Energy Audit Summary Report

AEE INTEC

Audit no. 37 – BUL03

School

19th of January 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. 37 - BUL03

1. Data of the auditor

1.1. Contact data of the auditor

Jürgen Fluch, Matthäus Hubmann

Number of audits preformed: 11

Date of the audit: 15.01.2012

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

Baba Tonka Secondary School of Mathematics

Sector	Secondary School
Products	none
No. of employees	n.a. (not available)

Current primary energy consumption 908 [MWh/a]

3.2. Flow sheet of the whole manufacturing side

There is no manufacturing part in the building.

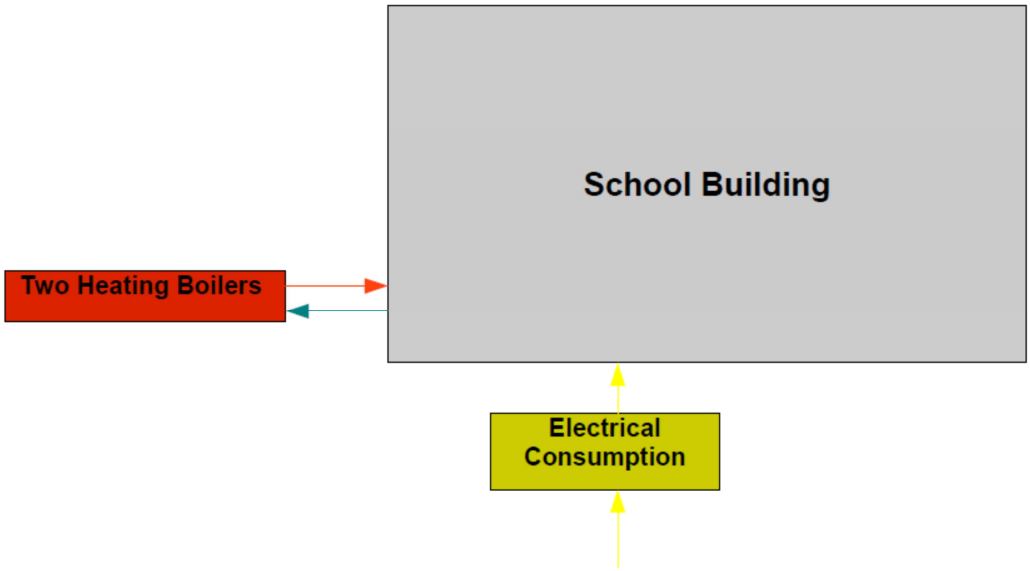

Figure 1: Flow sheet of school

Picture 1: boiler room

3.3. Description of the existing system

- **Energy Supply:**

The school is mainly consuming energy for heating purposes especially in the winter period. In addition it has electrical consumption for lighting and the electrical devices within the school.

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	746	82.15	746	89.54
Total electricity	162	17.85	87	10.46
Total (fuels + electricity)	**908**	**100.00**	**833**	**100.00**

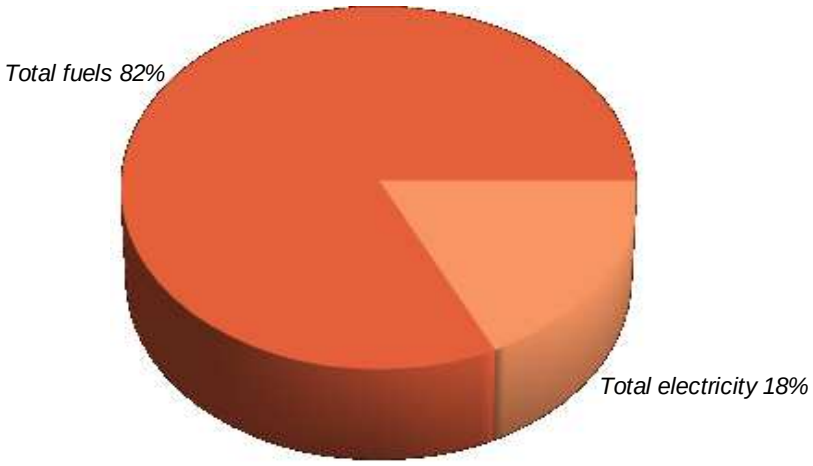

Figure 2: distribution of PEC by fuel type

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	678	92.62	678	95.89
Electricity	54	7.38	29	4.11
Total	732	100.00	707	100.00

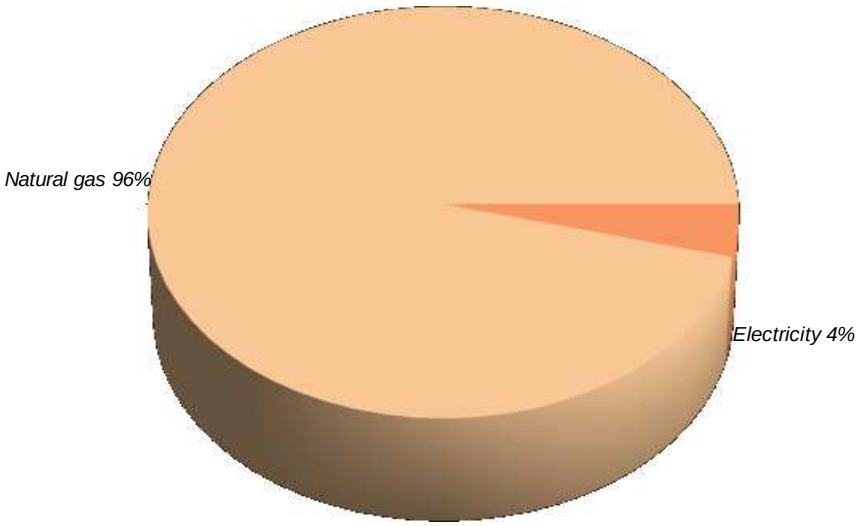

Figure 3: Total final energy consumption for thermal use (FET)

Table 3: Final energy consumption for thermal use (FET) by equipment
Explanation: Boiler 1 has no energy consumption as it is only a reserve boiler.

Equipment	Fuel type	FET by equipment	
		[MWh]	[% of Total]
HW heaters	Electricity	29	4.11
boiler 1	Natural gas	0	0.00
boiler 2	Natural gas	678	95.89
Total		**707**	**100.00**

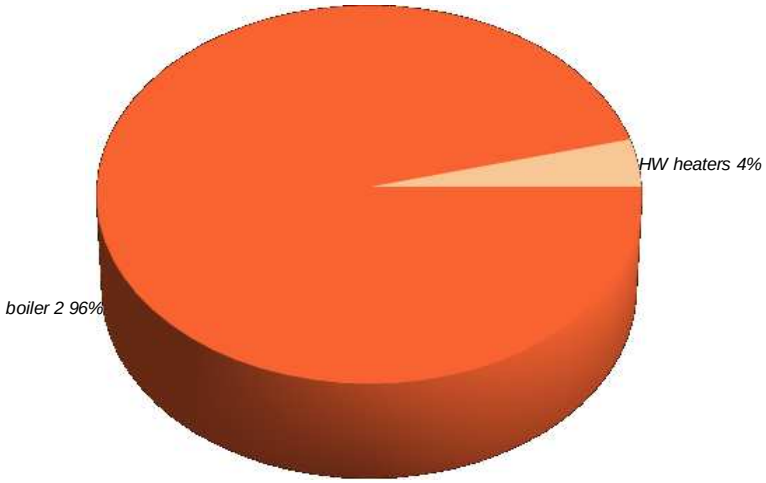

Figure 4: Final energy consumption for thermal use (FET) by equipment

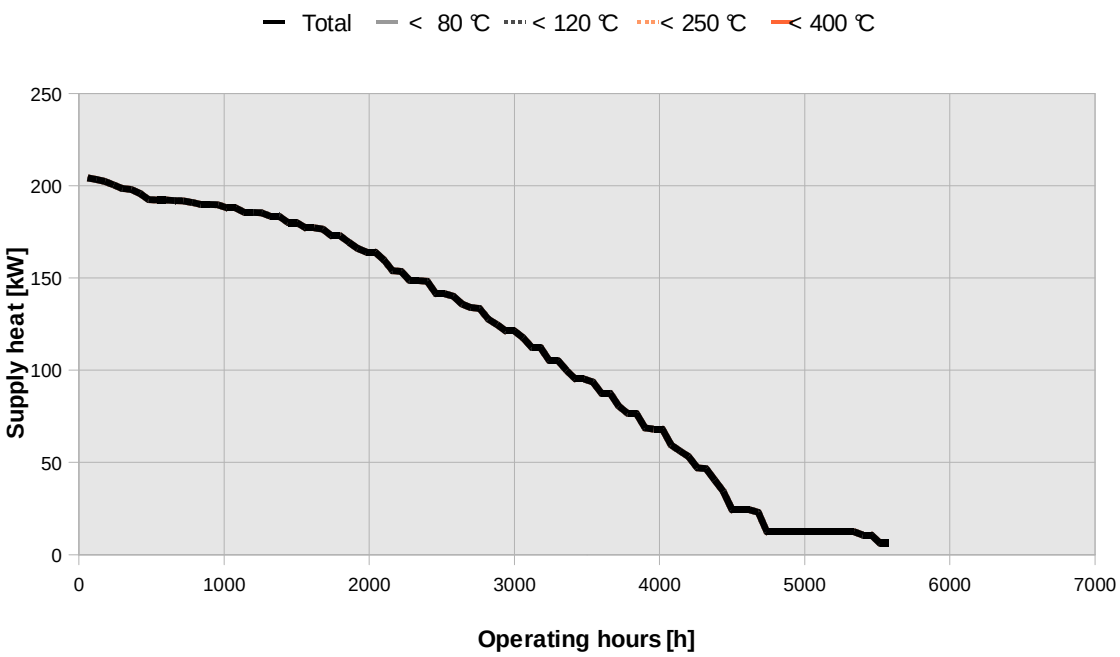

Figure 5: Distribution of supply heat by temperature levels and annual operating hours. Present state.

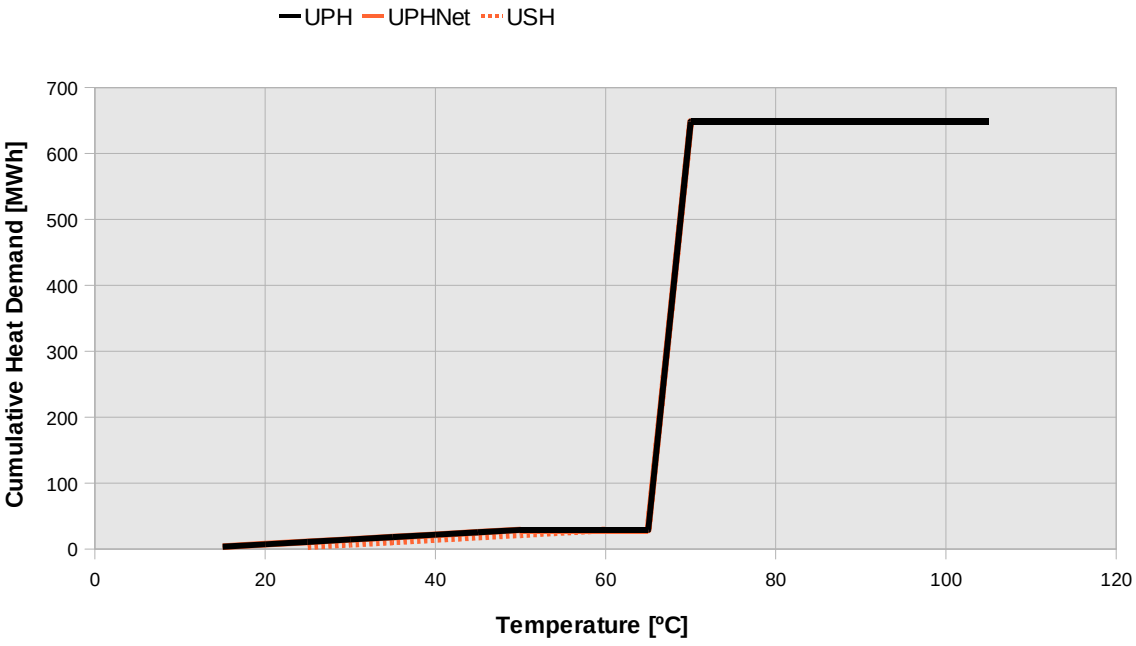

Figure 6: Distribution of the heat demand by temperature levels

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

Equipment	USH by equipment	
	[MWh]	[% of Total]
HW heaters	29	4.48
boiler 1	0	0.00
boiler 2	619	95.52
Total	**648**	**100.00**

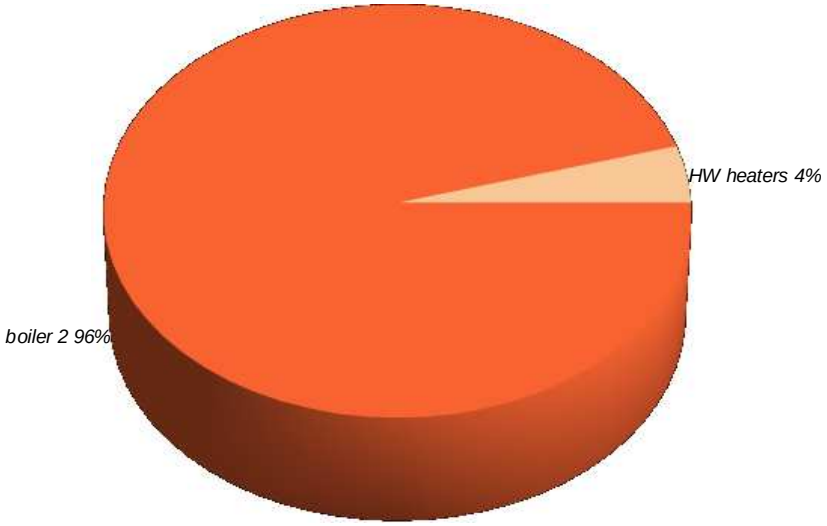

Figure 7: Useful supply heat (USH) by equipment. Present state.

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

Process	Total	Circulation	Maintenance	Start-up
	[MWh]	[MWh]	[MWh]	[MWh]
school_HW	29	29	0	0
school_heating	619	0	619	0
Total	**648**			

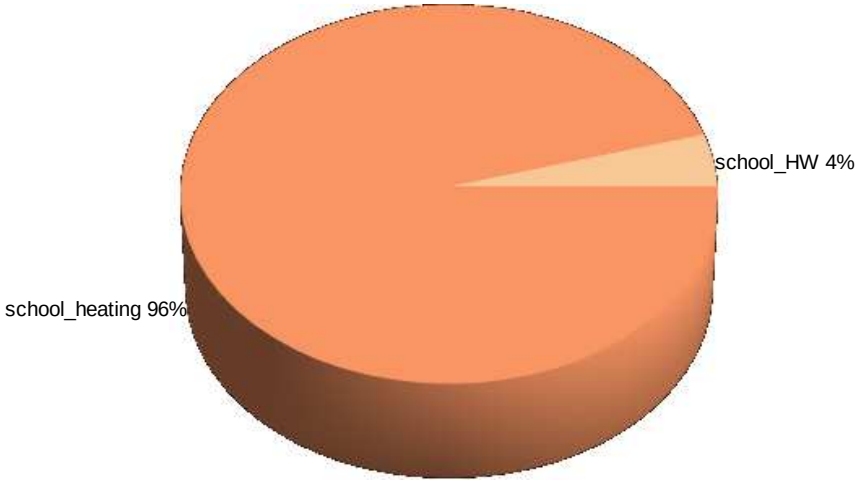

Figure 8: Useful process heat (UPH) by process

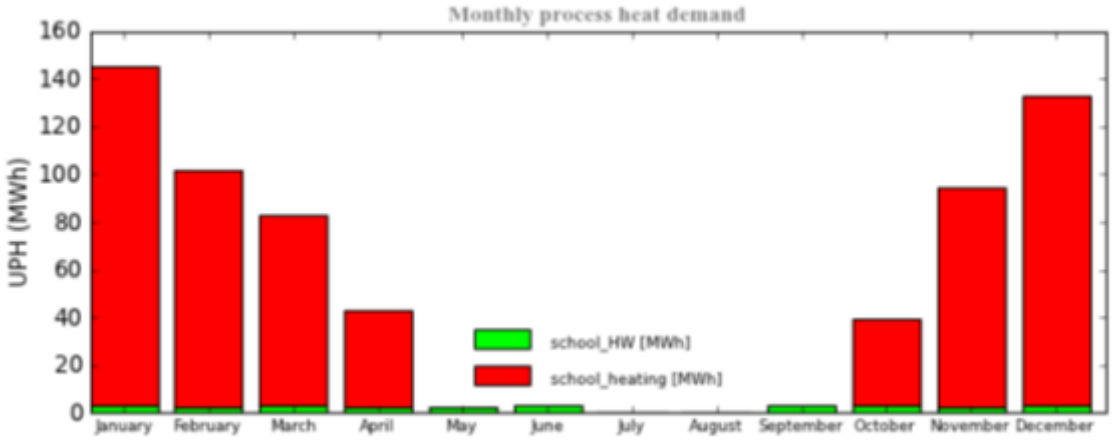

Figure 9: Distribution of useful process heat demand per month

3.4. General

- The target room temperature during winter is 22 °C.
- The hot water demand was estimated to be 2.4 m³ per day which corresponds to a hot water consumption of around 3 litres per day and person.

4. Comparative study

4.1. Proposed alternatives

There are four proposals made in this study. In the first one the hot water is also produced by the already existing boiler. In the second proposal a solar thermal system is installed and in the third one a new boiler is installed for heating. In the fourth proposal a new boiler for hot water generation and heating is newly installed.

Table 6: Overview of the alternative proposals studied

Short Name	Description
solar	Solar thermal plant is installed
HW by boiler	The hot water is also supplied by the existing boiler
new boiler	A new boiler is installed to supply the heating demand
HW by new boiler	A new boiler supplies the heat and the hot water demand

4.1.1. Heat Supply

- **Solar thermal:**

Collector type:	FPC (flat plate collectors)
Installed capacity:	79.1 kW
Installed collector area:	113 m²
Solar buffer storage volume:	5.65 m³
Solar fraction:	76.10 %
Annual energy yield:	279.49 kWh/kWa

Table 7: Overview of contribution to total heat supply by equipment

Equipment	Nominal capacity	Contribution to total heat and cooling supply	
	[kW]	[MWh]	[%]
Solar thermal system	79	22	3.41
boiler 1	635	626	96.59
boiler 2	870	0	0.00
Total	**1,584**	**648**	**200**

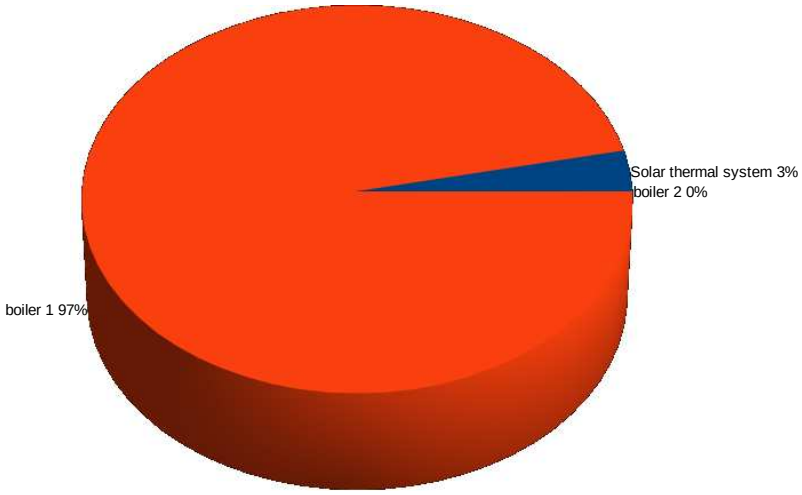

Figure 10: Contribution of each equipment to the total useful heat supply (USH).

- graphic: heat demand covered by solar:

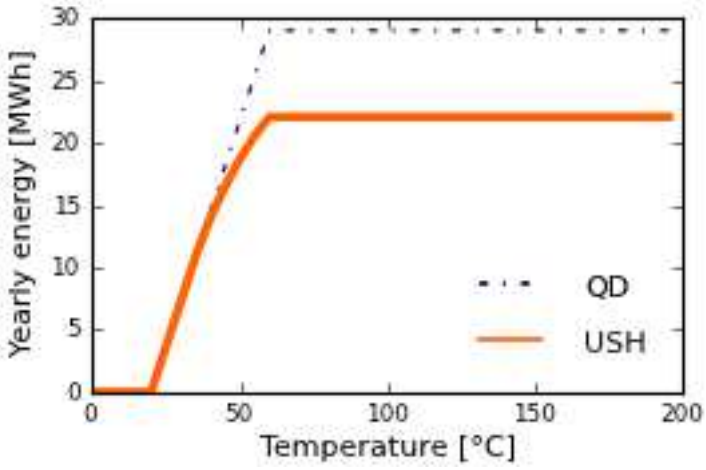

Figure 11: Heat demand and solar contribution

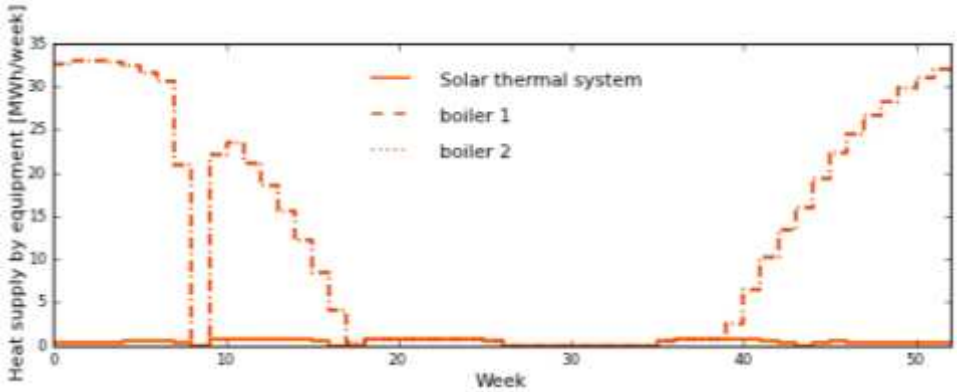

Figure 12: daily heat supply by equipment

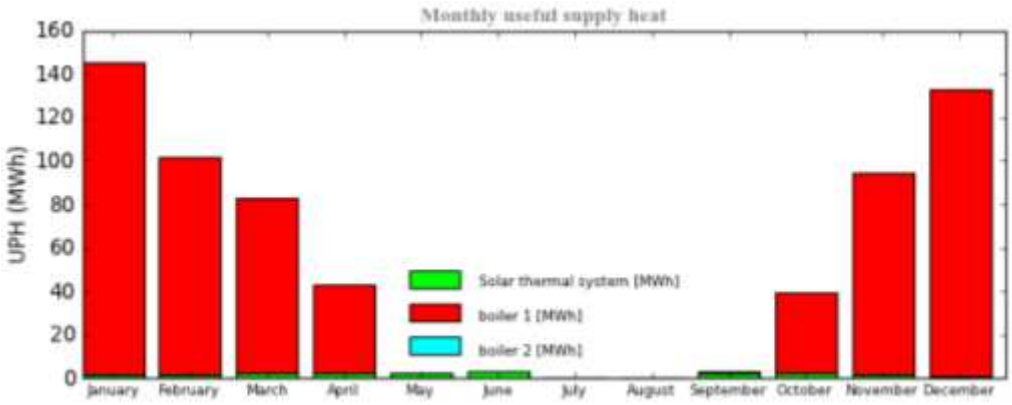

Figure 13: Distribution of useful process heat supply per month

- **HW (hot water) by Boiler**

Type of boiler	gas boiler
Nominal power	635 kW
Thermal efficiency	0.913
Operating hours	5,638 h

Table 8: Overview of contribution to total heat supply by equipment

Equipment	Nominal capacity	Contribution to total heat and cooling supply	
	[kW]	[MWh]	[%]
boiler 1	635	648	100.00
boiler 2	870	0	0.00
HW heaters	30	0	0.00
Total	**1,535**	**648**	**200**

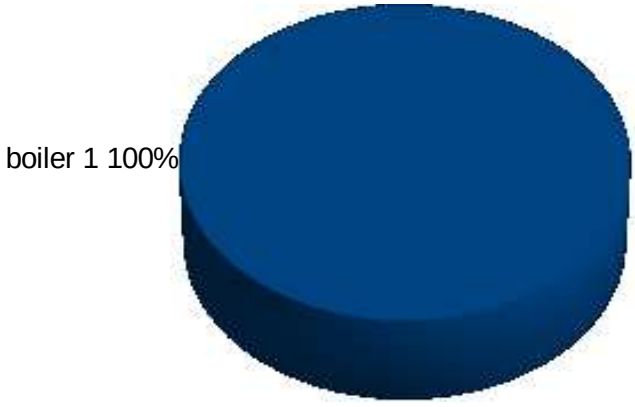

Figure 14: Contribution of each equipment to the total useful heat supply (USH).

- graphic: heat demand covered by boilers

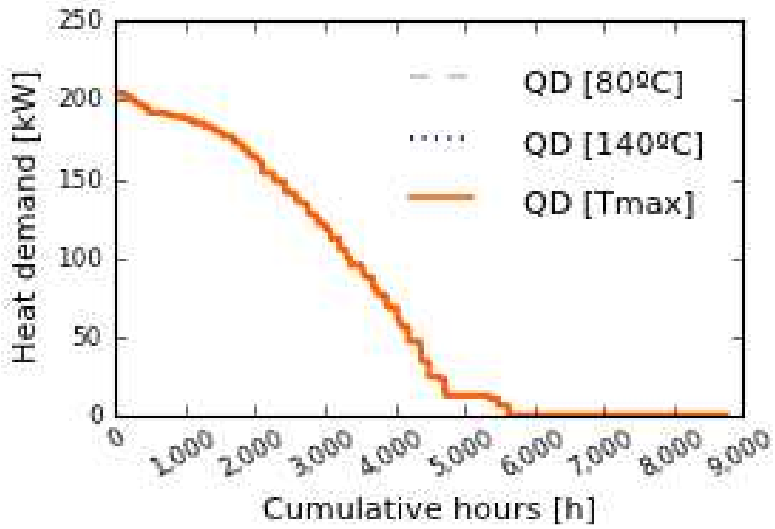

Figure 15: Cumulative heat demand to be covered by boilers

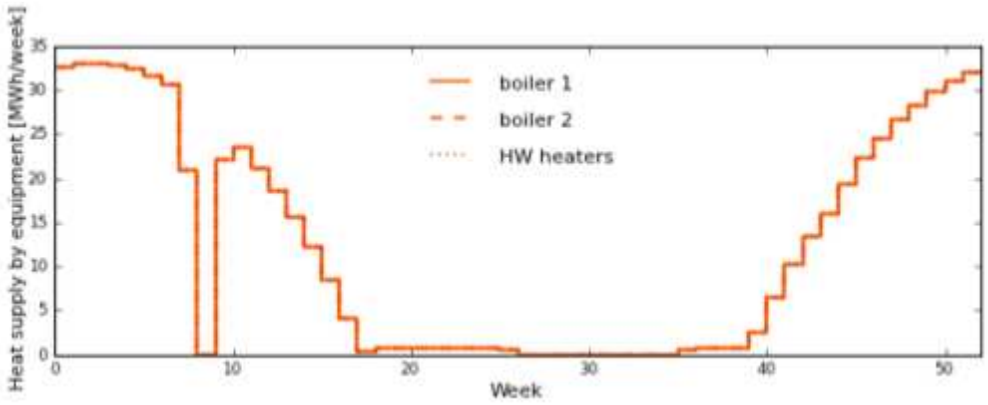

Figure 16: Daily heat supply by equipment

- **New Boiler**

Type of boiler	condensing boiler
Nominal power	350 kW
Thermal efficiency	1.13
Operating hours	4,848 h

Table 9: Overview of contribution to total heat supply by equipment

Equipment	Nominal capacity	Contribution to total heat and cooling supply	
	[kW]	[MWh]	[%]
HW heaters	30	29	4.48
New boiler 1	350	619	95.52
Total	**380**	**648**	**200**

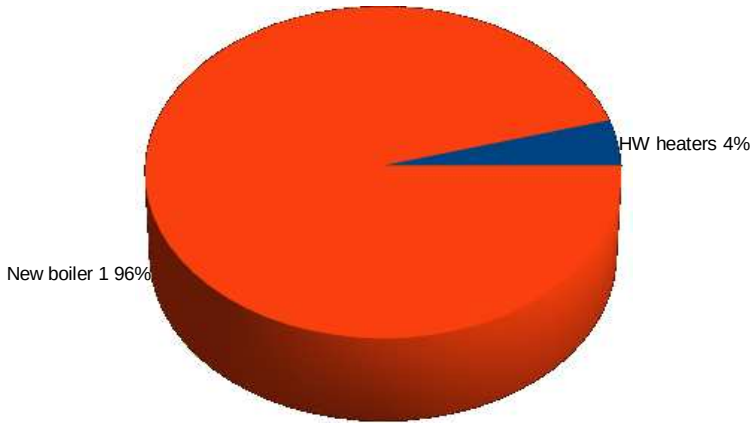

Figure 17: Contribution of each equipment to the total useful heat supply (USH).

- graphic: heat demand covered by boilers:

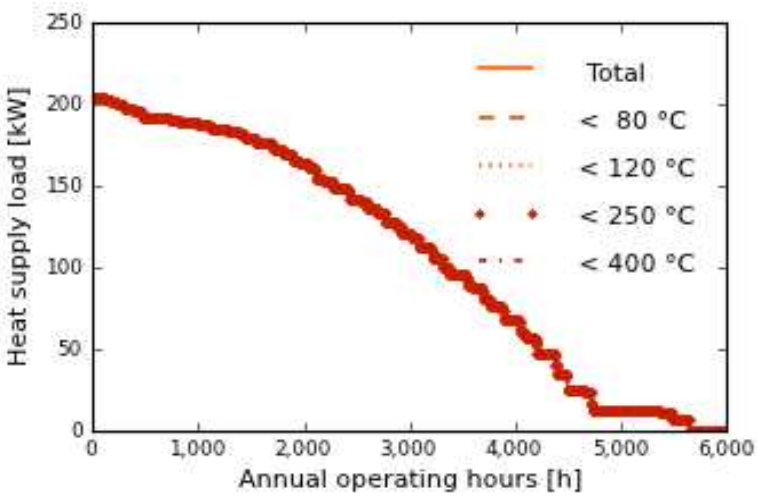

Figure 18: Cumulative heat supply to be covered by boilers

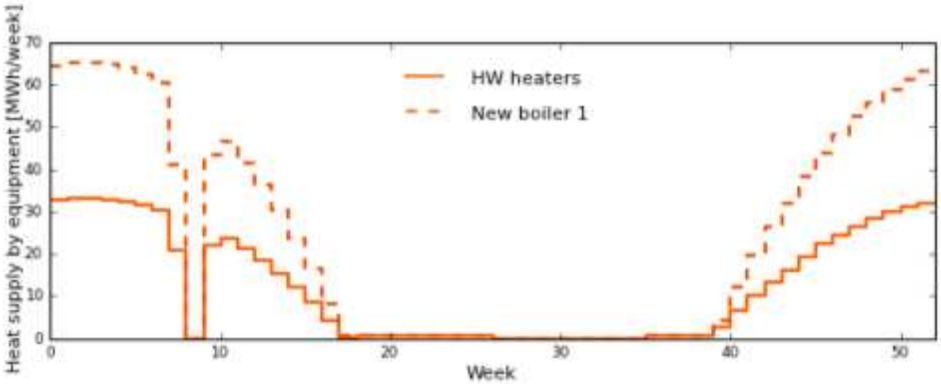

Figure 19: Daily heat supply by equipment

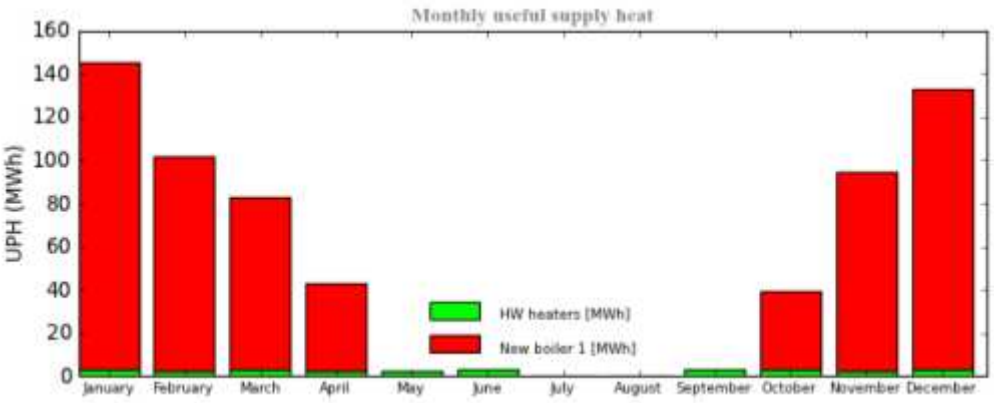

Figure 20: Distribution of useful process heat supply per month

- **HW (hot water) by New Boiler**

Type of boiler	gas boiler
Nominal power	350 kW
Thermal efficiency	1.13
Operating hours	5,638 h

Table 10: Overview of contribution to total heat supply by equipment

Equipment	Nominal capacity	Contribution to total heat and cooling supply	
	[kW]	[MWh]	[%]
New boiler 1	350	648	100.00
Total	**350**	**648**	**200**

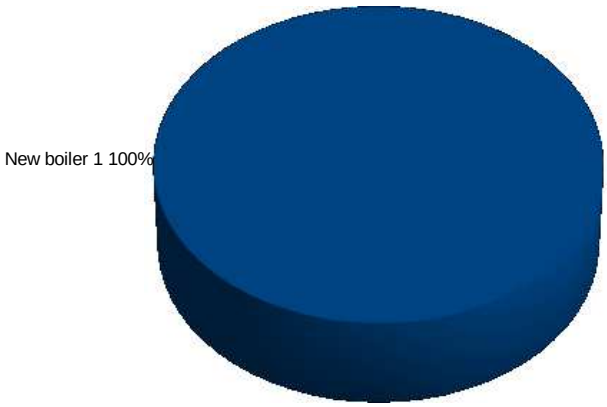

Figure 21: Contribution of each equipment to the total useful heat supply (USH).

- graphic: heat demand covered by boilers

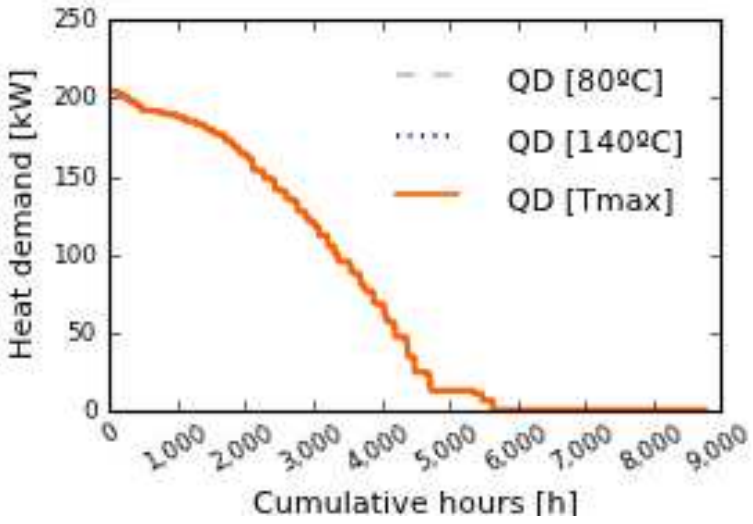

Figure 22: Cumulative heat demand to be covered by boilers

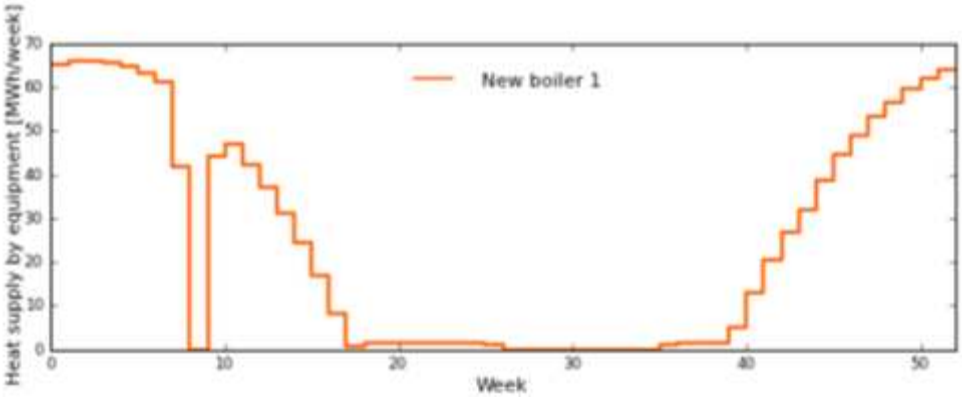

Figure 23: Daily heat supply by equipment

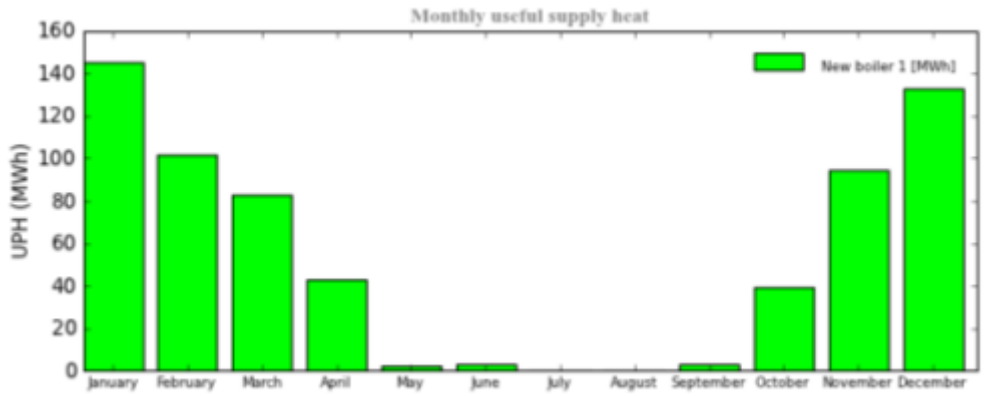

Figure 24: Distribution of useful process heat supply per month

- Primary energy consumption (PEC)

Table 11: primary energy consumption and savings

Alternative	Primary energy consumption	Savings	
	[MWh]	[MWh]	[%]
Present State (checked)	908	---	---
solar	830	78	8.60
HW by boiler	856	52	5.74
new boiler	781	127	13.97
HW by new boiler	723	185	20.36

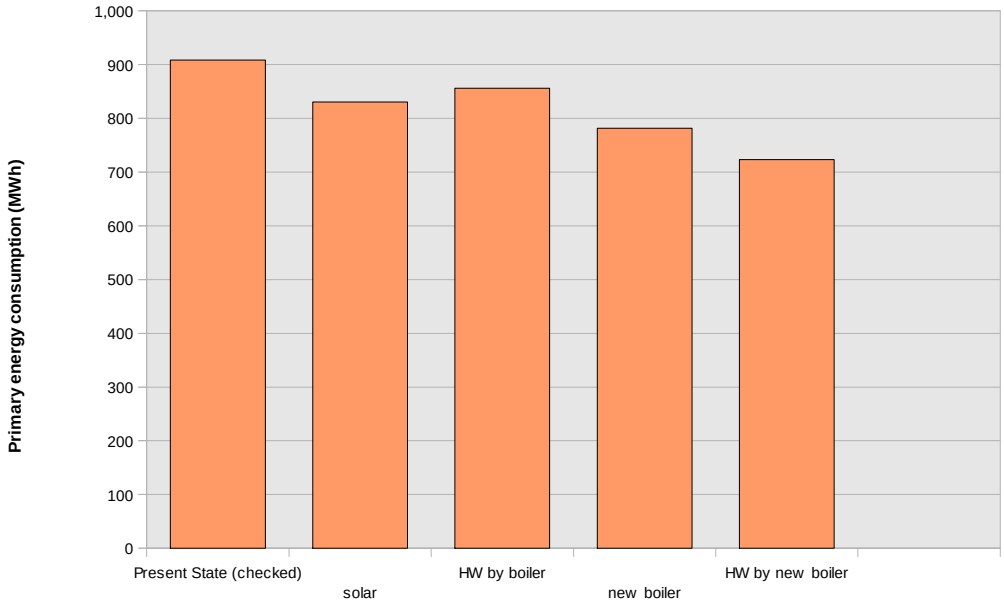

Figure 25: Comparison of alternatives: primary energy consumption

- 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 12: primary energy consumption and savings

Alternative	Useful process heat (UPH)	Savings UPH	Useful supply heat (USH)	Savings USH
	[MWh]	[MWh]	[MWh]	[MWh]
Present State (checked)	648	---	648	---
solar	648	0	648	0
HW by boiler	648	0	648	0
new boiler	648	0	648	0
HW by new boiler	648	0	648	0

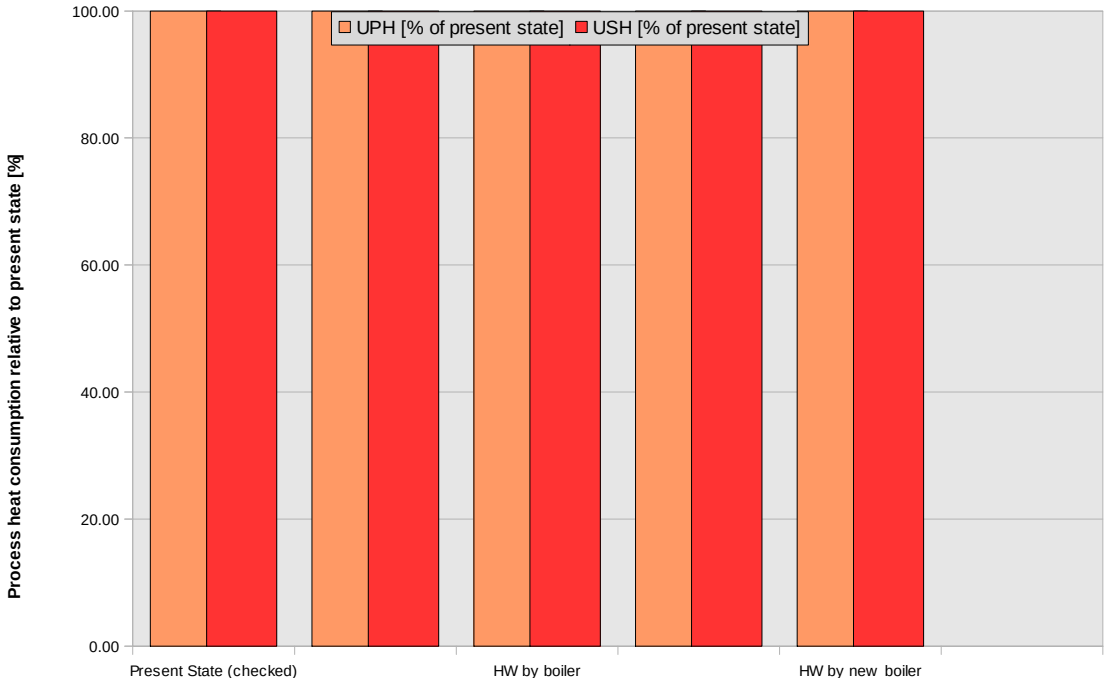

Figure 26: Comparison of alternatives: useful process heat supply

- Environmental impact

Table 13: CO2 production and CO2 savings per year

Alternative	Production of CO2	Water consumption
	[t]	[m3]
Present State (checked)	196.61	0.00
solar	184.10	0.00
HW by boiler	190.04	0.00
new boiler	166.79	0.00
HW by new boiler	158.82	0.00

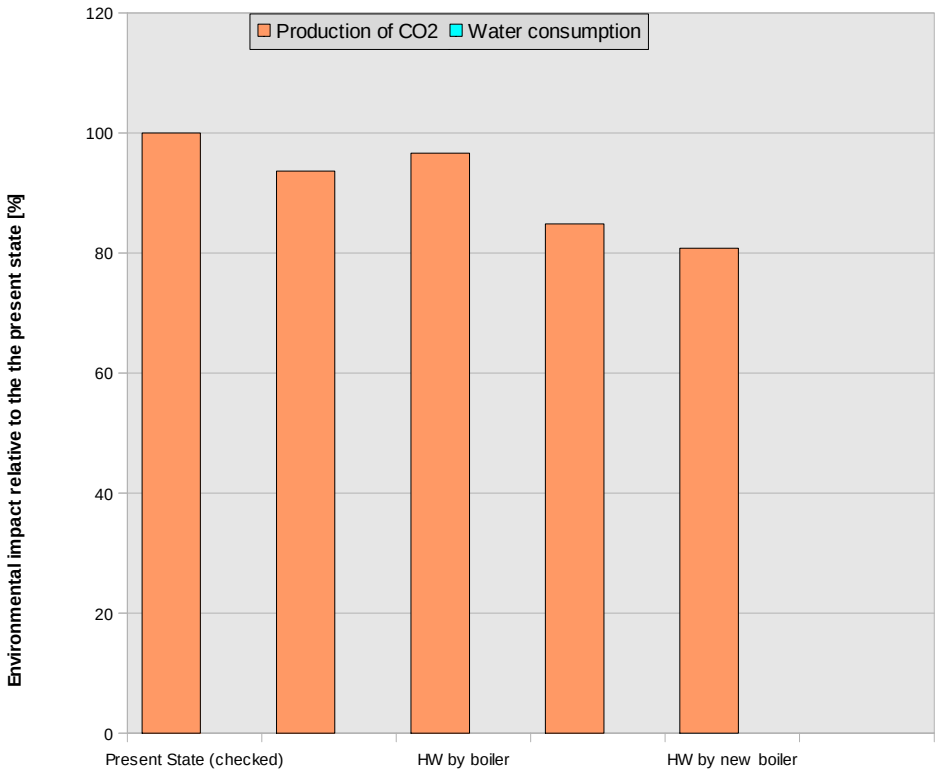

Figure 27: Comparison of alternatives: environmental impact

Table 14: Investment costs and subsidies of the proposals

Alternative	Total investment [€]	Own investment [€]	Subsidies [€]
Present State (checked)	---	---	---
solar	150,850	105,595	45,255
HW by boiler	100,000	100,000	0
new boiler	22,880	22,880	0
HW by new boiler	122,880	122,880	0

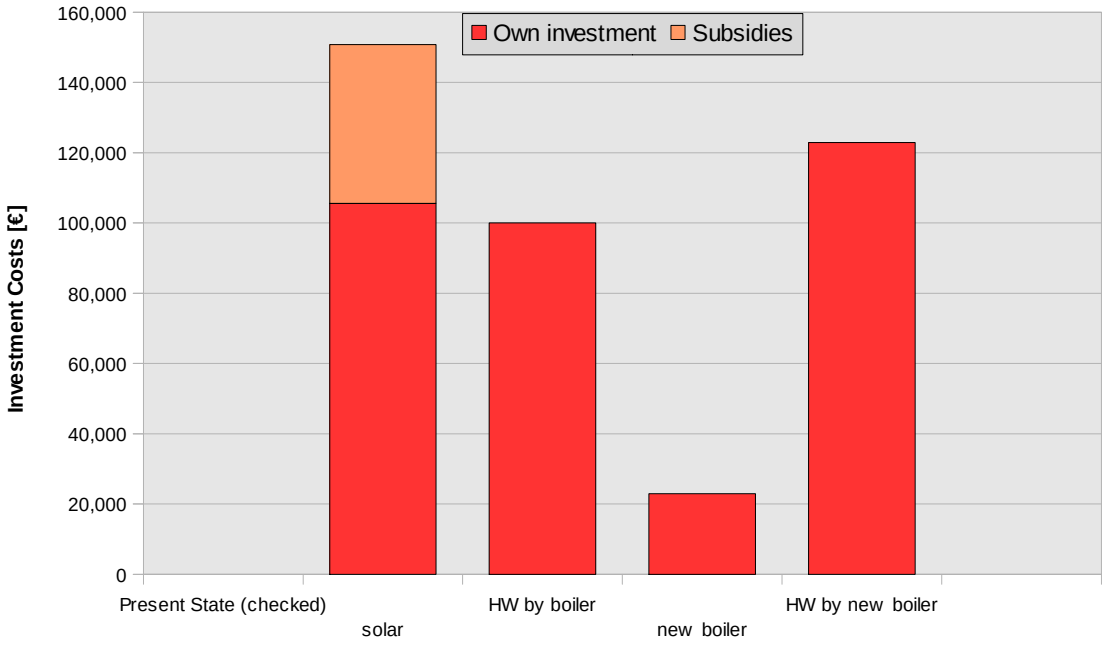

Figure 28: Comparison of alternatives investment cost

5. Selected alternative(s) and conclusions

5.1. Selected alternative

As selected alternative the "solar" proposal has been chosen, because of the short payback period and the high CO_2 savings per year.

5.1.1. Process optimisation (written proposals)

None

5.1.2. Heat Supply

Solar thermal:

Collector type:	FPC (flat plate collectors)
Installed capacity:	79.1 kW
Installed collector area:	113 m²
Solar buffer storage volume:	5.65 m³
Solar fraction:	76.10 %
Annual energy yield:	279.49 kWh/kWa

Table 15: Overview of contribution to total heat supply by equipment

Equipment	Nominal capacity	Contribution to total heat and cooling supply	
	[kW]	[MWh]	[%]
Solar thermal system	79	22	3.41
boiler 1	635	626	96.59
boiler 2	870	0	0.00
Total	**1,584**	**648**	**200**

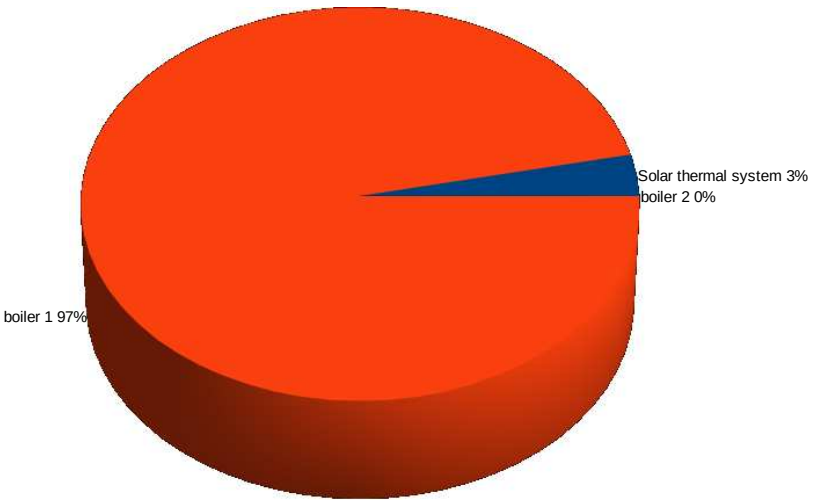

Figure 29: Contribution of each equipment to the total useful heat supply (USH).

5.1.3. Energy Consumption

Table 16: 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	755	90.89	755	99.91
Total electricity	76	9.11	1	0.09
Total (fuels + electricity)	**830**	**100.00**	**755**	**100.00**

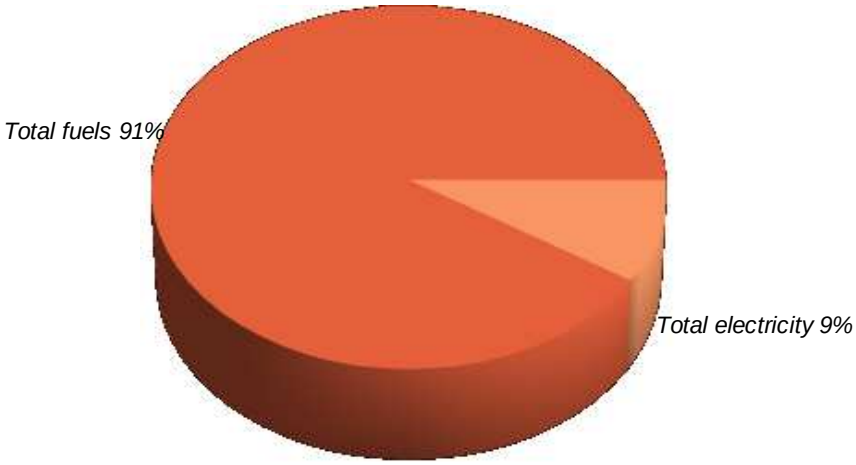

Figure 30: Distribution of PEC by fuel type

Table 17: 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	686	96.45	686	99.97
Electricity	25	3.55	0	0.03
Total	711	100.00	686	100.00

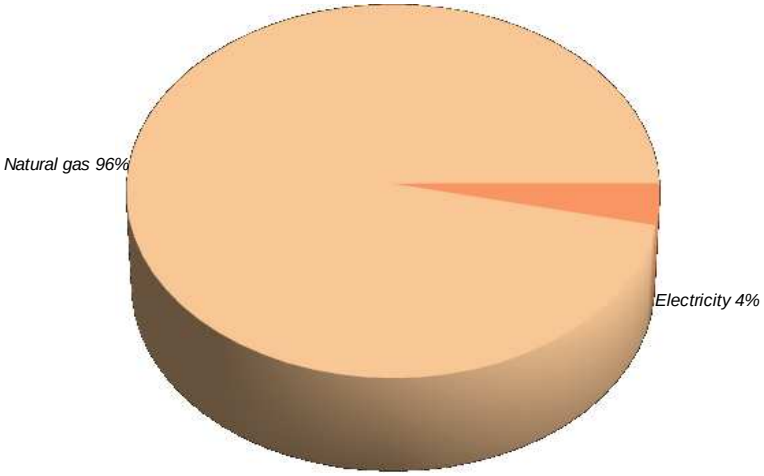

Figure 31: Total final energy consumption (FEC). Proposed final solution.

Table 18 : Final energy consumption for thermal use (FET) by equipment. Proposed final solution.

Equipment	Fuel type	FET by equipment	
		[MWh]	[% of Total]
boiler 1	Natural gas	686	99.97
boiler 2	Natural gas	0	0.00
Solar thermal system	Electricity	0	0.03
Total		**686**	**100**

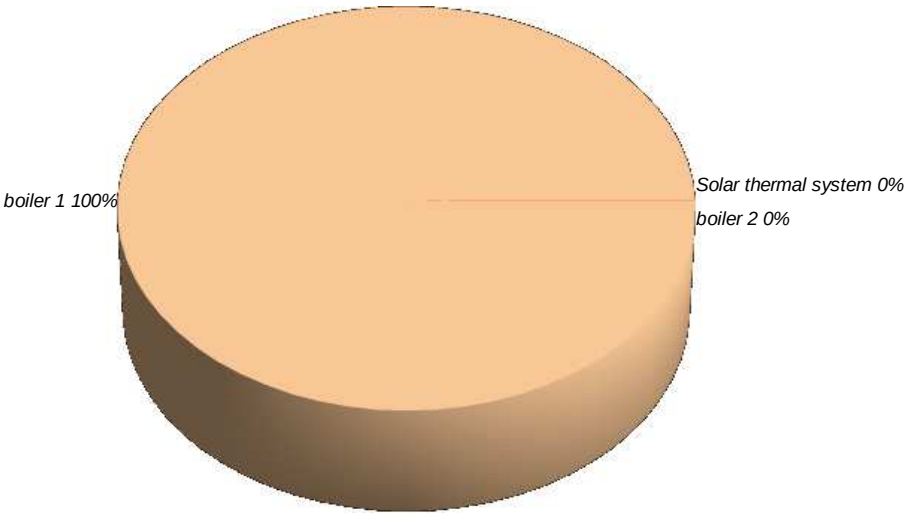

Figure 32: Final energy consumption for thermal use (FET) by equipment

Table 19 : Useful supply heat (USH) by equipment. Proposed final solution.

Equipment	USH by equipment	
	[MWh]	[% of Total]
boiler 1	626	96.59
boiler 2	0	0.00
Solar thermal system	22	3.41
Total	**648**	**100**

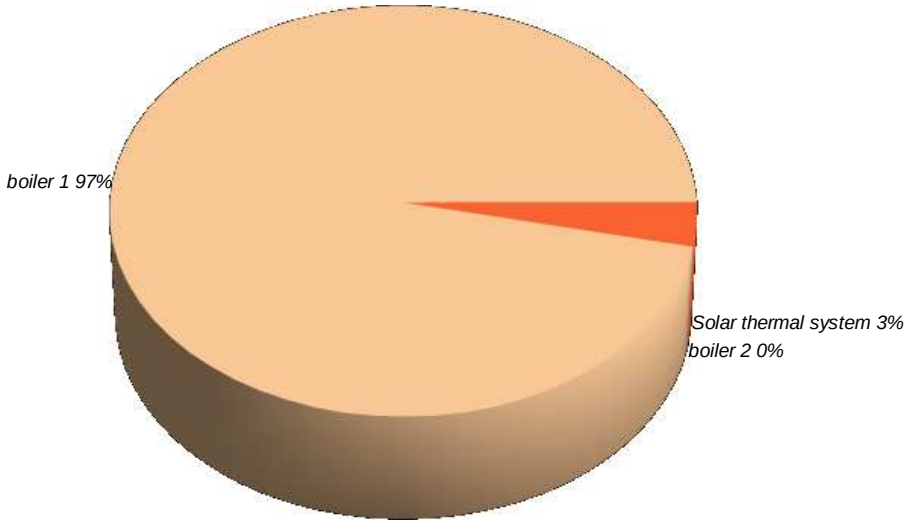

Figure 33: Useful supply heat (USH) by equipment. Proposed final solution

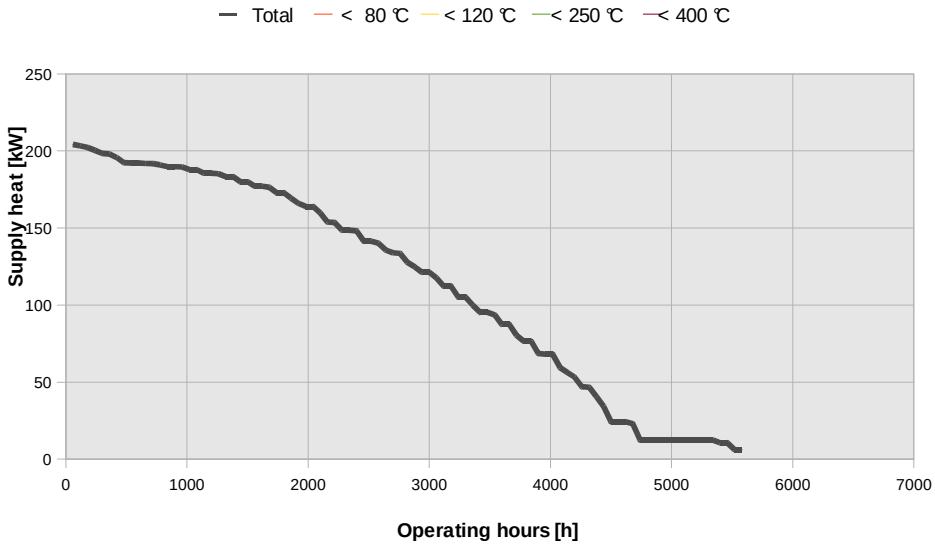

Figure 34: Distribution of supply heat by temperature levels and annual operating hours. Proposed final solution.

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 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% of the investment costs and have to be revised. Investment and installing cost are based on actual cost in Austria and not Bulgaria.

Table 20: Savings of the proposed alternative in comparison to the present state

		Present state	Alternative	Saving	[% savings]
Total primary energy consumption (1)					
- total	[MWh]	908	830	78	9%
- fuels	[MWh]	746	755	-9	-1%
- electricity	[MWh]	162	76	86	53%
Primary energy saving due to renewable energy	[MWh]		78		
CO_2 emissions	[t/a]	197	184	13	6%
Annual energy system cost (2)	[EUR]	25,301	23,565	1,736	7%
Total investment costs	[EUR]		150,850		
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 equipments 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.