Energy Audit Summary Report

AEE INTEC

Audit no. 32 – SVK03

Technogym

10th of May 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. 32 – SVK03

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: 10.05.2012

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	sports equipment manufacturer
Products	none
No. of employees	580 employees
Current primary energy consumption	18,751 [MWh/a]

3.2. Flow sheet of the whole manufacturing side

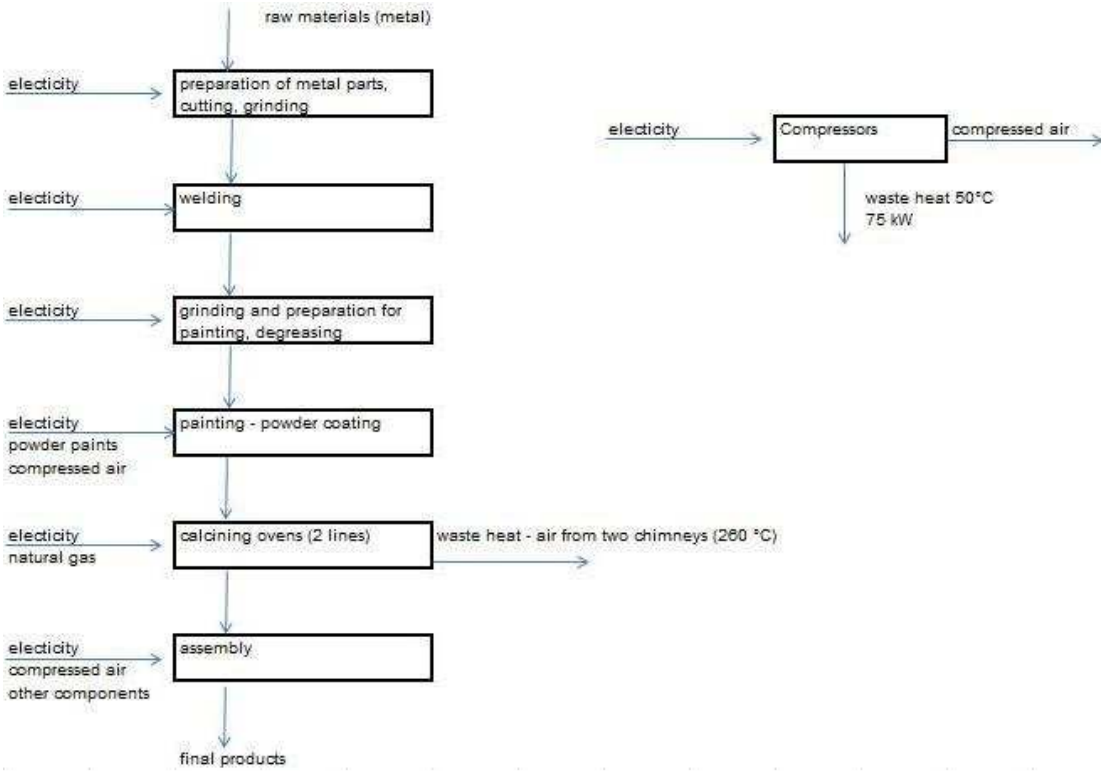

Figure 1: Flow sheet of the factory

3.3. Description of the existing system

- **Energy Supply:**

The factory is mainly consuming energy for the different metal treatment processes, in addition to the heating of the buildings. Besides it has electrical consumption of a air compressor.

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	7,810	41.65	7,810	100.00
Total electricity	10,941	58.35	0	0.00
Total (fuels + electricity)	**18,751**	**100.00**	**7,810**	**100.00**

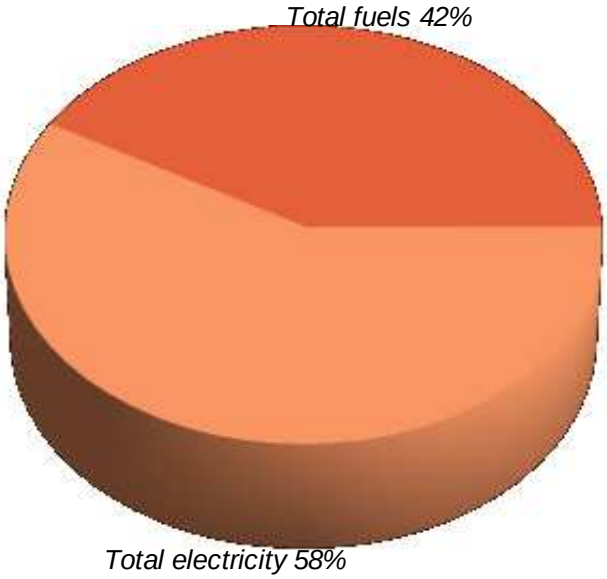

Figure 2: distribution of PEC by fuel type

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	7,100	66.06	7,100	100.00
Electricity	3,647	33.94	0	0.00
Total	10,747	100.00	7,100	100.00

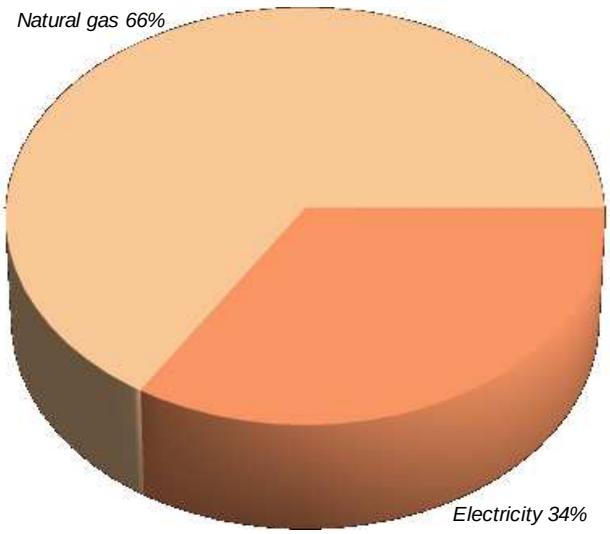

Figure 3: Total final energy consumption for thermal use (FET)
Table 3: Final energy consumption for thermal use (FET) by equipment

Equipment	Fuel type	FET by equipment	
		[MWh]	[% of Total]
Daikin IR	Natural gas	2,288	32.43
Viessmann 144 kW	Natural gas	515	7.30
Viessmann 84 kW	Natural gas	0	0.00
Viessmann 42 kW	Natural gas	0	0.00
calcining ovens	Natural gas	4,252	60.28
Total		**7,054**	**100.00**

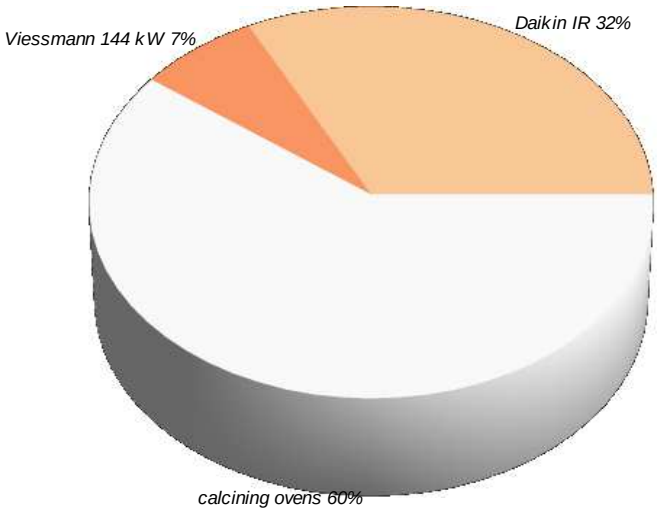

Figure 4: Final energy consumption for thermal use (FET) by equipment

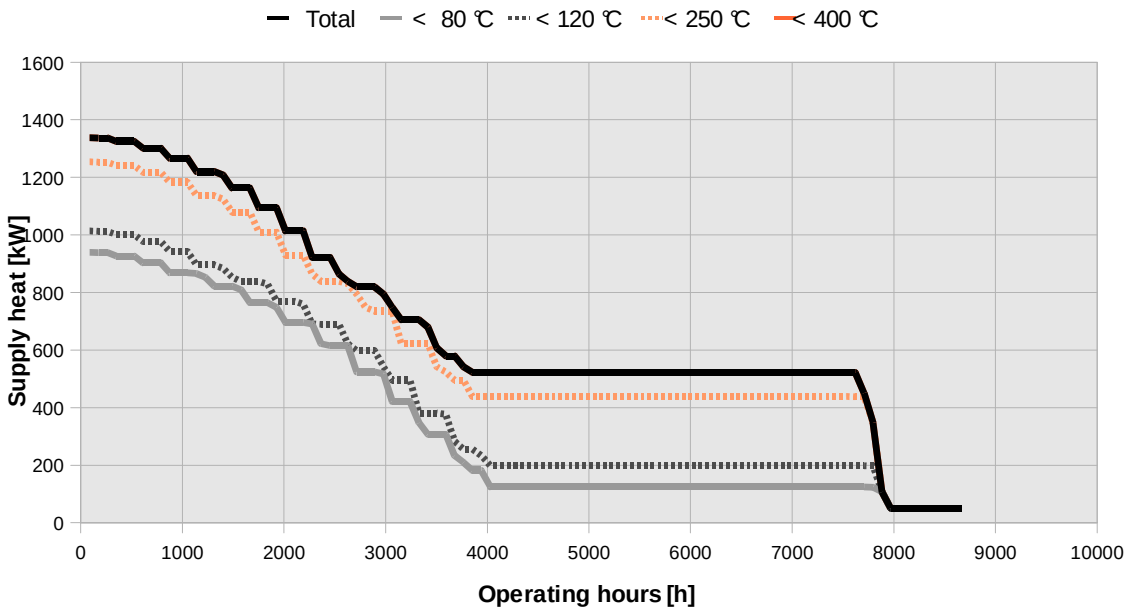

Figure 5: Distribution of supply heat by temperature levels and annual operating hours. Present state.

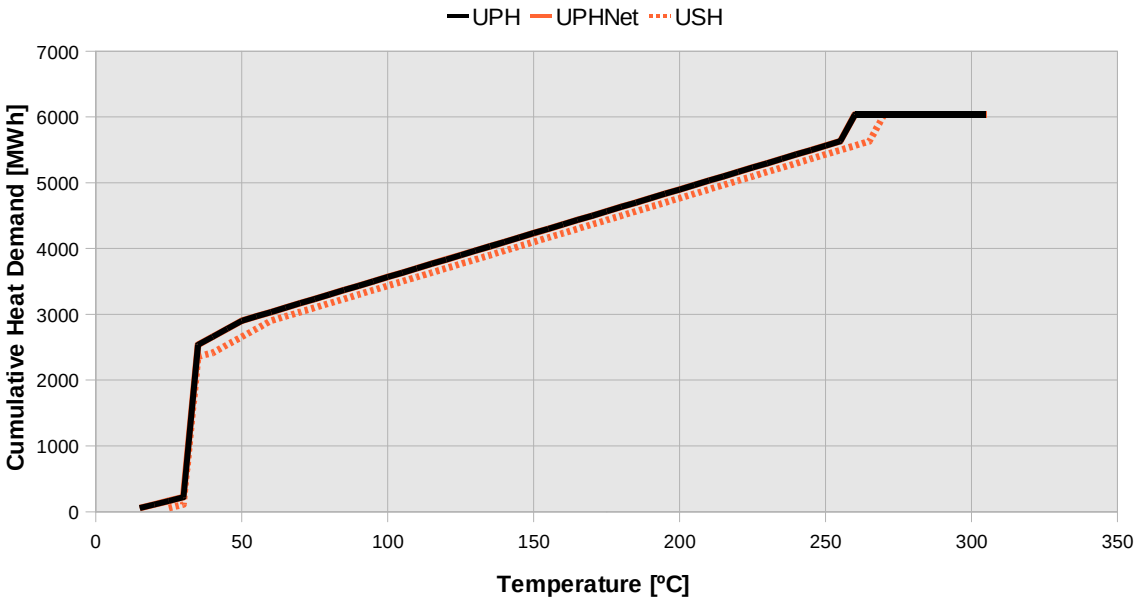

Figure 6: Distribution of the heat demand by temperature levels

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

Equipment	USH by equipment	
	[MWh]	[% of Total]
Daikin IR	2,172	35.99
Viessmann 144 kW	463	7.67
Viessmann 84 kW	0	0.00
Viessmann 42 kW	0	0.00
calcining ovens	3,400	56.34
Total	**6,035**	**100.00**

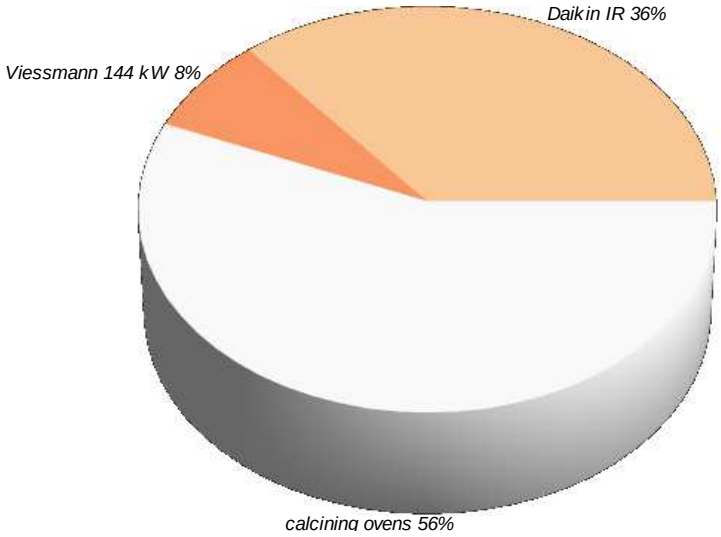

Figure 7: Useful supply heat (USH) by equipment. Present state

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

Process	Total	Circulation	Maintenance	Start-up
	[MWh]	[MWh]	[MWh]	[MWh]
calcining	3,400	3,062	338	0
production; storage_heating	2,172	0	2,172	0
production; storage_HW	442	442	0	0
office_heating	21	0	21	0
Total	**6,035**			

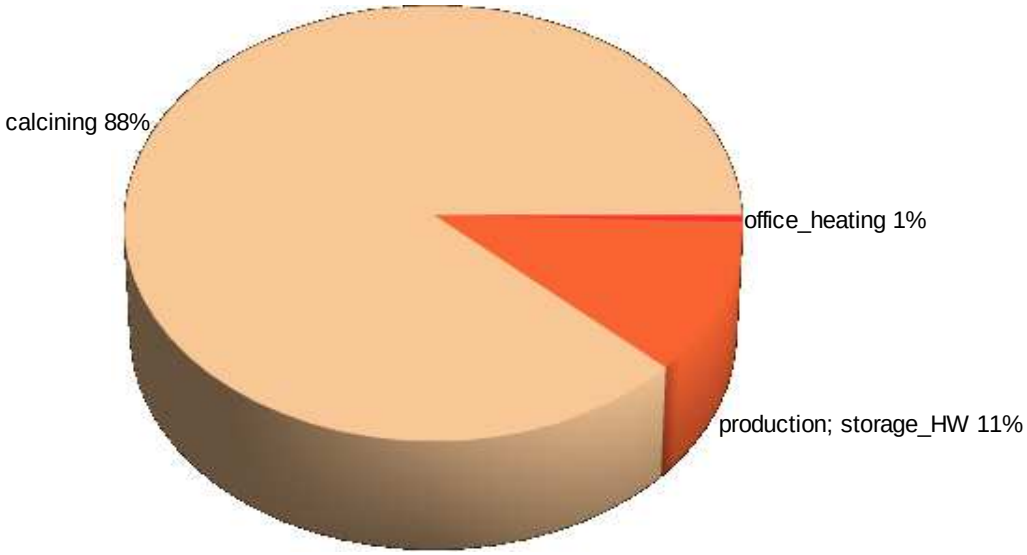

Figure 8: Useful process heat (UPH) by process

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 26 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 is another heat recovery option. The third proposal is a heat recovery with a new boiler. The fourth proposal is a heat recovery with a CHP plant. The fifth proposal is a heat recovery with a solar thermal system. The sixth proposal is a CHP plant.

Table 6: Overview of the alternative proposals studied

Short Name	Description
heat recovery	based on present state a heat recovery proposal is suggested by the software
HR	based on present state a heat recovery system is proposed
HR + new boiler	based on present state a heat recovery system is proposed and additionally a new boiler is suggested
HR+ CHP	based on present state a heat recovery system is proposed and additionally a new CHP (combined heat and power) plant is suggested
HR + solar	based on present state a heat recovery system is proposed and additionally a solar thermal system is suggested
CHP	based on present state a new CHP plant is suggested

4.1.1. Heat Supply

- **Heat Recovery 1:**

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_1	25	compressors	production; storage_HW	182	100.00
	25			**181.58**	**100**

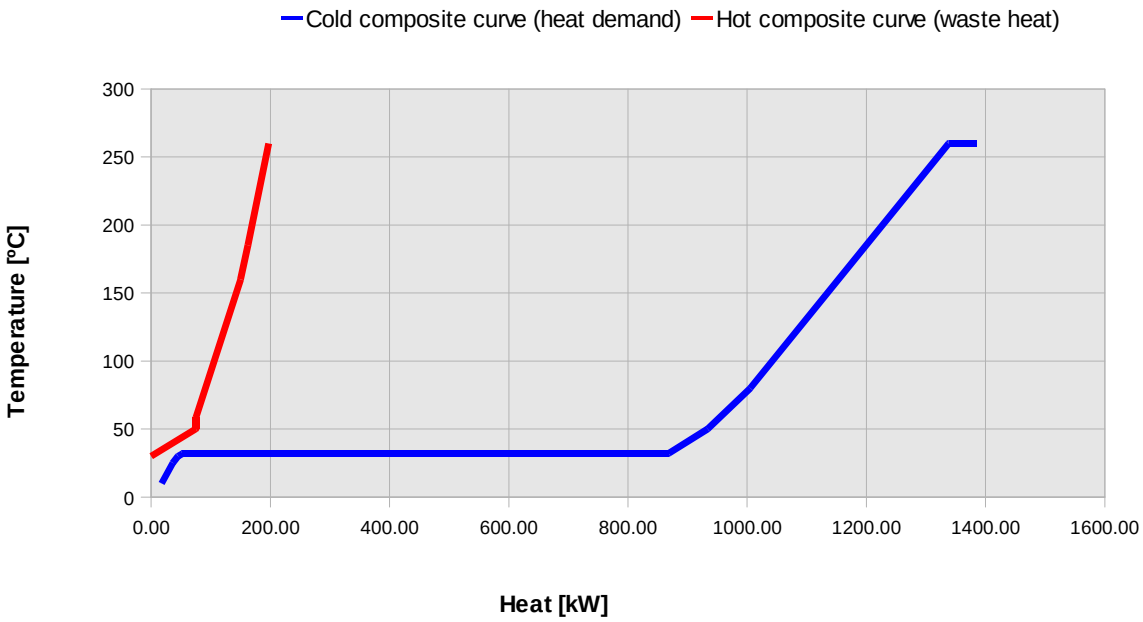

Figure 9: Pinch Analysis - Composite Curves

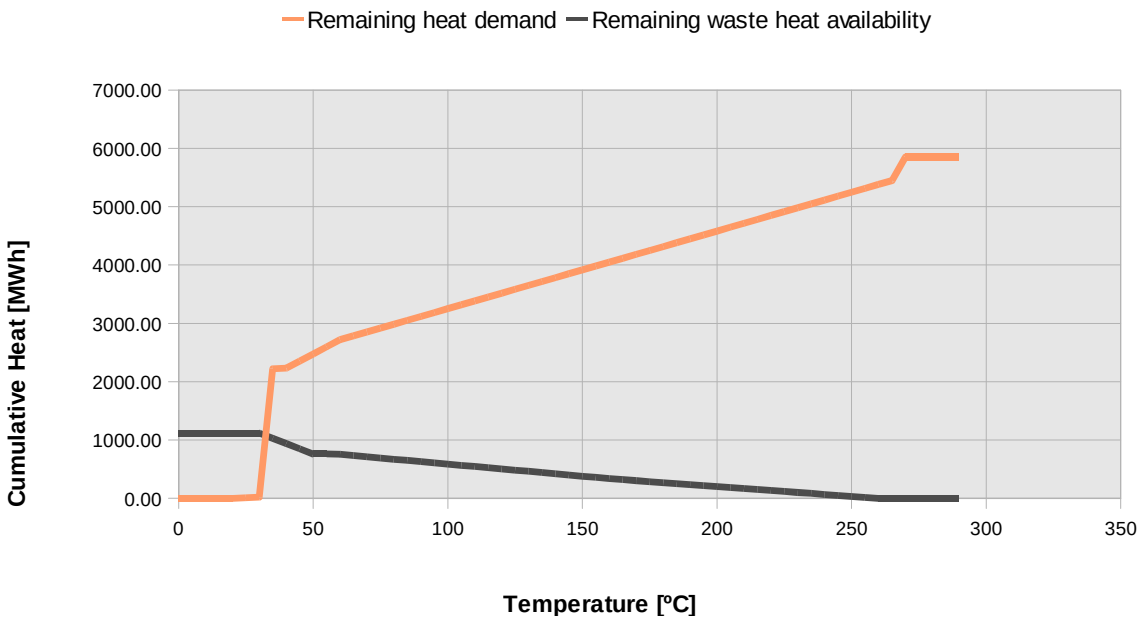

Figure 10: Pinch Analysis – Remaining yearly energy demand and energy availability

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]	[%]
Daikin IR	1,400	2,172	37.11
Viessmann 144 kW	144	281	4.81
Viessmann 84 kW	84	0	0.00
Viessmann 42 kW	42	0	0.00
calcining ovens	700	3,400	58.09
Total	**2,370**	**5,853**	**200**

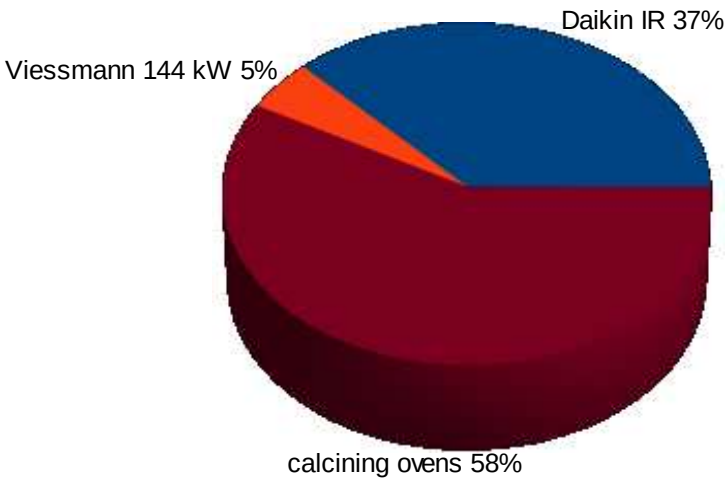

Figure 11: Contribution of each equipment to the total useful heat and useful cooling supply (USH & USC).

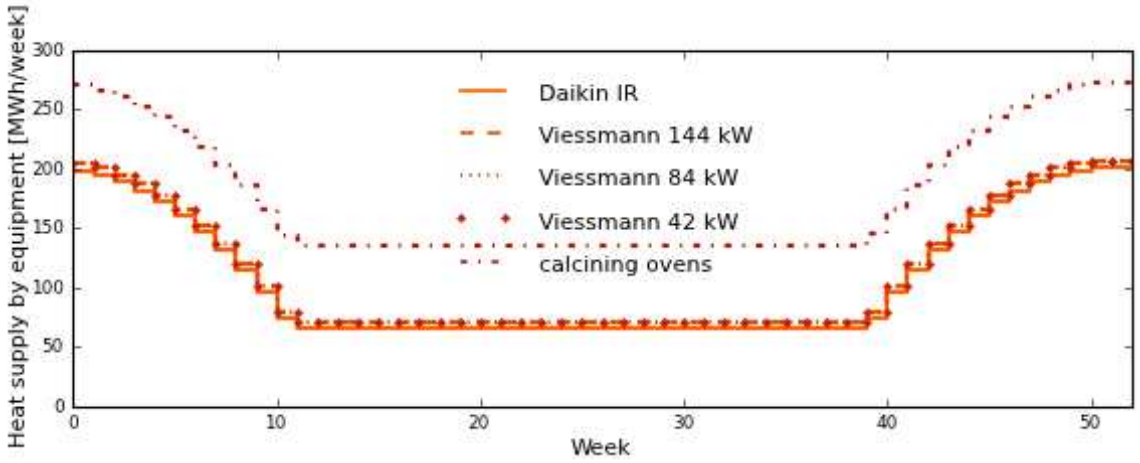

Figure 12: Weekly heat supply by equipment

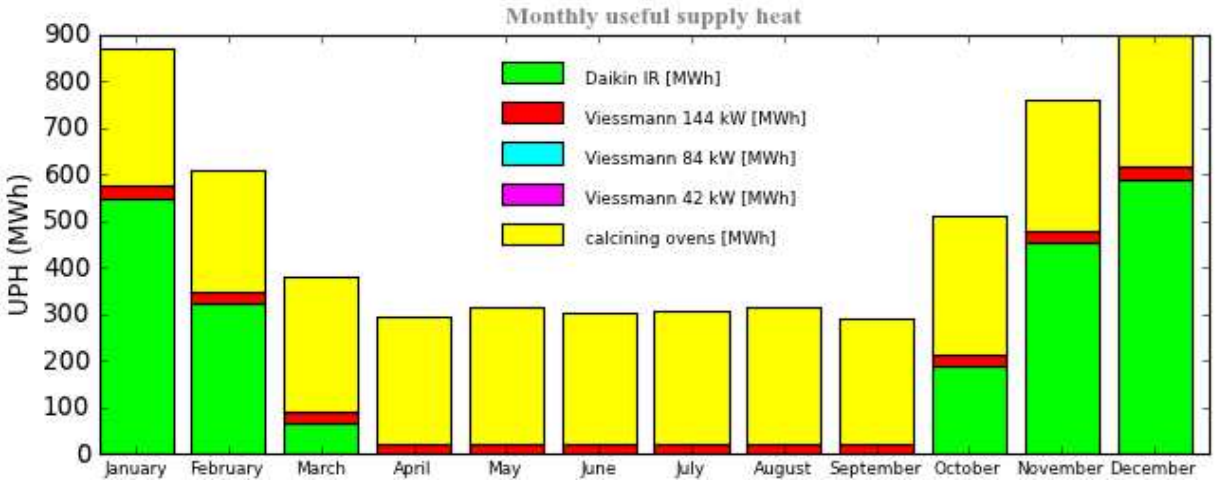

Figure 13: Distribution of useful process heat supply per month

- **Heat Recovery 2:**

  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 9: Heat exchangers and amount of recovered energy

Heat Exchanger	Power	Heat Source	Heat Sink	Amount of recovered energy	
	[kW]			[MWh]	[%]
compressor HR	32	compressors	production; storage_HW	276	72.68
ECO	14	calcining ovens	calcining ovens	104	27.32
Total	46			**379.41**	**100**

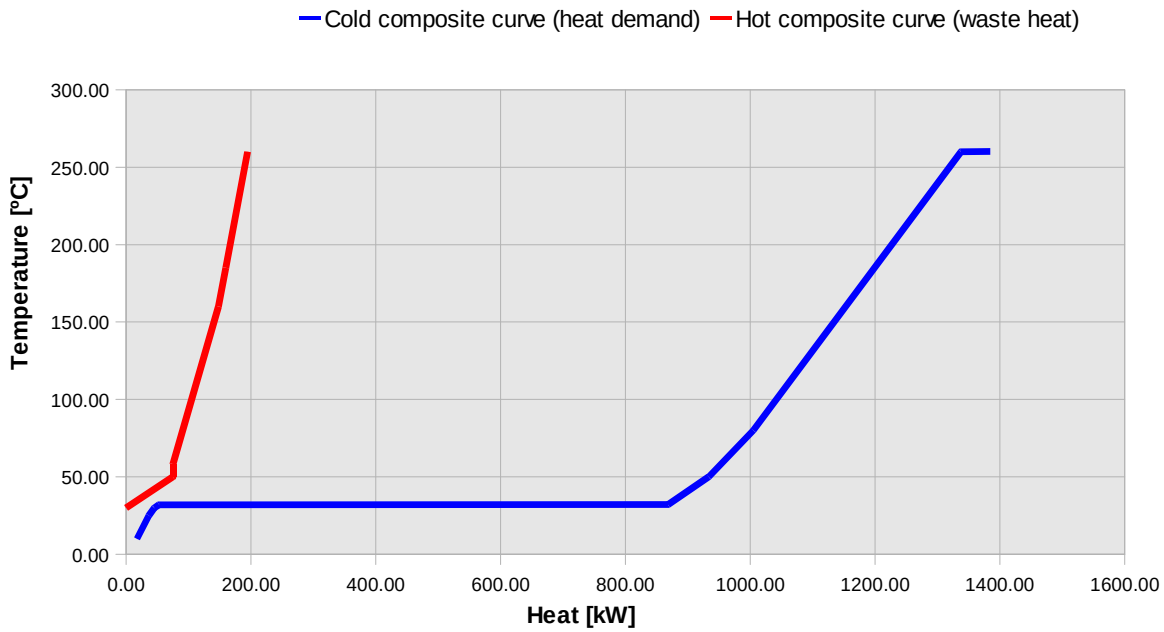

Figure 14: Pinch Analysis - Composite Curves

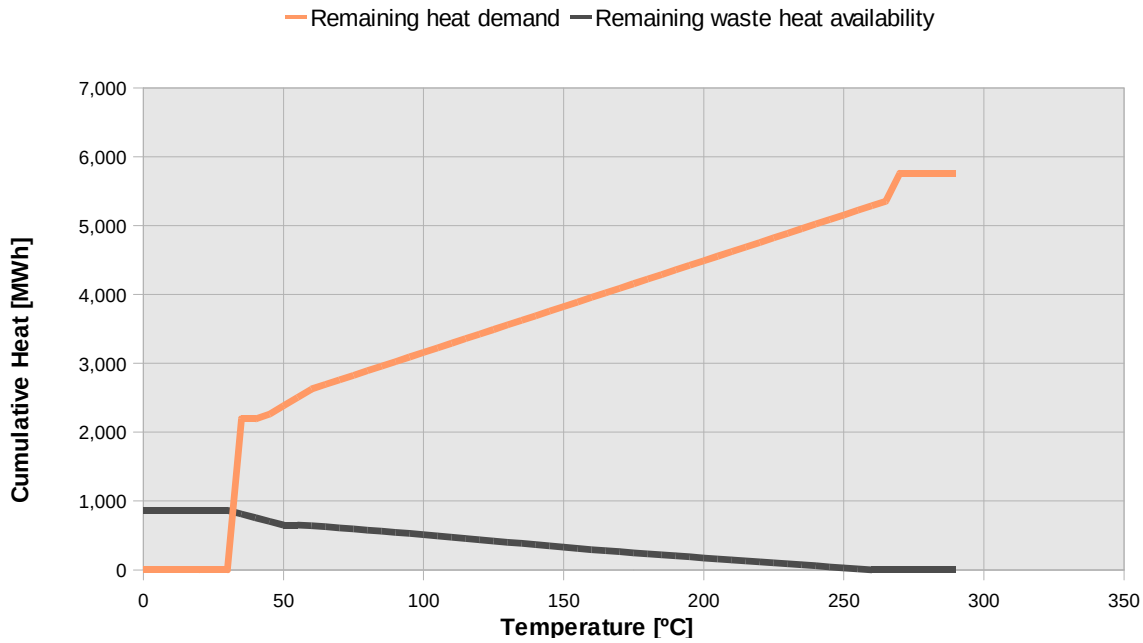

Figure 15: Pinch Analysis – Remaining yearly energy demand and energy availability

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]	[%]
Daikin IR	1,400	2,172	37.71
Viessmann 144 kW	144	187	3.25
Viessmann 84 kW	84	0	0.00
Viessmann 42 kW	42	0	0.00
calcining ovens	700	3,400	59.04
Total	**2,370**	**5,759**	**200**

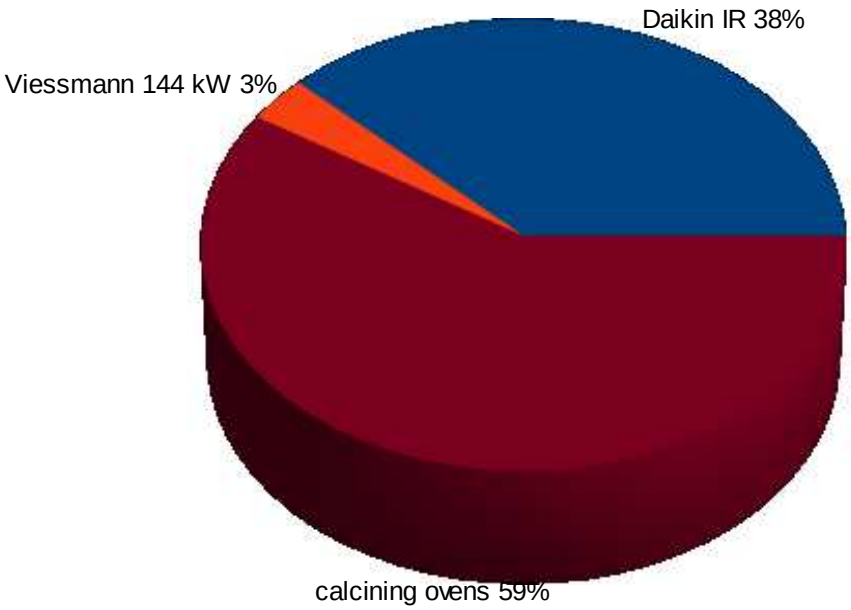

Figure 16: Contribution of each equipment to the total useful heat and useful cooling supply (USH & USC).

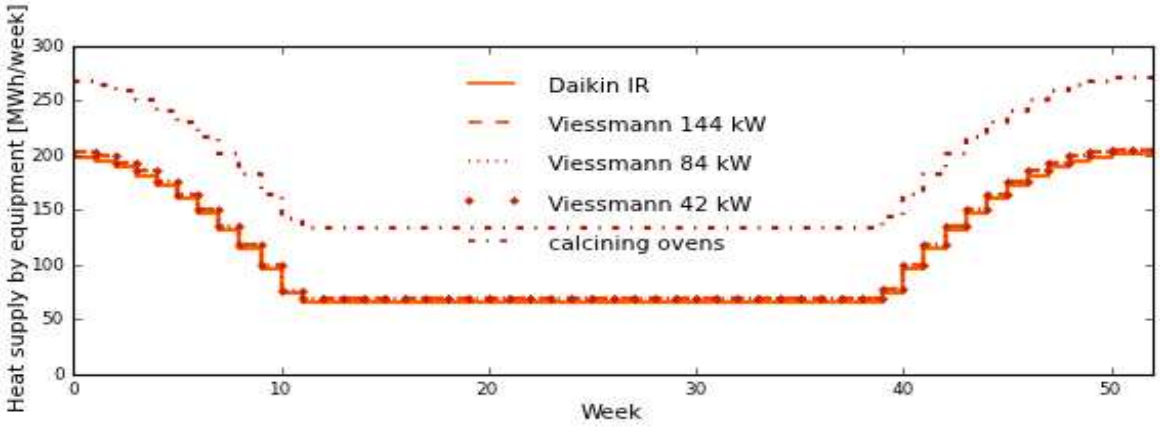

Figure 17: Weekly heat supply by equipment

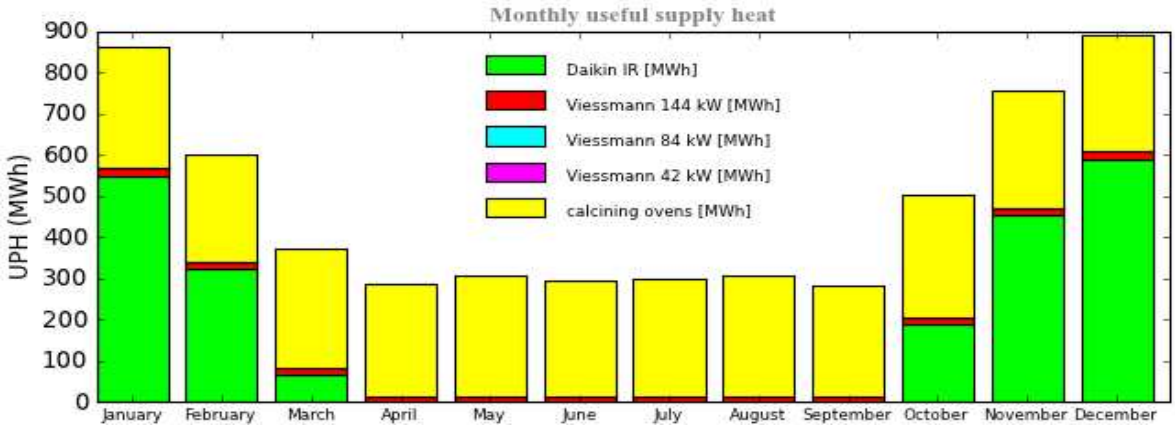

Figure 18: Distribution of useful process heat supply per month

- **HR + New Boiler:**

Type of boiler	condensing boiler
Nominal power	200 kW
Thermal efficiency	1.13
Operating hours	8760 h

Table 11: Heat exchangers and amount of recovered energy

Heat Exchanger	Power	Heat Source	Heat Sink	Amount of recovered energy	
	[kW]			[MWh]	[%]
compressor HR	31	compressors	production; storage_HW	275	72.66
ECO	14	calcining ovens	calcining ovens	104	27.34
Total	46			**379.14**	**100**

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 7	200	188	3.26
Daikin IR	1,400	2,172	37.71
Viessmann 144 kW	144	0	0.00
Viessmann 84 kW	84	0	0.00
Viessmann 42 kW	42	0	0.00
calcining ovens	700	3,400	59.03
Total	**2,570**	**5,760**	**200**

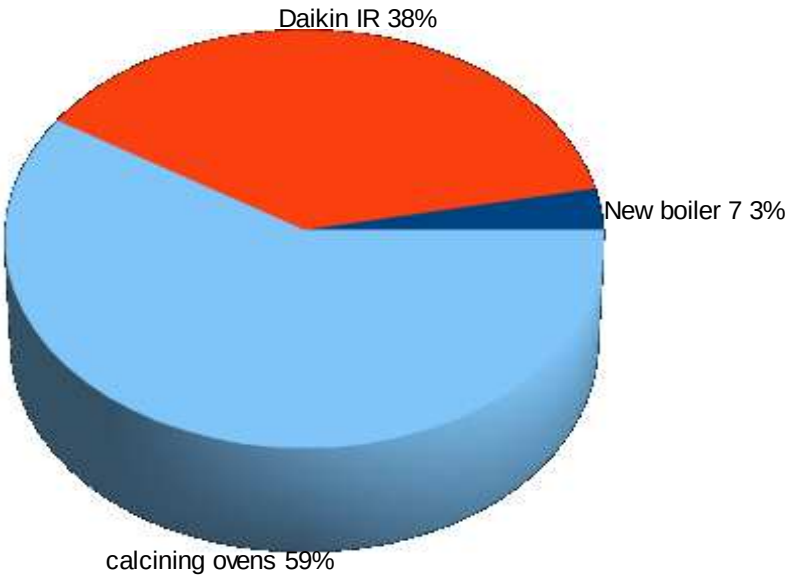

Figure 19: Contribution of each equipment to the total useful heat and useful cooling supply (USH & USC).

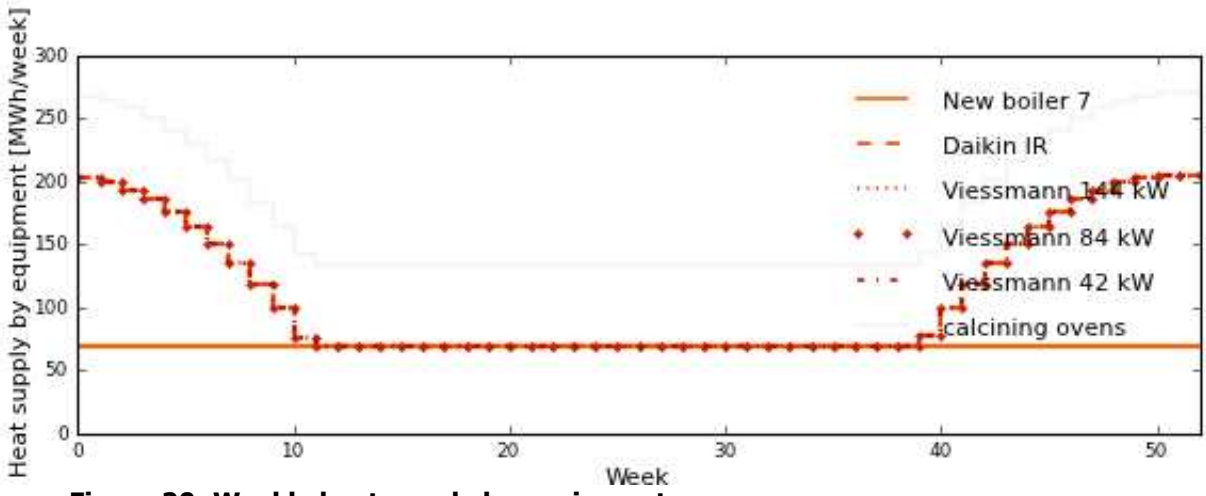

Figure 20: Weekly heat supply by equipment

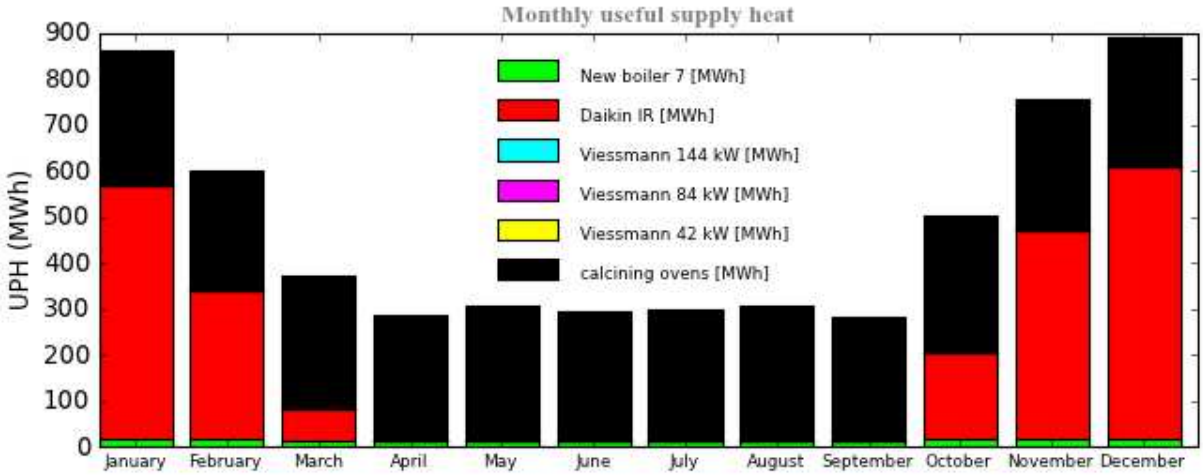

Figure 21: Distribution of useful process heat supply per month

- **Heat Recovery + CHP:**

Type	CHP engine
Nominal thermal power	333 kW
Nominal electric power	200 kW
Thermal efficiency	0.30
Electrical efficiency	0.51
Operating hours	2,505 h

Table 13: Heat exchangers and amount of recovered energy

Heat Exchanger	Power	Heat Source	Heat Sink	Amount of recovered energy	
	[kW]			[MWh]	[%]
compressor HR	31	compressors	production; storage_HW	275	74.09
ECO	13	calcining ovens	calcining ovens	96	25.91
Total	45			**371.6**	**100**

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 3	333	188	3.26
Daikin IR	1,400	2,172	37.71
Viessmann 144 kW	144	0	0.00
Viessmann 84 kW	84	0	0.00
Viessmann 42 kW	42	0	0.00
calcining ovens	700	3,400	59.03
Total	**2,703**	**5,760**	**200**

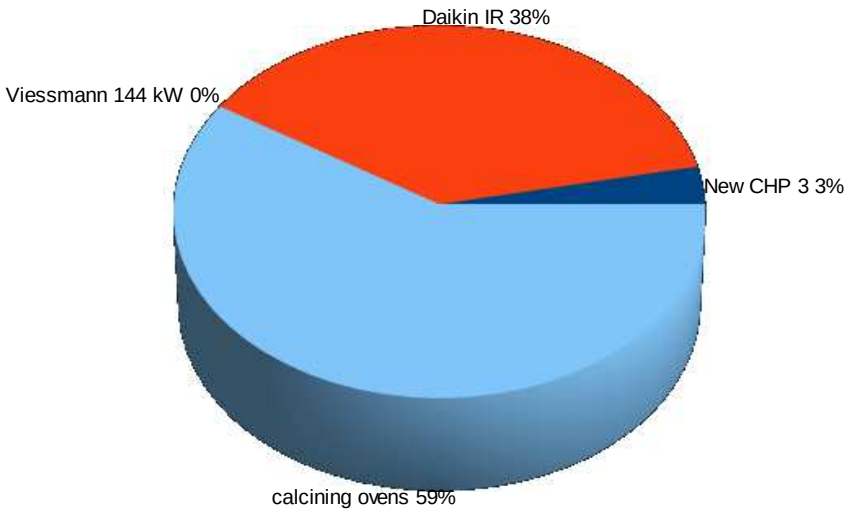

Figure 22: Contribution of each equipment to the total useful heat and useful cooling supply (USH & USC).

- graphic: heat demand covered by the CHP:

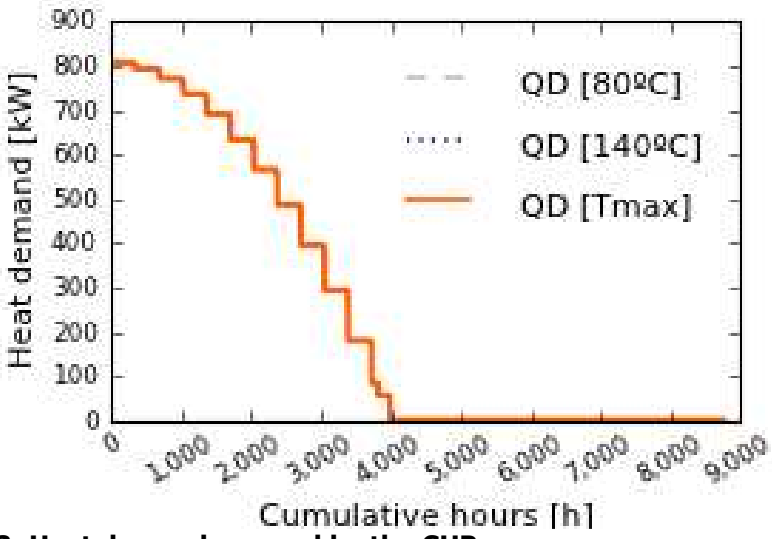

Figure 23: Heat demand covered by the CHP

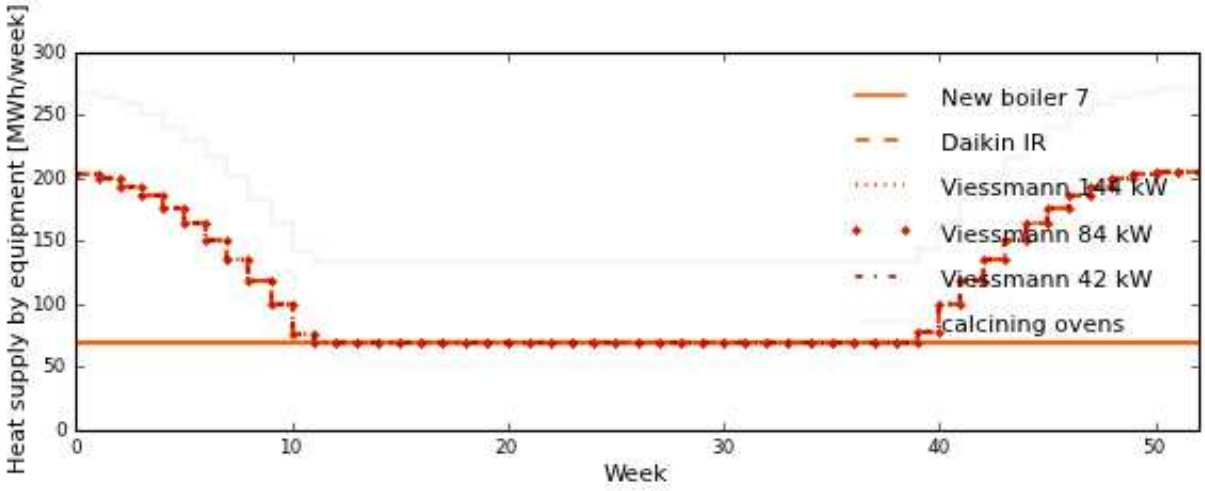

Figure 24: Weekly heat supply by equipment

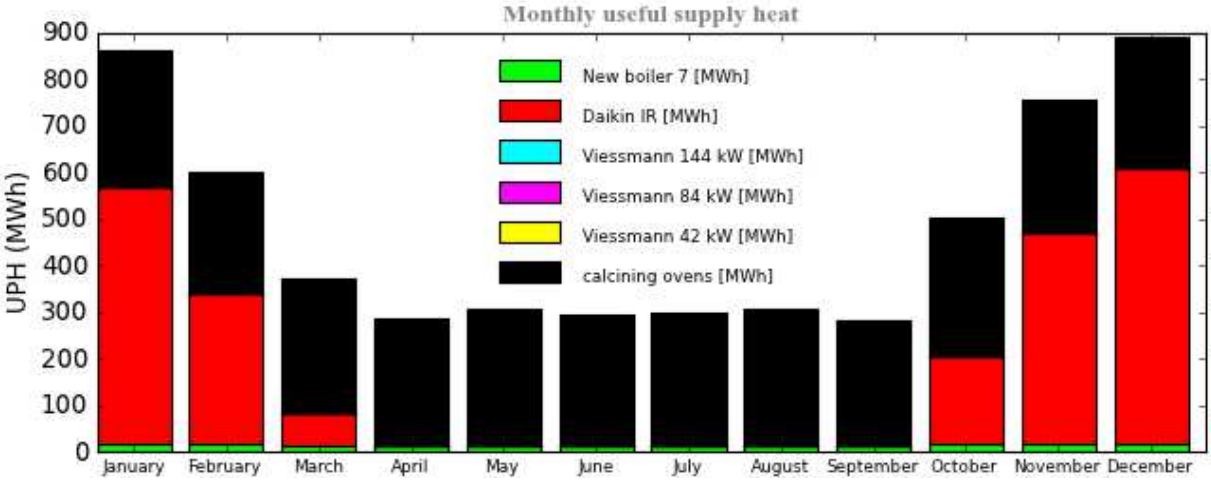

Figure 25: Distribution of useful process heat supply per month

- **HX + Solar:**

Collector type:	FPC (flat plate collectors)
Installed capacity:	331 kW
Installed collector area:	473 m²
Solar buffer storage volume:	24 m³
Solar fraction:	35.35 %
Annual energy yield:	200.44 kWh/kWa

Table 15: 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	331	66	1.15
Daikin IR	1,400	2,172	37.71
Viessmann 144 kW	144	121	2.11
Viessmann 84 kW	84	0	0.00
Viessmann 42 kW	42	0	0.00
calcining ovens	700	3,400	59.03
Total	**2,701**	**5,760**	**200**

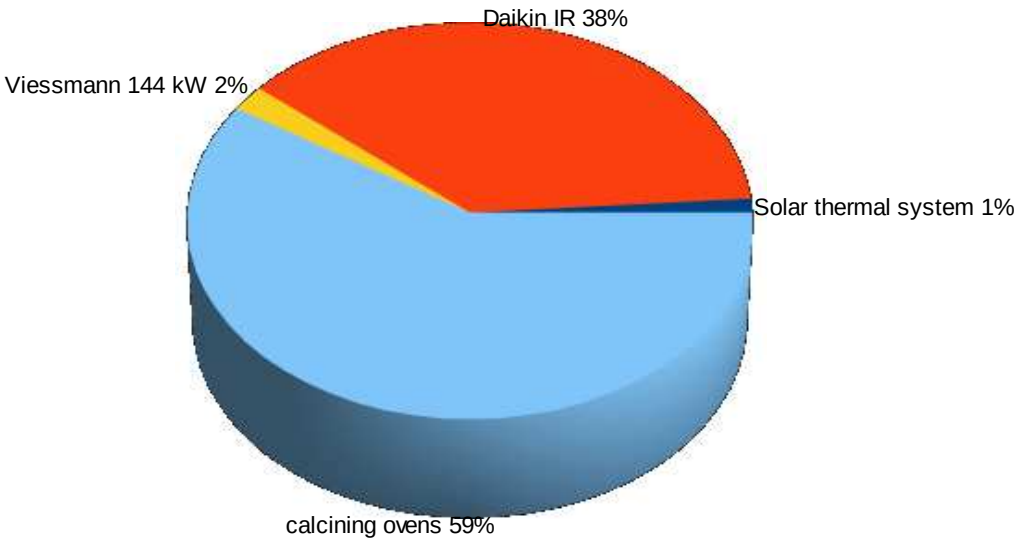

Figure 26: Contribution of each equipment to the total useful heat and useful cooling supply (USH & USC).

- graphic: heat demand covered by the solar thermal system:

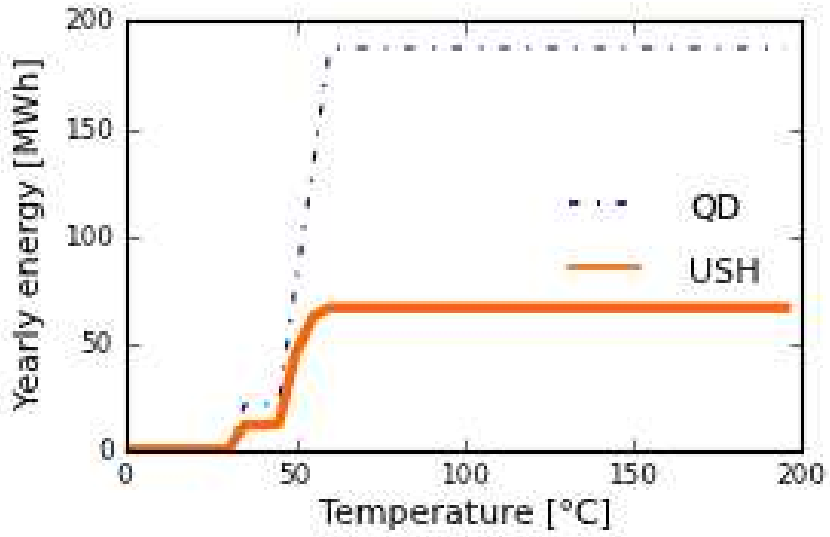

Figure 27: Heat demand covered by the solar thermal system

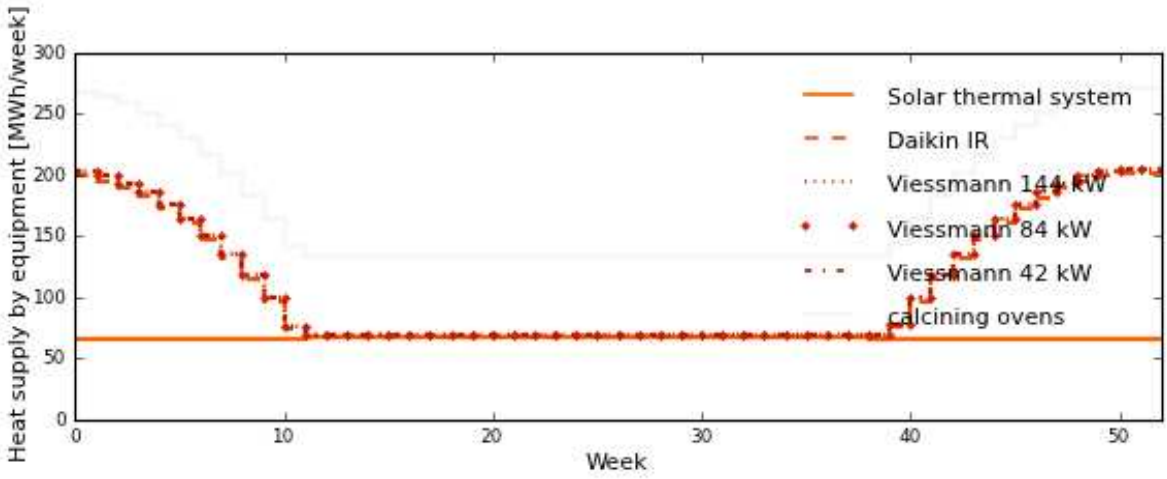

Figure 28:Weekly heat supply by equipment

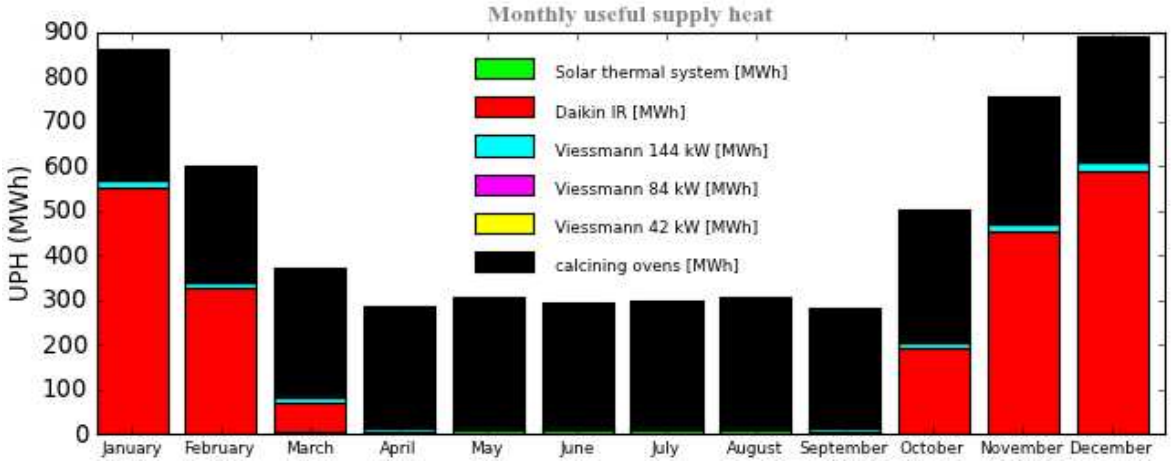

Figure 29: Distribution of useful process heat supply per month

- **CHP:**

Type	CHP engine
Nominal thermal power	469 kW
Nominal electric power	300 kW
Thermal efficiency	0.32
Electrical efficiency	0.5
Operating hours	4,355 h

Table 16: Heat and cooling supply equipment and contribution to total heat and cooling supply

Equipment	Type	Nominal capacity	Contribution to total heat and cooling supply	
		[kW]	[MWh]	[%]
New CHP 4	CHP engine	469	463	7.67
Daikin IR	hot water boiler	1,400	2,172	35.99
Viessmann 144 kW	hot water boiler	144	0	0.00
Viessmann 84 kW	hot water boiler	84	0	0.00
Viessmann 42 kW	hot water boiler	42	0	0.00
calcining ovens	burner (indirect heating)	700	3,400	56.34
Total		**2,839**	**6,035**	**200**

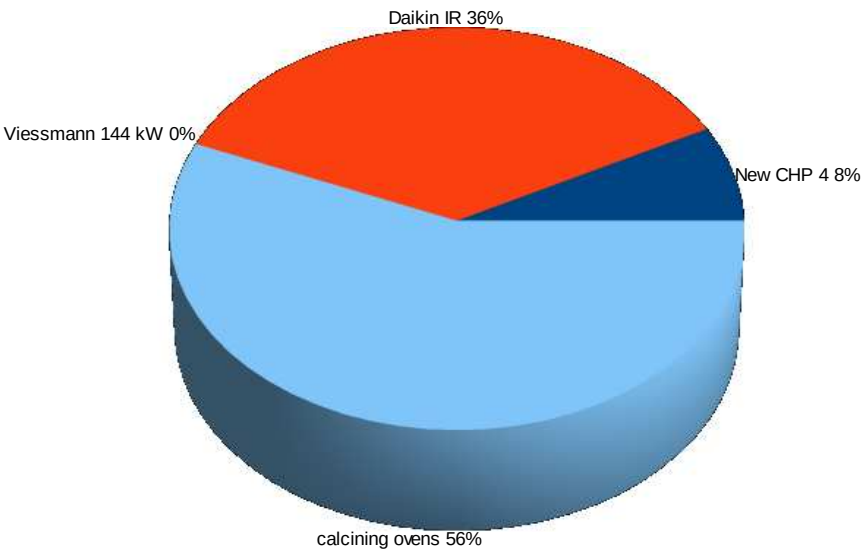

Figure 30: Contribution of each equipment to the total useful heat and useful cooling supply (USH & USC).

- graphic: heat demand covered by the CHP:

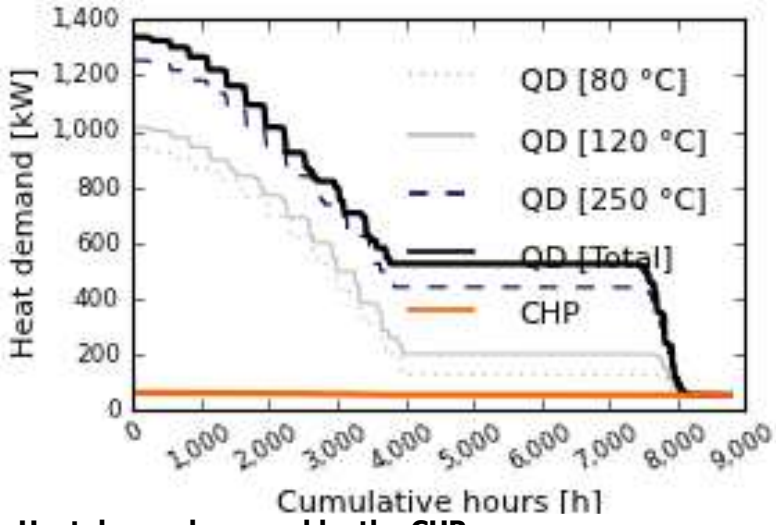

Figure 31: Heat demand covered by the CHP

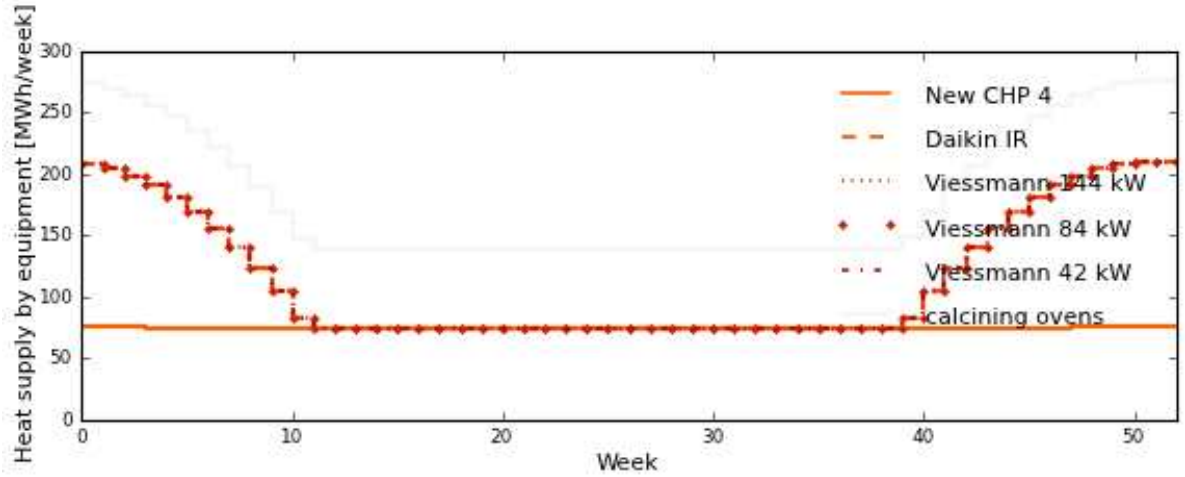

Figure 32: Weekly heat supply by equipment

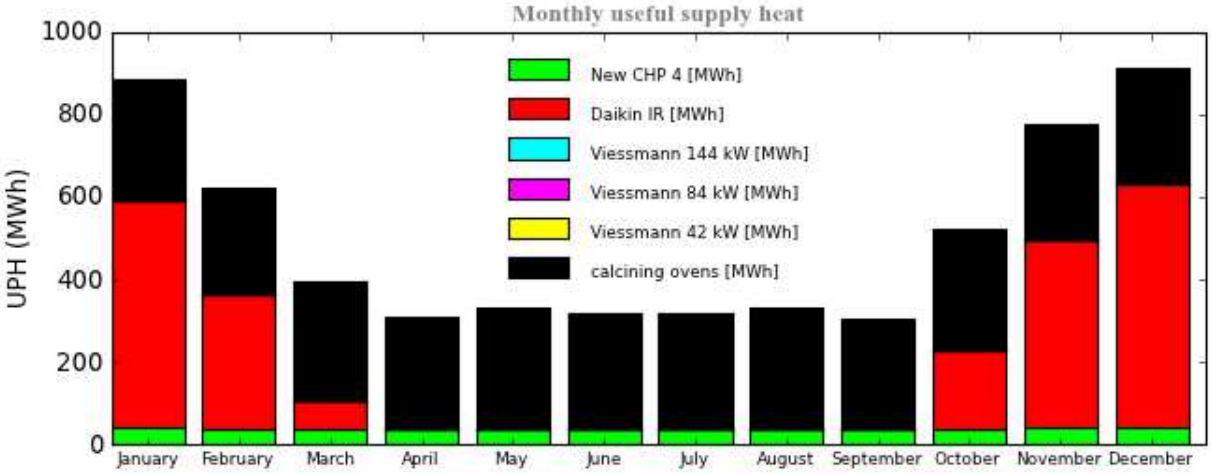

Figure 33: Distribution of useful process heat supply per month

- Primary energy consumption (PEC)

Table 17: primary energy consumption and savings

Alternative	Primary energy consumption	Savings	
	[MWh]	[MWh]	[%]
Present State (checked)	18,751	---	---
heat recovery	18,475	276	1.47
HR	18,360	391	2.09
HR + new boiler	18,319	432	2.31
HR+ CHP	18,214	537	2.86
HR + solar	18,281	470	2.51
CHP	18,285	466	2.48

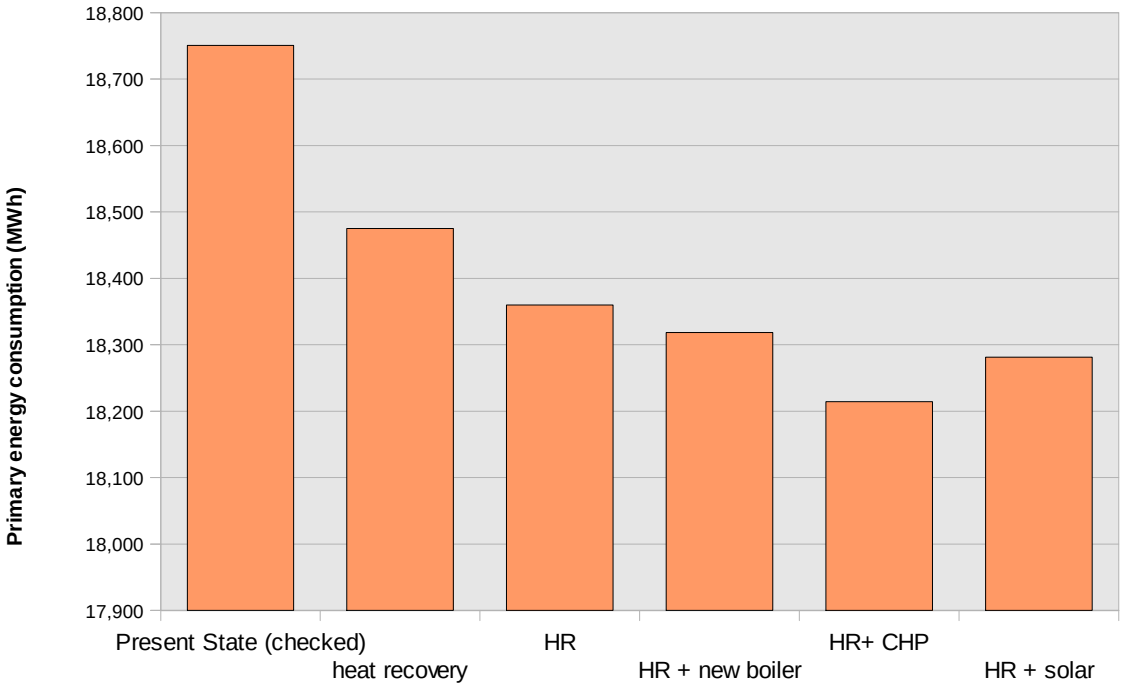

Figure 34: Comparison of alternatives: primary energy consumption

- 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 18: 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)	6,035	---	6,035	---
heat recovery	6,035	0	5,853	182
HR	6,035	0	5,759	276
HR + new boiler	6,035	0	5,760	276
HR+ CHP	6,035	0	5,760	275
HR + solar	6,035	0	5,760	276
CHP	6,035	0	6,035	0

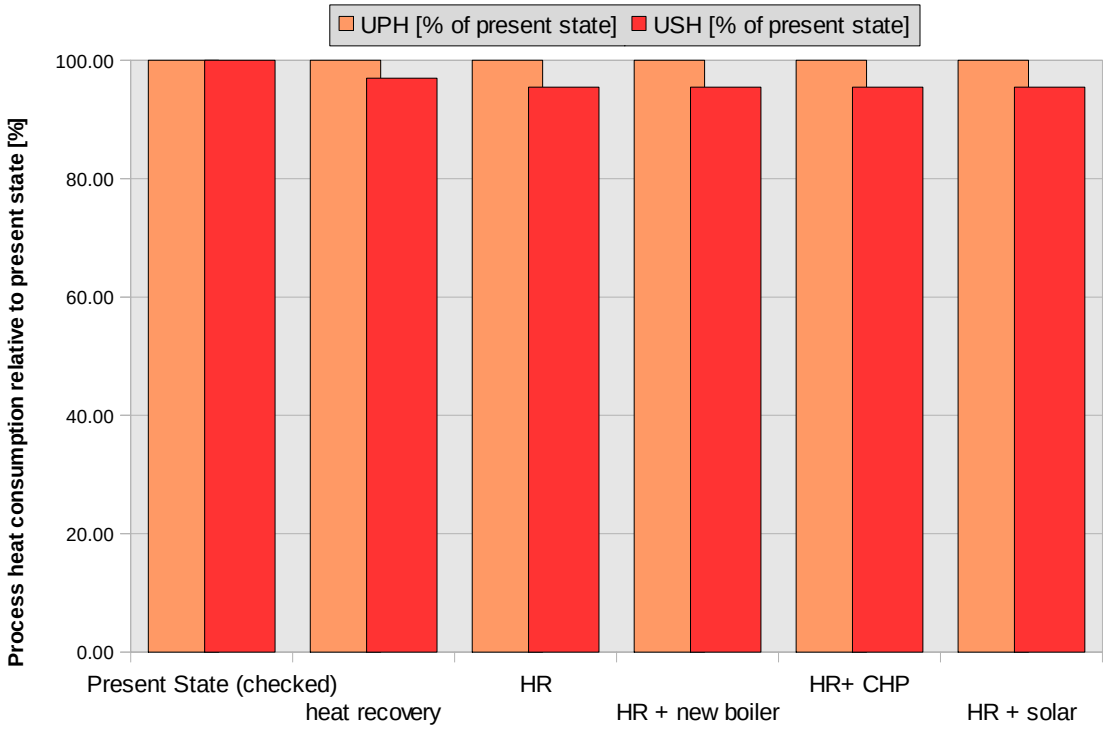

Figure 35: Comparison of alternatives: useful process heat supply

- Environmental impact

Table 19: CO2 production and CO2 savings per year

Alternative	Production of CO2 [t]	Water consumption [m³]
Present State (checked)	3598.50	0.00
heat recovery	3535.77	0.00
HR	3509.60	0.00
HR + new boiler	3499.91	0.00
HR+ CHP	3499.30	0.00
HR + solar	3491.59	0.00
CHP	3556.79	0.00

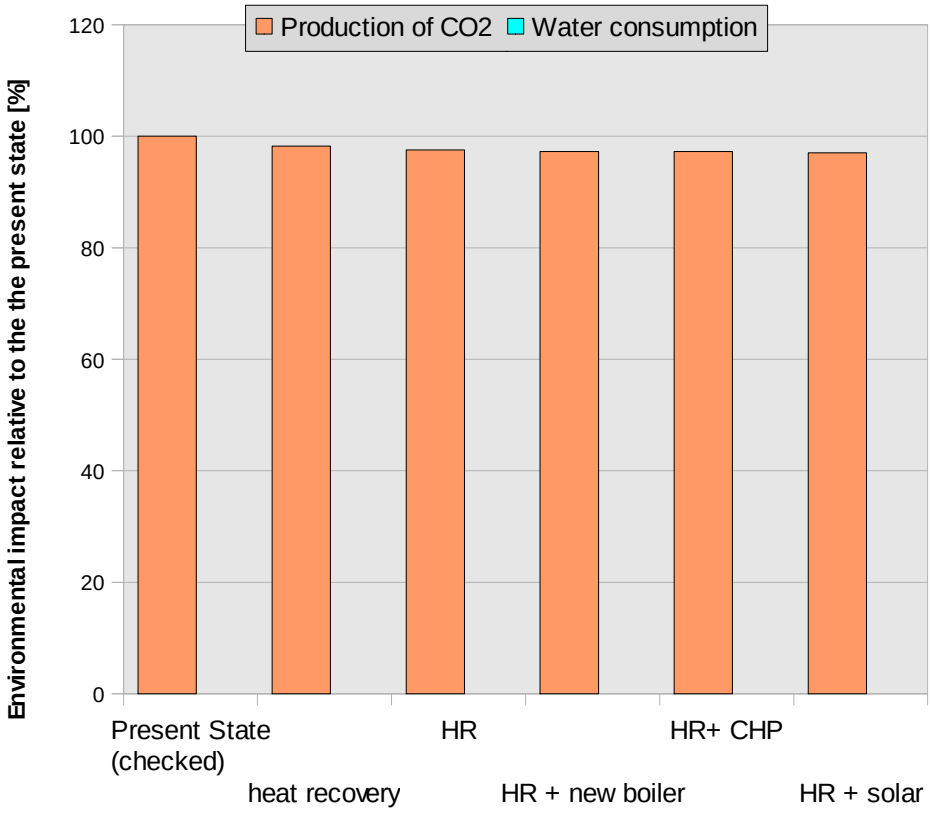

Figure 36: Comparison of alternatives: environmental impact

Table 20: Investment costs and subsidies of the proposals

Alternative	Total investment [€]	Own investment [€]	Subsidies [€]
Present State (checked)	---	---	---
heat recovery	7,500	7,500	0
HR	12,500	12,500	0
HR + new boiler	42,500	42,500	0
HR+ CHP	262,500	262,500	0
HR + solar	211,160	147,812	63,348
CHP	237,000	165,900	71,100

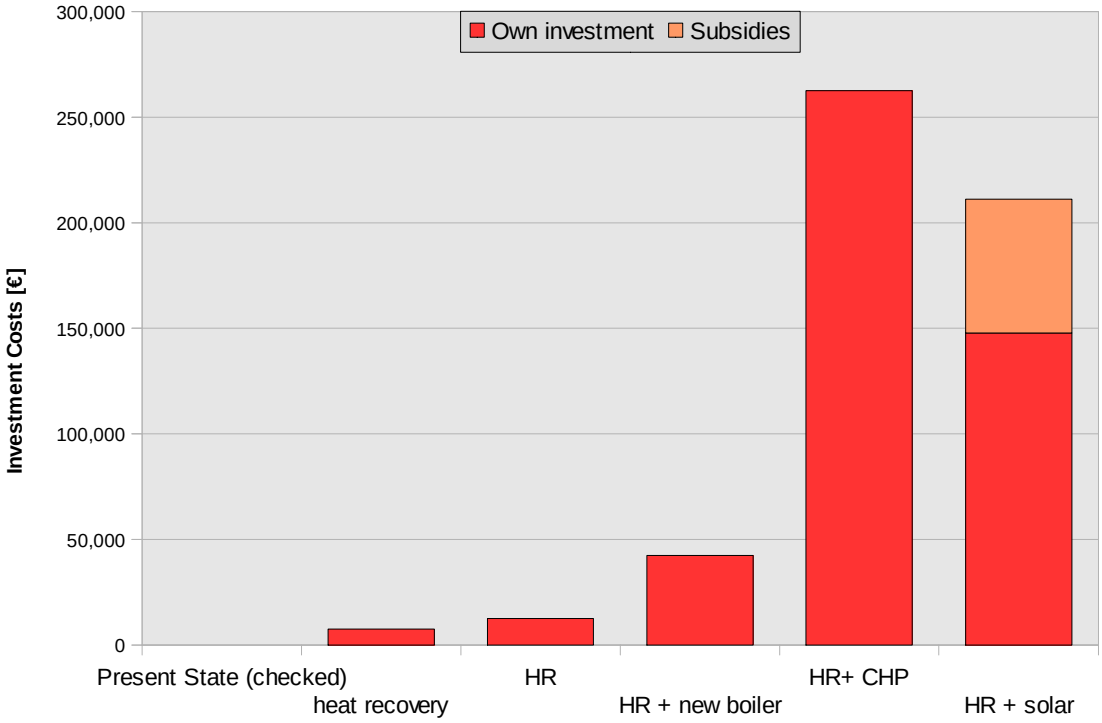

Figure 37: Comparison of alternatives investment cost

5. Selected alternative(s) and conclusions

5.1. Selected alternative

The selected alternative that has been chosen is the "Heat Recovery + Solar Thermal System".

5.1.1. Process optimisation (written proposals)

None

5.1.2. Heat Supply

HX + Solar:

Collector type:	FPC (flat plate collectors)
Installed capacity:	331 kW
Installed collector area:	473 m²
Solar buffer storage volume:	24 m³
Solar fraction:	35.35 %
Annual energy yield:	200.44 kWh/kWa

Table 21: 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	331	66	1.15
Daikin IR	1,400	2,172	37.71
Viessmann 144 kW	144	121	2.11
Viessmann 84 kW	84	0	0.00
Viessmann 42 kW	42	0	0.00
calcining ovens	700	3,400	59.03
Total	**2,701**	**5,760**	**200**

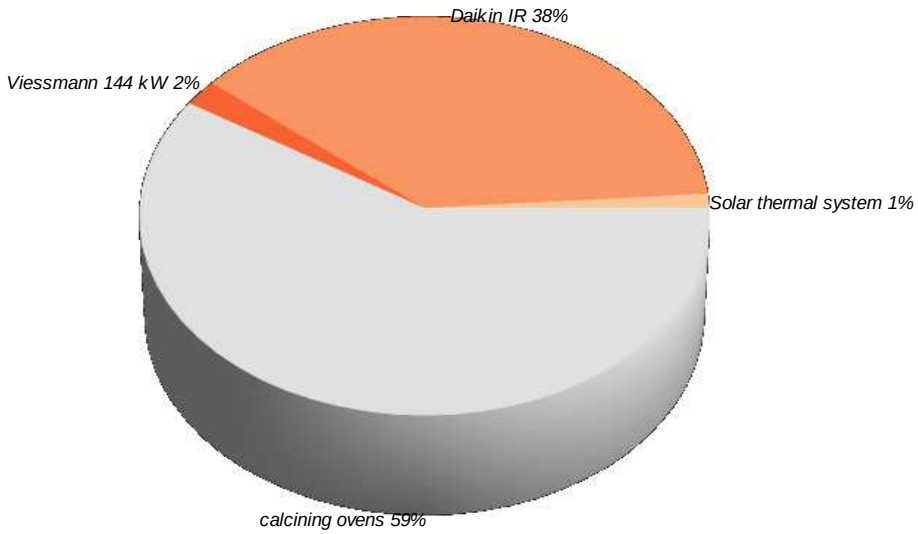

Figure 38: Contribution of each equipment to the total useful heat and useful cooling supply (USH & USC).

5.1.3. Energy Consumption

Table 22: 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	7,338	40.14	7,338	99.97
Total electricity	10,943	59.86	2	0.03
Total (fuels + electricity)	**18,281**	**100.00**	**7,340**	**100.00**

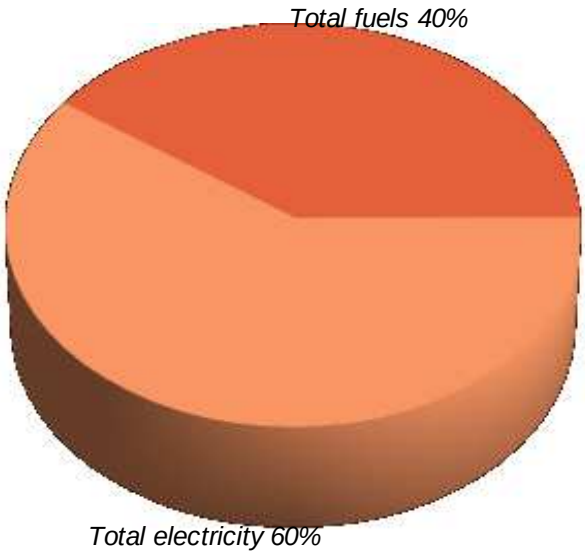

Figure 39: Distribution of PEC by fuel type

Table 23: 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	6,671	64.65	6,671	99.99
Electricity	3,648	35.35	1	0.01
Total	10,319	100.00	6,672	100.00

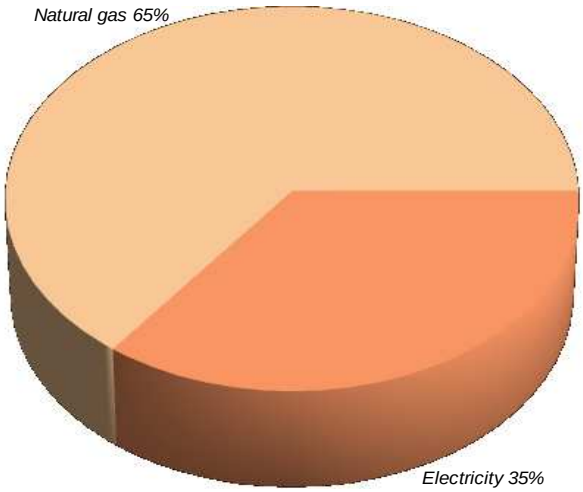

Figure 40: Total final energy consumption (FEC). Proposed final solution.

Table 24 : Final energy consumption for thermal use (FET) by equipment. Proposed final solution.

Equipment	Fuel type	FET by equipment	
		[MWh]	[% of Total]
Daikin IR	Natural gas	2,286	34.27
Viessmann 144 kW	Natural gas	135	2.02
Viessmann 84 kW	Natural gas	0	0.00
Viessmann 42 kW	Natural gas	0	0.00
calcining ovens	Natural gas	4,250	63.70
Solar thermal system	Electricity	1	0.01
Total		**6,672**	**100**

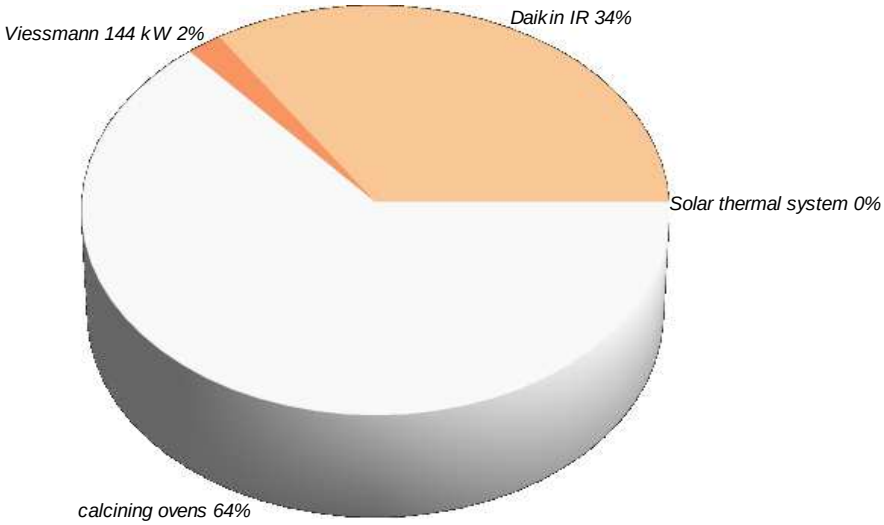

Figure 41: Final energy consumption for thermal use (FET) by equipment

Table 25 : Useful supply heat (USH) by equipment. Proposed final solution.

Equipment	USH by equipment	
	[MWh]	[% of Total]
Daikin IR	2,172	37.71
Viessmann 144 kW	121	2.11
Viessmann 84 kW	0	0.00
Viessmann 42 kW	0	0.00
calcining ovens	3,400	59.03
Solar thermal system	66	1.15
Total	**5,760**	**100**

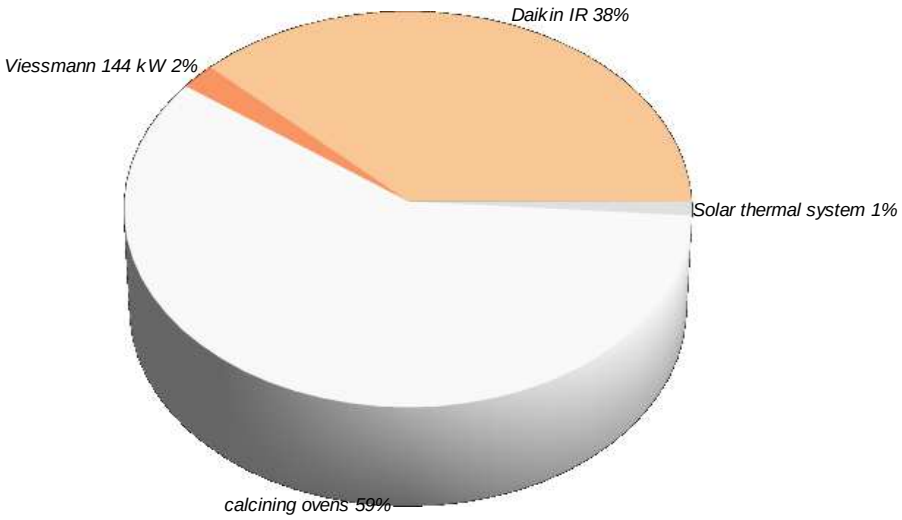

Figure 42: Useful supply heat (USH) by equipment. Proposed final solution

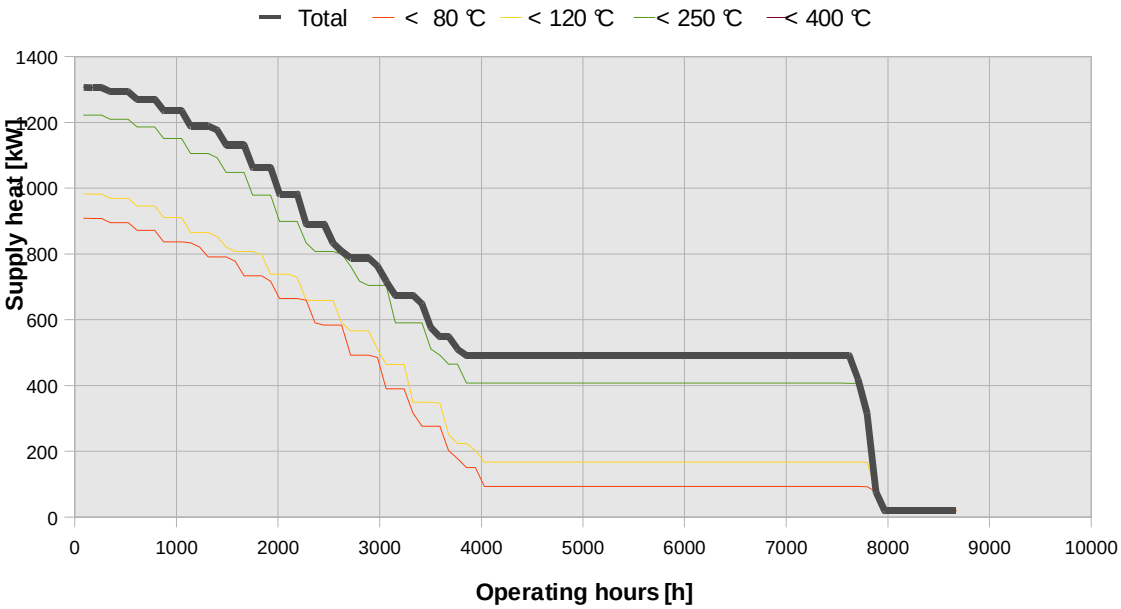

Figure 43: Distribution of supply heat by temperature levels and annual operating hours. Proposed final solution.

5.2. Comparative study and conclusions

5.2.1. Energy and environmental analysis

In the proposed alternative around 3 % 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 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]	18,751	18,281	470	3%
- fuels	[MWh]	7,810	7,338	472	6%
- electricity	[MWh]	10,941	10,943	-2	0%
Primary energy saving due to renewable energy	[MWh]		73		
CO2 emissions	[t/a]	3,598	3,491	107	3%
Annual energy system cost (2)	[EUR]	650,106	635,941	14,165	2%
Total investment costs	[EUR]		211,160		
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.