# Design & development of a laboratory building of CRES, with implementation of RES technologies, in Pikermi, Attiki (GREECE)

Location: CRES

Country: Greece

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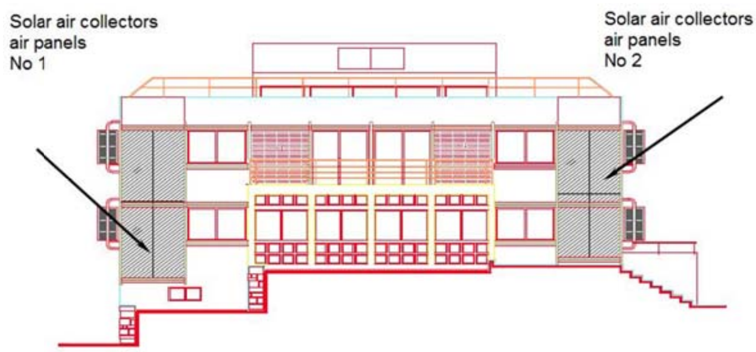
Source(s) of Information:
Project: "Design & development of a laboratory building of CRES, with implementation of RES technologies, in Pikermi, Attiki", OPERATIONAL PROGRAM FOR RESEARCH & TECHNOLOGY MEASURE 3.1

**Functionalities:**

- O Hot Water
- ● Heating
- O Cooling
- O Ventilation
- O Daylighting
- O Solar Overheating Protection
- O Other:

*Drawing/Sketch/Cross section*




**Stage of Development:**

- O Idea
- O Patent
- O Prototype
- ● Demonstrator
- O Commercial product

**Innovative Idea (short description)**

A significant amount of energy consumed in buildings can be saved with a simultaneous improvement in conditions for their occupants through passive and hybrid Solar Systems. CRES have applied several energy technologies in its' demonstration building in Pikermi. Among them CRES incorporated solar air collectors air panels with a total area of 17 m$^2$ into the south face of the building. **The collectors collect solar radiation and give off heat to the building either through openings (direct operation) or as preheated air to a heat pump on the roof (indirect operation).**

The cooling and heating load of the first floor is covered by a solar assisted 18 kW air-water heat pump. During the winter, the air, pre-warmed by the solar air collectors with a total area of 17 m$^2$ and with a specified supply rate of 1700 m$^3$/h, is drawn into the evaporator of the solar assisted air-water heat pump, aided by centrifugal fans and supplies heat to the refrigeration cycle.

**Motivation and advantages (short description)**

The design and construction of a bioclimatic and low energy consuming building which would use different soft energy forms and energy saving techniques was the aim of the project. The building includes a large number of systems based on renewable energy sources (RES) and energy technologies for demonstration purposes as well as for monitoring and evaluation of their efficiency.

The building design specified the incorporation of passive solar systems, the aim of which is to use solar energy for heating:

- Direct gain systems (openings on the south face with a total area of 17 $m^2$) for collecting solar radiation for passive heating during the winter.
- Greenhouse with an area of 8.25 $m^2$ added to the south face of the building, with openings of 12 $m^2$ where solar radiation is collected as heat and is distributed through openings in the building.
- Solar air collectors with a total area of 17 $m^2$ incorporated into the south face of the building.
- Solar atrium (glazed part of the roof of the building with an area of 14 $m^2$) to collect solar radiation and produce thermal energy to heat the central internal part of the building.
- Transparent insulation with a total area of 8 $m^2$ to reinforce solar gains on the south facing parts of the building.

The operation of solar air collectors is based on two modes:

- The direct heating mode is a bioclimatic-passive operation, in which heated air is supplied directly to the space in order to cover any thermal losses, provided that the heated air is able to cover directly these thermal losses (fig1)
- The indirect heating mode is a hybrid-active operation, in which heated air assists the evaporator of an air-to-water heat pump in order to enable an easier pumping and, hence, increase the efficiency of the solar heat. This happens because the heated air may be unable to cover directly the thermal losses of the spaces (fig2).

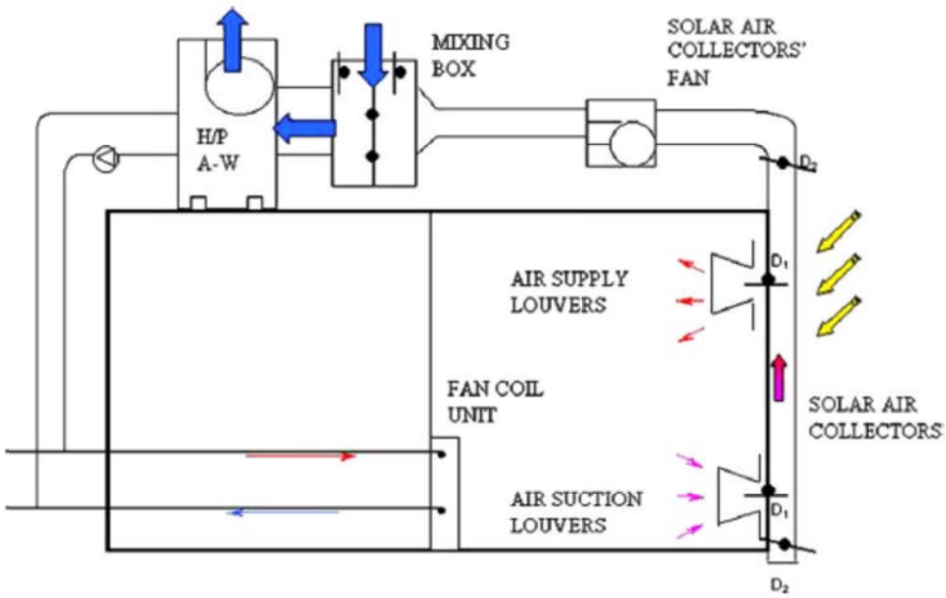



Fig. 1. System configuration with direct (passive) operation heating of the bioclimatic building (Bololia, 2002).

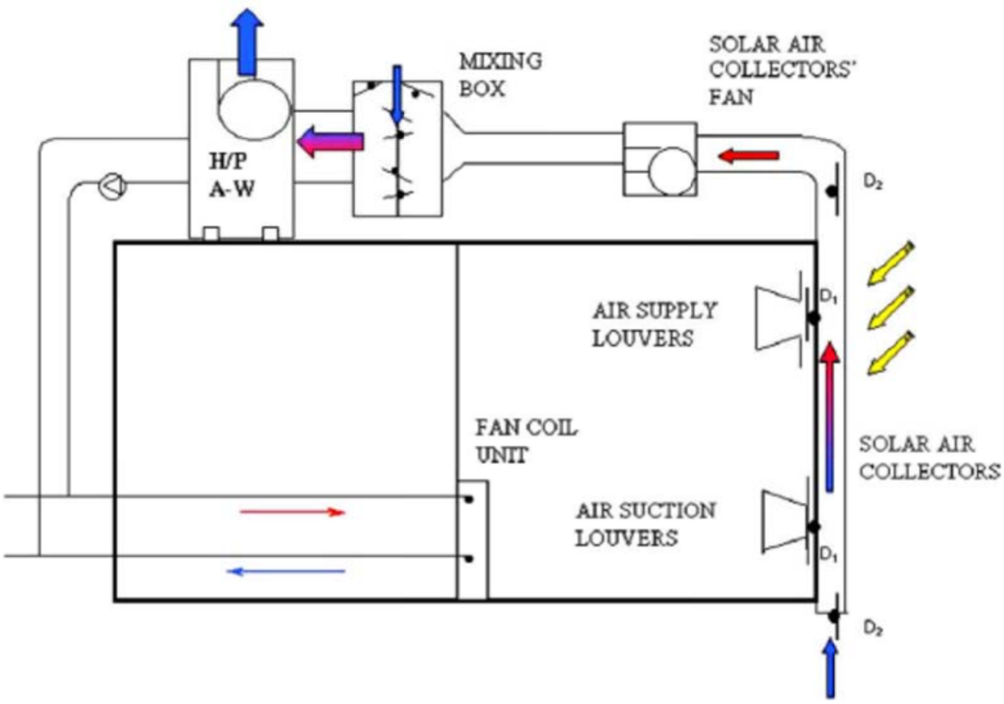



Fig. 2. System configuration with indirect (hybrid) heating of the bioclimatic building (Bololia, 2002).

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**Performance data:**

Based on:

- O Estimation
- ● Detailed simulation
- ● Measurement/testing

**Key performance parameter:**
Not available for the specific collectors, as they were a prototype model, specifically designed for the project.

Collector coefficients EN12975
a0=
a1=
a2=

**Other performance parameter:**

Light transmittance: %

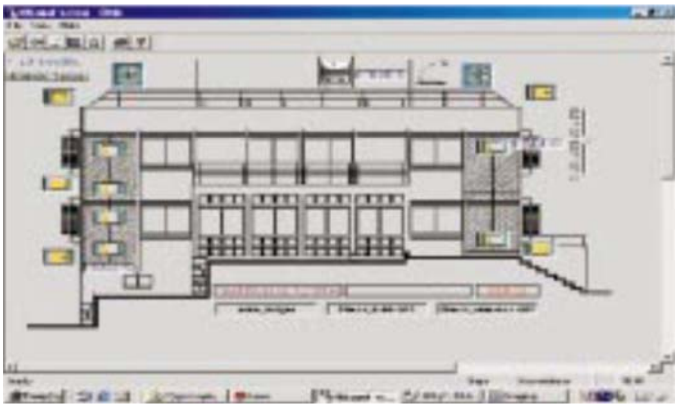
Solar transmittance: %

Total solar energy transmittance solar factor: %

U (component): [W/(m2K)]

*Construction phase*

*BMS screen which controls the performance of the solar air collectors*



Calculations of energy criteria and variations from TRNSYS of the simulation model TSAGAIR for an entire heating period (at direct heating mode).

| Energy criterion | Calculations with TRNSYS 15 | Calculations with TSAGAIR | Variation |
|---|---|---|---|
| Seasonal solar radiation | 430 $kWh/m^2_{c.s.}$ | 455 $kWh/m^2_{c.s.}$ | 5.81% |
| Seasonal production of solar air collectors | 93 $kWh/m^2_{c.s.}$ | 105 $kWh/m^2_{c.s.}$ | 12.90% |
| Total consumption of two offices (including internal gains) | 1878 kWh | 1935 kWh | 3.04% |
| Energy consumption indicator c.s. | 79.91 $kWh/m^2_{c.s.}$ | 82.34 $kWh/m^2_{c.s.}$ | 3.04% |
| Energy consumption indicator i.a. | 62.6 $kWh/m^2_{i.a.}$ | 64.5 $kWh/m^2_{i.a.}$ | 3.04% |
| Solar Fraction | 85.9% | 78.4% | −8.74% |

Simulation of the energy criteria on daily results for the overall plant efficiency ($COP_{tot}$) on 5th March.

| Energy criterion | Symbol | Direct mode | Indirect mode |
|---|---|---|---|
| Absorbed energy | $Q_{elH/P}$ ($Wh_{el}$) | 7857.97 | 8734.53 |
| H/P useful heat | $Q_{H/P}$ (Wh) | 23,181.00 | 35,112.82 |
| Building load | $Q_n(T_a)$ (Wh) | 35,112.82 | 35,112.82 |
| Collector useful heat to space | $Q_u(T_{set})$ (Wh) | 11,931.82 | |
| Collector useful heat to H/P | $Q_u(T_a)$ (Wh) | | 28,409.09 |
| Efficiency of H/P | $COP_{H/P}$ | 2.95 | 4.02 |
| Efficiency of plant | $COP_{tot}$ | 4.47 | 4.02 |