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Energy Performance Certificate for buildings as a strategy for the energy transition: Stakeholder insights on shortcomings

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Abstract. Improving building performance is key to tackling the challenges of climate change, considering that buildings account for 40% of the global energy consumption. The urgent need for energy efficiency improvement of buildings calls for the implementation of suitable policy instruments, including performance assessments. Currently, the performance of buildings is officially assessed by Energy Performance Certificate (EPC) schemes. However, EPCs certify the design more than the building, relying on simulations and assumptions rather than on the buildings' actual demand for energy which is partly determined by occupant behaviour, execution of the work and malfunctioning of the equipment. This work investigates how the governance of the performance certification scheme could be improved with the objective of a more robust EPC scheme. Based on a qualitative study through interviews with energy experts the current EPC system in Switzerland is characterized, allowing to understand important limitations. The insights help to shape a list of recommendations for further development of the EPC scheme. This research is relevant because the failure to correctly assess building performance leads to excess carbon emissions and higher energy costs, undermining the attainability of the energy policy targets.

1. Introduction

Improving building energy efficiency is key to tackling the challenges of climate change, considering that buildings account for 40% of the global energy consumption [1], and calls for the implementation of policy instruments including performance assessments [2]. The European Energy Performance of Buildings Directive (EPBD) includes measures that oblige all the Member States to adopt Energy Performance Certificate (EPC) for buildings that are constructed, sold or rented out to a new tenant [3]. The EPC reports the expected energy consumption if the building is used in compliance with the standards. The reliability of these EPCs, as well as of other private labelling systems such as Minergie [4], and of calculation-based performance evaluation more generally, becomes critical for achieving the UN Sustainable Development Goals (SDG) for sustainable cities [2]. EPCs certify the design more than the actual building, relying on standards and assumptions to compare buildings in different environmental contexts. However, EPCs are nowadays incorrectly used in many applications (e.g. to predict the savings of an energy retrofit) assuming that they indicate the buildings' measured energy consumption. Previous studies [5–7] highlighted the presence of a gap between the buildings' calculated consumption according to the EPC and the actual consumption, resulting in higher energy bills and environmental impacts [8,9]. Inaccurate calculations of the energy consumption in existing dwellings result in uncertain energy saving potentials when retrofitting [10] and make future climate scenarios unattainable [11], motivating the need to close the gap [12].

This work investigates how improvement of the governance could deliver a more robust EPC scheme. It is based on a qualitative study through interviews of a number of building energy practitioners in the field and it is compared to findings from the literature. The aim is to understand what the main limitations of the EPC are and to comprehend how those who use them every day propose to improve the scheme. This approach offers a better understanding of the interdependencies between the EPC Expert certifying the building, the local authorities, and the building owner.

This research was conducted in the context of Switzerland, but the findings provide useful insights for Europe in general, as the theoretical consumption is calculated with the method described by the EPBD [3], and the practices of building design, construction, commissioning and usage are similar across Europe. This research is relevant beyond the academic sphere because failure to correctly assess building performance leads to excess carbon emissions, higher energy costs paid by the buildings occupants, and undermines the attainability of sustainability targets defined by energy policy. Additionally, this work aims to address the SDG7 - affordable and clean energy - which calls for a tangible improvement in energy efficiency in buildings. Therefore, research towards developing a new generation of EPCs is highly relevant to policy makers, energy utilities, local authorities, and the general population.

2. Swiss Energy Performance Certificate

Switzerland has often been at the forefront of energy efficient design and construction in Europe [4,13] however the rate of energy efficiency improvement in Switzerland falls short of the objectives according to the Swiss Energy Strategy 2050 [14]. This raises questions about the suitability of the current energy policy including the buildings certification scheme. National energy regulations are drawn up jointly by the Swiss Cantons and specify technical requirements and new minimum energy performance levels [15]. However, each Canton is responsible for enacting the legislation (the federal government has only subsidiary competence), resulting in a range of different policies to achieve the targets [16], and making Switzerland an interesting case study.

One measure adopted to offer a common framework is the implementation of the Swiss Cantonal Energy Certificate for Buildings (CECB) [17] which, based on existing European standards (SN EN 15217; SN EN 15603) and national norms [18,19], primarily raises awareness and provides information about the level of energy efficiency of buildings. The CECB contains information on the building envelope and its overall energy efficiency regardless of the behaviour of its users, and it applies to both existing and new buildings. The CECB was designed to be produced by certified "CECB Experts" to provide a quick and cost-effective way of estimating the energy performance of existing buildings. The calculated performance is categorized into the energy labels A to G (very efficient to very inefficient) as well as "+" for net positive energy buildings. The CECB distinguishes two ratings. The first considers only the building envelope (walls, roof, windows, etc.) while the second includes the heating system, domestic hot water, and other loads (e.g. appliances). This work investigated the latter.

3. Method and Data

We conducted semi-structured interviews with open-ended questions to understand practitioners' experience and to subsequently compare findings to those found in the literature. The CECB association contacted selected CECB Experts proposing them to take part in our study. Fourteen interviews were performed in summer 2019, lasting 30-60 minutes each. Participants were encouraged to add information they found relevant even if it was beyond the scope of the proposed questions. The results gave insights into CECB Experts' practices and attitudes regarding the use of the energy certificate when constructing and/or retrofitting a building, and when designing the technical installations.
The following type of questions were asked:

- *"When planning a building construction/retrofit, how is the targeted CECB energy class defined and by whom?"*

- *"Is the company (construction company or project developer) in charge of the retrofit in any way linked to the CECB Expert who performs the assessment?"*
- *"Does it happen that a very good energy class was aimed for (e.g. A label) but that the attained label is less performing (e.g. C label)? If yes, how often does this happen?"*

The participants were chosen to provide a broader spectrum of respondents, especially in regard to the profession, the location of their activity, and the level of experience. Table 1 summarizes the participants' characteristics.

Table 1. Participants characteristics: "participant" is the code of the subject, "years of activity" identifies the level of expertise, "profession" represents the field of activity and "language area" denotes the geographical location of activity.

Participant	Years of activity	Profession	Language area
P1	0 - 5	Energy Consultant	French-speaking
P2	0 - 5	Energy utility	French-speaking
P3	5 - 10	Energy Consultant	German-speaking
P4	5 - 10	Researcher	Italian-speaking
P5	5 - 10	Energy utility	French-speaking
P6	> 10	Architect	Italian-speaking
P7	> 10	Architect	German-speaking
P8	> 10	Architect	German-speaking
P9	> 10	Energy Consultant	German-speaking
P10	> 10	Energy Consultant	Italian-speaking
P11	> 10	Researcher	German-speaking
P12	> 10	Researcher	German-speaking
P13	> 10	Researcher	German-speaking
P14	> 10	Energy utility	French-speaking

The number of years of activity reflects the experience of the subject in using the energy certificate and allows to include both experienced and more recent experts. The language spoken identifies the region of activity. This aspect is important because, although the energy certificate is national, many rules on buildings are subject to cantonal regulation and can vary greatly between regions. Of the participants, 50% originated from the German-speaking part of Switzerland, 29% from the French-speaking part, and 21% from the Italian-speaking part, roughly reflecting the distribution of population (65%, 25%, and 10% [20]).

4. Results and Discussion

The collected data was analysed by thematic area, based on the frequency of the key words used during the interviews. When stating findings expressed by several CECB Experts, we note the fraction of participants who made equivalent statements, e.g. (8/14) indicates 8 of the 14 interviewees made an equivalent statement.

4.1. Integration in the design process

A broad agreement among the participants working in consultancies and in utilities (7/14) was found in regard to the design process and certification timeline. In many cantons, the CECB is considered to be mainly an administrative requirement. It is not used to guide the design but is instead prepared only at the end of the design stage to validate the choices made after the architectural design stage, when the architect has already completed the design and the systems engineer has already sized the installation.

This leaves little scope for modification based on the CECB Experts' assessment. Participants P1, P3, and P10 suggested that the CECB should be initiated during the design phase to maximize its influence on the design choices, allowing to optimize the energy performance.

P3 also illustrated how the CECB Expert is typically involved in the retrofit process: generally the owner of the building calls a construction company to repair a defect (e.g. leak in the roof). If the building company assesses the cost to be more than a certain threshold (e.g. 10 000 CHF), they call the CECB Expert in order to receive subsides for the retrofit work. At that point the CECB Expert can only "confirm" the project proposed by the company, even if it is not always the most effective in terms of energy savings.

A holistic integration of the energy assessment in the design process from the early design stage, using the CECB as a tool supporting decision, would help to reduce the gap between the actual performance and the expected performance according to the certificate.

4.2. The CECB Expert

The CECB is produced by an accredited professional, called "CECB Expert"; anyone with an appropriate professional experience and adequate background can apply for this title. To be officially recognized as CECB Expert and be included in the national database, it is necessary to attend a course focused on the CECB tool and to pass an evaluation confirming the ability to assess the data received from the owner, to perform a site visit, and to produce the certificate.

However, architects and researchers interviewed (7/14) revealed that most CECB Experts are accredited with a single-day course and no real experience on a construction site. Therefore, they may have little knowledge of the problems that can arise during the construction process. This lack of training may contribute to the energy performance gap, as the mismatch between the building data in the certificate and the reality of the construction has been identified as a major cause of the gap [21].

The lack of qualification is partially linked to the sudden need of this role. For example, participant P1 highlighted that only a handful of Experts were active in the canton of Geneva until 2017, when the CECB was made compulsory to apply for subsidies of more than 10 000 CHF. Two years later (2019), there were already 65 CECB Experts for the same Canton. Participant P6, who is also a CECB trainer, stated that is crucial to enforce and update the training and that it may be necessary to combine a renewal of the CECB Expert accreditation with more demanding exams.

Finally, the majority of the participants (11/14) highlighted the constraints of the standard contract for the delivery a CECB, which allows 8 hours of work for a regular CECB and 14 hours for a CECB prior to retrofit (these time budgets typically include one site visit, next to the analytical work and the preparation of the report). This is mainly to minimize the cost of the assessment. However, this precludes any possibility of cross-checking information, obliging the CECB Expert to use simplified assumptions.

4.3. Monitoring

Most of the participants (10/14), except for the architects and P3, agreed on the lack of monitoring of the energy consumption after issuing of the certificate as major limitation of the current certification schemes. In theory, during the preparation phase of the certificate, the building owner is obliged to provide energy bills of the previous three years. This does not always happen, especially when a CECB is released after a retrofit (while a CECB is often prepared in the context of an energy retrofit, it may also be issued at a different point in time, e.g. prior to selling of the building). Thus, it becomes very difficult to assess the effectiveness of retrofit and to identify, and possibly close, the performance gap. Participants P4 and P13 implied that monitoring should become a requirement for certification, or mandatory by law.

4.4. Data quality

Another problem on which all the researchers and utility employees (7/14) shared the same opinion is related to the quality of the input data used for establishing the real energy consumption. For most existing buildings, heating consumption data are available over several years. The CECB Expert must request this data from the building owner for a minimum of three years, calculate the average and enter the value into the tool. This can help to cross-check and to adjust the calculated values of the final energy and heating demand. A range of +/- 15-20% is deemed acceptable. It is important to note that the accuracy of the actual consumption data and any cross-checking are entirely under the Expert's responsibility, neither the online tool nor any authorities can check them or enforce this process.

However, according to the interviewees, these internal quality cross-checks alone do not guarantee sufficient reliability of the overall results. All assertions made by the Expert on the certificate or in the report have to be consistent, plausible, and understandable not only for the authorities, but also for the client. The online tool itself has in-built range-checking for most data. However, P8 and P14 noted that these boundaries are fairly loose. Contradictory inputs should be highlighted to the Expert or messages should appear, and a final calculation should only be initiated after all input errors have been removed. However, a large share of participants (10/14) and the literature [11] confirmed that this is not the case and that there is still a lot of room for improving the tool.

On a cantonal level, the authorities handling the CECB reports in the context of subsidy requests can reject a report considered inaccurate or insufficient for other reasons. A quality check program was initiated in 2017 on a nationwide scale, not only to evaluate the quality of the certificates generated, but also to help the CECB Experts to improve their skills and to optimize the online tool itself. Participants P2, P4, P7, and P12 expressed the standpoint that more such programs must follow.

4.5. Collaboration between stakeholders

The majority of the participants (12/14) agreed that new business models may allow to bring together stakeholders who would otherwise not collaborate, from which the entire design process, construction, and use phase may benefit [22]. According to P5 and P14 the most promising options are Energy Performance Contracting and Energy Supply Contracting. These represent a collaboration between an owner, an energy service company and, possibly, a financial partner. This model has been successfully implemented for about 20 years in Germany, Austria, and many other countries, especially when initiated and supported by the local administration [23,24].

In the case of energy performance contracting the energy service company (ESCO) provides energy services, while improving the building's energy efficiency. Examples (given by P14) include insulation of the building envelope, energy-efficient lighting and shading, and measures to optimise and/or modernise the heating, ventilation and air-conditioning systems. These measures are financed by the savings in energy costs. The ESCO generally covers initial investments and/or provides an explicit savings guarantee for energy, energy costs and CO_2 emissions; and is remunerated according to proven energy savings.

P5 pointed out the ESCO's motivation to ensure a high level of energy efficiency in construction/retrofit and thus reduce consumption. However, there are a number of barriers to the introduction of energy contracting, explaining why it has so far not been successful in Switzerland. P11 suggested that one of these may be the high share of rented residential buildings where the long contracting periods needed are not feasible, since inhabitants change several times within the same contract period.

A related (but less demanding) solution proposed by several participants (5/14) is the Energy Optimization Contract [25]. In this type of business model, the ESCO is in charge of optimizing the consumption of a building over a period of at least 6 years (usually very large buildings in order to be profitable). At the end of each year, the owner reimburses the ESCO for the energy optimization while also paying the energy invoice. The owner's total cost typically does not exceed the cost before the optimization. Once the energy efficiency measures have been fully implemented (usually after 2 to 3 years), the owners' total bill (heating cost + contract bill) will decrease. The motivation of all the stakeholders involved, even if for different objectives, helps to reduce the consumption.

Participant P3 indicated that the system engineer (person responsible for heating system maintenance) is an important stakeholder in this type of contract. The engineer must ensure energy savings during the first 3-years period by visiting the building every 2 weeks to adjust and optimise the heating system.

To date, this type of business model is rather uncommon; more efforts need to be made in this area. Furthermore, P8 stated that energy performance contracting may be less suited for deep retrofits, as these involve high upfront costs resulting in very long contract periods, which generally imply a higher financial risk.

4.6. Subsidies and enforcement of the law

In many cantons, the CECB is a requirement for requesting subsidies. Participants P1, P2, P4, and P6 expressed their concern that this could lead to rather generous issuing of certificates. Subsidies aim to increase the number of retrofits and to trigger higher energy performance. However, P1 reported that subsidies usually cover about 30% of the costs related to energy retrofit, which in turn represent only about 30% of the total costs of renovating a building [26]. As a consequence, the subsidy amounts to less than 10% of the total cost. This may be insufficient to incentivize the owner to adopt more expensive energy-efficient measures. P4 and P6 estimated that the subsidies should instead cover at least 50% of the total cost. On the other hand, P3 noted that a massive expansion of the subsidy volume may not be affordable and would face acceptance problems from various stakeholders and the public. In Switzerland, according to P3, the political compromise that led to the Swiss Energy Strategy 2050 foresees gradual phasing out of subsidies in favour of market-based policy instruments [27].

Nevertheless, 10 participants underlined that subsidies can still help to improve the building stock's energy efficiency since the current building codes are very stringent and reaching them requires significant capital expenses. The example provided by participant P1 shows the type of trade-off made by the building owners: when renovating a roof of a building heated with an oil/gas boiler, owners in Switzerland are typically obliged to install solar thermal panels to compensate a part of the CO_2 emissions. Repairing a damaged or worn roof of 200 m^2 according to the rules may cost the owner around 315 000 CHF, as a sum of 180 000 for the solar thermal installation and 135 000 for the roof (already discounted by 25% subsidies). On the other hand, by renouncing subsidies and therefore the installation of the solar thermal system, the cost for the owner is reduced to the repair of the roof only, equal to 180 000 CHF (135 000 + 25% of the subsidies not received). P1 concluded, "*the repair alone incurs a much lower cost than of its combined installation with the solar thermal system, hence influencing the choice of the owner*". While being illegal, participants P1, P2, and P4 (all relatively new in the sector) agreed that this type of practice is not uncommon, due to the very high capital cost and the lack of control by the authorities. As a consequence, the high standards required to ensure high performance become partly ineffective, leading to a gap between expected and achieved energy performance.

Participant P13 said that a substantial part of the subsidies for energy retrofitting originate from the Swiss Federal Building Programme. The funding source of this programme is the Swiss CO_2 levy which currently amounts to 96 CHF per emitted tonne of CO_2. The mission of the Swiss Federal Building Programme is to save energy and to avoid CO_2 emissions [26]. However, 4 participants, all belonging to the French region, stated that there is indication that dishonest, strongly profit-oriented owners and their representatives (real estate agents, institutional investors) make use of these subsidies to renovate their buildings, with no or only limited attention to energy efficiency improvement. This is enabled by the lack of control of whether the intended energy efficiency level was actually achieved. There is hence a flagrant lack of enforcement which explains, at least in part, the existence of the performance gap. Participants P1 and P2 confirmed that misuse of subsidies is still considered as trivial offence ("peccadillo"). Raising awareness about the breach of law among the owners, authorities, real estate companies, consulting firms and construction companies may be the first step to take but is unlikely to be sufficiently effective without legal action resulting in severe penalties. To tackle this issue, P5 suggested three actions as part and parcel of systematic enforcement: monitoring of the energy use after completion of the energy retrofit, reporting of the values to the authorities, and sample checking by authorities.

5. Conclusions

The interviews with the professionals involved in the design process unveiled a number or practices which explain the existence of the energy performance gap. The insights allow to prepare a list of recommendations that may be used to improve the current structure/process of the Swiss certification scheme for buildings, but that can also be applied in the EU, thus contributing to reach the SDG-7. The main conclusions are:

- It is recommended to integrate the EPC in the design process, starting from the early design stage and using it as a decision-making tool.
- It is recommended to enforce and update the training of the EPC Expert, including more demanding exams and mandatory follow-up courses.
- It is recommended to allocate more time to the preparation of the EPC, in order to give the Expert time to thoroughly examine the building and provide solutions that are more energy efficient.
- It is recommended that especially larger buildings are monitored as pre-condition for good maintenance, fine-tuning and repair, whenever required.
- It is recommended to make use of service contracts, e.g. in the form of an Energy Optimization Contract (for simple tuning of the installation and its monitoring) or of Energy Contracting solutions (energy supply contracting or energy performance contracting) where good operation is in the contractor's own interest. In other words, the difference between the expected consumption and the achieved once can be minimized by holding all the actors involved accountable (economically and morally).
- A stronger commitment is also required from the national and/or local authorities, which can help to reduce energy consumption through more rigorous controls on the compliance with building codes, by means of sanctions in the case of non-compliance.

Very detailed research on the state of today's buildings would be needed in order to establish which of the solutions discussed above should be implemented first and to which extent, thereby accounting for their cost-effectiveness. However, it appeared clearly that although EPCs are not instruments to predict energy consumption, the lack of suitable alternatives makes them often used in this sense. It is important to further clarify their use and offer more adequate solutions to assess the actual consumption of a building. In any case, more attention should be paid to non-compliance with existing regulation since it seems to represent a significant risk to the attainment of energy and climate objectives.

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