EFFICIENT ENERGY SUPPLY SYSTEM IN THE DIRECTIONAL CENTRE OF CERDANYOLA

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THE DIRECTIONAL CENTRE

The 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 Municipality of Cerdanyola and the INCASOL (Catalan metropolitan institute for the land), responsible for implementing the urban development.

The Directional Centre 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 1.200 social dwellings and 2.100 private promotion dwellings; as well as a commercial area of 107.000 m^2.

Aerial picture of the Directional Centre (photomontage)

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, 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.

Synchrotron Light Laboratory ALBA

Energy demand

The expected total energy demand of the Directional Centre 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

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

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, using advanced cogeneration systems with the integration of renewable energy sources.

The Polygeneration System

A high efficiency energy system is to be implemented in the Directional Centre, in order to produce electricity, heat and cold. This polygeneration system will comprise 4 natural gas cogeneration plants with an electrical output of about 45 MWe, with thermal cooling facilities (absortion and adsorption chillers) and a district heating and cooling network within the Science and Technology Park, which represents the core of the Directional Centre, 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 represented by a gasification biomass plant of 1 MWe 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 the Direcctional Centre, 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.

Technical description

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

PLANT	ST-4	ST-5	ST-2	ST-3	TOTAL
CO-GENERATION ENGINES (MWel)	15	8,5	11	11	45,5
AB/ADSORTION CHILLERS (MWc)	12	5,3	7	8	32,3
COMPRESSION CHILLERS (MWc)	6	2	7	4	19
HEAT RECOVERY BOILERS (MWh)	10	4,5	8	8	30,5
CONVENTIONAL BOILERS (MWh)	5	2,5	4	4	15,5

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 of high efficiency.

The DH&C network will include storage systems for both chilled and hot water, used to take in variations of cooling and heating demand.

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 and adsorption chillers during peak loads

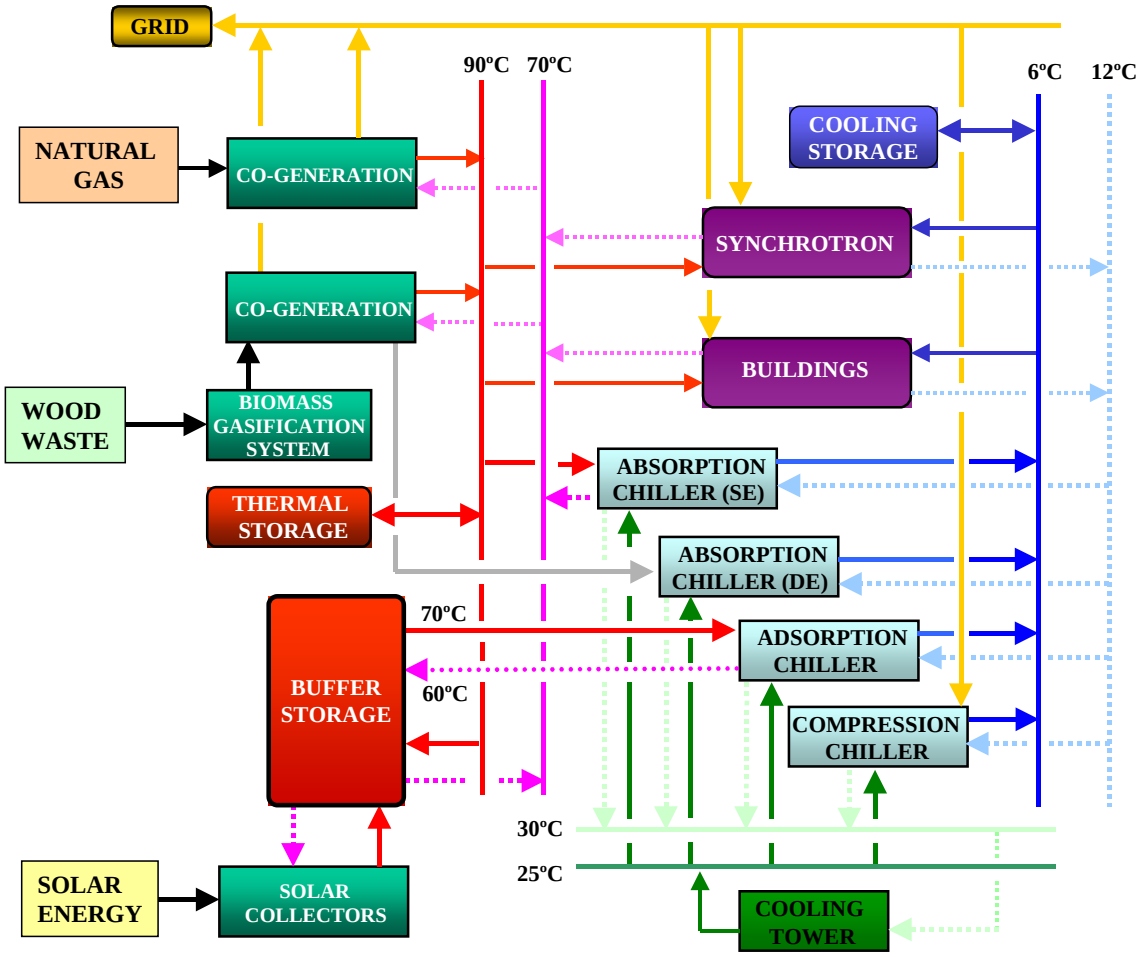
The innovative features and the incorporation of renewable energy sources, included in the Polycity project, will be represented by:

- 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. 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 MWel.

- Medium temperature solar thermal collectors with a total area of up to 2.000m^2 used to produce hot water to drive adsorption chillers.
- Up to 1 MW of cooling using an adsorption chiller driven by thermal solar energy at a temperature lower than 90ºC, which will work in parallel with the absorption chillers.
- The heat of the exhaust gases from the cogeneration engines will be recovered by direct-fired double-effect absorption chillers that will produce additional chilled water.

The following picture shows a simplified block diagram of the complete energy supply system of Cerdanyola's Directional Centre.



Implementation

This polygeneration system will be implemented in several stages, according to the pace of development within the Directional Centre. The results of the first stage (Polycity project), will determine the suitability of implementing greater RES in subsequent stages.

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 will be incorporated. The awarded company will possess an 80% stake of this new company (ESCO), whereas the other 20% will be 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. In this event, the participation of the awarded private company would be reduced to a 70% of the ESCO.

Once the first plant is installed, the ESCO will sell:

- Electricity to the grid
- Heat and cold to the Science and Technology Park, commercial areas and public equipment buildings.
- Electricity, heat and cold to CELLS (Synchrotron light laboratory)

The energy prices offered by the ESCO will be as follows:

	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	

*Thermal energy prices indexed to natural gas prices (tariff 2.4)

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