Energy Audit Summary Report

AEE INTEC

Audit no. 50 – BUL08

Mushroom Factory

15th of March 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. 50 - BUL08

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: 15.03.2012

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 2010.

3.1. General information of the company

Sector	Mushroom Factory
Products	Mushrooms
No. of employees	n.a. (not available)

Current primary energy consumption 258 [MWh/a]

3.2. Flow sheet of the whole manufacturing side

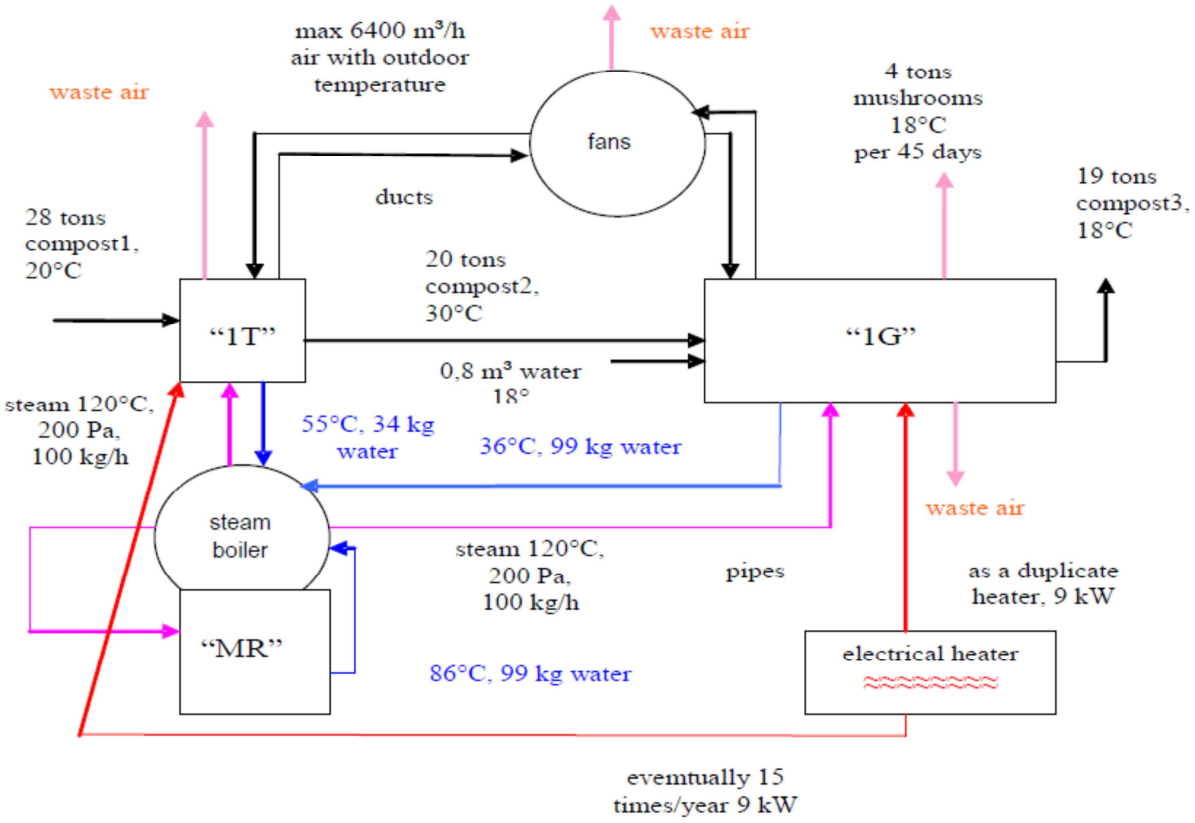

Figure 1: Flow sheet of the factory

3.3. Description of the existing system

- **Energy Supply:**

The factory is mainly consuming energy for heating purposes during the production. In addition it has electrical consumption for heating in winter and ventilation purposes.

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	198	76.74	198	76.74
Total electricity	60	23.26	60	23.26
Total (fuels + electricity)	**258**	**100.00**	**258**	**100.00**

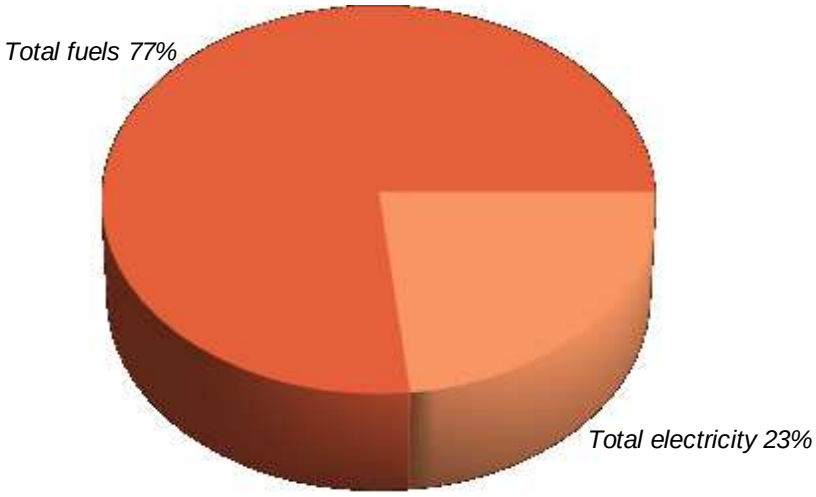

Figure 2: distribution of PEC by fuel type

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	180	90.00	180	90.00
Electricity	20	10.00	20	10.00
Total	200	100.00	200	100.00

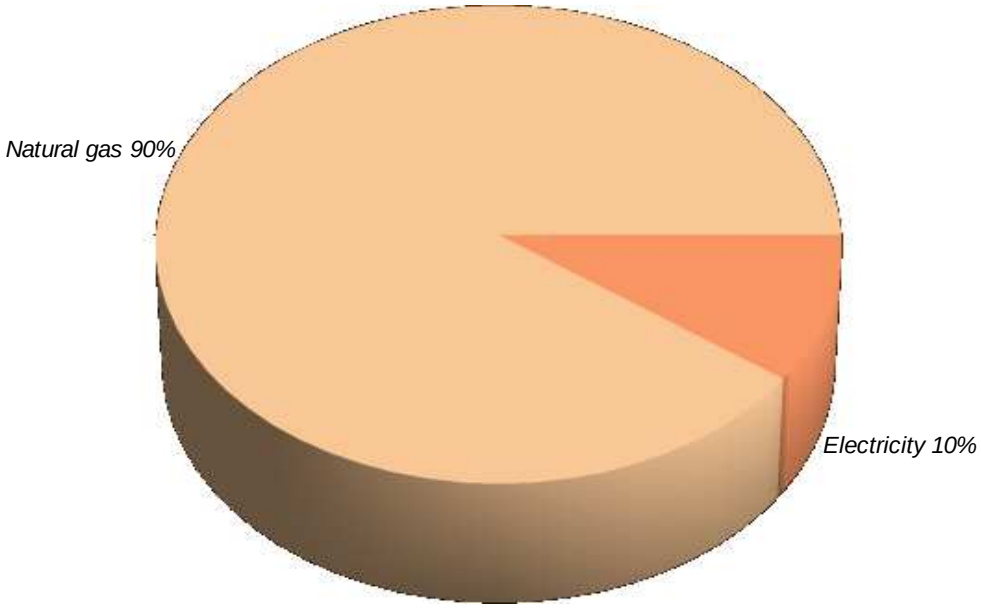

Figure 3: Total final energy consumption for thermal use (FET)

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

Equipment	Fuel type	FET by equipment	
		[MWh]	[% of Total]
steam boiler	Natural gas	180	90.00
fans	Electricity	10	4.90
electrical heaters	Electricity	10	5.10
Total		**200**	**100.00**

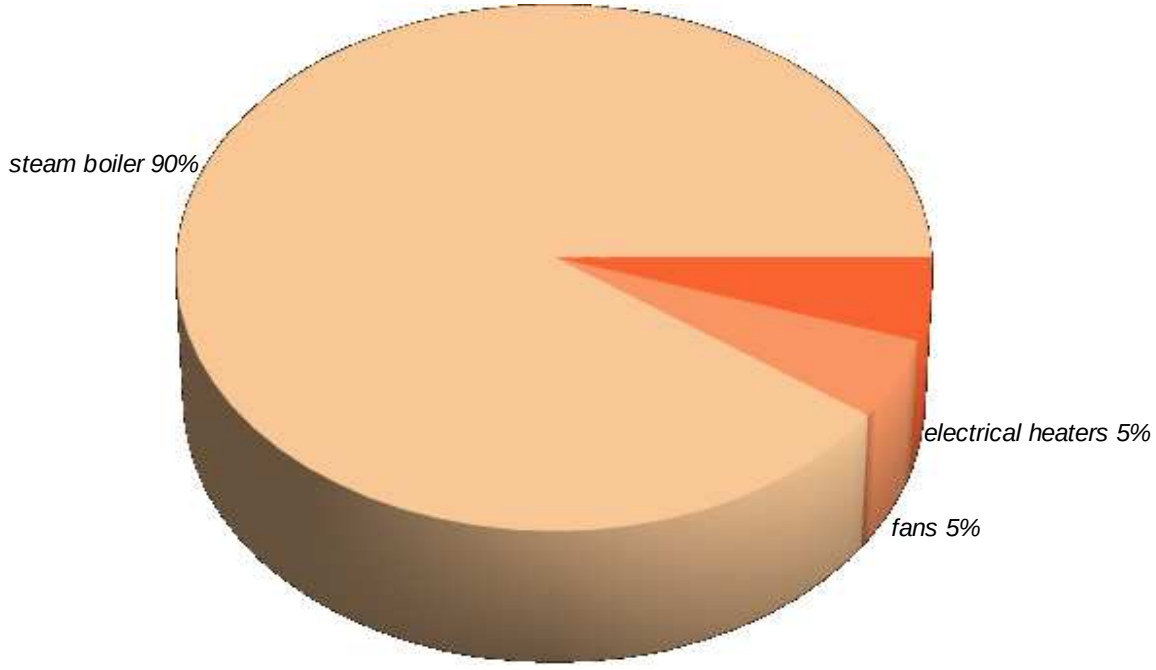

Figure 4: Final energy consumption for thermal use (FET) by equipment

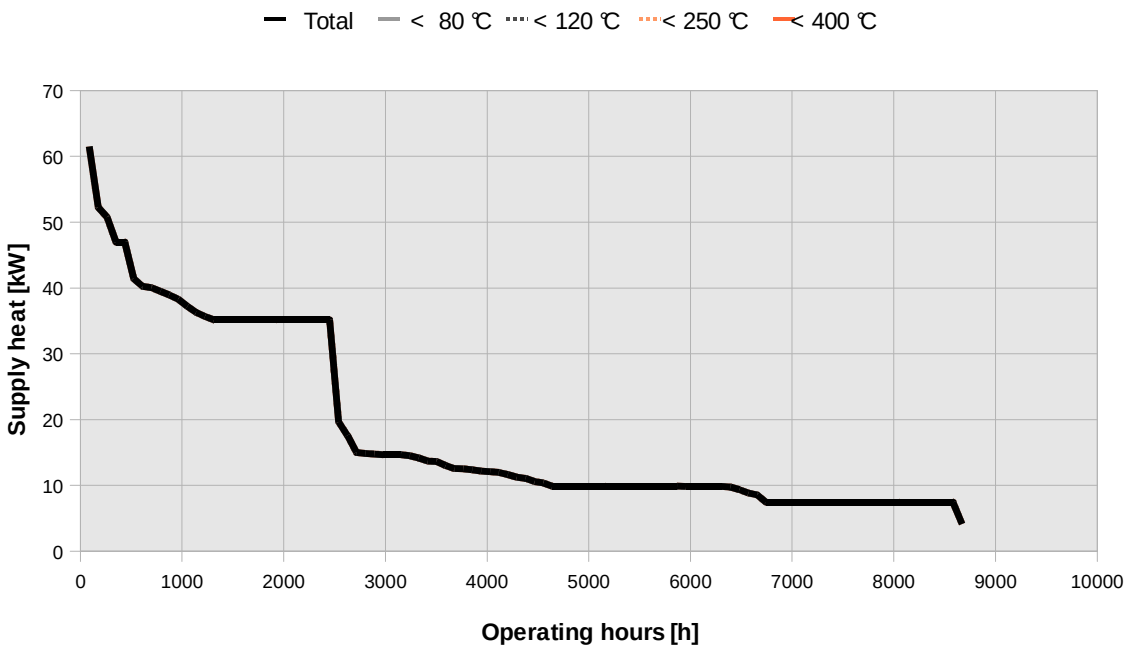

Figure 5: Distribution of supply heat by temperature levels and annual operating hours. Present state.

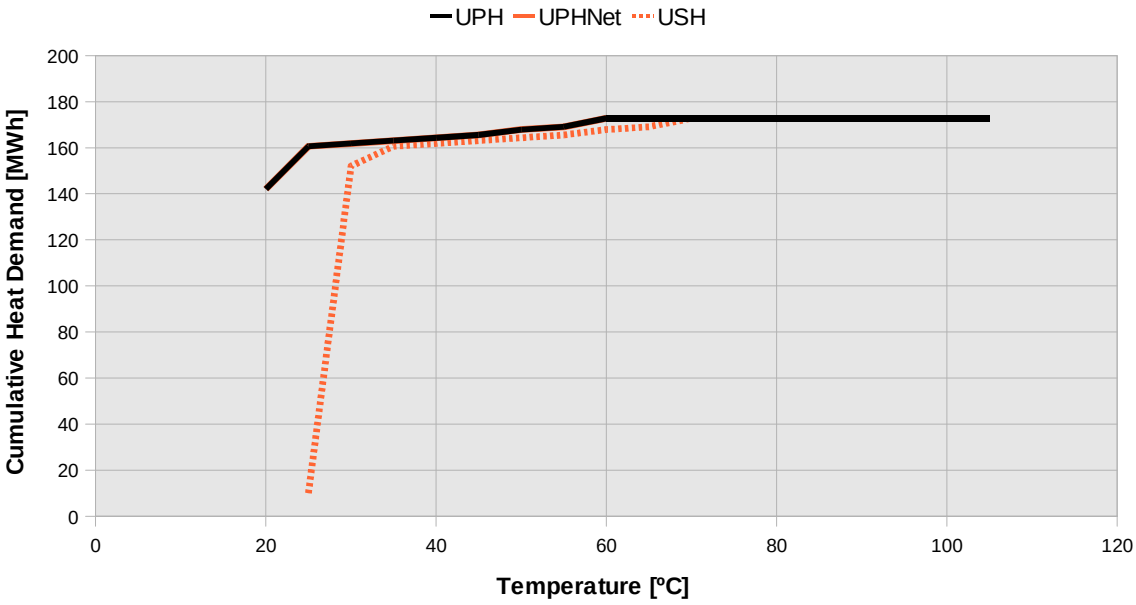

Figure 6: Distribution of the heat demand by temperature levels

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

Equipment	USH by equipment	
	[MWh]	[% of Total]
steam boiler	153	88.54
fans	10	5.67
electrical heaters	10	5.79
Total	**173**	**100.00**

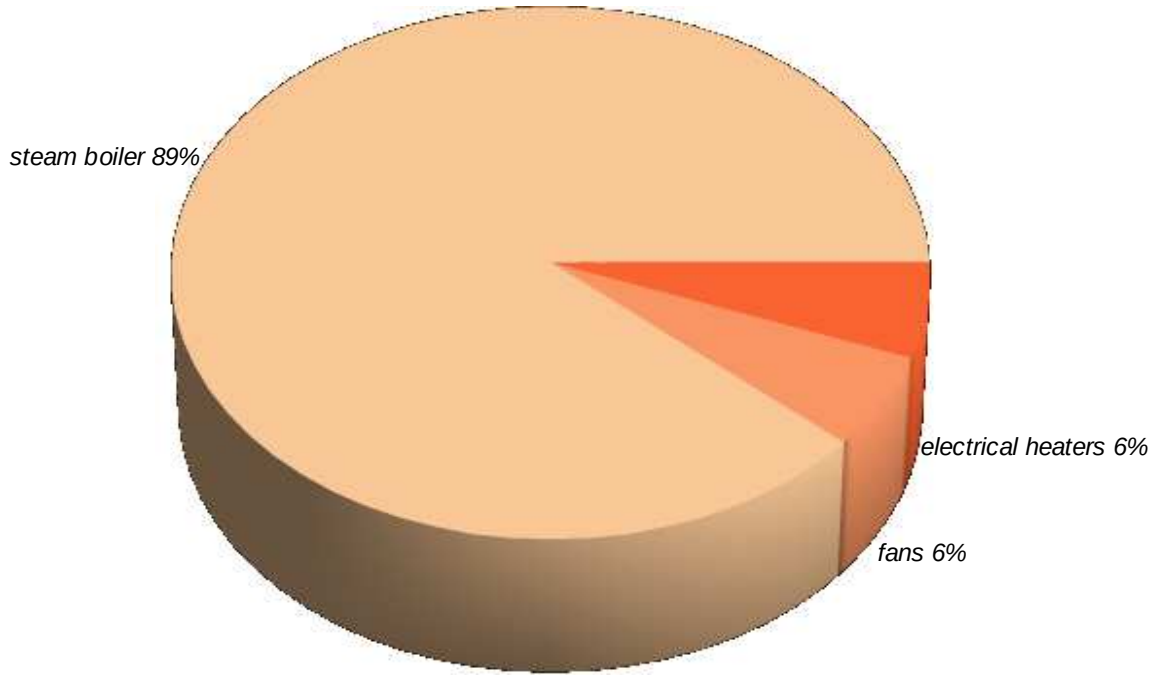

Figure 7: Useful supply heat (USH) by equipment. Present state

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

Process	Total	Circulation	Maintenance	Start-up
	[MWh]	[MWh]	[MWh]	[MWh]
pII-compost heating	11	10	1	0
pII-compost pasteurization	2	1	0	0
pII-compost holding temperature	1	1	0	0
pII-2.stage	7	1	6	0
pII-3.stage	59	1	58	0
pII-4.stage	15	2	12	0
pII-5.stage	59	4	55	0
ventilation	10	5	5	0
building_heating	10	0	10	0
Total	**173**			

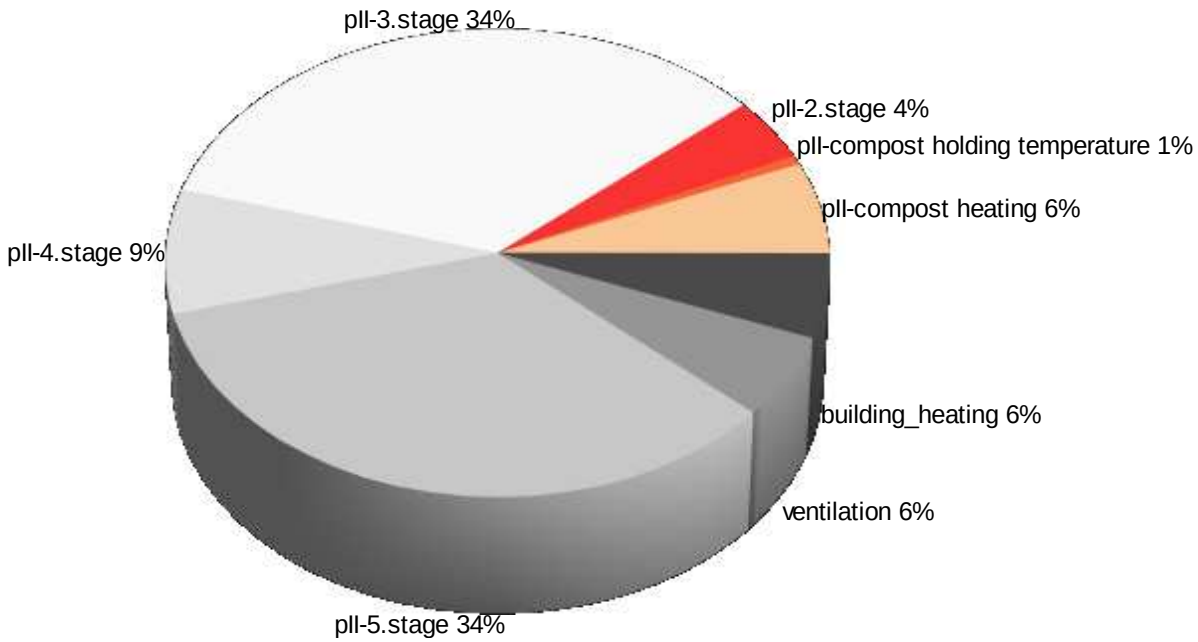

Figure 8: Useful process heat (UPH) by process

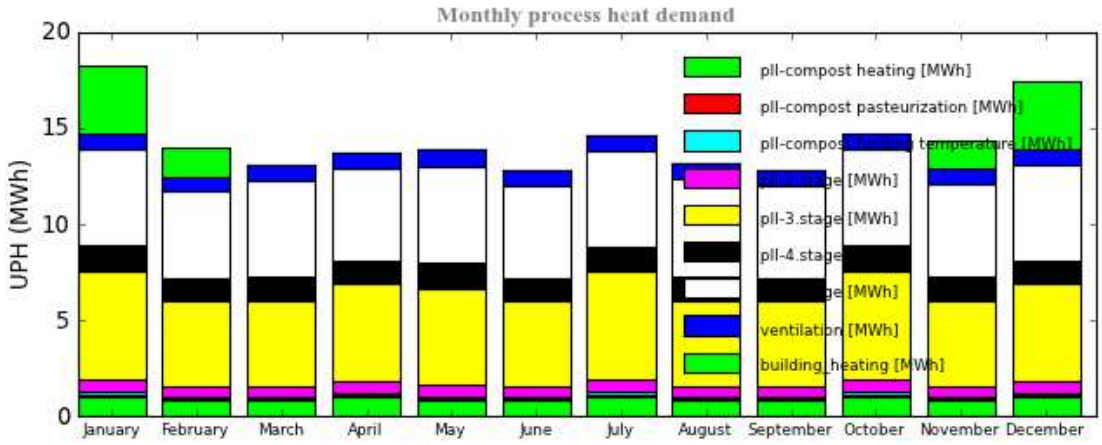

Figure 9: Distribution of useful process heat demand per month

3.4. General

- The target room temperature during winter is 25 °C for the production hall and 15 °C for the storage room.
- The hot water demand was estimated to be 0.3 m³ per day.

4. Comparative study

4.1. Proposed alternatives

There are three proposals made in this study. In the first proposal a solar thermal system is installed using flat plate collectors. The second proposal is a solar thermal system using evacuated tube collectors. The third proposal focuses on the installation of a new CHP (combined heat and power plant).

Table 6: Overview of the alternative proposals studied

Short Name	Description
solar FPC	based on present state a solar thermal system with flat plate collectors (FPC) is suggested
solar ETC	based on present state a solar thermal system with evacuated tube collectors (ETC) is suggested
CHP (ORC)	based on present state the installation of an CHP (combined heat and power) plant is suggested

4.1.1. Heat Supply

- **Solar (FPC):**

Collector type:	FPC (flat plate collectors)
Installed capacity:	117.6 kW
Installed collector area:	167 m²
Solar buffer storage volume:	8.4 m³
Solar fraction:	50.33 %
Annual energy yield:	739.52 kWh/kWa

Table 7: 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	118	87	50.33
steam boiler	250	76	44.08
fans	2	3	1.92
electrical heaters	9	6	3.67
Total	**378**	**173**	**200**

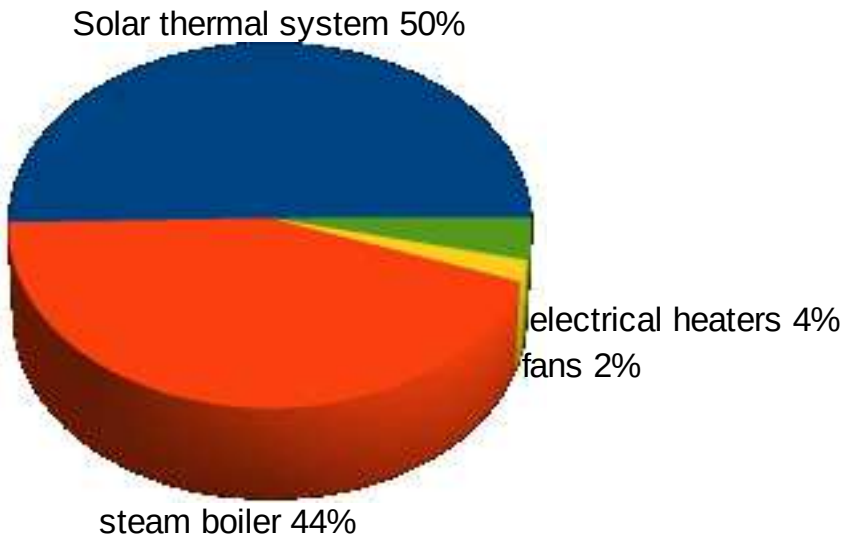

Figure 10: Contribution of each equipment to the total useful heat and useful cooling supply (USH & USC).

- graphic: heat demand covered by solar thermal system:

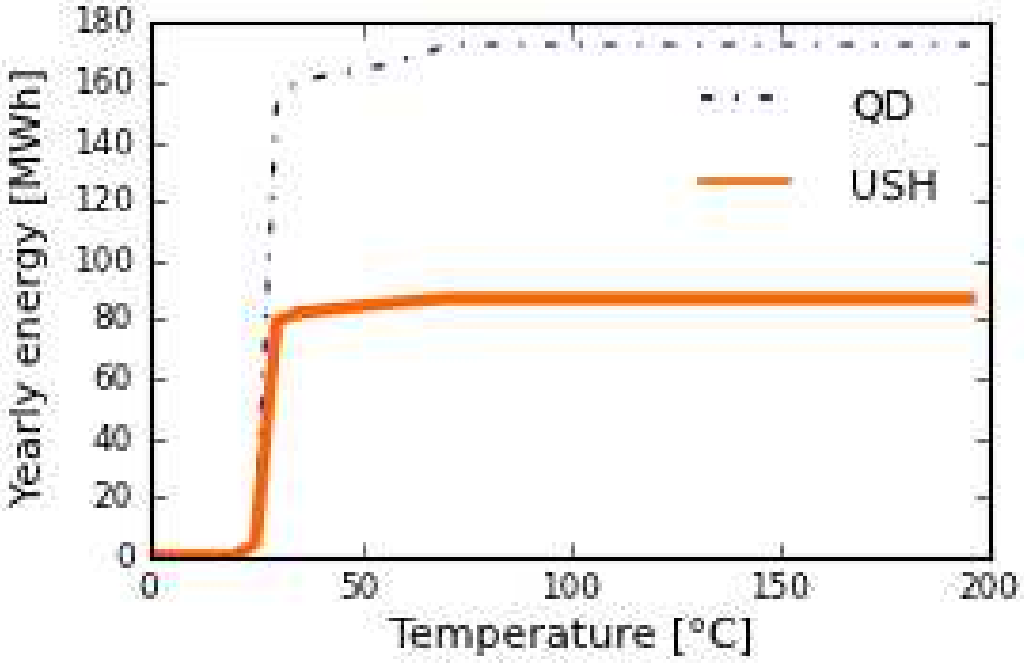

Figure 11: Heat demand and solar contribution

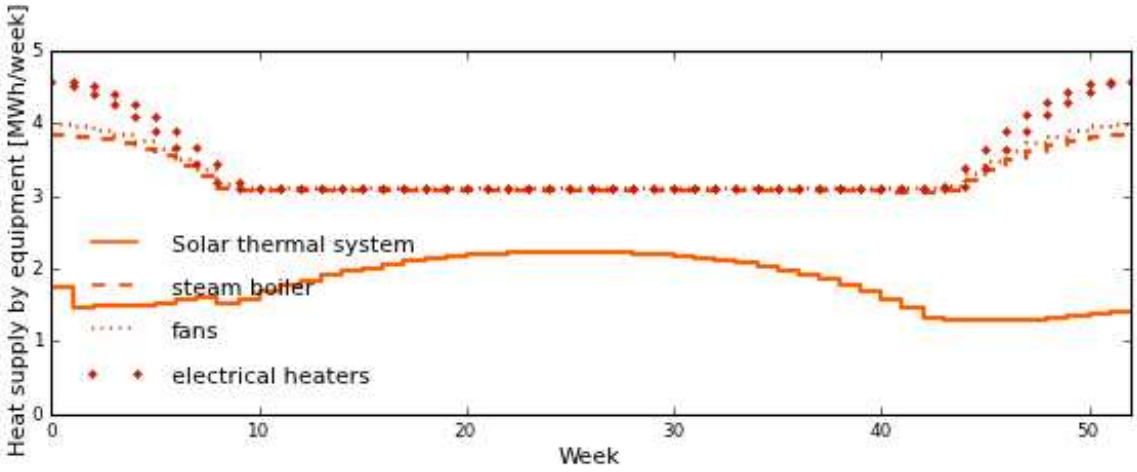

Figure 12: Daily heat supply by equipment

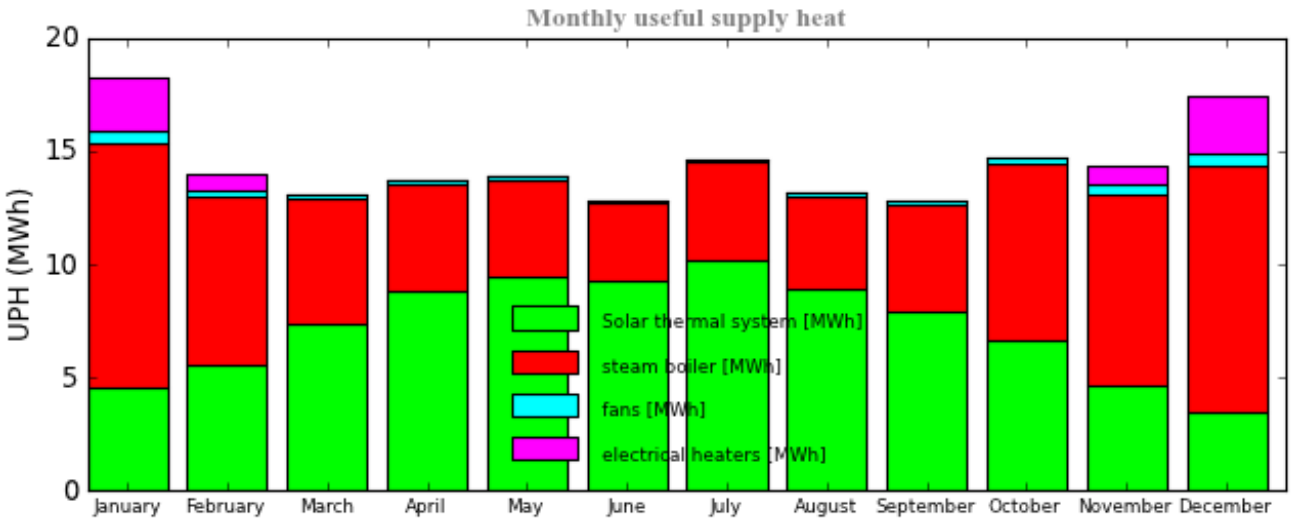

Figure 13: Distribution of useful process heat supply per month

- **Solar (ETC):**

Collector type:	ETC (Evacuated Tube Collectors)
Installed capacity:	81.9 kW
Installed collector area:	116 m²
Solar buffer storage volume:	5.85 m³
Solar fraction:	50.16 %
Annual energy yield:	1,058.24 kWh/kWa

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]	[%]
Solar thermal system	82	87	50.16
steam boiler	250	77	44.30
fans	2	3	1.91
electrical heaters	9	6	3.62
Total	**342**	**173**	**200**

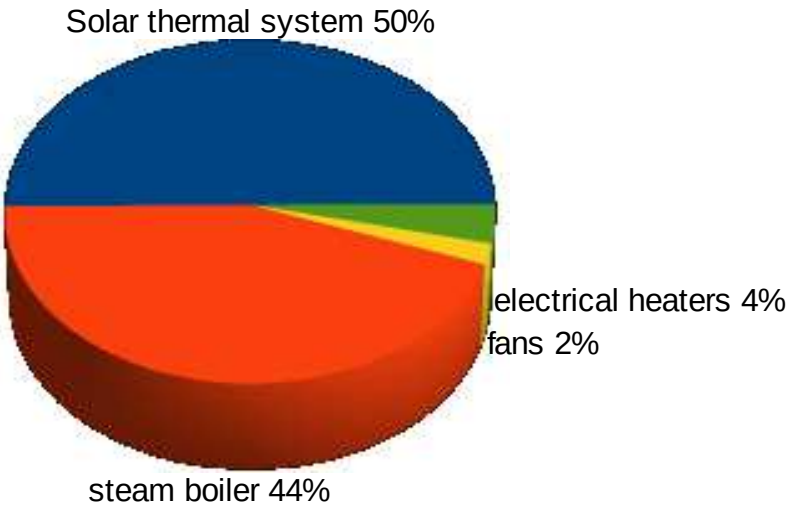

Figure 14: Contribution of each equipment to the total useful heat and useful cooling supply (USH & USC).

- graphic: heat demand covered by solar thermal system:

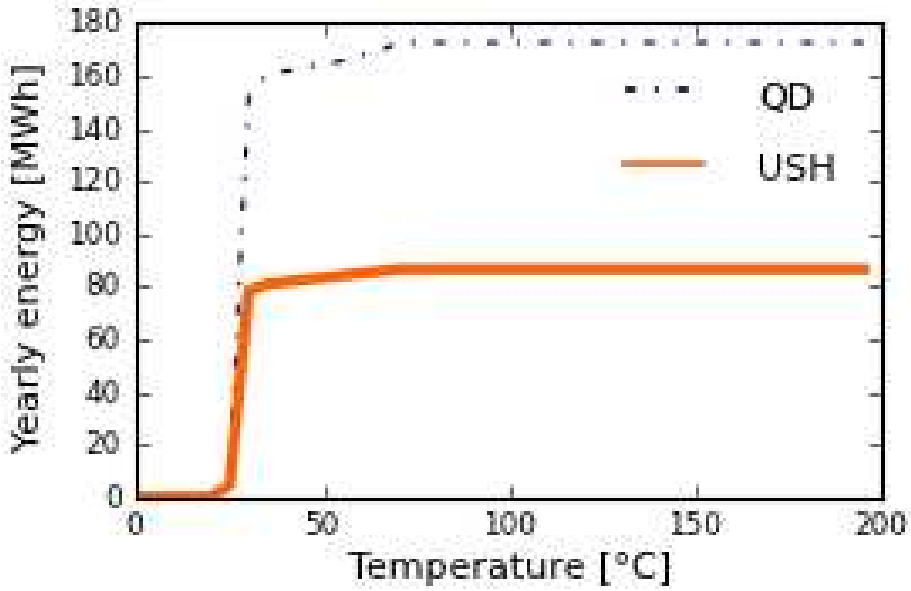

Figure 15: Heat demand and solar contribution

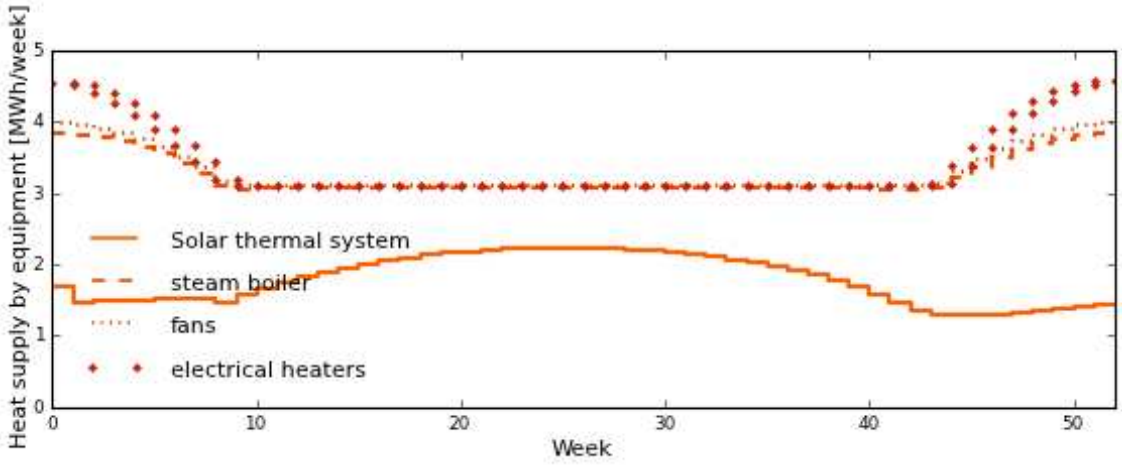

Figure 16: Daily heat supply by equipment

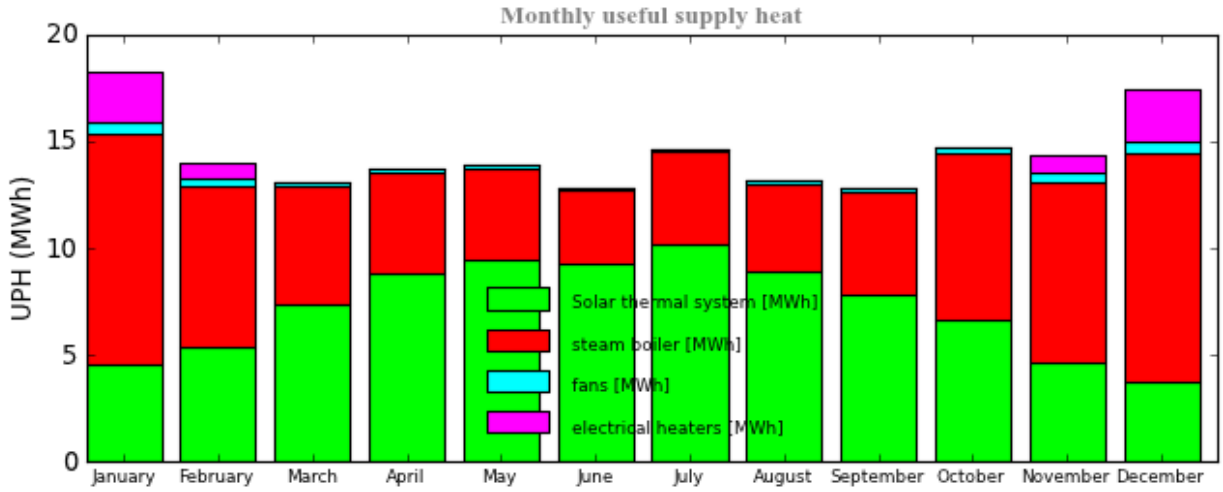

Figure 17: Distribution of useful process heat supply per month

- **CHP:**

Type	CHP engine
Nominal thermal power	93 kW
Nominal electrical power	50 kW
Thermal efficiency	0.52
Electrical efficiency	0.28
Operating hours	3,731 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 CHP 2	93	131	75.70
steam boiler	250	37	21.40
fans	2	5	2.62
electrical heaters	9	0	0.28
Total	**353**	**173**	**200**

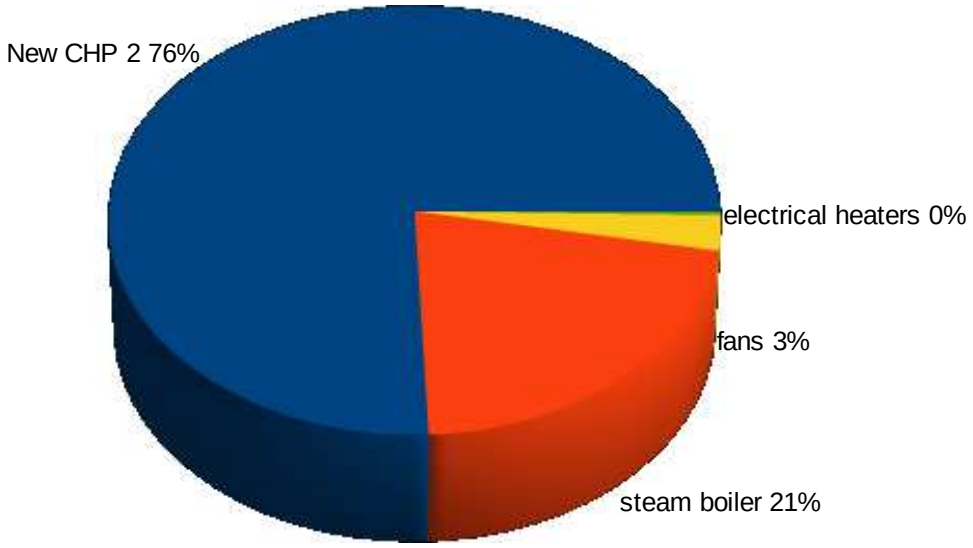

Figure 18: Contribution of each equipment to the total useful heat and useful cooling supply (USH & USC).

- graphic: heat demand covered by CHP:

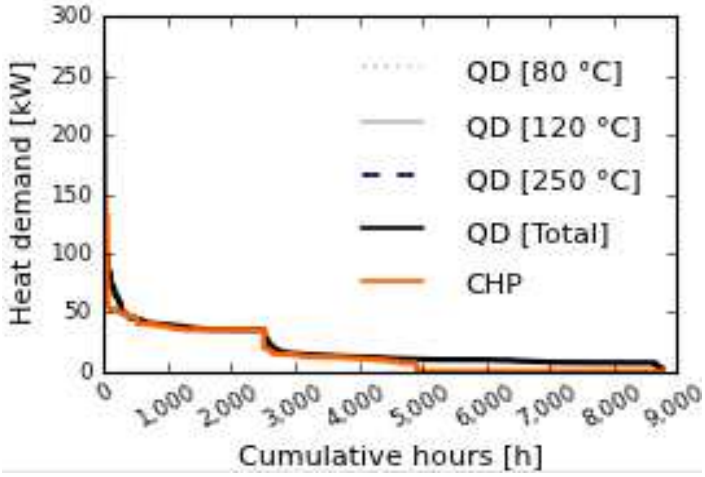

Figure 19: Cumulative heat supply to be covered by CHP

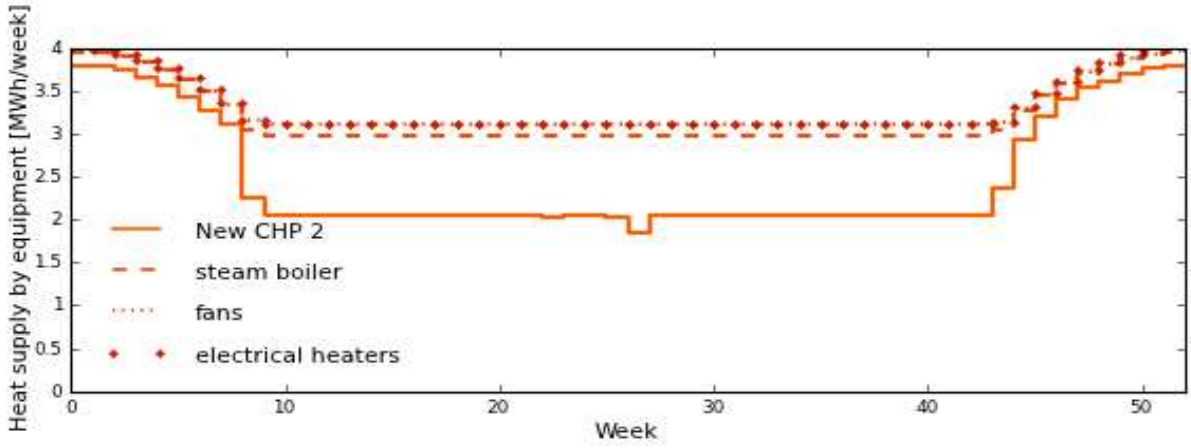

Figure 20: Daily heat supply by equipment

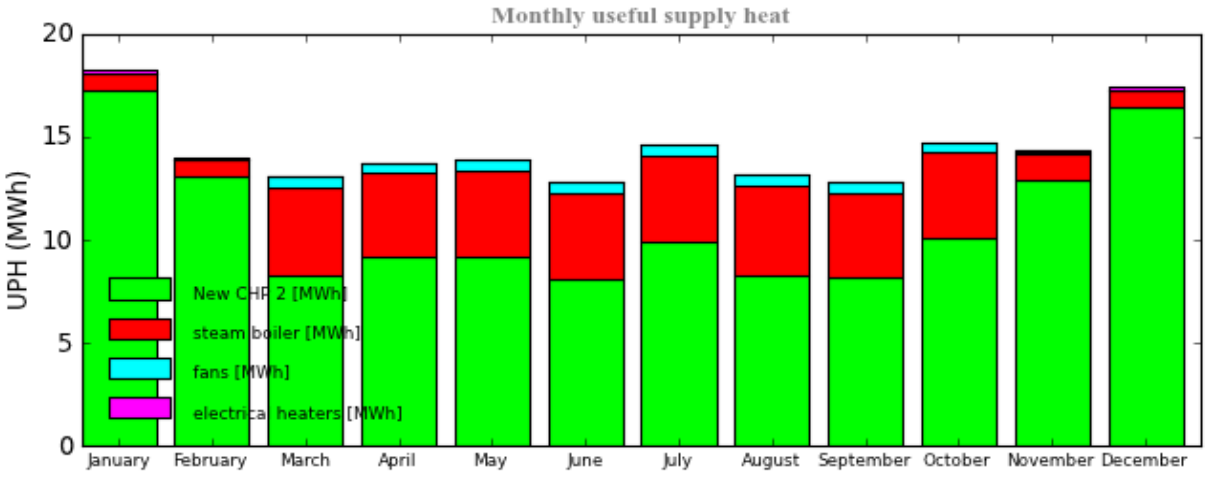

Figure 21: Distribution of useful process heat supply per month

- Primary energy consumption (PEC)

Table 10: primary energy consumption and savings

Alternative	Primary energy consumption	Savings	
	[MWh]	[MWh]	[%]
Present State (checked)	258	---	---
solar FPC	131	127	49.40
solar ETC	131	127	49.31
CHP (ORC)	133	124	48.27

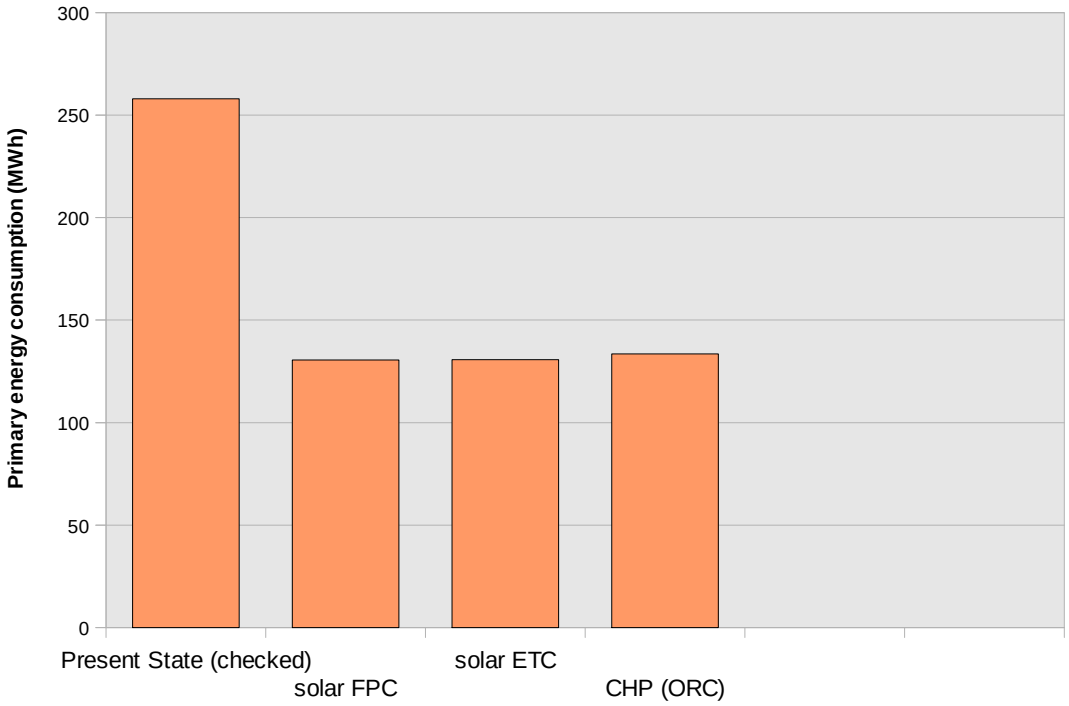

Figure 22: Comparison of alternatives: primary energy consumption

- 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 11: 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)	173	---	173	---
solar FPC	173	0	173	0
solar ETC	173	0	173	0
CHP (ORC)	173	0	173	0

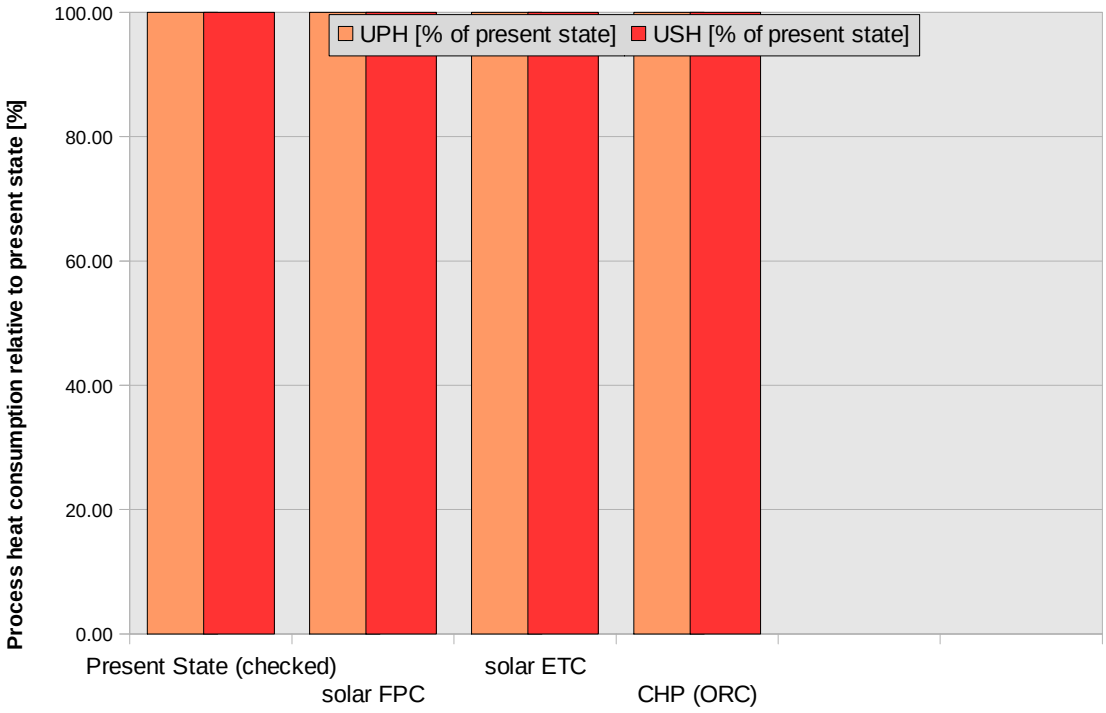

Figure 23: Comparison of alternatives: useful process heat supply

- Environmental impact

Table 12: CO2 production and CO2 savings per year

Alternative	Production of CO2	Water consumption
	[t]	[m³]
Present State (checked)	54.98	0.00
solar FPC	27.73	0.00
solar ETC	27.80	0.00
CHP (ORC)	43.22	0.00

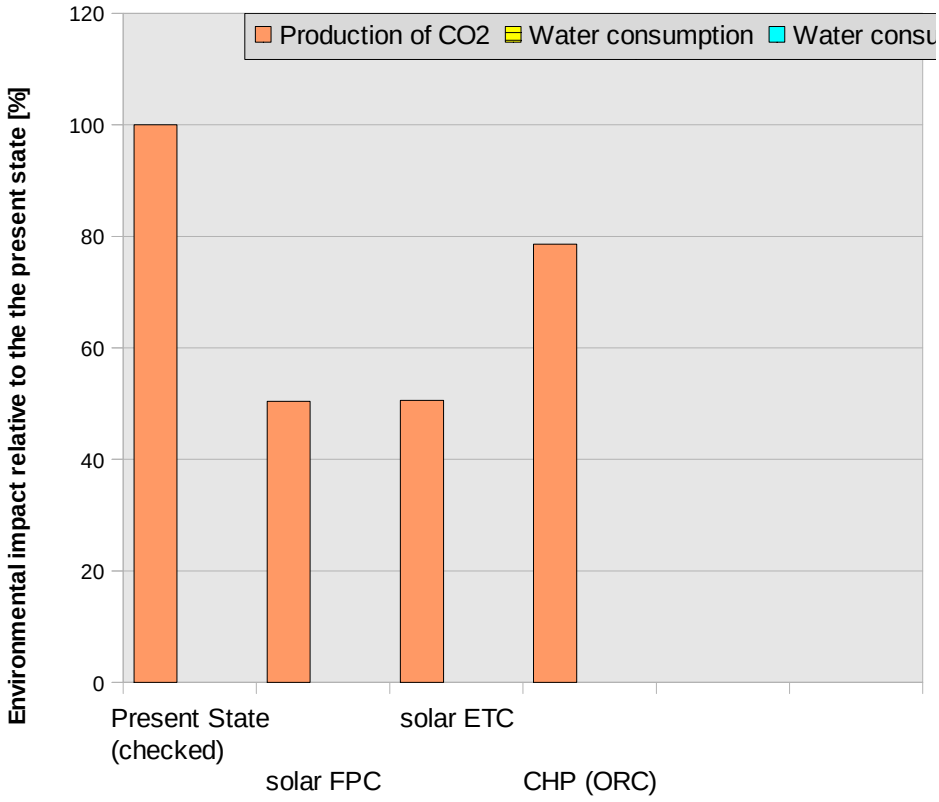

Figure 24: Comparison of alternatives: environmental impact

Table 13: Investment costs and subsidies of the proposals

Alternative	Total investment [€]	Own investment [€]	Subsidies [€]
Present State (checked)	---	---	---
solar FPC	70,714	49,500	21,214
solar ETC	63,643	44,550	19,093
CHP (ORC)	75,000	75,000	0

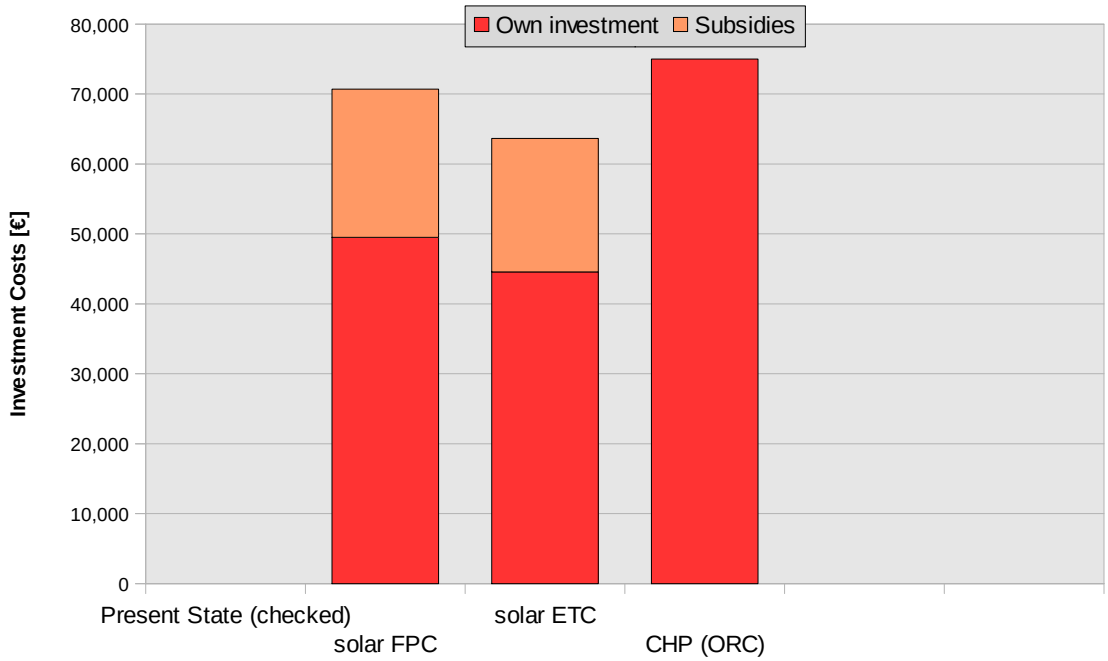

Figure 25: Comparison of alternatives investment cost

5. Selected alternative(s) and conclusions

5.1. Selected alternative

As selected alternative the "solar ETC" 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 (ETC):

Collector type:	ETC (Evacuated Tube Collectors)
Installed capacity:	81.9 kW
Installed collector area:	116 m²
Solar buffer storage volume:	5.85 m³
Solar fraction:	50.16 %
Annual energy yield:	1,058.24 kWh/kWa

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]	[%]
Solar thermal system	82	87	50.16
steam boiler	250	77	44.30
fans	2	3	1.91
electrical heaters	9	6	3.62
Total	**342**	**173**	**200**

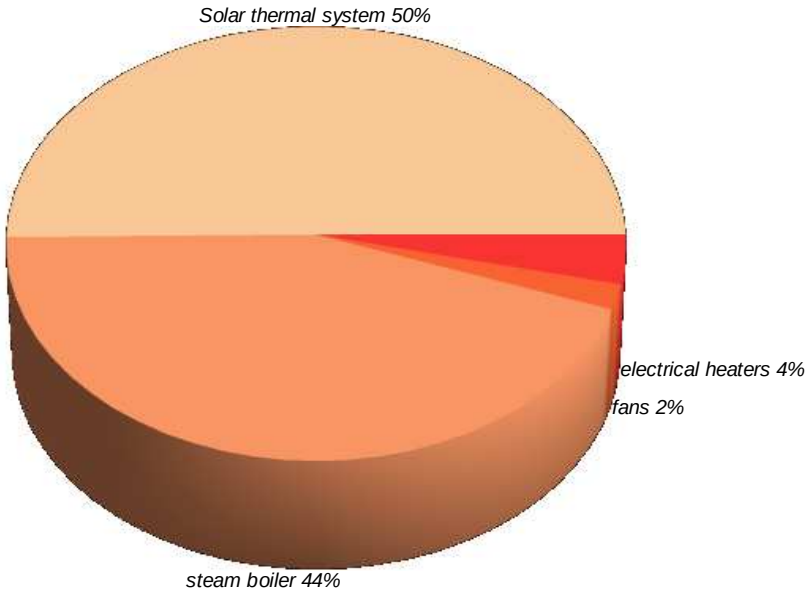

Figure 26: Contribution of each equipment to the total useful heat and useful cooling supply (USH & USC).

5.1.3. Energy Consumption

Table 15: 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	99	75.77	99	75.77
Total electricity	32	24.23	32	24.23
Total (fuels + electricity)	**131**	**100.00**	**131**	**100.00**

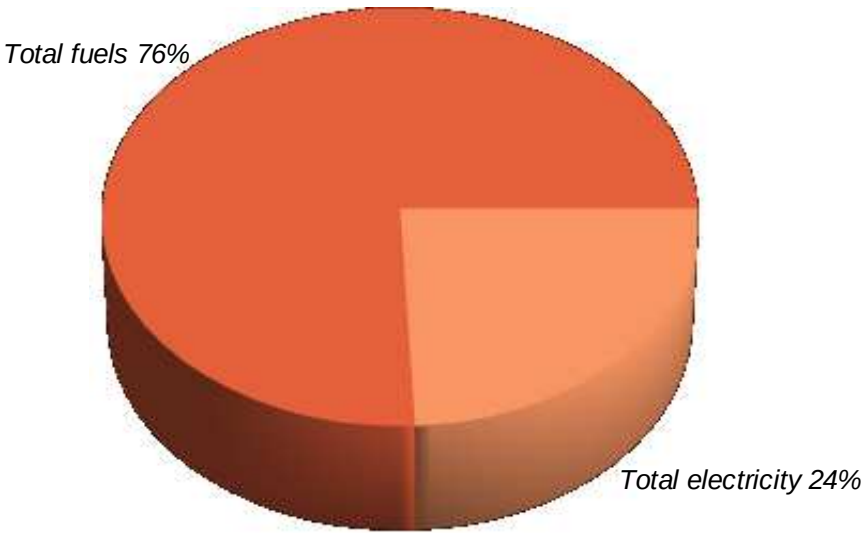

Figure 27: Distribution of PEC by fuel type

Table 16: 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	90	89.50	90	89.50
Electricity	11	10.50	11	10.50
Total	101	100.00	101	100.00

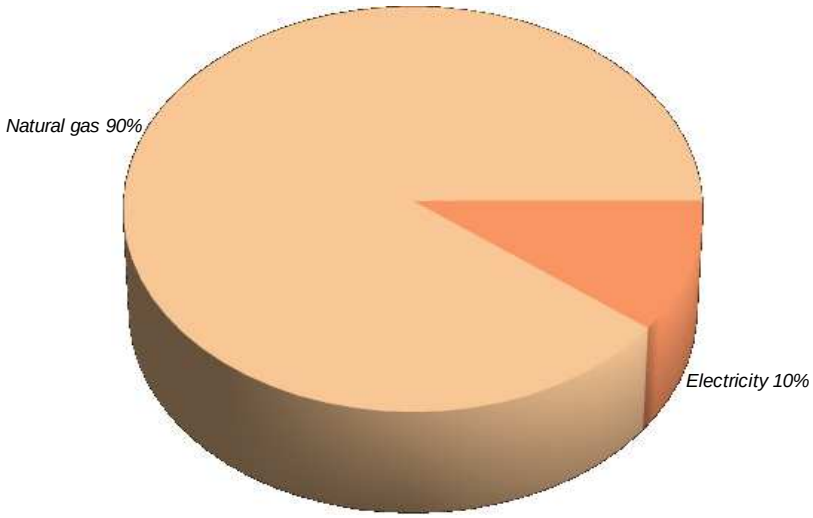

Figure 28: Total final energy consumption (FEC). Proposed final solution.

Table 17 : Final energy consumption for thermal use (FET) by equipment. Proposed final solution.

Equipment	Fuel type	FET by equipment	
		[MWh]	[% of Total]
steam boiler	Natural gas	90	89.50
fans	Electricity	3	3.29
electrical heaters	Electricity	6	6.35
Solar thermal system	Electricity	1	0.86
Total		**101**	**100**

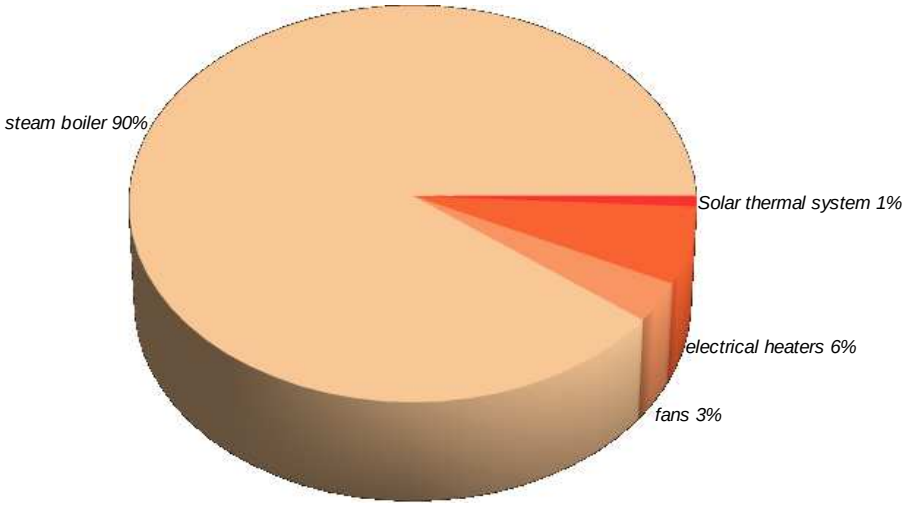

Figure 29: Final energy consumption for thermal use (FET) by equipment

Table 18 : Useful supply heat (USH) by equipment. Proposed final solution.

Equipment	USH by equipment	
	[MWh]	[% of Total]
steam boiler	77	44.30
fans	3	1.91
electrical heaters	6	3.62
Solar thermal system	87	50.16
Total	**173**	**100**

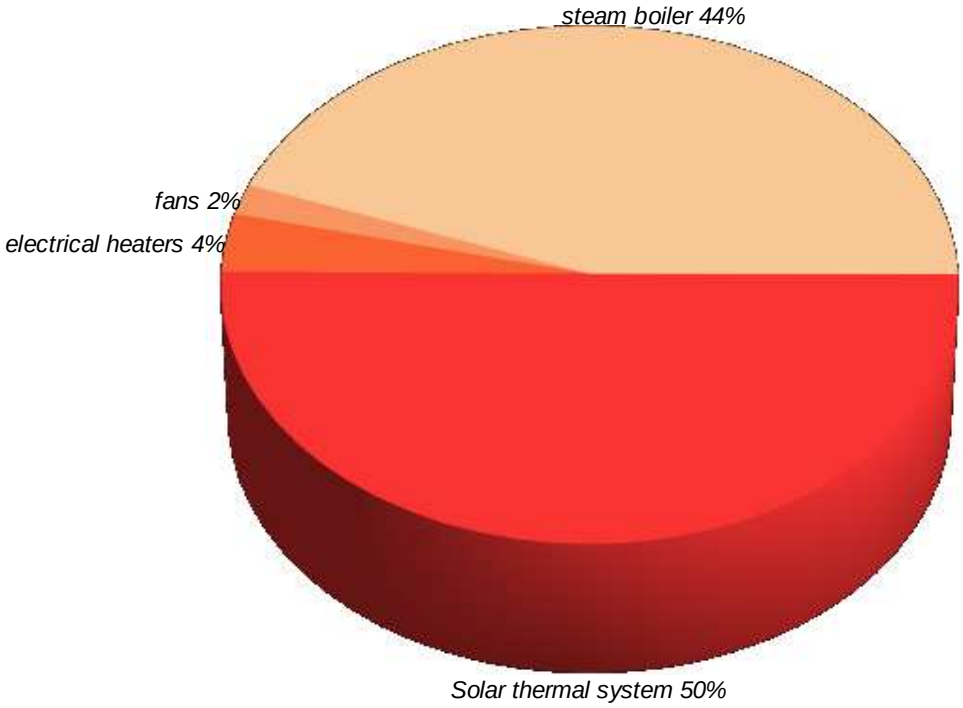

Figure 30: Useful supply heat (USH) by equipment. Proposed final solution

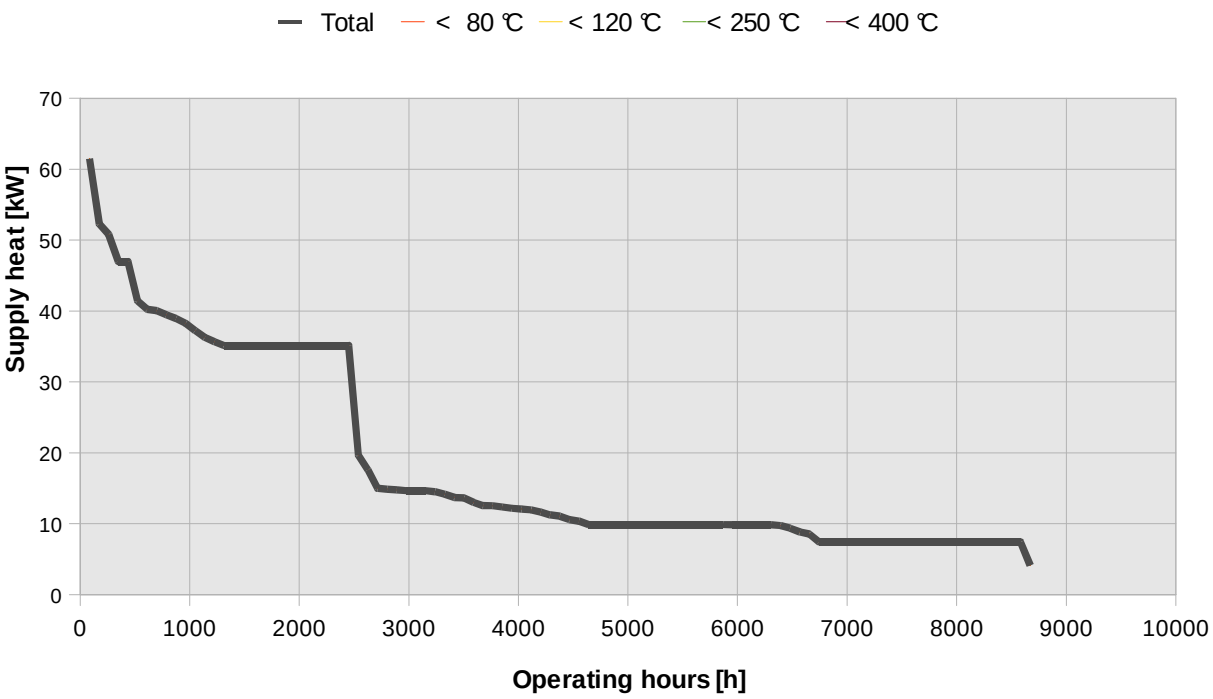

Figure 31: Distribution of supply heat by temperature levels and annual operating hours. Proposed final solution.

5.2. Comparative study and conclusions

5.2.1. Energy and environmental analysis

In the proposed alternative around 34 % of the CO_2 pollution can be saved.

5.2.2. Economic analysis

The payback period of about 12 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 Bulgaria.

Table 19: Savings of the proposed alternative in comparison to the present state

		Present state	Alternative	Saving	[% savings]
Total primary energy consumption (1)					
- total	[MWh]	258	131	127	49%
- fuels	[MWh]	198	99	99	50%
- electricity	[MWh]	60	32	28	47%
Primary energy saving due to renewable energy	[MWh]		99		
CO2 emissions	[t/a]	55	28	27	49%
Annual energy system cost (2)	[EUR]	7,358	3,999	3,359	46%
Total investment costs	[EUR]		63,643		
Payback period (3)	[years]		13		

(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.