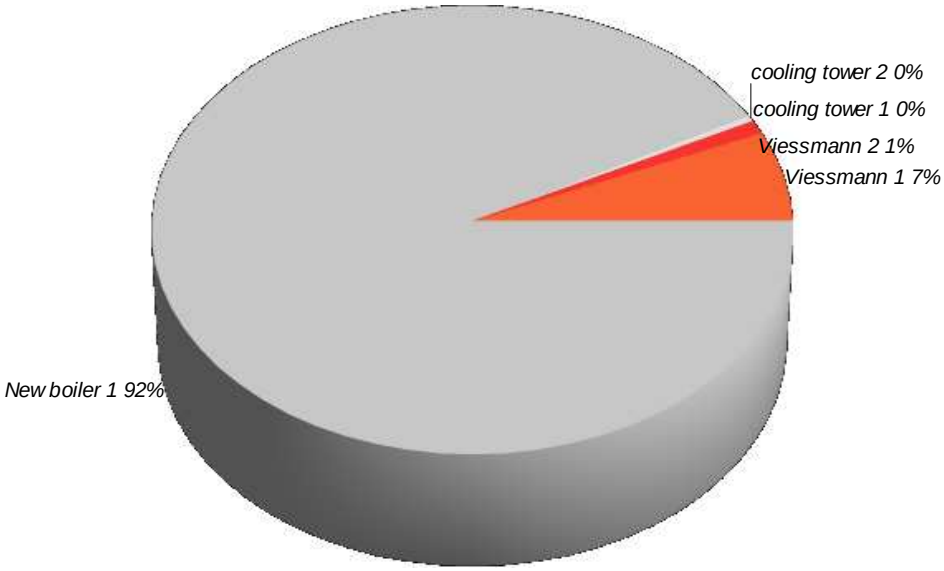

Figure 41: Final energy consumption for thermal use (FET) by equipment

Table 23 : Useful supply heat (USH) by equipment. Proposed final solution.

Equipment	USH by equipment	
	[MWh]	[% of Total]
LOOS steam boiler 1	0	0.00
LOOS steam boiler 2	0	0.00
Viessmann 1	690	6.75
Viessmann 2	103	1.00
New boiler 1	9,432	92.24
Total	**10,225**	**100**

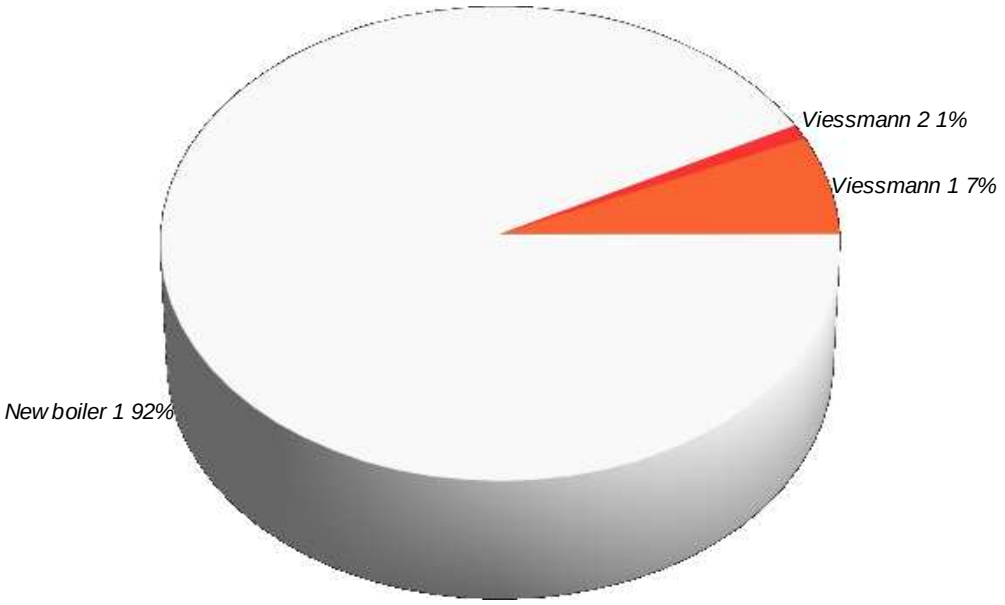

Figure 42: Useful supply heat (USH) by equipment. Proposed final solution

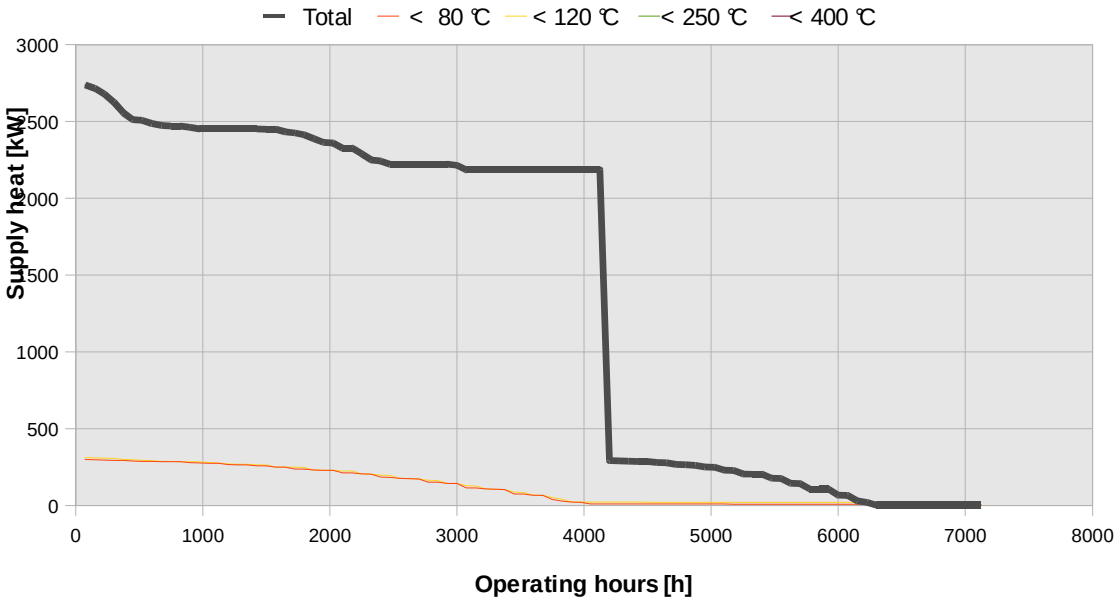

Figure 43: Distribution of supply heat by temperature levels and annual operating hours. Proposed final solution.

Table 24: Useful process heat demand (UPH) by process. Proposed final solution.

Process	Total	Circulation	Maintenance	Start-up
	[MWh]	[MWh]	[MWh]	[MWh]
expanding	1,934	62	1,872	0
forming	5,989	30	5,959	0
drying	1,509	21	1,489	0
main building_HW	12	12	0	0
main building_heating	781	0	781	0
cooling tower waste heat	0	0	0	0
Total	**10,225**			

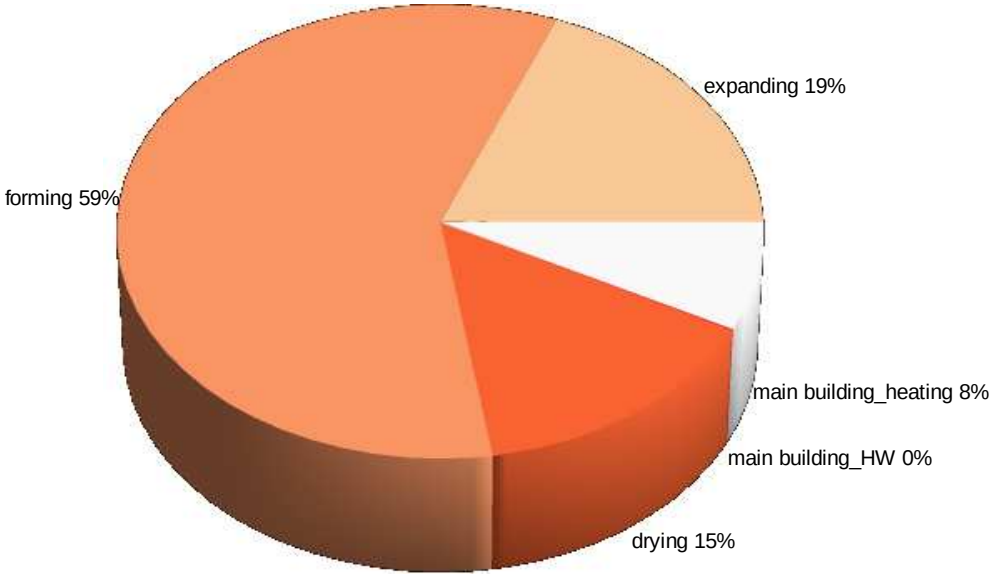

Figure 44: Useful process heat (UPH) by process. Proposed final solution.

Table 25: Useful process cooling demand (UPC) by process. Proposed final solution.

Process	Total	Circulation	Maintenance	Start-up
	[MWh]	[MWh]	[MWh]	[MWh]
cooling tower 1	869	869	0	0
forming	20,317	20,317	0	0
Total	**21,187**			

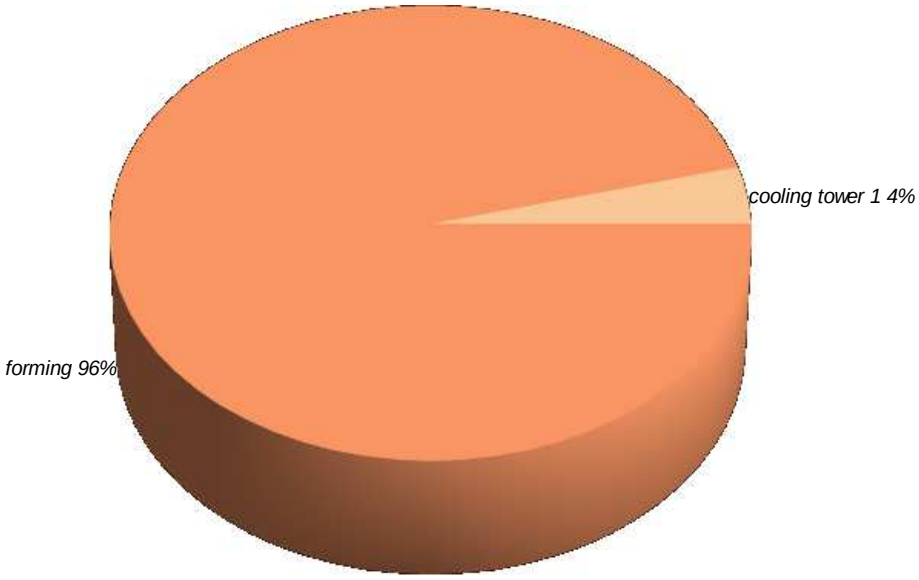

Figure 45: Useful process cooling (UPC) by process. Proposed final solution.

5.2. Comparative study and conclusions

5.2.1. Energy and environmental analysis

In the proposed alternative around 2 % or 191 tons of the CO_2 pollution can be saved.

5.2.2. Economic analysis

The payback period of about 4.2 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 Slovakia.

Table 26: Savings of the proposed alternative in comparison to the present state

		Present state	Alternative	Saving	[% savings]
Total primary energy consumption (1)					
- total	[MWh]	56,865	56,101	764	1%
- fuels	[MWh]	13,121	12,075	1,046	8%
- electricity	[MWh]	43,744	44,027	-283	-1%
Primary energy saving due to renewable energy	[MWh]		-		
CO2 emissions	[t/a]	10,273	10,082	191	2%
Annual energy system cost (2)	[EUR]	1,496,219	1,473,057	23,162	2%
Total investment costs	[EUR]		136,700		
Payback period (3)	[years]		4.2		

(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.