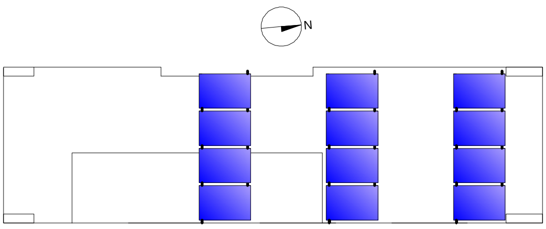
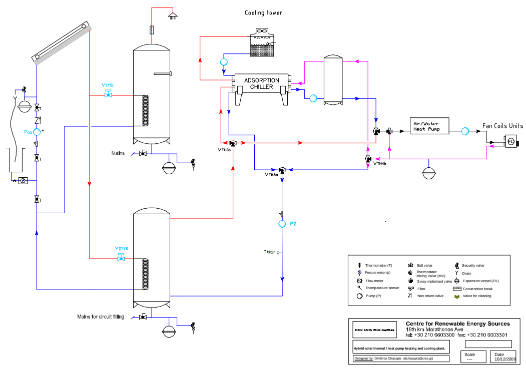
Feasibility Study

Office building in Piraeus





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Subject of Feasibility Study:
To design a solar combi+ system for an office building in Piraeus - Greece

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This feasibility study concerns the installation of a solar combi+ system in an office building in Drapetsona in the area of Piraeus. The office operates 6 days per week from 8:00 till about 19:00. The exact hours of operation per day are not standard but depend of the workload. On average, 8 hours of operation are considered. Since the company's field of work is BEMS, a very good energy conservation strategy is used both for heating and lighting.

Building data:

The building is a 3 floor building with an area of 94m² per floor. The net area of the office space is 74m². The building is very old with very high energy consumption. At the moment, no insulation is installed while single glazing windows are used. Soon renovation works will start to improve the energy consumption. The renovation will include external insulation with 5cm XPS, double glazing, roof insulation and installation of a kiosk on the roof for shading. After the renovation of the building, the expected energy consumption (heating) will be 80kWh/m²

The main key figures are as follows:

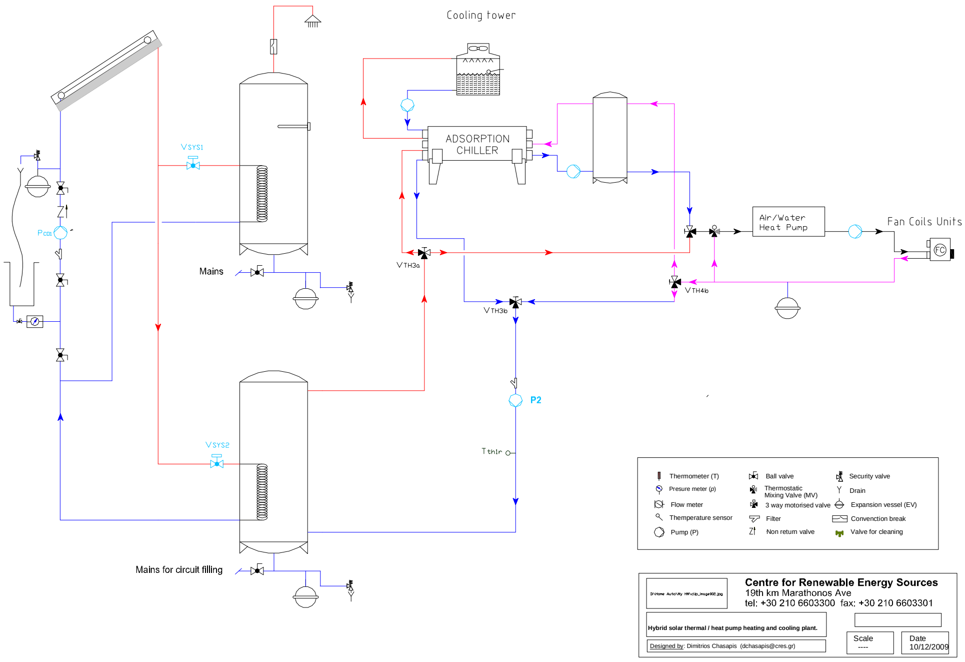
Space:	74 m²
Volume:	222 m³
Persons:	6
DHW load:	4.6 kWh
Space heating load:	9 kW (7.520 kWh/year)
Cooling load:	7 kW, max. 26°C room temperature
Ventilation:	Through the skylight vent (no ventilation system designated)
External wall:	double brick -XPS (5cm)-plaster
Roof:	flat insulated roof with shading
Orientation:	5°

Current situation:

No central heating system is installed. The heating and cooling of the building are implemented with very old split units. The DHW is supplied by a small electric heater.

Proposed system:

The proposed system is a small combi+ system designed to cover part of the buildings thermal and cooling loads. The system uses 2 hot storage tanks, one 100lt with internal heat exchanger for the DHW and one 1500lt buffer tank for the heating support. The two tanks are loaded by 30m² of selective flat plate solar thermal collectors. Since a distribution system is not installed and the retrofit of a floor heating system is not practically viable, Fan-Coils will be installed instead. The system will be backed up by an air/water heat pump connected in series with the Solar Combi+ system. The selection of the heat pump was made for two main reasons: Firstly, the installation of an oil burner was very difficult since many changes in the building had to be made for the supply hoses, chimney installation and oil storage and secondly the specific heat pump can cover both the extra heating and cooling loads. Whenever cooling is required, the system supplies hot water to an 8kW adsorption solar chiller connected in parallel to the distribution network. The re-cooling of the chiller is implemented through a 21kW hybrid cooling tower. At the output of the chiller, a 500lt cold water buffer tank is used. The purpose of the cold buffer is double. Firstly to accommodate the cold water production variability of the chiller and secondly to increases the chiller's efficiency. The layout of the system can be seen in the next picture.



Picture 1 Schematic layout of system

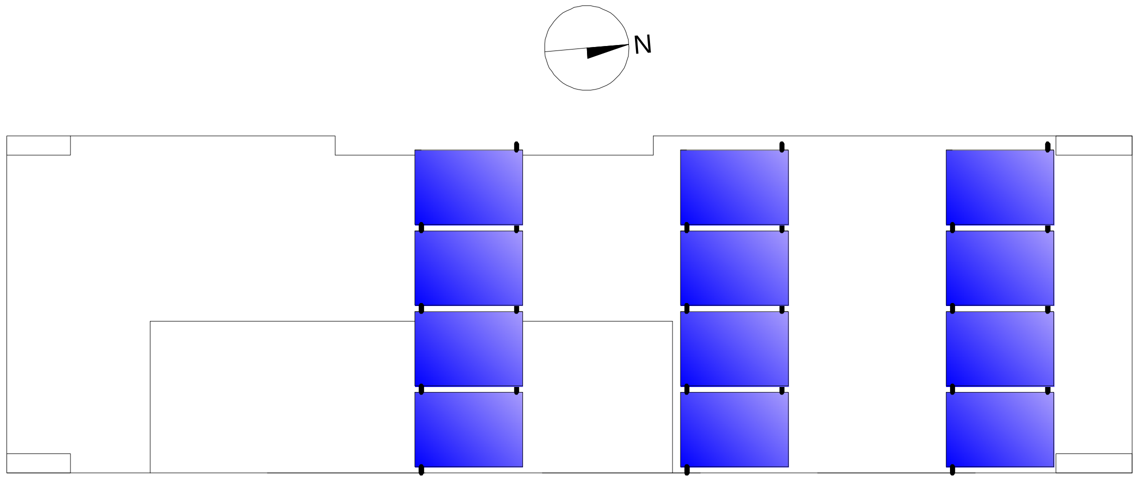
As priority, the solar collectors charge the DHW to 70°C. When this temperature in the DHW tank is reached, the collectors charge the SH tank. Whenever heating is required, the return temperature of the distribution network is measured and if the temperature of the water in the SH tank is higher, water is drawn from the SH tank. If extra heating is required, the heat pump operates to increase the temperature of the water. If the temperature of the water in the SH tank is sufficient to drive the fan-coils, the heat pump is turned off.

Whenever cooling is required, the distribution network is connected to the output of the chiller while the hot water from the system is directed to the chiller. If additional cooling energy is required (during late evening or early morning, the water is chilled by the heat pump.

The main system components are presented in the next table

Collectors	12 Climasol 2.5
DHW storage tank	DIANA 100
SH storage tank	DIANA 1500
CW storage tank	DIANA 500
Solar Chiller	SorTech ACS08

Since shading is going to be installed on the roof, the collectors will be integrated at the shading structure. The inclination of the collectors will be 30° in order to maximize the energy gains in the whole year. The azimuth of the collectors is almost at its optimal at 5°. The collector field is faced towards the front side (Northern) of the building in order to avoid shading from the neighbour buildings (from the South side)



Picture 2 Solar collector installation layout

Energetic contribution:

According to the system's simulations, the system should supply 100% of the DHW needs, 55% of the heating needs and 46% of the cooling needs. The average incident solar irradiation for Piraeus in a summer day is 6.2kWh/m². Under these conditions the system produces on average about 42kWh_c per day. In the worst winter days, the incident irradiation is about 2kWh/m² with an average system production of 21kWh_{th}.