"PARC DE L'ALBA": SUSTAINABLE URBAN DEVELOPMENT IN CERDANYOLA DEL VALLES USING A HIGH EFFICIENCY TRIGENERATION SYSTEM AND A DISTRICT HEATING AND COOLING NETWORK.

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DESCRIPTION

1. Parc de l'Alba

The "*Parc de l'Alba*" (also known as Directional Centre) is a new urban development with the aim to become a model of sustainable growth, located in Cerdanyola del Vallès, a city of 50.000 inhabitants in the area of Barcelona (Spain). The *Consorci Urbanístic del Centre Direccional* (CONSCD) is a public consortium, evenly formed by the City Council of Cerdanyola and the INCASOL (Catalan metropolitan institute for the land), responsible for implementing the urban development.
Parc de l'Alba comprises an area of roughly 3.400.000 m^2, of which 1.652.000 m^2 will be green spaces. It will include the Science and Technology Park, with a total built area of 1.460.000 m^2 and with a Synchrotron light laboratory (particle accelerator) as its main landmark. There will also be a residential area with a total built surface of 450.000 m^2, formed by 1.350 social dwellings and 2.100 private promotion dwellings; as well as a commercial area of 107.000 m^2.

Figure 1. Parc de l'Alba aerial view (photomontage)

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2. Goals of the urban plan

The strategic goals of this urban plan are the following:

- To promote Cerdanyola as a centre for science and business development, thanks to Synchrotron Light Laboratory and the Auntonomous University of Barcelona (UAB)
- High standards of urban quality: balance of land uses, advanced infrastructures, innovative buildings, public spaces.
- Excellence in environmental quality, in order to minimise the impact of the urban development: energy efficiency (supply and demand sides), landscape integration, restoration of local ecosystems, optimisation of natural resources and sustainable mobility.

3. Energy demand

The expected total energy demand of the urban plan is shown below (annual figures):

Area of the urban plan	Electric demand (MWh/year)	Thermal demand (MWh/year)		
		DHW	Heating	Cooling
Science & Technology Park[1]	203.400 (40.400)	2.112	90.200 (25.200)	167.800 (42.200)
Synchrotron	44.600	0	3.800	30.200
Residential area	12.270	8.350	9.300	2.970
Commercial area	20.800	160	9.600	13.100
Total (final stage)	**281.070**	**10.622**	**112.900**	**214.070**

Table 1: Forecasted energy demand of the urban plan

In order to minimise the consumption of primary energy implied by this high energy demand, it has been considered suitable to implement a high efficiency energy supply system, based on polygeneration technologies and a district heating and cooling network, which also takes into account security of supply and modularity criteria.

4. The Polygeneration System:

A high efficiency energy system is to be implemented in *Parc de l'Alba*, in order to produce electricity, heat and cold. This polygeneration system will comprise 4 natural gas cogeneration plants with an electrical output of about 47 MWe, with thermal cooling facilities (single and double effect absortion chillers) and a district heating and cooling network within the Science and Technology Park, which represents the core of *Parc de l'Alba*, as well as the commercial area and some of the public and private equipment buildings. The residential area has not been included in the DH&C network, since its demand profile does not justify the additional investment required.

The system will also include renewable energy sources (RES) represented by a gasification biomass plant and a solar thermal plant that will produce hot water for cooling purposes. A Communal Energy Management System (CEMS) that integrates supply and demand will be implemented to optimise the system exploitation.

The innovative energy measures considered in *Parc de l'Alba*, along with similar actions in the cities of Turin and Stuttgart, are included in the Polycity project (Energy networks in sustainable cities), which is a specific Concerto project within the Sixth Framework Programme of the European Union.

[1] Figures in brackets show the expected demand in the first stage of the urban development.

5. Technical description:

The high efficiency generation system will comprise 4 natural gas cogeneration plants, based on natural gas engines:

PLANT	ST-4	ST-5	ST-2	ST-3	TOTAL
Co-generation engines (MWel)	16,5	8,5	11	11	47
Absorption chillers (MWc)	13	5,3	7	8	33,3
Compression chillers (MWc)	5	2	7	4	18
Heat recovery boilers (MWh)	10	4,5	8	8	30,5
Conventional boilers(MWh)	5	2,5	4	4	15,5

Table 2: polygeneration system capacity

The waste heat given off by the engines will be recovered in the form of:

- Hot water at a temperature of around 90ºC, used for heating and also to produce chilled water by single-effect water/LiBr absorption chillers.
- Exhaust gases at a temperature of 398 ºC, directly used to produce chilled water by double-effect absorption chillers of higher efficiency. Eliminating the conversion of waste heat into hot water or steam as a medium for driving the chiller, improves the efficiency of the plant.

The DH&C network includes a storage system for chilled water, used to balance variations of cooling demand and shift peak loads.

Figure 2. District Heating and Cooling network and location of the cogeneration plants.

The system will also include the following back-up systems, used to cover the demand peaks of the thermal energy system or in case of emergency:

- Back-up gas boiler system
- Compression chillers, used as support of the absorption chillers during peak loads

The incorporation of renewable energy sources in the system will be represented by:

- A biomass gasification plant that will be fuelled either by wood waste from discarded furniture (e.g. plywood) or by subproducts from agricultural origin, in order to produce syngas (up to 2.500 m^3/h). The syngas will be used, mixed with natural gas, in an adapted co-

generation engine integrated with the rest of the plant. The estimated output of this engine is 1,58 MWel.

- High temperature solar thermal collectors (evacuated heat pipe) with a total area of up to 475 m^2 used to produce hot water to drive a single effect absorption chiller (100 kWc).

6. Implementation:

This polygeneration system will be implemented in several stages, according to the pace of development within Parc de l'Alba. The first stage (Polycity project) includes two polygeneration plants:

- Plant "ST-4" (already constructed and in operation)
- Plant "ST-2": includes the RES (in the engineering stage)

The results will determine the suitability of implementing greater RES in subsequent stages.

7. Management and operation:

In 2006, CONSCD started an invitation to tender process for the polygeneration system, which was concluded on 1 March 2007, when the board of directors of CONSCD agreed to award the contract to the joint venture formed by TECNOCONTROL and LONJAS TECNOLOGIA.
The scope of the contract includes the design, construction and exploitation during the next 30 years of the polygeneration system. For this purpose, a new public-private company was incorporated. The awarded joint venture possesses an 80% stake of this new company (ESCO), whereas the other 20% is equally owned by two public entities: *Consorci Urbanístic del Centre Direccional* and CELLS (Consortium for the Exploitation of the Synchrotron Light Laboratory). It is expected that public national and regional energy agencies (IDAE, ICAEN) take up to a 10% stake that they would buy from the private company.

Since September 2010 the ESCO sells:

- Electricity to the grid (subsidised by feed-in tariff)
- Electricity, heat and cold to CELLS (Synchrotron light laboratory)

In 2012, the ESCO will sell heat and cold to new customers that will be connected to the DH&C:

- A data centre from a financial institution
- An office building from an engineering company
- An analysis laboratory

The energy prices offered by the ESCO will be as indicated in table 3. Thermal energy prices will be indexed to natural gas prices (tariff 2.4).

	Heat*	Cold*	Electricity
Connection charge (€/kW)	42,00	127,00	CELLS 5% discount Over tariff 3.4
Fixed rate (€/kW yr)	11,65	19,18	
Variable rate (€/MWh)	23,00	23,00	

Table 3. Energy prices offered by the ESCO

8. Benefits and expected results:

The implementation of this efficient energy supply system is expected to reduce the consumption of primary energy and, therefore, to reduce the emissions of greenhouse gases. Specifically, the potential benefits of this polygeneration system have been quantified as follows:

Stage of development	Primary energy savings	Reduction of CO_2 emissions
First stage (plant ST-4)	38.100 MWh/year	7.500 Tm/year
Final stage (4 plants)	109.000 MWh/year	21.400 Tm/year

Table 4. Environmental benefits of the polygeneration system

Apart from these important environmental benefits, for a customer connected to the district heating and cooling network, the advantages of this system will have a different perspective, and will be as follows:

- Reduced initial investment
- Less space required for HVAC equipment
- Less operating and maintenance costs
- Flexibility in case of energy demand variation.