Project no. 238889

BEST ENERGY PROJECT

Built Environment Sustainability and Technology in Energy

Competitiveness and Innovation Framework Programme

ICT Policy Support Programme (ICT PSP)

D1.1: Report of the energetic assessment and the total energy concept of the buildings/places where the pilots are to be implemented

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Revision [1]

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Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

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1. Introduction

This document describes the buildings that are used for the presentations in the BEST ENERGY project.

The document has been prepared by each of the involved partners. The main responsible for the document has been Viborg Municipality.

2. Pilot fact sheets

2.1 Pilot B1

Building	**Pilot B1**
Photo	
Name	Paco Yoldi Sports Centre
Location	Paseo de Anoeta, 16, 20014 San Sebastián, Spain
Country	Spain
Type of Building	Sports Centre
Year of Construction	1974 / 2004
Net Floor Area	13.649 m^2
Occupancy	369.173 users/year
ICT System	
System Structure	OPC Client/Server based communication tool with a web-based interface
Technical requirements	Building management devices connected to an OPC server that offers their data to a third party software (read only)
Frontends and functions	Web frontend for all the public. Different access to basic or expert modules on the user role
Implementation date	1st Trim 2010

Physical information		
Net floor area	13.649	m^2
Average U-value of constructions	2,2	$W/(m^2 \cdot K)$
Average U-value of windows	2,9	$W/(m^2 \cdot K)$

Primary indicators (see D1.2 for further information)	**No.**	**Current (baseline)**	**Expected (after)**	**Unit (per year)**
Primary energy consumption	1	9.338,59	8.259,04	MWh
Specific primary energy consumption	1a	684,20	605,10	kWh/m^2
Delivered electricity	2	1.340,12	1.119,85	MWh
Specific delivered electricity	2a	98,18	82,05	kWh/m^2
Delivered heating energy	3	2.757,83	2.560,69	MWh
Specific delivered heating energy	3a	202,05	187,61	kWh/m^2
Delivered cooling energy *	4	515,21	515,21	MWh
Specific delivered cooling energy	4a	37,75	37,75	kWh/m^2
CO_2 Emissions	5	1.825,44	1.618,15	ton(CO_2)
Specific CO_2 Emissions	5a	133,74	118,55	kg(CO_2)/m^2
Relative reduction of CO_2 emissions	6	–	11	%
Relative energy savings in primary energy	7	–	12	%
Energy cost savings – actual costs	8	–	2,43	€/m^2
Relative energy cost savings – actual costs	8a	–	12	%

* cooling used for dehumidify

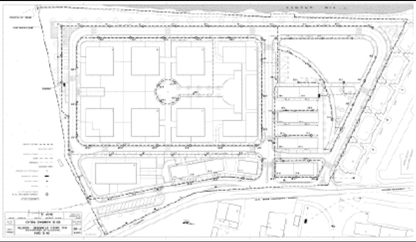
2.2 Pilot B2

Building	Pilot B2
Photo	
Name	Center of Informatics of Technical University of Braunschweig
Location	Mühlenpfordtstr. 23, 38106 Braunschweig, Germany
Country	Germany
Type of Building	Education / Office
Year of Construction	1976 / 2001
Occupancy	90-100 %
Energy supply	District heating and electrical grid
Building characteristic: Keywords	Educational building, office building, standard from 1970s, low energy building, high potential for energy savings
ICT System	
System Structure	*Energie Navigator*: client/server-based monitoring and analysis framework
Technical requirements	Existing building management system and data exchange interface, read-only connection to *Energie Navigator*
Frontends and functions	Web-frontends for generic information and expert frontends for specific analysis, information to users and building management experts
Date of Implementation	January 2010

Physical information	**Old part (1976)**	**New part (2001)**	
Net floor area	8570	8.945	m²
Average U-value of constructions	2,6	0,28	W/(m²·K)
Average U-value of windows	1,1 - 3,1	1,6	W/(m²·K)

Primary indicators (see D1.2 for further information)	**No.**	**Current (baseline)**	**Expected (after)**	**Unit (per year)**
Primary energy consumption	1	4.066,99	3.578,95	MWh
Specific primary energy consumption	1a	232,20	204,34	kWh/m²
Delivered electricity	2	1.228,19	1.080,81	MWh
Specific delivered electricity	2a	70,12	61,71	kWh/m²
Delivered heating energy	3	1.053,14	926,76	MWh
Specific delivered heating energy	3a	60,13	52,91	kWh/m²
Delivered cooling energy	4	-	-	MWh
Specific delivered cooling energy	4a	-	-	kWh/m²
CO_2 Emissions	5	1.003,57	883,14	ton(CO_2)
Specific CO_2 Emissions	5a	57,30	50,42	kg(CO_2)/m²
Relative reduction of CO_2 emissions	6	-	12,00	%
Relative energy savings in primary energy	7	-	12,00	%
Energy cost savings - actual costs	8	4,65	4,09	€/m²
Relative energy cost savings - actual costs	8a	-	12,00	%

2.3 Pilot L1

Building	Pilot L1 (Etxarriene)
Foto	
Name	Street lighting in Etxarriene
Location	Etxarriene neighbourhood, San Sebastian
Country	Spain
Type of Building	Residential neighbourhood.
Year of Construction	2008
Net Floor Area	Neighbourhood area: 16.000m^2
Number of lamps	79
ICT System	
System Structure	Public light control and management system and OPC server to offer this data
Technical requirements	Existence or installation of electronic ballasts and controller for each luminaire, the segment controller and OPC Server software reading the data from the ballasts and serving it to a third party software
Frontends and functions	Web based tool with different reports and modules based on the user role
Date of Implementation	1st Trim 2010

Primary indicators (see D1.2 for further information)	No.	Current (baseline)	Expected (after)	Unit (per year)
Primary energy consumption	1	157,48	104,99	MWh
Specific primary energy consumption	1a	1.993,45	1.328,97	kWh/lum
Total electrical energy consumption	2	47,58	31,72	MWh
Specific electrical energy consumption	2a	602,25	401,50	kWh/lum
CO2 emissions	3	29,36	19,57	ton(CO_2)
Specific CO2 emissions	3a	371,59	247,73	kg(CO_2)/lum
Relative reductions of CO2 emissions	4		33	%
Relative energy savings in primary energy	4a		33	%
Energy cost savings – actual costs	5		22,08	€/lum
Relative energy cost savings – actual costs	5a		33	%
Energy cost savings – European average	6			€/lum
Relative energy cost savings – European average	7			%

2.4 Pilot L2 Pilot L2

Building/Street Lighting System	**Pilot L2 (Almada Street Lighting Area)**
Foto	
Name	Almada Street Lighting Area
Location	Almada
Country	Portugal
Type of Building	Street
Year of Construction	2007
Net Floor Area	13,5 km
Number of lamps	Total number of Light Points 103, Sodium vapour lamps 42, Metal halide lamps 61. Electrical energy consumption: Total 43536 kWh, Per luminaire 423 kWh
ICT System	
System Structure	Public light control and management system that will allow the dimming of each light point individually
Technical requirements	Existence or installation of electronic ballasts and controller for each luminaire, the segment controller and the server and web based portal software from the system management
Frontends and functions	Web based portal for experts and managers, with flexibility of data, charts, and reports plotting
Date of Implementation	February 2010

Primary Indicators	**No.**	**Reference (baseline)**	**Expected**	**Unit (per year)**
Primary energy consumption	1	129	90	MWh
Specific primary energy consumption	1a	1251	876	kWh/lum
Delivered electricity	2	44	30	MWh
Specific delivered electricity	2a	423	296	kWh/lum
CO2 Emissions	5	28	19	ton(CO2)
Specific CO2 Emissions	5a	0,3	0,2	kg(CO2)/m²
Relative reduction of CO2 emissions	6	–	30	%
Relative energy savings in primary energy	7	–	30	%

Energy cost savings – actual costs	8	–	1140	€
Relative energy cost savings – actual costs	8a	–	30	%

2.5 Replication pilot R1.1

Building	**Pilot R1.1 (Belartza)**
Foto	
Name	Belartza:Municipal Centre for Social and Inclusive Companies
Location	Gurutzegi 14-16-18 20028 San Sebastián (Spain)
Country	Spain
Type of Building	Office
Year of Construction	2004
Net Floor Area	4.910 m^2
Occupancy	20.640 user/year
ICT System	
System Structure	OPC Client/Server based communication tool with a web-based interface
Technical requirements	Building management devices connected to an OPC server that offers their data to a third party software (read only)
Frontends and functions	Web frontend for all the public. Different access to basic or expert modules on the user role
Implementation date	-

Physical information		
Net floor area	4.910	m^2
Average U-value of constructions	0,8	$W/(m^2 \cdot K)$
Average U-value of windows	2,6	$W/(m^2 \cdot K)$

Primary indicators (see D1.2 for further information)	No.	Current (baseline)	Expected (after)	Unit (per year)
Primary energy consumption	1	2.333,80	2.080,27	MWh
Specific primary energy consumption	1a	475,32	423,68	kWh/m^2
Delivered electricity	2	705,08	628,48	MWh
Specific delivered electricity	2a	143,60	128,00	kWh/m^2
Delivered heating energy	3	270,05	235,68	MWh
Specific delivered heating energy	3a	55,00	48,00	kWh/m^2
Delivered cooling energy *	4	908,35	862,20	MWh
Specific delivered cooling energy	4a	185,00	175,60	kWh/m^2
CO_2 Emissions	5	435,03	387,77	ton(CO_2)
Specific CO_2 Emissions	5a	88,60	78,98	kg(CO_2)/m^2

Relative reduction of CO_2 emissions	6	–	11	%
Relative energy savings in primary energy	7	–	11	%
Energy cost savings – actual costs	8	–	1,59	€/m²
Relative energy cost savings – actual costs	8a	–	11	%

2.6 Pilot R1.1

Building	Pilot R1.1 (Cemei)
Foto	
Name	CEMEI: The Municipality Centre for Innovative Companies
Location	23 Portuetxe Street, A-B , 20018 San Sebastián
Country	Spain
Type of Building	Office
Year of Construction	2.004
Net Floor Area	17.541 m2
Occupancy	72.240 users/year
ICT System	
System Structure	OPC Client/Server based communication tool with a web-based interface
Technical requirements	Building management devices connected to an OPC server that offers their data to a third party software (read only)
Frontends and functions	Web frontend for all the public. Different access to basic or expert modules on the user role
Implementation date	–

Physical information		
Net floor area	17.541	m²
Average U-value of constructions	0,9	W/(m²·K)
Average U-value of windows	2,6	W/(m²·K)

Primary indicators (see D1.2 for further information)	No.	Current (baseline)	Expected (after)	Unit (per year)
Primary energy consumption	1	5.364,38	4.682,03	MWh
Specific primary energy consumption	1a	305,82	266,92	kWh/m²
Delivered electricity	2	1.260,27	1.113,20	MWh
Specific delivered electricity	2a	71,85	63,46	kWh/m²
Delivered heating energy	3	671,00	561,00	MWh
Specific delivered heating energy	3a	38,25	31,98	kWh/m²
Delivered cooling energy *	4	1.867,14	1.771,00	MWh

Specific delivered cooling energy	4a	106,44	100,96	kWh/m²
CO_2 Emissions	5	1.020,55	889,98	ton(CO_2)
Specific CO_2 Emissions	5a	58,18	50,74	kg(CO_2)/m²
Relative reduction of CO_2 emissions	6		13	%
Relative energy savings in primary energy	7		13	%
Energy cost savings – actual costs	8		1,74	€/m²
Relative energy cost savings – actual costs	8a		13	%

2.7 Replication pilot R1.1

Building	**Pilot R1.1 (Rozanes)**
Foto	
Name	Rozanes: Residence for lodging researchers.
Location	42 Duque de Baena Avenue, Castillo de Rozanés plot
Country	Spain
Type of Building	Residence
Year of Construction	Under construction
Net Floor Area	6.888 m^2
Occupancy	18.980 users/year
ICT System	
System Structure	OPC Client/Server based communication tool with a web-based interface
Technical requirements	Building management devices connected to an OPC server that offers their data to a third party software (read only)
Frontends and functions	Web frontend for all the public. Different access to basic or expert modules on the user role
Date of Implementation	–

Physical information		
Net floor area	6.888	m^2
Average U-value of constructions	0,6	$W/(m^2 \cdot K)$
Average U-value of windows	2,4	$W/(m^2 \cdot K)$

Primary indicators (see D1.2 for further information)	**No.**	**Current (baseline)**	**Expected (after)**	**Unit (per year)**
Primary energy consumption	1	1.990,18	1.734,96	MWh
Specific primary energy consumption	1a	288,93	251,88	kWh/m^2
Delivered electricity	2	543,36	471,77	MWh
Specific delivered electricity	2a	78,89	68,49	kWh/m^2
Delivered heating energy	3	723,24	654,36	MWh
Specific delivered heating energy	3a	105,00	95,00	kWh/m^2
Delivered cooling energy *	4	18,55	17,28	MWh
Specific delivered cooling energy	4a	2,69	2,51	kWh/m^2
CO_2 Emissions	5	335,98	291,74	$ton(CO_2)$
Specific CO_2 Emissions	5a	48,78	42,35	$kg(CO_2)/m^2$
Relative reduction of CO_2 emissions	6		13	%
Relative energy savings in primary energy	7		13	%
Energy cost savings – actual costs	8		1,65	€/m^2
Relative energy cost savings – actual costs	8a		12	%

2.8 Replication pilot R1.2

Building	**Pilot** R1.2 (National Theare Prague)
Foto	
Name	National Theare Prague
Location	Prague
Country	Czech Republic
Type of Building	Theatre
Year of Construction	Originaly in 19^{th} century, modernized in 20^{th} century
Net Floor Area	49.338 m^2
Occupancy	Average aoccupancy 1100 + plus visitors
ICT System	
System Structure	Energy supply, Gas, Electric energy
Technical requirements	The integration of ICT helps operators of the buildings to ensure low energy consumption and optimal indoor climate in the buildings.
Frontends and functions	National Theatre, historical and new energy intensive buildings, long-term energy efficiency programme, high efficient boilers, efficient chillers and heat pumps, advanced heating and cooling system, heat recovery, PV cells, high efficient lighting system
Date of Implementation	2011

Physical information	Size of area	Unit
Historic building of ND	10 258	m^2
Underground technical facility	24 477	m^2
Administrative building	7 260	m^2
New Scene of ND	7 343	m^2
Net floor area	49 338	m^2

Indicators (primary and secondary – see D1.2 for further information)	No.	Reference (baseline)	Unit (per year)
Primary energy consumption	1	27 789	MWh
Specific primary energy consumption	1a	563	kWh/m^2
Delivered electricity	2	5 959	MWh

Specific delivered electricity	2a	121	kWh/m²
Delivered heating energy	3	5 929	MWh
Specific delivered heating energy	3a	120	kWh/m²
Delivered cooling energy	4	805	MWh
Specific delivered cooling energy	4a	16	kWh/m²
CO_2 Emissions	5	5 319	ton(CO_2)
Specific CO_2 Emissions	5a	108	kg(CO_2)/m²
Relative reduction of CO_2 emissions	6	NA	%
Relative energy savings in primary energy	7	NA	%
Energy cost savings – actual costs	8	NA	€
Relative energy cost savings – actual costs	8a	NA	%

2.9 Pilot R2.1

Building	**Pilot R2.1**
Photo	
Name	Viborg Town Hall
Location	Prinsens Alle, 8800 Viborg
Country	Denmark
Type of Building	Office building
Year of Construction	Under construction
Net Floor Area	19.000 m^2
Occupancy	Daily occupancy estimated at 500 persons plus an unknown number of guests
ICT System	
System Structure	Server based communication tool including a web-based interface
Technical requirements	Building Energy Management System must be able to change setpoints, operation modes and make detailed reports of measurements.
Frontends and functions	Web-frontends for generic information and expert frontends for specific analysis, information to users and building management experts. May change according to actual chosen solution.
Implementation date	-

Physical information				
Net floor area	19.000	m^2		
Average U-value of constructions	0.2	$W/(m^2 \cdot K)$		
Average U-value of windows	1.0	$W/(m^2 \cdot K)$		

Primary indicators (see D1.2 for further information)	No.	Current (baseline)	Expected (after)	Unit (per year)
Primary energy consumption	1	4206	3254	MWh
Specific primary energy consumption	1a	218	168	kWh/m^2
Delivered electricity	2	1121	966	MWh
Specific delivered electricity	2a	58	50	kWh/m^2
Delivered heating energy	3	889	394	MWh
Specific delivered heating energy	3a	46	20	kWh/m^2
Delivered cooling energy	4	367	367	MWh
Specific delivered cooling energy	4a	19	19	kWh/m^2
CO_2 Emissions	5	914	695	ton(CO_2)
Specific CO_2 Emissions	5a	47	36	kg(CO_2)/m^2
Relative reduction of CO_2 emissions	6	-	24	%
Relative energy savings in primary energy	7	-	23	%
Energy cost savings - actual costs	8	-	81460	€/m^2
Relative energy cost savings - actual costs	8a	-	21,9	%

3. Pilot B1

This document contains a description of the data needed for the Paco Yoldi Sports Centre building as part of the BEST Energy project.

This document is prepared under Work Package 1, task 1.1.

3.1 Name of pilot

Paco Yoldi Sports Centre, San Sebastian (Spain)

3.2 Location

The Sports Centre is located in the city of San Sebastián, a city of 180.000 inhabitants in Basque Country, Spain.

It consists of several conjoined buildings and it is integrated in the Anoeta sports complex, which includes one Stadium, a velodrome and several installations for sports.

3.3 Building description

Paco Yodi Sports Centre is integrated in the Anoeta Sports Complex area, which includes one Stadium, a velodrome and several installations for sports.

Figure 1 Paco Yoldi Sports Centre

Obviously, this building is used for sports activities like the followings.

- Indoor swimming pool 1 (50x21 m)
- Indoor swimming pool 2 (25x12 m)
- Outdoor children swimming pool (4x4 m)
- 3 multiple use rooms (120 m2)
- Gym 1 (180 m2)
- Gym 2 (180 m2)
- Multi-sport court 3 modules of 50x30
- Basque ball game court (36x18m)

- Basque ball game court (55x18m)
- Pneumatic shooting room.

Building can be seen in the drawing shown below:

The

Figure 2 A plan of the Paco Yoldi Sports Centre

The structure of the building is a mix of concrete and metallic structure. Ceilings were constructed with sandwich panels and facades are made of face brick and are thermal insulated.

In order to complete the building description it is necessary to give some data about outdoor conditions that affect to it.

- Location:43°19
- Height (a.s.l.): 8 m
- Average Temperature (last 10 years): 15,5 °C
- Average humidity (last 10 years): 73,5%

3.4 Description of systems in building

3.4.1 Energy design

Paco Yoldi has several energetic installations. These installations are the following ones.

Boilers room

Paco Yoldi Sports Centre has three boilers for heating with a total of 1.669 kW of rated thermal output. These boilers also heat the water of the swimming pools.

Cogeneration

In order to meet the energy needs of the building there is a cogeneration systems with an electrical power of 90 kW.

The thermal energy generated by the engine is used to heat water at 90 °C. This water is used to supply hot water to the circuits of the Sports Centre.

Domestic Heat Water

To store the hot water for showers, there are three water tanks of 5.000 litres each.

The following drawing shows the energy installations schema

Figure 3 Energy installations schema

3.4.2 Current situation

The operation time of the building is, during all the year, from Monday to Friday from 7am to 10pm. Saturdays from 8am to 10pm and Sundays from 9am to 8pm.

Last year Paco Yoldi Sports Centre had 369.173 users.

3.4.3 Defining a baseline

The baseline for the Sports Centre is going to be based on existing measurements and data from building management.

The overall energy consumption is shown below, Table 1.

Table 1 Baselines

Type of energy	**Period of reference**	**Baseline**
Consumption of electricity	2008	1.340.119 kWh
Consumption of heating	2008	2.758.000 kWh

The consumptions for the 2009 year are currently measured.

3.4.4 Measurements status

Nowadays the main measurements of the installations are taken thanks to a control and telemanagement system.

The main measurements that this control system allows are the following ones:

Boiler room

It allows centralizing the management of the installation thanks to the readings of the temperatures through temperature probes. At the same time it allows the control of the opening of the motorized valves.

Cogeneration

The control system allows the follow up of the fuel consumption, impulsion and return temperatures and the state of the two and three port valves.

Domestic Heat Water meter

Each water tank has a temperature probe that allows display de value instantly. Also it can show the state of the two and three – way port valves.

Swimming pool

It allows control and display water condition, both chlorination and temperature. Also it measures the state of the valves.

3.5 Energy consumption

3.5.1 Measurements

The main consumptions measurements are described in the following. The net floor area for Paco Yoldi is 13.649 m2.

Energy consumption for heating

The following table shows the annual data for the energy consumption in the Paco Yoldi Sports Centre for 2008 year.

Table 2 Annual energy consumption for heating

	Annual energy consumption for heating [kWh/a]	Annual energy consumption for heating per net floor area [kWh/(m²a)]
2008	2.758.000	202,17*
2009	*currently metered*	*currently metered*

Total electrical energy consumption

The table 3 shows the annual data for the electrical energy consumption in the Sports Centre for year 2008.

Table 3 Annual electrical energy consumption

	Electrical energy consumption [kWh/a]	Electrical energy consumption per net area [kWh/(m²a)]
2008	*1.340.119*	*98,18*
2009	*currently metered*	*currently metered*

Monthly data for electrical energy consumption in the Sports Centre.

Table 4 Monthly electrical energy consumption

	Electrical energy consumption [MWh/month]	Electrical energy consumption per net area [kWh/(m²*month)]
January 2008	138,225	10,13
February 2008	111,736	8,19
March 2008	128,011	9,38
April 2008	90,562	6,64
May 2008	113,106	8,29
June 2008	122,213	8,95
July 2008	121,026	8,87
August 2008	111,633	8,18
September 2008	85,782	6,28

October 2008	105,895	7,76
November 2008	92,294	6,76
December 2008	112,636	8,25

Water consumption

The following table shows the monthly data for the water consumption in the Paco Yoldi Sports Centre.

Table 5 Water consumption

	Water consumption [m³]
January 2008	3.560
February 2008	3.360
March 2008	2.886
April 2008	3.136
May 2008	3.781
June 2008	3.595
July 2008	4.030
August 2008	3.667
September 2008	3.062
October 2008	0
November 2008	0
December 2008	3.835

Hot water consumption

The following table shows the three-monthly data for the hot water consumption in the Paco Yoldi Sports Centre.

Table 6 Hot water consumption

Period	Hot water consumption [m³]
January 2008 – March 2008	3.178
April 2008 – June 2008	3.160
July 2008 – September 2008	2.126
October 2008 – December 2008	2.413

3.5.2 Yearly cost of energy

Heating

The cost is calculated by multiplying the annual consumption with the average price for the gas that the sports centre pays.. The net floor area of the Sports Centre is 13.649 m2.

Average price for heating energy is 45,39 €/MWh

Table 7 shows data for year 2008.

Table 7 Annual cost for heating

	Gross annual cost for heating [€/a]	Gross annual cost for heating per area [€/(m²a)]
2008*	125.186	9,17*
2009	*currently metered*	*currently metered*

Electrical energy

The average price for electrical energy is 0,11 €/kWh.

Table 9 shows data for year 2008.

Table 8 Annual cost for electrical energy

	Gross annual cost for electrical energy [€/a]	Gross annual cost for electrical energy per area [€/(m²a)]
2008*	147.413	10,80*
2009	*currently metered*	*currently metered*

3.5.3 Future measurements

The future measures that will be taken are as follows:

- Primary energy consumption
- CO2 emmisions
- Thermal efficiency of boilers
- Cogeneration electric efficiency
- Cogeneration thermal efficiency
- Swimming pool thermal consumption
- Swimming pool electrical energy consumption
- Shower energy
- Hot water consumption

3.6 Energy production

3.6.1 Measurements

As it has been mentioned above, Paco Yoldi has a cogeneration engine for the production of thermal an electric energy.

Also, since October 2008 a solar photovoltaic system is operative in the Sports Centre.

Energy production for heating by cogeneration engine

The thermal energy generated by the cogeneration engine in 2008 is shown in the following table.

Table 9 Heating energy generated by cogeneration

Period	Heating energy generated [MWh]
January 2008 – March 2008	91,000
April 2008 – June 2008	57,615
July 2008 – September 2008	74,030
October 2008 – December 2008	67,174

Electrical energy production by cogeneration engine

The electrical energy generated by the cogeneration engine in 2008 is shown in the following table.

Table 10 Electrical energy generated by cogeneration

Period	Electrical energy generated [MWh]
January 2008 – March 2008	85,850
April 2008 – June 2008	56,148
July 2008 – September 2008	64,034
October 2008 – December 2008	43,112

Electrical energy production by photovoltaic installation

Table 11 Electrical energy production by photovoltaic

Period	Heating energy generated [MWh]
October 2008 – Present	6,363

3.6.2 Future measurements

Future measurements should allow to obtain all those parameters unknown at this moment in time. For example:

- Water consumption distribution
- Electricity consumtion distribution
- Useful energy demanded

3.7 Reporting

All energy data will be stored in the Building Management System (Cylon Unitron) and transferred to the Best Energy system.

Data from other systems, like access control system, also transfer data to the Best Energy system. The frequency of the data transfer has not yet been determined.

After rule-based analyze, Best Energy Best Energy tool provides decision makers with the necessary tools to plan energy savings measures.

3.7.1 Historic Data

The baseline of all measurements will be calculated on the bases of data measured in 2009.

3.7.2 Baseline data

The baseline of all measurements will be calculated on the bases of data measured in 2009.

4. Pilot B2

4.1 Name of pilot

Braunschweig (Germany): Centre for Informatics at the Technical University of Braunschweig

4.2 Location

The building is located in the city centre of Braunschweig, a city of 200.000 inhabitants in Lower Saxony, Germany.

The postal address is Mühlenpfordtstr. 23, 38106 Braunschweig, Germany.

4.3 Building description

The Centre of Informatics and Architecture of the Technical University in Braunschweig is situated in two buildings on the university campus. The first one, so called BS4, was built in 70s of the last century. The 13-storey building is the seat of several institutes of informatics and architecture and has been partially refurbished floor by floor over the last 10 years with minor improvements regarding the energy efficiency. The 10th floor was improved more through a demonstration project with measures including new glazing, lighting and glazed interior walls.

Figure 4 Informatics Centre of the TU Braunschweig: the new part next to the old 13-storey building

The construction of the New Centre of Informatics was completed in late 2001 as an addition to the north side of the existing multi-storey building. The aim of the extension was to assemble all institutes, laboratories and installations bound up with the Informatics Faculty in one building complex. First five floors of the old part are conjoined with the new part. The rest of the building was partly converted. However the main core of the building is almost the same and it looks like 11^{th} floor

Figure 5 A plan of the 1st floor of the Centre for Informatics: a new part and an old part

Figure 6 A plan for the 11th floor

Table 12 Short characteristic of the Centre of Informatics

The Centre of Informatics		
Type of building	office building	
	old building	new building
Completion	1976	2001
Gross building area [m²]	9.765	10.649
Net building area [m²]	8.570	8.945
Gross building volume [m³]	36.370	33.500
Net building volume [m³]	30.648	

4.4 Description of systems in the building

4.4.1 Energy design

Old Building

The old part of the building was built as a post-and-beam construction. It is heated by radiators. In addition to the natural ventilation the building is equipped with a mechanical ventilation system which is currently shut off in some parts of the building. Regular rooms have no cooling system.

Figure 7 Energy concept for an old part

New Building

The new building was completely designed as a demonstration building for energy efficiency funded by the German Ministry for Economics and Technology. The goal of the energy concept in the new part of the building was to improve energy demand of the building for heating, cooling and ventilation and increase user's comfort simultaneously. The target values for the annual primary energy demand were 100 kWh/(m^2a) including final energy of 40 kWh/(m^2a) for heating and 20 kWh/(m^2a) for electricity (without energy used for specific office equipment like computers, copiers, vending machines etc.). The building has been built around a glazed atrium which is used for natural ventilation. It has a conventional radiant heating system. Cooling systems are only installed for central IT rooms.

The reference area is the heated net floor area. The primary energy factor for district heating is 0,7 and 2,7 for electrical energy.

Figure 8 Energy concept for a new part – summer

Figure 9 Energy concept for a new part– winter

The new part of the building was constructed with reinforced concrete in frame construction and one additional storey in steel construction. The façade consists of an aluminium post and beam construction with parapet and lintel panels. All building parts have good thermal insulation.

The physical parameters of the glazing in the new part are adjusted to their respective orientations. East- and west-orientated windows as well as glazed surface of the atrium's roof have low g-values for sun protection. The inside walls toward the heated atrium are not insulated and single-glassed.

Moreover several rooms had been equipped with electrochrome sunshade glazing with changeable transparency. These glazing have been replaced by regular glazing after a testing phase.

4.4.2 Energy supply

Both parts of the building are supplied with power by external sources -district heating and the electrical grid. The new building atrium is supplied with air by natural ventilation through an underground duct for cooling. There is no additional power supplied to the building by renewable energy sources.

4.4.3 Heating / Cooling

Old part

The whole part of building is equipped with radiators supplied by district heating. There is no system for room cooling in the building, but only for servers.

New part

In winter the atrium is heated to 18 - 20°C by the ventilation with floor outlets on the basement level and by wall radiators on the first floor. All offices connected to external façade of the building are equipped with radiators and have individual air temperature control devices connected to the building management system. Offices with their facade towards the atrium have no heating system in the room. Except for the air conditioning units for the server rooms, no additional cooling units are installed in the building. The server rooms are cooled by wall-mounted cold water chests which are integrated into individual room control systems. The warm air exhaust from the cooling units is used by a heat recovery system for heating of the atrium in wintertime.

4.4.4 Ventilation

Old part

The old building is naturally ventilated through windows that can be opened manually. An existing ventilation system is not in operation and it is partly dismantled.

New part

The Atrium constitutes the core of the energy concept in NIZ. According to analyses and simulation, the idea of ventilation based on natural convection in an atrium was applied in the building and optimized for specific weather conditions during summer and winter.

In winter time, preheated air from the basement flows to the top of the atrium, supplying adjacent offices with air. Air quality and temperature in the atrium are permanently controlled. Permanent control of temperature and air quality in the atrium ensures a sufficient air exchange by opening ventilation flaps and in the roof.

In summer, the outside air is naturally cooled down while flowing through the underground duct work.

Office spaces are ventilated through natural ventilation either by external windows or to the atrium. For a better cooling effect, natural night ventilation was provided in the building with additional windows above doors. The intensity of the process depends on external and internal temperatures.

4.4.5 Office concept

Figure 10 Office concept BS4

Figure 11 Office concept NIZ

Sun protection

The old part of the building is protected against sun radiation by sun protection glazing and internal, manual shading devices. Additionally the southwest façade on the 4th floor is equipped with external shading systems and double skin (for experimental purposes).

The new building is protected against the overheating by external sunshades. Electrochromatic glazing had been installed in some offices during the demonstration phase but has been removed afterwards.

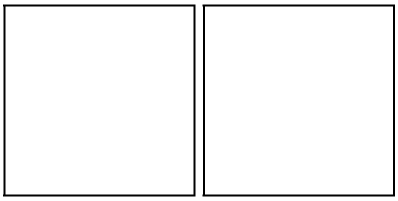


Figure 12 Electrochromatic glazing. Internal shading devices in the old part

Daylight usage

In the old building, deep rooms have only a limited access to daylight. Internal rooms partially have no daylight at all.

All workplaces in the new building have daylight, even the ones adjacent to the atrium.

Lighting

Old part

The lighting system is diverse on the individual floors. The first four floors (connected with the new part) have been refurbished and equipped with new suspended lamps and additionally direct lighting in the offices. The remaining part of the building is equipped with a variety of lighting systems.

New part

Artificial lighting is provided by direct (35%) and indirect (65%) lighting systems: suspended lamps with dimmers, electronic ballast of illuminant and bulb wattage 2 x 58 W per lamp. The standard office is equipped with two independent suspended lamps.

Lighting Management Systems

Old part

There is no central lighting management system in the old part of the building. The light is switched on and off manually by users. There are no motion or lightness sensors installed.

New part

Lighting management system is equipped with light and motion sensors. Generally, lighting in the office is switched on and off by user. However, an intensity of the light is controlled by light sensors and adjusted to 350 lx on the work desk. There is also a possibility of individual regulation by the user. The light is automatically switched off by a signal from motion sensors after 15 minutes of absence in the room.

4.4.6 Current situation

The old part of the building is a space allotted for offices and places for students. The building is divided into offices, lecture rooms as well as to stands and workshops for students.

About ¾ of total area of the new building is used for offices, management and educational purposes, remaining ¼ (mostly situated in the basement) constitutes laboratories. Aside from 168 workstations for regular employees there are also about 20 work- and about 10 laboratory stands for students.

The building is used for office and educational purposes – lecture rooms, stands and workshops for students. Due to its mixed use it is impossible to determine explicitly the time and way of use of the building. Generally it is used as an “office building” with operation time from Monday to Friday, from 9am to 6 pm. However students’ workshops are mostly in use during semester months (October – July) from midday to midnight. Laboratory and seminar rooms are used sporadically.

4.4.7 Defining a baseline

The baseline for the Centre of Informatics is going to be based on existing measurements and data from building management.

In addition to the overall energy consumption of the building, three detailed baselines will be established to evaluate the individual frontends, **¡Error!Argumento de modificador desconocido.**.

Table 13 Baselines

Evaluation	Part of the building/lighting system	Type of energy	Period of reference	Baseline
Frontend 1	floors 5^{th} – 8^{th}	Consumption of electricity	from 07.08.09	Currently measured
Frontend 2	floors 11^{th} – 12^{th}	Consumption of electricity	from 07.08.09	Currently measured
Frontend 3	Chiller plant	Coefficient of performance	2003 – 2006	2,6
All Frontends	Whole building	Consumption of electrical energy	2006 – 2008	1.228.188 kWh_E/a

All Frontends	Whole building	Consumption of district heat	2006 – 2008	1.053.137 kWh_E/a

The different baselines will increase the significance of the evaluation results and help to create more precise guidelines for future implementations of ICT systems. Above given baselines are based on the average data from last 3 years for consumption of electrical energy and district heat, current data for consumption of electrical energy for particular floors and data for 2006 for coefficient of performance of chillers.

Data for consumption of electrical energy and energy for heating presented above are not weather corrected. According to DIN EN 15603:2008 article 7.4 average data from at least 3 years do not have to be weather corrected.

4.4.8 Measurement status

The university uses two different kinds of metering systems. The Building Management System (BMS) of Siemens and Kieback & Peter are used to operate the systems and collect operation data like temperatures and valve positions. The additional System EnerGO is a Building Energy Management System (BEMS) that is only used for collecting data on energy consumption.

Since 2008 the total monthly energy consumption for heating and electricity is measured with the BEMS. Older data for energy consumption for heating, cooling and electricity are available only in annual values that have been collected manually.

4.5 Energy consumption

The following figures refer to final energy measured on site and to heated net floor area according to the German Standard DIN 277. The net floor area of the Centre for Informatics (old + new building) is 17.515 m^2. All data are received from building management TU Braunschweig.

4.5.1 Energy consumption for heating

The following table shows the annual data for the energy consumption in the Centre for Informatics at the TU of Braunschweig for period 2005-2008. The data is not weather corrected according to VDI 3807 (degree days).

Table 14 Annual energy consumption for heating

	Annual energy consumption for heating [kWh/a]	Annual energy consumption for heating per net floor area [kWh/(m²a)]
2005	1.019.879	58,23
2006	1.046.868	59,77
2007	1.099.803	62,79
2008	1.012.740	57,82
2009	*currently metered*	*currently metered*

Figure 13 Annual energy consumption for heating

Monthly data for energy consumption in the Centre for Informatics at the Technical University of Braunschweig are available since October 2008. The data is not weather corrected according to VDI 3807 (degree days).

Table 15 Monthly energy consumption for heating in period from October 2008 to October 2009

	Energy consumption for heating [MWh/a]	Energy consumption for heating per net floor area [kWh/(m²a)]
October 2008	68,146	3,89
November 2008	113,068	6,46
December 2008	173,859	9,93
January 2009	220,690	12,60
February 2009	148,367	8,47
March 2009	113,879	6,50
April 2009	41,920	2,39
May 2009	27,740	1,58
June 2009	17,930	1,02
July 2009	2,590	0,14
August 2009	0	0
September 2009	16,720	0,95
October 2009	91,552	5,22

4.5.2 Total electrical energy consumption

The next table shows the annual data for the electrical energy consumption in the Centre for Informatics at the Technical University of Braunschweig for period 2005-2008.

Table 16 Annual electrical energy consumption

	Electrical energy consumption [kWh/a]	Electrical energy consumption per net area [kWh/(m²a)]
2005	1.187.028	67,77
2006	1.252.209	71,49
2007	1.229.330	70,19
2008	1.203.025	68,69
2009	*currently metered*	*currently metered*

Figure 14 Annual electrical energy consumption

Monthly data for electrical energy consumption in the Centre for Informatics at the Technical University of Braunschweig are available since June 2008. All data are received from building management of TU Braunschweig.

Table 17 Monthly electrical energy consumption

	Electrical energy consumption [MWh/month]	Electrical energy consumption per net area [kWh/(m²*month)]
June 2008	31,887	1,82
July 2008	34,374	1,96
August 2008	32,688	1,87
September 2008	30,371	1,73
October 2008	32,730	1,87
November 2008	35,616	2,03
December 2008	33,815	1,93

January 2009	32,761	1,87
February 2009	32,025	1,83
March 2009	34,038	1,94
April 2009	32,371	1,85
May 2009	33,878	1,93
June 2009	29,391	1,67
July 2009	32,856	1,87
August 2009	36,121	2,06
September 2009	29,260	1,57
October 2009	31,277	1,78

4.5.3 Electrical energy consumption for cooling

The building is equipped with two chillers used for server cooling purposes. Energy consumption for chillers in period from 2003 to 2006 fluctuated round 98.000 kWh_E/a, what gives about 294.000 kWh_{PE}/a.

The values of COP of chillers for period from 2003 to 2006 amounted between 2,6 and 2,8.

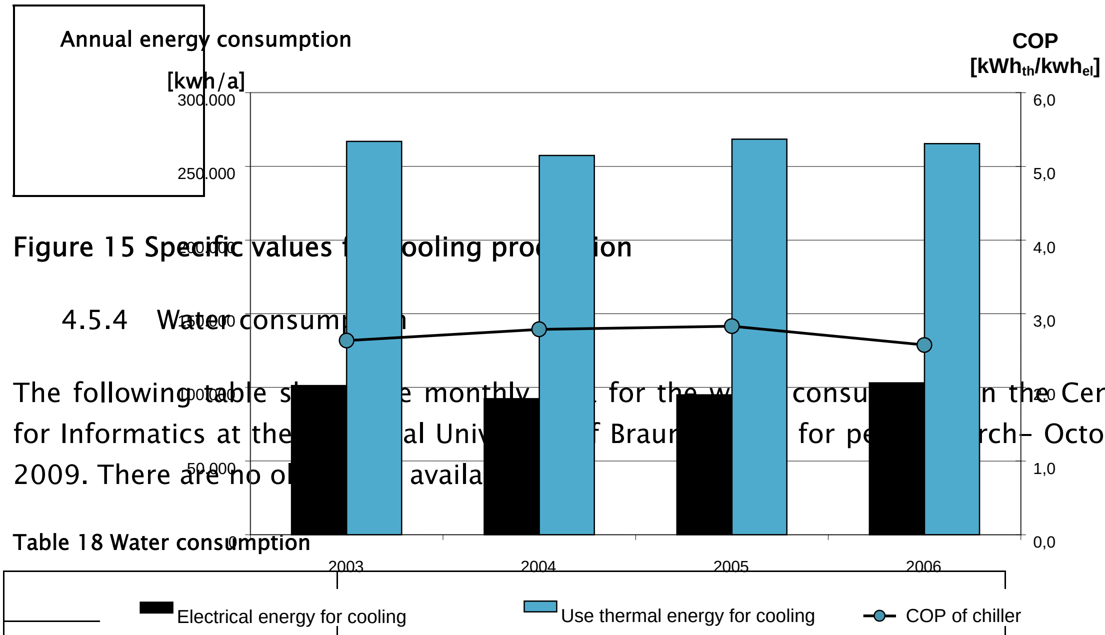


Figure 15 Specific values f[illegible]ooling pro[illegible]ion

4.5.4 Water consum[illegible]

The following table s[illegible]e monthly [illegible] for the w[illegible] consu[illegible]n the Centre for Informatics at the [illegible]al Univ[illegible]f Braun[illegible] for pe[illegible]rch– October 2009. There are no o[illegible] availa[illegible]

Table 18 Water consumption

[illegible]	[illegible]
March 2009	129,0
April 2009	130,7
May 2009	136,0
June 2009	126,7

July 2009	107,4
August 2009	107,8
September 2009	99,0
October 2009	123,2

4.5.5 Hot water consumption

There is no central hot water supply in the building, since most of the kitchens are equipped with electric instant water heaters. Electricity consumption for hot water is enclosed in total electricity consumption in the building.

4.6 Yearly cost of energy

The costs are calculated by multiplying the annual consumption (not normalized) with the average prices for energy that the university pays. All prices and cost figures include VAT and other taxes. The net floor area of the Centre for Informatics (old + new building) is 17.515 m². All data are received from building management TU Braunschweig.

4.6.1 Annual costs for heating

The costs of heating energy have been provided by the University. All data are received from building management TU Braunschweig. All prices and cost figures include VAT. The net floor area of the Centre for Informatics (old + new building) is 17.515 m².

Prices for heating energy oscillate around 48,58 – 79,49 €/MWh.

The next table shows data for the building for period 2005-2007.

Table 19 Annual cost for heating

Year	Gross annual cost for heating [€/a]	Gross annual cost for heating per area [€/(m²a)]
2005	58.086,47	3,32
2006	73.097,49	4,17
2007	84.302,59	4,81
2008	78.646,82	4,49

4.6.2 Cost of electrical energy

The price for electrical energy oscillates around 10,56 – 13,86 ct/kWh.

The next table shows data for the building for period 2005-2007. All data are received from building management TU Braunschweig.

Table 20 Annual cost for electricity

Year	Gross annual costs for electricity [€/a]	Gross annual cost for electricity per area [€/(m²a)]
2005	106.874,31	6,10
2006	142.295,55	8,12
2007	142.217,77	8,12
2008	166.756,90	9,52

4.7 Future measurements

The monitoring will include additional metering started summer 2009. It is planned to have at least 6 month of data to calculate a baseline for energy consumption. The metering will also allow a more detailed analysis of the distribution among different consumers.

The next figure shows the new metering concept with continuous meterings.

Figure 16 Metering concept

The metering concept shown above is connected to the building management system and collect data in time step of 15-minutes intervals.

In addition single appliances and lighting devices will be monitored over shorter periods of time to analyse their performance and use.

4.8 Reporting

The next figure shows the data management concept for the project.

Figure 17 Monitoring concept

All energy data will be stored in the facility energy management system of the university, all other data in the building management system.

Energy-Navigator works with the data from building management database carrying out several data checking procedures and transforming them into a format with equidistant time steps. The frequency of the data transfer to the Energy-Navigator has not yet been determined.

After rule-based analyse, final report and hints for user and building management are created.

4.8.1 Historic data

There have been several changes in the building through a change of use. The baseline of all measurements will be calculated on the bases of data measured in 2009. This ensures that the baseline reflects the current situation of the building and does not refer to a former state of the building.

4.8.2 Future measurements

According to a new measuring concept, measurements of energy consumption will be taken for:

- electricity for the whole building,
- electricity for the two parts separately,
- electricity for particular floors (from 5th to 12th, for lighting and appliances together),
- electricity for server's cooling.

Consumption of energy for heating will be measured for a new and old part of the building separately.

5. Pilot L1

This document contains a description of the street lighting systems.

5.1 Name of pilot

Etxarriene public street lighting

5.2 Location

Etxarriene is a residential neighbourhood located in San Sebastian-Donostia city. It has about 24600 m^2, of which 16000 m^2 are public area, and the rest are for houses, without no commercial activity. The public area has pedestrian and vehicular ways that are actually lighted with 79 light points.

5.3 Description of lighting system

5.3.1 Current system

The current lighting system is based on 150 W High Pressure Sodium (HPS) lamp, with 5 m light poles, staggered arrangement and 25 meters spacing. The luminaires are Philips Milewide SRS 421, made of aluminium with tempered glass closure, mounted on 5 m steel poles. The lighting installation is composed of 79 lighting points, distributed in a 16000 m^2 area. These luminaires are supplied through two 400 V three-Phase line, which have four conductors (3 Ph + N) in order to supply 230 V to each luminaire.

The 150 W HPS lamps have clear tubular outer bulb, high output and long reliable lifetime, its consumption with electromagnetic ballasts and starters is 177 W (230 V single phase supply voltage).

The light system is controlled by an astronomic programmable light sensitive switch, which operates lighting on/off programmes in accordance with sunrise and sunset times. It has two output contact, one for lighting on/off programme, and the other for lighting flow dimmer-stabilizer on/off programme. A lighting flow dimmer-stabilizer is installed in header, it stabilizes the voltage and reduces it down to 180 V, causing a reduction in light levels of 50%. This operation reduces power consumption about 40%.

In reference to measures, there is no automatic system to measure consumptions, the only reference is given by the power meter, and is shown in the invoice received from the power supplier.

5.3.2 Future system

The lighting system is based on 90 W Philips Cosmopolis System lamp, which have a very good CRI (Color Rendering index) value, this allows to reduce the lamp power without reduce the lighting characteristics in the area. In this case the **150 W HPS is changed by a** 90 W Philips Cosmopolis System (equals 100 W HSP). The 90 W lamp and its auxiliary equipment consume about 95 W (auxiliary equipment with very low consumption).

In reference to the control system, it will be Philips Starsense. This is a telemanagement system for monitoring, controlling, metering and diagnosing outdoor lighting. It enables individual light points to be switched on or off at any given time, or to be set to any dimming level. The light points at a specific location can be grouped to react at the same time. The age and condition of each lamp can be monitored and any failures are reported by exact location. These capabilities offer the opportunity to significantly reduce maintenance costs through extended lamp life and accurate planning of service calls.

This system uses power lines to communicate data between the elements of the system, these elements are:

- The **Outdoor Luminaire Controller (OLC)** switches and dims the lamp and detects lamp failures. It communicates to the Segment Controller via a power line to interface with the electronic ballast and a relay to switch it on and off.
- The **Segment Controller (SC)** controls a number of OLCs connected to the same power grid and gathers information from them to be sent, when required, to the remote PC via Internet, typically through GPRS.
- The **Starsense Supervisor Software** monitors and manages the data from the SCs. It collects, aggregates and filters data before storing it in a central database. It transforms data with the aim of extracting useful information and facilitating conclusions; energy analysis, problem detection, problem location, lamp lifetime forecast and many other features.

5.4 Energy consumption

5.4.1 Measurements (2008)

The following table shows the consumption registered by the power meter, shown in the invoice received from power supplier (monthly, sometimes bi-monthly).

Table 21 The consumption registered by the power meter

Month	Consumption (kWh)	Time On Light	Time On Dimmer	Time Off Light
December (2007)	no invoice (4947)			
January	9894 (4947)	18:00	00:00	8:28
February	no invoice (4153)	18:40	00:00	8:00
March	8307 (4153)	19:18	00:00	7:12
April	3821	19:50	00:00	6:21
May	3150	20:18	00:00	5:48
June	2588	20:40	00:00	5:28
July	2597	20:42	00:00	5:42
August	2735	20:12	00:00	6:08
September	3227	19:22	00:00	6:42
October	3448	18:32	00:00	7:12
November	3930	17:58	00:00	7:48
December	4594	17:48	00:00	8:18
TOTAL (2008)	**43343**			

5.4.2 Estimated energy consumption

Current System

Lighting time use per year is about 4300 hours (H_1):

- with lighting flow dimmer: 60% – 2580 hours (H_2)
- without lighting flow dimmer: 40% – 1720 hours (H_3)
- The lighting flow dimmer reduces 50 V (supply voltage at night: 240 V), avoiding the 40% of consumption (u_1=0'4 y u_2=0'6):

The theoretical annual consumption of the installation is as follows:

– Total consumption without lighting flow dimmer (time period H_1):

– Consumption with lighting flow dimmer (time period H_2):

– Consumption without lighting flow dimmer (time period H_3):

– Total consumption with lighting flow dimmer (time period H_1):

Calculating the consumption per m^2 (16000 m^2 of public area to light):

Future System

Lighting time use per year is about 4300 hours (H_1):

- with lighting flow dimmer: 60% – 2580 hours (H_2)
- without lighting flow dimmer: 40% – 1720 hours (H_3)

In this case, the Starsense-Cosmopolis lighting flow dimmer reducces a 50% of consumption with a proper parameterization of the telemanagement system (u_1=0'5 y u_2=0'5):

The theoretical annual consumption of the installation is as follows:

- Total consumption without lighting flow dimmer (time period H_1):

- Consumption with lighting flow dimmer (time period H_2):

- Consumption without lighting flow dimmer (time period H_3):

- Total consumption with lighting flow dimmer (time period H_1):

Calculating the consumption per m² (16000 m² of public area to light):

The future system saves about 50% of consumption compared with the current system (from 45,6 kWh to 23,32 kWh, theoretical values).

5.4.3 Future measurements

After installing the new lighting system, the following measurements will be done:

With Starsense telemanagement system, every three weeks, the next data will be checked:

- How system works ? (On, Off, Dimming)
- Consumption (daily, weekly, intervals with/without lighting flow dimmer)
- Monthly, the consumption measurement will be compared with the power supplier measurement (registered by the power meter, shown in the invoice).

In addition, quarterly, the lighting maintenance services will check in situ the lighting level (illuminance) and the operation of telemanagement system.

6. Pilot L2

6.1 Name of pilot

Almada Street Lighting Area

6.2 Location

Almada Portugal

6.3 Street Lighting Area Description

The implementation of the intelligent street lighting system will follow a step by step approach starting by a small scale project that can afterwards be replicated to other street lighting plants included in this area. The first stage will include the introduction of the system in an area near the limits with the neighbouring municipality of Seixal, where some tests with simple dimmers were already produced. This area is part of the new light rail system in Almada with a new Street lighting system but no intensity regulation or ICT systems.

The total area possible to have the new system includes all the new tram line which has an extension of 13,5 km, still at the first stage only a small area will be covered of about 0,5 km and including 103 public light points (70W metal halide for the pedestrian/cycling area – 61 light points –, and 100W sodium-vapour – 42 light points). The location where phase 1 of pilot L2 will take place is a heavy traffic area with pedestrian and cycling pathway and several services such as a gas station, a school, a bus depot, residential buildings and leisure areas in an extension of approximately 700 meters (**¡Error!Argumento de modificador desconocido.**).

Figure 18 Location and lighting system of phase 1 for pilot L2 – Av. 23 de Julho, Almada

6.4 Description of systems in building

The system is a straight forward public lightning system where the light points are high pressure sodium or metal halide lamps, equipped with magnetic ballasts and connected to a transformation station.

6.4.1 Current situation

The current operation of the system is fully automated using an astronomical clock and on location verification of the systems when necessary. Currently the operational procedure is not straight forward since operation (including levels and schedules of light; lamp operation; etc.) is a responsibility of the Municipality but maintenance procedure and installation of systems is totally a responsibility of the energy service provider.

6.4.2 Defining a baseline

Although the baseline for evaluation will be the energy consumption depicted in the next chapter extra baselines could be used to cross check targets and specify energy efficiency gainings associated with pilot L2. The use of estimates as a baseline is, in the particular case of Almada, the way to correctly evaluate impacts especially in what regards energy costs. In fact, payments for energy are based on these estimates and changes to billing procedures leveraged by the ICT information are a direct result of such intervention. Nevertheless, other data comparison will be useful such as: diagnostics measurements, and data from ICT with no dimming to quantify reduction achieved solely by introduction of electronic ballasts.

6.4.3 Measurement status

The measurement of the electrical energy consumption is, for now, solely possible through billing information from the energy service provider, and in most of the areas this accountancy is made in conjunction with other light points that are not a part of the pilot project area. There are some areas (i.e. the priority area of intervention) where some measurements were already taken and where the billing is also available solely to the specified light points in the pilot area. The available measurements include the ones made during the dimming tests already mentioned. It is an objective of introducing the ICT systems to improve all these aspects.

Although time of operation is not directly measured, it can be estimated trough the specifications of the astronomical clock.

6.5 Energy consumption

Data on energy consumption is for now only available through billing information which is based on estimates. Further on the development of the project, it will also be possible to obtain real measures from the diagnostics of the system.

6.5.1 Reference energy consumption

The energy consumption to be used as a baseline according the assumptions referred to in the previous chapter is depicted in table 22:

Table 22 Electrical energy consumption in pilot L2 – public lighting in Almada

	Annual electrical energy consumption [kWh]	Annual electrical energy consumption per luminaire [kWh/luminaire]
Year 2008	43536	423

6.5.1 Expected reference energy consumption

The expected reference energy consumption and other indicators can be seen there. The indicators used in the Almada public lighting project are defined in deliverable D1.2 and the method for calculating the indicators is explained in deliverable D1.4.

Table 23 Expected reference energy consumption and other indicators in pilot L2 – public lighting in Almada

Indicators (primary and secondary – see D1.2 for further information)	No.	Reference (baseline)	Expected	Unit (per year)
Primary energy consumption	1	129	90	MWh
Specific primary energy consumption	1a	1251	876	kWh/lum
Delivered electricity	2	44	30	MWh
Specific delivered electricity	2a	423	296	kWh/lum
CO_2 Emissions	5	28	19	ton(CO_2)
Specific CO_2 Emissions	5a	0,3	0,2	kg(CO_2)/m^2
Relative reduction of CO_2 emissions	6	–	30	%
Relative energy savings in primary energy	7	–	30	%
Energy cost savings – actual costs	8	–	1140	€
Relative energy cost savings – actual costs	8a	–	30	%
Electrical Energy Savings	S11	–	30	%
Energy cost per luminaire	S12	37	26	€/ Lum

Luminous flux per energy consumption	S13	–	–	Lux/kWh
CO_2 reduction cost per ton	S14	–	<0	€/ton(CO_2)

6.5.2 Expected yearly cost of energy

Total costs of the first stage of the pilot are available also through billing information from the energy service provider. In 2008, costs were roughly 3 800,00€ for the total electrical energy consumption. This means an average cost of 8,60 €cents per kWh.

Price varies according to daytime. Hours in the lower area of the load diagram have a cost of 6,10 €cents per kWh. Remaining operation hours have a price of 11,30 €cents per kW. The energy service provider assumes that from 22h00 until 8h00 is off peak, i.e., low demand price, and standard rate for the remaining hours.

6.5.3 Future measurements

In order to ensure effectiveness of the systems management, some extra detail is needed. After installing the ICT systems it will be possible to define new mearuments:

- Monitor and control each light point individually
- Easy access to energy consumption by light point
- Lifetime, usage time, estimated time left to end life of lamps and other components
- Regulation charts per light point with time evolution
- Charts and data with energy consumption and savings
- Provide system failure and warnings reports
- CO_2 emissions and CO_2 emissions savings charts and data relative to baseline
- Define and generate new data and charts as needed

7. Replication pilot R1.1 (Belartza)

This document contains a description of the building systems.

7.1 Name of pilot

Belartza, San Sebastián (Spain): Municipal Centre for Social and Inclusive Companies

7.2 Location

Gurutzegi 14-16-18 20028 San Sebastián

7.3 Building description

This Centre for Social and Inclusive Companies has 3 modules with the aim of housing 10 companies and surfaces from 180 to 1000 m2 for industrial purposes. The total built surface is 4.910,70 m2 above ground level.

The three modules are connected by a footbridge. The first module is located in 18 Gurutzegi Street, the second module in 16 Gurutzegi Street and the third module in 14 Gurutzegi Street.

The first module consists on 2 floors (ground and first floor) where is located one of the companies ("Company 10")

The second module consists on 2 floors (ground and first floor) where are located 8 companies: 4 on ground floor (Companies 2,3,4 and 5) and 4 on the first floor (companies 6,7,8 and 9). The secondary electricity room is located on ground floor with the company 5. There are toilets on this floor.

The third module consists on 2 floors (ground and first floor) where "Company 1" is located. The hall access to companies and common areas of the first floor is located on ground floor. From this hall is possible to access to: telecommunications room, lift room and electricity/water meter room. Solar photovoltaic energy inverter is located here. Common auditorium hall is located on the first floor.

The footbridge from the first to the second one, there is located a common use hall.

The footbridge from the second to the third module has a meeting room and an office at one´s disposal.

The companies located on the ground floor have vehicle and pedestrian access.

The ones located on the first floor have pedestrian access from east communication corridor getting from a lift or the stairs. Additionally there is a space reserved for installing a goods lift.

The building faces a free space to the north, east and south, and the street Gurutzegi to the west.

The building takes up 3.004,31 m2 of surface labelled as Social Equipment.

There are solar photovoltaic panels installed on the roof.

The surfaces are the following:

Table 24 Surfaces

COMPANY	SURFACE GROUND FLOOR	SURFACE FIRST FLOOR	TOTAL SURFACE
COMPANY 1	877,40 m2	706,50 m2	1583,90 m2
COMPANY 2	190,50 m2		190,50 m2
COMPANY 3	191,30 m2		191,30 m2
COMPANY 4	190,50 m2		190,50 m2
COMPANY 5	185,76 m2		185,76 m2
COMPANY 6		190,60 m2	190,60 m2
COMPANY 7		190,60 m2	190,60 m2
COMPANY 8		141,00 m2	141,00 m2
COMPANY 9		141,00 m2	141,00 m2
COMPANY 10	709,00 m2	709,00 m2	1418,00 m2
COMMON AREAS	58,00 m2	429,54 m2	487.54 m2
TOTAL	2402,46 m2	2508,24 m2	**4910,70 m2**

The construction of the building was carried out according to San Sebastian Council built license dated on 2004. The construction is already finished.

7.4 Description of systems in building

7.4.1. Heating/Cooling

The building is quite new building but there is not an innovative solution for energy design.

There is not central heating system. There is not heating/cooling system in the common areas. And each company manages its own system.

The heating and cooling system is electrical in all the building. There is not any town gas system.

There is an air conditioning system in the common areas. Each company manages its own consumption in the private areas with the local energy supplier Iberdrola. FSS do not manage these data.

7.4.2. Energy Supply

The three modules of the building are supplied by local energy supplier Iberdrola. There is also a solar photovoltaic system installed in order to sell it to Iberdrola.

The electricity system installation is made up of light/power points in the common areas, the power supply for the lift and light/power points in private areas.

There is not any kind of energy savings measurement assumed.

Fluorescent lighting is used in all the building.

Each company contracts directly the local energy supplier service. We do not have data referring to the private areas of the companies.

7.4.3. Water

There is a running water system installed in common areas (toilets). The consumption of this installation is managed by FSS.

Each company manages its own water consumption.

The water is electrically heated. But the system is disconnected.

There is not any kind of energy saving measurement assumed.

7.4.4. Building lighting system

Fluorescent lighting is used to illuminate all areas of the building.

There are 5 groups of light/movement sensors installed.

The light is switched on and off automatically depending if there is someone or during the night. By default, the lighting is switched off during the day.

7.4.5. Current operation of building or lighting system

Each company has got its own meter and its own contract with local energy supplier.

There are not light or motion detection sensors in the building.

The timetable for the auditorium and meeting rooms is established. But the timetable for the rest of common areas and companies sections is not established. There is not a limit of using the light for these areas (neither for weekends or holiday).

Measurements

Water: through meters and invoices. There are several specific invoices for common areas per floor and for each company.

Electricity: through meters and invoices. There are several specific invoices for common areas per floor and for each company.

Heating: this service is included in electricity consumption invoice.

How is it measured?

Through meters installed in several points.

Who measures this?

Water: Local water supplier (Council of San Sebastián) measures the regular and fire water consumption (in situ).

Electricity: Local electricity supplier (Iberdrola) measures the electricity consumption (tele- measurement system).

Where and how is it reported?

The invoice is the report.

Water: the consumption is measured by the supplier through the meters in situ. The invoice is sent each three-month period.

Electricity: the consumption is measured by the supplier through an automatic system. The invoice is sent each month.

Are data recorded automatically?

The consumption is recorded automatically in the meters. But the system does not allow to get historical data.

7.5 Energy consumption

Heating, electricity and water consumption is currently measured. But this measurement is used to know the cost and not the evolution of the consumption.

Since 2006, the consumption has been measured as it is explained above.

There are only two sources of consumption: water and electricity.

They should be measured taking into account:

- evolution of the consumption
- different spaces
- different needs for each area
- more detail for each use of the measured area
- distinction according to the season-time slot

7.5.1 Measurements

The main consumptions measurements are described in the following. The net floor area for Belartza is 4.910 m2.

For the common areas the total electricity consumption in 2008 was 14.659 Kwh.

There is no data from whole building electrical energy consumption. The following table shows the annual estimated total electrical energy consumption in Belartza for 2008 year.

Table 25 Annual electrical energy consumption

	Annual electrical energy consumption [kWh/a]	Annual electrical energy consumption per net floor area [kWh/(m²a)]
2008	705.080	143,60*

Energy consumption for heating (if more sources deliver heat to the building, data should be reported for each)

There is no data from energy consumption for heating.

There is only one invoice without detailed data for each system.

Energy (or electricity) consumption for cooling (if more sources deliver cooling energy to the building, data should be reported for each)

There is no data from energy consumption for cooling.

There is only one invoice without detailed data for each system.

Electricity use for building management (ventilators, pumps, lighting)

There is no data from energy consumption for building management.

There is only one invoice without detailed data for each system.

Electricity use for other appliances (computers, task lighting, printers, coffee machines). Only reported as possible

There is no data from energy consumption for other appliances.

There is only one invoice without detailed data for each system.

Water consumption

Water consumption for the period of 3 months in 2008 in common areas was 23m3.

Hot water consumption

There is not hot water in the common areas.

7.5.1 Yearly cost of the energy

Electrical energy

The average price for electrical energy is 10,1941 cts€/kWh.

Note: the rent of meters and other supplier services not included.

Table 26 Annual cost for electrical energy

	Gross annual cost for electrical energy [€/a]	Gross annual cost for electrical energy per area [€/(m²a)]
2008*	71.876	14,64*

Cost of water

The total water consumption for common areas in 2008: 92 m3.

The total cost of water consumption for common areas in 2008 was: 92 m3 x 0,6808 €/m3 = 62.63 €

Note: the rent of meters and other supplier services not included.

7.5.2 Future measurements

The plan for the future measurements should be to measure all the systems consumption separately and in different period of time.

Nowadays there is not any distinction of these systems consumption.

The new measuring system is under discussion.

The list of possible measurements is the following:

- Energy consumption for heating (if more sources deliver heat to the building, data should be reported for each)

- Energy (or electricity) consumption for cooling (if more sources deliver cooling energy to the building, data should be reported for each); there are only common areas
- Electricity use for building management (ventilators, pumps, lighting)
- Electricity use for other appliances (computers, tasks lighting, printers, coffee machines). It should be necessary to involve each company.
- Total electricity consumption
- Weather conditions (temperature, humidity, wind, irradiation)
- Indoor conditions (temperature, humidity, CO2, lighting levels, thermal confort)
- Measurements frequency: 10-15 minutes.

7.6 Energy production

There are 594 solar photovoltaic panels installed on the roof. The installation is connected to the main power supply with 91,58 KWp nominal power rating.

The batteries are located on the roof with south orientation and 30ª of inclination.

This installation generated 89.852,00 KWp in 2008.

7.6.1. Measurements

This energy is generated only for sale.

Table 27 Solar photovoltaic energy production BELARTZA

Solar photovoltaic energy production BELARTZA

Period: 2008

2008	KWp
January	4.588
February	6.617
March	7.388
April	8.809
May	10.138
June	9.163
July	10.663
August	8.972
September	9.259
October	7.830
November	3.528
December	3.084
Total	90.039

7.6.2. Future measurements

Specifically, the following values should be measured (if there will be possible) in the future:

CO_2 emissions: Kg/t.u. (Calculation)

Building primary energy consumption: Kwhpci/m2.t.u (Calculation)

Under discussion

Where: t.u.: time unit

7.7 Reporting

Data from systems in the building will be transferred to the Best Energy system. The frequency of the data transfer has not yet been determined.

After rule-based analyze, Best Energy Best Energy tool provides decision makers with the necessary tools to plan energy savings measures.

7.7.1 Current (historic) data

The baseline of all measurements will be calculated on the bases of data measured in 2009.

7.7.2 Baseline data

The baseline of all measurements will be calculated on the bases of data measured in 2009.

8. Replication pilot R1.1 (CEMEI)

This document contains a description of the building systems.

8.1 Name of pilot

CEMEI, San Sebastián (Spain): The Municipality Centre for Innovative Companies (CEMEI)

8.2 Location

23 Portuetxe Street, A-B, 20018 San Sebastián

8.3 Building description

The Municipal Centre for Innovative Companies (CEMEI) houses innovative companies that develop their activity in an emergent field.

In this building these companies have rooms for medium or long term rent. The characteristics of the building are the following:

- 9000 m2 for renting distributed in 5 floors.
- 58 rooms. Nine of them, for semi industrial clean companies, and 49 offices.
- 162 car parking places for the workers and 32 for visits/guests.
- It has common areas and services, such as an auditorium for 80 people, with videoconference and simultaneous interpreting; a multipurpose room equipped for presentations, meetings and business training; a meeting room an office and the capability for management and administration services.
- The advanced facilities in each room are: Individualized security system, individual access for electricity and gas wire, individual access for water wire in semi industrial rooms and technical floor and false ceiling in office rooms.

The building is distributed in 2 underground basements (car parking) and 5 floors.

The locals from first and second floors are used to semi industrial clean companies. They do not need any important manufacturing process and they are not contaminant.

The rest of modules from third, fourth and fifth floors are used to service activities.

Total useful surface: 4.432,29 m2

Roof surface: 12.949,64 m2

Max. ground floor use: 3.102,60 m2

Number of floors: 5

Max. Height: 19 m

Table 28 Use, nº business and Rented surface (m2)

Use	Nº Business	Rented surface (m2)
Semi-industrial use	9	3.492,50
Commercial	49	5.521
Common	3	433
Underground (car park)	162 places	4.682

Built total surface: 17.541 m2

8.4 Description of systems in building

8.4.1 Heating

There is a central town gas heating system for the common areas. And each company manages its own system. But there is only one invoice for all the building.

GIROA does the maintenance service for all the heating system in the building.

8.4.2 Cooling

There is an Air Conditioned system installed in all the building. It does not need the maintenance service.

Each company manages its own consumption in the private areas with the local energy supplier Iberdrola. FSS do not manage these data.

8.4.3 Energy supply

All the areas of the building are supplied by local energy supplier Iberdrola.

The electricity system installation is made up of light/power points in the common areas, the power supply for the four lift and light/power points in private areas.

There is not any kind of energy savings measurement assumed.

Fluorescent lighting is used in all the building.

Each company contracts directly the local energy supplier service. We do not have data referring to the private areas of the companies.

8.4.4 Water

There is a running water system installed in common areas (toilets). The consumption of this installation is managed by FSS.

Each company manages its own water consumption.

The water is electrically heated. But the system is disconnected.

There is not any kind of energy saving measurement assumed.

8.4.5 Building lighting system

Fluorescent lighting is used to illuminate all areas of the building.

There is not any kind of energy saving measurement assumed.

8.4.6 Current operation of building or lighting system

Each company has got its meter and they pay the invoice directly.

There are not sensors in the common areas to manage the intensity of the light.

There is not assumed any target values for annual consumption.

It is necessary to maintain switched on all the light during the day (even with sun days).

The timetable for the common areas is established. But the timetable for the companies sections is not established. There is not a limit of using the light for these areas (neither for weekends or holiday).

Two caretakers are working from 08:00am to 08:00pm who are in charge of switching off the light bulbs where no one is there.

What is measured?

Water: through meters and invoices. There are several specific invoices for common areas per floor and for each company.

Electricity: through meters and invoices. There are several specific invoices for common areas per floor and for each company.

Town gas: through meter and invoice. There is only one meter for all the building. Each company pays this service based on its surface.

How is it measured?

Through meters installed in several points.

Who measures this?

Water: Local water supplier (Council of San Sebastián) measures the regular and fire-water consumption (in situ).

Electricity: Local electricity supplier (Iberdrola) measures the electricity consumption (tele- measurement system).

Town gas: Local town gas supplier (Naturgas) measures the gas consumption (tele-measurement system).

Where and how is it reported?

The invoice is the report.

Water: the consumption is measured by the supplier through the meters in situ. The invoice is sent each three-month period.

Electricity: the consumption is measured by the supplier through a tele-measurement system. The invoice is sent each month.

Town gas: Electricity: the consumption is measured by the supplier through a tele-measurement system. The invoice is sent each month.

Are data recorded automatically?

The consumption is recorded automatically in the meters. But the system does not allow to get historical data.

8.5 Energy consumption

Heating, electricity and water consumption is currently measured. But this measurement is used to know the cost and not the evolution of the consumption.

What has been measured?

Since 2005 (date of construction), the consumption has been measured as it is explained above.

What should be measured?

There are only three sources of consumption: water, electricity and town gas.

They should be measured taking into account:

- evolution of the consumption
- different spaces
- different needs for each area
- more detail for each use of the measured area
- distinction according to the season-time slot

8.5.1 Measurements

The main consumptions measurements are described in the following. The net floor area for Cemei is 17.541 m2.

Total electrical energy consumption

For the common areas the total electricity consumption in 2008 was 162.020 Kwh, 332.32 Kwh/m2.

There is no data from whole building electrical energy consumption. The following table shows the annual estimated total electrical energy consumption in Cemei for 2008 year.

Table 29 Annual electrical energy consumption

	Annual electrical energy consumption [kWh/a]	Annual energy consumption for heating per net floor area [kWh/(m²a)]

2008	1.260.270	71,85*

Energy consumption for heating (if more sources deliver heat to the building, data should be reported for each). NaturGas send an invoice monthly where energy consumption for heating is detailed.

Energy (or electricity) consumption for cooling (if more sources deliver cooling energy to the building, data should be reported for each). There is no data from energy consumption for cooling. There is only one invoice from Iberdrola without detailed data for each system.

Electricity use for building management (ventilators, pumps, lighting)

There is no data from energy consumption for building management. There is only one invoice without detailed data for each system.

Electricity use for other appliances (computers, task lighting, printers, coffee machines). Only reported as posible. There is no data from energy consumption for other appliances. There is only one invoice without detailed data for each system.

Water consumption

Water consumption for the period of 3 months in 2008 in common areas was xx 1.032 m3.

Hot water consumption

The is not hot water in the building.

8.5.2 Yearly cost of the energy

Cost of electricity

The average price for electrical energy is 9,6381 cts€/kWh. Note: the rent of meters and other supplier services not included.

Table 30 Annual cost for electrical energy

	Gross annual cost for electrical energy [€/a]	Gross annual cost for electrical energy per area [€/(m²a)]
2008*	121.466	6,92*

Cost of water

The total water consumption for common areas in 2008: 4.128m3. The total cost of water consumption for common areas in 2008 was: 4.128 m3 x 0,6808 €/m3 = 2.810.34 € Note: the rent of meters and other supplier services not included. There are not available all invoices of town gas consumption. The total consumption could be more or less 175.162 KWh. And the total cost: 175.162 KWh x 0,03 €/Kwh = 5.254.86 €. Note: the rent of meters and other supplier services not included.

8.5.3 Future measurements

The plan for the future measurements should be to measure all the systems consumption separately and in different period of time. Nowadays there is not any distinction of these systems consumption. The new measuring system is under discussion. The list of possible measurements is the following:

- Energy consumption for heating (if more sources deliver heat to the building, data should be reported for each)
- Energy (or electricity) consumption for cooling (if more sources deliver cooling energy to the building, data should be reported for each); there are only common areas
- Electricity use for building management (ventilators, pumps, lighting)
- Electricity use for other appliances (computers, tasks lighting, printers, coffee machines). It should be necessary to involve each company.
- Total electricity consumption
- Weather conditions (temperature, humidity, wind, irradiation)
- Indoor conditions (temperature, humidity, CO_2, lighting levels, thermal confort)
- Measurements frequency: 10-15 minutes.

8.6 Energy production

There is not energy production system in this building.

8.6.1 Measurements

Most or all of the following sets of data should be reported.

8.6.2 Yearly savings from the energy production

The yearly savings should be correlated to the price of the energy which is replaced.

8.7 Reporting

Data from systems in the building will be transferred to the Best Energy system. The frequency of the data transfer has not yet been determined. After rule-based analyze, Best Energy Best Energy tool provides decision makers with the necessary tools to plan energy savings measures.

8.7.1 Current (historic) data

The baseline of all measurements will be calculated on the bases of data measured in 2009.

8.7.2 Baseline data

The baseline of all measurements will be calculated on the bases of data measured in 2009.

9. Replication pilot R1.1 (Rozanés)

This document contains a description of the building systems.

9.1 Name of pilot

Rozanes, San Sebastián (Spain): Rozanés Building will be a residence for lodging researchers.

9.2 Location

42 Duque de Baena Avenue, Castillo de Rozanés plot, San Sebastián

9.3 Building description

Rozanés housing is a new development under construction that will be placed in the Duque de Baena Avenue, 42 (Ayete), in the Castillo Rozanés plot.

Its plant will have a surface of 2086m2, and will be composed of apartments for lodging researchers and their families:

- Ground floor (1023 m2)
- First, second and third floor (1118 m2 each one)
- Penthouse (578 m2)
- Cellar -1 (1303 m2 placed on the ground level at the back side of the building)
- Cellar -2 (244 m2 It will be used as storing, launderette, and control area of the building).

Apart from the apartments, this building will have common areas for education, exhibition and dissemination purposes, always relating to research activities:

- Digital auditorium 106 m2 and with a capacity for, approximately 90 people.
- Gymnasium 55 m2
- Launderette
- Administration, management and meeting rooms with library, 91 m2
- Covered area in the patio to be used as a bar or place for exhibitions. (65m2).

- Living room, 78m2
- Multipurpose room for happenings and living room with mobile furniture.
- Terrace with a pergola, and living room (100 m2).

9.4 Description of systems in building

Bioclimatic Features

The project of this building for apartments for lodging researchers and their families is draw up in collaboration with CENER (Centro Nacional de Energías Renovables; Renewable Energies National Centre):

Light Search

The building will have large windows to create bright spaces and to enjoy de day sun light.

Thermical Isolation

The glazed facades will be built with efficient materials in order to reduce the thermical loss. This measure improves 65% the requirements of Technical Code.

Adjustable Facades

The facades have got a sliding windows in order to enable the sun light and the privacy control.

Energy Production

There will be installed two fhotovoltaic solar groups with a total of 27,72 kwp. This will allow a reduction of 22 ton/year of CO2.

Heat Production

Two combined cycle boiler of bio-mass will be used in order to get heating and regular water system. These systems will be connected to several solar receiver panels (they convert solar energy into thermical energy.

Ventilation System

The requirements of CTE will be fulfilled using heat recoup system reducing until 90%.

Heat Distribution and Regular Water System

There will be a central heat and regular water system. The distribution will be carried out with a primary circuit and sub-stations in each apartment. This architecture will allow to each one an individual regulation. The system will be integrated and measure.

9.5 Energy Systems Description

HOT AND REGULAR WATER SYSTEM

LEAKO system resolves efficiently the following services:

- Hot water production

- Control and distribution of heat
- Contribution to thermical solar system

Each user programs his own request of cold and hot through the control panel.

Each user has got two meters. The first one measures the quantity of heat used and the second measures the consumption of water.

Each apartment will have its own sub-station connected to primary energy circuit. These sub-stations provide a individual service of hot water and heating.

Solar photovoltaic system is connected to the primary circuit. If the return water temperature is lower than user required temperature, the regular boilers are used.

The system-user only interface is the control panel located in each apartment. This panel allows to:

- program the required temperature of hot water
- program the heating for diary or weekly service
- visualize the consumptions of water, electricity or heating (kwp and litre)
- supervise the system fonctinality: alarms, indicators, …

The management system (through web host) allows to get the following data:

- meters measures
- historical of all the installed systems per each apartment
- to create the invoices of consumptions
- to consult leaflet of the systems with alarms, warnings,…

For hot water and heating system there is estimated 360,4 Kw. There will be two boilers (Kapelbi Hack-200) with 2x200=400 Kw.

ENERGY SUPLLY

The 230/400 v. electricity will be provided by the local electricity company, Iberdrola.

There is estimated 398.500 W according to the following power distribution:

- 80 apartments: 257.600W
- Car parking areas: 3.450 W

- Common areas (office, meeting rooms,...): 137.450 W

AIR CONDITIONED SYSTEM

There will be air conditioned system in common areas, office and meeting room.

The building was designed to get energy efficiency in all of their systems.

SOLAR PHOTOVOLTAIC SYSTEM

There will be two spaces for solar photovoltaic panels.

- The first one will be located on the soth roof. There will be 36 panels inclined 30°. Total power: 7,92 kwp.
- The second space, it wil be located north shelter. There will be 90 panels. Total power: 19,80 kwp.

9.5.1 Current operation of building or lighting system

The building is not built.

9.6 Energy consumption

The construction of the building should finish by the end of 2010. Nowadays we do not have any consumption data. The power estimations are the following:

Electricity: 398.500 W

Photovoltaic: 27.72 KWp

9.7 Energy production

The energy production estimation from Photovoltaic system is: 27.72 KWp

9.8 Reporting

The end of the building construction is estimated for the end of 2010. Nowadays we do not have any consumption data.

10. Replication pilot R1.2

10.1 Name of pilot

National Theatre Prague

10.2 Location

Ostrovní 1, Praha (Prague), Czech Republic

Buildings of National Theatre Prague are located in the centre of Prague on the embankment of the Vltava river.

10.3 Building description

National Theatre Prague (ND) is the first dramatic scene in the Czech Republic. The ND historical building was built in 19th century. The complex reconstruction and expansion of ND have been completed in 1980s.

ND consists of 4 buildings and underground technical and service facilities:

- Historical building of National Theatre
- Underground technical and service facility (6 underground levels)
- Administrative (office and operational) building
- New Scene of National Theatre (theatre)
- Restaurant and office building (this building is not included into the project because the different owner)

10.3.1 Historic building of National Theatre Prague

Historic building is the main stage of the National Theatre. This building was built between 1868 and 1983. National theatre is a classical proscenium theatre with a capacity for 996 visitors.

Historical building was completely reconstructed in 1980s together with construction of new buildings and underground facilities.

10.3.2 Underground technical and service facility (utilities)

The underground facility interconnects Historic building, Administrative building and New Scene. This service facility has 6 underground levels. The 5th ground level is below the level of the Vltava river.

Inside underground area all utility equipment and technologies are located. These technologies include:

- Boiler room
- Cooling system
- Machine room of stage moving hydraulic oil system
- Hot water making and distribution system
- Electricity backup unit
- Air-conditioning machinery rooms
- Electricity distribution systems
- Fire protection system including machinery rooms and water fire reservoir

Entire utilities are provided from here to all connected buildings. This facility also serves as workshop, maintenance area, storage rooms (properties, wardrobe and dressing room), parking lots for 219 cars etc.

Building structure:

The technical facility is 17 to 20 meters under the ground level. The floor area is about 80 x 85 m. The monolithic structure is made from reinforced concrete.

10.3.3 Administrative building

This building serves as auxiliary facilities for theatre (rehearsal, audition, testing and training rooms, changing rooms etc.), administrative facility and customer's information and ticket office.

Building structure:

The 7^{th} floor building has steel structure; the ceilings are made from pre-stressed concrete slabs. Facade is coated by lightweight aluminium frames with duplex glass windows.

10.3.4 New Scene of National Theatre Prague

The New Scene serves as alternative stage of National Theatre. This building is equipped by all necessary facilities to perform various types of performances. The auditorium has variable capacity with 432, 516 or 584 seats.

Building structure:

The 6^{th} floor steel structure; the ceilings are made from pre-stressed concrete slabs.

Outside walls of the ground floor is a heavy sandwich construction with heat and sound insulation coated by decorative stone. The rest of building walls are made from bricks cover by decorative glass fittings (shaped as old TV screens).

The buildings can be seen in the pictures and drawings shown below:

The simple situation plan of ND buildings:

10.4 Description of systems in building

10.4.1 General description

Majority of systems were modified or modernized during implementation of EPC project. Substantial volumes of building spaces are air-conditioned. The auditorium of historical building has large ventilation system.

Space heating or cooling in the rooms is provided by combination of radiators (heat) or under-window units (fan coils) with provide heating or cooling. Majority of halls have air-conditioning system. The design of heating/cooling systems for specific rooms depends on their usage and size.

Heat is generated in the central boiler room. Boilers dominantly operate in condensing mode. Cooling is produced by 3 cooling machines (chillers). One of them is able operate in combine regime either cooling machine or heat pump. In heat pump mode is getting heat from Vltava river or transferring heat from chilled areas to heated areas of the buildings.

Heat recovery system in historical building recovers heat from exhaust air to fresh take in air. This savings measure significantly reduces the gas consumption for heating.

Heat generated by hydraulic devices moving stage in historical building is recovered by heat pump to heat domestic hot water. This measure eliminated consumption of drinking water which was used for cooling the hydraulic device and reduced consumption of gas.

The entire systems are controlled, monitored and operated by SAUTER EY3600 energy control system.

The current control system is not able to operate the entire energy systems effectively due its complexity and broad spectrum of operational regimes. This complexity means that there is a high requirement for energy management system (intelligent control systems) which expand the capabilities of energy control system.

The energy management system (EMS) optimizes operational modes of energy systems based on outside weather condition, indoor environment, occupancy and utilization of different rooms of ND.

The integration of ICT helps operators of the buildings to ensure low energy consumption and optimal indoor climate in the buildings.

10.4.2 The heating system – boiler room

For space heating and hot water:

- Two condensing gas boilers HOVAL, type: Gas 1440 Ultra D, output heat 2 x 1.44 MW
- Two low-temperature dual fuel (gas/light fuel oil) boilers type OMNIMAT 12 PGV 300, output heat 2x 3.12 MW. Producer of boilers CKD Dukla

Condensing boilers generate almost 100% of heat. The other 2 boilers are used us backups or in winter days with extreme outside temperature.

For air-conditioning (air humidification):

- Steam gas boiler LOOS, steam output 3 t/h

Natural gas is supplied by local utility. Fuel oil is stored in 5000 l tank situated in the 2nd basement.

Boilers are automatically operated (setpoint cascade) and interconnected to control system SAUTER.

Heating system scheme:

Heat recovery system scheme:

10.4.3 Air-conditioning (cooling system)

Air-conditioning equipment consists of 3 cooling machines, one of which is the combination of chiller and heat pump:

- cooling machine CARRIER 30 HXC 375 Global Chiller, heat pump operation: output 1422 kW of parameters 50/55 ° C, cooling operation: output 1197 kW of parameters 20/25 ° C
- 2 cooling machines TRAIN, cooling power of 800KW working with refrigerant (R134 a)

Condenser of cooling machines is cooled by Vltava cooling water. Cooling machine room is located on the 5th ground floor of underground facility.

Cooling system scheme:

10.4.4 Energy control system

The energy and other building systems are controlled, monitored and operated by SAUTER EY3600 energy control system. The all measured and collected data are transferred to central database in dispatch room and serve for monitoring and operation of systems.

- the current system has 4500 set points

- data are transferred from set points each 120 seconds (temperature, humidity, pressure etc.)
- all sub meters are read each ¼ hour
- data are stored ¼ hour
- data are collected and stored from the beginning of project implementation (from 2007)

10.4.5 Electric backup unit

Diesel engines with power output of 608 kVA.

10.4.6 PV cells (power plant)

The small PV power plant is installed on the roof of Administrative building. The PV cells are integrated in waterproofing course. The parameters of PV cells are the following:

- Installation period 09 – 12/2008
- Installed capacity 22,032 kWp
- Total roof area 927 m2
- PV cells area 554 m2
- Expected annual production of electricity 18 727 kWh

10.4.7 Lighting system

The modernization of inefficient lighting system has started in 2009. We supposed that new high efficient lights will be installed in the following 2 years. In the first phase the incandescent bulbs will be replaced by high efficient compact florescent, LED or halogen bulbs depends on usage of current lights.

In the second phase the occupancy sensors and high efficient florescent lights will be installed particularly in administrative building.

10.4.8 Current situation

The ND long term goal is to significantly reduced operational cost particularly energy costs. Because the historical and architectural character of the buildings their construction structure cannot be changed therefore the major effort has been focused on technical facilities their operation and operation of all buildings. Complex energy efficiency project has started in 2006. This project is based on guaranteed savings scheme (EPC – Energy Performance Contracting project).

The project also includes economical utilization of renewables. Photovoltaic cells were installed on the roof of Administrative building during its reconstruction. The PV cells are integrated in waterproofing course.

The key element of energy efficiency project has been implemented. The next step is finalized the modernization of lighting system and installation of second small PV power plant on the roof of New Scene.

Currently the operation of energy system is monitored, analyzed and optimized to be prepared for installation of ICT system.

10.4.9 Defining a baseline

The baseline for the Best Energy project in ND is year 2008. The baseline energy consumption and the data for calculation of all indicators are gathered from invoicing and installed sub meters. The calculation of success indicators except of indicators 3, 3a, 4, and 4a are based on invoicing meters of gas, electricity and PV electricity production for ND buildings. The success indicators of delivered heating and cooling energy (3, 3a, 4, and 4a) use the installed sub meters for their calculation.

The secondary indicators:

- Electricity generated by renewable (PV electric energy production) – invoicing meters
- Ratio of waste heat utilization (heat recovery system) – sub meters

10.4.10 Measurement status

The energy measurements – invoicing meters are as follows:

- Natural gas total consumption
- Electric energy total consumption
- PV electric energy total production
- Water total consumption

Data from gas and electricity invoicing meters have electronic (web) access. The data are available on web site (customer's account).

The energy measurements – sub meters are as follows:

- Boiler K2
- Boiler HOVAL K3.1 a K3.2 (gas consumption and heat production)
- Boiler HOVAL K4.1 a K4.2 (gas consumption and heat production)
- Water meter – domestic hot water – I. pressure level
- Water meter – domestic hot water – II. pressure level
- Electricity meter Carrier (1.1 PJ 1.1) – part A
- Electricity meter Carrier (1.1 PJ 2.1) – part B
- Electricity meter TRANE (2)
- Electricity meter TRANE (3)
- Cooling (heat) meter Carrier (1)
- Cooling meter TRANE (2)
- Cooling meter TRANE (3)
- Water cooling of hydraulic oil system
- Heat recovery from ventilation system

Energy control sysem – metering points

- All temperatures and pressures of heat supplied and return are measured
- All temperatures and flows of colling supplied and return are measured

Indoor rooms conditions

- Selected (5 reference rooms) rooms: temperature
- Air conditioned halls and rooms: temperature and humidity

10.5 Energy consumption

The energy consumption data of ND is recorded for several years. This historical data log has been used for valuation and verification of achieved savings of implemented energy efficiency project.

Due existing energy database the valuation of next phases of project which will be implemented under best Energy project will be very transparent.

10.5.1 Reference energy consumption

The indicators used in the ND are defined in deliverable D1.2 and the method for calculating the indicators is explained in deliverable D1.4.

The baseline data are created by using data metered by invoicing meters and indicators calculation methodology.

The indicators are the following for the project:

Table 31 Indicators

Indicators (primary and secondary – see D1.2 for further information)	No.	Reference (baseline)	Unit (per year)
Primary energy consumption	1	27 789	MWh
Specific primary energy consumption	1a	563	kWh/m²
Delivered electricity	2	5 959	MWh
Specific delivered electricity	2a	121	kWh/m²
Delivered heating energy	3	5 929	MWh
Specific delivered heating energy	3a	120	kWh/m²
Delivered cooling energy	4	805	MWh
Specific delivered cooling energy	4a	16	kWh/m²
CO_2 Emissions	5	5 319	ton(CO_2)
Specific CO_2 Emissions	5a	108	kg(CO_2)/m²
Relative reduction of CO_2 emissions	6	NA	%
Relative energy savings in primary energy	7	NA	%
Energy cost savings – actual costs	8	NA	€
Relative energy cost savings – actual costs	8a	NA	%
Electricity generated by renewable (PV cells)	S13	NA	kWh
Ratio of waste heat utilization (heat recovery system)	S14	NA	%

10.5.2 Future measurements

The following measurements are planned:

Rooms:

- Individual temperatures in links with its occupancy

Halls:

- Quality of indoor air

In frame of ongoing project it is planned that additional metering points will be installed. The installation of new meters will be carefully evaluated and meters having additional added value will be installed only.

10.6 Energy production

The only energy produced in ND is electric energy generated by PV cells. The amount of produced electricity will decrease the energy deliver or purchased by ND from the public electricity grid. The annual production of electric energy by PV cells is monthly measured and reported to electric utility.

The amount of electric energy produced annually will reduce the energy bill of ND. This costs savings will be reflected in calculation of energy costs savings indicators.

No data exists.

10.7 Reporting

All data serving for savings valuation and verification are recorded and reported monthly.

The current energy control system works on-line and all data and important part of the system are displayed on operators screen. All collected data are stored and can be available for at minimum of duration of project for later analysis and past verification. Data are stored in physical units.

All collected data from current operation can served as an input for the new implemented ICT (energy management system).

11. Replication pilot R2.1

11.1 Name of pilot

Viborg Town Hall

11.2 Location

Viborg, Denmark

11.3 Building description

The new Viborg Town Hall is a building which is currently being planned and will be finished June 2011. The Viborg Municipality is home to around 92.000 inhabitants.

The building is 18.500 m² on 6 stories

The goal is to have a low energy building, using less than 70.1 kWh/m² in primary energy for heating, cooling, lighting and electricity for operation of the building. In this case the heating (district heating) has a primary energy factor of 1 and electricity has a primary energy factor of 2.5.

Overall the building has a very good low energy design, with U-values of 0.14 W/(m² K) for outer walls, ceiling and basement walls. For the windows the average U-value is 0.15 W/(m² K), while the average solar transmittance is 0.49. Generally the building is constructed so that the building envelope shades direct sunlight during the summer period and lets it into the building during the winter period.

The building is mainly an office building with additional public areas for contact and service functions for the citizens in the Municipality. The building can be seen in the drawings shown below

11.4 Description of systems in building

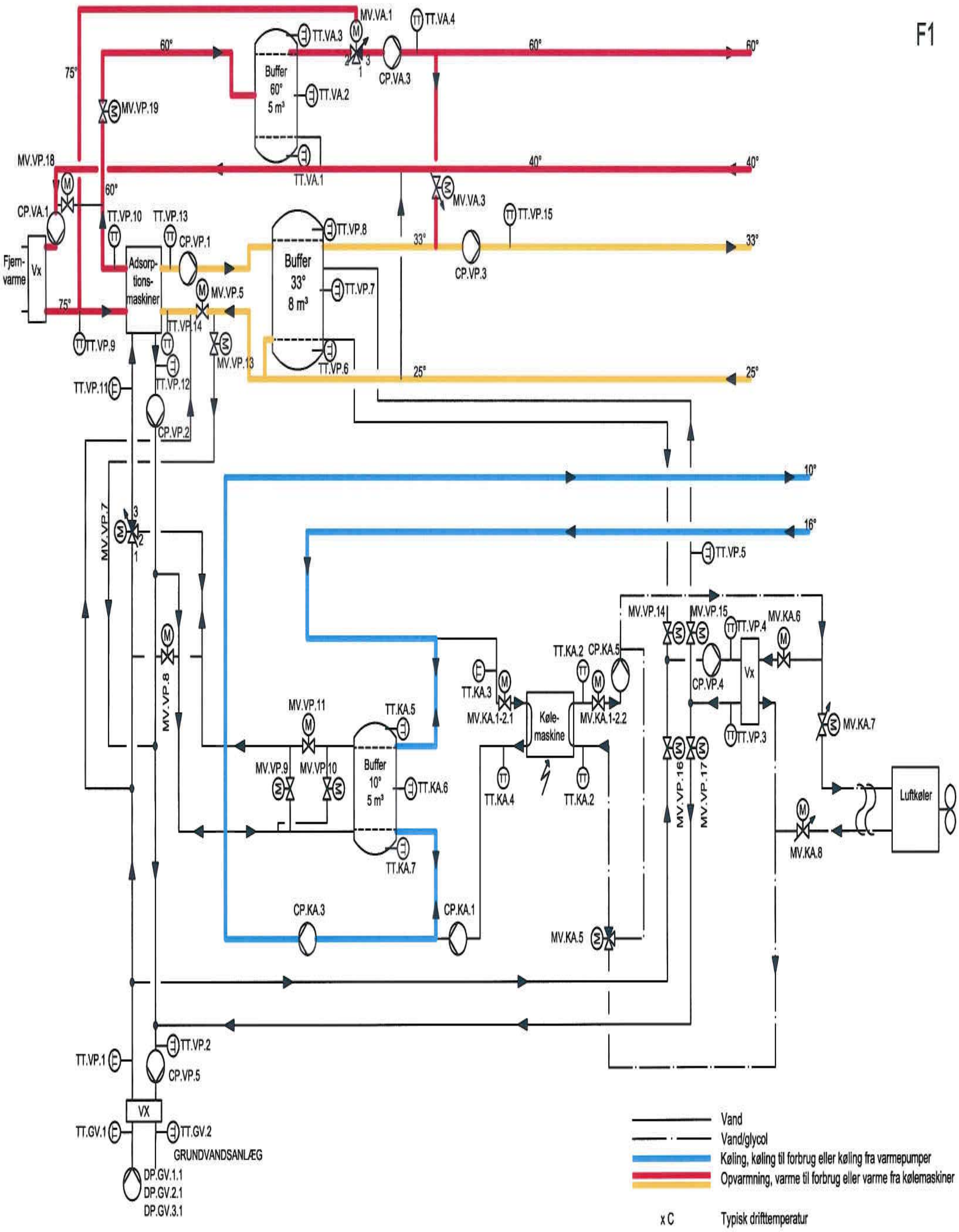
In headlines, the low energy consumption is based on the following design:

- Basic low energy design of the building envelope
- Extensive use of daylight
- Thermo active constructions
- Mix of natural and mechanical ventilation
- Low energy lighting
- Heat pumps (both heat driven and compressor/electrically driven)
- Groundwater borehole for both direct cooling and for assisting the heat pumps.
- Solar cells (expected)
- Intelligent control of the systems

The energy concept of the building is very complex. Among others it is possible to use the two types of heat pumps (compressor and heat driven) for both heating and cooling. Also it is possible to switch between them to utilise the most favourable operating conditions seen from an economic or environmental point of view. In addition, the heat pumps can be supplemented by direct cooling from the borehole.

This complexity means that there is a very large need for some sort of intelligent control of the systems. This control must be able to automatically switch between the different systems, when required. Therefore a number of functional diagrams have been defined. In total, nine different functional diagrams are defined along with four different operating modes. One functional diagram and one operating mode are shown below. Here the colored lines represent the flow in the functional diagram, while the remaining pipes and systems are not active.

The inclusion of ICT to assist in the operation of the building is crucial to ensure low energy consumption and optimal indoor climate in the building. The main task of the ICT solution is therefore to ensure that the correct information is available for the control system and further that it is possible to switch between the operating modes whenever the system finds this necessary.


F1
MV.VA.1
TT.VA.4
TT.VA.3
CP.VA.3
Buffer
60°
5 m³
TT.VA.2
TT.VA.1
60°
75°
MV.VP.19
MV.VP.18
40°
MV.VA.3
TT.VP.15
CP.VA.1
TT.VP.10
TT.VP.13
CP.VP.1
TT.VP.8
33°
Fjern-
varme
Vx
Adsorp-
tions-
maskiner
MV.VP.5
Buffer
33°
8 m³
TT.VP.7
CP.VP.3
TT.VP.9
TT.VP.14
MV.VP.13
TT.VP.6
25°
TT.VP.11
TT.VP.12
CP.VP.2
10°
16°
MV.VP.7
TT.VP.5
MV.VP.8
MV.VP.14
MV.VP.15
TT.VP.4
MV.KA.6
TT.KA.2
CP.KA.5
CP.VP.4
TT.KA.3
MV.VP.11
TT.KA.5
MV.KA.1-2.1
Køle-
maskine
MV.KA.1-2.2
TT.VP.3
MV.KA.7
MV.VP.9
MV.VP.10
Buffer
10°
5 m³
TT.KA.6
TT.KA.4
MV.VP.16
MV.VP.17
Luftkøler
MV.KA.8
TT.KA.7
CP.KA.3
CP.KA.1
MV.KA.5
TT.VP.2
TT.VP.1
CP.VP.5
VX
TT.GV.1
TT.GV.2
GRUNDVANDSANLÆG
DP.GV.1.1
DP.GV.2.1
DP.GV.3.1
Vand
Vand/glycol
Køling, køling til forbrug eller køling fra varmepumper
Opvarmning, varme til forbrug eller varme fra kølemaskiner
x C
Typisk drifttemperatur

11.4.1 Current situation

As this is a new building, there are no current measurements.

11.4.2 Defining a baseline

The baseline for the Viborg Town Hall is not going to be based on existing measurements.

In stead the baseline will be made up of a two-step approach.

1. Comparison to expected values for a similar new building without the ICT solutions used here which fulfils the standard requirements
2. Comparison to the actual building, without ICT and renewable energy activated

In the first step, comparisons will be made to a similar type building, which is just fulfilling the Danish building code, which is based on the Energy Performance of Buildings Directive. This first step will be used for the evaluation of the indicators, which are defined in the deliverable "D1.2 - List of Indicators".

In the second step, comparisons will be based on the building itself. This involves the measurements of the energy supply to the building, the energy consumption in the building and the local production of energy. In the building the heat pumps (heat driven and electrical), ground water cooling, and district heating. The point to these systems is to decrease the (primary) energy supply to the building. In the building, the goal of the ICT system is to optimize the gain from the free energy.

In stead the baseline will be measured along with the actual measurements for the heating and cooling demands. That is, since both production and consumption data are measured, it is going to be possible to compare the two in order to measure both baseline and actual data simultaneously.

The electricity consumption for operating the systems will also be included in the data for production of heating and cooling.

This approach makes it possible to find the energy consumption of the building and the production individually and based on this calculate the savings caused by the ICT system in the building. This will be done by both comparisons to model calculations and actual measurement data.

11.4.3 Measurement status

Again, since the building is not yet erected, there are no current measurements. See the sections below for further details on the proposed measurements.

11.5 Energy consumption

The measurements that are planned are described in the following.

11.5.1 Expected reference energy consumption

The indicators used in the Viborg Town Hall are defined in deliverable D1.2 and the method for calculating the indicators is explained in deliverable D1.4.

Since this is a new building the reference or baseline will be defined by a typical new building of the same type as the actual Viborg Town Hall. This means

The indicators are the following for the project:

Table 32 Indicators

Indicators (primary and secondary – see D1.2 for further information)	No.	Ref: Gemis	Expected: Gemis	Unit (per year)
Primary energy consumption	1	4206	3254	MWh
Specific primary energy consumption	1a	218	168	kWh/m²
Delivered electricity	2	1121	966	MWh
Specific delivered electricity	2a	58	50	kWh/m²
Delivered heating energy	3	889	394	MWh
Specific delivered heating energy	3a	46	20	kWh/m²
Delivered cooling energy	4	367	367	MWh
Specific delivered cooling energy	4a	19	19	kWh/m²
CO_2 Emissions	5	914	695	ton(CO_2)
Specific CO_2 Emissions	5a	47	36	kg(CO_2)/m²
Relative reduction of CO_2 emissions	6	–	24	%
Relative energy savings in primary energy	7	–	23	%
Energy cost savings – actual costs	8	–	81460	€
Relative energy cost savings – actual costs	8a	–	21,9	%
Energy used for heating	S15	50	10	kWh/m²
Energy used for cooling	S16	19	10	kWh/m²
Share of local renewable energy for heating	S17	0	51	%
Share of local renewable energy for	S18	0	47	%

cooling				

In step two the actual expected energy consumption data for the Viborg Town Hall is

11.5.2 Expected yearly cost of energy

Based on the table above, the total yearly cost of energy is expected to be and the energy costs

11.5.3 Future measurements

The energy measurements are as follows:

- District heating, total consumption
- District heating used by adsorption heat pump
- Hot water consumption
- Production of heating and cooling from electrical heat pump
- Production of heating and cooling from adsorption heat pump
- Exchange of energy with ground water storage, correlated to operating mode
- Total heating supplied to convectors, thermo active decks and ventilation units
- Heat to convectors
- Heat to thermo active decks and ventilation units
- Cooling to ventilation and thermo active decks

The following temperature measurements are planned:

- All temperatures from the above mentioned energy measurements. That is temperatures in supply and return
- Supply and return temperature in all mixing loops for convectors and thermo active decks
- Supply and return temperature for heating surfaces in all mixing loops ventilation units
- Supply and return temperature for cooling surfaces in all mixing loops ventilation units

In the building zones, the following should be measured:

- Temperatures (air temperatures)
- Humidity, dew point temperature
- Surface temperatures of the thermo active decks
- CO_2

It is also planned that all electricity consumption for building operation should be measured. That is electricity for fans, pumps, lighting and cooling. In total this means that the following will be measured:

- Lighting (fixed lighting including all auxiliary equipment)
- Pumps (distributed on production, circulation and ground water)
- Fans in ventilation units and exhaust units
- Cooling machines (for calculating COP)
- Cooling towers

In the ground water storage, temperature, flow and pressure should be measured in the wells together with temperatures and flows in the building. Further, the pressure drop across the filter in the ground water heat exchanger should be measured. The flow should be correlated to actual operating mode.

Finally all information on operating modes, time of usage of pumps, ventilation units, cooling units, adsorption heat pumps and each of the thermo active decks will be logged.

11.6 Energy production

The data on the energy production can be found in section 11.5.3.

11.6.1 Expected reference energy production

No data exists

11.6.2 Yearly savings from the energy production

No data exists.

11.7 Reporting

All data will be reported in both measurement reports on a monthly basis using 15 minutes data as well as directly shown on screen in the building automation system.

All data will be saved a minimum of two years in the building automation system for later analysis. Data will be stored in units of °C, kW, kWh, bar, m^3/h and the like.

Further it is also planned that a short-term storage should be present with two weeks of data in 60 second intervals that can be used for detailed energy analyses.

All measurement data can be used as feed-back to the control system, which will ensure that it is possible to get an optimal operation of the system.

11.7.1 Current (historic) data

No data exists

11.7.2 Baseline data

The baseline data will be found based on the measured data once the building has been built. See section 11.4.2.

11.7.3 Future measurements

The following data will be measured by the building automation system and reported on a monthly basis using 15 minute readings for each of the measurement positions. A total of 11 reports will be defined. These are shown in the figures below.

Appendix for Pilot B1

Equipment

Following some examples of the templates used for describe each zone of the building:

ZONA: BOILER AREA

QUANTITY	EQUIPMENT		OBERVATIONS	QUANTITY	GROUP	
1	BOILER YGNIS WA 550		735 Kw	1	BURNER WEISHAUPT G5/1 D ZMD	
2	CALDERA YGNIS WA 350		467 Kw	2	BURNER WEISHAUPT G3/1 E ZD	
3	PUMP RE-CIRCULATION WILO S 60 125 R					
1	VESSEL EXPANSION PNEUMATEX EG 1000 1					
3	SECURITY VALVE					
1	BOILER POWER CONTROL					
3	100% OR 0% VALVE					
1	PUMP AREA EXTRACTOR					

ZONA: PELOTA COURT CARMELO BALDA

QUANTITY	EQUIPMENT	OBERVATIONS	QUANTITY	GROUP
2	PUMP WILO IPN 80/224			

ZONA: SWIMMING POOL HEATING CIRCUIT

QUANTITY	EQUIPMENT		OBERVATIONS	QUANTITY	GROUP
2	PUMP WILO IP 80/200 3/4				
1	CHANGER SYGMACAL UF12/C,51		629 Kw		
1	VALVE 3V DN16 JOHNSON CONTROL ERA 2500 24150 EROS				
1	CHARGE PUMP WILO				
1	THERMOSTAT TEMP. LIMIT. TUBE PVC				

ZONA: HOT AND REGULAR WATER CIRCUIT PISCINAS YOLDI

QUANTITY	EQUIPMENT	OBERVATIONS	QUANTITY	GROUP
2	PUMP WILO IP 65/200 2.2/4 CHARGE			
3	DEPOSIT 5000 LITRES LAPESA TS 9100 82/4			
1	VALVE 3V JOHNSON CONTROL VA-7200-8001			
2	PUMP RE-CIRCULATION ACS GRUNDFOSS TF110 IP42			
1	MIX DEPOSIT REGULAR WATER.			
1	VALVE-SERVOMOTOR MIX LANDIS			
1	CHANGER SEDICAL			
1	AUTOMATIC EXPANSION VESSEL	200 Litres		
3	DEPOSIT SECURITY VALVES			
1	PRESSURE REGULATOR			

CHECKPOINT LIST

Following some examples of the checkpoints that are controlled at the moment:

REN202A00 - ID: 17				
P.	**Nº**	**DESCRIPtION**	**TYPE**	**CONNECTION MODULE**
I1	1	BOILER 1 Tª IMPULSION	A	
I2	2	BOILER 2 Tª IMPULSION	A	
I3	3	BOILER 3 Tª IMPULSION	A	
I4	4	RETURN COLECTOR Tª	A	
O1	9			
O2	10			
O3	11	M/P BRULER 1	D	
O4	12	M/P BRULER 2	D	
O5	13	M/P BRULER 3	D	
O6	14	OPEN / CLOSE V2V BOILER 1	D	
O7	15	OPEN / CLOSE V2V BOILER 2	D	
O8	16	OPEN / CLOSE V2V BOILER 3	D	

Appendix for Replication Pilot R1.2

Year 2008 – measured energy data:

Electric energy historical data:

Natural gas historical data:

Appendix for Replication Pilot R2.1

Energy measurements

Electrical measurements

Weather data

Mixing valves

Temperatures in main system

Ground water cooling system

Zone measurements

Operation and time of use

Adsorption heat pump

Lighting

Ventilation