Geneva's solution to bridge the performance gap in energy retrofit

L Rinquet[1], G Fowler[1], S Delmenico[1], D Iglesias[1], C Cacheiro[2]

[1] University of Applied Sciences Western Switzerland (HES SO), HEPIA, inPACT, 1202 Geneva
[2] Services industriels de Genève, éco-21, 1219 Le Lignon

* Corresponding author: lionel.riquet@hesge.ch

Abstract. Closing the performance gap between the energy consumption reduction calculated at the building renovation permit stage and the real consumption after retrofit works represents a major challenge for the achievement of climate goals in Switzerland. A study by the University of Geneva in 2018 showed that on average only 42% of expected savings are achieved. Considering these disappointing results, the canton of Geneva has launched a subsidised pilot programme consisting of energy monitoring by a qualified professional (Energy advisor) throughout the entire renovation process, from planning to commissioning. After six years, it is now possible to draw relevant conclusions, with the pilot programme demonstrating its efficacy: in the renovation projects that benefited from the programme, 94% of the expected energy savings were achieved. Results show that investing in an Energy Advisor mandate to maximise energy gains and close the performance gap is highly profitable from an energy point of view, at an extremely low relative cost. However, the future of this service is not guaranteed, and there is a risk that subsidies will be cut before the habit is established of hiring energy advisors without government support.

1. Introduction

Closing the performance gap between the energy consumption reduction calculated at the building renovation's permit stage and the real consumption after retrofit works took place represents a significant challenge in meeting public policy goals for CO2 emissions reduction and energy savings.

A case study[1] of 26 refurbished multifamily housing buildings (MFB) in Geneva, representative of the local building stock, undertaken in 2018 by the University of Geneva (UNIGE), revealed that, on average, only 42 % of the expected energy savings were realised. Another report from 2022[2] showed that the rate of efficient refurbishment (improvement by a minimum of two classes of the Swiss energy label, CECB/GEAK) in the canton of Geneva is approximately 0.2%, which is considerably less than the often quoted 1%. This demonstrates that the substantial investments and subsidies intended to improve the energy efficiency of the building stock could be more efficient. This situation needs to be improved since Geneva's legal obligation to reduce building consumption below specified thresholds and within predefined timeframes[3] should result in a very large number of renovation projects being launched over the next years.

Consequently, in 2019 the Canton of Geneva and its Industrial Services (SIG), with the support of field and academic partners (HEPIA), set up a subsidised pilot programme called AMO énergie (Energy Advisor). The objective of this initiative was to reduce the performance gaps by improving the quality of renovations, as well as to establish a pool of exemplary projects to encourage property owners to launch projects and set themselves ambitious targets.

The Energy Advisors are consultants specialising in energy retrofit projects. They oversee the entire project cycle, from feasibility study and extending up to two years after completion of the works. During this final phase, the Energy Advisors supervise the monitoring and the optimisation of the building's energy consumption. Following a period of observation by SIG and HEPIA spanning five years, the results of the pilot programme have become apparent, and the question of its continuation has been raised. The outcomes of the programme are presented in the chapter entitled "Results", and the subsequent steps are discussed in the conclusion section.

2. Methodology

2.1. Concept

Geneva's Energy Advisor pilot programme was designed to encourage MFB owners undertaking ambitious energy renovation projects (envelope refurbishment and/or replacement of fossil fuel technical installations). Owners call on Energy advisors to support them during the various phases of their project, including study, planning, construction and post-commissioning optimization. This support extends for a period of two years following the completion of the retrofit works (exploitation phase), allowing monitoring and adjustment of "teething problems" over two heating seasons.

The projects were accepted in the programme provided a minimum jump of three CECB/GEAK (Swiss cantonal building energy label) classes was targeted, alternatively a Minergie label or a HPE label (Geneva's High Energy Performance label), which implies that only global refurbishments were concerned. The Energy Advisor's mandate was funded by the State of Geneva with a subsidy of CHF 20 per m2 of ERA (energy reference area), capped at CHF 50'000. Additionally, a bonus equivalent to CHF 10 per m2 of ERA was also awarded to projects achieving at least 85 % of planned energy savings after two heating seasons. The pilot project and the associated subsidies were designed to test the initiative, build up a pool of exemplary projects and act as a catalyst to enable the scheme to become a standard amongst MFB owners, even without state subsidies.

Achievement of the targets that qualify for the bonus is measured by comparing the calculated heat consumption index (HCI) with the actual HCI after completion of the works and the optimisation of the installations over two heating seasons. The HCI is a key indicator of a building's specific energy performance, and in Geneva, MFB owners are obliged to communicate the index annually to the Cantonal Energy Office, which publishes it on the SITG geo-portal[4].

2.2. Calculation methodology

The HCI before renovation (Ef,avant,corr) corresponds to the final energy consumption measured before renovation works (average over 3 years), weighted by the respective shares of the various energy vectors, with climate correction (degrees days).

The target HCI (Ef,obj, i.e. final energy target) is calculated using a formula developed at HEPIA based on the actual heating (Qh,eff,) and domestic hot water (Qww) requirements calculated in accordance with the SIA 380/1 standard, the type of heat production (heat pump, district heating, oil, gas) and the weighting factors that apply to it, and any solar thermal production.

$$Ef,obj = \left(\frac{Qh,eff,reno}{Eff,ref,h} * fp,h\right) + \left(\left(\frac{Qww,reno}{Eff,ref,ww * 0{,}65} - Esol,th\right) * fp,ww\right)$$

Ef,obj = final energy target (KWh/m^2/year)
Qh, eff, reno = actual heating requirements after renovation (KWh/m^2/year)
Eff, ref, h = average heating system efficiency (-)
fp, h = Average heating weighting factor (-)
Qww, reno = actual domestic hot water requirements after renovation (KWh/m^2/year)
Eff, ref, ww = average domestic hot water production system efficiency (-)
0.65 = distribution losses (-)
Esol, Th = Estimated useful solar output for domestic hot water (KWh/m^2/year)
fFp, ww = Average domestic hot water weighting factor (-)

The HCI after works (Ef,apres,corr) corresponds to the actual final energy measured after works with climate correction, weighted by the respective shares of the various energy vectors. The performance (Perf %) of the renovation operation is established by calculating the ratio between the targeted energy saving (ΔEf,obj = Ef,avant,corr - Ef,obj) and the real saving (ΔEf,réel = Ef,avant,corr - Ef,apres,corr).

$$Perf\ \% = \frac{\Delta Ef, obj}{\Delta Ef, réel}$$

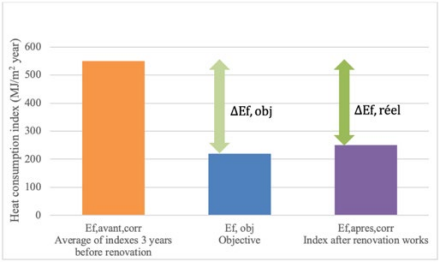

Figure 1. Calculation of performance for projects supported by the Energy Advisor

These values are usually expressed in MJ/m^2 of ERA (converted into kWh/m^2 of ERA by dividing the result in MJ by 3.6). In cases where a retrofit is combined with an extension of the ERA (additional floors), the two parts of the project are considered separately. The regulatory requirements for new constructions apply to the extension, while those for renovations to the pre-existing part of the building.

3. Results

The pilot programme was launched in 2019. Considering the timescale for construction projects and the necessity to incorporate two heating seasons to optimise technical installations, it was not possible to draw relevant conclusions until 2024. The results relate to 12 buildings constructed between 1961 and 2000, refurbished between 2019 and 2023 with a total energy reference area (ERA) of 79,109 m^2.

3.1. Energy savings

The main goal of the pilot programme was to demonstrate that a conscientious and targeted follow-up of the energy issues in a refurbishment project by a qualified professional, during the entire planning, construction and optimisation process, would result in a significant reduction in the performance gap.

Table 1. Projects' energy retrofit results

Building	Construction period	ERA	Heating system before works	Heating system after works	HCI before works (MJ/m2*year)	HCI target (MJ/m2*year)	Reduction target (MJ/m2*year)	Reduction target (%)	HCI after works (MJ/m2*year)	Reduction real (MJ/m2*year)	Reduction real (%)	Performance real (%)
1	1996-2000	410	1	4	550	216	334	-61%	239	311	-57%	93%
2	1961-1970	2 135	1	4	616	188	428	-69%	211	405	-66%	95%
3	1961-1970	13 352	3	3	433	251	182	-42%	239	194	-45%	107%
4	1971-1980	2 107	1	4	493	218	275	-56%	196	297	-60%	108%
5	1961-1970	6 574	1	4	398	122	276	-69%	161	237	-60%	86%
6	1971-1980	3 530	2	2	704	246	458	-65%	378	326	-46%	71%
7	1971-1980	13 492	1	1	408	237	171	-42%	243	165	-40%	96%
8	1961-1970	8 681	3	4	532	189	343	-64%	165	367	-69%	107%
9	1961-1970	19 992	1	4+2	585	174	411	-70%	269	316	-54%	77%
10	1971-1980	4 010	1	1	626	352	274	-44%	318	308	-49%	112%
11	1971-1980	3 206	2	2	414	204	210	-51%	224	190	-46%	90%
12	1991-1995	1 620	1	4	659	151	508	-77%	170	489	-74%	96%
Total/average		79 109			535	212	323	-58%	234	300	-55%	94%

Heating system : 1 = Oil /. 2 = Gas / 3 = District heating / 4 = Heat pump (air - water)

The 12 completed projects provide evidence that this objective has been achieved. The performance (real energy savings vs. targeted energy savings) spreads in a range from 71% to 112%, with an average

of 94% and a median of 95%. On average, the performance gap has been considerably reduced and is now close to zero for these projects that have benefited from the energy advisor's expertise. This represents a very substantial improvement compared to the 42% observed in the 2018 UNIGE study.

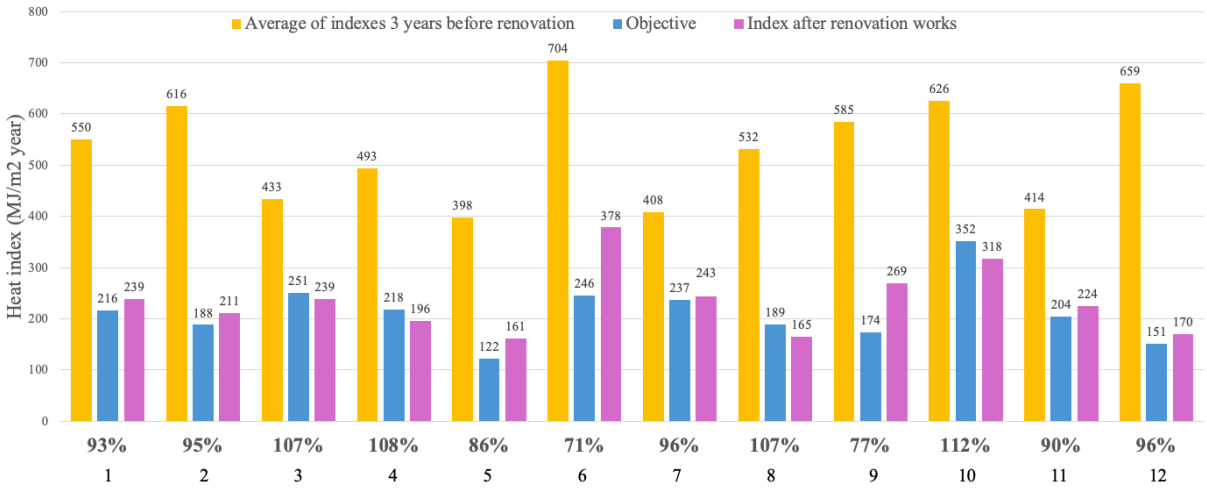

Figure 2. Performance of retrofit projects supported by the Energy Advisor pilot programme

This outcome cannot be attributed with certainty solely to the participation of the Energy Advisor. The buildings' owners participating in the pilot programme did so on a voluntary basis (even though subsidies may have had a windfall effect), demonstrating their interest in the energy issue, which was not necessarily the case for the buildings considered in the UNIGE study. Secondly, All the projects were carried out on sites occupied by the building's residents who were taught eco-gestures for the proper use of the renovated building. One project (building n°6) has benefited from a supplementary resource in form of a special support for tenants provided by social workers (AMU), who have accompanied tenants before and during the retrofit process to manage relations between property management, architects, contractors and tenants.

The aforementioned factors certainly contributed to the success of the projects. Nevertheless, we feel that the projects panel, the quantified results, and the feedback from the field are sufficiently compelling to consider that the Energy Advisors have contributed significantly to this positive outcome, through the following actions:

- Support the customer in defining ambitious energy targets for the project;
- Regular monitoring of the achievement of these objectives during the tender, construction and post-commissioning optimization phases;
- Pedagogy aimed at other members of the professional team and at contractors to draw their attention to the importance of energy targets.

It was expected that projects with relatively high savings targets would perform less well, as ambitious targets would be harder to achieve. However, this hypothesis is not clearly supported by the data. We can see that the most ambitious projects (65% savings target or more) struggle to come close to average performance, but there is no obvious correlation between the level of ambition of the project (i.e. targeted % of energy consumption reduction) and its performance (i.e. real % of energy consumption reduction). This is not a definitive conclusion since the panel of project is limited to 12 operations.

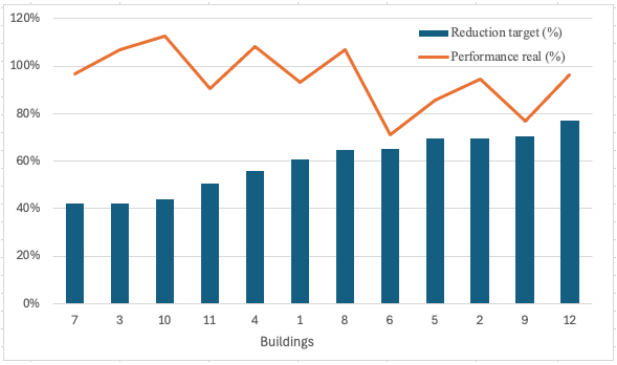

Figure 3. Targeted energy consumption reduction vs. performance

3.2. Financial impact

The participation of the Energy Advisor in the projects has often been perceived by other members of the professional team (architects, M&E engineers, building physicists) as interfering with their prerogatives. Moreover, owners may consider the Advisors' participation solely as an additional expense, the benefits of which are not obvious, given that heating costs are paid by the tenants. Both make the question of the Energy Advisor's fees a sensitive one which deserves to be put into perspective.

Table 2. Cost of the works and of the Energy Advisor contracts

Building	Construction period	ERA	Total cost of the works (CHF, rounded)	Cost of Energy advisor contract (CHF, rounded)	% (Advisor contract / total cost)
2	1961-1970	2 135	4 700 000	32 000	0.7%
3	1961-1970	13 352	27 200 000	94 000	0.3%
4	1971-1980	2 107	4 000 000	39 000	1.0%
7	1971-1980	13 492	1 500 000	36 000	2.4%
8	1961-1970	8 681	5 000 000	95 000	1.9%
9	1961-1970	19 992	59 000 000	38 000	0.1%
Average		9 960	16 900 000	55 667	0.6%

However, analysis of the costs associated with the Energy Advisors shows that: i. The sums of their contracts are very modest in relation to total project costs (from 0.1% to 2.4%, with an average of 0.6%), ii. They are not proportional to project costs. The greater the scope of the work, the greater the effectiveness of an Energy Advisor.

Due to the incompleteness of the financial data for four projects, and the absence of involvement of an Energy Advisor in all retrofit phases for two other projects, the sample used for the analysis of the financial impact was limited to only six buildings.

It is not yet possible to give a precise figure for the subsidies awarded under the pilot program (bonuses have not yet been confirmed for all projects), but at this stage we can estimate the total subsidies awarded at around CHF 450'000.

3.3. Relation between the energy saving and the cost of the Energy Advisor

As previously stated, it is impossible to prove that the performance gap was virtually eliminated by the intervention of the Energy Advisors alone. However, if we assume that the improvement is largely attributable to them, it is possible to quantify the energy impact of each CHF spent on their services.

Assuming that without the Energy Advisors, the objectives would have been achieved by an average of only 50%[1], that the lifespan of the renovated elements is on average 30 years[5], and considering the six buildings for which we have sufficient financial data, it emerges that, on average, each additional

kWh saved thanks to the Energy Advisor costs CHF 0.0009. Alternatively, each CHF invested in the Energy Advisor results 1'108 kWh of energy savings over the lifespan of the renovation works.

The analysis of the available data does not extend further than this point, due to the absence of a breakdown of the total cost of the work, which would make it possible to isolate the costs attributable to building energy improvements from those attributable to work with non-energy added value or to maintenance work (with no added value). However, a detailed breakdown is available in the UNIGE research. The findings of this research indicate that for each kWh of energy saved, a cost of CHF 0.16 was incurred.

Comparing CHF 0.0009 with CHF 0.16 wouldn't make sense, as they do not at all cover the same type of service and works. However, these figures show that investing in an Energy Advisor mandate to maximise energy gains and close the performance gap is highly profitable from an energy point of view, at an extremely low relative cost.

4. Conclusion and discussion

The projects that benefited from the Energy Advisors' pilot programme all achieved significantly better results (targeted energy savings reached at 94%) than the projects included in the 2018 UNIGE study (42%). While it is impossible to attribute this spectacular leap forward with certainty solely to the presence of the Energy Advisors, it is very likely that their contribution was crucial to the success of these projects, and at a very limited cost.

Interviews conducted in 2022, two years into the programme, with all parties involved in the pilot projects show that there are certain limits to the development of this service: at that time, building owners placed a higher value on the subsidies and bonuses on offer than on the potential energy savings, having no knowledge of the outcome. This situation may be set to change as a pool of exemplary projects is built up from the pilot programme, which could convince owners of future projects. In this context, the programme is confronted with the considerable timescales involved in refurbishment projects, which often extend over several years.

As of June 2025, the pilot program supports 68 projects in Geneva, but has undergone a series of modifications, including the reduction of subsidies and the end of the result-oriented bonus. This move may have happened too early, engendering a risk for the proper take-off of the programme. Conversely, the notion of providing ad aeternam subsidies to a pilot program appears illogical if the market doesn't take over. The result-oriented bonus was surely interesting, but two issues finally got the better of him: is it normal to subsidize a project that does not meet 100% of the energy savings set in the building permit? Aren't building owners tempted to set less ambitious targets to be sure of reaching the 85% mark? This opens a vast field of discussion.

Another issue for the program to reach cruising speed is the availability of resources. The role of Energy Advisor is very demanding and requires a wide range of skills. Consequently, the number of qualified professionals is limited. Training is essential to increase the pool of Energy Advisors and enable the programme to move from its pilot project stage to a more sustainable operation model.

The benefits of the scheme have been demonstrated and we believe it can make a significant contribution to reducing energy consumption and GHG emissions from the building stock. The questions that now arise are i. will the market be able to offer enough Energy Advisors if the practice becomes widespread? ii. To what extent and at what pace State support for the programme via subsidies must evolve for the program to become a market standard?

HEPIA being involved in the day-to-day follow up of the programme, further research and feedback is likely to be available in the future.

5. Acknowledgements

Thanks to all those involved in the projects who provided the necessary information, as well as to SIG and the Cantonal Energy Office.

6. References

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