ENERGY SAVING STRATEGIES FOR THE NEW MEYER CHILDREN HOSPITAL IN FLORENCE

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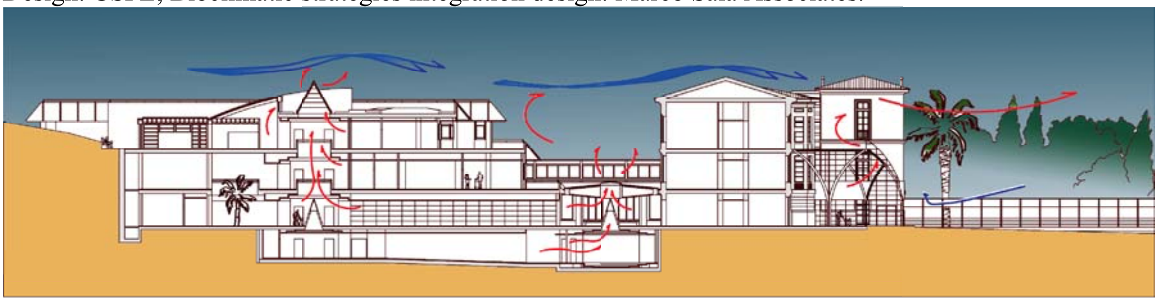
Abstract – The architectural integration of energy saving strategies has been the main aim of the new Meyer Children Hospital in Florence, the new Paediatric Hospital, that will rise in the area of the Medical Scientific University Pole of Careggi. An active cooperation of the Meyer Hospital administration has contributed to the carrying out of the preliminary and decisional phases with one important legal, administrative and procedural role. The building, under-construction, is one of the most important in the paediatric field in Italy and in Europe: its exemplary construction has great potential for dissemination and advancing the state of art on a European scale. The hospital is involved into a European Programme called HOSPITALS. The initiative aims at demonstrating the exploitation of the significant reduction of the total energy demand within the European health care building sector. Furthermore, these actions will contribute to significant reductions of CO_2 emissions. In particular the aim of the project is to apply appropriate and strategic low energy and sustainable techniques in Hospital building: this project consists of the demonstration that hospitals suit well with the application of sustainable design and energy conservation systems as well as to obtain a great healthcare outcomes.
Design: CSPE; Bioclimatic strategies integration design: Marco Sala Associates.



Section of the hospital.

1. INTRODUCTION

The Meyer Paediatric Hospital is located in a outskirt of Florence, Italy, in an existing hospital complex area. It's distributed in three storeys, about 31.000 m^2 and 150 beds. The site was chosen on the basis of being the most sheltered of various options, having good communications with existing hospital buildings to the north, and having excellent access and view to south.

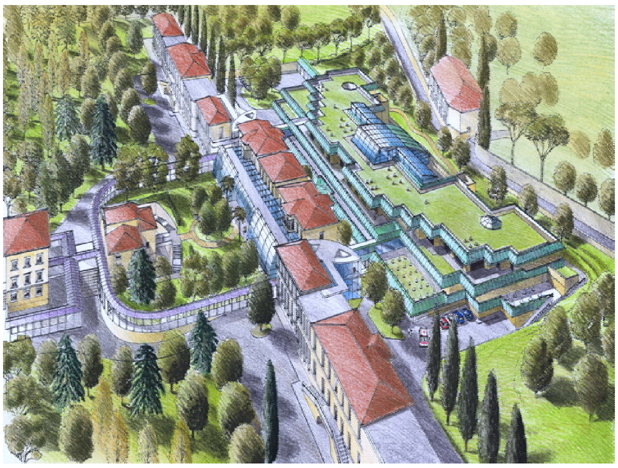
The project has been focused on the detailed planning and design of the healthcare environment and, particularly, the psychological effects of environment. This approach has been considered essential for neonatal intensive care environment and its subsequent effect on babies, their families and caretakers.

Special attention to interior rooms and surrounding view are achieved in order to obtain a better confinement period and to stimulate beneficial effects on patient health.

The section of the hospital has been designed partly sunk into the hill in order to diminish the impact of the building on the public side. Conservation is achieved on the site, through the sheltered plan, where the hospital is shielded from the prevailing winds by the hill and trees. The overall project design goal was to integrate modern hospital functions with energy saving strategies, while improving environmental quality.

The actual design approach is lacking in the objectives directed towards preparation of the building professionals, either for the low sensibility and interest of the Public Administrations, either for the national market lacking in innovative technological products.

Aim of the project is the reduction of the energy demand.



View of the environmental integration.

2. APPROACH

2.1 Italian Hospital Energy Situation

The standard practice in Italian hospital buildings shows the following situation:

- an inexistent indoor environmental control system;
- a sealed box approach in the design phase;
- a full dependence from air conditioning system in order to compensate deficiencies of the building design: 70% of Italian's hospitals use air conditioning system with low efficiency;
- high maintenance costs for the buildings and its plant.

Moreover it's important to note that energy consumption data is a rare available information: this is symptomatic of the lacking in the objectives geared toward the amelioration of the environmental quality and the improvement of energy saving in these buildings:

-obsolete environmental conditions for patients, visitors and staff related to air quality, thermal and visual quality;

-environmental-friendly and energy conscious design have been completely ignored due to a lack of knowledge about handling natural resources like natural day-lighting and ventilation;

-no environmental monitoring and control; i.e. no controlled ventilation: unfavourable and changeable conditions for patients.

Thus, a necessary approach for a sustainable future deals with successful solutions to decrease growing energy consumption effects of air conditioning in urban buildings cooling. In this frame, thus, Hospitals offer great margins of energetic improvement in order to promote sustainable approach.

2.2 Objective of the project

The most important objective of the project is the integration of good practice in the architectural field to support strategies to save energy (more than Italian normative contents of the Law 10/91) and to improve environmental quality in the respect of natural resources and ecosystem: control and recovery of the thermal loss, improvement of the day-lithing and natural ventilation, use of solar energy with PV, use of heat pumps and pipes connected to the ground, green inside and outside the building to mitigate the micro-climate and to improve the quality of the air, use of condensing-combi boilers and BEMS.

The innovative strategies for the renewable energy in buildings have addressed the planning of the "bioclimatic project" and of the whole hospital structure - hospitalisations, surgeries and laboratories- aiming to the better architectural integration of energy saving strategies with the purpose to reach the best control of the building envelope performance, to improve the energetic efficiency, thermal control and comfort of the internal spaces.

Strong collaboration among architects, engineers, doctors, staff of the hospital was very useful to understand necessities of patients and the project has been reviewed and developed taking into account the objectives of the HOSPITAL project: integration of energy saving strategies to reduce CO2 emissions, making aware all bodies involved and public administrations.

2.3 How can we reduce energy consumption?

Reduction of energy demand can be achieved through:

- an appropriate orientation of the buildings and window design;
- double glazed high quality windows and high insulated building;
- air infiltration control and use of natural ventilation. The air treatment system is low-velocity with air conditioning used only where necessary. A centralized energy management system is included to obtain the full potential from HVAC system an to select the most appropriate operational strategy. Natural ventilation is attained though a good organization design (double storey sunspace for stack effect);
- the glazed space occupying the north facade is acting as a buffer in order to reduce heat losses;
- passive cooling measures applied: use of deciduous trees in front of south façade and roof garden in the platform roof.

From the point of view of the materials and the constructive techniques this project aims to the sustainable use of renewable resources, eco-compatible materials and bio-architecture strategies.

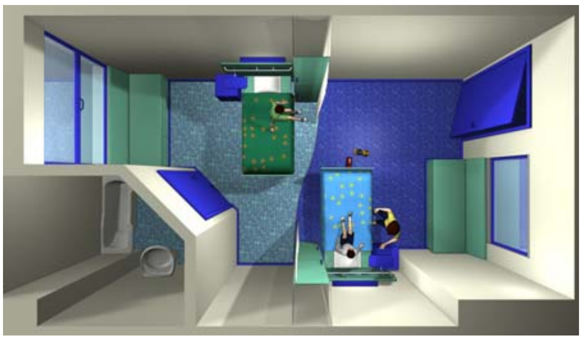
3. THE STUDY OF THE PATIENT ROOM

3.1 The patient room

The third floor of the building is dedicated to patient rooms, part of the design in which was applied a particular attention. It was calculated the effect of a better wall insulation and the use of an insulated green roof; defined the heating/cooling control, the thermal comfort has been achieved as exposed into following paragraphs.

Characteristics of the room:

- room for two children;
- floor area: 23 sqm;
- windows area: 3.42 sqm (double glazing);
- external wall: cavity insulated walls with 6 cm of insulation (0.32 W/m2K);
- green roof (0.79 W/m2K).



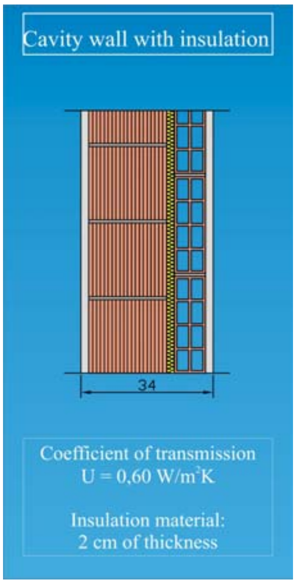
In the picture: a view of the patient room.

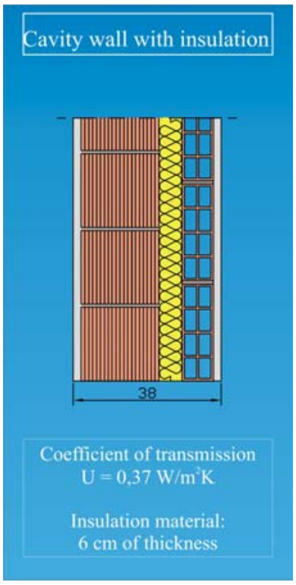
3.2 Wall Insulation

A building has to guarantee indoor thermal-comfort in relationship to activities that are conducted inside.

To optimize the thermal comportment it is necessary reducing thermal exchange.

Transmission losses are stated in terms of heat flow through the envelope, that is the quantity of energy passing through the envelope per unit of time. They depend mainly on the temperature difference between the inside and outside face of the envelope and the thermal resistance of the material – or combination of materials – of which the envelope is made. These losses take place through conduction, convection and radiation. A way of reducing them is to prevent heat conduction by adding thermal insulation to the envelope to increase its thermal resistance.





The patient room of the Meyer Hospital, has been studied: above, there are two drawings of external cavity wall with insulation inside. On the left is described a wall with 2 cm of thermal insulation material: the wall has a U value of 0.60 W/m^{2}K and it is the most common type of external wall used in this Italian area. Adding other 4 cm of thermal insulation we reach a wall with a U value of 0.37 W/m^{2}K. The use of this better insulated wall on surfaces that are directly exposed to external climatic conditions (19 mq for the patient chosen room), reduces the annual energy delivered for the heating and the **annual energy saving is @ 12%**.

3.3 Green Roof

To reduce transmission losses as much as possible it is necessary to insulate all opaque elements in the building, not just walls.

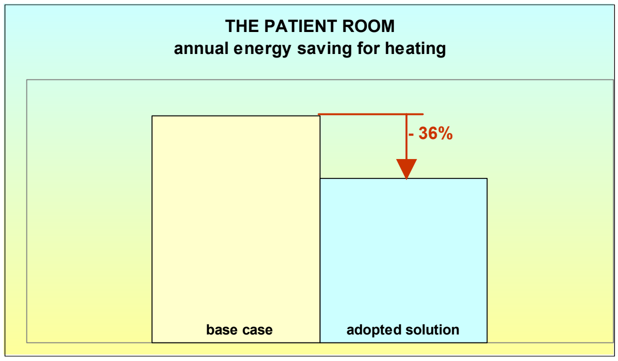
Investing in Green roof technologies helps to diminish the environmental impact on our communities whilst providing a fresh approach with visually appealing organic architecture.

Benefits:

- Diminishing environmental impact
- the grass absorbs the solar radiation and the evaporation process reduces the air temperature and delta t
- Reduces transmission loss

The green roof package studied for the Meyer Hospital has a U value of 0.79 W/m2K against a traditional flat roof with U value=1.16 W/m2K.

The proposed solution to increase the insulation material in the cavity wall and the contemporary use of a green roof, **reduces the annual energy demand for heating by 36% per patient room.**



3.4 Comfortable patient room

What we are looking for is a conscious energy design where the term conscious means that the aim of energy saving has to be compatible to reach a comfortable place.

The concept of “comfortable” has to be applied case per case and depends on a difficult valuation of three main factors: visual comfort, acoustic comfort and thermal comfort. All patient rooms are designed for children: the use of suitable colors and materials on walls, ceiling and floor, furniture and equipment all finalized for felling the room confident. Each room has a large window looking for green hills that are all around the Hospital Pole.

In terms of acoustic comfort, patient rooms are designed for no more than two children; construction materials adopted and the position of the hospital are able to guarantee no noise inside patient room.

To the occupants, especially for children in a hospital, the most important consideration to define a comfortable place is thermal comfort, defined as that “state of mind which expresses satisfaction with the thermal environment” (as defined by ASHRAE).

The "right" temperature will vary from person to person and from time to time depending on:

-people’s thermal experience;

-humidity and the air movement in the space;

-how much clothing people are wearing and their metabolic rate (how hard they are working).

The physical activity of a person is expressed in Metabolic rate that is the rate of heat production by the body when engaged in a task, often defined in terms of the resting metabolism (Mets).

Activity	M/A (W/m2)	M (W)	Met
Sleeping	43	77	0.7
Reclining	46	84	0.8
Sitting	58	104	1.0

Into the above table main patient's activities are summarized: sleeping, reclining and sitting are related to three similar actions but with a low different Mets.

The body exchanges thermal flux with the environment and the exchange depends also on the type of dress.

This type of thermal resistance is measured in clo (clothes). The clo unit was introduced to facilitate the visualisation of clothing level: for example a nude body has a clo value that is zero.

The clothing level depends on the season and for the evaluation of the predicted percentage dissatisfied, following values were used:

Season	Clo
Winter	1,5
Summer	0,5

A thermostatic valve inside the patient room area will measure temperature and relative humidity; when the temperature is below 21°C (during winter) and above 27°C (during summer) the heating/cooling system will be switched on.

The definition of a plant control system, that means control of temperature and relative humidity and air velocity, together with the clothing level value and the metabolic rate, give the **PPD-predicted percentage dissatisfied** that is the percentage of patients who will be dissatisfied (uncomfortable) into the patient room: it is predicted below the **6%**.

4. THE INTEGRATION OF RENEWABLE ENERGY

4.1 Photovoltaic Integration in architecture

The central pavilion of old Villa Ognissanti - more than **3000 m^2** - will become the general administration office of the new adjacent Paediatric Hospital, The Meyer Hospital. The Villa is constituted by three blocks and the architectural integration of a bioclimatic greenhouse and its photovoltaic plant is the main challenge of this ambitious project. The picture shows the Villa Ognissanti.

The Meyer Hospital foundation is one of the most important in the paediatric field in Italy and in Europe: its exemplary construction has great potential for dissemination and advancing the state of art on National and European scale.

The Meyer's greenhouse is a structure which is southern exposition and unobstructed solar access to the main solar glazing of the greenhouse in order to maximize the collection of winter sunshine; it is not only a particular type of structure but also, and more importantly, 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 "socializing" 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.

External view of the greenhouse.

The overall objectives (scientific and technical) of the project are:

- to contribute to the introduction of PV systems as an energy-significant option in urban areas in Italy

- improving technical performance of BIPV or other structures in the built environment
- to improve and demonstrate the attractive architectural medium (aesthetics value offered by PV)
- to inspire the future generation to become involved in renewable
- carry out project plans, feasible studies and analysis according to the National & European programs.

External view of the greenhouse

4.2 Scientific innovation and relevance

The Scientific innovation and relevance of the work consist in the experimentation and the diffusion of PV technology through an hospital as public administrations, especially PV integrated systems.

PV installation integrated in building greenhouse facades allow the possibility of combining energy production with other functions of the building envelope, such as shading, weather shielding and heat production. Cost savings through these combined functions can be substantial, e.g. in expensive façade systems where cladding costs may equal the costs of the PV modules. Additionally, no high – value land is required and no separate support structure is necessary. Electricity is generated at the point of use. This avoids transmission and distribution losses and reduces the utility company's capital and maintenance costs.

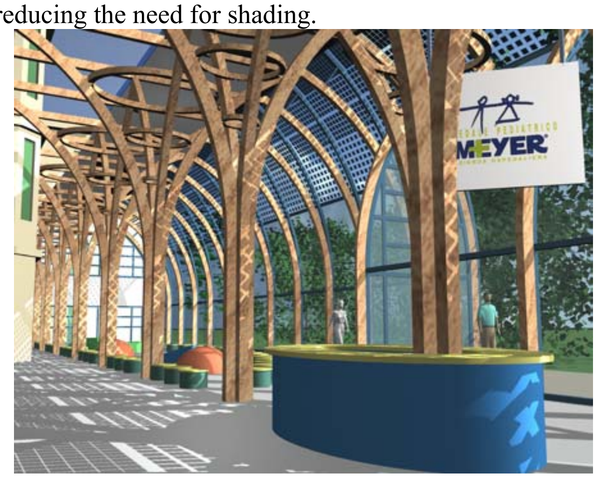
'Multiple integration' is perhaps the appropriate expression. Building integration does not just mean the mounting of PV modules. Real integration can involve much more, it includes all the steps incorporated in the process of new construction or in retrofitting building, starting from planning the production of the construction materials through to operation and recycling.

4.3 How to use the greenhouse

The aim is to transfer the European technical experience into the Italian photovoltaic solar energy market, involving Public Administrations and Managements to promote pilot actions in Italy, as well as improve practical application and visible prospects. Public Administrations will be provided with Architectural & Technical advice for a better PV systems integration in public buildings. This action fits perfectly each partners' activities (research and development) in PV fields, in order to allow a qualitative increase.

In order to prevent overheating during the summer season, following criteria are used:

- opening windows area > 40% of the greenhouse area in order to control overheating during summer;
- openable grids will be provide for heat dissipation (natural ventilation and night ventilation strategies), controlling by sensors;
- 300 m2 of semi-transparent PV cells will be installed, reducing the need for shading.



Internal view of the greenhouse

5. CONCLUSIONS

Demonstration with a pilot project that energy efficient and sustainable hospital building can fully meet all the architectural, functional, comfort, control and safety features through the application of innovative and intelligent design and integrated design. This demonstration effect could contribute to a better acceptance of innovative and renewable technologies in public buildings.

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