

Edifício Solar XXI

CEEETA

Rua Dr. António Cândido, 10 – 4.º, 1050-076 Lisboa, Portugal



1. General data

Year of construction	2004-2005
Type of construction	New building
Type of construction	Heavy, concrete structure and brick walls
Use of building	Office building
Building owner	INETI - National Institute for or Engineering, Technology and Innovation
Building leaser/tenants	INETI
Architect	Pedro Cabrito & Isabel Diniz (Project coordination: Hélder Gonçalves)
HVAC designer	Marcos Nogueira
Location/address	Estrada do Paço do Lumiar 22, Lisboa
Geographical location	38°460' North, 9°10' West
Situated (city or country side)	City
Heating/cooling degree days	1190 HDD (base 20 °C) CDD n.a. (design outdoor temperature: 32 °C)
Main technology for cooling	Underground earth ventilation, Ventilated façade, Natural Ventilation, Building mass activation.
Heated/cooled building area	1500 m ²



2. Description of the project

The building is located inside the INETI campus in Lisbon and it is the new office premises for the Renewable Energy Department of INETI. “Edifício Solar XXI” shall operate comfortably as an office building, while being a demonstration project for building solar passive and active technologies.

2.1. Architectural concept

The name given to the building, “Edifício Solar XXI”, (Solar building XXI), already defined the main concept beyond its project: large utilization of solar energy by using solar passive and active technologies (thermal and photovoltaic). Other important aspects of the architectural concept are:

- Building integration between office functionality and low energy, specially for space heating and cooling;
- Achieve good architectural building integration of solar active technologies, namely solar thermal and solar photovoltaics (BiPV) systems.

This last aspect is relevant, because there is a common accepted idea that building with solar systems are aesthetically poor. The building has about 1500 m² split by three floors, one of them lying underground in the South façade, with office rooms, meeting rooms and laboratories.



South façade



West and North façades

2.2. Energy concept

The project was developed and coordinated by a high expertise team from INETI (Dept. for Renewable Energies), that could put in practice an integrated methodology for achieving a very high energy efficient building. The energy concept was based in three steps:

1. Reducing external loads
2. Utilization of heating and cooling solar passive technologies
3. Utilization of solar active technologies

To put in practice this concept, the main strategies were:

- Optimisation of building envelope
- Main façade facing South with “direct gain” system, to reduce heating energy needs
- Earth passive cooling system
- Natural ventilated façade, by using the photovoltaic panels
- Natural ventilation and lighting
- Building Integrated Photovoltaic in South façade (12 kWp system)
- Solar thermal system complemented with a natural gas boiler for remaining heating energy needs

The main features regarding building envelope optimisation are the following:

- Internal space distribution according to solar direct gains during the day: permanent occupied room located in South part of the building while labs and meeting rooms (intermittent occupation) are located in North façade;
- In the central part of the building, there is a skylight that harnesses natural lighting for the three floors, as there are transparent elements between central corridor and adjacent rooms;
- Possible heat transfer by natural convection between South and North spaces due to the installation of openings in the internal doors;

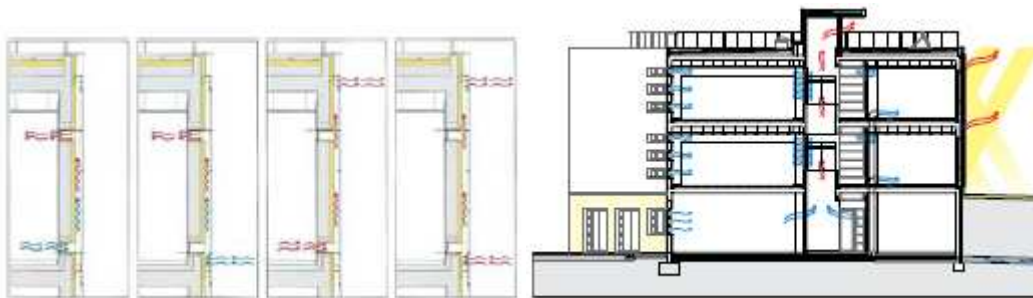
- External cavity brick walls with an U-value of 0,5 W/ m²K (6 cm of expanded polystyrene externally applied);
- Horizontal roof with an U-value of 0,3 W/ m²K made of massive slab and 10 cm of thermal insulation externally applied (5 cm of expanded polystyrene + 5 cm of extruded polystyrene);
- Floor slab is also thermal insulated (10 cm of expanded polystyrene);
- Double glazing with external movable Venetian blinds (solar factor of 0,04);
- Externally applied thermal insulation reduces or avoids thermal bridges and allows the thermal use of the building mass.

The solar photovoltaic system is expected to produce annually 12 MWh of electric energy, which means about 50% of the total expected electricity consumption of the building.

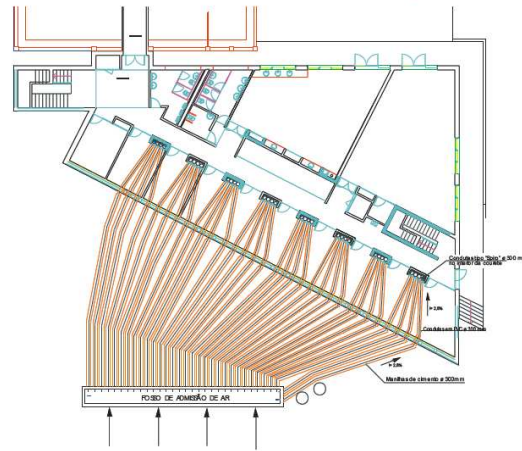
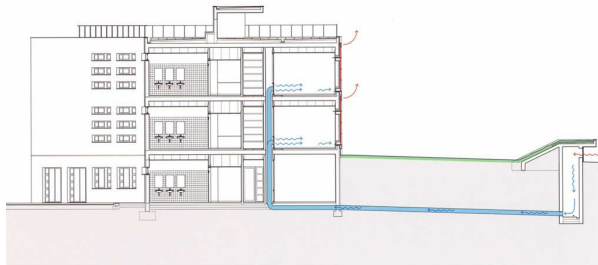
2.3. Passive cooling

Passive cooling strategies in the “Edifício Solar XXI” building are crucial, because they avoided the need to install a mechanical cooling system. These strategies are bare described as follows:

- **Sun protection:** external Venetian blinds, regulated manually (individual adaptation) ;
- **Natural ventilation:** two main techniques were applied:
 - o Ventilated façade: using the heat generated in the rear part of the photovoltaic panels, operating together with two openings in each room (at low and high height) to create a free convection air movement in the South façade;
 - o Stack effect: there are openings in the skylight and in the other parts of the building façade, to allow the night cooling ventilation;



- **Earth cooling tubes:** consists of 32 concrete buried pipes, 4,6 m underground, with 30 cm of diameter each, having a buried plenum 15 m away of the south façade of the building. The pipes take the outside air, cool it down, and conduct it into the building by a vertical distribution system (open “fresh air” system). In each room, there is an entrance for two pipes, that can be manually regulated, and a small fan for increasing the incoming air flow rate. This system can “explore” the temperature difference between outside air (in summer it can reach 30-35 °C) and soil (14-18 °C).



- **Insulation and thermal mass:** allow the control and regulation of heat transfer through the building envelope. Heat gains through opaque façades and roof during the daily period are i) reduced, ii) stored in the mass of the building and iii) released during the night to indoor spaces that can be sufficiently cooled down by natural ventilation.
- **Individual adaptation:** users are allowed to change their clothes, to open or close windows and doors, to regulate the position of the Venetian blind and to regulate the air flow rate coming into their room from the earth tubes.

2.4. Active cooling

There are no active cooling systems installed in the building.



2.5. Justification of why this is a best practice project

This project shows that it is possible for a building office located in Lisbon (Mediterranean climate) to meet the summer comfort needs without active cooling systems. Technologies used for passive cooling addresses the main techniques available: sun protection, thermal mass, individual adaptation, earth cooling, ventilated façade and natural ventilation. It is also shows a remarkable integration of sustainable technologies like solar passive heating, passive cooling and active solar thermal and solar photovoltaic systems.

3. Description of the implementation process

When the decision to erect a new office building that could demonstrate the integration of energy-efficient and renewable energies technologies, INETI decided to create a team that could coordinate and execute the research needed to its implementation. The team was coordinated by Helder Gonçalves and composed by some staff of the Dept. of Renewable Energy. The various designer teams were chosen by interviews and direct contacts. The project was co-funded by the national PRIME programme.

4. Results

There is only preliminary results for the photovoltaic system that shows it is performing according to the initial estimative.

4.1. Achieved comfort level

Being a new building, there is no data available yet.

4.2. Costs

Total costs were about 1,3 million Euros, which represents a costs/floor area ratio around the same as for the newly constructed buildings with a conventional cooling and heating system.