Energy Audit Summary Report
AEE INTEC
Audit no. 31 – SVK02
Johnson Control

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. 31 – SVK02

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: 27.03.2012

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	automotive
Products	SNB line: head rest for car seats
No. of employees	769 employees
Current primary energy consumption:	27,477 [MWh/a]

3.2. Flow sheet of the whole manufacturing side

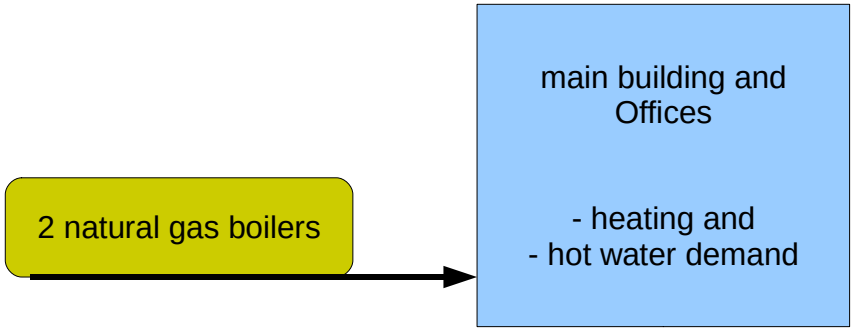

Figure 1: Flow sheet of the factory

3.3. Description of the existing system

- **Energy Supply:**

  The factory is mainly consuming energy for hot water production and heating of the buildings during winter.

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	5,385	19.60	5,385	100.00
Total electricity	22,092	80.40	0	0.00
Total (fuels + electricity)	**27,477**	**100.00**	**5,385**	**100.00**

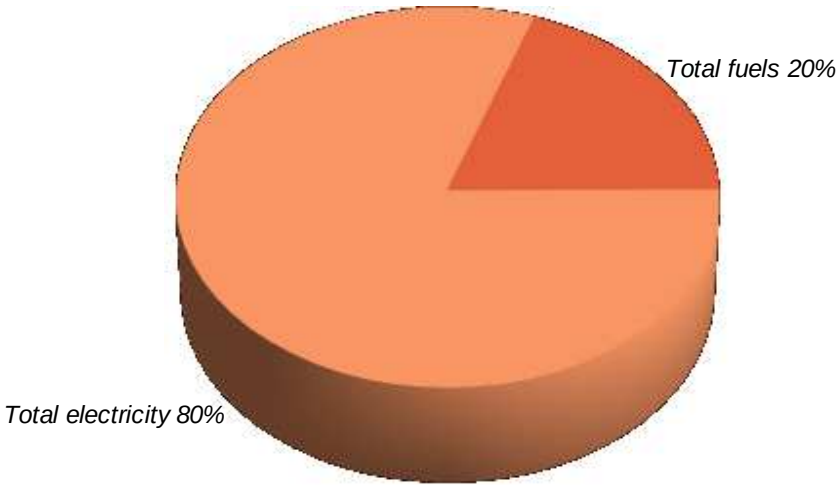

Figure 2: distribution of PEC by fuel type

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	4,896	39.93	4,896	100.00
Electricity	7,364	60.07	0	0.00
Total	12,260	100.00	4,896	100.00

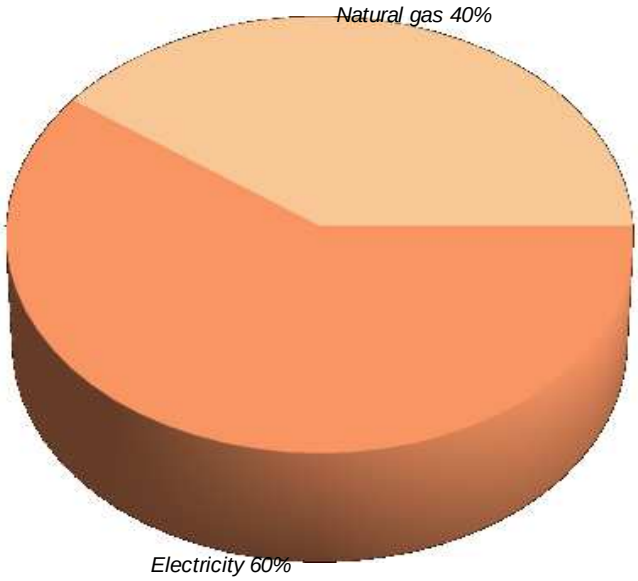

Figure 3: Total final energy consumption for thermal use (FET)

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

Equipment	Fuel type	FET by equipment	
		[MWh]	[% of Total]
Viessmann 1	Natural gas	2,542	49.99
Viessmann 2	Natural gas	2,543	50.01
Total		**5,085**	**100.00**

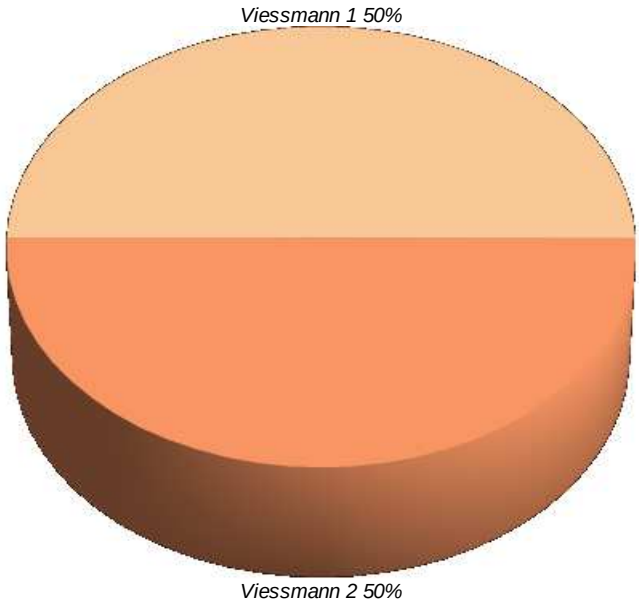

Figure 4: Final energy consumption for thermal use (FET) by equipment

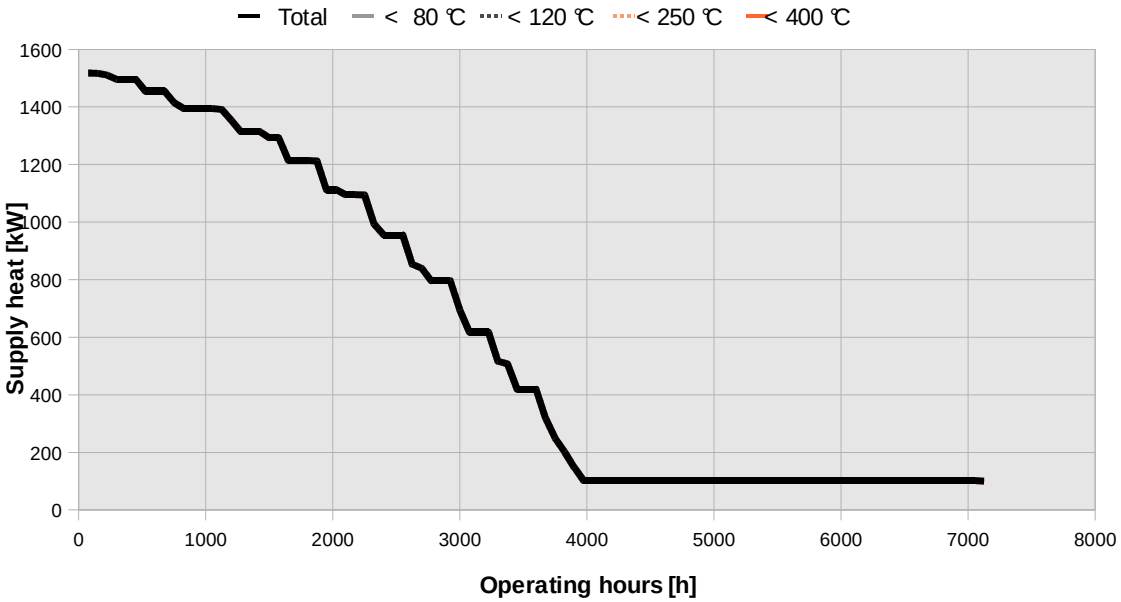

Figure 5: Distribution of supply heat by temperature levels and annual operating hours. Present state.

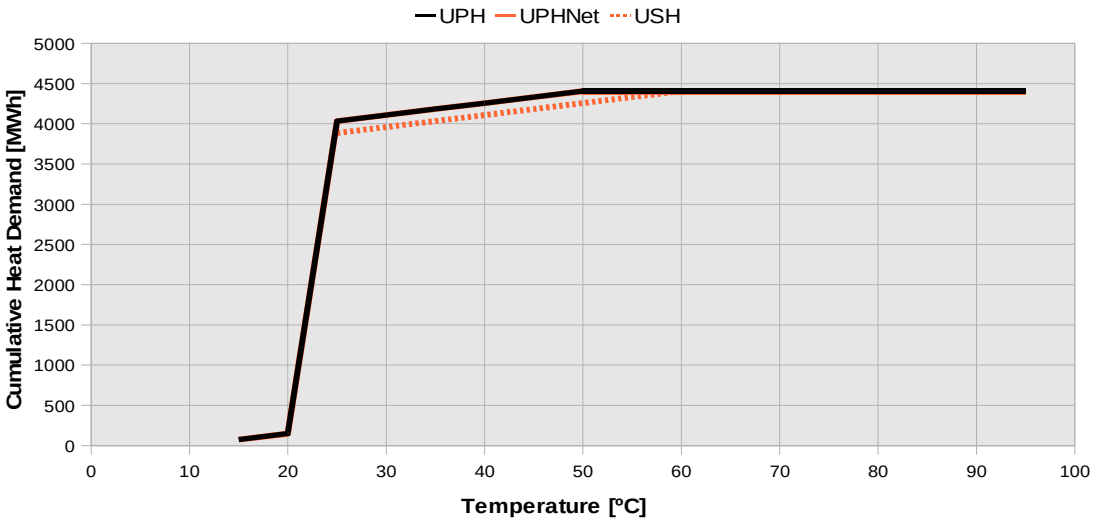

Figure 6: Distribution of the heat demand by temperature levels

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

Equipment	USH by equipment	
	[MWh]	[% of Total]
Viessmann 1	2,205	49.99
Viessmann 2	2,206	50.01
Total	**4,411**	**100.00**

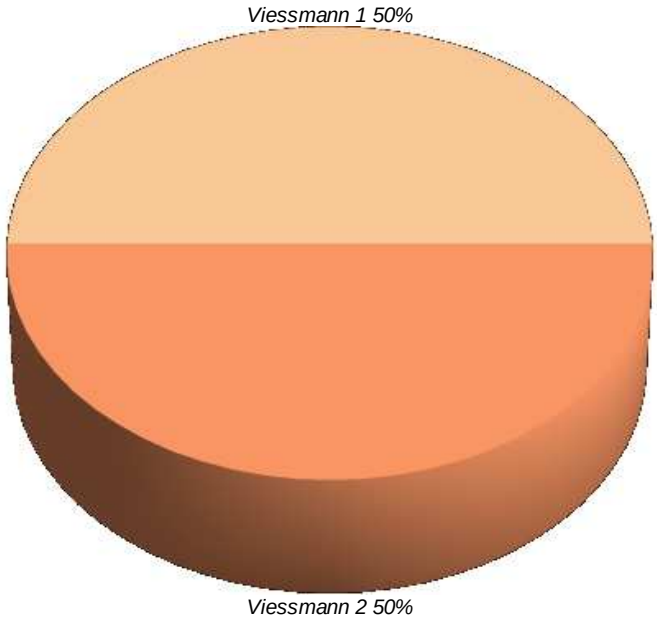

Figure 7: Useful supply heat (USH) by equipment. Present state

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

Process	Total	Circulation	Maintenance
	[MWh]	[MWh]	[MWh]
main building_HW	595	595	0
main building_heating	3,811	0	3,811
Total	**4,406**		

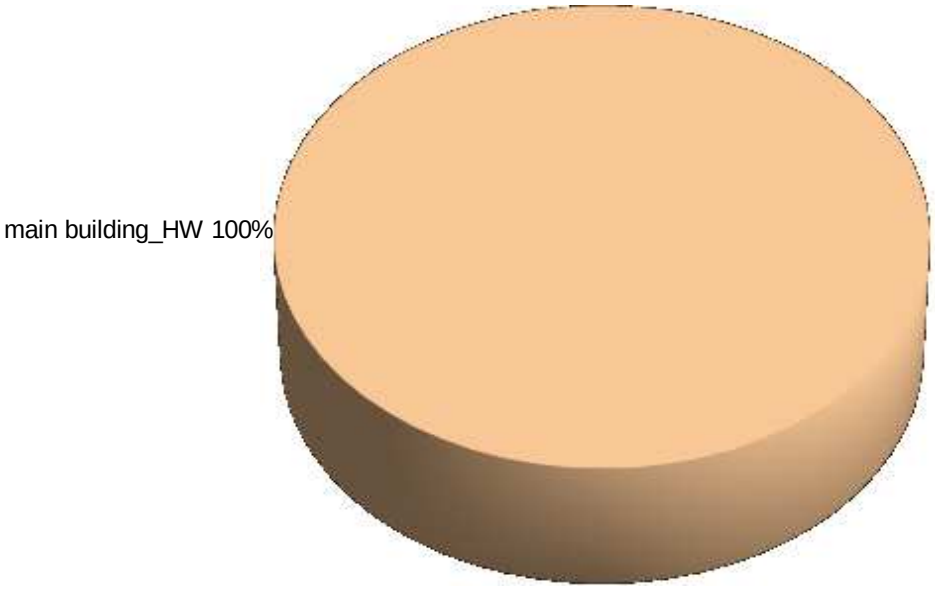

Figure 8: Useful process heat (UPH) by process

3.4. General

- The target room temperature during winter is 25 °C for the production hall and offices.
- The hot water demand was estimated to be 35 m³ per day.

4. Comparative study

4.1. Proposed alternatives

There are six proposals made in this study. In the first proposal is a heat recovery proposal. The second proposal has a new a boiler proposed. The third proposal includes installing a CHP plant. The fourth proposal is a solar thermal system. The fifth proposal is a heat exchanger system and a CHP plant. The sixth proposal is a heat recovery and a new boiler.

Table 6: Overview of the alternative proposals studied

Short Name	Description
heat recovery	based on present state
New boiler	based on present state
CHP	based on present state
solar	based on present state
HX + CHP	based on present state(modified alternative based on heat recovery)
heat recovery + new boiler	based on present state(modified alternative based on heat recovery)

4.1.1. Heat Supply

- **Heat Recovery:**

  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 7: Heat exchangers and amount of recovered energy

Heat Exchanger	Power	Heat Source	Heat Sink	Amount of recovered energy	
	[kW]			[MWh]	[%]
HX_AbovePinch_2	1	RTO	Viessmann 2	6	1.47
HX_AbovePinch_1	9	RTO	Viessmann 1	57	14.50
HX_AbovePinch_0	68	compressors	main building_HW	330	84.03
	78			**392.23**	**100**

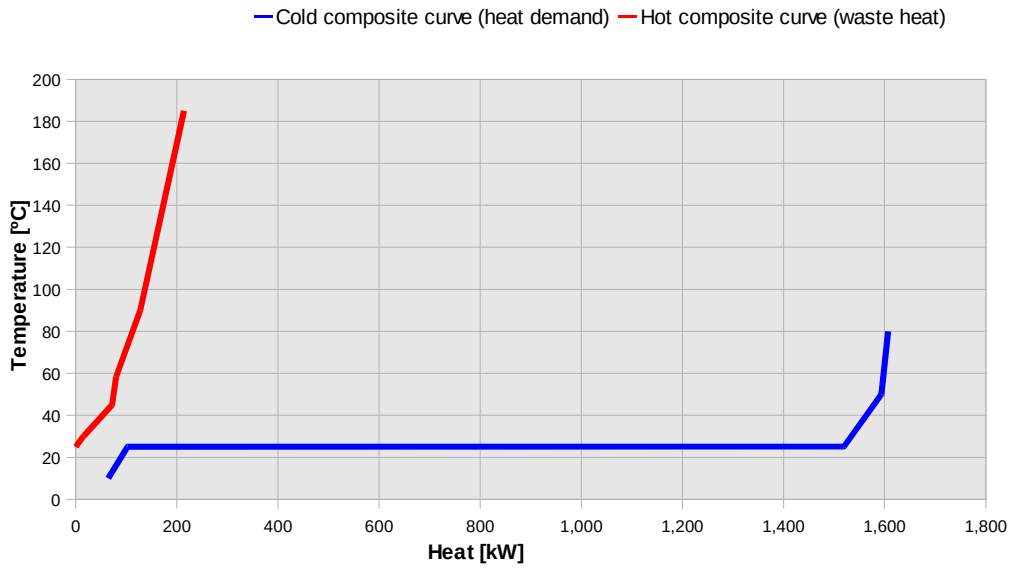

Figure 9: Pinch Analysis - Composite Curves

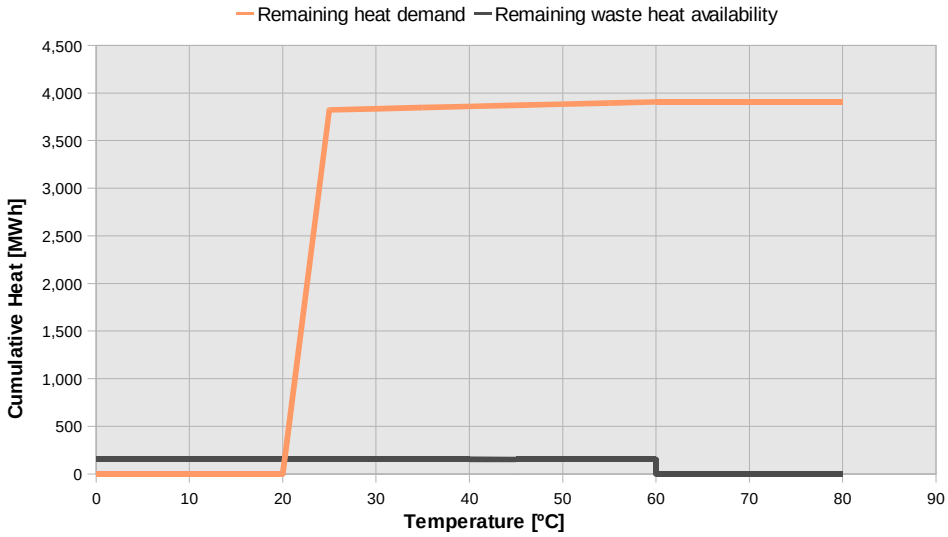

Figure 10: Pinch Analysis – Remaining yearly energy demand and energy availability

Table 8: 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]	[%]
Viessmann 1	1,400	3,892	99.63
Viessmann 2	1,400	14	0.37
Total	**2,800**	**3,906**	**200**

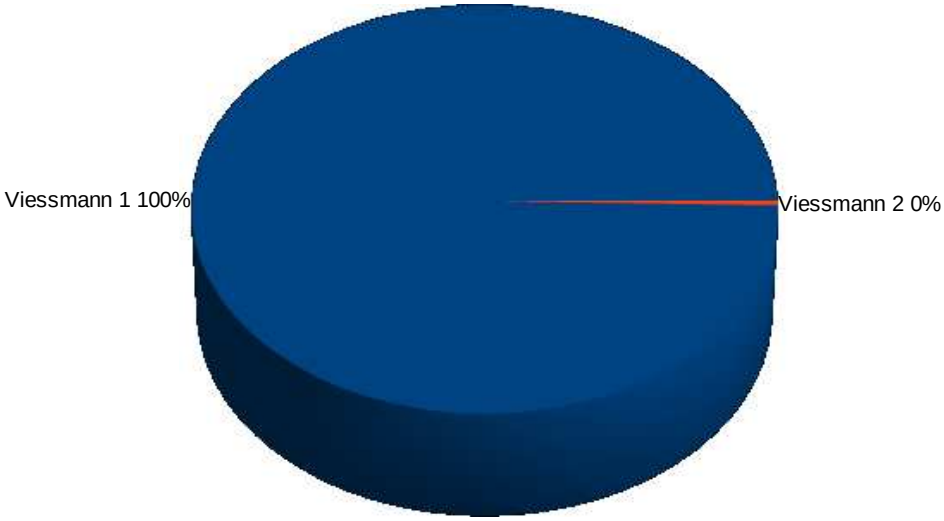

Figure 11: Contribution of each equipment to the total useful heat and useful cooling supply (USH & USC).

- graphic: performance curves of the HX

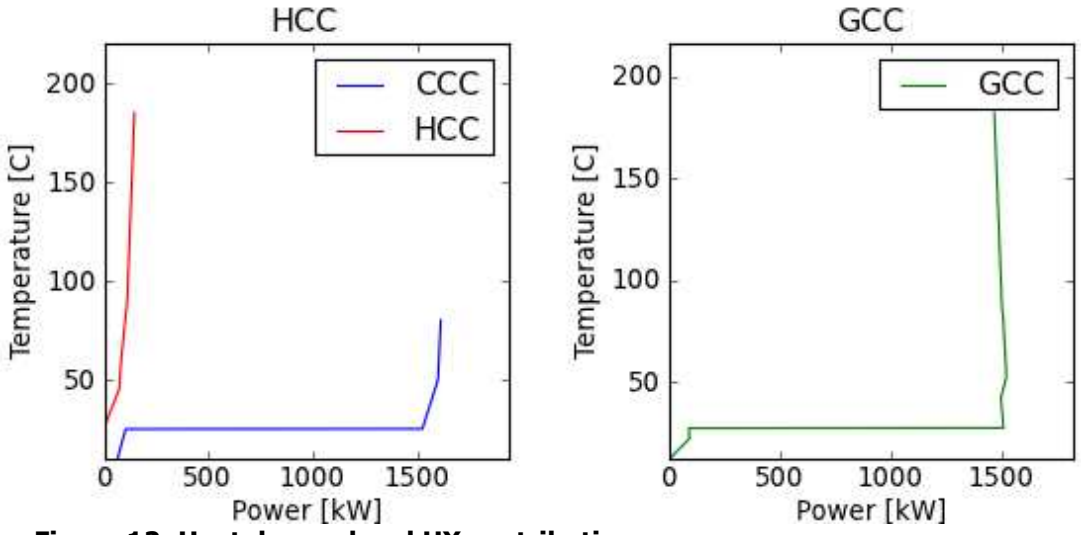

Figure 12: Heat demand and HX contribution

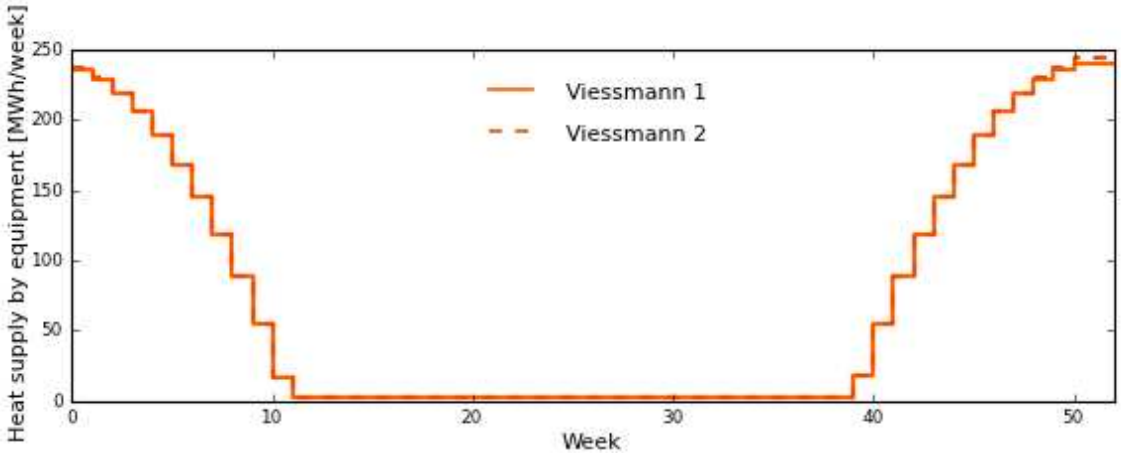

Figure 13: Weekly heat supply by equipment

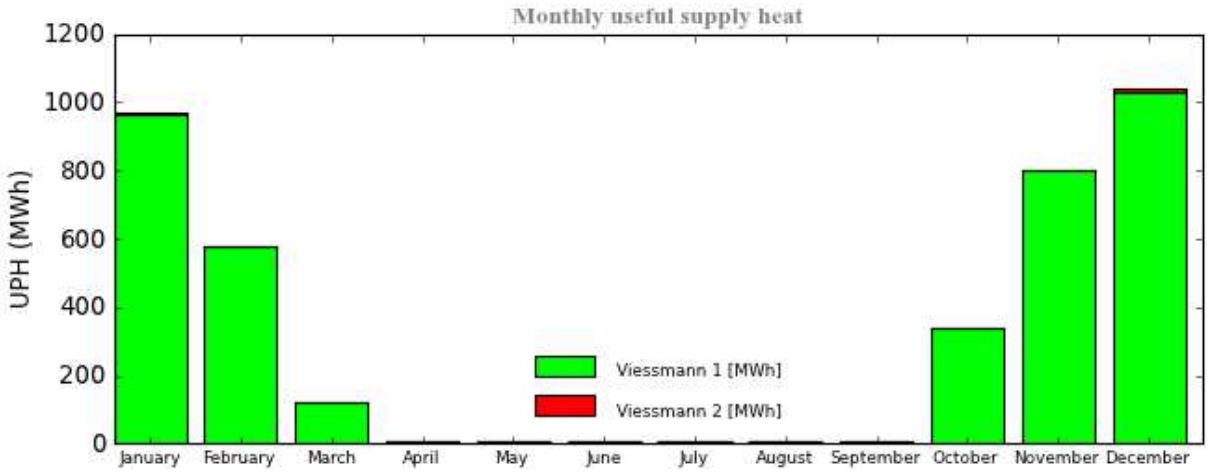

Figure 14: Distribution of useful process heat supply per month

- **New Boiler:**

Type of boiler	condensing boiler
Nominal power	1,000 kW
Thermal efficiency	1.1
Operating hours	7,168 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	1,000	3,639	82.60
Viessmann 1	1,400	767	17.40
Viessmann 2	1,400	0	0.00
Total	**3,800**	**4,406**	**200**

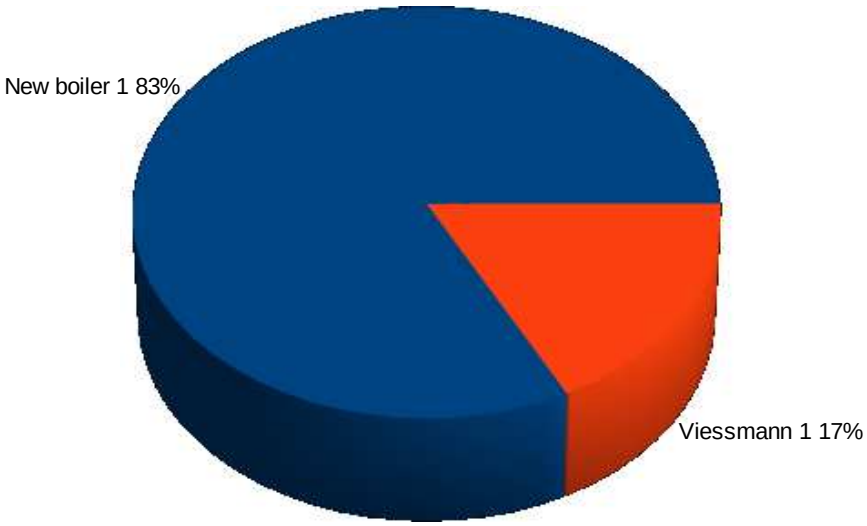

Figure 15: Contribution of each equipment to the total useful heat and useful cooling supply (USH & USC).

- graphic: heat demand covered by new boiler:

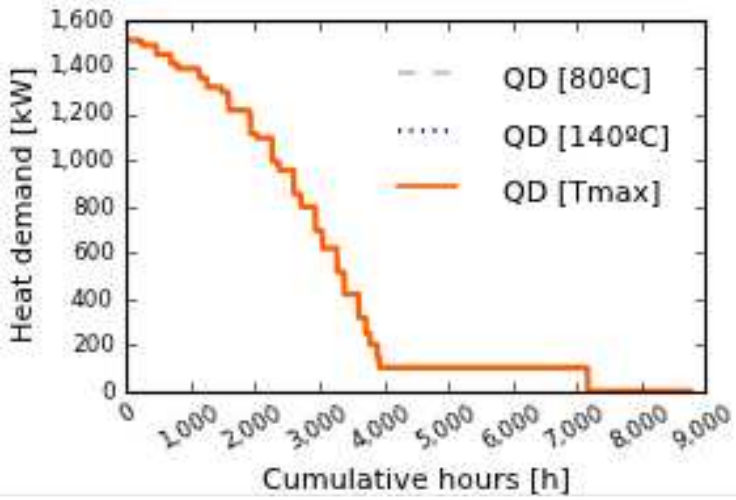

Figure 16: Heat demand covered by new boiler

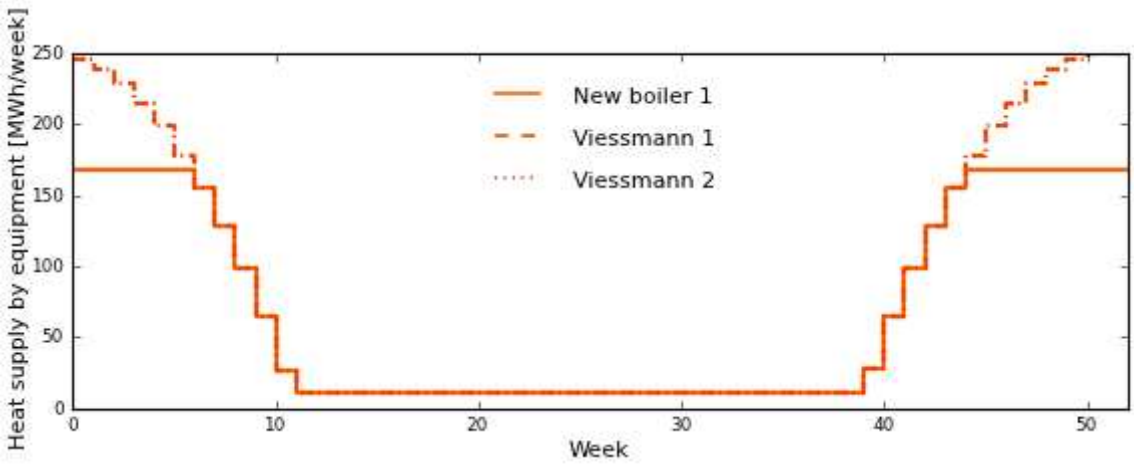

Figure 17: Weekly heat supply by equipment

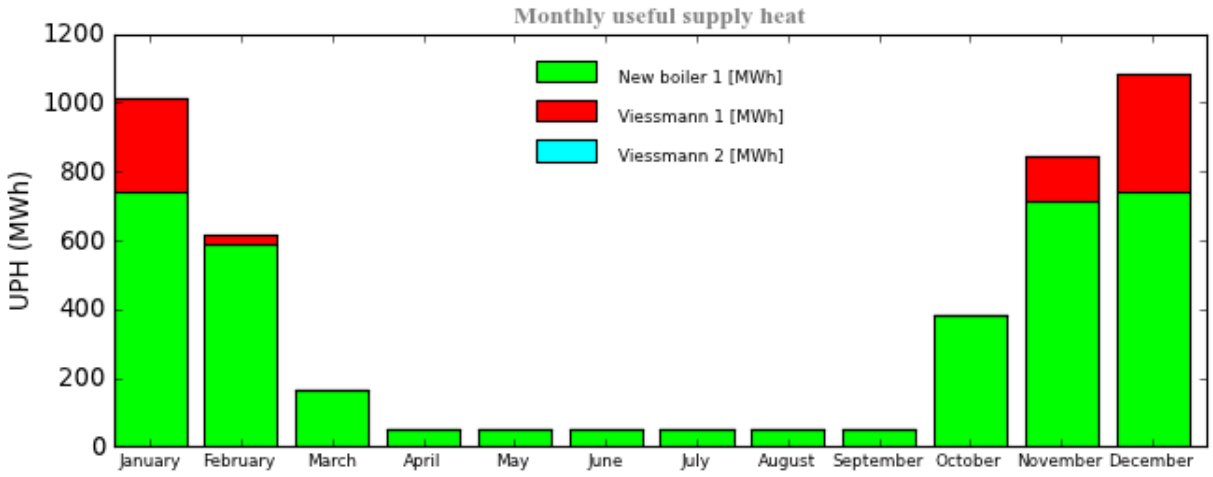

Figure 18: Distribution of useful process heat supply per month

- **CHP:**

Type	CHP engine
Nominal thermal power	686 kW
Nominal electric power	500 kW
Thermal efficiency	0.35
Electrical efficiency	0.48
Operating hours	5548 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 CHP 1	686	2,788	63.29
Viessmann 1	1,400	1,617	36.71
Viessmann 2	1,400	0	0.00
Total	**3,486**	**4,406**	**200**

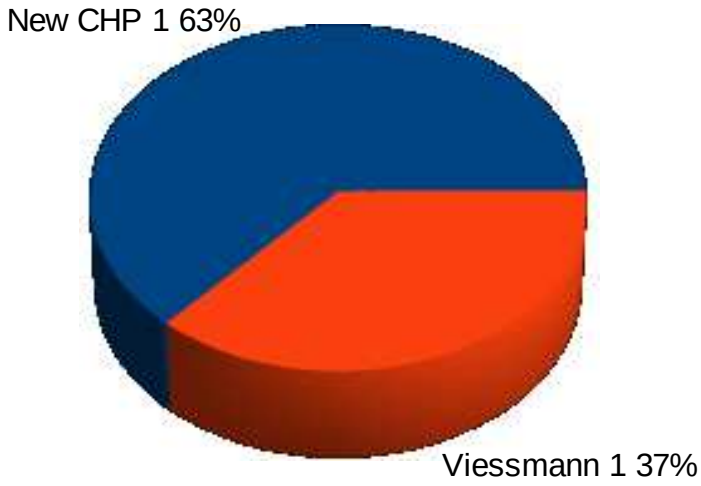

Figure 19: Contribution of each equipment to the total useful heat and useful cooling supply (USH & USC).

- graphic: heat demand covered by CHP:

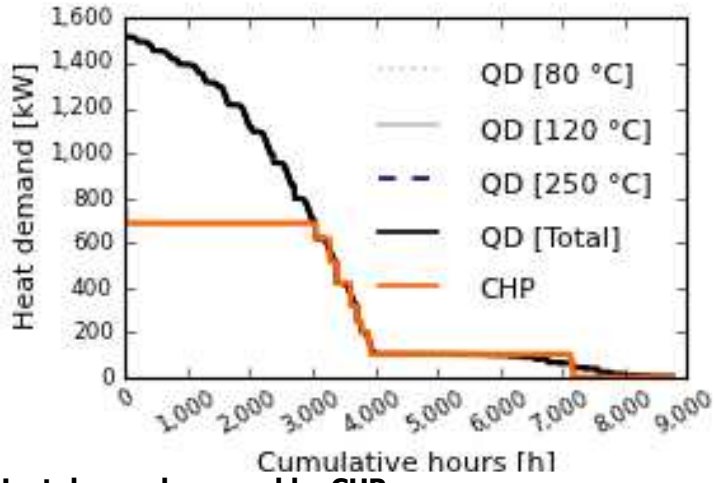

Figure 20: Heat demand covered by CHP

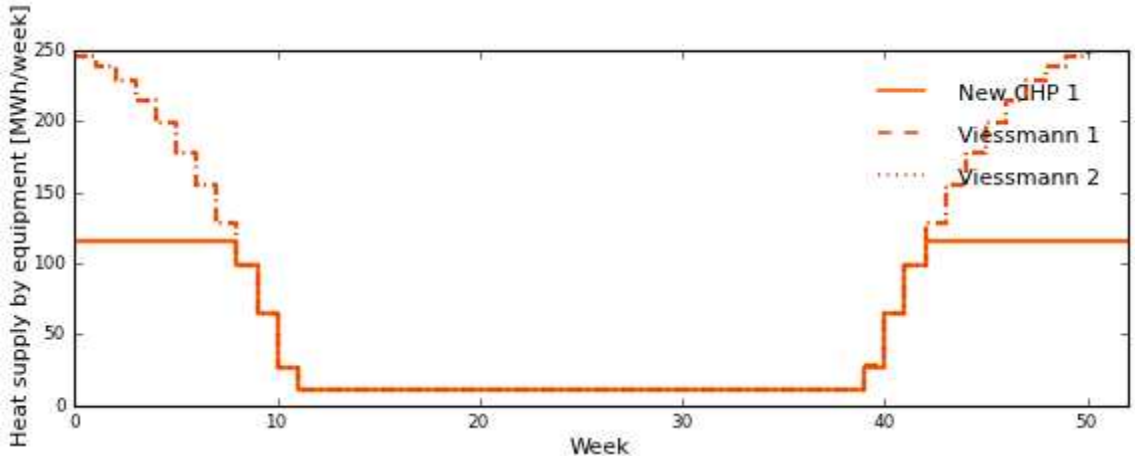

Figure 21: Weekly heat supply by equipment

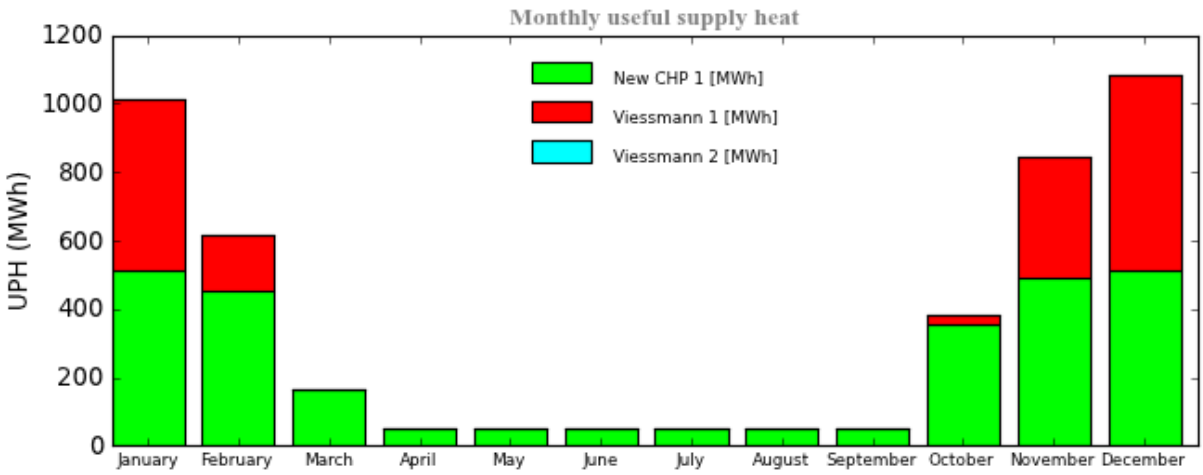

Figure 22: Distribution of useful process heat supply per month

- **Solar (FPC):**

Collector type:	FPC (flat plate collectors)
Installed capacity:	1,540 kW
Installed collector area:	2,200 m²
Solar buffer storage volume:	110 m³
Solar fraction:	10.48 %
Annual energy yield:	299.87 kWh/kWa

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]	[%]
Solar thermal system	1,540	462	10.48
Viessmann 1	1,400	3,896	88.42
Viessmann 2	1,400	48	1.09
Total	**4,340**	**4,406**	**200**

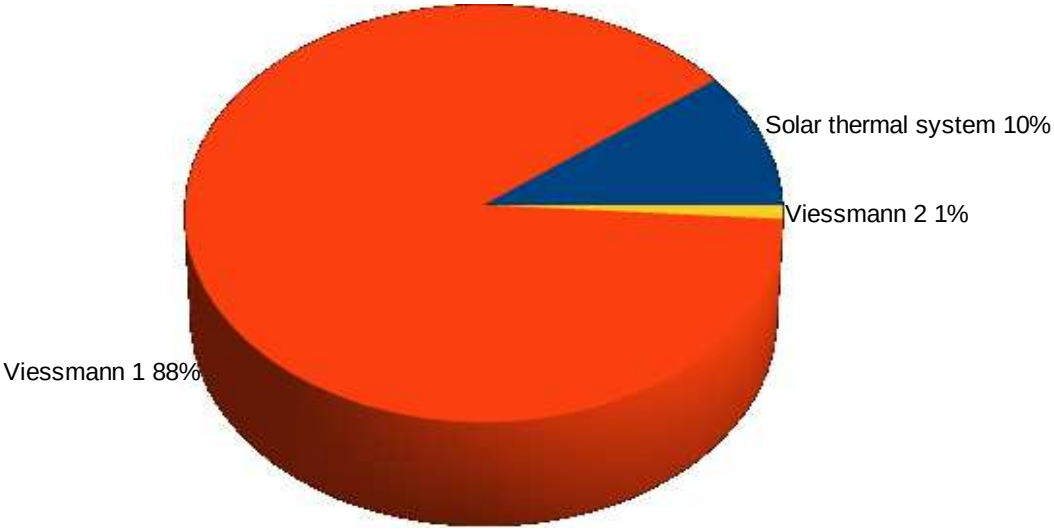

Figure 23: Contribution of each equipment to the total useful heat and useful cooling supply (USH & USC).

- graphic: heat demand covered by solar thermal system:

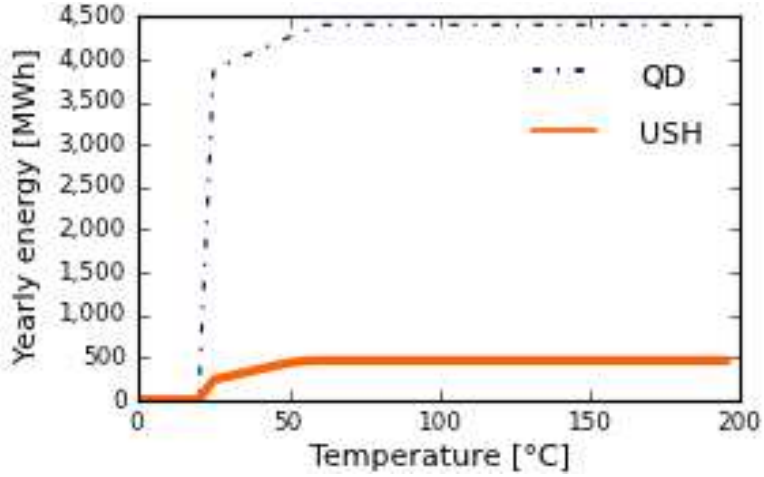

Figure 24: Heat demand covered by solar system

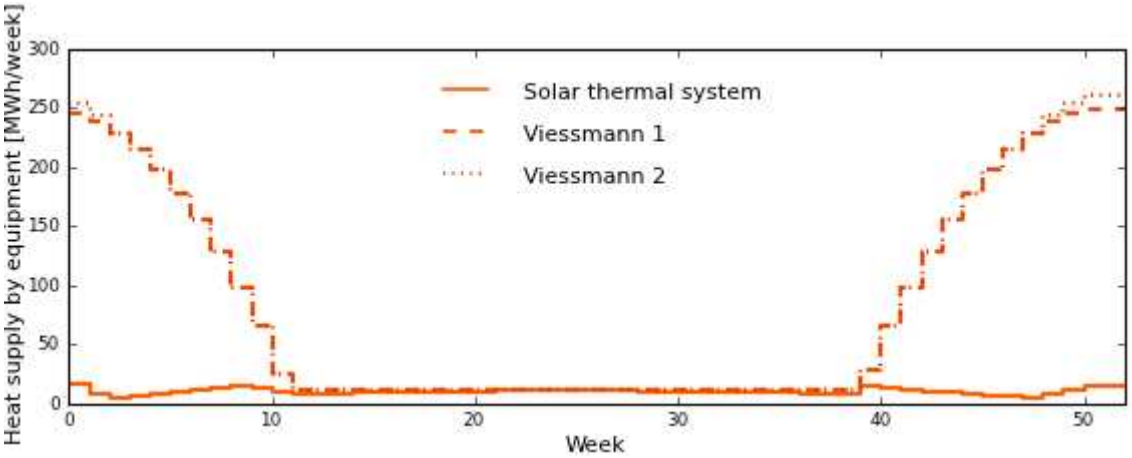

Figure 25: Weekly heat supply by equipment

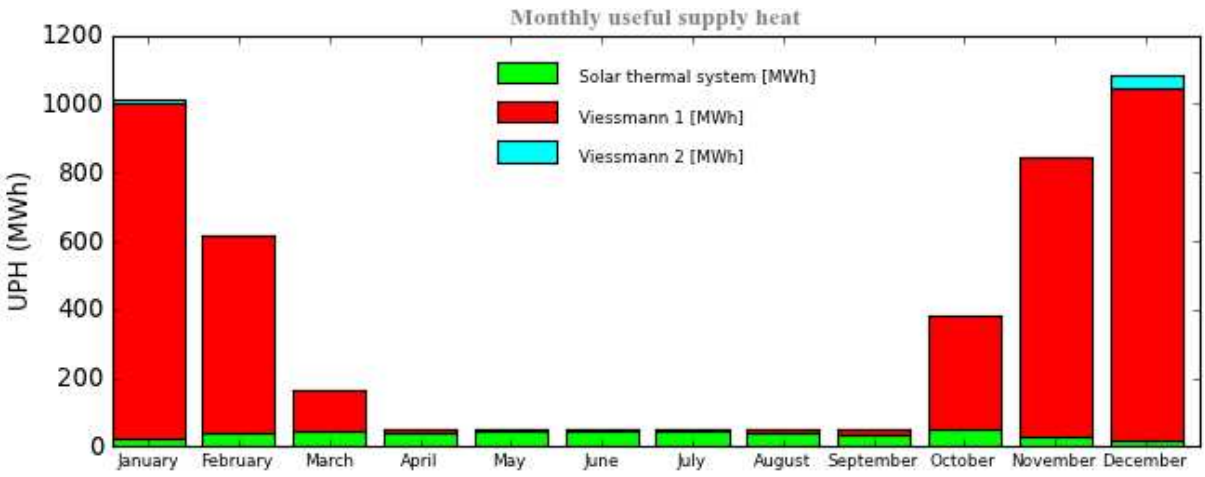

Figure 26: Distribution of useful process heat supply per month

- **HX + CHP:**

Type	CHP engine
Nominal thermal power	686 kW
Nominal electric power	500 kW
Thermal efficiency	0.35
Electrical efficiency	0.48
Operating hours	4,033 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 CHP 2	686	2,446	62.98
Viessmann 1	1,400	1,438	37.02
Viessmann 2	1,400	0	0.00
Total	**3,486**	**3,883**	**200**

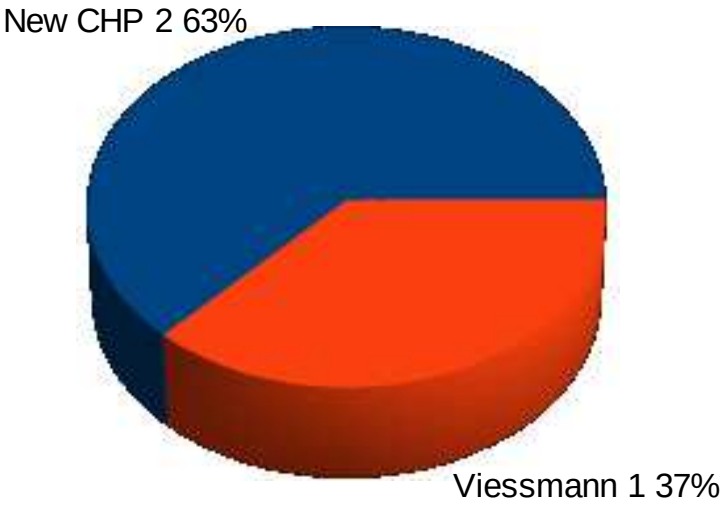

Figure 27: Contribution of each equipment to the total useful heat and useful cooling supply (USH & USC).

- graphic: heat demand covered by CHP:

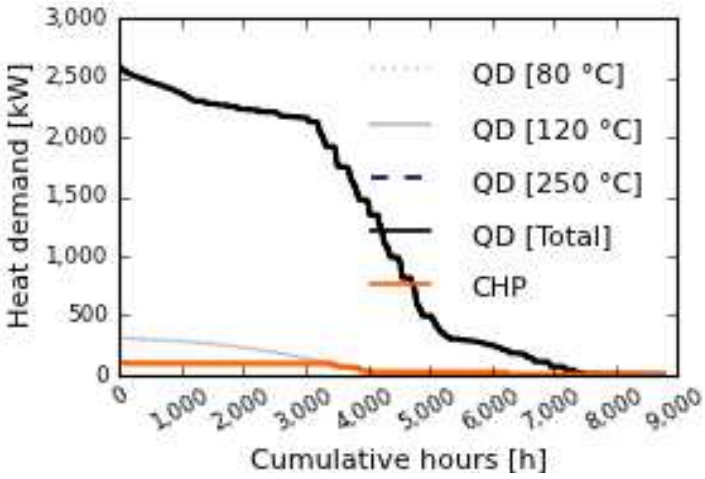

Figure 28: Heat demand covered by CHP

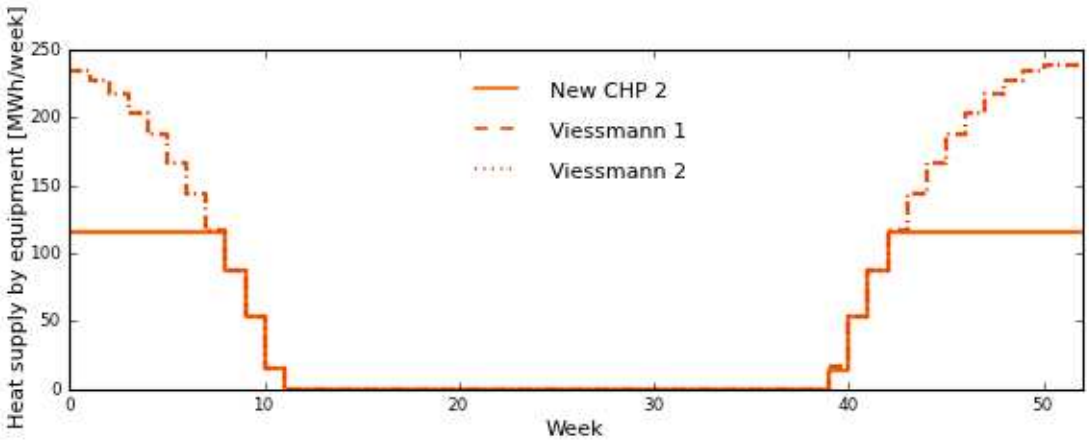

Figure 29: Weekly heat supply by equipment

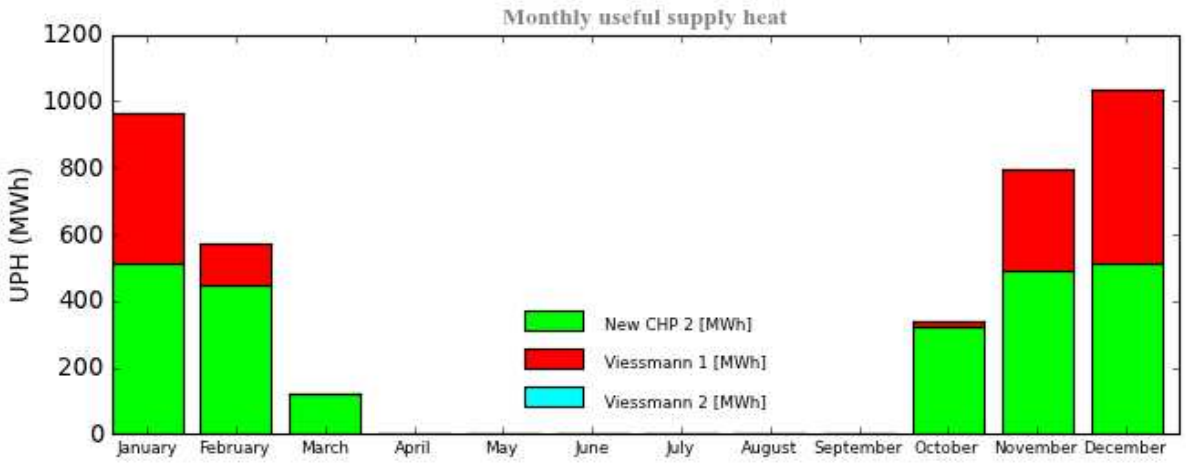

Figure 30: Distribution of useful process heat supply per month

- **Heat Recovery + New Boiler:**

Type of boiler	condensing boiler
Nominal power	1,000 kW
Thermal efficiency	1.1
Operating hours	4,390 h

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

Equipment	Nominal capacity	Contribution to total heat / cooling supply	
	[kW]	[MWh]	[%]
New boiler 5	1,000	3,264	83.85
Viessmann 1	1,400	628	16.15
Viessmann 2	1,400	0	0.00
Total	**3,800**	**3,892**	**200**

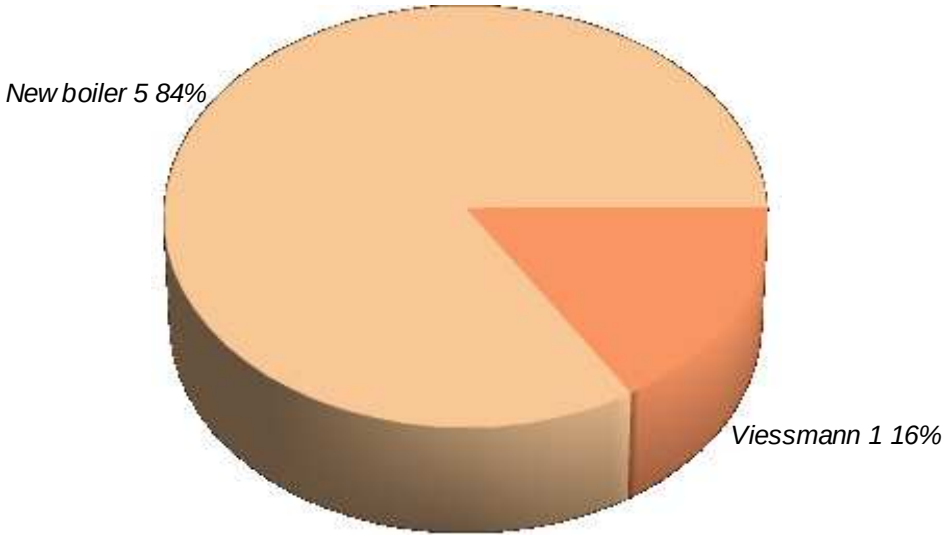

Figure 31: Contribution of each equipment to the total useful heat and useful cooling supply (USH & USC).

- graphic: heat demand covered by new boiler:

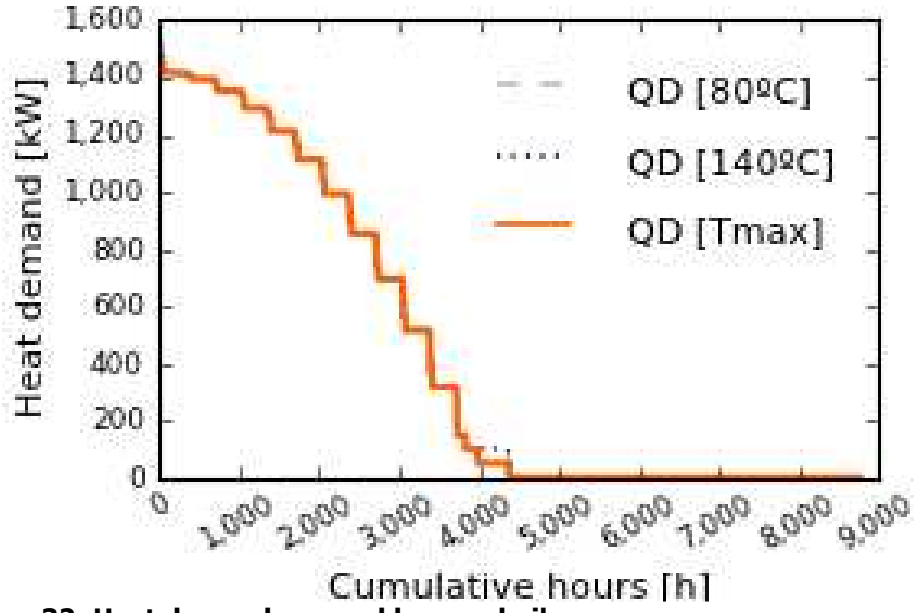

Figure 32: Heat demand covered by new boiler

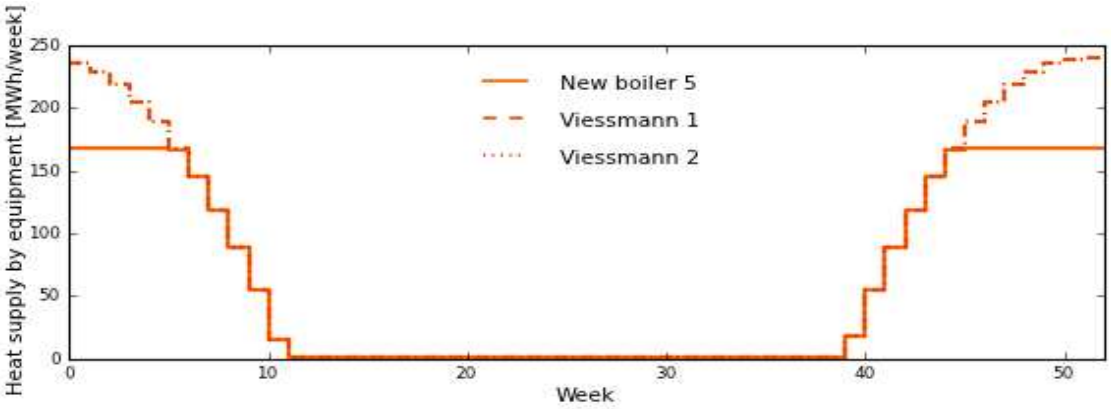

Figure 33: Weekly heat supply by equipment

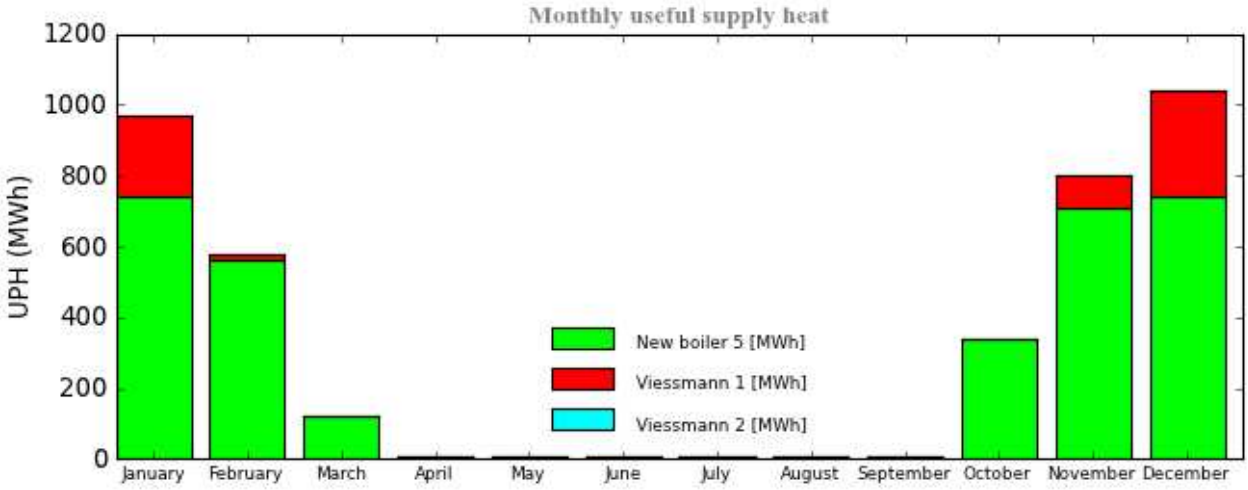

Figure 34: Distribution of useful process heat supply per month

- Primary energy consumption (PEC)

Table 14: primary energy consumption and savings

Alternative	Primary energy consumption	Savings	
	[MWh]	[MWh]	[%]
Present State (checked)	27,477	---	---
heat recovery	26,867	611	2.22
New boiler	26,768	710	2.58
CHP	24,378	3,100	11.28
solar	26,927	551	2.00
HX + CHP	24,115	3,363	12.24
heat recovery + new boiler	26,213	1,265	4.60

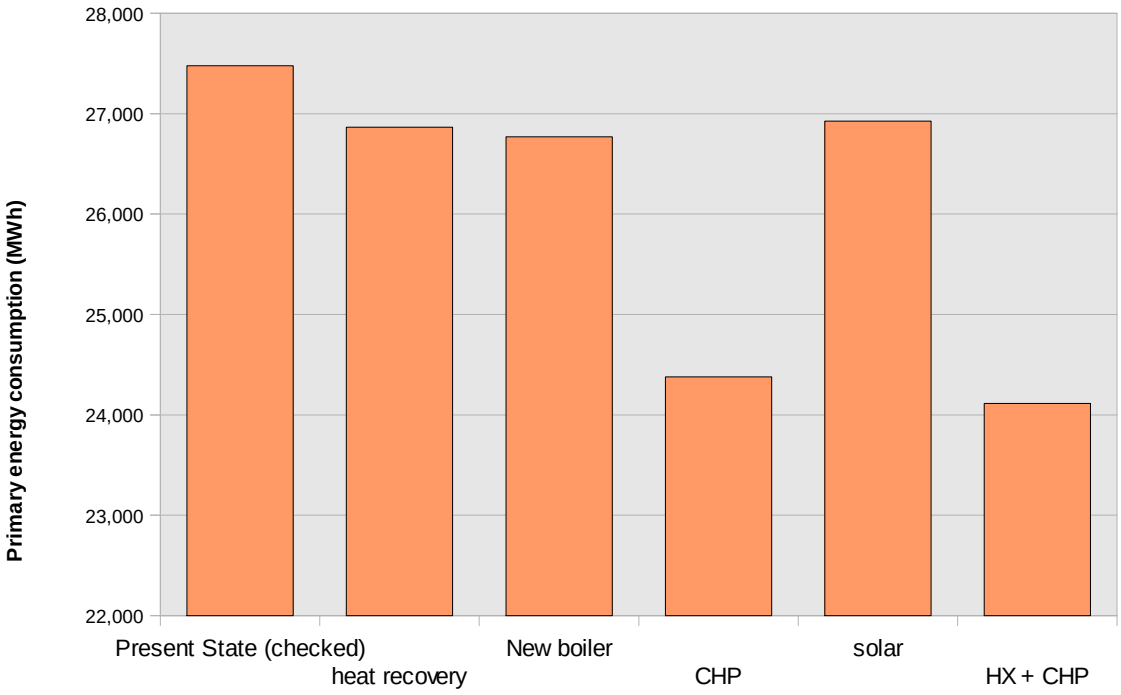

Figure 35: Comparison of alternatives: primary energy consumption

- 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)	4,406	---	4,430	---
heat recovery	4,406	0	3,906	524
New boiler	4,406	0	4,406	24
CHP	4,406	0	4,406	24
solar	4,406	0	4,406	24
HX + CHP	4,406	0	3,883	547
heat recovery + new boiler	4,406	0	3,892	538

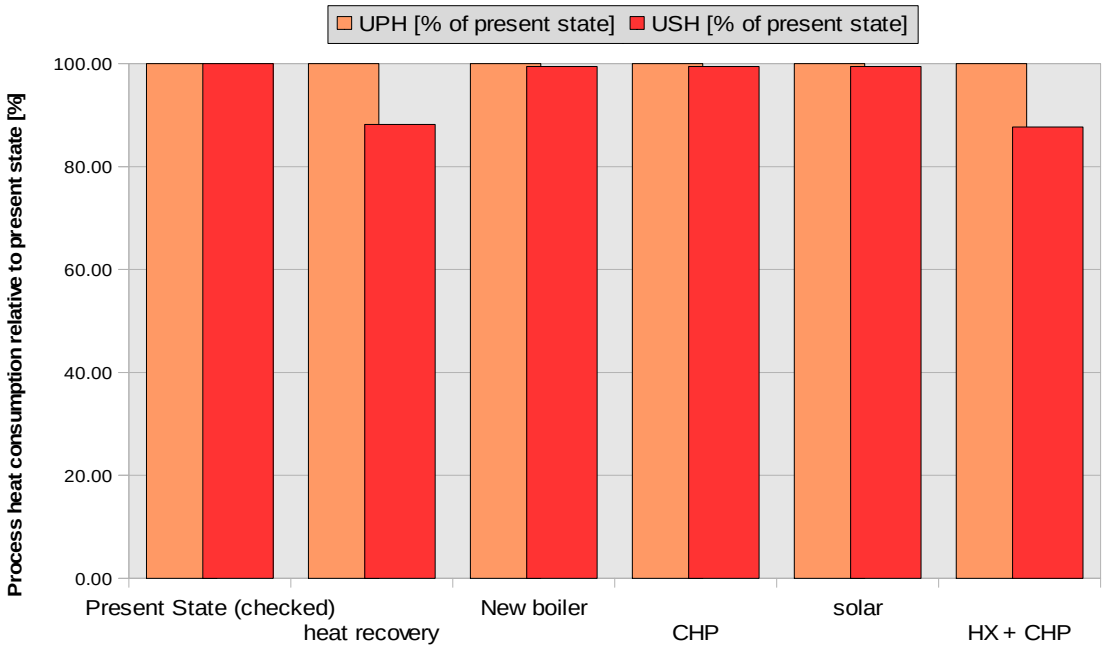

Figure 36: Comparison of alternatives: useful process heat supply

- Environmental impact

Table 16: CO2 production and CO2 savings per year

Alternative	Production of CO2	Water consumption
	[t]	[m³]
Present State (checked)	4905.94	0.00
heat recovery	4767.11	0.00
New boiler	4738.66	0.00
CHP	4593.88	0.00
solar	4779.95	0.00
HX + CHP	4478.66	0.00
heat recovery + new boiler	4613.16	0.00

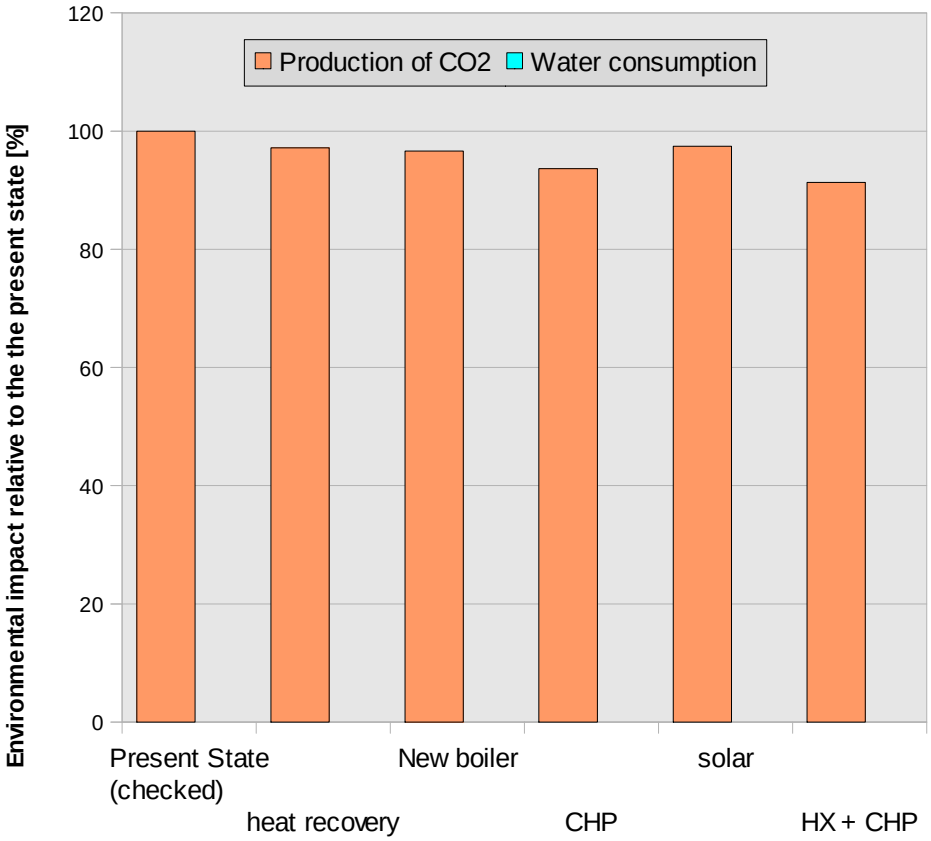

Figure 37: Comparison of alternatives: environmental impact

Table 17: Investment costs and subsidies of the proposals

Alternative	Total investment [€]	Own investment [€]	Subsidies [€]
Present State (checked)	---	---	---
heat recovery	25,000	25,000	0
New boiler	150,000	150,000	0
CHP	625,000	625,000	0
solar	924,000	646,800	277,200
HX + CHP	675,250	472,675	202,575
heat recovery + new boiler	175,000	175,000	0

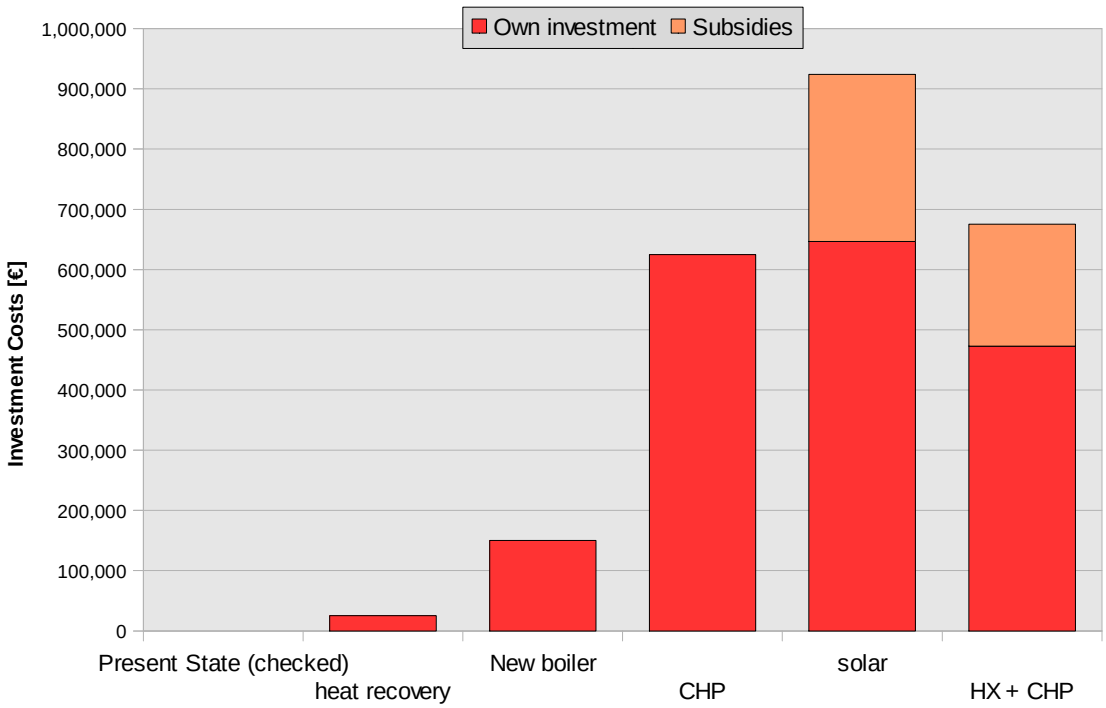

Figure 38: Comparison of alternatives investment cost

5. Selected alternative(s) and conclusions

5.1. Selected alternative

The selected alternative that has been chosen is the "Heat Recovery + New Boiler".

5.1.1. Process optimisation (written proposals)

None

5.1.2. Heat Supply

Heat Recovery + New Boiler:

Type of boiler	condensing boiler
Nominal power	1,000 kW
Thermal efficiency	1.1
Operating hours	4,390 h

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

Equipment	Nominal capacity	Contribution to total heat / cooling supply	
	[kW]	[MWh]	[%]
New boiler 5	1,000	3,264	83.85
Viessmann 1	1,400	628	16.15
Viessmann 2	1,400	0	0.00
Total	**3,800**	**3,892**	**200**

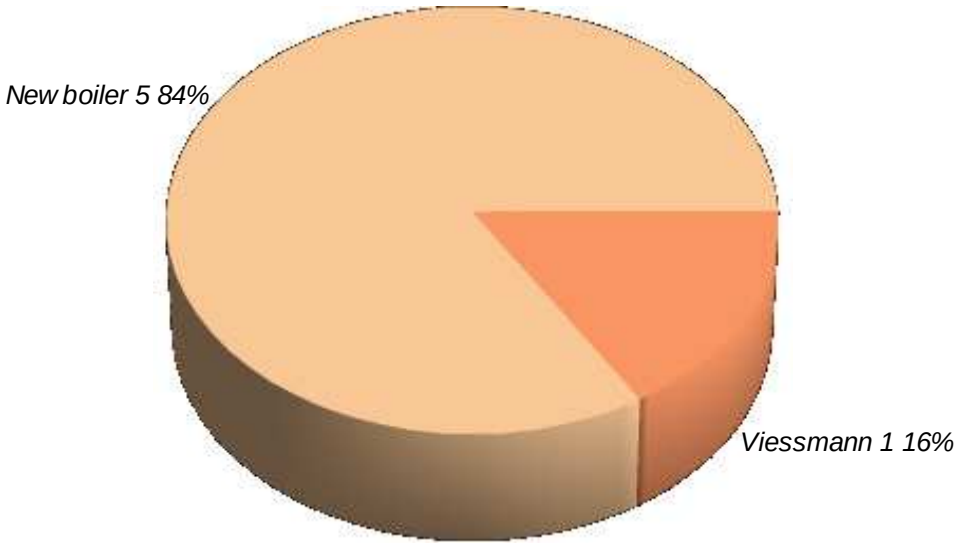

Figure 39: Contribution of each equipment to the total useful heat and useful cooling supply (USH & USC).

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	4,032	15.38	4,032	97.84
Total electricity	22,181	84.62	89	2.16
Total (fuels + electricity)	**26,213**	**100.00**	**4,121**	**100.00**

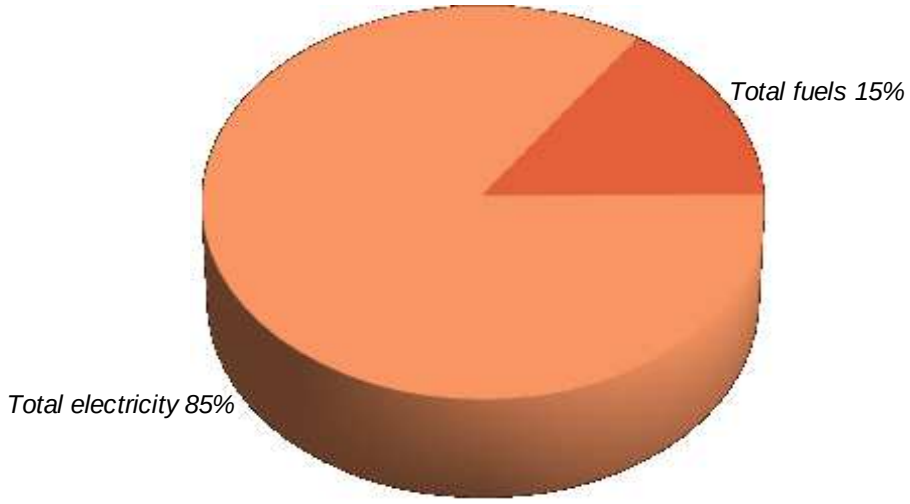

Figure 40: Distribution of PEC by fuel type

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	3,665	33.14	3,665	99.20
Electricity	7,394	66.86	30	0.80
Total	11,059	100.00	3,695	100.00

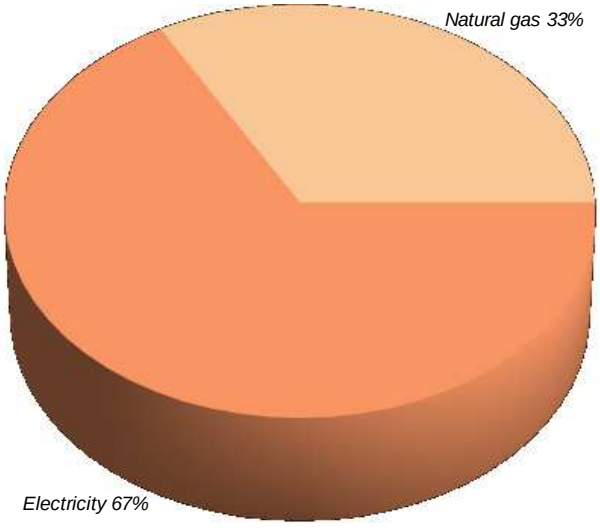

Figure 41: Total final energy consumption (FEC). Proposed final solution.

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

Equipment	Fuel type	FET by equipment	
		[MWh]	[% of Total]
Viessmann 1	Natural gas	698	18.90
Viessmann 2	Natural gas	0	0.00
New boiler 5	Natural gas	2,997	81.10
Total		**3,695**	**100**

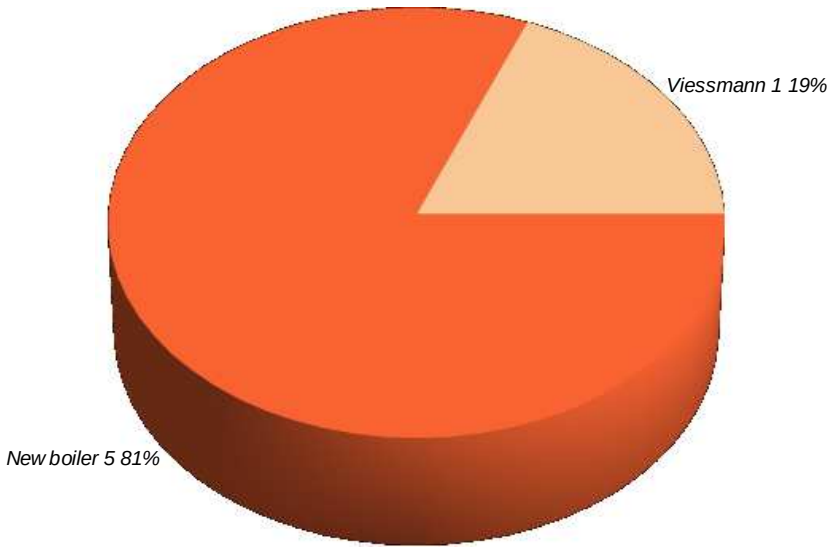

Figure 42: Final energy consumption for thermal use (FET) by equipment

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

Equipment	USH by equipment	
	[MWh]	[% of Total]
Viessmann 1	628	16.15
Viessmann 2	0	0.00
New boiler 5	3,264	83.85
Total	**3,892**	**100**

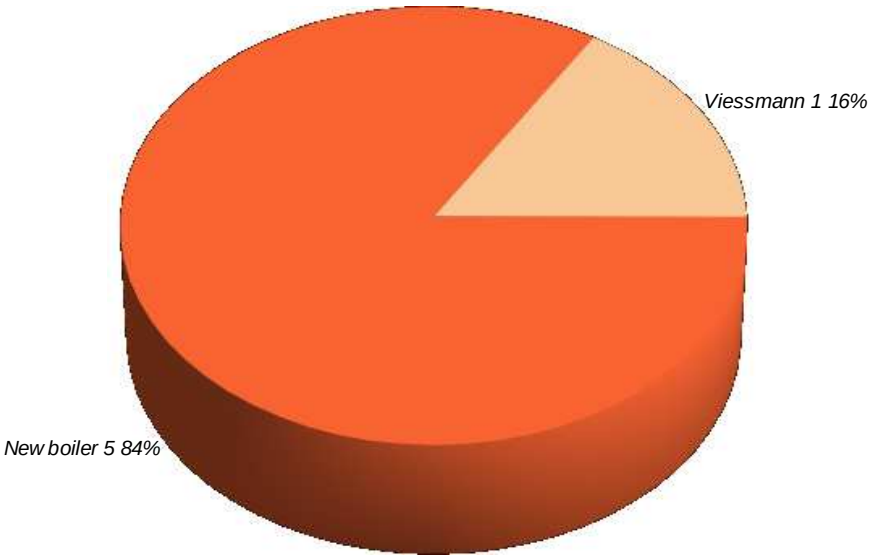

Figure 43: Useful supply heat (USH) by equipment. Proposed final solution

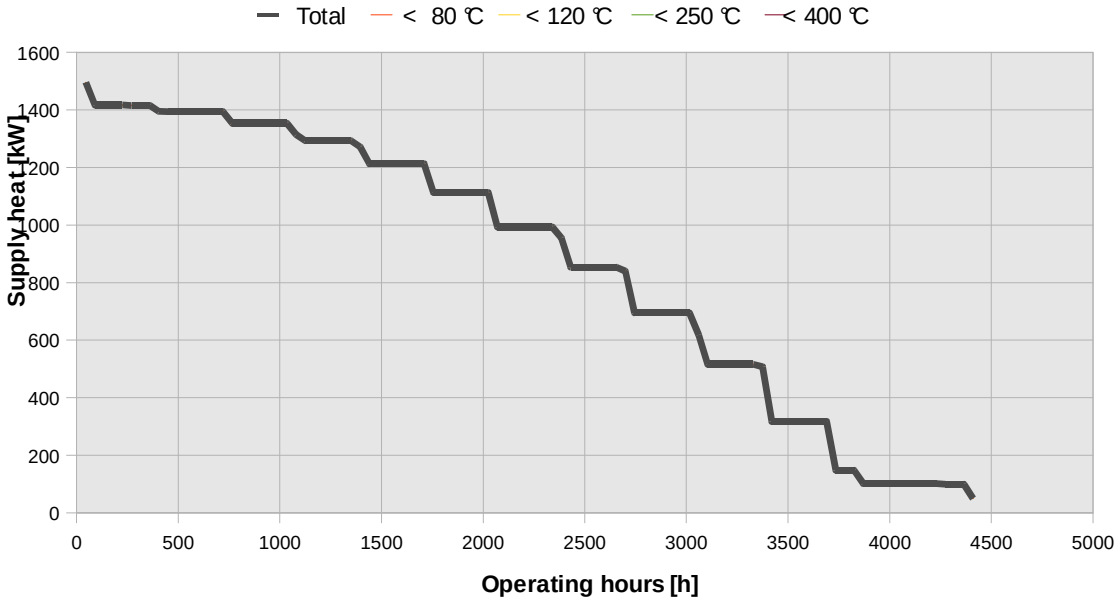

Figure 44: Distribution of supply heat by temperature levels and annual operating hours. Proposed final solution.

5.2. Comparative study and conclusions

5.2.1. Energy and environmental analysis

In the proposed alternative around 6 % of the CO_2 pollution can be saved.

5.2.2. Economic analysis

The payback period of about 8 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 23: Savings of the proposed alternative in comparison to the present state

		Present state	Alternative	Saving	[% savings]
Total primary energy consumption (1)					
- total	[MWh]	27,477	26,213	1,264	5%
- fuels	[MWh]	5,385	4,032	1,353	25%
- electricity	[MWh]	22,092	22,181	- 89	0%
Primary energy saving due to renewable energy	[MWh]		-		
CO2 emissions	[t/a]	4,905	4,613	292	6%
Annual energy system cost (2)	[EUR]	797,231	782,398	14,833	2%
Total investment costs	[EUR]		175,000		
Payback period (3)	[years]		8		

(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 numbers.
- 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.