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Net zero emissions for a seminar room in the University of Balearic Islands

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Abstract. The seminar room was built in the late 80s with an Air-Air Heat Pump System. The development of modern net zero-energy buildings (NZEB) became possible with the combination of solar thermal, photovoltaic and geothermal. A few fraction of auxiliary energy will be providing by heat pump systems (HP), the Renewable energy can cover all the energy consumption of the year. Solar heating with geothermal system for buildings has been designed to achieve different values of the fraction of a primary energy saving using the Flat Plate Collectors (FPC) for Solar Thermal (ST) and other supply energies like solar photovoltaic (PV) or wind technology, and having the higher efficiency of the system with net zero energy.

Key words

Solar Thermal, Heat Pump, Photovoltaic, geothermal, combisystems.

1. Introduction

Directive 2010/31/EU, the Article 9 requires that "Member States shall ensure that by 31 December 2018 all new buildings occupied and owned by public authorities are nearly zero-energy buildings. This requires a new concept and a big effort by the construction sector, including engineers, architects and ESCO.
This new concept will need reduce the demand of the building, use renewable energies and efficient systems.
Radiant cooling systems require usually less energy consumption than conventional cooling systems. The radiant systems are ideal system for cooling existing buildings, because cost in the retrofit.
Recently, reductions in electric PV costs and mature technology of heat pump have provided a new model: solar-electric assisted heat pump[3]. This system comes with fewer drawbacks than solar thermal energy, a smaller price tag for residential applications. Nevertheless, the best system will be a combination of both. The development of modern net zero-energy buildings (NZEB) became possible not only through the progress made in new renewable energy and construction technologies and techniques, but it has also been significantly improved by the combination of all the techniques and advanced combisystems.

Some research groups are studying the best combination for archive this goal. According to the thermal necessities and the weather conditions, the design has to be adapted in each area [1]. Radiant cooling (floor or ceiling) is not so often used but with the appearance of high efficiency aerothermal systems they have started to be installed with more frequency, though new constructions cover all thermal necessities (hot water, heating and cooling) with one system, especially at southern countries [2]. The building has been the first Rectorate, and the seminar room was built in the late 80s

2. New Design

The seminar room has an old Air-Air Heat Pump, with a fibber ducts. The old lights with halogens and incandesce have an electric power of 2037 W, with new light system the power will be 738 W. Using the Spanish official software (CALENER) [4]. The CO_2 emissions of the room give us the worst letter in the Spanish label (G), with a global emissions of 118,39 $kgCO_2/m^2$. For heating and cooling has and F with a maximum consumption of 72,48 and 8,36 kWh/m^2, with a maximum emissions of 80,89 and 8,07 $kgCO_2/m^2$.
Radiant panels[5] in the roof have replaced the old system. At summer is used geo-cooling from and existing well near the building, the temperature of the water is 17ºC, and is enough for the radiant system. In winter the solar collectors provides water from 30 to 40ºC, with a high efficiency.

The extreme days will be necessary the auxiliary heat pump, air-water system. The energy savings and consumption are shown in Table I.

Table I. – Energy Consumption and CO_2 emissions

	Before	**New system**
Electricity kWh/year	*3507*	*330*
Kg CO_2/year	*1708*	*0*
PV prod. kWh/year	*0*	*423*
Solar Thermal used	*0*	*748*

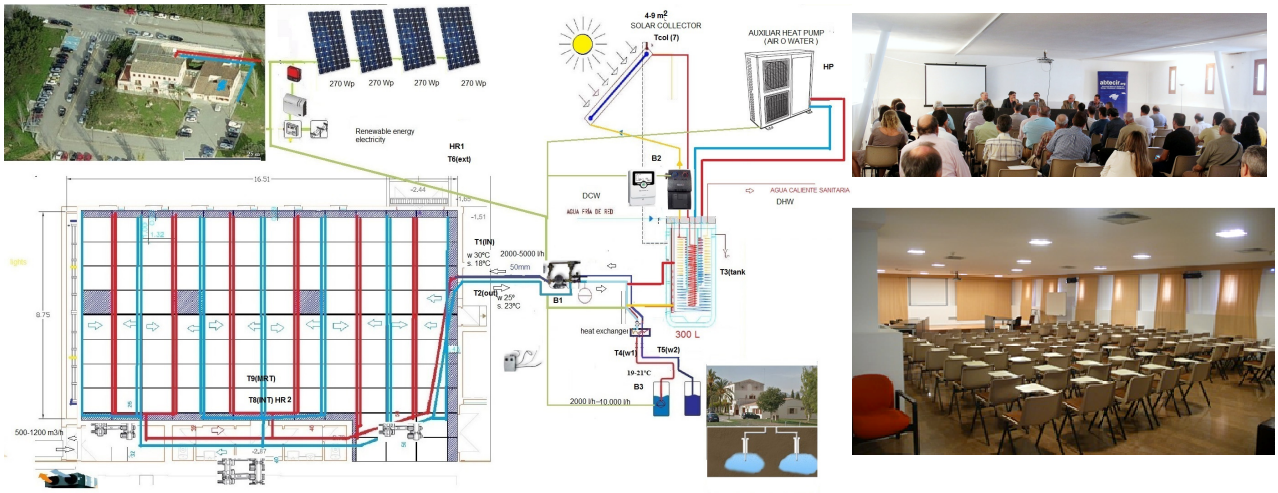

Fig. 1. Design of the system and view of the seminar room, with the new and old view.

3. Simulated and real Results

The system has been completely installed in September 2015. It's composed by a new radiant systems in the room, a well (geo-cooling system), Flat Plate Collectors, Air-Water Heat Pump, Storage Tank of 300L [7], Photovoltaics panels polycrystalline (PV) [6] with an inverter for the grid, a ventilation system, the control and data logger systems.
The initial results are very promising and will validate the simulated results, obtained using various software tools (TRANSOL, GREENIUS, CALENER), this results will be validated during one year of collecting data.

The radiant system reduce the working temperatures of the system (17-22ºC at summer and 28-33ºC at winter) and don't need any fan for transfer the heat, if we compare this with the fan coil, that they need to work (7-12ºC at summer and 40-45ºC), only this fact makes increase the efficiency of the heat pump a 30%.

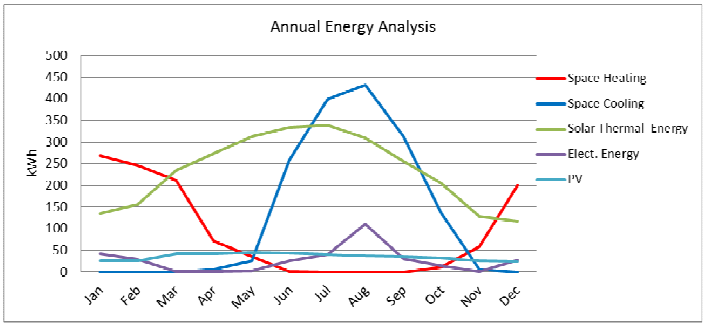

Fig. 2. Annual Energy Consumption and Mix of Renewable sources

The new system will use renewable energies during all the year, and the few electricity needed for pumps and auxiliary systems will be cover by a Net metering contract with the electrical company with the electric production of the PV system, to compensate the excess of summer with the low winter production.
It will be as well installed, as a demonstrative system, a small wind turbine of 500 W, even the expected working hours are less than 10% of the equivalent time, but will be a test for apply in the future in other locations with more wind and less solar radiation. From the simulated results it's clear that at summer the solar thermal collectors they have an over production, during this year will be studied as well to add a seasonal storage, according to the results of the real test will be dimensioned.

4. Conclusion

With the new system a 90% of the energy has been reduced.
Radiant cooling energy savings have a 30% compared to conventional systems (Fan coils or split) and can work with optimal temperatures for geothermal and Solar thermal energy.
PV will provide the few energy consumption of the new system.
Using the properly mix of renewable energies the room will be a real NZEB.

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