



Project n°: **TREN/05FP6EN/S07.43964/513481**

Acronym: **POLYCITY**

Title: **Energy networks in sustainable cities**

Instrument: **Integrated Project**

Thematic Priority: **[6.1] [SUSTAINABLE ENERGY SYSTEMS]**

Deliverable reference number and title:
DD 4.3 Environmental performance report

Due date of deliverable: **05/05/2010**

Actual submission date: **29/04/2010**

Start date of project: **6th May 2005**

Duration: **6 years**

Organisation name of lead contractor for this deliverable: **POLITO**

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Revision: **Version 1**

Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006)		
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)	

. no.	Deliverable name	Workpackage no.	Date due	Actual/Forecast delivery date	Estimated indicative person-months*)	Used indicative person-months *)	Lead contractor
DD 4.3	Environmental performance report	DE 4	05/05/10	29/04/10			

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1 Environmental Report on Scharnhauser Park, Ostfildern

1.1 Power scheme of the Energy Production and metering

1.1.1 Situation in 2005

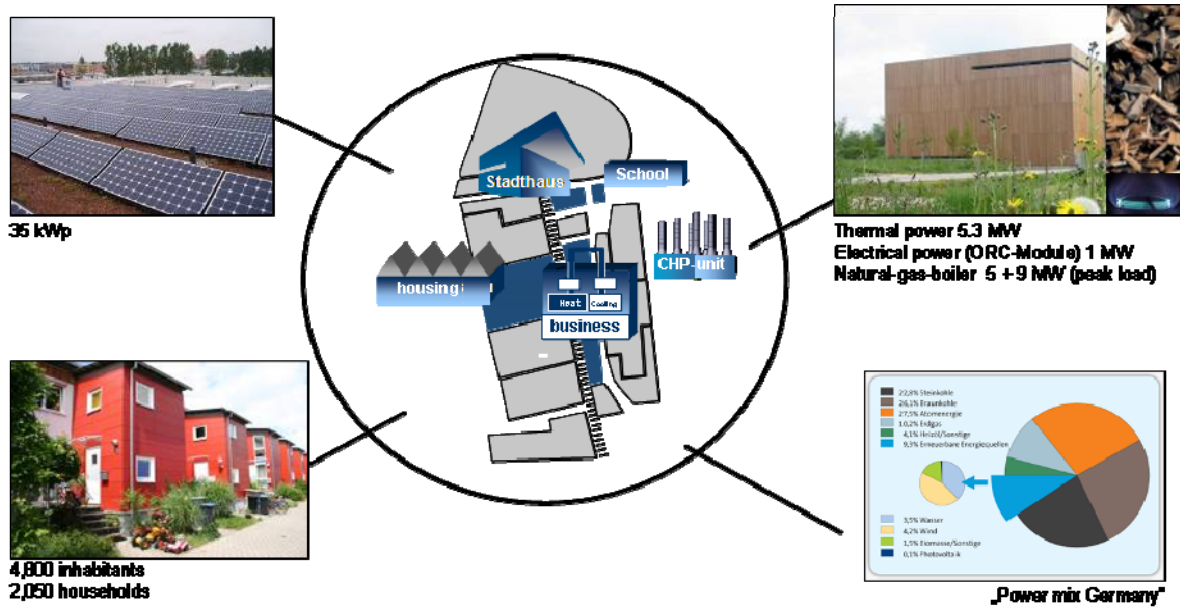


Figure 1

1.1.2 Situation in 2010

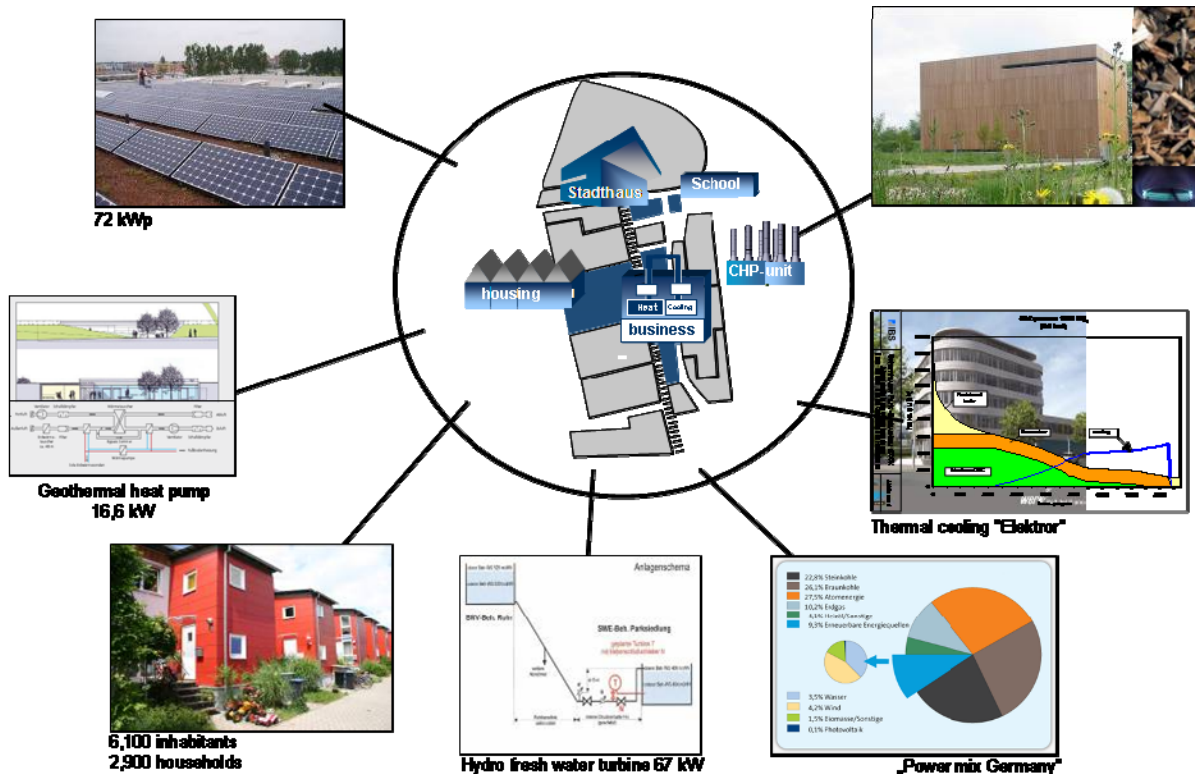


Figure 2

1.2 Environmental Indicators

The document DD4.2 give the definitions of the environmental indicators which allow to evaluate the environmental impact of Polycity project.

The indicators proposed in the above document are 6:

A1: Use of Conventional Energy

A2: Renewable energy sources (RES) final energy use

A3: RES (Renewable Energy Sources) Capacity

A4: Thermal energy consumption in buildings

A5: Emissions

A6: Gross area of new built high performance eco buildings

1.2.1 Indicator A1: Conventional Energy

		2005	2006	2007	2008	2009
Natural Gas Boiler	(kWh)	7,504,547	5,970,025	5,760,631	12,728,754	26,350,000
German Electricity Mix*	(kWh)	9,493,485	11,256,892	9,189,816	9,377,587	12,777,441
German Electricity Mix**	(kWh)	10,733,685	11,809,732	12,792,016	13,182,354	13,572,692

* Electricity from RES is subtracted

** Electricity from RES is not taken into account

1.2.2 Indicator A2: Renewable energy sources (RES) final energy use

			2005	2006	2007	2008	2009
Heat	Biomass CHP-unit	(kWh)	17,220,100	19,716,100	19,441,000	16,924,300	6,632,400
	Solar thermal Appliances	no info	no info	no info	no info	no info	no info
	Geothermal Heat Pump*	(kWh)	0	0	18,405	18,405	18,405
Electricity	Biomass CHP-unit	(kWh)	1,211,600	277,840	3,327,220	3,527,360	516,940
	Photovoltaic modules	(kWh)	28,600	55,000	55,000	57,168	58,251
	Hydro fresh water turbine	(kWh)	0	220,000	220,000	220,000	220,000

*planning data

1.2.3 Indicator A3: RES Capacity

		2005	2006	2007	2008	2009
Heat	Biomass CHP-unit	(kW)	5,300	5,300	5,300	5,300
	Solar thermal Appliances	(m ²)	60	60	60	60
	Geothermal Heat Pump	(kW)	0	0	16.6	16.6
	Thermal Cooling	(kW)	0	0	0	105
Electricity	Biomass CHP-unit	(kW)	1,000	1,000	1,000	1,000
	Photovoltaic modules	(kW)	35	70	70	72
	Hydro fresh water turbine	(kW)	0	67	67	67
Total*		(kW)	6,395	6,497	6,514	6,621

* Without solar thermal appliances

1.2.4 Indicator A4: Thermal Energy Consumption in Buildings

			2006	2007	2008	2009	2010
SWS building	Heating energy consumption	kWh/y	123408	98005	88451	94714	96198
		kWh/a m ²	73,1	58,1	52,4	56,1	57
	Heating energy consumption for warm water	kWh/a	10434	12117,75	20913,15	17034	20609
		kWh/a m ²	6,2	7,2	12,4	10,1	12,2
All Residential Buildings	Thermal energy consumption (heating + warm water)	kWh/a	18153188	19379707	20367350	23013004	

Siedlungswerk Multi-family houses	12 flats	30 flats	8 flats
Prim. Energy in kWh/m ² a	90,00	81,31	85,54
POLYCITY	55,60	34,32	30,16
Reduction	- 38,2 %	- 57,8 %	- 64,7 %
Transm. Los, HT [°] (W/m ² K)	0,601	0,687	0,647
POLYCITY	0,478	0,472	0,444
Reduction	- 20,7 %	- 31,3 %	- 31,4 %

1.2.5 Indicator A5: Emissions

		2005	2006	2007	2008	2009
CO ₂ -emissions (Direct)	(yearly t/capita)	1.50	1.47	1.13	1.34	2.07
CO ₂ -emissions (LCA)	(yearly t/capita)	1.81	1.76	1.39	1.63	2.44
SO ₂ (LCA)	(yearly t/capita)	3.54	3.48	3.11	2.88	3.07
NO _x (LCA)	(yearly t/capita)	2.84	2.76	2.50	2.48	2.92

1.2.6 Indicator A6: Gross Area of New Built High Performance Eco Buildings

Siedlungswerk residential buildings			
Type	Number	Total area m ²	Living space m ²
Row houses	17	13.220	10.589
One-family houses	19		
Multi family-house 1	50 flats		

2 Environmental Performance Report of Cerdanyola del Vallès site

2.1 Power scheme of the Energy Production and metering

The partial plan of the Directional Center of Cerdanyola del Valles (Barcelona), provides urban planning interventions that integrate residential, clean activities of new technologies and scientific activities, with the installation of the laboratory synchrotron light (CELLS) named Alba.

All these facilities have a considerably demand for electricity, heat and cooling. Electricity demand is met through a substation of 220/25 kV REE, which has a dedicated transformer for CELLS. There is a polygeneration plant (ST-4) coupled in parallel with the network that can deliver electricity to CELLS on island, in case of failure of network. The polygeneration plant also supplies heat and cooling energy for CELLS and for the rest of the Park of Science and Technology, through a network of District Heating and Cooling Network (DHC).

The polygeneration plant ST-4 is based on high-performance gas reciprocating engines with a total power of 16 MWe. Due to the degree of development of the Park of Science and Technology, the construction of this plant is foreseen in two phases, the first of which includes 3 engines with an output of 10 MWe and a second phase when the remaining 2 engines will be installed. The configuration of the plant can be seen in Figure 3.

The biomass gasification plant and the solar thermal cooling plant will be implemented in ST-2 Polygeneration Plant. While ST-4 Plant is finished and will start its normal operation on June 2010, ST-2 Plant is being affected by several problems that have appeared during the start-up of Plant ST-4. All these problems involve a delay in construction and start-up of plant ST-2 that won't be finished until the end of 2012.

For this reason and because ST-4 hasn't started its normal operation no real data is available at the moment and all the information contained in this deliverable is based on simulations of different future scenarios.

It is also important to remark that no monitoring data of the buildings is available yet due to delays in the occupation of the dwellings.

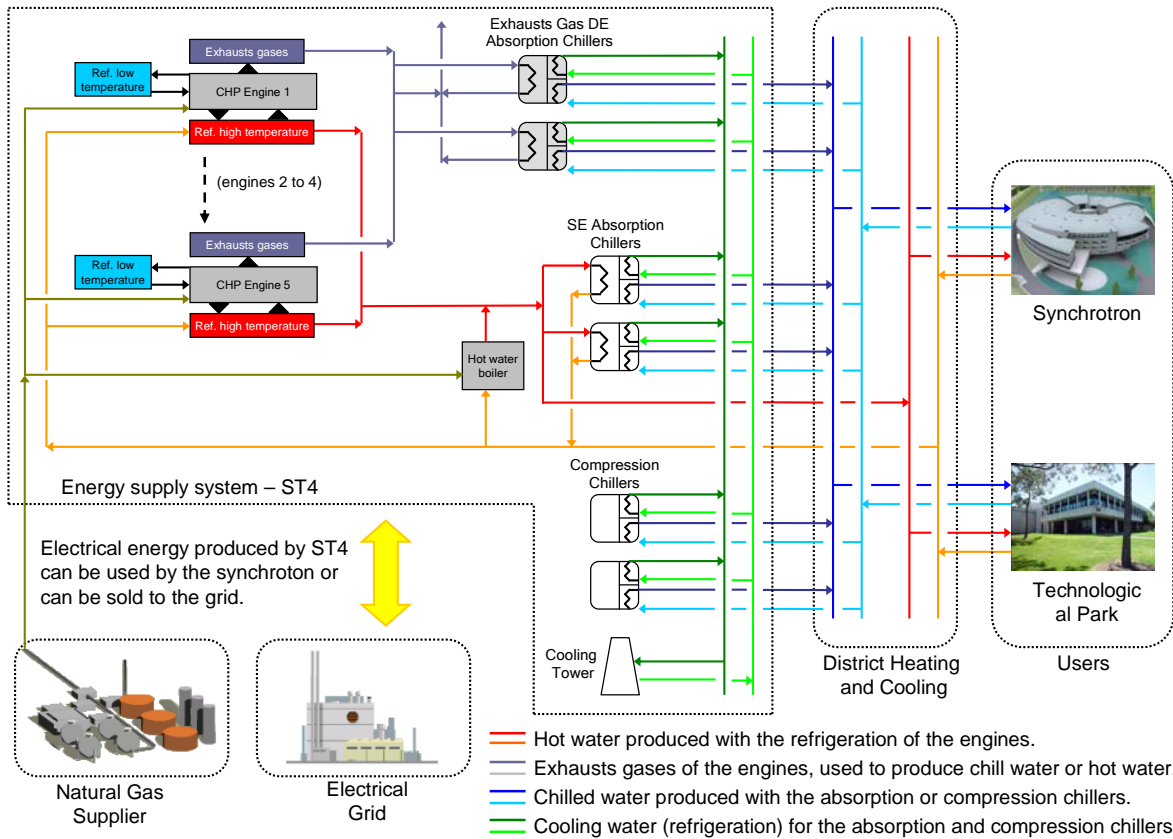


Figure 3 - Configuration of the ST-4 plant after the conclusion of phase II

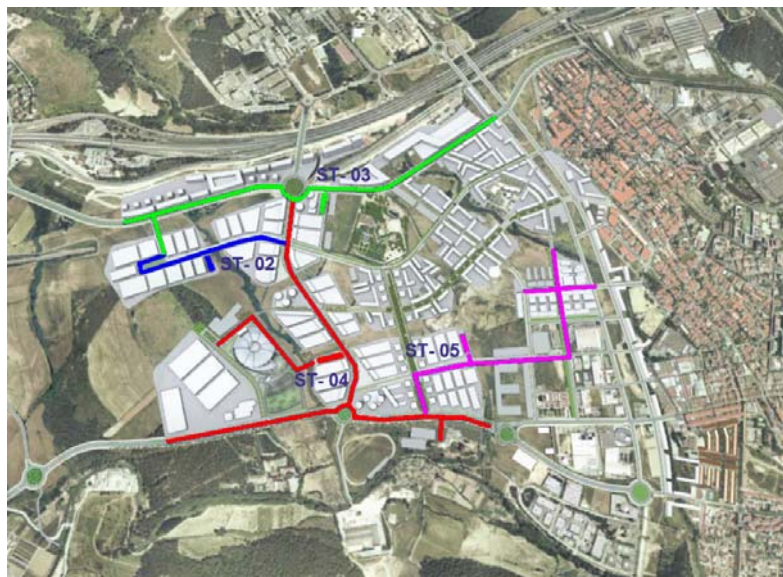


Figure 4 - District Heating and Cooling network for Cerdanyola

2.2 Metering system

2.2.1 Metering system of ST-4 Polygeneration Plant

Due to the delay of the construction of the ST-2 Plant the only metering system detailed is the one implemented in ST-4 Plant and described below.

The purpose of the CEMS system will be the calculation of components and plant efficiencies, report the energy performance of the plant, remote monitoring through a web

interface and provide recommendations for scheduling according to operational costs and energy saving objective functions. In Figure 5 the interconnection of CEMS with the automation system of the Cerdanyola site is represented.

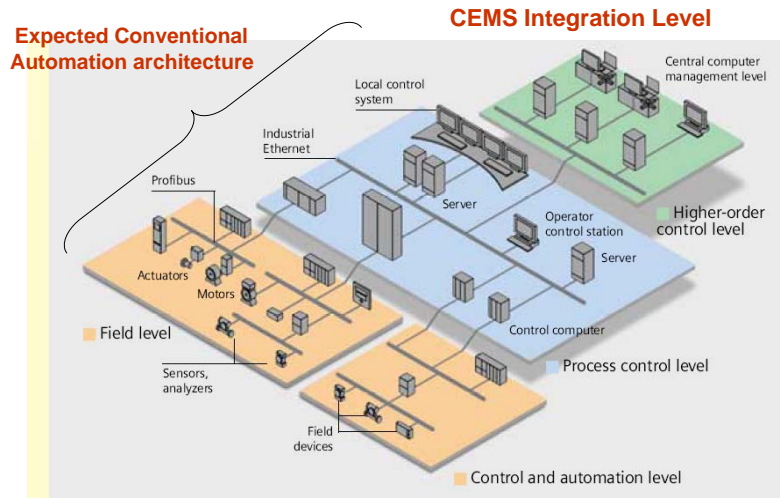


Figure 5 - Interconnection of CEMS with the automation system of the Cerdanyola site.

Figure 6 and Figure 7 show the monitoring of the chilled water produced with the compression and double effect absorption chillers. For the chilled water circuit the monitoring is similar for both single and double absorption chillers, and only the double effect absorption chiller is shown. The collector of the chilled water is shown at the left in these figures.

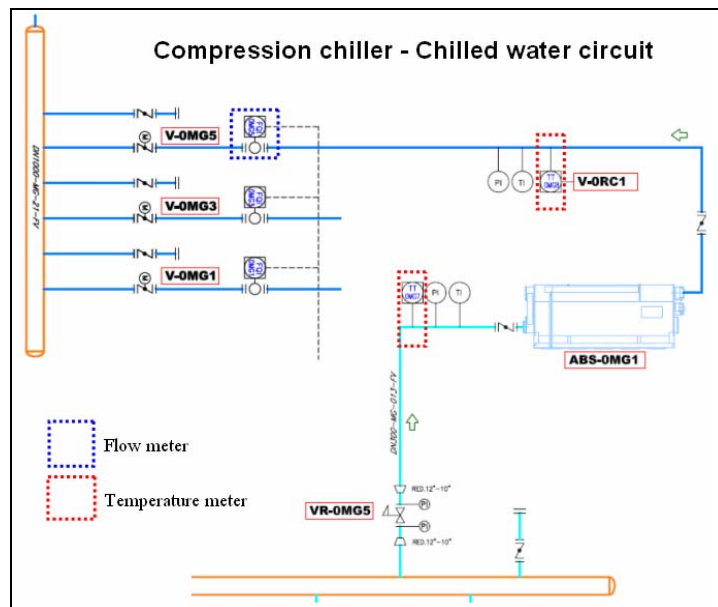


Figure 6 – Monitoring of the chilled water produced with the compression chiller.

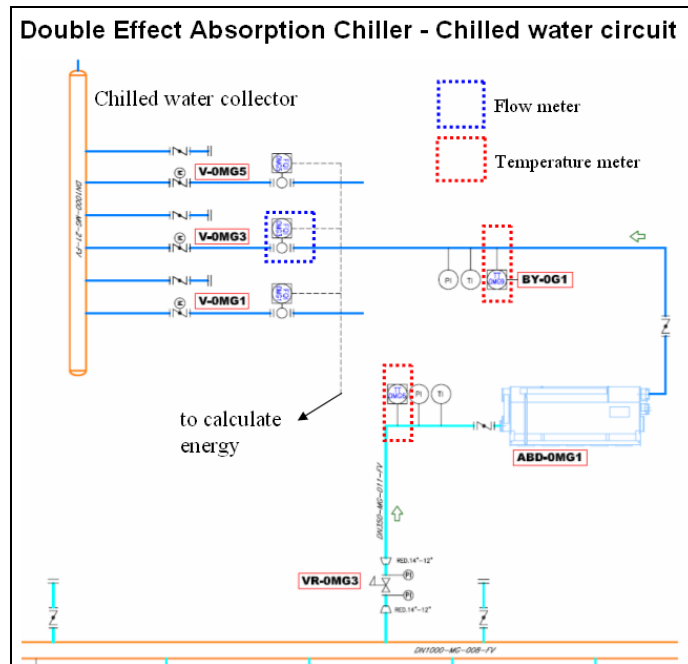


Figure 7 – Monitoring of the chilled water provided by the double effect absorption chiller.

Figure 8 and Figure 9 show the cooling water circuit for the absorption chillers. The monitoring for the case of the compression chiller is the same. There is a collector for both the supply and the return cooling water flow. The fans of the cooling tower are controlled as a function of the output temperature of the cooling water from the cooling tower.

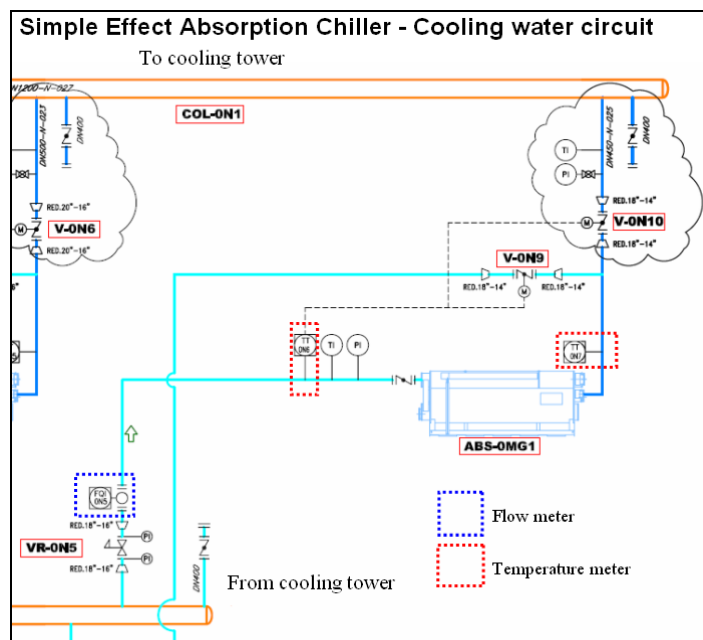


Figure 8 – Monitoring of the cooling water for the simple effect absorption chiller.

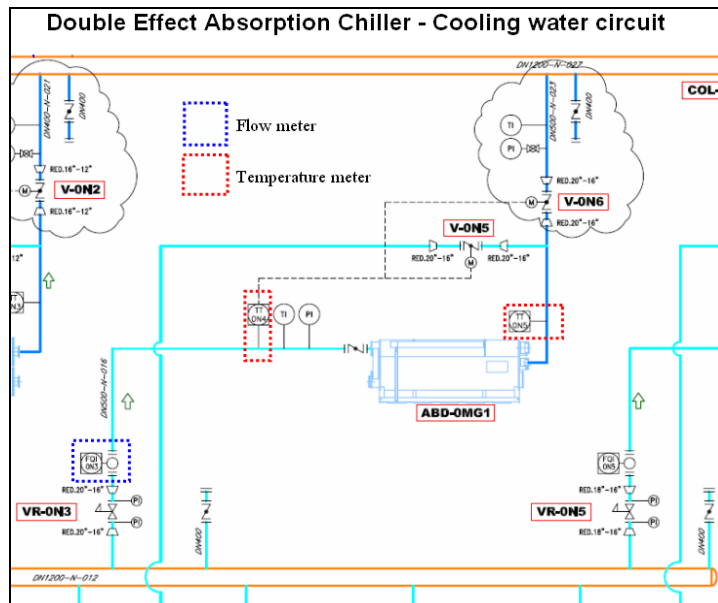


Figure 9 – Monitoring of the cooling water provided to the double effect absorption chiller.

The simple effect absorption chiller is driven with the hot water produced by the cooling of the engines. The hot water at the outlet of the absorption chiller is collected together with the return hot water of the DH. Figure 10 shows the monitoring of the hot water circuit.

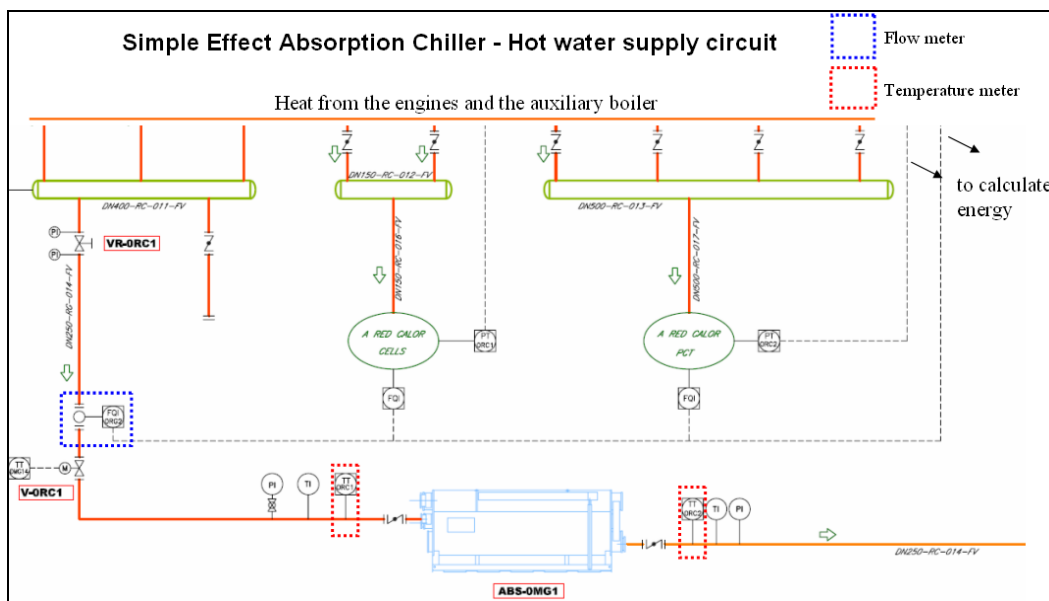


Figure 10 – Monitoring of the hot water provided to the absorption chiller.

The double effect absorption chiller is directly driven with the exhausts gases produced by the cogeneration units. At the left of Figure 11 is shown the collector of the exhausts gases from the engines. At the inlet of the absorption chiller there is a bypass to regulate the flow rate through the absorption chiller. Figure 12 shows the exhausts gas output from the engines.

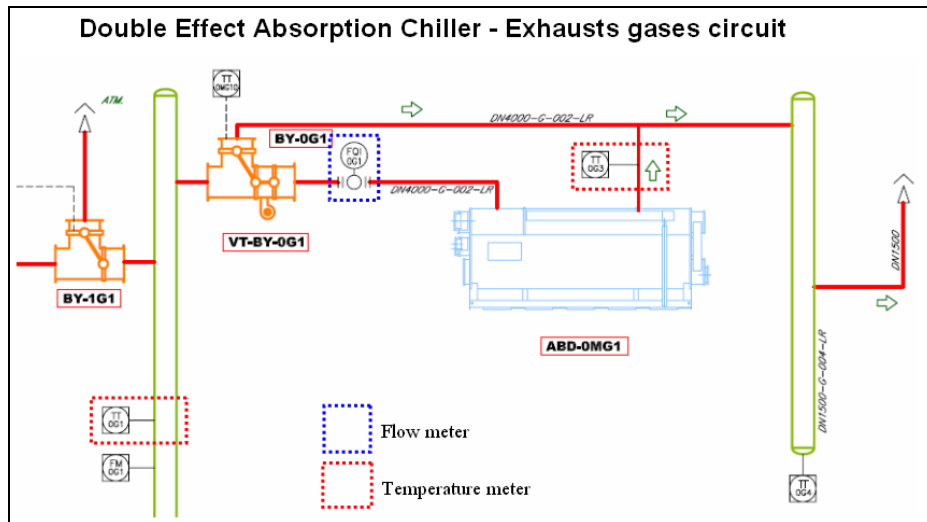


Figure 11 – Monitoring of the exhausts gases through the double effect absorption chiller.

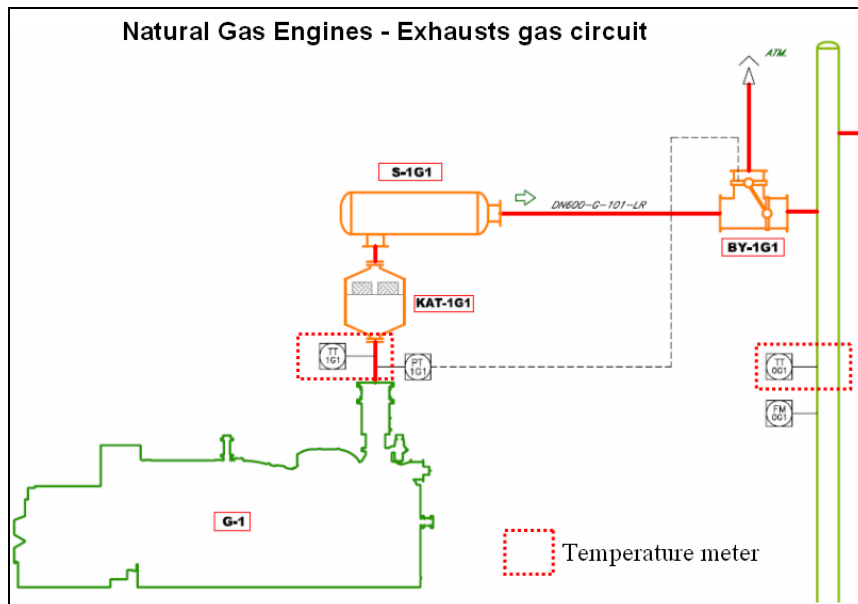


Figure 12 – Exhausts gas temperature measurement of the cogeneration engines.

Figure 13 and Figure 14 show the cooling circuits of the cogeneration units. The first figure corresponds to the low temperature circuit to refrigerate the oil circuit of the engine. Due to the low temperature, the heat is dissipated in cooling towers. Figure 14 is the high temperature circuit and the heat recovered is used in a simple effect absorption chiller and used in the district heating and cooling network.

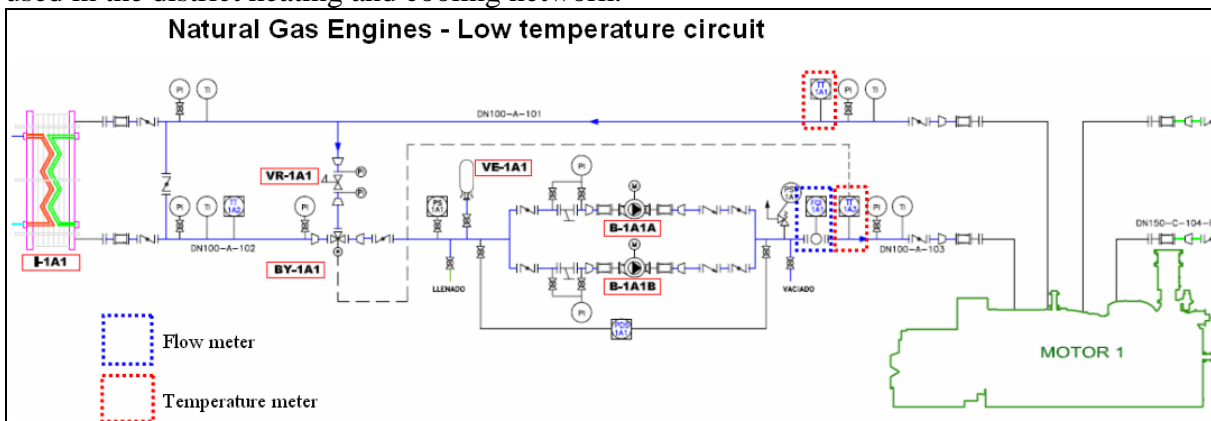
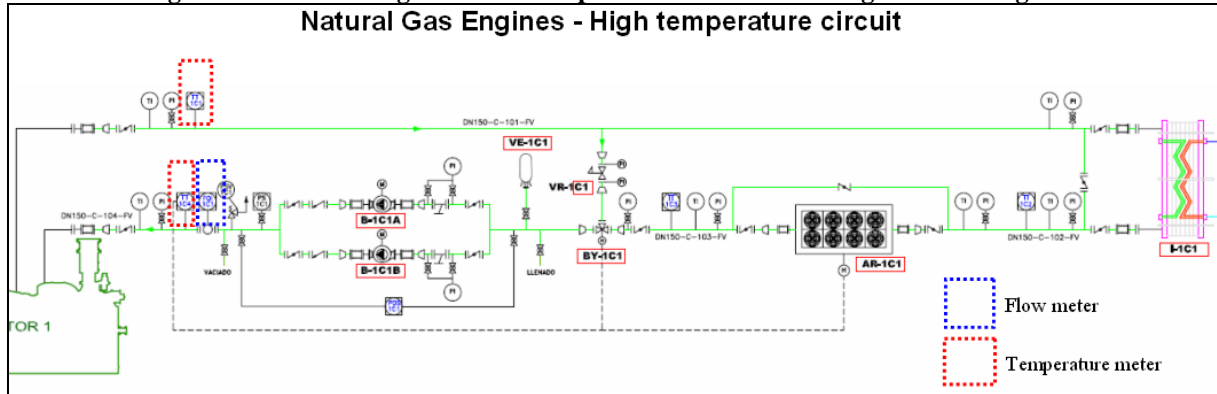


Figure 13 – Monitoring of the low temperature circuit in the cogeneration engines.**Figure 14 – Monitoring of the high temperature circuit in the cogeneration engines.**

2.2.2 Metering system of the Residential buildings

Four dwellings belonging to two separate buildings will be monitored.

- La Clota Residential building

For each dwelling analysed (2 out of 53) the following information will be recorded:

- Total electrical and natural gas consumption.
- Heating and DHW.
- Lighting consumption.
- Indoor temperature and relative humidity.

Data of temperature/HR, energy demand for heating, DHW, and lighting will be collected every 5 min. Consumption of electricity and natural gas will be collected every month. All this information will be analysed and submitted every 3 months.

- Córdoba Residential building

For the whole building the following information will be recorded:

- Lighting and lifts in communal areas.
- Outside temperature, relative humidity and wind.

For each dwelling analysed (2 out of 24):

- Total electrical and natural gas consumption.
- Lighting consumption.
- Heating and DHW.
- Indoor temperature and relative humidity.

For all the dwellings (#24):

- Electrical consumption.
- Water and Natural Gas consumption.

Monitoring will be carried out by the building promoter. Data of temperature/HR, energy demand for heating, DHW, lighting and electrical appliances will be collected every hour and sent via modem regularly

2.3 Environmental performance indicators

2.3.1 Polygeneration System

In Table 1 the initial estimation of installed engines and operational conditions of ST-4 and ST-2 plant are described. Due to the lack of more actualised and detailed information, the energy performance report and calculations are based on these estimations.

The electrical, thermal and cooling demand of the synchrotron is supplied by the ST4 plant and the surplus of electricity is sold to the grid. ST4 plant also produces heating and cooling to fulfil the energetic requirements of the park.

The ST4 plant is composed of cogeneration engines, simple and double effect absorption chillers, compression chillers and a backup boiler of 5 MW. Nowadays, only the units corresponding to the year 2010 and the boiler are installed.

The ST2 plant is expected to be finished by the end of 2012. ST2 plant consists of a solar cooling plant and a gasification plant to produce synthesis gas for a cogeneration engine, the main characteristics of these plants are:

- Solar cooling plant, up to 2,000 m². Using flat plate collectors with adsorption chillers, or evacuated tube collectors, working at higher temperatures with absorption chillers.

- A gasification plant working with sub products from the local industry and other residues. The synthesis gas is used in a cogeneration engine to produce electricity and cooling using absorption chiller.

The biomass gasification plant is integrated with a cogeneration engine of 1 MWe and fed with wood biomass, with an estimated consumption of 1,000 kg/h of residues. The production rate of synthesis gas is estimated according to the results obtained from the operation of the biomass plant “*Energia Natural de Móra, S.L.*” (*Enamora*). This plant is installed in the *Pere Escribà, S.A.* Company and works with almond rind producing 2,500 Nm³/h of synthesis gas (LHV 5.319 kJ/Nm³) for each 1,000 kg/h of biomass supplied. In the biomass gasification processes, air is used as gasifying agent and a low calorific value gas is generated. The biomass is converted into a gaseous fuel, the major components being carbon monoxide and hydrogen. These gas produced is used as a fuel for the generation of heat and electricity.

Table 1: Installed engines and initially expected operational conditions by Lonjas

Year	Engines	Operation
2010	1 JGS620	16 hours/day – 5 days/week – 52 weeks
	2 JGS620	24 hours/day – 7 days/week – 38 weeks
2011	1 JGS620+1 JGS620 SG*	16 hours/day – 5 days/week – 52 weeks
	2 JGS620	24 hours/day – 7 days/week – 38 weeks
2012	1 JGS620+1 JGS620 SG*	16 hours/day – 5 days/week – 52 weeks
	2 JGS620	24 hours/day – 7 days/week – 38 weeks
2013	3 JGS620+1 JGS620 SG*	16 hours/day – 5 days/week – 52 weeks
	2 JGS620	24 hours/day – 7 days/week – 38 weeks
2014	3 JGS620+1 JGS620 SG*	16 hours/day – 5 days/week – 52 weeks
	2 JGS620	24 hours/day – 7 days/week – 38 weeks

JGS620 SG* : CHP engine working with the synthesis gas produced in the gasification plant

Table 2: Installed capacity for the chillers

Year	Intalated capacity (kW)	Total capacity (kW)	Useful (5% loss) (kW)
2010	SE: 3,060	SE: 3,060	SE: 2,907
	DE: 5,028	DE: 5,028	DE: 4,776
	Comp: 5,000	Comp: 5,000	Comp: 4,750
2011	SE: 3,060	SE: 3,060	SE: 2,907
	DE: 5,028	DE: 5,028	DE: 4,776
	Comp: 5,000	Comp: 5,000	Comp: 4,750
2012	SE: 3,060	SE: 3,060	SE: 2,907
	DE: 5,028	DE: 5,028	DE: 4,776
	Comp: 5,000+5,000	Comp: 10,000	Comp: 9,500
2013	SE: 3,060+2,040	SE: 5,100	SE: 4,845
	DE: 5,028+3,352	DE: 8,380	DE: 7,961
	Comp: 5,000+5,000	Comp: 10,000	Comp: 9,500
2014	SE *: 3,060+2,040	SE: 5,100	SE: 4,845
	DE *: 5,028+3,352	DE: 8,380	DE: 7,961
	Comp *: 5,000+5,000	Comp: 10,000	Comp: 9,500

* SE: Absorption Simple Effect

* DE: Absorption Double Effect

* Comp: Compression chiller

2.3.1.1 Polygeneration Plants ST-4 and ST-2

This scenario is the initial configuration, operation and load profiles included in the Lonjas technical reports, including the biomass gasification plant and the solar cooling plant (The energy and operational costs are obtained from the Lonjas technical reports). Table 3 shows the different parameters of the equipments included in ST-2 and ST-4 Polygeneration plants. Table 4 and Table 5 show the results for this scenario.

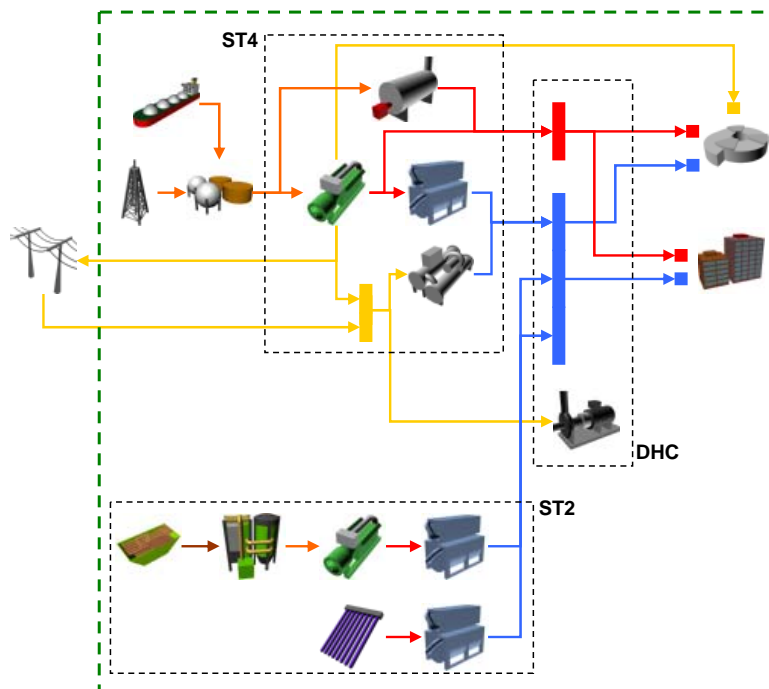


Figure 15 - Scheme for the ST4+ST2 scenario.

Table 3: Parameters of the Polygeneration plants









	Import-Export Electricity	Combined cycle, overall efficiency = 49.8%
	ST4, Electricity and heating	Cogeneration engines $\eta_{\text{elec}} = 45.0\%$ $\eta_{\text{hot water}} = 23.5\%$ $\eta_{\text{exhaust gases}} = 18.1\%$
	ST4, Cooling	SE Abs. Chillers COP = 0.75 DE Abs. Chillers COP = 1.3
	ST4, Cooling	Compression chillers COP = 5
	ST4, heating	Boiler, $\eta = 90\%$
	ST2, solar plant	
	ST2, biomass plant	Biomass plant, consists of a gasifier, a cogeneration engine and an absorption chiller. $\eta_{\text{gasifier}} = 80\%$ $\eta_{\text{CHP,elec}} = 36\%$ $\eta_{\text{hot water}} = 24.4\%$ $\eta_{\text{exhaust gases}} = 22.3\%$ $\text{COP}_{\text{abs}} = 1.0$
	Pumping	As a function of the energy demand

Table 4: Results for the ST4+ST2 scenario.

Year	CO ₂ equivalent (ton/year)	SO ₂ equivalent (ton/year)
2010	19,164	27.0
2011	17,776	29.9
2012	18,833	31.1
2013	20,248	35.0
2014	22,960	38.2
2015 to 2025	22,960	38.2

Table 5: Results for the ST4+ST2 scenario.

Year	Renewable capacity (kW)	Electrical renewable production (%)	Cooling renewable production (%)
2010	0	0	0
2011	2,930	8.1	15.0
2012	2,930	8.1	12.2
2013	2,930	5.6	10.4
2014	2,930	5.6	8.0
2015 to 2025	2,930	6.2	7.5

2.3.1.2 Polygeneration Plant ST-4

This scenario is the initial configuration, operation and load profiles included in the Lonjas technical reports, without including the biomass gasification plant and the solar cooling plant. The energy and operational costs are obtained from the Lonjas technical reports. shows the different parameters of the equipments included in ST-2 and ST-4 Polygeneration plants.

Table 6 shows the different parameters of the equipments included in ST-4 Polygeneration plant. Table 7 show the results for this scenario.

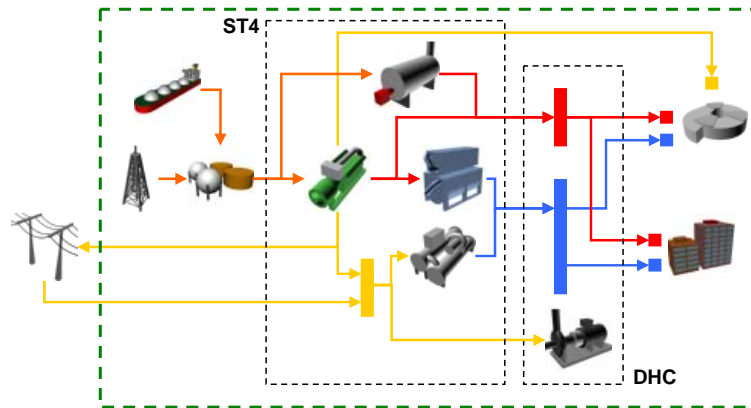


Figure 16 - Scheme for the ST4 scenario

Table 6: Parameters of the plant.







	Import-Export Electricity	Combined cycle, overall efficiency = 49.8%
	ST4, Electricity and heating	Cogeneration engines $\eta_{\text{elec}} = 45.0\%$ $\eta_{\text{hot water}} = 23.5\%$ $\eta_{\text{exhaust gases}} = 18.1\%$
	ST4, Cooling	SE Abs. Chillers COP = 0.75 DE Abs. Chillers COP = 1.3
	ST4, Cooling	Compression chillers COP = 5
	ST4, heating	Boiler, $\eta = 90\%$
	Pumping	As a function of the energy demand

Table 7: Results for the ST4 scenario.

Year	CO ₂ equivalent (ton/year)	SO ₂ equivalent (ton/year)	Cash flow
2010	19,164	27.0	$2.1 \cdot 10^6$
2011	19,950	27.9	$2.4 \cdot 10^6$
2012	21,107	29.3	$2.5 \cdot 10^6$
2013	22,497	33.1	$3.8 \cdot 10^6$
2014	25,182	36.3	$4.1 \cdot 10^6$
2015 to 2025	25,312	36.5	$4.1 \cdot 10^6$

2.3.2 Buildings

2.3.2.1 La Clota Residential Building

The results from the energy simulation of La Clota building and for instance the energy savings are presented in the next table:

Table 8: Final energy savings achieved in La Clota residential building

	Reference energy demand	Energy demand estimated through simulation	Energy savings		
	(kWh _t /m ² year)	(kWh _t /m ² year)	(kWh _t /m ² year)	(kWh _t /year)	(%)
Heating	54	15.8	38.2	74,990	70.7

As the whole energy considered is thermal energy, according to the CO₂ emission factors presented in Table 9, the factor used in this section in order to determine the CO₂ emission savings will be 2.01x10⁻⁴ t CO₂/kWh_t.

Table 9: CO₂ emission factors (DMAH, 2009)

Thermal energy, assuming natural gas (kg CO ₂ /MWht)	201
Power supply electricity (kg CO ₂ /MWhe)	450

Table 10: CO₂ and energy savings achieved in La Clota residential building

	Energy savings	CO ₂ savings
	(kWh _t /year)	(t CO ₂ /year)
Heating	74,990	15.1

2.3.2.2 Cordoba Residential Building

The results from the energy simulation of Còrdova Residential building and for instance the energy savings are presented in the next table:

Table 11: Final energy savings achieved in Còrdova Residential building

	Reference energy demand	Energy demand estimated through simulation	Energy savings		
	(kWh _t /m ² year)	(kWh _t /m ² year)	(kWh _t /m ² year)	(kWh _t /year)	(%)
Heating	54	8.3	45.7	73,869	84.6

As the whole energy considered is thermal energy, according to the CO₂ emission factors presented in Table 9, the factor used in this section in order to determine the CO₂ emission savings will be 2.01x10⁻⁴ t CO₂/kWh_t.

Table 12: CO₂ savings achieved in Còrdova Residential building

	Energy savings	CO ₂ savings
	(kWh _t /year)	(t CO ₂ /year)
Heating	73,869	14.8

2.3.2.3 Synchrotron Office Building

The results from the energy simulation of Synchrotron Office Building and for instance the energy savings are presented in the next table:

Table 13: Final energy savings achieved in Synchrotron Office building

	Reference energy demand	Energy demand estimated through simulation	Energy savings		
	(kWh/m ² year)	(kWh/m ² year)	(kWh/m ² year)	(kWh/year)	(%)
Heating	50.5	18.0	32.5	124,273	64.4
Cooling	77	19.9	57.1	218,339	74.2
TOTAL	127.5	37.9	89.6	342,612	70.3

As the whole energy considered is thermal energy, according to the CO₂ emission factors presented in Table 9, the factor used in this section in order to determine the CO₂ emission savings will be 2.01×10^{-4} t CO₂/kWh_t.

Table 14: CO₂ savings achieved in Synchrotron Office building

	Energy savings	CO ₂ savings
	(kWh/year)	(t CO ₂ /year)
Heating	124,273	25.0
Cooling	218,339	43.9
TOTAL	342,612	68.9

2.4 Important considerations

It is important to remark that all data included in this deliverable come from simulations and estimations. For this reason the final energy and emissions savings can differ from the ones included here due to changes in demand and supply energy profiles. These changes have been caused by several problems that have appeared during the start-up of ST-4 Plant and a dramatic reduction in thermal energy demand due to:

- A budget reduction to the Synchrotron light laboratory that will only operate 720 h/year (-76%).

- Other real estate promoters have abandoned or postponed their investments in the area because of the economic downturn.

For these reasons, new energy demand and supply profiles are still under negotiation between CELLS and ST-4 Plant but it is expected a thermal energy demand of :

- 1st year: Alba Synchrotron → Cold: 3.438 (14.323) MWh / Heat: 335 (1.394) MWh
- 2nd year: New data centre building → Cold: 6.132 MWh (minimum)
- Subsequent years: up to 70% of potential demand → Cold: 58.528 MWh / Heat: 27.885 MWh.

3 Environmental Report on ARQUATA - TORINO

3.1 Power scheme of the Energy Production and metering at Arquata

The energy production in the Arquata project is synthesized in the scheme of Figure 17.

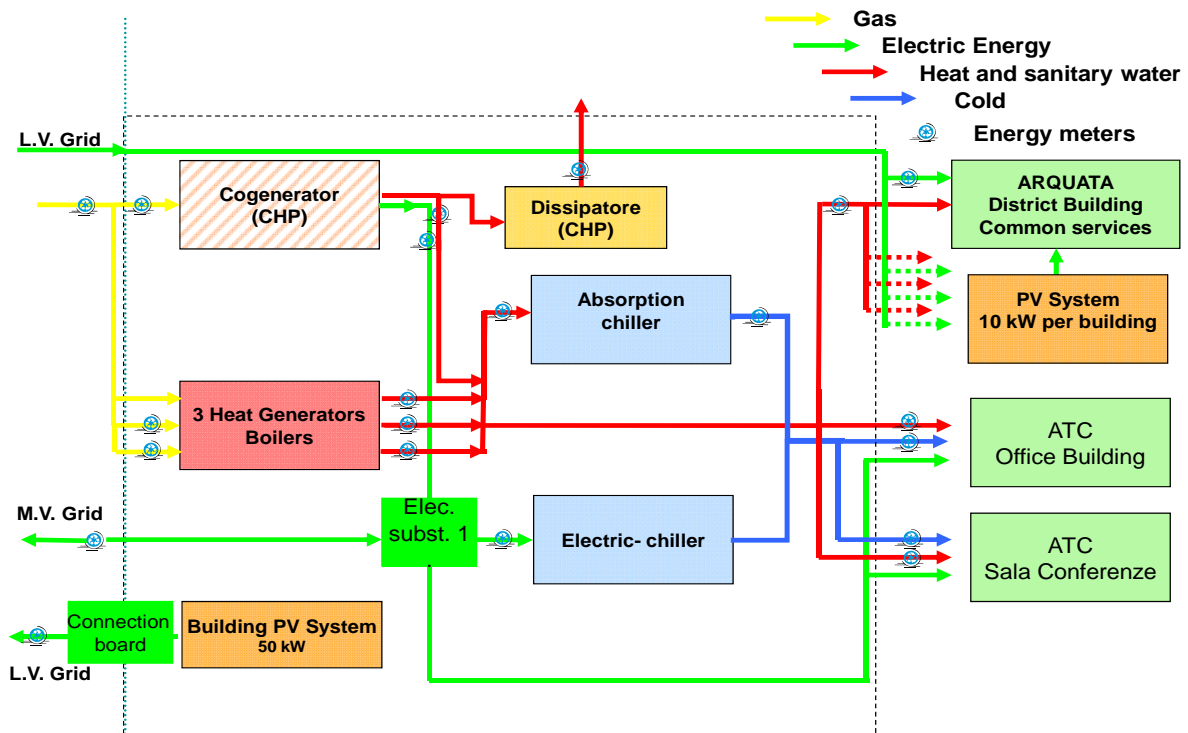


Figure 17 - Arquata energetic and metering system

In the thermal plant at the lower level of the building ATC are installed:

- one natural gas substation which supplies the thermal generation plant (3 heat boilers) and the CHP;
- one electric substation connects the medium voltage grid to the transformers for supplying the office building power system and the CHP generator;
- an interface “connection board” between the PV system of the Office Building and the low voltage grid.

The figure also represents the chillers and the heat sink of the building office.

The Arquata project includes 31 buildings in Arquata District. Photovoltaic installations on the roofs of 12 district buildings have been installed and the above scheme shows their connections to the low voltage grid as far as it is concerned with building common electric services.

The electric grid supplying Arquata district building is shown in Figure 18 with a simple representation of an example of building connection with and without PV building system.

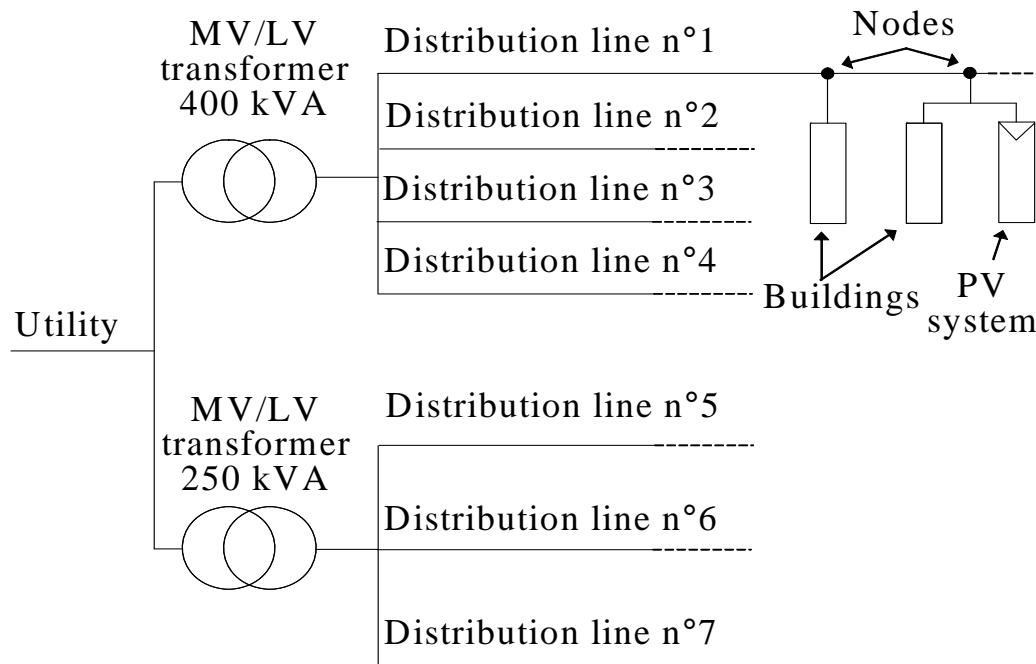


Figure 18 - Electric scheme of the Utility (AEMD) grid supplying Arquata District buildings

The scheme of Figure 17 give information's on the available metering system. It is important to outline that this metering system has not been designed at the start of all Arquata interventions but it is a consequence of successive installations performed in a 5 year time with the preliminary installation of the 3 boilers (since 2000 to 2005) to supply the district heating and the successive installations of the CHP and absorption and electric chillers (from 2005 to 2007).

As far as it is concerned with the electric energy the energy meters of the utility are used. Because of the large number of electric users it was found useful to collect the following energy data:

- Office building energy exchanged with the medium voltage (MV) grid through the sub-station;
- Office building PV system supplied to the low voltage (LV) grid;
- Energy supplied by the two sub-stations (Figure 18) to the overall district;
- Energy generated and exchanged of the 12 district PV systems;
- Energy consumed by 10 characteristic district users like samples of domestic loads.

In the used metering system some instruments give us continuous data which can be analyzed on-line (mainly CHP quantities) while other ones (electric consumptions and PV generated energy) are available with some delay and (up to now) they are not yet automatically loaded into the Arquata project experimental data archive.

We are waiting also for further information on the exhaust gas composition from the boilers and from the CHP.

In Arquata district it is also installed a small meteorological station which measures external temperature, wind speed and direction, external relative humidity, solar radiation, air pressure and rain collector.

The measuring system is necessary to compute some indexes to make the environmental and energetic performance evaluations.

In the following chapter some comments on the measuring system and on its main characteristics are given.

The continuously measured quantities are collected by means of the CEMS while experimental data from AEMD are available with one or more weeks delay.

3.2 Environmental Indicators

The document DD 4.2 give the definitions of the environmental indicators which allow to evaluate the environmental impact of Polycity project.

The indicators proposed in the above document are 6:

A1: Use of Conventional Energy

A2: Renewable energy sources (RES) final energy use

A3: RES (Renewable Energy Sources) Capacity

A4: Thermal energy consumption in buildings

A5: Emissions

A6: Gross area of new built high performance eco buildings

3.2.1 Indicator A1: Conventional Energy

Two types of conventional energy have to considered:

- Natural gas, that supplies the CHP and the three boilers;
- Electricity import (ATC building and council buildings).

Only the PV systems can be considered as Renewable Energy Sources: the CHP can not be considered as RES because it is supplied by fossil fuel.

The data about the electricity consumption of council building are derived by the analys on bills done in *DD 2.1a Report on methodology for energy performance assessment in the CONCERTO communities*.

Some measures about the PV systems production are not available. Then some data in the table are prediction calculated considering the installed power.

Table 15: Conventional energy

			2007/2008 *	2008/2009 *
Fossil fuel consumption	Boilers	(kWh)	4,712,578.91	5,354,594.64
	CHP	(kWh)	11,903,128.13	9,248,883.44
	Total	(kWh)	16,615,707.04	14,603,478.08
Electricity consumption	ATC building	(kWh)	1,446,860.63	1,227,366.12
	Council buildings	(kWh)	1,155,000.00	1,155,000.00
	Auxiliary CHP	(kWh)	155,055.00	137,150.00
	Total	(kWh)	2,756,915.63	2,519,516.12
Electricity RES production	ATC building PV system	(kWh)	** 54,000.00	54,964.00
	District PV systems	(kWh)	** 124,800.00	** 124,800.00
	Total RES	(kWh)	178,800.00	179,764.00
RES share ***	National data	(%)	15.7	18.7
Conventional energy		(kWh)	18,759,837.35	16,471,743.06

* The period analyzed runs from October to September.

** These data are a prediction. About this variable are available measured values only by August 2009.

*** The RES share were calculated considering the data in the document of Terna "Statistical data on electricity in Italy 2008".

The table computations are based on the following base formulas.

Conventional energy per year CE :

$$CE = FF + [0.01 * (100 - RES\%) * (E_{consumer} + E_{aux}) - ERES]$$

Where:

- FF is the fossil fuel used in the respective area;
- $RES\%$ is the share of RES in national electricity mix;
- $E_{consumer}$ is the electricity consumption by regular customers;
- E_{aux} is the electricity consumption by CHP plant;
- $ERES$ is the electricity production by RES.

3.2.2 Indicator A2: Renewable energy sources (RES) final energy use

Data are collected on the renewable energy sources within the site and the RES energy produced in the analysed year.

In the Italian site the only Renewable Energy Source is the PV system.

The PV systems are installed in 2008:

- 50 kW on the façades of ATC building;
- 120 kW on the roofs of the council buildings.

Table 16: RES final energy use

		2007/2008 *	2008/2009 *
ATC building PV system production	(kWh)	** 54,000	54,964.00
District PV systems production	(kWh)	** 124,800.00	** 124,800.00
Total RES production	(kWh)	178,800.00	179,764.00
Total electricity consumption	(kWh)	2,756,915.63	2,519,516.12
% of RES in electricity consumption	(%)	6.5	7.1

* The period analyzed runs from October to September.

** These data are a prediction because measured data are not available. About this variable are available measured values only by August 2009.

As regards the reference year (2007/2008) the consumption of RES is increased.

3.2.3 Indicator A3: RES Capacity

The Arquata district is supplied by two MV/LV substations and by the CHP (only the ATC building).

The Polycity interventions included the installation of 150 kW. Instead 170 kW were installed: RES capacity is the 9.5% of the whole capacity of the electrical network.

All the PV systems (ATC building and Arquata district) are installed in 2008.

Table 17: RES capacity

			Planned	Realized
Conventional electric plants capacity	Substation 1	(kW)	400	400
	Substation 2	(kW)	250	250
	CHP	(kW)	970	970
	Total	(kW)	1620	1620
RES electric plants capacity	ATC building PV system	(kW)	50	50
	District PV systems	(kW)	100	120
	Total	(kW)	150	170
Total electric plants capacity		(kW)	1770	1790

% RES electric plants capacity	(%)	8.5	9.5
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3.2.4 Indicator A4: Thermal Energy Consumption in Buildings

In the thermal energy consumption the water heating and the network losses are not considered.

Table 18: Thermal energy consumption in buildings

			2007/2008	2008/2009
ATC building	Thermal energy consumption	(kWh/y)	966,660.00	1,026,190.00
	Surface	(m ²)	11,350	11,350
	Thermal energy consumption / m ²	kWh/(y*m ²)	85.17	90.41
Arquata district	Thermal energy consumption / m ²	kWh/(y*m ²)	<i>datum not available</i>	122.24
Total thermal energy consumption		kWh/(y*m ²)		212.65

Because of the lack of data it is not possible to compare the two years analyzed.

3.2.5 Indicator A5: Emissions

All the CO₂ emissions were calculated using the emission factors and considering:

- the natural gas consumption to calculate the local emissions;
- the import of electricity to calculate the imported emissions.

Table 19: Emissions

			2007/2008	2008/2009
Local emissions	Emission factor for stoichiometric gas combustion (1)	(kg CO ₂ /kWh)	0.202	0.202
	Total natural gas import	(kWh)	16,615,707.04	14,603,478.08
	Local CO ₂ emissions	(t/y)	3,356.37	2,949.90
Imported emissions	Emission factor for Italian electrical system (2)	(kg CO ₂ /kWh)	0.614	0.614
	Electricity import	(kWh)	1,030,200.00	1,030,200.00
	Electricity export	(kWh)	3,195,829.37	2,334,087.88
	Imported electricity related CO ₂ emissions	(t/y)	632.54	632.54
	CO ₂ reduction related to electricity export	(t/y)	-1,962.24	-1,433.13
Total CO₂ emission		(t/y)	2,026.68	2,149.32

For the calculation of emissions the same factors used in DD 2.1a were used.

(1) Analysis on emission factors in the transport sector ("Analisi dei fattori di emissione di CO₂ dal settore dei trasporti"), APAT.

(2) Thermo-electric production emission factor – form Italian Greenhouse Gas Inventory 1990-2003, APAT.

3.2.6 Index A6: Gross Area of New Built High Performance Eco Buildings

Under a literal definition of the A6 indicator, no new eco building has been built in Arquata but it is necessary to clarify that the 3 sites projects are based on quite different interventions. In particular Arquata project is dedicated to existing buildings and it includes some interventions of building insulation in the case of office building and a few modification in some district building flats where only some windows have been changed. Other interventions

were the installation of a CHP, PV generating sets and an suitable management of energy production and use. These interventions are described in previous deliverables.

4 References

- [1] Till Jenssen, Bastian Rühle, “*DD 4.2 Definition of environmental, economic, and sociological indicators*”, May 2005.
- [2] “*The CONCERTO Guide*”, October 2007.