Energy Saving Potential in Italian Buildings: Beyond the Standards

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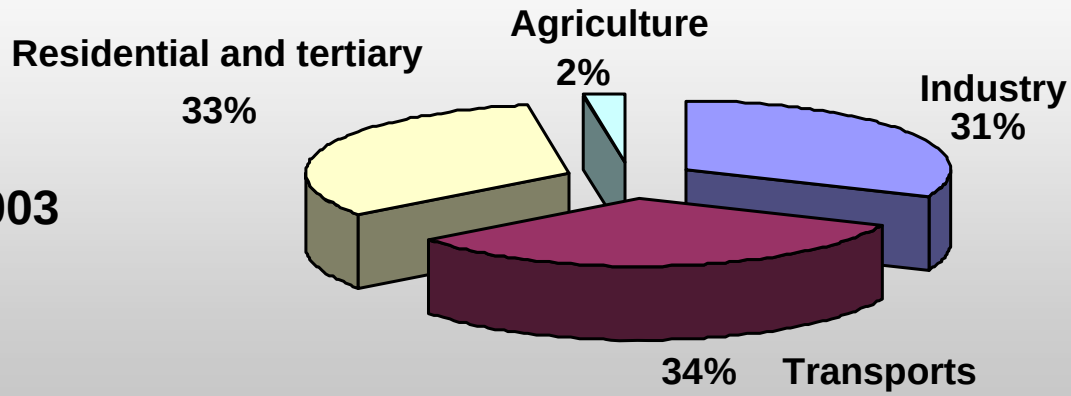
Energy consumption in Italy - 2003



At present 95% of energy consumption for heating, domestic hot water, air cond., lighting and ventilation **in Europe** are related to buildings built before 1980.

In order to achieve the Kyoto Protocol targets, the immediate priorities could be to improve the energy performance of these buildings!

Excursus on building energy standard in Italy

The most representative period for our built environment is that after the 2° World War (’50-’70): low performance buildings…(ab. 70% of the building stock!)

1976 Maximum envelope specific heat loss transmission coefficients “Cd”

i.e. envelope insulation (only for new buildings!)

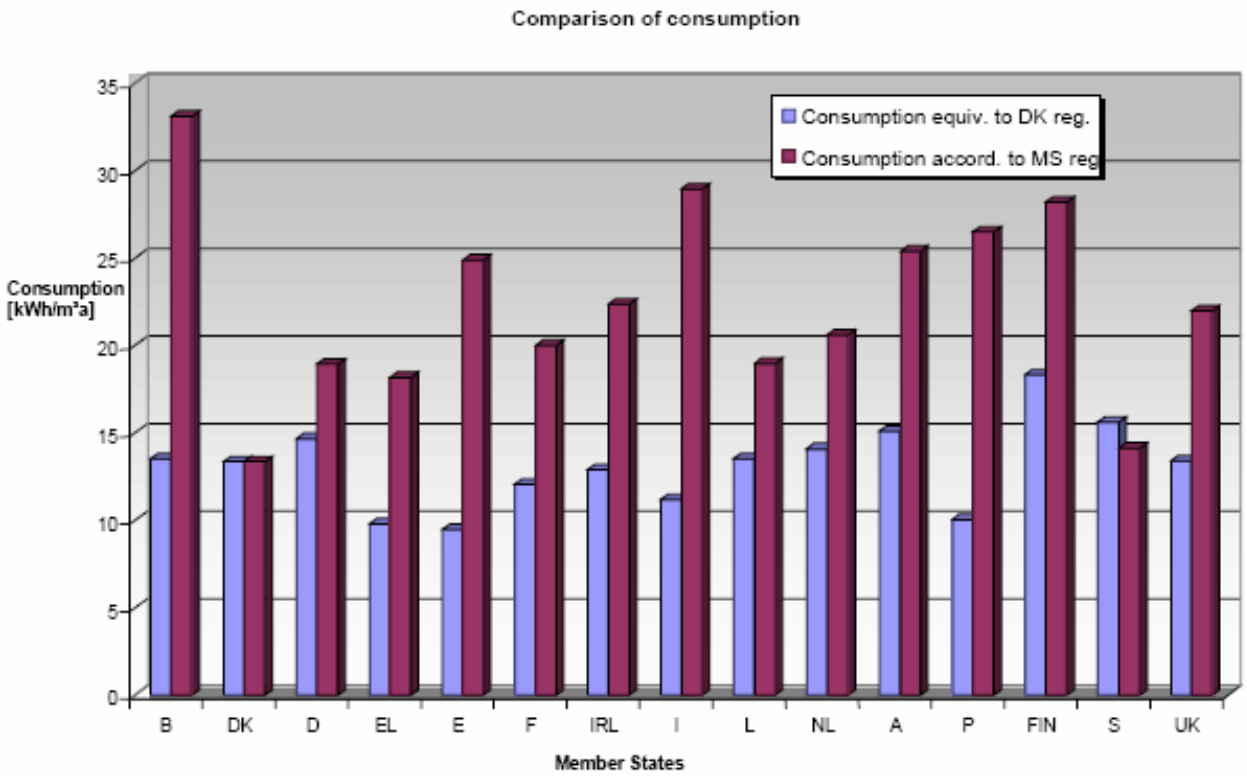
1986 More restrictive Cd (…)

1991-93 Maximum values of building heating energy demands

i.e. envelope insulation + efficiency of the heating system (only for new buildings or new heating systems!)

European Energy Performance of Buildings at year 2000

Figure 3: Energy consumption in Member States according to their existing national building regulations compared to the Danish model regulation adjusted for climatic differences[18 19].



European Energy Performance of Buildings Directive (EPBD) delivered in 2002

Energy performances of buildings shall integrate the following aspects:

- thermal insulation of building
- heating installation and hot water supply
- air-conditioning installation
- ventilation system
- lighting installation
- position and orientation of houses and apartments
- passive solar systems and shading devices
- natural daylighting and ventilation
- Indoor quality

The positive influence of the following aspects shall be taken into account:

- solar systems and other heating and electricity systems based on renewable energy sources
- electricity produced by CHP and/or district heating systems

Indicators: energy efficiency and CO_2 emission .

In Italy, based on the 2002-EPBD:

2005 new national benchmarks (ref. 2006 and 2009) for heating energy efficiencies in buildings (maximum values of building Primary Energy Demand)

i.e. envelope insulation + efficiency of the heating systems (including Domestic Hot Water)

mandatory also for the retrofit actions in existing buildings!

Rehabilitation strategies on large scale based on standards

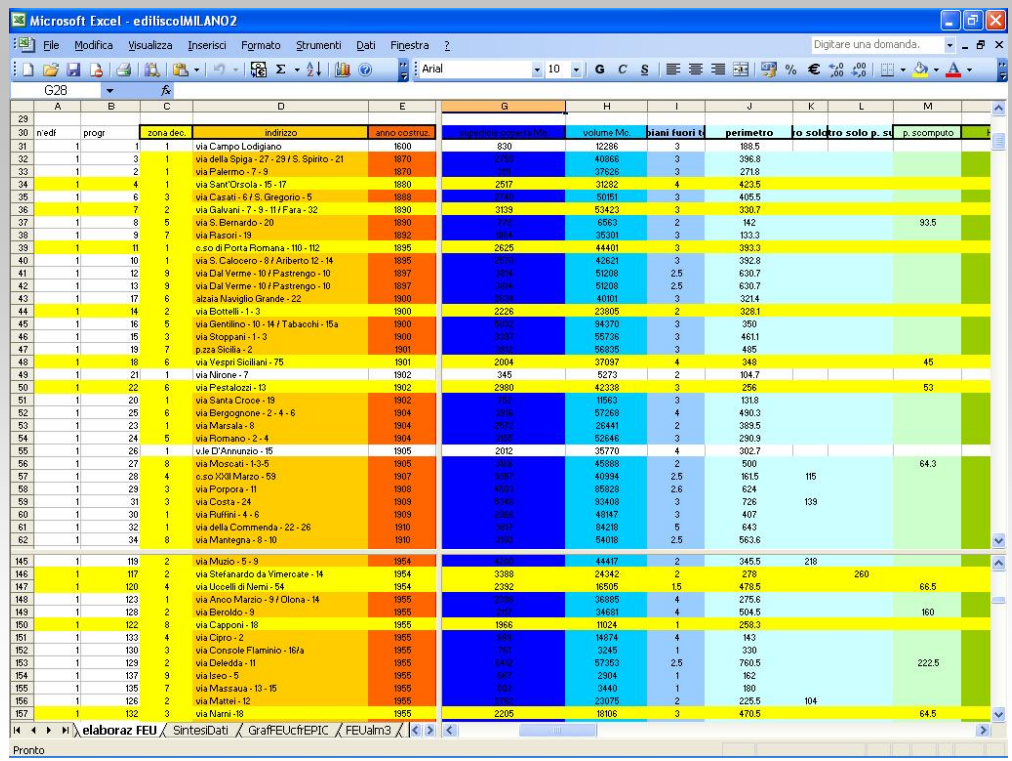
Case study:

Heating energy saving potential of a **Public school building stock** located in the district of the Municipality of Milan

Building data from **several** public offices, generally **recorded on administrative criteria** (address, age, volume, total floor area, owner, etc.)

627 schools have been identified, of which 517 buildings owned by the Municipality

The final database having full information on the building characteristics consists of **458** buildings built before 1984.



The building database was **grouped by ages** referring to the most significant changes in the construction technologies:

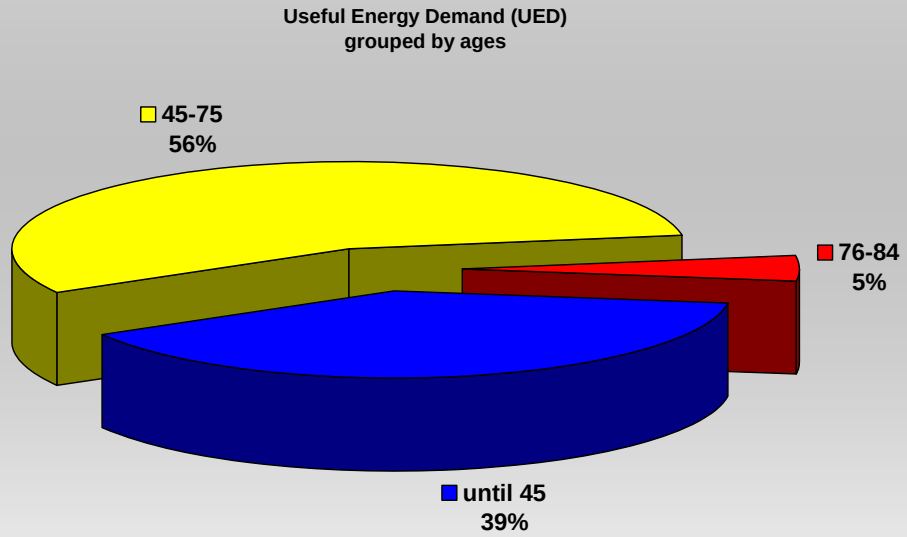
- **until 1945** (before the II World war)
- **from ’45 to ’75** (between the war and the first Italian standard on envelope energy performance)
- **from ‘76** (after the first National standard on envelopes)

Typical envelope insulation performances (external walls, roofs, basements and windows) **were assigned**.

In relation to the heated volume and to the daily use of the building in heating season (Degree Days) results the **Useful Energy Demand (UED)** for heating

$Cd = \Sigma U_i \times S_i/Vol\ [W/(m^3K)]$ $Cv = 0.175\ [W/(m^3K)]$ $Cg = Cd+Cv$

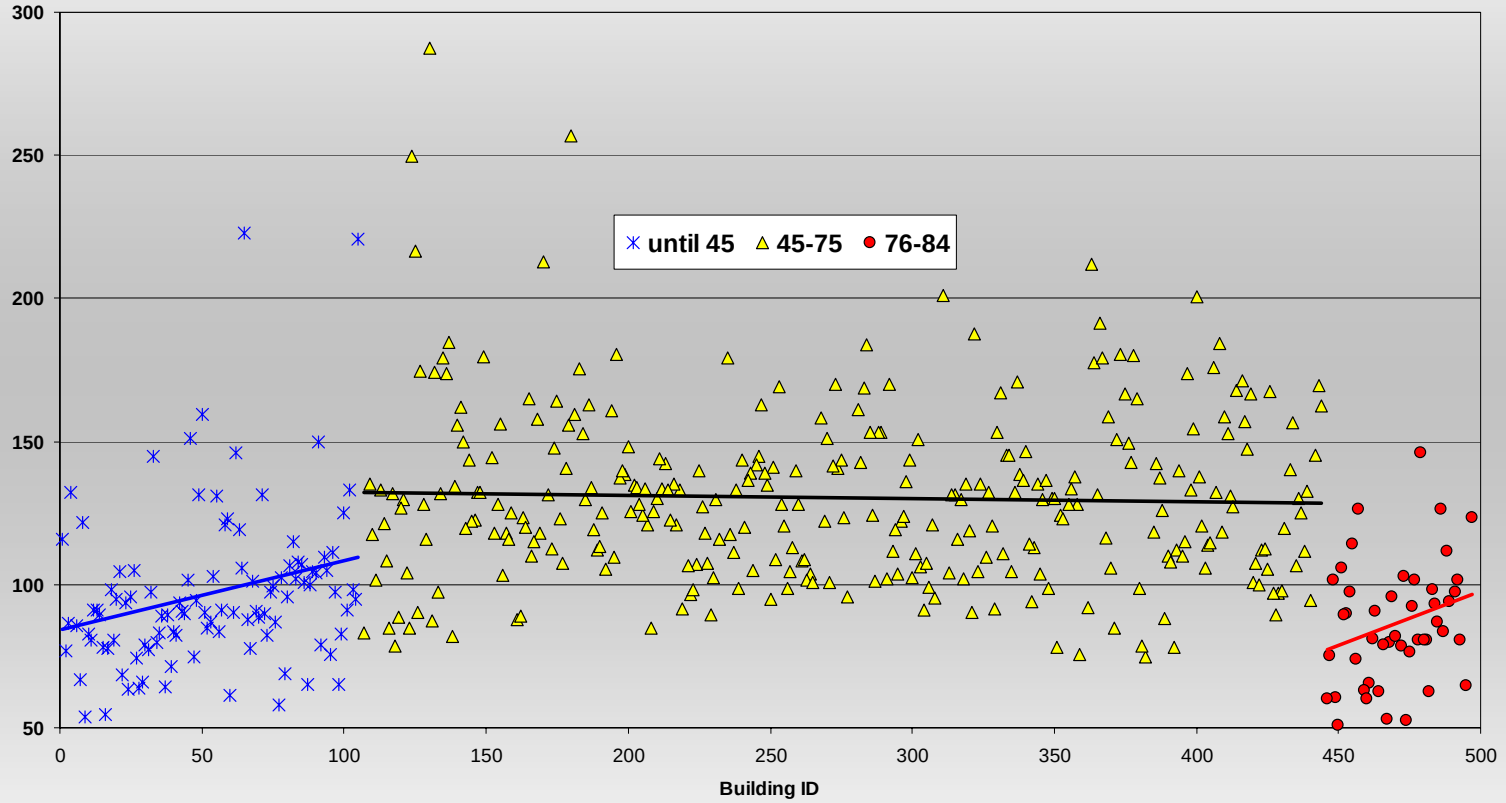
$UED = Cg \times V \times DD \times 86,4\ [kJ]$



Age before war represents less than 40% of total energy demand, while its volume is 45%

Age 45-75: 56% of the total UED related to the 48% of the total volume!

Specific Buildings Useful Energy Demand by ages (MJ/m^3)



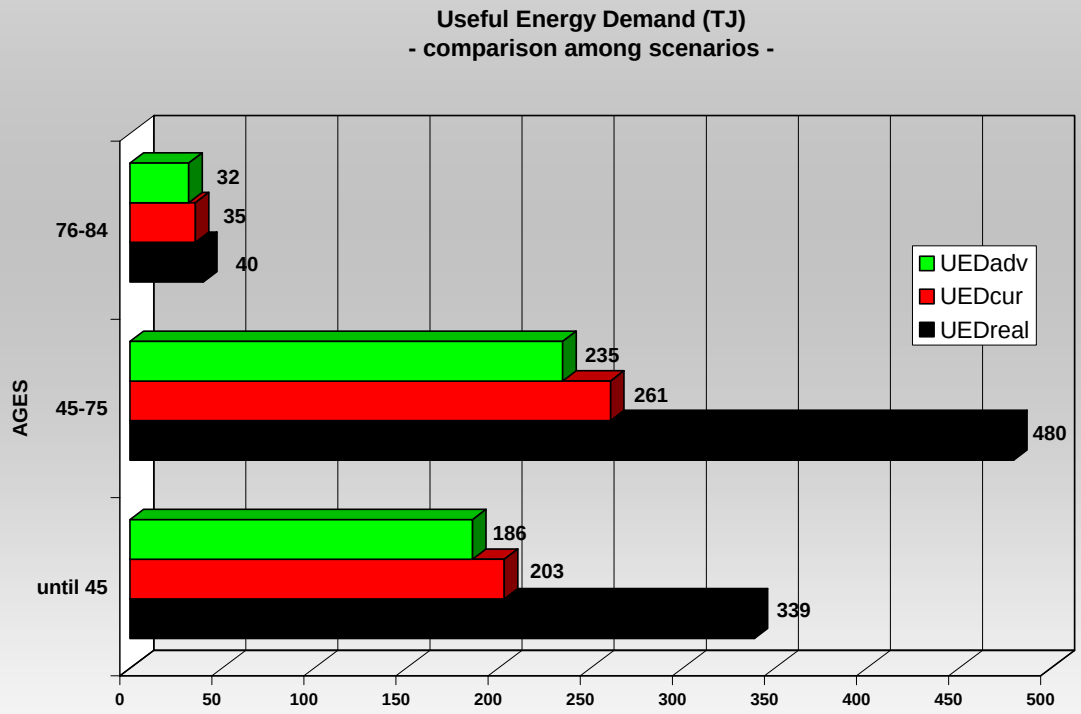
Buildings ’45-’75 are the most significant group of the stock that require retrofit actions

Hypothesis of refurbishment: maximum heat loss transmission coefficient *U-values* provided by new Italian standards based on EPBD (as a function of the Climatic Zones, two deadlines of implementation)

Maximum U-values for Milan (climatic zone E)

Zone E **2101- 3000 DD**	from 2006 (W/m^2K)	from 2009 (W/m^2K)
Basements and roofs	0.43	0.34
Opaque external walls	0.46	0.37
Windows (glass + frame)	2.8	2.5

Rehabilitations scenarios for building stock according to:
- current new 2006 standards (UED_{cur})
- advanced 2009 standards (UED_{adv})

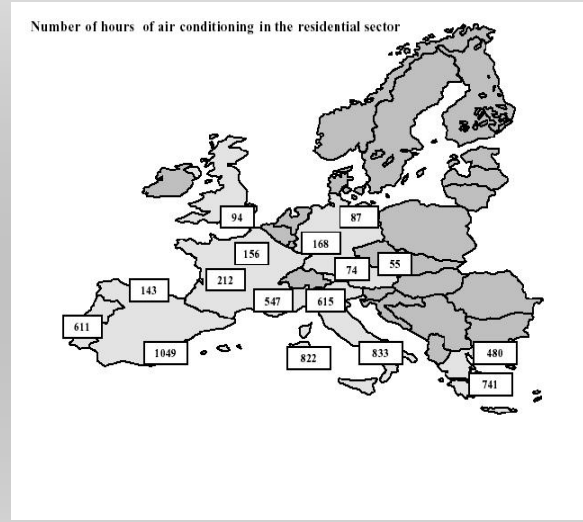


• Older buildings: a reduction from 40% (2006) to 45% (2009) of the thermal energy demand.

• **Buildings of the worst period: from 46% (2006) to 51% (2009).**

• Most recent building stock results only a maximum of 20% reduction

First Italian standard on EPBD implementation compared to current building energy performances reveals a **large potential of energy- environmental improvement**.



MOREOVER: we are waiting for next new rules concerning

- air-conditioning installation
- ventilation system
- lighting installation
- position and orientation of houses and apartments
- passive solar systems and shading devices
- natural daylighting and ventilation
- Indoor quality
- heating and electricity systems based on renewable energy sources
- electricity produced by CHP and/or district heating systems

Improving energy savings in retrofit beyond the standards:

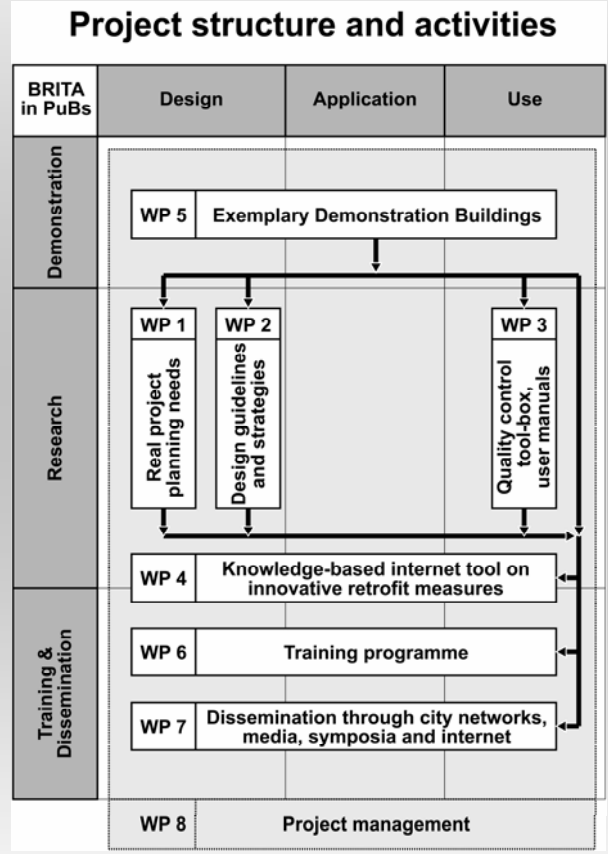
Case study:

Efficient retrofitting measures in a student hostel of Politecnico di Milano

The Politecnico of Milan with 22 European partners from public administration, research, design and consultancies has submitted a project, approved as one of the few Integrated Projects in the field of Eco-buildings.

BRITA in PuBs

EIE 6th Framework Project
Bringing Retrofit Innovation to Application in Public Buildings BRITA in PuBs
www.brita-in-pubs.com



In this frame was proposed the case-study

Rehabilitation of a student hostel: Daniel's Palace

Built on **1950**, the complex, consisting of four buildings, was built as a public hostel owned by **Municipality of Milan**.

Politecnico of Milan has rented this building for 35 years, to adapt it as a student house.

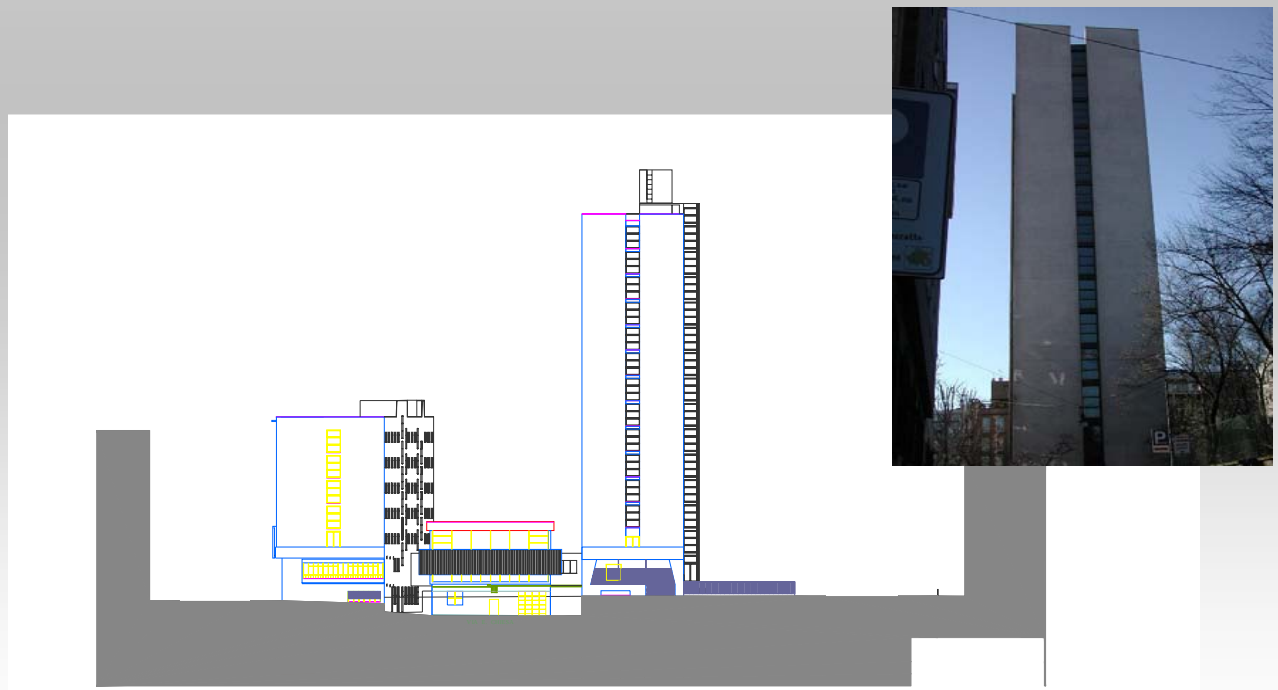
The Daniel's Palace is considered as **"relevant building"** from Municipal Authority: any modification of the façades is permitted, **any mandatory on energy saving standard!**

CONVENTIONAL REFURBISHMENT VERY SOFT ON ENERGY SAVINGS

The building was realised without thermal insulation and with an old heating system concept:

- a single central heating plant, without distinct thermal zones, serves all the radiators;
- several electrical boilers are installed to provide hot water.

The BRITA-proposal measures are focussed on improvement of the building envelope and of HVAC system energy performances.



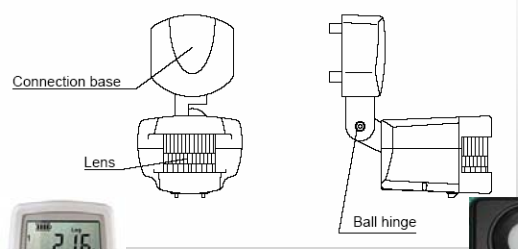
South view

Energy saving measures also include advanced control and management systems:

"comfort on demand strategies"
<u>local energy supply provided only when required!</u>

Over-use of the energy supplies are often significant in terms of energy wastes.

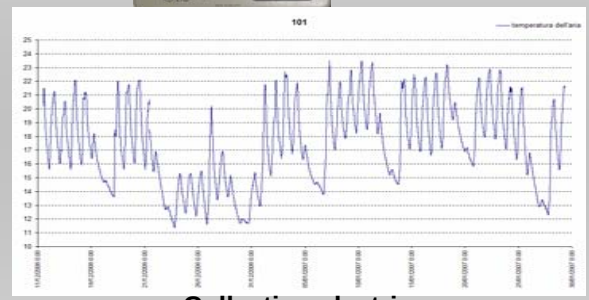
- carelessness of the users behaviour (in particular in a public building, no personal additional cost)
- absence of any equipment dedicated to perform specific controls



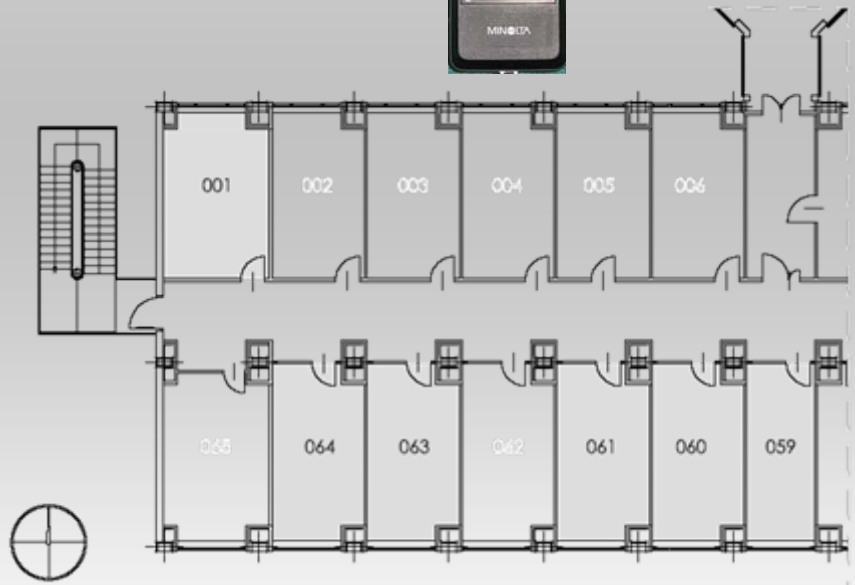
Collecting data by presence detectors and luminance levels

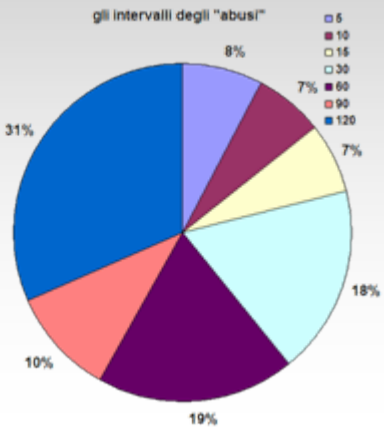
CUEPE – BEST research project

Experimental diagnosis in Politecnico di Milano offices (work in progress…)



Collecting electric consumption





Energy conservation.

The envelope measures finalized to **reduce the U-value**:

• for opaque surface:
- insulating layer into the air gap of the walls
- insulating layer on the interior surfaces
- insulation of roofs

• for windows: advanced glazing instead of the standard double glass windows

Moreover:

• Internal components for **daylighting control**

• radiant heating and cooling systems activated by **presence sensors.**

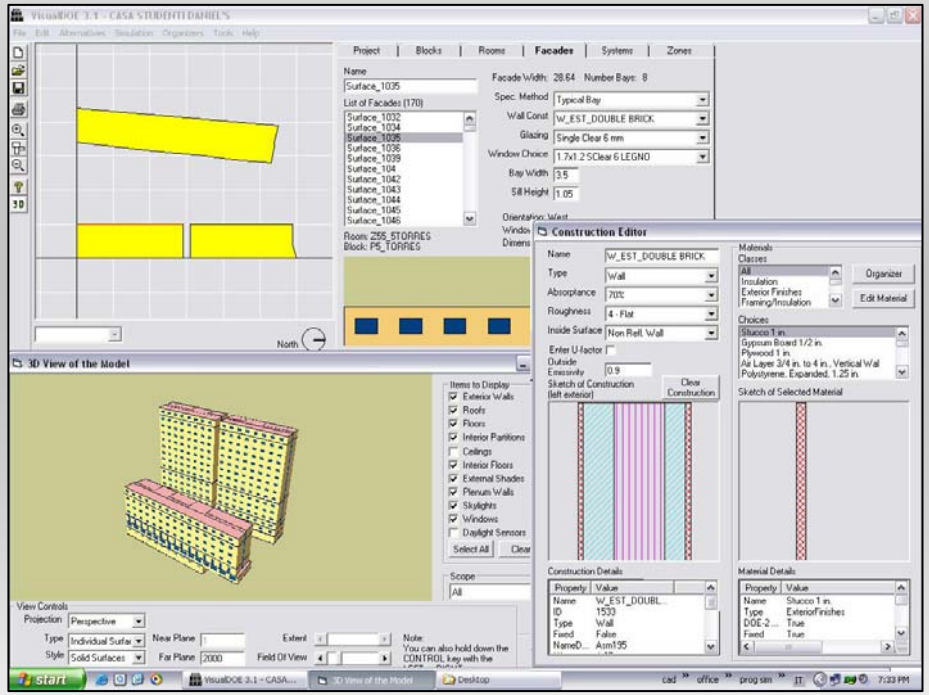
Efficient energy production

Instead of the new conventional heating boilers and electric chillers:

Building equipped with a **tri-generation** system for heating, cooling (with absorbtion chillers) and electricity production.

Energy Saving Potential in Italian Buildings: Beyond the Standards

Design evaluation: dynamic building energy simulation based on hourly climatic data.



- **Calibration of the simulation model with registered consumptions**
- **Implementation of the model with**

  - conventional refurbishment

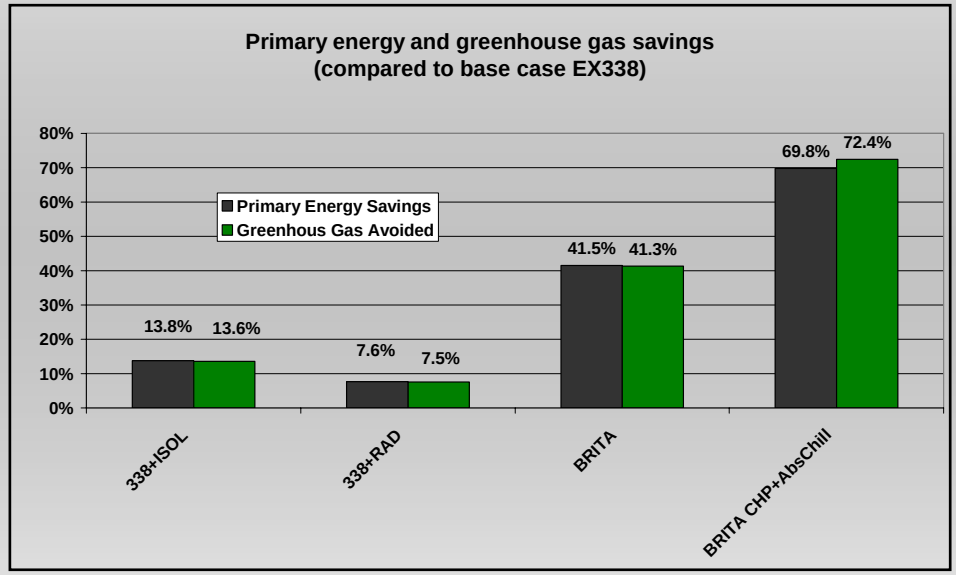
  and

  - advanced (BRITA) rehabilitation

From the conventional refurbishment to the advanced energy rehabilitation

Reference case: conventional refurbishment (**base case**)

- **Case 338ISOL:** thermal insulation for opaque surfaces + double panes low-e glass
- **Case 338RAD:** radiant ceiling for students apartments (85% of building)
- **Case BRITA:** 338ISOL + 338RAD + "comfort on demand" strategies
- **Case BRITA CHP+AbsChill:** BITA + Tri-generation

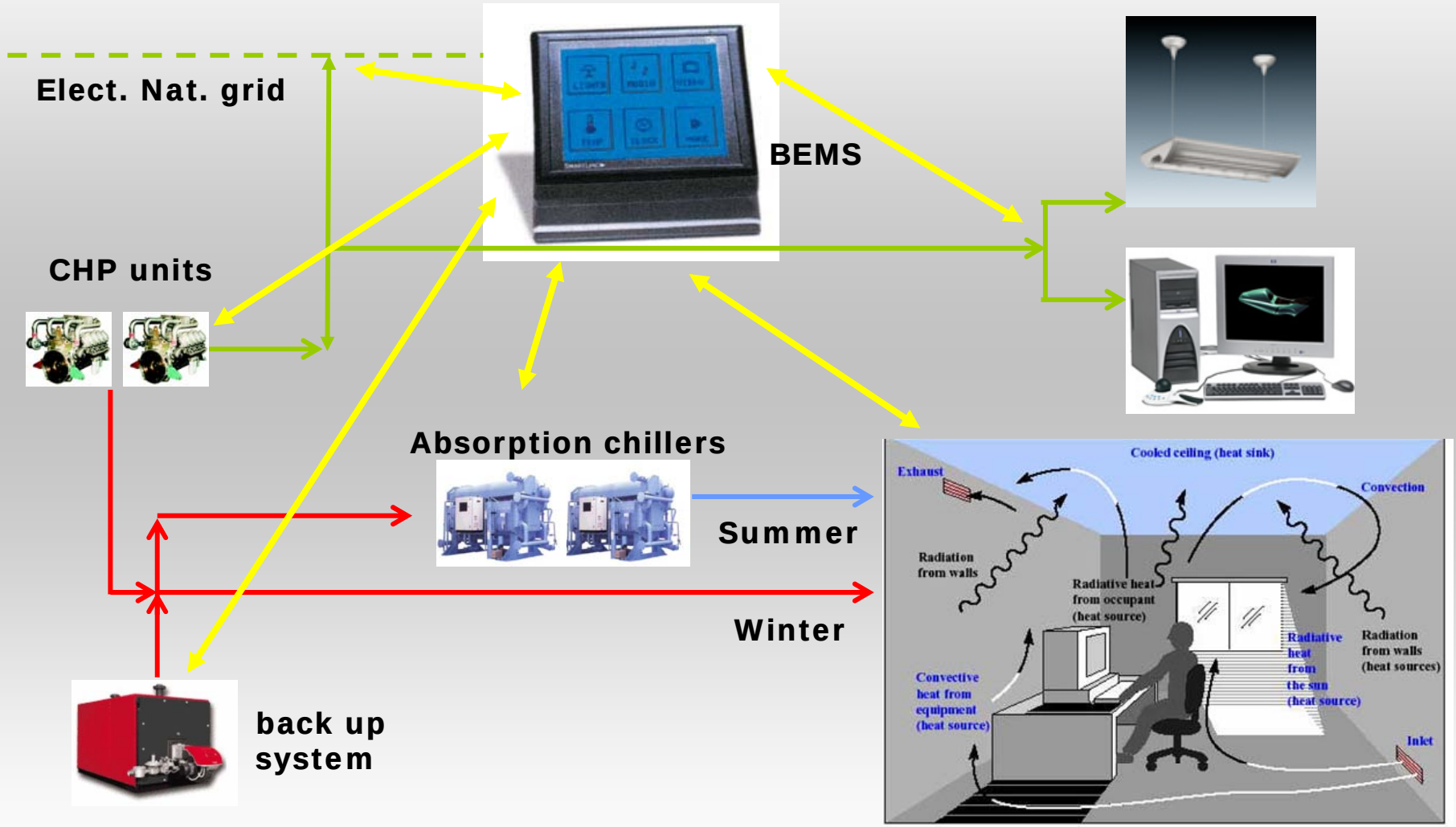


Improved primary energy savings with all the **BRITA solutions are about 40% in respect of base case** (referring to the same new conventional energy production system)

"Comfort on demand" control strategies contribute for about 20% of energy savings.

Moreover, **about 30% additional energy saving** can be considered **with tri-generation** (BRITA CHP+AbsChill) because of the electric surplus feed to the grid.

Energy Saving Potential in Italian Buildings: Beyond the Standards



Improving energy savings in NEW buildings beyond the standards:

Case study:

A Nursery School in Milan

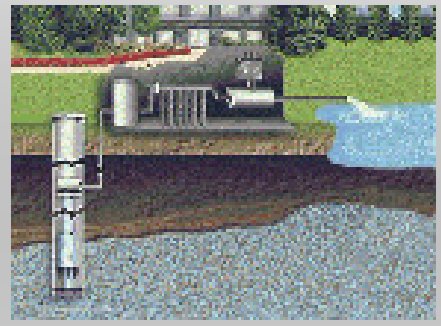
The DESIGN TEAM

close collaboration across disciplines for developing integrated solutions since the early step of the design process:

essential to the achievement of a low energy consumption building.

THE SITE POTENTIAL

underground water resources prompted early discussions with the design team about the possibility of exploiting this source for heating and cooling of the building

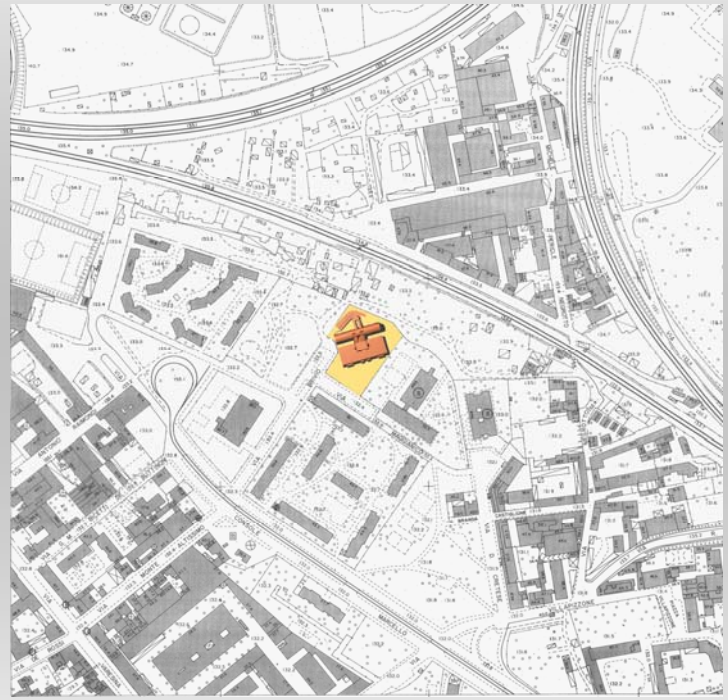


GroundWaterHP

- **high performances, both in winter and, if required, in summer (reversible type, cooling mode)**
- **no urban pollution**
- **conservation of global CO_2 emissions**
- **active contribution in controlling the water table level and revitalization of the nearby canal**

THE SITE POTENTIAL

<u>solar energy</u> approach included since the first design phases of the building:

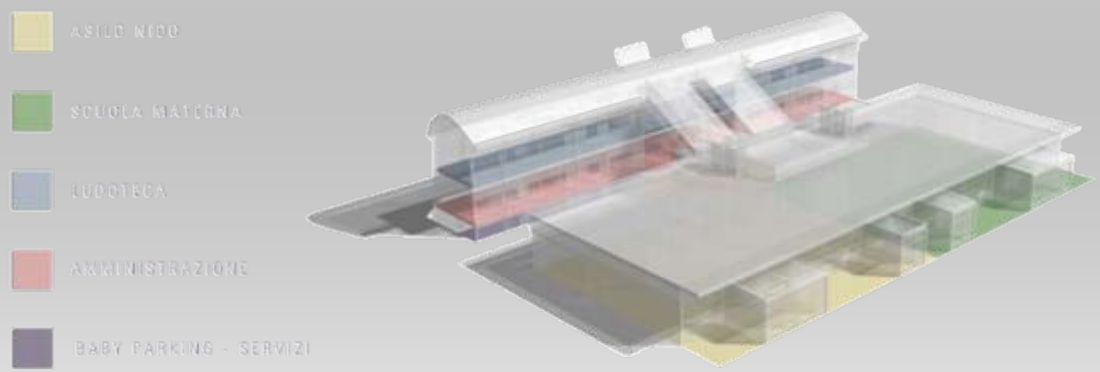


in respect to the sun path

- **rotation of the foot-mark originally foreseen for the building area**
- **optimization of building shape**

BUILDING DESCRIPTION

The New Childhood Centre (floor area of 1800 m^2) consists of a nursery school, a kindergarten, a fully independent baby-parking (babies can be accommodated for few hours) and the associated spaces.

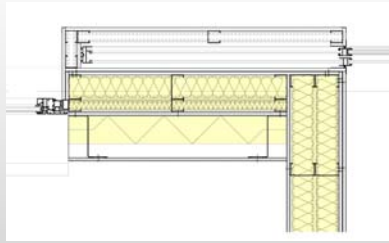


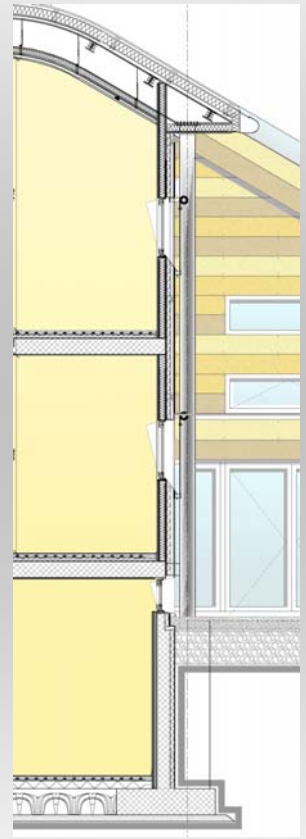
Passive design concepts

In order to optimize the solar heat gains during winter time, the parallel wings of the "H" shape extend from east to west, creating two inner courtyards.

- **south facing classrooms**
- **greenhouses-laboratories and offices**
- **north oriented services (i.e. kitchen, laundry rooms, dormitory areas).**

Building envelope



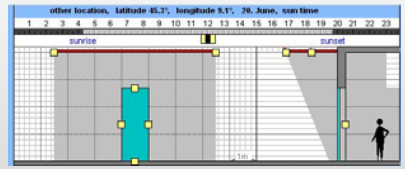


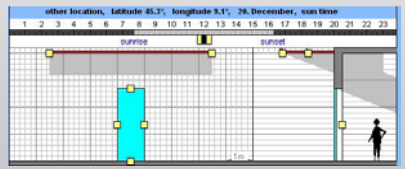
high–performance opaque and transparent enclosures:

U–values lower (by 25%) than the national standards proposed for 2009 by the first national implementation of EPBD).

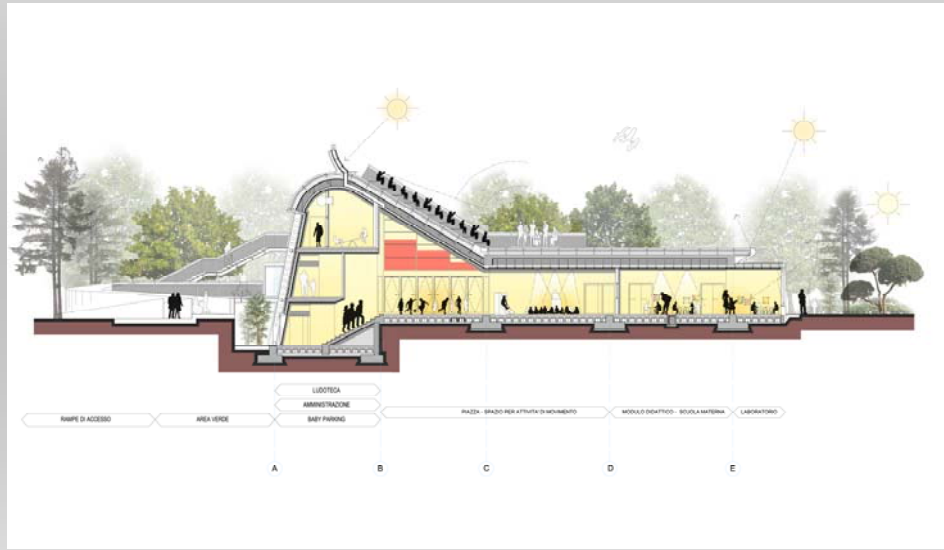
Envelope U-value (W/m^{2}K)			
Surfaces	**From 1/1/2006**	**From 1/1/2009**	**Childhood Centre**
Opaque Vertical	**< 0.46**	**< 0.37**	**< 0.28**
Opaque Horizontal	**< 0.43**	**< 0.34**	**< 0.26**
Windows	**< 2.4**	**< 1.9**	**< 1.43**

Building envelope

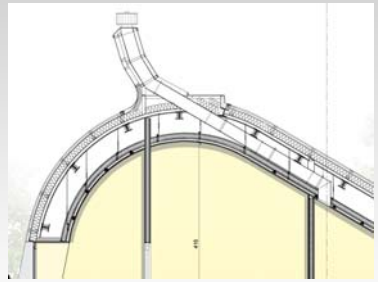




- **external overhangs and venetian-blinds for the solar control on transparent components**



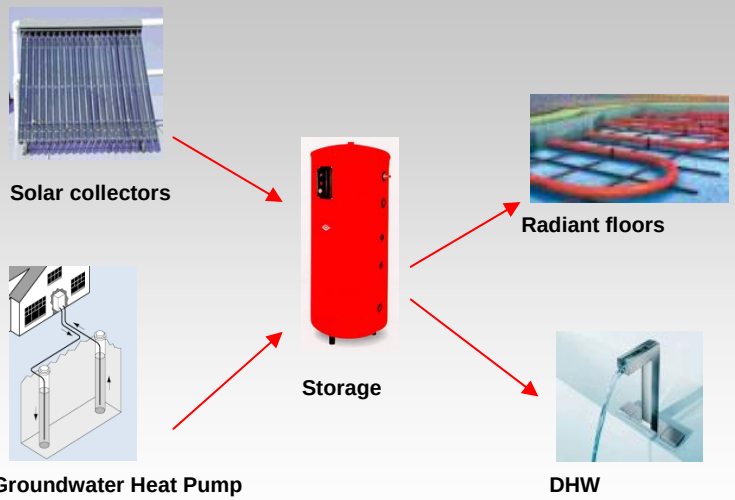
- **positioning of the windows and a solar chimney help in providing natural ventilation** (important for a public school building, where usually there is no provision for summer air conditioning)



Heating system

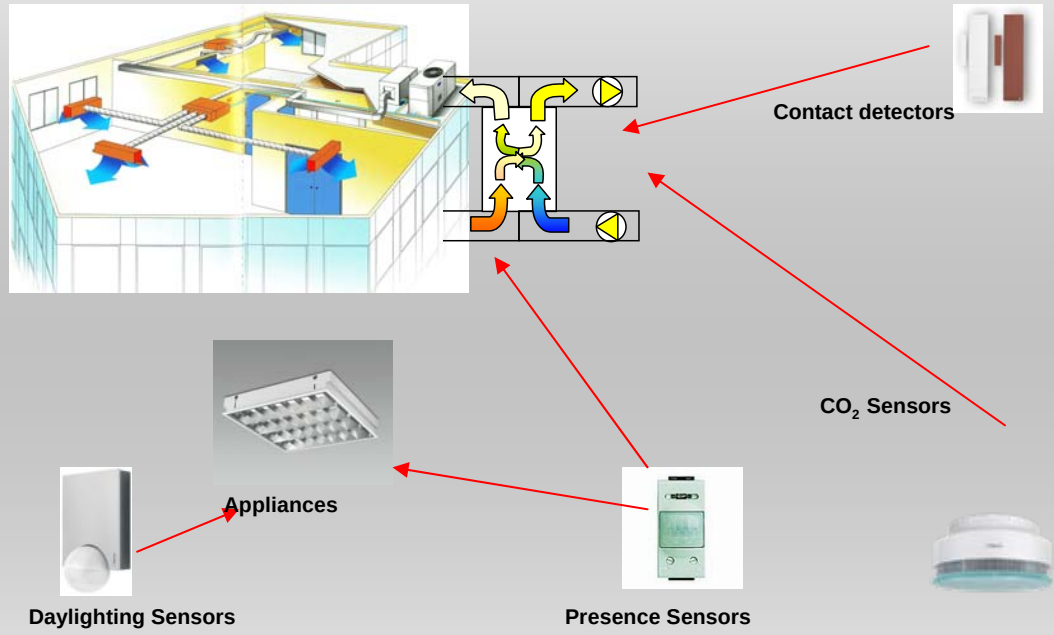
• **primary air ventilation** system (ensuring IAQ) with **heat recovery (ab. 70%)**
• **floor warming**
(low temperature, high level of thermal comfort, warm floor surface particularly suitable for children).

• **groundwater heat pump system supplies hot water in winter for space heating and DHW, through storage tanks.**



During the rest of the year, evacuated solar thermal collectors, placed on south facing roof, provide hot water for DHW (also contribute to hot water in storage tanks during winter).

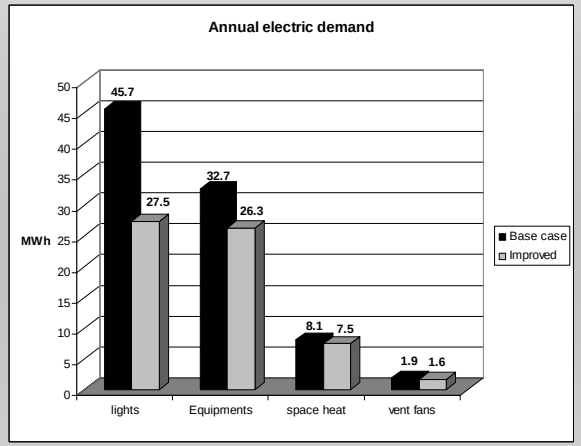
Control systems



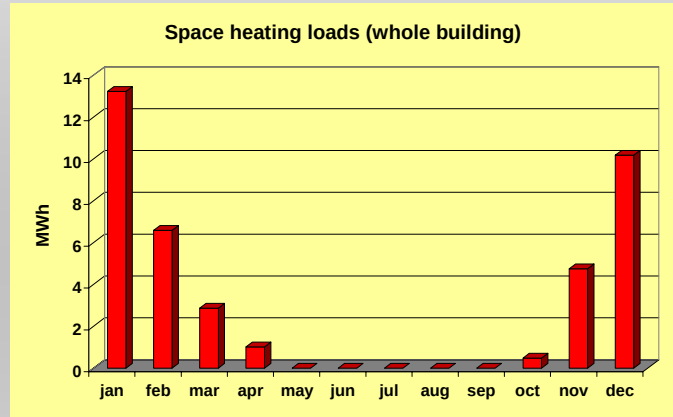
- **presence detectors coupled by daylighting sensors, for controlling both electricity and thermal energy supply**
- **primary air ventilation operation mode will be also controlled by contact detectors for windows and CO_2-sensors.**

THE ENERGY AND ENVIRONMENTAL PERFORMANCE

Simulations to verify the building energy performances during the design development phase of the project



20 kWh/m² of annual heating energy demand



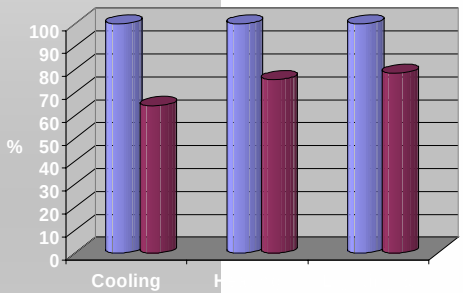
electric energy savings (30% less) due to the control systems

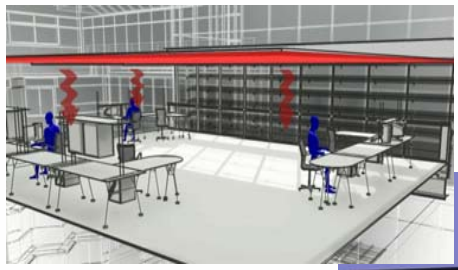
groundwater heat pump (comparison to a conventional gas boiler for heating): reduction of 53% of primary energy and 50% of GHG emission.

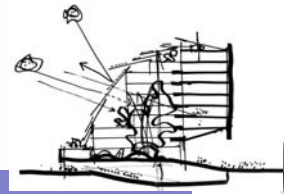
Heating type	Primary energy (kWh/y)	GHG (kg/y)
Conventional Gas boiler	43431	10713
GW-HP	20623	5393

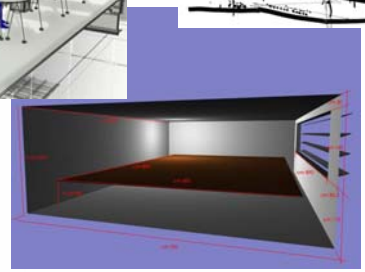
Improving energy savings in NEW buildings beyond the standards: SIEEB (Sino - Italy Environment and Energy Building)

Low energy and high environmental quality building for teaching and research activities in the Tsinghua University of Beijing: **Kyoto Protocol target (CDM Mechanism)**



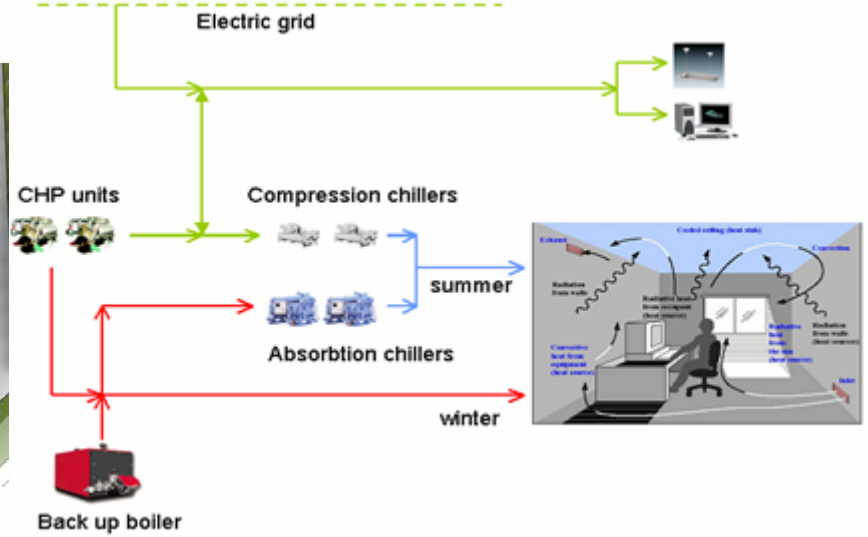






Partner: MOST
Ministry of Science and Technology of the People's Republic of China

Ministry for the Environment and Territory



Conclusions

Dec 2006: last Italian EPBD implementation

- **updated the 2005 heating energy benchmarks with more restrictive values**
- **50% of DHW demand provided by solar thermal systems mandatory**

Good!

but how many time can we wait for the other topics foreseen by the EPBD?

environment emergency, limited fossil sources, urban pollution, etc…

Energy efficiency in buildings should become a key issue in current practices, beyond mandatory standards.

Grazie per l'attenzione!