Energy Audit Summary Report

AEE INTEC

Audit no. 03 – AUT03

Brewery

3rd of August 2011

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

AUDIT no. 03 – AUT03

1. Data of the auditor

1.1. Contact data of the auditor

Name of the auditor: Matthaeus Hubmann

Organisation: AEE INTEC

Country: Austria

Number of audits preformed: 3

date of the audit: 03.08.2011

duration of the audit: 4 weeks

AEE-Intec, Gleisdorf, Austria

2. Introduction

2.1. Objectives

Evaluate renewable energy supply possibilities for the brewery.

3. Status Quo: processes, distribution, energy supply

The reference year of the data and information is 2009.

(Date of the visit 03.08.2011 and 10.08.2011)

3.1. General info of company

Sector	Brewery, Beverage industry
Products	Beer
Yearly production	about 1.000.000 hl of beer
No. of employees	n.a. (not available)
Current final energy consumption:	Natural gas 18.200 [MWh/a]

3.2. Flow sheet of the whole manufacturing side (processes, distribution, energy supply) in form of a block diagram

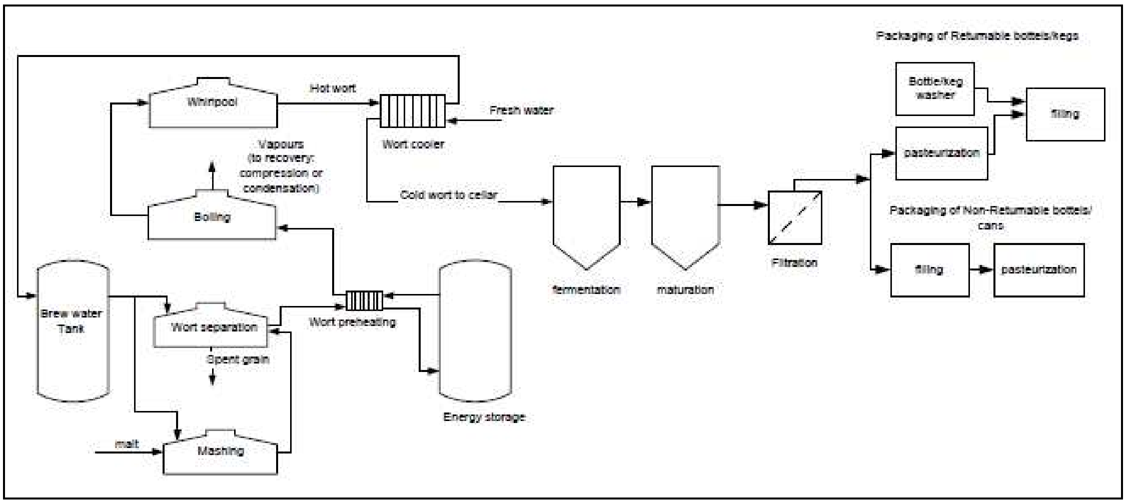

Figure 1 Flow sheet of the brewery

3.3. Description of the existing system

- *Energy Supply*

The existing heat generation system is based on two hot water boilers operating in alternating mode (one week boiler 1, one week boiler 2). Efficiency of the boiler has been determined at 91% in a former energy audit. The boilers run on natural gas.

Final energy consumption is 18.200 MWh/year.

The cooling during maturation and storage is done by several (14) chillers, with a COP ranging from 2,25 to 3,35 and an installed cooling capacity of 2.556 MW with a yearly consumption of 1.700 MWh of electricity. In order to reduce the number of chillers which have to be simulated in the Einstein tool the number of chillers was reduced to 3 main chillers, which represent the three different chiller types used in the brewery.

- *Distribution system*

Media: hot water (145 °C) and Glycol Water (-5 °C)

Table 1: 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]
Natural gas	20.020	42,04	20.020	42,04
Electricity	27.600	57,96	27.600	57,96
Total	**47.620**	**100,00**	**47.620**	**100,00**

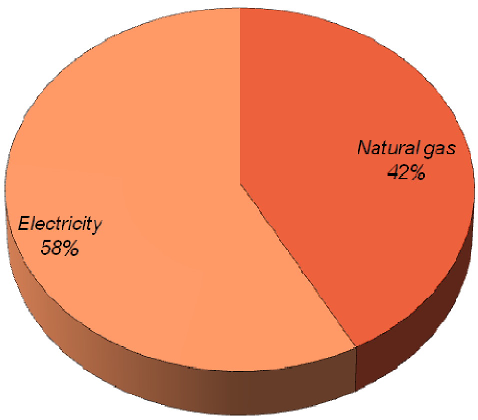

Figure 2: Distribution of PEC by fuel type
Explanations: conversion factors for primary energy: electricity - 3; natural gas – 1.1

Table 2: Total final energy consumption (FEC) and final energy for thermal use (FET); present state

Fuel type	FEC		FET	
	[MWh]	[% of Total]	[MWh]	[% of Total]
Natural gas	18.200	66,42	18.200	66,42
Electricity	9.200	33,58	9.200	33,58
Total	27.400	100,00	27.400	100,00

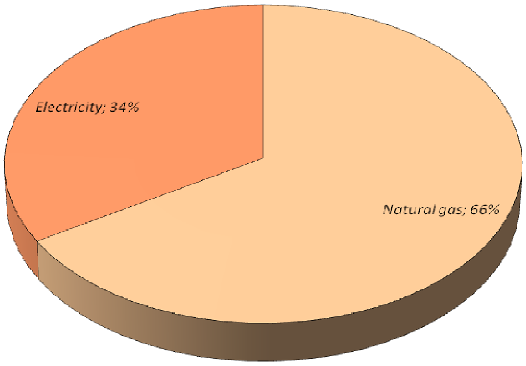

Figure 3: Total final energy consumption for thermal use (FET); present state

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

Equipment	Fuel type	FET by equipment	
		[MWh]	[% of Total]
hot water boiler	Natural gas	18.200	91,41
Chillers	Electricity	1.710	8,59
		19.910	**100,00**

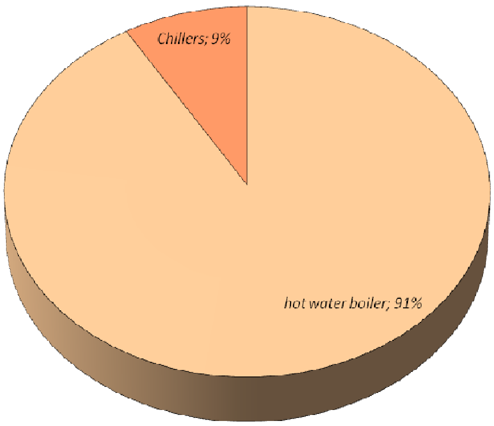

Figure 4: Final energy consumption for thermal use (FET) by equipment

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

Equipment	USH by equipment	
	[MWh]	[% of Total]
hot water boiler	16.562	100,00
	16.562	**100,00**

Table 5: Useful supply cooling (USC) by equipment; present state

Equipment	USC by equipment	
	[MWh]	[% of Total]
Chillers	4.470	100,00
	4.470	**100,00**

Table 6: Heat exchanger network and amount of recovered energy. Present state

Heat Exchanger	Heat Source	Heat Sink	Heat transferred	
			[MWh]	[%]
HX - mashing	wort boiling	mashing water	6.000	44,44
HX - lautering	wort boiling	lautering water	3.800	28,14
HX - rest	wort boiling	hot water brewhouse	3.700	27,42

Allocation of thermal energy demand to the different processes calculated by the tool as follows:

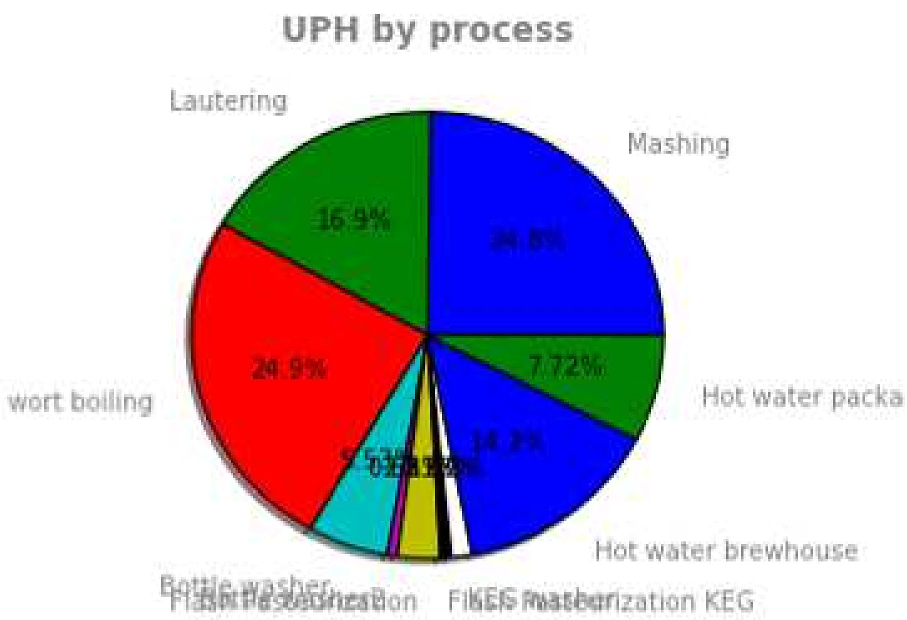

Figure 5: Distribution of process heat demand (UPH Total) by processes

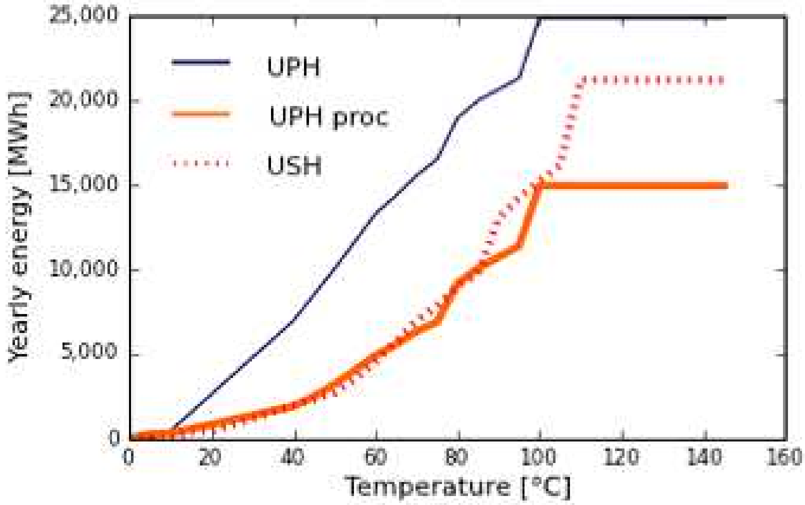

Figure 6: Distribution of heat demand (UPH) and supply (USH) by process temperature

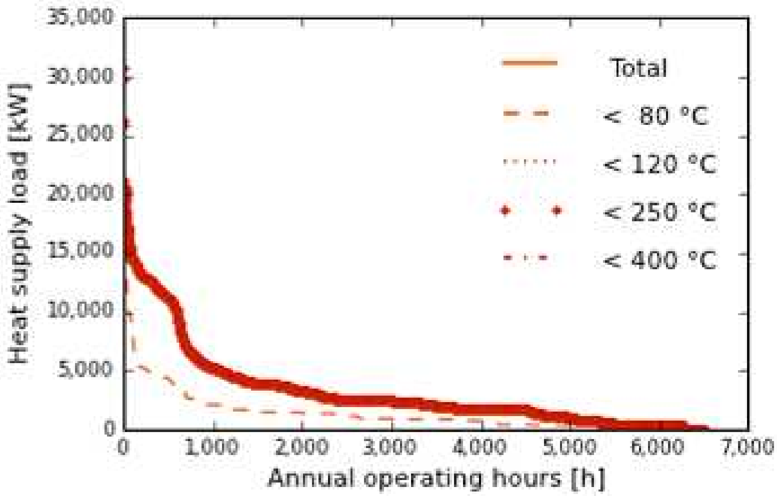

Figure 7: Cumulative heat demand (USH)

3.4. General

The brewery has already a hot water storage implemented in the brew process where the heat of the hot wort is used to heat up the mashing and lautering water. Additionally an energy storage is in place that uses the heat of the vapours from wort boiling to preheat the wort.

4. Comparative study

4.1. Proposed alternatives

The brewery has already done a lot in optimizing its energy efficiency, e.g. several heat exchangers are implemented and projects for improving the hot water household are ongoing. Therefore the focus of the Einstein energy audit was to analyse the potential for alternative energy sources that can be calculated by the EINSTEIN tool. Therefore solar thermal integration and CHP could be considered:

- Solar thermal integration: **Solar Proposal**

collector type:	flat plate collectors
installed capacity:	1,554 kW
solar puffer storage volume:	111 m³
solar fraction:	3,23 %
annual energy yield:	420 kWh/kWa

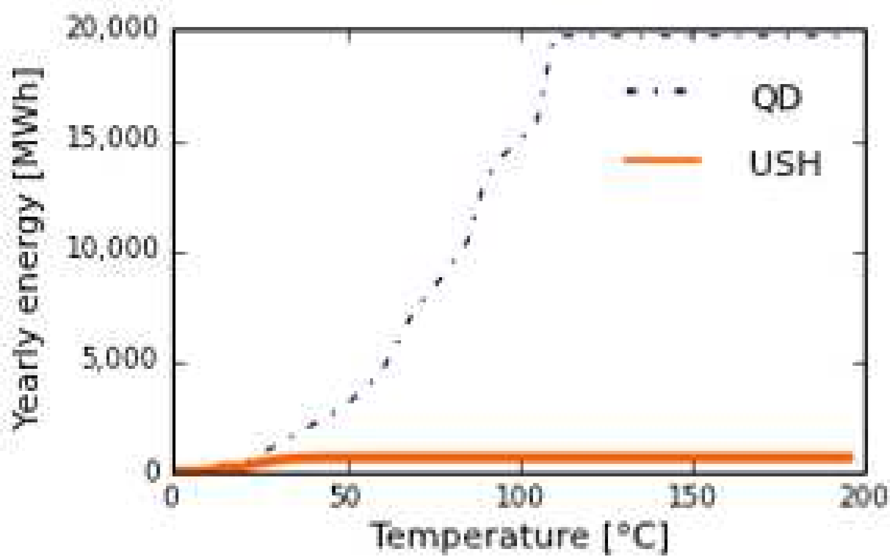

Figure 8: Heat demand and solar contribution

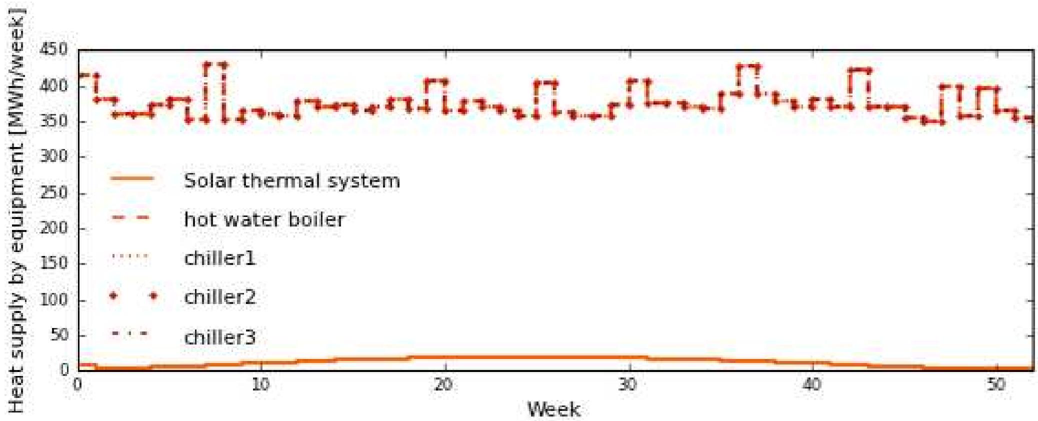

Figure 9: Daily heat supply by equipment

- CHP system: **CHP Proposal**

CHP type:	gas turbine
Electrical efficiency:	0.32
Operating hours:	6,053 h
installed electrical capacity:	650 kW

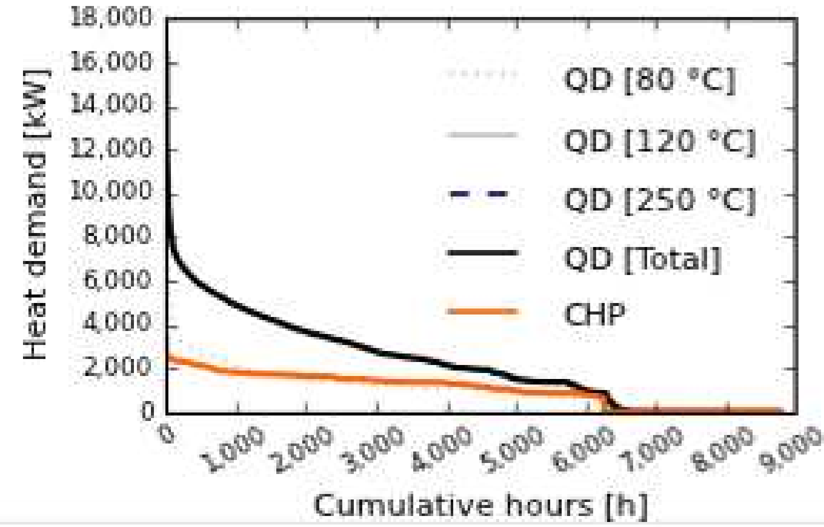

Figure 10: Cumulative heat demand to be covered by CHP

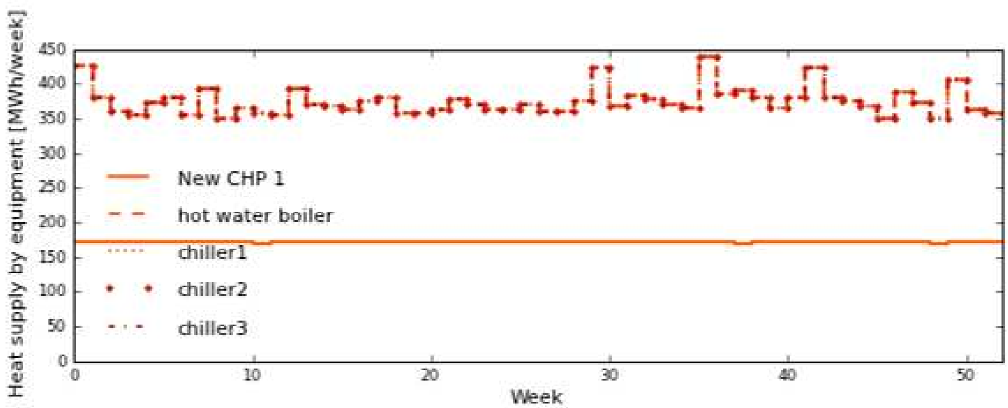

Figure 11: Daily heat supply by equipment

Table 7: primary energy consumption and savings

Alternative	Primary energy consumption	Savings	
	[MWh]	[MWh]	[%]
Present State (checked)	47.620		
CHP Proposal	35.935	11.685	24,54
Solar Proposal	46.902	718	1,51

Table 8: Environmental impact: present state and alternative proposals.

Alternative	Production of CO2	savings CO2	% savings
	[t]	[t]	[% savings]
Present state	11.905		
CHP Proposal	10.053	1.852	15,56
Solar Proposal	11.726	179	1,51

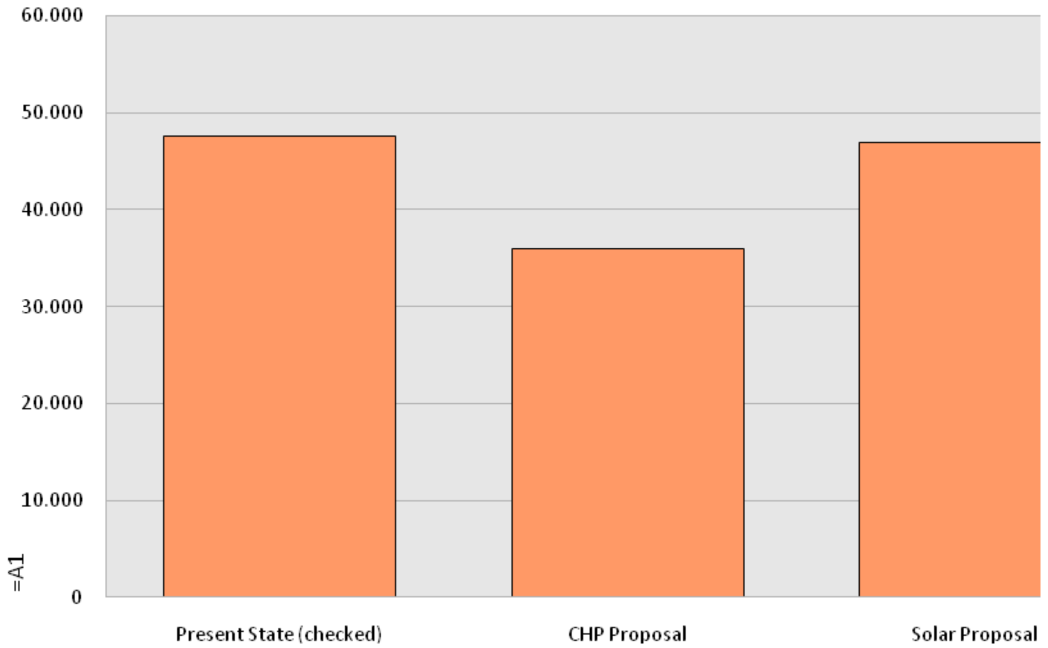

Figure 12: Comparison of alternatives: primary energy consumption in MWh

5. Selected alternative(s) and conclusions

5.1. Selected alternative

As stated above the brewery has invested already a lot to improve the energy efficiency onsite and the focus of the energy audit was to see the potential of solar thermal and CHP integration calculated by the EINSTEIN tool. The CHP alternative shows the better economics, therefore further data is shown for this alternative. It has to be stressed however that such changes in the energy supply system would require changes in the energy distribution system which are not foreseen within the next years

5.1.1. Process optimisation (written proposals)

The heat recovery system of the brewery is well implemented. Only optimization in regulation and management of energy storages might be beneficial. Details will be analysed in future projects.

5.2. Comparative study and conclusions

		Present state	Alternative	Saving
Total primary energy consumption (1)	[MWh]	47,620	26,335	11,685
fuels	[MWh]	20,020	20,020	-
electricity	[MWh]	27,600	15915	11,685
Share of renewable energy	[%]	-	-	-
CO_2 emissions	[tons/a]	11,905	10,053	1,852
Annual energy system cost (2)	[EUR]	1,632,376	1,266,472	365,904
Total investment costs	[EUR]	-	815,100	
Payback period (3)	[years]		1.2	

(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)

5.2.1. Energy and environmental analysis

In the shown alternative more than 15% of CO2 saving can be achieved.

5.2.2. Conclusions and outlook

Reports on the assumptions and constraints under which the results can be considered valid:

The energy balance done by EINSTEIN shows higher energy consumption based on rough data entry than the actual consumption. This shows that for a process with many batch processes, such as a brewery, the data entry of process schedules needs to be done in detail to reflect the real energy consumption. However, a deviation between calculated energy demand and actual energy demand of 10-20% is well acceptable for a fast energy audit tool.

The areas where a more detailed analysis would be necessary and the next steps with the company:

The ongoing work in the field of energy optimization of the brewery has shown that further analysis will be done in the following areas:

- Optimization of energy storages in connection with the existing heat recovery system
- Close consideration of distribution systems for identifying possible distribution losses
- Use of efficient motor drives
- CO_2 savings by making use of the own biogenic resources (e.g. biogas production)