Is the tailor recommendation useful? Policy suggestions to upgrade the EPC recommendation report

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Abstract. The Energy Performance of Building Directive (EPBD) have asked to Member States (MSs) to include an Energy Performance Certificate (EPC) every time a dwelling is sold, rented or built. Additionally, the EPC must include a report that contains a list of recommended measures for improving their energy performance in a cost-effective way. Considering that the Directive does not directly mandate investments or any increase in renovation activity, building owners remain the single decision-makers to invest or not. Due to this, the recommendation list of measure is one of the main tools that can actually encourage building owners to perform renovation activities, avoiding the implementation of sub-optimal investments and preventing lost opportunities. The latest update of the directive, introduced in June 2018, has its main purpose to support and further reinforce the renovation of existing buildings. Despite this, the recommendation reports have not been modified and the latest evaluation of the directive states that it is not performing as expected. Little information can be found about it, either in the academic or institutional level. The article aims to provide a better understanding of the barriers that the energy recommendations report faces in its current state and proposing measures that can be uses to overcome these issues.

1. Introduction

In order to mitigate climate change and reduce carbon emissions, the European Union (EU) has set a long-term strategy based on three milestones; reduced Greenhouse Gas emissions (GGH) by 20% in 2020, by 40% in 2030 and by 80-95% in 2050, compared with the 1990 emission level (1). Actions taken to achieve these goals begin with the European Climate Change Program (ECCP) launched in 2000 as a strategy for the implementation of the Kyoto protocol. The second report from the ECCP highlights the importance of the building sector to reduce energy consumption and CO2 emission, since 40.7 % of the energy consumption in the EU is used in the residential and tertiary sector. Space heating is by far the largest energy end-use of households in Member States (57%), followed by water heating (25%) (2). To addresses this issue, in 2002 the Energy Performance of Buildings Directive (EPBD) 2002/91/EC was adopted aiming is to promote improvement of the energy performance of residential and non-residential buildings. The EPBD is the main legislative instrument at EU level to achieve better energy performance in buildings (3) and its main objective is to accelerate the cost-effective renovation

of existing buildings (4). One of the main actions of the EPBD of 2002 was the introduction of the Energy Performance Certificate, which is required whenever a building is constructed or for existing buildings, before it is marketed for sale or rent [6]. EPCs are produced using standard methods with standard assumptions about energy usage so that the energy efficiency of one building can easily be compared with another building of the same type (5). This allows prospective buyers, tenants, owners, and occupants to see and compare information on the energy efficiency and carbon emissions from a building, so they can consider energy efficiency and fuel costs as part of their investment decision. Several actions were expected due to its introduction, such as influencing the demand for buildings with excellent energy efficiency performance and a high proportion of energy from renewable sources, increasing their market value, and thus influencing building owners to renovate their buildings (6).

Concerning existing buildings, the EPC includes a recommendation report, listing cost-optimal or cost-effective measures to improve the energy performance of existing buildings. According with the EPBD the Recommendation List of Measures (RLMs) should be in connection with a major renovation of the building envelope or technical building system and it should contain information on the steps to be taken to implement the recommendations. It is added that these recommendations should be technically feasible for the specific building and may provide an estimate for the range of payback periods or cost-benefits over its economic lifecycle. Other information on related topics, such as energy audits or incentives of a financial or other nature, and financing possibilities, may also be provided to the owner or tenant (7). The main goal of the EPC along with the RLMs and inspection reports intend to provide information to building owners and tenants on the energy performance of their buildings, heating and air-conditioning systems, and on effective ways to improve these through building renovation works (8).

With the second version of the directive in 2010, the quality and recognition of the scheme was upgraded to a level that helps address many issues. For policymakers, they could become a source of building data to get a very good overview of the problem and design policies to an extent necessary to target the issue it the appropriate degree. Owners of existing residential buildings could through their EPCs be provided with links to funding opportunities, or directed to one-stop-shops linking them with businesses running innovative business models that deliver renovations and energy savings at no additional costs to the owner (9). However, many of these modifications did not meet the expectations. The data that could be obtained from EPCs are not available in all MS (9, 10), therefore policymakers have limited sources of information to produce and test renovations and energy efficiency policies. Similar case can be seen with homeowners, since the information from the EPC and RLMs have shown little progress in terms of renovation rate. Studies on this subject suggest there are many barriers that are not considered as part of the energy efficiency policies, such as uncertainty on energy prices (11, 12), split incentive (13), insufficient information about EPCs to understand the financing costs and benefits related to energy efficiency (14), limited access to capital (15, 16), payback period (17, 18), and access to loans (15, 19).

In order to prepare the current version of the directive 2018/844, the results from research reports, public consultation, stakeholder meetings and scientific publications were taken into account to review the performance of the EPBD (4). One of the most comprehensive studies delivered by the commission is the Evaluation of Directive 2010/31/EU (3). In this document, extensive documentation is discussed on the implementation of the EPC. Nevertheless, little attention concerning the RLMs was given, along with other documents mentioned in the Proposal for amending the directive, such as the impact assessment (20) and the public consultation(21). One of the main findings on the evaluation and public consultation regarding the RLMs is its limited impact on the renovation rates, lack of relevant recommendations and limited trust from the building owners.

The relevance of the RLMs lies in that it targets existing buildings, and due to its inefficiency, the potential renovation rate may be compromised. Considering that the main objective of revising the directive is to support and further reinforce the renovation of existing buildings (22). The importance of this matter is mentioned in many documents delivered by the Commission, acknowledging that 75% of the existing buildings in the EU are inefficient, since they were constructed with minimal or no energy

performance requirements in building codes (23). Even more heating and cooling are consumed in three main sectors, being the residential (mainly households buildings) the one with the highest share (45% of final energy heating and cooling consumption in 2012) (23). At current renovation rates, it will take more than 100 years to renovate the EU building stock. Increasing the rate, quality and effectiveness of building renovations is certainly the biggest challenge for the coming decades (20). Considering the above, it is clear that there is a need to stimulate the renovation of existing buildings, with the RLMs being one of the tools that presents great opportunities.

Through the information gathered from the commission reports, collaborators from several institutions and scientific research, three shortcomings stand out:

- Lack of definition and calculation procedures regarding the cost-effectiveness of the RLMs.
- Lack of insight from certifiers need and capabilities to produces valuable RLM.
- Lack of consensus about the impact of the energy gap and its influence on the RLMs quality and usability.

In the evaluation of the directive, which is the document that compiles much of the existing information on the performance of the EPC, the RLM is scarcely mentioned, hinting at the disagreement between different actors on how to reform this tool, the positions either contemplate improving and give greater technical attributes to the tool, or aim to simplify this procedure. This article aims to provide recent information and understanding of the RLM and its barriers, contributing with insights on how the RLMs can be updated and implemented to increase its impact on renovation rates. All findings presented in the following sections come from recent European commission reports, scientific articles on EPCs and complementary interviews with certifiers.

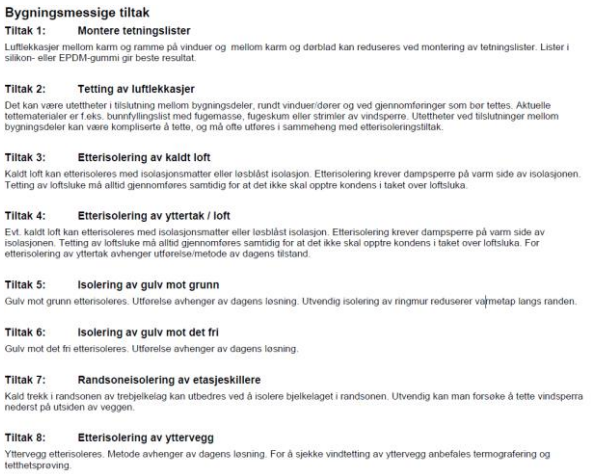
2. Cost-effectiveness

The EPBD set several requirements and procedures that need to be followed in order to be in compliance. However, many aspects were left open, to be adjusted to the local situation. Evidence on variations in the implementation of the certification system can be seen in several research, performed by BPIE (24), CA-EPBD (25) where it can be seen that the implementation of the EPBD varies largely from country to country. Differences can be seen in terms of procedure, methodologies and national structures. Even more, to date, the EPC scheme have not yet been fully implemented in all MSs (26). Regarding the RLMs, as can be seen in Table 1, these requirements broadly defined how the recommendations should be calculated, how much it has to cover and the minimum complementary information. For instance, “recommendation must be cost-optimal or cost-effective”, to fulfil the cost optimal conditions the directive have a complementary material known as “comparative methodology framework” 244/2012 (27). This methodology supports the objective of minimizing costs during a building’s lifecycle, while maximizing environmental benefits by combining uniform calculation rules with national data (28). On the other hand, the EPBD has not defined the cost-effectiveness nor its calculation method, which is a concern presented in the Public Consultation (21). As reported by JRC (29) some MSs did not submit at all a cost-effective approach to renovations and some others provided very generic considerations not supported by reliable assessments. Furthermore, only a small number of MSs have defined cost-effectiveness (30). The lack of clarity in its definition acquires relevance since in local regulations, the certifiers are required to provide recommendations only based on cost-effectiveness. This is because, the use of the cost-optimal method for every individual building, it would be impossible, as it is stated in the comparative methodology framework. Therefore, recommendations from the certifiers are likely to be made based on personal experience or theoretical principles without any evidence that ensure cost-effectiveness.

Table 1. EPBD requirement concerning the RLMs

Direct requirement	**Recommendation must be Cost-optimal or Cost effective (Art. 11(2))**
	Recommendations must be in connection with major renovation and for individual building elements (Art. 11(2))
	Recommendations must be technically feasible (Art. 11(3))
	Measures to improve further the energy performance of buildings should take into account climatic and local conditions as well as indoor climate environment and cost-effectiveness.
	Steps to implement the recommendation must be given (Art. 11(4))
	EPC must be carried out by qualified and/or accredited experts (Art.17)
	Experts shall be accredited taking into account their competence (Art.17).
	It must be available to the public an official list of qualified and/or accredited experts or lists of accredited companies (Art.17).

Regarding the RLM variations, CA EPBD (31) based on the national reports from 2014, stated that the RLM have been introduced by MSs in four different forms: automatic standard list, measure selected by an expert from a standard list, list developed by an expert, and a "different approach". According to these RLM variations and regulation framework, the main differences relies on who produces the measures, by the directive instructions (automatic) or by an expert (certifier). Either case, they present undefined issues that allows the lack of quality consistency. Examples of these procedure can be seen in figures 1-3.



Bygningsmessige tiltak

Tiltak 1: Montere tetningslister

Luftlekkasjer mellom karm og ramme på vinduer og mellom karm og dørblad kan reduseres ved montering av tetningslister. Lister i silikon- eller EPDM-gummi gir beste resultat.

Tiltak 2: Tetting av luftlekkasjer

Det kan være utettheter i tilslutning mellom bygningsdeler, rundt vinduer/dører og ved gjennomføringer som bør tettes. Aktuelle tettemateriale er f.eks. bunnfyllingslist med fugemasse, fugeskum eller strimler av vindsperre. Utettheter ved tilslutninger mellom bygningsdeler kan være kompliserte å tette, og må ofte utføres i sammenheng med etterisoleringstiltak.

Tiltak 3: Etterisolering av kaldt loft

Kaldt loft kan etterisoleres med isolasjonsmatter eller løsblåst isolasjon. Etterisolering krever dampsperre på varm side av isolasjonen. Tetting av loftsluke må alltid gjennomføres samtidig for at det ikke skal opptre kondens i taket over loftsluka.

Tiltak 4: Etterisolering av yttertak / loft

Evt. kaldt loft kan etterisoleres med isolasjonsmatter eller løsblåst isolasjon. Etterisolering krever dampsperre på varm side av isolasjonen. Tetting av loftsluke må alltid gjennomføres samtidig for at det ikke skal opptre kondens i taket over loftsluka. For etterisolering av yttertak avhenger utførelse/metode av dagens tilstand.

Tiltak 5: Isolering av gulv mot grunn

Gulv mot grunn etterisoleres. Utførelse avhenger av dagens løsning. Utvendig isolering av ringmur reduserer varmetap langs randen.

Tiltak 6: Isolering av gulv mot det fri

Gulv mot det fri etterisoleres. Utførelse avhenger av dagens løsning.

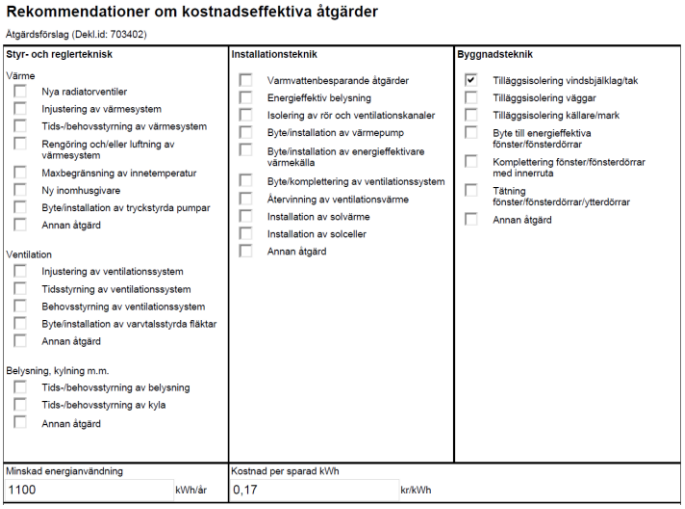
Tiltak 7: Randsoneisolering av etasjeskillere

Kald trekk i randsonen av trebjelkelag kan utbedres ved å isolere bjelkelaget i randsonen. Utvendig kan man forsøke å tette vindsperra nederst på utsiden av veggen.

Tiltak 8: Etterisolering av yttervegg

Yttervegg etterisoleres. Metode avhenger av dagens løsning. For å sjekke vindtetting av yttervegg anbefales termografering og tetthetsprøving.

Figure 1. RLMs from Norway



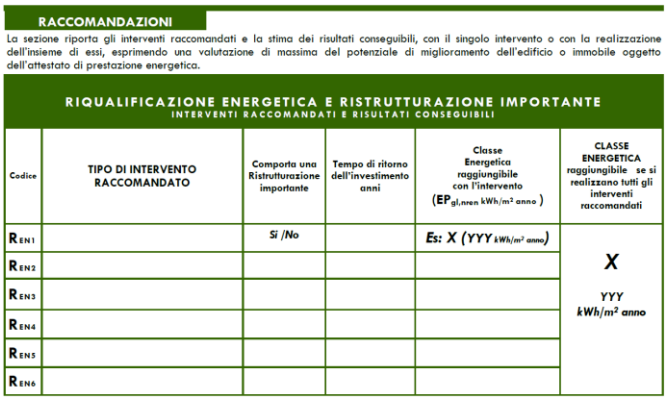
Rekommendationer om kostnadseffektiva åtgärder

Åtgärdsförslag (Dekl.id: 703402)

Styr- och reglerteknisk	Installationsteknik	Byggnadsteknik
Värme	☐ Varmvattenbesparande åtgärder	☑ Tilläggsisolering vindsbjälklag/tak
☐ Nya radiatorventiler	☐ Energieffektiv belysning	☐ Tilläggsisolering väggar
☐ Injustering av värmesystem	☐ Isolering av rör och ventilationskanaler	☐ Tilläggsisolering källare/mark
☐ Tids-/behovsstyrning av värmesystem	☐ Byte/installation av värmepump	☐ Byte till energieffektiva fönster/fönsterdörrar
☐ Rengöring och/eller luftning av värmesystem	☐ Byte/installation av energieffektivare värmekälla	☐ Komplettering fönster/fönsterdörrar med innerruta
☐ Maxbegränsning av innetemperatur	☐ Byte/komplettering av ventilationssystem	☐ Tätning fönster/fönsterdörrar/ytterdörrar
☐ Ny inomhusgivare	☐ Återvinning av ventilationsvärme	☐ Annan åtgärd
☐ Byte/installation av tryckstyrda pumpar	☐ Installation av solvärme	
☐ Annan åtgärd	☐ Installation av solceller	
Ventilation	☐ Annan åtgärd	
☐ Injustering av ventilationssystem		
☐ Tidsstyrning av ventilationssystem		
☐ Behovsstyrning av ventilationssystem		
☐ Byte/installation av varvtalsstyrda fläktar		
☐ Annan åtgärd		
Belysning, kylning m.m.		
☐ Tids-/behovsstyrning av belysning		
☐ Tids-/behovsstyrning av kyla		
☐ Annan åtgärd		

Minskad energianvändning	Kostnad per sparad kWh
1100 kWh/år	0,17 kr/kWh

Figure 2. RLMs from Sweden



RACCOMANDAZIONI

La sezione riporta gli interventi raccomandati e la stima dei risultati conseguibili, con il singolo intervento o con la realizzazione dell'insieme di essi, esprimendo una valutazione di massima del potenziale di miglioramento dell'edificio o immobile oggetto dell'attestato di prestazione energetica.

RIQUALIFICAZIONE ENERGETICA E RISTRUTTURAZIONE IMPORTANTE
INTERVENTI RACCOMANDATI E RISULTATI CONSEGUIBILI

Codice	TIPO DI INTERVENTO RACCOMANDATO	Comporta una Ristrutturazione importante	Tempo di ritorno dell'investimento anni	Classe Energetica raggiungibile con l'intervento ($EP_{gl,ren}$ kWh/m² anno)	CLASSE ENERGETICA raggiungibile se si realizzano tutti gli interventi raccomandati
R_{EN1}		Si /No		Es: X (YYY kWh/m² anno)	X YYY kWh/m² anno
R_{EN2}					
R_{EN3}					
R_{EN4}					
R_{EN5}					
R_{EN6}					

Figure 3. RLMs from Italy

Automatic list: these types of RLM come automatically when the EPC is introduced to the certification system, the output will be the official certificate, which will include the RLM. The list of measures will be selected by the system, according to the information of the building, such as age of construction, predominant construction materiality, architectonic typology (detached, semi-detached, row etc.). Examples of the uses of this method can be seen among others in The Netherland and Norway.

- Measure selected by an expert from a standard list: In this case, the list will come automatically, it may be sorted by the same criteria as the automatic list. However, the certifier should choose the most relevant recommendations for the specific house; and possibly add more information or additional measures. Example of the uses of this method can be seen among others in UK, Spain and Denmark.
- List developed by an expert: the certifier will perform the entire selection of the cost-effectiveness measures. Example of the use of this method can be seen in Italy.

3. Certifier feedback

The certifier fulfils a fundamental role in the success of the EPC. The quality and accuracy of the certificate, and by extension the impression of the public on the robustness and reliability of the certificate, are subject to the quality of the performance by the certifier. Key tasks define the quality of the results, such as field inspection, collecting technical properties of buildings, prepared well thought

assumptions, perform energy simulations according to the national methodology, define relevant recommendations and sometime estimated their costs, and finally to issue the certificate. At the same time, the certifier's work is under constant evaluation, rules and penalties must be set by the MS which should be effective, proportionate and dissuasive.

When it comes to field-inspection procedures, the challenges encountered are obtaining the dimension of the dwellings and performing measurements. To establish the geometry and the dimension of the building does not require specialized tools or knowledge. This task will however consume time, the detached single-family houses being the building typologies that is potentially more difficult to measure due to its complex and often irregular geometry. The second challenge is to identify valuable information from the existing building that can be used to propose energy recommendations. Influential factors on the energy base can be occupant behavior (32, 33), U -values (26, 34), thermal bridges (35) and airtightness (26), the latter being the one that might be most influential (36) along with being the most difficult to estimate (37). Guidelines (38) and methodologies (39) to estimate these parameter can be seen in audit studies. However, to implement these methods under the EPC inspection scheme is a challenge, mainly because of the costs, time and knowledge that these procedures require. The third challenge found is the financial assessment that supports the recommendations. As stated in the directive, independent of how the measures are produced, they must be cost-optimal or cost effective. In that sense, the certifier should guarantee that the recommendations are appropriate, and that the investment will be pay for itself through the energy reduction. In that sense, some profitability calculations are expected to meet the mentioned requirements and delivering reliable retrofitting measures with low risk. Overall, these challenges are difficult to overcome in the current situation where the EPCs costs are based on the market demand. Considering that field inspections last less than an hour and that there are many other tasks that are needed in order to issue a certificate, accuracy might be compromised. Due to this, experts have emphasized that there is tension between speed/cost, accuracy and reproducibility (40).

4. Energy gap

The gap between the estimated energy savings and actual energy consumption has been highlighted as parts of the issues that the current RLM need to overcome. The approach in the certification system to rate the energy does not depend on actual conditions of occupancy and behavior (41) as it is normalized through the appropriate choice of the reference energy consumption (42). The European housing sector often reports savings lower than expected for retrofit projects (43). Because of this, prediction of energy savings should be based on actual energy consumption; this way more efficient renovation measures can be achieved and identified for different typologies of buildings (44). Confidence of the expected results is an important factor considered by the homeowners. Due to this the energy gap should be carefully examined, since this is one of the reasons that makes retrofits a highly uncertain investment (45, 46). To reduce risk, it requires several calculations and simulations to support the decision making, which are not considered in the current scheme in some countries where the RLMs are automatic. Verification is one of the procedures that must guarantee a correct evaluation of the performance of the building and issuing of relevant recommendations. However, by 2013 only 14 MSs performed quality checks and only 10 countries considered a detailed EPC evaluation (47).According to certifiers, RLMs are a good start, since they provide information to the building owners about what could be improved as an inspiration. Nevertheless, this information is not accurate enough to guarantee that the modification will be cost-effective (48). Studies suggest that to obtain more realistic energy savings, EPCs should use both standards inputs and real occupation data in its calculations (49, 50). Additionally, there are gaps concerning the actual state of the building stock in Europe, currently available data sources often are not representative, incomplete, outdated, and/or inconsistent (51). Despite that EPC are a good source of information, they are designed to serve different purposes than building stock monitoring, and do not necessarily represent the latest state of the building. Similarly, EPC database have different purposes, data structure and administrators, as well as different access rights and formats for users (52). In fact, almost all MSs have a EPC collecting system but these were mostly focusing on meeting the requirement

in the EPBD, specifically the Article 18, prescribing an independent control system to ensure EPC quality (53). Improved monitoring is needed to assess the correctness of EPC predictions and give confidence regarding the quality and performance of the renovated building (50).

5. Conclusion and recommendations

Most of the Ms have included the RLMs into their certification system. However, these recommendations are not adequately tailored to the needs of the owner and do not motivate them into action (54). The recommendations often do not substitute a detailed assessment needed for renovation planning and costing. As results, building owners do not apply efficiency measures among other factors, due to the lack of adequate information to assess options and potential savings. Based on the shortcomings presented in this article, the following recommendations are made.

The RLMs should reach a minimum level: Information based on generic recommendations are likely to be only for inspiration. However, by defining a cost-effectiveness methodology, recommendations can be tailored for each building providing a wide range of reliable information, such as cost, energy savings, packages of key measures and an updated state of the building. The methodology should include as a procedure a simple pay back calculation, non-standardized inputs for simulations and mandatory field visit to the building. These should be possible since some countries have already introduced some of this task into the EPC system, such as Italy, Greece and Denmark.

Certifiers need training and tools: The key actor in the elaboration of the RLMs are the certifiers. However, little information is available related to the challenges that they face. Cost of their services should consider the actual working load and training on field inspection should examine the time that it is required to perform such a task in an efficient way. Time and accuracy can be obtaining by delivering appropriate tools that facilitate the calculations and other activities. Example of this are the Total concept (55) project to calculate the costs and energy measure packages, the uses of smart meter to obtained quality inputs for simulations (56, 57) and online services that can calibrated energy model based on the energy bill such as Apidae Calibrator or open source software such as Autotune.

Consider the data gathered from the RLMs for long term renovation plan: By designing the field inspections not only for verifying purposes, such as maintenance status. Many valuable data can be acquired to develop a robust base model for long term renovation plans. For instance, by developing a BIM model not only the EPC can be produced, but other analysis and procedures can be performed and be automatized. This can give a wide range of possibilities, such as the base of a Building Passport, source of data for investor or construction companies, it can be monitored through smart meters, etc.

Single field inspection: The inclusion of a robust assessment of the building by introducing measurements could be an important source of information for long term renovations. An example of this can be seen in the US, under the energy program Home Energy Squad. The home visits are scheduled so energy squads can perform many in the same neighborhood on the same day. Several units in the area are inspected, and measurement are performed including a blower door test, during the walk-through with the homeowners, showing them what they can do to save energy, pointing out efficiency measures at reduced cost such as CFLs, weather-stripping, programmable thermostats, low-flow showerheads, and faucet aerators. This in connection with scanning tools such as Geoslam, which could be use during the walk-through, providing high-quality 3D cloud point to develop a BIM model.

The implementation of the recommendations should be tracked: There is little evidence that the RLMs and their implementation are recorded. Lack of guidance on design and implementation of EPC registers resulted in a large variety of data available in the registers across Europe (58). By implementing BIM, these can be greatly improved, since standards to register data are already developed such as Open BIM. Different recommendations and their cost-effectiveness can be codified and included in a database.

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