Project acronym: GROUND-MED

Project title: Advanced ground source heat pump systems for heating and cooling in Mediterranean climate

Start date of project: 1 January 2009

Duration: 60 months

Deliverable D5.6: Engineering design of ECOSERVEIS sun-factory demo system in Barcelona, Spain

Version: Final

Due date of deliverable: 31 October 2010

Actual submission date: 31 October 2010

Organisation name of lead contractor for this deliverable:

ECOSERVEIS

Project co-funded by the European Commission within FP7 Programme		
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)	

GROUND-MED WP5 DELIVERABLE
DEMO SITE ENGINEERING DESIGN

D5.6 ECOSERVEIS

ENGINEERING DESIGN OF THE DEMO SITE

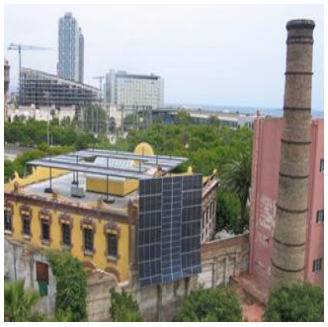
Chapter I. Air Conditioned Spaces and Building Characteristics

LA FABRICA DEL SOL, BARCELONA (SPAIN)

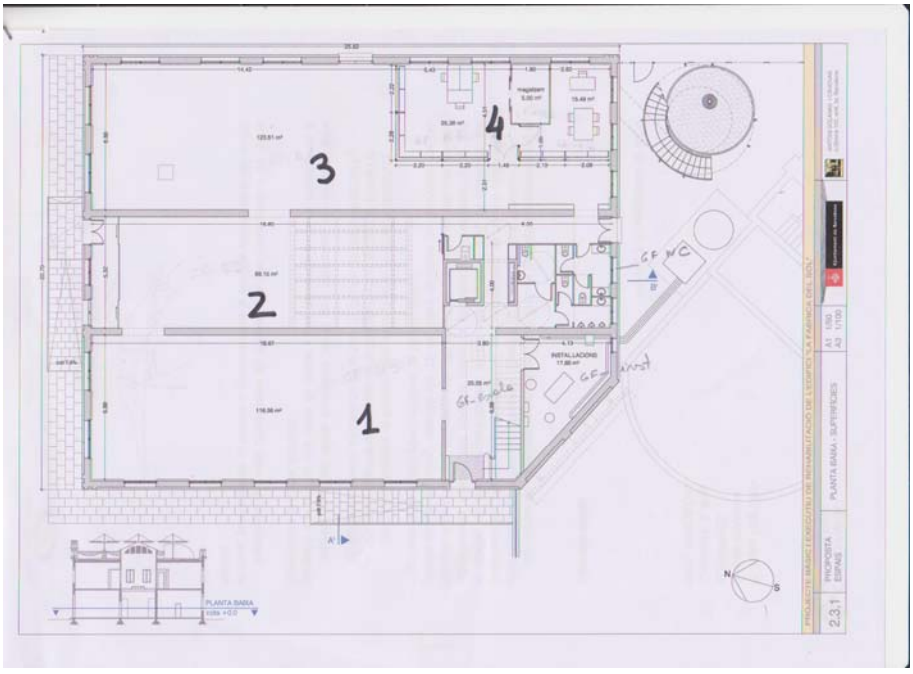
I.1 Building Location, Type and Use

La Fabrica del Sol is an existing building of an old gas factory, being renovated, comprising workshop, offices and social rooms for an information center for renewable energies

Geographical location: City (Country)	Barcelona (Spain)
Latitude	41.18ºN
Longitud	2.11E
Altitude	8 m
Building use	Demonstration Centre
Building type	Offices, Exhibition rooms



The area to be conditioned with the geothermal heat pump corresponds to the ground floor of the building. To have more precise calculations, the 375m^2 have been classified into 4 areas according to the following diagram.



ZONE	m^2
1	116.56
2	89.15
3	123.51
4	45.87

I.2 Building Constructive Data

La Fabrica del Sol is a detached rectangular building with two floors and an accessible roof.

Structure: This is a fixed building with foundations supported by a structure of solid materials and work fabric such as steel, corrugated steel and concrete.

Roof: The roof is made of metal beams and semicircled between beams.

Insulation: The building was retrofitted in 2008 and an extra 6 cm cork has been incorporated to the walls. Cork nominal density is 160kg/m^3, thermal conductivity is 0,045 kcal m/m^2 ºC at 20ºC

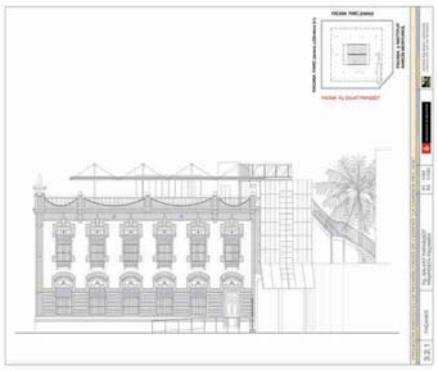
Pave: The material of the pave is concrete

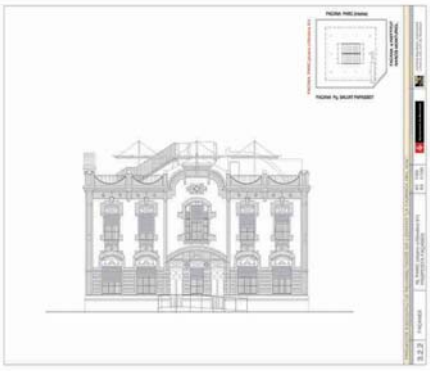
Interior divisions: Ceramics and other biodegradable materials

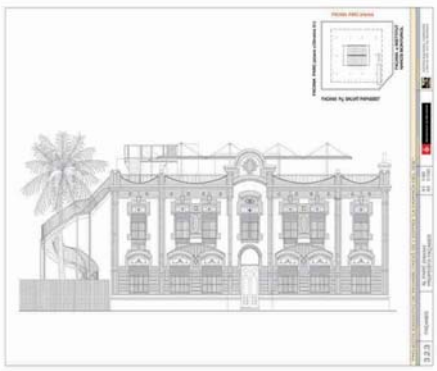
Coating/covering: Clay and plaster

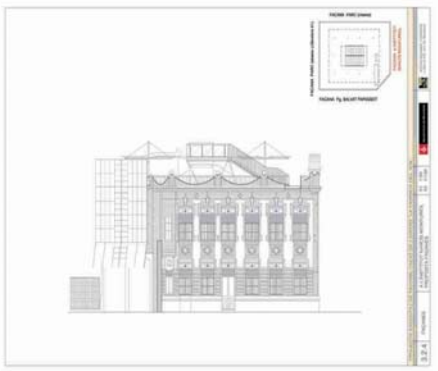
I.3 Windows

The ground floor of this building has a total of 24 windows distributed more or less regularly along the facade.









The windows area and orientation for each air conditioned zone is the following:

BUILDING ZONE	YN (m^2)	YS (m^2)	XE (m^2)	XW (m^2)
ZONE 1	x	15.75	x	7.56
ZONE 2	x	x	x	10.44
ZONE 3	16.620	x	2.520	7.56
ZONE 4	11.34	x	5.04	x

I.4 Walls

Outdoor Walls

The walls area and orientation for each conditioned zone is the following:

BUILDING ZONE	YN (m^2)	YS (m^2)	XE (m^2)	XW (m^2)
ZONE 1	x	69.5	x	28.69
ZONE 2	x	x	x	22.18
ZONE 3	60.13	x	9.63	28.69
ZONE 4	54.13	x	18.81	x

Indoor Walls

The interior walls area border to adjacent areas is the following

BUILDING ZONE	ZONE 1	ZONE 2	ZONE 3	ZONE 4
ZONE 1	x	69.51	x	x
ZONE 2	69.51	x	69.22	x
ZONE 3	x	69.22	x	68.59
ZONE 4	x	x	68.59	x

Boundary Condition Walls

The boundary walls area to a conditioned area is the following:

BUILDING ZONE	AREA (m^2)
ZONE 1	98.19
ZONE 2	160.62
ZONE 3	129.52
ZONE 4	129.81

I.5 Use, Occupancy and Thermal loads calculations

The ground floor of La Fabrica del Sol is an environmental educational centre with different uses such as museistic, auditorium, canteen room and offices.
The centre is opened from Monday to Saturday an average of 10h/day, from 10.am to 20h although depending on the activities the timetable could be flexibilized.

I.5.1 Internal gains, ventilation, infiltration, air coupling

To identify internal gains in the ground floor of La Fabrica del Sol we have taken into account the following specifications:

THERMAL GAINS (W/m^2)	Number of people
People	W
According to ISO 7730 and UNE EN 13779:2004	150
Computer	250
Artificial lighting	8
Total heat gain W/m^2	13
Convective part	0.4

The internal gains taking into account people activity, computers and artificial lighting is the following:

BUILDING ZONE	Number of people	Number of computers	Zone A (m^2)	People (W)	Computers (W)	Artificial Lighting(W)
ZONE 1	46	0	116.56	6900	0	1515.28
ZONE 2	45	2	89.15	6750	500	1158.95
ZONE 3	42	0	123.51	6300	0	1605.63
ZONE 4	8	4	45.87	1200	1000	596.31

Concerning the **ventilation**, the renovation period with the outside air is 3.4 times per hour.
The air coupling is 0 between contiguous zones and 1 between the stairs and zone 1

I.5.2 Thermal loads results (Peak loads and monthly loads)

REFRIGERATION	m^2	Wtotal maximum
ZONE 1	116.56	21191
ZONE 2	89.15	18561
ZONE 3	123.51	18973
ZONE 4	45.87	7995
TOTAL REFRIGERATION		**66.720W**

HEATING	m^2	Wtotal maximum
ZONE 1	116.56	16477
ZONE 2	89.15	13160
ZONE 3	123.51	14909
ZONE 4	45.87	7119
TOTAL HEATING		**51.665W**

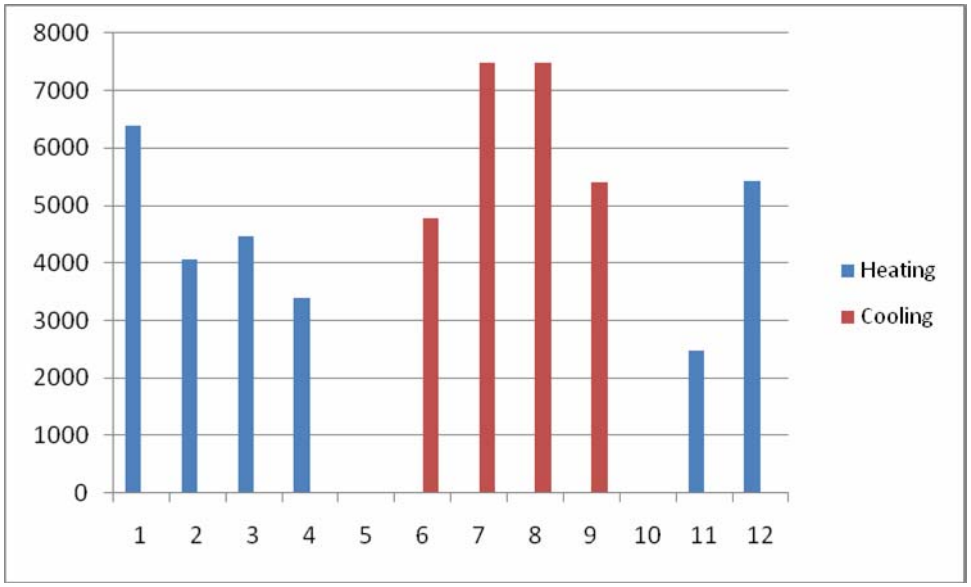
Summer peak load (July

): 50kW

Winter peak load (February): 50kW

Thermal monthly loads

The monthly loads and peak loads for each month are:



	Total loads kWh		Peak loads kW	
BUILDING ZONE	Heating	Cooling	Heating	Cooling
January	6154,617501	0	33,357014	0
February	4837,224016	0	27,7582869	0
March	3127,966564	0	26,7790742	0
April	1821,572084	0	13,4598068	0
May	0	3776,988342	0	27,3962168
June	0	6474,892293	0	31,879039
July	0	9845,465023	0	43,6066896
August	0	8289,801666	0	43,6066896
September	0	6734,138308	0	39,5398933
October	0	3464,324317	0	24,7072707
November	3496,263278	0	23,7366588	0
December	4598,852209	0	25,7905111	0

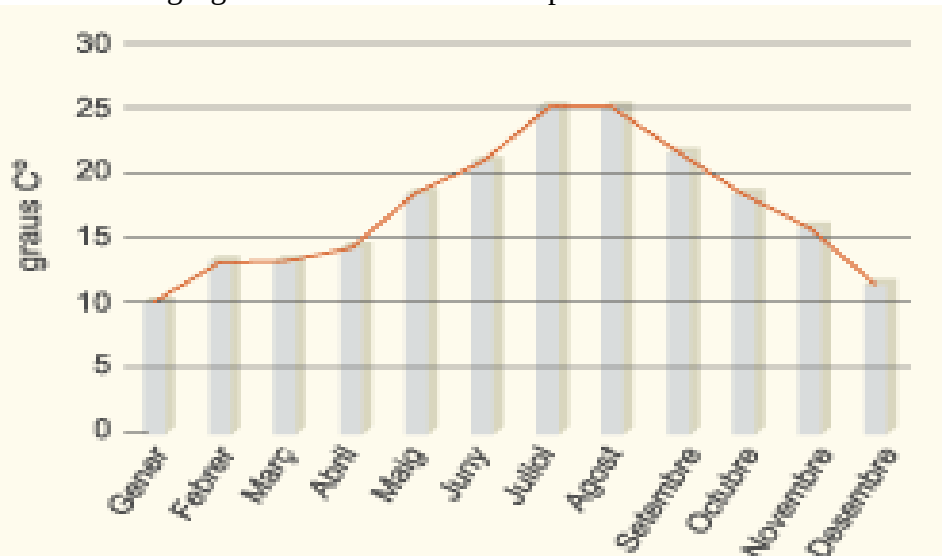
Chapter II. Climate Description and Geology

II.1 Demo site Climate Description

II.1.2 Temperature

Geographical location: City (Country)	Barcelona (Spain)
Latitude	41.18ºN
Longitud	2.11E
Altitude	8 m
Average annual air temperature (ºC)	15.9ºC
Average annual air Relative Humidity (%)	77%

The following figure shows the month temperature

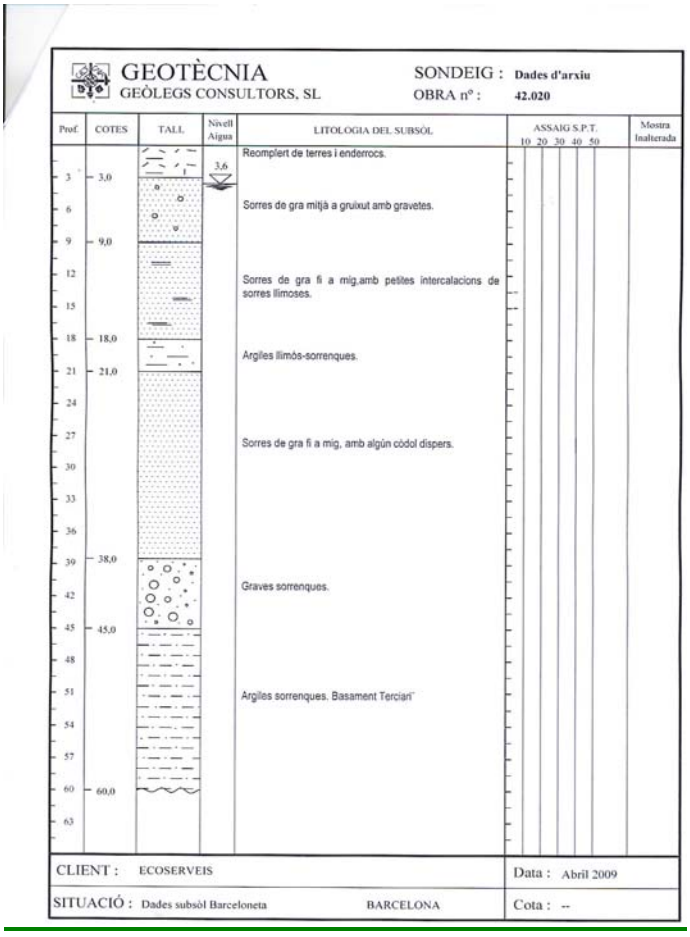


II.2 Soil and Geology

II.2.1 General Geology

	Soil Parameters	
Location type (rural, build up, field or paved)	paved	
General soil profile	coarse sands and clay	
Estimate of Conductivity	2,22	W/mK
Estimate of Volumetric Heat	2400	kJ/Km3
Ground water flow (qualitative: no, high,low)		
Freatic groundwater level	3,6	m

II.2.2 Geological Profile(if available)



Chapter III. System Description

III.1 Heat Pump Description

III.1.1 Water temperature conditions and nominal flow rate considered for the design

	SUMMER	WINTER
Temperature return from building (ºC)	15	35
Temperature to the building (ºC)	10	40
Temperature return from ground (ºC)	27	15
Temperature to the ground (ºC)	32	10
Condenser capacity (kW)	71	68
Condenser water flow rate (m^3/h)	12.2	11.7
Evaporator capacity (kW)	61	56
Evaporator water flow rate (m^3/h)	10.5	9.7

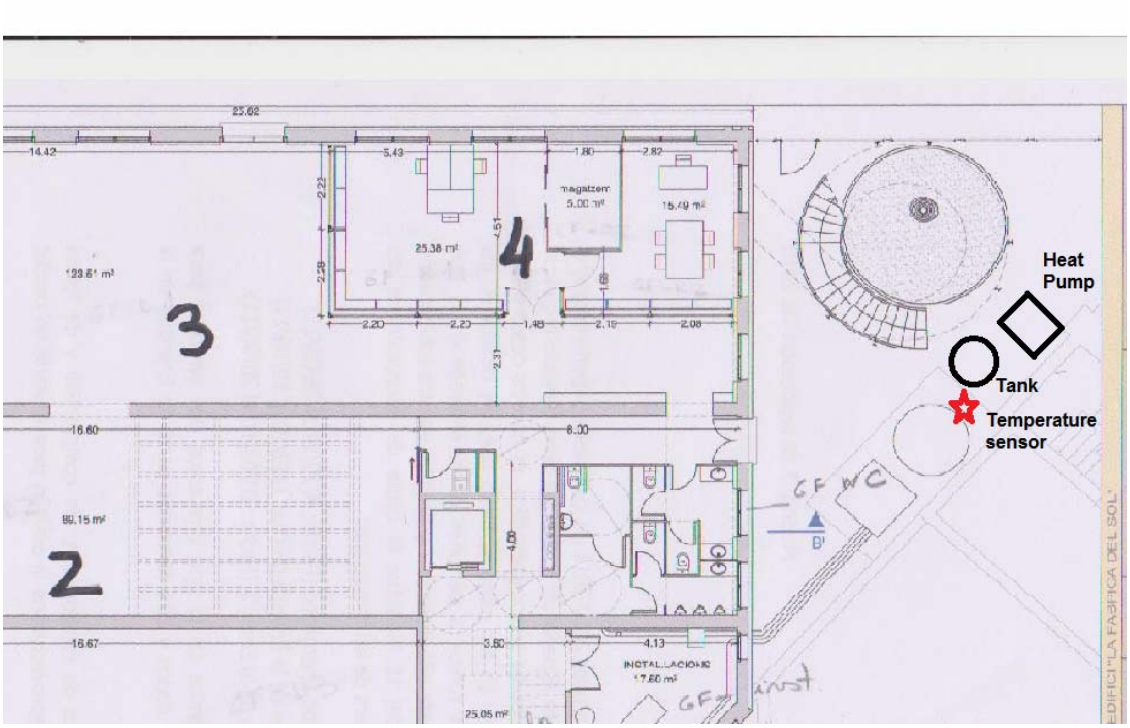
III.1.2 Heat Pump Capacity for cooling and heating mode

50kW heating and 50kW cooling

III. 2 Indoor Loop Description

III.2.1 Hydraulic Loop Description

III.2.2 Internal Tank: volume and position and Temperature sensor



Tank volume: 500l

III.2.4 Hydraulic pipes distribution system: schema of the distribution specifying external and internal diameter and flow rate.

III.2.5 Circulation pump selected:

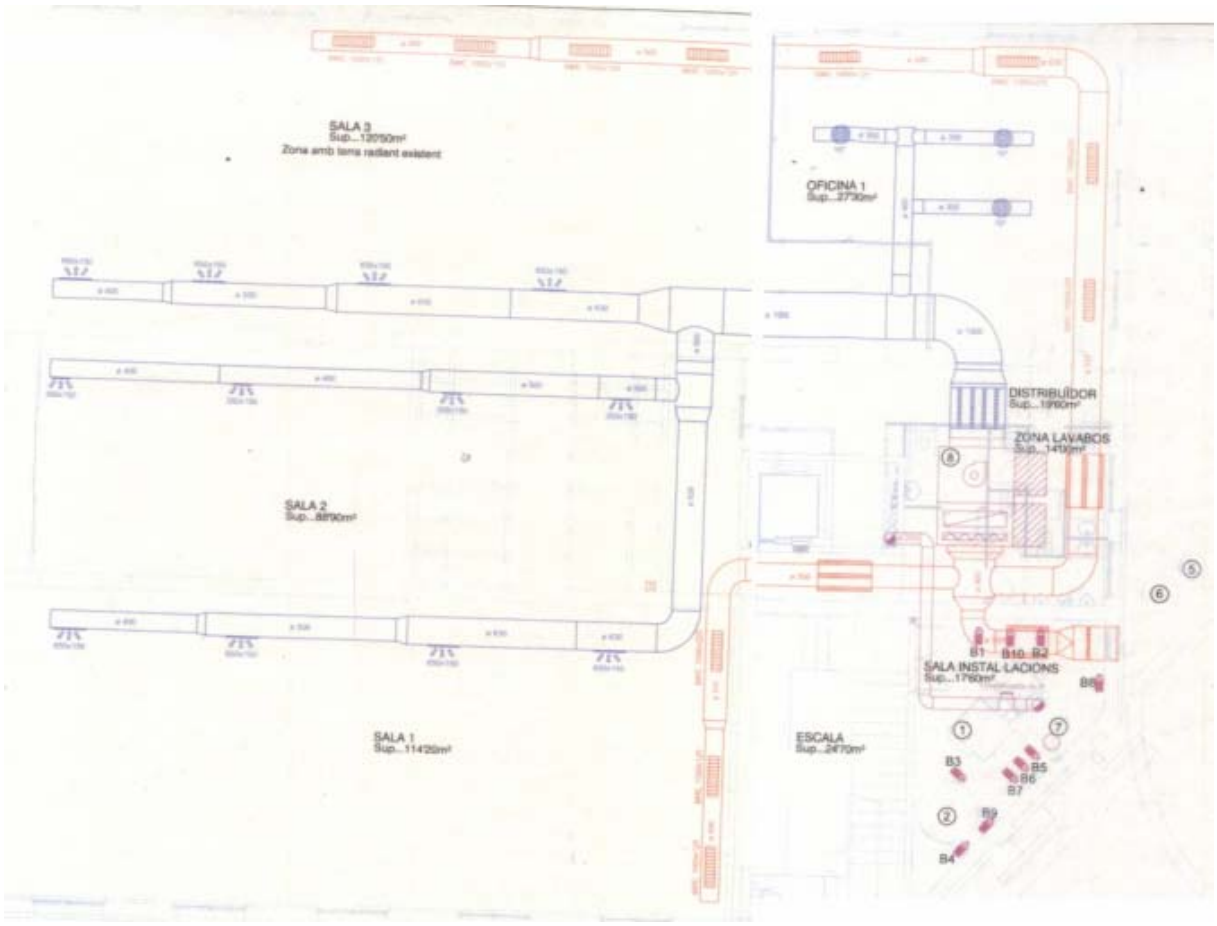
Specify the total pressure drop and water flow rate that must be provided by the circulation pump.

Manufacturer, model, type (fixed velocity or variable velocity) and catalogue data (performance curves)

III.2.3 Fan Coil/ AHU Technical Description

At a first stage the existing AHU will be considered. The specifications are:

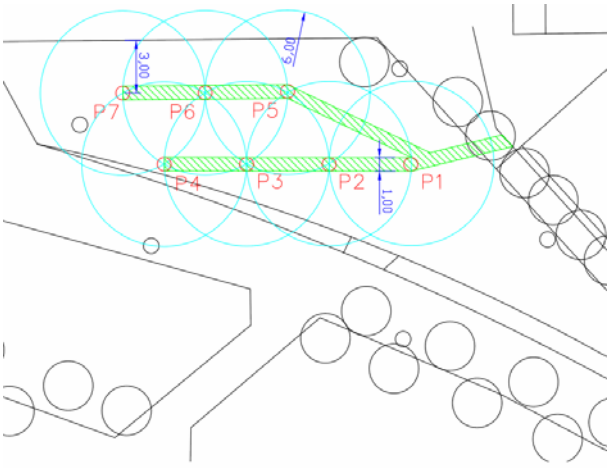
Model: VAIRING VA-121-H
Air filtre
Water battery (75kW thermal in cold)
Dimensioned for an entrance water temperature of 7ºC and a thermal rise of 5ºC
Ventilator 12.180 m^3/h
The following figure shows the existing distribution system


SALA 3
Sup...120'50m²
Zona amb terra radiant existent
OFICINA 1
Sup...27'30m²
DISTRIBUÏDOR
Sup...19'60m²
ZONA LAVABOS
Sup...14'00m²
SALA 2
Sup...88'90m²
SALA INSTAL·LACIONS
Sup...17'60m²
B1
B10
B2
B3
B5
B6
B7
B9
B4
SALA 1
Sup...114'20m²
ESCALA
Sup...24'70m²

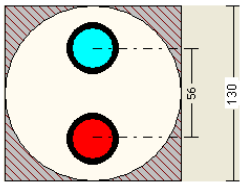
III.3 Outdoor Loop Description

II.3.1 Ground Source Heat Exchanger Description

Type of configuration (rectangular, line....etc):
A rectangle configuration has been design following this scheme.



Single U or Double U (specifying diameters with drawings)
Single U



Number of boreholes	7	mm
Borehole depht	110	m
Borehole diameter (d)	130	mm
Spacing between single tubes	56	mm
Spacing between individual boreholes	6	mm

Grout material and conductivity : High conductivity material or coarse sand will be used
Working fluid: Water

III.3.2 Hydraulic Loop Description

III.3.3 Hydraulic pipes distribution system: schema of the distribution specifying external and internal diameter and flow rate.

III.3.4 Circulation pump selected:

Specify the total pressure drop and water flow rate that must be provided by the circulation pump.

Manufacturer, model, type (fixed velocity or variable velocity) and catalogue data (performance curves)

Chapter IV. OPEN ISSUES

During this first stage of the project, some complexities and difficulties have appeared at La Fabrica del Sol demo site. All these problems can be summarized into 2 aspects: disagreements with Ecoserveis colleagues concerning the heat pump installation despite having permits from the owner of the building (Ajuntament of Barcelona) and inefficient installed fancoils installed at the first floor of the building where initially, the heat pump was designed for.

After some months of discussion, an agreement was taken with all the parts: the heat pump was going to give heating and cooling to the ground floor and not to the first floor as it was planned before.

All the time needed to reach an agreement and the time needed to recalculate the technical design has delayed 2 months the demo site installation. This is why, by the time of writing this deliverable, some technical points of the design had not being captured yet. However, all this information should be completed in less than a month so then, we will be able to update and complete this deliverable containing La Fabrica del Sol demo-site engineering design.