Strategy for low emission refurbishment, the offices of Meyer hospital. A case study in Florence

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STRATEGY FOR LOW EMISSION REFURBISHMENT, THE OFFICES OF MEYER HOSPITAL. A CASE STUDY IN FLORENCE

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ABSTRACT

In most European cities there is a vast stock of existing buildings, many of which are getting to the end of their useful life. To replace the stock would take several decades and incur an unrealistic financial burden; so retrofitting actions offer an answer to the problems of the aging building stock of most European countries, including deteriorating building fabric, obsolete mechanical networks, the lack of adequate space for the ever increasing needs, disruptive acoustics, and the need to improve the indoor environment and the user comfort. The overall objective of this paper is to demonstrate how a holistic approach in refurbishment of existing buildings can provide energy efficient system with the only inclusion of some new, not invasive extension (i.e. a greenhouse).

In detail the aims of this work have been to evaluate energy and environmental performances of an old building refurbishment and to obtain significant reductions of primary energy use, CO_2 emissions and peak electricity demand. The case study was the refurbishment of Villa Ognissanti, the old part of the Meyer Hospital in Florence, one of the most important paediatric institutions throughout Italy and Europe: the realization of its new headquarters in the old building retrofitted.

The present retrofitting project has achieved the specific energy targets, as it results, with very substantial total energy reduction, more than 28%. It is estimate that the application of proposed measures to the case study building may easily achieve a very substantial reduction of CO2 emission up to 25%, heating loads up to 31 % and of electrical loads for lighting, cooling and ventilation up to 27 %.

The realization of its new headquarters in the old building retrofitted, has had a great potential for dissemination and for advancing the state of the art on sustainable issues on a National and European scale. The architectural integration of bioclimatic greenhouse and its photovoltaic plant was been the main challenge of this renovation project.

Keywords: Sustainable refurbishment, energy recovery, building office

INTRODUCTION

The Meyer Hospital as one of the most important paediatric institutions throughout Italy and Europe: the realization of its new headquarters in the old building retrofitted, has been a great potential for dissemination and for advancing the state of the art on sustainable issues on a National and European scale. This recovery project participated, as Italian case study, to the REVIVAL[1] project , financed by EU Commission, so the results of this project was to provide also with a direct guidance, complete with architectural and engineering examples, for design

[1] 'Retrofitting for Environmental Viability Improvement of Valued Architectural Landmarks' is a five-year project funded under the European Commission 5th Framework 'ENERGIE' Programme.

professional and hospital authorities, setting a new standard for energy consumption in this special offices buildings [1].

The overall objective of this project was to demonstrate how a holistic approach in refurbishment of existing buildings can provide energy efficient system with the only inclusion of some new, not invasive extension (the greenhouse used as general hall). The architectural integration of bioclimatic greenhouse and its photovoltaic plant becomes the main challenge of this renovation project.

These innovative measures that were implemented in this project, have shown that can be widely used within the office-building sector in financially and functionally attractive mode, especially for the key-decision makers, the constructors and the users. This may only be investigated and documented through "real life situations", meaning that the individual measures must be designed, implemented and monitored in real situations. The application of such innovative features have not applied before in Italy in these kind of building, so there were some problems concerning unforeseeable technical difficulties (i.e. implementation of passive techniques as a greenhouse in an hospital office building). In fact many installed techniques have been already tested but generally in other sectors (in particular in residential buildings, …), thus there was no real life experience of the performance they had in a office building which has specific needs and characteristics. These problems has required an especially careful planning and studies in cooperation with expert in the field, involved in the project, because these features not have been tried in this application before [2].

In particular the project was designed to evaluate energy and environmental performances of the old building refurbishment and to obtain significant reductions of primary energy use, CO_2 emissions and peak electricity demand.

The Villa Ognissanti building had some characteristics of poor insulation standards, an over-provision of glazing, inefficient plant, and degraded fabric. The design teams developed refurbishment packages of fabric and servicing system improvements, aimed at improving energy performance, whilst simultaneously addressing the problem of fabric degradation and the quality of the internal environment. They included both 'design-based' solutions, which has involved re-modelling and re-organisation, and 'product-based' solutions that has applied innovative products newly available from industry.

This project involved the refurbishment of Villa Ognissanti with the global objective to demonstrate that tertiary buildings from post – war and pre- energy conscious era, can be economically improved in their energy performance and environmental impact obtaining significant reductions of primary energy use, CO_2 emissions and peak electricity demand.

DISCUSSION

Historical Background

At the beginning of 1900, in Florence, a new building was needed to be the new hospital as a branch of the existing one which had become insufficient. Careggi estate, a wide beautiful green hill area, was considered a suitable site where the new hospital could be built, thus in the 1912 works started and finished by 1936. The new building took the name of Villa Ognissanti and its plan consisted of three rectangular-shaped pavilions, oriented on the east-west axis: a larger and central one and two symmetrical wings.

The plan of Villa Ognissanti is based on the typology of the triple module, which is no more suitable at present for a purely medical function. Thus, according to the project, pavilion spaces will be converted into a reception and offices for administrative and managerial functions. The central pavilion of the old villa - more than 3000 mq - become the general

administration office of the new adjacent Paediatric Hospital, The Meyer Hospital, that increased in the extended area of the Medical Scientific University Pole of Careggi in Florence (fig. 1).

Figure 1: The building before the refurbishment

Refurbishment strategies

The project was aims at achieving high inner air quality level, thermal comfort and relevant savings in energy consumption, so the strategies adopted to obtain such results can be all synthesized in the following main categories [3]:

Indoor environment improvement

The project has been focused on the detailed planning and design of the healthcare environment and, particularly, the psychological effects of environment. This approach has been considered essential for children ambulatories environment and its subsequent effect on babies, their families and caretakers. All offices and ambulatories are designed in order to obtain the optimal comfort conditions thanks to the application of high efficiency systems, high performance materials and energy saving devices. In each room temperature and humidity levels are regulated in order to guarantee optimal comfort conditions.

Energy and Resource consumption (energy efficiency, renewable energy)

A lot of measures have been adopted in order to improve energy efficiency and integration of renewable energy. In particular for building improvements ventilated roof and insulation has been realized, solar shading and double glazing with super low energy panes have been installed, wood window frames in bad condition have been replaced with low-conductivity ones. Moreover the function of pre-heating, heat storage and reduction of heat loss of greenhouse has been considered. As whom to renewable energy the PV system is integrated on the top of curved surface of the greenhouse, with a southern orientation; this active solar system provide to generate electrical energy (31 kWp that are consumed directly by the same building needs).

Emissions and waste (renewable materials and CO_2 emission)

The main objective of the Villa Ognissanti refurbishment was to obtain significant reductions of primary energy use, CO_2 emissions and peak electricity demand.

The architectural integration of bioclimatic greenhouse and its photovoltaic plant was been the main challenge of this ambitious project. In fact the Meyer's greenhouse is a structure which is not heated or cooled by mechanical means and thanks to his southern exposition and unobstructed solar access to the main solar glazing, the greenhouse makes a net contribution to space heating: up to 17 % of the total heating loads. As far as the materials and the constructive techniques are concerned this greenhouse project aims to use eco-compatible materials: natural paint and wood for structural elements.

Environmental management

The Objective of Meyer's refurbishment activity was the integration into offices and ambulatories of strategies that have the aim of significantly reducing the total energy demand.

This is why Villa Ognissanti complex is characterised by the use of building management devices. Thanks to a control system was been possible to obtin a constant monitoring of the spaces' thermal conditions in order to control temperature, relative humidity and air velocity levels. In each office and ambulatory, the occupants can modify the inside conditions by reducing or augmenting the temperature of about 3 ° C thanks to the presence of temperature sensor-probe on walls. The energy management system, which selects the best operational strategy in order to obtain the optimal indoor conditions, allow optimizing plants use and control, to increase plants safety level, to reduce costs and to plan maintenance activity.

Sustainable Building Technologies implemented

Energy saving and recovery: installation of a HVAC plant equipped with a heat recovery system; construction of a greenhouse which main characteristics are:

- It works as a buffer space in winter, to minimize heat losses;
- It increases natural ventilation through a stack effect, reducing cooling demand in summer;
- It is not heated or cooled by mechanical means;
- It has southern exposition in order to maximize the collection of winter sunshine;

It is protected on three sides by walls, while the southern side is a glazed surface;
According to such proposals the Villa Ognissanti pavilions refurbishment design also deals with the realization of three new volumes: a bioclimatic greenhouse including an integrated photovoltaic plant and two new staircases, whose purpose is that of connecting old volumes (fig.2). The 960 sqm bioclimatic greenhouse - placed along the central pavilion and protected by the two other ones on east and west sides - is the general hall for the whole hospital complex: it has thus great visibility and represents a pilot action for the development of the semi-transparent photovoltaic technology being the first significant example in Italy.

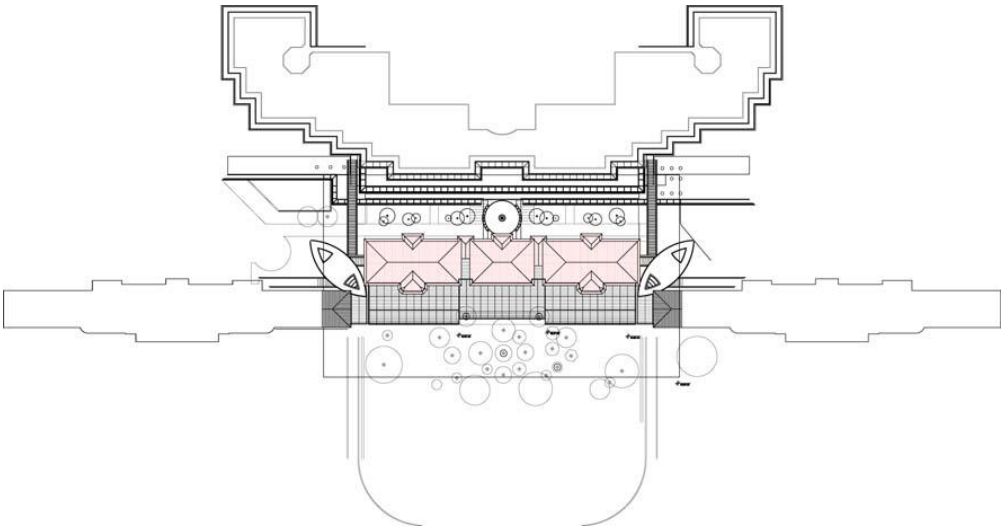

Figure 2: The greenhouse with the integrated photovoltaic plant

Measures to avoid potential overheating problems in summer have been adopted:

- opening area > 40 % of the greenhouse area;
- open able grids provide for heat dissipation (natural ventilation and night ventilation strategies), controlling by sensors;
- 300 m^2 of semi-transparent PV cells installed, reduce the need for shading;

part of the greenhouse roof is opaque and specific grids have been provided in the glazed roof in order to reduce during the night condensation in its internal space.

A special photovoltaic system is integrated on the upper part of the greenhouse and has a southern orientation: cells are inserted in the glazing curved surface, in decreasing density from top to bottom making the upper part of greenhouse almost opaque. Thus this active solar system will fulfil to a double goal: shading the greenhouse' inner space and generating electrical energy. It is a small solar power station (31 kWp) and provided clean electricity will be totally consumed by hospital energetic demand.
So such a solar shading system is able to provide the inner space with very pleasant shade in summer: as cells are placed in the upper part they can guarantee a good protection from high summer rays without interfering with low winter solar radiation. This system also aids the filtration and modulation of daylight, lowering its fastidious glaring effects during summer (fig.3).

Figure 3: The PV plant integration in the greenhouse

Finally specific grids are provided in the glazed roof in order to reduce night condensation on the internal glass surface. If all these measures will be correctly adopted there will be a good habitability in summer as well.
The architectural integration of bioclimatic greenhouse and its photovoltaic plant is the main challenge of the of Villa Ognissanti ambitious refurbishment project.
Under these preliminary considerations, the Meyer's greenhouse is not only a particular type of structure but also a particular kind of space. So, the design objective has not considered only energy and environmental aspects but also social impact: the primary objective is to create a pleasant and "socialising" space which can be used for semi-outdoor activities through much of the year without any extra energy space, a social space well integrated with the adjacent green park.

This greenhouse project has to be evaluated not only the significant energy reduction of the adjacent buildings or for the PV system integration in an existing architecture but especially for its social effect: the improvement of the working conditions, comfort conditions and productivity for staff and consequently quality of life can have a big payoff whenever an office is turned into a eco-building office, the pay back of any expenses is often much quicker than projected because of a great increase in employee productivity. When employees feel that their work environment is healthy and stimulating, it is inspiring what they can accomplish! And it makes their employers more competitive, too [4].

Figure 3: View of greenhouse's interior

CONCLUSION

Today the energy use for space heating, cooling and electricity in the office building is considerably higher per m^2 area than in almost all other building typology. This means that market opportunities for energy conscious building designs and components are present. As consequence of the increasing energy prices the office administrations attention towards these possibilities is increasing too. This proposal has provided thorough information about the possibilities of reducing these costs significantly to the office building administrations in Italy, stimulating that energy conscious designs and components are requested for future office buildings.

In fact the present retrofitting project has achieved the specific energy targets, as it results, with very substantial total energy reduction, more than 28%. It is estimate that the application of proposed measures to the case study building may easily achieve a very substantial reduction of CO_2 emission up to 25%, heating loads up to 31 % and of electrical loads for lighting, cooling and ventilation up to 27 %.

Besides setting up demands from the key-end users with respect to minimised energy use and attractive comfort conditions, the project has helped improving the competitiveness for those designers, manufacturers and contractor witch provide/offer concepts fulfilling these needs set up by the office building administrations

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