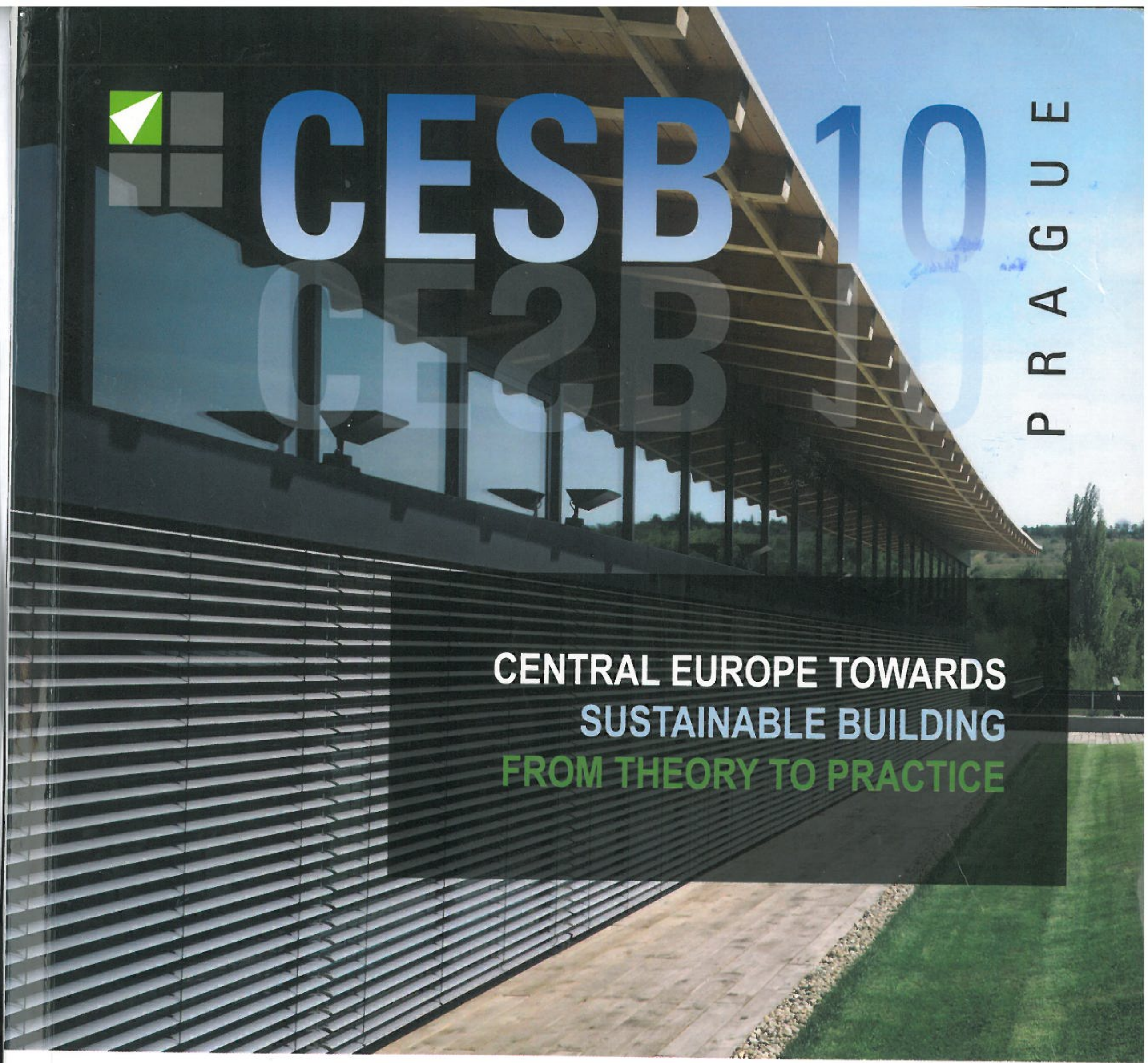

CESB 10 PRAGUE

CENTRAL EUROPE TOWARDS SUSTAINABLE BUILDING FROM THEORY TO PRACTICE

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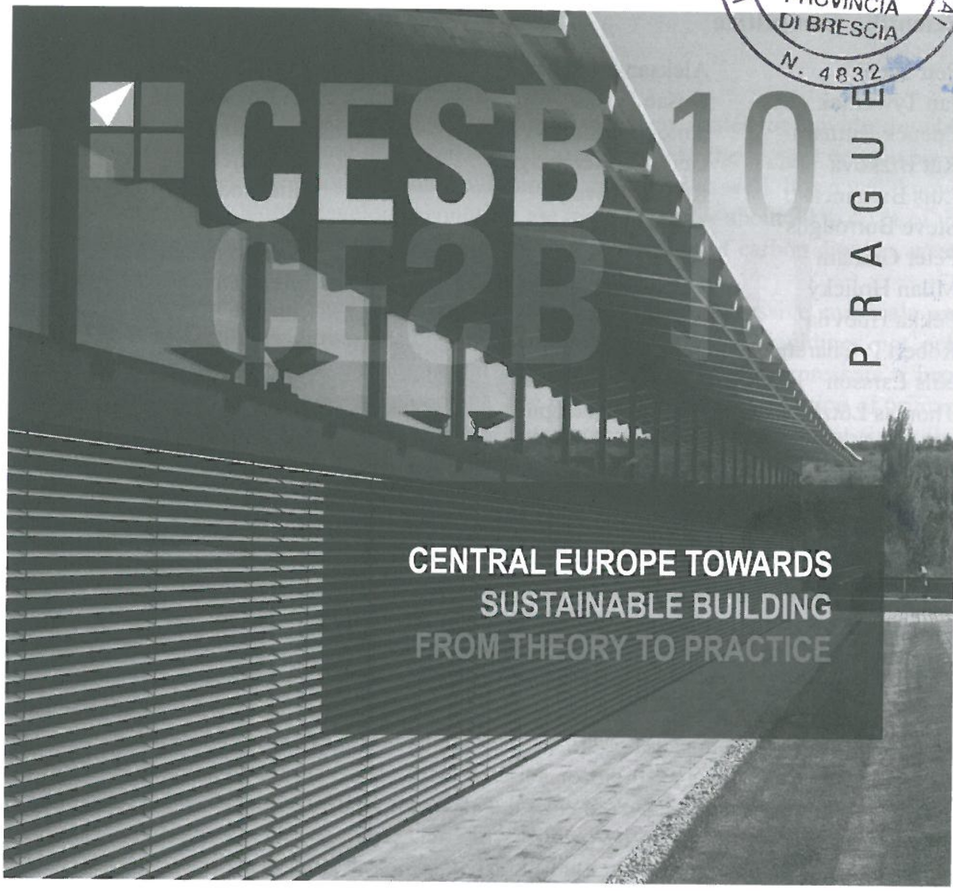

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A CASE STUDY OF LOW-ENERGY HOUSES IN NORTHERN ITALY

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Summary

In 2007, the "passive house" concepts were applied at the construction of 16 houses in Selvino Bergamo, Italy. Using a holistic design process characterized by the integration of architectural and technological choices, the ambitious target of 30 kWh/m²a was reached (useful energy). Passive strategies are used to keep the indoor comfort: very high insulating levels; high winter solar gains; small window area in the north façade with high performance; large openings and conservatory space in the south façade. The mechanical plant system is composed by solar photovoltaic panels installed on the south-facing roof; electrical radiant floor heating system; high efficiency electric boiler; mechanical ventilation with heat recovery. This paper shows a real example of a holistic design process integrating architectural, technological and energetic issues; the result is a low-energy building with a contemporary architecture that suite perfectly to the specific context.

Keywords: low energy consumption, sustainable building, high thermal insulation, conservatory space.

1 Introduction

1.1 Aims of work

The new settlement in Selvino was born after the approval of the new local energy code in 2006. Selvino is a small village in the north of Italy (it is lies at more than 900 m above the sea level) where about the 70% of the house are for vacation. The design group answered to these goals and in particular: satisfying the need of social housing, providing a good example of low-energy architecture, testing innovative construction and systems services technologies. Comfort expectations and energy efficiency imperatives require the control of environmental conditions by adjusting room temperatures, luminance levels and ventilation rates. This requires a very strict integration of building envelope and technical services, in order to reduce the use of non-renewable energy. Every building should be suited to climate, function and local technical standards (Isaksson et al. 2006). In order to answer to this challenging situation, it was important to bring together the architect, the mechanical engineer, the municipality and the energy consultant at the very short of the project. The holistic approach, adopted by the group, permits to define immediately different energy and architectural concepts and to save time afterwards to adjust the design.

1.2 Architectural project and general sustainable strategies

The ecological settlement in Selvino (Fig.1) is an ambitious initiative aiming for a sustainable development of the village (Salvalai et. al, 2010). The climate is characterized by cold winters and temperate summers. This is represented by 200 heating days and 3433 heating degree days (the design temperature is equal to -9 °C).

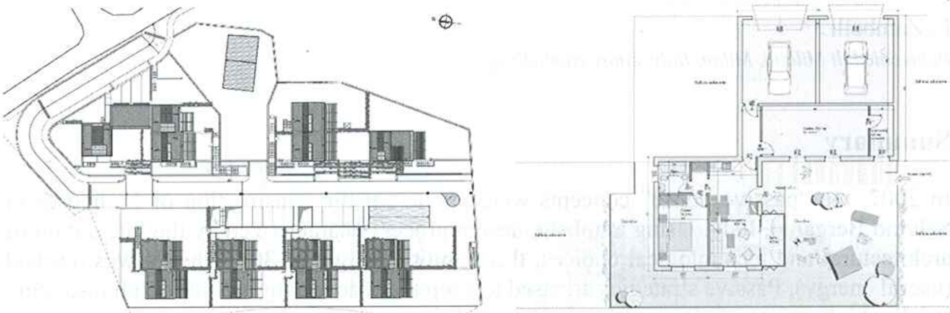

Fig. 1 Left side: plan view of the settlement. Right side: interior design of a residential module

From the sustainable point of view the project aimed for a high level of comfort, allowing at the same time a significant reduction of energy consumption and CO_2 emissions. The project consists of 16 residential units of different sizes (from 50 to 115 m²), located sideways to the district street. Thanks to the close cooperation between designers (architectural and mechanical), the owner and the building constructor, the project is scheduled, in according with CasaClima labeling, as "Class A" with an energy demand (for the winter seasons) lower than 30 kWh/m²a (Imperadori et al. 2006; Masera et al. 2004). Moreover, the buildings will also have the "ECO" label due to the material quality, the use of renewable energy sources and the environmental impact (Zambelli et al. 2002). From the architectural point of view, the buildings are characterized by a large windows facing south, with a greenhouse to maximize the solar gains in winter and to reduce the heating energy demand of about 5 kWh/m²a (Persson et al.2006) (Salvalai, 2008). The north and east façades are opaque in order to minimize the transmission losses and improve privacy. The internal spatial distribution is done optimizing the space; the result is simple but really comfortable: each module has a living room-kitchen (20 m²) expandable through openings windows to the greenhouse (4.5 m²), a bedroom (14 m²) and a toilet (4 m²). Laundry and storage facilities take place into the basement, connected by external stairs.

1.3 Plant systems and energy consumption

Considering the ambitious target of the houses, characterized by long unused period (the settlement is planned to be use for vacation and holidays), the mechanical system is designed to take advances from the solar energy, thus limiting CO_2 emissions. The PV panels convert directly the solar energy in electricity to meet the energy needs (heating and electrical use) of the building. The 2.5 kW of photovoltaic roof allow producing 2722 kWh of electrical energy, distributed as reported in Fig.2. The electricity produced can be directly used when the user are at home or sell it to the grid (40 Euro cents per kWh) when it is not needed or is over-produced (summer time mainly). In detail the system is designed as following: solar photovoltaic panels installed on the south-facing roof, electrical radiant heating system placed in the floor, high efficiency electric boiler producing domestic hot water, mechanical ventilation with heat recovery (90% efficiency) to reduce ventilation losses and improve the air quality. An hypothetical occupant schedule for the energy analysis is considered: it is assumed that the houses are occupied regularly during the week-end and in the winter and summer vacation.

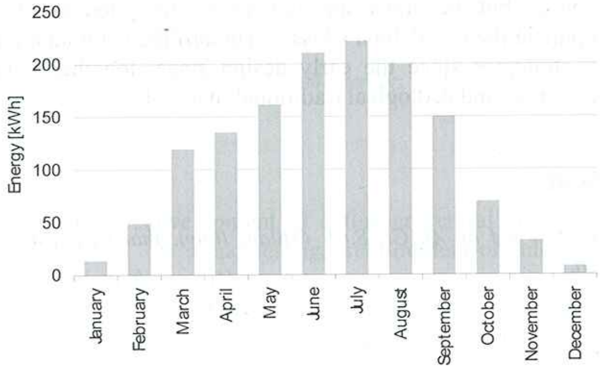

Fig. 2 Monthly energy produced by 2.5 kW roof photovoltaic modules

Particularly, the graphic of Fig. 3 shows the monthly energy need for heating and domestic hot water. During the summer months, the balance between the produced and used energy, is negative and the over-produced energy will be sold to the national grid. In winter the "free energy" is used in order to satisfy the energy demand of the electrical floor heating and of the boiler. Considering the complete year, the energy need for heating and hot water is about 9 kWh/m²a.

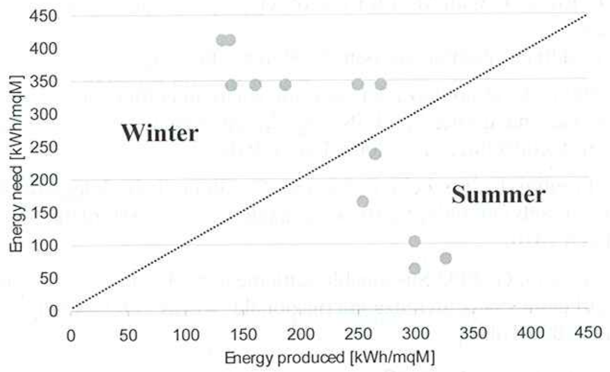

Fig. 3 Energy produced versus energy need [kWh/mqM]. The straight line represents the balance between the local energy produced and the energy need of the building. The green dots indicate the real energy consumption. Under the line, over-produced energy and over the line under-production energy.

2 Conclusions

This paper showed a practical example of a holistic design process integrating architectural, technological and energetic issues; the result is a low-energy building (heating and electrical useful energy demand below 10 kWh/m²a) with a contemporary architecture that is suited to the specific context. The settlement is now in the final construction phase. Up to now the authors have not monitoring data to assess the real behavior of the houses, but the first inspection reveals the good quality achieved by the design group. To pursue the CasaClima ClassA standard the team adopted different active and passive solar strategies since the early design stage, together with a large use of renewable energy sources and ecological traditional materials.

Acknowledgment

The design process was led by AIACE S.r.l. (Milan, Italy), that was also responsible for the technological design.

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