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Social Housing Policies and Best Practice Review for Retrofit Action - Case Studies from Parma (IT)

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Abstract. The paper aims at investigating the most suitable Energy Saving Measures –ESMs– for the retrofitting of Social Housing Stock –SHS– in Europe. A global awareness has been increasing, as well as education and training among architects and building sectors employees, in order to identify tailored financing schemes and advanced integrated retrofitting solutions. Several European financed programmes have been tested so far and the results are here summarized and deeply investigated in order to increase the energy performance of social housing buildings, to improve knowledge of problems associated with the retrofitting of these households, in order to provide the most appropriate solutions to be applied. Afterward, the best practices selected have been applied to some study cases in Italy, to demonstrate that the large variety of SH programmes in Europe can seriously be used, promoting the best practises' application. A lot of theoretical and analytical work has been carried out by many European projects in the last decade, defining different approaches according to typologies of social housing buildings, focusing on national or regional regulation, on existing typologies and building techniques, on retrofitting solutions, on energy saving strategies and other managing approaches and energy saving devices. Due to the high participation of social housing organisations –SHO– and related European financed programmes, this academic research is focused on the most effective ESMs in order to encompass a large variety of needs and related solutions, even though some of them are still on course and other ones have already been completed. This research clearly demonstrates the valuable contribution these kinds of programme have in exchanging and sharing of knowledge and experience in the field of retrofit of Social Housing building across Europe, in order to primary improve the energy performance of the existing building stock and the quality of life of their inhabitants.

1. Introduction

Addressing the question of retrofit for Social Housing Stock SHS [1] means dealing with a huge range of existing building types, dissimilar in diffusion and consistency, in each European country and region. The experiences that come from numerous researches and design experiences converge to fix some critical points to work on to restore, or to give acceptable performance in even the recent existing built fabric, already severely ruined. The interventions so far proposed are usually made in order to rearrange the building structure and envelope in a way that can greatly affect the environmental conditions (acting in many directions and at different project scales).

Considering the Italian ageing stock, characterized by a strong built identity and cultural significance for its diffusion and social importance, every retrofit action should keep in mind that the most of these buildings were not built with energy efficiency in mind, since most of them are dating from 1960 [2].

Similar results can be identified in several countries in Europe with a large variety of retrofit programs to be applied to residential buildings. All these European retrofit programs originate from the Intelligent Energy Europe IEE [3], launched in 2003 and now closed, that has defined many instruments to create an energy-intelligent future, involving energy efficiency and renewable energy policies, with a view to reaching the EU 2020 targets. IEE aimed at creating better conditions for a more sustainable energy future in several areas, as varied as renewable energy, energy-efficient buildings and many more. With this idea, IEE was divide in three parts, among those, *Energy efficiency and the rational use of energy* (SAVE) is the one involving the improvement of energy effectiveness and the rational use of resources in building sectors, by providing training and practical suggestion on construction techniques that can grant energy savings. SAVE involves though many programs in order to address energy saving actions for Social Housing Building stock. More than 40 European Retrofit programs for social housing stock have here been evaluated in order to classify the most suitable and effective practices to be transferred in Italy (table 1).

Considering that European Countries have a large residential building stock, erected from 1920 to 1970, which have to undergo energy retrofit or which need to be interested by urban renewal interventions, countries and related building technologies have to be considered separately, according to the climatic and heating needs, as well as consistent with different social housing policies [4].

Table 1. Selection of most interesting SH retrofit European Programs and related ESMs

Name [a]	*Applicability*	*Most relevant ESMs*
ROSH	Building Envelope & Heating system	Retrofit to grant quality and indoor comfort for inhabitants
SURE-FIT	Building Envelope & Heating system	Commissioning measures
EURO-PHIT	General measures for Quality assurance for tenants	Step by step renovation and refurbishment towards PH standards
TABULA	Managing measures for tenants and landlords	Retro-commissioning (RECx) measures
EPISCOPE	General measures for Quality assurance for tenants	Energy Performance Indicator Tracking Schemes for the Continuous Optimization of Refurbishment Processes in European Housing Stocks
CERTUS	Managing measures for tenants and landlords/ Building Envelope &Heating system	Cost Efficient Options and Financing Mechanisms for nearly Zero Energy Renovation of existing Buildings Stock
ELIH- MED	Managing measures for tenants and landlords	Energy efficiency measures for Low-income housing Mediterranean regions
BECA	Managing measures for tenants and landlords	Balanced European Conservation Approach made by ICT
AFTER	Building Envelope & Heating system	Cost optimum and standard solution for maintenance and management
REQUEST 2 ACTION	General measures for Quality assurance for tenants	Removing barriers to low carbon retrofit by improving access to data and insight of the benefits to key market actors
RESHAPE	General measures for Quality assurance for tenants	Energy performance certification and the development of renovation strategies in social housing

[a] For specific reference and a complete description, please refer to programmes' website.

2. Strategies and measures for sustainable Social Housing retrofit

The type of interventions carried out for the refurbishment of social housing stocks can differ greatly in the amount of resources needed and in performances obtained, as well as according to different county regulations and climatic needs. The overall energy performance optimization is therefore generally focused on two main aspects: the improvement of building insulation (i.e. addition of external insulation coating, roof insulation) and the increase of efficiency of heating systems (i.e. replacement of boiler, distribution system, as well as district heating). Considering the microclimatic condition adopting passive strategies like greenhouses or Trombe solar walls and proper shading systems can be implemented as well, although they must be carefully designed to be integrated into the building envelope and rooftop [5].

The results of this research have led to a guide of best practices, distinguishing among retrofit actions on building envelope, on energy devices and other categories (table 1-3), discriminating in measures to be used before intervention, during intervention phase and after retrofit action.

This research aims at supporting the assessment of the ESMs to be used in retrofit and refurbishment actions, deriving the best practices used in the most popular and valuable EU program for Social Housing (table 1), through establishing a common conceptual framework with precise definitions of the performance indicators and how to use them according to building type, building technologies and the geographical region and climate. The comparability of these measures and their related performances rely on a common understanding of the performance indicators and an identical methodology to measure them. Every measure assessed in the following tables is part of one or more than one programs (table 1), with specific attention to the building envelope, to thermal station for heating or cooling, and any other management measures. The conceptual framework carried out for each programme consists of: a global inventory of measures and actions to detect the best one to be applied according to specific building needs, in order to accomplish the economic, environmental and social impact of each measure; the creation of a sort of sourcebook, with definitions of the performance indicators to prove the applicability of interventions and the following performances to enhance building's energetic behaviour.

Table 2. Best Practice selection according to the European Social Housing Project assessed

Type of measures	*# ESM*	Best Practices
First evaluation of the building's conditions	#01	Primary building inspection
	#02	Sectorial Survey
	#03	Tenant's survey
	#04	Self-assessment tools for landlords
Monitoring phase to evaluate energy consumption	#05	First Energy Analysis (FEA)
	#06	Energy audits
	#07	Quality assurance in the running period (QAEEU)
	#08	Energy Performance Contract (EPC)
	#09	Use and implementation of the Energy Performance of Buildings Directive (EPBD) regulations
	#10	Model Quality Control Matrix (MQC)
	#11	Installing Resource Management Systems (RMS) instruments
	#12	Database of building typology and materials
Existing buildings management	#13	Operating management of the building
	#14	Running management
	#15	Financial support instruments
	#16	Selection of an Energy Services Companies (ESCO)
Specific measures for social housing tenants	#17	Workshop and trainings
	#18	Energy Performance Contract (EPC) for comparing costs
	#19	Global vision for energy and management costs
	#20	Creation of support groups

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Table 3. Selection of best practices related to improving energy efficiency on existing buildings

Type of measures	ESM #	Best Practices
Building Envelope Measures	#22	External insulation of exterior wall and facade
	#23	Internal insulation of exterior wall and facade
	#24	Sloped roof insulation between or on the rafters
	#25	Top floor insulation
	#26	Cellar ceiling first floors insulation
	#27	Windows constructions replacement
	#28	Thermal bridges correction
	#29	Heat buffer on balcony and/or loggia
	#30	Passive solar systems
	#31	Air tightness of the building shell
	#32	Solar shading devices
	#33	Acoustic insulation from interior noises
	#34	Natural cooling
	#35	Rooftop addition: contrast
	#36	Rooftop addition: extension
	#37	Rooftop addition: integration
Technical measures for the energy supply and distribution	#38	Installing a condensation boiler
	#39	Installing air-water heat pump
	#40	Installing a geothermal heat pump
	#41	District heating
	#42	Installation of ventilation systems with heat recovery
	#43	Installation of a solar thermal system for hot water
	#44	Insulation of distribution conduits
	#45	Installation of thermostatic valves on radiators
	#46	Use of renewable energy
	#47	Replacement of energy equipment
Quality assurance Measures	#48	Quality assurance in the planning period (QAEEP)
	#49	Professional training of craftsmen and installers
	#50	Life Cycle Assessment (LCA) of the building materials

The following measures (table 4) thus regards diagnostic and monitoring actions, building envelope management, technical measures to address specific building components (roof, walls, foundation, windows & frames, sun protection), as well as technical measures for the energy supply and distribution (heating /cooling) system, solar thermal installations photovoltaic, ventilation and heat recovery).

Table 4. Selection of best practices after the retrofit intervention

Type of measures	*ESM #*	Best Practices
Expected results final assessment	51	Quality assurance in the construction period (QAEEC)
	52	Commissioning
	53	Retro-commissioning (RECx)
	54	Evaluation of financial investments

3. Best practises application on 80's Social Housing buildings in Parma (IT)

The social housing building Stock in Italy is in a critical condition from several points of views, such as energy consumption, maintenance, inadequacy of size and facilities of the dwellings, barriers to accessibility [6].

Refurbishment of social housing stock has to consider multiple dimensions at once and to face these inadequate conditions. The study here presented, based on the previous ESMs survey, aims at testing a selection of those measures in two Italian Social Housing Building, erected in Parma in the early 80's. The two projects, which involved a whole re-design of a social housing building envelope and heating systems, aim at improving accessibility, indoor space distribution and sizing, is by focusing specifically on the energy performance improvement achievable through the envelope and heating system retrofitting. The two Social Housing edifices described were chosen because of they are the same age, but building construction techniques are totally different, making possible to test and evaluate the reliability of the Energy Saving Measures selected and proposed.

The approach adopted can be applied to numerous analogous projects on Social Housing Stock, both at the building and the urban neighbourhood scale. The evaluation of the performance through software simulation have been made according to regional energetic regulation (Regione Emilia Romagna [7]) in order to accurately appraise the enhanced outcomes of such projects and to disseminate them for effective refurbishment policies in the Italian Social Housing Stock.

3.1. Buildings description and simulation model specifications

The buildings here investigated (from now on called Bld. A and Bld. B) were built in 1985 and 1982 and they are located in the suburban area of Parma, in the north of Italy. Both of them typically exemplify social housing building standards, as they were erected in the 80's, by using prefabricated concrete technologies (Bld. A) and bricks layer (Bld. B) for the building shell.

The Municipality of Parma is still the owner of both buildings and their 68 (Bld. A) and 32 (Bld. B) apartments. Building A has 4 levels and Building B has 6. The thermal analysis of a sample apartment for both of them, thanks to an Italian building-energy calculation software and in accordance to the latest Italian energy regulation for residential building has shown that the primary energy demand for heating and domestic hot water is up to 218,28 kWh/m^2 per year (Bld. A) and 187,8 kWh/m^2 per year (Bld. B). These values show that the building-shell components quality is still inadequate and energy consuming, requiring an effective retrofit action.

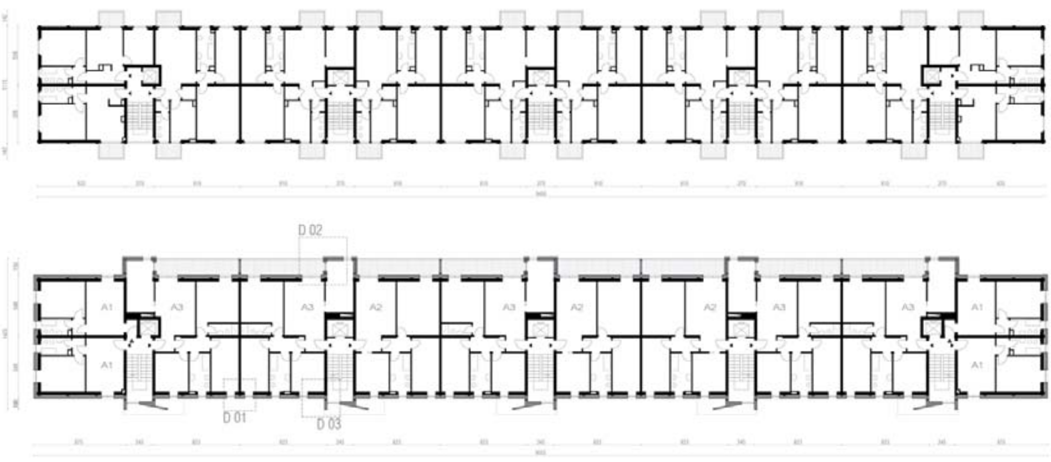

Figure 1. Building A floor plans, before and after refurbishment

The retrofit projects have both been done selecting the best practices relevant to buildings' needs. The approach has been finalized to a total retrofit of the building, instead of a simple thermal retrofit that ensure the reduction of the dispersion only through the replacement of heat generator or windows, in accordance to the selected measures, as presented in table 2-4. The best practices selected for the retrofit project are listed below in accordance with each building.

Figure 2. Building A South elevation, before and after refurbishment

Table 5. Building envelope components ESMs -as previously identified- for the existing building the renovated one

(Building A)			
Envelope Components	Construction concepts Before Retrofit	# ESMs applied	Construction concepts After Retrofit
External wall	25-cm thick brick walls, 7-cm polystyrene layer in-between. U-Value =0,61 W/m^{2}K	#22	Prefabricated structure made of timber frame and an insulation layer interposed
		#28	Thermal bridges correction
		#31	Airtightness of the building shell
Floor slab on the cellar	Concrete, brick, concrete, plaster U-Value =1,12 W/m^{2}K	#24	Sloped roof insulation and addition of new attic floor: wood fibre panel covering the X-Lam bearing structure, U-Value=0,09 W/m^{2}K
		#31	Acoustic insulation
		#26	Fireproof layer of mineral wool panels
Roof	Concrete prefabricated roof U-Value =1,22 W/m^{2}K	#36	Rooftop addition, extension. X-Lam structure by 150 mm thick panels insulated outside with 300 mm of wood fibre panels. U-Value= 0,09 W/m^{2}K
Windows	Double glazing 4mm wood frame U-Value of 3,20 W/m^{2}K	#27	Double-glazing glass and PVC frame will be installed on the new prefabricated façade. The double-glazing glass, LowE. U-Value= 0,70 W/m^{2}K
		#32	Solar shading devices on balconies and windows
Heating system	Individual gas boiler connected with radiators	#41	Switching to district heating
		#42	Installation of a solar thermal system for hot water
		#45	Installation of thermostatic valves on radiators
		#46	PV panels installed on the new roof.
Average ENERGY PERFORMANCE 218,8 kWh/m^{2}y			Average ENERGY PERFORMANCE 35,01 kWh/m^{2}y

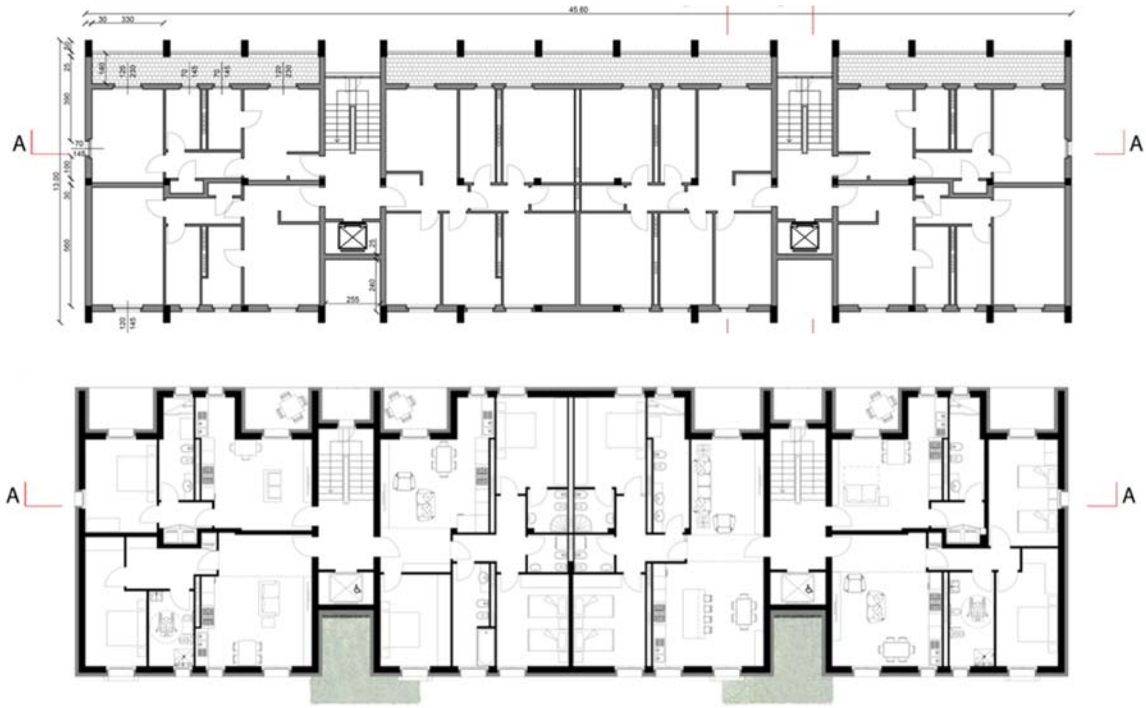

Figure 3. Building B plans, before and after refurbishment

Figure 4. Building B South Est elevation, before and after refurbishment

4. Conclusions

Moreover, the best practices selected have been assessed with the energy calculation software. The primary energy consumption after retrofit is 35.01 kWh/m^2 per year (Bld. A) and 40.40 kWh/m^{2}per year (Bld. B), valuable results if compared to newly constructed buildings.

The primary energy consumption has been reduced by 84% (Bld. A) and 78% (Bld. B). In terms of energy savings, interventions on building shell can reduce the demand in the most effective way, since a heating system replacement only does not solve the problem of heating losses. The comparison among the different ESMs options considered in both energies retrofit interventions have to take into account the minimization of primary energy with respect to cost and in respect of CO_2 emissions. The increase of indoor quality reduces the possibility of structural damages and offers additional benefit for tenants. This kind of approach can achieve better energy-savings measures, getting to a faster return of investments, but mostly ensures benefit for indoor air quality and general indoor comfort for dwellers as demonstrated in may retrofit Italian projects [8] [9]. High costs also do not necessarily affect the cost-benefit ratio, especially using best practices that allow an increase of the building value, such as rooftop addition; these measures can reduce the payback period, by maximizing capital return.

Table 6. The building envelope components for the existing building and retrofit solutions, related to ESMs as previously identified

BUILDING B			
Envelope Components	Construction concepts Before Retrofit	# ESMs applied	Construction concepts After Retrofit
External wall	Plaster, 3 wythes brick, insulation panel, plaster. U-Value = 0,61 W/m^{2}K	#22	Plaster, 3 wythes brick, XPS 16-cm, plaster. U-Value=0,172 W/m^{2}K
		#22	Plaster, 3 wythes brick, XPS 16-cm, air, steel frame, Green wall. U-Value=0,09 W/m^{2}K
		#28	Thermal bridges correction
		#31	Airtightness of the building shell
Floor slab on the cellar	Ceramic, brick, concrete, plaster. U-Value =1,12 W/m^{2}K	#24	Sloped roof insulation and addition of new attic floor: wood fibre panel covering the X-Lam bearing structure, U-Value=0,09 W/m^{2}K
Roof	Concrete prefabricated roof. U-Value =1,22 W/m^{2}K	#36	P.E., polyurethane 15 cm, Concrete +brick-concrete+ plaster. U-Value = 0,220 W/m^{2}K
Windows	Double glazing 4mm wood frame. U-Value of 3,80 W/m^{2}K	#27	Double glazing 4mm-15mm-4mm, LowE. U-Value= 1,6 W/m^{2}K
		#32	Solar shading devices made of external
Heating system	Individual gas boiler connected with radiators	#41	Switching to district heating
		#42	Installation of a solar thermal system for hot water
		#45	Installation of thermostatic valves on radiators
		#46	PV panels installed on the new roof.
Average ENERGY PERFORMANCE 187,8 kWh/m^{2}y			Average ENERGY PERFORMANCE 40,4 kWh/m^{2}y

These projects aim at demonstrating that are several parameters that can greatly influence the choice of a specific renovation strategy and they are constrained both by technical factors, such as existing building features, heating systems and structural constraints, and by economic factors, such as investment cost and payback time. Energy service costs and comfort conditions provide also an important factor to be considered to obtain a consistent result. Considering that in Italy there is large number of SH buildings, from different ages and with different features, it is hard to define a standard protocol to use in retrofit action, but this kind of approach clearly demonstrate that the introduction of these energy saving measures can help in reducing the costs of running SH buildings. The lower income due to reduced energy consumptions could have compensated by an increase of prices per unit. Exchanging best practices thanks to the precise application of selected measures can thus increase building sectors knowledge and improve general expertise.

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