ECOLOGICAL BUILDING:
a sustainable approach to design, construction and operation of buildings

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Session 4: Green Society Concept and Practice
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Ecological building is a multi-faceted process aiming at mitigating the negative environmental impacts of building constructions as well as rationalising the use of resources and enhancing health and comfort for users.

The sustainable approach to ecological building can be described through the following aspects:

1. **Climate change**
2. **Strategies**
3. **Standards**
4. **Evaluation tools: life cycle cost**
5. **Technolgies**
   - **5.1. Water saving**
   - **5.2. Indoor air quality and materials**
   - **5.3. Construction systems**
   - **5.4. Energy and indoor microclimate control**
   - **5.5. Technological and architectural integration**

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1
CLIMATE CHANGE

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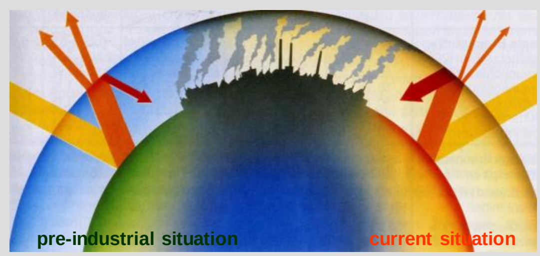
Global warming due to greenhouse gasses emission and concentration in the atmosphere



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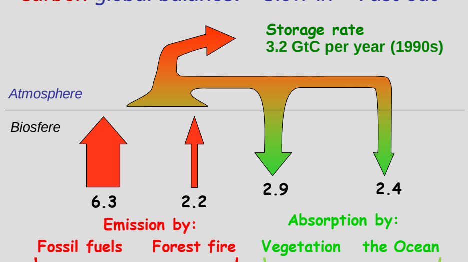
Carbon global balance: "Slow in – Fast out"



Quick processes (1 – 10^2 days) Slow processes (10^3 – 10^4 days)

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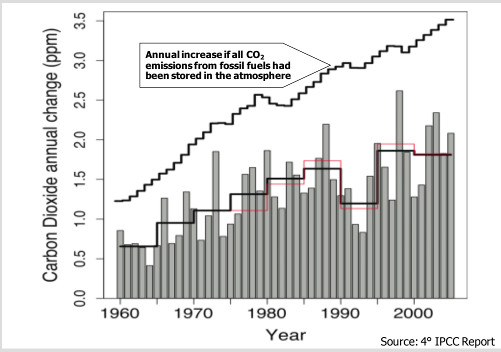
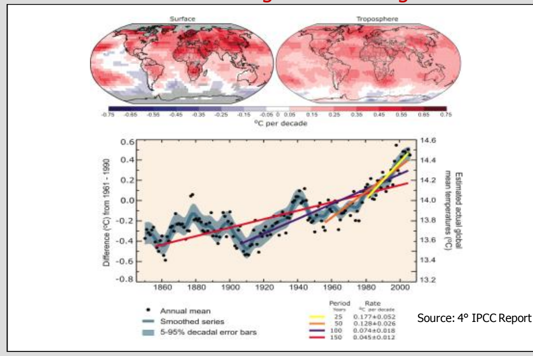


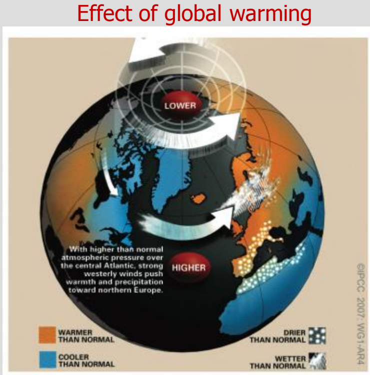
Source: 4° IPCC Report

Estimated global warming



Source: 4° IPCC Report

Effect of global warming



Effect of global warming

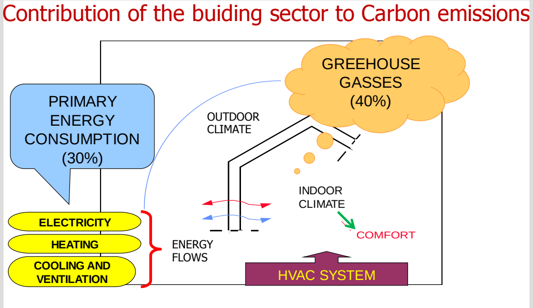
Il ghiacciaio del Grosglockner (3.798 m *s.l.m.*), Austria

Anno 1900

Anno 2000

Courtesy of Norbert Lantschner

Contribution of the buiding sector to Carbon emissions



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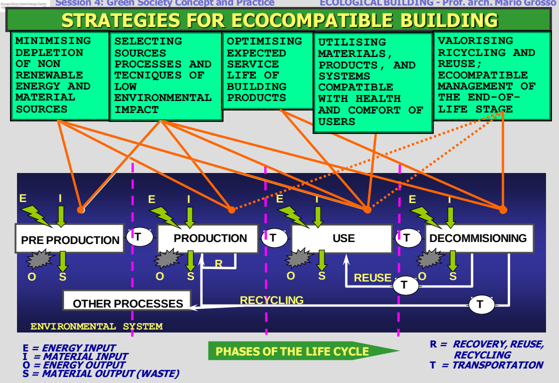
STRATEGIES



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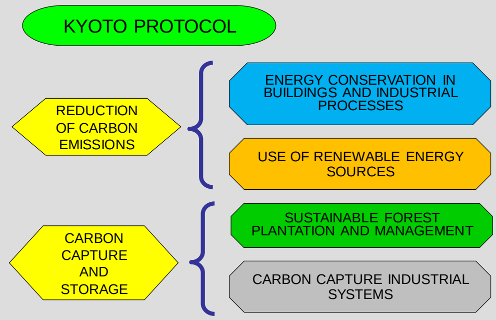
Strategies for reducing global warming potential



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3

STANDARDS

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Sustainability of Construction Works – CEN/TC350

- European horizontal standards for the sustainability assessment of buildings → One system in Europe
- Sustainability assessment with the performance based approach in terms of:
  - Environmental performance (Mandate M/350)
  - Social performance
  - Economic performance
- Life cycle approach with the quantifiable indicators

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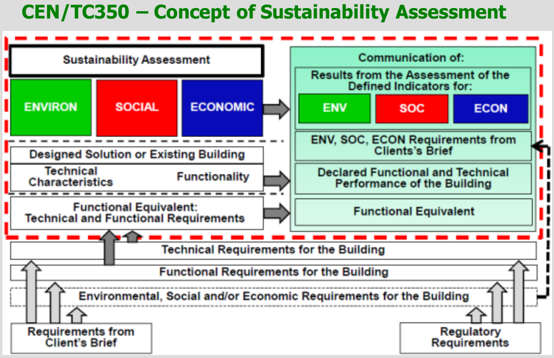
CEN/TC350 – Concept of Sustainability Assessment



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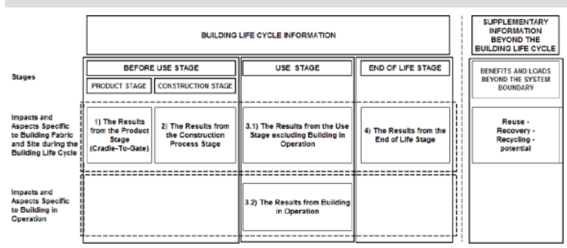
CEN/TC350 – The organisation of th results of the assessment in accordance with the life cycle stages and the information groups



4

EVALUATION TOOLS: LIFE CYCLE COST

Life Cycle Costing: a method to calculate an *economic-environmental efficiency factor* for building design

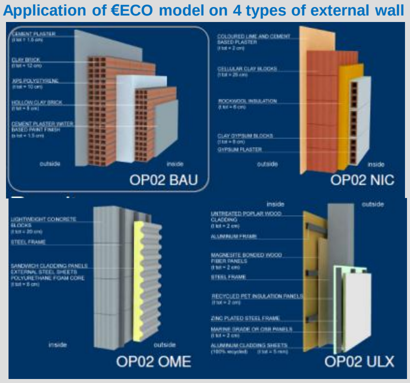
It is a useful tool for guiding the decision process of designers and clients at a preliminary level.
The factor, named **€CO**, integrates the economic aspect into an environmental evaluation model.
It is based on life cycle at the scale of the technical component (building envelope).

$$€CO = (X_{LCC} * \eta_{LCC}) + (X_{GWP} * \eta_{GWP}) + (X_{CED} * \eta_{CED})$$

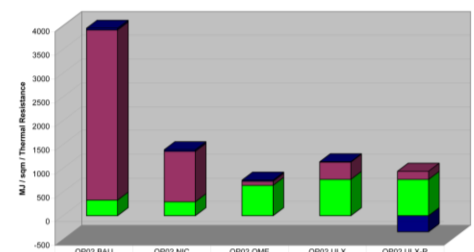
X_{LCC} = Economic Performance
X_{GWP} = Environmental Performance (Global Warming Potential)
X_{CED} = Environmental Performance (Cumulative Energy Demand)

η_{LCC} = Weight of LCC
η_{GWP} = Weight of GWP
η_{CED} = Weight of CED

Application of €ECO model on 4 types of external wall



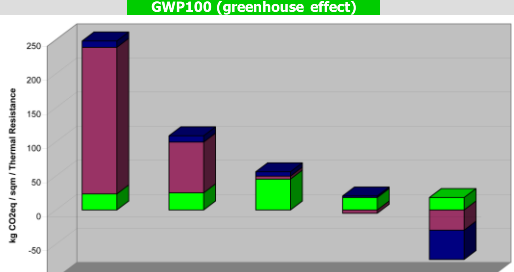
IMPACT ASSESSMENT
CED (Cumulative energy demand)



	OP02 BAU	OP02 NIC	OP02 OME	OP02 ULX	OP02 ULX-R
CED End of life	35,3	35,1	24,2	8,7	-338
CED Use	3580	1060	85	363	173
CED Production	328	293	638	763	763

building envelope solutions

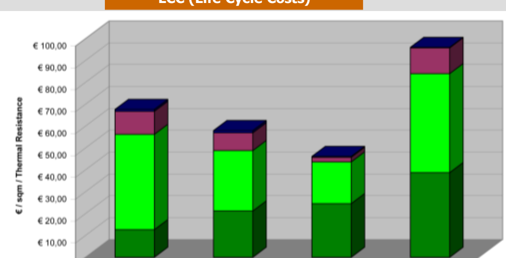
IMPACT ASSESSMENT
GWP100 (greenhouse effect)



	OP02 BAU	OP02 NIC	OP02 OME	OP02 ULX	OP02 ULX-R
GWP End of life	9,31	9,26	6,39	2,3	-43
GWP Use	215	74,4	4,36	-4,81	-29,6
GWP Production	23,6	25,2	45,3	18,3	18,3

building envelope solutions

IMPACT ASSESSMENT
LCC (Life Cycle Costs)



	OP02 BAU	OP02 NIC	OP02 OME	OP02 ULX
End of life costs	€ 0,91	€ 1,02	€ 0,39	€ 0,20
Use and Maintenance costs	€ 10,50	€ 8,11	€ 2,12	€ 11,80
Installation costs	€ 43,59	€ 27,64	€ 19,07	€ 45,28
Purchase costs	€ 12,62	€ 21,16	€ 24,52	€ 38,70

building envelope solutions

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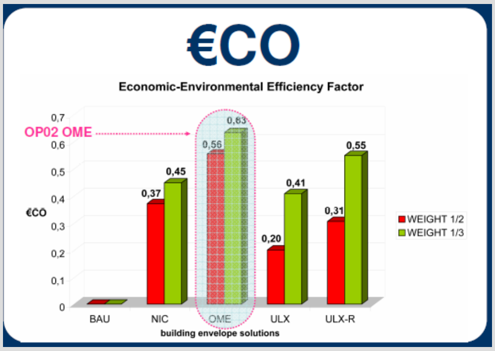
RESULTS



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5

TECHNOLOGIES

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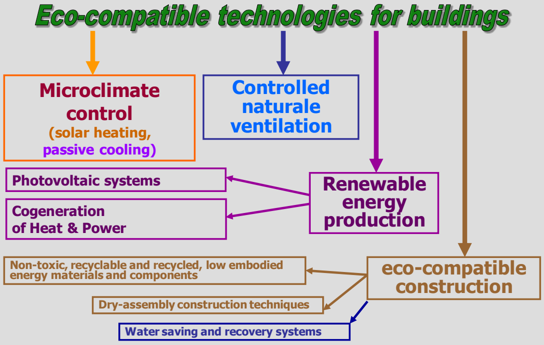
Eco-compatible technologies for buildings



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5.1

WATER SAVING

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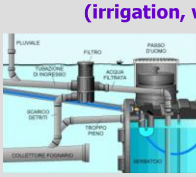
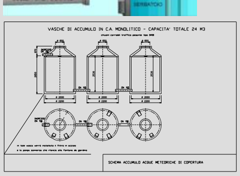
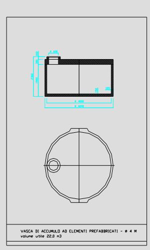
Storm water storage for non-potable reuse (irrigation, washing, ...)



Storage tanks and filtering devices





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5.2

INDOOR AIR QUALITY AND MATERIALS

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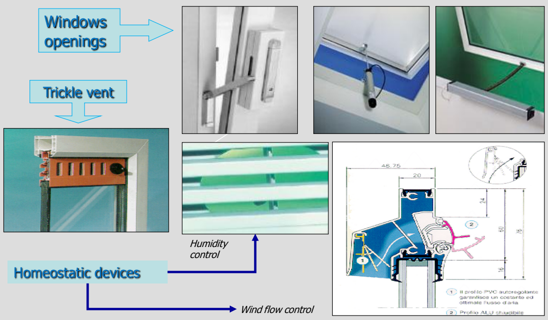
Natural ventilation through automatically controlled openings



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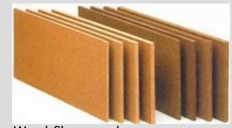
Bbuilding products of natural components


Cellulose fiber panels


Wood fiber panels


Wood brick-like elements


Cooked clay panels

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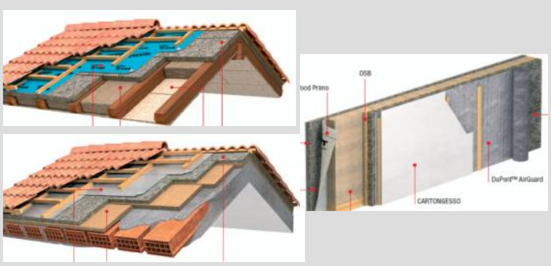
Wood-cement insulation panels



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Recycled materials

http://www.matrec.it/

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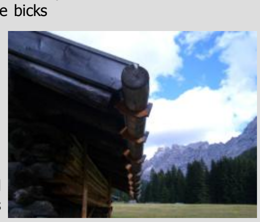
Embodied energy in materials

1600 °C process temperature
to produce cement

900° process temperature
to produce bicks



Solar energy to grow wood
Electricity do process timber in mills

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5.3

CONSTRUCTION SYSTEMS

DRY ASSEMBLY CONSTRUCTION SYSTEM

International Exibition "Colombiadi", Genoa (1985-92) – arch. Renzo Piano

Brick panel

DRY ASSEMBLY CONSTRUCTION SYSTEM

BUILDING "C1", POTSDAMER PLATZ, BERLINO
Arch. R. PIANO e Arch. KOHLBECKER

Brick panels

Detail

DRY ASSEMBLY CONSTRUCTION SYSTEM

RESIDENTIAL BUILDING, SAINT MARTIN D'HERES, GRENOBLE, 1996 – Archs. DUBOSC E LANDOWSKY

Modular metal cladding with acoustic insulation.

View from street

Wood cladding with diagonal layout

View from courtyeard

DRY ASSEMBLY CONSTRUCTION SYSTEM

EMSHER PARK, ESSEN, Archs. JOURDA e PEROUDIN

Roof panels of double glazing with interplaced FV cells

Local wood pillars, with bolted steel joints to the roof

Modular pre-fabbricated wall

DRY ASSEMBLY CONSTRUCTION SYSTEM

Office building, Environment Park, Turin
Archs. Dotta e Fassi

Energy-environmental Consultant: Mario Grosso

5.4

ENERGY AND MICROCLIMATE CONTROL

SPACE HEATING

Thermal control

- **Solar storage**
- **Thermal inertia**
- **Thermal insulation**

Solar heating

passive

- Sun space
- Trombe-Michel wall
- Solar chimney wall

active

- Water solar collectors
- Air solar collectors

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SPACE COOLING

Thermal control

- **Solar control**
- **Thermal inertia**
- **Internal gains**

Natural cooling (thermal sinks)

convection

- microclimate (ventilation through outdoor air)
- geothermal (air-to-earth exchange through horizontal buried pipes)
- evaporative cooling (through sprayed water)
- radiant cooling (through air ducts)

conduction-radiant exchange

- geothermal (hypogeum buildings, water-to-earth exchange)
- radiant (direct)

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ENERGY PRODUCTION FOR SERVICES

ELECTRICITY

- *PV systems to grid*
- *PV stand-alone systems*
- *Other RES system (wind, micro-hydro)*
- *H&P Co-generation systems*

WATER HEATING

- *Solar systems*
- *District heating*

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Thermal control: green roofs

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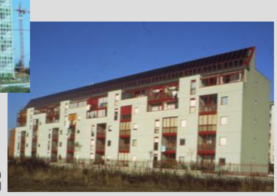
Passive and active Solar space heating

EU-funded residential buildings programme, Piedmont, Italy, 1983-86

Air solar collector on walls



Air solar collector on roof and sun spaces on the south wall

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Passive and active Solar space heating

EU-funded residential buildings programme, Piedmont, Italy, 1983-86

Air solar collector on roof

Passive and active Solar space heating

Water solar collector on roof and sun spaces on the south wall

EU-funded residential buildings programme, Piedmont, Italy, 1983-86

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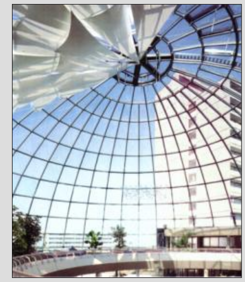
Solar control

Siville, Spain: mobile canvasses on a street.



Arch. Reidemeister und Glassel, Dome of Bad Neutadt Hospital, Berlin

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Solar control

Kiessel + Partner, Scientific Park, Gelsenkirchen, Germany

Renzo Piano Building Workshop, Refurbishment of Lingotto Building, Turin, Italy

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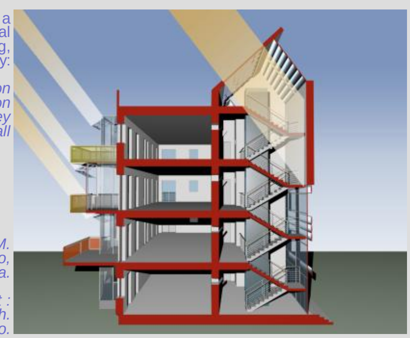
Solar-chimney-driven ventilation

Design of a residential building, Rome, Italy:

3-D representation of solar irradiation on the chimney wall



Designer: Arch. M. Irene Cardillo, Roma.

Consultant : Prof. arch. M. Grosso.

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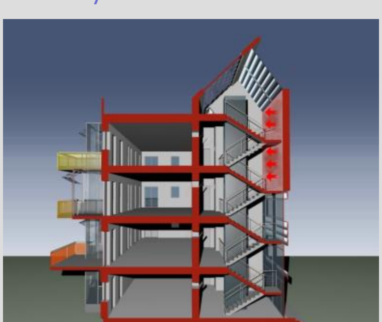
Solar-chimney-driven ventilation

Design of a residential building, Rome, Italy:

3-D representation of night re-irradiation from the solar chimney wall.



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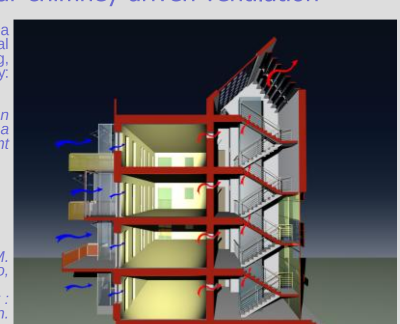
Solar-chimney-driven ventilation

Design of a residential building, Rome, Italy:

3-D representation of airflow during a summer night



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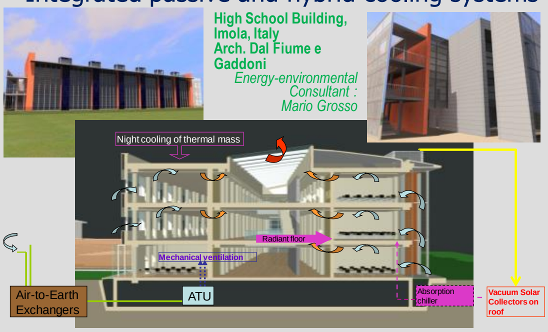
Integrated passive and hybrid cooling systems



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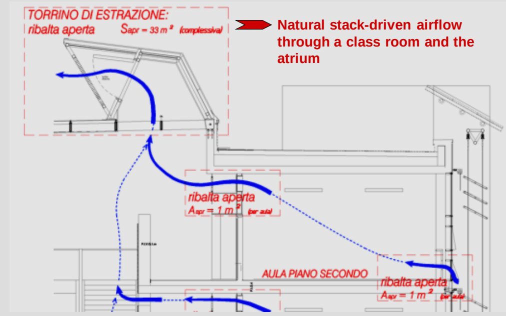
High School Building, Imola, Italy

Night cooling of thermal mass

Natural stack-driven airflow through a class room and the atrium



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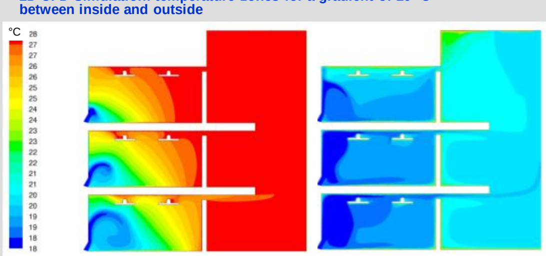
High School Building, Imola, Italy

Night cooling of thermal mass

2D CFD Simulation: temperature zones for a gradient of 10 °C between inside and outside



after 1 minute   after 10 minutes

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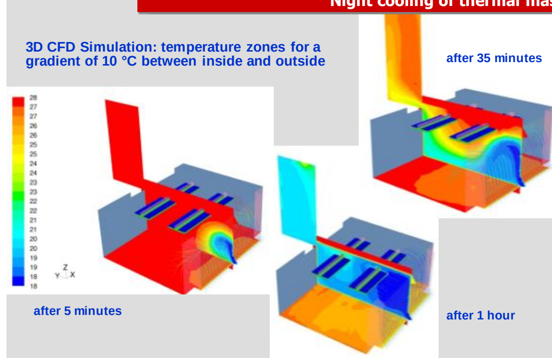
High School Building, Imola, Italy

Night cooling of thermal mass

3D CFD Simulation: temperature zones for a gradient of 10 °C between inside and outside



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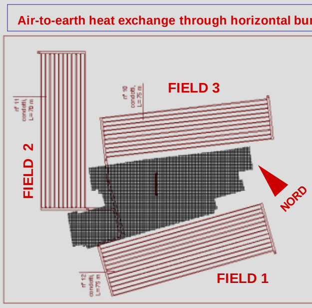
High School Building, Imola, Italy

Ait-to-earth heat exchangers

Air-to-earth heat exchange through horizontal buried pipes



Characteristics:

- 40000 m^3 treated air
- Pipes average depth: 2.5 m
- Pipe material: Polyethilene
- Small pipe diameter = 0.25 m
- Large pipe diameter = 0.80 m
- Total pipe length: about 2 Km
- Filter of air and water drainage

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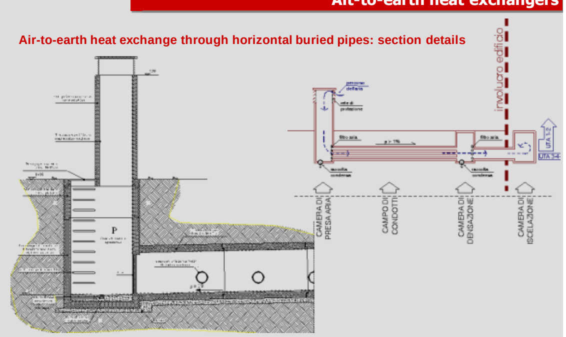
High School Building, Imola, Italy

Ait-to-earth heat exchangers

Air-to-earth heat exchange through horizontal buried pipes: section details



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ECOLOGICAL BUILDING - Prof. arch. Mario Grosso

High School Building, Imola, Italy
Ait-to-earth heat exchangers

Pipes installation

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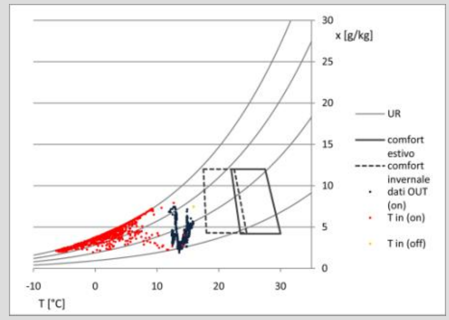
Elaboration of the first moitoring data
(December, 2010)



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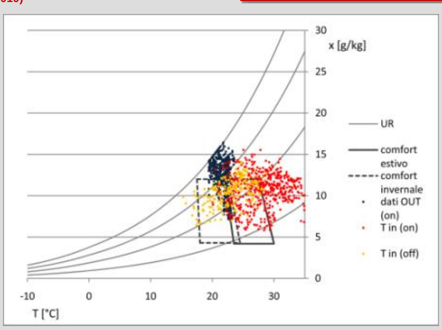

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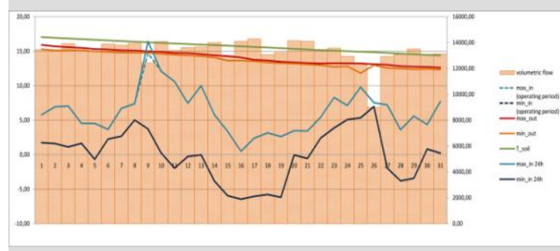

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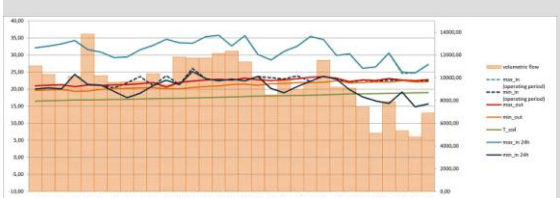

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5.5

TECHNOLOGICAL AND ARCHITECTURAL INTEGRATION

INTEGRATION OF SOLAR COLLECTOR ON ROOF AND WOOD CLADDING OF WALL

Nursery buiding Nichelino (Turin, Italy), Arch. Valerio Sticca, and Giancarlo Pavoni

Consultant : Mario Grosso

INTEGRATION OF A SEMI-HYPOGEUM BUILDING IN A LANDSCAPED CONTEXT

Arts Park, Turin, Italy
Arch. Alessandro Fassi