Digital steering tool for real estate owners in the era of energetic transition

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Abstract. Real estate portfolio owners face a huge challenge with the combination of the necessity to refurbish ageing buildings inherited from the booming construction period of 1950 to 1980 and the need for decarbonization of the heating systems of the building stock to preserve the environment. Many property owners facing this challenge do not have a clear overview of their portfolio and do not know where and how to start renovation work on their existing buildings, and lack basic instruments to help them in the strategic planning phase.

A very simple and transparent digital tool has been developed by the HES-SO /HEPIA, Geneva, on behalf of a real estate foundation in Geneva to give its board a clear vision on the Foundation assets and help it to define intervention priorities amongst its building. This tool, based on a multicriteria and interdisciplinary approach, is be one of the instruments that can help real estate portfolio owners to tackle the challenge they are facing today, in a simple and autonomous way.

Keywords: Building Energetic Refurbishment; Real Estate, Portfolio Steering Tool

1 Context

1.1 Buildings and CO2 Emissions

With 18 million tons of CO2 equivalent, home heating is the second-largest source of greenhouse gas emissions in Swiss households, just behind transportation [1], and the picture is likely to look similar in adjacent countries.

Decarbonization of the building stock is therefore a vital challenge for the ecological transition of our society. This goal will be achieved by efficient envelopes (reduction of energy demand) and/or switching from fossil fuels to renewable energies (decarbonization).

Whist this challenge is relatively straightforward for new buildings (technical and constructive solutions are available at reasonable cost), the situation is much more difficult for the existing building stock.

In Switzerland, multi-housing buildings built between 1946 and 1990, to respond the demographic growth and of that time, account for the largest percentage of housing currently in use in the country [2] and were largely constructed with very little attention paid to their energy consumption. It is only in the 1980's, after the 1970's oil shocks, that recommendations and then standards on insulation of buildings have been established to mitigate the energy consumption of the building stock.

Buildings of this time represent a major source of energy saving and often require, seventy to forty years after their construction, important refurbishment works to maintain their value and bring them up to current standards.

1.2 Real Estate Owners Challenge

Over the past decade, awareness of the need to decarbonise our society has been growing among the Swiss population, resulting in the adoption in 2020 by the federal parliament of a CO2 law which provides for the elimination of greenhouse gas emissions from existing buildings in case of replacement of the heat production installation by 2040.

The law puts pressure on building owners to take action and to improve the carbon footprint of their buildings, renovation techniques and the skills of companies and professional teams are progressing, and financing has never been as cheap as it is today. All the conditions seem to be in place for a transition of the building stock towards more sustainability. However, the rate of energy renovation of the existing building stock in Switzerland is currently only 0.9% per year, which corresponds more or less to the natural renovation cycle in the absence of a support program. A rate of around 2.2% would be necessary to achieve the objectives of the federal energy strategy 2050 [3]. Low return of investment on refurbishment works and housing shortage in Switzerland give an explanation to the phenomenon, but they are not the only obstacles, especially for "virtuous" owners that are ready to overcome them.

The issue often lies between the will to take action and its implementation. When facing the challenge, at a very initial time of the process, building owners are left alone to decide in which direction to launch a project, and this situation becomes far more complex when the owner has to manage the challenge of a stock of several buildings, of different typologies, periods of construction and sizes.

What strategic goals to follow? Where to start? How to set the priorities? How to take advantage of economies of scale? When facing these questions, the owner may feel helpless and overwhelmed by the complexity of the task and the multiplicity of parameters.

2 The Reno-VE Project

2.1 Project's Roots

The Fondation communale de Versoix - Samuel May (hereafter the Foundation) is a municipal foundation of public interest whose aim is to provide, as a priority, the population of Versoix with comfortable housing at prices corresponding to its needs, as well as professional, commercial, artisanal or general interest premises.

The Foundation's attention had been drawn to the eREN project [2], developed by the HES-SO, proposing a global approach for the building envelope in energetic refurbishment projects.

In 2018, the Foundation board contacted HES SO / HEPIA (Engineering and architecture faculty of the HES-SO), in Geneva, with a demand for the development of a simple and transparent tool to help its board to better plan the renovation interventions of its real estate assets. The project was launched in 2019 and completed in 2020, resulting in a methodology for evaluating the building stock and a steering tool, based on a simple spreadsheet, which makes it possible for the Foundation board to set intervention priorities on the basis of its strategic criteria.

2.2 The Foundation Portfolio

The Foundation owns some twenty buildings on the Versoix municipality territory, mainly collective housing with some commercial activities, but very eclectic in size, time of construction and style and with several buildings in need for refurbishment (fig. 1).

The Foundation's portfolio consists of 18 buildings built between the 18th century and 2015, with a total of 25,500m2 of energy reference area, 233 flats, commercial and craft areas. The energy performance of the buildings varies greatly. The HDI (heat expenditure index) of the buildings varies from 307 MJ/m2 year to 660 MJ/m2 year, with an average of 457 MJ/m2 year, fairly representative of Geneva's housing stock.

Like many public owned foundations in Switzerland, the Foundation is run by a "militia" board, made up of members chosen on a political basis in which each political party present in the Municipal Council is represented by a member, whose experience in the real estate and construction fields can be very varied. A property management agency is contracted by the foundation to handle the relations with the tenants and their daily needs.

Fig.1 . Photography of 16 of the 18 Foundation's properties

For the Foundation board, setting priorities for action is not straightforward, because i) decision-making is a collective process and board members come from various backgrounds and political parties ii) until now decisions were made on a opportunistic "piecemeal" basis iii) deep knowledge of the buildings characteristic maintenance level is not systematically available iv) decisions cannot be based on the sole criterion (energy for instance). Therefore, many criteria, multiplied by twenty buildings, make it very difficult to have a clear and objective view of the status and potential portfolio, without the help of some kind of computerized steering tool.

In this context, HEPIA's mandate consisted in defining a multi-criteria and interdisciplinary approach to form an analysis grid to be used by the steering tool. A comprehensive inventory of the situation of the real estate portfolio of the Foundation based on the analysis grid was carried out, and finally a simple, open-source and transparent digital tool was developed, to help the board to set priorities for renovation works of the building stock.

A deliberate choice of digital sobriety in order to comply with the decarbonation objectives of the foundation, an ergonomic facility and educational choice of having the best chance of success between the technicians of the foundation, brought us to choose a very accessible spreadsheet, with all calculations on open-source. We hope that this choice of robustness will contribute to the dissemination of knowledge and uses of this tool.

2.3 Criteria Analysis Grid

The tool being intended for the board, acting at a strategic level, it was important to give a synthetic and easily understandable view of the issues. Avoiding a “black box” effect, was always at the center of preoccupations.

As a consequence, the number of criteria had therefore to be limited in order to be embraced with a single glance. The limit was set to 10 criteria that have to cover the entire spectrum of issues to be considered for a transformation and renovation project.

Further reflections led to the consideration of buildings not only from the point of view of their current status (energy consumption, obsolescence, economic performance) but also their potential for a refurbishment project (architectural and constructive complexity, regulation limitations, potential for a transition towards renewable energy sources, etc.).

The analysis grid was therefore composed with five status criteria (in black) and five potential criteria (in red), as shown on below (fig. 2).

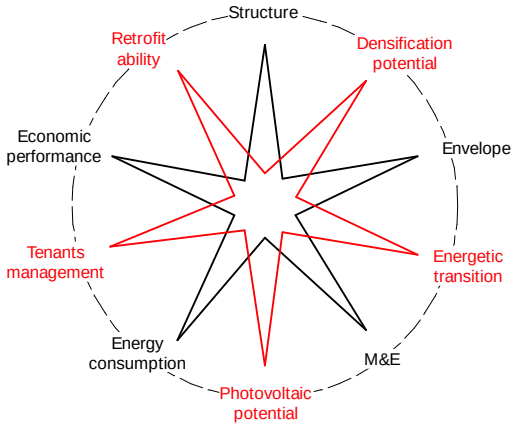

Fig. 2 . Status and potential criteria

2.4 Portfolio Assessment

All of the Foundation buildings were inspected in situ, data was collected in order to rank them against the above set criteria. A comprehensive report was produced for each building, allowing to produce a synthesis for the whole portfolio, giving an easily understandable picture of its status and potential (fig. 3). A first priority list can be established by simply calculating the average of the different marks attributed to each criterion.

Fondation communale de Versoix - Samuel May MULTI CRITERIA MATRIX			Buildings															
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
ETAT	I.1	Envelope	3	1	2	2	3	3	3	1	2	1	1	1	2	2	2	1	3
	I.2	Structure	2	1	1	1	1	2	1	1	1	1	1	1	1	1	1	2	2
	I.3	M&E	2	1	2	1	1	1	1	1	2	1	2	1	2	2	2	1	3
	I.4	Energy consumption	5	3	2	3	4	4	3	1	2	2	5	2	4	2	2	1	4
	I.5	Economic performance	3	3	2	4	4	5	5	3	4	1	3	2	3	2	4	3	1
POTENTIEL	II.1	Retrofit ability	3	5	3	5	4	4	3	5	5	5	3	2	3	4	2	3	5
	II.2	Densification potential	4	4	2	1	3	2	2	1	1	1	1	1	1	1	1	1	5
	II.3	Energetic transition	5	5	2	4	5	4	3	0	4	4	5	4	5	4	4	4	5
	II.4	Photovoltaic potential	4	2	2	4	5	2	2	5	5	5	3	3	3	3	4	4	5
	II.5	Tenants management	2	1	3	2	3	2	3	3	4	5	5	5	3	4	5	4	5
Priority (rank on average of criteria)			2	9	14	6	2	3	6	10	2	5	2	6	2	3	2	2	1

Good	Good state, no work needed / good potential
Correct	Slightly degraded, to be monitored, maintenance works to be planned
Medium	Degraded, retrofit works to be planned / medium potential
Bad	Very degraded, works to be carried out in near future / bad potential
Very Bad	End of life, works to be undertaken as a matter of urgency / very bad potential

Fig. 3 . Stage one : ranking of Versoix Foundation buildings.

Digital data obtained from SITG (Geneva territorial information system https://ge.ch/sitg/) were especially useful. SITG, an organization based on a network of public partners with the aim of coordinating, centralizing and widely disseminating data relating to the Geneva territory, gathers a lot of information about all buildings in the Canton of Geneva. In this project it was used to collect buildings energy consumptions using the heat expenditure index (IDC) which is an indicator of the energy consumption of a building to cover its heat needs (https://www.ge.ch/optimiser-consommation-chaleur-batiment). This index allows the assess and comparison the energy performance of a building from one year to the next and his annual calculation is a legal obligation for each building owner. Other data like solar photo voltaic (PV) potential for each building roof [3], boiler register and finally very valuable information at the regulatory level, such as building restrictions, dimensions, heritage protection, noise protection zones, etc.

However, diving into this big data, which offers a wealth of information, has shown that the quality of the data is not 100% reliable and that a manual control is essential,

especially when working on the scale of a building or a medium-sized portfolio. In this context, statistical noise is not acceptable.

2.5 Digital Steering Tool

This first stage of "raw analysis" as shown on above (fig. 3) is not sufficient to set priorities because i) there are synergies between criteria to be considered to form refurbishment strategic options (looking at the sole envelope, for instance, is not a strategic option) and ii) the strategic options can be weighted to reflect as close as possible the owner's sensitivity to these options.

The buildings in the portfolio must therefore be evaluated against strategic intervention axes constructed on the basis of the different criteria, and the axes must be weighted according to the sensitivity of the owner to these strategic options. This is the core of the digital steering tool.

The four strategic axes were defined as follows:

- Energy
- Obsolescence
- Ease of intervention
- Return on investment

The digital steering tools first combine the various criteria to produce a rating against each strategic axis. For instance, the energy axis is a combination of the size of the building and the five different status and potential criteria (actual energy consumption, potential for transition to renewable energy source, photovoltaic potential, refurbishment ability and envelope obsolescence), each of them having different weights in the evaluation. In this instance:

*Overall Energy rating = (envelope obsolescence*2 + energy consumption * 4 + refurbishment ability * 2 +PV potential *2) + (renewable energy transition *4 + PV potential *2) / 2 * size factor.*

Ratings are then converted on a scale from zero to five to make them equivalent. At this stage the digital steering tools is able to set priorities of intervention, with all strategic options being equivalent (fig. 4). In other words, as if for the owner all strategic axes had the same weight (neutral owner).

The neutral profile (equal weight for all strategic axes)

FONDATION COMMUNALE DE VERSOIX SAMUEL MAY	Buildings																
Strategic options	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Energy strategy	5.00	4.55	0.13	2.29	0.89	1.42	1.97	1.21	2.85	1.04	0.20	0.00	0.96	0.20	0.07	0.43	0.03
Obsolescence strategy	3.50	1.50	2.00	2.50	3.00	3.50	2.50	1.50	3.00	1.50	1.00	0.00	2.00	2.50	1.50	1.00	5.00
Ease of intervention strategy	0.00	1.00	1.00	2.00	2.00	1.00	1.00	3.00	4.00	5.00	3.00	2.00	1.00	3.00	2.00	2.00	5.00
Profitability strategy	1.11	1.11	0.00	3.33	3.61	4.72	5.00	2.22	4.44	0.00	2.78	0.83	1.67	0.83	4.17	2.22	0.00
Rank (priority)	**4.00**	**9.00**	**16.00**	**3.00**	**7.00**	**6.00**	**5.00**	**8.00**	**1.00**	**13.00**	**10.00**	**17.00**	**15.00**	**12.00**	**11.00**	**14.00**	**2.00**

Fig. 4 . Neutral ranking

Buildings are now ranked by intervention priority, and a color code divides them into three categories: first priority group (green), second priority group (orange) and third priority group (red).

The last stage in the digital tool consists in determining the owner strategic profile and put a weight to the axes, on a scale from zero to five. The zero to five scale was subjected to a sensitivity analysis which proved that it was the correct scale to be used in the steering tool. Reducing the scale leads to difficulties in clearly differentiating priorities, enlarging it does not lead to more differentiation, with the risk for the user to get lost in too large a scale.

We see that the owner's strategic profile has an important impact on the priority list. There are $5^5 - 4 = 3121$ possible owners' profiles. We are showing below two extreme profiles (fig. 5 & 6), that result, for the same real estate portfolio, in totally different intervention priorities, reflecting opposite owner's profiles.

<u>The virtuous profile</u> (exclusive focus energy and obsolescence).

	Energy	Obsolescence	Ease of intervention	Profitability
Weights	**5**	**5**	**0**	**0**

	Buildings																
Strategic options	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Energy strategy	25.00	22.76	0.66	11.43	4.47	7.12	9.86	6.06	14.24	5.18	1.02	0.00	4.81	1.00	0.33	2.17	0.16
Obsolescence strategy	17.50	7.50	10.00	12.50	15.00	17.50	12.50	7.50	15.00	7.50	5.00	0.00	10.00	12.50	7.50	5.00	25.00
Ease of intervention strategy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Profitability strategy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rank (priority)	**1.00**	**3.00**	**13.00**	**4.00**	**7.00**	**5.00**	**6.00**	**9.00**	**2.00**	**10.00**	**14.00**	**17.00**	**8.00**	**11.00**	**16.00**	**12.00**	**15.00**

Fig. 6 . the virtuous profile

<u>The lazy moneymaker profile</u> (exclusive focus on profitability and ease of intervention).

	Energy	Obsolescence	Ease of intervention	Profitability
Weights	0	0	3	5

	Buildings																
Strategic options	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Energy strategy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Obsolescence strategy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ease of intervention strategy	0.00	3.00	3.00	6.00	6.00	3.00	3.00	9.00	12.00	15.00	9.00	6.00	3.00	9.00	6.00	6.00	15.00
Profitability strategy	5.56	5.56	0.00	16.67	18.06	23.61	25.00	11.11	22.22	0.00	13.89	4.17	8.33	4.17	20.83	11.11	0.00
Rank (priority)	**14.00**	**13.00**	**14.00**	**6.00**	**4.00**	**8.00**	**7.00**	**5.00**	**1.00**	**14.00**	**2.00**	**11.00**	**12.00**	**10.00**	**3.00**	**9.00**	**14.00**

Fig. 6 . The lazy money maker profile

We note for instance that building n°1 is ranked in the fourth position with a neutral profile, in the first position with the virtuous profile and in the fourteenth position (upon 17 buildings) with le lazy moneymaker profile. This demonstrates the fundamental importance for the owner to think carefully about his strategic goals and set a profile accordingly, before thinking about setting priorities with the help of the steering tool.

To complete the information, the tool also produces radar diagrams (fig. 7), showing the weight of each strategic axis in the ranking of the building and the group category of the building (first, second and third priority groups).

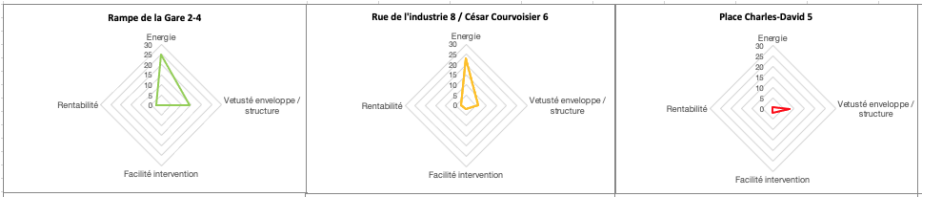

Fig. 7 . Radar diagrams showing the respective weight of strategic axes in the ranking of buildings.

3 Discussion

As explained in the introduction, the energetic transition of the existing building stock is essential to the energetic transition of our society. In this perspective, owners have a decisive role to play, by launching and financing ambitious refurbishment projects.

There is a general awareness in Switzerland amongst the population of the need to act in this sense. This awareness has been built over the last decade thanks to government communication and information programs and regulation evolutions. Today, we are all aware of the issue and energy labels, for cars, light bulbs, household appliances,

etc. have become are totally part of our daily lives. It is no surprise that building's owners question more and more the energetic performance of their assets.

However, a building is not a light bulb. You do not just replace it by a new one when it is outdated or broken. Schematically the process the owner will follow is as shown below (fig. 8).

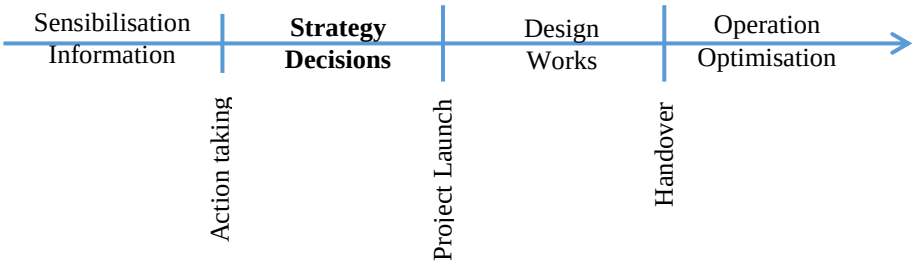

Fig. 8 . Owner's global route to energetic improvement of portfolio

As described above, the first phase (sensibilisation and information) is well underway, supported by government, owners and tenants' associations and by the growth of general awareness to the energy issue. The third and fourth phases are also quite straightforward, as the owner can rely in most of the cases on the skills of professionals (architects, engineers, contractors, property managers) who are more and more aware of the constructive and managerial solutions to solve the problem.

In the second phase, however, the owner is generally left alone. If he is a real estate professional, he might cope with the challenge. If not, his task will be much more complex, and it is precisely during this essential phase that decisions that will impact the building stock for decades must be made. Having simple tools to help the owner to answer certain basic questions at this stage, in complete autonomy, is very important.

The developed tool is part of the panel of instruments that should allow the owner to pass this phase in the best possible conditions and to make rational choices in line with his strategic goals.

However, care must be taken. The decision-making process of the owner may be based on the priorities extracted from the tool, but it will inevitably need to be completed by elements of analysis, often decisive, which are not taken into account in the analysis criteria because they are too subjective or subject to rapid change over time. We think here about political issues, neighbourly relations, investment capacity, etc.

Coming back to the specific project of the Foundation, two major findings appeared during the project, only partially related to its goals:

i) Information about the buildings was very dispersed between the Foundation, the property manager and the building concierges, each of them detaining part of the information. Furthermore, it not only often incomplete, but also in many instances inconsistent between the various sources. In this kind of structure, over time, information is diluted, and very dependent on human factors: when someone quits the Foundation or the agency, or at the occasion of agency changes, part of the building history disappears, because it was never correctly documented.

Governance issues also emerged. The division of responsibilities between the Foundation Board and the property manager is unclear. Some daily decisions (mainly on maintenance works) are taken directly by the board, without consulting or even notifying the agency, because some members are active as entrepreneurs in the construction industry and find it more efficient to manage issues directly. As a result, the level of information is inconsistent and financial statements may be corrupted.

The project has helped to raise these issues and the duly documented multi-criterion diagnostics at least provide a clear and objective view of the condition and potential of the various buildings. They are supposed to be updated on a regular basis, as refurbishment and maintenance works are carried out, which in turn will update the steering tool database. This is essential, because the tool is to be used in the long run, with priorities being updated to reflect the works undertaken at any time.

ii) When time came to define the Foundation board strategic profile (allocate weights to the four strategic axes), it appeared to be unclear for the board on which side to tip the balance. The Board was clearly aware that its building stock needed to be maintained and renovated in some cases and decided to launch the project for the sake of good management and to meet the challenges of maintaining the value and habitability of its buildings and improving their energy performance and carbon footprint but did not have a strategic vision to weigh the options. This situation is certainly the lot of many owners, a fortiori those whose decision-making body is composed of a more or less heterogeneous assembly of individuals.

In this case, no steering or decision-making tool will help. The first duty of the owner is to question its strategic objectives in the context of the life cycle and renovations of its portfolio. What is the deep reason or mix of reasons between the need for refurbishment? This work of reflection still needs to be carried out in Versoix.

4 Perspectives

Perspectives are threefold:

- Follow up with the Foundation
- Evolving maintenance regarding the scientific and regulatory framework
- Dissemination of the steering tool to other owners

In Versoix, the need for a long-term strategy for the Foundation's building stock has been acknowledged. Some buildings are certainly in need for refurbishment and action must be taken, but the challenge is more global, with more than simple technical issues to be taken into account.

The small town of Versoix, 10km from Geneva city center, is experiencing important changes:

i) Having been increasingly integrated into the Geneva agglomeration in recent decades, Versoix saw it population change and grow (+30% since 2000).

ii) The city is undergoing an upgrade of its city center. The only access road to Geneva from Switzerland (apart from the freeway) runs through it, with a strong impact of motorized traffic. This road is undergoing since 2017 and until 2021 major requalification work (fig. 9) to mitigate traffic impact and enhance the spatial quality of the public space, to give it back to inhabitants. Several of the Foundation buildings adjoin this road and will find themselves in a more enviable position than before.

iii) Two train stations of the municipality are connected since 2019 to the new Leman Express train line, planned to be the new backbone of Geneva's public transport system, running every 15 minutes and connecting Versoix directly with the most important infrastructures and the new urban developments in the agglomeration.

Fig. 9 . Computer image of the Route Suisse requalification Project, source : Canton de Genève, Département du territoire.

It is therefore evident that a strategy for the Foundation building stock has to take these elements into consideration. A global and multidisciplinary approach is the way forward to seize the challenge. In this context, the digital steering tool will be one of the instruments for solving the multi-unit equation of building the Foundation's long-term strategy and implementing it through its portfolio.

Due to Covid-19 and to local elections, that led to changes in the composition of the board, discussions with the foundation have been stalled for a year.

The canton of Geneva declared a climate emergency state in 2019. Therefore, the Foundation, like the other regional real-estate stakeholders, is now facing a rapid change of the regulatory framework regarding the acceleration of the building renovation process in order to fulfil the challenge of climate change. In a regulatory point of view, the foundation is considered public utility foundation which has now to face improved renovation standards. This constitutes a new challenge to fulfil with his traditional social objectives. This tool will also enable to project the building portfolio of the Foundation as an active urban planning actor helping the improvement of territorial energy concept in the town of Versoix.

Being a public owned entity, the Foundation had no adverse comment on disseminating the tool (based on a standard spreadsheet) and proposing it free of charge to other building stock owners.

The project has been presented at the last BRENET (Building and renewable energy network Switzerland) congress in Aarau in autumn 2020 and contacts are underway at local level with the Geneva Energy Agency (OCEN), the federation of architects and

engineers (FAI) and the property managers' association (USPI) with the intention of proposing the tool to a broader audience.

We are convinced that simple, transparent and efficient digital tools will be of great help to real estate portfolio owners, especially of small to medium size, to tackle the issue of the refurbishment and energetic transition of their building stock, especially in the intermediate stage of strategy construction and strategic decisions, so important for the success of any project.

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