School “Tito Maccio Plauto” – Cesena (IT)

1. INTRODUCTION

PROJECT SUMMARY

- *Major renovation of a primary school, built in the 60s*
- *389 students, 49 employees*
- *17 classes (about 22 students each)*
- *Area: 6.420 m^2; Volume: 24.554 m^3*
- *No previous energy renovation*
- *Measures on:*
  - *building envelope*
  - *heating system*
  - *RES and lighting*

SPECIAL FEATURES

- *Limited additional costs*
- *External insulation with re-design of architectural aesthetic features.*
- *Users’ participation*

ARCHITECT

- *Municipality of Cesena - Department of Public Works Technical Office*

OWNER

- *Municipality of Cesena*

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IEA SHC Task 47
Renovation of Non-Residential Buildings towards Sustainable Standards

SHC SOLAR HEATING & COOLING PROGRAMME INTERNATIONAL ENERGY AGENCY

2. CONTEXT AND BACKGROUND

BACKGROUND

- *The school is located in a modern neighborhood in a medium size town*
- *Occupational profile: the school is occupied from 8.00 to 13.00; Gym and music hall are occupied in the afternoon and in the evening, with variable schedules (no summer use)*

Critical points

- *Installation of controlled mechanical ventilation system would interfere with existing control devices and require expensive work for architectural integration*

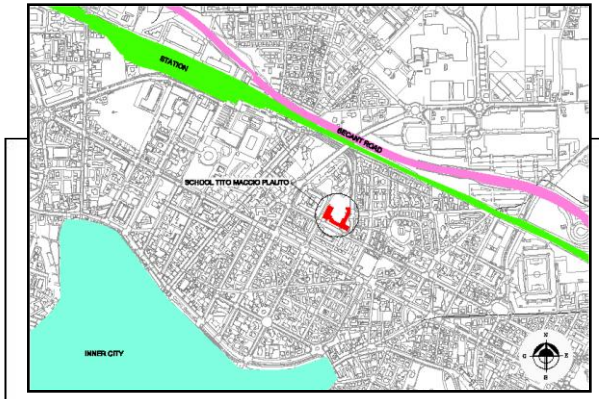
OBJECTIVES OF THE RENOVATION

- *Reduction on heating and total energy consumption*
- *Improve indoor comfort*

SUMMARY OF THE RENOVATION

- *Relevant heating and total energy consumption reduction*
- *Total envelop refurbishment and user's participation*
- *Low construction and maintenance costs.*

City Plan



Ground floor Plan

3. DECISION MAKING PROCESSES

SELECTION

The building was chosen, according to the municipal plan of refurbishment, because of:

- *low energy and indoor comfort performance*
- *need for architectural maintenance*

FUNDING

- *Municipal funding program for energy refurbishment of the school building stock*
- *European funds used (7th FWP, about 603 k€, funded at 75%)*

ACTORS INVOLVED *(so far…)*

- *Municipality of Cesena - Department for Public Works and Projects Office*
- *Municipal General Director staff*
- *In-house company: "Energie per la citta spa"*
- *Partnership with EU 7th FP Project:" School of the Future" (experts for renovation)*
- *Building users*

DESIGN PHASES

- *Building inspection and survey, mapping pathologies and defects*
- *Design simulations by a software based on Italian UNI TS 11300 calculation standard for energy certification)*
- *Evaluation of renovation solutions*
- *Open call for tenders beginning 2012*

A standard classroom

Timeline for the decision making process

Idea was born
At the beginning of 2011

First brief project description completed
April 2011

Detailed project description completed
December 2011

Tendering process started
at the beginning of 2012

Signing of contract with main contractor
Spring 2012

Start renovation
Summer 2012

Renovation completed
at the beginning of 2014

Evaluation among occupants
February 2016

4. BUILDING ENVELOPE

Roof construction (Gym) *U-value: 0,28 W/m².K*

(new) polystyrene insulation	*100 mm*
Mortar concrete and bricks	*300mm*
Total	*400 mm*

Wall construction (school) *U-value: 0,30*

Brick and internal plastering	*300 mm*
(new) Glass wool panels	*120mm*
Total	*420 mm*

Slab/ceiling *(attic floor) U-value: 0,185 W/m².K*

Mortar concrete and bricks	*210 mm*
(new) glass wool rolls insulation	*200 mm*
Total	*410 mm*

Floor/slab *(ground basement)* *U-value: 0,31*

Mortar concrete and bricks	*210 mm*
(new) polystyrene insulation	*100 mm*
Total	*310 mm*

Windows: *U-value: 1,14 W/m2.K*
(new) PVC with argon frames, double glazing

Thermal bridge avoidance:
Continuity of the insulation by window sill, corners connections. A facade wall strip close to the walkways will not be insulated

Summary of U-values	Before	After
Slab/ceiling (attic floor)	2,31	0,185 (-92%)
Walls (school)	1,85	0,30 (- 84%)
Floor/slab (basement)	1,33	0,31 (-77%)
Windows	5,71	1,14 (-80%)
Gym roof	2,32	0,28 (-88%)
Gym Walls	1,85	0,37 (-80%)

Before:

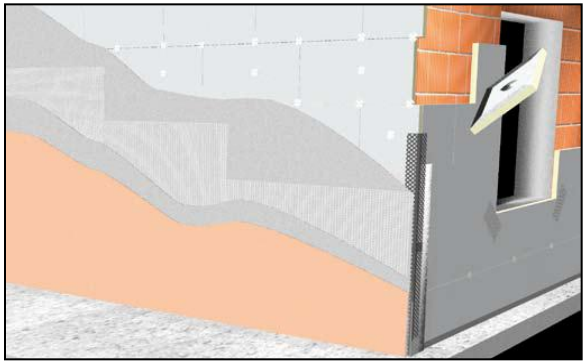
Wall: Fair faced bricks walls

Windows: single glazed windows with iron frame

Roof and slab/ceiling (unheated attic floor) : concrete and brick masonry

Retrofit:

Project details in course …



5. BUILDING SERVICES SYSTEM

OVERALL DESIGN STRATEGY:

-Complete envelope refurbishment
-Heating system renovation
-RES covering electric energy needs – lighting control and h. efficient lamps

HEATING SYSTEM

-Before: Natural gas boilers (firebox power 385+385 kW)
-After: Condensing and modulating boilers, radiators in the classrooms and fan-coils in the gym

COOLING SYSTEM

- Before and after: no cooling system

VENTILATION

-Before: natural ventilation only
-After: controlled ventilation (humidity)

-HOT WATER PRODUCTION

-Before: Natural gas boilers
-Condensing Boilers

RENEWABLE ENERGY SYSTEMS

-After: PV system on the Gym roof covers electric annual energy need

Before

The existing natural gas boilers (installed in 1977)

- radiators in the classrooms

- fan-coils in the Gym

After Retrofit:

- *Condensing and modulating boilers*
- *Thermostatic valves installed on radiators*
- *New monitoring system for managing the heating system*
- *Monitoring system connected to the Municipality energy centralized one*

BENEFITS:

- *Increased average seasonal efficiency ratio*
- *Occupancy control will make the heating system work according to the external temperature and the actual use of the classrooms*

6. ENERGY PERFORMANCES

Global EP index:

-Before: 154,3 (kWh/m2)

-After: 41,04 (kWh/m2) (IT practice: 79)

Heating EP index

-Before: 137 (kWh/m2)
-After: 34 (kWh/m2)

Renewable Energy Use

-45-55 kW PV system on the Gym roof covering 100% electricity need (from all electric devices, lighting, computers, etc)

-a new air plant heating system (Roof Top) for the Gym (under consideration)

Thermal And Electric Consumption And Costs (Before And After)

-See tables on the side

Primary energy consumption

-Primary energy consumption is defined as delivered energy multiplied with primary energy factors

-All energy numbers are primary energy

Consumptions & costs

Heating energy (year 2009)	
Before: Year	**Annual consumption (kWh/m2 anno)**
2010	123,12
Average value (last 5 years)	**117,45**

Natural gas consumption (year 2009)
72.418 m^3

Users	**Electricity consumption (year 2010)**
Lighting, Lift Pumps and heaters, Offices and Labs	**68.328** kWh 10,64 kWh/m2 **11.890** EURO

Degree Days (DD)	Actual days of heating
1.933	183
Hours of heating	
Classrooms	
1.304	
Offices Area	Gymnasium Area
1.357	1.631

After retrofit:

Heating EP index reduction:

75%

Global EP index reduction:

67%

Electric energy covered by Renewable Energy Systems

up to 100%

7. ENVIRONMENTAL PERFORMANCE

•WATER MANAGEMENT
•WASTE MANAGEMENT
•ECOLOGICAL MATERIALS
•CERTIFICATION / LABELS
•LIFE CYCLE ANALYSIS
•WHOLE LIFE COSTS
•LIGHTING QUALITY
No particular attention and analysis

• INDOOR CLIMATE
• INCREASING QUALITY OF LIFE
• INDOOR AIR QUALITY

- The original working temperature for the heating system (65-75° C) will be reduced to improve the indoor quality

- New lighting system with regulation of the light intensity according to the external natural light

- Reduction of indoor noise due to double glazing

All 3 aspects will be monitored after the retrofit.

7. MORE INFORMATION

RENOVATION COSTS

- *Low costs 100€/m^2, according to initial planning. Effective costs will increase after the detail project*
- *Individual energy saving and expected pay back time will be assessed during the design phase*
- *No data are available yet*

FINANCING MODEL

- *Public (traditional)*
- *EU 7 FP contribution (603 k€, funded at 75%), Municipality will cover the residual cost*

OTHER INTERESTING ASPECTS

- *Users' participation (administration employees, teachers, pupils)*
- *2 classrooms will be equipped with mechanical ventilation system and the measured data will be compared with the ones without natural ventilation*

Work is in progress …

Updates will be uploaded on the SHC Task 47 website