

Solution Renovation – typological guidelines for the energetic retrofit of multi housing residential buildings in Geneva

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Abstract. The project “Solution Renovation” aims to promote the energy transition and renovation of existing multi housing buildings in canton Geneva by providing incentives and assistance to owners to trigger renovation decisions. Solution Renovation offers to the owners’ project guidelines (meta-diagnostics) for their buildings, in relation to their renovation potential, based on a typological analysis of structures and envelopes. The building population has been classified into nine different façade typologies. For each typology 1 or 2 detailed refurbishment scenarios have been developed, with cost and energy saving estimations to serve as guidelines to owners.

1. Foreword

Solution Renovation is a project supported by SIG (Geneva State Energy provider) and OCEN (Geneva energy state office) in Geneva, resulting from the finding that one of the main barriers to the retrofit process of the existing buildings is the owners’ lack of knowledge with regard to the energy saving potential of their buildings, the cost of retrofit works and the constructive options. The project is about giving owners a clear overview of what is feasible, and at which cost, in order to motivate them to embark on a renovation project.

2. Population of buildings included in the project

Compared to other buildings, multi-unit residential units are major energy heat consumers in the Canton Geneva, accounting for 1’825 GWh/a and representing an energetic reference area (SRE) of some 19’300’000 m³ [1]. It was therefore decided to focus on this category, showing the biggest potential for energy saving.

The first recommendations for the thermal insulation of buildings (SIA 180) were issued in 1970, but it was not until 1980 that the first cantonal laws appeared (in some cantons) and the federal decree on the economical and rational use of energy came into force only in 1990 [2]. Consequently, 1990 was set as the upper construction time limit to characterize the population. Buildings from the early 20th century and before, likely to be protected in some way for heritage purposes and representing a lesser surface are left aside. The lower construction time limit is therefore set at the end of World War 2.

Finally, small blocks (less than 3-4 dwellings) a SRE lower than 500m² were ignored as well.



The population of buildings to be included in the study therefore includes

- multi housing buildings (SIA category 1)
- built between 1946 and 1990
- with an energy reference surface (SRE) > 500m²;

This represents 5523 buildings and 10'468'000m² of SRE, accounting for 51% of the SRE of multi-unit residential housing in canton Geneva [Source : SITG]. The majority of these buildings is located in “downtown” Geneva and in the 1960 “satellite cities” of Meyrin and Onex as well as in the municipalities of Carouge and Chêne-Bourg.

3. Architectural and constructive typologies catalogue

The idea is to distribute the sample population amongst a manageable number of building typologies where at least 80% of the buildings would fit, mainly determined by the architectural and constructive characteristics of their envelopes. Such a typological classification does not exist in Geneva. Some detailed surveys were carried out for specific area of the canton [3], but they do not cover the entire cantonal building stock. The eREN project [4] also proved to be a very useful source of information, with several typologies that could be recuperated. Therefore, in the absence of comprehensive sources in the literature, the following method was applied to build a robust typological catalogue:



Figure 1. Method applied to build the typological catalogue

At the end of phases 1 and 2, eleven typological families were identified. Phase 3 allowed to reduce this number to the nine typologies described below, and a peer review (retired architects, active during the 1960 – 1990 period) confirmed the soundness of the catalogue. This review was the opportunity to realize the importance of transmitting constructive and architectural memory on objects of an ordinary nature, most of the time ignored by architectural literature.

Type 1 “Familia” buildings

Built in the immediate post-war period to house the working classes, in general on plots with a large green area. They are characterized by a great construction economy, and techniques in the continuity of the pre-war period (cement blockwork, hollow core-slabs, etc.), low height, simple volume, low-sloped terracotta tiles roofs, rendered facades with no insulation, timber shutters and small balconies. These buildings sometimes form a homogeneous set comprising several building entrances.



Type 2 Fifties buildings

The "1950s" type buildings were built in response to population growth and urban planning of the city in the 1950s. Generally of average height (6-7 levels), they are characterized by the mixed use of masonry and reinforced concrete for the structure (in particular the floor slabs) and by a particular care given to the window reveals and sills and to ornaments often made of artificial stone that structure the facade. The solid parts of the facades are



generally rendered but can also be covered with natural or artificial stone. Roofs are flat or with a low slope, and always have an eaves. Balconies are often made of half-loggia.

Type 3 Honegger style buildings

They are generally the result of the large scale real estate developments in patrician domains, that marked the city's development in the 1950s and 1960s. Usually of large dimensions, comprising several buildings, these developments are characterized by the repetitiveness and standardization of the construction elements, resulting from prefabrication, and by concrete box slabs used on a large scale. The exterior spaces are made up of generous loggias with continuous slabs. Roofs are most often flat. Although they are not the authors of all buildings in this category, the Honegger brothers, architects, engineers and entrepreneurs, have greatly influenced the style and expression of these buildings, which are characteristic of the urban fabric of Geneva. These buildings have most of the times an undeniable architectural interest.



Type 4 Linear balconies

The "linear balconies" type, often oblong in shape, has, on at least one main elevation, continuous striped balconies, which structure the facade and clearly mark the horizontals. These buildings were built in 1960-70's. They generally include 5 to 10 levels, with flat roofs and no eaves. The balcony system sometimes turns over on one of the gables, when the orientation is favourable. The second facade, if it does not include linear balconies, is generally more closed, with windows in openings. The structure is made of reinforced concrete, often composed of perpendicular shear walls to the main elevations thus freed from any structural function.



Type 5 Blocks

Built in the 1960-70's, these buildings are characterized by relatively closed façades where blind surfaces (in situ or pre-cast concrete) dominate over voids (light filling elements - windows). The perimeter walls are load-bearing (reinforced concrete), usually with an inner lining and a void filled with a thin layer of insulation. The windows are inserted in holes in the perimeter walls. Balconies are non-continuous (protruding concrete slabs, no thermal break) or loggias.



Type 6 Grids

Buildings of the "grids & fillings" type, built between the 60's and 70's, show regular facades that expresses the structural framework of the building. This framework made of concrete shear walls and slabs, is materialized on the facades, marking the slab and wall heads, or translated by precast concrete elements, with no thermal breaks. This orthogonal grid is filled either by glazed elements (sometimes by more massive brick or composite panels), or by hollow loggias. Some buildings have continuous horizontal bands that are more pronounced than vertical ones. In all in cases, the filling elements represent a proportionally larger surface area important than the structural elements of the grid.



Type 7 Curtain wall

The "Curtain wall" type dates back to the 60's to 80's. The envelope is non-load-bearing, often a curtain wall facade, composed of a metal frame (aluminium), and infills (vision or enamelled glass). The load bearing structure of the building (concrete shear walls and slabs) is not directly apparent, but sometimes expressed on the facade by sheet metal elements, eventually used as blind boxes. There are usually no balconies. These building often show comfort problems.



Type 8 Precast concrete

These buildings built in the 1980's and 90's are characterized by the use of precast concrete elements on the facades, sometimes accompanied by metal elements (oriels, glass roofs, railings, etc.) and post-modern style ornaments. Usually of average size, they are insulated with 8-10cm insulation between the inner perimeter load-bearing concrete walls and the precast concrete elements. Balconies are often generous and complex in shape. Some buildings show marked signs of carbonation of the precast concrete elements.



Type 9 First perimeter insulation

This type built since the 1980's, relatively heterogeneous at the morphological level, is mainly characterized by the use of the first peripheral rendered insulations, resulting from the introduction of energy standards. They often show degradation (moulds, drips, blistering on render for example) after thirty to forty years of operation. The structure is in reinforced concrete with part in masonry. The perimeter walls are load-bearing.



A final field validation of the catalogue was carried out on the municipality of Carouge, proposing a large diversity of building typologies. A detailed survey of all buildings fitting within the population was carried out, resulting in the validation of the catalogue : out of 193 buildings in the survey, 188 (95%) fitted in one of the nine typologies. This validation demonstrated the robustness of the catalogue for the Geneva urban area, but we are quite confident that with some adaptation it would fit with most urban areas in Switzerland.

4. Guidelines

Refurbishment guidelines, respectful of the architectural identity of each type have been developed. They are divided in three sections:

- Characteristics of each type, showing their energy, architectural and constructive issues
- General descriptions of the proposed scenarios, with their advantages and disadvantages, energy saving potential and cost
- Construction details, U values and works description for every construction element

The first section give an overview of the particularities of each typology, an estimated range of energy consumption (actual energy consumption of a sample of more than 10 buildings for each type),

and a quick assessment of the building ability to undergo a refurbishment process, built around 4 criteria (fig.2).

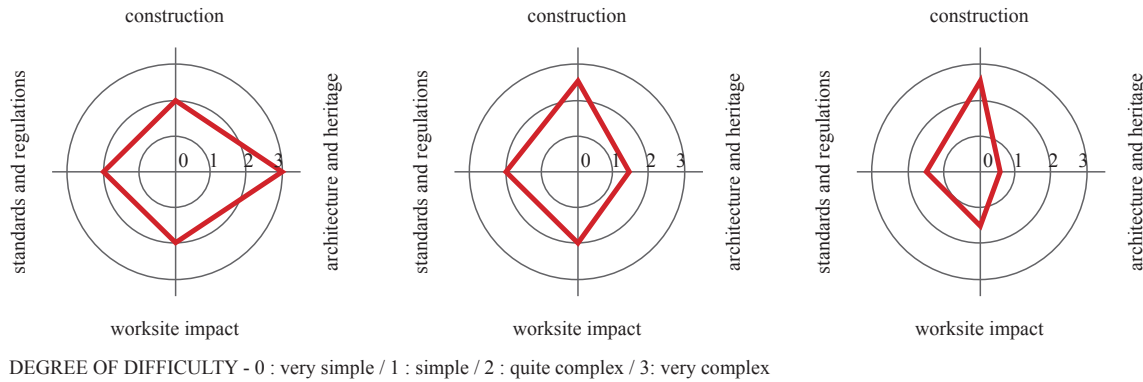


Figure 2. Quick assessments radars, examples (types 3, 4 and 8)

The second section describes one to two refurbishment options, showing the proposed constructive strategy with texts and diagrams (Fig. 3), the estimated cost of the options, their potential for energy saving and an assessment of the advantages and disadvantages of each option.

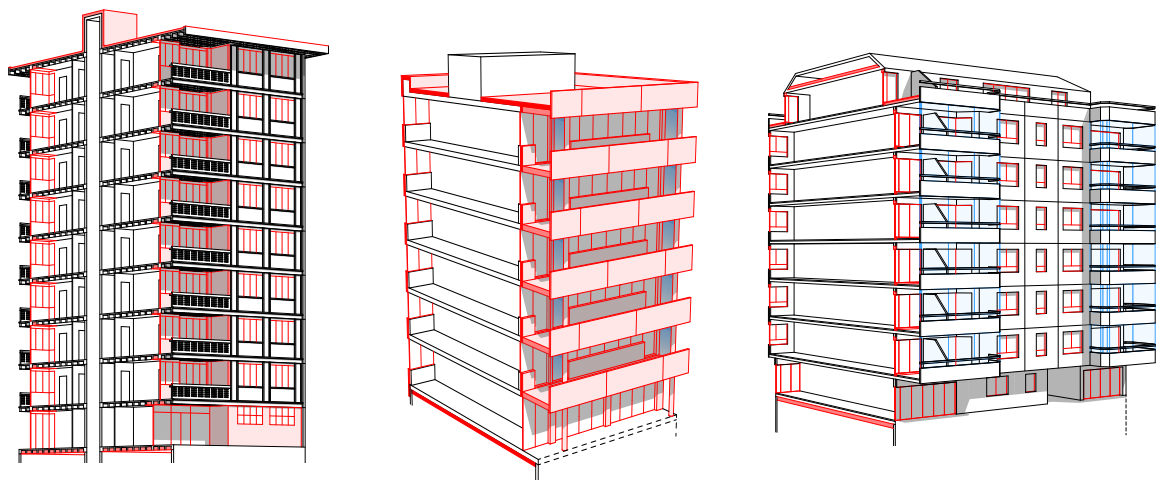


Figure 3. Retrofit diagrams examples (types 3, 4 and 8)

The third section provides detailed constructive information. Texts and detailed sections (before and after retrofit works), element compositions, expected U values, etc. are presented for every option.

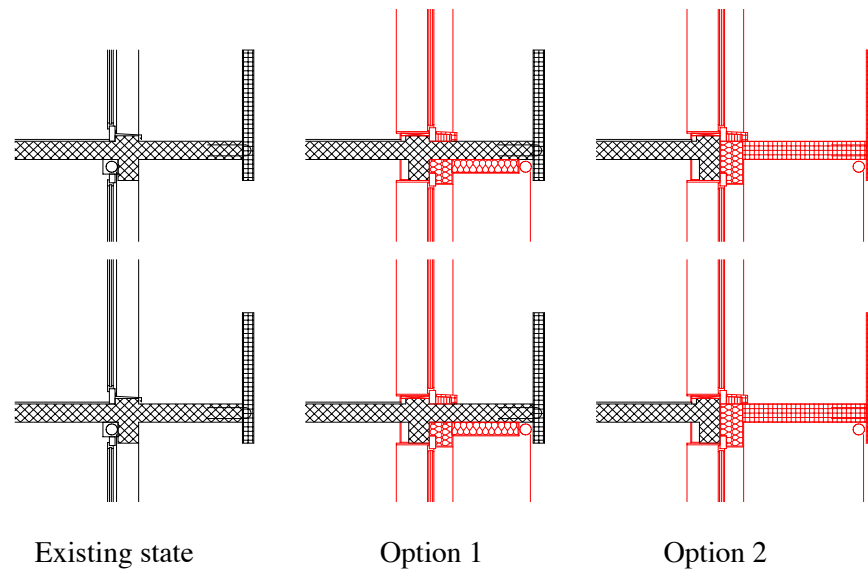


Figure 4. Detailed sections example (type 4)

5. Conclusion

On one side, refurbishment projects, especially when they deal primarily with energetic aspects, are too often seen by professional teams as a technical issue, dealt with by thermic engineers, with one or maximum two options, whatever the architectural and constructive typology of the envelope.

On the other side, although we have been talking about improving the energetic performance of the buildings stock for years, owners' lack of knowledge is a clear problem and explains in part the low refurbishment rate of the building stock. They often consider refurbishment as costly and complex and have no clear view of the options they have in order to reach fulfil legal energetic requirements.

Each period has different architectural and constructive characteristics and it would be harmful to propose uniform solutions for these different types of buildings, which ultimately make up the identity of our cities. The purpose of Solution Renovation is to propose guidelines showing energy retrofit scenarios consistent with the architecture and construction methods of the buildings, showing the potential energy savings and the cost to achieve them. The project does not aim at exploring exhaustively all the possible refurbishment options but aims at triggering further reflection among the owners by offering them a concrete (renovation options, constructive details) and quantified perspective. In this sense we hope that they will make homeowners want to think further about retrofit and thus contribute to the implementation of public policies to reduce energy consumption

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