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Location in article	**Query / remark**
AU1, page 287	OK as edited? ☐
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AU3, page 289	Which figure shows the map? ☐
AU4, page 292	Not sure what you mean by this - pls clarify ☐
AU5, page 293	Should these be plural? ☐
AU6, page 294	Are these unit square meters - i.e. should the 2 be superscripted? ☐

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AU17, page 319	hotter?	☐
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AU19, page 323	Is this the figure caption?	☐

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AU21, page 290	Please provide better quality images 1, 3, 5, 9, 10, 11, 12, 14, 15, 17 to 21, 23 to 25, 27 to 31, 33 to 38, 40 to 44 if available	☐
AU22, page 291	To accommodate the placement of figures in the exact location, we have split the figures in few instances to avoid short pages. Already we have left short pages as the text was less and figures were large in size. Please check.	☐

Chapter 11

c0011 [AU1] [AU2]
Sustainable Buildings in Mediterranean Area

Marco Sala and Alessandra Carta
Università degli studi di Firenze, Firenze, Italy

Chapter Outline

Sustainability, Energy and Architecture. ISBN: 9780123972699

s0010 11.1 ABITARE MEDITERRANEO PROJECT

p0010 Abitare Mediterraneo is an applied research project, sponsored by the Tuscany Region under POR CREO FESR 2007–2013, and developed by the University of Florence in synergy with some construction companies.

p0015 The Project aims to realize an 'Open System' to promote technological innovation and architectural quality in the construction process, in order to encourage the development of building initiatives focused on high energy efficacy; the catalogue of the 'Open System' is a flexible tool dedicated to help enterprises to promote innovative products in Mediterranean areas. The research proposes a formula to create a synergy between research and production in the building sector, and also involves a 'construction model' to adopt for architecture in this kind of climate.

p0020 It is dedicated to draftsmen and enterprises as a promotion tool supporting design and planning in the Mediterranean climate. Its purpose is to transform Tuscany into an International Laboratory for Research into high quality living in the Mediterranean area; to develop the analysis of case studies in order to promote the future of Environmental Sustainable Buildings, designed in the context of history, culture and the Mediterranean climate.

p0025 One key objective fosters the creation of a 'Center for Technological Competence' as a benchmark for research, innovation and implementation of environmental sustainability, eco-efficiency, quality and livability.

p0030 Innovative results:

u0010 • Test Cell – outdoor laboratory for looking at the thermal dynamic behavior of facade components

p0040 Prototypes:

u0015 • MIA – temporary living module specific to the Mediterranean climate
u0020 • Domino – facade system that guarantees significant energy savings
u0025 • AIW – facade system with an integrated heat exchanger
u0030 • Shading Screen – innovative ventilated wall

p0065 Experimentation:

u0035 • Lorenzana/Rispescia – two innovative residential houses designed within a sustainable approach

s0015 11.2 EULEB

p0075 The EULEB project – 'European high quality low energy buildings' provides information on existing, public, non-residential, high quality and low energy buildings from all over Europe.

p0080 This project was realized within two years (2005–2006) and has been partially funded by the 'Intelligent Energy Europe' program of the European Commission.

p0085 The following case study analysis is taken from EULEB (www.euleb.info) and from Abitare Mediterraneo research (www.abitaremediterraneo.eu), with the aim of providing information on high-quality public buildings in the Mediterranean area of Europe.

s0020 11.2.1 Location

p0090 Europe contains a large variety of differences in buildings´ boundary conditions.
[AU3] The map shows the location and climatic conditions of buildings, classified according to the KOEPPEN classification system.

p0095 This system uses letter codes to identify the major climate zones: (A) tropical forest, (B) dry forest, (C) warm temperate rainy, (D) cold forest and (E) polar regions. Further subdivision according to temperature, rainfall, and seasonal variations is described through sub-codes:

u0040 BSk: Mid-latitude steppe. Semiarid, cool or cold.
u0045 Csa: Interior Mediterranean. Mild winter and dry hot summer.
u0050 Csb: Coastal Mediterranean. Mild winter and dry, short, warm summer.
u0055 Cfa: Humid subtropical. Mild winter and moist in all seasons.
u0060 Cfb: Marine. Mild winter and moist in all seasons. Warm summer.
u0065 Cfc: Marine. Mild winter and moist in all seasons. Short cool summer.
u0070 Dfb: Humid continental. Severe winter, moist in all seasons with a short warm summer.
u0075 Dfc: Subarctic. Severe winter, moist in all seasons with a short, cool summer.
u0080 ET: Tundra. Very short summer.

s0025 11.2.2 Building Classification

p0145 Three building types are considered:

p0150 **Education**:

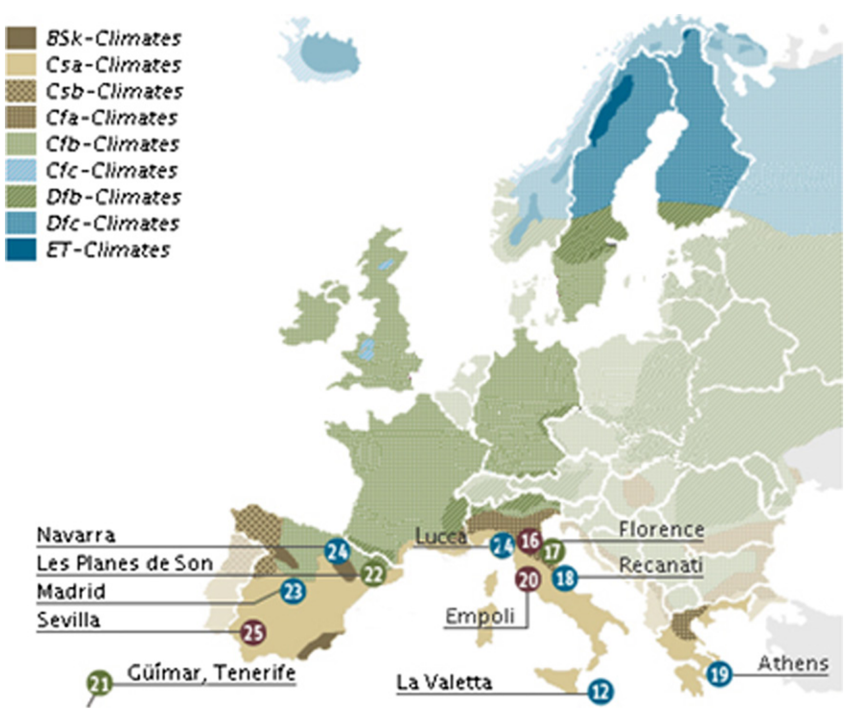
p0155 This group contains buildings which are dedicated to education on different levels. School and university buildings can be found here.

p0160 **Office**:

p0165 Public office buildings are mainly administrative buildings of the national or regional government, but research institutes also form part of this group.

p0170 **Leisure facilities**:

p0175 This group consists of a selection of museums and exhibition centers.



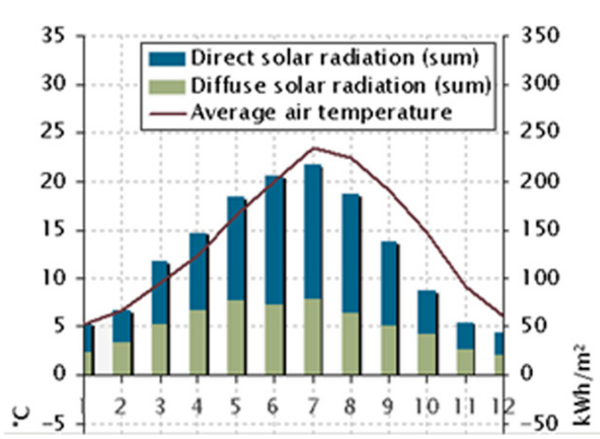
[AU21]
f0010

s0030 **11.2.3 Sustainable Buildings in the Mediterranean Area**

s0035 *11.2.3.1 Identification*

p0180
u0085 Name: Technological and business incubator
u0090 Owner: Camera di commercio Industria ed Artigianato Lucca
u0095 Country: Italy
u0100 City: Lucca
u0105 Street: Via della Chiesa in Sorbano del Giudice
u0110 Occupant(s) of Building: Arbitral Chamber of Lucca Headquarters
u0115 Typical days/hours of use: 9 h.
u0120 Designers: District of Lucca
u0125 Engineers: District of Lucca
u0130 Energy consultants:Centro Interuniversitario ABITA Prof. Marco Sala
u0135 Contractors: Skills center and ICT
u0140 Energy sources:
u0145 Solar tubes – Greenhouse
u0150 Photovoltaic – Daylighting strategies
u0155 Natural ventilation – Radiant panels
u0160 Year of completion: 2011

f0015



[AU22]

f0020

f0025

s0040 11.2.3.2 General Data

p0265
u0165 Number of floors above ground: 3
u0170 Number of floors below ground: 0
u0175 Heating or cooling gross floor area: 17.092 sqm
u0180 Usable floor area: 3.813 sqm
u0185 Building envelope area: 7.312 sqm
u0190 Average number of occupants: 300

s0045 11.2.3.3 Outdoor and Indoor Climate

p0300
u0195 Microclimate: urban
u0200 ASHRAE degree days heating/cooling: 2060 / 1917 Kd
u0205 Outdoor design temperatures/humidities: –2°C; RH 50%
u0210 Indoor design temperatures/humidities: 20°C
u0215 Design ventilation rates: 25 air changes of outside air per hour
u0220 Design illuminance levels:
u0225 Offices: 500 lux
u0230 Labs: 500 lux

p0345 The project's goal was to create a real technological pole including a group of buildings featuring environmentally friendly solutions. The content is as important as the container for this project. [AU4] Natural solutions are developed according to the most modern standards of sustainable housing and energy saving so as to really serve innovation.

p0350 Strategy of the project:

u0235 • Choice of orientation and shape of the building;
u0240 • Highly efficient envelope integrated;
u0245 • Roof garden;
u0250 • Active integrated system for the exploitation of solar energy (solar and photovoltaics);
u0255 • Use of geothermal heat pumps and combined with trigeneration;

u0260 • Use of natural ventilation;
u0265 • Analysis of natural lighting of offices and labs;
u0270 • Use of innovative Intelligent windows system;
u0275 • Sliding shutters for vertical and horizontal surfaces;
u0280 • Use of radiant floors and roofs;
u0285 • Use of 'natural' materials (mortar, plaster, stone and wood coatings, natural insulating);

f0030

s0050 ## 11.3 TECHNOLOGICAL AND BUSINESS INCUBATOR – LUCCA, ITALY

s0055 ### 11.3.1 Insulation

p0410 [AU5] Efficient thermal insulation, realized with a polystyrene panel, a fiberglass mattress and a steam barrier contribute to the energy-saving design of the building. The external walls of the offices and laboratories are designed as thermo-ventilated walls, faced with aluminum panels. The thermo-ventilated wall is characterized by the presence of a thermal insulation layer and an air gap, which give the envelope high thermal performance during the whole year, with a U-value of 0.29 W/mqK; they are composed of the following layers: lightweight plaster, blockwork, polystyrene insulation (6 cm), ventilated cavity (4 cm), aluminum panels.

f0035

s0060 11.3.2 Solar Control

s0065 *11.3.2.1 Windows and Shading*

p0415 Dynamic and innovative elements were designed for the south-west facing facades to improve the summer and winter performance of the building, containing integrated photovoltaic panels. The facade was designed to be a sun-breaker system, with grilles and openings to satisfy the various climatic needs. The philosophy which inspired is not to be affected by the climatic conditions, but rather to exploit them.

p0420 Windows: south and east facade: clear inner glass: Uw = 0.9 W/m2K, matt inner glass: Uw = 0.9 W/m2K, vertical shielding, mosquito nets frame, glass [AU6] and external photovoltaic panel; total UW = 1.1 W/m2K

f0040

s0070 11.3.3 Lighting

f0045

p0425

p0430 Large windows that connect the interiors, greenhouse and skylights on the roof are designed to deliver optimum levels of natural light in the work spaces and other open spaces, in order to minimize the using of artificial lighting. The openings and shields have been designed to prevent direct glare, ensuring a good distribution of natural light into the space. All installed lamps are high efficiency installations, and the total annual electricity demand is 12.3 kWh/m2. These give an energy saving of about 35% compared to the energy demand of a similar building without these features.

p0435 Sun pipes and light ducts are used to improve daylight in laboratories; sun pipes are installed in the roof garden, and they contribute to the daylight levels in the labs. The use of sun pipes allows the artificial lights to be switched off during the morning throughout the year.

s0075 11.3.4 Cooling

p0440 Radiant panels for cooling and heating were installed in the offices; radiant solutions for cooling allow transmit physiologic wellbeing free of the costs and damage caused by air conditioning systems. Air conditioning is often the cause of cooling. [AU7]

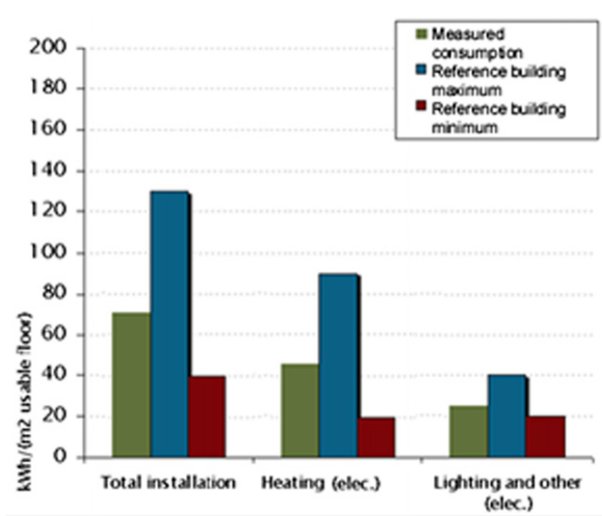
s0080 11.3.5 Ventilation

p0445 The decision to fit the facade systems with domestic systems to enable natural ventilation during the intermediate seasons and summer has produced a further 30% reduction in energy needs compared to a traditional building. It was also decided to equip the outer components (doors and windows) with heat reducers. These further cut down on energy consumption in winter by recovering the heat from the outgoing exhaust air and reusing it to heat the incoming air. Some protected openings are specifically dedicated to ventilation, either automatically or semi-automatically controlled. These allow the formation of air currents inside the building, thus guaranteeing appropriate natural ventilation.

s0085 11.3.6 Energy Performance

p0450 The annual estimated specific energy consumption is 75 kWh/m2 per year. The specific values shown in the figure include the mechanical installation for cooling/heating system, which is 50 kWh/m2, and the other electrical installations [AU8] for lighting, which is 25 kWh/m2.

p0455 Estimated heating energy consumption during the winter is 25 kWh/m2 per year.

f0050


p0460 Annual primary energy consumption per m² usable floor area

s0090 11.3.7 Monitored Comfort

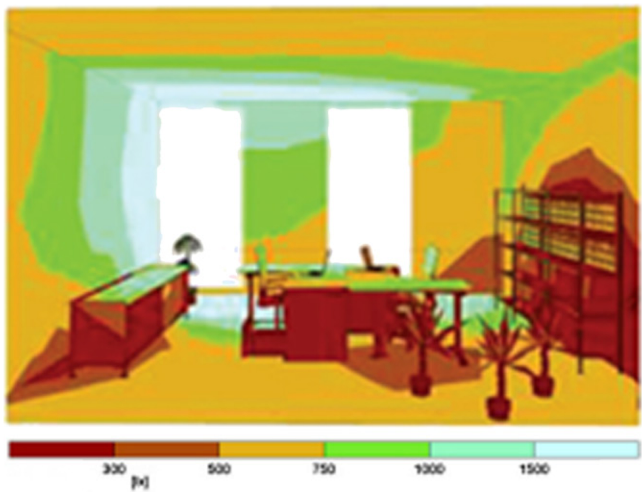
p0465

u0290 Location: Office; the view is of south facing facade

u0295 System: Low emission glazing

u0300 Sky condition: Sunny day with direct sun on facade

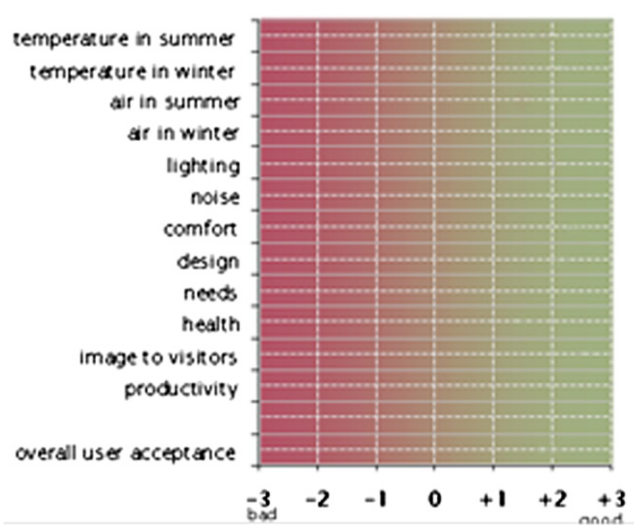
u0305 Description: The luminance picture shows a good distribution of luminance on surfaces, also into the depth of the rooms



f0055

s0095 ### 11.3.8 User Acceptance

p0490 Future users of this building are reacting well to the project specifications. It was not possible to measure user acceptance, because the building will only [AU9] open in November 2011 .



f0060

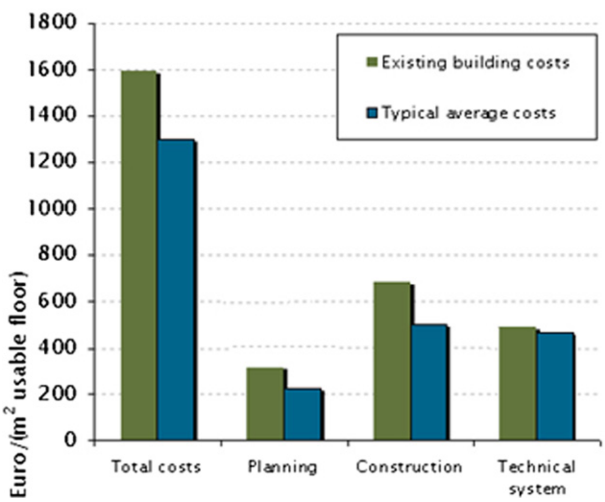
s0100 11.3.9 Financial Data

p0495 Building:

p0500 The total investment cost of the building per m² of gross floor area is 1637,00 €.

p0505 The total cost is divided into:

u0310 Planning and safety; 340,00 €/sqm
u0315 Construction; 710,00 €/sqm
u0320 Technical systems; 586 €/sqm divided into:
u0325 Electrical systems 129 €/sqm
u0330 Thermal systems 180 €/sqm
u0335 Fixture 29 €/sqm
u0340 Special systems 248€/sqm



f0065

s0105 11.4 BARDINI MUSEUM – FLORENCE, ITALY

p0545
f0070

s0110 11.4.1 General Data

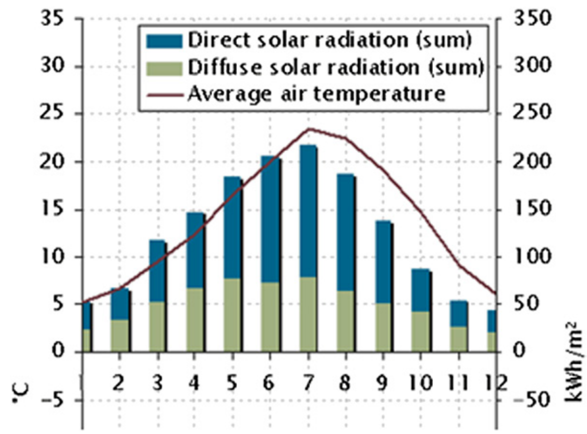
p0550
u0345 Number of floors above ground: 3
u0350 Number of floors below ground: 0
u0355 Heating or cooling gross floor area: 3.200 sqm
u0360 Heated or cooled volume: 76.784.4 m3
u0365 Building envelope area: 3.431 sqm
u0370 Average number of occupants: 150

s0115 11.4.2 Identification

p0585
u0375 Name: Bardini Museum
u0380 Owner: Municipality of Florence
u0385 Country: Italy
u0390 City: Florence
u0395 Street: Piazza dei Mozzi 1
u0400 Occupant(s) of Building: Bardini Museum
u0405 Primary Use: Museum
u0410 Typical days/hours of use: From Monday to Saturday 9.30 am to 19.00 pm, except during summer
u0415 Designers: Arch. Lombardi
u0420 Engineers: Structural Eng. Giancarlo De Renzis; Electromechanical Eng. Roberto Innocenti; Electromechanical Eng. Raffaele Viscomi
u0425 Energy consultants: Centro Interuniversitario ABITA Prof. Marco Sala, Prof. Paola Gallo
u0430 Contractors: Municipality of Florence
u0435 Centro Interuniversitario ABITA
u0440 Energy sources: Daylighting strategies
u0445 Natural ventilation
u0450 Year of completion: 2003

s0120 11.4.3 Outdoor and Indoor Climate

p0670
u0455 Microclimate: urban
u0460 ASHRAE degree days heating/cooling: 2060 / 1917 Kd
u0465 Outdoor design temperatures/humidities: −2°C; RH 50%
u0470 Indoor design temperatures/humidities: 20°C
u0475 Design ventilation rates: 16 changes of outside air per hour
u0480 Design illuminance levels: 200 lux on oil paintings, 50 lux for watercolors



f0075

p0705 The building achieves specific energy targets with very substantial energy reductions, more than 30% according to measurements. It is estimated that application of the proposed measures to the studied building may easily achieve:

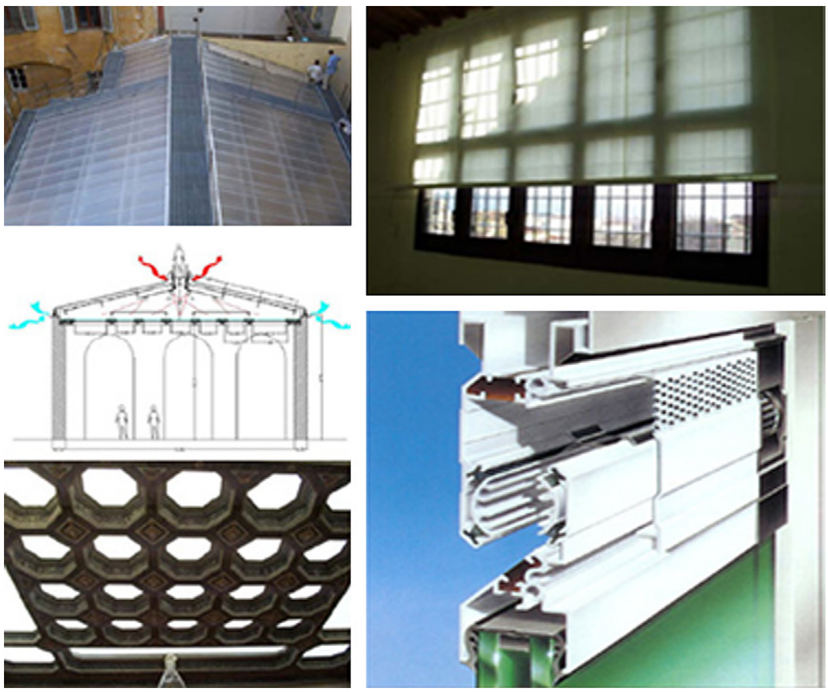
- u0485 up to 30% reduction of CO2 emissions,
- u0490 up to 25% reduction of heating loads,
- u0495 up to 30% reduction of electrical loads.

p0725 The set targets have been achieved with acceptable investment and running costs; in fact the application of the total package will be achieved within an amortization period of close to 15 years. In order to reach the proposed standards, the project works on three levels of intervention:

o0010 **1.** Thermal comfort by the installation of an HVAC system.

o0015 **2.** Energy saving supplementing passive strategies and the use of low efficiency appliances.

o0020 **3.** Daylighting comfort through the design of skylights and the installation of new lamps.

f0080 

s0125 11.5 BARDINI MUSEUM – FLORENCE, ITALY

[AU10]

s0130 11.5.1 Solar Control

p0745 Top floor windows are fitted with system METRA NC 65 STH frames, in painted aluminum 6060 according to UNI EN 573 UNI EN 755-5 to the physical state T5 according to UNI EN 515. For solar control, the design foresees double glazing (6/7+gap 12+8/9) with UV film applied in order to reduce the glare effect on the exhibited materials. For the reduction of heat gains and direct sunlight ingress, new windows have been equipped with a special UV absorbing glass in order to reduce ultraviolet radiation to 75 microwatts per lumen, and screens have been placed in front of the windows.

s0135 11.5.2 Lighting

p0750 The high electrical consumption of the Bardini Museum was caused by excessive power, low control flexibility and inefficient lamps.

p0755 The first action was to reduce the installed power by replacing the existing lamps with high efficiency ones. This action has not only drastically reduced the energy consumption, but has also increased visual comfort inside the exhibition halls. This is due to devices equipped with special reflecting floodlights, which can direct more light into the exhibition space, reducing glare and ensuring optimal illuminance levels while using only half the number of lamps used previously.

p0760 To optimize daylighting, after simulations had been performed using specific software tools (Radiance), the glazed elements of the central skylight were entirely removed and replaced, together with the overhanging transparent roofing.

s0140 11.5.3 First Floor

p0765 Instead of the heavy glazed roofing, Thermoclear luminaries were used: these are composed of a transparent, 30 mm, twin-welled, polycarbonate panel with a special reflector which can reduce glare and increase illumination levels. With regard to the existing wooden false ceiling, all the bullet-proof glass will be replaced with special high transmittance diffuser components (Barrisol system).

s0145 11.5.4 Ground Floor

p0770 With regard to different types of exhibitions, new lamps have been installed in order to ensure the right illuminance levels as follows (combining daylight and electric light):

u0500 • 200 lux on oil paintings
u0505 • 50 lux for watercolors

f0085

s0150 11.5.5 Cooling

p0785 The installed centralized heat pump system (two pipes) has a reversible direct expansion cycle with a variable cooling volume, of a modular sort, and is divided into four zones. The system uses ecological cooling gases such as R407C. A cooling/heating controlled air system has also been installed that, combined with passive natural cooling strategies, allows optimal temperature and relative humidity parameters to be achieved.

s0155 11.5.6 Ventilation

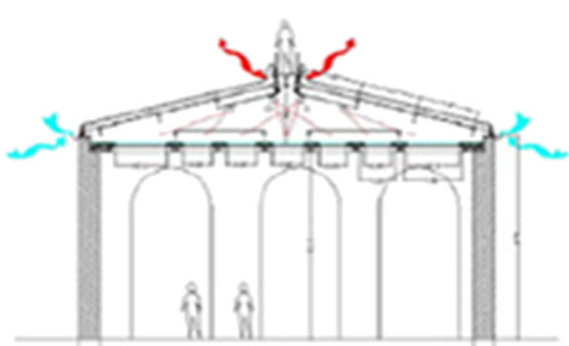
p0790 A ventilated roof system was designed to carry out two different kinds of 'air circulation' in the roof:

u0510 ● The first micro-ventilation under the tiles is essential to prevent stagnation of humidity

u0515 ● The second macro-ventilation under the roof, activated between the tiles and the insulating layer.

p0805 During the summer season, heat stored by wrap thermal mass and transferred to the internal spaces is dispersed during the night by opening special grids built into the window frames. Based on this principle, proportions have been determined using thermal exchange during the night from 10.00 pm to 8.00 am and installing special windows with grids that can be easily kept open during
[AU11] summer so as to improve stack effect. The combined effects of these measures decreases the maximum internal temperature by 1–2°C during the day, giving a substantial energy saving. To complete the natural ventilation strategies, special double glazed (6–12–8 mm) windows (with solar control K=2.8 W/m°C) have been tested and equipped with ventilation grids for natural air change in order to create a controlled natural ventilation system (intelligent ventilated windows).

p0810 The intelligent windows allow different interconnected functions such as ventilation, solar and anti-glare protection, heating, cooling and sound insulation for summer and winter on a largely individual basis without losing the psychological effect of an opening.



f0090

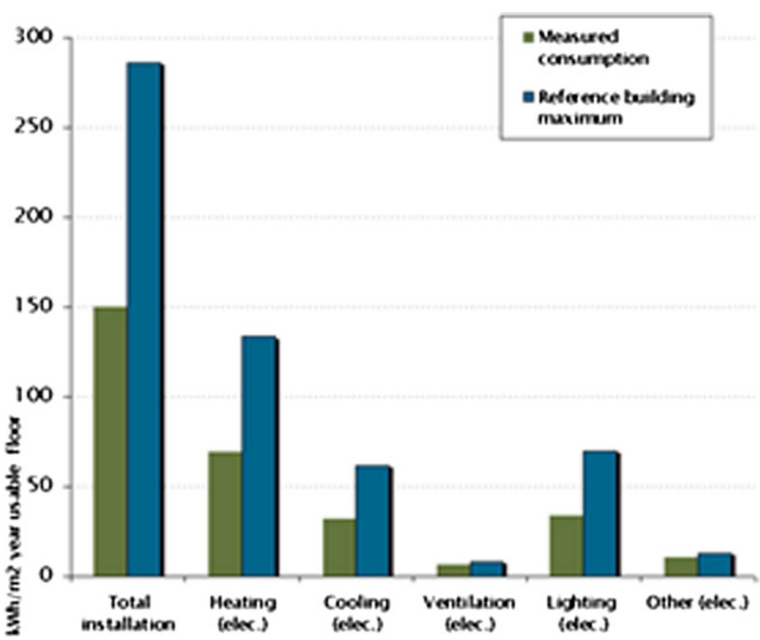
s0160 11.6 BARDINI MUSEUM – FLORENCE, ITALY

s0165 11.6.1 Energy Performance

p0815 The project increased the roof insulation levels, and installed a cooling/heating controlled air system and passive natural cooling strategies: these allowed optimal temperature and relative humidity parameters to be achieved (to suit both staff and exhibits). The increase in insulation has produced a reduction in the roof's U-value from 1.90 W/m2°C to U = 0.36 W/ m2°C. The insulating panels (10 cm) are made of natural cork, installed without artificial additives and adhesives.

p0820 In a museum, the difficulty of maintaining set environmental conditions without increasing the energy consumption needs advanced control systems to optimize the final energy balance. These intelligent systems, formed from three basic elements (sensor, controller, actuator), can manage a large number of sensors (such as fire-alarms, smoke-alarms, ventilation, security and air treatment plants) according to the various required internal comfort levels. In the Bardini Museum project, BMS has been used for thermal-hygrometric and daylighting control of the rooms using humidity, temperature, occupancy and illuminance sensors.

p0825 The chart shows the difference between thermal and electrical consumption calculated in kWh/m2 per year, in standard buildings and in the revamped museum. The overally savings are: heating 48%, cooling 48%, ventilation 26%, lighting 53%, other 20%; total energy saving 48%.



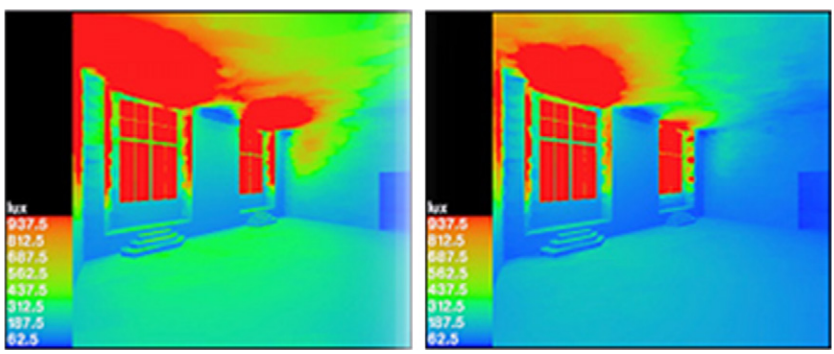
f0095

s0170 11.6.2 Monitored Comfort

p0830 [AU12] The as-is state (picture on the left) shows the surface at the back of the image with an illuminance value that is over the maximum admitted by the laws. To reduce the illuminance to around 200 lux, the project (picture on the right) foresees the introduction of a glass film and of a translucent diffuser that is set inside the window panes and can be lowered or raised, as a flowing curtain, in order to exploit the possible penetration of natural light during periods of low luminance, while always trying to avoid the entry of direct solar rays.

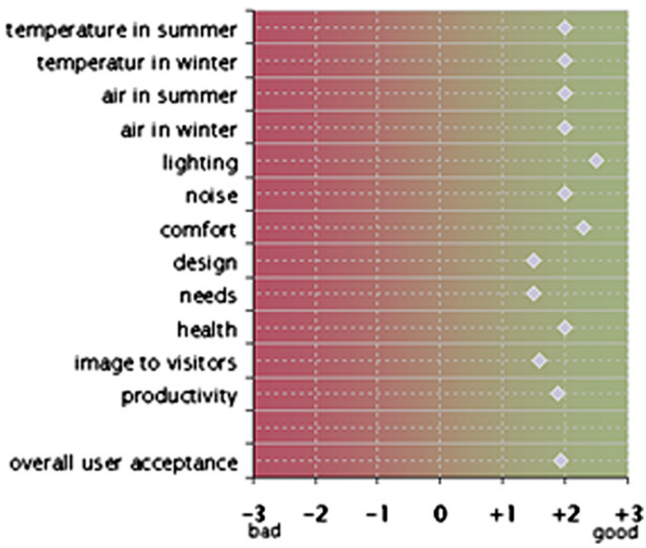
p0835 Thanks to this screening system the illuminance of the wall complies with the limits set by law.

f0100



s0175 11.6.3 User Acceptance

p0840 Questionnaires have shown a general increase in perceived comfort, both by staff and visitors. Employees have reported a great improvement in thermal comfort during both winter and summer. This is probably because they become accustomed to working in unheated/cooled spaces. They also noted not just that the temperature had increased in winter and decreased in summer, but that they really felt good, being comfortable throughout the year.



f0105

s0180 ### 11.6.4 Financial Data

p0845

u0520 Architectural design; € 42.000

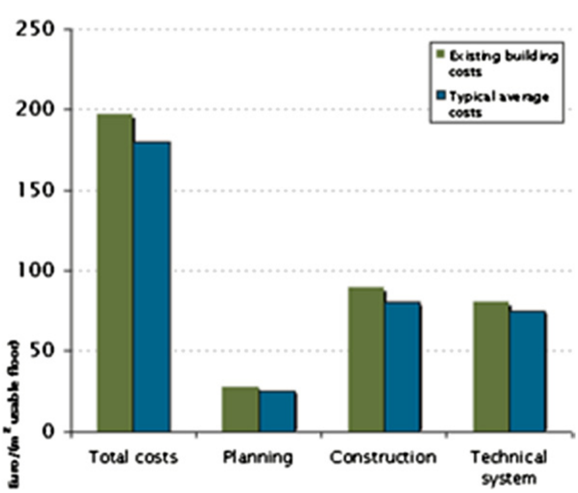
u0525 Energy and Environmental Design; € 47.000

u0530 Construction; € 29.000

u0535 Monitoring; € 27.000

u0540 TOTAL; € 145.000

p0875 The chart shows that immediate cost savings are mostly achieved in the building construction, planning and technical systems, which impact the total cost. But we must always remember that this type of building requires lower maintenance, so reducing future general management costs, which will have a higher impact in the future and shorten the payback time.



f0110

s0185 11.7 NEW MEYER HOSPITAL – FLORENCE, ITALY

p0880
f0115

s0190 11.7.1 General Data

p0885
u0545 Number of floors above ground: 2
u0550 Number of floors below ground: 1
u0555 Heating or cooling gross floor area: 21.600 sqm
u0560 Usable floor area: 15.000 sqm
u0565 Heated or cooled volume: 60.238 m3
u0570 Building envelope area: 32.671 sqm
u0575 Average number of occupants: 130 patients + 35 day patients

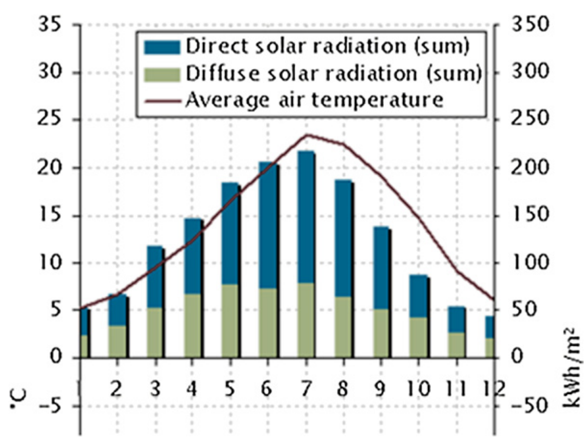
s0195 11.7.2 Identification

p0925
u0580 Name: Meyer Children´s Hospital
u0585 Owner: Fondazione Meyer
u0590 Country: Italy
u0595 City: Florence
u0600 Street: Careggi
u0605 Occupant(s) of Building: Meyer Children´s Hospital Staff
u0610 Use: Hospital
u0615 Typical days/hours of use: 24h
u0620 Designers: Studio Cspe-Anshen Dyer – Studio Chiarugi
u0625 Engineers: A6l Ingegneri Associati – CMZ – Studio Lombardini Engineering
u0630 Contractors: First site (central pavillion and technological platform area): Grassetto e Gemmo, Second site (lateral parts and greenhouse): Cogepa,
u0635 Parking: Montinaro
u0640 Energy sources: Solar tubes greenhouse, lighting strategies, thermal mass, photovoltaic

u0645 Natural ventilation
u0650 Year of completion: 2006

s0200 11.7.3 Outdoor and Indoor Climate

p1005
u0655 Microclimate: urban, ASHRAE degree days heating/cooling: 2060 / 1917 Kd
u0660 Outdoor design temperatures/humidities: minimum 10.6°C maximum 40.2°C
u0665 Indoor design temperatures/humidities: 22°C
u0670 Design ventilation rates: 35 air changes of outside air per hour
u0675 Design illuminance levels:
u0680 Offices: 420 lux
u0685 Atrium: 280 lux,
u0690 Circulation space: 150 lux
u0695 Patient rooms: 350 lux.



f0120

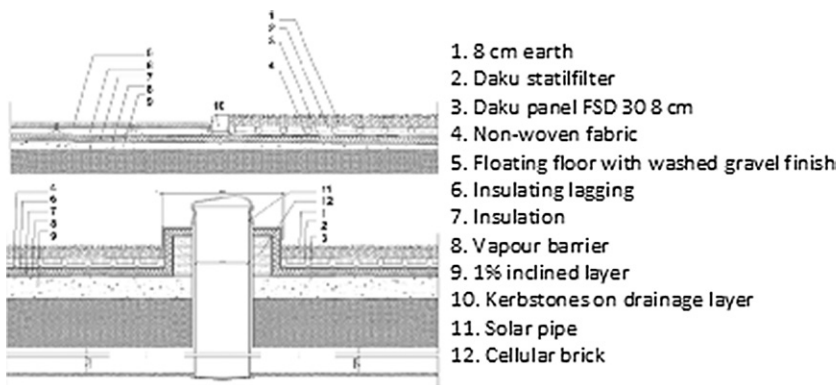
p1055 Innovative technologies in Meyer Children's Hospital include:

u0700 • Sun pipes and light ducts: daylight inside the hospital will not only be a good solution for energy saving, but will impact on good spirits.
u0705 • Green roof: the green roof has a strong character in this project.

p1070 The idea that the hospital is a place in which psychological aspects are very important for children and parents suggested the creation of green roof terracing with gardens.

u0710 • Buffer space on north facade: this will be used during rainy days in winter as a hall. The particular section and orientation of the buffer space will contribute to solar gains during winter. In summer, it is partly openable to reduce overheating.
u0715 • Optimum insulation inside walls: simulations have been done to find the optimum cavity insulation.

- u0720 Insulation material used on the first and second floors is recycled material.
- u0725 Radiant panels: to achieve a better and uniform temperature in patient rooms.
- u0730 Condensing Comby Boilers for a high efficiency heating system.
- u0735 Shading for patient rooms and halls.



f0125 Green roof and solar pipe sections:

[AU13]

s0205 11.8 NEW MEYER HOSPITAL – FLORENCE, ITALY

p1105 Transmission losses are stated in terms of the heat flow through the envelope: that is, the quantity of energy which passes through the envelope per unit of time. These losses depend mainly on the temperature difference between the inside and outside faces 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. One method of reducing them is to prevent heat conduction by adding thermal insulation to the envelope in order to increase its thermal resistance.

p1110 The patient room of the Meyer Hospital has been carefully studied: note the two drawings of the external cavity wall with insulation inside. The description is of the wall used for the hospital building, with 4 cm of thermal insulation and a U-value of 0.37 W/m2K. The use of this improved wall insulation on surfaces that are directly exposed to external climatic conditions (19 sqm for the chosen patient room) reduces annual energy consumption for heating, giving an annual energy saving of 12%.

s0210 11.8.1 Green Roof

p1115 To reduce transmission losses as much as possible it is necessary to insulate all the opaque elements in the building, not just the walls.

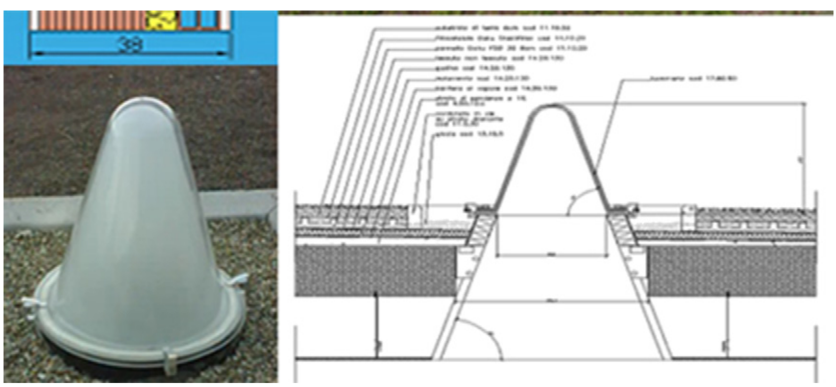
p1120 Investing in green roof technologies helps to diminish the environmental impact on our communities while providing a fresh approach with visually appealing organic architecture.

p1125 Benefits:

- u0740 Lower environmental impact
- u0745 The grass absorbs the solar radiation and the evaporation process reduces air temperature and delta T
- u0750 Transmission loss reduction.

p1145 The green roof package produced for the Meyer Hospital has a U-value of 0.79 W/m2K compared to a traditional flat roof with a U-value of 1.16 W/m2K.

p1150 The proposed solution increases 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.



f0130

s0215 11.8.2 Solar Control

s0220 *11.8.2.1 Windows and Shading*

p1155 The windows are constructed with wooden frames. Patient rooms are protected from direct sunlight by an overhanging structure externally covered with copper plates, to reduce the visual impact of the building in the park, with an internal surface covered in wood. The greenhouse is shaded by internal white blinds, which are adjusted by an automatic control system. This shading device is a system of sails.

f0135

s0225 11.8.3 Lighting, Sun Pipes and Light Ducts

p1160 Sun pipes and light ducts are used to improve daylight levels in corridors and halls. Sun pipes are installed in corridors in front of patient room windows: they add just a small contribution in terms of daylight factor in the rooms themselves, but they have a positive impact on patients psychologically. The use of sun pipes allows artificial light in corridors to be switched off during the morning, throughout the year. Sun pipes send sufficient daylight into patient rooms every day of the year.

p1165 The best possible energy saving is around 60%, but this will depend on the efficiency of the energy facility manager of the hospital and on the system being used sensibly.

p1170 Positive surroundings, with plenty of daylight and high thermal comfort levels, are an important aspect of patients' wellbeing. Sun pipes are installed to achieve a good illuminance value in patient rooms. Solar-tubes and roof-lights in corridors and halls give a good level of daylight. During an overcast day, a DF of 2.5% in the principal corridors and 1.5% in the others without windows can be reached; this means that it should not be necessary to use artificial light in several spaces during the morning.

p1175 For daylight calculations we have to specify an overcast sky, but in the climatic area analyzed there are fewer cloudy days than sunny days.

p1180 All installed lamps are high efficiency and the total annual electricity demand is 12.3 kWh/m2. Compared to the energy demand in which all these features are not applied, the energy saving is of about 35%.

s0230 11.8.4 Heating

p1185 Heat pumps are used to generate heating and cooling. These are appropriate where both summer cooling and winter heating are required. Radiant panels and high efficiency boilers are used for the heating system. Radiant floor heating panels are installed in patient rooms, in which we want to achieve a good level of thermal comfort at a low energy cost.

p1190 For winter heating and DHW generation there are two boilers: they are condensing combi boilers with an efficiency of about 106%. The boilers use gas and not electricity. Another, conventional boiler is also installed.

s0235 11.8.5 Cooling

p1195 For summer cooling there are two electrical chillers. A third chiller is of the water/water type: the heat generated from this last machine is used for DHW.

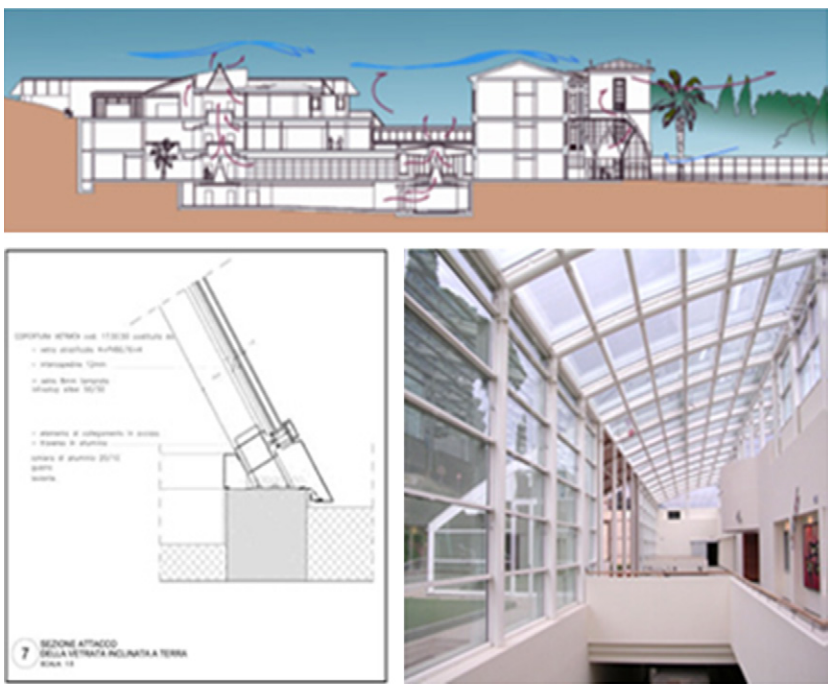
p1200 In the hospital there are also two heat-pumps to be used in case of emergency (i.e., if the gas does not reach the hospital because of gas supply problems). They are also used in summer, but only when necessary. A thermostatic valve inside the patient room area will measure temperature and relative humidity; when the temperature falls below 21°C (in winter) or above 27°C (in summer) the heating/cooling system will be switched on.

p1205 The installation of a control system to set temperature, relative humidity and air velocity, together with the clothing level value and metabolic rate, will give a predicted PPD (predicted percentage dissatisfied) of below 6%. This is the percentage of patients who are dissatisfied (uncomfortable) in their patient room.

s0240 11.8.6 Ventilation

p1210 Ventilation is done by manually opening windows, which move up and down.

p1215 A combination of shading and ventilation systems can keep the indoor temperature 10°C below the outside temperature. To save on cooling energy, passive cooling and ventilation techniques are used as much as possible, with air conditioning operating only where necessary. A sun space functions as a buffer area for the building. The heated air is used to create solar draughts, thus providing a natural air flow through the building. A centralized energy management system selects the best operational strategy in each case.



f0140

s0245 11.8.7 Renewable Energy

p1220 The Meyer's photovoltaic greenhouse is a south facing structure with unobstructed solar access to the main solar glazing 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. The design objective not only considered energy and environmental aspects but also its social impact. The primary objective was to create a pleasant 'socializing' space which can be used for semi-outdoor activities during most of the year without any extra energy needed; a social space well integrated into the adjacent green park. PV installation integrated into building greenhouse facades allows energy production to be combined 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 facade systems, the 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. The photovoltaic system is 30 kWp and uses glass/glass PV modules.

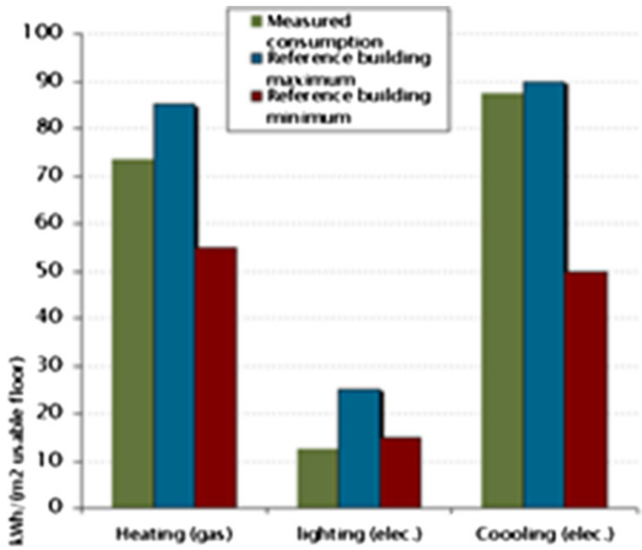
s0250 11.8.8 Co-Generation

p1225 The co-generation plant is a gas turbine, with an electrical power of 7.5 Mwe (ISO), which allows self-produced energy to be used in the hospital complex. The annual electrical efficiency of the turbine is 29.9%. The annual thermal efficiency of the turbine – calculated as the ratio between produced and used thermal energy and the amount of thermal energy supplied by the methane's combustion – is 40.5%. On the basis of these values, it is also possible to calculate the total efficiency with respect to the supplied thermal energy, which is 70.4%. The obtainable annual energy saving as equivalent energy is equal to around 4.400 Tep.

s0255 11.8.9 Energy Performance

p1230 The performance objective was to achieve a 40% reduction in consumed energy. Results of energy consumption are discussed in this section, and are derived by simulation, calculation and monitoring. Specific energy consump-
[AU14] tion targets were: Lighting Sun pipes and roof-light in corridors and halls provide a good level of daylight. Furthermore all installed lamps are high efficiency.

p1235 The total annual electricity demand is 12.3 kWh/m², giving an energy saving of 35% compared to the energy demand of a building without all these features. The heating and cooling internal temperatures and relative humidities measured during the monitoring phase are in accordance with simulations. The insulation used in the walls and roof gives an energy saving of 35% for heating and cooling. The annual heating demand is 73.4 kWh/m². The annual cooling demand is 87.3 kWh/m². During the summer period, two chiller machines are used for cooling the hospital. The heat produced is used for DHW. The annual heating for DHW demand is 13% less than in a conventional Italian hospital. Co-generation plant It was not considered for energy performance because it
[AU15] must be completed.



f0145

s0260 ## 11.8.10 Monitored Comfort

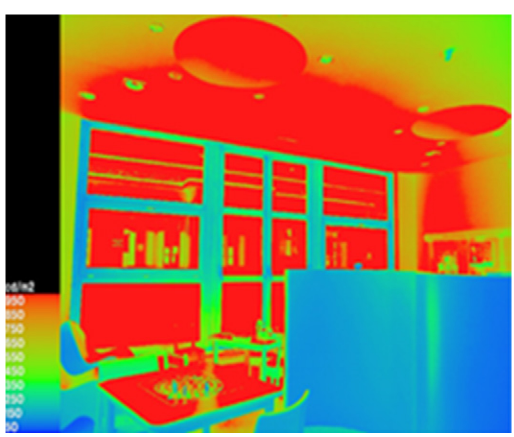
p1240

u0755 Location: Children's playroom, 2nd floor, south facing facade

u0760 System: External overhang roof and low emission glazing

u0765 Sky condition: Sunny day with direct sun on facade

u0770 Description: The luminance picture shows a good distribution of luminance on surfaces, also into the depth of the room. Lighting is also maximized by the presence of two light ducts.



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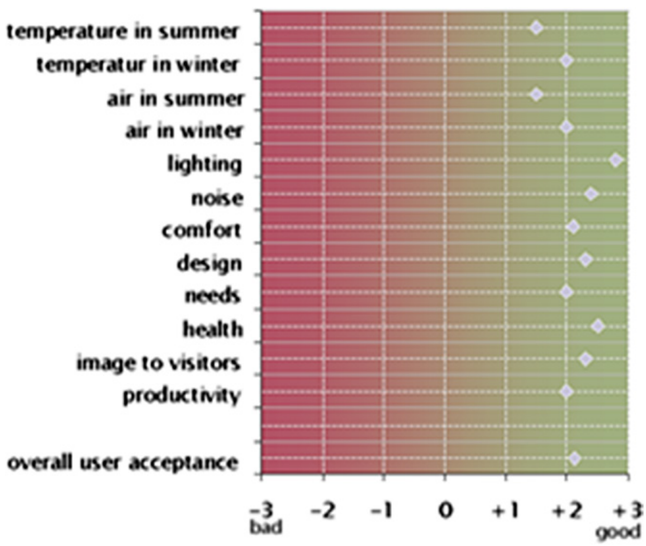
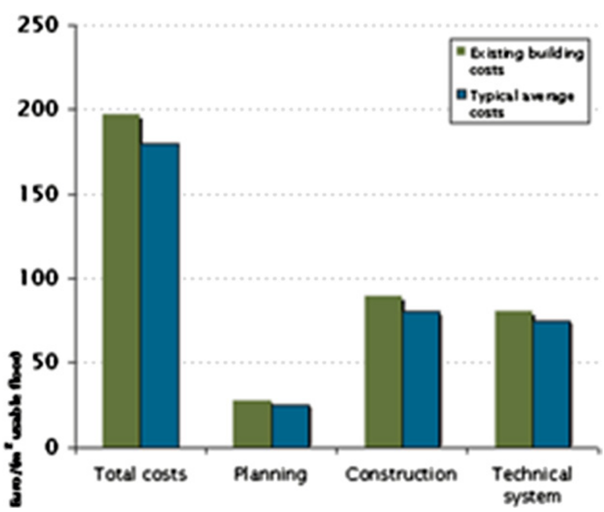


f0155

s0265 11.8.11 User Acceptance

p1265 The graph shows that the children's hospital achieved an excellent user rating. In fact all the values are above +2 on a seven point scale which goes from −3 (bad) to +3 (good), with an overall user acceptance of +2.23.

s0270 11.8.12 Financial Data



p1270
f0160

p1275 Total cost: € 1.160.000,00, of which € 960.000,00 was for the structure and € 200.000,00 was for furnishing. The co-generation plant was not included in [AU16] these figures, because it has yet to be completed and will be financed by the district.

p1280 The costs of the energy saved or produced annually is € 181.679.

s0275 11.9 PRIMARY SCHOOL – EMPOLI, ITALY

p1285

f0165

s0280 11.9.1 General Data

p1290

u0775 Number of floors above ground: 1
u0780 Number of floors below ground: 0
u0785 Heating or cooling gross floor area: 1800 sqm
u0790 Usable floor area: 1800 sqm
u0795 Heated or cooled volume: 7500 m3
u0800 Building envelope area: 600 sqm
u0805 Average number of occupants: 70

s0285 11.9.2 Identification

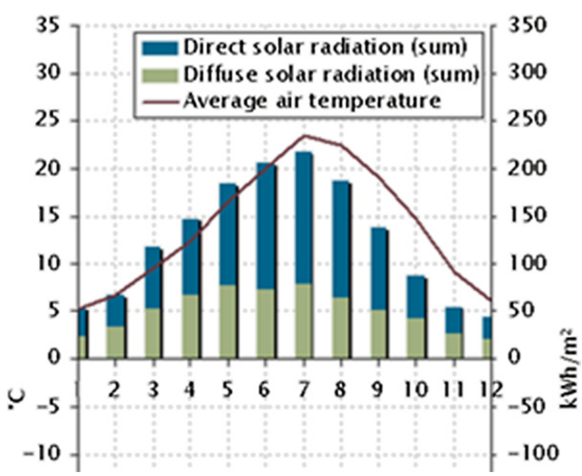
p1330

u0810 Name: Ponzano Primary and Nursery School
u0815 Owner: Empoli municipality
u0820 Country: Italy
u0825 City: Empoli
u0830 Street: Via di Ponzano

u0835 Occupant(s) of Building: Ponzano Primary and Nursery School
u0840 Primary Use: School
u0845 Typical days/hours of use: 8.00– 17.00
u0850 Designers: Marco Sala Associati
u0855 Engineer: Ing. Luigi Campa – Structures CMZ – Plant Enginering
u0860 Contractors: Muicipality of Empoli
u0865 Manufacturers of energy saving Products: Consage
u0870 Energy sources: Radiant panels, condensing combi boiler
u0875 Year of completion: 2001

s0290 11.9.3 Outdoor and Indoor

p1405
u0880 Microclimate: urban, ASHRAE degree days heating/cooling: 2060 / 1917 Kd
u0885 Outdoor design temperatures/humidities: –2°C; RH 50%
u0890 Indoor design temperatures/humidities: 20°C
u0895 Design ventilation rates: 30/h
u0900 Design illuminance levels:
u0905 Classrooms: 500 lux
u0910 Circulation space: 150 lux



f0170

p1445 The building was constructed with a reinforced concrete skeleton system and an innovative insulation system. Window types were employed depending on orientation and function.

p1450 A high thermal floor insulated with radiant heating was planned. Shading devices were used for the southern side of the building.

p1455 The windows have double pane thermal protective glazing and timber-PVC frames, with internal air exchangers to regulate the entry of air. A double ventilated roof guarantees good insulation and building ventilation. t0010

BUILDING COMPONENT	U-VALUE (W/M^2K)
External wall with bricks	0.28
Window	1.7
Ventilated Roof	0.28
Floor: Store and technic	0.50
Average U-value	0.43

s0295 11.9.4 Insulation

p1460 Properly sealed, moisture-protected, insulated walls help increase comfort, reduce noise, and reduce energy costs. The walls are however the most complex component of the building envelope. The precast insulation wall is an innovative system which uses concrete walls able to combine mechanical resistance and insulation. The precast element is in casing form, having two polyester panels (EPS) facing each other and connected by a separator which creates a cavity between the two surfaces. This insulating system is able to ensure a trasmittance U-value of 0.15 [W/m^2K].

s0300 11.9.5 Solar Control

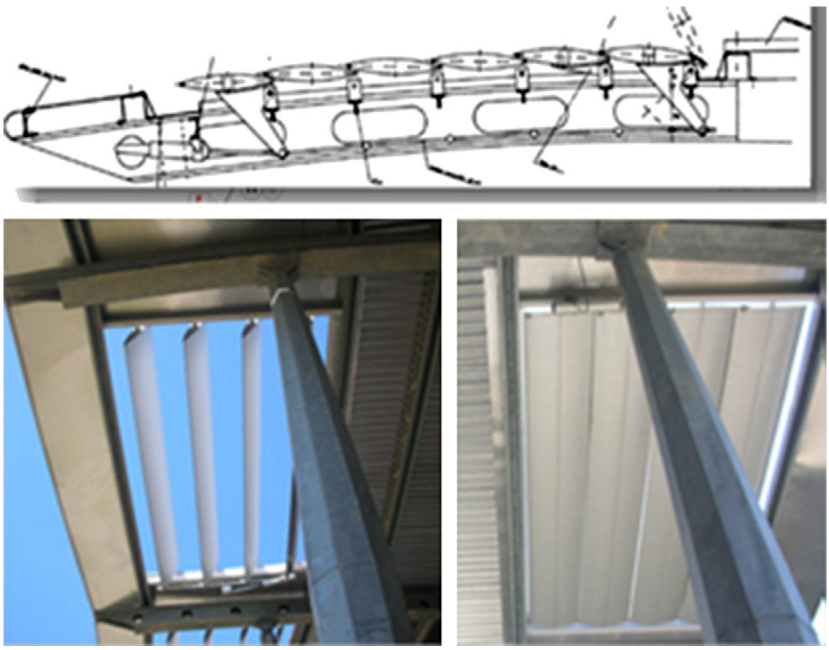
p1465 Well-designed sun control and shading devices dramatically reduce building peak heat gain and cooling requirements, and improve the natural lighting quality of the interiors. The school reduces the amount of annual cooling energy consumption from 5% to 15%. Sun control and shading devices also improve user visual comfort by controlling glare and reducing contrast ratios. This often leads to increased satisfaction and comfort. Shading devices offer the opportunity of differentiating one building facade from another which can add interest and human scale to an otherwise undistinguished design.

p1470 The use of sun control and shading devices is an important aspect of this energy efficient building; particularly in employing passive solar heating and daylighting through sun control.

p1475 During cooling seasons, external window shading is an excellent way to pre-
[AU17] vent unwanted solar heat gain from entering an air-conditioned space. Shading is provided by movable aluminum overhangs.

p1480 Exterior shading devices are particularly efficient in conjunction with the clear glass facades of the 'intelligent windows'.

p1485 Lighting is controlled by the 'intelligent window', essentially a facade device which acts as an intelligent interface between inside and outside, as it is installed on the ‘skin’ of the building. It provides the appropriate thermal insulation and air exchanges necessary for improving indoor conditions. Its use parameters may be described as: solar energy control, daylight and ventilation control, building facade aesthetics, cost saving in heating or air conditioning and automatic adjustment through neural network.



f0175

s0305 11.9.6 Lighting

p1490 Lighting is controlled by the 'intelligent window', essentially a facade device which acts as an intelligent interface between inside and outside, as it is installed on the ‘skin’ of the building. It provides the appropriate thermal insulation and air exchanges necessary for improving indoor conditions. Its use parameters may be described as: solar energy control, daylight and ventilation control, building facade aesthetics, cost saving in heating or air conditioning and automatic adjustment through neural network. The creation of an intelligent interface between indoor and outdoor conditions remains the primary objective. The window includes a set of elements, each with a specific or variable function, depending on outdoor conditions. The elements are contained in two main sections: the upper section contains glazing panels which in turn enclose variable transparency film operated on a roller system. The employed materials are PVC frame, temperate glass, low emissive glass, a roller system, air flow control.

s0310 11.9.7 Heating

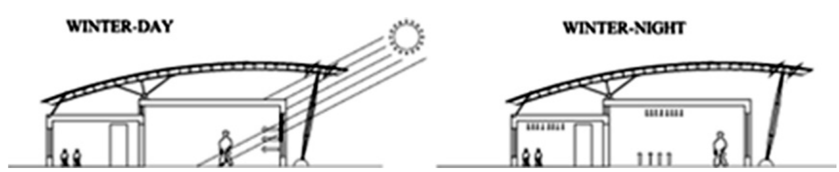
p1495 The best high efficiency boilers can operate with seasonal efficiencies in excess of 90%, by recovering and using heat that would otherwise be lost in the flue. Recovering heat from the flue reduces the temperature of the flue gases to a point where the water vapor produced during combustion ‘condenses out’. Thus the name: high efficiency condensing boiler. A side effect is that this ‘condensed out’ water, known as condensate, which is usually acidic, has to be piped away to a drain or soakaway. All condensing boilers will produce ‘pluming’ from the flue terminal which appears as steam. This pluming can drift into neighboring property, causing annoyance and possible condensation on window glass or frames, therefore careful consideration should be given to the positioning of the flue terminal, especially if it can affect neighboring property.

p1500 A condensing boiler is a highly efficient modern boiler that incorporates either a larger or even a second heat exchanger. It produces lower flue gas temperatures, lower flue gas emissions and reduced fuel consumption. It typically converts more than 88% of the fuel used into useful heat, compared to, typically, the 78% of modern conventional types.

s0315 11.9.8 Natural Ventilation

p1505 Natural ventilation is guaranteed by many incorporating south and north facing openings. During the daytime winter season 'intelligent windows' enact a natural ventilation control together with the air exchanger and window apertures. The roof is ventilated and double: one hollow block floor and a second roof realized with structural steelwork and aluminum panels. Air flows from north to south, also ventilating classrooms from the window.

f0180



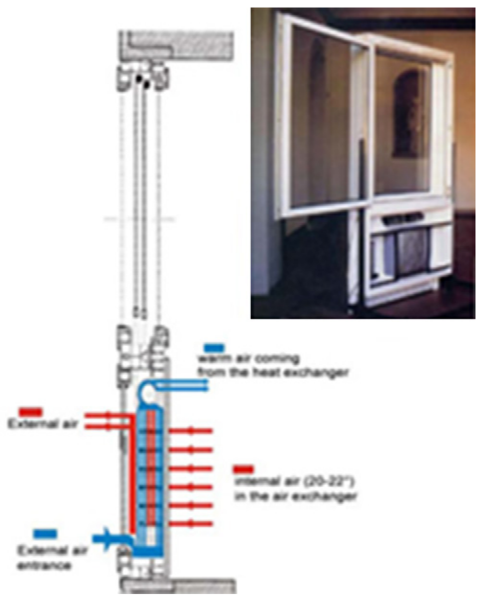
s0320 11.9.9 Cooling

p1510 Natural cooling is guaranteed by the presence of the 'intelligent window', formed by a number of elements each with a specific or variable function, depending on the outdoor conditions. The elements are contained in two main sections:

u0915 - The upper section contains glazing panels, which in turn enclose a variable transparency film on a roller system.
u0920 - The lower section contained inside a compartment, internally clad with a filter panel and externally with an opaque glass panel.

p1525 Within these panels the heat exchanger and the upper and vertically mounted fans for air intake and exhaust are respectively located. The intelligent control system, sensors and the local control for different configurations, are also located within this section. The window heating strategy includes the concepts of solar collection, heat storage and heat distribution, while the cooling strategy comprises solar control, minimizing internal gain and heat dissipation. Shading component: Roller shutter with 30% of radiation control; two air flow controls

with T shape valve for reducing heat in summer and preheating air ventilation
[AU18] in winter.



f0185

p1530 Effect:

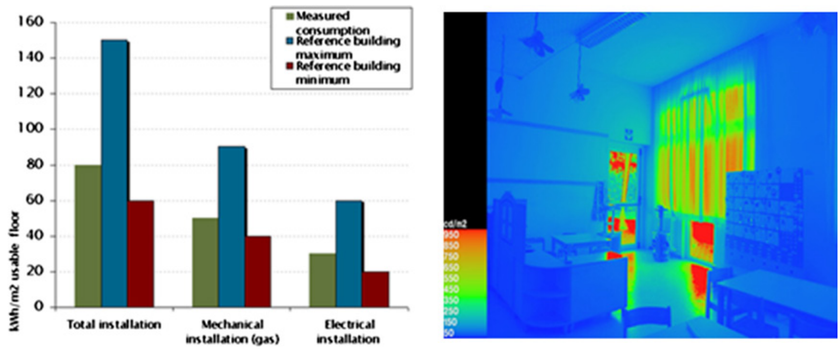
u0925 • high solar gain
u0930 • active solar systems
u0935 • high ventilation rate
u0940 • control of solar radiation
u0945 • night cooling
u0950 • u-factor: U= 1.7W/m²K
u0955 • visible transmittance: U glass = 3.5 W/m²K
u0960 • admissible chance air: m = 50 m³/

s0325 11.9.10 Monitored Comfort

p1575 The total energy consumption was monitored for twelve months between October 2000 and September 2001, and was found to be 80 kWh/m2 year. The diagram shows how the adopted passive systems reduce energy consumption for both mechanical and electrical installation.

u0965 Location:
u0970 Classroom on ground floor; the view is of south facing facade
u0975 System: Intelligent windows with inside louvers and curtaining
u0980 Sky condition: Sunny day with direct sun on facade

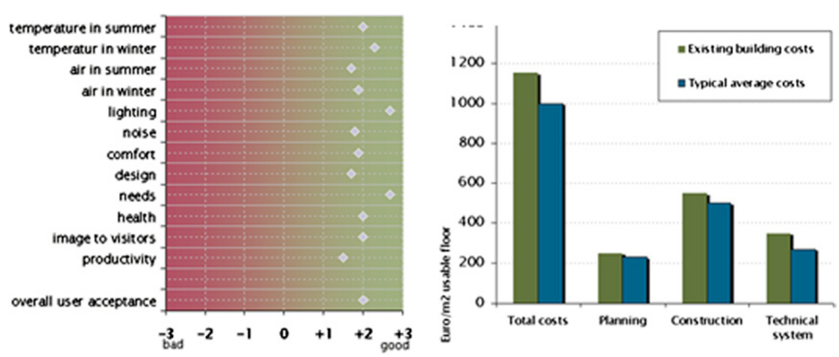
u0985 Description: The luminance picture shows a good shading distribution and a good luminance on surfaces, also into the depth of the room. [AU19]



f0190

s0330 11.9.11 User Acceptance

p1605 The mean responses of occupants voting on a seven-point scale from bad (−3) to good (+3), were 2.18 – which is a really good evaluation. The school building thus rates well on productivity, occupant control and air quality.



f0195

s0335 11.9.12 Financial Data

p1610 Total building cost: € 1.200.000

p1615 The chart shows that an immediate cost saving is mostly found in the building's construction (planning and technical systems remain the same) which impacts the total costs. However, we must remember that this type of building has lower maintenance costs, which will have a higher impact in the future and hence shorten the payback time.

s0340 11.10 MALTA STOCK EXCHANGE – LA VILLETTA, MALTA

p1620
f0200

s0345 11.10.1 General Data

p1625
u0990 Number of floors above ground: 3
u0995 Number of floors below ground: 3
u1000 Heating or cooling gross floor area: 1862 m2
u1005 Usable floor area: 1271 m2
u1010 Heated or cooled volume: 7600 m3
u1015 Building envelope area: 2800 m2
u1020 Average number of occupants: 45 occupants

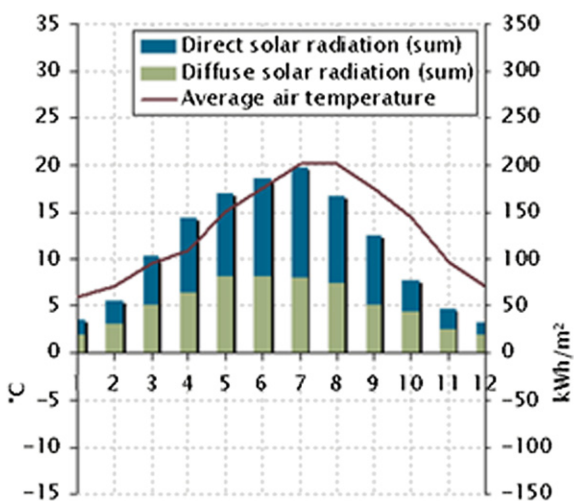
s0350 11.10.2 Identification

p1665
u1025 Name: Malta Stock Exchange
u1030 Owner: State of Malta
u1035 Country: Malta
u1040 City: Valletta
u1045 Street: Garrison Chapel, Castille Place
u1050 Occupant(s) of Building: Malta Stock Exchange
u1055 Primary Use: Office
u1060 Typical days/hours of use: 7:00 – 17:00 Monday to Friday
u1065 Designers: Architecture Project, Brian Ford & Associates
u1070 Engineer: TBA, Frank Franjou, MTS
u1075 Contractors: Medairco, Vassallo Builders, Peter Cox
u1080 Manufacturers of energy saving Products: Grundfos

u1085 Energy sources: Electricity
u1090 Year of completion: 2001

s0355 11.10.3 Outdoor and Indoor Climate

u1095 Microclimate: Mediterranean; site: exposed city center ASHRAE degree days
p1740 heating/cooling: 832 / 3080 Kd
u1100 Outdoor design temperatures/humidities:
u1105 T summer : 38°C, RH=30–80%
u1110 T winter : 8°C, RH=30–80%
u1115 Indoor design temperatures/humidities:
u1120 T summer : 24–25°C, RH=70–75%
u1125 T winter : 21°C, RH= 70–75%
u1130 Design ventilation rates:
u1135 Design illuminance levels: 300–500 lux



f0205

s0360 11.11 MALTA STOCK EXCHANGE – LA VILLETTA, MALTA [AU20]

s0365 11.11.1 Identification

p1790

s0370 11.11.2 General Data

p1795 The project involved the refurbishment of an existing listed building. The converted building incorporates a five-storey atrium surrounded by perimeter cellular offices. A new metal inner structure divided by concrete slabs has been inserted into the original stone building envelope. The thickness of the stone walls is 60 cm. The glazing ratio is about 5%. The offices are separated from each other by gypsum board partitions and are bounded by glazed partitions facing towards the central atrium. The roof structure is of wood. The roof has a U-value of 2.5 W/m2K.

s0375 11.11.3 Cooling

p1800 The cellular offices and the meeting rooms of the Malta Stock Exchange are air-conditioned. The central atrium is cooled by three complementary strategies, as follows:

u1140 Indirect cooling: Two chilled water circuits serve cooling coils installed in the roof ridge. They are linked to the automatic vents and operate in conjunction with each other. The rising warm air passes over and through the coils resulting in a down draught of cooled air.

u1145 Direct cooling: The passive downdraught evaporative cooling system (PDEC) relies on hydraulic nozzles. The air is moisturized by the micronisers situated on the ridge. The downdraught process drives the airflow pattern inside the building, hence avoiding the need for fans, ductwork and a suspended ceiling.

u1150 Night time convective cooling: This comes into operation when the external temperature drops below 23°C. The movement of the air is driven by buoyancy forces reversing the daytime air movement pattern (also see 'Ventilation' below).

s0380 11.11.4 Ventilation

u1155 High level window vents in the ridge of the roof and low level vents on the
p1820 lower ground floor mounted in the east, west and south walls provide ventilation if opened.

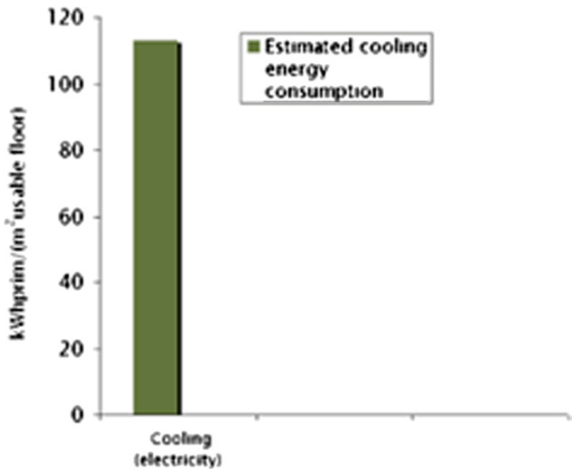
u1160 Night time convective ventilation comes into operation when the external temperature drops below 23°C. When this is initiated, all low and high level vents are fully opened. The movement of the air is driven by buoyancy forces reversing the daytime air movement pattern. Air enters below ground level and rises by a stack effect to exit via the roof-ridge vents. The thermal capacity of the masonry helps stabilize conditions within the building, while the timber louvers on the main window prevent solar gain.

s0385 11.11.5 Energy Performance

p1835 All conversions of delivered energy in primary energy were made according to the German Standard DIN V 18599-1:2005-07. Only the non-renewable energy part is considered.

u1165 Electricity-Mix: 2.7

u1170 Estimated cooling energy consumption: 113 kWh/ m2/year



f0210

s0390 11.11.6 Monitored Comfort

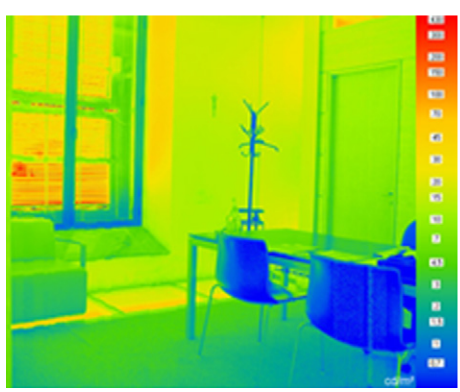
p1850

u1175 Location: Office room, 1st floor, south facing facade

u1180 System: Folding shutters, completely closed

u1185 Sky condition: Clear with direct sun on facade

u1190 Description: The luminance picture shows an even distribution with low values due to the completely closed shutters on the outside. As there is only part of the space visible a more detailed description here is not possible.

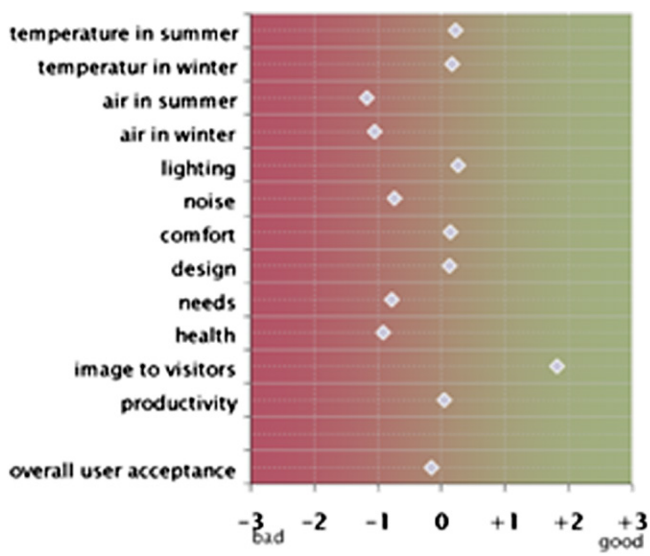


f0215

s0395 11.11.7 User Acceptance

p1875 The figure shows the subjective perception of comfort in the building. The occupants' subjective evaluation is given as the arithmetic mean of the responses given by a population consisting of 23 persons. The occupants voted on a seven-point scale from bad (−3) to good (+3), as illustrated in the figure. The visitors' impression of the building is a relatively high rating.

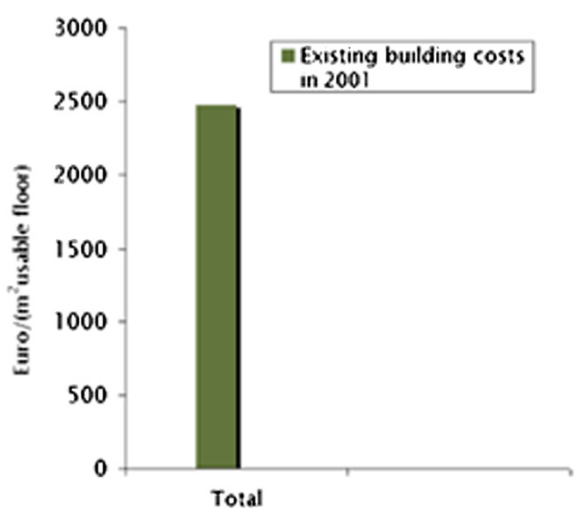
p1880 The majority of the responses are values between −1 and +1. Some concerns have been raised regarding the air quality in winter and summer. The overall user acceptance and the comfort have a rating value close to 0.



f0220

s0400 11.11.8 Financial Data

p1885 The total cost in 2001 is 2,470 euro/m2 including taxes.



f0225

SAYIGH: 11

Non-Print Items

Abstract
The building sector plays an important role in energy consumption. In order to tap this potential for energy savings and reduction of CO_2 emissions the energy efficiency of buildings must be improved as soon as possible. An important step into this direction has been taken with the European 'Energy Performance of Buildings Directive' (EPBD), which has to be turned into national law by the member states. Unfortunately energy efficient buildings in Mediterranean areas are usually facing problems resulting from the use of Northern Europe examples, which do not face summer climate problems.
With a selection of 11 Mediterranean, high quality, low energy buildings and detailed information about their architecture, building concepts, measured energy performance and building costs, this chapter is intended to help to improve the image of energy efficient buildings, and to promote the spread of technologies used to deal with issues in buildings which are associated with hot summers.

Keywords: Mediterranean; energy efficiency; building; low energy building; sustainability; eco-efficiency