School “Tito Maccio Plauto” – Cesena (IT)

1. INTRODUCTION

PROJECT SUMMARY

- *Major renovation of a primary school, built in the 60s’*
- *440 students, 50 employees*
- *20 classes (about 22 students)*
- *Area: 6.420 m^2; Volume: 24.554 m^3*
- *No previous energy renovation*
- *Intervention on:*
  - *building envelope*
  - *heating and ventilation system*
  - *RES*

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

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2. CONTEXT AND BACKGROUND

BACKGROUND

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

Critical points

- *Installation of mechanical ventilation in most of the classrooms interfered with existing control devices and required expensive works for architectural integration*

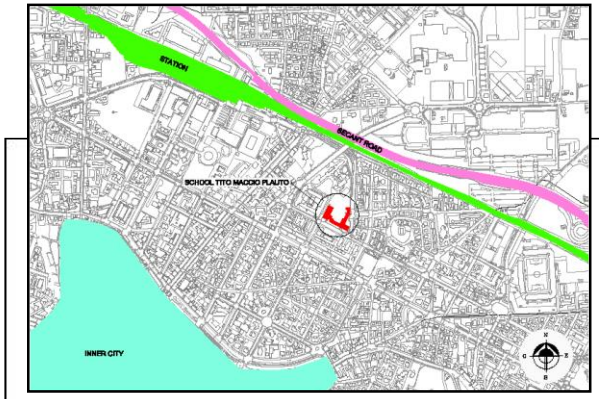
OBJECTIVES OF THE RENOVATION

- *Reduction of heating and global energy consumption*
- *Improve indoor comfort*

SUMMARY OF THE RENOVATION

- *Relevant heating and global energy consumption reduction*
- *Total envelop refurbishment and user's participation*
- *Low 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 are used (7th FWP, about 603 k€, funded at 75%)*

ACTORS INVOLVED

- *Municipality of Cesena - department for public works and Projects Office*
- *Municipal general director staff*
- *In-house company: "Energie per la citta spa"*
- *Partnership of EU 7th FP Project:" School of the Future" (experts for renovation)*
- *Building users, ENEA (Italian EE Agency)*

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 in 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
Springs 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:

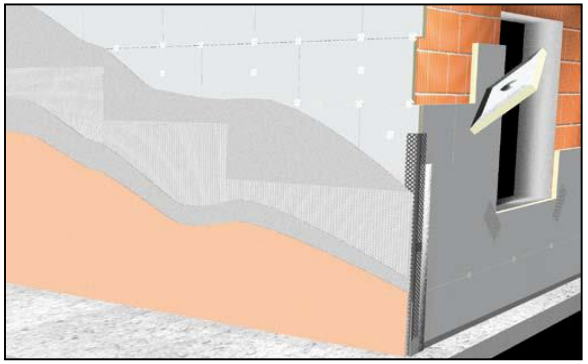
Wall: Fair faced bricks walls

Windows: single glazed windows with iron frame

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

Retrofit:

Insulation system



5. BUILDING SERVICES SYSTEM

OVERALL DESIGN STRATEGY:

- *Complete envelope refurbishment*
- *Heating system renovation*
- *RES covering electricity needs*
- *BEMS*

HEATING SYSTEM

- *Before: Natural gas boilers (firebox power 385+385 kW)*
- *After: Condensing and modulating boilers, radiators with thermostats (classrooms) and heat convectors (gym hall)*

COOLING SYSTEM

- *Before and after: no cooling system*

VENTILATION

-*Before: natural ventilation only*
-*After: mechanical ventilation with recovery*

-HOT WATER PRODUCTION

-*Before: Natural gas boilers*
- *Condensing Boilers*

RENEWABLE ENERGY SYSTEMS

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

Before

The existing natural gas boilers (installed in 1977)

- radiators in the classrooms

- heat-convectors in the Gym Hall

After Retrofit:

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

BENEFITS:

- *Increased average seasonal efficiency ratio*
- *Occupancy control makes 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: 32,3 (kWh/m2) (Practice in Italy: 79)

Heating EP index

- Before: 137 (kWh/m2)
- After: 32,3 (kWh/m2)

Renewable Energy Use

- 64,5 kW PV system on the School roof covering 100% electric energy need (from all electric devices, lighting, computers, *etc,)*

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)

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 m³

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:

Global EP index reduction:

79%

Heating EP index reduction:

76%

Electric energy covered by Renewable Energy Systems

100%

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CLARIFICATION: the energy calculations and given energy numbers will be according to the national standards which might vary between countries., i.e. numbers are not always comparable

7. ENVIRONMENTAL PERFORMANCE

No particular attention and analysis to the following environmental issues:

- water management
- waste management
- ecological materials

No use of:

- labels
- life cycle analysis
- Life cycle costs

Benefits:

- **INDOOR CLIMATE**
  - *The original functioning temperature (65-75°C) was reduced.*
  - *Efficient windows improved the winter thermal comfort*
  - *Installed sun-shading improved the thermal comfort during the intermediate season*
- **INDOOR AIR QUALITY**

Mechanical ventilation improved the indoor air quality

- **.QUALITY OF LIFE**

- Reduction of indoor noise due double glazing
- General improvement from first feedback questionnaires completed by the occupants.

7. MORE INFORMATION

- **RENOVATION COSTS**

  Low renovation costs (120€/m2), slightly increased compared to the initial planning, essentially due to unpredicted conditions during the executive phase.

- **FINANCING &CONTRACTING MODEL**
  - *Public financing (traditional)*
  - *EU 7 FP contribution (603 k€, funded at 75%), Municipality will cover the residual costt*
  - *No public tender: Contractors were chosen by private auction through a simple negotiated procedure, according to the Italian "public contracts code" 163/2006, for benefit of time saving.*
- **OTHER ASPECTS**
  - *Particular challenges resided in guaranteeing continuous functionality to the school for lessons, facilities and office activities (eg. scaffoldings on the classrooms facades, fire escape measures)*
  - *The school coordinator, assistants, pupils, sport societies were involved in the renovation. They completed feedback questionnaires and will be involved in POE (Post Occupancy Evaluation).*
  - *The participation in the EU project http://www.school-of-the-future.eu/ encouraged networking, periodical evaluation and reporting.*