Certified ClimateHouse building in Mediterranean climate

CRISTINA BECCHIO
TEBE Research Group, DENERG,
Politecnico di Torino, Italy,
cristina.becchio@polito.it

GIANNI CARLO LA LOGGIA
Architetto La Loggia – Studio Architettura
Trino (VC), Italy
laloggia@libero.it

LARA ORLIETTI
TEBE Research Group, DENERG,
Politecnico di Torino, Italy,
lara.orlietti@studenti.polito.it

The need to plan and construct high performing buildings is higher than ever. This paper presents an example of low energy building in Mediterranean climate.

Keywords: low energy building, ClimateHouse certification, passive design strategies.

The construction of buildings and their operation contribute to a large proportion of total energy end-use worldwide; indeed, buildings account for 40% of the total energy consumption and for 36% of CO_2 emissions in the European Union. The sector is expanding, which is bound to increase its energy consumption. This trend raises some environmental issues such as the exhaustion of energy resources, global warming, the depletion of the ozone layer and climatic changes. The Commission's Roadmap showed that greenhouse gas emissions in this sector could be reduced by around 90% by 2050 compared to 1990. The most immediate and cost-effective way of achieving this target is through a combination of cutting energy demand in buildings through increased energy efficiency and a wider deployment of renewable technologies. In order to reduce the growing energy expenditure, the European Directive imposes the adoption of measures to improve the energy efficiency in buildings. The recast of the Directive on the Energy Performance of Buildings defined all new buildings will be nearly zero-energy buildings by the end of 2020.

The case study

The case study hereby analysed, called *Eco Sil House*, consists of two similar single family houses realized in 2010, which rise up on an actually expanding flat area (**Figure 1**, **Figure 2**). Located in Trino, in north-west of

Figure 1. The *Eco Sil House*, south view.

Figure 2. Two new buildings located in Trino (VC).

Italy, in the Vercelli province, they were designed aiming to a healthy and sustainable environment, achieving the goals of a ClimateHouse A. The place in which they are located is characterized by a typical Mediterranean climate; not so cold winter and hot summer.

Each building, whose conditioned net surface is about 185 m², is characterized by two floors plus a non-habitable attic. The house has a rectangular plan with the living area and a technical system room on the ground floor; bedrooms are on the first floor.

The low energy needs and uses of the building are obtained thanks to the suitable combination of passive and active design strategies.

Passive design strategies

Passive solar design involves using the surrounding environment to ensure a comfortable indoor climate all year round, with minimal external purchased energy. The aim of exploiting passive solar design is that of achieving the performance target passively, through the usual methods of:

- positioning and orientation of the building for solar access and cooling breezes;
- super-insulation of the ceiling, walls, floor, windows, the main entrance and exit doors;
- careful placement of shading devices and wide openings for summertime;
- thermal mass for temperature smoothing.

The two buildings have been design according to the above principles. Indeed, each building, that has a rectangular plan, has been placed with the longer axis running east-west, in order to maximize solar heat gain. Living and sleeping rooms are placed toward the southern front; despite of that, on the northern side there are services and distribution spaces. The openings are present only in the above-mentioned facades; fronts toward East and West are fully blind. Rolling shutters have been installed in order to provide shading in summer periods.

Buildings are characterised by high insulation levels and compact volumes (**Figure 3**). An exterior thermal insulation has been adopted. Two different insulating materials have been used: the former is made of sintered polystyrene panels, the latter one of cellulose fibre. There is not any particular thermal reason to justify this choice, but it responds to a curiosity of the architect Gianni Carlo La Loggia of analysing contingent different behaviours and durability of materials in future. Both choices lead the thermal transmittance to a very low value, ranging from 0.13 to 0.16 W/m²K.

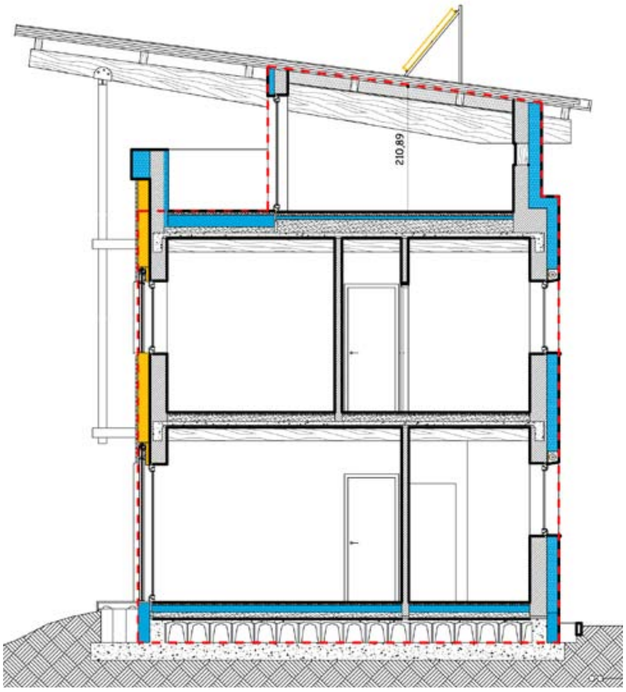

Figure 3. Vertical section of one of the buildings, with indication of heated volume and insulation layers.

Also the roof, which consists of a wooden structure, is characterized by a high insulation level, with wood-fibre insulation panels applied on the internal side. Thermal transmittance reaches a value of 0.18 W/m²K. All these solutions enable to totally eliminate every kind of thermal bridge; this is fundamental in achieving the goals of a ClimateHouse A.

A decisive role in achieving the energy performance goals is played by highly insulated windows. Buildings are provided with triple glazed windows, made of wood with aluminium-clad exterior, filled with Argon (U_g = 0.7 W/m²K) or Krypton (U_g = 0.6 W/m²K). In order to achieve the best energy performance of the windows, the openings have been wrapped by an insulating tape; in this way a low U value of 1.20 W/m²K is guaranteed.

The thermal masses, used for peak temperature smoothing typically of Mediterranean summer period, are concentrated in the external walls that consists of autoclaved aerated concrete blocks.

Another fundamental aspect it's represented by the air tightness of the envelope. Once completed the construction, the Blower Door test (**Figure 4**) has been performed in order to measure the air tightness of the buildings, which have passed the test, resulting within the limits required for ClimateHouse A classification ($n_{50,lim}$ = 1 h^{-1}).

Figure 4. Blower Door test.

Thanks to the adopted passive design strategies, it's been possible to reduce energy demand; the energy need for space heating is low and equal to 23 kWh/m²y.

Active design strategies

Concerning active design strategies, the heating system is composed of a condensing boiler fuelled by natural gas, characterized by a modulated power of 5 kW up to 25 kW. The boiler provides space heating and domestic hot water too. The condensing boiler is coupled with four flat plate solar collectors, which cover a surface of 9.32 m² for each building, and with a hot water storage tank of 500 litres. The production of solar collectors satisfies about 96% of thermal needs.

The emission system is constituted by wall radiant panels, installed on the external wall, in **Figure 5**: this system guarantees energy savings up to 50% or more on heating costs in comparison with a traditional one.

It has been installed a 2.94 kWp photovoltaic system, characterized by monocrystalline silicon panels.

In order to reach a ClimateHouse A certification, the utilization of a mechanical ventilation system with heat recovery has been indispensable.

Figure 5. Installation of wall radiant panels.

Since the buildings are classified as ClimateHouse A, the savings in terms of energy consumptions for heating are about 80%, compared to traditional building consumptions, and CO_2 emissions are consequently reduced to 18 kg/m² year.

Monitoring data

The monitoring of the energy performance of the two buildings has been carried out for the first years through the evaluation of two data:

- indoor temperature, by means of thermostats, installed in every room;
- comfort perceived by each member of the families, in a range of five levels.

After the first year, buildings owners revealed to be really satisfied of the energy performance of their dwellings; the quality of living, achieved by a low energy construction, is part of everyday life and has a crucial effect on health. In the first year, they pay a bill equal to 480 € for space heating.

Monitoring data testified that coupling passive design strategies, characterized by substantial reduction of heat losses through the envelope and by maximization of solar gains, with active design strategies, consist of a suitable exploitation of renewable sources is a successful action. ■

References

1. Simpson C., Energy efficient renovation makes economic sense, Build Up, 2012.
2. www.agenziacasaclima.it.
3. *Prima CasaClima A in Provincia di Vercelli* in KlimaHaus – CasaClima, February 2011, p. 56.