ΥΠΟΥΡΓΕΙΟ ΠΕΡΙΒΑΛΛΟΝΤΟΣ ΕΝΕΡΓΕΙΑΣ & ΚΛΙΜΑΤΙΚΗΣ ΑΛΛΑΓΗΣ

ΚΑΠΕ CRES | CENTRE FOR RENEWABLE ENERGY SOURCES AND SAVING

Examples of ICT solutions to improve the energy performance of buildings in Greece

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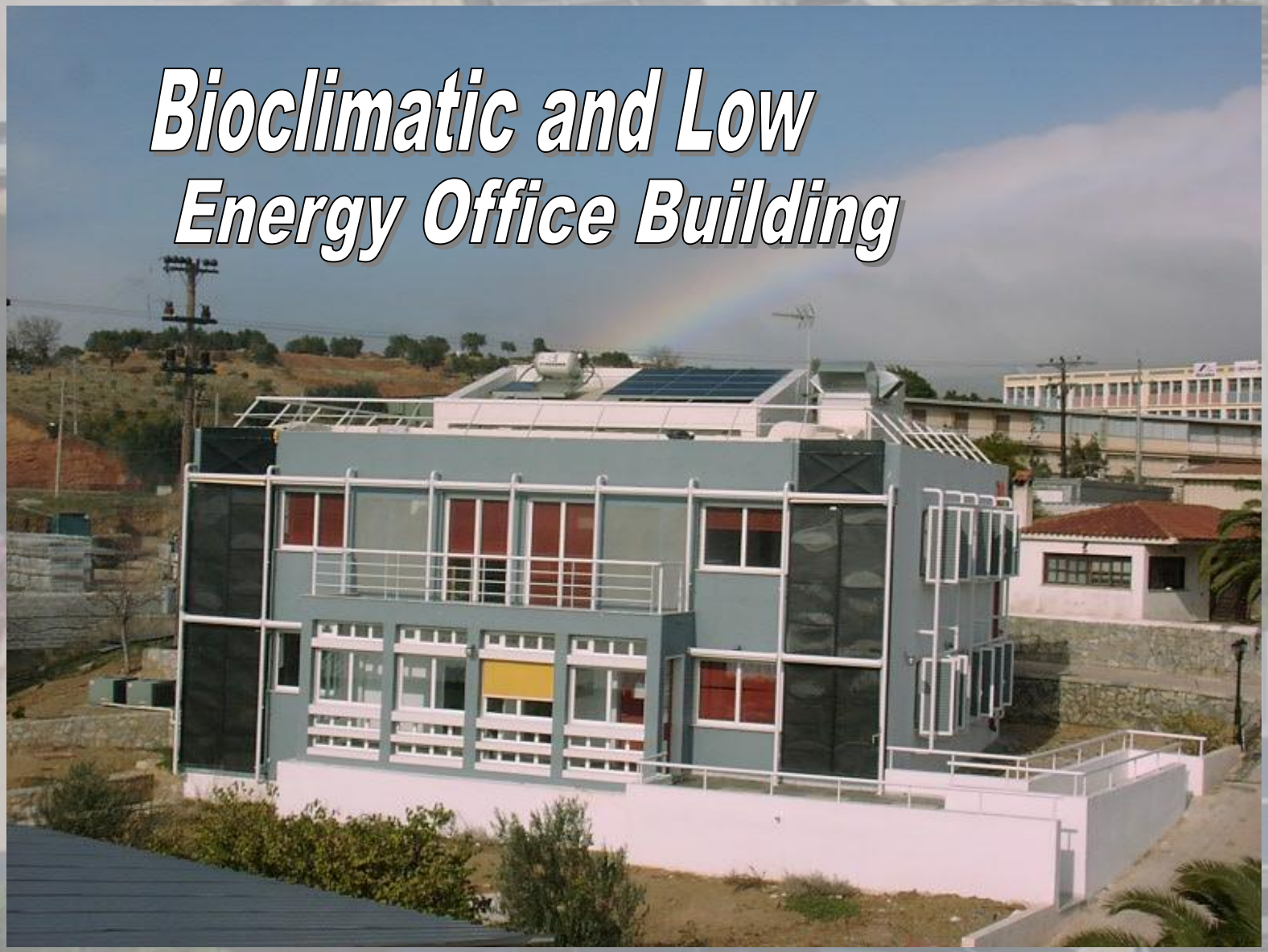
Architectural Engineer MSc

Department of Buildings

Energy Efficiency Division

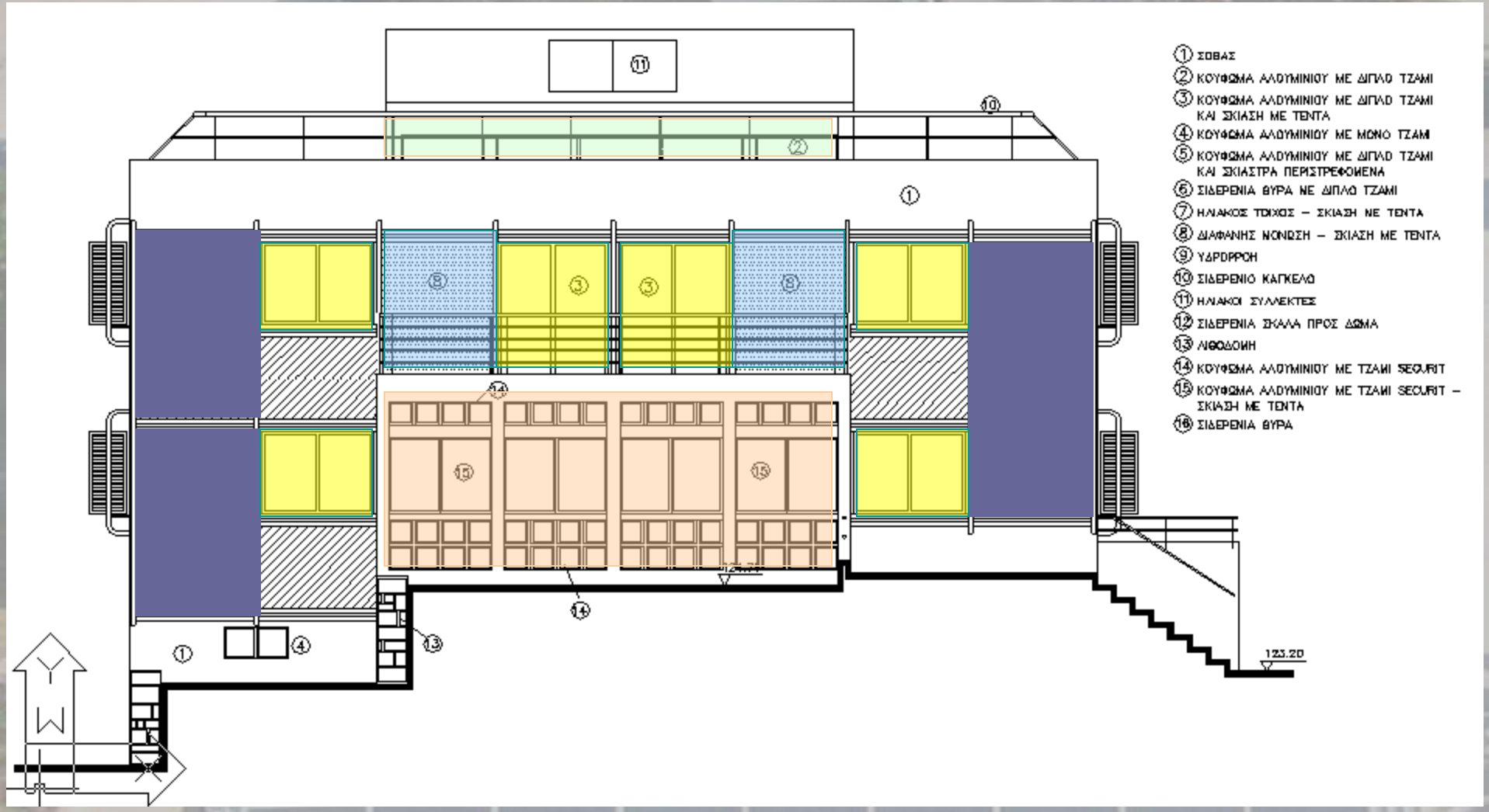
Covenant of Mayors Contact Person

Application of a Building Energy Management System (2001)



The building: CRES building in Pikermi, Attica

South view of the building – passive solar systems



Solar Air Walls with a total area of 17m2

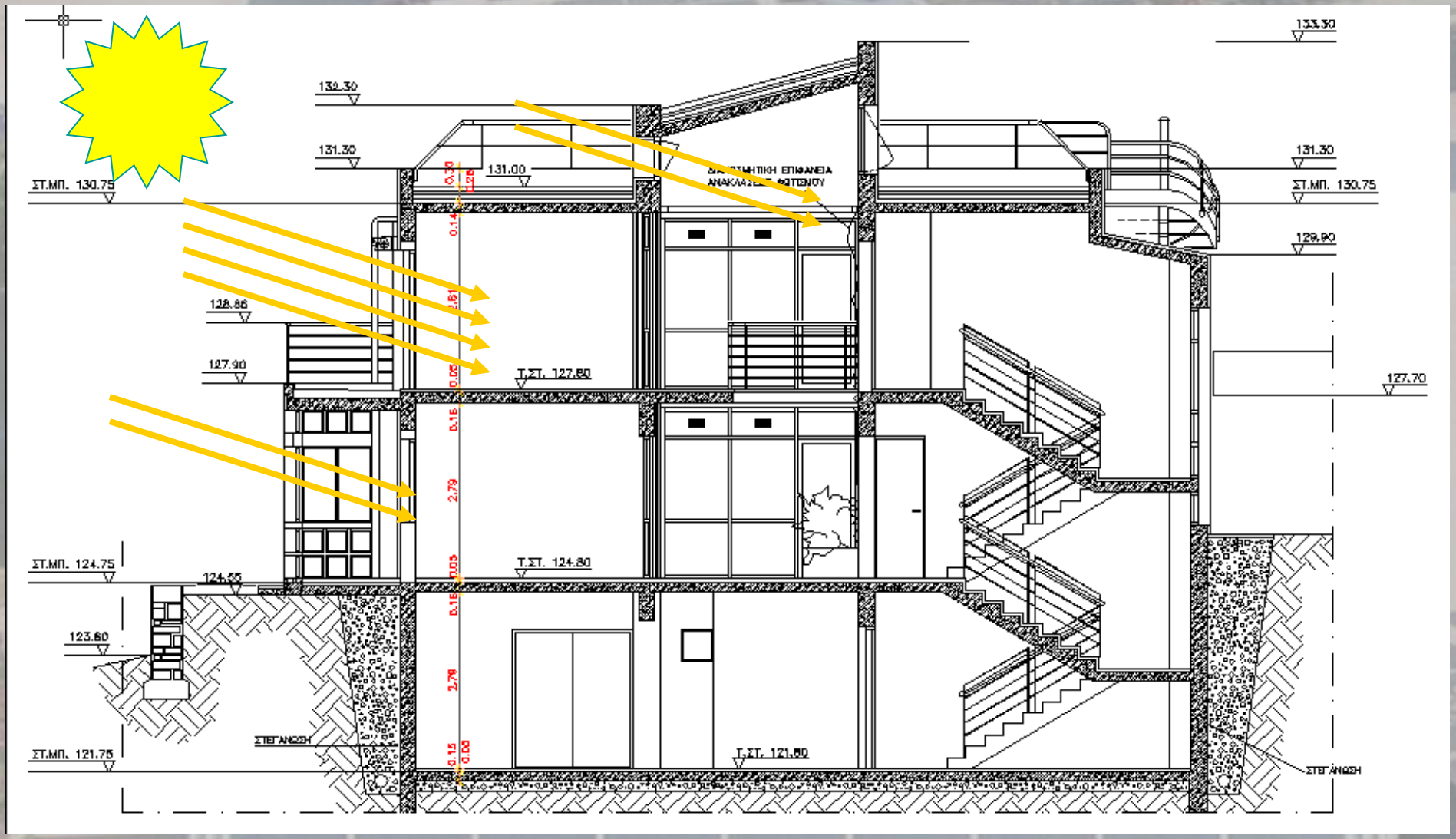
Solar Atrium (glazed part of the roof of the building with an area of 14 m2)

Transparent insulation with a total area of 8m2

Greenhouse with an area of 8.25m2 added to the south face of the building, with openings of 12m2

Direct gain systems (openings with a total area of 17 m2)

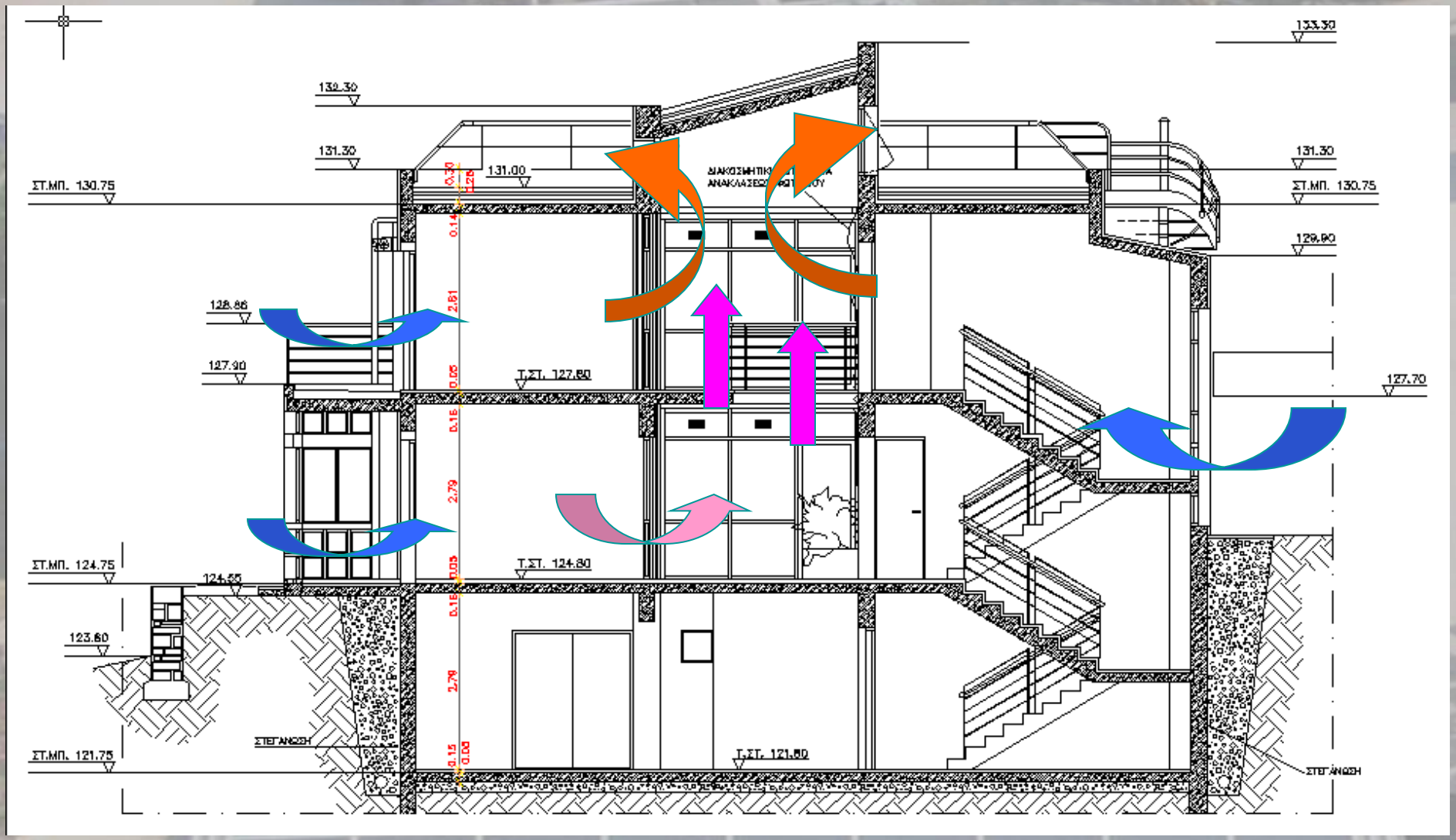
2001/ 5/16



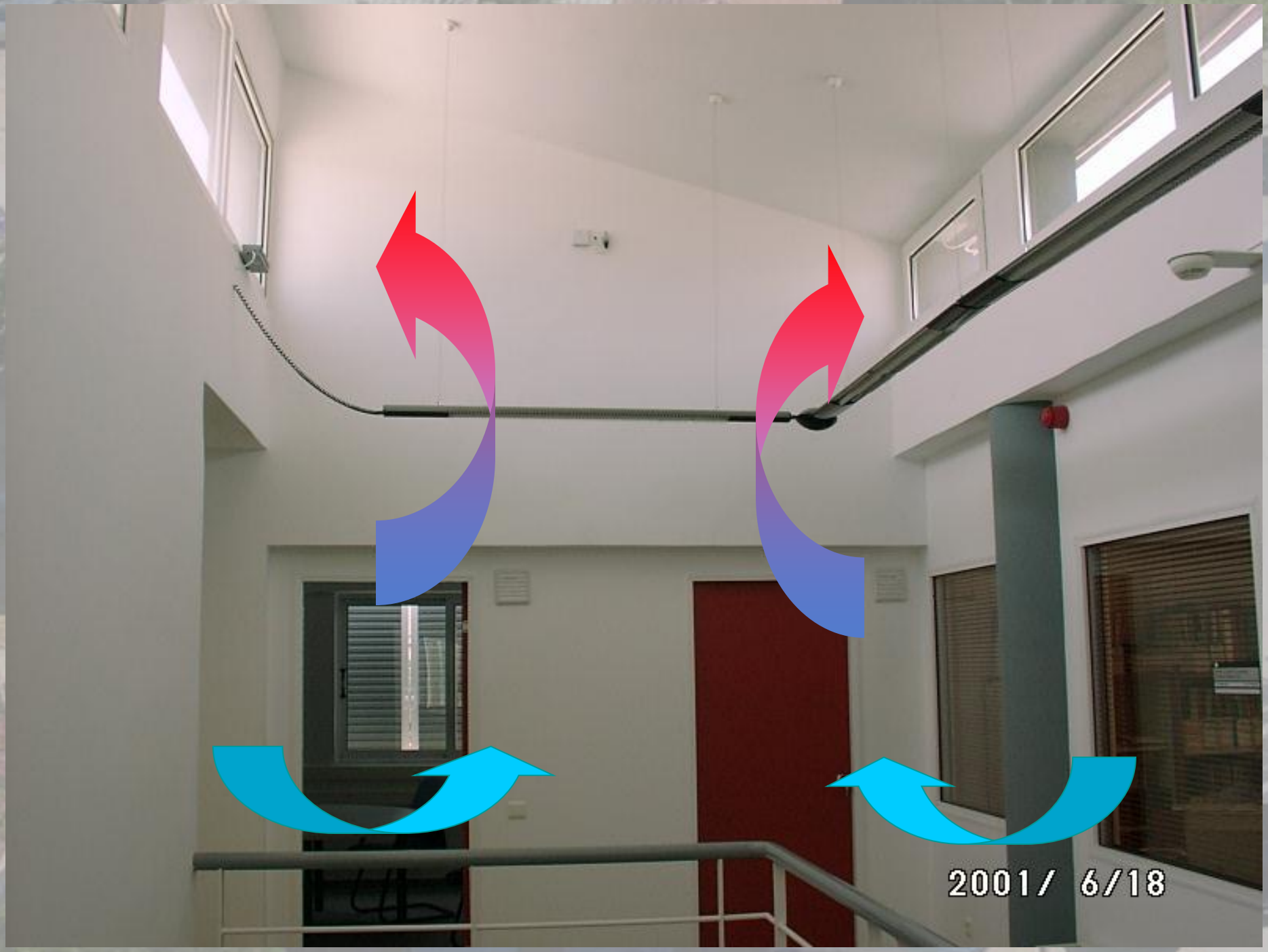
Daylighting techniques

Sun protection system on the south facade

Sun protection system on the east & west facades



The solar atrium is used as a passive cooling system


2001/ 6/18

Geothermal water to water heat pump

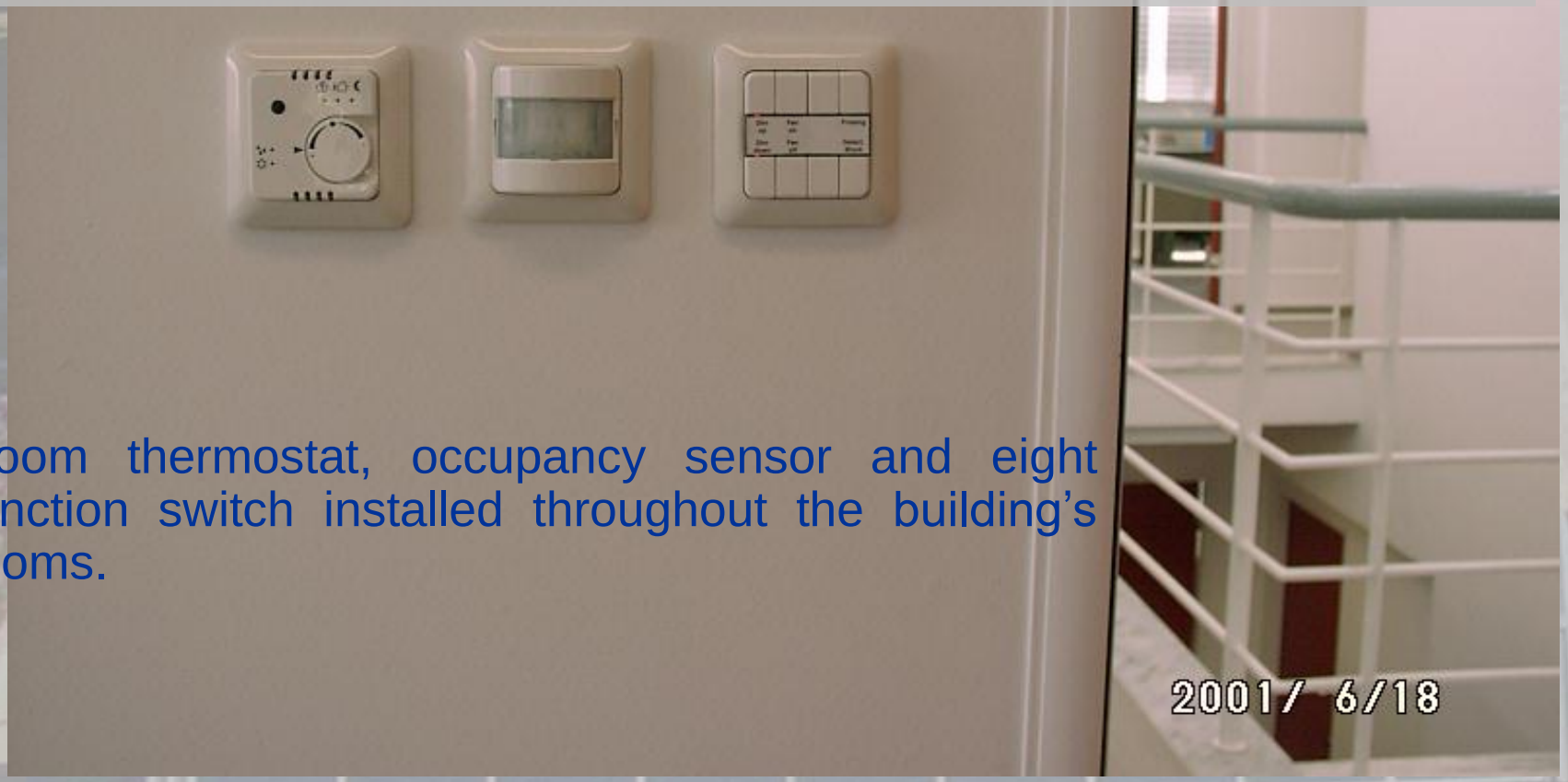
Solar assisted water-air heat pump

Scope of BEMS installation

- monitoring and automatic control of electrical and mechanical installations
  - immediate access
  - uninterrupted operation,
  - settings adjustment
  - data analysis
- of all the building and system functions from a single control station
- monitoring and recording the performance of the renewable energy systems installed in the building
- keeping an archive of statistical data.

The central control unit and the 1st floor control board.

The system is based on the EIB (European Installation Bus) communication protocol.
The system is composed of independent structural elements which have been selected and connected to each other so as to allow control and monitoring of the building from a central point by computer.



Room thermostat, occupancy sensor and eight function switch installed throughout the building's rooms.

Σύστημα κλιμ_θέρμ - Elvis

File View Help

>Πρώτη σελίδα

ΕΓΚ. ΠΑΡΑΓΩΓΗΣ ΨΥΧΡΟΥ - ΘΕΡΜΟΥ ΝΕΡΟΥ ΟΡΟΦΟΥ

41,36 C

41,12 C

ΑΠΟΥΠΡΟΣ FCU ΟΡΟΦΟΥ

ΕΓΚ. ΠΑΡΑΓΩΓΗΣ ΨΥΧΡΟΥ - ΘΕΡΜΟΥ ΝΕΡΟΥ ΙΣΟΓΕΙΟΥ

42,64 C

15,36 C

15,2 C

44,64 C

ΑΠΟΥΠΡΟΣ FCU ΙΣΟΓΕΙΟΥ

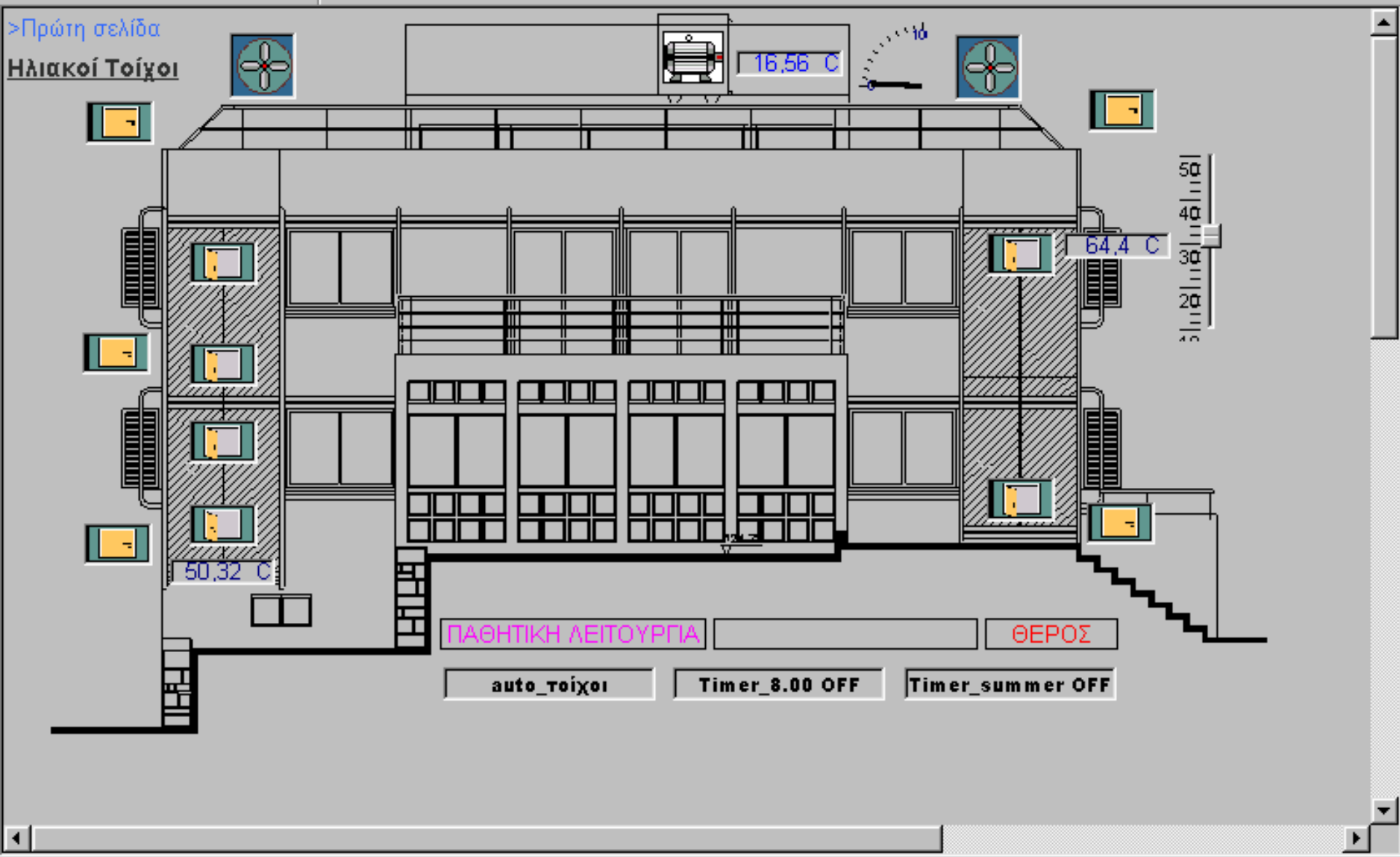
winterON summerOFF

Ready kape administrator CAP NUM

Έναρξη kape Σύστημα κλιμ_... Log Microsoft Photo Editor En 10:40 μμ

Ηλιακοί τοίχοι - Elvis

File View Help



Ready | kape | Administrator | NUM

Έναρξη | Εξερεύνηση ... | kape | Ηλιακοί το... | H01g7 - Elvis... | Imaging | En | 2:27 μμ

Όροφος κλιμ_θέρμ_αερισμ - Elvis

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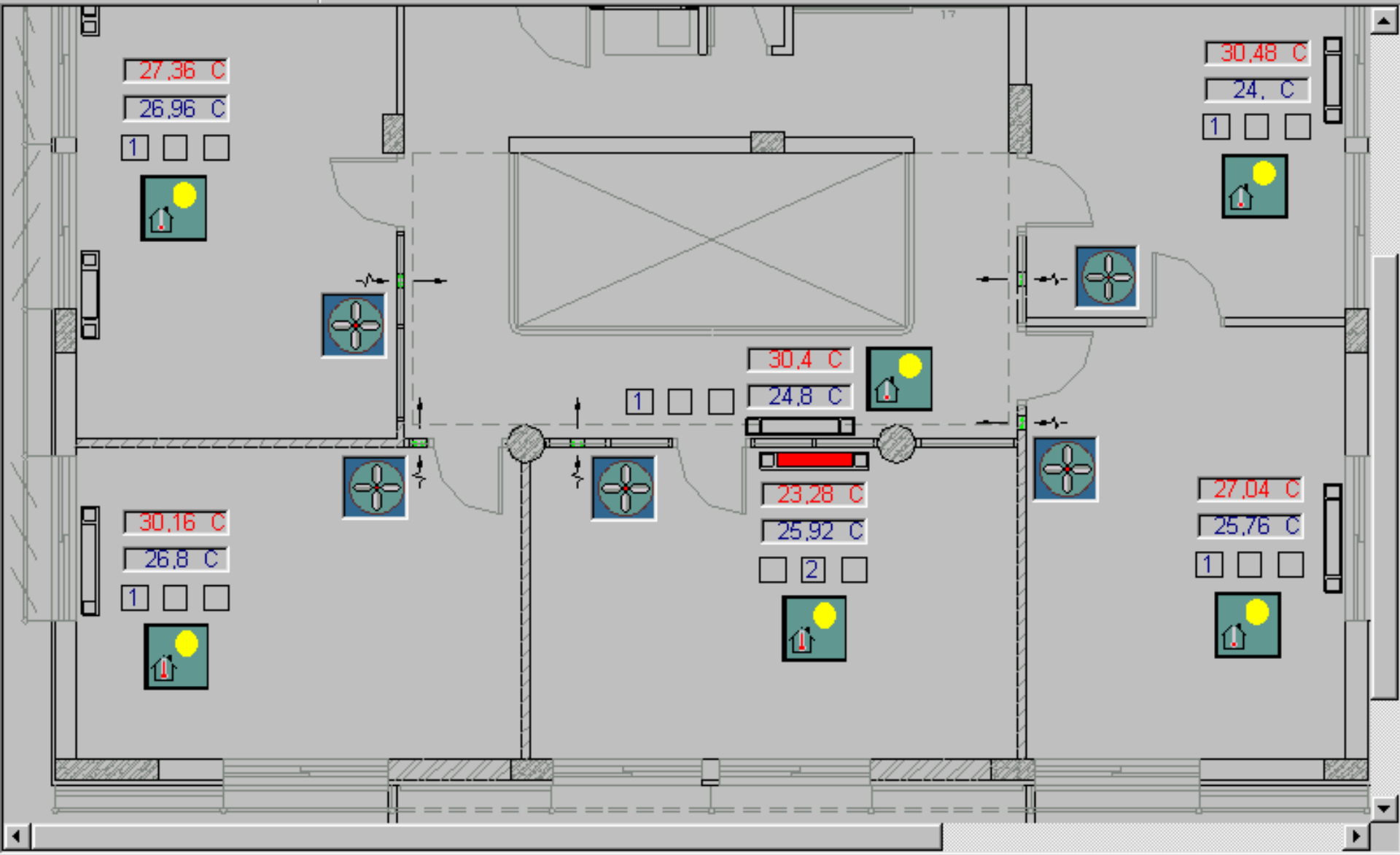
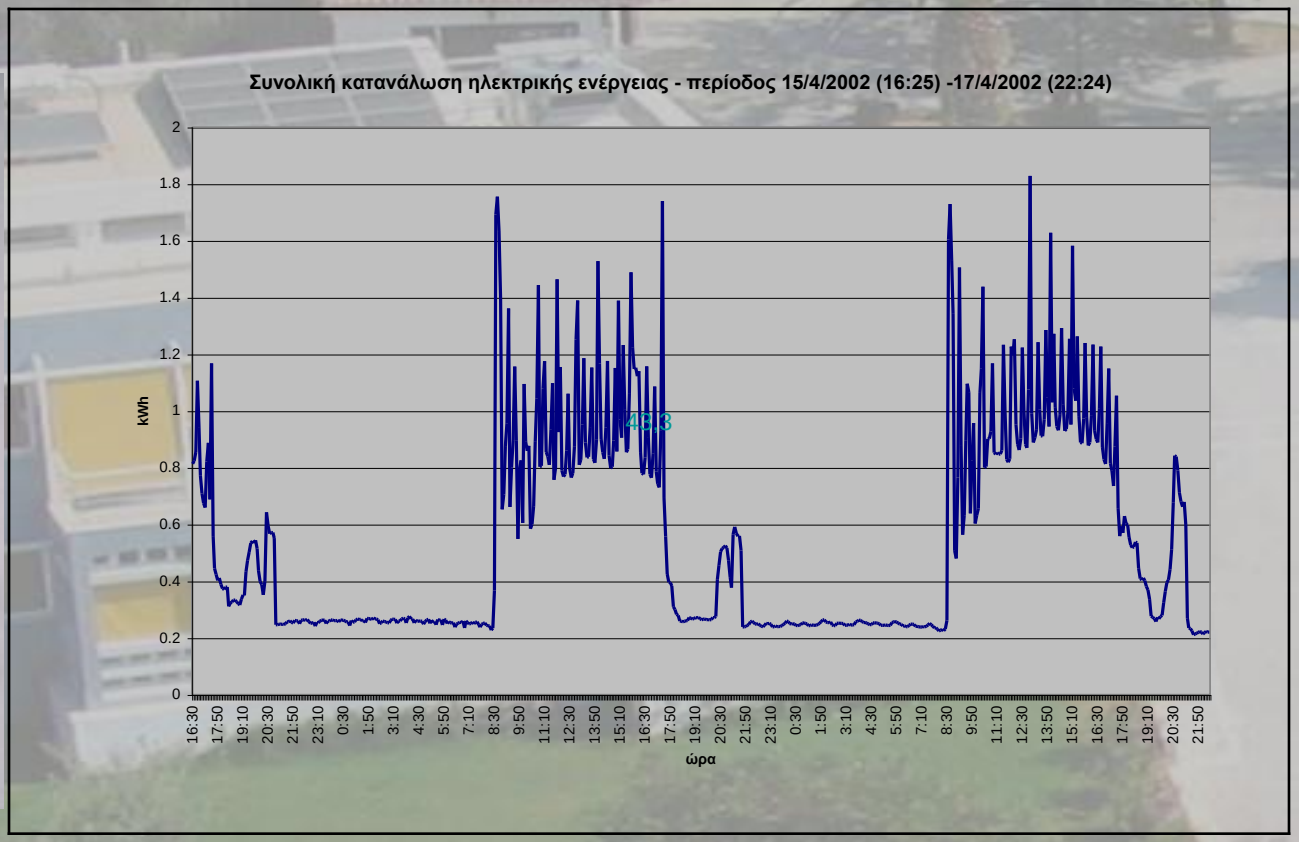


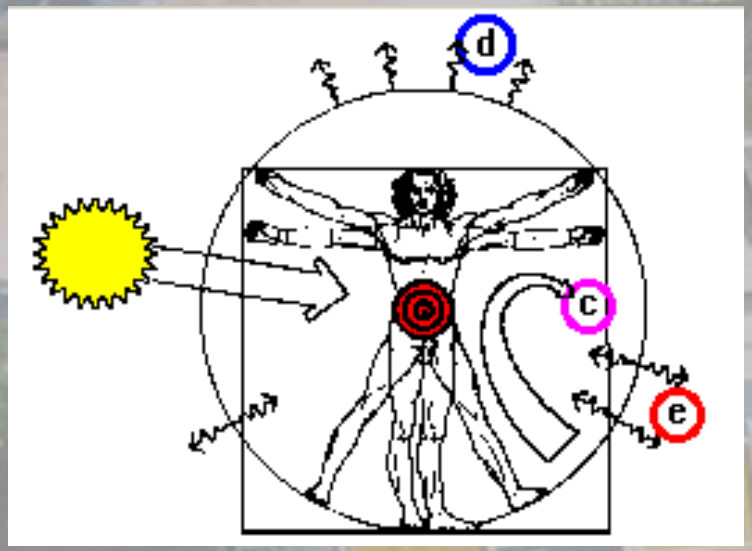
Ready | kape | Administrator | NUM

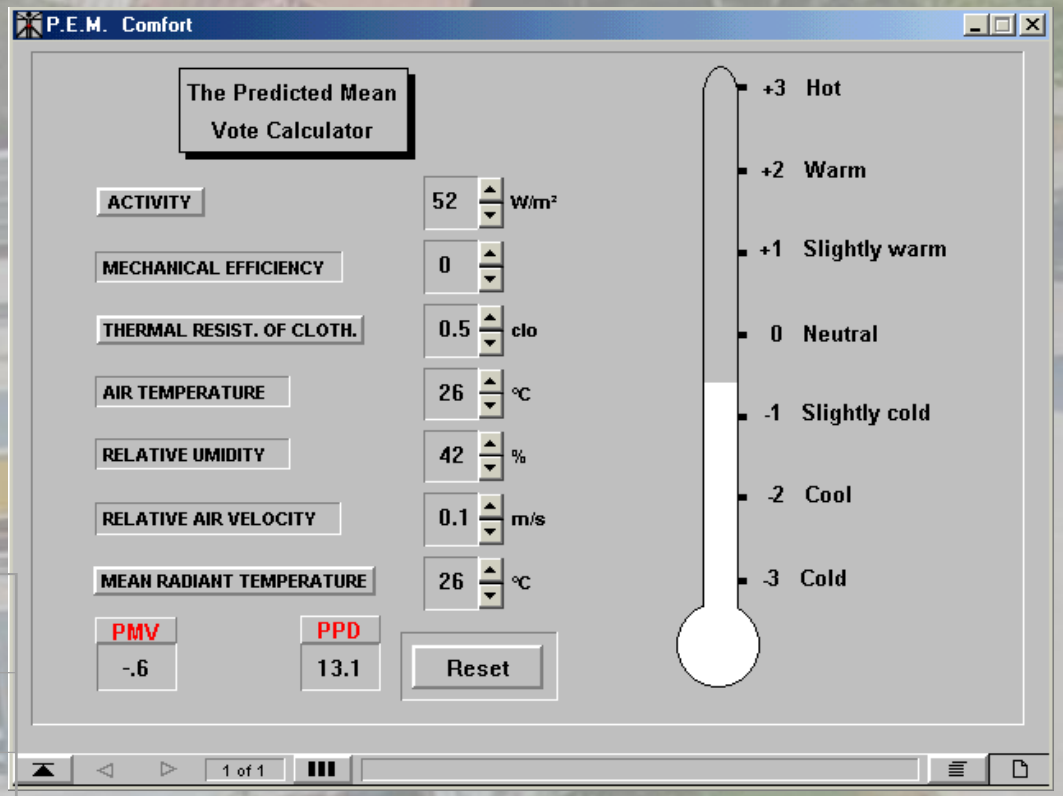
Έναρξη | Εξερεύνηση ... | kape | Όροφος κ... | Έγγραφο - ... | En | 2:30 μμ

Electrical consumption of the building



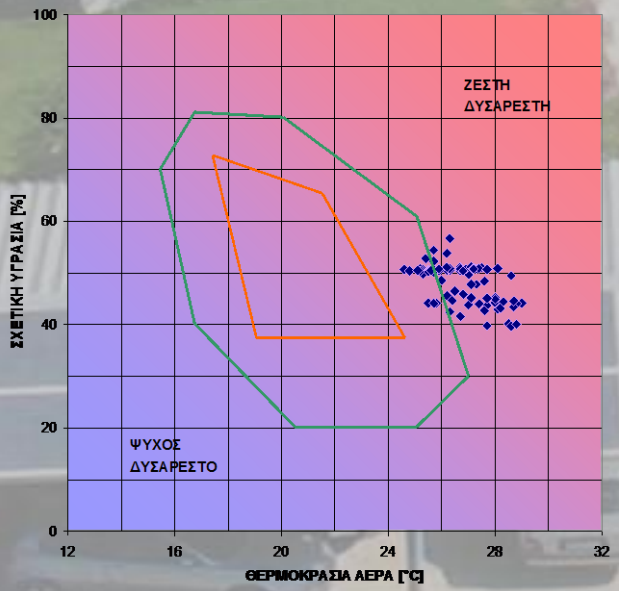
	COOLING	HEATING	LIGHTING	ELECT. APPLIANCES	TOTAL	PVS
	kWh/m2	*kWh/m2*	*kWh/m2*	*kWh/m2*	***kWh/m2***	
Conventional Office Building	**33.0**	**101.3**	**20.0**	**48.0**	**202.3**	
Bioclimatic Office building	**41.8**	**27.1**	**10.6**	**25.5**	**107.1**	**1.7**



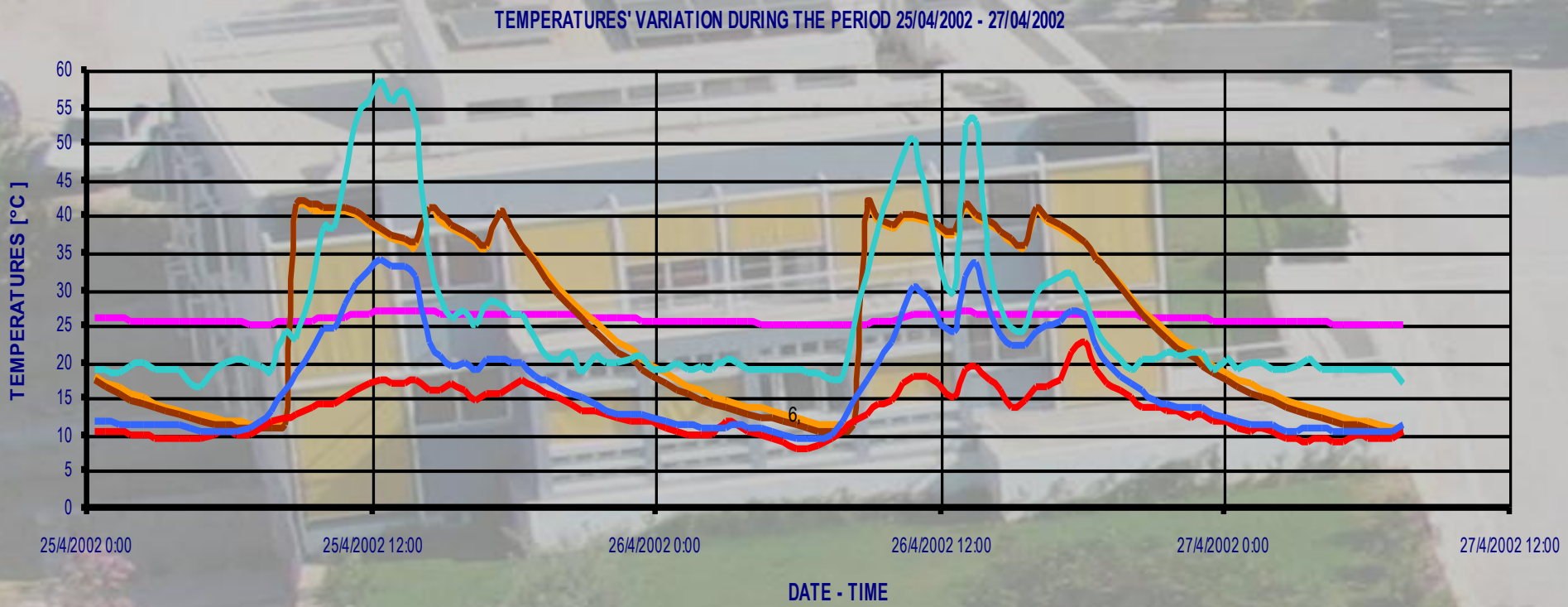


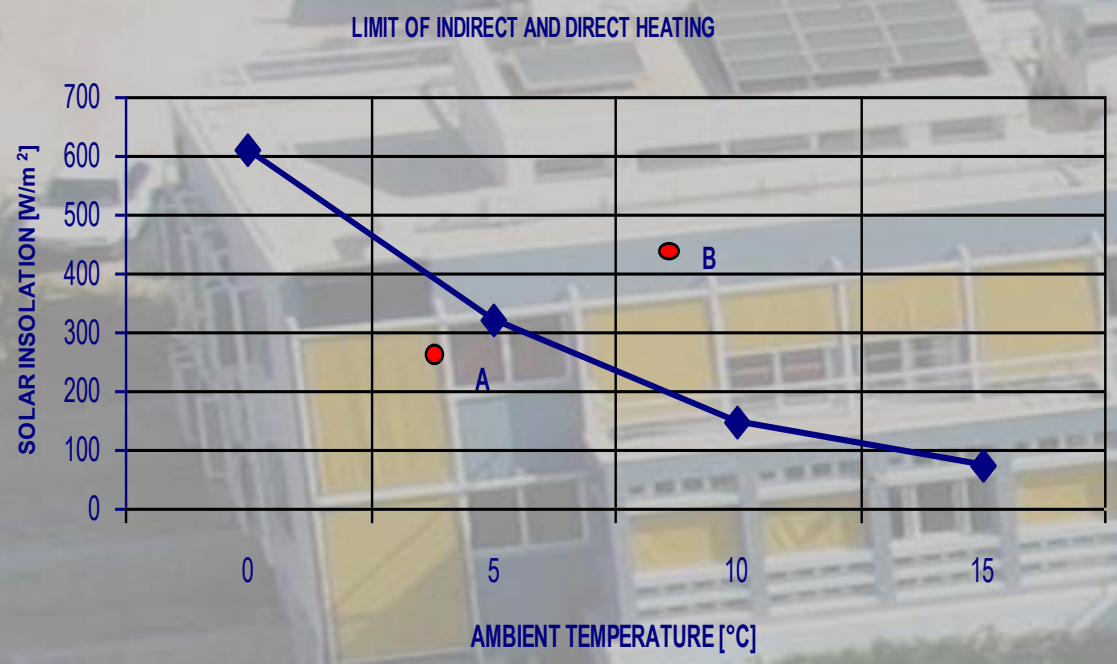
PRESENTAGE OF THERMAL COMFORT (table II)

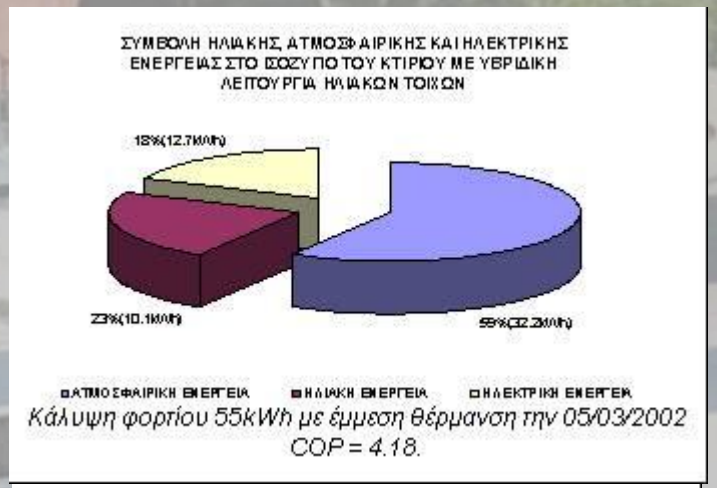
CONDITION	%
NEUTRAL [±0.5]	61.9
SLIGHTLY WARM [+1]	4.8
SLIGHTLY COLD [-1]	31
WARM [+2]	0
COOL [-2]	2.4
HOT [+3]	0
COLD [-3]	0
TOTAL	100



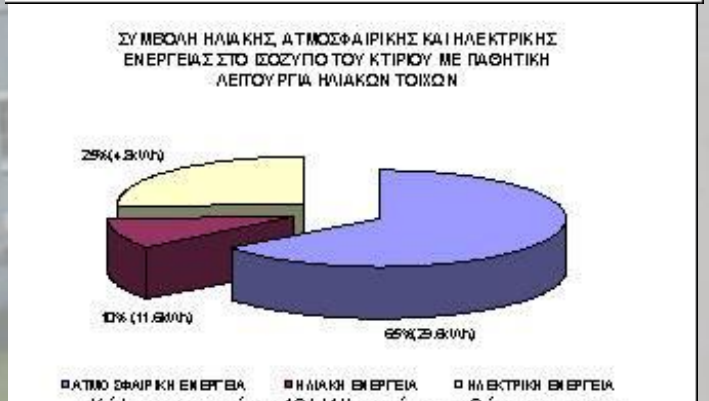
Air solar walls


TEMPERATURES' VARIATION DURING THE PERIOD 25/04/2002 - 27/04/2002
TEMPERATURES [°C]
60
55
50
45
40
35
30
25
20
15
10
5
0
25/4/2002 0:00
25/4/2002 12:00
26/4/2002 0:00
26/4/2002 12:00
27/4/2002 0:00
27/4/2002 12:00
DATE - TIME
AIR TEMPERATURES IN AREA A4
WATER TEMPERATURES WHEN RETURNING TO THE HEAT PUMP
INDUCTION WATER TEMPERATURES TO THE FCU
AMBIENT TEMPERATURE
AIR TEMPERATURES IN A HIGH LEVEL OF SOLAR AIR COLLECTOR
AIR TEMPERATURES IN A LOW LEVEL OF SOLAR AIR COLLECTOR

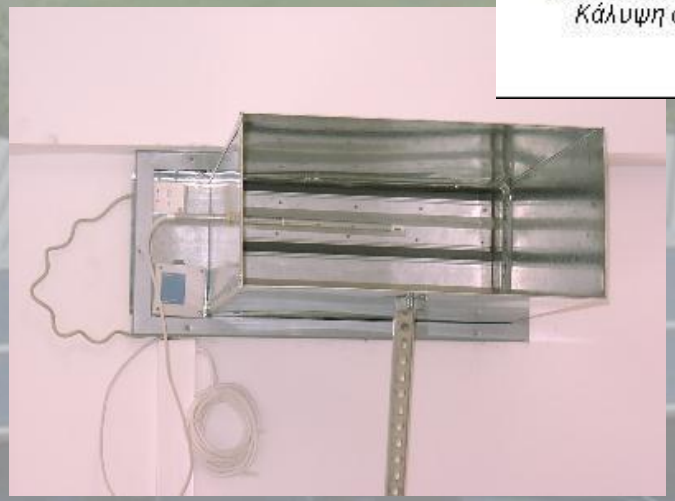




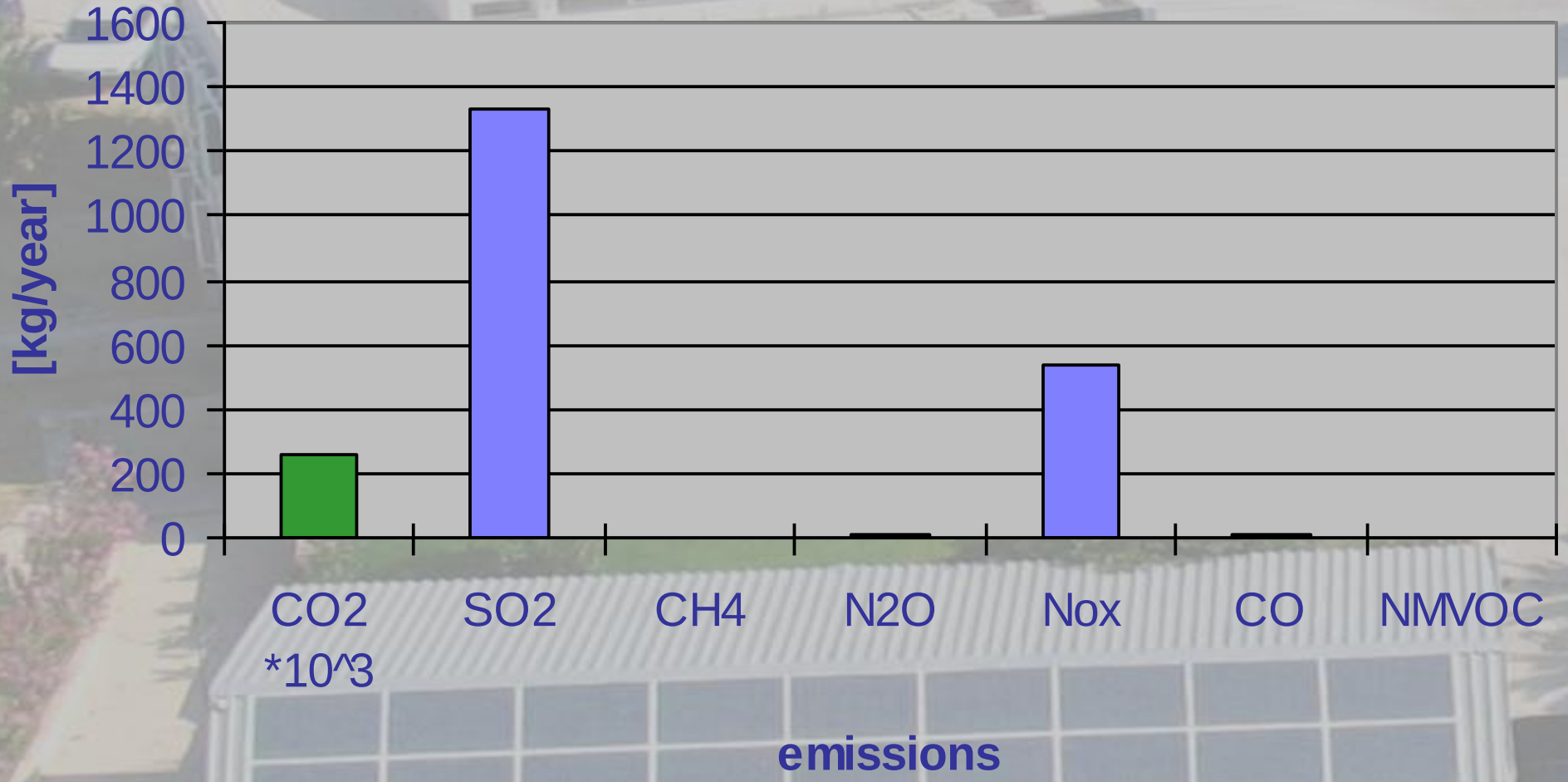
Κάλυψη φορτίου 55kWh με έμμεση θέρμανση την 05/03/2002 COP = 4.18.



Κάλυψη φορτίου 46kWh με άμεση θέρμανση την 25/04/2002 COP = 3.55.



Reduction of annual of gas emissions



BUILDING PERFORMANCE

- ☑ The energy technologies and systems installed in the building cost, in 1999 prices, 11% (39.780 Euro) of the total cost of the building
- ☑ Based on the results of the six-year energy measurements in the building and on the calculated energy saving (50354Kwh/year or 47%).
- ☑ Compared with similar “conventional” buildings, there is a simple payback period of 11 years
- ☑ Respectable decrease CO_2 emissions (255 ton CO_2)
- ☑ High levels of thermal and visual comfort

BUILDING ENERGY MANAGEMENT SYSTEMS TODAY

- ☑ Many tertiary building applications of BEMS
- ☑ Projects under way to integrate Smart Metering in residential buildings
- ☑ Developing real-time management, analytics and forecasting services for energy distribution networks

NRG4CAST

ENERGY FORECASTING

Project overview

Call: FP7-2012-NMP-ENV-ENERGY-ICT-EeB**Activity EEB-ICT-2011.6.5: ICT for energy-positive neighbourhoods**

SEVENTH FRAMEWORK PROGRAMME

NRG4Cast - Introduction

- Duration 3 years: 1.12.2012 – 1.12. 2015

- 8 partners:
  1. Institut Jozef Stefan (JSI), Slovenia
  2. Forschungsinstitut fuer Rationalisierung, (FIR) Germany
  3. Consorzio per il sistema Informativo, (CSI PIEMONTE), Italy
  4. IREN Rinnovabili SRL, (IREN) Italy
  5. Envigence, Okoljska Inteligenca, d.o.o., (ENV), Slovenia
  6. National Technical University of Athens, (NTUA), Greece
  7. Kentro Ananeosimon Pigon ke Exikonomisis Energeias - Centre for Renewable Energy Sources and saving Kape (CRES), Greece
  8. SingularLogic Sanonymi Etairia Pliroforiakon Sistimaton kai Efarmogon Pliroforikis (SINGULARLOGIC), Greece

NRG4Cast – Summary

NRG4Cast is developing real-time management, analytics and forecasting services for energy distribution networks

- analyse information:
  - network topology and devices,
  - energy demand and consumption,
  - environmental data and energy prices data.
- software module pipeline providing **prediction** and the **decision support system** based on network monitoring, anomaly detection, route cause analysis, trend detection, planning and optimisation.
- Technologies: machine learning, data and text mining, stream mining, link analysis, information extraction, knowledge formalisation and reasoning.

Focus on electric power networks through the development of a generic framework that will be able to **control, manage, analyse** and **predict behaviour** in an extensible manner on other **energy networks** like gas distribution, heat water distribution and alternative energy distribution networks.

Expected results

- generic toolkit with programmable data adapters
- a set of real-time monitoring and prediction services provide to different stakeholders unique service for:
  - energy planning,
  - network failure and
  - energy price prediction

- Challenges:
  - different types of information
  - highly dynamic environment of energy distribution networks
  - those services have to be applicable in any type of energy distribution network

Case studies

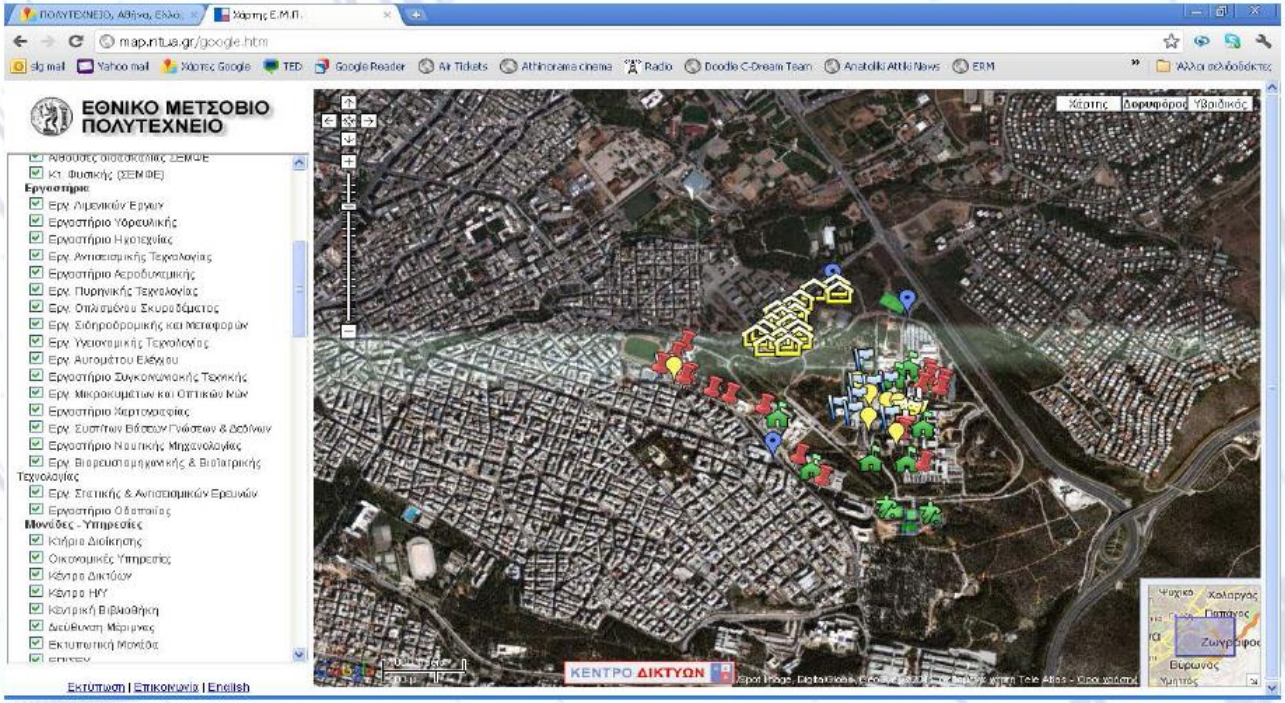
The project is focused on local communities:

- Information from different local infrastructures:
  - the streetlight network, local gas distribution network, local heat distribution network and public buildings.
- Evolution of electric cars usage and micro energy productions

- Case studies:
  - Energy Efficiency in municipalities (Miren - Kostanjevica)
    - Living Laboratory; Miren-Kostanjevica will also integrate its urban environment monitoring service
  - NTUA Campus – energy positive buildings
    - Internal and external data sources
  - Energy efficiency in city districts
    - data from the network consisted from traditional and renewable energy sources as the energy provider/distributor
  - Smart Charging - FIR
    - The involvement of an emerging energy model with unpredictable behaviour into traditional energy distribution network.

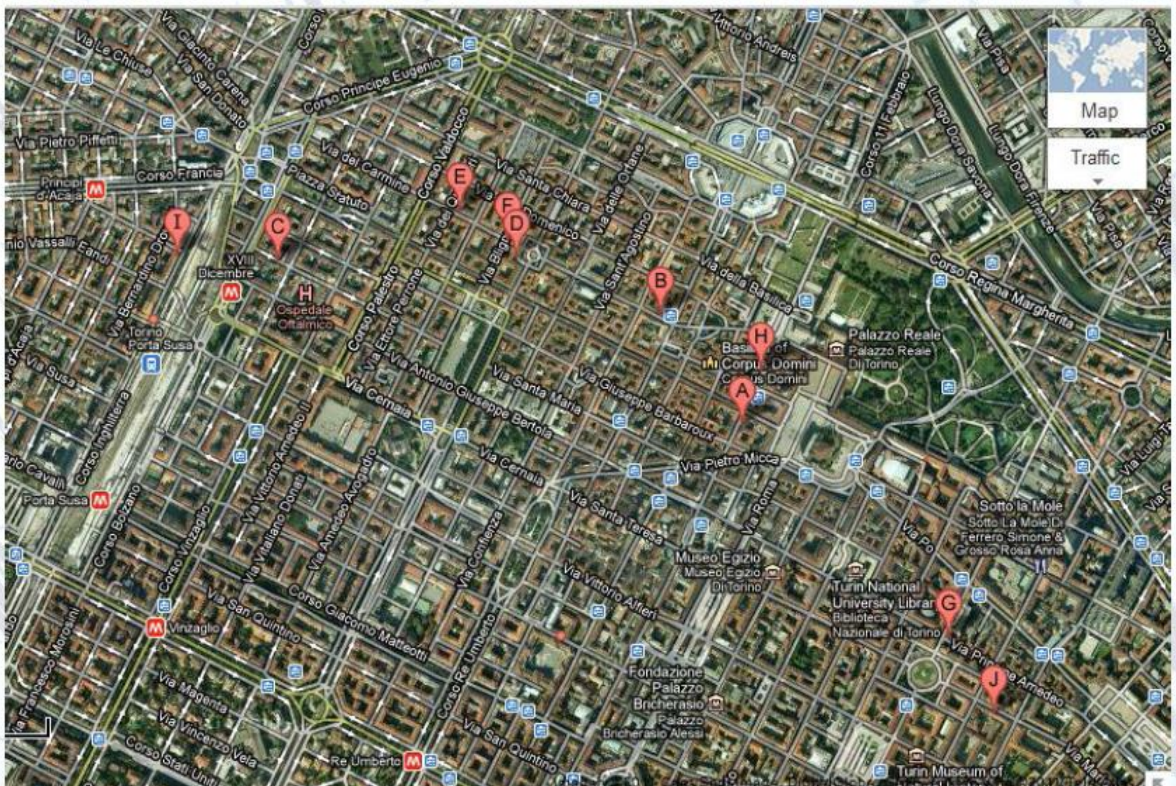
A University Campus Pilot

- **Neighbourhood**: A University Campus (Athens, Greece) with 62 buildings with high demand in electricity, heating and cooling, with serious considerations of monitoring energy consumption both from environmental but also economical point of view.



City district

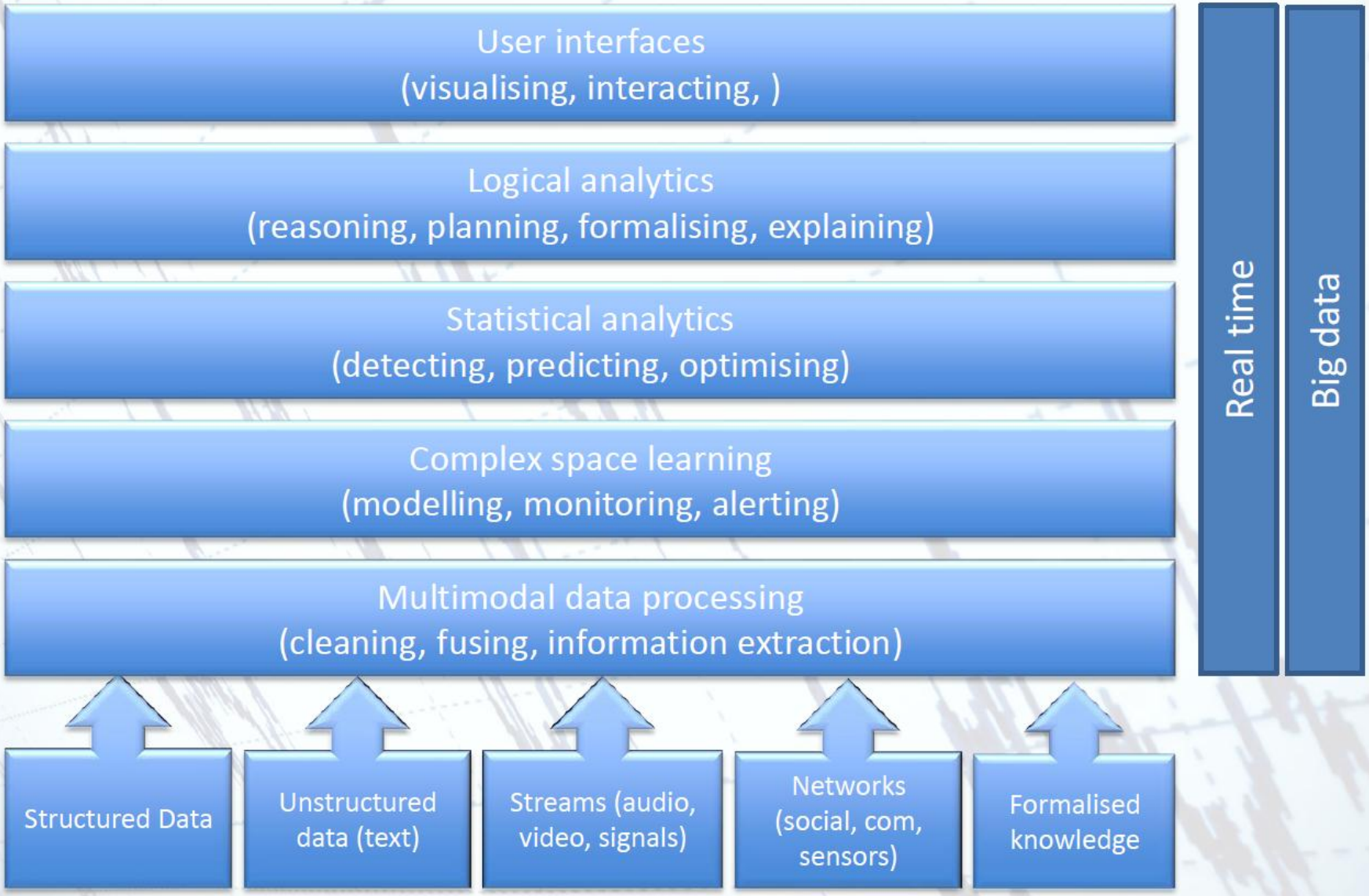
- **Old city buildings**: energy consumption in historical city (Torino, Italy) for improving energy efficiency and predicting the energy consumption in historical buildings.



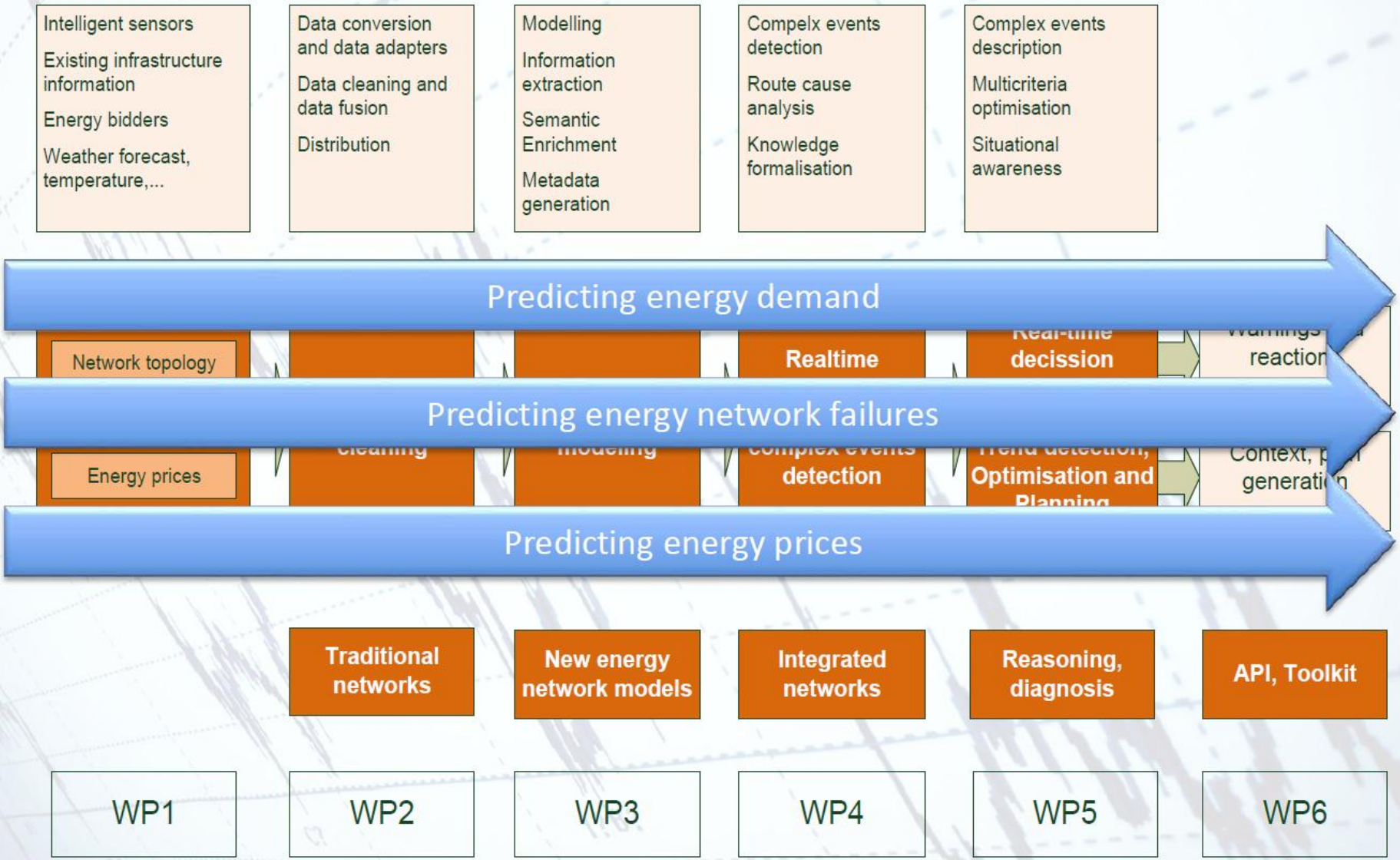
Energy4Cast goals

- The aim of NRG4Cast project is to develop advanced solutions for predicting behavior of large energy networks for the three fundamental scenarios:
  - Predicting energy demand on several granularity levels (region, country, energy distribution operator, city, business, household),
  - Predicting energy network failures on an international, national and local network topologies,
  - Detecting short term trends in energy prices and long term trends in national energy policies.

How do we do that?



NRG4Cast project



NRG4CAST

ENERGY FORECASTING

Case Studies and Demos session

NTUA pilot case

Athens, Greece

SEVENTH FRAMEWORK PROGRAMME

NTUA pilot in brief

NRG4CAST ENERGY FORECASTING

Aims

- Monitoring of the energy consumption
- Prediction of the energy demand of the Campus
- Providing guidance towards energy reduction measures
- Reducing the energy consumption by 2%

Means

- Monitoring of the electricity consumption for heating, cooling and lighting
- Monitoring of the thermal comfort of a typical office

Use Cases

1. Streaming data integration and management
2. Real-time analysis, reasoning and network behaviour prediction for Public buildings

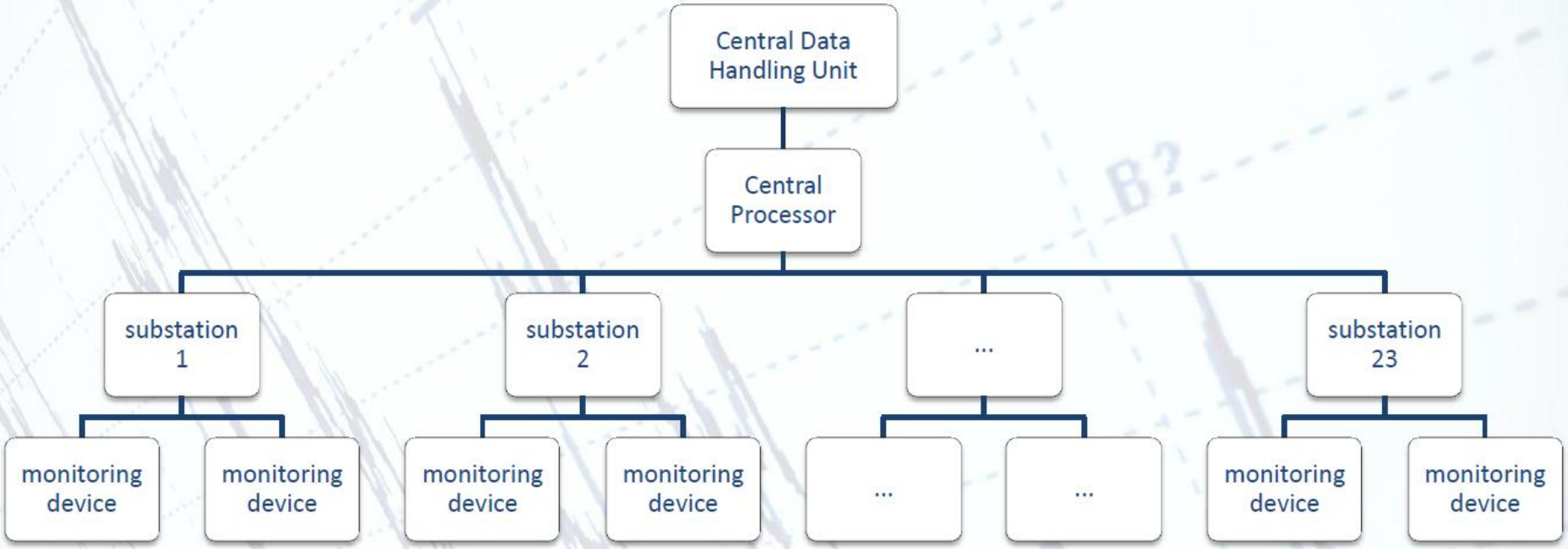
NTUA Campus map showing the lodges of the electricity meters

Objectives

NRG4CAST ENERGY FORECASTING

- Monitoring the energy consumption for heating, cooling and lighting
  - 47 electricity meters
  - 50 power inverters
  - 23 analogue to digital converters
  - 2 PLCs
- Monitoring the thermal comfort of a typical office
  - 4 temperature sensors
  - 4 lux meters
  - 4 relative humidity sensors
  - 4 lux meters
- Developing a data acquisition system to collect and integrate data from different network topologies

Objectives



NTUA monitoring system configuration

Expected results

NRG4CAST ENERGY FORECASTING

- **Prediction of the NTUA's energy demand**
  - Selection of the most profitable electricity provider
  - Public information for the NTUA's energy consumption
- **Assistance in the energy management strategy and the decision making process**
  - Selection of the best cost-efficient measures for renovations
  - HVAC systems upgrade
  - RES systems installation

*The overall aim is the **energy saving by 2%** and the **forecast of the energy demand** through the **tight monitoring of the energy consumption** of the whole NTUA Campus.*

Streaming data integration and management
Real-time analysis, reasoning and network behaviour prediction for Public buildings

NRG4CAST ENERGY FORECASTING

Description of the flow of information and the improvement on the prediction of the energy consumption regarding the energy consumption of the Campus buildings, correlated with external data.

- Target dimension
  - Energy consumption
  - Energy savings
  - Monetary savings
- Energy type: electricity, natural gas
- Partners
  - Occupants of the buildings (Professors, employees, researchers, students),
  - Public Power Corporation
  - Ministry of Energy and Climate Change
- Decisions
  - Taking measures - giving recommendations to save energy and
  - Giving intensives to Schools and building occupants to save energy
- Necessary information
  - Weather forecast (temperature, relative humidity, solar radiation, wind)
  - Occupancy level
  - Energy prices

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