Energy Audit Summary Report

AEE INTEC

Audit no. 36 – BUL02

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. 36 – BUL02

1. Data of the auditor

1.1. Contact data of the auditor

Jürgen Fluch, Matthäus Hubmann

Number of audits preformed: 10

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

Levski (Bulgaria)

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

Current primary energy consumption 1,074 [MWh/a]

3.2. Flow sheet of the whole manufacturing side

There is no manufacturing part in the building.

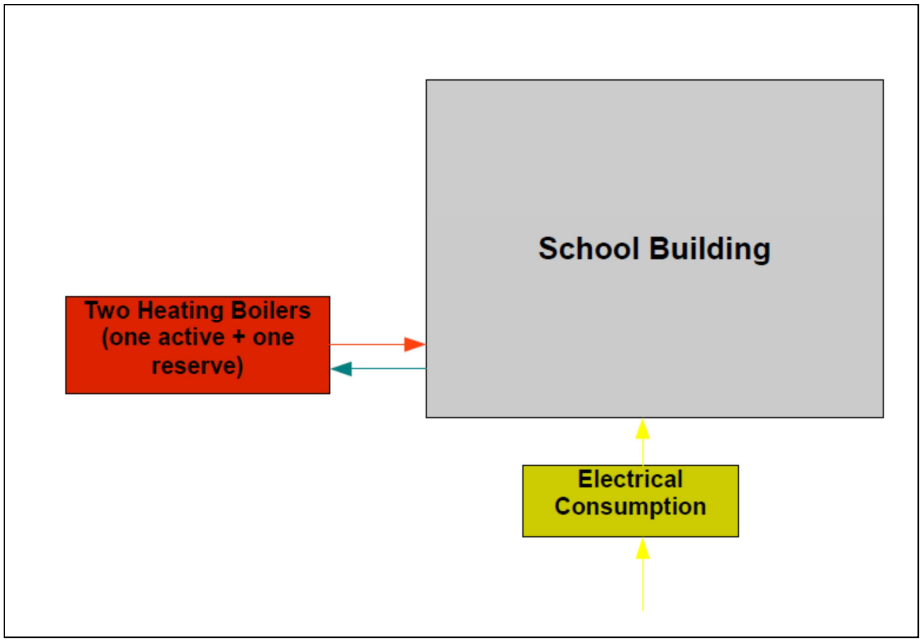


Figure 1: Flow sheet of school

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	543	50.55	543	65.09
Total electricity	531	49.45	291	34.91
Total (fuels + electricity)	**1,074**	**100.00**	**834**	**100.00**

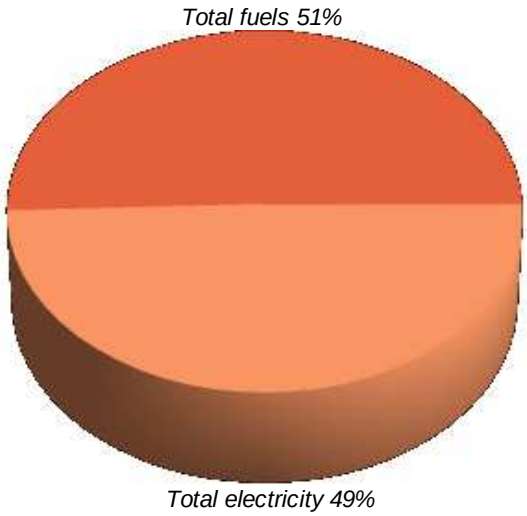


Figure 2: distribution of PEC by fuel type

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	494	73.60	494	83.57
Electricity	177	26.40	97	16.43
Total	671	100.00	591	100.00

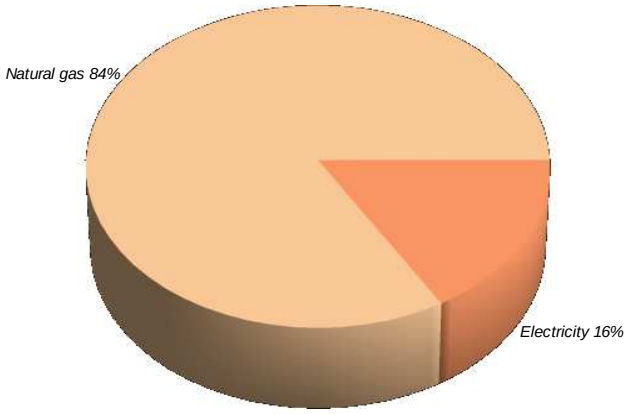


Figure 3: Total final energy consumption for thermal use (FET)

Table 3: Final energy consumption for thermal use (FET) by equipment
Explanation: The big boiler works as an substitution boiler and is therefore not in use

Equipment	Fuel type	FET by equipment	
		[MWh]	[% of Total]
big boiler	Natural gas	0	0.00
small boiler	Natural gas	494	83.57
HW heaters	Electricity	97	16.43
Total		**591**	**100.00**

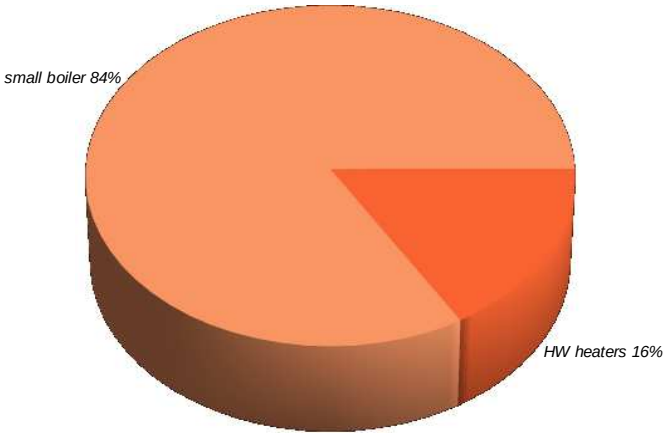


Figure 4: Final energy consumption for thermal use (FET) by equipment

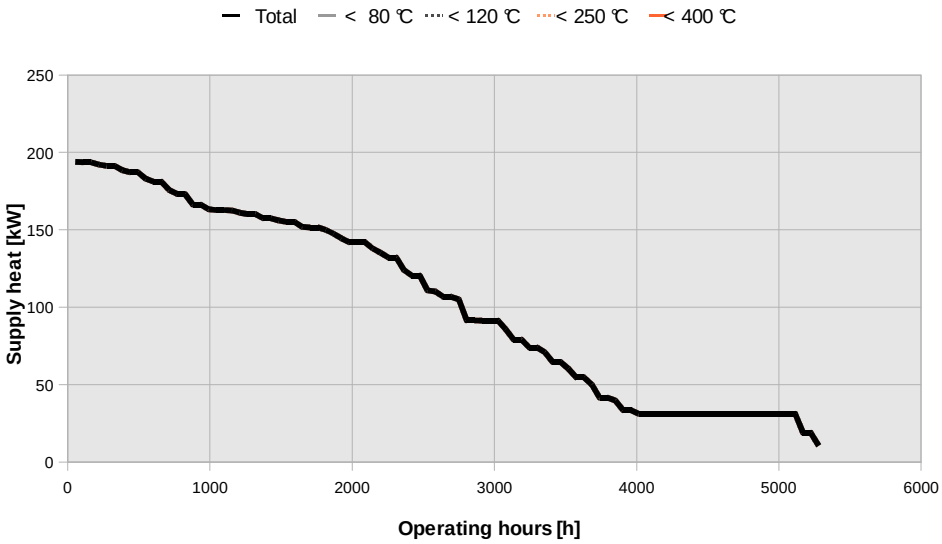


Figure 5: Distribution of supply heat by temperature levels and annual operating hours. Present state.

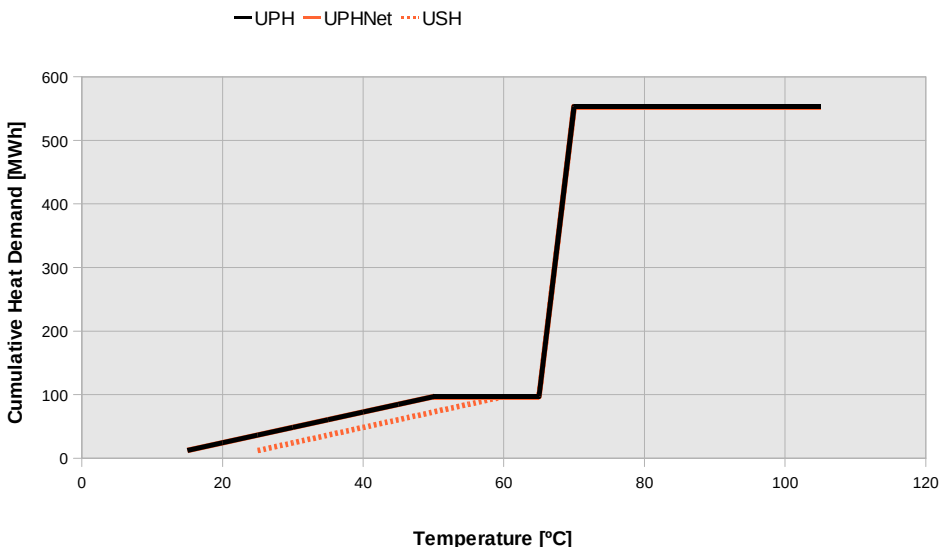


Figure 6: Distribution of the heat demand by temperature levels

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

Equipment	USH by equipment	
	[MWh]	[% of Total]
big boiler	0	0.00
small boiler	456	82.45
HW heaters	97	17.55
Total	**553**	**100.00**

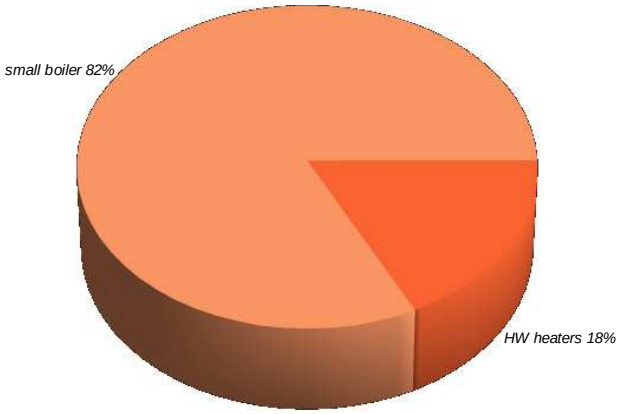


Figure 7: Useful supply heat (USH) by equipment. Present state.

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

Process	Total	Circulation	Maintenance	Start-up
	[MWh]	[MWh]	[MWh]	[MWh]
school_HW	97	97	0	0
school_heating	456	0	456	0
Total	**553**			

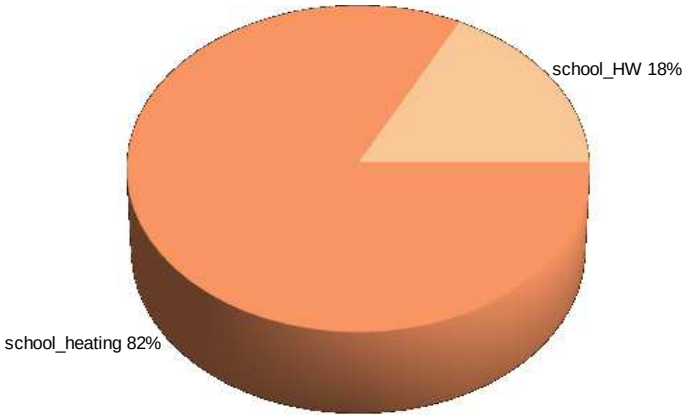


Figure 8: Useful process heat (UPH) by process

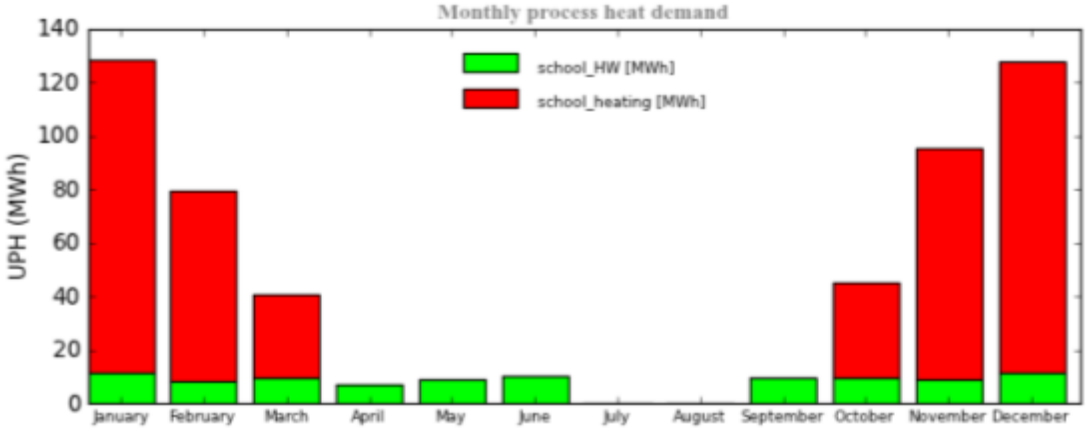


Figure 9: Distribution of useful process heat demand per month

3.4. General

- The target room temperature during winter is 22 °C.
- The hot water demand was estimated to be 8.02 m³ per day which corresponds to a hot water consumption of around 4 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 for hot water generation and in the third one the existing boiler is substituted by a condensing boiler. In the fourth study a new boiler is installed for hot water and heating.

Table 6: Overview of the alternative proposals studied

Short Name	Description
HW by boiler	existing boiler produces also hot water
solar	Solar thermal system produces hot water supported by the existing boiler
New boiler	The existing boiler is substituted by a condensing boiler only supplying the heating demand of the building
HW by new boiler	New boiler supplies heat for heating and hot water

4.1.1. Heat Supply

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

Type of boiler	gas boiler
Nominal power	290 kW
Thermal efficiency	0.924
Operating hours	5,316 h

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

Equipment	Nominal capacity	Contribution to total heat and cooling supply	
	[kW]	[MWh]	[%]
small boiler	290	553	100.00
big boiler	1,040	0	0.00
HW heaters	150	0	0.00
Total	**1,480**	**553**	**200**

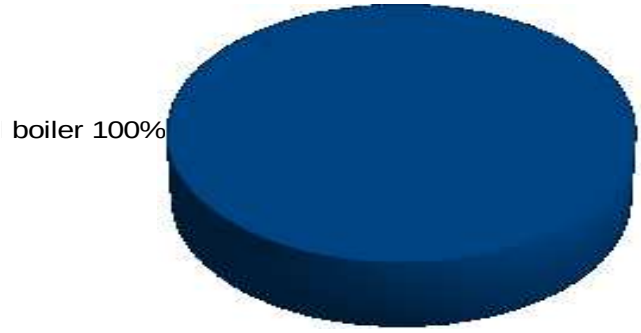
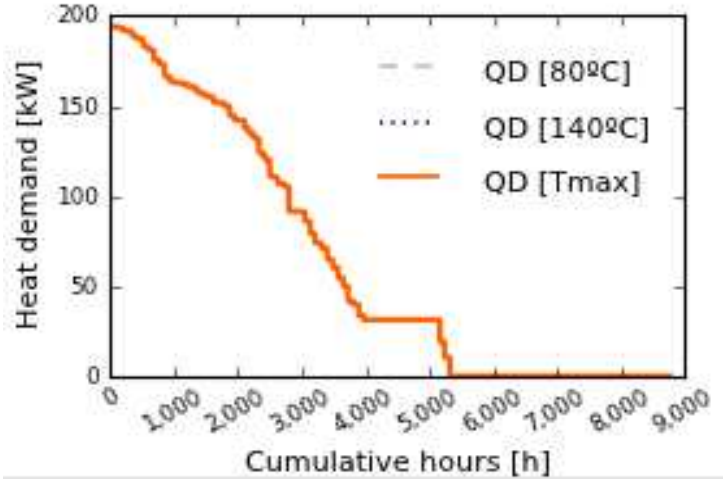


Figure 10: Contribution of each equipment to the total useful heat supply (USH).

- graphic: heat demand covered by boilers



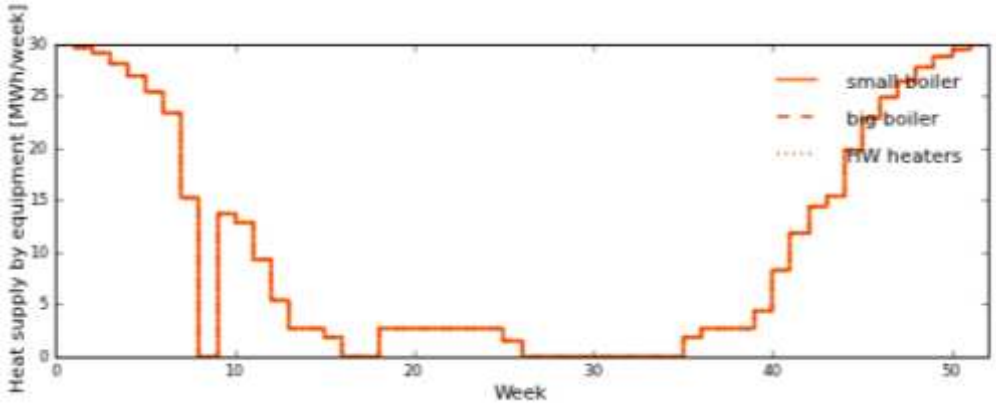


Figure 11: Daily heat supply by equipment

- **Solar thermal:**

Collector type:	FPC (flat plate collectors)
Installed capacity:	246 kW
Installed collector area:	352 m²
Solar buffer storage volume:	17.6 m³
Solar fraction:	75.77 %
Annual energy yield:	298.5 kWh/kWa

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

Equipment	Nominal capacity	Contribution to total heat and cooling supply	
	[kW]	[MWh]	[%]
Solar thermal system	246	74	13.30
big boiler	1,040	456	82.45
small boiler	290	24	4.25
Total	**1,576**	**553**	**200**

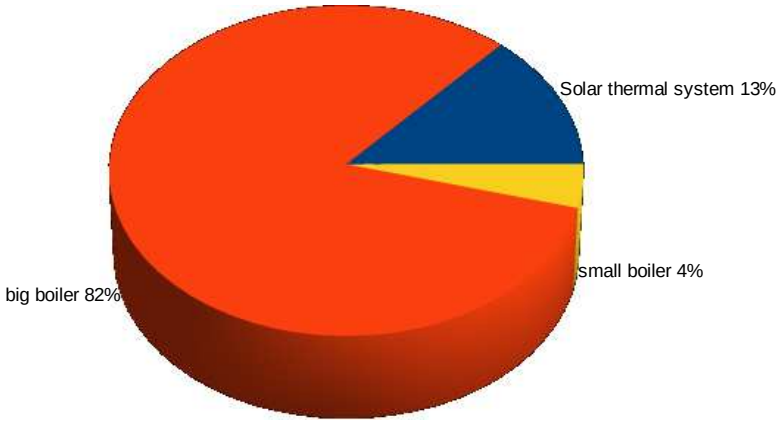


Figure 12: Contribution of each equipment to the total useful heat supply (USH).

- graphic: heat demand covered by solar:

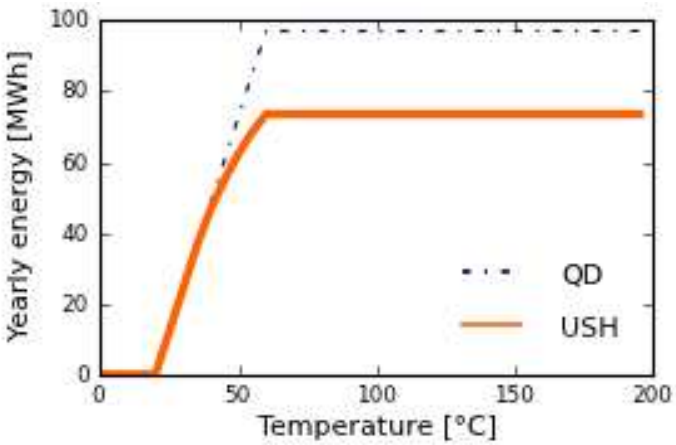


Figure 13: Heat demand and solar contribution

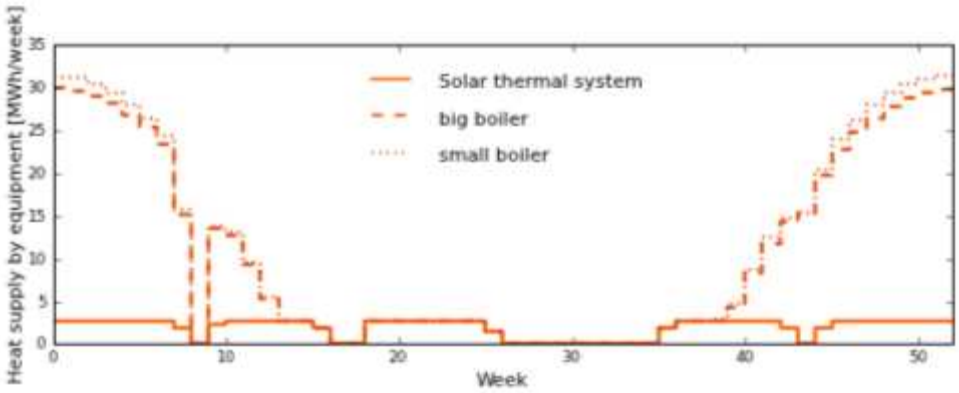


Figure 14: Daily heat supply by equipment

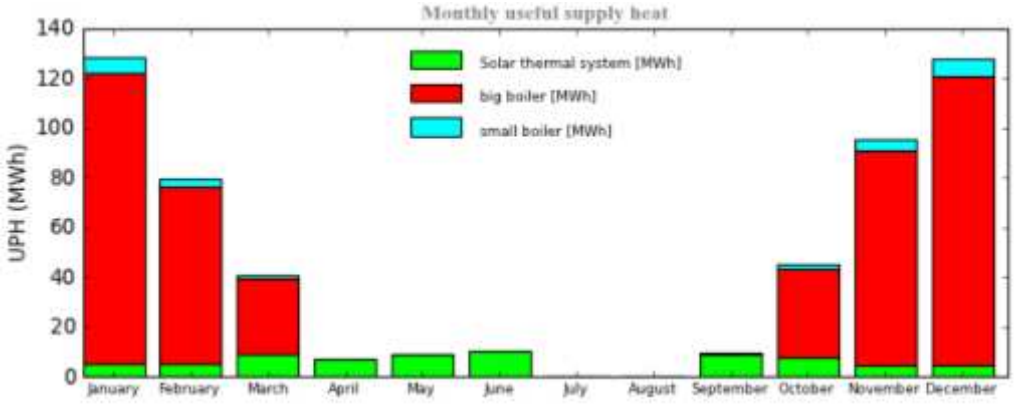


Figure 15: Distribution of useful process heat supply per month

- **New Boiler**

Type of boiler	condensing boiler
Nominal power	200 kW
Thermal efficiency	1.13
Operating hours	4,128 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	150	97	17.55
New boiler 2	200	456	82.45
Total	**350**	**553**	**200**

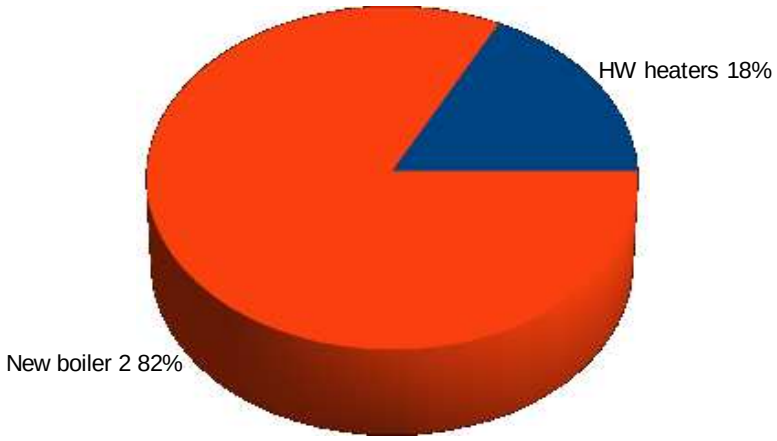


Figure 16: Contribution of each equipment to the total useful heat supply (USH).

- graphic: heat demand covered by boilers

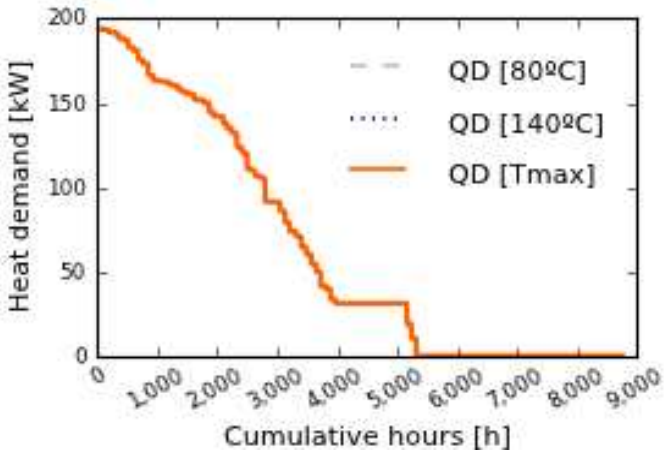


Figure 17: Cumulative heat demand to be covered by boilers

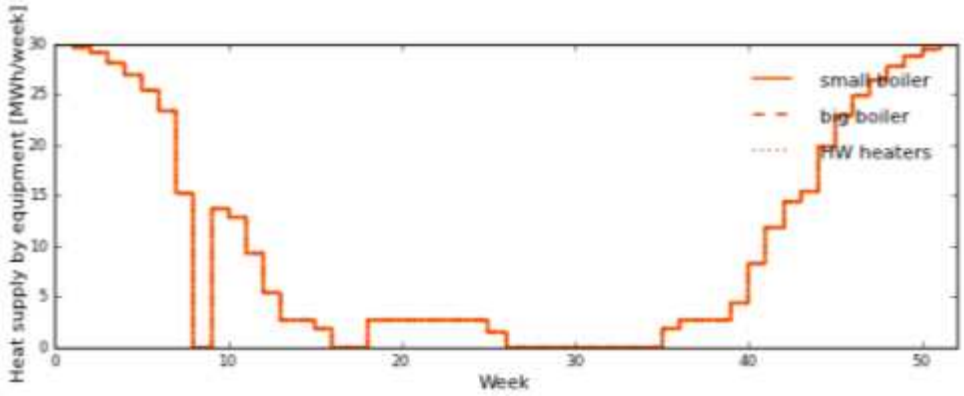


Figure 18: Daily heat supply by equipment

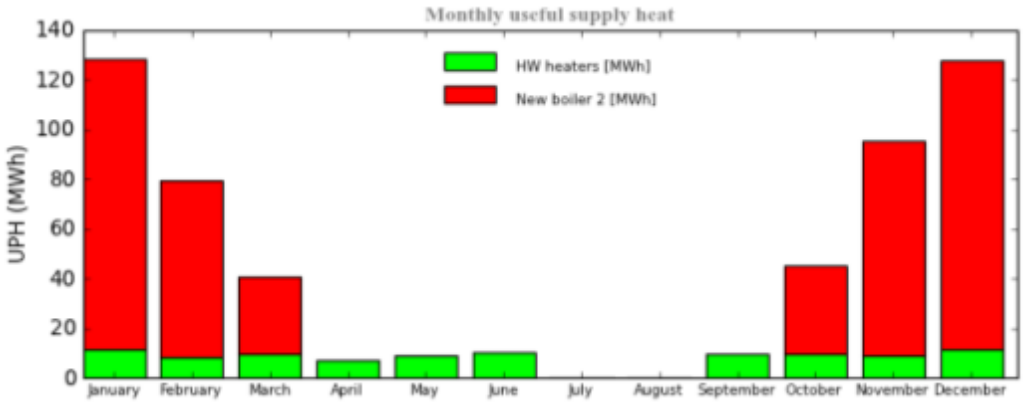


Figure 19: Distribution of useful process heat supply per month

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

Type of boiler	gas boiler
Nominal power	200 kW
Thermal efficiency	1.13
Operating hours	5,316 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 2	200	553	100.00
HW heaters	150	0	0.00
Total	**350**	**553**	**200**

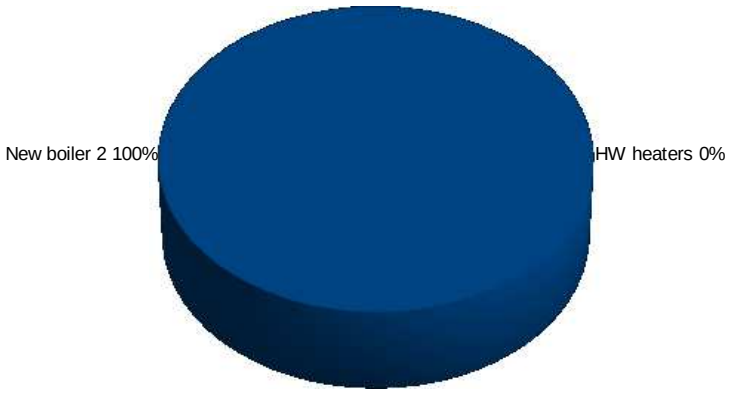


Figure 20: Contribution of each equipment to the total useful heat supply (USH).

- graphic: heat demand covered by boilers

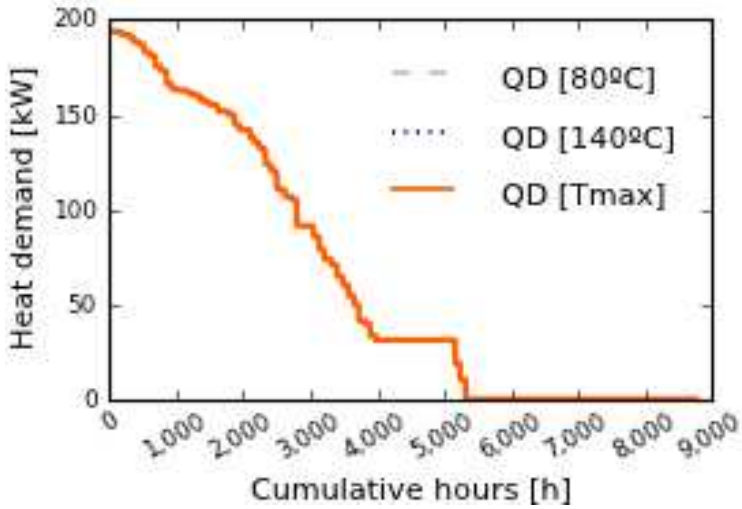


Figure 21: Cumulative heat demand to be covered by boilers

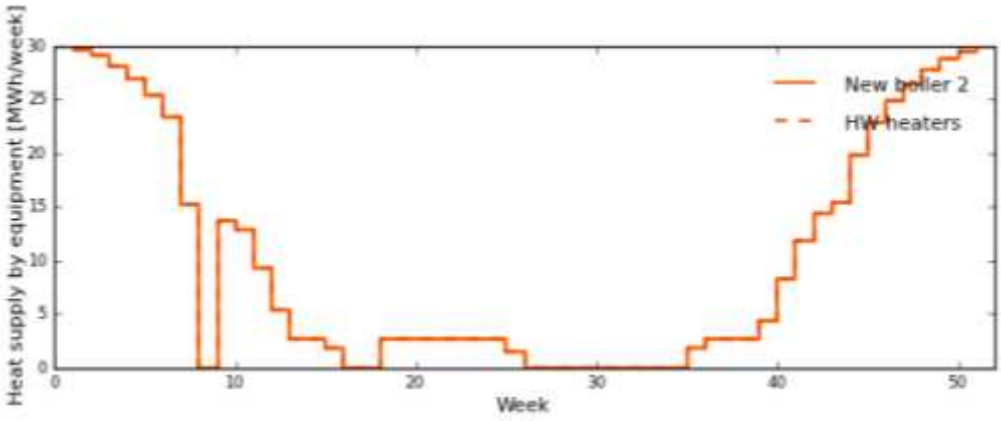


Figure 22: Daily heat supply by equipment

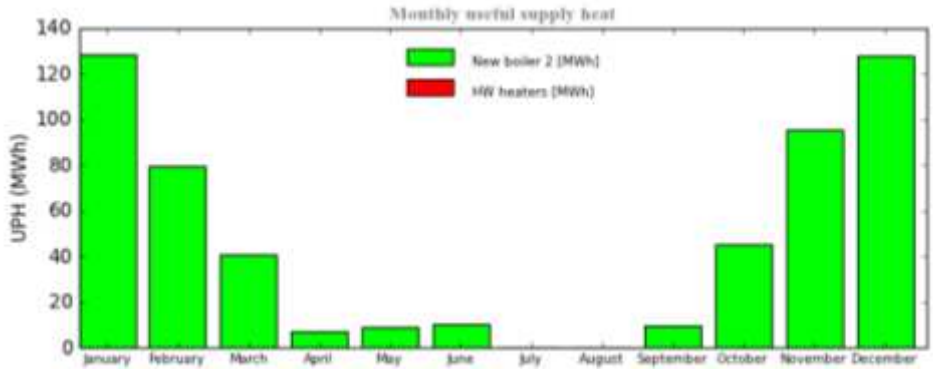


Figure 23: Distribution of useful process heat supply per month

- Primary energy consumption (PEC)

Table 11: primary energy consumption and savings

Alternative	Primary energy consumption	Savings	
	[MWh]	[MWh]	[%]
Present State (checked)	1,074	---	---
HW by boiler	899	176	16.35
solar	804	270	25.16
New boiler	987	87	8.09
HW by New boiler	793	281	26.16

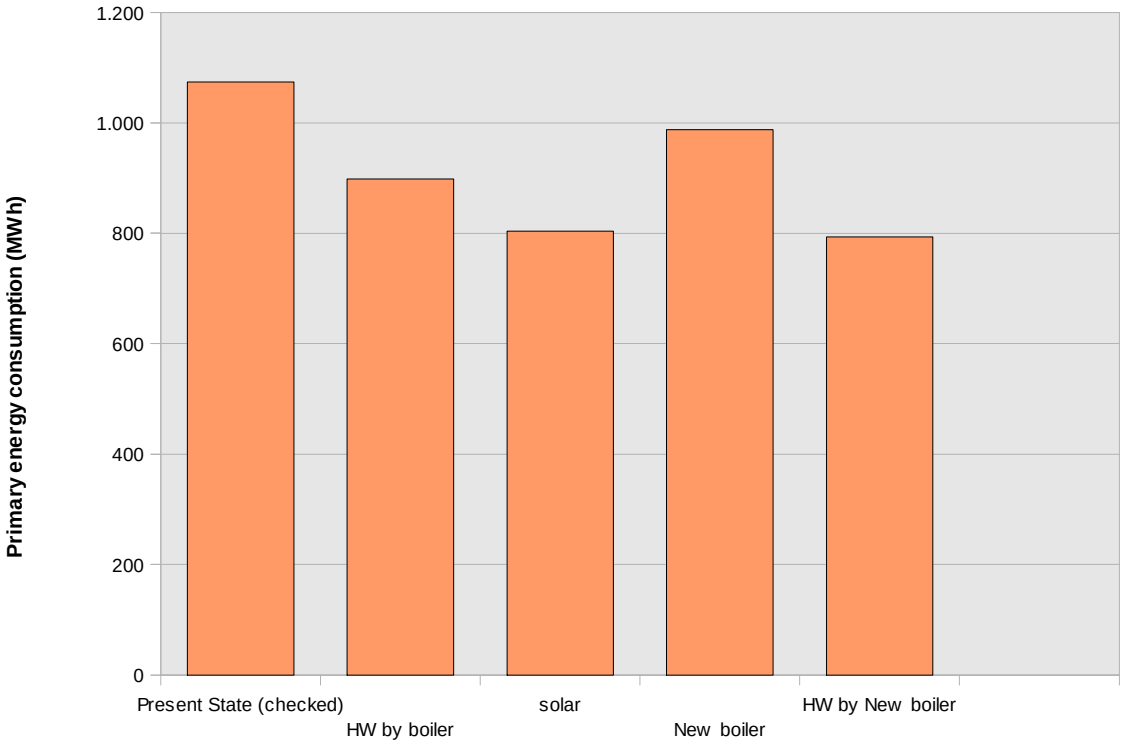


Figure 24: Comparison of alternatives: primary energy consumption

- 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) [MWh]	Savings UPH [MWh]	Useful supply heat (USH) [MWh]	Savings USH [MWh]
Present State (checked)	553	---	553	---
HW by boiler	553	0	553	0
solar	553	0	553	0
New boiler	553	0	553	0
HW by New boiler	553	0	553	0

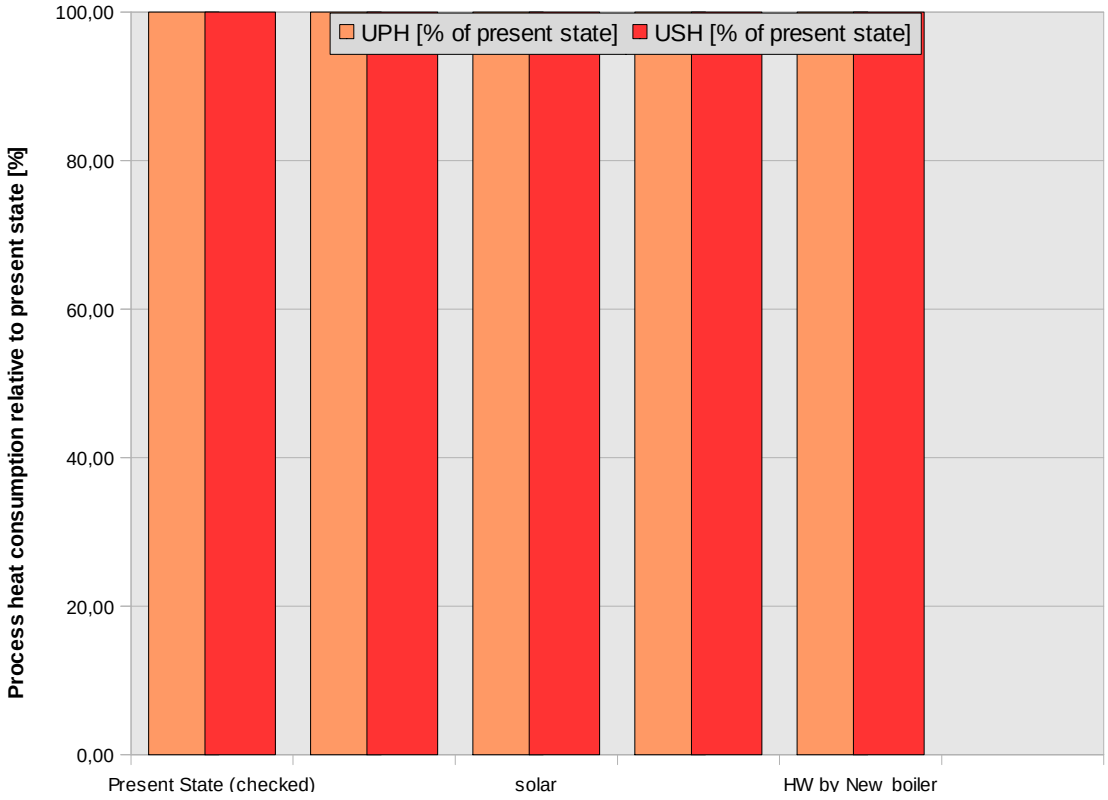


Figure 25: Comparison of alternatives: useful process heat supply

- Environmental impact

Table 13: CO2 Production and CO2 savings per year

Alternative	Production of CO2	Water consumption
	[t]	[m3]
Present State (checked)	211.95	0.00
HW by boiler	189.68	0.00
solar	168.05	0.00
New boiler	191.47	0.00
HW by New boiler	164.84	0.00

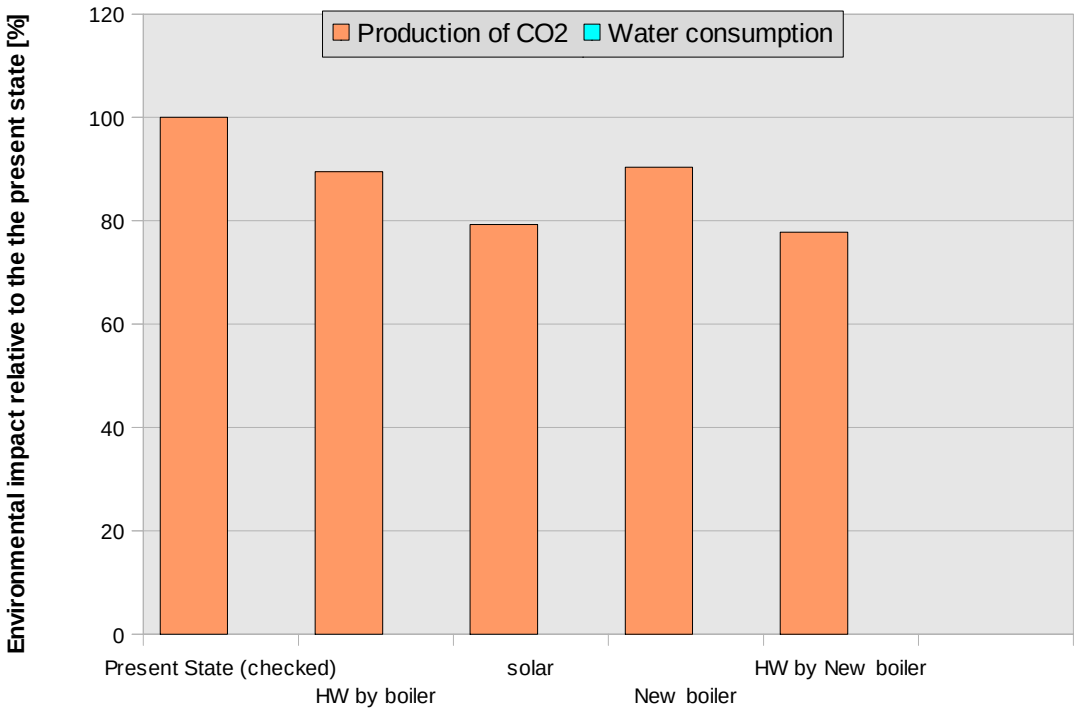


Figure 26: Comparison of alternatives: environmental impact

Table 14: Investment costs and subsidies of the proposals

Alternative	Total investment [€]	Own investment [€]	Subsidies [€]
Present State (checked)	---	---	---
HW by boiler	100,000	100,000	0
solar	258,400	180,880	77,520
New boiler	20,850	20,850	0
HW by New boiler	120,850	120,850	0

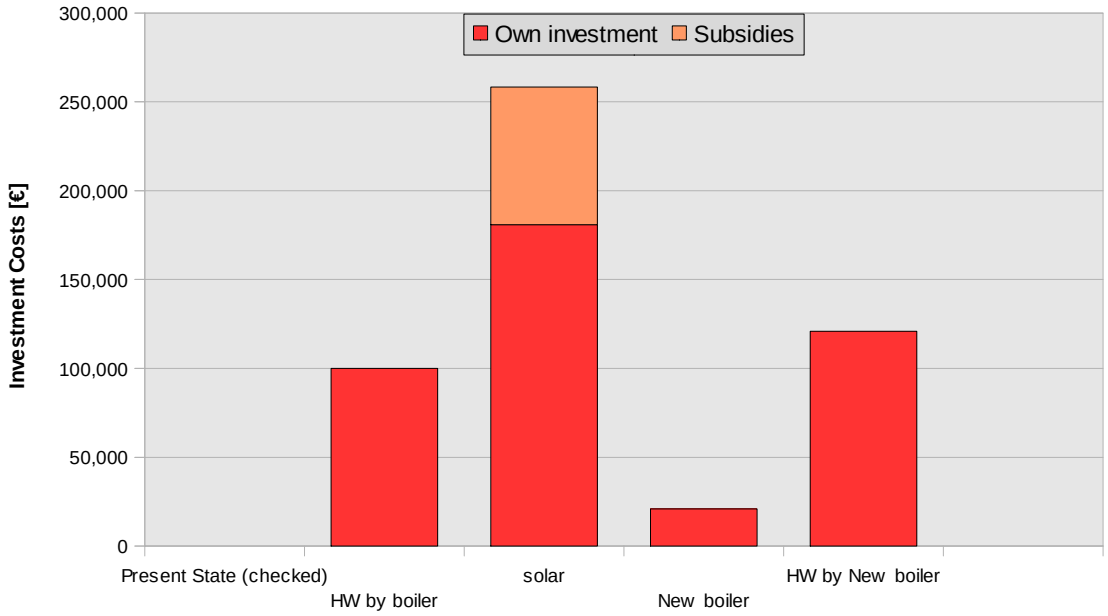


Figure 27: Comparison of alternatives: investment cost

5. Selected alternative(s) and conclusions

5.1. Selected alternative

As selected alternative the "solar" proposal has been chosen, because it has a short payback period and high CO2 savings per year.

5.1.1. Process optimisation

None

5.1.2. Heat Supply

Solar thermal:

Collector type:	FPC (flat plate collectors)
Installed capacity:	246 kW
Installed collector area:	352 m²
Solar buffer storage volume:	17.6 m³
Solar fraction:	75.77 %
Annual energy yield:	298.5 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	246	74	13.30
big boiler	1,040	456	82.45
small boiler	290	24	4.25
Total	**1,576**	**553**	**200**

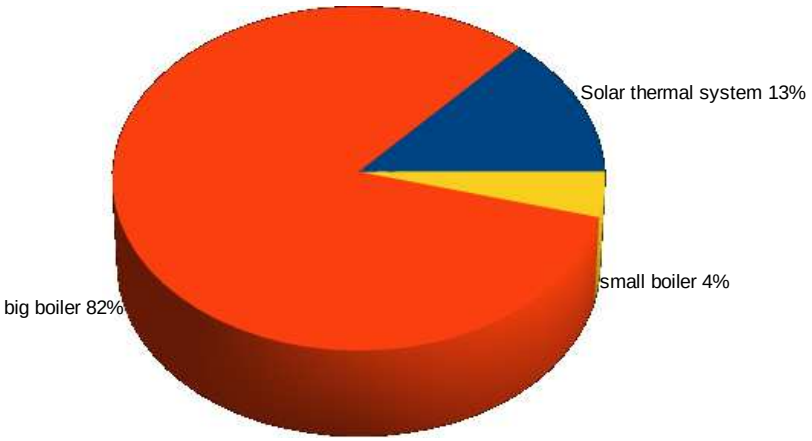


Figure 28: Contribution of each equipment to the total useful heat supply (USH

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	562	69.87	562	99.61
Total electricity	242	30.13	2	0.39
Total (fuels + electricity)	**804**	**100.00**	**564**	**100.00**

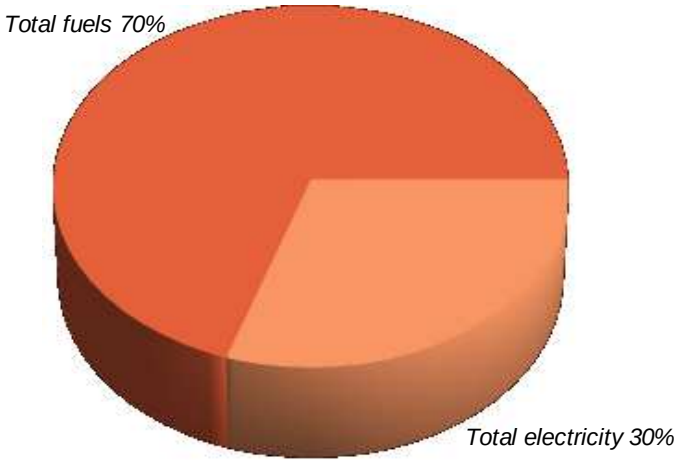


Figure 29: Distribution of PEC by fuel type

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	511	86.35	511	99.86
Electricity	81	13.65	1	0.14
Total	591	100.00	511	100.00

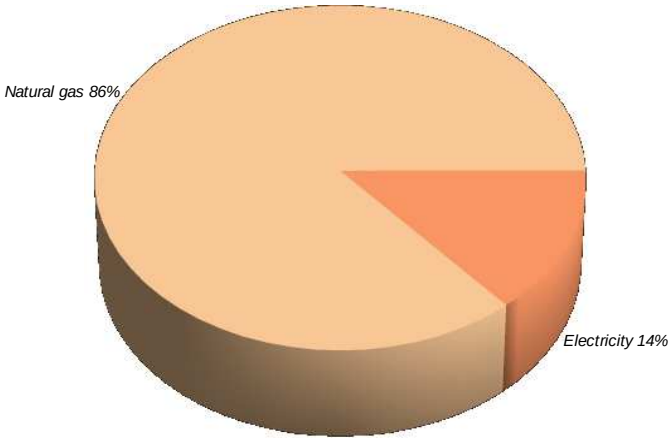


Figure 30: Total final energy consumption (FEC). Proposed final solution.

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

Equipment	Fuel type	FET by equipment	
		[MWh]	[% of Total]
big boiler	Natural gas	485	94.88
small boiler	Natural gas	25	4.98
Solar thermal system	Electricity	1	0.14
Total		**511**	**100**

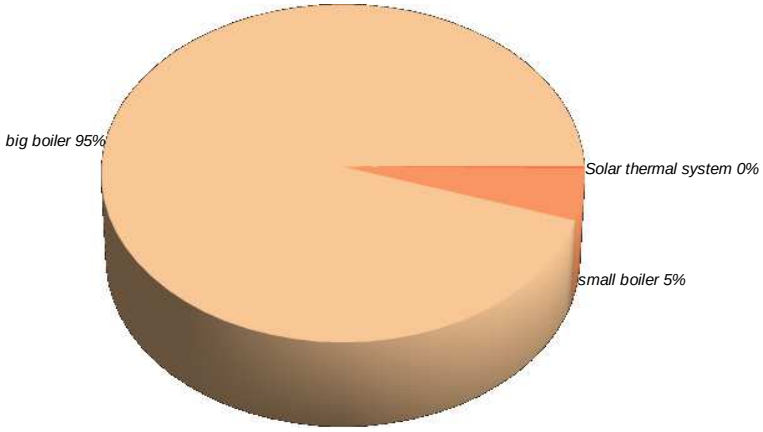


Figure 31: Final energy consumption for thermal use (FET) by equipment

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

Equipment	USH by equipment	
	[MWh]	[% of Total]
big boiler	456	82.45
small boiler	24	4.25
Solar thermal system	74	13.30
Total	**553**	**100**

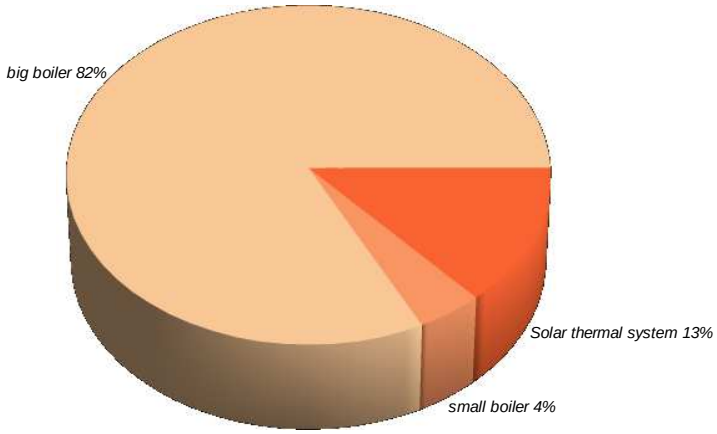


Figure 32: Useful supply heat (USH) by equipment. Proposed final solution

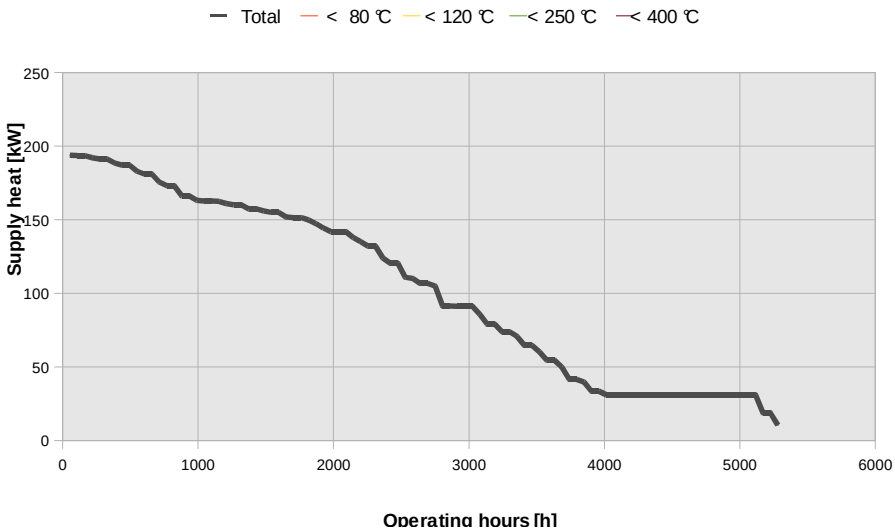


Figure 33: Distribution of supply heat by temperature levels and annual operating hours. Proposed final solution.

5.2. Comparative study and conclusions

5.2.1. Energy and environmental analysis

In the proposed alternative around 13 % 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% of the investment costs and have to be revised. Investment and installing cost are based on actual costs 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]	1,074	804	270	25%
- fuels	[MWh]	543	562	-19	-3%
- electricity	[MWh]	531	242	289	54%
Primary energy saving due to renewable energy	[MWh]				
CO_2 emissions	[t/a]	212	168	44	21%
Annual energy system cost (2)	[EUR]	81,122	57,168	23,954	30%
Total investment costs	[EUR]		258,400		
Payback period (3)	[years]		5		

(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.