POLYCITY Innovation

Energy and environmental concepts of the POLYCITY project in Cerdanyola del Vallès
The POLYCITY project

Energy supply in the Directional Centre
The Cerdanyola del Vallès polygeneration system
The district heating and cooling network
Incorporation of renewable energy sources

A sustainable urban development
The Synchrotron office building
“La Clota” residential building
The residential building within the Directional Centre

Monitoring of the implementation of the measures
Energy efficiency of the supply system
Reduction of energy demand of buildings
The POLYCITY project

The objective of the POLYCITY project, financed by the European Commission CONCERTO (VI Framework Programme) is to reduce the consumption of fossil and non-renewable fuels by means of:

- Measures to reduce the energy demand of buildings
- Improvements in the energy efficiency of energy production and supply systems (polygeneration)
- Increase in the use of renewable energy systems.

The research developed in the framework of the project focuses on technological innovation that enables energy saving. In this sense, simulation processes are used to optimise energy production and to improve the design of buildings. POLYCITY respectively supports different aspects of the urban development of three European cities: new buildings and polygeneration system in the Directional Centre of Cerdanyola del Vallès (Barcelona), rehabilitation of the Arquata district of Turin, and new buildings and improvement of the supply in Scharnhauser Park, a former military zone near Stuttgart.

POLYCITY’s innovation and demonstration in these three urban areas are managed by the different regional partners that ensure the effective exploitation and dissemination of the results. At the halfway stage of the five-year period of the project it is interesting to publish the preliminary technical results by means of this leaflet. For further information, please contact the Directional Centre Urban Development Consortium.

Contact
Consorci Urbanístic del Centre Direccional de Cerdanyola del Vallès Passeig d’Horta 66-68 E-08290 Cerdanyola del Vallès Tel. (+34) 93 591 07 80 correu@consorcicd.org www.parcdelalba.com www.polycity.net

POLICY projects are located in Germany, Italy and Spain
Energy supply in the Directional Centre

The Cerdanyola del Vallès polygeneration system

The Cerdanyola del Vallès Directional Centre project incorporates a highly efficient system for simultaneously producing electricity, heating and cooling. This polygeneration system represents a step forward in terms of the district’s energy efficiency. On the one hand, the distributed production of electricity reduces losses through transportation; on the other hand the transformation of residual heat from the cogeneration engines into useful thermal energy (heating and cooling for air conditioning) provides a major saving in primary energy consumption with respect to conventional systems of producing useful thermal energy from the electricity network. Additionally, polygeneration contributes to energy supply safety and diversification.

The polygeneration system to be implemented in the Directional Centre is made up of 4 cogeneration plants, mainly using natural gas, with an electrical power output of 47 MWe. It will also include single- and double-effect absorption chillers to take advantage of part of the heat given off by the engines for the production of cold water. Another part of the heat from the engines will be used to produce hot water by means of heat recovery boilers. Both the cold water and the hot water are distributed by means of a district heating and cooling network that will satisfy most of the air conditioning needs of the Directional Centre.

This system will also include renewable energy sources represented by a biomass gasification plant and a solar thermal plant, as described in the following section.

A communal energy management system will be incorporated to integrate production and energy demand in order to optimise exploitation.

The design, implementation and exploitation of this polygeneration system by means of a 30-year...
The district heating and cooling network

The Cerdanyola del Vallès Directional Centre project includes providing the area with a heating and cooling distribution network that will supply hot and cold water to the buildings in the Science and Technology park, including the Synchrotron building as well as commercial and public buildings. This 4-pipe network (2 pipes for hot water and 2 for cold water) has been designed to interconnect the 4 polygeneration plants according to criteria of maximum availability and modularity and it will have a length of approximately 31 km. For safety reasons, the Synchrotron Alba building will have a direct connection to the ST-4 plant. The pipes will be ST.37 steel pre-insulated with injected polyurethane, an aluminium diffusion layer and a high-density polyethylene external protection layer. The diameters will range from DN 100 (200 mm ext.) to DN 800 (1000 mm ext.).
Incorporation of renewable energy sources

Biomass gasification

The term biomass refers to plants or animal organic material, including materials from natural or artificial transformation. The Cerdanyola del Vallès project will use biomass gasification from a different source: waste furniture, waste industrial pallets and/or by-products from the agricultural and food industry. Gasification is a thermo-chemical process that transforms biomass into a gas called syngas. The biomass gasification plant includes a gasifier for the processes of drying, pyrolysis, combustion and reduction to produce the syngas, which is mainly carbon monoxide and hydrogen. This gas is subsequently used, mixed with natural gas, in a cogeneration engine to produce electricity and useful thermal energy. The gasification plant is planned to have a capacity of 1000 kg/h of biomass, which will allow an electrical output of 1MWe.

In order to guarantee the economic viability of the plant, it will run for approximately 7500 h/year.

Solar energy for cooling

Combining thermal solar energy with thermal cooling equipment produces solar climatization systems. These systems have the great virtue of satisfying the maximum cooling demand when most solar energy is available, i.e. in summer. It is used as a source of renewable energy that enables there to be a reduction in the use of fossil fuels and consequently CO₂ emissions.

In Cerdanyola de Vallès a solar thermal plant with a surface area of 1600 m² is to be constructed with flat plate solar collectors. These collectors will be connected to adsorption chillers with a thermal output of 600 kW in order to obtain an annual production of 700 MWh of cold water at 7°C to be distributed by the district heating and cooling network.
A sustainable urban development

The second area of work and research to save energy in the urban development to be carried out by POLYCITY is the significant reduction of the energy demand of buildings. This set of buildings, if no energy saving measures were applied to their design, would generate a significant additional energy demand that would need to be reduced. In this sense, POLYCITY establishes the following energy demand objectives (see table). The achievement of these objectives would mean a total energy saving and CO₂ emissions reduction in the Directional Centre buildings of about 20% and 30%. The current Partial Plan establishes that the new urban development is based on energy saving and low environmental impact. In fact, its regulations define a series of energy saving and efficiency measures to ensure that new buildings have low energy consumption and consequently low CO₂ emissions. In this sense, the POLYCITY project provides technical and financial support to allow the first two buildings that are being constructed in the Directional Centre to incorporate different measures that enable a reduction in the buildings’ energy consumption and become useful experiences for the rest of the buildings that will be constructed in this area.

Furthermore, the buildings have been simulated using EnergyPlus software in order to verify the energy requirements of the project. The buildings have also been analysed to ensure the compliance with applicable regional and national regulations.

<table>
<thead>
<tr>
<th>Demand objectives (kWh/m²)</th>
<th>Office buildings</th>
<th>Residential buildings</th>
<th>Demand type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating</td>
<td>40,5</td>
<td>43</td>
<td>Thermal</td>
</tr>
<tr>
<td>Cooling</td>
<td>54</td>
<td>7</td>
<td>Thermal</td>
</tr>
<tr>
<td>Lighting</td>
<td>25,5</td>
<td>3</td>
<td>Electric</td>
</tr>
<tr>
<td>Equipment</td>
<td>34,5</td>
<td>47</td>
<td>Electric</td>
</tr>
</tbody>
</table>

A built area of 1,910,512 m² is planned as follows:

- 450,777 m² residential (3,300 residences)
- 1,320,512 m² science and technology park
- 103,464 m² commercial use
- 35,759 m² equipment
The Synchrotron office building

The office building (4,054 m²) of the Synchrotron Light Laboratory constitutes the first specific example of the application of measures to reduce energy demand. The developer of the building is CELLS (Consortium for the Construction, Equipment and Exploitation of the Synchrotron Light Laboratory – www.cells.es) and the architectural and engineering team is the company Master Ingeniería y Arquitectura (www.masteringenieria.com). The energy efficiency measures that have been incorporated into the executive project are:

Office building of Synchrotron

Thermal behaviour facade

Layer high performance SUN-GUARD
LOW E 1.1N GUARDIAN

Outside

Transmitted Energy
Absorbed Energy

Reflected Energy

= 24%

Inside
• **South façade**: The main façade faces south and this provides a significant reduction in the heating demand but also an increase in the cooling demand. In order to avoid this, the façade will have a solar protection system.

• **Building envelope**: The main façade of the building is made of glass with low thermal transmittance. This means that, as shown in the figure (page 10), the façade reduces the transmission of energy by radiation and conduction with respect to conventional glass.

• **Connection to the district heating and cooling network**: This building will consume thermal energy produced by the ST-4 cogeneration plant distributed by the district heating and cooling network.
“La Clota” residential building

One of the residential buildings in the POLYCITY project is “Clota Social Residences Block B”, developed by the public company INCASOL and designed by architect Jaime Pastor Sánchez. The building (see general layout and apartment in the picture) has a built area of 2,786 m² and has 53 dwellings of between 40 and 43 m² each. These dwellings are designed to be rented to young people.

The energy efficiency measures applied to the building are:

- Volumetric design and solar orientation: Galleries that in winter allow the interior of the residences to be heated by means of greenhouse effect and in summer favour natural ventilation have been designed in the south of the building.

- Building envelope: The envelope of the building has a high level of insulation and the windows have mobile solar protection systems.

- Ventilation: The residences have been designed with an intermediate space that contains devices to create and regulate natural ventilation in summer.

"La Clota” residential building works

(next page left)
General layout and dwelling

(next page right)
Thermal operation
The residential building within the Directional Centre

The second residential building of the POLYCITY project has 24 subsidised dwellings to be rented to families and it is located in plot R2 01 01 of the Directional Centre. It is also being developed by the public company INCASOL and it has been designed by the Frutos-Sanmartin firm of architects. The building (see the general layout in next page) has a built area of 2,172 m² with residences with a net usable area of between 71 and 77 m² each. The energy efficiency measures applied to the building are:
**Building envelope**

There is additional insulation made of recycled materials that will provide lower thermal transmittance than that demanded by the POLYCITY project and the national regulations.
- Walls: $U < 0.6 \text{ W/m}^2\text{K}$
- Roof: $U < 0.3 \text{ W/m}^2\text{K}$
- Floor: $U < 0.5 \text{ W/m}^2\text{K}$

All the windows will be double glazed with a thermal transmittance of 1.3 W/m²K.

**Trombe wall**

All the residences have Trombe wall modules in the southern façade for preheating in winter and ventilation in summer.

**Natural Ventilation**

All the residences have been designed to facilitate natural ventilation, with windows on both façades and with access to a chimney with a manual opening.
Monitoring of the implementation of the measures

One of the strictest requirements of the EC is that all POLYCITY measures must be monitored for a minimum period of one year in order to evaluate their effectiveness with real data.

This monitoring can be structured into two main types:

- Efficiency measures of the energy supply system
- Measures to reduce the energy demand of the buildings

The Cerdanyola SIE has been conceived to improve the operational performance of the whole energy production and demand system. The data obtained can be used to calculate the best operational conditions from the economic and environmental perspectives.
Energy efficiency of the supply system

The supply system shown in the next figure is composed of different equipment financed by POLYCITY, whose operation and efficiency will be monitored. This equipment is: the biomass gasification system, the solar collectors, the adsorption and absorption chillers, the cogeneration system and the storage and distribution systems. Within the general monitoring of the supply system, the efficiency of the use of biomass and solar energy will be analysed in depth.

The management, supervision and control of the generation system, the heating and cooling network and the energy demand are integrated within the “Cerdanyola del Vallés Energy Information System” (SIE).
Reduction of energy demand of buildings

In order to monitor the energy efficiency of the buildings, the POLYCITY project supports the monitoring of the three demonstration buildings by measuring the monthly values of heating demand, demand for hot water, the electrical demand for lighting and the demand of other electrical equipment. All data from the meters will be sent to the project coordinator by modem for scientific analysis.

Additionally, there will be monitoring of the heating and cooling systems of the buildings connected to the Directional Centre heating and cooling network.

In fact, this data will be integrated into the Cerdanyola del Vallès Energy Information System, which has been created by Cerdanyola Council with the support of the Department of the Environment and Housing. This system has been designed by the International Centre for Numerical Methods in Engineering (CIMNE) of the Technical University of Catalonia and the company Gassó Serveis for the government.