

Comparison of Frameworks for the Assessment of Decarbonisation of European National Building Stocks

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Abstract – The European Union (EU), aware that having an energy efficient building stock is crucial to achieve decarbonisation goals and to improve people's quality of life, has established a legislative framework made up of Energy Performance of Buildings Directive (EPBDs) and Energy Efficiency Directive (EEDs) to support Member States' (MS) governments in boosting energy performance of buildings by offering a broad range of policies and support measures. Since 2014, all EU countries must establish a long-term renovation strategy (LTRS) every three years to support the renovation of their national building stock into a highly energy efficient and decarbonised building stock by 2050, contributing to achieving the Member States' energy and climate plans (NECPs) targets. The requirement for EU countries to adopt a LTRS was first set out in the EED (2012/27/EU) and was revised in 2018 EPBD (2018/844/EU). With the aim of facilitating the interpretation of the latter directive by the national governments, Commission Recommendation (EU) 2019/786 was published. In this recommendation a voluntary framework based on progress indicators to assess the decarbonisation of the building stock was proposed. Later, in 2021, a proposal for the recast of the EPBD was launched, and in 2023 it was amended. In these new versions, the LTRs are strengthened towards Building renovation plans (BRP). The plans will include national targets in a more unified and comparable approach, and progress will be measured through a compulsory assessment framework based on indicators, among other issues. In this paper, the assessment frameworks proposed in the Commission Recommendation (EU) 2019/786, the proposal for the EPBD recast (2021 version) and the 2023 amended version of the EPBD recast are compared. Additionally, 2020 Member States' LTRs are analysed, focusing on the indicators that each one proposes to assess the renovation progress in the country. Finally, the level of alignment between the indicators proposed by each national strategy and by the 2023 amended version of the EPBD recast is evaluated, in order to identify best practices among MS to get closer to the future 'Building renovation plans'.

Keywords – Building renovation; building stock decarbonisation; European building stock; national renovation strategies; progress indicators.

Nomenclature		
BRP	Building Renovation Plan	–
EC	European Commission	–

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EU	European Union	–
EED	Energy Efficiency Directive	–
EPBD	Energy Performance of Buildings Directive	–
MS	Member State	–
NECP	National Energy and Climate Plan	–
LTRS	Long-term Renovation Strategy	–

1. INTRODUCTION

Europe is at a key moment to comply with the commitments under the Paris Agreement on climate change. For this reason, it has set itself the challenge of reducing GHG net emissions by 55 % by 2030 compared to 1990 [1]. Buildings play a very important role in this mission because they are responsible for 36 % of the GHG emissions of the European Union (EU). Thus, intervening in existing buildings to reduce their carbon footprint and improve their energy performance through deep renovation is one of the most cost-effective and convenient options. However, current renovation rates are far from the value –3 % annually that the European Commission (EC) deems necessary to meet climate targets [2], [3].

One of the legislative tools available in the EU to establish requirements related to building energy efficiency and to foster renovation are the Energy Efficiency Directives (EEDs) and the Energy Performance of Buildings Directives (EPBDs). Specifically, on the one hand, EPBD (2010/31/EU) [4] established that Member States (MS) should draw up national plans for increasing the number of nearly zero-energy buildings (nZEB), including the transformation of renovated buildings into nZEBs. On the other hand, EED (2012/27/EU) [5] made it mandatory for MSs to draw up a long-term renovation strategy (LTRS) in 2014, which should be updated every three years and submitted to the EC as part of the National Energy Efficiency Action Plans, with the aim of promoting the renovation of national building stocks with a focus on their energy efficiency.

In Article 4 of Directive 2012/27/EU [5] on energy efficiency, the contents that the strategies should encompass were established. Those included an overview of the national building stocks, the identification of cost-effective approaches to renovations according to the building type and climate zone, policies, and measures to stimulate cost-effective deep renovations of buildings, forward-looking perspective to guide investment decisions of individuals, the construction industry and financial institutions, and an evidence-based estimate of expected energy savings and wider benefits.

In 2018 the EPBD was amended by Directive (EU) 2018/844 [2] to accelerate building renovation. In this Directive a step forward in the definition of LTRSs was taken, qualifying, and expanding their contents. Additionally, it was established that MS ‘*shall set out a roadmap with measures and domestically established measurable progress indicators (...). The roadmap shall include indicative milestones for 2030, 2040 and 2050*’. However, the definition of which indicators and milestones would make up the framework was left to the choice of each country. Conducting a comprehensive analysis of renovation and decarbonisation policies is essential to assess their impacts and contribution to the achievement of the objectives previously set [6]. A combination of quantitative and qualitative analysis is an appropriate tool to encompass the wide-ranging information necessary to cover the diversity of aspects to be considered when deciding the most appropriate policy measures [7] and to be able to identify the policies that best fulfil the needs of every country [8]. The inclusion of a progress measurement framework, not only for buildings renovation but also for the entire decarbonisation process, is of crucial relevance

[9] as it enables to determine the status towards the EU targets and make informed decisions, such as redirecting policies, when needed [10], [11] and evaluating its impact [12]. In fact, as expressed in the Swedish LTRS [13] *‘progress indicators are used not only to monitor the milestones, but also to show particularly important statistics which can and should be followed up in order to monitor progress’*. For this reason, and with the aim of supporting MSs in the transposition and implementation of the most complex provisions related to building renovation of the EPBD, the EC published the Commission Recommendation (EU) 2019/786 [14] in 2019. In this document, the roadmap that the MSs should draw up in their LTRSs to decarbonise their national building stocks was addressed, proposing a possible assessment framework made up of *‘measurable progress indicators’* and *‘indicative milestones’*.

When this paper was written, the EPBD was being revised as part of the Commission Work Programme ‘Fit for 55’, which has the goal of paving the way for achieving a fully decarbonised building stock by 2050. A first version of the proposal for the EPBD recast was launched in 2021 [15], a revised version was shared in the third trimester of 2022 [16] and a revised proposal with amendments by the European Parliament was published on 14 March 2023 [3]. In these proposals, LTRSs are replaced by building renovation plans (BRP), which must be updated every five years. One of the novelties of the EPBD recast is that it includes a framework of mandatory and optional indicators that the MSs must collect to evaluate the progress of the implementation of their plans. Therefore, it is no longer a suggested or exemplary assessment framework, but a mandatory one, which will make it possible to establish comparisons among different countries.

Considering all these premises, this work has a double objective: on the one hand, to analyse the evolution of renovation assessment frameworks by comparing those included in Commission Recommendation (EU) 2019/786, in the 2021 proposal for the EPBD recast, and in the 2023 version, which includes the amendments adopted by the European Parliament. On the other hand, to determine the level of alignment between the framework proposed by each national LTRS and those for the future BRPs, identifying best practices among MS.

This paper is structured as follows: in section 1, a brief overview on the assessment of the decarbonisation progress and on LTRSs is given; in section 2 the methodology followed in this research is explained. The results obtained applying the mentioned methodology are presented and discussed in section 3. Finally, conclusions are presented in section 4.

2. METHODS AND METHODOLOGY

The research presented in this paper is made up of two fundamental parts:

2.1. Study of the EU Frameworks for the Assessment of the Building Stock and Comparison of Their Indicators

In this step, the European directives and recommendations that include a decarbonisation assessment framework were studied and compared:

- Commission Recommendation (EU) 2019/786 of 8 May 2019 on building renovation, which is considered the first assessment framework [14];
- 2021 Proposal for a Directive of the European Parliament and of the Council on the energy performance of buildings (recast) [15], which was the first proposal with a mandatory framework;
- 2022 Note on the Proposal for a Directive of the European Parliament and of the Council on the energy performance of buildings (recast) [16]. An in-depth analysis of this framework is not included since it is a temporary version and not of significant importance;

- 2023 Revised proposal for a Directive of the European Parliament and of the Council on the energy performance of buildings (recast) [3], which includes the amendments adopted by the European Parliament and is closer to the definitive directive.

The indicators that they include were compared to identify a trend in the assessment frameworks. To do so, each framework was compared with the previous one, this is, the framework proposed by the 2021 proposal for the EPBD recast was compared with the one from Commission Recommendation (EU) 2019/786, whereas the one on the 2023 version of the proposal for the EPBD recast was compared with the 2021 proposal. In each case, we identified, indicator by indicator, if each data field was adopted in the following framework (E), if it was adopted undergoing some modifications (M), including changing the domain it belongs to (MD) – if it was removed (R) and does not appear on the next version, or if a new indicator was added (A).

2.2. Comparison Between the MSs LTRSs' Indicators and the Ones Suggested by the 2023 Amended Version of the Proposal for the EPBD Recast

In parallel to the previous stage, the indicators proposed by the 29 available LTRSs by the different MSs and Belgian regions were compared with the ones specified in the 2023 version of the proposal for the EPBD recast. The following LTRSs were considered: Austria, Brussels (Belgium), Flanders (Belgium), Wallonia (Belgium), Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, and Sweden.

Due to the breadth of ways to provide the information, we have categorised it into Equivalent or Similar Indicators. On the one hand, Equivalent Indicators (EI) are those defined in the 2023 version of the proposal for the EPBD recast or directly related ones that allow us to collect them. For example: the number of renovated buildings per type is provided by the national source instead of their percentage, which is the data required by the EPBD proposal. On the other hand, Similar Indicators (SI) are those which have a similar objective but do not collect the same data. For example: the percentage of less efficient buildings is provided by the source instead of the number of buildings per energy class.

For each indicator of the mentioned framework, we analysed the degree of development of each indicator, whether it is only included to be studied in the future (included), if it is already defined and units of measurement are proposed (included + defined), or whether it is already fully developed and has progress milestones associated (included + defined + with milestones).

Based on this analysis, relevant considerations, and best practices from LTRSs were identified.

3. RESULTS AND DISCUSSION

In this section, the results obtained following the mentioned methodology are presented and discussed.

3.1. Results on the Study of the EU Framework for the Assessment of the Building Stock and Comparison of Their Indicators

In 2019, Commission Recommendation (EU) 2019/786 introduced an assessment framework consisting of 12 domains or categories with 70 optional indicators, which marked a significant contribution as the first European framework for measuring decarbonisation progress. Later, the 2021 proposal for the EPBD recast mandated a framework that requires inclusion in the BRPs of all MSs. This framework reduced the number of domains to 4, but substantially increased the number of indicators to 177, with 77 (66 %) of them being mandatory and common for all

countries, and 40 being optional, allowing for flexibility to adapt to the specific characteristics of each state. Finally, the 2023 version of the proposal for the EPBD recast refined the previous framework, adding 1 new domain and some new indicators, resulting in a total of 156 indicators, of which 124 (79 %) are mandatory, increasing the proportion of common indicators compared to the previous version. Table 1 shows the changes in terms of indicators, including those that remain the same, those with some alteration, those added, and those eliminated. Notably, the second framework only maintained 11 indicators (which means 9 %) from the previous framework, modified 29 of them, and added 78. On the contrary, the second and third frameworks share more similarities, with 89 indicators (57 %) remaining the same, and 23 being modified (the complete comparative table is presented in Table A1 of the Annex).

TABLE 1. COMPARISON OF THE ASSESSMENT FRAMEWORKS IN TERMS OF INDICATORS

	Commission Recommendation (EU) 2019/786	2021 Proposal for the EPBD recast compared to Rec. (EU) 2019/786	2023 amended version for the EPBD recast compared to 2021 EPBD Proposal
Total number of domains	12	4	5
Total number of indicators	70	118	156
Mandatory indicators	0	76	124
Optional indicators	70	41	32
% of mandatory indicators	0	66	79
Existing indicators (E)	–	11	89
Modified indicators (M)	–	29	23
Added indicators (A)	–	78	44
Removed indicators (R)	–	36	6

The evolution of the frameworks achieved conceptual simplification: in the framework in Commission Recommendation (EU) 2019/786, domains were very heterogeneous and some of them contained only one indicator, which was confusing. However, the next frameworks are much clearer, providing a vision of national building stocks, establishing targets for 2030, 2040, and 2050, outlining the needs to achieve them, and giving an overview of planned and implemented policies and measures to contribute to the final objectives. Although the framework became more complex again in the 2022 version, the latest version maintains the structure of 2021 and just added a new domain: a roadmap on energy poverty. In Fig. 1 the relative weight in terms of the number of indicators for each domain is presented. In all three cases, the ‘overview of the national building stock’ domain is clearly predominant, followed by the ‘evidence-based estimate of expected energy savings and wider benefits’ domain in the case of the Recommendation framework (a category that disappears in the subsequent versions). In the other two cases, the ‘overview of implemented and planned policies and measures’ and the ‘roadmap for 2030, 2040, 2050’ are the second and third domains. Furthermore, during the development process of the upcoming EPBD some relevant topics were relocated or added into some sections, but they lack an associated measurable indicator. This is the case, for example, for the improvement of fire safety, that was included as an optional indicator in the ‘Overview of implemented and planned policies and measures’ section but this do not represent something measurable. The ambiguity of the indicator and the lack of units for its measurement makes it uncertain and can lead to confusion or very unequal developments between the different MS.

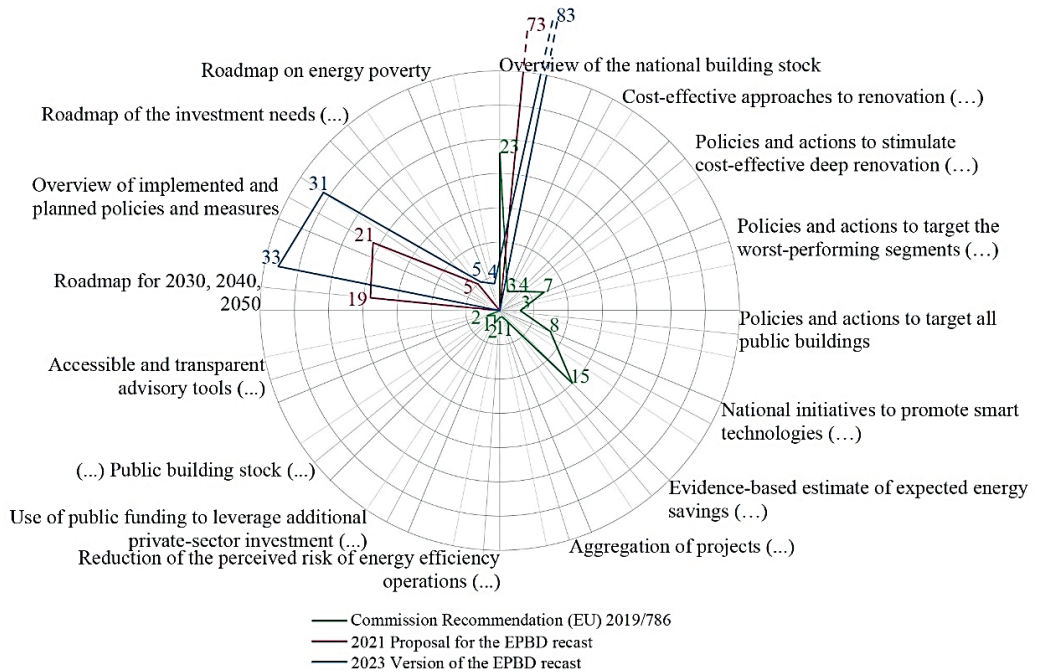


Fig. 1. Number of indicators in each category of the frameworks in CR (EU) 2019/786, 2021 proposal for the EPBD recast and 2023 amended version of the proposal for the EPBD recast.

But which is especially interesting is to understand the evolution in what is being measured. Although the theme is common across all the studied frameworks, there are some alterations in specific issues. Comparing Commission Recommendation (EU) 2019/786 with the EPBD proposals, it can be noticed that some of the issues addressed by the Recommendation disappeared or lost relevance in the following versions. This is the case for the dwelling scale for the analysis of national building stocks (EPBDs only consider the building scale), or for indicators based on estimates, which are replaced by real values for topics such as energy savings and emissions reduction. The same applies to indicators classified as wider social benefits, such as thermal comfort index (TCI), cost of avoided illnesses or reduction in health costs attributable to energy efficiency measures, which reduce their importance in the following versions. Another aspect that disappeared in the EPBD proposals is the quantification of the aggregated projects which, however, seems very relevant because this practice is necessary to achieve the established renovation goals. Indicators related with research on energy efficiency were also left out. On the contrary, numerous concepts were included for measurement in the EPBD versions. Those include indicators related to energy use and consumption, as well as to renewable energy, a topic that was excluded from the Recommendation framework and seems essential considering the purpose of the EPBDs. In addition to measuring these issues, as mentioned before, countries are required, for the first time, to establish targets for 2030, 2040, and 2050, and to provide an overview of the measures and policies that will be implemented to achieve those objectives.

Alongside the positive developments that have occurred in the transition from the Recommendation framework to that of the EPBDs, incorporating very relevant topics that were left out and trying to structure the framework in an increasingly understandable and flexible way, there has also been a significant evolution between the 2021, 2022, and 2023 versions of the EPBD. In this regard, the latest version places more emphasis than the previous ones on the

analysis of technical systems in buildings, with the objective of getting to know their energy source and evaluate how the transition to more sustainable systems is progressing. Additionally, the 2023 version introduces the concept of Global Warming Potential and makes it mandatory to analyse the labour capacities of the construction, energy efficiency, and renewable energy sectors. Finally, a specific roadmap on energy poverty is created, which also includes a gender perspective, which had been included in 2022 for the first time. In contrast, it is regrettable that the latest version has omitted relevant issues that were included in the 2022 proposal, such as highlighting the difference between operational and embodied energy in buildings or the inclusion of the life cycle and material circularity assessment.

3.2. Results on the Comparison Between the MSs LTRS' Indicators and the Ones Suggested by the 2023 amended Version of the Proposal for the EPBD Recast

The alignment between the indicators proposed by the MSs' LTRSs and the ones from the 2023 amended version of the EPBD recast was studied to establish whether the MSs are on the right track to develop their future BRPs and is summarised in Fig. 2.

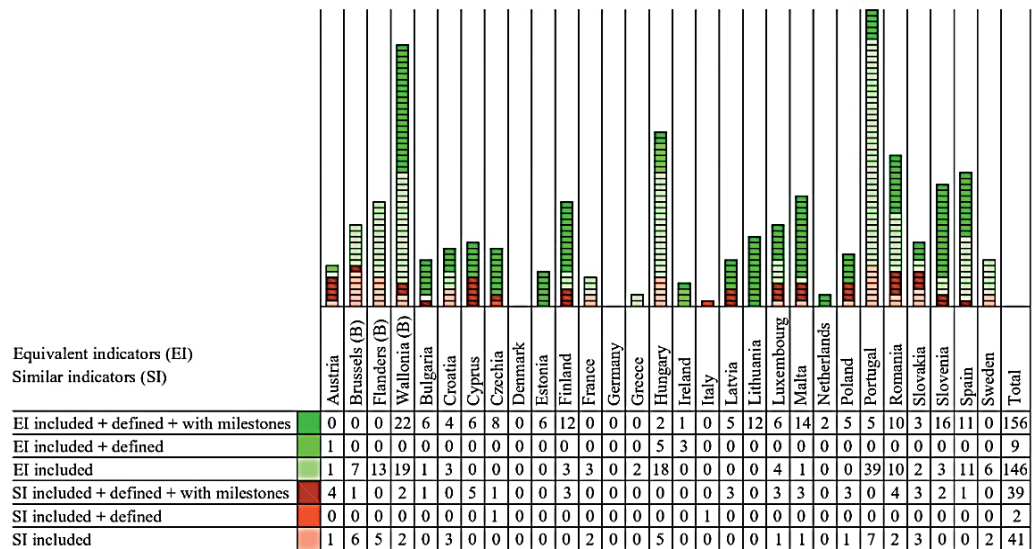


Fig. 2. Number of indicators from national LTRSs aligned with the framework from the 2023 amended version of the EPBD recast.

It can be appreciated that there are significant inequalities in the development status and in the approaches of the countries. Based on the data collected, LTRSs were grouped in four clusters according to their level of development and alignment with the proposal for the new EPBD: LTRSs with a low number of indicators or with a very low alignment, LTRSs with a large group of progress indicators proposed but still pending development, LTRSs with an already mature framework, and LTRSs focused on specific topics, which are widely developed. In the first group, LTRSs with a very low alignment with the mentioned frameworks are placed. This is the case for some countries that did not introduce any indicator aligned with the 2023 amended version of the EPBD recast in their framework, such as Denmark and Germany, or for others that only proposed one slightly aligned indicator, like Italy. In a second group, there are countries that propose a large number of indicators aligned with those in the Directive proposal, such as Portugal (51), Hungary

(30) or Flanders (18), which, despite identifying and considering these indicators, do not develop them in depth. That is to say, they do not include an appropriate definition that allows understanding the objective and reason of each indicator, nor milestones to evaluate their progress. In the third group, there are countries such as Wallonia (45), Romania (26), Spain (23), Slovenia (21), Malta (19) or Finland (18) that, in addition to containing a good number of indicators aligned with the Directive proposal, those are well identified and defined, and they provide milestones for their assessment. Finally, in the fourth group there are some countries which seem interesting due to their focus on addressing in great detail issues that are relevant within their national context. As indicated in [17], this is the case for Romania, which places great importance on evaluating energy poverty, or Luxembourg, which is highly focused on characterizing the technical aspects of its building stock (the complete analysis is presented in Table A2 of the Annex).

Through this analysis, it can be concluded that most countries still need to make a significant effort to adapt their strategies to the new requirements of the BRPs. However, those who have already started to reflect, characterise, and include coherent milestones for what they consider relevant to measure, have a certain advantage. Those with a more developed indicators system currently (those with more than 10 aligned and fully developed indicators) are Wallonia (22), Slovenia (16), Malta (14), Lithuania (12), Finland (12), Spain (11) and Romania (10), which is aligned with the BPIE report [18], where the quality of the LTRSs is analysed. In the mentioned report, only the strategies presented up to the time of its elaboration (14) were evaluated. Among them were those of Spain and Finland, which obtained the highest score along with that of Flanders.

Additionally, having already a well-established infrastructure for the collection of data is highly relevant since one of the main difficulties expressed by several MS's LTRSs is harvesting information to generate the indicators. Therefore, having a consolidated data infrastructure will make it easier for the MS to comply not only with the new EPBD indicators framework and the requirements for the upcoming BRPs, but also with future requirements on data management, analysis and sharing pursued by the EC. As an example, Wallonia shows a wide network of information that is highly elaborated to obtain the indicators whereas, for example, France, Germany, and Lithuania recognise that the lack of institutional coordination and infrastructures to obtain information is a relevant barrier in this process. Moreover, a significant progress is being made by Lithuania and Bulgaria, that recognise the problem and establish objectives to solve it and define which are the responsible organizations for providing the requested information.

4. CONCLUSIONS

This paper studied the evolution of the frameworks for the assessment of the decarbonisation of the European building stocks. The alignment between LTRSs and the framework of the 2023 amended version of the EPBD recast was determined. It can be concluded that the assessment frameworks have evolved in a good way, with a trend towards conceptual simplification and increased flexibility, to provide tools that allow comparisons between different countries but also adapt the framework to the context of each MS.

However, the last EPBD proposals include indicators that may not be classified as such since they are not quantifiable. This group includes indicators on policies, market barriers and failures, which are not measurable themselves. However, the results produced by them are quantifiable, but the lack of clear definitions, guidelines, and units obstructs their collection.

In the proposals for the EPBD recast the approach to such an important issue as the energy sources used by buildings is relegated to the presentation of primary energy factors. However, the approach of several LTRSs, that account for the number of households using each energy source such as Poland and the GHG emissions from each of these sources, is more appropriate. Is of

particular interest the case of Slovakia, that quantifies the transition from polluting sources to cleaner ones.

Regarding the alignment between LTRSs and the mentioned framework, there is a great heterogeneity among countries, and each one needs to be studied separately to extract further conclusions.

Based on their actual degree of development of the progress indicators four clusters of LTRS were recognised: LTRSs with a low number of indicators aligned with the European Directives, LTRSs proposing a large set of progress indicators which are not developed, LTRSs with an already mature indicators framework and LTRSs focused on specific topics, which are fully developed.

The LTRSs with an already mature framework of fully developed indicators (more than 10 aligned and fully developed indicators) are Wallonia (22), Slovenia (16), Malta (14), Lithuania (12), Finland (12), Spain (11) and Romania (10), which is aligned with the mentioned BPiE report.

The main barrier that the LTRSs highlight to generate progress indicators is the lack of institutional coordination and infrastructures to collect information. Special mention deserves Wallonia for the development of its infrastructure as well as Lithuania and Bulgaria, that are facing the problem through the definition of a responsible organization for providing the requested information.

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ANNEX

An Annex including complementary tables with the complete information of the research conducted is available at <https://zenodo.org/record/8377304>.

The Annex includes:

- Table A1. Comparison of the Assessment Frameworks in Terms of Indicators;
- Table A2. Indicators Between the Indicators of the National LTRSs and Those of the 2023 Amended Version of the EPBD Recast.

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