2nd World Sustainability Forum

1-30 November 2012

Retrofit and new PV integrated Buildings in Tuscany, Italy: case studies

ARCH. LUCIA CECCHERINI NELLI

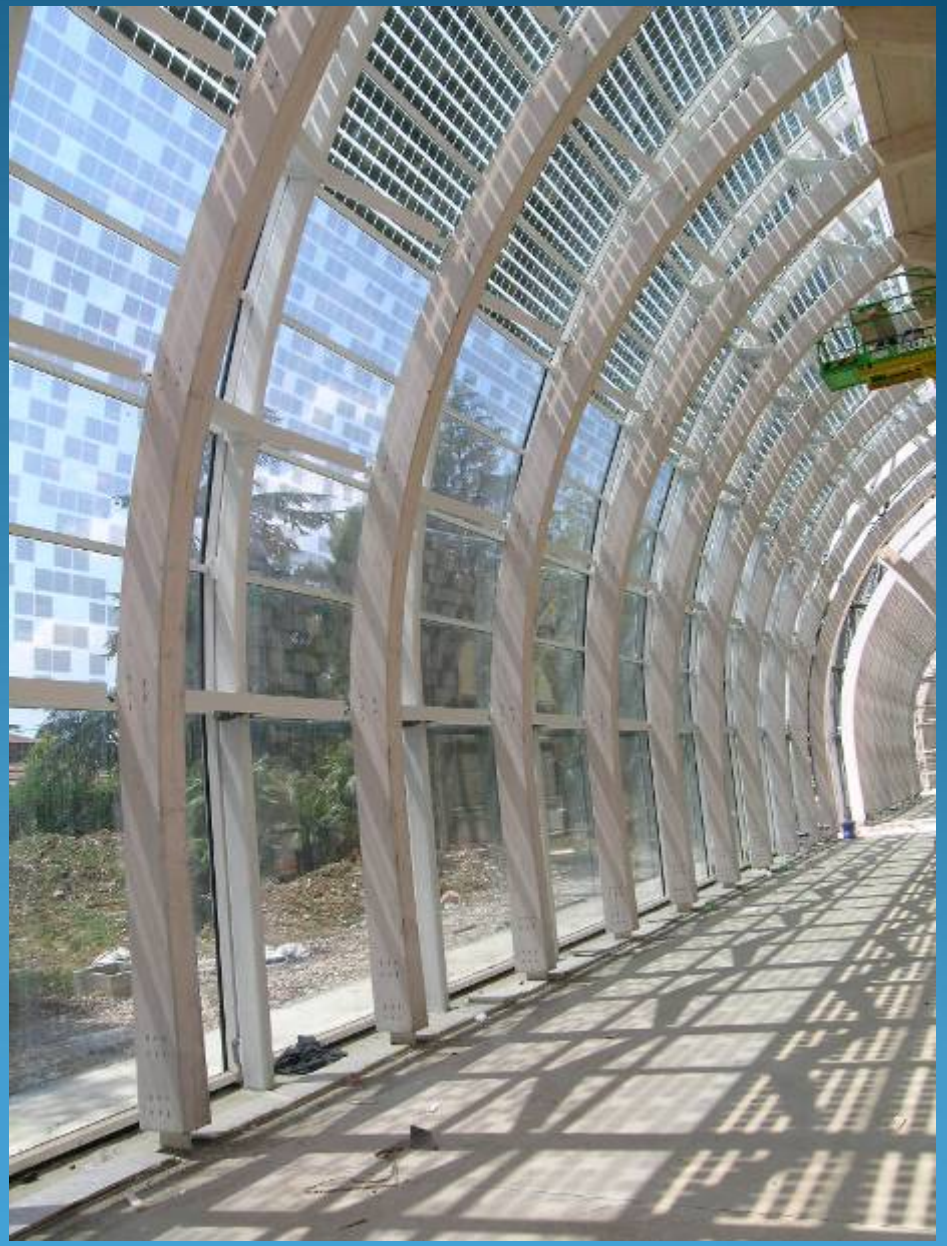
Centro Interuniversitario ABITA sede Firenze

Via S.Niccolò 93 Firenze tel 055 2055556 e-mail lucia.ceccherini@taed.unifi.it

MEYER HOSPITAL FLORENCE ITALY 30 kWp

The solar system includes solar panels with cells spaced integrated in the architecture and construction of the greenhouse.
The greenhouse is in fact an innovative atrium for the control of air conditioning, light and color are articulated in a language of materials: pillars, transformed into symbolic trees, are an expression of the technology of laminated wood on which is anchored the photovoltaic system that also acts as a shading device of the glass surface.
The heat input due to overheating of the cells contributes to the heating of the air in winter; while, in summer the ascensional convective motions improve the natural ventilation, and assist the natural cooling through openings located on the top of the greenhouse.

PV-laminates (size 220 x 100 cm) are arranged in parallel rows, supported by the main structure and along the vertical axis. Horizontally connected by means of the crosspieces of the structure, however, placed in the intrados of the greenhouse, to ensure a continuity of composition and structural of the glass surface in the outer part.



TYPOLOGY

The system created is composed by 181 photovoltaic modules made with glass of different sizes, the total energy power is about 32 kWp.
The modules have been integrated into the facade of the greenhouse and photovoltaic most have size 220x93, 8 cm with a power of 201 Wp, others are smaller. The group of conversion can convert the direct current into alternating current was laid on the roof of the greenhouse, the control panel and interface with the network is located in the center of the greenhouse inside a wooden structure.

SIZING

The system created is made up of three fields fotovoltaiici, lot east, lot and batch central west, each field feeds each of the three phases of the electricity network of the hospital.

In order to optimize the conversion efficiency of the modules connected to each inverter have all the same inclination (tolerance allowed up to 6 °). The modules occupy at most two adjacent rows so that the plant can be fairly homogeneous.

1. lot east

55 modules of 201 Wp (B1)

12 modules of 88 Wp (B1 / 2)

5 inverters SMA SB2500

2. lot central

35 modules of 188 Wp (B2)

12 modules of 88 Wp (B2 / 2)

1 inverter SMA SB3000 inverters SMA SB3300 + 1

3. lot west

55 modules of 201 Wp (B1)

12 modules from 88Wp (B1 / 2)

5 inverters SMA SB2500

Photovoltaic modules

The different types of modules are 4 (B1, B2, B1 / 2, B2 / 2) and can be grouped essentially in two types, modules 2 meters long with a power of 200W and modules 1 meter long with 88W power. The SE project has realized electrically compatible modules in order to avoid mismatching of current in the strings. The modules are certified and both sides are tempered glass HST (guaranteed 20 years).

Wiring

The cable resistance DC side is minimized by the size of the cables:

1. in each string the conductor is 6 mm2
2. the inverter interface board the conductor is 16 mm2
3. from the interface board to the overview section of the conductor is 25 mm2.

The connections are made with terminals compression and sometimes by means of soft soldering. In such conditions, the decrease in efficiency due to the parasitic resistances is less than 2 percentage points and the voltage drop are considered negligible.

Inverter
They were chosen from outside of the SMA inverter, the average yield is about 94%, the input voltage reaches 550 VDC class protection against atmospheric agents is IP65.Gli inverter are located on the roof of the greenhouse.

components

inverter
10 inverters SMA Sunny Boy SB 2500
1 inverter SMA Sunny Boy SB3000
1 inverter SMA Sunny Boy SB 3300

Double glazing and photovoltaic cells
110 modules of 201 Wp type B1 (2200x938) mm SE Project
n. 35 modules of 188 Wp type B2 (2076x938) mm SE Project
n. 24 modules of 88 Wp B1 / 2 (1089x938) mm SE Project
n. 12 modules of 88 Wp type B2 / 2 (1026x938) mm SE Project
20 years warranty

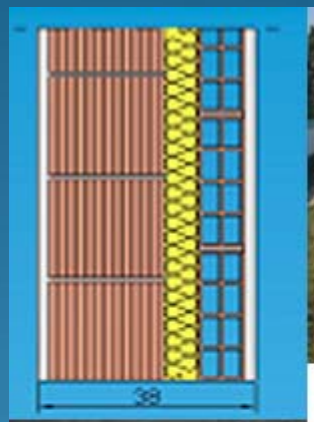
Side wiring of the Civil Code
Wiring the AC side
Connection cables D.C. FG7-OR with Sections 6 mm2. Baldassari
Spiral sheath Matufless
Ducting of insulating material wall IBOCO

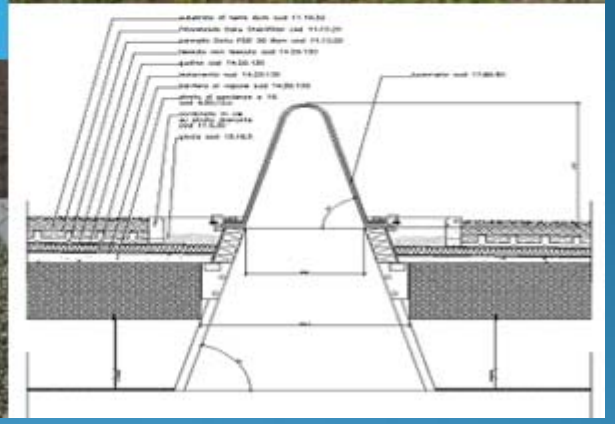
Interface protection
3 pictures of the field for the cutting of DC and AC co fuse disconnectors and circuit breakers bipolar bipolar.
Units from ext to 24, 36 Mod.din
1 interface board
1 device network security Gavazzi DPC 02
1 ABB contactor 53 A AC1 and network analyzer.
20A circuit breaker ABB S204
32A circuit breaker ABB S204
Sezionatoru with fuse 10 ° ABB
Pairs of traps DEHN 600V Dehn (D).

THERMAL INSULATION

The building must ensure the optimal conditions for thermal comfort in relation to the activities that are carried out inside.

- To optimize the thermal behavior is necessary to pay attention to the reduction of heat loss.
- A solution to overcome the problem is to try to achieve a high value of thermal resistance by means of a high level of insulation.





The local hospital type is characterized by a vertical element with a layer of insulating material with a thickness of 6 cm. The wall reaches a thermal transmittance value equal to 0.37 W/m2K, contributes significantly to the reduction of the annual energy consumption for heating, with a percentage of energy saving of 12%.

GREEN ROOF The use of a green roof allows to reduce leakage through the cover and also reduces the visual impact on the surrounding environment of the building.

The green roof realized Hospital Meyer is characterized by a thermal transmittance value equal to 0.79 W/m2K against 1 .16 W/m2K of the traditional type of hedge. The solution adopted for the entire building envelope will reduce the annual energy requirement of 36% for each hospital room.

WINDOWS AND SCREENING

The windows used are characterized by wooden profiles.

The patient rooms are sheltered from direct solar radiation through a structure projecting with the upper cladding copper pre-oxidized, green color, and with the bottom covered with wood. In this way you get a perfect integration in the context of the surrounding park and a reduction of the visual impact.

The shading system adopted in the greenhouse is constituted by internal blinds white whose movement is controlled through an automated control system.

The tents reproduce a system of sails.

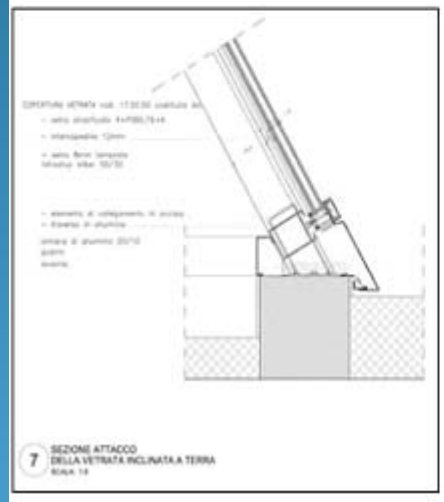
LIGHT PIPES AND SOLAR CHIMNEY

Light pipes and solar chimneys have been used to increase the amount of natural lighting within the corridors in front of the patient rooms.
These devices will allow a higher level of natural lighting but also will have a positive impact on the psychological well-being of patients will feel a more comfortable environment than just a traditional hospital.

The use of these devices allows to estimate a saving on energy consumption for lighting by approximately 60%, however variable value in relation to the efficiency of the activity carried out by the Head of Energy and the behavior of individual users (more or less sensitive issues of energy savings).
All lamps are high-efficiency, low energy consumption, with an annual demand for electricity equal to 12.3 kWh/m2, resulting in energy savings of 35%.

VENTILAZIONE

La ventilazione nell'Ospedale è garantita da aperture posizionate nelle parti alte e basse dell'edificio, prive di un controllo automatizzato.



Una combinazione tra i dispositivi di oscuramento ed i sistemi di ventilazione permette che la temperatura interna non superi più di 10°C quella esterna. Per ottenere una diminuzione dei consumi energetici per raffrescamento sono state adottate tecniche per favorire la ventilazione naturale in modo tale da utilizzare il meno possibile, e solo se necessario, l'impianto di raffrescamento. La serra svolge la funzione di spazio cuscinetto per l'intero edificio. L'aria riscaldata viene utilizzata per creare un flusso d'aria naturale che attraversa l'edificio.

.

Construction of a new building experimental ZERO ENERGY NEW CENTER IN ENVIRONMENTS AND ICT VIRTULALI LUCCA

The main objective of the project was to:
reduce the energy consumption of the building
ensure optimal indoor comfort conditions.

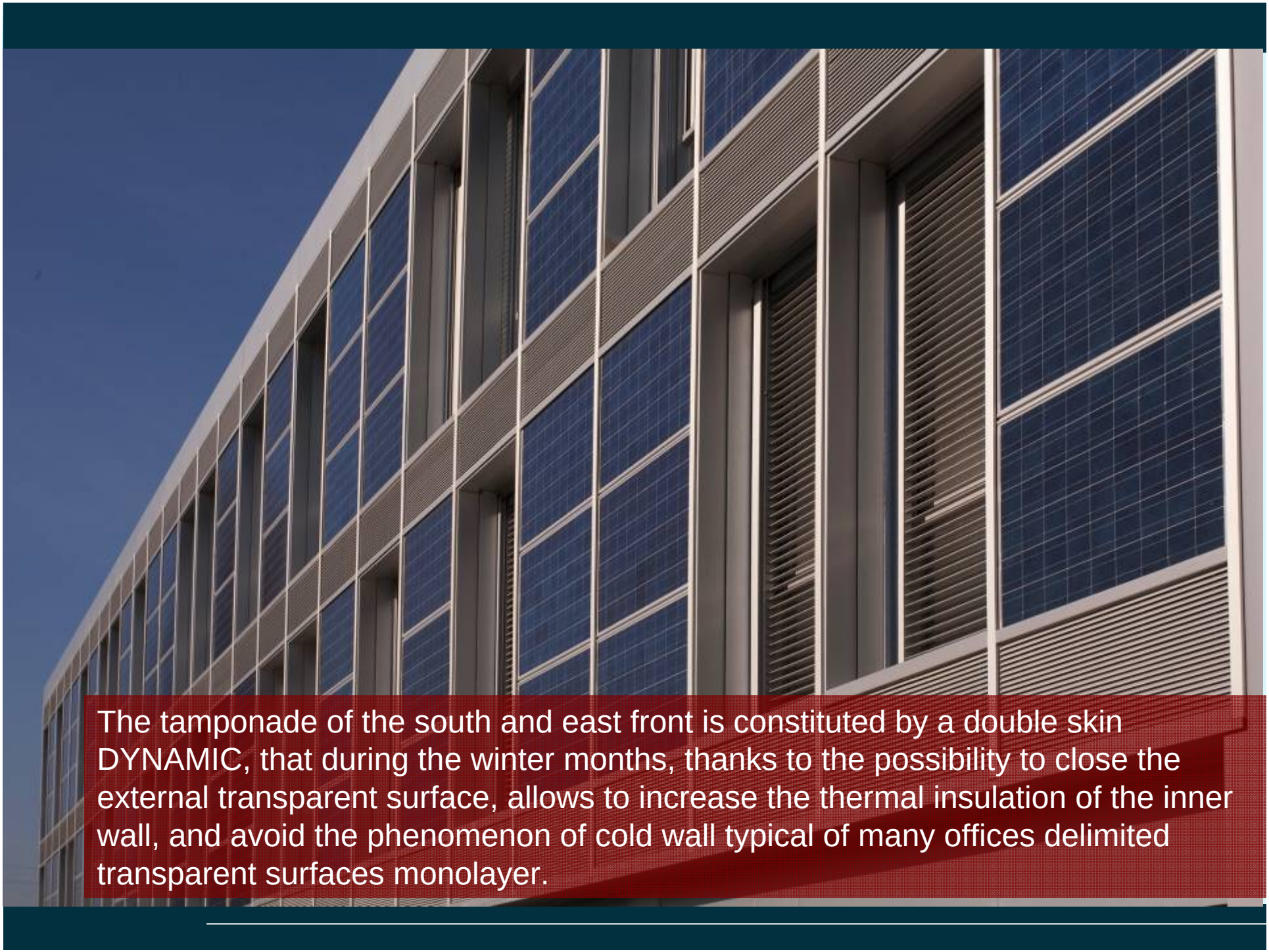
Client: Chamber of commerce
Implementing agency: Province of Lucca
Project: Province of Lucca and Studio Marco Sala Associati – Centro Abita UNIFI

Energy savings strategies

E’ stata prestata grande attenzione alla **PROGETTAZIONE DELL’INVOLUCRO** e degli impianti di climatizzazione, così da garantire, durante tutte le stagioni, corrette condizioni di:

- temperatura,
- umidità e velocità dell’aria.

In particular, all four buildings are characterized by solutions of facade with INSULATION AND WALL FORCED, so as to ensure very high transmittance values .



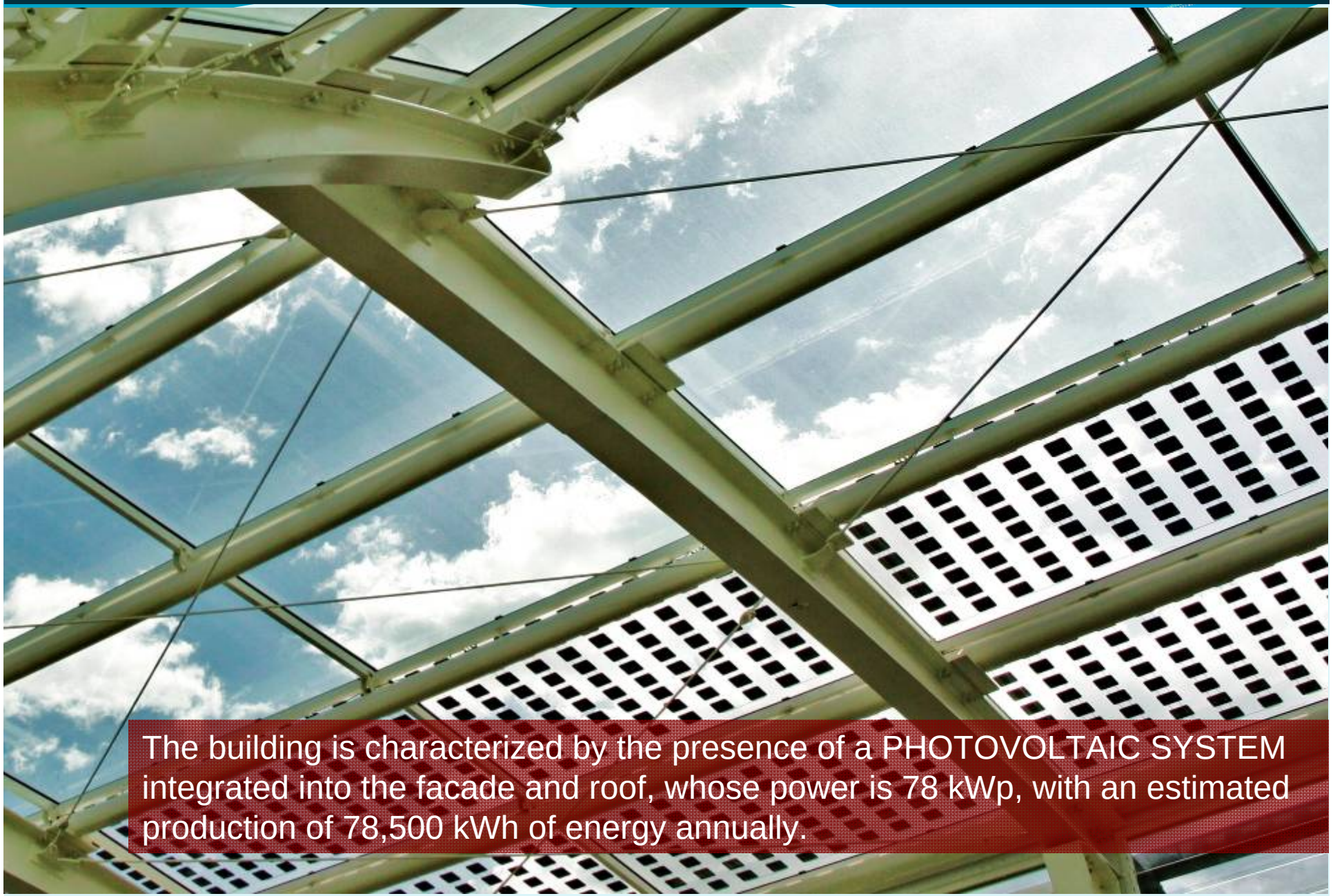
The tamponade of the south and east front is constituted by a double skin DYNAMIC, that during the winter months, thanks to the possibility to close the external transparent surface, allows to increase the thermal insulation of the inner wall, and avoid the phenomenon of cold wall typical of many offices delimited transparent surfaces monolayer.

Photovoltaic facade.

The photovoltaic system in question is composed of 84 modules. In each of the front panel (2.92 x 1.48 m) will be made 3 PV modules placed horizontally.
The photovoltaic facade is classified as an "integrated system", has a power of 15.96 kW and an estimated production of 12 840.59 kWh of energy per year, resulting from 84 modules occupying an area of 120.71 m².

The PV array is divided into six sub-two strings, each string will have a painting of field with an isolating and possible blocking diode.

Data sheet. general data
Classification integrated architectural
Generator
Fixed support structure
Number of surfaces available 28
Total extent available 120.71 m²
Total extension used 120.71 m²
Total area 120.71 m² modules
Module inclination (tilt) 90 °
Orientation of the modules (Azimut) 7 °
Annual solar radiation at the level of modules 1 074,01 kWh / m²
technical Data
Total power 15.96 kW
Total 84 modules
Total number inverter 6
energy performance
Total annual energy 12 840.59 kWh
form
Brand - Model SANYO HIP
inverter
Brand - Model ITALY SMA SB 3300TL


The building is characterized by the presence of a PHOTOVOLTAIC SYSTEM integrated into the facade and roof, whose power is 78 kWp, with an estimated production of 78,500 kWh of energy annually.

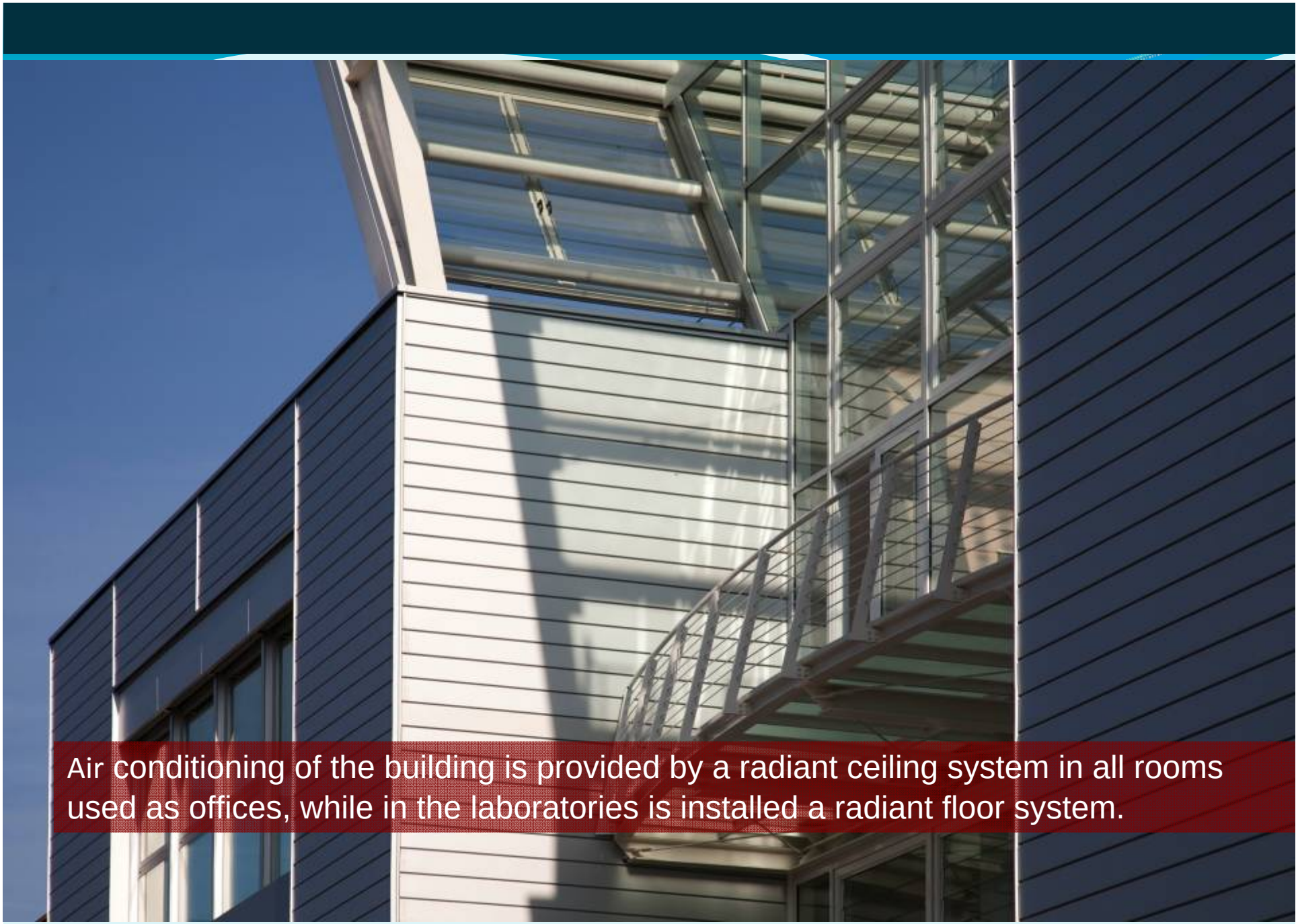
Photovoltaic cover glass (greenhouse).
The photovoltaic cover glass (greenhouse) is an "integrated system", has a power of 5.76 kW and an estimated production of 6615.98 kWh of energy per year, resulting in 24 transparent glass-glass photovoltaic panels (system glass camara), of dimensions 3.020 x 1.620 m, arranged in parallel rows of 12 panels each, occupying an area of 117.5 m².
Each panel has a peak power of 240 W, produced for 96 cells.
The PV array is divided into six subfields as one string, each connected to an inverter.
For the system design were considered two different angles of the panels: 16 ° and 13 °.

Panels at an angle of 16 °.
general data integrated generator
Fixed support structure
Number of surfaces available 1
Total extent available 58.70 m²
Total extension used 58.70 m²
Total area 58.70 m² modules
Module inclination (tilt) 16 °
Orientation of the modules (Azimut) 7 °
Annual solar radiation on the surface of the modules
1 541.21 kWh / m²
technical Data
Total power 2.88 kW
Total number of modules 12
Total number inverter 3
energy performance
3327.69 kWh total annual energy
form
Module module with 96 solar cells with a power of 240 W
inverter
Brand - Model SMA ITALY - SB 1100-IT
Modules strings x 1 x 4

Data sheet of the panels section with an angle of 13 °.
general data
Classification integrated architectural Generator
Fixed support structure
Number of surfaces available 1
Total extent available 58.70 m²
Total extension used 58.70 m²
Total area 58.70 m² modules
Module inclination (tilt) 13 °
Orientation of the modules (Azimut) 7 °
Annual solar radiation at the level of modules 1 522.96 kWh / m²
technical Data
Total power 2.88 kW
Total number of modules 12
Total number inverter 3
energy performance
3 288.29 kWh total annual energy
form
Brand - Model module with 96 solar cells for power
240 W
inverter
Brand - Model SMA ITALY - SB 1100-IT
Modules strings x 1 x 4

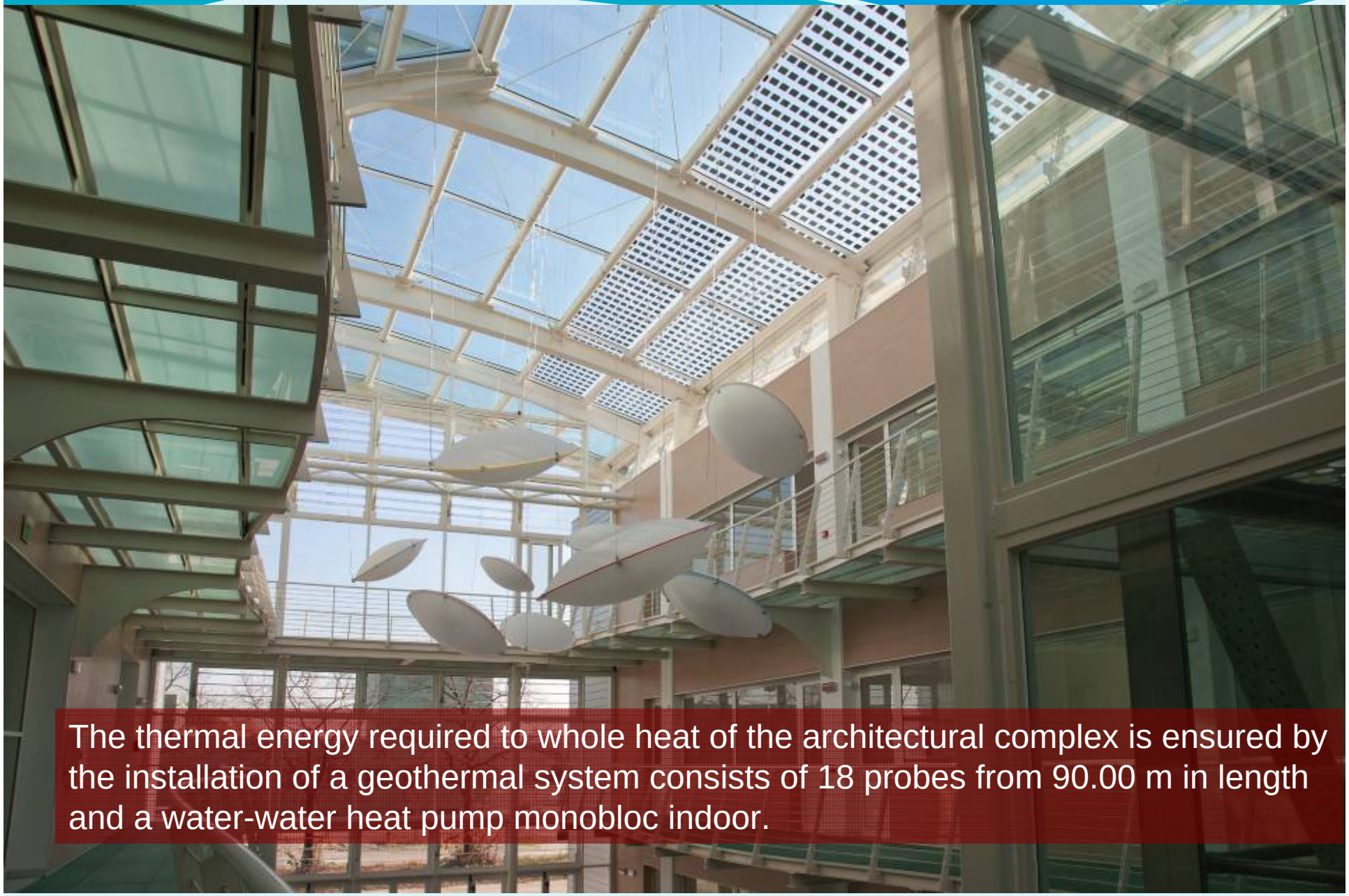

Laminated glass tempered glass-glass (6 +6)

KEY FEATURES OF 3 PV SYSTEM
Three-phase connection in BT, interface protection (IP) only and external converters DC / AC
Generator system G1 South Facade
POWER Wp tot = 15.96 kW
MODULES (make, model, power) SANYO HIP - 190BE11, 190 W
INVERTER (make, model, power) SMA ITALY, SB 3300TL HC, 3000W
Composition subsystem (2 strings x 7 Modules) (x3)
Power subsystem Wp tot = 2.66 kW (x3)
Generator G2 system cover Serra (13 ° - 16 °)
POWER Wp tot = 2.88 kW
MODULES (make, model, power) module with 96 solar cells with a power of 240 W
INVERTER (make, model, power) SMA ITALY, SB 1100-IT, 1000 W
Composition subsystem (1 x 4 Strings Modules) (x3)
Power subsystem Wp tot = 0.96 kW (x3)
Generator G3 plant cover
POWER Wp tot = 5.77 kW
thin Film

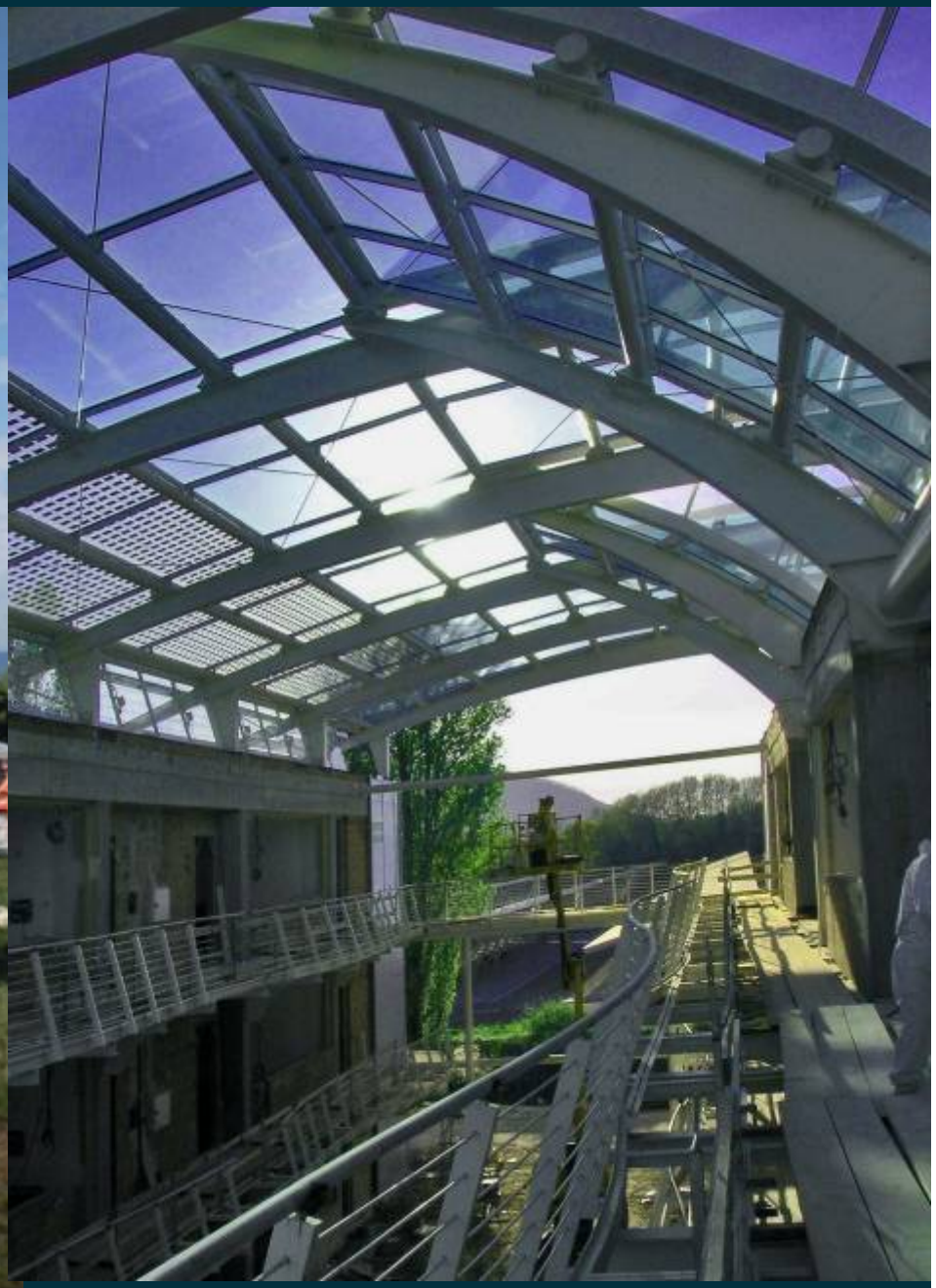


Air conditioning of the building is provided by a radiant ceiling system in all rooms used as offices, while in the laboratories is installed a radiant floor system.

Was created an hydraulic system that uses GROUNDWATER UNTREATED for flushing the toilet building and irrigation of the roof garden and the relevant areas outside. All baths, moreover, are equipped with taps equipped with flow reducers and WC with flushing cistern with jet differentiated.



The thermal energy required to whole heat of the architectural complex is ensured by the installation of a geothermal system consists of 18 probes from 90.00 m in length and a water-water heat pump monobloc indoor.



Library and classrooms building . University of Florence

Impianto fotovoltaico da 20kwp per l'edificio aule e biblioteca al Polo Scientifico di Sesto Fiorentino

Committente:Università degli Studi di Firenze
Energy Manager: Prof. Giorgio Raffellini
Ufficio responsabile: DIVISIONE SERVIZI PATRIMONIALI - UFFICIO PROGRAMMAZIONE E PIANIFICAZIONE EDILIZIA - Dirigente: Arch. Giuseppe Fialà,
Responsabile del procedimento: Arch. Maurizio Salvi, con la collaborazione di Arch. Patrizia Giunti.
Coordinatore alla sicurezza: Geom. Sergio Cozzolino

PROGETTAZIONE:
Architettonica e direzione dei lavori:Arch. Lucia Ceccherini Nelli - Centro ABITA-Firenze
Impianto Elettrico: ETA Florence – Ing. Gianluca Tondi, Ing. Francesco Cariello
Strutture metalliche: Ing. Luigi Campa

MONITORAGGIO:
Arch. Lucia Ceccherini Nelli - Centro ABITA-Firenze
ETA Florence – Ing. Gianluca Tondi, Ing. Lorenzo Corbella

IMPRESA: ATI Gechelin FIMA
Formata da Gechelin Group per l'installazione fotovoltaica e FIMA COSMA SILOS per le strutture metalliche
Lavori ultimati nel mese di Febbraio 2004

FINANZIAMENTI:
Ministero dell'Ambiente "*Programma Tetti Fotovoltaici*", Regione Toscana.
Comunità Europea RICERCA EUROPEA "PV ENLARGEMENT" contratto n: NNE5-2001-736

Coordinamento del progetto europeo:
WIP Munich - Ing.Matthias Grotthe, PV Enlargement project coordinator. http://www.pvenlargement.com/

The project involved the construction of a photovoltaic system integrated power of 20 kWp installed in the courtyard of the building used for classrooms and the library of the Scientific Centre of Sesto Fiorentino by Bernardini 6.

Funded by the Ministry of the Environment program "Roofs PV"
European project "PV Enlargement"

Description of the system

The photovoltaic system has an installed capacity of 20 kWp and is composed of n ° 160 photovoltaic modules glass / Tedlar transparent with a peak power of 125 W average / each, divided into five subsystems of 4000 Wp each.

The photovoltaic system consists of the following elements:

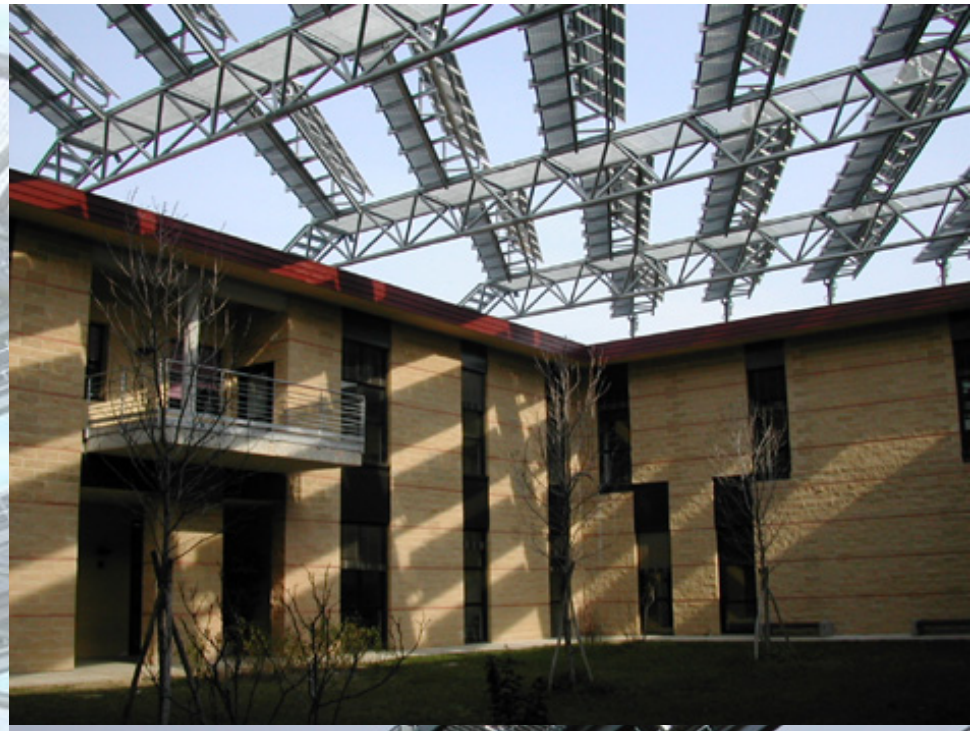
1 Main structure -
4 trusses of about 22 m each positioned on the short side of the courtyard

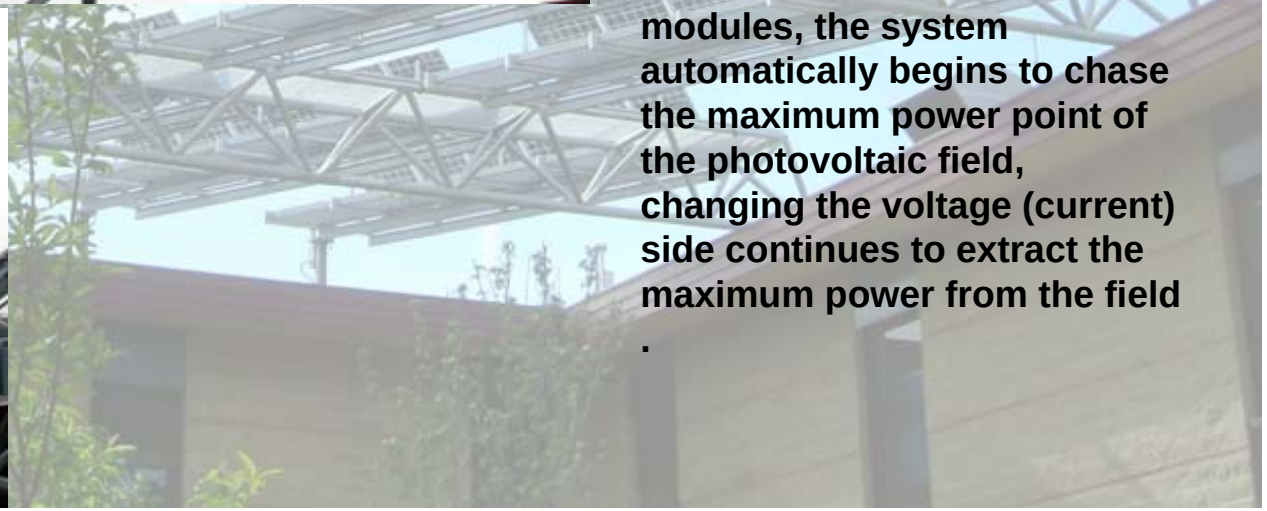
2 Secondary structure -
25 beams produced with 2 IPE beams resting on girders

3 Structure of support modules -
the modules are arranged on the long side in the direction of the support beams. The modules glass / transparent Tedlar are provided with profile frame made of perforated aluminum on the back on both sides. The modules are then anchored (with screw) to omega profiles welded stands consist of three L profiles in galvanized steel.

4 Passerelle -
to ensure the maintenance of the photovoltaic system have been realized in grating type (Orsogril) of footbridges placed: on the main and secondary beams to form a trench in the first case 1 m wide and 60 cm in the second.

5 On trenches were mounted 4 "lines of life" to be used with safety belts to allow maintenance of the system in conditions of safety.





The photovoltaic modules are tilted at 35 ° in the horizontal plane and facing south.

The electrical energy into direct current produced by the photovoltaic modules, converted into electrical energy into alternating current at 220 V, 50Hz is fed into the Enel distribution.

The system has a fully automatic and does not require an aid to regular exercise.
During the early hours of the day, when it reached a minimum threshold of radiation on the surface of the modules, the system automatically begins to chase the maximum power point of the photovoltaic field, changing the voltage (current) side continues to extract the maximum power from the field .

System Features

The system consists of five sub-systems for a total installed capacity of 20 kWp.

Each subsystem (4000 Wp) is connected in series.

The data for each string are:
Rated power Wp-4000
-Open circuit voltage Voc 516.8 V
-Short circuit current Isc 10 A
-Maximum power voltage Vm 414.4 V
-Maximum power current Im 9,6 A
-Panel field with traps and switches the DC and AC.

The choice of the division of the system into subsystems belonging each to a dedicated inverter was made in such a way as to guarantee the operation of the plant even in the presence of a malfunction of one of the subsystems.

Photovoltaic modules

The modules forming the photovoltaic generator are of the type glass / Tedlar transparent polycrystalline silicon, the cells are connected together in series and encapsulated in a sandwich glass with high transmittance front, EVA encapsulant and Tedlar rear, with the following main features:

- **Minimum power (guaranteed): 125 Wp**
- **Dimensions: 1237 x 822 x 38 mm**
- **Voltage Voc: 25.7 V**
- **Short circuit current Isc: 5A**
- **Voltage at max power Vm 32 V**
- **Current at max power Im: 5.64 A**
- **Weight: 12.5 kg**
- **Frame: anodized aluminum**
- **Temperature B = - 118 mV / ° C**
- **Power 1000W / m²: 25 ° C, AM 1.5**
- **Maximum 600V DC**

strings

Each string is composed of 16 modules connected in series with the following characteristics:

Number of modules 16
String power 2.000 Wp
Open circuit voltage 516.8 V
Short circuit current 5 A
Maximum power 414.4 V
Maximum current 4.8 A

The interface section of strings, each of the delivery is made by the blocking diode.

Connections string

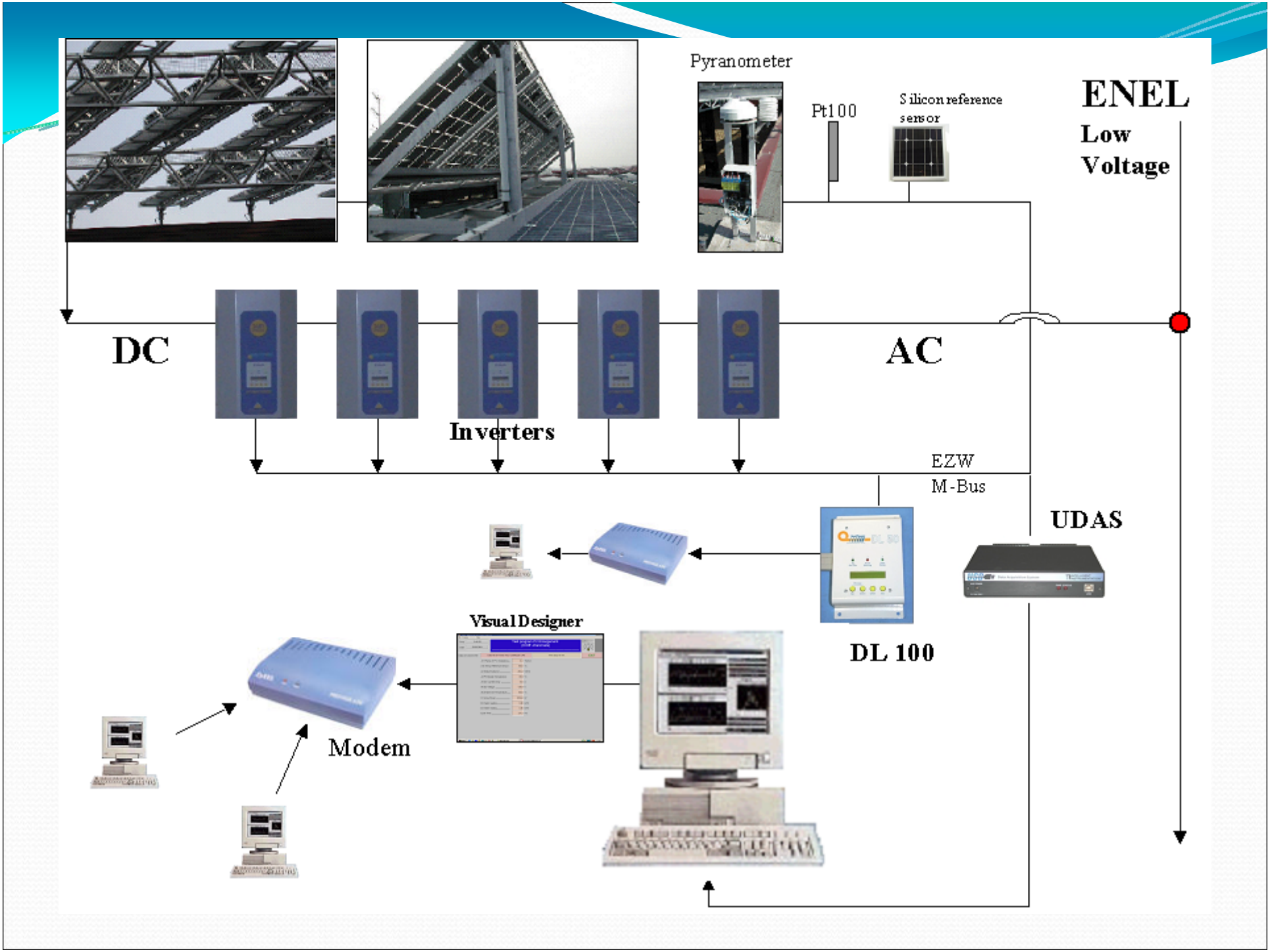
Were made 5 connections string to put the strings in parallel in groups of 2.
Power 4.000 Wp
Open circuit voltage (V) 516.8 V
Open circuit voltage 9.6 A
Maximum power 414.4 V
Maximum current 10 A

Conversion assembly and delivery of the electrical energy

This group consists of five inverters each devoted to a subsystem, complete with junction box, for the conversion of energy into direct current produced by the solar generator in energy into alternating current for the grid.
it is 5 inverters produced by the company Sun Power Solartechnik GmbH, SP 3100-600, 3.3 kW single-phase inverter DC side (ie 4.2 kWp photovoltaic side).
The conversion system, control, processing and delivery of the energy produced is made from 5 single-phase inverter connected to the PV generator by means of the section of arrival and to the mains BT ca through the delivery section.

System Control and Monitoring
For diagnostics and real-time monitoring of the PV system the Scientific Pole university Sesto Fiorentino was installed a sophisticated monitoring system: the system will be fully operational in late summer 2004 and the estimated costs for the construction will be largely offset from increased efficiency in power generation and a more uniform overall performance of the PV system.

The objectives of monitoring are summarized in the following points:
· Ensure that the overall system is working properly
· Evaluate the performance of the various components
· Identify the defective equipment or components that work below their nominal capacities
· Allow the calibration of the PV system for greater production efficiency
· Suggest guidelines for possible improvements and optimizations
· The experience obtained during the monitoring activities will be an important wealth of experience to the construction of photovoltaic plants of the same size.


Pyranometer
Pt100
Silicon reference sensor
ENEL
Low Voltage
DC
AC
Inverters
EZW
M-Bus
UDAS
DL 100
Visual Designer
Modem

Physics laboratory building in Sesto Fiorentino University of Florence

The Pv integrated system is a 50 kWp divided in two systems, one in the façade and the second in the roof as shading devices.
The 3 subsystems are realised by 60, 54 e 74 photovoltaic modules divided in variable strings from 9 to 12 modules.
The total panel numbers is
1 Subsystem: 54 modules 290Wp - 15,66 kWp
2 Subsystem: 60 modules 290Wp - 17,40 kWp
3 Subsystem: 74 modules 225Wp - 16,65 kWp
Total peack power: 49,71 kWp, for a total production: 51.766 kWh
The PV modules area
The photovoltaic modules used are of the type with high peak power composed of 60 multicrystalline solar cells 156x156 mm.
The integration of the photovoltaic shading devices in the facade can improve the thermal comfort conditions in summer, the facade

The total installed peak power is equal to 49.71 kWp.

The photovoltaic modules are placed in the field with the following values of the tilt and azimuth: Subfields 1/2/3: 30.0 ° TILT - Azimut 32 °.

subfield 1 54 modules of 290Wp - 15.66 kWp
subfield 2 60 modules of 290Wp - 17.40 kWp
subfield 3 74 modules of 225Wp - 16.65 kWp




The project was funded under the Notice of the Ministry of Environment and Protection of the Sea Call "measure3"
Properties: University of Florence
Project integration of photovoltaics: Arch lucia Ceccherini Nelli - Interuniversity Centre
Realization: Company FEDI SYSTEMS Srl - Checks System - Studio Fredducci
Project manager: Studio tables S.r.l. Society of Environmental Engineering

University residential student building in Florence. University of Florence 20kWp

The system is integrated into the roof of the building of the university residences in Mezzetta Street in Florence.
The plant type is grid-connected and the connection mode is "in-phase low voltage." The power plant is equal to 19.92 kWp, and the estimated production of 21 320 kWh of energy per year (minimum value to ensure), derives from 94 amorphous silicon modules occupying an area of approximately 220 m2 and 34 silicon modules monocrystalline occupying an area of 44 m2 approx., power, respectively: - 12.784 kWp - 7.14 kWp.

Modules in amorphous Si thin film

The photovoltaic panels are made from a sheet of aluminum 10/10, high corrosion resistance, having dimensions of 5700 mm x 467 mm, which supports the laminates described above by gluing, to be mounted parallel to the slabs of the building roof.

IMonocrystalline modules

At the bottom in the roof is arranged a row of photovoltaic modules in hybrid technology (monocrystalline silicon surrounded by ultra-thin amorphous silicon film) parallel to the roof covering.

The modules are placed side by side with each other and fixed to the cover by means of special aluminum profiles and in adherence of the roof covering existing exploiting the existing inclination (about 35 ° above the horizon).

This plant (consisting of No. 34 modules) of the rated power of 7.14 kWp, will complement the other plant resulting in a system "mixed" 19.92 kWp total.

Generator (G1 + G2)
description
The generator has a power of 19.92 kWp and an estimated production of 21,320 kWh of energy per year (value minimum guarantee), resulting from 128 modules occupying an area of 264 m².

Classification integrated architectural Generator
Fixed support structure
Number of surfaces available 1
Total extent available 427 m²
Total extension used 427 m²
Total surface area 264 m² modules
Module inclination (tilt) 15 ° (average value)
Orientation of the modules (Azimut) 24 °
Annual solar radiation at the level of modules 1 591.70 kWh / r
technical Data
19.92 kWp total power
Total number of modules 128
Total energy inverter 4Prestazioni
Energy total annual 21,320 kWh (minimum value guarantee) Form

Generator 1 (G1)
Peak power 136 Wp
Voc 46.2 V
Vmp 33 V
Isc 5.1 A
Imp 4.1 A
Inverter No. 1.2 (Power One PVI 6000 OUTD-IT)
Number two inverters installed
Max Power Inverter 6000W
Strings x Modules (Inverter 1) 3x8 + 3x8 (MPPT in parallel)
Strings x Modules (Inverter 2) 3x8 + 2x11 (MMPT independent)
Form Generator 2 (G2)
Peak power 210 Wp
Voc 50.9 V
Vmp 41.3 V
Isc 5.57 A
Imp 5.09 A
Inverter No. 3.4 (Power One PVI 3600 OUTD-IT)
Number two inverters installed
Max Power Inverter 6000W
Strings x Modules (Inverter 1) 1x8 + 1x9 (independent MPPT)
Strings x Modules (Inverter 2) 1x8 + 1x9 (MMPT independent)

Electrical checks cables
Analysis of DC cables upstream of the inverter (string of 8 panels)
Insulation type EPR - SOLAR CABLE 359.00 Vm V
Number ducts loaded 2 Im A 5.17
Number of circuits grouped 1 Voltage dips 1.38%
Ambient temperature 80 ° C
Length 28.8 m
4 mm2





The project was funded under the Ministry of Environment and Protection of the Sea Call "measure3"
Properties: University of Florence
Project integration of photovoltaics: Arch Lucia Ceccherini Nelli - ABITA Interuniversity Centre
Realization: Company SAEET S.p.A.
Project manager: Studio tables S.r.l. Society of Environmental Engineering