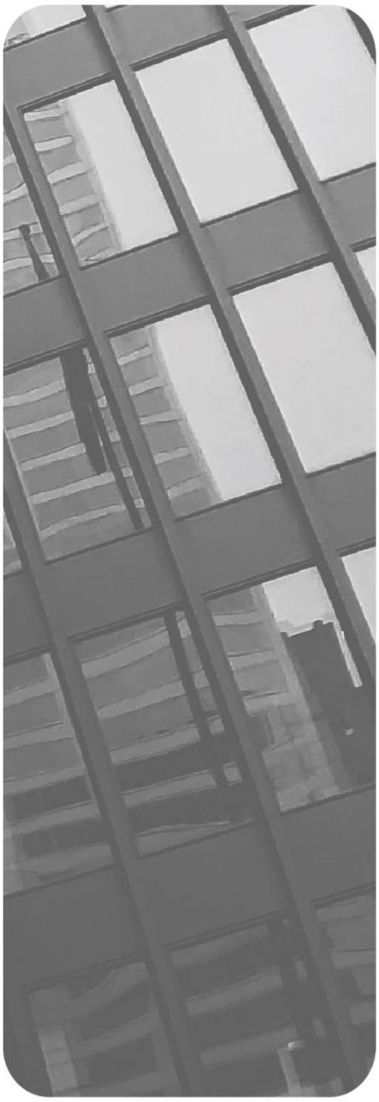
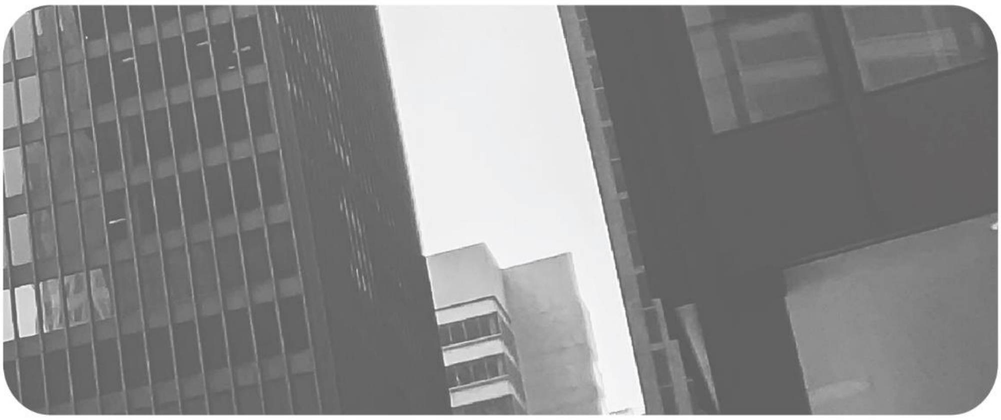


D4.4 Recommendations to implement the results in local EPCs and voluntary certification schemes



U-CERT
User-Centred Energy Performance Assessment and Certification

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the grant agreement number 839937. The European Union is not liable for any use that may be made of the information contained in this document, which is merely representing the authors' view.

Project duration: 1st September 2019 – 31st August 2022
Grant Agreement number: 839937 (Coordination and Support Action)
WP: 4 **Deliverable:** 4.4
Lead beneficiary: IVE
Submission Date: 30 April 2022
Dissemination Level: Public
Due date: M32
U-CERT Website: www.u-certproject.eu
Revision History:

DATE	VERSION	AUTHOR/CONTRIBUTOR[1]	REVISION BY[1]	COMMENTS
30/04/2022	0.0	Pablo CARNERO MELERO, IVE; Borja PALLAS VÁZQUEZ, IVE;	-	First version
13/05/2022	0.1	Pedro VICENTE QUILES, ATECYR; Martina PASINI, AiCARR; Stanislav ANDREEV, EnEffect; Carsten RODE, DTU; Zoltan MAGYAR and Gabor NEMETH, COM.		Revised version with contributions from Case Studies

Acknowledgements:

U-CERT Consortium would like to acknowledge the financial support of the European Commission under the H2020 programme. This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement number 839937.

[1] Name SURNAME, ORGANIZATION

Index

List of Figures

List of Tables

Task 4.3 Disclaimer.

Deliverable 4.3 was initially due in M26. However, given the delay the final versions in key methodology developing tasks – Task 3.1 and Task 3.2, it was not possible to finish Deliverable 4.3 without such input.

Introduction to U-CERT

Under the Energy Performance of Buildings Directive (EPBD), all EU countries have established independent energy performance certification systems supported by independent mechanisms of control and verification. These Energy Performance Certification (EPC) schemes have stood in the past as one of the most important sources of knowledge on the energy performance (EP) of the European building stock. However, there are still several barriers to overcome towards a widely supported and successful implementation of the Energy Performance Certificates (EPCs) as effective tools to support the revised EPBD [1]. One of the main obstacles is users' understanding and acceptance of EPCs, nowadays held back by the lack of user-friendliness, reliability – and therefore lack of credibility – and cost effectiveness. Another barrier is that some implementations of the certification and assessment schemes seem to be not fully compliant with EU legislation, which is necessary to instil trust in the market and to incite investments and to support decision making, both on new energy efficient buildings as on deep renovation. Moreover, EPCs often fail in evaluating the impact of innovative technical solutions on buildings' energy performances. Current calculation methods used in EPCs typically do not enable realistic prediction of performances of innovative technologies, so that building designers and EPCs assessors are led to miscalculate or even discard daring design options, thus hindering their market uptake.

Since 2017, there is a new opportunity as the EPCs can rely on the new set of EPB standards for their assessment methodology. These standards address the afore-mentioned challenges by proposing a holistic and modular approach. In principle, this modular approach can enable a step-by-step implementation, starting with the overarching EPB standard and other key modules. However, there is still a clear need for guidance and support with respect to the structure of the set of EPB standards and the application of individual standards or clusters of standards, both on a local and a national level. The standards and technical reports provide a lot of information, but based on the feedback received so far, it appears difficult to find or recognize the information that is searched for. Information must be made accessible and applicable for the Member States (MS) to support them in their investigation on how the EPB standards can be used.

Summarizing, current practices and tools of EPB Assessment and certification applied across Europe, clearly face several challenges [2]. To meet them they should become more reliable, by being compliant with EU legislation and facilitating convergence of EPCs across EU. They also should become more user-friendly, by offering support in decision making; and more cost-effective, increasingly reflecting the smart dimension of buildings and ensuring a technology neutral approach.

In this context is where the U-CERT project is developed.

Executive Summary

The U-CERT project is focused on introducing a next generation of user-centred EPCs to value buildings in a holistic and cost-effective manner by means of five measurable objectives:

- Stimulating and enabling the co-creation and implementation of the new generation of EPC Schemes with a wide based support.
- Enhancing the new certification schemes to be more practical, reliable, understandable, and desirable by a holistic and user-centred approach.
- Making the new certification schemes easily accessible for a wide range of users and stakeholders by the services of the EPB Center.
- Providing evidence of applicability and usefulness developed schemes by testing the U-CERT approach in selected cases.
- To foster the EU-wide uptake by motivating and activating EU interest groups and national certifying and standardization bodies.

Providing evidence of applicability and usefulness developed schemes (WP2, 3 and 5) by testing the U-CERT EPC approach, in selected cases is WP4's main contribution to U-CERT. Thus, the results and analyses of the realistic cases will be used as feedback for WP2, 3 and 5 to adjust and fine-tune the methodologies, tools, services and supporting business models. Therefore, study cases act as 'field labs' for testing and validating the use of the U-CERT's value proposition.

The general fitting of WP4 within U-CERT project is the following.

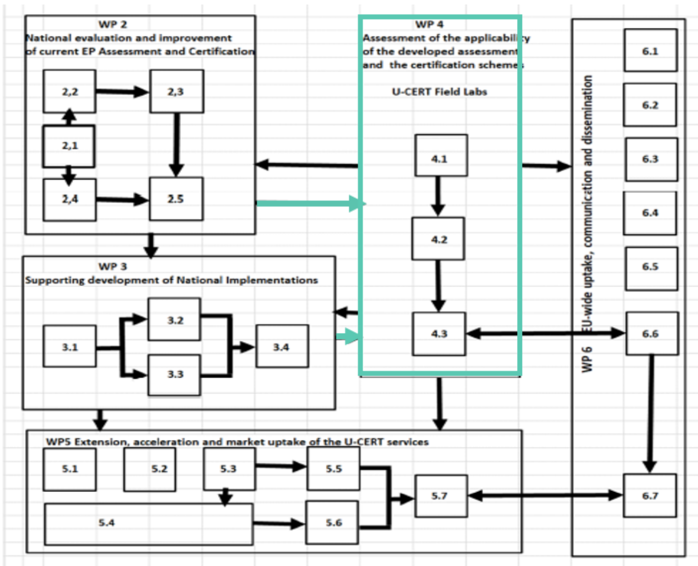


Figure 1. Synergies between Work Packages within U-CERT. Source: U-CERT's GA

As stated in U-CERT's Grant Agreement (GA), *"the objective of WP4 is to test and demonstrate the methodology as developed in WP2 and WP3 through the practical implementation of the procedures by cases from 11 countries".*

Definitions

The underlying document uses certain concepts which may be unfamiliar to the public and also for EPB assessors without deep knowledge of the EPB standards.

For deeper knowledge of the terms and definitions used in the scope of energy performance calculations, refer to EN ISO 52000-1 section 3 [1], EN ISO 52016-1 section 3 [2], and EN ISO 52018-1 section 3 [3].

Introduction

This deliverable aims at providing recommendations to improve user-friendliness, reliability, quality, and cost effectiveness of EPB Assessments and Certification schemes. In short, **the objective is to foster the uptake of U-CERT's related value propositions.** This is, U-CERT's calculation methodology for converged EPB Assessments, ensuring alignment with the set of EPB Standards - Deliverable 3.1 [4]. Also, U-CERT's proposal of user-centric and effective indicators, and the design of a new flexible EPC report - Deliverable 3.2 [5].

U-CERT has performed a detailed characterisation of the national context in relation to EPB Assessments and Certification schemes in 11 countries involved as Case Studies. From a policy and technical perspective, a detailed mapping of local EPCs was performed - Deliverable 2.1 [6], however not all National Annexes could be retrieved. Also, a social characterisation was performed through the ethnographic analysis of users' perception with regards to EPCs in each context - Deliverable 2.3 [7]. Previous WP4 tasks dealt with testing the applicability of U-CERT's value propositions in each context, a thorough analysis was produced - Deliverable 4.3 [8]. Thus, the project is in a reasonable position to offer meaningful insights to enhance the quality and user-friendliness of national EPB Assessments and Certification schemes. U-CERT's recommendations have been fine-tunned to ensure alignment with the provisions outlined by the latest EPBD revision [9].

Moreover, leveraging U-CERT's modular structure – U-CERT's calculation methodology follows EPB Standards' Annex A organisation, and U-CERT's proposed indicators are divided into categories –, the project also aims to influence voluntary certification schemes.

This document contains the recommendations to support the adaptation of national EPB Assessments and Certification schemes towards U-CERT's value propositions. The detail in the recommendations, as exposed in Deliverable 4.1 [10], is different among the partner countries. The main source of difference is the availability of National Annexes – only made available for Spain and Italy -, which constitute the most detailed source of information with regards to national EPB Assessments. Thus, although general recommendations are given to every country, U-CERT's ambition was to provide as much detail to all contexts as for Spain and Italy. Modular elements within U-CERT are also selected and recommended to be implemented in Voluntary Certification Schemes.

U-CERT's value proposition in relation to EPBD recast

U-CERT's contribution to next-generation EPB Assessments and Certification schemes has coincided with the revision of the Energy Performance of Buildings Directive. Revisiting this legislative document is a requirement after the publication of the Renovation Wave strategy [11], also because existing EPBD framework has been proven to be insufficient to deliver the 2030 Climate Target Plan [12]. Thus, the focus of the EPBD revision is to adopt measures with a view to boosting building renovation. U-CERT's recommendations aim at complementing the ones provided by the Next Generation Energy Performance Certificates H2020Cluster sister projects[1], explicitly reacting to the latest provisions on EPB policy.

During the EPBD revision consultation processes, dedicated workshops were held, in which U-CERT participated along with an average of more than 200 other agents. In relation to the role of Energy Performance Certificates, the view of the stakeholders was summarized as *"EPCs need to be updated and the quality improved according to a clear majority (65%) and an even stronger one (76%) backed harmonising energy performance certificates"*.

In relation to the **framework for the calculation of energy performance of buildings**, the revised EPBD proposal explicitly opens the door to the use of **metered energy**, to issue **measured EPB Assessments**, and to **verify correctness of calculated EPB Assessments**. U-CERT considers EN 15378-3 [13] as the base standard to build a comprehensive methodology for measured EPB Assessments in buildings, and identifies CEN-CE project's EN 15378-3 supporting spreadsheet as a valid starting point for the development of the procedure. Moreover, U-CERT also addresses the performance gap between calculated and measured procedures, providing a protocol to reduce it [5]. In relation to the **calculation intervals**, the proposal opts unequivocally for **hourly or sub-hourly time calculation intervals**. U-CERT's recommendation is completely aligned [4], rejecting the use of monthly time calculation intervals for EPB Assessments, and opting for an hourly matching factor between produced and used electricity. As for the **calculation methodology**, U-CERT's methodology considers every aspect outlined in the revised EPBD Annex I, and is expressed according to choices on EPB Standards' Annex A structure [4]. In relation to **energy performance requirements for technical building systems**, the revised EPBD indicates they should apply to whole systems, rather than standalone components. U-CERT's EPC includes the *rated general installation efficiency* as part of the **partial EP indicators** considered in U-CERT's EPC [5].

The proposed new EPBD states the importance of **indoor environmental quality (IEQ)**, also during the summer period. U-CERT includes within the **overall EP indicators** the *winter thermal comfort* and *summer thermal comfort* indicators. Moreover, it includes the ALDREN Thermal Score [14] as core evaluation parameter of the building's IEQ. U-CERT has also promoted the field testing of ALDREN TAIL index [15], and has included it – as voluntary indicator – in U-CERT's EPC [5].

The **Smart Readiness Indicator (SRI)** is reinforced by the EPBD proposal. U-CERT has participated in the testing phases of the technical support group, and has decided to included the SRI, as developed in the final report [16], into U-CERT's EPC proposition. Furthermore, U-CERT has outlined a cost-effective way of integrating the SRI assessment into EPB Assessments, reducing the

[1] Know more about U-CERT sister projects: https://u-certproject.eu/epc-sister-projects/

workload for EPB assessors. This approach is consistent with the spirit of the revised EPBD of combining inspections and certifications as far as possible.

The revised EPBD uses the concept of **staged renovation**, in relation to **voluntary building renovation passports.** U-CERT's EPC [5] proposes including renovation scenarios, composed by more elemental renovation actions, with a view to triggering deep renovations, even if they should occur step-by-step.

The proposal states the need to **digitalise** EPCs and integrate them into databases facilitating data exchange and administrative procedures. In that regard, U-CERT's EPC is conceived as a repository of holistic indicators and information. Although the proposed EPC report is presented as a static document [5], the itemization of the U-CERT EPCs' content aims to lay the foundation for a further integration of EPCs into databases and digital building logbooks. Moreover, some interactive features within the proposed U-CERT's EPC are included, which will only increase in future initiatives that further digitise EPCs.

Thus, it becomes clear that U-CERT's value propositions are aligned with the diagnostics of what is needed in relation to short-term evolution of EPCs. As Member States are mandated to adapt their national EPB Assessments and Certification schemes, they may benefit from U-CERT's results to tackle their national procedures comprehensively. Furthermore, in following U-CERT's guidelines EU harmonisation and convergence will be increased.

Although different from the initial approach, the proposal of revised EPBD provides great flexibility to Member States in relation to updating and improving the quality of national EPB Assessments and Certification Schemes. However, it reinforces the mandate to Member States to describe their national calculation methodology according to Annex A's EPB Standards. **U-CERT has found the lack of these National Annexes a major barrier in the roll-out of the project's objectives.**

General recommendations to national EPB Assessments and Certification schemes

U-CERT's contribution to next-generation EPB Assessments and Certification schemes is two-fold. On the one hand, **U-CERT advocates for member states to adopt the project's propositions in terms of EPB Assessment methodology** – as presented in Deliverable 3.1 [4]. On the other hand, **U-CERT encourages national certification schemes to consider the set of effective indicators proposed, as well as the innovative user-friendly design for next-generation EPCs** – as exposed in Deliverable 3.2 [5]. Furthermore, U-CERT urges member states who have not still done so to develop and publish their National Annexes.

Although held back by the general lack of each participant country's National Annexes, the tentative analysis of the impact adopting U-CERT's value propositions may have on national procedures has been outlined in Deliverable 4.3 [8]. The comparative analysis covers the Calculated EPB Assessment, and the indicators considered in national EPCs. Next, some general remarks are provided as a result. Refer to Annex. Specific recommendations to national EPB Assessments and Certification schemes for specific country recommendations.

Calculated EPB Assessment

The comparison was made based on the following choices:

- EN ISO 52000-1. A.16 – **primary energy weighting factors (PEF).**
- EN ISO 52000-1. A.17 – **exported energy factor (k_{exp}).**
- EN ISO 52000-1. A.27 – **basis for the energy performance assessments in buildings.**

With respect to the **primary energy weighting factors and CO_2 emission coefficients**, all analysed member states use annually constant factors. These factors are similar between partner countries in terms of non-renewable and renewable primary energy, as well as CO_2 emissions. Moreover, **every partner country defines greater non-renewable primary energy factors for grid electricity compared to gas.** This is seen as a market signal going against widespread electrification of final energy use in buildings. This is significant given that electrification is considered the main driver towards decarbonisation [17].

As the simplified comparison from Deliverable 4.3 showed, current PEF for grid electricity over penalise electrified buildings, thus favouring the decision of gas as final energy use, hampering the substitution of fossil-fuel equipment by electric and more efficient alternatives.

Member states are recommended to consider more accurate calculation of their national PEF, to reflect the environmental impact of grid electricity compared to gas, which is steadily decreasing as more renewable energy sources populate Europe's electricity mix. Furthermore, member states may consider defining hourly PEFs, in line with the increasing presence of real-time electricity generation data [18].

In relation to the **exported energy factor**, great discrepancies exist among partner countries. Hungary, Slovenia, and France are the only analysed countries which consider the effect of the exported energy in EPB Assessments. Moreover, all of them consider 100% of the surplus energy. **The rest fail to account for any surplus electricity production.**

As the simplified comparison from Deliverable 4.3 showed, having k_{exp} greater than zero is favourable market signal for renewable electricity production in non-electrified buildings. The main reason is because when exported energy is not considered, the onsite renewable electricity production can only compensate the coinciding electricity use. Thus, given that the electricity demand in non-electrified buildings is low, renewable electricity production self-use is extremely limited. For electrified buildings, without consideration of the exported energy, and considering the matching factor between produced and used electricity, renewable electricity production will have greater impact in the EPB Assessment than for non-electrified buildings. However, the full renewable electricity generation potential may not be leveraged, given that all the production not matching the electricity use will not be included in the calculation. Consequently, the non-renewable primary energy consumption will increase in exported energy is included in the EPB Assessment. Nevertheless, considering the 100% of the surplus electricity production may cause a rebound effect by relegating energy efficiency actions in favour of renewable electricity generation. This is, EPB assessors may be tempted to forsake energy efficiency measures if they can meet the requirements and obtain maximum EPC rating just by installing renewable electricity generation.

Member states are recommended to consider exported energy in EPB Assessments. However, the final decision on which value to give k_{exp} should be carefully made with a view to avoid relegating the energy efficiency first principle.

To balance energy performance assessments, partner countries are given the recommendation of carefully deciding on the indicator for each type of application. U-CERT's suggestion is to define the following **overall EP indicators** as basis for requirements:

- **Overall non-renewable primary energy use [kWh/m²] [kWh].** Calculated according to H5 in Annex H in ISO 52000-1 [1]; thus, considering compensation between different energy carriers and the effect of exported energy.
  This indicator assesses the final global impact the energy performance of the building has. An excess consumption during certain moments during the year may be balanced by surplus of energy in others. **It constitutes the main EP indicator.**
- **Overall total primary energy use [kWh/m²] [kWh]**. Calculated not considering compensation between different energy carriers nor the effect of exported energy.
  This indicator assesses the total primary energy the building requires to operate according to the energy needs, technical building system efficiency and renewable contribution to the onsite energy use. It seeks to prevent buildings to balance a poor envelope and inefficient systems with oversized renewable generation.

Thus, while the **overall non-renewable primary energy use** considers the positive impact of compensation between different energy carriers and the effect of exported energy, the **overall total primary energy use** does not. This is intentionally designed as a check and balance to avoid relegating the "energy efficiency first" principle in case that k_{exp} is defined close or equal to 1. Thus, for example, one may think of increasing the renewable electricity production, aware of the positive effect it will have on the overall non-renewable primary energy use, calculated in step B. However, given that compensation is not allowed for the overall total primary energy use, calculated in step A, then there is the risk of exceeding the limitation set in the requirements for total primary energy consumption. Therefore, the renewable electricity production would necessarily need to be balanced by a reduction on the building's energy needs and increase in the technical building systems' energy efficiency.

Additionally, given the recommendation to go for the **presence of system principle** for every application of the EPB Assessment, three additional check and balance indicators as basis for requirements are defined in terms of thermal comfort.

- **Summer thermal comfort [K·h]**.
  This indicator serves to account for overheating during the cooling period. It refers to the amount of (weighted) occupation hours the temperature is above a certain reference temperature. The source for the definition of the reference temperature can be found in Deliverable 3.1.
- **Winter thermal comfort**. **[K·h]**.
  This indicator serves to account for underheating during the heating period. It refers to the amount of (weighted) occupation hours the temperature is below a certain reference temperature. The source for the definition of the reference temperature can be found in Deliverable 3.1.
- **Domestic Hot Water thermal comfort [K·h]**.
  This indicator serves to check that sanitary hot water is provided, when there is demand, at a certain minimum reference temperature.

Thus, the calculation would occur as depicted in Figure 2.

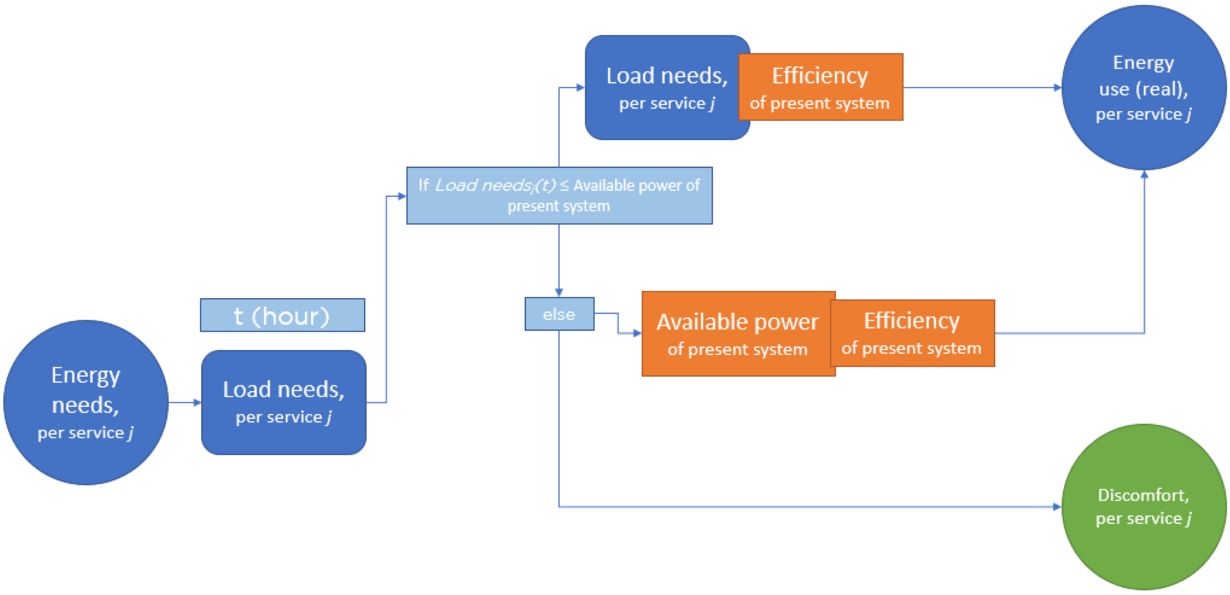


Figure 2. Energy performance assessment with presence of system principle.

Apart from the aforementioned overall energy performance indicators as basis for requirements, U-CERT proposes additional ones, as well as others addressing partial energy performance. U-CERT recommends member states to used them to increasingly define requirements.

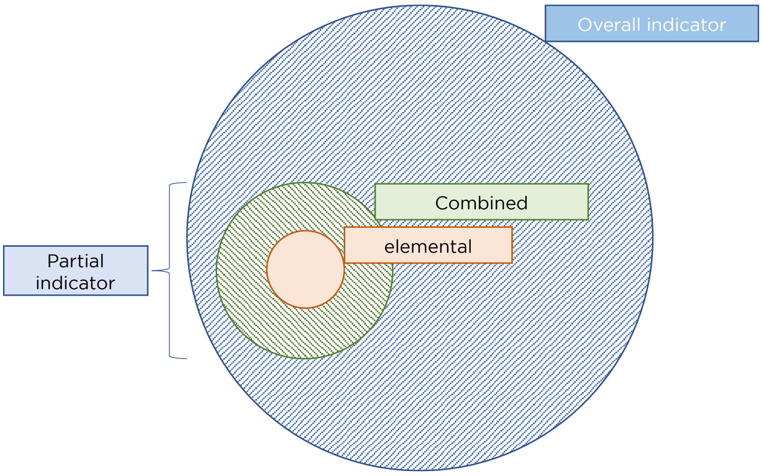


Figure 3. Graphical representation of overall and partial indicators

The **overall indicators** represent a comprehensive view of the building. They allow for design freedom, provided certain limitations are fulfilled. They could be regarded as an “outer” limitation, a maximum that should not be exceeded. The **partial indicators** at **elemental** level constitute the most specific assessment and focus on a single item. They are the basis from which the design is built. They could be regarded as an “inner” limitation, a minimum that should always be fulfilled. When a **combined** partial indicator is defined, a certain design freedom is created in the region between the elemental and the combined indicator. These concepts are illustrated in Figure 3. The “design freedom” is represented by the diagonal line pattern.

Calculated Energy Performance Certificates

Energy performance certificates are one particular application of EPB Assessments. As outlined by Deliverable 4.3, most member states’ EPCs are based on calculated EPB Assessments, performed under standardised weather and use. Therefore, although the concepts of EP indicators behaving as basis for requirements may not be applicable to EPCs, the methodology used for the calculation as outlined in Deliverable 3.1 is valid. As are the general recommendations provided in the previous subsection. For an extensive outline of U-CERT’s value propositions in relation to EPCs, refer to Deliverable 3.2. There, also a proposal for EPCs based on measurements is introduced.

EPCs have the particularity of needing a rating scale, which is based on the **main EP indicator**. U-CERT’s recommendation is to rely on the **overall non-renewable primary energy use [kWh/m^2] [kWh].** Calculated according to H5 in Annex H in ISO 52000-1 [1]; thus, considering compensation between different energy carriers and the effect of exported energy. However, a crucial aspect of the EPC rating is that it ought to be comparable between different buildings. Nevertheless, if the **presence of system principle** is applied, buildings without or undersized technical building systems may obtain a lower main EP indicator, which could mislead final users into suboptimal choices in terms of energy performance. Thus, U-CERT proposes that the main EP indicator – just for the application of obtaining the main EP rating – should be performed under the assumed system principle. Following the logic depicted in Figure 4.

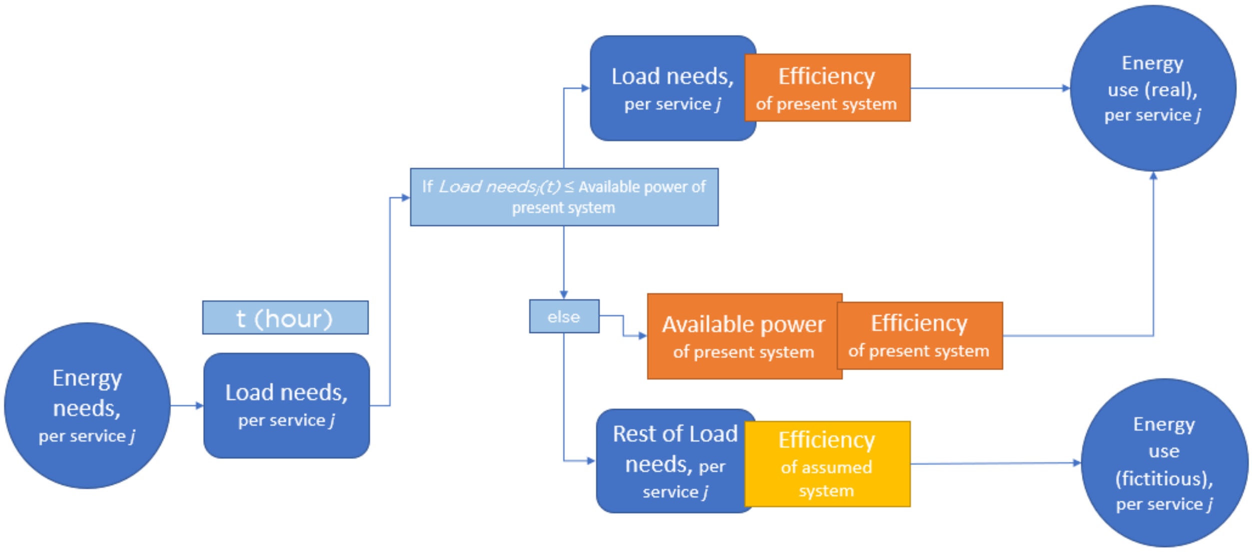


Figure 4. Energy performance assessment with assumed system principle.

Note that the **assumed system principle** would only be applied for placing a certain building in the EP scale. For any other endeavour related to the EPC, the **presence of system** depicted in Figure 2 shall be used.

In addition to the set of overall and partial energy performance indicators proposed by U-CERT for calculated EPC reports are listed in Table 1.

Table 1. Indicators related to U-CERT's Calculated EPB Assessment and Certification Scheme

Category	Indicators	U-CERT EPB Assessment and Certification Scheme	
		Included	Left as voluntary
Energy Performance	Overall EP indicators	X	-
	Partial EP indicators	X	-
Smart Readiness	SRI	X	-
IEQ	ALDREN Thermal score	X	-
	ALDREN TAIL	-	X
Cost	Cost	-	-

Accordingly, member states are encouraged to integrate the **SRI** and **IEQ** indicators into their calculated EPCs. Note that guidelines for smooth integration of SRI as designed in [16] into EPB Assessments are provided in Deliverable 3.2. When issuing an EPC for existing buildings, all the proposed indicators should be recalculated for the renovation actions constituting the step-by-step renovation scenario. Thus, any user interacting with the EPC would clearly identify the improvements and effects on the building of the renovation.

Lastly, member states are encouraged to define **flexible** and **dynamic** EPC reports, which shall adapt to the type of user and building situation. In Annex I in Deliverable 3.2 an example is provided. Note how the first page contains the most valuable information in a visual and user-friendly manner. Furthermore, member states are recommended to define EPCs in a modular way with a view to ease the integration into databases and digital building logbooks.

Measured EPB Assessment

As presented in Deliverable 4.3, most official national EPB Assessments are based on calculations. Although, some countries allow for some degree of measurement-based calculations when assessing energy performance of buildings (e.g., Sweden, Estonia, Slovenia, Bulgaria, France, and Denmark). However, there are important discrepancies in the way they proceed (i.e., service consideration and separation, weather and use normalisation, etc.) In addition to the low methodological readiness, there is uneven availability of reliable and standardised monitoring equipment across Europe; this is, smart meters. Therefore, the basis for the widespread implementation of measurement based EPB Assessments is not as mature as for their calculated counterparts. U-CERT's provision is for member states to boost the installation of electricity smart meters [19] in countries with low penetration. As for regions with low fossil fuel metering, U-CERT's recommendation is to prioritize the electrification of energy end use over the installation of gas or oil smart metering. Electrification is the main driver towards decarbonisation, so having detailed measurement of the electricity final energy consumption is necessary, whereas gas smart meters may quickly become stranded assets.

Also, there is a lack of a comprehensive set of EPB Standards dealing with measured EPB Assessments, which has prevented U-CERT to develop a complete and coherent methodology [4]. Currently **there is only one CEN Standard dealing with it, and only covering the heating and DHW services**. It is the EN 15378-3. Energy performance of buildings. Heating and DHW systems in buildings. Part 3: Measured energy performance [13]. Despite the limitation that neglecting the rest of EPB uses (i.e., cooling, mechanical ventilation, humidification and dehumidification, and lighting) may have on the reliability of measured EPB Assessments it is considered a good starting point for the development of a comprehensive measurement-based assessment. Heating represents the single highest share of final energy consumption across all EU member states[2]. Moreover, together with sanitary hot water production represent the total fossil fuel use of EPB uses.

In Deliverable 3.2 a set of considerations in relation to challenges which should be carefully considered when developing measured EPB Assessments are outlined.

They constitute the guiding principles of U-CERT's recommendations for the development of any measurement-based EPB Assessment:

- **service separation** (i.e., unless there are dedicated meters per each service included in the assessment, there is need to separate EPB uses from non-EPB uses and to enable use normalisation and weather standardisation),
- **use normalisation** (i.e., measured data is implicitly influenced by actual user behaviour and building use) and
- **weather standardisation** (i.e., measured data is implicitly affected by actual climate and period, if different from full year).

On account of the aforementioned considerations regarding monitoring equipment available, specially in existing buildings, any measurement based EPB Assessment should consider:

[2] According to the Odyssee-Mure project. More information at: https://www.odyssee-mure.eu/publications/efficiency-by-sector/households/energy-consumption-by-end-use.html

- time intervals according to the available input data coming from the measurement devices. There should be a balance between data availability and accuracy of the methodology.

Further research is needed to overcome the limitations that standalone measurement based EPB Assessments face (i.e., checks and balances of the performance assessment, predicting impact of renovation scenarios, etc.). Also, to develop comprehensive methodologies covering all building's EPB uses.

Calculated-Measured EPB Assessment

Insights about the interaction of calculated and measured EPB Assessments are given in Deliverable 3.2. Member states may consider the coexistence of both methods, leveraging the added value their synergies may bring. Sweden is already pursuing this path, mandating that calculated EPB Assessments must be validated with measurements.

A guidance from U-CERT's proposal is reproduced below:

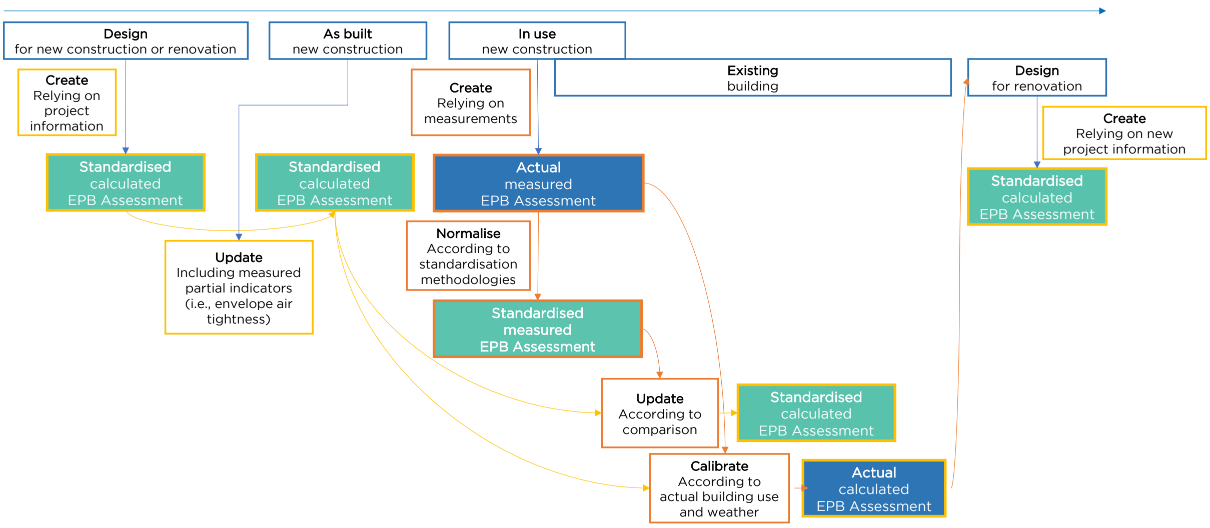


Figure 5. Interrelation of EPB Assessment types during a building's lifecycle

From Figure 5 it is inferred that using both calculated and measured EPB Assessments may increase the quality of EPB Assessments. However, unless seamless integration is ensured, it may represent additional work for EPB Assessors, which might hinder the promotion of EPB Assessments and Certification schemes altogether.

General recommendations to Voluntary Certification Schemes

For Voluntary Certification Schemes which have their own EPB Assessment methodology, the recommendations outlined in the previous section apply. Special consideration should be given to those presented in Calculated Energy Performance Certificates. Next, some general remarks are provided as a result. Refer to Annex. Specific recommendations to Voluntary Certification schemes for specific country recommendations.

I. Annex. Specific recommendations to national EPB Assessments and Certification schemes

From the **comparison** between U-CERT's EPB Assessment methodology and certain countries presented in Deliverable 4.3, a series of specific recommendations can be drawn.

A. Spain

1. Calculated EPB Assessment

A comparative analysis was performed between U-CERT's National Datasheets, as included in Deliverable 3.1, and Spain's National Annexes [20]. Moreover, Spain was one of the contexts where the **detailed comparison** in the scope of Task 4.3 was performed.

Table I-1. Portion of comparative analysis between National Datasheets and Annexes.

OrderAll	OrderSt	EPB standard			-	A	
				Order of sorting types (0 = ignore; higher = more dominant)	0	9	In accordance with Spanish law?
7	6	EN ISO 52000-1	Table A/B.6 — Differentiation of space categories			1	Yes
8	7	EN ISO 52000-1	Table A/B.7 — Space categories			1	Similar
17	16	EN ISO 52000-1	Table A/B.16 — Weighting factors (based on gross or net calorific value)			1	No
18	17	EN ISO 52000-1	Table A/B.17 — kexp-factor			1	No
19	18	EN ISO 52000-1	Table A/B.18 — Building services considered in the energy performance calculation			1	Similar
20	19	EN ISO 52000-1	Table A/B.19 — Principle assumed presence of systems			1	Similar
21	20	EN ISO 52000-1	Table A/B.20 — Specification of the useful floor area			1	Similar
22	21	EN ISO 52000-1	Table A/B.21 — Type or types of metric for the building size			1	Yes
23	22	EN ISO 52000-1	Table A/B.22 — Which space categories are contributing to the reference size			1	Similar
24	23	EN ISO 52000-1	Table A/B.23 — Perimeter specification			1	Yes
25	24	EN ISO 52000-1	Table A/B.24 — Perimeter choice			1	Yes
28	27	EN ISO 52000-1	Table A/B.27 — Basis for the energy performance of buildings			1	Similar
31	30	EN ISO 52000-1	Table A/B.30 — Energy flows taken into account in the building balance			1	Similar

From the comparative analysis outlined in Table I-1, several findings were made. There were certain EPB Standard choices that were equally defined in the national methodology with respect to U-CERT's proposal. Also, there were some choices that differed; some were more precisely defined in the Spanish methodology (i.e., Spain, unlike U-CERT, considers thermal coupling between thermal zones), whereas others were not. As outlined in Deliverable 4.1, the focus was made on the choices in which Spanish EPB Assessment methodology could be improved. Thus, the following set of EPB Standard choices:

- Pre-processing and calculation:
  - EN 16798-1. Table A/B.5 – Temperature ranges for hourly calculation of cooling and heating energy in four categories of indoor environment;
  - EN 16798-1. Clause A/B.8 – Occupants schedules for energy calculations;
  - EN ISO 52010-1. Table A/B.2 – Weather station and climatic data set;
- Post-processing:
  - EN ISO 52000-1. Table A/B.16 – Weighting factors;
  - EN ISO 52000-1. Table A/B.17 – k_{exp} factor;
  - EN ISO 52000-1. Table A/B.32 – Matching factor for produced energy

The choices considered present certain degree of interdependence beyond the fact that any modification on choices upstream the assessment flow will affect the impact of those downstream (e.g., pre-processing parameters will affect the calculation and the impact of the post-processing choices).

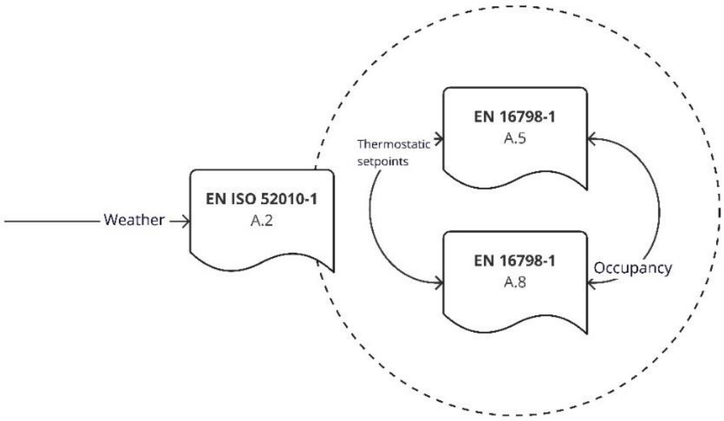


Figure I-1. Building use and weather-related choices.

In Figure I-1 there a schematic representation of how the definition of the **building use** - thermostatic setpoints and the occupancy - should be intertwined. Thus, comfort conditions are a requirement for the spaces with occupation, and the thermostatic settings should be sensible to the occupation. In Figure I-2 and Figure I-3 a graphic representation of Spain's definition of the building use for residential buildings is presented. For non-residential buildings, the thermostatic setpoints and occupation are project data, thus left for the free definition of the EPB assessor.

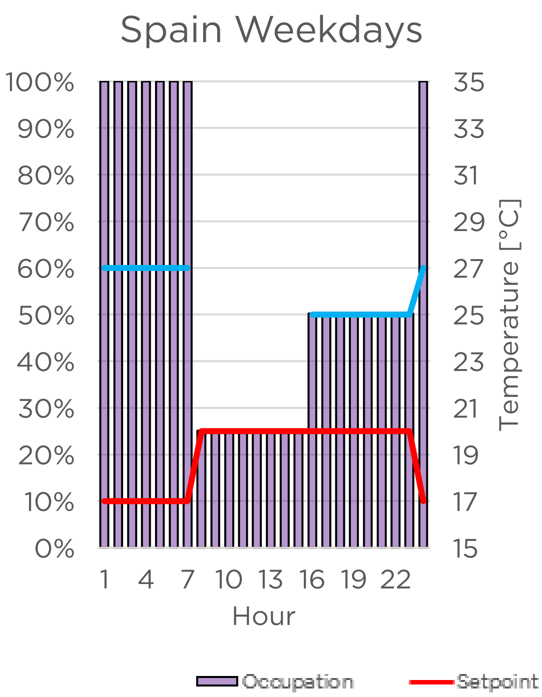


Figure I-2. Weekday building use. Spain's National Annexes.

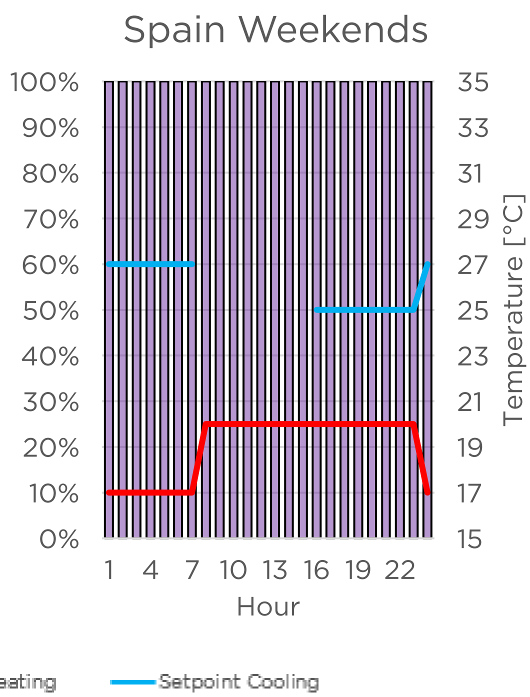


Figure I-3. Weekend building use. Spain's National Annexes.

Spain's National Annexes considers the weekday occupation to be maximum during the night, low during the typical working hours, and average during the evening. This pattern could be correlated with people working or studying out of the house. Accordingly, the heating thermostatic setpoint does not let the indoor temperature to go below 17°C during the night, increasing to 20°C setpoint for the rest of the day. This trend would seem to follow the logic that during the night people's activity is reduced and the degree of clothing is increased (i.e., sleeping), not requiring such a warm indoor environment. However, it is found odd that for hours with the lowest occupation the thermostatic setpoint is the most restrictive. When comparing Figure I-2 and Figure I-4 there is a clear contrast. The thermostatic setpoint defined by U-CERT has the laxest setpoint coinciding with the lowest occupation, being more strict during the evening and night. The recommendation for the Spanish National Annexes regarding the heating setpoint during the weekdays is to consider the positive aspects drawn from the comparison. Thus, 17°C could be the setpoint from 01:00h to 6:00h, 20°C from 7:00h to 9:00h, 17°C from 10:00h to 16:00h, 20°C from 19:00h to 22:00h, and 17°C from 23:00h to 00:00h. Note that the definition of the building use is very sensible to the culture and local customs. As for the cooling setpoint, the tend is analogous with 27°C at night and 25°C during the evening, except for the fact that during the typical working hours the thermostatic setpoint is left free. Thus, from 8:00h to 16:00h the cooling demand is neglected. This pattern could be related to the fact that most cooling technical systems are not hydronic, thus having low inertia, and only being used during occupation hours. There are discrepancies between Figure I-2 and U-CERT's considerations, shown in Figure I-3. As a suggestion to improve Spain's National Annexes, the cooling setpoint for weekdays could be modified adopting U-CERT's 32°C to the current free-running period, maintaining the current definition for the remaining hours. This modification of Spain's National Annexes could cause a slight increase in the cooling energy needs for the EPB Assessments on residential buildings.

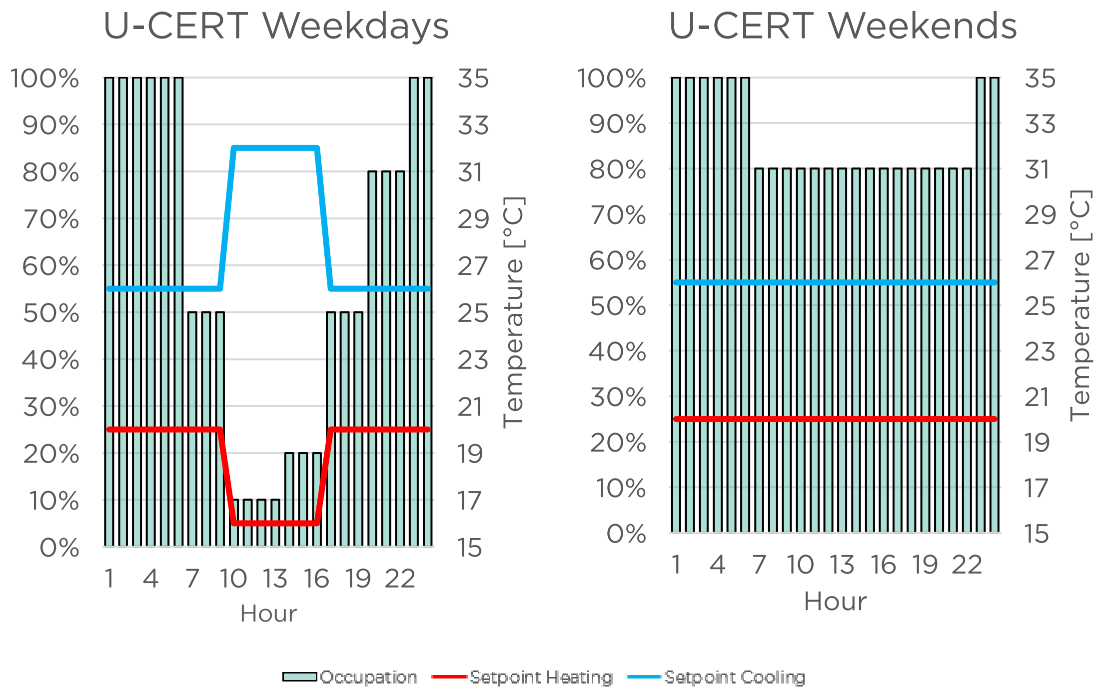


Figure I-4. Weekday building use. U-CERT National Datasheets.

Figure I-5. Weekend building use. U-CERT National Datasheets.

In relation to the weekend, the hourly thermostatic setpoints are kept the same, whereas the occupation is maximum throughout the day. The pattern from Figure I-3 with regards to the heating thermostatic setpoint can be understood following the same logic as for Figure I-2. It is considered a valid definition, and thus it is advised to be left untouched for the weekends. Nevertheless, this is not the case for the cooling thermostatic setpoint because during the weekend the cooling setpoint from 8:00h and 16:00h is left free running despite the occupation being maximum. This is considered to be incoherent and should be revised. When analysing U-CERT's definition of building use in Figure I-4, it is found that the thermostatic setpoints for both heating and cooling are kept constant in the values linked to maximum occupation. The recommendation to improve building use parametrisation during the weekend in Spain's EPB Assessment methodology is to extend the 25°C setpoint from 8:00h to 16:00h.

With regards to the applicability of the heating and cooling service, the monthly availability defined by Spain's National Annexes is considered valid. Heating from January to May and October to December, cooling from June to September.

U-CERT's occupation, although following the same general trend, is more stepped. This is positive and may be considered by Spain's National Annexes.

The recommendations on parametrization of the building use are summarized in Figure I-8 and Figure I-9.

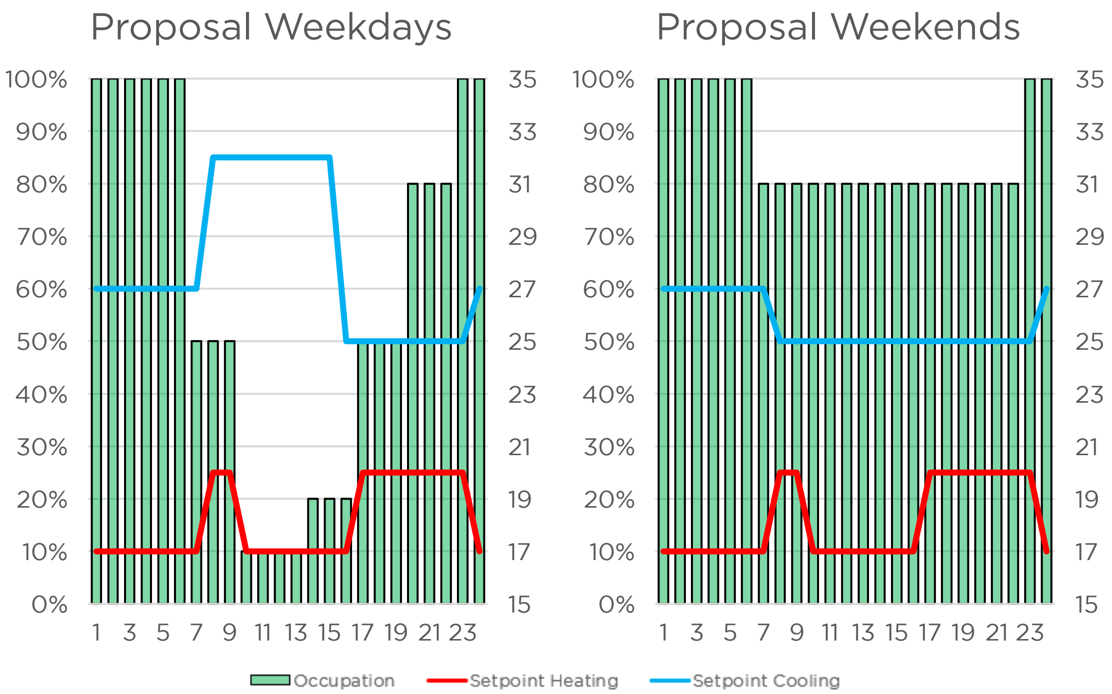


Figure I-6. Weekday building use. Recommendation.

Figure I-7. Weekend building use. Recommendation

The other choice outlined in Figure I-1 with strong impact on the energy needs is the **weather** used for the EPB Assessment. The detailed comparison did not consider many distinct locations, therefore the conclusions drawn can't be generalized. However, the recommendation to Spain's EPB Assessment methodology is to adopt U-CERT's suggestion and use the TMY weather file generator. The two main reasons are the fact that <u>the datasets are dynamic and may evolve during time</u>, better reflecting the variations in weather due to climate change. Also, because it is a step towards EU harmonisation of national and regional EPB Assessments.

Addressing the post-processing choices, additional intertwinement arises.

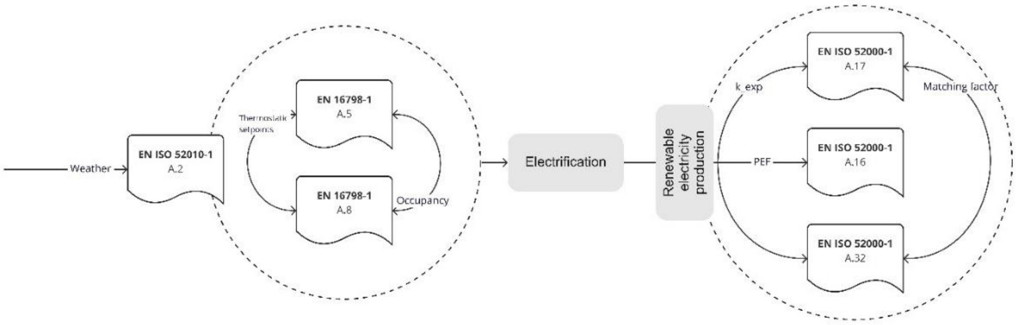


Figure I-8. Intertwinement of all choices considered.

In Figure I-8, the schematic representation from Figure I-1 is further enriched with the post-processing choices included in the analysis. From the pre-processing and calculation choices the energy needs are obtained, yielding the building's final energy use. Depending on the degree of electrification and the renewable electricity production capacity, the produced and used electricity is compensated according to the **matching factor**. Then, each energy vector present in the EPB Assessment is weighted through to the **primary energy weighting factors and CO_2 coefficients (PEF)** and the surplus renewable electricity production is exported through the **k_{exp} factor**. According to Spain's National Annexes, the matching factor is monthly, the weighting factors are annually constant and depicted in Table I-2 for the main energy vectors, and there is no consideration of exported energy.

Table I-2. PEF and CO_2 emission coefficients. Spain

Energy vector	$kgCO_2/kWh_{final\ energy}$	$kWh_{EP,ren}/kWh_{final\ energy}$	$kWh_{EP,non-ren}/kWh_{final\ energy}$
Peninsular grid Electricity	0.331	0.414	1.954
Natural Gas	0.252	0.005	1.190

As it was detailly discussed in Deliverable 4.3, grid electricity **primary energy weighting factors** for are much higher than natural gas. This is also true for U-CERT's default values. As for those of fossil fuel used as final energy, the calculations tend to just consider the environmental impact of the final use through the calorific value. This neglects any further impact of the transport and distribution, moreover it hinders the fair comparison between energy end use decisions. Further investigation is needed to more accurately define the PEF for fossil fuel thermal end use.

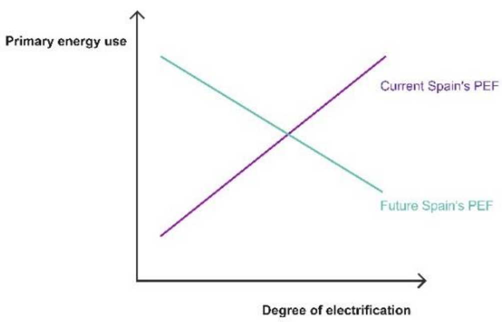


Figure I-9. EPB Assessment without renewable electricity production. Schematic.

With current Spain's PEF, the higher the electrification of a building, the higher the primary energy use and environmental impact. This situation should be reverted, specially considering the recent REPowerEU[3], and the increased interest in energy sovereignty. Spain's National Annexes should evolve to send clear signals to the market and key stakehoplders towards electrification, as the main driver for decarbonisation [21].

[3] More information at: https://ec.europa.eu/commission/presscorner/detail/en/ip_22_1511

Note that this is as true for dwellings as for non-residential buildings.

The recommendation for the improvement of Spain's EPB Assessment methodology is to update the values with a view to reducing the gap between the environmental impact of grid electricity and fossil fuel use for heating. The current definition of grid electricity's has not benefitted from the latest research on the field of electricity energy intensity definition with actual data from ENTSO-E[4]. This methodology not only considers the growing presence of renewable energy sources in the electricity mix, but also allows to obtain up to hourly resolution.

The **matching factor** impacts the balance between produced and used electricity in the building object of the EPB Assessment. See Figure I-10 for a schematic representation.

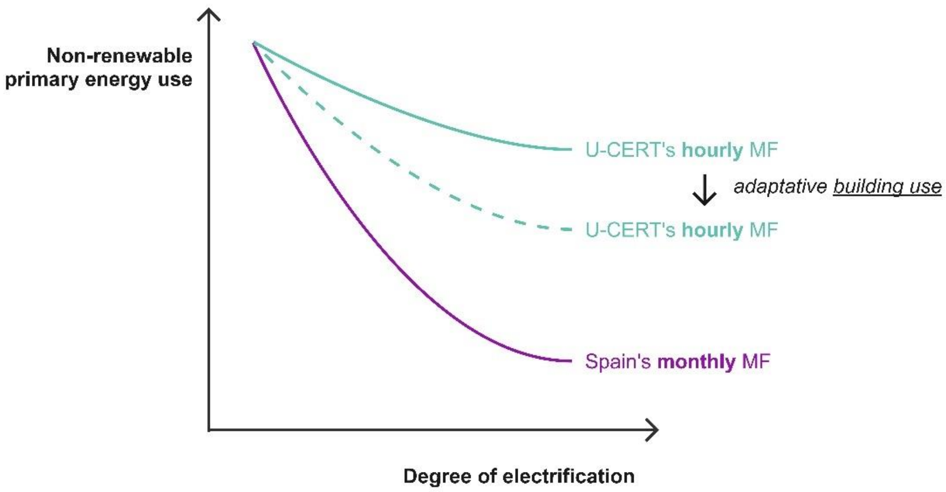


Figure I-10. EPB Assessment with renewable electricity production. MF impact. Schematic.

Note that when a building has exceptionally low degree of electrification the energy performance is independent of the matching factor. This is, when there is no electricity consumption it is not possible to compensate it with self-production. As the degree of electrification increases, the energy performance with monthly matching factor outperforms the hourly. When the matching factor is hourly, the self-use of produced electricity is restricted to the hours in which there is electricity demand. Thus, if a matching factor is used, having adaptative building use is of utmost importance. According to Spanish National Annexes this is possible for non-residential buildings, but not for the residential typology. Also, the use of energy storage would be beneficial to increase the energy efficiency of a building when using hourly matching factor for the EPB Assessment. Alternatively, using a monthly matching factor allows to compensate any electricity consumption with electricity production within the month. Thus, removing the need for adaptative user behaviour and/or energy storage. A middle ground option may be the use of daily matching factor.

When analysing the **exported energy factor**, as the detailed comparison from Deliverable 4.3 showed, without consideration of the surplus production there

[4] The weighting factors to be used are hourly values, defined according to EN 17423 [26], following the methodology published by E. Marrasso, et al [22].

is no incentive for lowly electrified buildings to install renewable electricity production. As depicted in Figure I-11, the non-renewable primary energy use of a building with low electrification (i.e., fossil fuel dependency for space and water heating) is not significantly affected by the size of the renewable electricity production. Increasing the installed renewable electricity production power does not impact the energy performance of a building once the self-use potential is fully covered. This situation tends to happen for lowly electrified buildings at reduced rated powers. This even happens regardless the matching factor between used and produced electricity. Thus, defining k_{exp} greater than zero is the only manner of nudging onsite renewable electricity generation in non-electrified buildings.

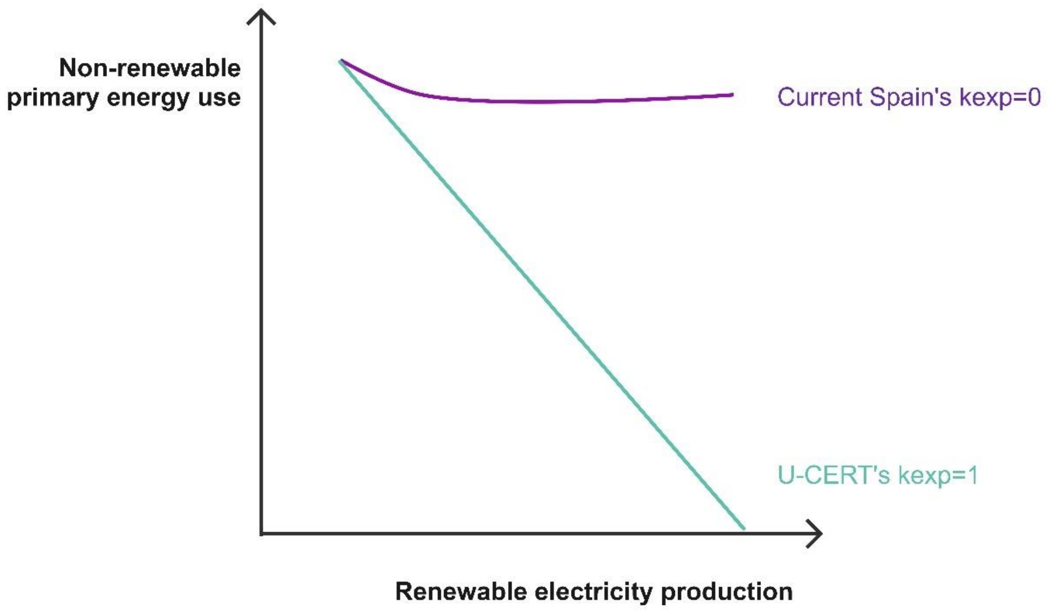


Figure I-11. EPB Assessment with renewable electricity production for lowly electrified buildings. Schematic.

Alternatively, in the event that all surplus electricity is allowed to be exported (i.e., k_{exp}=1), only with renewable electricity production a maximum energy performance may be reached. For instance, a building poorly insulated with fossil-fuel dependent and inefficient technical building systems may obtain a maximum EPC rating by installing an oversized photovoltaic generation. This will neglect the “energy efficiency first” principle. Thus, defining a k_{exp} close to the unit may remove the incentive for deep renovations, given that great size renewable electricity production may compensate high energy needs and poor technical building systems efficiency.

For the **actual** definition of the **matching factor** and the **exported energy factor** the interdependencies between them ought to be carefully analysed.

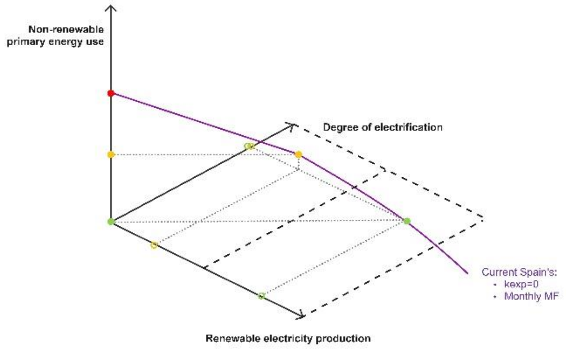


Figure I-12. EPB Assessment. Impact of Spain's k_{exp} and MF. Schematic.

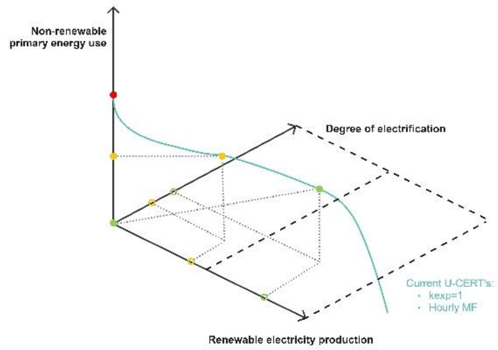


Figure I-13. EPB Assessment. Impact of U-CERT's k_{exp} and MF. Schematic.

In the schematic representation from Figure I-12, Spain's choices on exported energy and matching factors tend to underestimate the positive impact of renewable electricity production in lowly electrified buildings. This is, for renewable electricity production to influence the EPB Assessment, there is the need to surpass a minimum threshold of electrification.

As for U-CERT's, depicted in Figure I-13, the prime is on the renewable electricity production, with the degree of electrification having little-to-no effect on the energy performance. This is, once a certain level of renewable electricity production is reached, the impact of electrification and energy efficiency measures do not have significant effect on the EPB Assessment.

One significant finding from the detailed comparison from Deliverable 4.3 was that the pair of matching factor and exported energy factor could have similar impacts on energy performance in some cases as long as their definition is balanced (i.e., monthly matching factor and no exported energy consideration, or hourly matching factor and exported energy consideration). However, it becomes clear that jointly applying monthly matching factor and k_{exp}=1 would not be a valid solution as it would over incentivize the installation of renewable electricity production over energy efficiency measures. Thus, the recommendation of modification for the Spanish National Annexes is to adopt k_{exp}=0.5 and hourly matching factor for residential buildings. For non-residential buildings it is advised to reduce the exported energy factor to 0.25, as the potential to self-use on-site renewable electricity production is greater on account of the flexibility in the building use modelling.

A summary of the recommendations is depicted in Table I-3.

Table I-3. Summary of recommendations to Spain's National Annexes.

<table>
<tr><th>EPB Standard</th><th>Table / Clause</th><th>Description</th><th colspan="2">Recommendation</th></tr>
<tr><td rowspan="2">EN 16798-1</td><td rowspan="2">A.5</td><td rowspan="2">Temperature ranges for hourly calculation of cooling and heating energy in four categories of indoor environment</td><td colspan="2">Thermostatic setpoints for residential buildings:</td></tr>
<tr><td>• Weekdays:
○ Heating:
▪ 01:00h-07:00h: 17°C
▪ 08:00h-09:00h: 20°C
▪ 10:00h-16:00h: 17°C
▪ 17:00h-23:00h: 20°C
▪ 00:00h: 17°C
○ Cooling:
▪ 01:00h-07:00h: 27°C
▪ 08:00h-15:00h: 32°C
▪ 16:00h-23:00h: 25°C
▪ 00:00h: 27°C</td><td>• Weekends:
○ Heating:
▪ 01:00h-07:00h: 17°C
▪ 08:00h-23:00h: 20°C
▪ 00:00h: 17°C
○ Cooling:
▪ 01:00h-07:00h: 27°C
▪ 08:00h-23:00h: 25°C
▪ 00:00h: 27°C</td></tr>
<tr><td rowspan="2">EN 16798-1</td><td rowspan="2">A.8</td><td rowspan="2">Occupants' schedules for energy calculations</td><td colspan="2">Occupation schedule for residential buildings:</td></tr>
<tr><td>• Weekdays:
○ 01:00h-06:00h: 100%
○ 07:00h-09:00h: 50%
○ 10:00h-13:00h: 10%
○ 14:00h-16:00h: 20%
○ 17:00h-19:00h: 50%
○ 20:00h-22:00h: 80%
○ 23:00h-00:00h: 100%</td><td>• Weekends:
○ 01:00h-06:00h: 100%
○ 07:00h-22:00h: 80%
○ 23:00h-00:00h: 100%</td></tr>
<tr><td>EN ISO 52010-1</td><td>A.2</td><td>Weather station and climatic data set</td><td colspan="2">JRC TMY generator</td></tr>
<tr><td>EN ISO 52000-1</td><td>A.16</td><td>Weighting factors</td><td colspan="2">Hourly grid electricity calculated according to [22]. More severe ones for fossil-fuels.</td></tr>
<tr><td>EN ISO 52000-1</td><td>A.17</td><td>k_{exp} factor</td><td colspan="2">• k_{exp} =0.5 for dwellings,
• k_{exp} =0.25 for non-residential buildings</td></tr>
<tr><td>EN ISO 52000-1</td><td>A.32</td><td>Matching factor for produced energy</td><td colspan="2">Hourly matching factor.</td></tr>
</table>

B. Italy

A comparative analysis was performed between U-CERT's National Datasheets, as included in Deliverable 3.1, and Italy's National Annexes.

Italy, together with Spain, was one of the contexts where the **detailed comparison** in the scope of Task 4.3 was performed.

As can be seen from table Table I-4, Italy is quite in line with the choices made during the U-CERT project, however, in some cases it allows more options than those allowed by U-CERT, or it is more stringent on the possibility to compensate a non-optimal design of the building and its system, with photovoltaic installation.

Table I-4. Comparative analysis between National Datasheets and Annexes.

OrderAll	OrderSt	EPB standard	Table / Clause	In accordance with the law in Italy?
7	6	EN ISO 52000-1	Table A.6 — Differentiation of space categories	Yes
8	7	EN ISO 52000-1	Table A.7 — Space categories	Similar, but splitted in residential and non-residential
17	16	EN ISO 52000-1	Table A.16 — Weighting factors (based on gross or net calorific value)	Similar, but with values decided in the Ministerial Decree of June 26th, 2015
18	17	EN ISO 52000-1	Table A.17 — kexp-factor	No
19	18	EN ISO 52000-1	Table A.18 — Building services considered in the energy performance calculation	No (Non-Residential includes people transport)
20	19	EN ISO 52000-1	Table A.19 — Principle assumed presence of systems	Similar, principle of assumed system is required for Heating and Domestic Hot Water for EPCs (not clear in UCERT assumed cooling and ventilation)
21	20	EN ISO 52000-1	Table A.20 — Specification of the useful floor area	Similar (internal net floor area, instead of gross)
22	21	EN ISO 52000-1	Table A.21 — Type or types of metric for the building size	Yes
23	22	EN ISO 52000-1	Table A.22 — Which space categories are	Similar

			contributing to the reference size	
24	23	EN ISO 52000-1	Table A.23 — Perimeter specification	Similar, but for electricity a dedicated connection is required
25	24	EN ISO 52000-1	Table A.24 — Perimeter choice	Similar, but RER calculation for renewable energy allows Distant Perimeter choice
28	27	EN ISO 52000-1	Table A.27 — Basis for the energy performance of buildings	Similar, but non-renewable energy performance is not always the choice
31	30	EN ISO 52000-1	Table A.30 — Energy flows taken into account in the building balance	Similar, but free cooling and heating are counted
32	31	EN ISO 52000-1	Table A.31 — Electrical uses not satisfied by on-site electricity production	Similar, but heating, cooling and domestic hot water systems based on Joule effect are not allowed
33	32	EN ISO 52000-1	Table A.32 — Matching factor of produced and used electricity	Similar, but matching factor defined for monthly calculation are still allowed
37	2	EN ISO 52003-1	Table A.2 — Default choices with respect to the overall EPB requirements	No, all the requirements are mandatory, not informative, with exceptions regulated by Legislative Decree 192/2015 and subsequent amendments and application decrees, and the SRI and Produced renewable energy (on site) are not considered
38	3	EN ISO 52003-1	Table A.3 — Numeric indicator used for the requirement on the total primary energy use	No, values calculated using National Reference Building as regulated by Legislative Decree 192/2015 and subsequent amendments and application decrees.

39	4	EN ISO 52003-1	Table A.4 — Numeric indicator used for the requirement on the non-renewable primary energy use	No, values calculated using National Reference Building as regulated by Legislative Decree 192/2015 and subsequent amendments and application decrees.
40	5	EN ISO 52003-1	Table A.5 — Numeric indicator used for the requirement on the renewable primary energy use	No, values calculated using National Reference Building as regulated by Legislative Decree 192/2015 and subsequent amendments and application decrees.
41	6	EN ISO 52003-1	Table A.6 — Energy rating methods	Similar (4 Subclasses to expand the A class, Boundary for the reference position, nref 1 (A1))
46	2	EN ISO 52010-1	Table A.2 — Weather station and climatic data set	Yes
56	1	EN 16798-1	Table A.1 — Default categories for design of mechanical heated and cooled buildings	No, only the first three categories are considered
59	4	EN 16798-1	Clause A.2.2 Default acceptable indoor temperatures for buildings without mechanical cooling systems	Yes
61	6	EN 16798-1	Table A.5 — Temperature ranges for hourly calculation of cooling and heating energy in four categories of indoor environment	Similar, but with the definition of a higher number of type of space and adapted to the Italian context
80	25	EN 16798-1	Clause A.8 and Annex C: Occupants schedules for energy calculations	No, three category (instead of four) with the value of each parameter adapted to the Italian context

84	2	EN ISO 52016-1	Table A.2 — Choice between hourly or monthly calculation method	No (both method allowed in Italy)
85	3	EN ISO 52016-1	Table A.3 — Thermal zoning rules	Yes
89	7	EN ISO 52016-1	Table A.7 — Choice between calculations with thermally coupled or uncoupled thermal zones	No (both method allowed in Italy)
92	10	EN ISO 52016-1	Table A.10 — Alternative choices in modelling	Similar, but with an alternative method for the conversion of physical properties of building elements into properties per layer (node)
102	20	EN ISO 52016-1	Table A.20 — Choice of method for moisture absorption and desorption in materials	Yes
107	25	EN ISO 52016-1	Table A.25 — Choices between options and methods for calculation of shading by external objects	Yes
134	2	EN ISO 52018-1	Table A.2 — Choices with respect to the mix of partial EPB requirements related to thermal energy balance and fabric features	No
135	3	EN ISO 52018-1	Table A.3 — Numeric indicator used for the requirement on the summer thermal comfort	No
136	4	EN ISO 52018-1	Table A.4 — Numeric indicator used for the requirement on the winter thermal comfort	No

137	5	EN ISO 52018-1	Table A.5 — Numeric indicator used for the requirement on the energy “need” for heating	No
138	6	EN ISO 52018-1	Table A.6 — Numeric indicator used for the requirement on the energy “need” for cooling	No
139	7	EN ISO 52018-1	Table A.7 — Numeric indicator used for the requirement on the combined energy “need” for heating and cooling (and possibly still other quantities)	No
140	8	EN ISO 52018-1	Table A.8 — Numeric indicator used for the requirement on the overall thermal insulation of the thermal envelope	No
144	12	EN ISO 52018-1	Table A.12 — Numeric indicator used for the requirement on the thermal envelope air tightness	No
145	13	EN ISO 52018-1	Table A.13 — Numeric indicator used for the requirement on the solar control	No
146	14	EN ISO 52018-1	Table A.14 — Numeric indicator used for other requirements	No
224	33	prEN 15316-4-2:2021	Table A.32 — Source temperature calculation path	(Italian National Annex still in preparation)
225	34	prEN 15316-4-2:2021	Table A.33 — Sink temperature calculation path	(Italian National Annex still in preparation)
226	35	prEN 15316-4-2:2021	Table A.34 — Calculation path for	(Italian National Annex still in preparation)

			full load heat power output	
227	36	prEN 15316-4-2:2021	Table A.35 — Calculation path for energy input and auxiliary energy	(Italian National Annex still in preparation)
228	37	prEN 15316-4-2:2021	Table A.36 — Calculation path for part load correction factor of COP (path A)	(Italian National Annex still in preparation)
246	14	EN 16798-7	Clause A 3.3.7 Ventilation effectiveness	The ventilation effectiveness has value 0,8 instead of 1
275	14	EN 16798-5-1	Table A.13 — Quantitative process design data	The majority of the data should be inferred from design or inspection

Following the focus outlined in Deliverable 4.1, i.e. assessing which U-CERT choices could contribute in improving the Italian EPB Assessment methodology, the following set of EPB Standard choices have been take into consideration:

- Pre-processing and calculation:
    - EN ISO 52016-1. Table A/B.2 — Choice between hourly or monthly calculation method;
- Post-processing:
    - EN ISO 52000-1. Table A/B.16 – Weighting factors;
    - EN ISO 52000-1. Table A/B.27— Basis for the energy performance of buildings;
    - EN ISO 52018-1. Table UU.4bis — Numeric indicator used for the requirement or key information on the combined summer and winter thermal comfort

In the following, each of the identified choice will be further addressed.

EN ISO 52016-1. Table A.2 — Choice between hourly or monthly calculation method

As far as concerns the hourly calculation, Italy allows both hourly and monthly calculations.

However it is recommended to adopt U-CERT choice, following which only hourly calculation must be allowed. As a matter of fact, this is the best available choice to:

- quantify the performance of innovative (or evenly not standard) building element and systems;
- quantify the production and use of renewable sources.

Quantifying the difference among the results obtained by a monthly or hourly method was beyond the goal of the U-CERT project, while assessing the influence of this difference in considering the production and contextual use of renewable sources was one of the task of the comparative analysis, whose results have been summarized in Deliverable 4.3.

As can be seen from the results reported in Deliverable 4.3 and more precisely from Table II-2 and from Figure II-2 to Figure II-4, the monthly method does not detect the time mismatch between the production of electricity from a PV system and its consumption from the building (this mismatch takes place when no battery is installed in the system).

It is important to emphasize that the shift to an hourly procedure will not necessitate significant additional burden to professionals. This is thanks to the methodology described in the new set of EPB Standards, especially in standard EN ISO 52016-1.

Consequently it is strongly recommended to allow only one calculation method to take a step forward in been able to compare different Energy Performance Certificates (EPCs).

EN ISO 52000-1. Table A.16 – Weighting factors

Weighting factors are a political choice (in this particular case the values of the factors adopted in Italy are not too different from those suggested by U-CERT as can be seen from the results reported in Deliverable 4.3, specifically from Table II-3), however the suggestion to use time-dependent factor, considering the change in the calculation method previously suggested, is another aspect that can contribute toward a better evaluation of the availability of renewable sources.

Time-dependent weighting factors is not only the methodology employed by the U-CERT Project, but it is also proposed as a minimum requirement for Energy Performance Assessments in each European country in the new EPBD proposal.

EN ISO 52000-1. Table A.27— Basis for the energy performance of buildings

Italy has chosen different basis to quantify the energy performance of building for the different applications that involve such evaluation, using in some cases the total energy performance and in others the non-renewable energy performance.

The U-CERT project suggests to use the non-renewable energy performance for all the energy rating methods. This suggestion could be useful in focusing the attention to a singular index, which is the one that quantifies the use of non-renewable sources, with a view to the decarbonisation of the building sector.

EN ISO 52018-1: EPCs Indicators

Given that an assumed system is not always considered for all the possible system that could be supplied with the building (e.g. cooling and mechanical ventilation), indicators that quantify the internal comfort of the building, thermal, as well as environmental (air, pollutants, acoustic, luminous) is very important to provide more information to a user who needs to compare different EPCs.

Table I-5. Summary of recommendations to Italy's National Annexes.

EPB Standard	Table / Clause	Description	Recommendation

EN ISO 52016-1	Table A/B.2	hourly or monthly calculation method	Allow only hourly calculation method to consider properly the exploitation of renewable sources
EN ISO 52000-1	A.16	Weighting factors	Implement time-dependent weighting factors.
EN ISO 52000-1	A.27	Basis for the energy performance of buildings	Use the non-renewable energy performance for all the energy rating methods
EN ISO 52018-1		EPCs Indicators	• ALDREN Thermal score (Included) • ALDREN TAIL (voluntary)

C. Bulgaria

In Bulgaria, **calculated-measured EPB assessment** is currently applied, and the process is similar to that shown in Figure 5. Measured values are used for the total consumption of electricity, fuels and water, as well as for the outside air temperature. **Use of normalization** and **weather standardization** as proposed by U-CERT are applied already in the national methodology. However, **service separation** of EPB uses from non-EPB uses, and the inclusion of only the EPB uses in the EPCs, is not fully implemented.

At this stage, the implementation of **measured EPB assessment** is practically impossible as only a negligible part of the existing buildings are technically equipped with the necessary measurement devices. This could largely change with the introduction of smart metering of electricity and natural gas consumption and the gradual replacement/ban on the use of solid and liquid fossil fuels for heating.

So far, due to the negligible percentage of buildings with renewable energy installations and due to the still undeveloped regulatory framework in the direction of the introduction of net-metering and establishment of energy communities for shared production and consumption of renewable energy, a general indicator for **non-renewable primary energy [kWh/m²]**, considering compensation between different energy carriers and the effect of exported energy certification of buildings does not exist in EPCs. With the expected rapid increase of the number of renewable energy installations in buildings, this option should be considered, and the value of **exported energy factor** (**k_{exp}**) to be specified in the national annex to standard EN ISO 52000-1 in Table A/B.17, should be carefully analysed. The high value of this indicator means that most of the produced renewable energy surplus will be taken into account when determining the energy performance of the building, which will favour the more frequent offer of such investment measures by the energy auditors. However, it must be born in mind that the necessary balance needs to be found so that proposing measures for the construction of renewable energy installations does not come at the expense of neglecting energy efficiency measures in buildings.

Among the other indicators to the standard EN ISO 52000-1, for which a choice should be made in the national annexes, we suggest paying special attention to the following:

- Table A/B.16 - Primary energy weighting factors (PEF)
- Table A/B.18 - Building services considered in the energy performance certification
- Table A/B.19 - Principle assumed presence of systems

The current value of the **primary energy weighting factors (PEF)** for grid electricity has been determined back in time during the initial development of the regulatory framework for certification of buildings and has not changed since then. During this time, the share of renewable electricity in the national mix reached a value of over 20%, which probably affects the value of this factor. The high value of PEF for electricity does not favour the electrification of heating in buildings at the expense of the use of fossil fuels. We propose to analyse and determine the actual value of PEF for electricity and if it is needed to update *Ordinance 7 on Energy Efficiency in Buildings* accordingly and to set a deadline by which this indicator should be updated.

Additionally, the **emission factor for electricity** should also be reconsidered. An assessment of the national emission factor for electricity is published annually in the reports from the national inventories of greenhouse gas emissions. The current value of the emission factor is significantly lower than the value specified in *Ordinance 7 on energy efficiency in buildings*, which is used for the certification of buildings. We propose the national emission factor for electricity from the national inventory reports to be used in the future. The value of the emission factor to be published annually in a designated public place, to be determined in Ordinance 7.

Appropriate definition of **building services considered in the energy performance certification** is particularly important to ensure an accurate and fair comparison between the individual certified buildings of the respective type. Currently in Bulgaria the general indicator for determining the energy class of buildings includes the energy consumption of various electrical appliances. The ownership and use of different electrical appliances in each building is different according to the preferences and capabilities of the building occupant. When changing the occupant, and under the influence of other factors, the use of various electrical appliances can change significantly. At the same time, the energy consumption of electrical appliances affects the overall heat balance of the building. We believe that in the current way of accounting for the energy consumption of electrical appliances when determining the energy class a correct comparison of the energy performance of different buildings cannot be provided. We propose to exclude electrical appliances from **building services considered in the energy performance certification**. As an alternative, we propose to develop and regulate values for specific annual energy consumption of electrical appliances for individual types of buildings and to use these values when determining the general indicator for the energy class of the building. At the same time, in order to assess the effect of energy saving measures in each specific building, to take into account the actual energy consumption of electrical appliances in the overall energy balance of the building, as it is currently done.

The total annual energy consumption of the building without the energy consumption of electrical appliances, as well as **the percentage of renewable energy used in the building without the energy consumption of electrical appliances** are important indicators that must be included in the EPCs due to the text of the national definition of "Nearly zero-energy building":

(a) the energy consumption of the building, defined as primary energy, complies with Class A on the scale of energy consumption classes for buildings of the relevant type;

(b) not less than 55 per cent of the energy consumed (supplied) for heating, cooling, ventilation, domestic hot water and lighting is energy from renewable sources produced on-site or near the building.

These indicators currently do not appear in this certificate. Whether the building meets the definition is indicated only by a tick in a checkbox, and there is no similar possibility to indicate whether the building will meet the definition if the proposed measures are implemented.

The application of **principle assumed presence of systems** is also important to ensure a correct comparison of buildings of one type. The application of this principle means that the energy consumption of all building systems that are legally required for the respective type of building must be assessed, regardless of whether they are built/operative in the specific building. The practice in Bulgaria is that this principle must be applied only to heating systems. For other systems, **presence of system principle** is more commonly applied. In this way, buildings with non-functioning building systems receive a better assessment of their energy performance. Our proposal is to regulate the application of **principle assumed presence of systems** for all building systems when determining the energy class of the building if such systems a required by the norms for the respective building type.

The proposed new EPBD states the importance of **indoor environmental quality (IEQ)**, also during the summer period, as well as the **Smart Readiness Indicator (SRI)**. U-CERT proposes to introduce the following **IEQ** indicators in the certificates: **winter thermal comfort [K h]**; **summer thermal comfort [K h]** and **domestic hot water thermal comfort [K h]**. Also ALDREN's Thermal Score and Smart Readiness Indicator.

Specialists can find out from the content of the current Bulgarian EPC whether the building maintains the required regulatory temperature comfort, but this could be a challenge for most of the non-specialists. U-CERT offers an effective way of integrating the IEQ and SRI assessment into EPB Assessments and scales to illustrate the assessments in the certificates, both in the assessment of the current energy condition of the building and after the implementation of the proposed energy saving measures.

Regarding **service separation**, in our opinion, the assessment of the energy class in Bulgaria incorrectly includes the energy consumption of non-electrical appliances that do not directly affect the thermal balance of the building, such as outdoor lighting, etc. Regardless of the presence or absence of electrical appliances in the national choice for **building services considered in the energy performance certification** the energy consumption of electrical appliances that do not directly affect the thermal balance of the building should not be considered when determining the energy class. We propose that this issue to be regulated in the normative documents.

For the performance of **weather standardization** energy auditors in Bulgaria use different data sources for the current outdoor temperature in the settlement where the audited building is located. We propose to regulate a specific data source and to provide a free and easy access of all energy auditors to this source.

D. Denmark

The below report on the national EPB Certification Scheme for Denmark contains some (translated) citations from the Executive Order on Handbook for Energy Consultants (HB2021), BEK no. 939 of 19/05/2021, The Danish Ministry of Climate, Energy and Utilities, 2021.

The Danish energy certificate is based on a **monthly calculation method**, which is a derivate of EN13790. The method is described in **SBI Direction 213**, Energy Demand of Buildings (BUILD, 2018a) from the Danish Building Research Institute, SBi, which now under the name "BUILD", as a department under Aalborg University, upholds the statutory role as issuer of the calculation method. The Direction is ensued by a calculation method in the form of a computer program, which must be used in its current edition by the time of approving a building project. The current edition is ***Be18*** (BUILD, 2018b). The program produces an XML file, which must be submitted in conjunction with the application to the municipal authorities when applying for a building permit.

The Report of the Building Energy Certificate must comprise:

- The Building Energy Certificate itself; The scale of the Energy Certificate comprises two grades: A2020 and A2015, which refer to the Building Regulation's (BR18, The Danish Housing and Planning Agency, 2018) low energy class, or a regular building built according the Building regulation 2015 or 2018.
  When calculating the total energy requirement for use in placing the building on the energy label scale, the energy consumption of the individual forms of energy must be multiplied by the energy factor, which appears from the building regulations. This is done automatically in the energy label reporting programs. The current energy factor is 1.9 for electricity, 0.85 for district heating, and 1.0 for other energy sources.
- An assessment of whether the Danish Building Regulation's requirements for dimensioning transmission heat losses has been complied with;
- An assessment of whether the requirements for minimum thermal insulation of building parts as well as efficiency etc. of heat distribution, ventilation and heating systems, etc. are met.
- A description of any discrepancies between the building and the building permit. The building permit is primarily based on an energy frame calculation.
- The Energy Consultant's conclusion.

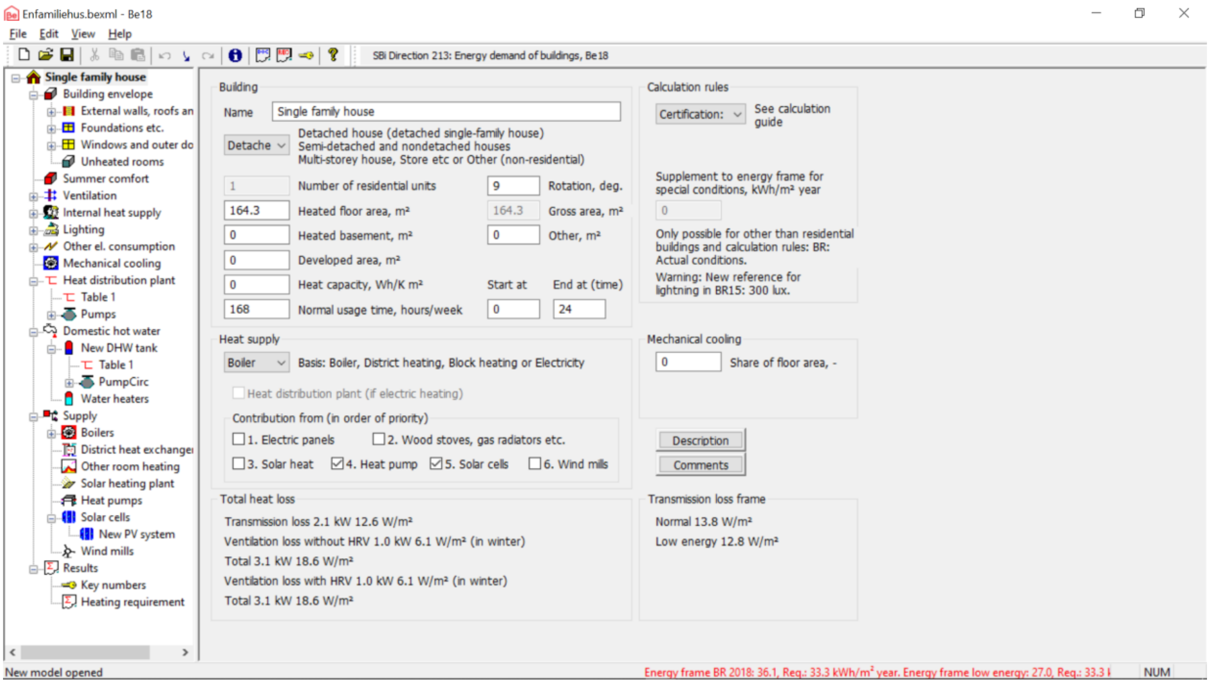
Existing buildings get an energy certificate comprising three parts:

- An energy label based on a scale from A2010, B, C, ..., G (or better if relevant, as energy classes 2015 and 2020 existed as voluntary classes before the upcoming of those years).
- An Energy plan, which is an overview of proposals for energy-improving and energy-saving measures in the building.
- Documentation for the energy label and other relevant information, including assumptions for the energy label and registrations from the review of the building and its installations, which have been used to calculate the energy label and the assessment of proposals for energy-improving and energy-saving measures.

Energy certificates are mandatory when buildings are sold, and they have a validity of 10 years. The certificates used to be criticised for being erroneous.

A new digitized system should eliminate the risk for failures, and a new report design (since 2021) makes it easily presentable for building owners in the market to identify the most relevant opportunities for energy refurbishment.

Figure I-14. New Danish Energy Certificate presents in a double-pager the three most prevalent opportunities for energy refurbishment of a building.



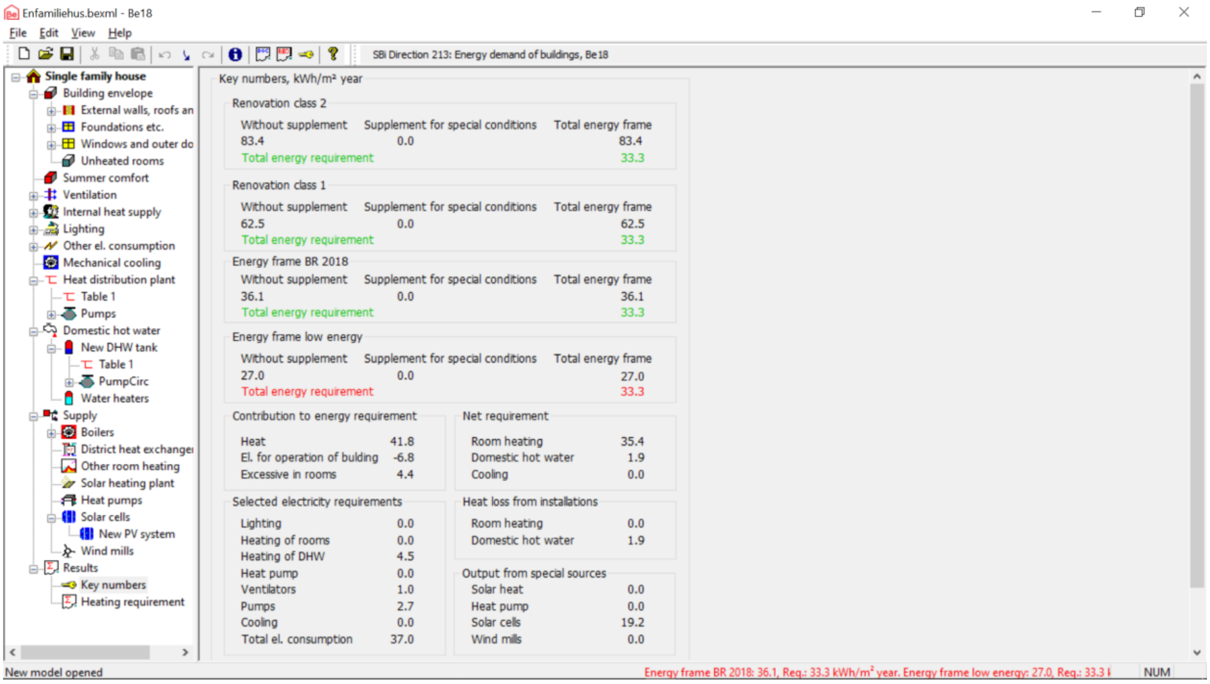


Figure I-15. Screen dumps from the Be18 program illustrating energy use and sources considered by the model. Top: Main screen of the program showing the compositions of a building being considered; Bottom: Key numbers expressed in kWh/(m²·yr).

For **Be18, energy uses (consumptions)** such as boilers/heaters, lighting, mechanical ventilation, domestic hot water, pumps, and plug loads are considered along with **losses** through heat transmission and ventilation. For **energy supply**, boilers, district heating, heat pumps, photovoltaics, solar heating, and wind turbines are considered.

The **energy supply situation in Denmark** is such that 65% of all households are supplied by district heating, while this number is 98% for Copenhagen. The energy sources of district heating are 72% based on renewable energy, such as solar, wind, biomass, biogas, and geothermal.

There seems to be no immediate discussion of an **exported energy factor** (k_{exp}) in connection with the Danish Energy Certificate system. However, for photovoltaics, there exists three groups of payments schemes, which are variations of a net metering scheme:

- Group 1 is an hourly-based settlement where all of a household's electricity production is sold and then bought back as needed.
- Group 2 also settles on an hourly basis. Here, however, only the surplus production is sent out to the electricity grid. The surplus production is available to the household within the first hour of its production.
- Group 6 is more complicated in the sense that it is a year-based net settlement. The group contains the original guidelines and provisions prescribed by the net metering scheme, but it is only for systems acquired before 19 November 2012.

Smart Readiness implementations are not directly mentioned in conjunction with the Danish Energy Certificate scheme. However, it has been a requirement since 20 October 2020 that remotely red meters should be installed in new built, byt total installation and renovation in existing buildings. From 1 January 2027, this shall be mandatory in all cases. Only buildings, which in the past were exempted from individual metering, and buildings in which it can be proven not to be cost effective considering potential energy savings to have remotely read meters, will remain to be exempted from the requirement.

There are requirements in BR18 for documentation of the **thermal indoor climate**. The documentation must be made by calculation on the basis of the conditions in the critical rooms and is based on Design Reference Year. For homes, a simplified calculation can be used. For dwellings, the provision can usually be considered complied with when it can be demonstrated through calculation that there is a maximum of 100 hours per year, where the room temperature exceeds 27 °C and 25 hours per year where the room temperature exceeds 28 °C. For buildings other than dwellings, the client determines the maximum number of hours per. years of service life, where a room temperature of 26 ° C and 27 ° C respectively must be exceeded. For many types of buildings with a service life corresponding to office buildings, exceeding a maximum of 100 hours above 26 ° C and 25 hours above 27 ° C will normally comply with the provision.

All in all, it may be said that the current Energy Certificate System in Denmark has become well-functioning after many years of critique. The energy certificates and the assessment according to the Be18 tool are fundamental constituents of the system. Like U-CERT's proposal, **overall non-renewable primary energy use [kWh/m^2],** is the fundamental indicator in the system. The situation in Denmark for energy supply with a deep implementation of district heating, and with a still relatively low degree of own building integrated production of energy, mean that some elements of U-CERT's value proposition aim slightly different than the system, which is implemented in Denmark, and focus sometimes om some other key indicators. Despite all, it may well be possible that the systems could co-exist, and that they could gradually be merged.

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II. Annex. Specific recommendations to Voluntary Certification schemes

From the expert knowledge of key partners involved in the project some specific recommendations can be drawn with regards to capitalising U-CERT's value propositions in existing Voluntary Certification Schemes.

A. BES Oficina

BES Oficina[5] voluntary certificate created by Instituto Valenciano de la Edificación (IVE)'s. Being IVE a partner in U-CERT, some recommendations are going to be presented for the capitalization of the main project's results into the existing Voluntary Certification Scheme.

BES Oficinas is structured around three technical modules:

- Environmental Protection;
- Health and Wellbeing;
- Space Quality.

Each of these modules is composed by sections. The most relevant for U-CERT's capitalization are:

- Energy savings (*AE Ahorro de energía* according to the Spanish methodology);
- Air quality (*QA Calidad del aire*);
- Thermal comfort (*CT Confort térmico*);
- Acoustic comfort *(CA Confort acústico*);
- Light comfort (*CL Confort lumínico*).

Next, each of the sections are going to be further discussed. Although BES Oficinas defines certain requirements, and has its own internal weighting, the recommendations are focused on the definition of the indicators. Plus, the inclusion of an additional technical module considering the Smart Readiness is proposed. For the calculation, the methodology adopted by U-CERT is considered valid. Note that there are elements considered now in BES Oficinas that are similar to individual items of the Smart Readiness Indicator calculation methodology (i.e., dynamic envelope, control and regulation of devices, etc., monitoring).

The certification's internal codification is maintained to ensure more user-friendly reading and to ease the consideration of the recommendations.

1. Energy Savings

The energy savings section is constructed on the base of the building regulation in Spain (i.e., Código Técnico de la Edificación [23], and Certificación de Eficiencia Energética de los Edificios [24]). Thus, it uses the same indicators and calculation methodologies as the official EPB Assessment, whose recommendations have been discussed in section Spain. Consequently, the specific recommendations given for the national EPB Assessment would also apply to BES Oficinas.

Among the considered indicators:

- AE01a. **Limitation of non-renewable primary energy consumption**.

[5] More information at: https://www.five.es/oficinas/

Incremental points are given depending on the EPC rating obtained based on the non-renewable primary energy consumption. The recommendation is to use the **overall non-renewable primary energy use [kWh/m²] [kWh].** Calculated according to H5 in Annex H in ISO 52000-1 [1]; thus, considering compensation between different energy carriers and the effect of exported energy.

- QA01a. **Air quality category**.

It is recommended to enrich the current description of the criteria by the inclusion of the I module within ALDREN TAIL.

- CT01a. **Environmental thermal comfort parameters**.

It is recommended to substitute the current description of the criteria by the inclusion of the ALDREN Thermal Score. Moreover, additional bonus points could be given by assessing the T module within ALDREN TAIL.

- CL01a. **Lighting level and quality.**

It is recommended to substitute the current description of the criteria by the inclusion of lighting needs indicator considered in U-CERT – daylight availability - and calculated according to [25].

B. Active House Alliance

The Active House Alliance (http://www.activehouse.info) is a not-for-profit member-driven association, which strives to stimulate and demonstrate sustainable buildings. Buildings are assessed according to a rather pragmatic evaluation scheme that focuses on the three main criteria of Comfort, Energy and Environment, with a total of 9 subcategories as follows:

- **Comfort**: Daylight, Thermal Comfort, Indoor Air Quality, and Acoustic Quality
- **Energy**: Energy Supply, Primary Energy Performance, and Energy Demand
- **Environment**: Sustainable Construction, and Freshwater Consumption

The themes and their potential valuation for a specific building project are illustrated in the figure below. Key to the Active House alliance and its take on sustainability is the holistic view upon the assessed themes. The system is further described in the **Specifications** (Active House Alliance, 2020).

Figure II-1. Building Active House **Radar** for assessment of evaluation criteria on a scale 1 to 4, with '1' being the highest (best) level, and '4', the lowest.

At a first glance, and due to the example projects developed until date as Active Houses, it is clear that Active Houses have so far covered mostly the residential sector – and mostly new buildings. However, there are examples also of commercial and institutional buildings, as well as examples of renovation projects, and these are areas in which it can be anticipated to see more cases in future evolutions. The two Danish Active Houses projects which have been nominated as cases for the U-CERT project are a university building (11a *Green Lighthouse*) and a private household (11b *Home for Life*).

The criteria of the Active House Specifications (Active House Alliance, 2020) are divided in **qualitative** and **quantitative** groups with a consequent first mentioning of the qualitative ones (46 in total) before the quantitative. Active house states that "the **qualitative aspects** are the 'softer' aspects, although they can have a profound influence on the design and design process of a building". Furthermore that "these aspects are often process-oriented; some provide guidance on how to achieve the performance level described in the quantitative part, some provide guidance on how to achieve a more holistic approach (biodiversity, culture and local setting)". In 2021, Active became a partner in EU's *New European Bauhaus* initiative (NEB), which is supposed to connect the *European Green Deal* to the daily lives and living spaces. Focal points of New European Bauhaus are **Sustainability**, **Aesthetics**, and **Inclusion**. It is pleasing to see how Active House by partnering with NEB has opportunity to contribute to humanizing the technical aspects of advanced, sustainable construction.

The **quantitative aspects** of the Active House Specifications are linked to the 9 criteria mentioned above and seen in the radar.

Some similarities and joint key marks can be noted between the Active House criteria and the U-CERT's value propositions. First of all, there is of course the focus on *Energy*, but also the fact that U-CERT highlights the importance of *Indoor Environmental Quality* (versus Active House's focus on *Comfort*). For energy, when Active House subdivides into specifications on: *Energy Supply*, *Primary Energy Performance*, and *Energy Demand*, it goes very well hand-in-hand with U-CERT's focus on *Primary energy weighing factors*, *Overall non-renewable primary energy use*, and *Overall total primary energy use*, and possibly the U-CERT discussion on the *Exported energy factor*.

For energy calculations, U-CERT discusses the value of hourly calculations over monthly calculations with a clear recommendation of the former. Active House specifies no particular building energy simulation/calculation method, but indicates that "for building energy demand, primary energy performance, and energy supply can be calculated according to diverse national building energy assessment methods". But Active House also expresses that "for deeper insight in building energy performance or need for comprehensive comparative analysis between design concepts under different climate conditions, dynamic energy performance calculations can be used". Furthermore, Active House explicitly highlights that "dynamic energy simulations enable to consider time dependent design factors such as hourly resolution of yearly climate data", whereby it can be stated that Active House and U-CERT recommendations are well aligned.

Furthermore, regarding the thermal indoor environment, Active House specification states: "To objectify the risk of overheating, a dynamic thermal simulation tool is used to determine hourly values of indoor operative temperature at room level…". So again, this highlights the need for hourly simulations, as also U-CERT recommends.

Users can freely choose their dynamic simulation tool(s) of preference to make the energy simulations as long as it is among tools that have been validated by the *US BESTEST (ANSI/ASHRAE Standard 140),* https://www.buildingenergysoftwaretools.com/.

In addition to the thermal building simulation, the Active House Alliance has made a **tool**, whereby users can enter information about their building project to draw the holistic *radar*: https://radar.activehouse.info/project-information/main

The current (2020) edition of the Active House specifications is version 3.0. It is expected that the specifications will be revised every five years, and the time until next revision will be used to discuss and prepare themes for upcoming revisions with members and stakeholders, and inspired by the still more numerous Active House projects in Europe and elsewhere.

U-CERT and the EPBD have focus on some themes, which are still not so prevalent in Active Houses. U-CERT's keen interest for *Smart Readiness* Indicators (SRI) is an example of an area where Active House specification may very likely adopt and set more specific requirements/recommendations in future upgrades, and it is obvious to be aligned with EPBD's stipulations – like also U-CERT. Overall, both U-CERT and the Active House alliance should have a joint interest in, and thus potentially collaborate on *digitalization* of building projects.

Aligned with EU's Renovation Wave is also U-CERT's priority for EPCs in conjunction with renovation of buildings. As mentioned above, there are already some examples of renovation cases among Active House projects, although they are still not so prevalent. Future Active House activity should clearly do more in this area in respect of the importance of renovation to ensure that the building sector can make sufficient contributions to society's ambitions for CO_2 reductions (e.g. by 2050). The Active House Alliance may benefit from collaboration with U-CERT and use new EPC schemes to further this development.

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U-CERT

User-Centred Energy Performance Assessment and Certification

OUR TEAM

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the grant agreement number 839937. The European Union is not liable for any use that may be made of the information contained in this document, which is merely representing the authors' view.