A ventilative cooling system in a School Building, Imola, Italy

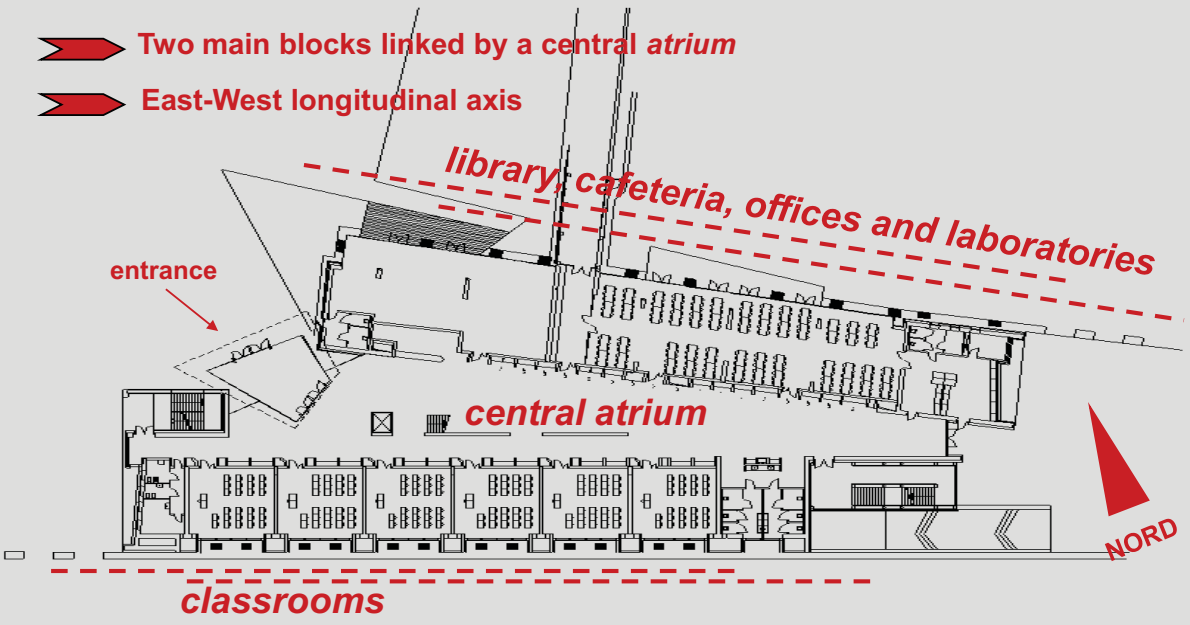
Prof. Arch. Mario GROSSO,
Associate Professor of Architectural Technology

Energy-Environmental Consultant

mario.grosso@polito.it

International Workshop: Ventilative Cooling
Need, Challenges and Solution Examples

Building layout

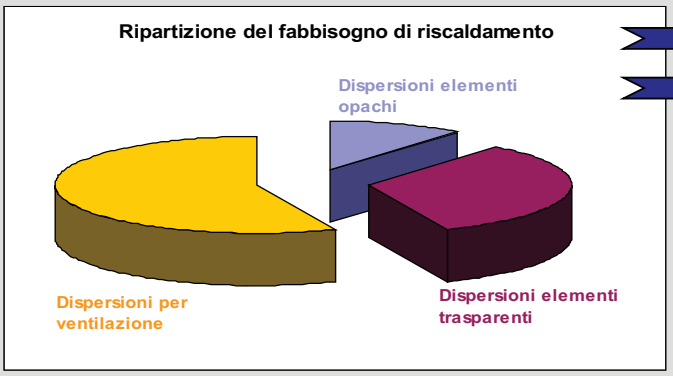


Brussels, March 19-20, 2013 mario.grosso@polito.it

Estimate of energy needs

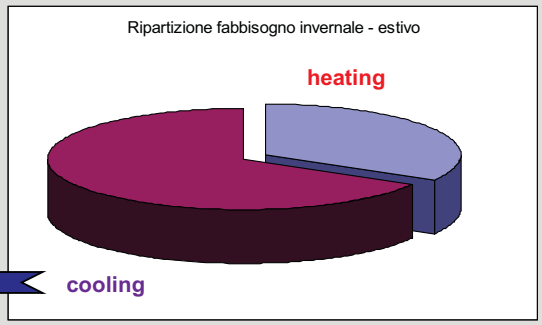
PRELIMINARY - PHASE 1

- Focussed simulations of energy strategies and comparison to a benchmark configuration
- Calculation of annual energy needs using simplified tools



Data related to the South-West block

- attention to ventilation load
- need to high-performance glazing



Data related to the South-West block for an occupation period from September to July

- priority to application of passive cooling systems

International Workshop: Ventilative Cooling
Need, Challenges and Solution Examples

Estimate of energy needs

PRELIMINARY - PHASE 2

- Evaluation of energ-saving benefit related to alternative strategies

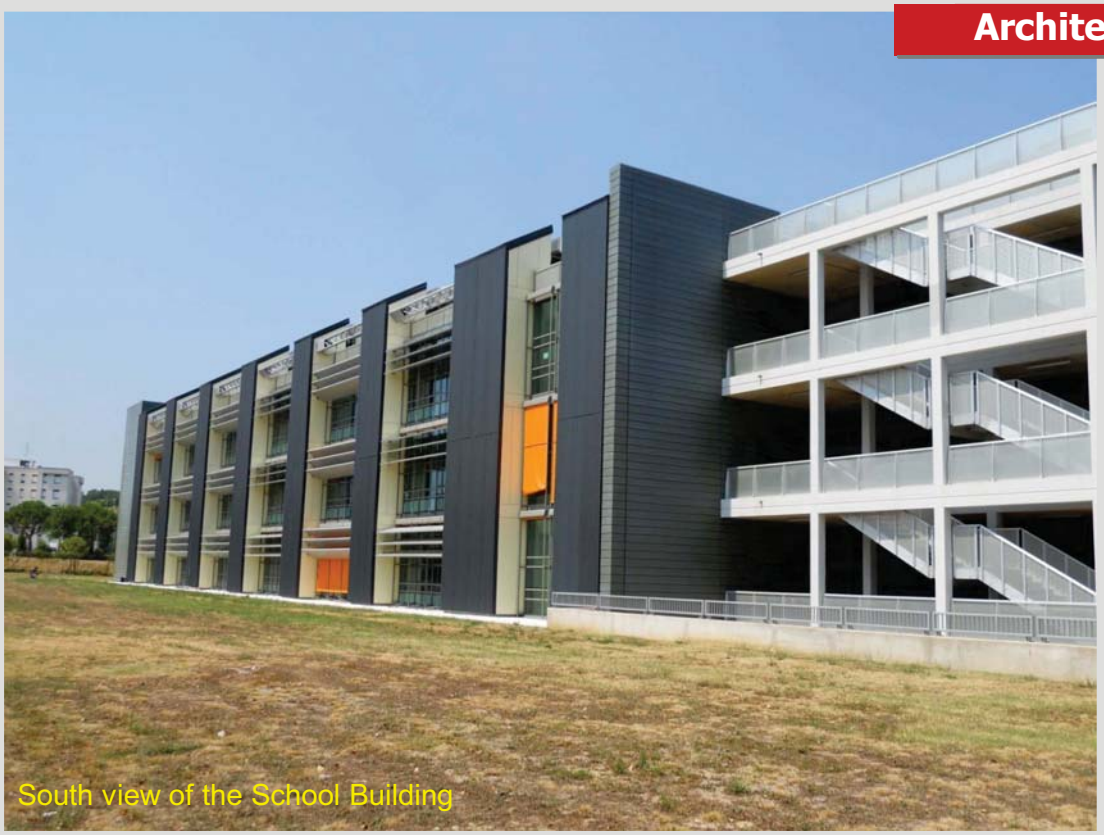
	BLOCCO AULE S-O	Fabbisogno di energia [KWh/m² anno]	
		RISCALDAMENTO	*RAFFRESCAMENTO*
A	SIMULAZIONE - A *- ventilazione minima* *- struttura leggera*	13.6	-83.7
B	SIMULAZIONE - B *- ventilazione extra* *- struttura leggera*	13.6	-31.9
C	SIMULAZIONE - C *- ventilazione minima* *- struttura medio - pesante*	21.1	-41.4
D	SIMULAZIONE - D *- ventilazione extra* *- struttura medio - pesante*	21.1	-9.8

SOLUTION D

to optimise yearly energy balance

TECHNOLOGICAL OPTIONS FOR INDOOR CLIMATE CONTROL SYSTEMS

Architecture



South view of the School Building

mario.grosso@polito.it

International Workshop: Ventilative Cooling
Need, Challenges and Solution Examples

Architecture

North view of the School Building

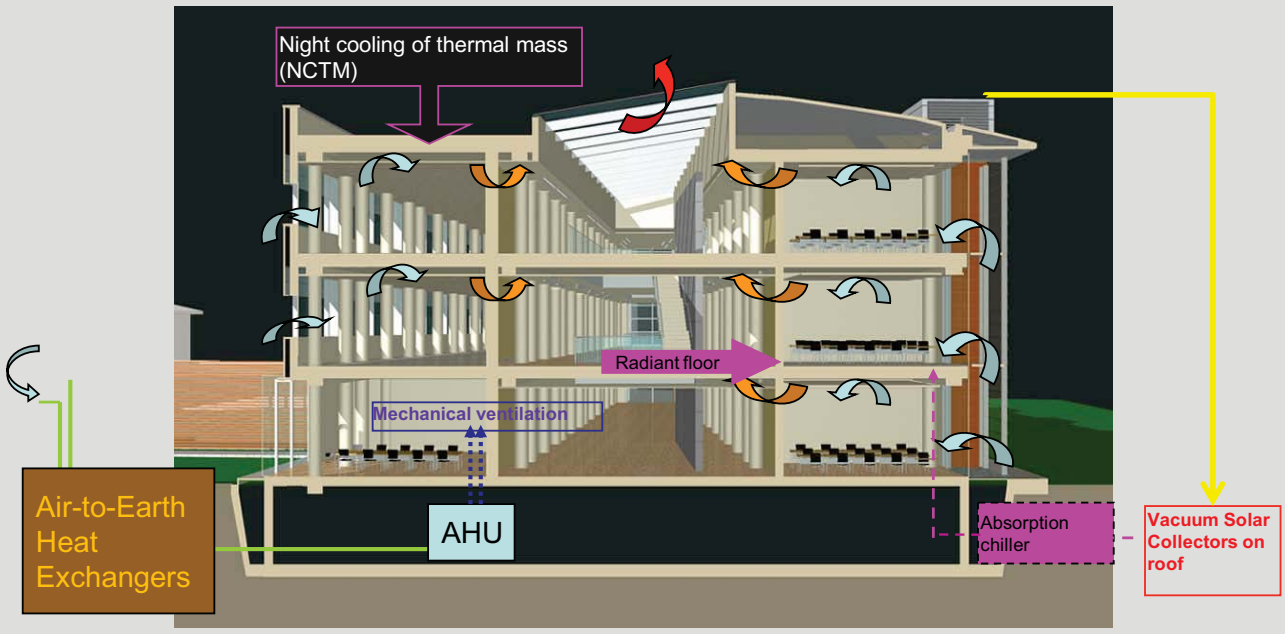
Brussels, March 19-20, 2013
mario.grosso@polito.it

Ventilation system

- Hybrid system (controlled natural/mechanical system)
- Controlled natural ventilation (CNV): motorised sensor-driven openings related to IAQ and thermal comfort

International Workshop: Ventilative Cooling
Need, Challenges and Solution Examples

Cooling system



Brussels, March 19-20, 2013 mario.grosso@polito.it

Night cooling of thermal mass

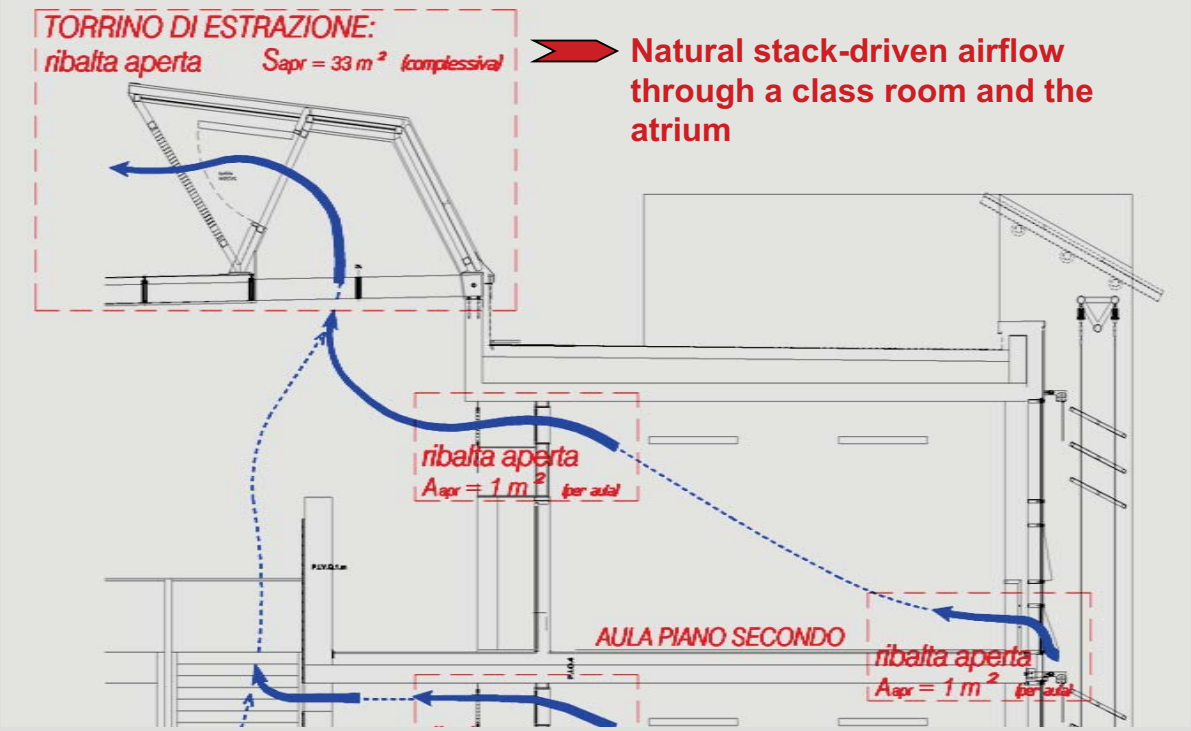
internal view of the atrium

south glazed wall with hopper window openings

vented clerestory

International Workshop: Ventilative Cooling
Need, Challenges and Solution Examples

Night cooling of thermal mass

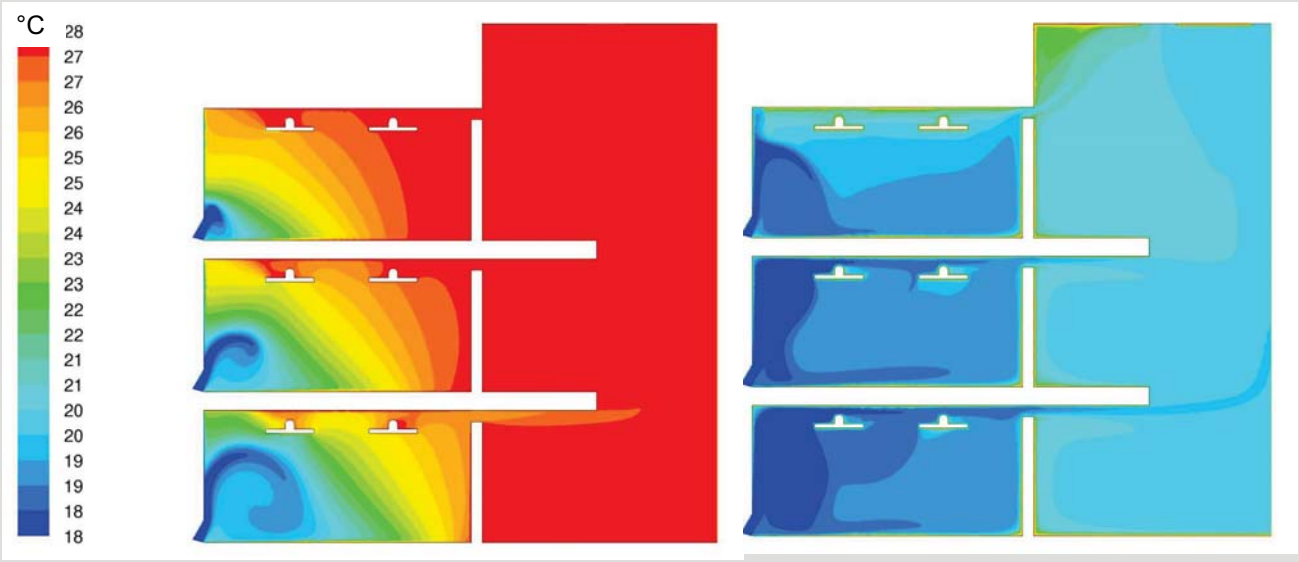


Natural stack-driven airflow through a class room and the atrium

Brussels, March 19-20, 2013 mario.grosso@polito.it

Night cooling of thermal mass

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



after 1 minute

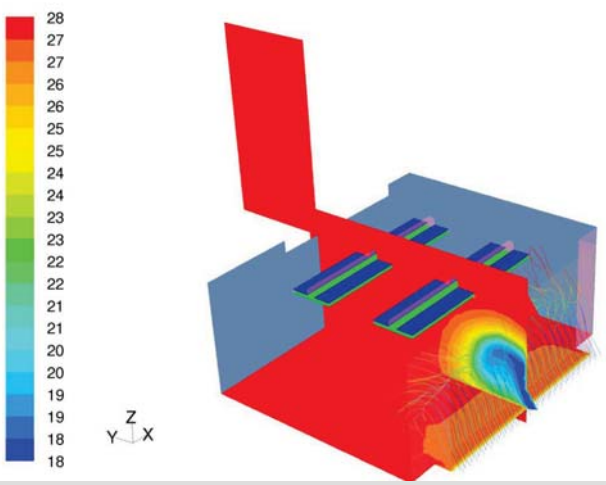
after 10 minutes

mario.grosso@polito.it

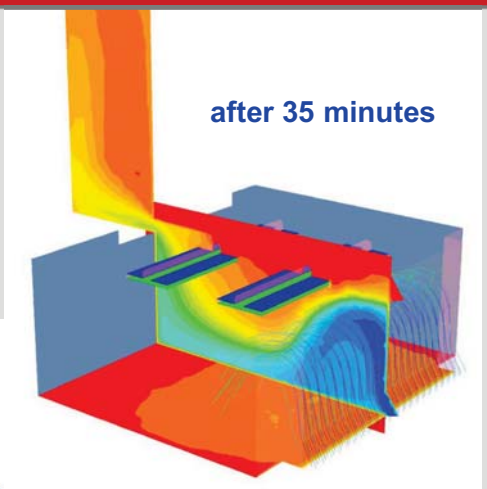
International Workshop: Ventilative Cooling
Need, Challenges and Solution Examples

Night cooling of thermal mass

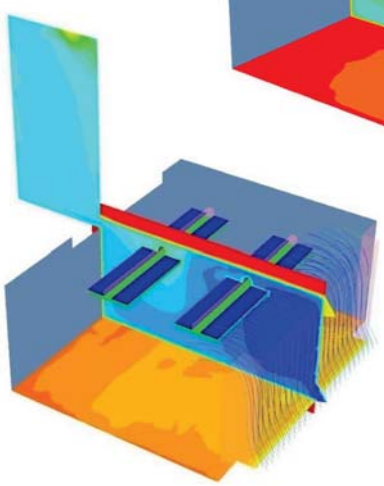
3D CFD simulation: temperature zones for a gradient of 10 °C between inside and outside



after 5 minutes



after 35 minutes



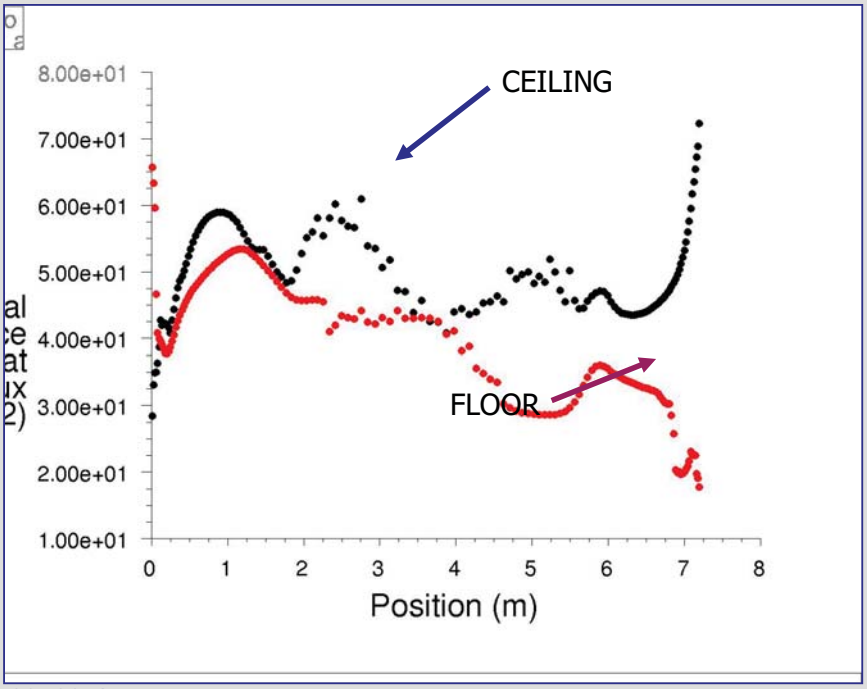
after 1 hour

Brussels, March 19-20, 2013

mario.grosso@polito.it

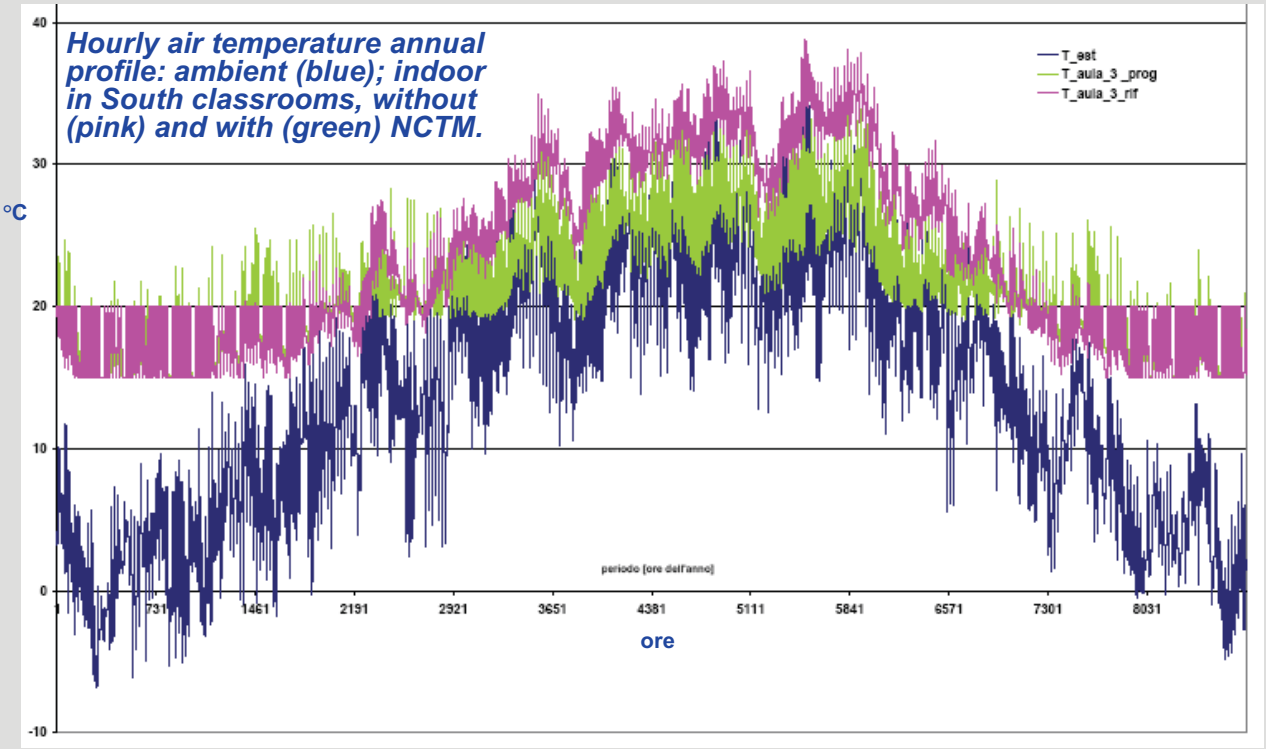
Night cooling of thermal mass

CFD airflow simulation: global thermal exchange between air and surfaces



International Workshop: Ventilative Cooling
Need, Challenges and Solution Examples

Night cooling of thermal mass



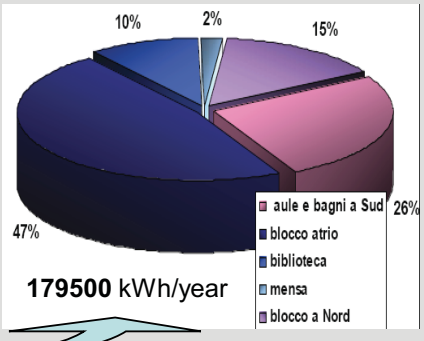
Contribution to energy saving of RES & RUE technologies (prediction)

Technology	Annual energy intensity [kWh/m²-gfa]	
	heating	cooling
Reference configuration (a)	79.5	22.4
Reference configuration (b)	141.0	38.3
High insulation (opaque components)	72.7	25.1
High insulation (glazed components)	66.2	28.6
Time optimisation of mechanical ventilation (OMV)	64.9	15.4
Shading devices (fixed)	84.0	15.8
Shading devices (fixed and movable)	86.8	14.0
Total of envelope technologies (ET)	67.0	20.1
ET+ OVM + heat recovery	44.3	13.4
ET+ OVM + Solarwall®	42.5	13.4
ET+ OVM + NCTM	54.1	6.6
TOTAL	37.4	6.6

U_{value} (walls) = **0,45** W/m²K
U_{value} (glazing) = **2,65** W/m²K
Mech. Vent. for 12 h/day

As configuration (a) with Mech. Vent. for 24 h/day

U_{value} (walls) = **0,30** W/m²K
U_{value} (glazing) = **1,57** W/m²K



179500 kWh/year

mario.grosso@polito.it