Abstract

Buildings energetic retrofit is key to the « 2050 Energetic strategy », but the refurbishment rate is low. eREN has analysed the 20th century multi-dwelling housing stock in Western Switzerland from a constructive point of view and developed refurbishment scenarios for the envelope of 10 buildings. The goal was to achieve well-balanced solutions between energy efficiency, constructive feasibility, building physics, cost and architecture. Teachings: “wrapping” is not the only solution to meet the standard, whatever the solution it is technically complex, the cost are high but could be mitigated and a serious effort must be made to achieve interdisciplinarity.

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1- Context

With more than 40% of the energy consumption and CO2 emissions, the building sector is a key issue to the “2050 Energetic strategy” of the Swiss government [2]. However, the refurbishment rate is today well below the 2% required to hit the target. Easy measures (replacement of single glazed windows by more performing frames with insulated glazed units) have been carried out on many buildings and the next step will be technically more demanding and may create problems, in building physics in particular. Taking into account that financial incentive is too week at today’s energy price to decide owners to undertake works, public authorities develop subsidised incentive programs to switch to renewable energy for heat production and to improve the insulation of the existing buildings. This policy, relayed by
insulation producers and energy consultants, has serious consequences. Most interventions consist in wrapping the building with perimeter insulation, carried out without a global overview, bypassing architectural and constructive issues, putting building physics at risk, and slowly but surely changing the image of our urban environment.

2- eREN origins

eREN is first of all an attempt led by architects to regain control on a topic disregarded and left to energy engineers (many of them lacking of construction background and architectural sensitiveness) and for which insufficient effort has been made in the academic curriculum of architects training. Our intention is to put back at the centre of concerns the architectural and social aspects of refurbishment, together with energy saving. Retrofit is necessarily an interdisciplinary issue. It requires a synthetic vision that should be a responsibility taken by the architect. This synthetic vision should aim at weighting interests and find a well-balanced solution for energy savings, constructive details and physical issues, architecture, cost, and the tenants benefits and losses after the works.

3- Constructive typologies of the existing building stock

An inventory of the most recurrent constructive typologies of the multi-dwelling buildings stock of the 20th century in Western Switzerland (sample showing the highest potential for energy saving) was done. Properties with 3 flats and more and 3 levels and more, erected before the energy standards of the 80th and 90th form some 80% of the pre-’90 building stock in the area. 193 buildings in Geneva, Vaud and Fribourg were analysed. This analysis was carried out on 8 key elements to establish the dominant constructive typologies across time:

1. Flooring against unheated spaces
2. Flooring between heated spaces
3. Façade walls
4. Roof
5. Windows
6. Window jambs
7. Solar protections
8. Balconies

4- Case studies

10 study cases buildings, characteristic of the more common typologies, were analysed: original drawings, surveys, on site measurements of U values, etc. were confronted to establish a realistic view of the construction details and performance of each building envelope. A refurbishment strategy was then chosen for each building:

Maintain the typical features / Rebuild the typical features / Add new features or change the image of the envelope

Calculations of the actual thermal performance according to SIA 380/1 were carried out and compared to the energy consumptions extracted from the available data (energy bills or the Indice de dépense de chaleur). Discrepancies above 20% (which was set as an acceptable gap) could be explained by users impacts, air infiltration rates, U Values of construction elements, etc. Refurbishment scenarios were then developed for each study case responding to the chosen strategy and checked against the requirement set by SIA 380/1 (global thermal balance sheet). The scenarios have been through an iterative process by the team’s architects and engineers which eventually resulted in solutions satisfying in every instance both the energy requirements and the other criteria.
The scenario that complies with the SIA 380/1 (2009) standard is summarised on building-sheets where details are shown together with the thermal and financial results and an assessment of its impacts on the other criteria.

5- eREN teachings

Can we reach the energetic standard (SIA 380/1) without destroying the identity of the building?

In all cases a scenario that meets the energy standards was achieved, respecting the architectural substance and identifying the critic details in term of building physics. What is qualified as a valuable architectural feature worth maintaining or not was left to the sole authors appreciation. It is therefore subject to discussion and to evolve in time.

But, the task is huge. First, because care for banal architecture, seen as an heritage component of the urban fabric, is restricted to the circle of architects and historians. Energy specialists and energy public services are less aware of the issue and naturally promote solutions to maximise the energy gain, such as “insulation wrapping”, often incompatible with a respectful approach of the building characteristics and history.

For instance: the “Programme bâtiment” [4] subsidises envelopes refurbishments that comply with a punctual U value of 0.2w/m2k on at least 90% of the surface of the external envelope. The 10 eREN scenarios demonstrate that an alternative approach meets the legal energy saving target, but only 5 of them would be eligible for subsidies.

Second, the complexity of refurbishment is under estimated. The current regulation does not take into account the specificities and limits of existing buildings. It has been developed for new constructions and adapted to retrofit. In the majority of existing buildings, insulation thickness will be at some point limited by floor heights, property boundaries, balconies deepness or minimum room surface. Thermal bridges, durability of internal insulation (vapour barrier integrity), treatment of blind boxes and of embrasures, existing pipes to the underside of ground floor slabs, etc. are all issues that the “red line strategy”, reducing the design work to a simple red line drawn around the building envelope (Fig. 6), totally misses. The resolution of details and their implementation requires a lot of care. A good result will only be reached using qualified design teams and contractors.
As interventions on existing buildings represent a growing percentage of the market, it is time for architects to take 
interest in refurbishment projects and to regain control of the process...or to accept that our cities will undergo a deep 
impoverishment of their identities and that the field is abandoned to energy engineers. It is also time for the 
prescribers to understand that the strengths and weaknesses of an existing buildings should be considered when it 
comes to energy savings, because placing the bar too high will be counterproductive.

What is the method to achieve such goal?

The goal could be achieved only through interdisciplinarity and much iteration. We strongly believe in this method, but 
as any orchestra it requires a conductor with an aptitude for overview. This is the role of the architect, as long as he/she has interest and competences in all concerned fields. He/she has a responsibility to integrate energy 
concerns at the very beginning of the process and to follow it through the construction phase and commissioning. 
However, interdisciplinarity is an illusion if qualified professionals are not available. Should a real boost be given to 
energetic retrofit, the market would not cope, due to the lack of qualified architects, engineers and contractors.

It is the professional schools and universities duty to propose training in the field, much more than today, where 
teaching programmes are greatly oriented towards new constructions.

eREN has the ambition of giving some best practices advice and its currently used in Western Switzerland as a tool 
for professional training.

At what cost?

Energetic refurbishment is expansive and hardly profitable at today's energy price, especially since the reduction of 
heating cost benefits only the tenants and since rents can be increased taking into account only a fraction of the cost 
of the works (see OBLF art. 14 [5], with some cantons, like Geneva, even more restrictive).

The total cost of each scenario was weighted so that the costs directly induced by the energy saving measures 
(weighting technique was developed in house, as no recognised method for such allocation exists in Switzerland).

Despite this, the average depreciation period of the works on the 10 study cases is 90 years, far more than the life 
expectancy of any of the implemented solution. Subsidies would improve the financial result but would not 
compensate the whole gap. The motivation for energetic refurbishment is to be found in the owner's will to maintain 
his property in good condition or to increase its market value, in his "eco-consciousness", but not in profitability.

A path to be explored to cushion the cost of renovation would be to combine it with an increase of the rental. eREN2, 
actually undergoing, will shed some light on this subject.

The comparison of cost and thermal performance of the scenarios presents a contrasted picture.
In 50% of the cases where more than one scenario had to be developed, the first scenario already reaches some 
80% of the required saving, at reasonable expense, with the last 20% implying a large increase in cost (Fig. 7).

In other words, a sound proportion of the refurbishment projects that would already greatly mitigate buildings energy 
consumption might not be launched because the financial effort to gain the last MJ to hit the standard is too high.

Financially, doing nothing would be the most reasonable approach. And to those tempted by a State coercive 
approach, the Swiss voters, in majority liberal, would, in our opinion, promptly give a disappointing answer.
Amongst the pleasing results of eREN was the finding that on two of the study cases, where perimeter insulation wrapping was priced in a parallel study, the cost difference was contained within very reasonable limits (-2% to +14%). A complementary study to give more robustness to this hypothesis has been ordered in 2016 by the CRDE (Conference Romande des Délégué à l’Energie) and the preliminary results are encouraging for the alternatives to “wrapping”.

Is there a link between constructive typologies and refurbishment strategies?

Obviously there is a link between construction typology and retrofit strategy. An early 20th century building, with a rich decorated stone façade, will accept nothing else but internal insulation. However, it is impossible to claim that a specific typology is fitter for refurbishment than the others. They all have their strength and weaknesses. Buildings of the ’60, of large dimension and repetitive, offer opportunities for standardisation and rationalisation of the details. But the presence of linear balconies with the concrete slabs protruding out causes serious thermal bridges issues.

It appears that targeting a specific typology because it would be easier to treat than another one is not a start point.

As often, the right pathway is likely to be found in the middle way, where potential for energy saving, easiness of constructive details, building physics, architecture preservation and use value offer the best compromise (see eREN radar). This approach implies an individual analysis of each building, sometimes based on several scenarios, simply because alike human beings, buildings can belong to the same family, but they will always show differences and demand an individual treatment.

6- eREN follow up

Two projects, already mentioned above, with completion due in summer 2017 (still undergoing at the date of writing this article) have emerged out of eREN.

eREN-2, based on the same study cases aims at determining the potential for expansion of the buildings rental surfaces (vertical or horizontal expansion) and its impact on the profitability of the refurbishment process.

eREN-C, again based on the same building, proposing a comparison between the retained eREN scenarios and a standard “wrapping” solution, in terms of cost, architectural impact, building physics, details and use value.

Their outcomes will be presented in due course.

Bibliography


[5] Ordonnance sur le bail à loyer et le bail à ferme d’habitations et de locaux commerciaux (OBFL), art. 14 al.1, état 28 mars 2017